TECHNICAL MANUAL

SERVICE

RADAR SETS

AN/FPS-6, AN/FPS-6A, AN/FPS-6B, AN/FPS-90 AND AN/MPS-14

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4-52	Original
4-53	10 Aug 65
4-54	Original
4-55	15 Sept 61
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4-57	15 Sept 61
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4-121	15 Sept 61
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SECTION I
DESCRIPTION

Note

Unless otherwise stated, all references to Radar Set AN/FPS-6 also apply to Radar Sets AN/FPS-6A, AN/FPS-6B and AN/FPS-90. Similarly, unless otherwise stated, all references to Radar Set AN/FPS-6A also apply to Radar Sets AN/FPS-6B and AN/FPS-90; and all references to Radar Set AN/FPS-6B, except for the variable-nod mechanism, also apply to Radar Set AN/FPS-90. Information applicable to Radar Set AN/MPS-14 is covered in Appendix A.

1–1. EQUIPMENT IDENTIFICATION

(See figure 1–1.)

Note

None of the operations buildings of the associated search radar, necessary for housing the control units of Radar Set AN/FPS-6, are shown in figure 1–1.

1–2. This is a technical manual of service instructions for high-power, fixed-station Radar Set AN/FPS-6, designed to operate as the height-finding facility for a suitable search radar installation. Radar Set AN/FPS-6 is manufactured by the General Electric Company, Heavy Military Electronics Department, Court Street, Syracuse, New York.

1–2A. Radar Set AN/FPS-90 nomenclature has been assigned to Radar Sets AN/FPS-6( ) which have had the mechanical variable-nod mechanism removed from the antenna. The variable-nod controls remain in place, but are not used. The following Radar Sets AN/FPS-6( ), identified by serial number, have been nomenclated as Radar Set AN/FPS-90:

20	296	315	332	352	537
21	297	316	333	353	
28	299	317	334	355	
35	302	318	335	356	
74	304	319	336	357	
117	306	320	338	358	
188	307	321	341	361	
189	308	324	343	362	
285	309	327	345	363	
290	310	328	348	368	
291	312	329	349	515	
293	313	330	350	521	
294	314	331	351	528	

1–3. EQUIPMENT SUPPLIED.

1–4. Figure 1–2 contains an alphabetical listing by common name of the major assemblies and the physically-removable subassemblies of Radar Set AN/FPS-6. The major operating assemblies are distinguished from the subassemblies in the Quantity per Equipment column, where the entries for the latter are enclosed in parentheses. Figure 1–2 also lists the official nomenclature, where assigned, for each unit. The common name is used throughout this technical manual, except in illustration titles where the official nomenclature is employed.

Quantity per Equipment	Common Name of Unit	Official Nomenclature of Unit	AN/FPS-6	AN/FPS-6A	AN/FPS-6B	AN/MPS-14
1	AMPLIDYNE	Motor-Generator PU-293/G or PU-293A/G	X	X	X	X
1	ANTENNA EQUIPMENT including:					
(1)	Base Ring (top)	Adapter, Base MX-1547/GP	X	X	X	X
(2)	Outrigger Leg	Leg, Antenna Pedestal MT-1091/MPS-14				X
(1)	Outrigger Leg (gin pole)					X
(3)	Outrigger Foot Assembly					X
	Antenna Assembly consisting of	Antenna Group OA-389/FPS-6	X			X
		OA-2035/FPS-6A		X		
		OA-2040/FPS-6B			X	
		*OA-4540/FPS-90				
(1)	Antenna Reflector including:	Reflector, Antenna AT-374/FPS-6	X	X		X
		AT-873/FPS-6B			X	
(1)	Reflector (center section)	p/o Reflector Antenna AT-374/FPS-6	X	X		X
(1)	Reflector (center section)	p/o Reflector Antenna AT-873/FPS-6B			X	

Figure 1–2. Equipment Supplied (Sheet 1 of 9)

Quantity per Equipment	Common Name of Unit	Official Nomenclature of Unit	AN/FPS-6	AN/FPS-6A	AN/FPS-6B	AN/MPS-14
(1)	Reflector (end section, top)		X	X	X	X
(1)	Reflector (end section, bottom)		X	X	X	X
(1)	Antenna Horn	Horn, Antenna AT-375/FPS-6	X	X	X	X
(1)	Antenna Horn Support including:	Support, Antenna AB-284/FPS-6	X	X	X	X
(1)	Horn Outrigger (top)		X	X	X	X
(1)	Horn Outrigger (bottom)		X	X	X	X
(1)	Cross Brace		X	X	X	X
(1)	Tie Rod Assembly					X
(1)	Strut		X	X		
(1)	Horn Yoke		X	X	X	X
(1)	Yoke Assembly including:	Support, Antenna Reflector AB-283/FPS-6	X			X
		AB-578/FPS-6A		X		
		AB-580/FPS-6B			X	
		*AB-776/FPS-90				
(1)	Main Girder Assembly (yoke hub and sections)		X	X	X	X
(1)	Yoke Arm (left)		X	X	X	X
(1)	Yoke Arm (right)		X	X	X	X
(1)	Connecting Rod	p/o Support, Antenna Reflector AB-283/FPS-6 and AB-587/FPS-6A	X	X		X
(1)	Connecting Rod	p/o Support, Antenna Reflector AB-580/FPS-6B			X	
(1)	Girder Junction Box	p/o Support, Antenna Reflector AB-283/FPS-6 and AB-578/FPS-6A	X	X		X
(1)	Girder Junction Box	p/o Support, Antenna Reflector AB-580/FPS-6B			X	
(1)	Elevation Drive Motor		X	X	X	X
(1)	Elevation Selsyn and Angle Mark Unit	p/o Support, Antenna Reflector AB-283//FPS-6	X			X
(1)	Elevation Selsyn and Angle Mark Unit	p/o Support, Antenna Reflector AB-578/FPS-6A and AB-580/FPS-6B		X	X	
(1)	Elevation Rotating Joint	Coupler, Rotary Transmission Line UG-950/FPS-6	X	X	X	X
(1)	Brake Assembly including:					
(1)	Brake (shoe and handle)		X	X	X	X
(1)	Interlock		X	X	X	X
(1)	Brake Bracket		X	X	X	X
(1)	Elevation Motor Bracket	p/o Support, Antenna Reflector AB-283/FPS-6 and AB-578/FPS-6A	X	X		X
(1)	Elevation Motor Bracket	p/o Support, Antenna Reflector AB-580/FPS-6B			X	
(1)	Dial and Ring Assembly		X	X	X	X

Figure 1–2. Equipment Supplied (Sheet 2 of 9)

Quantity per Equipment	Common Name of Unit	Official Nomenclature of Unit	AN/FPS-6	AN/FPS-6A	AN/FPS-6B	AN/MPS-14
(1)	Variable-nod Mechanism				X	
(1)	Azimuth Rotating Joint	Coupler, Rotary Transmission Line UG-960/FPS-6	X	X	X	X
(1)	Transmission Line consisting of:					
(1)	Waveguide Elbow	Elbow, Waveguide UG-951/FPS-6	X	X	X	X
(2)	Flexible Waveguide	Waveguide Assembly UG-945	X	X	X	X
(1)	Waveguide Assembly	Waveguide Assembly CG-953/U	X	X	X	X
(1)	Waveguide Assembly	Waveguide Assembly CG-941/FPS-6	X	X	X	X
(1)	Waveguide Assembly	Waveguide Assembly CG-940/FPS-6	X	X	X	X
(1)	Waveguide Assembly	Waveguide Assembly CG-952/U	X	X	X	X
(1)	Waveguide Assembly	Waveguide Assembly CG-939/FPS-6	X	X		X
(1)	Waveguide Assembly	Waveguide Assembly CG-939A/FPS-6			X	
(1)	Antenna Base including:	Base, Antenna AB-285/FPS-6	X	X	X	X
(1)	Cone Assembly	p/o Base, Antenna AB-285/FPS-6	X	X	X	X
(1)	Mounting Ring Assembly		X	X	X	X
(1)	Base Ring (bottom)		X	X	X	X
(1)	Azimuth Drive Unit Assembly including:		X	X	X	X
(1)	Azimuth Drive Unit	p/o Base, Antenna AB-285/FPS-6	X	X	X	X
(1)	Azimuth Drive Motor and Selsyn Unit		X	X	X	X
(1)	Miscellaneous Hardware (braces, clamps, junctions, plates, connectors, straps, etc.)					X
(1)	Interconnection Cables (antenna only)					X
(1)	Safety Box	Control, Antenna C-1055/FPS-6	X	X	X	X
(1)	Erection Equipment including:		X	X	X	X
(1)	Gin Pole (two sections)		X	X	X	X
(1)	Tool Kit		X	X	X	X
(1)	Erection Hardware		X	X	X	X
(2)	Erection Sling		X	X	X	X
(1)	Spare Erection Hardware		X	X	X	X
(1)	Erection Trestle Ladder		X	X	X	X
(2)	Rope Sling		X	X	X	X
(1)	Folding Stepladder		X	X	X	X
(2)	Endless Rope		X	X	X	X
(1)	A-Frame Assembly					X
(4)	Block and Tackle		X	X	X	X

Figure 1–2. Equipment Supplied (Sheet 3 of 9)

Quantity per Equipment	Common Name of Unit	Official Nomenclature of Unit	AN/FPS-6	AN/FPS-6A	AN/FPS-6B	AN/MPS-14
(1)	Chain Hoist		X	X	X	X
(3)	Guy Cables		X	X	X	X
(3)	Jacks					X
(8)	Shoring Blocks					X
(1)	Focus Gage		X	X	X	X
(1)	Checking Rod		X	X	X	X
(1)	Reflector Template		X	X	X	X
1	AZIMUTH BLANKER	Blanker, Interference MX-1739A/FPS-6		X	X	
4	AZIMUTH CONTROL OVERLAY	Control, Antenna C-1050/FPS-6	X	X	X	X
1	AZIMUTH SWITCH BOX	Control, Antenna C-1048/FPS-6	X			X
1	CABLES, INTERUNIT					X
1	CONTROL GROUP ASSEMBLY consisting of:	Radar Set Group OA-320/FPS-6	X			X
		OA-2036/FPS-6A		X		
		OA-2036/FPS-6B			X	
	Control Group Cabinet Assembly	Cabinet, Electrical Equipment CY-1123/FPS-6	X			X
		CY-2486/FPS-6A		X	X	
	Antenna Control Assembly consisting of:	Control, Antenna C-991/FPS-6	X	X	X	X
	Antenna Control Panel	p/o Control, Antenna C-991/FPS-6	X	X	X	X
	Servo Amplifier	Amplifier, Electronic Control AM-646/FPS-6	X	X	X	X
	Hunt Indicator	Assembly, Hunt Indicator, p/o Control, Antenna C-991/FPS-6	X	X	X	X
	Control Group Power Supply consisting of:	Power Supply PP-757/FPS-6	X	X	X	X
	Control Group Power Supply No. 1	Power Supply Subassembly MX-1360/FPS-6	X	X	X	X
	Control Group Power Supply No. 2	Power Supply Subassembly MX-1359/FPS-6	X	X	X	X
	Generator-Blanker Assembly consisting of:	Generator, Pulse TD-73/FPS-6	X			X
		TD-243/FPS-6A		X	X	
	Generator-Blanker Panel	p/o Generator, Pulse TD-73/FPS-6	X			X
		TD-243/FPS-6A		X	X	
	Range Mark Generator	Calibrator, Range TS-735/FPS-6	X	X	X	X
	Angle Mark Generator	Calibrator, Elevation TS-736/FPS-6	X	X	X	X
	Elevation Data Generator	Control, Indicator C-993/FPS-6	X			X
	Elevation Data Generator	Calibrator, Elevation TD-170/FPS-6A		X	X	
	Interference Blanker	Blanker, Interference MX-1316/FPS-6	X	X	X	X
	Power Distribution Panel	Panel, Power Distribution SB-225/FPS-6	X	X	X	X

Figure 1–2. Equipment Supplied (Sheet 4 of 9)

Quantity per Equipment	Common Name of Unit	Official Nomenclature of Unit	AN/FPS-6	AN/FPS-6A	AN/FPS-6B	AN/MPS-14
1	TIME-SHARING MASTER CONTROL	Control, Antenna C-1049/FPS-6	X	X	X	X
3	TRAILERS consisting of:					X
(1)	Antenna Pedestal Trailer No. 1	Trailer, Antenna Pedestal V-65/MPS-14				X
(1)	Transmitter-Modulator Trailer No. 2	Trailer, Transmitter-Modulator V-67/MPS-14				X
1	TRANSMISSION LINE including:					
(1)	Waveguide Elbow Assembly consisting of:		X	X	X	X
(1)	Waveguide Elbow	Waveguide Assembly UG-1014/MPS-14				X
(1)	Waveguide Elbow	Waveguide Assembly UG-1015/MPS-14				X
(1)	Waveguide Assembly	Waveguide Assembly CG-1047/MPS-14				X
(1)	Waveguide Assembly	Waveguide Assembly CG-942/U	X	X	X	X
(2)	Flexible Waveguide Assembly (preformed)	Waveguide Assembly CG-947/U	X	X	X	X
(1)	Flexible Waveguide Assembly	Waveguide Assembly CG-1048/MPS-14				X
(1)	Waveguide Mounting Assembly		X	X	X	X
6	TRUCKS TYPE M-35 consisting of:					X
(1)	Control Equipment Truck (M-35 modified)					X
(1)	Cable Truck No. 1 (M-35 modified)					X
(1)	Cable Truck No. 2 (M-35 modified)					X
(1)	Spares Truck (M-35 modified)					X
(2)	Shelter Truck (M-35 modified)					X

Figure 1–2. Equipment Supplied (Sheet 9 of 9)

1–5. EQUIPMENT REQUIRED BUT NOT SUPPLIED.

1–6. Except for the associated search radar installation and power sources, no auxiliary equipment is required for operation of Radar Set AN/FPS-6.

1–7. PUBLICATIONS COVERING THE EQUIPMENT.

1–8. See figure 1–3 for a complete list of equipment technical manuals for Radar Set AN/FPS-6.

1–9. PURPOSE OF EQUIPMENT.

1–10. Radar Set AN/FPS-6 is an air-transportable, high-power, long-range fixed-station, height-finding equipment for use in association with a search radar of comparable range capability. The equipment can be installed as a fixed station, with its antenna and r-f units mounted on a tower and its control and indicating units installed within the operations building of the associated search radar.

1–11. The purpose of Radar Set AN/FPS-6 is to determine the height of targets selected by the PPI operators of the associated search radar. Each PPI operator, in turn, can direct the antenna of Radar Set AN/FPS-6 to scan in elevation the azimuth sector containing the selected target. This target then appears on the range-height indicator (RHI) of Radar Set AN/FPS-6. The height determination made by the RHI operator of Radar Set AN/FPS-6 is communicated to the PPI operator both by telephone and by means of a remote height indicator device on the PPI.

Current Publication		Former Publication	
T.O. Number	Title	T.O. Number	Title
T.O. 31P3-2FPS6-1	Technical Manual, Operating Instructions for Radar Sets AN/FPS-6, AN/FPS-6A, AN/FPS-6B, and AN/MPS-14	T.O. 31P3-2FPS6-1[1]	Handbook of Operating Instructions, Radar Sets AN/FPS-6 and AN/MPS-14
T.O. 31P3-2FPS6-2	Technical Manual, Service Instructions for Radar Sets AN/FPS-6, AN/FPS-6A, AN/FPS-6B, and AN/MPS-14	T.O. 31P3-2FPS6-2[1]	Handbook of Maintenance Instructions, Radar Sets AN/FPS-6 and AN/MPS-14
		T.O. 31P3-2FPS6-12[1]	Handbook of Maintenance Instructions, Antenna System of Radar Sets AN/FPS-6 and AN/MPS-14
		T.O. 31P3-2FPS6-22[1]	Handbook of Maintenance Instructions, Transmitter-Receiver System of Radar Sets AN/FPS-6 and AN/MPS-14
		T.O. 31P3-2FPS6-32[1]	Handbook of Maintenance Instructions, Pressurizer and Dehydrator of Radar Sets AN/FPS-6 and AN/MPS-14
		T.O. 31P3-2FPS6-42[1]	Handbook of Maintenance Instructions, Heat Exchanger of Radar Sets AN/FPS-6 and AN/MPS-14
		T.O. 31P3-2FPS6-52[1]	Handbook of Maintenance Instructions, Range-Height Indicator of Radar Sets AN/FPS-6 and AN/MPS-14
		T.O. 31P3-2FPS6-62[1]	Handbook of Maintenance Instructions, Control Group Assembly of Radar Sets AN/FPS-6 and AN/MPS-14
		T.O. 31P3-2FPS6-72[1]	Handbook of Maintenance Instructions, Azimuth Switch Box, Time-Sharing Master Control, and Junction Box of Radar Sets AN/FPS-6 and AN/MPS-14
		T.O. 31P3-2FPS6-82[1]	Handbook of Maintenance Instructions, Azimuth Control Overlay and Remote Height Display of Radar Sets AN/FPS-6 and AN/MPS-14
		T.O. 31P3-2FPS6-132	Handbook of Service Instructions, Indicator Group OA-1040/GPS of Radar Set AN/FPS-6A
		T.O. 31P3-2FPS6-142	Handbook of Service Instructions, Indicator Group OA-929/FPS-6A of Radar Set AN/FPS-6A
		T.O. 31P3-2MPS14-3[1]	Handbook of Service Instructions, Trailers, Shelter, and Accessories of Radar Set AN/MPS-14

[1]Only applicable information from the former publication is contained in the current publication(s).

Figure 1–3. Publications Covering the Equipment (Sheet 1 of 2)

Current Publication		Former Publication	
T.O. Number	Title	T.O. Number	Title
T.O. 31P3-2FPS6-3	Technical Manual, Overhaul Instructions for Radar Sets AN/FPS-6, AN/FPS-6A, AN/FPS-6B, and AN/MPS-14		
T.O. 31P3-2FPS6-4	Illustrated Parts Breakdown for Radar Sets AN/FPS-6, AN/FPS-6A, and AN/MPS-14	T.O. 31P3-2FPS6-14	Parts Catalog for Antenna System of Radar Sets AN/FPS-6, AN/FPS-6A, and AN/MPS-14
		T.O. 31P3-2FPS6-24	Parts Catalog for Transmitter-Receiver System of Radar Sets AN/FPS-6, AN/FPS-6A, and AN/MPS-14
		T.O. 31P3-2FPS6-34	Parts Catalog for Electric Desiccant Dehydrator of Radar Sets AN/FPS-6, AN/FPS-6A, and AN/MPS-14
		T.O. 31P3-2FPS6-44	Parts Catalog for Heat Exchanger of Radar Sets AN/FPS-6, AN/FPS-6A, and AN/MPS-14
		T.O. 31P3-2FPS6-54	Parts Catalog for Range-Height Indicator of Radar Sets AN/FPS-6 and AN/MPS-14
		T.O. 31P3-2FPS6-64	Parts Catalog for Control Group Assembly of Radar Sets AN/FPS-6, AN/FPS-6A, and AN/MPS-14
		T.O. 31P3-2FPS6-74	Parts Catalog for Azimuth Control and Time-Sharing Master Control for Radar Sets AN/FPS-6, AN/FPS-6A, and AN/MPS-14
		T.O. 31P3-2FPS6-84	Parts Catalog for Azimuth Control Overlay and Remote Height Display of Radar Sets AN/FPS-6, AN/FPS-6A, and AN/MPS-14
		T.O. 31P3-2FPS6-134	Illustrated Parts Breakdown for Indicator Group OA-1040/GPS of Radar Set AN/FPS-6A
		T.O. 31P3-2FPS6-144	Illustrated Parts Breakdown for Indicator Group OA-929/FPS-6A of Radar Set AN/FPS-6A
		T.O. 31P3-2MPS14-4	Parts Catalog for Trailers, Shelter, and Accessories of Radar Set AN/MPS-14
T.O. 31P3-2FPS6-5	Technical Manual, Installation Instructions for Arctic Tower AB-259/FPS-6	T.O. 31P3-2FPS6-1[1]	Handbook of Operating Instructions for Radar Sets AN/FPS-6 and AN-MPS-14
T.O. 31P3-2FPS6-125	Technical Manual, Installation Instructions for Temperate Tower AB-258/FPS-6		
T.O. 31P3-2FPS6-165	Technical Manual, Installation Instructions for Radar Sets AN/FPS-6, AN/FPS-6A, AN/FPS-6B, and AN/MPS-14		

[1]Only applicable information from the former publication is contained in the current publication(s).

Figure 1–3. Publications Covering the Equipment (Sheet 2 of 2)

1–12. CAPABILITIES AND LIMITATIONS.

1–13. RANGE AND RESOLVING POWER.

1–14. Radar Set AN/FPS-6 is capable of making height determinations for aircraft targets flying within the elevation-angle limits of −2 and +32 degrees for any azimuth throughout 360 degrees. The equipment has a maximum slant-range capability of 200 nautical miles and a maximum height capability of 75,000 feet, and may be operated at altitudes up to 10,000 feet. (One nautical mile equals 6080.2 feet.) The resolution capability of the equipment is such that it is possible to distinguish two single aircraft separated by 3/8 nautical mile or 1/2 percent in range, 3.2 degrees in azimuth, or 0.9 degree in elevation.

1–15. Radar Set AN/FPS-6A has a maximum slant-range capability of 300 nautical miles and a maximum height capability of 100,000 feet. Radar Set AN/FPS-6B has characteristics similar to those of Radar Set AN/FPS-6A with the added feature of variable elevation scan from a minimum of 1 degree to a maximum of 34 degrees. The center of the arc is also available.

1–16. PROTECTION AGAINST ADVERSE CLIMATIC CONDITIONS.

1–17. Radar Set AN/FPS-6 can operate in temperate, arctic, and tropical climates. It is effectively impervious to the harmful effects of salt atmosphere, sand and dust particles, and the entry or growth of small insects and fungi. The climatic and altitude ranges which the equipment can withstand during operation and nonoperation are listed in figure 1–4.

Climatic Condition	Range
Ambient Temperature:	
Operating Limits (outdoor components)	−54°C (−65°F) to 60°C (140°F)
(indoor components)	−29°C (−20°F) to 60°C (140°F)
Nonoperating Limits	−54°C (−65°F) to 60°C (140°F)
Barometric Pressure:	
Operating Limits	20 in. Hg (10,000 ft) to 30 in. Hg (sea level)
Nonoperating Limits	7 in. Hg (35,000 ft) to 30 in. Hg (sea level)
Relative Humidity	100%
Wind Velocity:	
Operating Limits (no ice) (with radome)	109 knots[1]
(without radome)	52 knots[1]
Nonoperating Limits (without radome)	75 knots[1]

[1]One knot equals one nautical mile per hour.

Figure 1–4. Effects of Climatic Conditions

1–18. In a temperate installation, the antenna and amplidyne are placed on the top platform of the four-sided tower and the r-f components and auxiliaries are housed within the enclosed platform beneath the antenna. In an arctic installation, the antenna and amplidyne are placed on the top platform of the 12-sided tower structure, a protective radome erected over the antenna, and the r-f components and auxiliaries are housed within the enclosed second floor beneath the antenna.

1–19. In both the temperate and arctic installations, the control and indicating components are installed within the operations building of the associated search radar.

1–20. TRANSPORTABILITY.

1–21. AIR TRANSPORTABILITY. With the exception of the antenna and tower, which must be disassembled, the major components of Radar Set AN/FPS-6 are transportable in cargo type aircraft without disassembly.

1–22. GROUND TRANSPORTABILITY. The major components of Radar Set AN/FPS-6 are transportable in standard army vehicles such as the 2-1/2 ton six-by-six truck.

1–23. MOBILE EQUIPMENT. In a mobile version of Radar Set AN/FPS-6, the components are transported in specially modified trucks and trailers and set up for use on trailers and outriggers. This mobile equipment, Radar Set AN/MPS-14, is fully described in appendix A of this technical manual.

1–24. SYSTEM CHARACTERISTICS.

1–25. RADAR SET AN/FPS-6.

1–26. MODULATING AND TRANSMITTING SYSTEMS. A single modulator, capable of producing 2-microsecond pulses at a nominal repetition rate of 360 pps, is synchronized by system trigger pulses from the associated search radar. The modulator is energized by its regulated high-voltage power supply. The modulator pulses are delivered to the magnetron assembly where, after passing through a pulse transformer, they are applied to a magnetron oscillator to produce the required high-power transmitted signal.

1–27. This r-f signal is delivered via a flexible waveguide to the r-f assembly, where it passes through r-f transmission (power-monitoring and duplexing) components prior to transmission to the antenna. The radiated pulse is in the frequency band of 2700 to 2900 megacycles with a peak power of approximately 5 megawatts. A pressurized waveguide system is employed throughout the transmitter and antenna systems to insure satisfactory operation at the high power level required by this equipment.

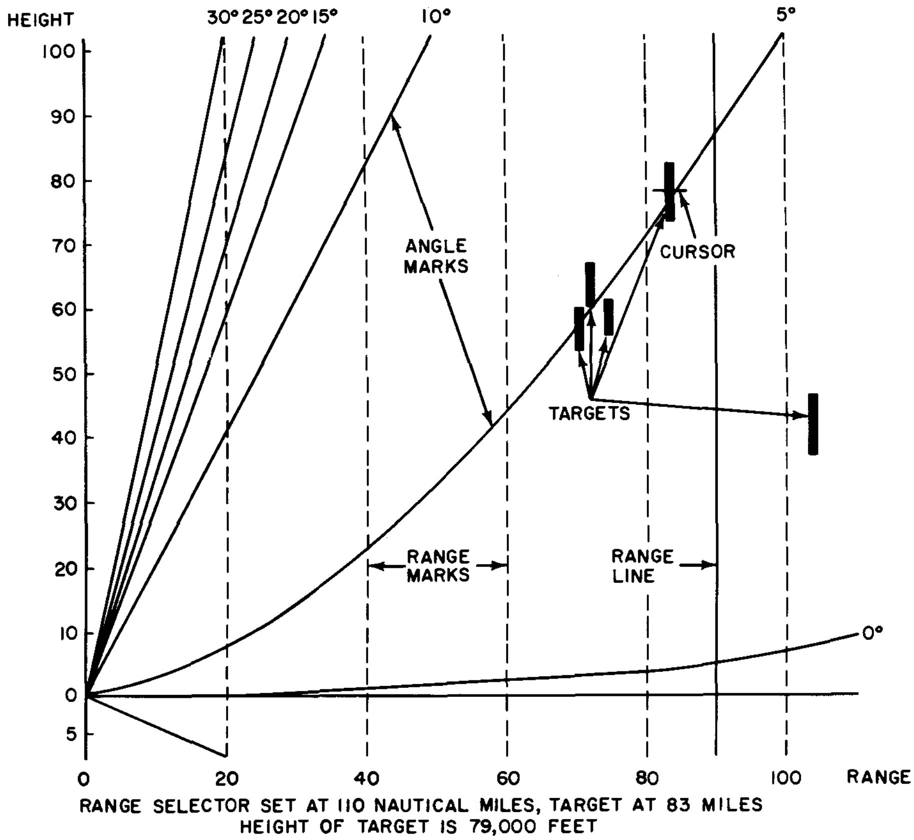


Figure 1–9. RHI Presentation for Radar Set AN/FPS-6A

Circuit Breaker or Fuse	Panel Designation or Circuit	Max Current (amp)	Approx Actual Current (amp)
S6401	ELECTRONIC POWER	100	60
S6402	ANTENNA POWER	50	25[1]
S6403	H. V. IND. REG	50	25
S6404	MODULATOR power	20	6
S6405	XMITTER-Receiver group power	25	20
S6406	CONTROL GROUP power	15	6
S6407	R. H. I. power	30	15
S6408	JUNCTION BOX power	3	1
F6401	Utility outlet	8	
F6402	Blower motor	5	3

[1]Not including starting surge.

Figure 1–10. Current Requirements

1–38. RADAR SET AN/FPS-6B.

1–39. Radar Set AN/FPS-6B differs from Radar Set AN/FPS-6A as follows:

a. The elevation scan angle or arc is continuously variable from a maximum of 34 degrees (−2 to +32 degrees) to a minimum of 1 degree, as is the center of the arc. This is accomplished by means of a variable-nod mechanism in the antenna assembly and appropriate controls.

b. A new preamplifier and a new mixer have been added.

1–40. PHYSICAL AND FUNCTIONAL DESCRIPTION OF MAJOR COMPONENTS.

1–41. TRANSMITTER-RECEIVER SYSTEM.

1–42. COMPONENTS. The major components of the transmitter-receiver system of Radar Set AN/FPS-6 are located on the floor of the tower immediately beneath the top platform supporting the antenna. These components are:

a. R-f assembly

b. Magnetron assembly

c. Modulator assembly

d. Modulator high-voltage power supply

e. Modulator high-voltage regulator

f. Heat exchanger for magnetron

g. Pressurizer and dehydrator

1–43. The transmitter-receiver system of Radar Set AN/FPS-6A contains the following additional major components:

a. Heat exchanger for ferrite isolator

b. Ferrite isolator

c. Performance monitor

d. New preamplifier and mixer (for Radar Set AN/FPS-6B only)

1–44. R-F ASSEMBLY. The r-f assembly (figure 1–11) is located beneath the antenna and is coupled to it by waveguide sections. The power and control circuits for the r-f assembly, as well as the other units in this system, originate from the operations building of the search radar. The r-f assembly has local facilities used only in maintenance and initial adjustment procedures. The actual tactical operation of the assembly is controlled from the remote r-f control panel of the control group assembly in the operations building.

1–45. The r-f transmission signal pulse is generated in the adjacent magnetron assembly. This signal is delivered through a flexible waveguide section to the r-f assembly,

Figure 1–11. R-f Assembly; Radar Set Group OA-357/FPS-6

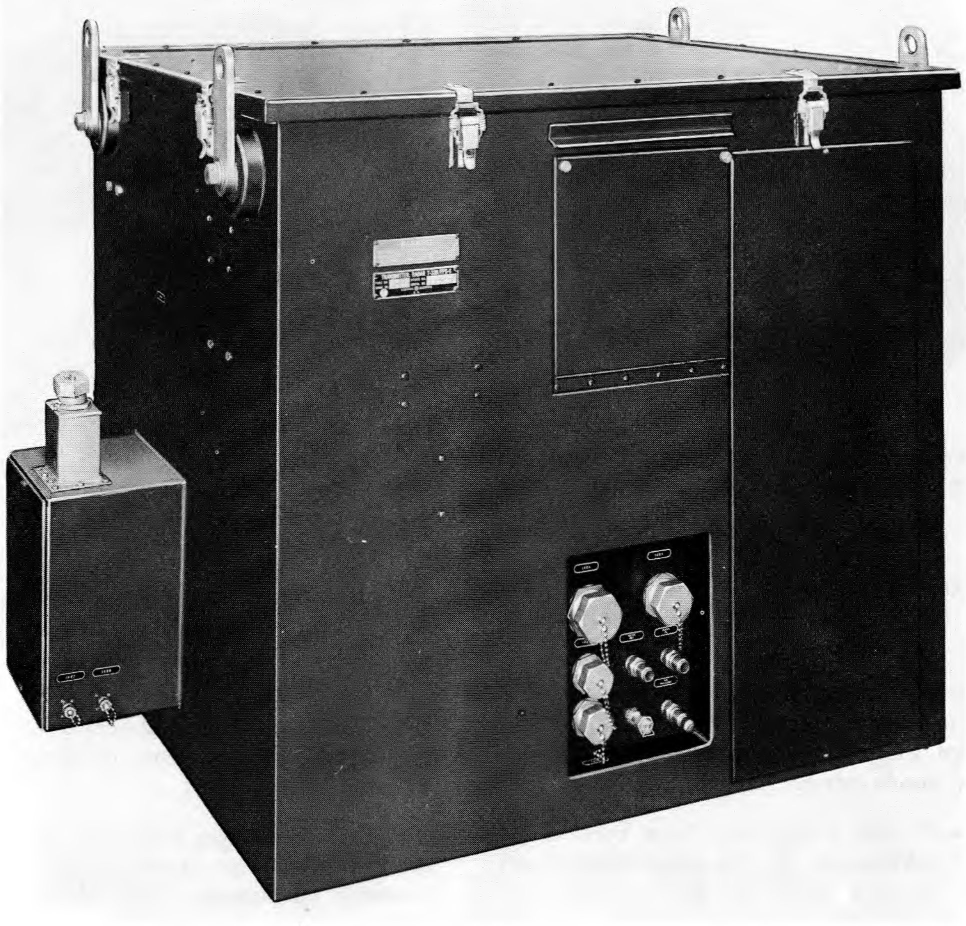


Figure 1–12. Magnetron Assembly; Transmitter, Radar T-338A/FPS-6

where it passes through r-f transmission, power monitoring, and duplexing components prior to transmission through waveguide sections to the antenna. The antenna radiates the transmitter signal and then intercepts the returning echo signal. After passing through a duplexer in the r-f assembly, the echo signal is amplified and mixed with the signal from a local oscillator. The frequency of the local oscillator signal is maintained constant by afc circuits. The resulting i-f signal is applied to the receiver in the control group assembly.

1–46. The r-f assembly of Radar Sets AN/FPS-6A and AN/FPS-6B differs from that of Radar Set AN/FPS-6 as follows:

a. In the AFC-LO assembly, a new relative tuning unit, part of the performance monitor circuits (paragraph 1–57), has been added.

b. The meter and controls associated with the new relative tuning unit added to the AFC-LO assembly have been mounted on the local control panel of the local control assembly.

c. In the local control assembly, a new noise figure modulator, part of the performance monitor circuits, has been added. This modulator replaces the r-f noise source of Radar Set AN/FPS-6.

d. The waveguide noise source switch and r-f noise probe of Radar Set AN/FPS-6 have been replaced with a straight-through waveguide section.

e. A new preamplifier and mixer are used in Radar Set AN/FPS-6B.

1–47. MAGNETRON ASSEMBLY. The magnetron assembly (figure 1–12) contains the magnetron oscillator, which is the source of the transmission signal. This signal is transferred to the adjacent r-f assembly by a short section of flexible waveguide. In addition, the magnetron assembly contains a pulse transformer, the magnetron filament heating transformer, and a cooling system. The pulse transformer amplifies and couples the modulator pulse to the magnetron oscillator. The magnetron is maintained at a safe operating temperature by a liquid cooling system which operates in conjunction with the heat exchanger. X-ray radiation from the top of the magnetron is reduced by a lead cap.

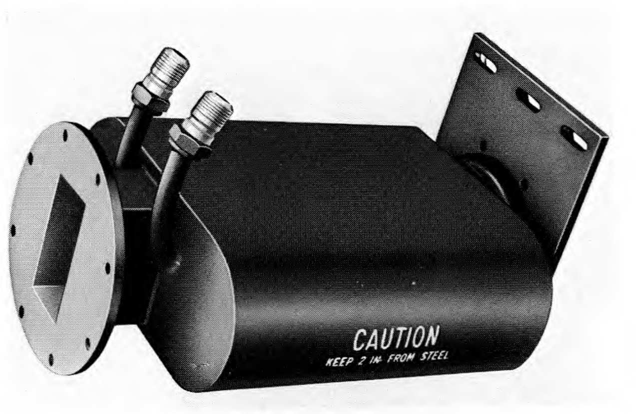


Figure 1–13. Ferrite Isolator; Isolator, Radio Frequency Reflector CU-492/FPS-6A

1–48. The magnetron assembly of Radar Set AN/FPS-6A differs from that of Radar Set AN/FPS-6 as follows:

a. A relay has been added to the magnetron average-current metering circuit. This relay shorts out the circuit when the magnetron arcs, thereby preventing overload of the anode current meters.

b. A meter and other components have been added to provide for calibration of the magnetron heater current circuit.

c. The interlock of the new ferrite isolator connects to the magnetron cabinet.

1–49. FERRITE ISOLATOR. Radar Set AN/FPS-6A contains ferrite isolator CU-492/FPS-6A (figure 1–13) which isolates the magnetron electrically from the transmission line. The isolator is mounted directly on the output of the magnetron assembly cabinet and has an insertion loss of about 300 watts, which is dissipated in an additional heat exchanger (paragraph 1–55) provided for this purpose. Ferrite Isolator CU-492A/FPS-6A (figure 1–14) is a newer type isolator used on some units. This isolator is similar electrically to the older type, but is blower-cooled and therefore requires no heat exchanger.

1–50. MODULATOR ASSEMBLY. The modulator assembly (figure 1–15) amplifies a system trigger received from the range mark generator and shapes it into the steep-sided, flat-topped modulating pulse required by the magnetron. Local control facilities are located in the modulator control unit of the assembly. This control unit also contains regulation circuits for the magnetron and modulator filaments as well as a protective circuit which lowers the high voltage when the magnetron arcs excessively. The modulator assembly is energized by a nearby high-voltage power supply and a regulator unit.

Figure 1–14. Ferrite Isolator; Isolator, Radio Frequency Reflector CU-492A/FPS-6A

1–51. The modulator assembly of Radar Set AN/FPS-6A differs from that of Radar Set AN/FPS-6 as follows:

a. Circuit changes have been made to comply with the improved meter protection circuit in the magnetron assembly (paragraph 1–48) of Radar Set AN/FPS-6A.

b. A high-voltage interlock test switch and associated indicator lamp have been added.

c. The thyratron capsule voltage control transformer and meter have been relocated for easier removal of the thyratron cradle.

d. Covers have been added over components mounted at the rear of the upper right compartment door.

e. A blower air deflector has been added to provide improved cooling of the upper right side of the lower compartment.

1–52. MODULATOR HIGH-VOLTAGE POWER SUPPLY. The modulator high-voltage power supply (figure 1–16) employs 3-phase, full-wave rectification to supply 12 kilovolts dc at 0.72 ampere, nonregulated, for modulator operation.

1–53. MODULATOR HIGH-VOLTAGE REGULATOR. The modulator high-voltage regulator (figure 1–17) is a conventional induction regulator used to control the input to the modulator high-voltage power supply. A motor-driven adjustment system with remote manual control is provided.

1–54. HEAT EXCHANGER FOR MAGNETRON. A heat exchanger (figure 1–18), which uses a solution of ethylene gylcol and water as a coolant, is provided for

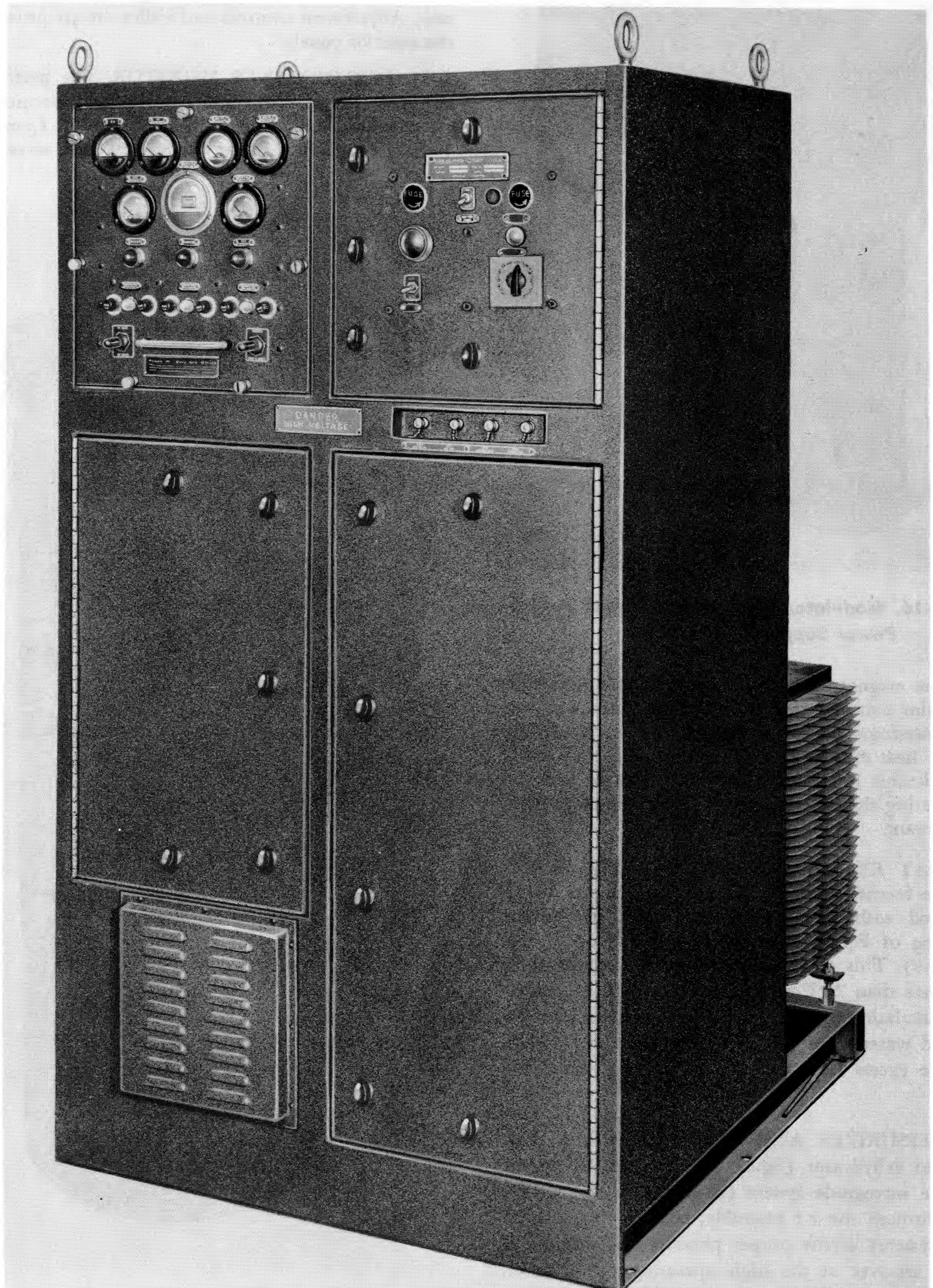


Figure 1–15. Modulator Assembly; Modulator Group OA-329A/FPS-6

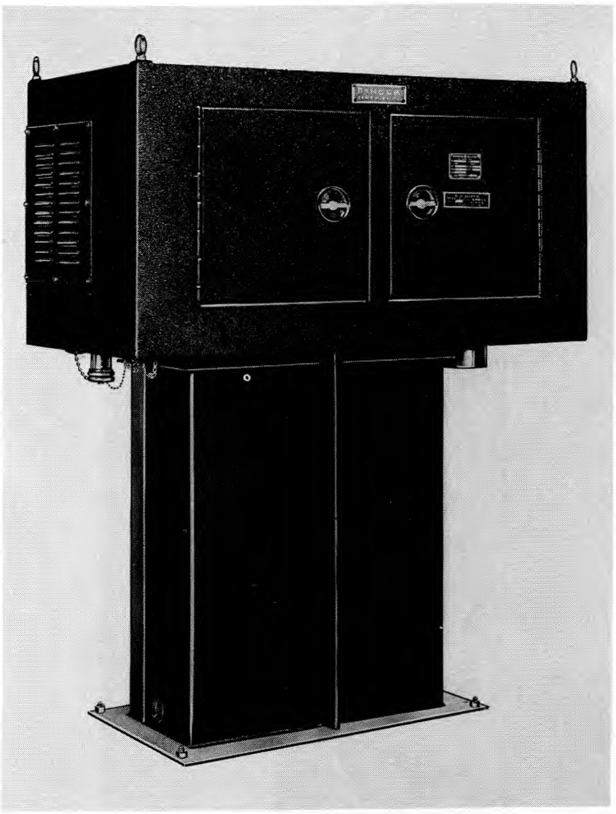


Figure 1–16. Modulator High-voltage Power Supply; Power Supply PP-783/FPS-6

cooling the magnetron in the magnetron assembly. This unit contains a storage reservoir for the coolant, a motor-driven centrifugal pump for circulating the coolant between the heat exchanger and the magnetron assembly through flexible hose coupling, and a radiator and fan for dissipating the heat transferred from the magnetron to the coolant.

1–55. HEAT EXCHANGER FOR FERRITE ISOLATOR. The ferrite isolator heat exchanger (figure 1–19) is provided with Radar Set AN/FPS-6A to prevent overheating of Ferrite Isolator CU-492/FPS-6A (paragraph 1–49). This component maintains a temperature of not more than 70°C (140°F) in the ferrite termination by circulating a coolant fluid consisting of ethylene glycol and water through the termination and by dissipating the excess heat across a finned-surface cooling coil.

1–56. PRESSURIZER AND DEHYDRATOR. A pressurizer and dehydrator (figure 1–20) maintains the air within the waveguide system (from the magnetron assembly, through the r-f assembly, and up through the antenna system) at the proper pressure and dryness to minimize arc-over at the high operating power level. This unit is equipped with a pump for maintaining the air pressure and a dehydrating system containing filters and the necessary desiccant for conditioning the air supplied to the waveguide system. A dual dehydrating system is employed, arranged so that one section is in use while the other is being reactivated. The alternate use of these two sections is controlled automatically within the unit. Adjustment controls and indicators are provided on the exterior panels.

1–57. PERFORMANCE MONITOR. The performance monitor (figure 1–21) and its associated circuits in the r-f assembly and control group assembly (paragraphs 1–46 and 1–58) of Radar Set AN/FPS-6A serve several

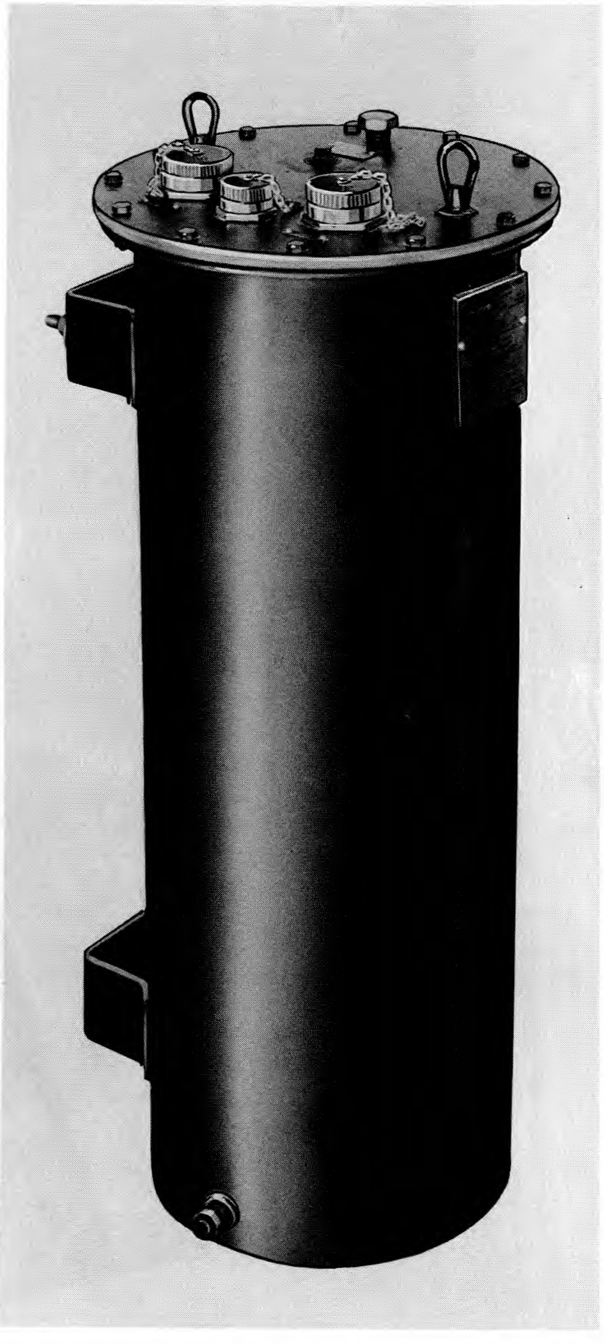


Figure 1–17. Modulator High-voltage Regulator; Voltage Regulator CN-93/CPS-6B

purposes. The performance monitor and its circuits provide for a continuous reading of the receiver noise figure (on local and remote noise figure meters), a continuous measurement of transmitter power output, and a continuous monitoring of receiver intermediate frequency. The performance monitor cabinet houses two major assemblies: the power and noise figure assembly and the performance monitor power supply. The power and noise figure assembly consists of a noise figure gate generator, noise figure detector, noise figure i-f amplifier, and power and VSWR monitor. Both the power supply and the power and noise figure assembly are drawer-type units. The performance monitor is mounted on top of the r-f assembly of Radar Set AN/FPS-6A by means of brackets supplied with the monitor.

Figure 1–18. Heat Exchanger for Magnetron; Cooler, Liquid, Electron Tube HD-188/FPS-6

Figure 1–19. Heat Exchanger for Ferrite Isolator; Cooler, Liquid, R-f Isolator HD-289/FPS-6A (Used With Ferrite Isolator CU-492/FPS-6A Only)

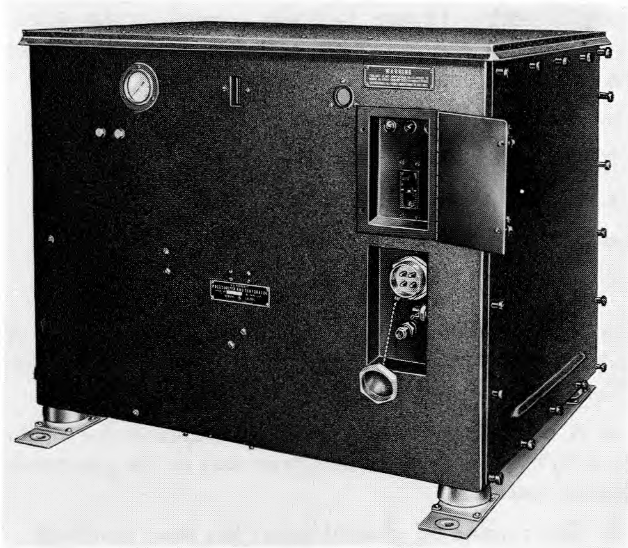


Figure 1–20. Pressurizer and Dehydrator; Dehydrator, Desiccant, Electric HD-187/FPS-6

Figure 1–21. Performance Monitor; Indicator Group OA-1385/GPA-40

1–58. CONTROL GROUP ASSEMBLY.

1–59. COMPONENTS. The control panel and circuits of the control group assembly allow maintenance and operating personnel of the associated search radar to control Radar Set AN/FPS-6 remotely. The control group assembly (figure 1–22) is located in the operations room of the associated search radar and contains the following units:

a. Antenna control assembly

b. Generator-blanker assembly

c. Control group power supply

d. Power distribution panel

e. Remote r-f control panel

1–60. The control group assembly (figure 1–23) of Radar Set AN/FPS-6A differs from that of Radar Set AN/FPS-6 as follows:

a. A new elevation data generator replaces the Radar Set AN/FPS-6 elevation data generator in the generator-blanker assembly.

b. The remote r-f control panel has been modified.

c. Relay K6903, three associated 25-ohm power resistors, and jack J6941 have been added to the control group cabinet to accommodate the azimuth blanker (paragraph 1–86).

d. The control cabinet wiring has been changed to accommodate the addition of the RHI antenna control (paragraph 1–83). In addition, a +275-volt d-c reference is supplied to the RHI assembly of Radar Set AN/FPS-6A.

1–61. ANTENNA CONTROL ASSEMBLY. The antenna control assembly is a track-mounted, drawer-type unit which contains the antenna control panel, the servo amplifier, and the hunt indicator circuit.

1–62. The antenna control panel provides facilities for control of the azimuth and elevation drives of the antenna reflector. The elevation drive can be operated at either a slow rate (20 nods per minute) or a fast rate (30 nods per minute) or it can be stopped. The azimuth drive controls permit starting and stopping of the azimuth drive amplidyne. (The antenna control panel does not provide controls for the azimuth orientation of the antenna, which is accomplished at the azimuth control overlays and/or at the azimuth switch box.) Indicator lamps indicate the status of the antenna controls. The antenna control panel also contains three indicator lamps and a reset switch for the hunt indicator circuit described in paragraph 1–64.

Note

In Radar Set AN/FPS-6A, a new RHI antenna control unit (paragraph 1–83) is used for azimuth orientation of the antenna instead of the azimuth switch box employed in Radar Set AN/FPS-6.

1–63. The servo amplifier is a high-gain d-c amplifier which amplifies the error signals resulting from lack of agreement between the position of the antenna and the setting of the azimuth control overlay or azimuth switch box. Following amplification, these error signals are fed to the amplidyne where appropriate correcting drive power for the azimuth drive motor is produced.

1–64. The hunt indicator circuit automatically stops all azimuth motion when the antenna hunts excessively. Two indicator lamps on the antenna control panel flicker when hunting begins. If hunting persists, azimuth drive power is automatically removed and a red lockout indicator lamp lights on the antenna control panel. A reset switch on the antenna control panel is used to restore azimuth drive power and clear the hunt indicator circuit.

1–65. GENERATOR-BLANKER ASSEMBLY FOR RADAR SET AN/FPS-6 ONLY. The generator-blanker assembly of the control group assembly contains several subassembly units which generate marker and blanking signals for use in the RHI. These units are:

a. Angle mark generator

b. Elevation data generator

c. Interference blanker

d. Range mark generator

e. Generator-blanker panel

1–66. The generator-blanker assembly of Radar Set AN/FPS-6A differs from that of Radar Set AN/FPS-6 in that a new elevation data generator replaces the elevation data generator of Radar Set AN/FPS-6.

1–67. ANGLE MARK GENERATOR. The angle mark generator combines the system triggers with pulse signals resulting from the action of a pair of commutator segments in the elevation selsyn and angle mark unit on the antenna to produce 2-microsecond pulses synchronized with the trigger. This occurs when the antenna reflector is at 0, 5, 10, 15, 20, 25, or 30 degrees in elevation from the horizontal. These pulses are used in the RHI to produce angle marks for the display (figures 1–8 and 1–9).

1–68. ELEVATION DATA GENERATOR. The elevation data generator converts the elevation of the antenna into a d-c voltage which is applied to the height sweep of the RHI assembly. This voltage causes the sweep trace to move up and down in synchronism with the nodding of the antenna. First, the elevation data generator produces a 1500-cycle signal which excites a synchro in the elevation selsyn and angle mark unit. The output of this synchro is then converted by the elevation data generator into a d-c voltage proportional to the sine of the elevation angle of the antenna.

1–69. INTERFERENCE BLANKER. The interference blanker is designed to eliminate interference in the RHI display caused by r-f radiation from the associated friendly radar set(s). This is accomplished by blanking the video channel when a trigger is received from the associated radar set(s).

Figure 1–22. Control Group Assembly; Radar Set Group OA-320/FPS-6

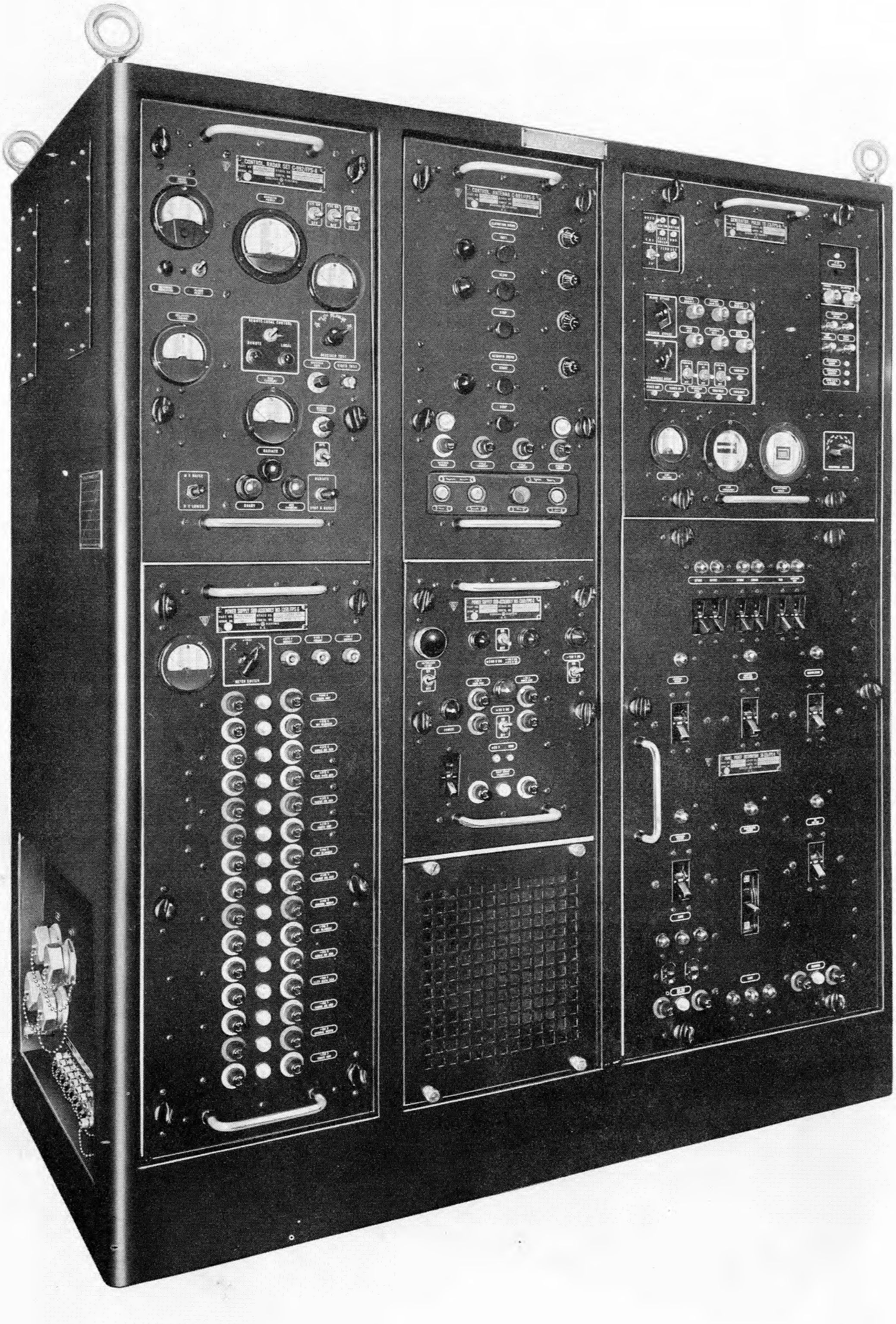


Figure 1–23. Control Group Assembly; Radar Set Group OA-2036/FPS-6A

1–70. RANGE MARK GENERATOR. The range mark generator produces a series of system triggers which synchronize the various units of the radar. This generator also produces marker-pulse signals which appear as markers on the RHI display of Radar Set AN/FPS-6 only. The markers represent 10-mile intervals along the range scale, with intensification at 50-mile intervals.

1–71. GENERATOR-BLANKER PANEL. The generator-blanker panel contains a monitoring switch and three meters: a line voltage, a line frequency, and an elapsed time meter. The monitoring switch permits connecting the line voltage meter to each of six phases, three for antenna power and three for electronic power.

1–72. REMOTE R-F CONTROL PANEL. The remote r-f control panel is a drawer-type assembly which contains switches, controls, meters, and indicators used for remote control of the r-f noise source and adjustment of the afc and other circuits. These controls are also used for tuning of the receiver in the transmitter-receiver assembly and for operation of the modulator. The remote r-f control panel duplicates the operating controls on the r-f assembly and thus facilitiates tactical operation of the set from the operations center.

1–73. The remote r-f control panel of Radar Set AN/FPS-6A is similar to that of Radar Set AN/FPS-6, except that meters and controls used with the performance monitor (paragraph 1–57) have been added. These components include a relative-tuning meter, a noise-figure meter, and a power meter.

1–74. POWER DISTRIBUTION PANEL. The power distribution panel is the distribution center for primary power (i.e., power for the electronic circuits and for the antenna drive systems) to all components of Radar Set AN/FPS-6. This panel contains circuit breakers and indicator lamps for main power, antenna power, the modulator high-voltage regulator, the modulator assembly, the r-f assembly, the control group assembly, the RHI assemblies, and the junction box.

1–75. CONTROL GROUP POWER SUPPLY. The control group power supply provides a-c heater voltages and both positive and negative, regulated d-c voltages for all units in the control group assembly. Metering and adjustment facilities for all outputs are provided on the front panel. All output circuits are fused; the fuses and their associated indicator lamps are also located on the front panel. For better space utilization and heat dissipation, this power supply is built in two sections, each mounted on its own drawer-type chassis. A series interlock-switch system in the control group assembly cabinet is arranged to de-energize this power supply when any chassis in the assembly is withdrawn.

1–76. TIME-SHARING AND ANTENNA CONTROL SYSTEM.

1–77. COMPONENTS. The time-sharing system consists of the following components:

a. Time-sharing master control

b. Azimuth control overlays

c. Remote height displays

d. Azimuth switch box

e. RHI antenna control

f. Junction box

g. Azimuth blanker

1–78. TIME-SHARING MASTER CONTROL. The time-sharing master control (figure 1–24) apportions the time of use of the antenna among the PPI operators of the associated search radar. This unit provides controls for determining the sequence in which the operators have control of the antenna azimuth motion, the time allotted to each operator, and manual designation of control. In any control sequence, the time available to any operator is adjustable from 20 to a maximum of 90 seconds. The time-sharing master control is mounted on the control officer's desk.

1–79. AZIMUTH CONTROL OVERLAYS. Four azimuth control overlay units (figure 1–25) are supplied. Each overlay is fitted to the face of a PPI assembly of the associated search radar and permits the PPI operator to orient the antenna of Radar Set AN/FPS-6 in azi-

Figure 1–24. Time-sharing Master Control; Control, Antenna C-1049/FPS-6

muth toward any desired target on the PPI screen. The unit consists basically of a transparent disk with an etched radial cursor line. The disk is rotated by a small handwheel below it. Two synchro generators geared to this mechanical drive feed an error signal to the servo amplifier in the control group assembly in order to position the antenna. An azimuth scale calibrated in degrees (10-degree major divisions) surrounds the transparent cursor disk.

1–80. The PPI operators using these overlay controls share time in the use of the antenna control facilities. A control switch at the lower left of the disk permits the overlay unit to be on (active) and effective for its operator during the apportioned time periods, or off (inactive) and the time period allotted to it remain unused, or pass (i.e., the unit will be eliminated from the time-sharing group and control passes to the next PPI operator as determined by the time-sharing master control). In addition, an indicator lamp above and to the left of the disk lights when the overlay control is active.

Figure 1–25. Azimuth Control Overlay; Control, Antenna C-1050/FPS-6

Figure 1–26. Remote Height Display; Indicator, Height ID-331/FPS-6

1–81. REMOTE HEIGHT DISPLAYS. A remote height display (RHD) (figure 1–26) is mounted next to each azimuth control overlay at the associated search radar. The RHD contains a motor-driven counter and a dial which provide the PPI operator with absolute and relative height information sought and determined at the RHI. The RHD counter and dial are controlled by synchro signals generated in association with the height-measuring controls at the RHI assembly. Each RHD is also provided with four indicator lamps which indicate the PPI assembly that is receiving the height information.

Note

In some installations, the azimuth control overlays and the RHD's are not supplied. Instead, units built into the PPI consoles of the associated search radar perform these functions.

1–82. AZIMUTH SWITCH BOX. The azimuth switch box (figure 1–27), used with Radar Set AN/FPS-6 only, is located near the RHI assembly. This unit permits the

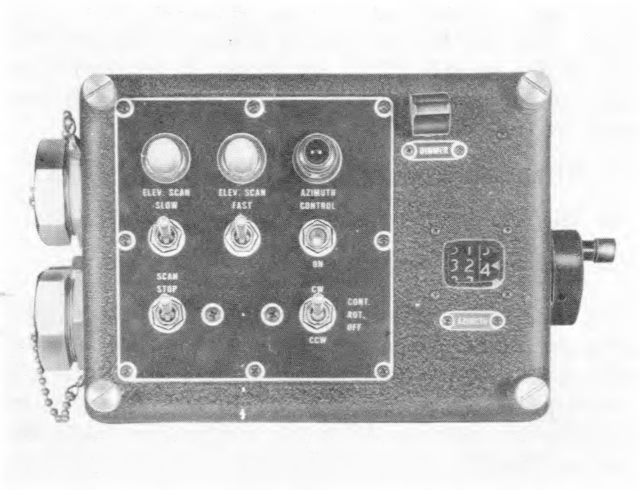


Figure 1–27. Azimuth Switch Box for Radar Set AN/FPS-6; Control, Antenna C-1048/FPS-6

RHI operator to stop the elevation drive motor or operate it at a slow or fast rate and slew the antenna clockwise or counterclockwise in azimuth. By operation of a switch on this switch box, the RHI operator can also obtain azimuth position control. A handwheel geared to a digital indicator and to two synchro generators is used for this position control. One azimuth switch box is supplied as part of Radar Set AN/FPS-6. However, provisions are made in the control circuits to accommodate two units.

1–83. RHI ANTENNA CONTROL. In Radar Set AN/FPS-6A, the RHI antenna control (figure 1–28) replaces the azimuth switch box supplied with Radar Set AN/FPS-6. Front panel controls on the RHI antenna control can be used to stop the antenna elevation drive motor and to set it for fast or slow antenna nodding speeds. A MODE switch on the RHI antenna control can be used to give the RHI operator azimuth control of the antenna, to set it for azimuth sector scanning, and to permit the RHI operator to set the antenna for continuous clockwise or counterclockwise rotation. Additional controls and indicators permit the RHI operator to adjust the antenna ±4.5 degrees in azimuth away from the position designated by the PPI operator of the associated search radar. These controls indicate antenna azimuth position and, on Radar Set AN/FPS-6B, allow the RHI operator to control the amplitude and center position of the antenna nodding sector.

1–84. JUNCTION BOX. The junction box (figure 1–29) contains switching relays for interconnecting the RHI assemblies, azimuth control overlays, remote height displays, time-sharing master control, azimuth switch box, and the control group assembly. Fuses and fuse indicator lamps are provided for all lines. The junction box is completely enclosed and can be mounted on the floor or wall of the operations room of the associated search radar.

1–85. The junction box of Radar Set AN/FPS-6B is electrically identical to that of Radar Set AN/FPS-6A. Physically, Terminal Box J-910/FPS-6B is 5-3/8 inches longer and 2-7/16 inches wider.

1–86. AZIMUTH BLANKER. The azimuth blanker (figure 1–30), supplied with Radar Set AN/FPS-6A, provides the means for preventing the radar set from transmitting when the antenna enters an azimuth where its r-f radiation could disturb the operation of adjacent radars. The width of the azimuth sector blanked can be adjusted at the azimuth blanker from ±5 to ±45 degrees about the center, and the center can be continuously varied in azimuth. Should the radar antenna remain in the blanked sector for 5 seconds, protection circuits in the azimuth blanker will slew the antenna out of the blanked sector and cause a warning buzzer to sound. When this automatic feature does not operate and the antenna remains in the blanked sector for more than 30

Figure 1–28. RHI Antenna Control; Control, Antenna C-1830/GPS

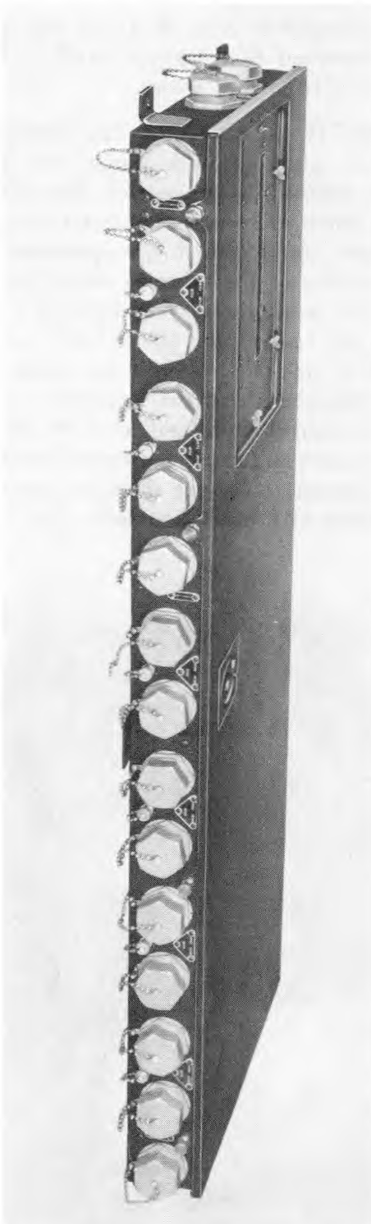


Figure 1–29. Junction Box; Terminal Box J-470/FPS-6

seconds, the system trigger is automatically removed from the modulator so that the high-voltage modulating pulse cannot be generated. This prevents damage to the magnetron. The azimuth blanker is mounted on top of the control group assembly and all operating controls and indicators are located on the front panel of the unit.

1–87. INDICATORS AND DISPLAYS.

1–88. COMPONENTS. Two types of displays are provided, the RHD described as part of the time-sharing system and the RHI oscilloscope presentation. Radar Set AN/FPS-6A is also provided with a raid size indicator.

1–89. RHI ASSEMBLIES FOR RADAR SET AN/FPS-6. The two RHI assemblies (figure 1–31) supplied with Radar Set AN/FPS-6 are located in the operations room of the associated search radar. Each assembly contains the following units:

a. RHI oscilloscope

b. High-voltage power supply

c. Low-voltage power supply

1–90. The RHI oscilloscope displays a rectangular plot of range and height on the face of a 12-inch cathode-ray tube (CRT). Range is displayed along a horizontal axis and height along a vertical axis. Three range scales are available for selection: 0 to 100 miles, 0 to 200 miles, and an adjustable-delay range scale in which any section of the range scale from 0 to 150 miles can be suppressed. In the latter scale, the range displayed covers 50 miles beyond the point of suppression. Four height scales are available for selection: —5000 to 75,000 feet, —5000 to 25,000 feet, 20,000 to 50,000 feet, and 45,000 to 75,000 feet.

1–91. Height line and relative height controls and numerical indicators are also provided to enable the RHI operator to determine accurately the height of a designated target and the relative height of a second target with respect to the first. A range line input permits the operator to make similar accurate determination of the target range. (This control is not used in Radar Set AN/FPS-6.) Switches enable the operator to add range, height, and angle markers to the display. The customary brilliance, focusing and panel- and scale-illumination controls are also supplied.

Figure 1–30. Azimuth Blanker; Blanker, Interference MX-1739A/FPS-6

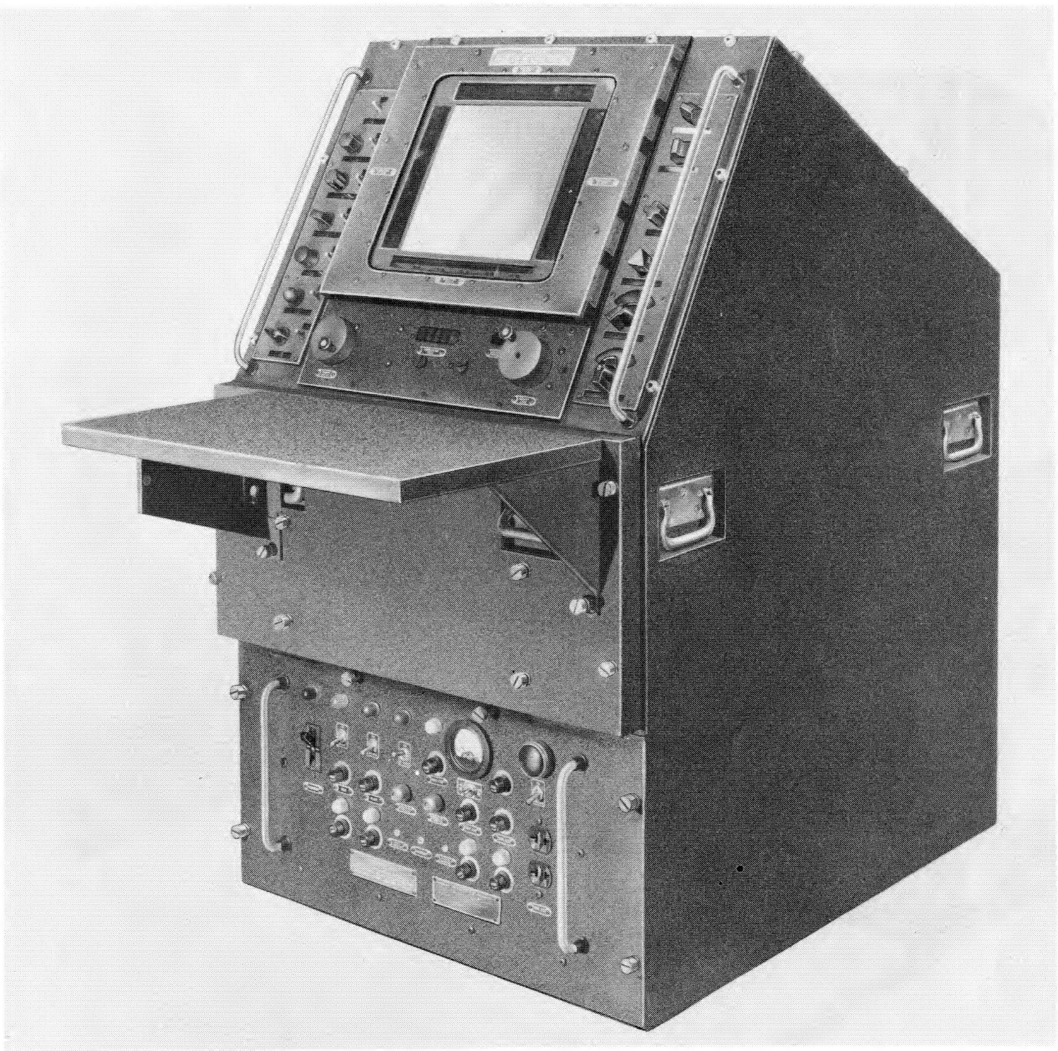


Figure 1–31. RHI Assembly; Radar Set Group OA-270/FPS-6

1–92. The RHI oscilloscope occupies the upper main chassis of the RHI assembly. The oscilloscope consists of the CRT chassis together with the right- and left-hand chassis all mounted on a drawer-type assembly. The CRT chassis proper contains the CRT and a front panel on which are mounted the range and height scales and range-delay and height-determining controls. The right- and left-hand chassis contain all of the signal, control, and deflection circuits. These chassis are hinged at their rear vertical edges to the CRT chassis so that, when the main chassis assembly is withdrawn, the side chassis can be swung out for servicing. Operating controls and switches for these chassis are located along the upper forward sloping surfaces. Calibrating adjustment controls are mounted along the upper rear sloping surfaces. When the main chassis is in the operating position, access to these calibrating controls is through hinged covers in the cabinet top.

1–93. The low-voltage power supply occupies a drawer-type chassis in the lower forward portion of the main assembly. This power supply provides heater power and well-regulated voltages for the tubes of the signal chassis. The front panel of this unit contains the appropriate fuses, indicator lamps, and controls and switches necessary for operation of the unit.

1–94. The high-voltage power supply is a subchassis of the low-voltage power supply. The high-voltage power supply functions to energize the CRT.

1–95. RHI ASSEMBLIES FOR RADAR SET AN/FPS-6A. The two RHI assemblies (figure 1–32) supplied with Radar Set AN/FPS-6A are located in the operations rooms of the associated search radar. Each assembly contains the following units:

a. RHI oscilloscope

b. RHI power supply

c. RHI component case

1–96. The RHI oscilloscope displays a rectangular plot of range and height on the face of a 12-inch CRT

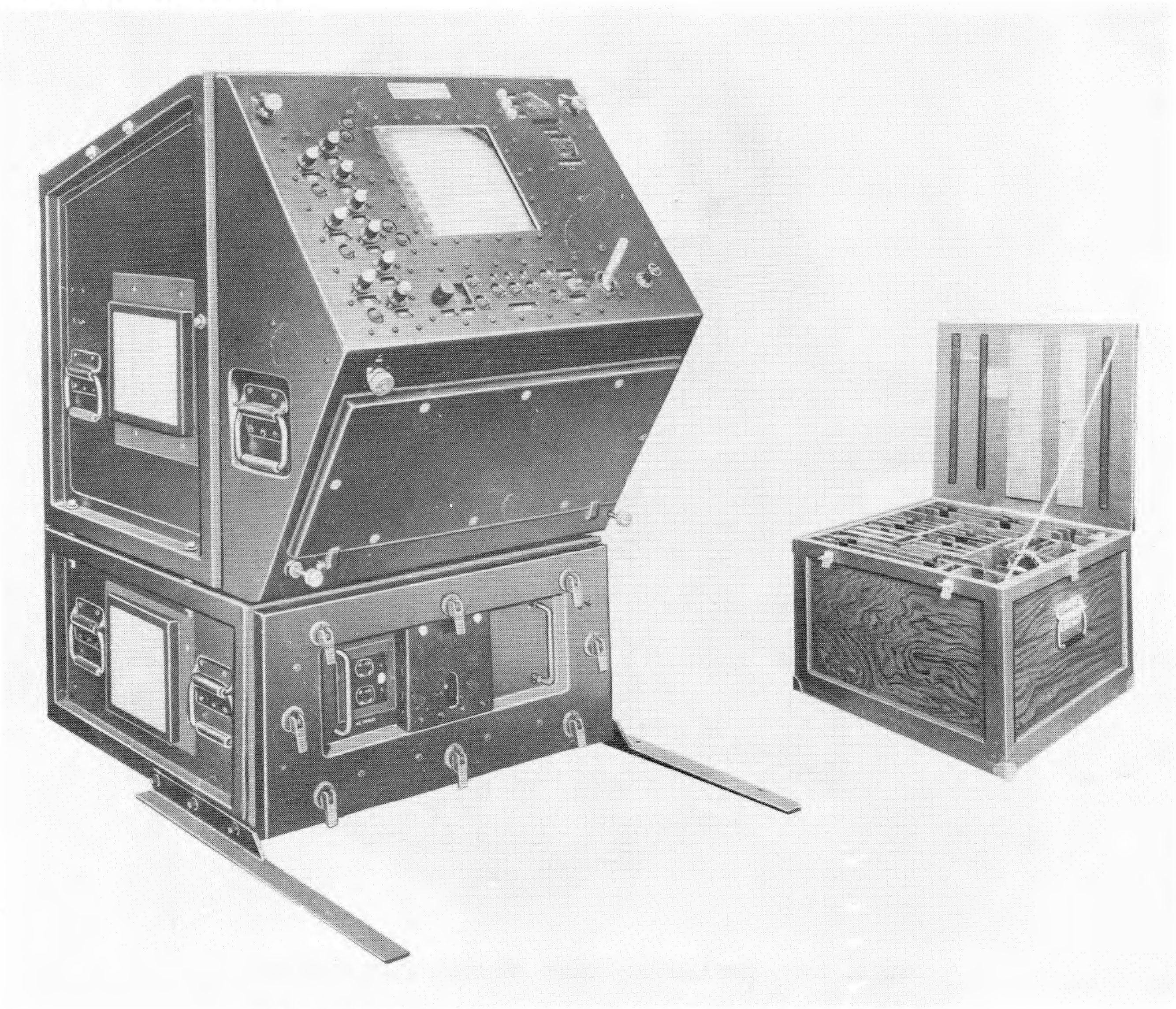


Figure 1–32. RHI Assembly; Indicator Group OA-929/FPS-6A

(figure 1–9). Range is displayed along a horizontal axis and height along a vertical axis. Range is continuously variable from 50 to 300 miles, with a fixed height display of 5,000 to 100,000 feet for elevation angles of —2 to +32 degrees. The RHI oscilloscope generates 10-, 20-, and 50-mile range marks which are automatically selected by the front panel range control; range marks generated within the control group assembly are available for emergency use or for calibration. An earth-curvature correction pattern is also generated internally for accurate height determination.

1–97. The angle mark pulses produced in the antenna assembly of the radar set are converted in the RHI oscilloscope to gating signals which intensify the sweeps at every 5 degrees of antenna elevation. A range line is used to indicate the target for which height information is required. Finally, an electronic cursor generated by the RHI oscilloscope is used to provide the absolute height of a target as well as the relative height of two targets. This cursor, displayed as a short intensified horizontal line, is controlled by the RHI operator and positioned to intersect the target under consideration. When the cursor is positioned properly, absolute or relative target height is read from respective height counters on the front panel of the oscilloscope.

1–98. The RHI oscilloscope is housed in an aluminum cabinet containing the CRT and associated high-voltage power supply, deflection circuits, and video and control circuits. This unit is normally mounted and bolted in position on top of the RHI power supply. All operating controls and indicators are located on the upper half of the front cover of the unit. Adjustment controls and indicators are available when the access cover on the lower half of the front cover is removed. The CRT and subassemblies of the RHI oscilloscope are mounted on a frame assembly. For maintenance purposes, the entire frame assembly is withdrawn from the cabinet on drawer slides, and the front cover of the unit is opened on hinges located at the right side of the cover. Subassemblies at the sides and top of the frame assembly are mounted on hinged supports which can be moved outward for access to component parts.

1–99. The RHI power supply provides the operating voltages for the RHI oscilloscope. This power supply consists of an aluminum cabinet with a drawer-type regulator chassis located at the front of the unit and input transformers and rectifiers mounted at the rear of the unit. The input transformer and rectifier circuit is accessible when the front panel and associated regulator chassis are withdrawn from the power supply cabinet. A power switch and indicator, fuses and blown fuse indiactors, and two convenience outlets are located on the front panel. Recessed receptacles at the rear of the RHI power supply are used to connect the power supply to the RHI oscilloscope and to Radar Set AN/FPS-6A.

1–100. The plywood RHI component case is used to transport and store the following items: two interconnecting cable assemblies, used to connect the RHI power supply to the RHI oscilloscope; an edge-lighted desk shelf with plexiglass plate, normally mounted on the RHI oscilloscope; two telephone mounting plates, which can be installed on either side of the RHI oscilloscope to accommodate telephone components; a CRT clear window; a CRT light filter; and splash plates.

1–101. RAID SIZE INDICATOR GROUP. The raid size indicator group (figure 1–33) consists of two components: a raid size indicator and a raid size remote unit. The raid size indicator is mounted on top of the RHI antenna control (paragraph 1–83) and the raid size remote unit is located near a PPI unit of the associated search radar.

1–102. Essentially, the raid size indicator is an A-oscilloscope with a 5-inch CRT on which either a 5- or 2-1/2-mile sweep can be displayed. Video information from Radar Set AN/FPS-6A is presented on these sweeps for detailed examination. For example, distant targets can be checked for the number of aircraft in the target, the distance between them, and the type of formation. Range

Figure 1–33. Raid Size Indicator Group; Indicator Group OA-1040/GPA

lines etched on the CRT window represent 1000 to 2000 feet in range, depending upon the front panel switch positions. Front panel controls of the raid size indicator are used to adjust the display and to transmit target information to the raid size remote unit upon request. Dials at the front of the raid size remote unit indicate the information requested.

1–103. Generally, the sequence of operations is as follows: The PPI operator at the raid size remote unit requests information on a distant target by supplying a range delayed trigger to the raid size indicator. The RHI operator at the raid size indicator location then examines this target on the indicator and transmits the desired information so that it appears on the remote unit. The raid size indicator group receives primary a-c power and video inputs from Radar Set AN/FPS-6A and the range delayed trigger from the associated search radar equipment.

1–104. ANTENNA SYSTEM.

1–105. COMPONENTS. The major components of the antenna system for Radar Set AN/FPS-6 are the antenna assembly and the amplidyne (figure 1–34).

1–106. The antenna system for Radar Set AN/FPS-6A is the same as that for Radar Set AN/FPS-6, except that the elevation selsyn and angle mark unit has been modified. The selsyn has been replaced by a different type and the angle mark commutator has been changed slightly.

1–107. The antenna system for Radar Set AN/FPS-6B is the same as that for Radar Set AN/FPS-6A, except that a nod position and nod amplitude mechanism has been added in the elevation drive. This mechanism permits continuous control of the length of the nodding arc, through angles of 1 to 34 degrees, and adjustment of the center of this arc. These adjustments are made at the RHI antenna control (paragraph 1–83). A new girder junction box and elevation motor bracket have been provided for the nod modulation mechanism and there is also a new waveguide, type CG-939A/FPS-6.

1–108. ANTENNA ASSEMBLY. The antenna assembly (figure 1–5) consists of a truncated, semiparabolic reflector and a feedhorn mounted on a supporting yoke which permits the reflector to be rotated through 34 degrees of elevation (−2 through +32 degrees). The yoke is mounted on a cone assembly and base rings and can be rotated through 360 degrees of azimuth. Separate drive motors are provided for both elevation and azimuth motion. The elevation drive oscillates the reflector between the elevation angle limits at rates of 20 or 30 cpm, depending upon the control settings. The azimuth drive motor is reversible, permitting clockwise or counterclockwise rotation according to the requirements of the control operator. Both motions are controlled remotely from the operations building in normal tactical operation, and locally at the antenna for adjustments, maintenance, and repairs.

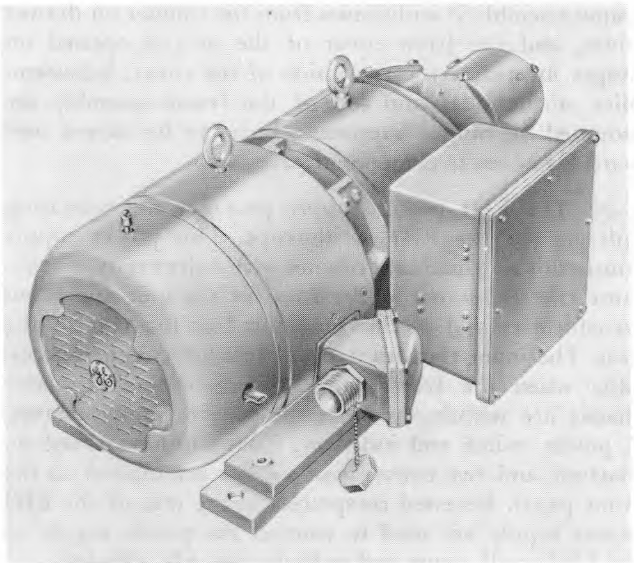


Figure 1–34. Amplidyne; Motor-generator PU-293/G or PU-293A/G

1–109. All power and signal circuits, except the transmitted and received r-f signal circuit, to and from the antenna system pass through the junction box of the cone assembly. Slip ring connections in the cone assembly carry circuits to devices on the yoke and reflector. The transmitted and received r-f signals are carried by a waveguide transmission line from the base rings to the feedhorn. Two rotating joints, one permitting azimuth rotation and the other elevation motion, are provided in the waveguide system. The major components of the antenna assembly are:

a. Base rings and mounting ring assembly

b. Cone assembly

c. Yoke assembly

d. Reflector assembly

e. Horn assembly

f. Transmission line system

g. Safety box

1–110. BASE RINGS AND MOUNTING RING ASSEMBLY. In the temperature tower installation, two hexagonal, cross-braced, steel-framed base rings support the mounting ring assembly, which is hexagonal at its base and triangular at the top. The bottom base ring is secured to the top platform of the tower. The mounting ring assembly supports the antenna assembly and serves as a housing for the azimuth rotating joint of the waveguide system. The arctic tower installation is similar, but employs only one base ring.

1–111. CONE ASSEMBLY. The cone assembly includes the azimuth drive system (azimuth drive motor, gearing, and vertical shaft), the upper azimuth bearing, and the brush-and-slip-ring assembly on the vertical shaft by which power and signal circuits are transferred from the stationary to the rotating parts of the system. A junction box on the cone assembly connects power and signal cables from other parts of the equipment. Thermostatically-controlled heating units built into the cone assembly prevent damage to the interior as a result of moisture condensation. The cone assembly is mounted on the mounting ring assembly.

1-112. YOKE ASSEMBLY. The fork-like yoke assembly consists of a horizontal main girder assembly (yoke hub and left and right yoke sections) and two slanting yoke arms which support the reflector assembly. The yoke assembly is mounted on the upper end of the rotating shaft of the cone assembly. At the upper end of each yoke arm, a trunnion bearing supports the reflector and permits it to rotate about the horizontal axis. The right-hand bearing (when viewed from the front of the reflector) contains an elevation selsyn and angle mark unit which provides elevation angle data signals for use in the control group assembly. The left-hand bearing contains an elevation rotating joint for the waveguide system. The main girder assembly supports the elevation drive motor and brake and the girder junction box. The elevation drive motor tilts the reflector by means of a connecting rod secured to its crank arm. The girder junction box serves as a distribution point for the power and signal circuits transferred through the slip rings of the cone assembly. The yoke assembly is also equipped with a number of mounting brackets for support of the waveguide system and several units for local control of the reflector assembly.

1-113. REFLECTOR ASSEMBLY. The reflector assembly consists of a perforated sheet-aluminum reflecting surface supported by a framework. The reflecting surface is a 30-foot long, 7-1/2-foot wide section of a half of a paraboloid of revolution. The left side of the concave surface corresponds to the intersection of a vertical plane with the paraboloid surface. The reflecting surface is perforated to reduce both weight and wind resistance. The reflector consists of three sections bolted together during installation. This makes air transport possible, since the dimensions of the assembled reflector make it impossible to accommodate it in the specified type of cargo aircraft. Provisions are made on the supporting structure for attachment of the elevation drive connecting rod. The reflector assembly is mounted on the yoke assembly by bolting its hub plates to the trunnion bearings on the support arms.

1-114. HORN ASSEMBLY. The r-f signal energy is directed onto the reflector by the horn assembly at the focal point of the reflecting surface. The horn assembly and its associated transmission line are supported at the left of the reflector by outriggers and braces. The waveguide transmission line is connected to the elevation rotating joint in the bearing assembly on the left yoke arm.

1-115. TRANSMISSION LINE SYSTEM. The r-f signal transmission line system of the antenna consists of the azimuth rotating joint in the base ring assembly. The transmission line system of the antenna also contains several waveguide sections leading up through the hollow shaft of the cone assembly, across the main girder assembly, and up the outside of the left yoke arm to the elevation rotating joint where connection is made with the transmission line to the feedhorn. These waveguide sections are supported on brackets located at appropriate points on the main girder assembly and left yoke arm.

1-116. SAFETY BOX. The safety box (figure 1-76) contains SAFE-RUN and HV SAFE-OPER switches for the protection of maintenance personnel working near the antenna assembly. The SAFE-RUN switch is a master interlock which removes nodding and rotating power from the antenna. The HV SAFE-OPER switch is a master interlock which turns off r-f power. The safety box also contains SLOW-FAST and STOP elevation switches which are used to control nodding of the antenna during maintenance operations. These controls are interconnected with similar controls at the azimuth switch box and antenna control panel. The safety box is mounted near the personnel hatch on the antenna platform.

1-117. AMPLIDYNE. The amplidyne (figure 1-34) provides drive power to the azimuth drive motor for rotating the antenna in azimuth. The output power of the amplidyne is controlled by the output of the azimuth servo amplifier in the control group assembly. The drive power is directly proportional to the amplified error signal.

1-118. CONDENSED FACTUAL DATA.

1-119. LEADING PARTICULARS.

1-120. Leading particulars for Radar Sets AN/FPS-6 and AN/MPS-14 are presented in figure 1-35.

1-121. INPUT AND OUTPUT CHARACTERISTICS.

1-122. The input and output characteristics of major components of Radar Sets AN/FPS-6, AN/FPS-6A, AN/FPS-6B, and AN/MPS-14 are given in figure 1-36.

1-123. TUBE AND FUSE COMPLEMENTS.

1-124. The tube and fuse complements for components of Radar Sets AN/FPS-6, AN/FPS-6A, AN/FPS-6B, and AN/MPS-14 are listed in figures 1-37 and 1-38, respectively.

1-125. INDICATOR LAMP COMPLEMENT.

1-126. The indicator lamp complement for Radar Sets AN/FPS-6, AN/FPS-6A, AN/FPS-6B, and AN/MPS-14 is provided in figure 1-39.

Characteristic	Data for Radar Sets AN/FPS-6 and AN/MPS-14	Data for Radar Set AN/FPS-6A (Where Different from AN/FPS-6)
Type of equipment	Height-finding radar; antenna azimuth controlled by associated search radar personnel	—
Function	Displays relative and absolute target height data on RHI radar scopes and height-calibrated counters	Also displays raid size information
Maximum range	200 nautical miles	300 nautical miles
Accuracy at maximum range	±2 nautical miles	—
Azimuth bearing capability	360 degrees	—
Maximum height capability	75,000 feet	100,000 feet
Minimum height capability	—5000 feet (site permitting)	—
Range resolving power	3/8 nautical mile or 1/2 percent	—
Antenna scanning pattern (azimuth)	Slew to fixed position or continuously rotatable (See figure 1–7.)	Also sector scan
Antenna scanning pattern (elevation)	Nodding scan: −2 to 32 degrees (See figure 1–7.)	Continuously variable within limits and center of arc
Antenna nodding frequencies	20 and 30 cpm	—
Antenna beam (azimuth sector)	3.2 degrees	—
Antenna beam (elevation sector)	0.85 degree	—
Antenna polarization	Vertical	—
Antenna gain	38.5 db	—
Height-determination method	Range and elevation angle data are combined in an RHI and result is translated into selsyn orders and fed to remote height display. Veeder-Root counter displays absolute height in thousands of feet	—
CRT presentation	Range versus height (RHI); range along horizontal axis; height along vertical axis (See figure 1–8.)	(See figure 1–9.)
RHI's (local)	Two 12-inch, long-persistence screen CRT assemblies with associated mechanical counter assemblies incorporating selsyn transmitters	—
Height displays (remote)	Four absolute and relative height-calibrated, selsyn-controlled counters	—
Range scales	0 to 110 miles, 90 to 200 miles, and adjustable-delay range scale	Continuously variable from 50 to 300 miles; 10-, 20-, or 50-mile markers selected by rubber range scale setting

Figure 1–35. Leading Particulars (Sheet 1 of 2)

Characteristic	Data for Radar Sets AN/FPS-6 and AN/MPS-14	Data for Radar Set AN/FPS-6A (Where Different from AN/FPS-6)
Range markers	Vertical lines on CRT screen, 10 nautical miles apart; range markers intensified at 50-mile intervals	As selected by range scale setting
Range line	Range marker triggered by associated search radar to intersect designated target and command attention of height-finder operators	—
Height scales	—5000 to 75,000 feet —5000 to 65,000 feet 20,000 to 50,000 feet	—5000 to 100,000 feet
Height markers	Horizontal lines on CRT's at 20,000, 40,000, and 60,000 feet	—
Height line	Horizontal line; position adjustable to intersect designated target. Adjustment crank geared to mechanical counter calibrated in feet and to selsyn transmitter which transmits voltages to remote height counters also calibrated in feet	Short horizontal line position adjustable by means of control stick to intersect designated target
Elevation angle markers	Seven lines on CRT originating in lower left-hand corner of screen and corresponding to angle marks every five degrees from 0 to 30 degrees	—
Peak modulating pulse	—65 kilovolts	—
Pulse duration	2 ± 0.1 microsecond	—
Pulse repetition frequency	300 to 400 cps	—
Transmitter tube	Type QK338 or QK338A magnetron	—
Carrier frequency	Fixed frequency in 2700- to 2900-megacycle band	—
Transmission medium	Rectangular waveguide 1-1/2 x 3 inches	—
Peak r-f power	5 megawatts	—
Peak magnetron anode current	130 amperes	—
Average magnetron anode current	93.5 milliamperes	—
Magnetron filament current	As marked on tube	—
Receiver input circuit	Duplexing assembly, TR tube, and balanced crystal mixer	—
Local oscillator	Type 726C reflex klystron	—
Intermediate frequency	30 megacycles	—
Receiver antijamming features	Fast time constant (FTC), sensitivity time control (STC), and automatic video noise limiting (AVNL) circuits	—

Figure 1–35. Leading Particulars (Sheet 2 of 2)

Inputs	Outputs
ANTENNA ASSEMBLY	
3-phase, 208/120 volts, 60 cycles ac from control group assembly	Beamed r-f energy radiated from reflector to targets
R-f energy to be radiated from r-f assembly	R-f echo pulses to r-f assembly
R-f echo pulses from targets	Azimuth position data to azimuth control overlays and azimuth switch boxes through control group assembly and junction box
Excitation power for azimuth selsyns from control group assembly	Elevation position data to control group assembly
Excitation power for elevation selsyn from control group assembly	Elevation angle mark pulses to control group assembly
120 volts ac for convenience outlets	
Excitation power to nod-position and nod-amplitude motors	
MODULATOR HIGH-VOLTAGE REGULATOR	
3-phase, 208/120 volts, 60 cycles ac from control group assembly	Regulated, variable, 170- to 240-volt, 3-phase, 60-cycle a-c line-to-line modulator high-voltage power supply
MODULATOR HIGH-VOLTAGE POWER SUPPLY	
Regulated 3-phase, 170 to 240 volts ac line-to-line from modulator high-voltage regulator	8.4 to 12 kilovolts dc to modulator assembly
High-voltage interlock control power from modulator assembly	High-voltage interlock control power to modulator assembly
MODULATOR ASSEMBLY	
System trigger pulses from control group assembly	8.5- to 11.5-kilovolt modulating pulses to magnetron assembly
8.4 to 12 kilovolts dc from modulator high-voltage power supply	Regulated magnetron filament power to magnetron assembly
208/120-volt, 3-phase, 60-cycle a-c filament and control power from control group assembly	High-voltage interlock power to r-f assembly
High-voltage interlock power from magnetron assembly	
MAGNETRON ASSEMBLY	
8.5- to 11.5-kilovolt modulating pulses from modulator assembly	R-f pulses to waveguide components of r-f assembly (in AN/FPS-6A systems, r-f pulses are applied through ferrite isolator)
Regulated magnetron filament power from modulator assembly	Pressurized and dehumidified air to waveguide components of r-f assembly
High-voltage interlock and utility power from r-f assembly	Liquid coolant (heated) to heat exchanger

Figure 1–36. Input and Output Characteristics of Major Components (Sheet 1 of 5)

Inputs	Outputs
MAGNETRON ASSEMBLY (cont)	
Pressurized and dehumidified air from pressurizer and dehydrator Liquid coolant for magnetron anode and pulse transformer from heat exchanger	
HEAT EXCHANGER FOR MAGNETRON	
3-phase, 208/120 volts, 60 cycles ac from control group assembly through r-f assembly Liquid coolant (heated) from magnetron assembly	Liquid coolant to magnetron assembly
HEAT EXCHANGER FOR FERRITE ISOLATOR	
3-phase, 208/120 volts 60 cycles ac from control group assembly through r-f assembly Liquid coolant (heated) from ferrite isolator	Liquid coolant to ferrite isolator (CU-492/FPS-6A only)
FERRITE ISOLATOR	
R-f pulses from magnetron. Reflected r-f pulses caused by mismatch in transmission line Liquid coolant from heat exchanger for ferrite isolator	R-f pulse to waveguide components of r-f assembly
PRESSURIZER AND DEHYDRATOR	
3-phase, 208/120 volts, 60 cycles ac from control group assembly through r-f assembly	Pressurized and dehumidified air to magnetron assembly
R-F ASSEMBLY	
R-f pulses from magnetron assembly (in AN/FPS-6A system, from ferrite isolator)	R-f pulses to antenna assembly
R-f echo pulses from antenna assembly	30- megacycle i-f pulses to control group assembly
3-phase, 208/120 volts, 60 cycles ac from control group assembly	3-phase, 208/120 volts, 60 cycles ac to heat exchanger(s) and to pressurizer and dehydrator r-f noise (for test purposes) to control group assembly
+28-volt d-c control power from control group assembly	High-voltage interlock and utility power to magnetron assembly
High-voltage interlock power from modulator assembly	
Pressurized, dehumidified air from pressurizer and dehydrator through magnetron output waveguide	
CONTROL GROUP ASSEMBLY	
Sync trigger from associated search radar for range mark generator	Video pulses (blanked or unblanked) to RHI and RSI assemblies
Angle mark pulses from angle mark commutator in antenna assembly	System trigger to modulator assemblies

Figure 1–36. Input and Output Characteristics of Major Components (Sheet 2 of 5)

Inputs	Outputs
CONTROL GROUP ASSEMBLY (cont)	
1500-cps selsyn stator signal from elevation selsyn and angle mark unit in antenna assembly	D-c power to amplidyne control fields in antenna assembly
Blanking trigger from interfering radar	10- and 50-mile range mark pulses to RHI assemblies
Selsyn signals from azimuth control overlays through junction box	2-microsecond angle mark pulses to RHI assemblies
30-megacycle i-f pulses from r-f assembly	Elevation angle data voltage to RHI assemblies
3-phase, 208/120 volts, 60 cycles ac from associated search radar power source	+28-volt d-c control power to r-f assembly and exciter
	3-phase 208/120 volts, 60 cycles ac to modulator high-voltage regulator, modulator assembly, r-f assembly, and amplidyne generator set
	+28-volt d-c exciter power to amplidyne generator set exciter
	3-phase, 208/120 volts, 60 cycles ac to elevation drive motor
RHI ASSEMBLIES	
Video signals from control group assembly	Absolute and relative height selsyn orders to remote height displays through junction box
Range mark pulses from control group assembly	
Angle mark trigger pulses from control group assembly	
Range line trigger pulse from associated search radar	
Elevation angle data voltage from control group assembly	
120-volt a-c height selsyn signal from control group assembly	
AZIMUTH SWITCH BOX (Replaced by RHI Antenna Control in AN/FPS-6A Systems)	
28-volt d-c switching voltage from junction box	Refer to azimuth switch box inputs
6.3-volt a-c azimuth control indicator voltage	
Antenna selsyn stator signals from antenna selsyns through junction box	
120 volts ac for slewing voltage	
120 volts for elevation control voltages	
Antenna elevation control indicator voltages	
TIME-SHARING MASTER CONTROL	
120 volts ac indicator voltage from junction box	6.3-volt a-c control indicator voltages to remote height displays (RHD's) through junction box
28-volt d-c height indicator cutout voltage from junction box	28-volt d-c switching signals to PPI relay groups in junction box

Figure 1–36. Input and Output Characteristics of Major Components (Sheet 3 of 5)

Inputs	Outputs
JUNCTION BOX	
28-volt d-c switching signals from time-sharing master control	6.3-volt a-c control indicator voltages to RHD's
6.3-volt a-c RHD control indicator voltages from time-sharing master control	Height data (selsyn stator signals) to RHD's
28-volt d-c switching signals from azimuth switch box AZIMUTH CONTROL switches	28-volt d-c height data lock (HDL) to RHD's
Antenna azimuth selsyn stator signals from antenna selsyns	28-volt d-c brake voltage to RHD's
Antenna azimuth error signals from azimuth control overlay selsyns	28-volt d-c absolute-relative height relay signal to RHD's
Antenna azimuth error signals from azimuth switch boxes	120-volt a-c phase B power to RHD's
120-volt a-c slewing voltage from azimuth RHI switch boxes	120-volt a-c selsyn excitation to RHD's
Height data (selsyn stator signals) from RHI	6.3-volt a-c control indicator voltages to azimuth control overlays
28-volt d-c absolute-relative height relay signal from RHI	Antenna azimuth stator signals to azimuth control overlay selsyns
Range line from search radar (not used in some installations)	6.3-volt a-c control indicator voltages to azimuth switch boxes
Antenna elevation control voltages from control group assembly	Antenna azimuth stator signals to azimuth switch boxes
Antenna elevation control voltages from azimuth switch boxes	Antenna azimuth error signals to control group assembly
	Antenna slewing voltage to control group assembly
	28-volt d-c power to RHI
	28-volt d-c power to time-sharing master control
	28-volt d-c height indicator cutout voltage to time-sharing master control
	Antenna elevation control voltages to azimuth switch boxes
	Antenna elevation control voltages to control group assembly
	Antenna elevation indicator voltages to azimuth switch boxes
AZIMUTH BLANKER	
Antenna azimuth selsyn signals	System trigger
System trigger	Antenna slewout selsyn signals
	120 volts to relay K6903 in control group assembly cabinet

Figure 1–36. Input and Output Characteristics of Major Components (Sheet 4 of 5)

Inputs	Outputs
PERFORMANCE MONITOR	
Noise signal from r-f assembly	Power and VSWR reading to remote r-f control panel
120 volts for power supply	Noise figure reading to remote r-f control panel
Samples of forward and reverse r-f signals from r-f assembly	Noise gate to noise modulator
System trigger	
AZIMUTH CONTROL OVERLAY	
1- and 36-speed selsyn stator signals from antenna azimuth selsyns through control group assembly and junction box; 28-volt d-c switching signals from time-sharing circuits; switched 6.3 volts ac for control indicator from time-sharing circuits	1- and 36-speed selsyn error signals to servo amplifier in control group assembly through junction box; PASS switching pulse to time-sharing circuits through junction box
REMOTE HEIGHT DISPLAY	
1- and 10-speed absolute height selsyn stator signals; 1-speed relative height selsyn stator signals, relay switching signals; all from RHI assembly through junction box	None (terminal equipment)
RAID SIZE INDICATOR (RSI)	
Trigger pulse from associated search radar	6.3-volt a-c signals designating number, formation, and separation of target
Video; continuous video information from control group assembly	
Power; single phase, 115 volts, 60 cps, 250 watts from control group assembly	
RAID SIZE REMOTE UNIT (RSRU)	
6.3-volt a-c signals	Request or cancel signal
RHI ANTENNA CONTROL	
Stator signals from antenna azimuth synchros	Rotor signals to servo amplifier in control group assembly
Continuous rotation voltage from junction box	Elevation slow, fast, and stop voltages to control group assembly
Elevation slow, fast, and stop voltages from control group assembly	Vernier control stator
	Signals to PPI control overlay 36X selsyns; 28-volt cutoff signal to time-sharing master control

Figure 1–36. Input and Output Characteristics of Major Components (Sheet 5 of 5)

Note

Circuits are designed to accommodate either standard or ruggedized tubes. When replacing tubes, use whichever type is available from stock.

Symbol	JAN Type	Function
AZIMUTH BLANKER		
CR101 through CR109	1N93	Rectifier
	CONTROL GROUP ASSEMBLY	
Range Mark Generator		
V5201	12AU7 only	Trigger discriminator, buffer, and blocking oscillator
V5202	5687	Trigger source
V5203	5687	Trigger source
V5204	5814WA	One-shot multivibrator
V5205	12AU7 only	Crystal oscillator and crystal blocking oscillator
V5206	5725/6AS6W	Crystal oscillator output gating
V5207	5725/6AS6W	10-mile marker gating
V5208	5814WA	Inverter and cathode follower
V5209	5726/6AL5W	Trigger coupling to half-frequency multivibrator
V510	5814WA	Half-frequency multivibrator
V5211	5814WA	10-mile oscillator and feedback
V5212	5751WA	Clipper amplifier and clamper
V5213	12AU7 only	Buffer and 10-mile blocking oscillator
V5214	12AU7 only	Buffer and 50-mile blocking oscillator
V5215	5687	10- and 50-mile mixer
Angle Mark Generator		
V5301	5814WA	Amplifier
V5302	5726/6AL5W	Diode coupler
V5303	5814WA	Multivibrator
V5304	5814WA	Blocking oscillator
Elevation Data Generator[1]		
V5401	6005/6AQ5W	1500-cps oscillator
V5402	5814WA	Phase inverter and input cathode follower
V5403	5814WA	Resolver
V5404	5814WA	Phase shifter and output cathode follower

[1] For Radar Set AN/FPS-6 only

Figure 1–37. Tube Complement (Sheet 1 of 12)

Symbol	JAN Type	Function
CONTROL GROUP ASSEMBLY (cont)		
Elevation Data Generator[2]		
V5701	12AT7WA	AGC amplifier
V5702	12AT7WA	1500-cps oscillator
V5703	6AU6WA	Cathode follower
V5704	6005/6AQ5W	Driver
V5705	5726/6AL5W	Detector
V5706	12AT7WA	Amplifier
V5707	12AT7WA	Amplifier
V5708	6AU6WA	Amplifier
V5709	12AT7WA	Cathode follower
V5710	5726/6AL5W	Clamper
V5711	12AT7WA	Clamper-cathode follower
Interference Blanker		
V5501	5814WA	Trigger amplifier
V5502	5687	Trigger amplifier
V5503	5814WA	Gating multivibrator
V5504	5725/6AS6W	Blanking control stage
V5505	5725/6AS6W	Blanking stage
V5506	5814WA	Inverter-clamper
V5507	5687	Output cathode follower
Control Group Power Supply		
V5601	5R4WGY	500-volt rectifier
V5602	5R4WGY	+275-volt rectifier
V5603	5R4WGY	+275-volt rectifier
V5604	6080	+275-volt series regulator
V5605	6080	+275-volt series regulator
V5606	6AH6	+275-volt control amplifier
V5607	OB2	+275-volt gaseous regulator
V5608	6AH6	140-volt control amplifier
V5609	6080	140-volt series regulator
V5610	5R4WGY	−150-volt rectifier
V5611	6080	—150-volt series regulator
V5612	12AT7WA	−150-volt control amplifier
V5613	OB2WA	−150-volt gaseous regulator
Servo Amplifier		
V6001	5751WA	Input cathode followers
V6002	12AT7WA	Synchronizing amplifier

[2] For Radar Set AN/FPS-6A

Figure 1–37. Tube Complement (Sheet 2 of 12)

Symbol	JAN Type	Function
CONTROL GROUP ASSEMBLY (cont)		
Servo Amplifier (cont)		
V6003	5726/6AL5W	Phase detector
V6004	5726/6AL5W	Phase detector
V6005	5726/6AL5W	Limiter
V6006	5726/6AL5W	Speed limiter
V6007	5726/6AL5W	Azimuth drive current limiter
V6008	12AT7WA	
V6009	5751WA	Phase inverter Driver
V6010	5933	Power output
V6011	5933	Power output
V6012	OB2WA	Gaseous regulator
V6013	OB2WA	Gaseous regulator
Normal Receiver		
V21701	5654/6AK5W	First i-f amplifier
V21702	5654/6AK5W	Second i-f amplifier
V21703	5654/6AK5W	Third i-f amplifier
V21704	5654/6AK5W	Fourth i-f amplifier
V21705	5654/6AK5W	Fifth i-f amplifier
V21706	5726/6AL5W	Detector-clamper
V21707	5814WA	Meter tube
V21708	5725/6AS6W	Balanced modulator
V21709	5725/6AS6W	Balanced modulator
V21710	5654/6AK5W	Video amplifier
V21711	5725/6AS6W	Limiter
V21712	12AT7WA	Limit control and d-c restorer
V21713	5687	Video output
V21714	5725/6AS6W	AVNL amplifier
V21715	5814WA	AVNL detector and output
V21716	5814WA	AVNL erase
V21717	12AT7WA	Sample gate
V21718	12AT7WA	Erase gate
V21719	12AT7WA	Sample and erase delay
V21720	5687	STC amplifier
V21721	6X4W	STC rectifier
CR21701 through CR21705	1N70	Clamper
CR3001 through CR3004	1N255	Rectifier
MODULATOR ASSEMBLY		
Modulator Trigger Amplifier		
V2001	5814WA	Cathode follower and blocking oscillator
V2002	5814WA	Cathode follower and blocking oscillator
V2003	3C45/6130	Thyratron switch
V2004	6X4W	Charging and reverse-current diode
V2005	6X4W	Rectifier
V2006	6X4W	Rectifier

Figure 1–37. Tube Complement (Sheet 3 of 12)

Symbol	JAN Type	Function
MODULATOR ASSEMBLY (cont)		
Modulator Control Unit		
V2101	5814WA	Reverse-current control
V2102	5814WA	Magnetron filament control
V2103	5814WA	Preheat control
V2104	OB2WA	Gas regulator
V2105	5726/6AL5W	Reverse-current pulse rectifier
V2106	5814WA	Reverse-current control and rectifier
V2107	5814WA	Magnetron anode current control
Modulator Cabinet Assembly		
V2201	5948/1754	Thyratron switch
V2202	576/576A	Reverse-current diode
V2203	576/576A	Reverse-current diode
MODULATOR HIGH-VOLTAGE POWER SUPPLY		
V10401 through V10406	371B	Rectifiers
MAGNETRON ASSEMBLY		
V601	5410/QK338 or QK338A	Transmitting tube (magnetron)
R-F ASSEMBLY		
R-f Cabinet Assembly		
V919	6117 or 1B58	TR tube
CR901	1N21B	AFC crystal[3]
Duplexer		
V901 through V915 (for CU-296A) or through V916 (for CU-296)	GL6621	Polarization shifters
AFC-LO Unit		
V21301	6AH6	I-f amplifier
V21302	5726/6AL5W	Discriminator
V21303	5751WA	Video sweep stopper
V21304	5725/6AS6W	Phantastron sweep generator
V21305	726C	Klystron local oscillator
R-f Noise Source		
V1401	2K41	Noise frequency generator

[3] For Radar Set AN/FPS-6B

Figure 1–37. Tube Complement (Sheet 4 of 12)

Symbol	JAN Type	Function
R-F ASSEMBLY (cont)		
Preamplifier-LO Power Supply		
V1101	5R4WGA	Rectifier
V1103	6080	Series regulator
V1104	5751WA	Voltage amplifier
V1105	6X4W	Rectifier
V1106	5R4WGA	Rectifier
V1107	6080	Series regulator
V1108	6X4W	Rectifier
V1109	OB2WA	Voltage regulator
V1110	OB2WA	Voltage regulator
V1111	5R4WGA	Rectifier
V1112	5751WA	Voltage amplifier
V1113	5751WA	Voltage amplifier
V1114	5651WA	Regulator
V1115	5651WA	Regulator
Preamplifier		
V21501	5847	Neutralized amplifier
V21502	5842	Grounded grid amplifier
V21503	5654/6AK5W	Normal i-f amplifier
V21504	5654/6AK5W	MTI i-f amplifier
V21505	5654/6AK5W	Normal i-f amplifier
V21506	12AT7WA	Cathode follower
CR21501	1N21E	Signal crystal[3]
CR21502	1N21E	Signal crystal[3]
PERFORMANCE MONITOR		
Detector and AGC Unit		
CR8201	1N69	Rectifier
CR8202	1N69	Rectifier
V8201	5726/6AL5W	Diode bridge
V8202	5726/6AL5W	Diode bridge
V8203	5726/6AL5W	Diode bridge
V8204	5726/6AL5W	Diode bridge
V8205	12AT7WA	D-c amplifier
V8206	12AT7WA	Amplifier
V8207	5814WA	Amplifier-cathode follower
Gate Generator		
V8001	5725/6AS6W	Delay generator
V8002	5814WA	Cathode follower
V8003	5751WA	Inverter
V8004	12AT7WA	Half-frequency multivibrator
V8005	5751WA	Inverter
V8006	5751WA	Gate generator
V8007	5751WA	Inverter
V8008	5751WA	Gate generator
V8009	5814WA	Cathode follower
V8010	5814WA	Mixer
I-f Amplifier AM-1619/GPS-40		
CR7901	1N69	Detector
CR7902	1N69	Clamper

[3] For Radar Set AN/FPS-6B

Figure 1-37. Tube Complement (Sheet 5 of 12)

Symbol	JAN Type	Function
PERFORMANCE MONITOR (cont)		
I-f Amplifier AM-1619/GPS-40 (cont)		
V7901	5654/6AK5W	I-f amplifier
V7902	5654/6AK5W	I-f amplifier
V7903	5654/6AK5W	I-f amplifier
V7904	5654/6AK5W	I-f amplifier
V7905	5654/6AK5W	I-f amplifier
V7906	5814WA	Cathode follower-inverter
V7907	5814WA	Video amplifier-cathode follower
I-f Amplifier ID-606/GPA-40		
V501	6AH6	I-f amplifier
V502	6AH6	I-f amplifier
V503	6AH6	I-f amplifier
V504	6AH6	I-f amplifier
V505	5726/6AL5W	Discriminator
V506	5814WA	Difference amplifier
V507	5654/6AK5W	I-f cathode follower
Noise Source (in r-f cabinet)		
V918	(Roger White Inc. No. GNWS-18A)	Noise tube
Power and VSWR Monitor		
CR7701	1N457	Rectifier
CR7702	1N457	Rectifier
CR7703	1N457	Rectifier
CR7704	1N457	Rectifier
CR7705	1N457	Rectifier
CR7706	1N457	Rectifier
V7701	5751WA	Oscillator
V7702	6AU6WA	Amplifier
V7703	5687	Amplifier
V7704	6AU6WA	Amplifier
V7705	5814WA	Meter tube
Power Supply		
V7801	5R4WGA	Rectifier
V7802	6080WA	Series regulator
V7803	6AH6	Amplifier
V7804	OB2WA	Voltage regulator
V7805	6AH6	Amplifier
V7806	6080WA	Series regulator
V7807	6X4W	Rectifier
V7808	6005/6AQ5W	Regulator
V7809	12AT7/WA	Amplifier
V7810	OB2WA	Voltage regulator
Pulse Generator		
V8101	6L6WGB	Amplifier
V8102	6X4W	Damping diode
V8103	6005/6AQ5W	Amplifier
V8104	12AT7WA	Inverter-cathode follower
V8105	6X4W	Rectifier

Figure 1-37. Tube Complement (Sheet 6 of 12)

Symbol	JAN Type	Function
RAID SIZE INDICATOR		
V23001	5ADP2	Cathode-ray tube
V23002	5R4WGA	Low-voltage rectifier
V23201	6L6WGB	High-voltage oscillator
V23101	6AU6WA	Error amplifier
V23102	6080WA	Series regulator
V23103	OB2WA	Regulator
V23104	OB2WA	Regulator
V23301	12AT7WA	Trigger amplifier and multivibrator
V23302	12AT7WA	Cutoff amplifier and multivibrator
V23303	5725/6AS6W	Sweep generator
V23304	12AT7WA	Sweep driver
V23305	6AU6WA	Intensifier
V23401	6AH6	Video amplifier
V23402	12AT7WA	Cathode follower
V23403, 4	6AG7Y	Video drivers
RANGE-HEIGHT INDICATOR[1]		
V4001	5933	Horizontal sweep driver
V4002	5933	Horizontal sweep driver
V4004	6AH6	Horizontal sweep inverter
V4005	5933	Vertical sweep driver
V4006	5933	Vertical sweep driver
V4007	6005/6AQ5W	Vertical centering
V4008	6005/6AQ5W	Vertical centering
V4009	6005/6AQ5W	Vertical centering
V4101	5R4WGA	220-volt supply rectifier
V4102	5R4WGA	220-volt supply rectifier
V4103	5R4WGA	220-volt supply rectifier
V4104	5R4WGA	—180-volt supply rectifier
V4105	6080	220-volt supply regulator
V4106	6080	220-volt supply regulator
V4107	6080	220-volt supply regulator
V4108	6080	300-volt supply regulator
V4109	12AT7WA	300-volt supply control cathode follower
V4110	12AT7WA	220-volt supply control cathode follower
V4111	6080	—180-volt and 220-volt supply regulator
V4112	12AT7 only	—180-volt supply control amplifier
V4113	OB2WA	Gaseous regulator
V4150	6L6WGB	High-voltage supply oscillator
V4151	5814WA	High-voltage supply regulator

[1] For Radar Set AN/FPS-6 only

Figure 1–37. Tube Complement (Sheet 7 of 12)

Symbol	JAN Type	Function
RANGE-HEIGHT INDICATOR[1] (cont)		
V4201	12SP7	Cathode-ray tube
V4301	12AT7WA	System trigger amplifier
V4302	5814WA	Gate multivibrator
V4303	5814WA	Inverter and cathode follower
V4304	12AT7WA	Gate amplifier
V4305	5726/6AL5W	Cutoff diodes
V4306	12AT7WA	Gate amplifier and cathode follower
V4307	12AT7WA	Gate amplifier
V4308	12AT7 only	Gate amplifier
V4309	5814WA	Gate cathode follower
V4401	5726/6AL5W	Cutoff diodes
V4402	5814WA	Horizontal sweep generator and amplifier
V4403	5814WA	Amplifier and cathode follower
V4404	12AT7WA	Cathode follower
V4405	12AT7WA	Amplifier and cathode follower
V4406	6AH6	Amplifier
V4407	12AT7WA	Cathode follower
V4501	12AT7WA	Vertical sweep amplifier and cathode follower
V4502	6AH6	Sweep delay amplifier
V4503	5814WA	Cathode follower
V4601	5814WA	Range marker amplifier
V4602	5814WA	Range marker amplifier and cathode follower
V4603	5814WA	Angle marker amplifier and half of angle marker multivibrator
V4604	5814WA	Half of angle marker multivibrator and cathode follower
V4605	5814WA	Clamp and cathode follower
V4701	5726/6AL5W	Gated clamp
V4702	5814WA	Vertical sweep generator
V4703	5814WA	Amplifier
V4704	5814WA	Cathode follower
V4705	12AT7WA	Cathode follower
V4706	12AT7WA	Height line regenerative amplifier
V4707	12AT7WA	Height line blocking oscillator
V4708	5726/6AL5W	Filament compensator
V4801	12AT7WA	20,000-foot height marker regenerative amplifier
V4802	5814WA	Height marker amplifier
V4803	12AT7WA	40,000-foot height marker regenerative amplifier

[1] For Radar Set AN/FPS-6 only

Figure 1–37. Tube Complement (Sheet 8 of 12)

Symbol	JAN Type	Function
RANGE-HEIGHT INDICATOR[1] (cont)		
V4804	12AT7WA	60,000-foot height marker regenerative amplifier
V4805	5814WA	Height marker blocking oscillator
V4901	6AH6	Video amplifier
V4902	6AG7Y	Video amplifier
V4903	6AG7Y	Cathode follower
V4904	5726/6AL5W	D-c restorer
RANGE-HEIGHT INDICATOR[2]		
V22101	12ABP7-A	Cathode-ray tube
V22104	6L6WGB	High-voltage oscillator
V22201, 2	5726/6AL5W	Gating diodes
V22203	12AT7WA	Comparator and amplifier
V22204, 7	6AU6WA	Sweep voltage amplifiers
V22205, 8	5933	Sweep drivers
V22206	12AT7WA	Sweep amplifier
V22251	12AT7WA	Ring multivibrator and oscillator clamp
V22252	12AT7WA	Ring multivibrator
V22253	12AT7WA	Oscillator and regenerative amplifier
V22254	12AT7WA	Marker pulse amplifier and blocking oscillator
V22301, 2	5726/6AL5W	Gating diodes
V22303	12AT7WA	Comparator and amplifier
V22304, 7	6AU6WA	Sweep voltage amplifier
V22305, 8	5933	Sweep drivers
V22306	12AT7WA	Sweep amplifier
V22309	5726/6AL5W	Clamping diode
V22401	5725/6AS6	Video mixer
V22402	12AT7WA	Video and intensity compensation cathode followers
V22403	5725/6AS6W	Video amplifier
V22404	5726/6AL5W	D-c restorer
V22405	6005/6AQ5W	Video output
V22406	12AT7WA	Cursor intensity regenerative amplifier
V22407	12AT7WA	Angle mark trigger amplifier
V22408	12AT7WA	Angle mark gate generator
V22501	12AT7WA	Trigger amplifiers
V22502	12AT7WA	Gate multivibrator
V22503	5814WA	Negative and positive gate cathode followers
V22504	5751WA	Shutoff amplifier and shutoff cathode follower

[1] For Radar Set AN/FPS-6 only
[2] For Radar Set AN/FPS-6A

Figure 1–37. Tube Complement (Sheet 9 of 12)

Symbol	JAN Type	Function
RANGE-HEIGHT INDICATOR[2] (cont)		
V22505	5726/6AL5W	Sweep clamp and isolation diode
V22506	5751WA	Shutoff cathode followers
V22507	12AT7WA	Recovery multivibrator
V22508	6AU6WA	Recovery sweep amplifier
V22509	12AT7WA	Trigger amplifier and recovery sweep cathode follower
V22510	5814WA	Regenerative amplifier
V22601	12AT7WA	Gate and sweep discharge cathode followers
V22602	5726/6AL5W	Gating diodes
V22603	5814WA	Sweep discharge amplifier and sweep output cathode follower
V22604	12AT7WA	Comparator and amplifier
V22605	12AT7WA	Sweep amplifiers
V22606	12AT7WA	Sweep clamp and sweep clamp cathode follower
V22607	12AT7WA	Comparator and amplifier
V22608	5726/6AL5W	Negative and positive angle feedback diodes
V22651	12AT7WA	System reference comparator and amplifier
V22652	12AT7WA	Test trigger generator and cursor modulation oscillator
V22701	12AT7WA	Blocking oscillator and trigger amplifier
V22702	5814WA	Video blanking multivibrator
V22703	5751WA	Mulitvibrator shutoff amplifiers
V22704	5814WA	Time-share multivibrator
V22705	12AT7WA	Sweep cathode follower and sweep clamp
V22706	12AT7WA	Video intensity and blanking cathode followers
V22707	5726/6AL5W	Isolation and clamping diodes
V22751	12AT7WA	First auto zero amplifier
V22752	6AU6WA	Second auto zero amplifier
V22753	12AT7WA	Output cathode follower and inverter
V22781	12AT7WA	Comparator and amplifier
V22782	5687	Error amplifier and —90-volt cathode follower

[2] For Radar Set AN/FPS-6A

Figure 1–37. Tube Complement (Sheet 10 of 12)

Symbol	JAN Type	Function
RANGE-HEIGHT INDICATOR[2] (cont)		
V22801	5814WA	Gate cathode follower and sweep clamp cathode follower
V22802	12AT7WA	Gate inverter and sweep discharge amplifier
V22803	5726/6AL5W	Sweep discharge and clamp feedback diodes
V22804	12AT7WA	Comparator and amplifier
V22805	12AT7WA	Sweep amplifier
V22806	12AT7WA	Comparator and amplifier
V22807	5814WA	Sweep clamp amplifier and sweep output cathode follower
V22851	12AT7WA	First and second voltage amplifiers
V22852	12AT7WA	Phase inverter and voltage amplifier
V22853, 4	6005/6AQ5W	Motor drivers (one half)
V22911, 2	5R4WGA	+220-volt rectifiers
V22813, 4	5R4WGA	−220-volt rectifiers
V22915, 6	5R4WGA	+250-volt rectifiers
V22931, 2	6080WA	+220-volt series regulators
V22933	6AU6WA	Error amplifier
V22934	12AT7WA	Comparator and amplifier
V22961, 2	6080WA	−220-volt series regulators
V22963	12AT7WA	Reference voltage cathode follower
V22964	12AT7WA	Auto zero cathode follower and first error amplifier
V22965	6AU6WA	Second error amplifier
V22966	5651	Voltage reference
CR22251	1N69	Rectifier
CR22401	1N69	Rectifier
CR22402	1N69	Rectifier
CR22403	1N69	Rectifier
CR22501	1N69	
CR22701 through CR22707	1N69	Rectifier
CR22751	1N69	Rectifier
CR22752	1N69	Rectifier
CR22801	1N69	Rectifier
REMOTE HEIGHT DISPLAY		
V3701	12AT7WA	Phase inverter
V3702	6005/6AQ5W	Push-pull amplifier (one half)
V3703	6005/6AQ5W	Push-pull amplifier (one half)
V3704	6X4W	Rectifier
V3705	6X4W	Rectifier

[2] For Radar Set AN/FPS-6A

Figure 1–37. Tube Complement (Sheet 11 of 12)

Symbol	JAN Type	Function
TIME-SHARING MASTER CONTROL		
V3801	5726/6AL5W	Rectifier
V3802	5687	Timer
RHI ANTENNA CONTROL		
V6501	5687	Servo amplifier phase discriminator and preamplifier
TY6501	Thyrite resistor	Limits 36-speed error signal in selsyn mixing network
CR6502	1N93	Rectifier
CR6503	1N93	Rectifier

Figure 1–37. Tube Complement (Sheet 12 of 12)

Symbol	Ampere Rating	Circuit Protected
CONTROL GROUP ASSEMBLY		
Control Group Power Supply		
F5601	1/4	500-volt line to servo amplifier
F5602	1/16	275-volt line to interference blanker generator
F5603	1/16	275-volt line to elevation data generator
F5604	1/16	275-volt line to angle mark generator
F5605	1/4	275-volt line to range mark generator
F5606	1/16	275-volt line to servo amplifier
F5607	1/16	140-volt line to interference blanker

Note

On low-serial numbered systems, fuse F5607 is not a slow-blow type. Personnel are cautioned to check this fuse to be sure that a slow-blow type has been substituted.

Symbol	Ampere Rating	Circuit Protected
F5608	1/16	140-volt line to range mark generator
F5609	1/4	140-volt line to normal receiver
F5610	1/16	−150-volt line to interference blanker
F5611	1/16	−150-volt line to angle mark generator
F5612	1/16	−150-volt line to elevation data generator
F5613	1/16	−150-volt line to range mark generator
F5614	1/4	−150-volt line to normal receiver
F5615	1/16	−150-volt line to servo amplifier
F5616	5	28-volt line to junction box
F5617	5	28-volt line to r-f assembly
F5618	2	120-volt phase C, ac

Figure 1–38. Fuse Complement (Sheet 1 of 4)

Symbol	Ampere Rating	Circuit Protected
CONTROL GROUP ASSEMBLY (cont)		
Remote R-f Control Unit		
F6101[1]	1	Phase 1, 120 volts ac
Antenna Control Panel		
F6201	5	Azimuth drive motor shunt field
F6202	5	Azimuth drive motor shunt field
F6203	20	120 volts ac
F6204	5	Selsyn power
Power Distribution Panel		
F6401	8	Utility outlet
F6402[2]	5	Blower motor
MODULATOR ASSEMBLY		
Modulator Control Unit		
F2101	15	Modulator filaments
F2102	15	Magnetron filaments
F2103	8	Modulator control
Modulator Cabinet Assembly		
F2201	8	Convenience outlets
F2202	3/8[2]	Modulator trigger amplifier
MAGNETRON ASSEMBLY		
F601	8	120 volts ac
PERFORMANCE MONITOR		
Performance Monitor Power Supply		
F7801	1/16	+250 volts dc to noise figure monitor
F7802	1/4	+140 volts dc to noise figure monitor
F7803	1/4	+140 volts dc to power monitor
F7804	1/16	−150 volts dc to noise figure monitor
R-F ASSEMBLY		
R-f Cabinet Assembly		
F901	5	Cabinet blower
F902	8	120-volt a-c outlet
Local Control Panel		
F1001[2]	2	R-f noise
F1002	1	Keep-alive
Preamplifier-LO Power Supply		
F1101	1/4	+140 volts dc
F1102	1/16	+300 volts dc
F1103	1/16	−210 volts dc
F1104	1/16	+250 volts dc

[1] For Radar Set AN/FPS-6 only

[2] Slow-blow type

Figure 1–38. Fuse Complement (Sheet 2 of 4)

Symbol	Ampere Rating	Circuit Protected
R-F ASSEMBLY (cont)		
Preamplifier-LO Power Supply (cont)		
F1105	1/4	−105 volts dc
F1106	1/4	+250 volts dc (unregulated)
F1107	5	Filament AFC-LO
F1108	2	Filament preamplifier
F1109	5	Filament AFC-LO
F1110	1	D-c filaments
REMOTE R-F CONTROL ASSEMBLY		
Remote R-f Control Panel		
F6101[2]	1	Noise amplitude
RANGE-HEIGHT INDICATOR FOR RADAR SET AN/FPS-6A		
F22921, 2	8	A-c input line fuses
F22923, 4	8	Convenience outlet fuses
F22925, 6	8	Spare fuses
RAID SIZE INDICATOR		
F23001	3	A-c input line fuse
F23002	3	A-c input line fuse
RANGE-HEIGHT INDICATOR FOR RADAR SET AN/FPS-6		
RHI Power Supply		
F4101	8	120-volt a-c line
F4102[2]	5	Filaments
F4103[2]	1/4	−180 volts dc
F4104	1	+200 volts dc
F4105	1	+300 volts dc
S4101 (circuit breaker)	10	Filament supply
JUNCTION BOX		
F9701	2	6-volt indicators at azimuth control overlay No. 1
F9702	2	6-volt indicators at azimuth overlay No. 2
F9703	2	6-volt indicators at azimuth overlay No. 3
F9704	2	6-volt indicators at azimuth overlay No. 4
F9705	2	Monitor indicator at azimuth switch box No. 1
F9706	2	Monitor indicator at azimuth switch box No. 2
F9707	2	PPI indicator in time-sharing master control

[2] Slow-blow type

Figure 1–38. Fuse Complement (Sheet 3 of 4)

Symbol	Ampere Rating	Circuit Protected
		JUNCTION BOX (cont)
F9708	2	28 volts (RHD No. 1)
F9709	2	28 volts (RHD No. 2)
F9710	2	28 volts (RHD No. 3)
F9711	2	28 volts (RHD No. 4)
F9712	2	28 volts dc (azimuth switch box No. 1)
F9713	2	28 volts dc (azimuth switch box No. 2)
F9714	2	28 volts dc (time-sharing master control)
F9715	2	Phase B, 120 volts ac (RHD No. 1)
F9716	2	Phase B, 120 volts ac (RHD No. 2)
F9717	2	Phase B, 120 volts ac (RHD No. 3)
F9718	2	Phase B, 120 volts ac (RHD No. 4)
F9719	15	Phase B, 120 volts ac (RHI No. 1)
F9720	15	Phase B, 120 volts ac (RHI No. 2)
F9721	2	Phase B, 120 volts ac (time-sharing master control)
F9722	2	Phase B, 120 volts ac (transformer T9701)
		AZIMUTH BLANKER
F101	1	120-volt, Phase B input
		FERRITE ISOLATOR BLOWER ASSEMBLY[1]
F2351	1/2[2]	Ferrite isolator blower motor

[1] For Radar Set AN/FPS-6A
[2] Slow-blow type

Figure 1–38. Fuse Complement (Sheet 4 of 4)

Symbol	Type	Rating	Function
		AZIMUTH BLANKER	
I101	NE51	1/25 watt, neon	Indicator, F1
I102	NE51	1/25 watt, neon	Blank
I103	6S6DC–125	6 watts, 125 volts	Antenna drive failure
I104	NE51	1/25 watt, neon	Blanker bypass
		MAGNETRON CABINET	
I602	NE51	1/25 watt, neon	Indicator, F1
		R-F ASSEMBLY	
I901	NE51	1/25 watt, neon	Indicator, F1
I902	NE51	1/25 watt, neon	Indicator, F2
I903	NE51	1/25 watt, neon	Indicator, interlock test

Figure 1–39. Indicator Lamp Complement (Sheet 1 of 10)

Symbol	Type	Rating	Function
		R-F ASSEMBLY (cont)	
I904	Mazda 50A/RS	50 watts, 120 volts	Cabinet light
I905	Mazda 6S6DC	6 watts, 120 volts	Panel lighting
I906	Mazda 6S6DC	6 watts, 120 volts	Panel lighting
I907	Mazda 6S6DC	6 watts, 120 volts	Panel lighting
		LOCAL CONTROL UNIT[1]	
I1003	NE51	1/25 watt, neon	Noise measure attenuator in
I1004	Mazda 313	24 to 32 volts, 0.17 amp	Noise frequency low limit
I1005	Mazda 313	24 to 32 volts, 0.17 amp	Noise frequency high limit
I1006	Mazda 313	24 to 32 volts, 0.17 amp	Noise on-off
I1009	NE51	1/25 watt, neon	Indicator, F1
		LOCAL CONTROL UNIT[2]	
I1001	Mazda 313	24 to 32 volts, 0.17 amp	Indicator, local control
I1002	Mazda 313	24 to 32 volts, 0.17 amp	Indicator, remote control
I1003	NE51	1/25 watt, neon	Relative tuning warning
I1007	Mazda 6S6DC	6 watts, 120 volts	Indicator, interlock short
I1008	Mazda 6S6DC	6 watts, 120 volts	Indicator, main power
I1010	NE51	1/25 watt, neon	Indicator, F2
		PREAMPLIFIER-LO POWER SUPPLY	
I1101	NE51	1/25 watt, neon	Indicator, +140 volts dc
I1102	NE51	1/25 watt, neon	Indicator, +300 volts dc
I1103	NE51	1/25 watt, neon	Indicator, –210 volts dc
I1104	NE51	1/25 watt, neon	Indicator, +250 volts dc
I1105	NE51	1/25 watt, neon	Indicator, –105 volts dc
I1106	NE51	1/25 watt, neon	Indicator, +250 volts dc, unregulated
I1107	Mazda 6S6DC	6 watts, 120 volts	Indicator, plate

[1] For Radar Set AN/FPS-6 only
[2] For Radar Set AN/FPS-6A

Figure 1–39. Indicator Lamp Complement (Sheet 2 of 10)

Symbol	Type	Rating	Function
PREAMPLIFIER-LO POWER SUPPLY (cont)			
I1108	Mazda 6S6DC	6 watts, 120 volts	Indicator, main
MODULATOR CONTROL UNIT			
I2101	NE51	1/25 watt, neon	Indicator, F1
I2102	NE51	1/25 watt, neon	Indicator, F2
I2103	NE51	1/25 watt, neon	Indicator, F3
I2105	6S6DC	6 watts, 120 volts	Indicator, radiate
I2106	6S6DC	6 watts, 120 volts	Indicator, ready
I2107	6S6DC	6 watts, 120 volts	Indicator, reverse current trip
MODULATOR CABINET			
I2201	Mazda 50A/RS	50 watts, 120 volts	Illumination
I2202	NE51	1/25 watt, neon	Indicator, F1
I2203	NE51	1/25 watt, neon	Indicator, F2
I2251	M7481921P2 No. 115, size 4	120 volts, 60 cps, Edwards Co	Signal buzzer-reverse current
I2252	6S6DC	6 watts, 120 volts	Indicator-battle short
I2253	NE51	1/25 watt, neon	Indicator, interlock test (used on EH60026 only)
AZIMUTH CONTROL OVERLAY			
I3061	GE47	6 volts, 0.15 amp	Indicator, control
I3602	GE47	6 volts, 0.15 amp	Illumination
I3603	GE47	6 volts, 0.15 amp	Illumination
I3604	GE47	6 volts, 0.15 amp	Illumination
I3605	GE47	6 volts, 0.15 amp	Illumination
I3606	GE47	6 volts, 0.15 amp	Illumination
REMOTE HEIGHT DISPLAY			
I3701	GE47	6 volts, 0.15 amp	Indicator
I3702	GE47	6 volts, 0.15 amp	Indicator
I3703	GE47	6 volts, 0.15 amp	Indicator
I3704	GE47	6 volts, 0.15 amp	Indicator
I3705	GE47	6 volts, 0.15 amp	Counter
I3706	GE47	6 volts, 0.15 amp	Dial
TIME-SHARING MASTER CONTROL			
I3801	GE47	6 volts, 0.15 amp	Indicator
I3802	GE47	6 volts, 0.15 amp	Indicator
I3803	GE47	6 volts, 0.15 amp	Indicator
I3804	GE47	6 volts, 0.15 amp	Indicator
I3805	GE47	6 volts, 0.15 amp	Indicator

Figure 1–39. Indicator Lamp Complement (Sheet 3 of 10)

Symbol	Type	Rating	Function
AZIMUTH SWITCH BOX[1]			
I3901	NE51	1/25 watt, neon	Indicator, slow scan
I3902	NE51	1/25 watt, neon	Indicator, fast scan
I3903	GE47	6 volts, 0.15 amp	Dial
I3904	GE47	6 volts, 0.15 amp	Indicator, pilot
RHI POWER SUPPLY[1]			
I4101	NE51	1/25 watt, neon	Indicator, F1
I4102	NE51	1/25 watt, neon	Indicator, F2
I4103	NE51	1/25 watt, neon	Indicator, F3
I4104	NE51	1/25 watt, neon	Indicator, F4
I4105	NE51	1/25 watt, neon	Indicator, F5
I4106	No. 1816	12 volts	Filament, green hood
I4107	No. 1816	12 volts	—180 volts, amber hood
I4108	No. 1816	12 volts	+220 volts, +350 volts, red hood
I4109	No. 1816	12 volts	High voltage, red hood
I4110	6S6DC-125	6 watts, 125 volts	Interlock short, red hood
RHI MAIN CABINET[1]			
I4201	GE47	6 volts, 0.15 amp	Scale lighting
I4202	GE47	6 volts, 0.15 amp	Scale lighting
I4203	Mazda 51	6 volts, 0.2 amp	Scale lighting
I4204	Mazda 51	6 volts, 0.2 amp	Scale lighting
I4203	Mazda 51	6 volts, 0.2 amp	Scale lighting
I4204	Mazda 51	6 volts, 0.2 amp	Scale lighting
I4205	Mazda 51	6 volts, 0.2 amp	Scale lighting
RHI CABINET ASSEMBLY[1]			
I4206	Mazda 51	6 volts, 0.2 amp	Scale lighting
I4207	Mazda 51	6 volts, 0.2 amp	Scale lighting
I4208	Mazda 51	6 volts, 0.2 amp	Scale lighting
I4209	Mazda 51	6 volts, 0.2 amp	Scale lighting
I4210	Mazda 51	6 volts, 0.2 amp	Scale lighting
I4211	GE47	6 volts, 0.15 amp	Panel lighting, right
I4212	GE47	6 volts, 0.15 amp	Panel lighting, right
I4213	GE47	6 volts, 0.15 amp	Panel lighting, right
I4214	GE47	6 volts, 0.15 amp	Panel lighting, left
I4215	GE47	6 volts, 0.15 amp	Panel lighting, left

[1] For Radar Set AN/FPS-6 only

Figure 1–39. Indicator Lamp Complement (Sheet 4 of 10)

Symbol	Type	Rating	Function
RHI CABINET ASSEMBLY[1] (cont)			
I4216	GE47	6 volts, 0.15 amp	Panel lighting, left
I4217	GE47	6 volts, 0.15 amp	Panel lighting, left
CONTROL GROUP POWER SUPPLY			
I5601	NE51	1/25 watt, neon	Indicator, F1
I5602	NE51	1/25 watt, neon	Indicator, F2
I5603	NE51	1/25 watt, neon	Indicator, F3
I5604	NE51	1/25 watt, neon	Indicator, F4
I5605	NE51	1/25 watt, neon	Indicator, F5
I5606	NE51	1/25 watt, neon	Indicator, F6
I5607	NE51	1/25 watt, neon	Indicator, F7
I5608	NE51	1/25 watt, neon	Indicator, F8
I5609	NE51	1/25 watt, neon	Indicator, F9
I5610	NE51	1/25 watt, neon	Indicator, F10
I5611	NE51	1/25 watt, neon	Indicator, F11
I5612	NE51	1/25 watt, neon	Indicator, F12
I5613	NE51	1/25 watt, neon	Indicator, F13
I5614	NE51	1/25 watt, neon	Indicator, F14
I5615	NE51	1/25 watt, neon	Indicator, F15
I5616	NE51	1/25 watt, neon	Indicator, F16
I5617	6S6DC–125	6 watts, 125 volts	Indicator, +500 volts
I5618	6S6DC–125	6 watts, 125 volts	Indicator, +275 volts
I5619	6S6DC–125	6 watts, 125 volts	Indicator, −150 volts
I5620	6S6DC–125	6 watts, 125 volts	Indicator, +28 volts
I5621	6S6DC–125	6 watts, 125 volts	Interlock short
I5622	6S6DC–125	6 watts, 125 volts	Indicator, 120 volts ac
REMOTE CONTROL UNIT[1]			
I6105	NE51	1/25 watt, neon	3-db attenuator
I6106	Mazda 313	24 to 32 volts, 0.17 amp	Noise high frequency limit
I6107	Mazda 313	24 to 32 volts, 0.17 amp	Noise low frequency limit
I6108	Mazda 313	24 to 32 volts, 0.17 amp	Noise on-off
I6111	NE51	1/25 watt, neon	Indicator, fuse (noise source)
REMOTE CONTROL UNIT[2]			
I6101	M7481921P2	120 volts ±5%	Buzzer, reverse current
I6102	6S6DC	6 watts, 120 volts	Indicator, reverse
I6103	6S6DC	6 watts, 120 volts	Indicator, reverse
I6104	6S6DC	6 watts, 120 volts	Indicator, radiate

[1] Radar Set AN/FPS-6 only
[2] Radar Set AN/FPS-6A

Figure 1–39. Indicator Lamp Complement (Sheet 5 of 10)

Symbol	Type	Rating	Function
REMOTE CONTROL UNIT[2] (cont)			
I6105	NE51	1/25 watt, neon	Relative tuning warning
I6109	Mazda 313	28 volts, 0.17 amp	Remote indicator
I6110	Mazda 313	28 volts, 0.17 amp	Local indicator
ANTENNA CONTROL PANEL			
I6201	6S6DC	6 watts, 120 volts	Elevation drive fast speed
I6202	6S6DC	6 watts, 120 volts	Elevation drive slow speed
I6203	6S6DC	6 watts, 120 volts	Azimuth drive on
I6204	NE51	1/25 watt, neon	Indicator, F3
I6205	NE51	1/25 watt, neon	Indicator, F4
I6206	NE51	1/25 watt, neon	Lockout indicator
I6207	NE51	1/25 watt, neon	Azimuth servo CW indicator
I6208	NE51	1/25 watt, neon	Azimuth servo CCW indicator
POWER DISTRIBUTION PANEL			
I6401	NE51	1/25 watt, neon	Phase A electronic power
I6402	NE51	1/25 watt, neon	Phase B electronic power
I6403	NE51	1/25 watt, neon	Phase C electronic power
I6404	NE51	1/25 watt, neon	Phase D antenna power
I6405	NE51	1/25 watt, neon	Phase E antenna power
I6406	NE51	1/25 watt, neon	Phase F antenna power
I6407	NE51	1/25 watt, neon	S–3 (Induct. Reg) on phase A, B, and C
I6408	NE51	1/25 watt, neon	S–4 (Modulator) on phase A, B, and C
I6409	NE51	1/25 watt, neon	S–5 (Transmitter and Receiver Group) on phase A, B, and C
I6410	NE51	1/25 watt, neon	S–6 (Control Group) on phase A, B, and C
I6411	NE51	1/25 watt, neon	S–7 (RHI) on phase B
I6412	NE51	1/25 watt, neon	S–10 (Spare) phase A
I6413	NE51	1/25 watt, neon	S–11 (Spare) phase B
I6414	NE51	1/25 watt, neon	S–12 (Spare) phase C

[2] Radar Set AN/FPS-6A

Figure 1–39. Indicator Lamp Complement (Sheet 6 of 10)

Symbol	Type	Rating	Function
POWER DISTRIBUTION PANEL (cont)			
I6415	NE51	1/25 watt, neon	S-9 (Spare) phase C
I6416	NE51	1/25 watt, neon	S-8 (Junction Box) phase B
I6417	NE51	1/25 watt, neon	S-2 (Antenna Power) on phase D, E, and F
I6418	NE51	1/25 watt, neon	Indicator, F1
I6419	NE51	1/25 watt, neon	Indicator, F2
I6420	NE51	1/25 watt, neon	S-1 (Main Power) on phase A, B, and C
RHI ANTENNA CONTROL[2]			
I6501	NE51	1/25 watt, neon	Slow scan
I6502	NE51	1/25 watt, neon	Fast scan
I6503	No. 313	28 volts, 0.17 amp	Local control
I6504	NE51	1/25 watt, neon	Circular polarization
I6505	No. 328	6 volts, 0.2 amp	Panel illumination
I6506	No. 328	6 volts, 0.2 amp	Panel illumination
I6507	No. 328	6 volts, 0.2 amp	Panel illumination
I6508	No. 328	6 volts, 0.2 amp	Panel illumination
I6509	No. 328	6 volts, 0.2 amp	Panel illumination
I6510	No. 328	6 volts, 0.2 amp	Panel illumination
I6511	No. 328	6 volts, 0.2 amp	Panel illumination
I6512	No. 328	6 volts, 0.2 amp	Panel illumination
I6513	No. 328	6 volts, 0.2 amp	Panel illumination
I6514	No. 328	6 volts, 0.2 amp	Panel illumination
PERFORMANCE MONITOR POWER SUPPLY[2]			
I7801	NE51	1/25 watt, neon	Power line
I7802	6S6DC-125	6 watts, 125 volts	Filaments
I7803	6S6DC-125	6 watts, 125 volts	Interlock short
I7804	6S6DC-125	6 watts, 125 volts	Bias
I7805	6S6DC-125	6 watts, 125 volts	Plate
I7806	NE51	1/25 watt, neon	Indicator, F1
I7807	NE51	1/25 watt, neon	Indicator, F2
I7808	NE51	1/25 watt, neon	Indicator, F3
I7809	NE51	1/25 watt, neon	Indicator, F4
JUNCTION BOX			
I9701	NE51	1/25 watt, neon	Indicator, F15
I9702	NE51	1/25 watt, neon	Indicator, F16

[2] Radar Set AN/FPS-6A

Figure 1–39. Indicator Lamp Complement (Sheet 7 of 10)

Symbol	Type	Rating	Function
JUNCTION BOX (cont)			
I9703	NE51	1/25 watt, neon	Indicator, F17
I9704	NE51	1/25 watt, neon	Indicator, F18
I9705	NE51	1/25 watt, neon	Indicator, F19
I9706	NE51	1/25 watt, neon	Indicator, F20
I9707	NE51	1/25 watt, neon	Indicator, F21
I9708	NE51	1/25 watt, neon	Indicator, F22
PRESSURIZER AND DEHYDRATOR			
I1803	NE51	1/25 watt, neon	Left reactivation indicator
I1804	NE51	1/25 watt, neon	Power on
I1805	NE51	1/25 watt, neon	Right reactivation indicator
FERRITE ISOLATOR BLOWER ASSEMBLY[2]			
I2351	NE51	1/25 watt, neon	Indicator, F51
RHI OSCILLOSCOPE[2]			
DS22051	NE51	1/25 watt, neon	Abnormal voltage warning
DS22052	NE51	1/25 watt, neon	Cabinet overheat warning
DS22053	GE47	6 volts, 0.15 amp	Calibration indicator
DS22054	Mazda 51	6 volts, 0.2 amp	10-mile range mark indicator
DS22055	Mazda 51	6 volts, 0.2 amp	20-mile range mark indicator
DS22056	Mazda 51	6 volts, 0.2 amp	50-mile range mark indicator
DS22066	Mazda 51	6 volts, 0.2 amp	Relative height indicator
DS22067	Mazda 51	6 volts, 0.2 amp	Absolute height indicator
DS22101	NE51	1/25 watt, neon	Abnormal range sweep generator warning
DS22102	NE51	1/25 watt, neon	Abnormal range sweep clamp warning
DS22103	NE51	1/25 watt, neon	Abnormal height sweep generator warning
DS22104	NE51	1/25 watt, neon	Abnormal height sweep clamp warning
DS22105	NE51	1/25 watt, neon	Abnormal range sweep driver warning

[2] For Radar Set AN/FPS-6A

Figure 1–39. Indicator Lamp Complement (Sheet 8 of 10)

Symbol	Type	Rating	Function
RHI OSCILLOSCOPE[2] (cont)			
DS22106	NE51	1/25 watt, neon	Abnormal height sweep driver warning
DS22107	NE51	1/25 watt, neon	Abnormal —220-volt supply warning
DS22108	NE51	1/25 watt, neon	Abnormal 220-volt supply warning
DS22109	NE51	1/25 watt, neon	Abnormal —90-volt supply warning
DS22110	NE51	1/25 watt, neon	Abnormal automatic zero control amplifier warning
DS22921	GE47	6 volts, 0.15 amp	Power on indicator
RAID SIZE INDICATOR[2]			
DS23001	Mazda 51	6 volts, 0.2 amp	Power on indicator
DS23002	Mazda 51	6 volts, 0.2 amp	Raid size request indicator

[2] Radar Set AN/FPS-6A

Figure 1–39. Indicator Lamp Complement (Sheet 9 of 10)

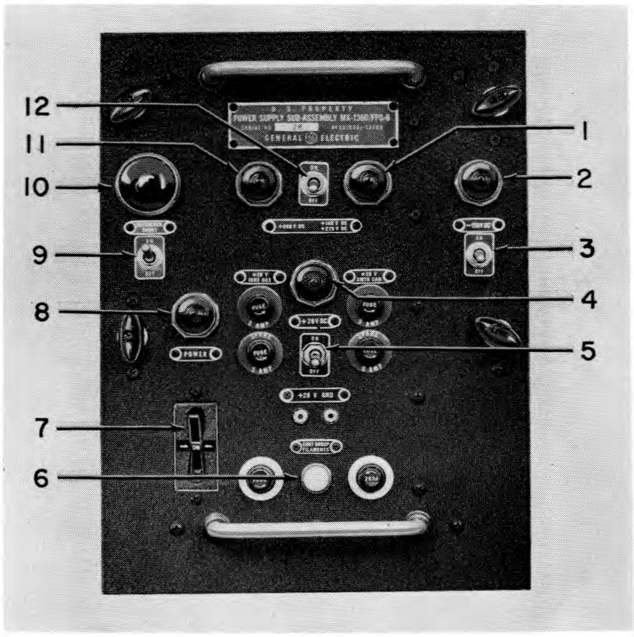
Symbol	Type	Rating	Function
RAID SIZE REMOTE UNIT[2]			
DS23501	Mazda 51	6 volts, 0.2 amp	Power on indicator
DS23502	Mazda 51	6 volts, 0.2 amp	Cancellation indicator
DS23507-14	Mazda 51	6 volts, 0.2 amp	Raid size indicators
DS23515-18	Mazda 51	6 volts, 0.2 amp	Distance indicators
DS23519-22	Mazda 51	6 volts, 0.2 amp	Formation indicators

[2] Radar Set AN/FPS-6A

Figure 1–39. Indicator Lamp Complement (Sheet 10 of 10)

1–127. OPERATING AND ADJUSTMENT CONTROLS.

1–128. Figures 1–40 through 1–76 illustrate and list the operating and adjustment controls used during normal operation of Radar Sets AN/FPS-6, AN/FPS-6A, AN/FPS-6B, and AN/MPS-14.



1 *+140V DC +275V DC indicator I5618 lights when plate supply switch is in ON position, signifying that +275- and +140-volt d-c circuits are connected*

2 *—150V DC indicator I5619 lights when —150V DC POWER switch is in ON position*

3 *—150V DC power switch S5603 turns bias supply on and off*

4 *+28V DC power indicator I5620 lights when +28V DC POWER switch is in ON position*

5 *+28V DC power switch S5602 turns ±28-volt d-c power circuit on and off*

6 *CONT GROUP FILAMENT indicator I5615 lights when adjacent fuse has blown*

7 *POWER switch S5601 turns power supply on and off*

8 *POWER indicator I5622 lights when POWER switch is in ON position*

9 *INTERLOCK SHORT switch S5606 shorts out control group assembly interlocks when in ON position*

10 *INTERLOCK SHORT indicator I5621 lights when INTERLOCK SHORT switch is in ON position*

11 *+500V DC indicator I5617 lights after 15-second delay has elapsed from time AZIMUTH DRIVE button is pressed and plate supply switch is in ON position, signifying that +500-volt d-c circuit is connected*

12 *Plate supply switch S5604 turns +500-, +275-, and +140-volt d-c circuits on and off*

Figure 1–40. Control Group Power Supply No. 1; Power Supply Subassembly MX-1360/FPS-6: Part of Radar Set Group OA-320/FPS-6, Controls and Indicators

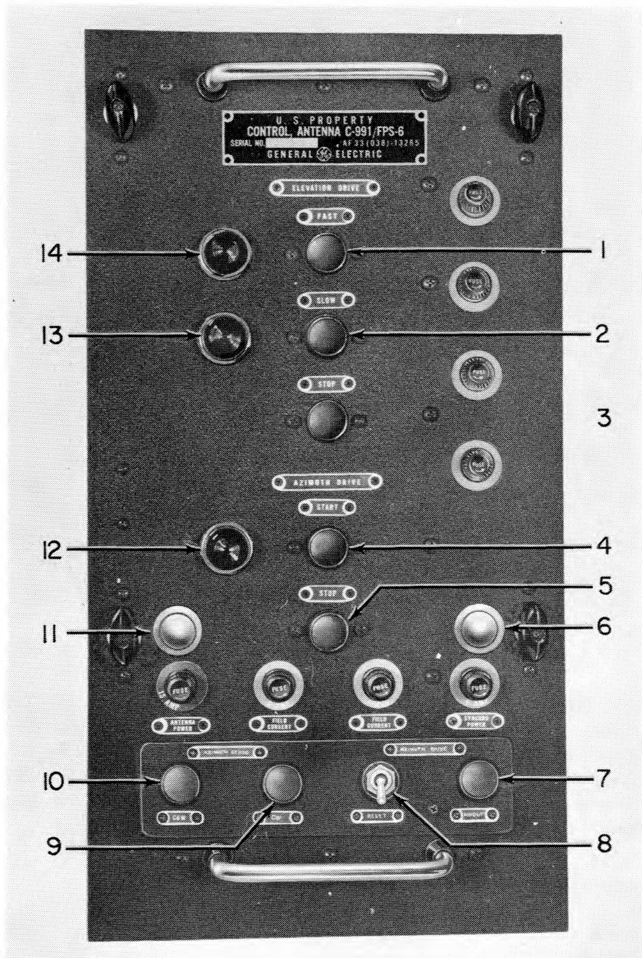


Figure 1–41. Antenna Control Panel; Part of Control, Antenna C-991/FPS-6: Part of Radar Set Group OA-320/FPS-6, Controls and Indicators

← LEGEND FOR FIGURE 1–41

1 *ELEVATION DRIVE FAST pushbutton switch S6201 is pressed for antenna scanning in elevation at a fast rate*

2 *ELEVATION DRIVE SLOW pushbutton switch S6202 is pressed for antenna scanning in elevation at a slow rate*

3 *ELEVATION DRIVE STOP pushbutton switch S6203 is pressed to stop antenna scanning in elevation*

4 *AZIMUTH DRIVE START pushbutton switch S6204 is pressed to start antenna azimuth drive*

5 *AZIMUTH DRIVE STOP pushbutton switch S6205 is pressed to stop antenna azimuth drive*

6 *SYNCHRO POWER fuse indicator I6205 lights when fuse F6204 has blown*

7 *AZIMUTH DRIVE LOCKOUT indicator I6206 lights when azimuth drive power is removed from antenna by hunt lockout relay K6208*

8 *AZIMUTH DRIVE RESET switch S6206 resets antihunt circuit after automatic lockout of antenna due to hunting, and permits restoration of azimuth control power*

9 *CW indicator I6208 flickers alternately with AZIMUTH SERVO CCW indicator when antenna is hunting*

10 *CCW indicator I6207 flickers alternately with AZIMUTH SERVO CW indicator when antenna is hunting*

11 *ANTENNA POWER indicator I6204 lights when fuse F6203 has blown*

12 *AZIMUTH DRIVE START indicator I6203 lights when AZIMUTH DRIVE START button is pressed*

13 *ELEVATION DRIVE SLOW indicator I6202 lights when ELEVATION DRIVE SLOW button is pressed*

14 *ELEVATION DRIVE FAST indicator I6201 lights when ELEVATION DRIVE FAST button is pressed*

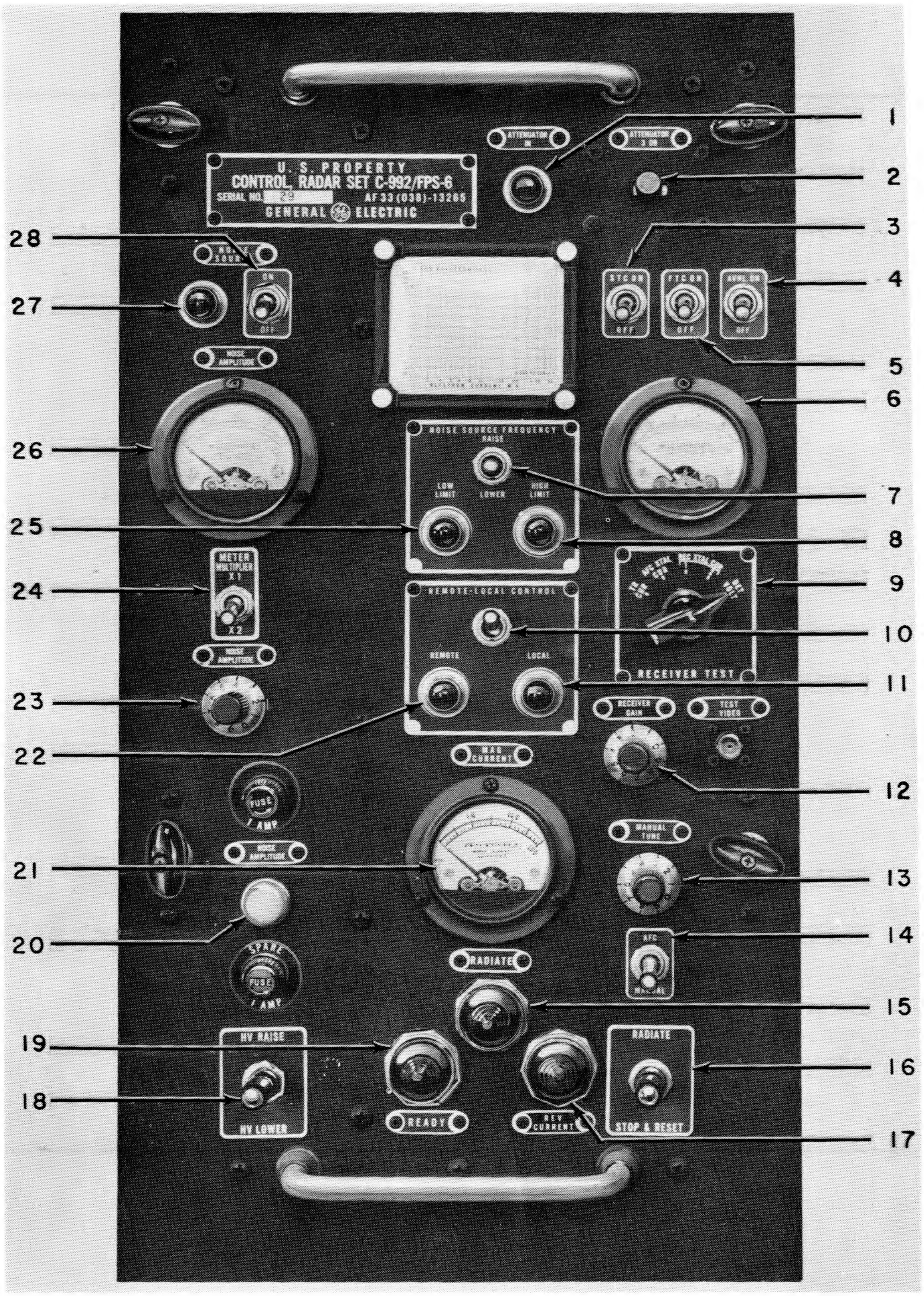


Figure 1–42. Remote R-f Control Panel; Control, Radar Set C-992/FPS-6: Part of Radar Set Group OA-320/FPS-6, Controls and Indicators

LEGEND FOR FIGURE 1–42

1 *ATTENUATOR IN indicator I6105 lights when ATTENUATOR 3 DB switch is operated*

2 *ATTENUATOR 3DB switch S6014 attenuates 30-mc intermediate frequency signal for measuring noise performance of receiver. This switch is pressed to operate and repressed to release*

3 *STC ON-OFF switch S6112 is placed in ON position only when it is necessary to decrease receiver sensitivity in order to prevent blocking due to high amplitude ground target returns*

4 *AVNL ON-OFF switch S6114 is placed in ON position to adjust for optimum normal receiver gain automatically under video noise conditions*

5 *FTC ON-OFF switch S6113 is placed in ON position only when it is necessary to eliminate long pulse jamming signals*

6 *Receiver test meter M6103 measures circuits indicated by RECEIVER TEST switch*

7 *NOISE SOURCE FREQUENCY RAISE-LOWER switch S6105 raises or lowers noise source frequency when held in indicated position*

8 *HIGH LIMIT indicator I6106 lights when noise source tuning mechanism reaches its high-frequency point*

9 *RECEIVER TEST switch S6111 connects current meter to indicated circuits*

10 *REMOTE-LOCAL CONTROL switch S6109 selects panel adjustment location. In REMOTE position, adjustments are made at remote r-f control panel; in LOCAL position, adjustments are made at local control assembly in r-f assembly*

11 *LOCAL* indicator *I6110 lights when REMOTE-LOCAL CONTROL switch is in LOCAL position*

12 *RECEIVER GAIN control R6103 adjusts receiver gain in r-f assembly*

13 *MANUAL TUNE control R6105 provides manual coarse adjustment of local oscillator frequency*

14 *AFC-MANUAL switch S6108 provides automatic frequency control of local oscillator when in AFC position after local oscillator coarse adjustment has been made manually with switch in MANUAL position*

15 *RADIATE indicator I6104 lights when RADIATE-STOP & RESET switch is set to RADIATE position and equipment is radiating*

16 *RADIATE-STOP & CONTROL switch S6101 causes modulator to fire magnetron when in RADIATE position. In STOP & RESET position, causes modulator to cease firing of magnetron*

17 *REV CURRENT indicator I6102 lights when modulator stops firing due to reverse current in magnetron*

18 *HV RAISE-HV LOW switch S6102 raises or lowers modulator high voltage when held in indicated position*

19 *READY indicator I6103 lights when 15-minute warmup time delay has elapsed and modulator is ready to fire magnetron*

20 *NOISE AMPLITUDE fuse indicator I6111 lights when fuse F6101 has blown*

21 *MAG CURRENT meter M6101 measures magnetron current*

22 *REMOTE indicator I6109 lights when REMOTE-LOCAL CONTROL switch is in REMOTE position*

23 *NOISE AMPLITUDE control R6104 adjusts amplitude of noise source*

24 *METER MULTIPLIER switch S6110 changes range of NOISE AMPLITUDE meter as indicated*

25 *LOW LIMIT indicator I6107 lights when noise source tuning mechanism reaches its low-frequency point*

26 *NOISE AMPLITUDE meter M6102 measures noise source klystron current*

27 *NOISE SOURCE indicator I6108 lights when NOISE SOURCE switch is in ON position*

28 *NOISE SOURCE switch S6106 turns noise source on and off*

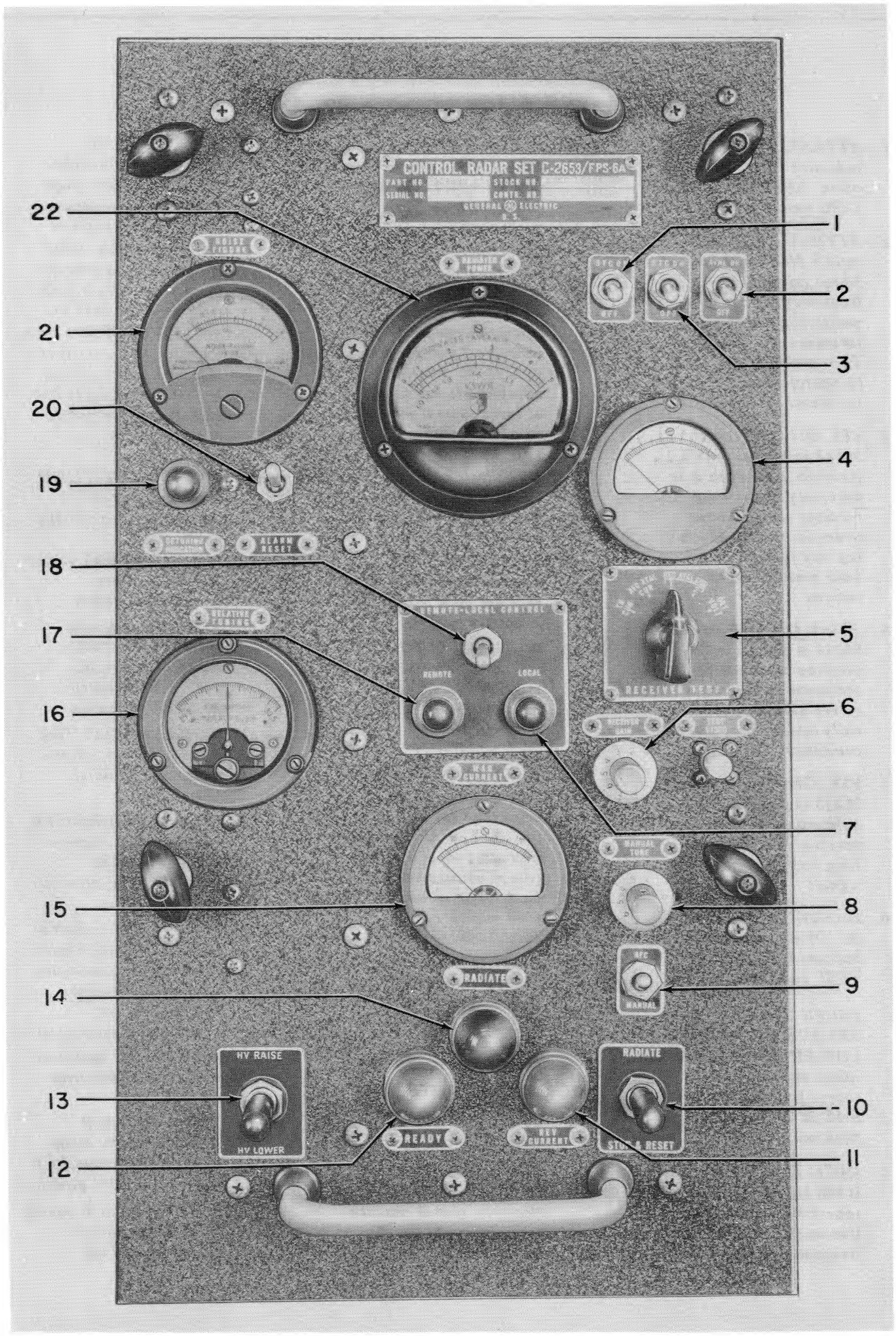


Figure 1–43. Remote R-f Control Panel; Control, Radar Set C-2653/FPS-6A and C-2655/FPS-6B: Part of Radar Set Group OA-2036/FPS-6A and OA-2038/FPS-6B, Controls and Indicators

LEGEND FOR FIGURE 1–43

1 *STC ON-OFF switch S6112 is placed in ON position only when it is necessary to decrease receiver sensitivity in order to prevent blocking due to high amplitude ground target returns*

2 *AVNL ON-OFF switch S6114 is placed in ON position to adjust for optimum normal receiver gain automatically under video noise conditions*

3 *FTC ON-OFF switch S6113 is placed in ON position only when it is necessary to eliminate long pulse jamming signals*

4 *Receiver test meter M6103 measures circuit indicated by RECEIVER TEST switch*

5 *RECEIVER TEST switch S6111 connects current meter to indicated circuits*

6 *RECEIVER GAIN control R6103 adjusts receiver gain in r-f assembly*

7 *LOCAL indicator I6110 lights when REMOTE-LOCAL CONTROL switch is in LOCAL position*

8 *MANUAL TUNE control R6105 provides manual coarse adjustment of local oscillator frequency*

9 *AFC-MANUAL switch S6108 provides automatic frequency control of local oscillator when in AFC position after local oscillator coarse adjustment has been made manually with switch in MANUAL position*

10 *RADIATE-STOP & RESET switch S6101 causes modulator to fire magnetron when in RADIATE position. In STOP & RESET position, causes modulator to stop firing of magnetron*

11 *REV CURRENT indicator I6102 lights when modulator stops firing due to reverse current in magnetron*

12 *READY indicator I6103 lights when 15-minute warmup time delay has elapsed and modulator is ready to fire magnetron*

13 *HV RAISE-HV LOWER switch S6102 raises or lowers modulator high voltage when held in indicated position*

14 *RADIATE indicator I6104 lights when RADIATE-STOP & RESET switch is set to RADIATE position and equipment is radiating*

15 *MAG CURRENT meter M6101 measures magnetron current*

16 *RELATIVE TUNING meter M6105 indicates deviation, if any, of intermediate frequency from its normal 30-mc value*

17 *REMOTE indicator I6109 lights when REMOTE-LOCAL CONTROL switch is in REMOTE position*

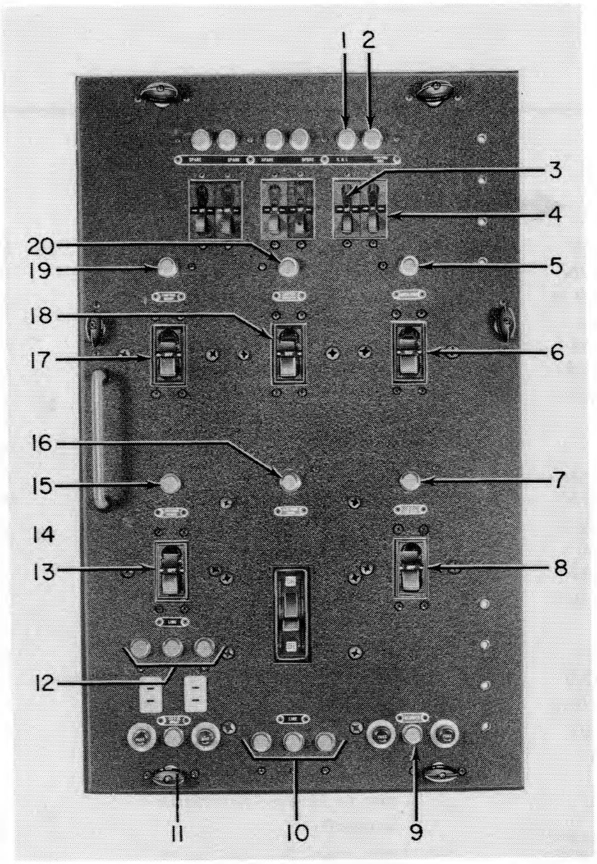
18 *REMOTE-LOCAL switch S6109 selects panel adjustment location. In REMOTE position, adjustments are made at remote r-f control panel; in LOCAL position, adjustments are made at local control assembly in r-f assembly*

19 *DETUNING INDICATION indicator I6105 lights to indicate excessive i-f deviation from normal value and remains illuminated until deviation is reduced and ALARM RESET switch is actuated*

20 *ALARM RESET switch S6103 resets relative tuning indicator circuit for normal operation after i-f deviation has been corrected*

21 *NOISE FIGURE meter M6102 provides a continuous reading of receiver noise figure*

22 *RADIATED POWER meter M6104 provides a remote reading of forward power*



1 *RHI indicator I6411 lights when RHI power switch is in ON position*

2 *JUNCTION BOX indicator I6416 lights when JUNCTION BOX power switch is in ON position*

3 *RHI power switch S6407 turns power to RHI assemblies on and off*

4 *JUNCTION BOX power switch S6408 turns power to junction box on and off*

5 *MODULATOR indicator I6408 lights when MODULATOR power switch is in ON position*

6 *MODULATOR power switch S6404 turns power to modulator assembly on and off*

7 *HV IND REG indicator I6407 lights when HV IND REG power switch is in ON position*

8 *HV IND REG switch S6403 turns power to modulator high-voltage regulator on and off*

9 *BLOWER fuse indicator I6419 lights when adjacent fuse has blown*

10 *LINE indicators I6401 through I6403 light when three-phase electronic power is being delivered to control group assembly*

11 *120V AC OUTLET fuse indicator I6418 lights when adjacent fuse has blown*

12 *LINE indicators I6404 through I6406 light when three-phase antenna power is being delivered to control group assembly*

13\. *ANTENNA POWER switch S6402 turns antenna power on and off*

14 *ELECTRONIC POWER switch S6401 turns all electronic power on and off*

15 *ANTENNA POWER indicator I6417 lights when ANTENNA POWER switch is in ON position*

16 *ELECTRONIC POWER indicator I6420 lights when ELECTRONIC POWER switch is in ON position*

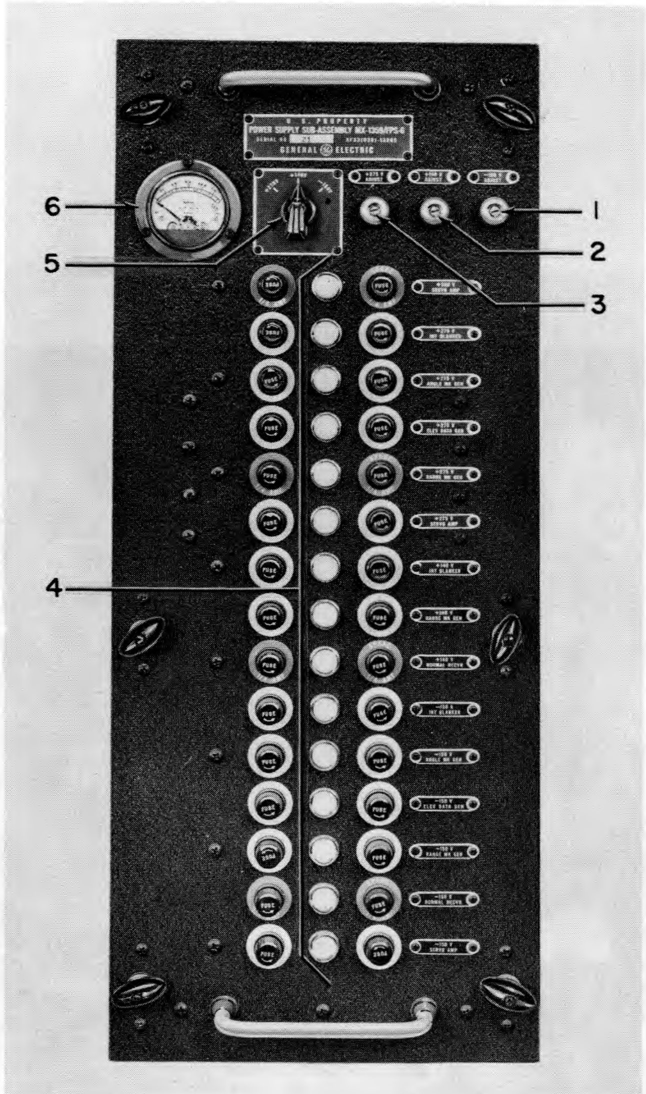
17 *CONTROL GROUP power switch S6406 turns power to control group assembly units on and off*

18 *XMITTER RECEIVER power switch S6405 turns power to r-f assembly on and off*

19 *CONTROL GROUP indicator I6410 lights when CONTROL GROUP power switch is is ON position*

20 *XMITTER RECEIVER indicator I6409 lights when XMITTER RECEIVER POWER switch is in ON position*

Figure 1–44. Power Distribution Panel: Panel, Power Distribution SB-225/FPS-6: Part of Radar Set Group OA-320/FPS-6, Controls and Indicators



1 *—150V ADJUST control R5653 adjusts —150-volt d-c voltage circuit*

2 *+140V ADJUST control R5636 adjusts +140-volt d-c voltage circuit*

3 *+275V ADJUST control R5625 adjusts +275-volt d-c voltage circuit*

4 *Fuse indicators I5601 through I5615 light when respective adjacent fuse has blown*

5 *Meter switch S5605 connects voltmeter to indicated voltage circuits*

6 *Voltmeter M5601 measures voltages selected by meter switch S5605*

Figure 1–45. Control Group Power Supply No. 2: Power Supply Subassembly MX-1359/FPS-6: Part of Radar Set Group OA-320/FPS-6, Controls and Indicators

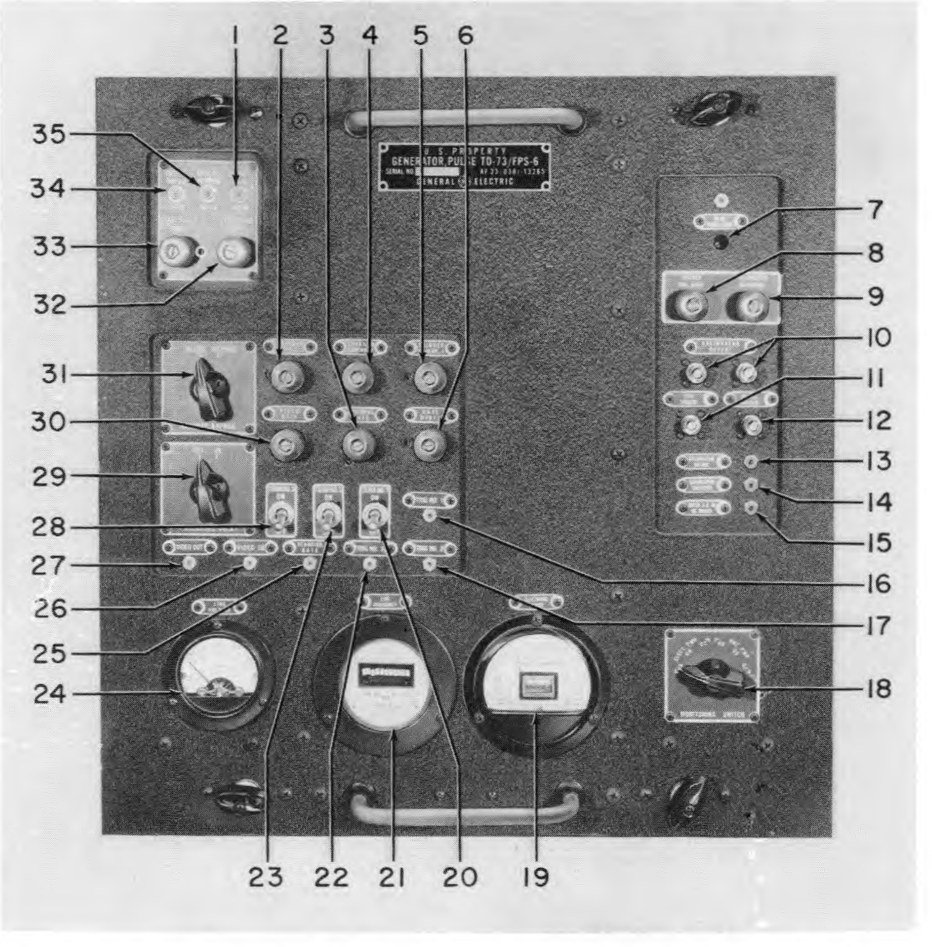


Figure 1–46. Generator-Blanker Assembly; Generator, Pulse TD-73/FPS-6: Part of Radar Set Group OA-320/FPS-6, Controls and Indicators

LEGEND FOR FIGURE 1–46

1 *ELEV SWEEP jack J5406 is used during alinement*

2 *TRIGGER GAIN NO. 3 control R5512 adjusts gain of trigger signal from No. 3 friendly radar set to provide a clearly defined rectangular gate as measured at BLANKING GATE jack J5509*

3 *RESIDUAL GATE control R5523 is adjusted for zero residual gate as measured at VIDEO OUT jack J5505*

4 *TRIGGER GAIN NO. 2 control R5511 adjusts gain of trigger signal from No. 2 friendly radar set to provide a clearly defined rectangular gate as measured at BLANKING GATE jack J5509*

5 *TRIGGER GAIN NO. 1 control R5510 adjusts gain of trigger signal from No. 1 friendly radar set to provide a clearly defined rectangular gate as measured at BLANKING GATE jack J5509*

6 *GATE WIDTH control R5517 is adjusted to blank out all interference from friendly radar sets as measured at VIDEO OUT jack J5505*

7 *10 MI OSCILLATOR tuning coil L5202 is used during alinement*

8 *TRIGGER REP. RATE control R5207 adjusts for proper trigger repetition rate. Number of range marks depends upon trigger rate of associated search radar and is as follows: 400-pps trigger rate, 20 range marks; 360-pps trigger rate, 22 range marks*

9 *CALIBRATOR COUNTING control R5222 adjusts crystal calibrator circuit in calibration procedure of range mark generator*

10 *CALIBRATOR OUTPUT jacks J5210 and J5211 are used during alinement*

11 *TEST TRIGGER jack J5202 is used during alinement*

12 *RANGE MARKS jack J5214 is used during alinement*

13 *CALIBRATOR GATING jack J5207 is used during alinement*

14 *CALIBRATOR COUNTER jack J5208 is used during alinement*

15 *GATED 5 & 10 MI MARK jack J5209 is used during alinement*

16 *TRIG NO. 1 jack J5506 is used during alinement*

17 *TRIG NO. 2 jack J5507 is used during alinement*

18 *MONITORING SWITCH S6301 connects LINE VOLTAGE meter to indicated phase of electronic antenna power sources*

19 *ELECTRONIC POWER time meter M6303 measures total time in hours that electronic power has been used*

20 *TERM NO. 1 switch S5501 is normally kept in ON position. Switch is placed in OFF position only when trigger from No. 1 friendly radar set is too weak to activate gating multiplier network of interference blanker*

21 *LINE FREQUENCY meter M6302 measures frequency of electronic and antenna a-c power sources*

22 *TRIG NO. 3 jack J5508 is used during alinement*

23 *TERM NO. 2 switch S5502 is normally kept in ON position. Switch is placed in OFF position only when trigger from No. 2 friendly radar set is too weak to activate gating amplifier network of interference blanker*

24 *LINE VOLTAGE meter M6301 measures voltage selected by MONITORING switch S6301*

25 *BLANKING GATE jack J5509 is used during alinement*

26 *VIDEO IN jack J5504 is used during alinement*

27 *VIDEO OUT jack J5505 is used during alinement*

28 *TERM NO. 3 switch S5503 is normally kept in ON position. Switch is placed in OFF position only when trigger from No. 3 friendly radar set is too weak to activate gating multiplier network of interference blanker*

29 *1 MICROSEC DELAY switch S5505 is used only in IN position when a large timing lag occurs between delivery of friendly radar trigger to interference blanker through coaxial line and reception of same trigger pulse sent out over air by friendly radar set and received by Radar Set AN/FPS-6 receiving equipment*

30 *VIDEO GAIN control R5536 adjusts input and output signals to same level as measured at VIDEO IN jack J5504 and VIDEO OUT jack J5505*

31 *BLANKER BYPASS switch S5504 places interference blanker in use when in BLANKER position to reduce and remove interference from friendly radar sets. In BYPASS position, removes interference blanker from system*

32 *ELEV ZERO SET control R5410 adjusts 0 degree angle mark to proper position on RHI screen presentation when antenna is scanning in elevation at a fast rate.*

33 *ELEV PHASE SHIFT control R5418 adjusts 0 degree angle mark to proper position on RHI screen presentation when antenna is scanning in elevation at a slow rate*

34 *1500 ~ ROTOR jack J5404 is used during alinement*

35 *1500 ~ STATOR jack J5405 is used during alinement*

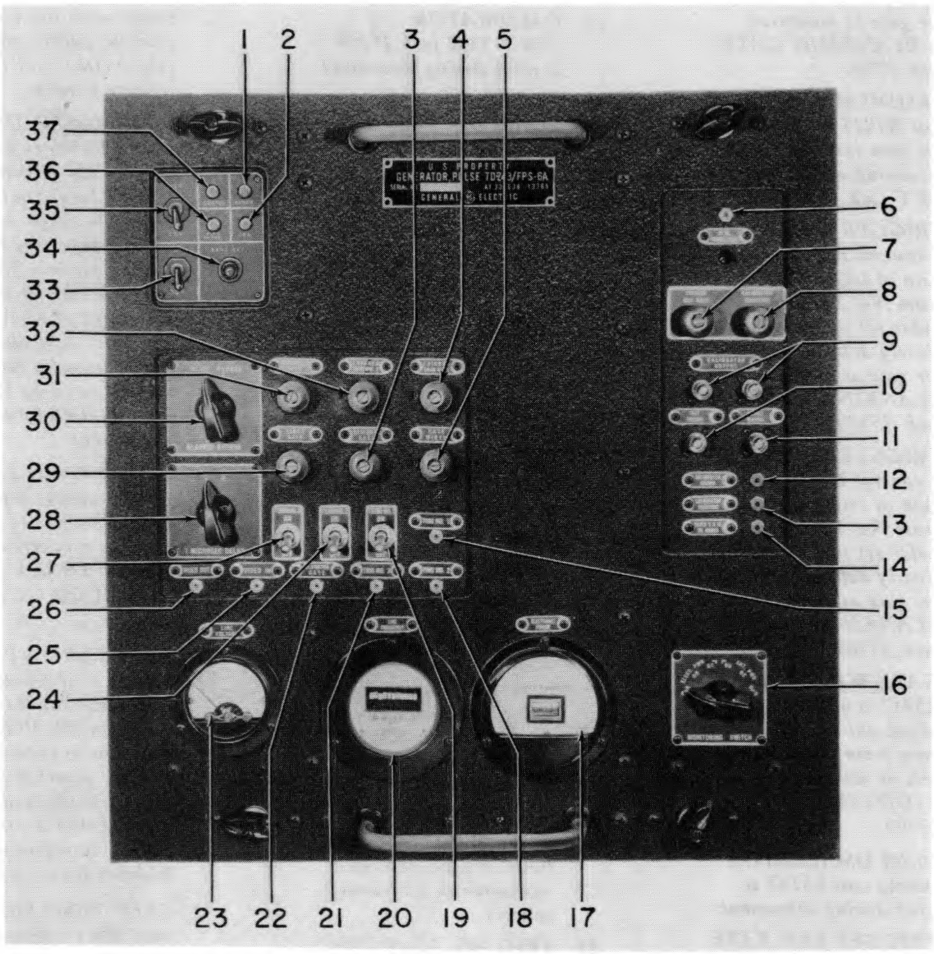


Figure 1–47. Generator-Blanker Assembly; Generator, Pulse TD-243/FPS-6A: Part of Radar Set Group OA-2036/FPS-6A and OA-2038/FPS-6B, Controls and Indicators

LEGEND FOR FIGURE 1–47

1 *ROTOR jack J5704 is used during alinement*
2 *GROUND jack is used during alinement*
3 *RESIDUAL GATE control R5523 is adjusted for zero residual gate as measured at VIDEO OUT jack J5505*
4 *TRIGGER GAIN NO. 1 control R5510 adjusts gain of trigger signal from No. 1 friendly radar set to provide a clearly defined rectangular gate as measured at BLANKING GATE jack J5509*
5 *GATE WIDTH control R5517 is adjusted to blank out all interference from friendly radar sets as measured at VIDEO OUT jack J5505*
6 *10 MI OSCILLATOR tuning coil L5202 is used during alinement*
7 *TRIGGER REP RATE control R5207 adjusts for proper trigger repetition rate. Number of range marks depends upon trigger rate of associated search radar and is as follows: 400-pps trigger rate, 20 range marks; 360-pps trigger rate, 22 range marks*
8 *CALIBRATOR COUNTING control R5222 adjusts crystal calibrator circuit in calibration procedure of range mark generator*
9 *CALIBRATOR OUTPUT jacks J5210 and J5211 are used during alinement*
10 *TEST TRIGGER jack J5202 is used during alinement*
11 *RANGE MARKS jack J5214 is used during alinement*
12 *CALIBRATOR GATING jack J5207 is used during alinement*
13 *CALIBRATOR COUNTER jack J5208 is used during alinement*
14 *GATED 5 & 10 MI. MARK jack J5209 is used during alinement*
15 *TRIG NO. 1 jack J5506 is used during alinement*
16 *MONITORING SWITCH S6301 connects LINE VOLTAGE meter to indicated phase of electronic antenna power sources*
17 *ELECTRONIC POWER time meter M6303 measures total time in hours that electronic power has been used*
18 *TRIG NO. 2 jack J5507 is used during alinement*
19 *TERM NO. 1 switch S5501 is normally kept in ON position. Switch is placed in OFF position only when trigger from No. 1 friendly radar set is too weak to activate gating multivibrator of interference blanker*
20 *LINE FREQUENCY meter M6302 measures frequency of electronic and antenna a-c power sources*
21 *TRIG NO. 3 jack J5508 is used during alinement*
22 *BLANKING GATE jack J5509 is used during alinement*
23 *LINE VOLTAGE meter M6301 measures voltage selected by MONITORING SWITCH S6301*
24 *TERM NO. 2 switch S5502 is normally kept in ON position. Switch is placed in OFF position only when trigger from No. 2 friendly radar set is too weak to activate gating multivibrator of interference blanker*
25 *VIDEO IN jack J5504 is used during alinement*
26 *VIDEO OUT jack J5505 is used during alinement*
27 *TERM NO. 3 switch S5503 is normally kept in ON position. Switch is placed in OFF position only when trigger from No. 3 friendly radar set is too weak to activate gating multivibrator of interference blanker*
28 *1 MICROSEC DELAY switch S5505 is used only in IN position when a large timing lag occurs between delivery of friendly radar trigger to interference blanker through coaxial line and reception of same trigger pulse sent out over air by friendly radar set and received by Radar Set AN/FPS-6 receiving equipment*
29 *VIDEO GAIN control R5536 adjusts input and output signals to same level as measured at VIDEO IN jack J5504 and VIDEO OUT jack J5505*
30 *BLANKER BYPASS switch S5504 places interference blanker in use when in BLANKER position to reduce and remove interference from friendly radar sets. In BYPASS position, removes interference blanker from system*
31 *TRIGGER GAIN NO. 3 control R5512 adjusts gain of trigger signal from No. 3 friendly radar set to provide a clearly defined rectangular gate as measured at BLANKING GATE jack J5509*
32 *TRIGGER GAIN NO. 2 control R5511 adjusts gain of trigger signal from No. 2 friendly radar set to provide a clearly defined rectangular gate as measured at BLANKING GATE jack J5509.*
33 *0-30 switch S5702 selects 0- and 30-degree reference voltages used in alining and calibrating elevation data generator*
34 *ZERO SET control R5733 is used to aline elevation data generator*
35 *OPER CAL switch S5701 places elevation data generator in operation in system when in OPER position; in CAL position, generator can be alined and calibrated*
36 *ELEV SWEEP jack J5706 issued during alinement*
37 *STATOR jack J5705 is used during alinement*

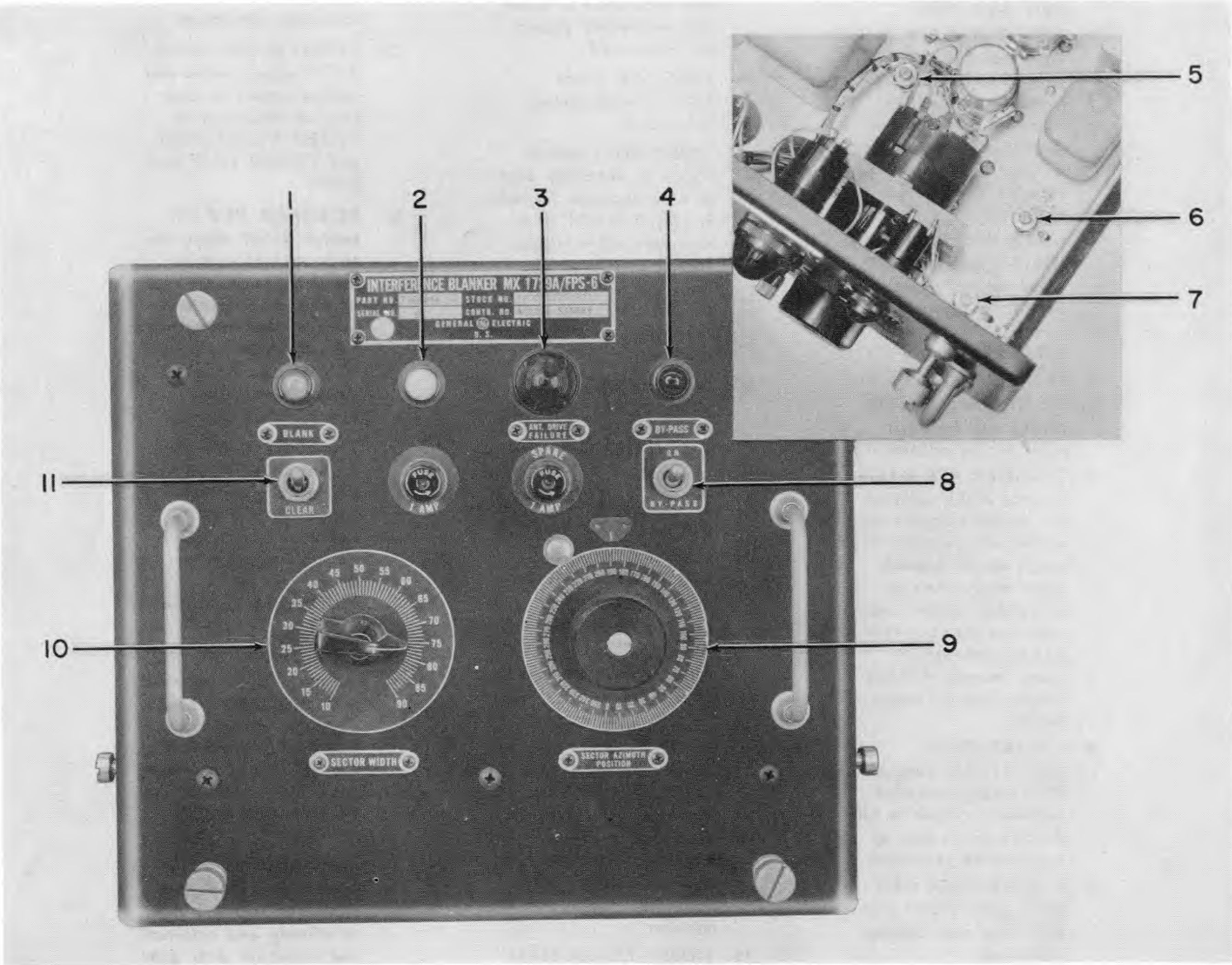


Figure 1–48. Azimuth Blanker: Blanker, Interference MX-1739A/FPS-6, Controls and Indicators

LEGEND FOR FIGURE 1–48

1 *BLANK indicator I102 lights when antenna is in blanked sector*

2 *Blown fuse indicator I101 lights when fuse F101 in 120-wave input circuit has blown*

3 *ANT DRIVE FAILER indicator I103 lights when antenna remains in a blanked sector for more than 25 seconds, indicating failure in azimuth drive system*

4 *BYPASS indicator I104 lights when azimuth blanker is bypassed by throwing ON-BY-PASS switch to BY-PASS position*

5 *AMBIGUITY ADJUST control R109 adjusts operating point of relay K102 to prevent blanking from occurring during false zero point*

6 *MIN SECTOR ADJUST control R106 sets minimum sector limit to which SECTOR WIDTH control can operate*

7 *MAX SECTOR ADJUST control R108 sets maximum sector limit to which SECTOR WIDTH control can operate*

8 *BYPASS switch S101 permits unit to function when in ON position; in BY-PASS position, unit is inoperative (blanking cannot occur)*

9 *SECTOR AZIMUTH POSITION synchro B101 determines center of blanker sector*

10 *SECTOR WIDTH control R107 determines width of blanker sector*

11 *CLEAR switch S102 breaks holding path of relay K105 when pressed, restoring circuit to normal after automatic slewing action has occurred*

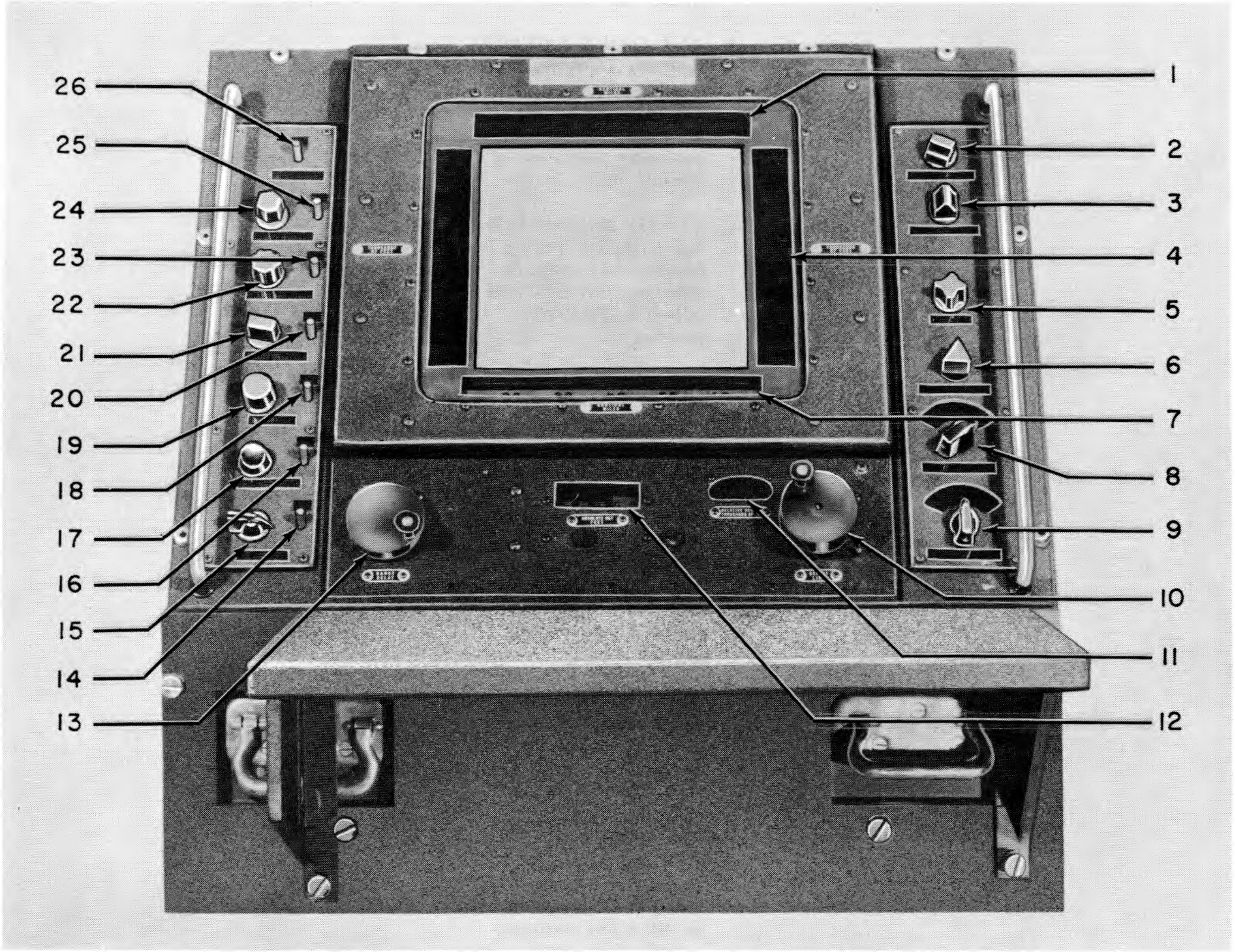


Figure 1–49. Range Height Indicator (RHI) Assembly Front Panel: Part of Radar Set Group OA-270/FPS-6, Controls and Indicators

LEGEND FOR FIGURE 1–49

1 *Range scales indicate range of screen presentation target according to setting of RANGE SELECTOR switch*

2 *PANEL BRILLIANCE control R4203 adjusts brilliance of panel lighting*

3 *SCALE BRILLIANCE control R4202 adjusts brilliance of screen presentation scale lighting*

4 *Height scales indicate height of screen presentation target according to setting of HEIGHT SELECTOR switch*

5 *FOCUS control R4201 adjusts focus of screen presentation traces*

6 *TRACE BRILLIANCE control R4923 adjusts brilliance of screen presentation traces*

7 *Range delay scale set by RANGE DELAY handcrank for any 50-mile increment of range*

8 *HEIGHT SELECTOR switch S4501 permits operator to select height range increment which provides best screen presentation*

9 *RANGE SELECTOR switch S4402 permits operator to select height range increment which provides best screen presentation. In DELAY position, allows operator to examine screen presentation for any 50-mile range increment set by RANGE DELAY handcrank*

10 *HEIGHT LINE handcrank moves height line vertically on screen presentation to any desired location. ABSOLUTE HEIGHT counter will indicate height of target*

11 *RELATIVE HEIGHT dial gives height of selected secondary target in relation to primary screen presentation target in ±thousands of feet*

12 *ABSOLUTE HGT counter gives absolute height of selected screen presentation target in feet*

13 *RANGE DELAY handcrank adjusts RHI circuits and sets range delay scale for any 50-mile range increment operator desires to see on screen presentation*

14 *HEIGHT LINE switch S4702 causes variable height line (horizontal line across screen) to appear on screen presentation when in ON position. Location of height line is controlled by HEIGHT LINE handcrank*

15 *HEIGHT LINE control R4741 controls intensity of height line on screen presentation*

16 *HEIGHT MARKERS switch S4801 causes 20,000-,40,000-, and 60,000-feet height markers (horizontal lines across screen) to appear on screen presentation when in ON position*

17 *HEIGHT MARKERS control R4839 controls intensity of height markers on screen presentation*

18 *RANGE LINE switch S4602 allows variable range line (vertical line) to appear on screen presentation when in ON position. Location of this line on screen presentation is controlled by PPI operator through controls of associated search radar PPI indicator. (Switch not used in Radar Set AN/FPS-6 operations.)*

19 *RANGE LINE control R4609 controls intensity of range line on screen presentation (not used in Radar Set AN/FPS-6 operations)*

20 *RANGE MARKER switch S4601 causes 10-mile range markers (vertical lines) to appear on screen presentation when in ON position*

21 *RANGE MARKERS control R4601 controls intensity of range markers on screen presentation*

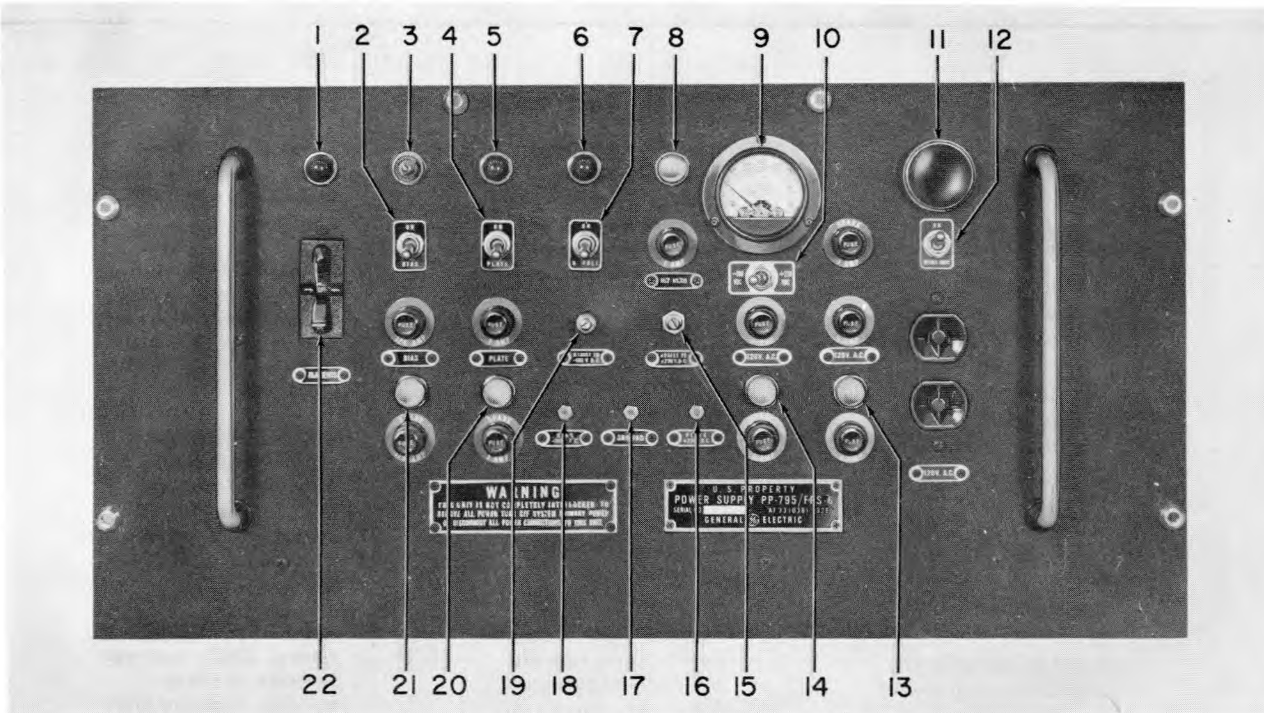
22 *SIGNAL BRILLIANCE control R4920 controls intensity of range markers on screen presentation*

23 *SIGNAL BRILLIANCE switch S4901 cuts off all target and "grass" signals from screen presentation when in OFF position. In ON position, allows target and grass signals to appear on screen presentation*

24 *ANGLE MARKERS control R4629 controls intensity of angle mark traces on screen presentation*

25 *ANGLE MARKERS switch S4620 causes angle marks to appear on screen presentation when in ON position*

26 *DC RESTORER switch S4902 prevents fading of weak signals due to presence of strong signals when in ON position*



1 *FILAMENT indicator I4106 lights when FILAMENTS switch is in ON position*

2 *BIAS switch S4103 turns bias supply on and off*

3 *BIAS indicator I4107 lights when BIAS switch is in ON position*

4 *PLATE switch S4104 turns plate supply on and off*

5 *PLATE indicator I4108 lights when PLATE switch is in ON position*

6 *H. VOLT indicator I4109 lights when H. VOLT switch is in ON position*

7 *H. VOLT switch S4105 turns high-voltage supply on and off*

8 *+300 VDC fuse indicator I4105 lights when +300 VDC fuse directly below has blown*

9 *VOLTMETER M4101 measures bias and plate supply voltages*

10 *—180 VDC +220 VDC switch S4106 selects voltages to be measured by voltmeter M4101*

11 *INTLK SHORT indicator I4110 lights when INTERLK SHORT switch is in ON position*

12 *INTERLK SHORT switch S4102 shorts out interlock switches when in ON position*

13 *120 VAC fuse indicator I4102 lights when fuse directly above has blown*

14 *120 VAC fuse indicator I4102 lights when fuse directly above has blown*

15 *ADJUST to +200VDC control R4124 adjusts plate voltage to +220 volts dc*

16 *PLATE +220 VDC jack J4103 permits accurate measurement of plate voltage*

17 *GROUND jack J4105 provides ground when measuring bias or plate voltage with an external voltmeter*

18 *BIAS —180 VDC jack J4102 permits accurate measurement of bias voltage*

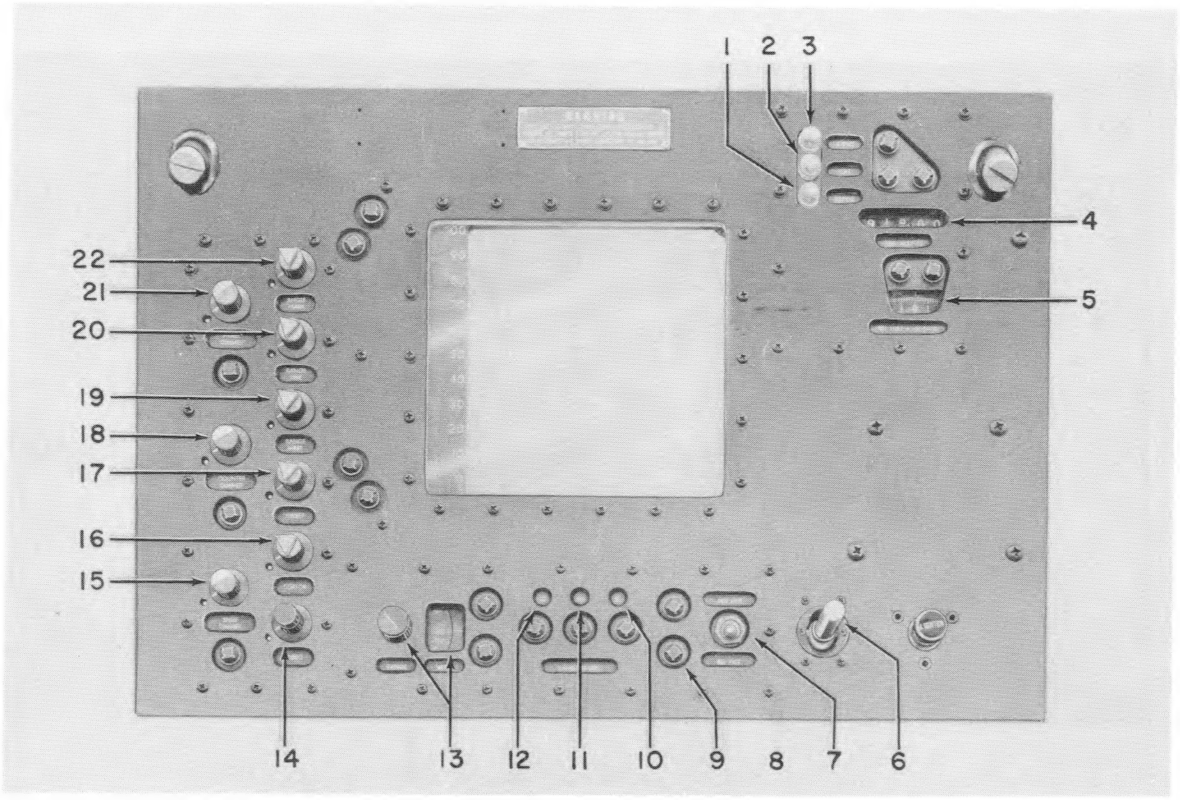
19 *ADJUST TO —180 VDC control R4138 adjusts bias voltage to —180 volts dc*

20 *PLATE fuse indicator I4104 lights when fuse directly above has blown*

21 *BIAS fuse indicator I4103 lights when fuse directly above has blown*

22 *FILAMENT switch S4101 turns live power and filaments of power supply on and off*

Figure 1–50. RHI Power Supply; Power Supply PP-795/FPS-6: Part of Radar Set Group OA-270/FPS-6, Controls and Indicators



1 *ERROR indicator DS22051 lights when there is abnormal voltage within one of 10 sampled circuits*

2 *CAL indicator DS22053 lights when any one of five calibration panel switches is actuated*

3 *OVHT indicator DS22052 lights when there is excessive temperature within equipment*

4 *ABS HGT-FT counter indicates absolute height of target when cursor is alined with target. Readings are controlled by movement of control stick*

5 *REL HGT X 1000 FT dial indicates relative height between targets when RELATIVE-ABSOLUTE switch is in RELATIVE position and control stick is moved from one target to another*

6 *Control stick positions range and height of electronic cursor and control readings of REL HGT X 1000 FT dial and ABS HGT-FT counters*

7 *ABS HGT-REL HGT switch S22053 causes REL HGT and ABS HGT indicators to light, illuminating REL HGT X 1000 FT dial and ABS HGT-FT counter, when placed in REL HGT position. In ABS HGT position, ABS HGT indicator lights, illuminating ABS HGT-FT counter*

8 *ABS HGT indicator DS22067 lights when ABS HGT-REL HGT switch is in ABS HGT position*

9 *REL HGT indicator DS22066 lights when ABS HGT-REL HGT switch is in REL HGT position. ABS HGT indicator also lights in this position*

10 *RANGE MARKS 50 indicator DS22056 lights to indicate distance of 50 radar miles between range marks on CRT (controlled by setting of RANGE control and dial)*

11 *RANGE MARKS 20 indicator DS22055 lights to indicate distance of 20 radar miles between range marks on CRT (controlled by setting of RANGE control and dial)*

12 *RANGE MARKS 10 indicator DS22054 lights to indicate distance of 10 radar miles between range marks on CRT (controlled by setting of RANGE control and dial)*

13 *RANGE control and dial R22061 provides continuous variation of sweep display from 50 to 300 radar miles and indicates selected range*

14 *VIDEO control R22057 turns on video and controls its intensity on CRT*

15 *SHELF DIMMER control R22060 varies intensity of desk shelf indicators*

16 *CURSOR control R22055 turns on cursor and controls its brilliance on CRT*

17 *SWEEP control R22054 controls sweep brilliance on CRT*

18 *COUNTER DIMMER control R22059 varies intensity of counter indicators*

19 *RANGE MARK control R22053 turns on range marks and controls their intensity on CRT*

20 *RANGE LINE control R22052 turns on range line and controls its intensity on CRT*

21 *PANEL DIMMER control R22058 varies intensity of panel indicators*

22 *ANGLE MARK control R22051 turns on angle marks and controls their intensity on CRT*

Figure 1–51. RHI Oscilloscope Front Panel; Part of Indicator Group OA-929/FPS-6A, Controls and Indicators

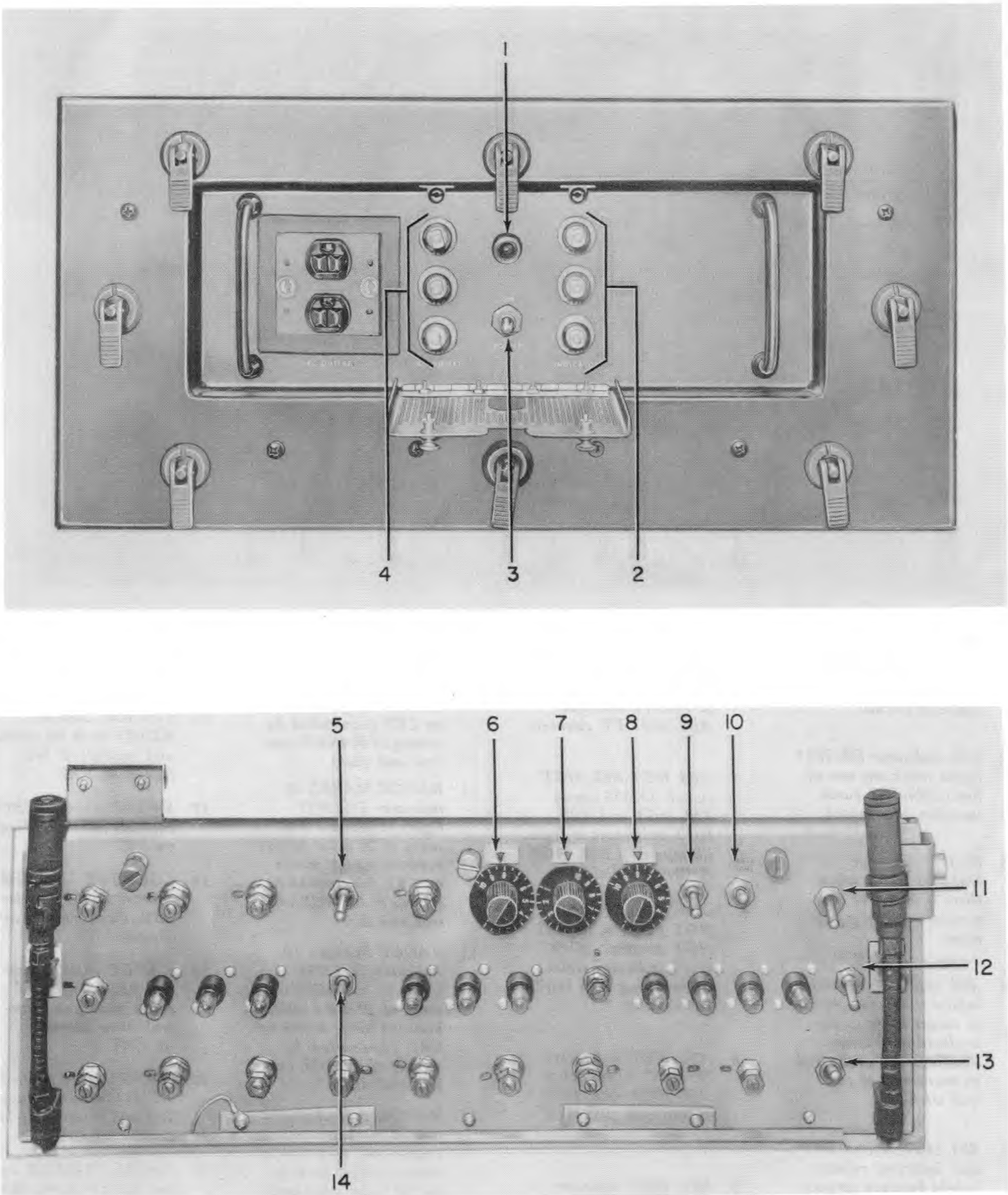


Figure 1–52. RHI Oscilloscope Calibration Panel and Power Supply: Part of Indicator Group OA-929/FPS-6A, Controls and Indicators

LEGEND FOR FIGURE 1–52

1 *POWER ON indicator DS22921 lights when POWER switch is in ON position*

2 *Blown fuse indicators F22921, through F22923 light when their associated fuses have blown*

3 *POWER switch S22921 controls application of power to RHI. In ON position, applies 115 volts ac to power supply; 115 volts ac and +220 and —220 volts dc to RHI; and completes illuminating path for POWER ON indicator. In OFF position, removes all power from both RHI and power supply and opens illuminating path for POWER ON indicator*

4 *Blown fuse indicators F22923 through F22925 light when their associated fuses have blown*

5 *SWEEP CURVATURE switch S22103 applies earth curvature correction to sweep from EARTH CURVATURE control R22126 when in up position. In down position, earth curvature correction is removed from sweep*

6 *20-30,000 REFR CORR control R22130 provides fine adjustment control for cursor height (controlled by HGT CURSOR CURVATURE switch)*

7 *10-20,000 REFR CORR control R22129 provides fine adjustment control for cursor height (controlled by HGT CURSOR CURVATURE switch)*

8 *0-10,000 REFR CORR control R22128 provides fine adjustment control for cursor height (controlled by HGT CURSOR CURVATURE switch)*

9 *HGT CURSOR CURVATURE switch S22104 applies refraction correction to cursor when in ON position. In OFF position, removes refraction correction from cursor*

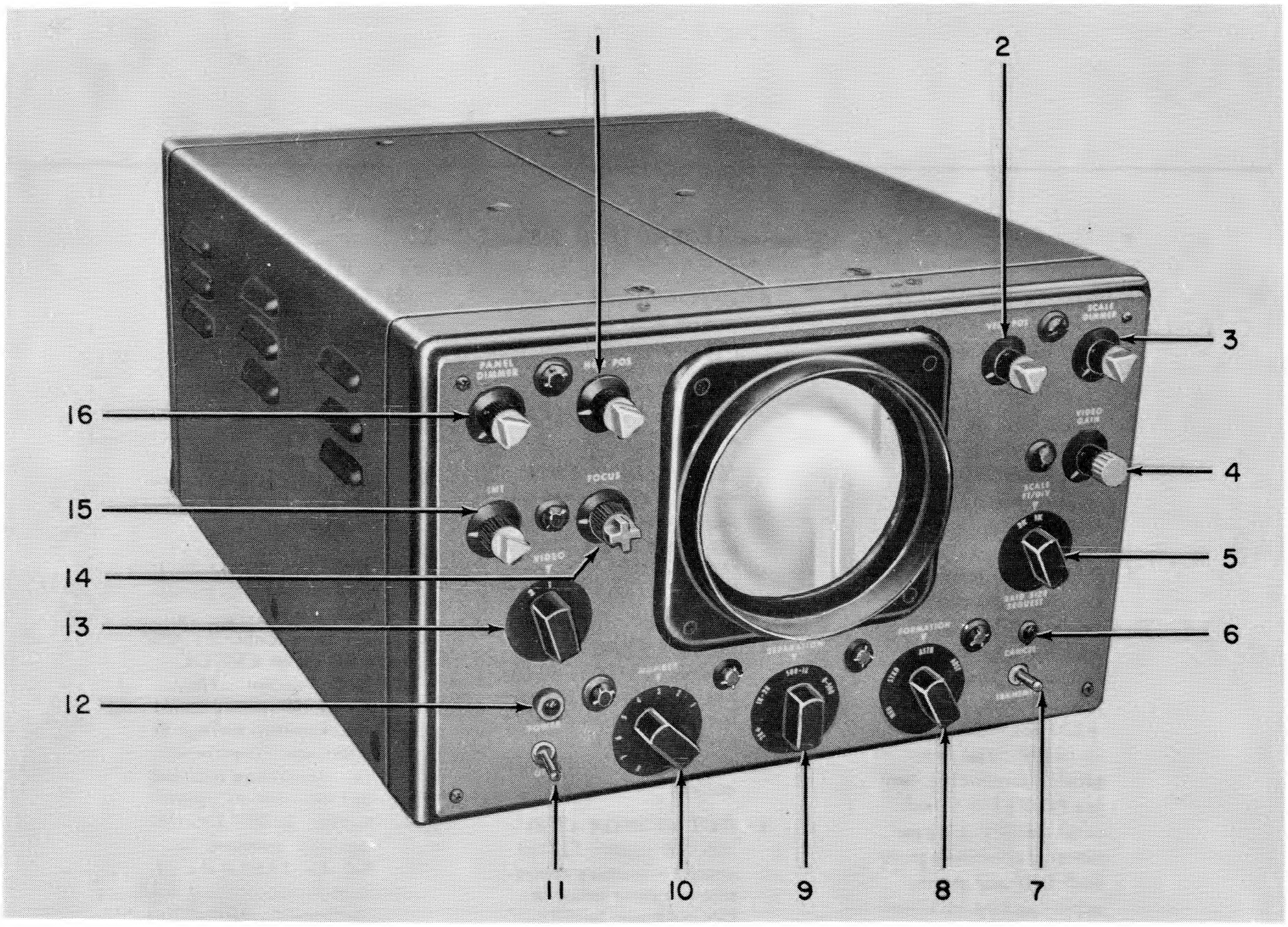
10 *PANEL LIGHT switch S22108 lights panel indicators DS22111 and DS22112 when in ON position. In OFF position, extinguishes these indicators*

11 *INT CURSOR-EXT CURSOR switch S22107 permits cursor control by RHI when in INT CURSOR position. In EXT CURSOR position, cursor is controlled by other radar system inputs*

12 *EXT TRIG-INT-TRIG switch S22102 determines source of RHI indicating trigger. In EXT TRIG position, applies trigger to RHI components. In INT TRIG position, applies internally generated test trigger to RHI component*

13 *EXT DC REF-INT DC REF switch S22105 controls d-c reference voltage from Radar Set AN/FPS-6A. In EXT DC REF position, applies Radar Set AN/FPS-6A d-c reference voltage to automatic zero circuit for comparison with output of —200-volt power supply. In INT DC REF position, removes Radar Set AN/FPS-6A d-c reference voltage from RHI and permits internal calibration of —200-volt power supply*

14 *ANT REF-ZERO ELEV 200 FT/M switch S22101 controls height component of CRT trace. In ANT REF position, applies input from Radar Set AN/FPS-6A for vertical deflection of trace. In ZERO ELEV position, removes vertical component of trace. In 200 FT/M position, applies 200-foot per mile vertical component for CRT trace*



1 *HOR POS control R23006 positions sweep in horizontal plane*

2 *VERT POS control R23010 positions CRT display in vertical plane*

3 *SCALE DIMMER control R23008 varies intensity of indicators*

4 *VIDEO GAIN control R23012 controls amplitude of targets appearing on CRT*

5 *SCALE FT/DIV switch S23003 selects scale divisions etched on CRT window. In 1K position, scale division is 1000 feet apart (2-1/2-mile range). In 2K position, scale division is 2000 feet apart (5-mile range)*

6 *RAID SIZE REQUEST indicator DS23002 flashes when a request has been made from RSRU and remains lighted when information has been transmitted to RSRU*

7 *CANCEL-TRANSMIT switch S23004 transmits information to RSRU which appears on NUMBER, SEPARATION, and FORMATION switches, when in TRANSMIT position. In CANCEL position, transmitted information is removed and CANCN indicator on RSRU lights*

8 *FORMATION switch S23007 selects type of formation for a particular group of targets*

9 *SEPARATION switch S23006 selects spacing between targets*

10 *NUMBER switch S23005 selects number of targets in a particular raid*

11 *POWER switch S23001 applies a-c power to RSI and RSRU when in ON position. In OFF position, removes a-c power*

12 *POWER indicator DS23001 lights when a-c power is applied to RSI*

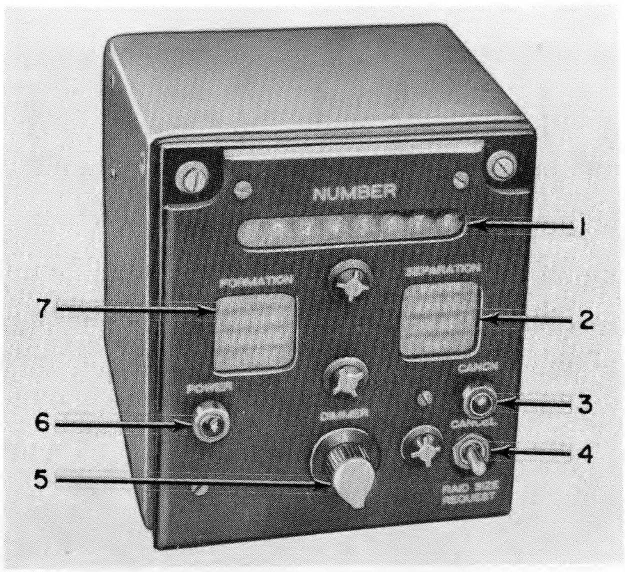
13 *VIDEO switch S23002 selects video inputs from parallel-connected jacks J6 and J7 in 1 position. In 2 position, selects video inputs from parallel-connected jacks J8 and J9*

14 *FOCUS control R23026 sharpens display appearing on CRT*

15 *INT control R23022 controls intensity of CRT display*

16 *PANEL DIMMER control R23009 varies intensity of panel indicators*

Figure 1–53. Raid Size Indicator; Indicator, Range IP-402/GPS: Part of Indicator Group OA-1040/GPA, Controls and Indicators



1 *NUMBER display indicators DS23607 through DS23614 light to indicate quantity of targets within a raid*

2 *SEPARATION display indicators DS23615 through DS23618 light to indicate type of formation for a group of targets*

3 *CANCN indicator DS23602 lights when RHI operator has canceled previously submitted information*

4 *CANCEL-RAID SIZE REQUEST switch S23601 cancels all information and returns RSI and RSRU to normal state when in CANCEL position. In RAID SIZE REQUEST position, RAID SIZE REQUEST indicator on RSI flashes*

5 *DIMMER control R23601 varies panel illumination*

6 *POWER indicator DS23601 lights when power is applied to RSI and RSRU*

7 *FORMATION display indicators DS23619 through DS23622 light to indicate distance between targets*

Figure 1–54. Raid Size Remote Unit; Indicator, Flight Formation Data ID-593/GPS: Part of Indicator Group OA-1040/GPA, Controls and Indicators

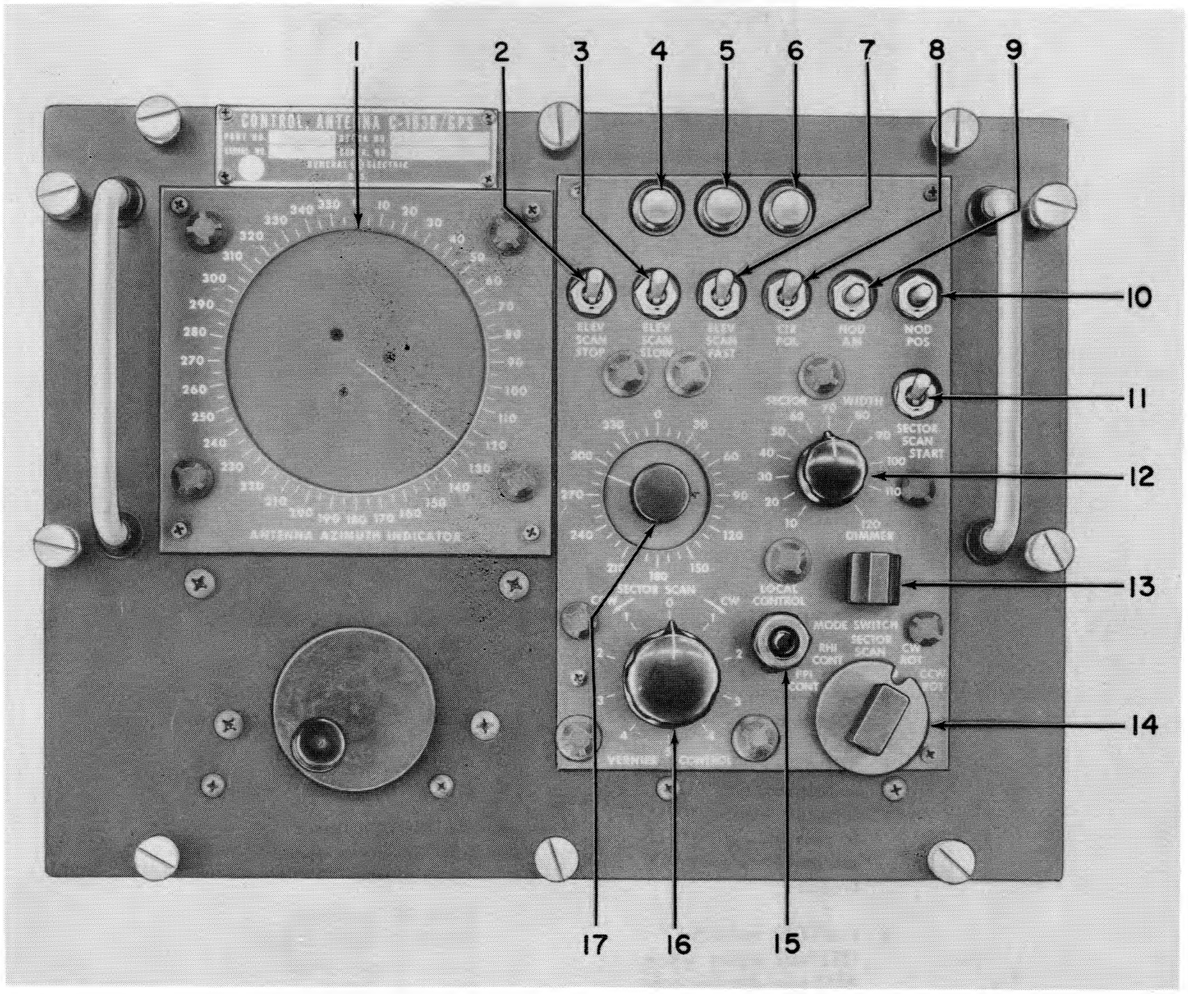


Figure 1–55. RHI Antenna Control; Control, Antenna, C-1830/GPS for Radar Set AN/FPS-6A, Controls and Indicators

LEGEND FOR FIGURE 1–55

1 *ANTENNA AZIMUTH INDICATOR dial O6501 indicates azimuth of antenna at any instant*

2 *ELEV SCAN STOP switch S6502 stops elevation scan*

3 *ELEV SCAN SLOW switch S6503 causes antenna to nod at 20 cpm*

4 *ELEV SCAN SLOW indicator I6501 lights when ELEV SCAN SLOW switch is in ON position*

5 *ELEV SCAN FAST indicator I6502 lights when ELEV SCAN FAST switch is in ON position*

6 *CIR POL indicator I6504 is not used at present*

7 *ELEV SCAN FAST switch S6504 causes antenna to nod at 30 cpm*

8 *CIR POL switch S6507 is not used at present*

9 *NOD AM switch S6508 controls amplitude of antenna nodding*

10 *NOD POS switch S6509 controls center of nodding sector*

11 *SECTOR SCAN START switch S6506 starts antenna sectoring in azimuth*

12 *SECTOR WIDTH control R6517 controls width of azimuth sector during sector scan mode*

13 *DIMMER control R6521 adjusts intensity of illumination around front panel dials*

14 *MODE SWITCH S6501 selects mode of antenna operation as follows: In PPI CONT position, antenna azimuth is controlled by PPI operator and in RHI CONT position antenna azimuth is controlled by RHI operator. Antenna sectors between two points up to 120 degrees apart when switch is set to SECTOR SCAN. In CW ROT position, antenna rotates clockwise continuously at 60 or 90 degrees per minute; in CCW ROT position, antenna rotates counterclockwise continuously at 60 or 90 degrees per minute*

15 *LOCAL CONTROL indicator I6503 lights when MODE SWITCH is in any position but PPI CONT, indicating that RHI operator has taken control of antenna from PPI operator*

16 *VERNIER CONTROL selsyn B6503 modifies azimuth position of antenna up to ±4.5 degrees from that set by PPI operator*

17 *SECTOR SCAN control B6504 and dial O6502 are set by RHI operator to center of desired azimuth sector*

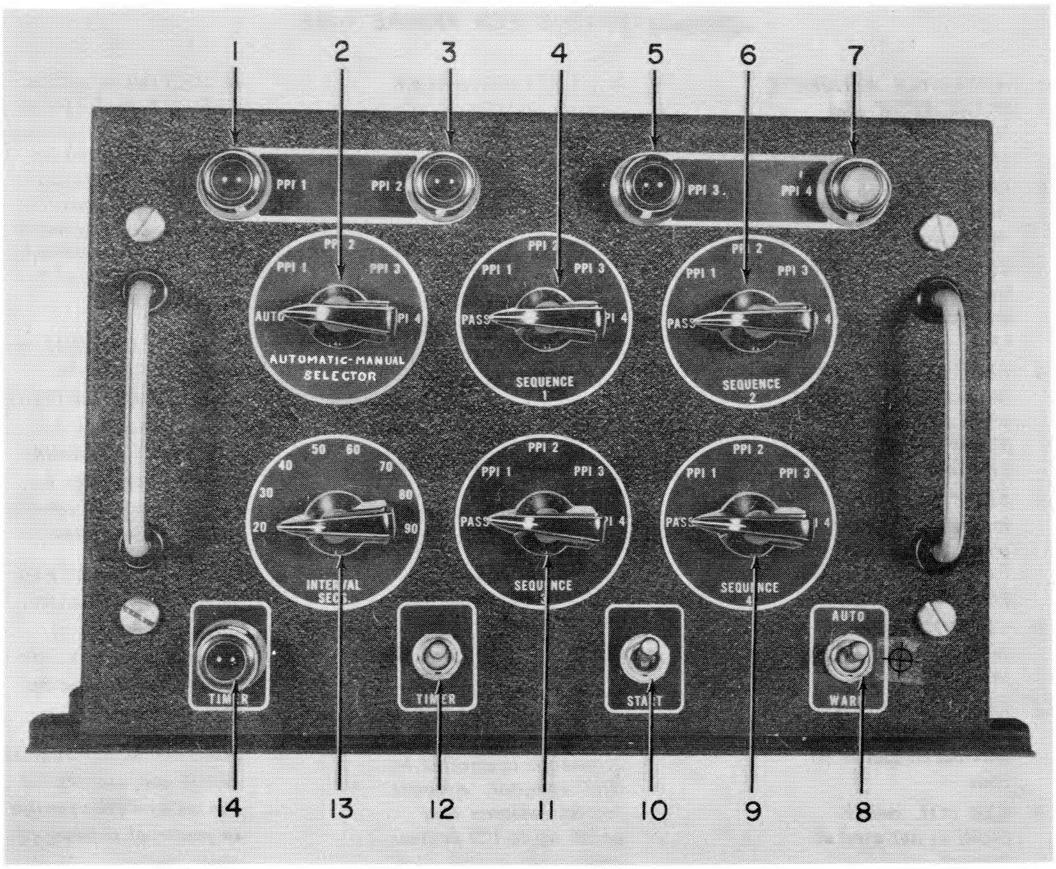


Figure 1–56. Time-sharing Master Control; Control, Antenna, C-1049/FPS-6, Controls and Indicators

LEGEND FOR FIGURE 1–56

1 *PPI 1 indicator I3804 lights when PPI No. 1 has control of antenna. Flashes when PPI No. 1 has obtained extended period of control over antenna*

2 *AUTOMATIC-MANUAL SELECTOR switch S3801 assigns manual control of antenna to an azimuth control overlay when switch is rotated to any of four indicated PPI positions. In AUTOMATIC position, control of antenna is automatically assigned to azimuth control overlays in sequence for which time-sharing master control SEQUENCE switches have been set*

3 *PPI 2 indicator I3803 lights when PPI No. 2 has control of antenna. Flashes when PPI No. 2 has obtained extended period of control over antenna*

4 *SEQUENCE 1 switch S3802 assigns antenna control to azimuth control overlay of indicated PPI for first part of time sequence set up by time-sharing master control when placed in any indicated PPI position. In PASS position, first part of time sequence is eliminated and control is passed to azimuth control overlay of PPI next in sequence*

5 *PPI 3 indicator I3802 lights when PPI No. 3 has control of antenna. Flashes when PPI No. 3 has obtained extended period of control over antenna*

6 *SEQUENCE 2 switch S3803 assigns antenna control to azimuth control overlay of indicated PPI for second part of time sequence set up by time-sharing master control when placed in any indicated PPI position. In PASS position, second part of time sequence is eliminated and control is passed to azimuth control overlay of PPI next in sequence*

7 *PPI 4 indicator I3801 lights when PPI No. 4 has control of antenna. Flashes when PPI No. 4 has obtained extended period of control over antenna.*

Note

PPI indicators I3801-I3804 are adjustable for greater brilliance by clockwise rotation of lamp socket face.

8 *AUTO-WARN switch S3807 is normally kept in AUTO position to allow time sequence to proceed automatically as previously established by control settings of time-sharing master control. In WARN position, timing sequence is suspended and extended control of antenna is given to PPI operator in control when switch was placed in WARN position. When switch is returned to AUTO position, automatic timing sequence is returned*

9 *SEQUENCE 4 switch S3805 assigns antenna control to azimuth control overlay of indicated PPI for fourth part of time sequence set up by time-sharing master control when placed in any indicated PPI position. In PASS position, fourth part of time sequence is eliminated and control is passed to azimuth control overlay of PPI next in sequence*

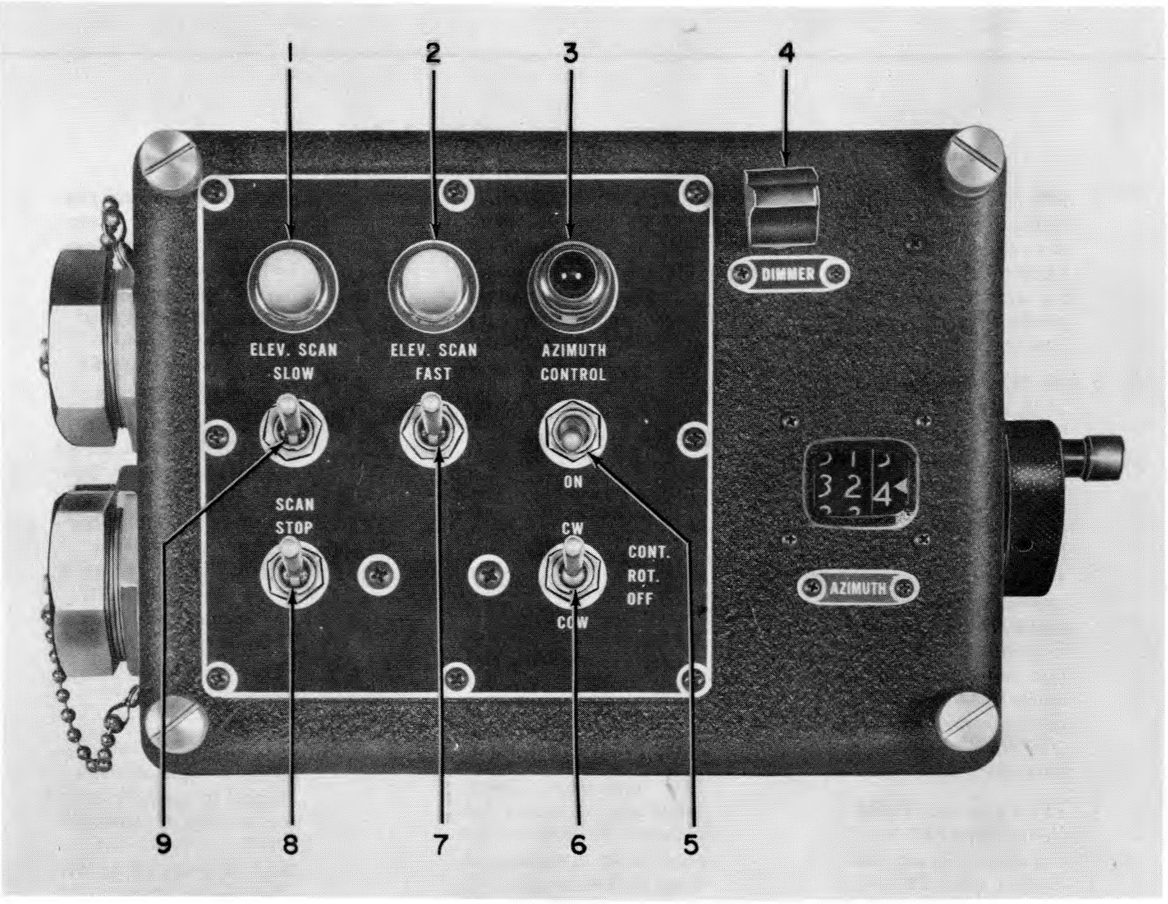
10 *START switch S3806 starts timing sequence of time-sharing master control when pressed down momentarily to START position and then released. Timing sequence may be returned to its beginning at any time by momentarily pressing down switch to START position and then releasing*

11 *SEQUENCE 3 switch S3804 assigns antenna control to azimuth control overlay of indicated PPI for third part of time sequence set up by time-sharing master control when placed in any indicated PPI position. In PASS position, third part of time sequence is eliminated and control is passed to azimuth control overlay of PPI next in sequence*

12 *TIMER switch S3808 applies power to time-sharing master control tubes when in TIMER position*

13 *INTERVAL SECS control R3803 adjusts length of time interval of time sequence and determines amount of time each PPI operator in sequence has control over antenna*

14 *TIMER indicator I3805 lights when TIMER switch is in TIMER position*



1 *ELEV SCAN SLOW indicator I3901 lights when antenna is scanning in elevation at slow rate*

2 *ELEV SCAN FAST indicator I3902 lights when antenna is scanning in elevation at fast rate*

3 *AZIMUTH CONTROL indicator I3904 lights when AZIMUTH CONTROL switch is in ON position*

4 *DIMMER control R3903 adjusts scale lighting*

5 *AZIMUTH CONTROL switch S3904 enables RHI operator to obtain control of antenna from PPI operators when placed in ON position. In OFF position, control of antenna reverts to PPI operators in accordance with sequence determined by time-sharing master control*

6 *Azimuth rotation switch S3903 allows operator to slew antenna in azimuth to any point in azimuth by use of azimuth handcrank and AZIMUTH scale when placed in CONT. ROT. OFF position. In CW position, operator can slew antenna in azimuth continuously in clockwise direction. In CCW position, operator can slew antenna in azimuth continuously in counterclockwise direction. AZIMUTH CONTROL switch must be in ON position when this switch is used*

7 *ELEV SCAN FAST switch S3902 is pressed momentarily and released to cause antenna to scan in elevation at fast rate*

8 *SCAN STOP switch S3905 is pressed momentarily and released to stop antenna scanning in elevation*

9 *ELEV SCAN SLOW switch S3901 is pressed momentarily and released to cause antenna to scan in elevation at slow rate*

Figure 1–57. Azimuth Switch Box; Control, Antenna C-1048/FPS-6, Controls and Indicators

1 *CLEAR switch S3701 releases RELATIVE HEIGHT scale and returns it to zero when placed and momentarily held to the right. REMOTE HEIGHT counter is locked in step with RHI counter and receives its new information from this source*

2 *ABSOLUTE HEIGHT scale registers absolute target height in feet as obtained by range height indicator. Scale lights and locks against further information when RHI has delivered final target height information*

3 *RELATIVE HEIGHT scale registers relative target height in ± thousands of feet as obtained by range height indicator. Scale lights and locks against further information when RHI has delivered final relative target height information*

4 *DIMMER control R3722 controls lighting of ABSOLUTE HEIGHT and RELATIVE HEIGHT scales*

5 *PPI 4 indicator I3704 lights when PPI No. 4 has control of antenna. Flashes when PPI No. 4 has obtained extended period of control over antenna*

6 *PPI 3 indicator I3703 lights when PPI No. 3 has control of antenna. Flashes when PPI No. 3 has obtained extended period of control over antenna*

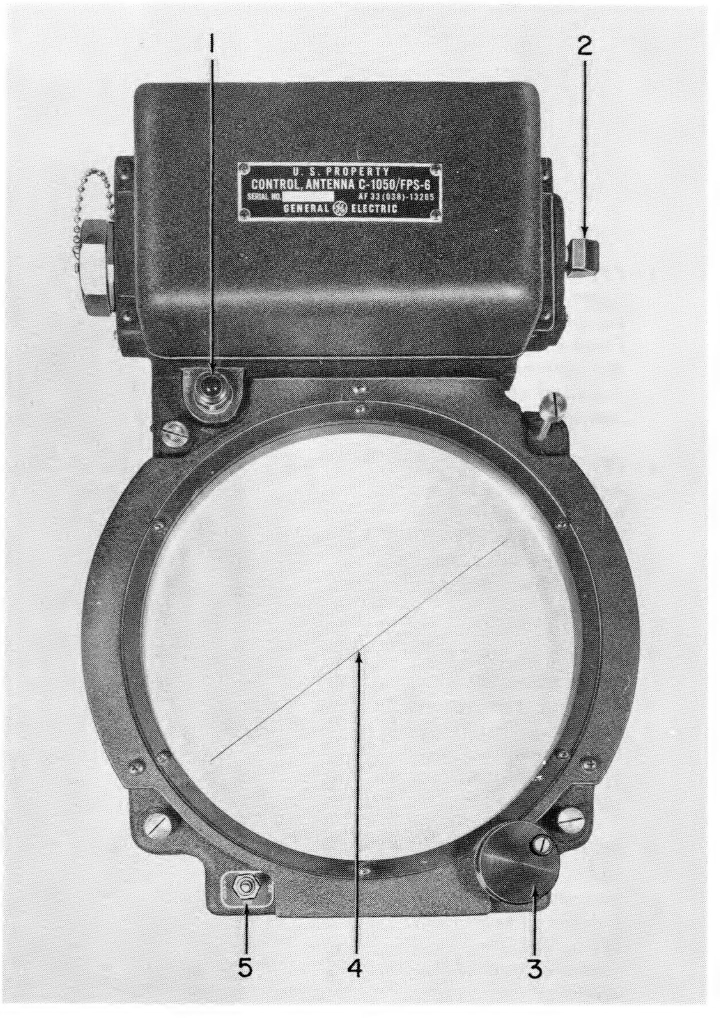
7 *PPI 2 indicator I3702 lights when PPI No. 2 has control of antenna. Flashes when PPI No. 2 has obtained extended period of control over antenna*

8 *PPI 1 indicator I3701 lights when PPI No. 1 has control of antenna. Flashes when PPI No. 1 has obtained extended period of control over antenna*

Note

PPI indicators I3701 through I3704 are adjustable for greater brilliance by clockwise rotation of lamp socket face.

Figure 1–58. Remote Height Display; Indicator, Height 1D-331/FPS-6, Controls and Indicators



1 *Control indicator I3601 lights only when PASS-ON-OFF switch is in ON position and azimuth control overlay has obtained period of control over antenna. Indicator is adjustable for greater brilliance by clockwise rotation of lamp socket face*

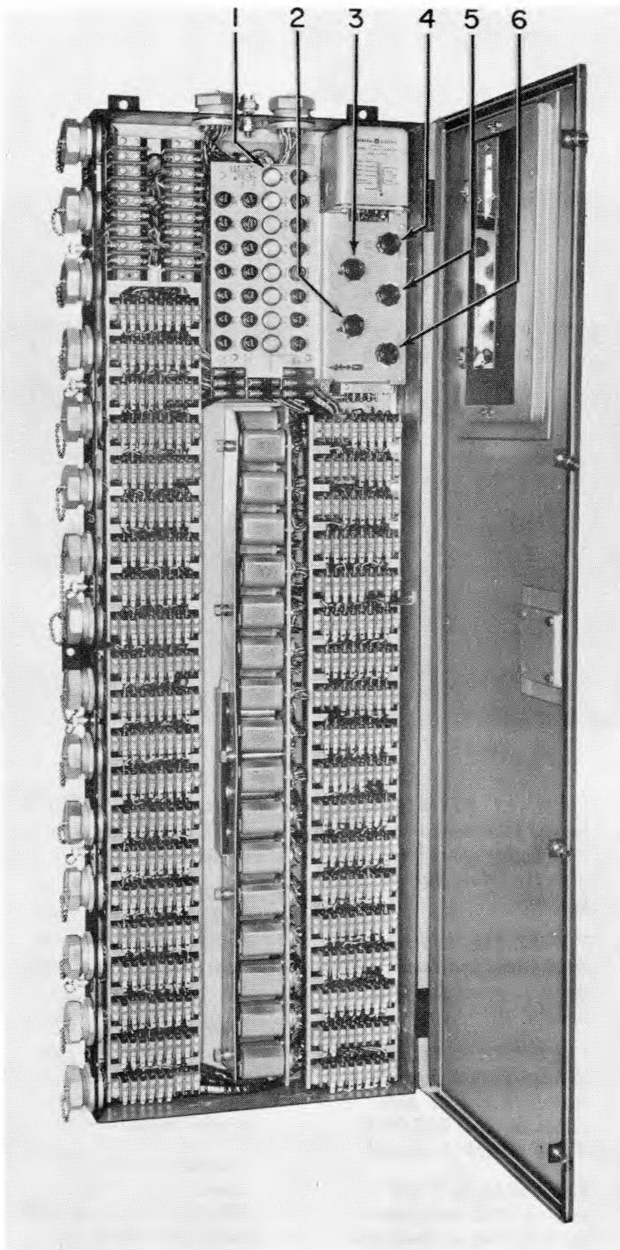
2 *Dimmer control R3601 adjusts brilliance of scale lighting*

3 *Azimuth handcrank rotates azimuth bearing cursor*

4 *Bearing cursor line rotated by azimuth handcrank to intersect desired target. Bearing of target is indicated by bearing cursor line at azimuth scale*

5 *PASS-ON-OFF switch S3601 provides azimuth control overlay with control of antenna and CONTROL indicator lights when in ON position. In PASS position, control of antenna is passed to next PPI operator as determined by time-sharing master control. In OFF position, control of antenna is retained but not used*

Figure 1–59. Azimuth Control Overlay; Control, Antenna C-1050/FPS-6, Controls and Indicators



1 *Fuse indicators I9701 through I9708 light when respective fuses have blown*

2 *S-2 switch S9702 connects PPI No. 2 of associated search radar equipment to either of two RHI's*

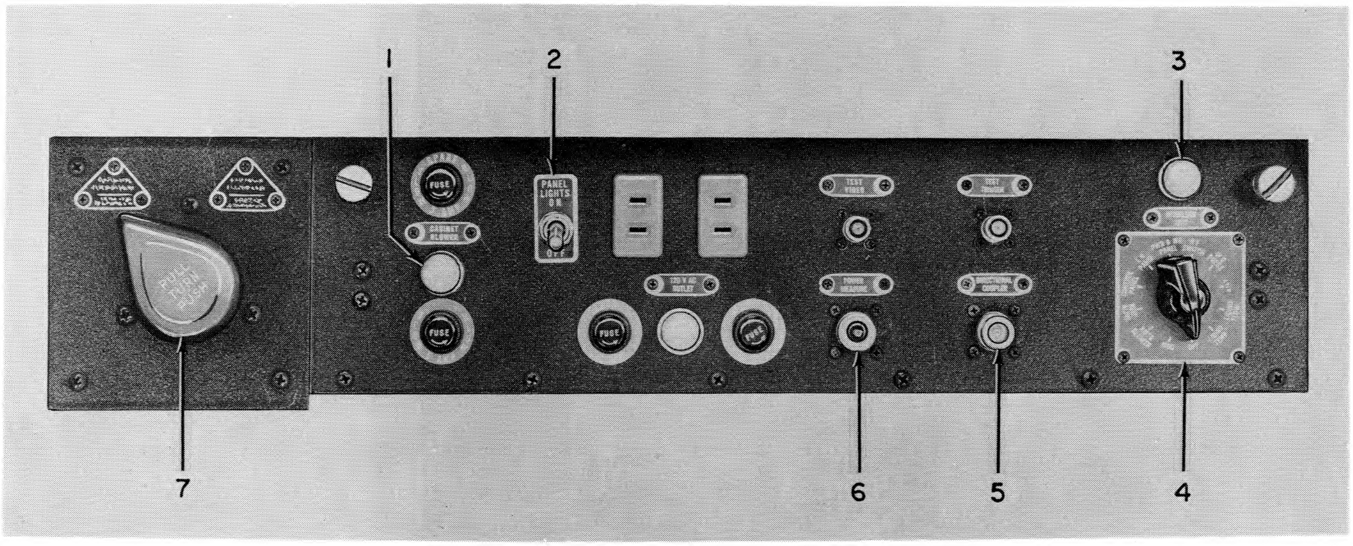
3 *S-5 switch S9705 connects azimuth switch box for Radar Set AN/FPS-6 or RHI antenna control for Radar Set AN/FPS-6A into circuit. Used only in ASB-1 position*

4 *S-4 switch S9704 connects PPI No. 4 of associated search radar equipment to either of two RHI's*

5 *S-3 switch S9703 connects PPI No. 3 of associated search radar equipment to either of two RHI's*

6 *S-1 switch S9701 connects PPI No. 1 of associated search radar equipment to either of two RHI's*

Figure 1–60. Junction Box; Terminal Box J-470/FPS-6, Controls and Indicators



1 *CABINET BLOWER blown fuse indicator I901 lights when fuse directly below has blown*

2 *PANEL LIGHTS switch S914 turns indicator and test panel lighting on and off*

3 *INTERLOCK TEST indicator I903 lights when interlock circuit indicated by INTERLOCK TEST switch is closed*

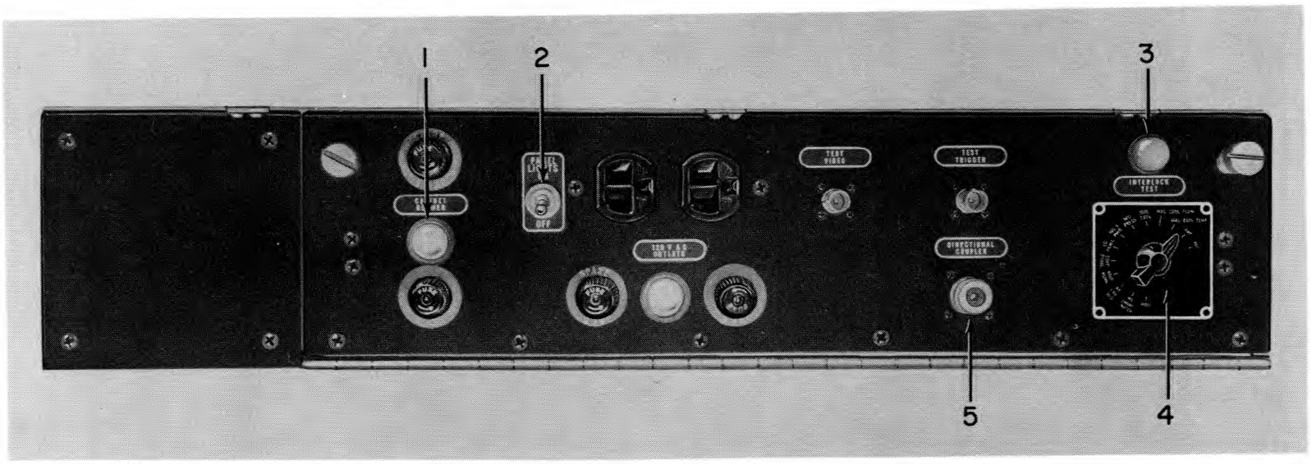
4 *INTERLOCK TEST switch S912 tests interlock circuits as indicated by switch positions. Switch is rotated to indicated position; if indicated interlock circuit is closed, INTERLOCK TEST indicator directly above lights*

5 *DIRECTIONAL COUPLER jack J936 permits connection of echo box or S-band signal generator*

6 *POWER MEASURE jack J904 permits connection of external power meter to make power measurements*

7 *Coaxial switch S905 connects POWER MEASURE jack to indicated position to measure radiated and reflected power for standing wave ratio measurements*

Figure 1–61. Indicator and Test Panel: Part of Radar Set Group OA-357/FPS-6, Controls and Indicators



1 *CABINET BLOWER blown fuse indicator I901 lights when fuse directly below has blown*

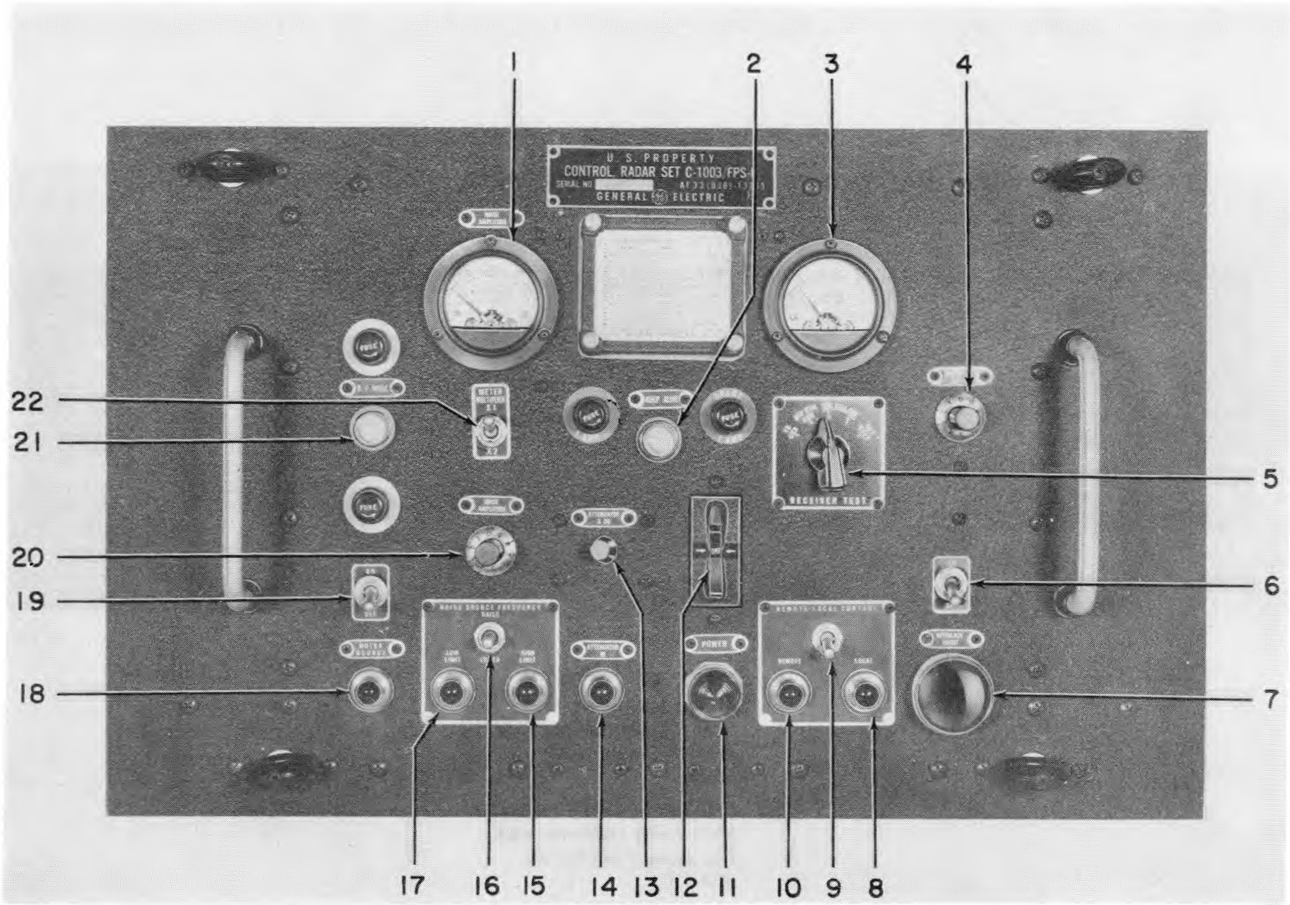
2 *PANEL LIGHTS switch S914 turns indicator and test panel lighting on and off*

3 *INTERLOCK TEST indicator I903 lights when interlock circuit indicated by INTERLOCK TEST switch is closed*

4 *INTERLOCK TEST switch S912 tests interlock circuits as indicated by switch positions. Switch is rotated to indicated position; if indicated interlock circuit is closed, INTERLOCK TEST indicator directly above lights*

5 *DIRECTIONAL COUPLER jack J936 permits connection of echo box or S-band signal generator*

Figure 1–62. Indicator and Test Panel: Part of Radar Set Group OA-2037/FPS-6A and OA-2039/FPS-6B, Controls and Indicators



1 *NOISE AMPLITUDE meter M1001 measures noise source klystron current*

2 *KEEP ALIVE blown fuse indicator I1010 lights when adjacent fuse has blown*

3 *Receiver test meter M1002 measures circuits indicated by RECEIVER TEST switch*

4 *RECEIVER GAIN control R1003 adjusts receiver gain*

5 *RECEIVER TEST switch S1004 connects current meter to indicated circuits*

6 *INTERLOCK SHORT switch S1009 shorts out interlock when in ON position*

7 *INTERLOCK SHORT indicator I1007 lights when INTERLOCK SHORT switch is in ON position*

8 *LOCAL indicator I1002 lights when REMOTE-LOCAL CONTROL switch is in LOCAL position*

9 *REMOTE-LOCAL CONTROL switch S1001 selects panel adjustment location. In REMOTE position, adjustments are made at remote r-f control panel in control group assembly. In LOCAL position, adjustments are made at local control panel*

10 *REMOTE indicator I1001 lights when REMOTE-LOCAL CONTROL switch is in REMOTE position*

11 *POWER indicator I1008 lights when POWER switch is in ON position*

12 *POWER switch S1008 turns power to local control assembly on and off*

13 *ATTENUATOR 3 DB switch S1005 attenuates 30-mc radio-frequency signal. Switch is pushed in to operate and pushed in again to release. Used for measuring noise performance of receiver*

14 *ATTENUATOR IN indicator I1003 lights when ATTENUATOR 3DB switch is operated*

15 *HIGH LIMIT indicator I1005 lights when noise source tuning mechanism reaches its high end point*

16 *NOISE SOURCE FREQUENCY switch S1006 raises or lowers noise source frequency when held in indicated position. Switch must be released when LOW LIMIT or HIGH LIMIT indicator lights*

17 *LOW LIMIT indicator I1004 lights when noise source tuning mechanism reaches its low end point*

18 *NOISE SOURCE indicator I1006 lights when NOISE SOURCE switch is in ON position*

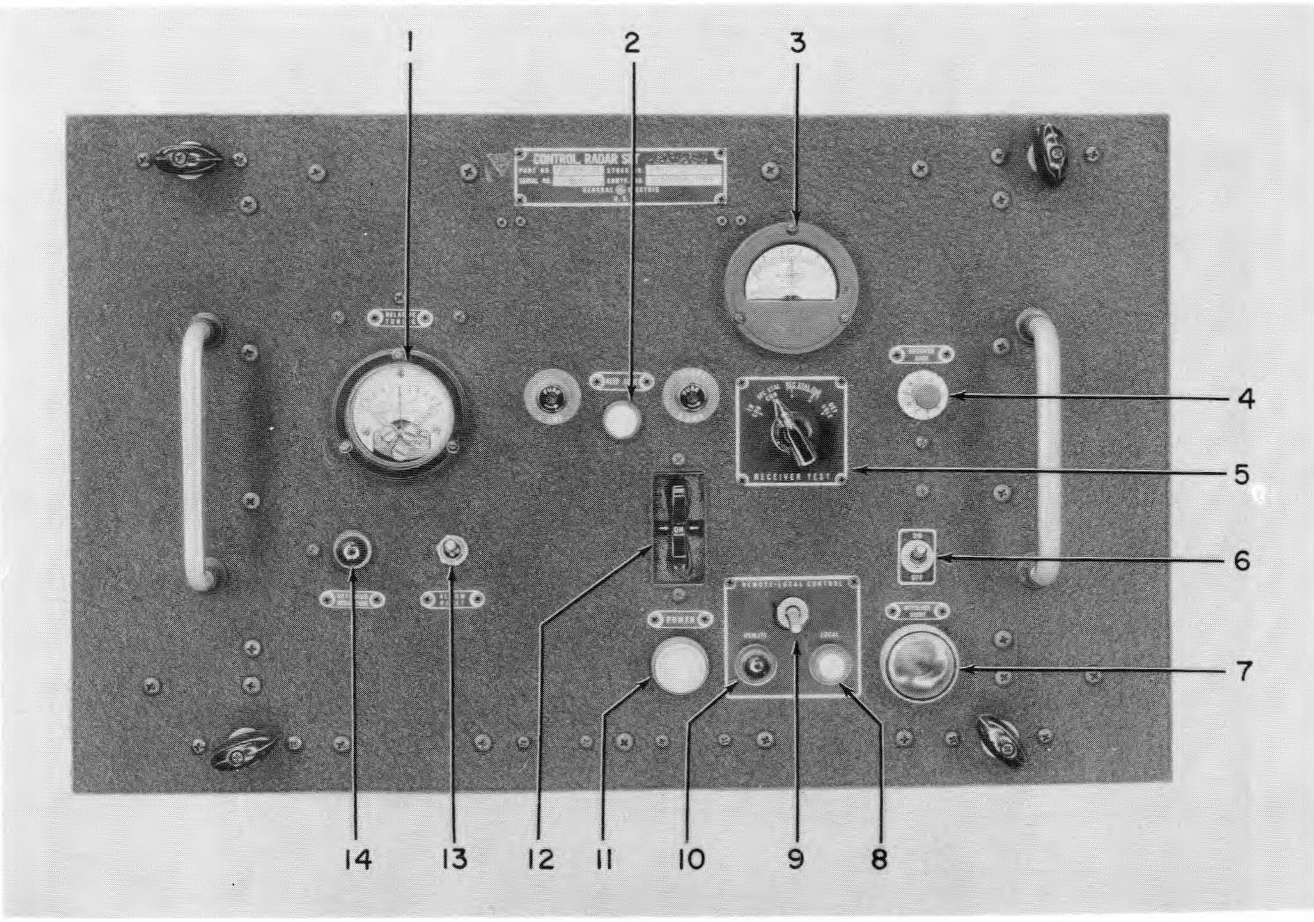
19 *NOISE SOURCE switch S1002 turns noise source ON and OFF*

20 *NOISE AMPLITUDE control R1009 adjusts amplitude of noise source*

21 *RF NOISE blown fuse indicator I1009 lights when associated fuse directly above has blown*

22 *METER MULTIPLIER switch S1007 changes range of NOISE AMPLITUDE meter as indicated*

Figure 1–63. Local Control Panel; Control, Radar Set C-1003/FPS-6: Part of Radar Set Group OA-357/FPS-6, Controls and Indicators



1 *RELATIVE TUNING meter M1001 indicates any deviation of intermediate frequency from its normal 30-mc value*

2 *KEEP ALIVE fuse indicator I1010 lights when adjacent fuse has blown*

3 *RECEIVER TEST meter M1002 measures circuits indicated by RECEIVER TEST switch*

4 *RECEIVER GAIN control R1003 adjusts receiver gain*

5 *RECEIVER TEST switch S1004 connects current meter to indicated circuits*

6 *INTERLOCK SHORT switch S1009 shorts out interlock when in ON position*

7 *INTERLOCK SHORT indicator I1007 lights when INTERLOCK SHORT switch is in ON position*

8 *LOCAL indicator I1002 lights when REMOTE-LOCAL CONTROL switch is in LOCAL position*

9 *REMOTE-LOCAL CONTROL switch S1001 selects panel adjustment location. In REMOTE position, adjustments are made at remote r-f control panel in control group assembly. In LOCAL position, adjustments are made at local control panel*

10 *REMOTE indicator I1001 lights when REMOTE-LOCAL CONTROL switch is in REMOTE position*

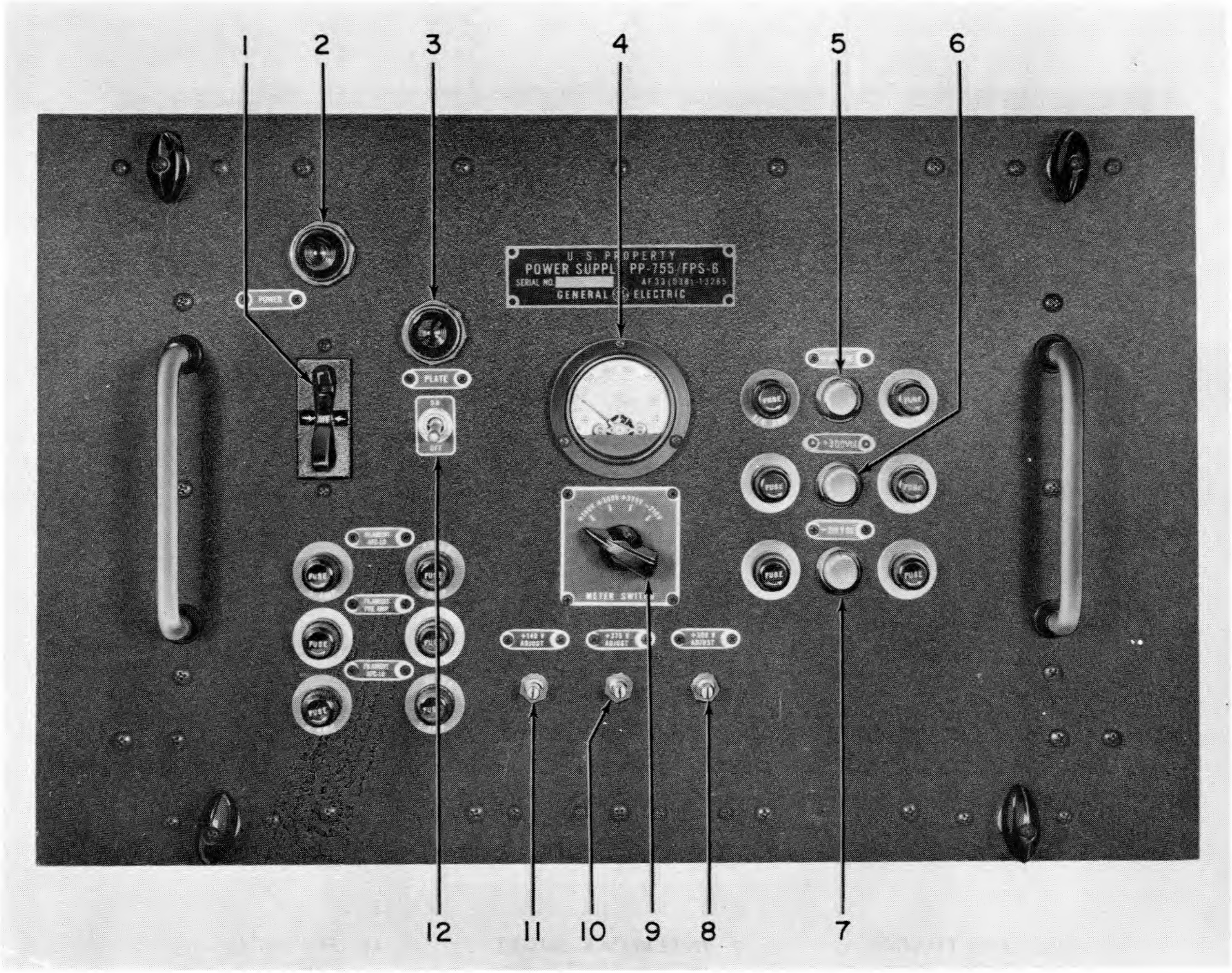
11 *POWER indicator I1008 lights when POWER switch is in ON position*

12 *POWER switch S1008 turns power to local control assembly on and off*

13 *ALARM RESET switch S1003 resets RELATIVE TUNING meter M1001 reading for normal operation after r-f deviation has been corrected*

14 *DETUNING INDICATOR I1003 lights when radio frequency deviates from normal 30-mc value and remains lighted until deviation is reduced and ALARM RESET switch S1003 is actuated*

Figure 1–64. Local Control Panel; Control, Radar Set C-2654/FPS-6A and C-2656/FPS-6B: Part of Radar Set Group OA-2037/FPS-6A and OA-2039/FPS-6B, Controls and Indicators



1 *POWER switch S1102 turns power on and off*

2 *POWER indicator I1108 lights when POWER switch is in ON position*

3 *PLATE indicator I1107 lights when PLATE switch is in ON position*

4 *Voltmeter M1102 measures circuit voltage indicated by METER switch*

5 *+140 VDC fuse indicator I1101 lights when adjacent fuse has blown*

6 *+300 V DC fuse indicator I1102 lights when adjacent fuse has blown*

7 *—210 V DC fuse indicator I1103 lights when adjacent fuse has blown*

8 *+300 V ADJUST control R1122 adjusts +300-volt supply*

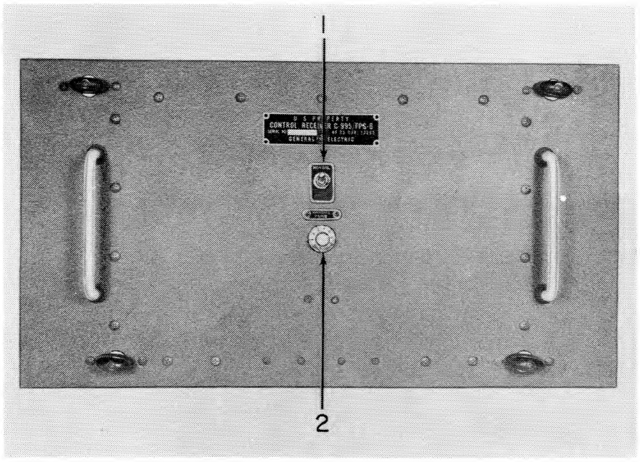
9 *METER SWITCH S1101 switches voltmeter to indicated circuits*

10 *+375 V ADJUST control R1145 adjusts +375-volt supply*

11 *+140 V ADJUST control R1121 adjusts +140-volt supply*

12 *PLATE switch S1104 turns plate supply on and off*

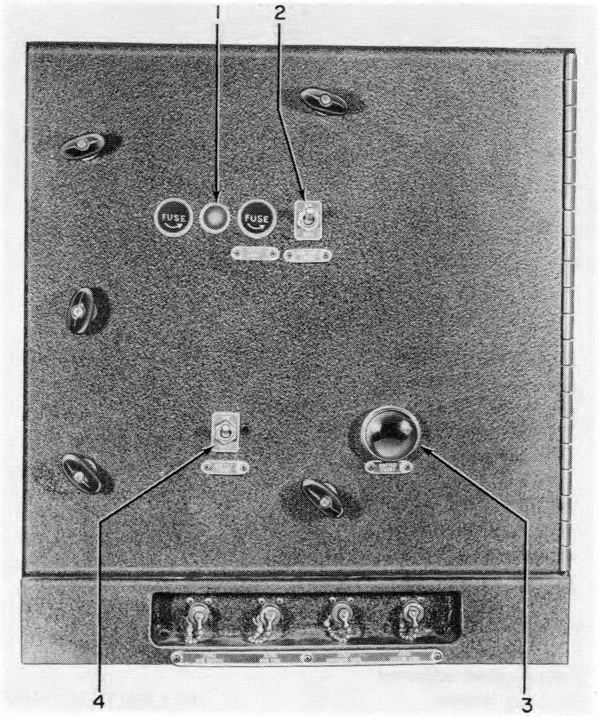
Figure 1–65. Preamplifier-LO Power Supply; Power Supply PP-755/FPS-6: Part of Radar Set Group OA-357/FPS-6, Controls and Indicators



1 *MANUAL-AFC switch S701 provides automatic frequency control of local oscillator when in AFC position after local oscillator coarse adjustment has been made manually with switch in MANUAL position*

2 *MANUAL TUNE control R702 provides manual coarse adjustment of local oscillator frequency*

Figure 1–66. AFC-LO Panel: Part of Control, Receiver C-995/FPS-6 or C-2662/FPS-6A, Controls and Indicators



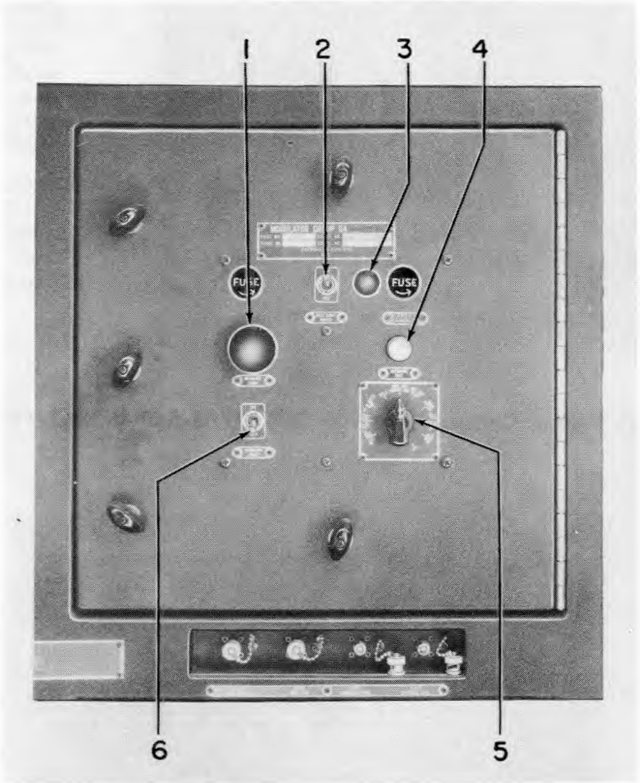
1 *TRIG AMP blown fuse indicator I2203 lights when adjacent fuse has blown*

2 *MOD CONT POWER switch S2250 turns modulator control power on and off*

3 *BATTLE SHORT indicator I2252 lights when BATTLE SHORT switch is in ON position*

4 *BATTLE SHORT switch S2251 shorts out modulator assembly interlock circuits when in ON position*

Figure 1–67. Power Panel: Part of Modulator Group OA-329/FPS-6, Controls and Indicators



1 *INTERLOCK SHORT indicator I2252 lights when INTERLOCK SHORT switch is in ON position*

2 *MOD CONT POWER switch S2250 turns modulator control power on and off*

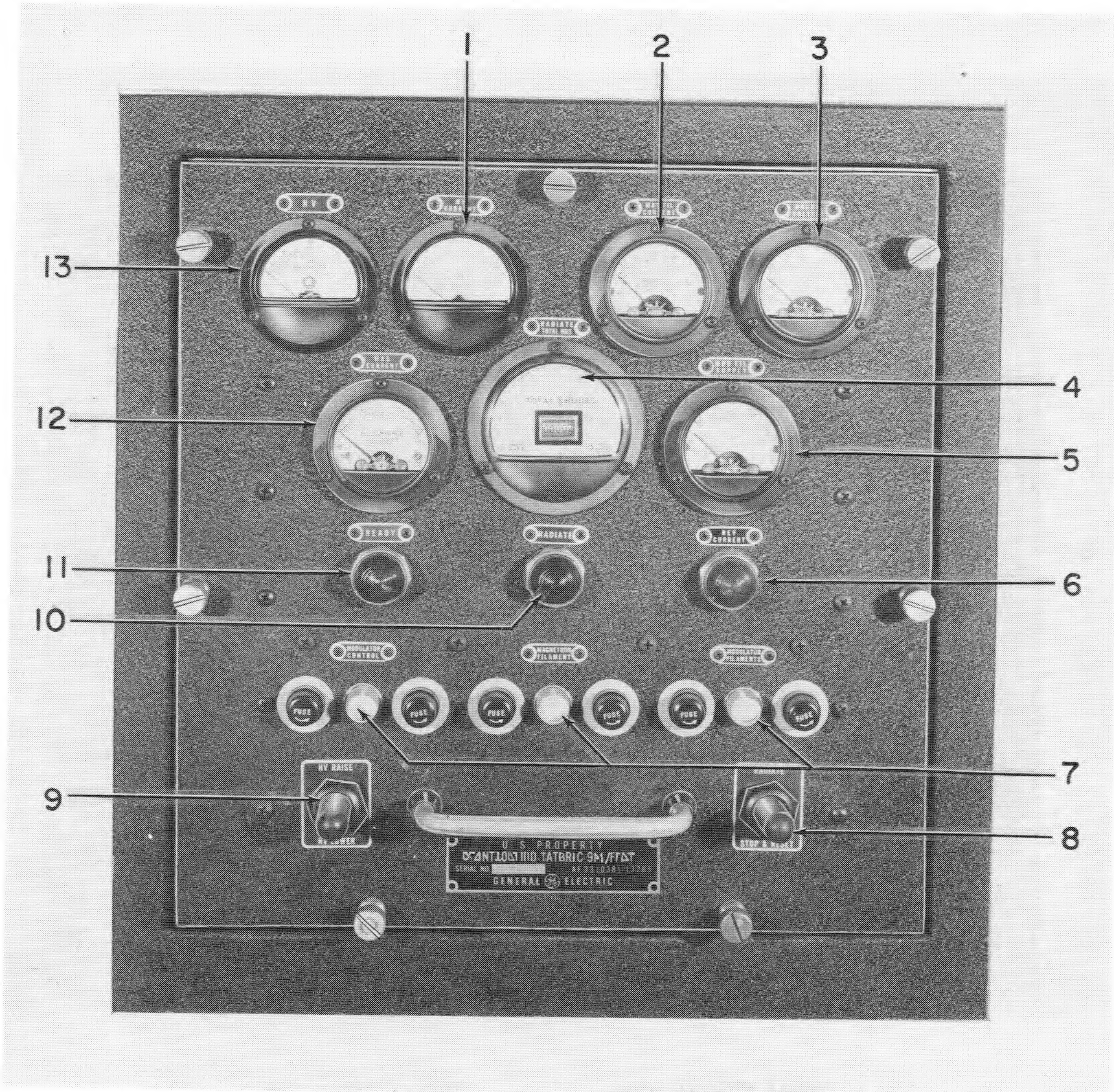
3 *TRIG AMPL blown fuse indicator I2203 lights when adjacent fuse has blown*

4 *INTERLOCK TEST indicator I2253 lights when interlock circuit indicated by INTERLOCK TEST switch is closed*

5 *INTERLOCK TEST switch S2253 is used to test interlock circuits as indicated by switch positions. Switch is rotated to each position and, if indicated circuit is closed, INTERLOCK TEST indicator will light*

6 *INTERLOCK SHORT switch S2251 shorts out modulator assembly interlock circuit when in ON position*

Figure 1–68. Power Panel: Part of Modulator Group OA-329A/FPS-6, Controls and Indicators



1 *HV CURRENT meter M2104 measures modulator high voltage d-c current*

2 *MAG FIL CURRENT meter M2105 measures magnetron filament current*

3 *MAG FIL VOLTAGE meter M2106 measures magnetron filament voltage*

4 *RADIATE TOTAL HRS meter M2101 measures total magnetron radiation time*

5 *MOD FIL SUPPLY meter M2107 measures modulator filament supply voltage*

6 *REV CURRENT indicator I2107 lights when modulator ceases firing due to reverse current in magnetron*

7 *Blown fuse indicators I2101 through I2103 light when respective adjacent fuses have blown*

8 *RADIATE-STOP & RESET switch S2101 causes modulator to fire magnetron when in RADIATE position. In STOP & RESET position, causes modulator to cease firing magnetron*

9 *HV RAISE-HV LOWER switch S2120 raises or lowers modulator high voltage when held in indicated position*

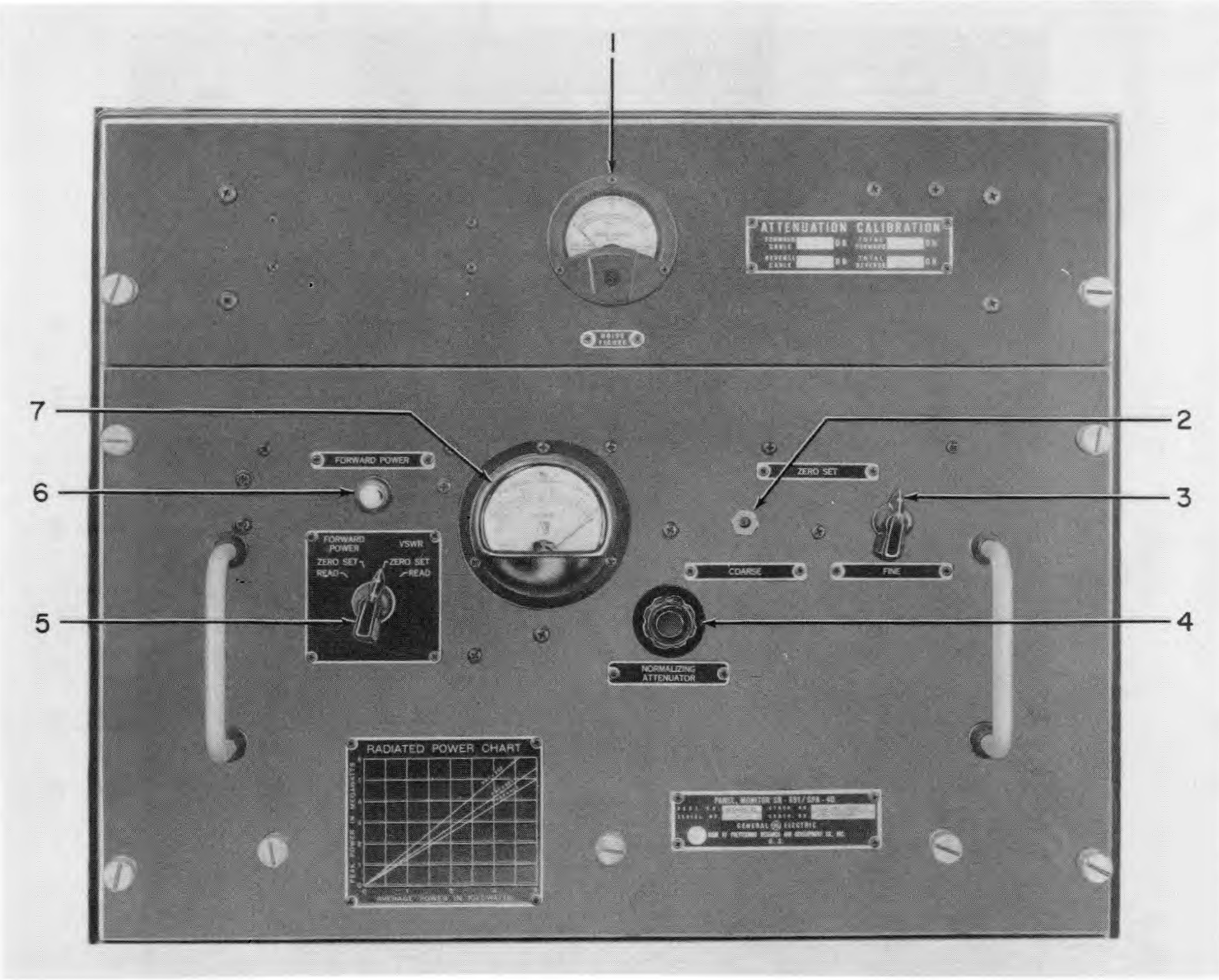
10 *RADIATE indicator I2105 lights when RADIATE-STOP & RESET switch is in RADIATE position*

11 *READY indicator I2106 lights when 15-minute warmup time delay has elapsed and modulator is ready to fire magnetron*

12 *MAG. CURRENT meter M2102 measures magnetron current*

13 *HV meter M2103 measures modulator high voltage*

Figure 1–69. Modulator Control Panel; Regulator, Current and Voltage CN-187/FPS-6: Part of Modulator Group OA-329/FPS-6 and OA-329A/FPS-6, Controls and Indicators



1 *NOISE FIGURE meter M8301 provides continuous reading of receiver noise figure*

2 *ZERO SET-COARSE switch S7755 supplies coarse zero-setting control for power and VSWR meter*

3 *ZERO SET-FINE control R7754 provides vernier zero-setting control for power and VSWR meter*

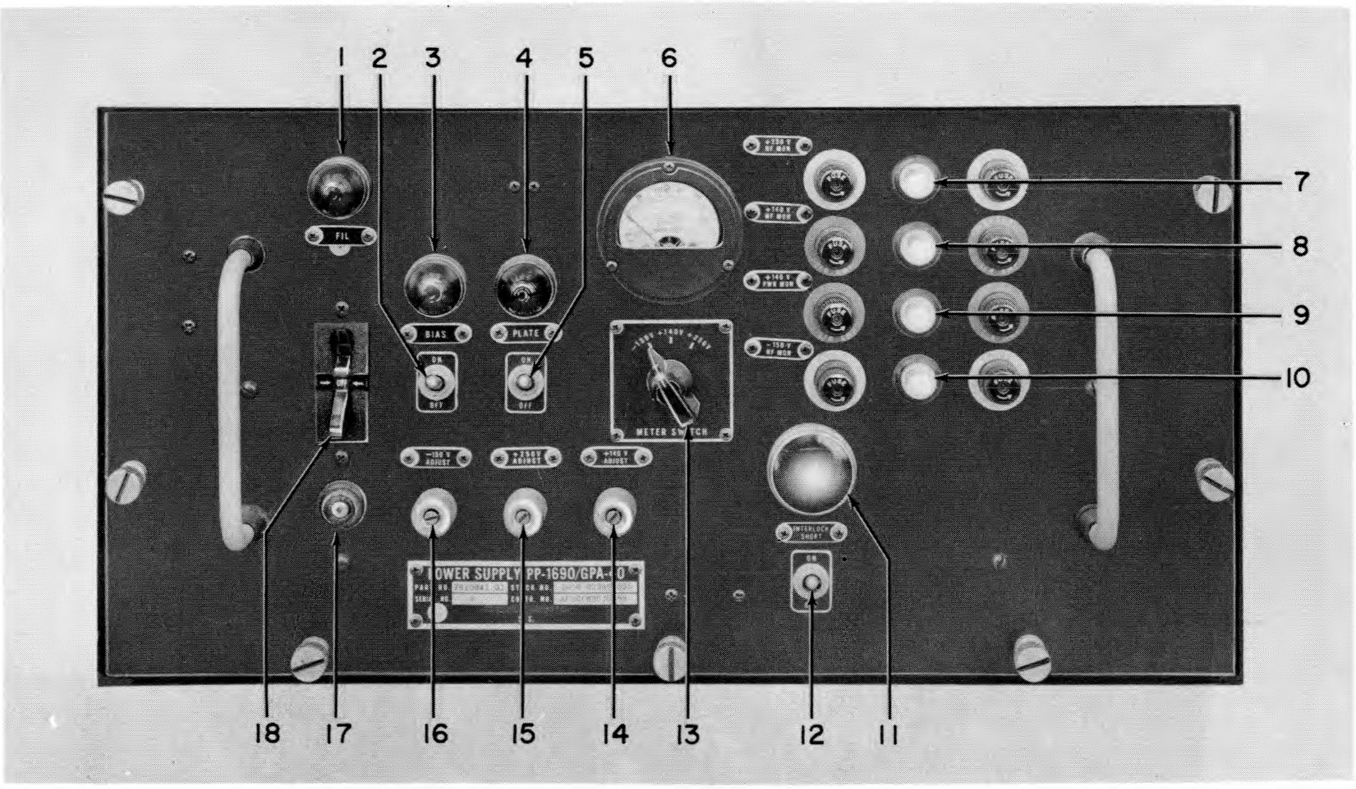
4 *NORMALIZING ATTENUATOR control AT7701 restores bridge network balance*

5 *FORWARD POWER-VSWR switch S7702 is used with power and VSWR meter for zero-setting meter and reading forward power or VSWR, as indicated by switch position*

6 *Power and VSWR meter M7701 provides reading of either forward power or VSWR*

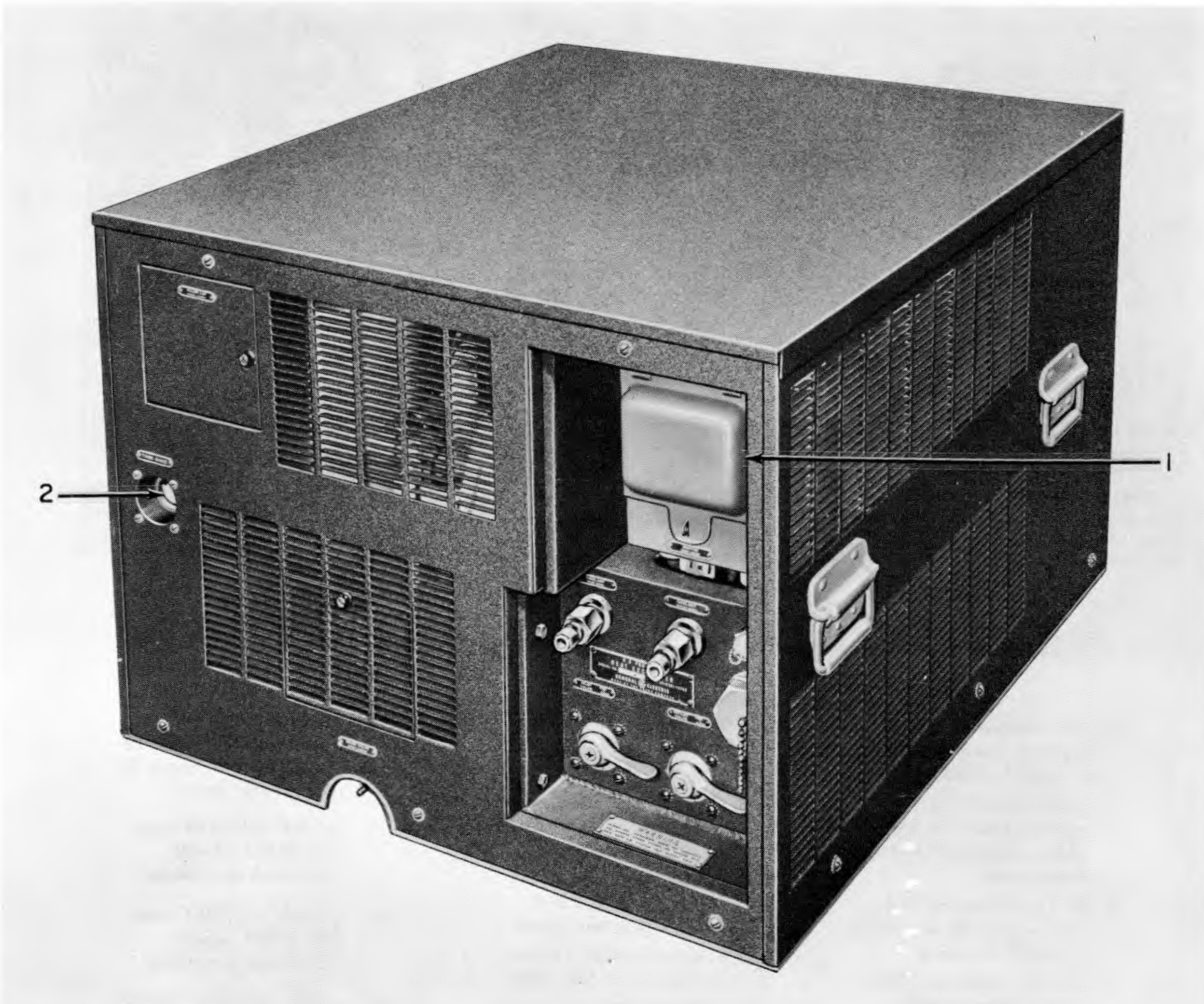
7 *FORWARD POWER indicator DS7701 lights when NORMALIZING ATTENUATOR control is set to a nominal 8.3 db and FORWARD POWER-VSWR switch is in FORWARD POWER position*

Figure 1–70. Power and Noise Figure Assembly; Panel, Monitor SB-691/GPA-40; Part of Indicator Group OA-1385/GPA-40, Controls and Indicators



1. *FIL indicator I7802 lights when FIL switch is in ON position*
2. *BIAS switch S7802 applies power to bias supply regulator power transformer*
3. *BIAS indicator I7804 lights when BIAS switch is in ON position*
4. *PLATE indicator I7805 lights when PLATE switch is in ON position*
5. *PLATE switch S7803 supplies power to plate supply regulator power transformer*
6. *DC voltmeter M7801 checks outputs of —150, +140, and +250 volts d-c selected by METER switch*
7. *Indicator I7806 lights when +250V NF MON fuse has blown*
8. *Indicator I7807 lights when +140V NF MON fuse has blown*
9. *Indicator I7808 lights when +140V PWR MON fuse has blown*
10. *Indicator I7809 lights when —150 NF MON fuse has blown*
11. *INTERLOCK SHORT indicator I7803 lights when INTERLOCK SHORT switch is in ON position*
12. *INTERLOCK SHORT switch S7804 shorts out performance monitor interlock when in ON position*
13. *METER SWITCH S7805 selects power supply output voltage to be read on test meter*
14. *+140V ADJUST control R7823 adjusts +140-volt d-c output*
15. *+250V ADJUST control R7809 adjusts +250-volt d-c output*
16. *—150V ADJUST R7833 control adjusts —150-volt d-c output*
17. *Power indicator I7801 lights when unit is connected to 120-volt a-c input sources*
18. *FIL switch S7801 applies filament supply voltage to unit*

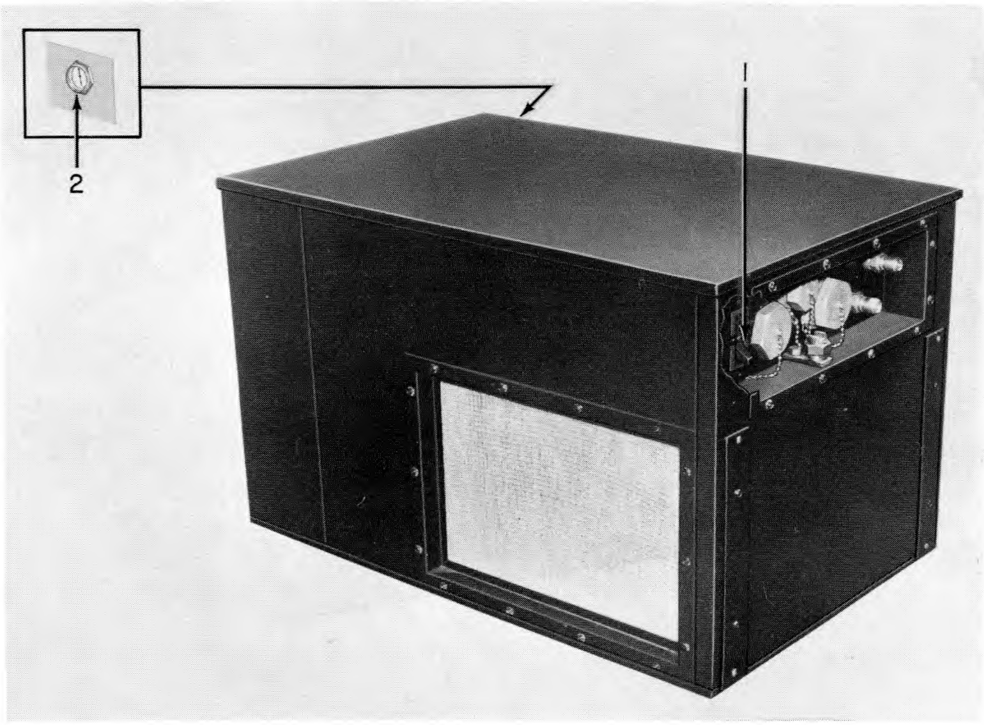
Figure 1–71. Performance Monitor Power Supply; Power Supply PP-1690/GPA-40: Part of Indicator Group OA-1385/GPA-40, Controls and Indicators



1 *Power switch S1901 turns unit on and off*

2 *Tank gage indicates amount of coolant in heat exchanger tank*

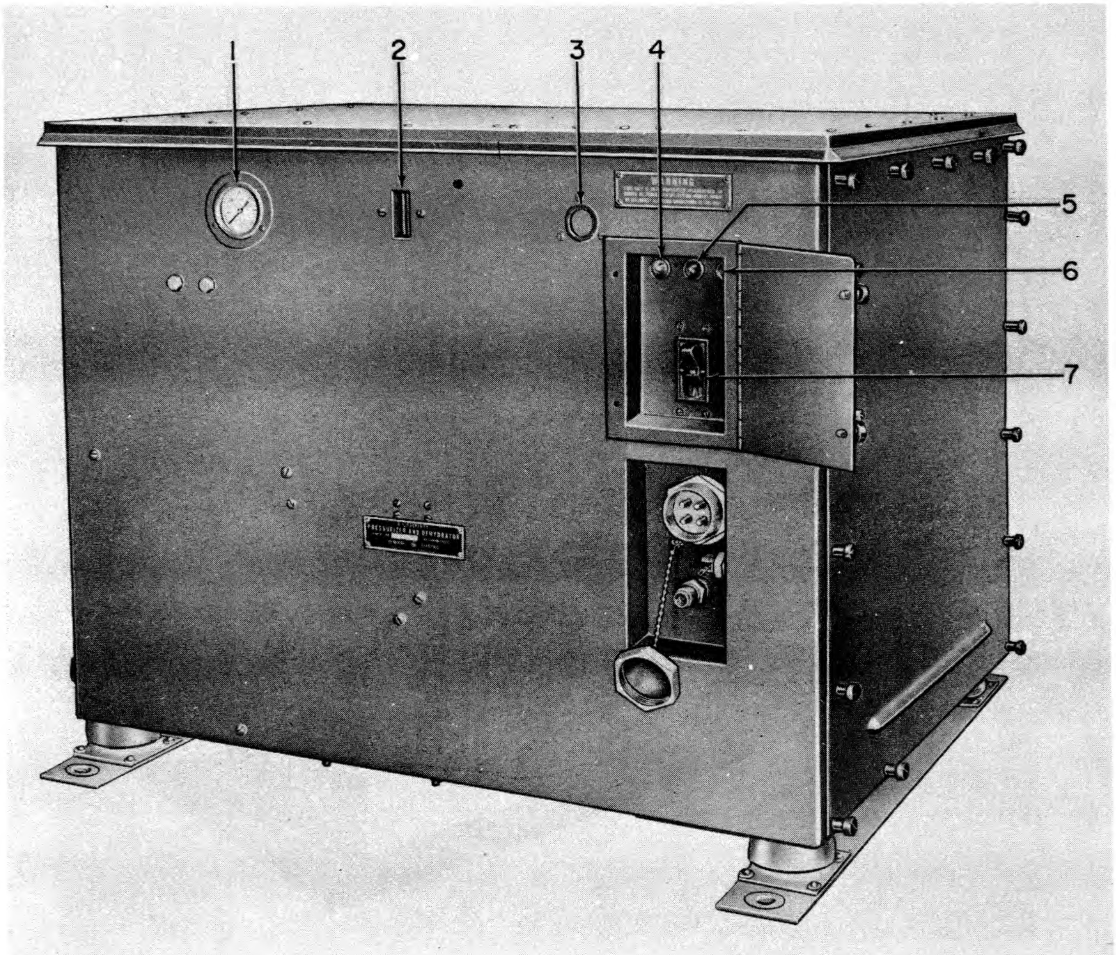
Figure 1–72. Heat Exchanger for Magnetron; Cooler, Liquid, Electron Tube HD-188/FPS-6, Controls and Indicators



1 *Power switch S2301 turns unit on and off*

2 *Liquid level gage indicates amount of coolant in heat exchanger tank*

Figure 1–73. Heat Exchanger for Ferrite Isolator; Cooler, Liquid, HD-289/FPS-6A, for Radar Set AN/FPS-6A (Used with Ferrite Isolator CU-492/FPS-6A Only), Controls and Indicators



1 *Line pressure gage I1801 indicates air pressure of waveguide system*

2 *Flow rate gage O1804 indicates rate of air flow in system*

3 *Humidity indicator M1802 indicates blue or pink color for flow or high humidity, respectively*

4 *Left reactivation indicator I1803 lights when left dehydrating cylinder is being reactivated*

5 *Power on indicator I1804 lights when unit is energized*

6 *Right reactivation indicator I1805 lights when right dehydrating cylinder is being reactivated*

7 *Power switch S1805 turns unit on and off, except heaters, which are controlled by a thermostat and connected directly to power circuit of unit*

Figure 1–74. Pressurizer and Dehydrator; Dehydrator, Desiccant, Electric HD-187/FPS-6, Controls and Indicators

SECTION II

TEST EQUIPMENT AND TOOLS

Note

Unless otherwise stated, all references to Radar Set AN/FPS-6 also apply to Radar Sets AN/FPS-6A, AN/FPS-6B and AN/FPS-90. Similarly, unless otherwise stated, all references to Radar Set AN/FPS-6A also apply to Radar Sets AN/FPS-6B and AN/FPS-90; and all references to Radar Set AN/FPS-6B, except for the variable-nod mechanism, also apply to Radar Set AN/FPS-90. Information applicable to Radar Set AN/MPS-14 is covered in Appendix A.

2–1. GENERAL.

2–2. The test equipment, test equipment accessories, and tools required for maintenance of Radar Set AN/FPS-6 are listed in this section. This equipment is used to perform the maintenance, test, and alinement functions described in Sections V and VI of this technical manual. Standard test equipment and common tools may be requisitioned, as required, from the appropriate supply class in accordance with the applicable equipment component list or unit authorization list.

2–3. TEST EQUIPMENT AND TEST EQUIPMENT ACCESSORIES.

2–4. The test equipment and test equipment accessories supplied with Radar Set AN/FPS-6 are listed in figure 2–1. This figure provides the name and AN type designation of each equipment and accessory, the quantity required, the leading characteristics of each piece of equipment, and an alternate equipment (where available) which may be used. Figure 2–1 also gives the application of each piece of equipment in the maintenance of Radar Set AN/FPS-6.

2–5. TOOLS.

2–6. The different types of special tools supplied with Radar Set AN/FPS-6 are listed in figure 2–2 and illustrated in figure 2–3. These tools are not all of the tools supplied, but only those of a special nature which have a specific function in Radar Set AN/FPS-6. Common tools, such as screwdrivers, pliers, side cutters, drills, etc., are not listed.

2–7. In addition to the name of each special tool, figure 2–2 lists the quantity, part number, characteristics, and application of the tool in Radar Set AN/FPS-6. The Figure and Index No. column refers to the illustration of the tool.

Quantity	Name	AN Type Designation	Characteristics	Alternate	Application
			TEST EQUIPMENT		
1	Crystal Rectifier Test Set	TS-268/U	Tests 1N21, 1N21A, 1N21B, 1N21C, 1N21E, 1N23, and 1N23B crystals	—	Crystal diode test
1	Echo Box	TS-270A/U	Range: 2630 to 2970 megacycles	—	Overall r-f performance tests and tuning
1	Multimeter	TS-297/U	1000-ohm-per-volt, a-c and d-c volt-ohm-milliammeter	—	General voltage, current, and resistance measurement
1	Multimeter	AN/PSM-6	1000- and 20,000-ohm-per-volt, d-c volt-ohm-milliammeter	—	General voltage, current, and resistance measurement
1	Multimeter	TS-505A/U	General purpose vacuum tube voltmeter (VTVM)	—	General overall tests
1	Oscilloscope	OS-8/U	General purpose oscilloscope	—	General overall tests

Figure 2–1. Test Equipment and Test Equipment Accessories Required for Maintenance (Sheet 1 of 3)

Quantity	Name	AN Type Designation	Characteristics	Alternate	Application
			TEST EQUIPMENT (cont)		
1	Power Measuring Kit[1]	MX-1309/URM-23	Range: 1000 to 4000 megacycles; 50-milliwatt full-scale sensitivity	Power Meter TS-125/AP	Transmitter power level tests
1	Signal Generator	AN/URM-61	C-w, f-m, or pulsed, r-f signal generator; range: 1800 to 4000 megacycles	Signal Generator TS-403/U	R-f tests
1	Synchroscope	AN/USM-24	General purpose synchroscope	—	General overall tests
1	Thermometer	Weston No. 2261	Range: $-50°C$ ($-58°F$) to $+100°C$ ($+212°F$)	—	Temperature measurement
1	Tube Tester	TV-7/U	A-c operated	Tube Tester TV-3	Tube tests
1	Voltmeter	ME-6/U	High-impedance input VTVM	TS-375A/U	Voltage measurement
1	Wavemeter	TS-117/GP	Range: 2400 to 3400 megacycles	—	R-f frequency measurement
1	R-f Probe	MX-925/U	Crystal detector range: 20 to 42 megacycles	—	I-f alinement and tests
1	Audio Oscillator	TS-382A/U	Generates test signals; range: 20 to 200,000 cps	—	General overall tests
1	Signal Generator	TS-452B/U	F-m signal generator; range: 5 to 100 megacycles	—	I-f amplifier tests
1	Summation Bridge	TS-730/URM	—	—	—
1	Dummy Load	DA-61/U	12.5 ohms, 8000 watts	—	Modulator dummy load
1	Test Set	AN/TRM-3	Radar test set	—	General overall tests
			TEST EQUIPMENT ACCESSORIES		
2	Adapter	M-358	UHF T-adapter		UHF connector coupling
2	Adapter	M-359	UHF right-angle connector		Test connection
1	Adapter	UG-29/U	Type N double female		Test connection
2	Adapter	UG-83/U	Type N to UHF adapter		Test connection
2	Adapter	UG-146/U	Type N to UHF adapter		Test connection
1	Adapter	MX-1385/CPS-6B	(Used with Adapter Connector UG-400/U)		Test connection
1	Adapter Connector	UG-400/U	Waveguide to type N connector		I-f amplifier tests
1	Attenuator	CN-29/UP	20-db attenuator		R-f tests
1	Attenuator	CN-42/UP	10-db attenuator		R-f tests

[1]Not supplied with Radar Set AN/FPS-6A

Figure 2–1. Test Equipment and Test Equipment Acccessories Required for Maintenance (Sheet 2 of 3)

Quantity	Name	AN Type Designation	Characteristics	Alternate	Application
TEST EQUIPMENT ACCESSORIES (cont)					
1	Attenuator	PRD Co Type 130B	6-db attenuator pad		I-f amplifier tests
3	Cord	CD-502	Black test lead; 2 ft 4 in. lg		Test connection
3	Cord	CD-502	Red test lead; 2 ft 4 in. lg		Test connection
3	Cord	CD-503	Black test lead; 8 ft 6 in. lg		Test connection
3	Cord	CD-503	Red test lead; 8 ft 6 in. lg		Test connection
2	Cord	CD-505-A	A-c power lead; 50 ft lg		Test connection
2	Cord	CG-70/MPN	RG-9/U cable with type N connectors; 8 ft lg		Test connection
2	Cord	CG-92/U	RG-9/U cable with type N connectors; 8 ft lg		Test connection
2	Cord	CG-295/U	RG-5/U cable with UHF connector and alligator clips; 6 ft lg		Test connection
1	Cord	CG-409/U	RG-58/U cable with UHF connector and alligator clips; 6 ft lg		Test connection
2	Crystal Adapter	UG-119/UP	Mounts crystal rectifier UG-88/U connectors		I-f amplifier tests
10	Crystal Rectifier	1N21B	UHF rectifier		For use with Crystal Adapter UG-119/U
2	Dummy Crystal	MX-1304/CPS-6B	300-ohm crystal simulator		I-f amplifier tests
2	R-f Adapter	UG-27A/U	Type N right-angle adapter		Type N connector coupling
2	R-f Adapter	UG-30/U	Double female pressurized panel connector		Test connection
2	R-f Adapter	UG-57/U	Type N double male connector		Type N connector coupling

Figure 2–1. Test Equipment and Test Equipment Acccessories Required for Maintenance (Sheet 3 of 3)

Quantity	Part No.	Name	Characteristics	Application	Figure 2–3 Index No.
1	208A857P1	Bar	Wrenching Bar	For locknut wrench	1
1	209A759G1	Tool box	—	—	2
1	173B603G1	Wrench	Spline type	For 8AN132 locknut	3
1	173B601G1	Wrench	4-9/16-in. opening	For jack screws	4
1	173B600G1	Wrench	3-9/16-in. opening	—	5
1	7021944G2	Duplexer tool	—	For removal and replacement of duplexer tubes	6

Figure 2–2. List of Special Tools Required for Maintenance

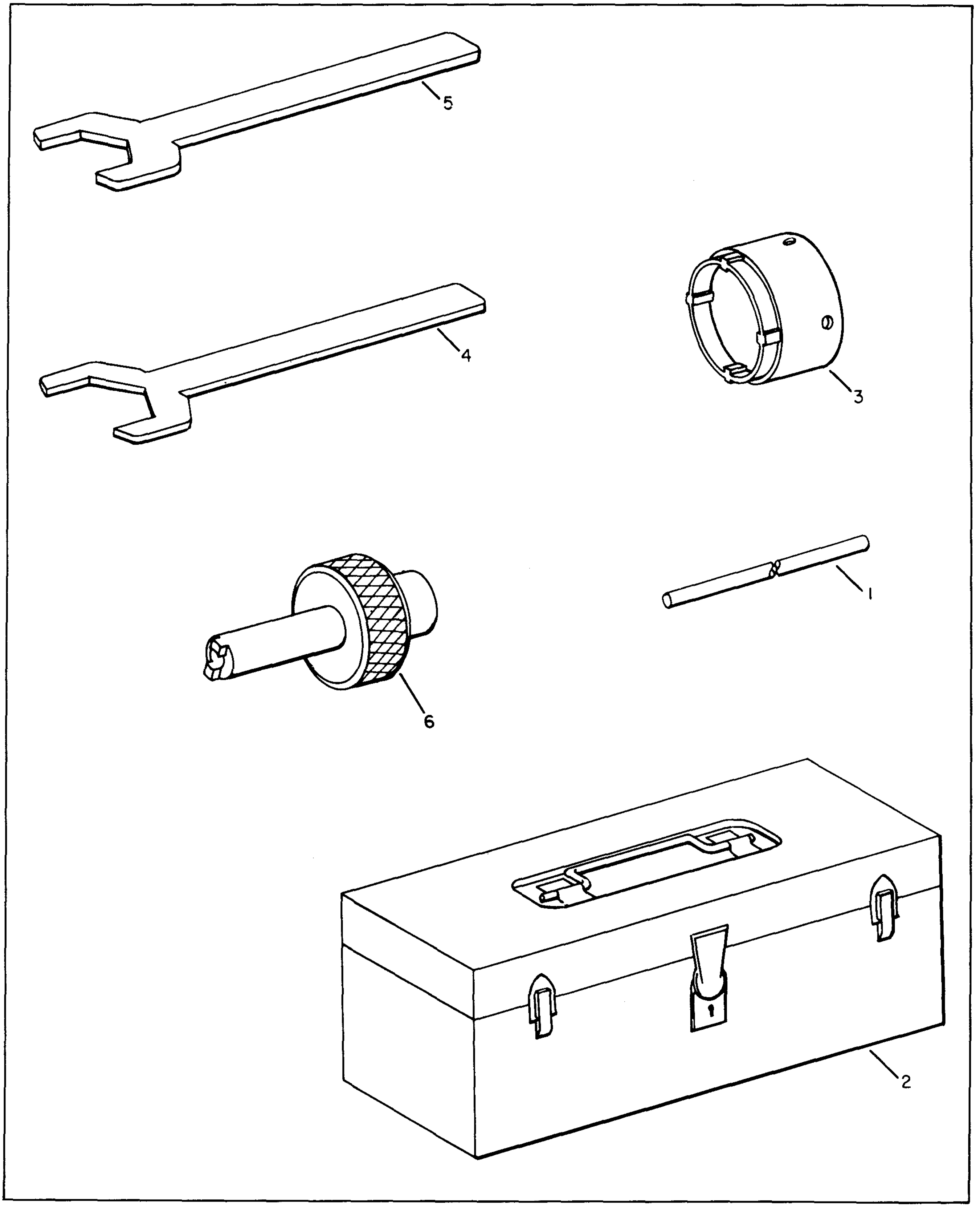


Figure 2-3. Special Tools Required for Maintenance

Component	Nomenclature	Location
Raid size indicator[2]	Indicator Group OA-1040/GPA	Housed with search radar
RHI assembly[1]	Radar Set Group OA-270/FPS-6	Housed with search radar
RHI assembly[2]	Indicator Group OA-929/FPS-6A	Housed with search radar
Azimuth control overlay	Control, Antenna C-1050/FPS-6	Housed with search radar
Remote height display	Indicator, Height ID-331/FPS-6	Housed with search radar
Time-sharing master control	Control, Antenna C-1049/FPS-6	Housed with search radar
Azimuth switch box[1]	Control, Antenna C-1048/FPS-6	Housed with search radar
RHI antenna control[2]	Control, Antenna C-1830/GPS	Housed with search radar
Junction box	Terminal Box J-470/FPS-6 or J-910/FPS-6A[2] or J-910/FPS-6B[3]	Housed with search radar
Azimuth blanker[2]	Blanker, Interference MX-1739A/FPS-6	Tower
Flexible waveguide	Waveguide Assembly CG-930/U	Tower
Waveguide	Waveguide Assembly CG-946/U (ft in.)	Tower
Waveguide	Waveguide Assembly CG-942/U (ft in.)	Tower
Preformed flexible waveguide	Waveguide Assembly CG-947/U	Tower
Radome operating equipment	—	Tower
Anemometer	—	External to tower
Radome erection equipment	Installation Kit MX-1070/CPS-6B	Tower
Radome and repair kit	Radome CW-209/CPS-6B	Tower
Cables	—	(See figure 3–12)

[1]One supplied
[2]Components of Radar Set AN/FPS-6A
[3]Components of Radar Set AN/FPS-6B

Figure 3–1. Location of Shipping Packages (Sheet 2 of 2)

3–8. REMOVAL OF MAGNETRON FOR RESHIPMENT.

3–9. Remove the magnetron from the magnetron assembly as follows:

CAUTION

Handle all magnetrons carefully, including those suspected of being defective. Frequently, a magnetron suspected of being defective checks out satisfactorily at the depot maintenance shop.

a. With all power removed from equipment, turn off inlet and outlet liquid flow valves in magnetron assembly (figure 3–4).

b. Carefully disconnect inlet and outlet liquid flow valves from magnetron cooling jacket and connect to cabinet fixtures.

c. Install two Hanson fittings with pipe plugs on mating coolant input fittings of magnetron anode block.

CAUTION

Avoid spilling coolant around transformer cathode well. Coolant dripping into cathode well when magnetron is removed could result in oil contamination and affect the life of the tube and transformer.

d. Close oil breather valve and oil flow valve (figure 3–4) on pulse transformer oil reservoir.

Note

The following procedure applies to the removal of the magnetron from a unit equipped with air-cooled Ferrite Isolator CU-492A/FPS-6A only. Refer to paragraph 3–10 for the procedure for removal from a unit equipped with liquid-cooled Ferrite Isolator CU-492/FPS-6A.

e. Remove waveguide Marmon clamp (figure 3–5) from output of magnetron and waveguide section.

Note

Weight of ferrite isolator and waveguide section must be supported during removal.

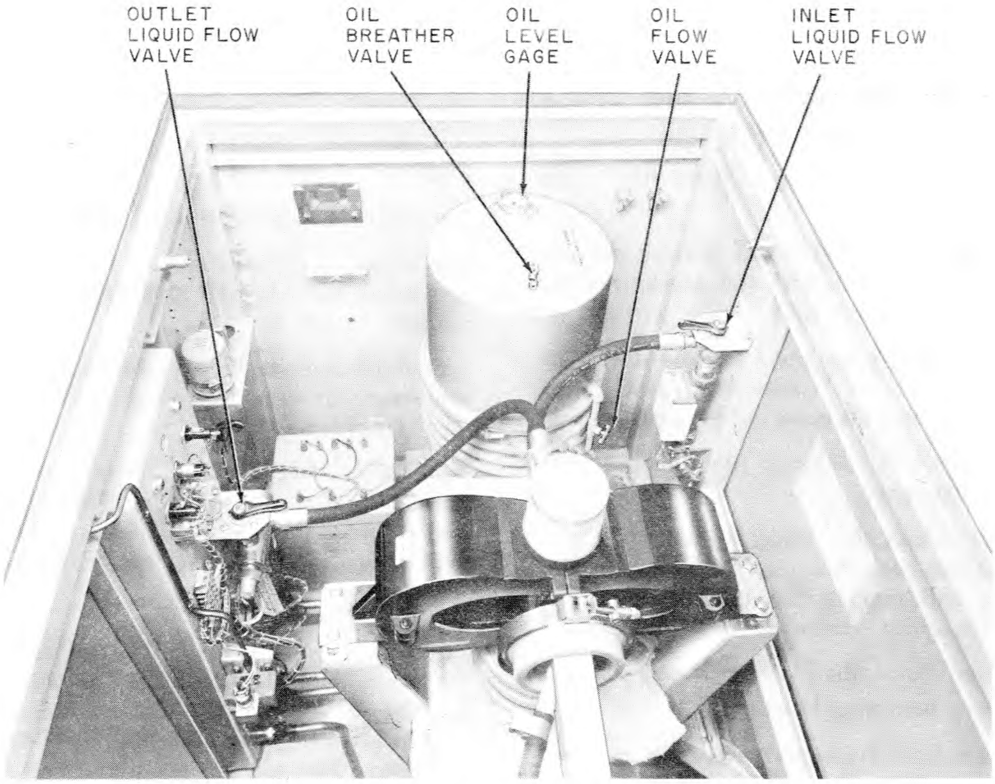


Figure 3–4. Magnetron Assembly for Radar Set AN/FPS-6. Internal View

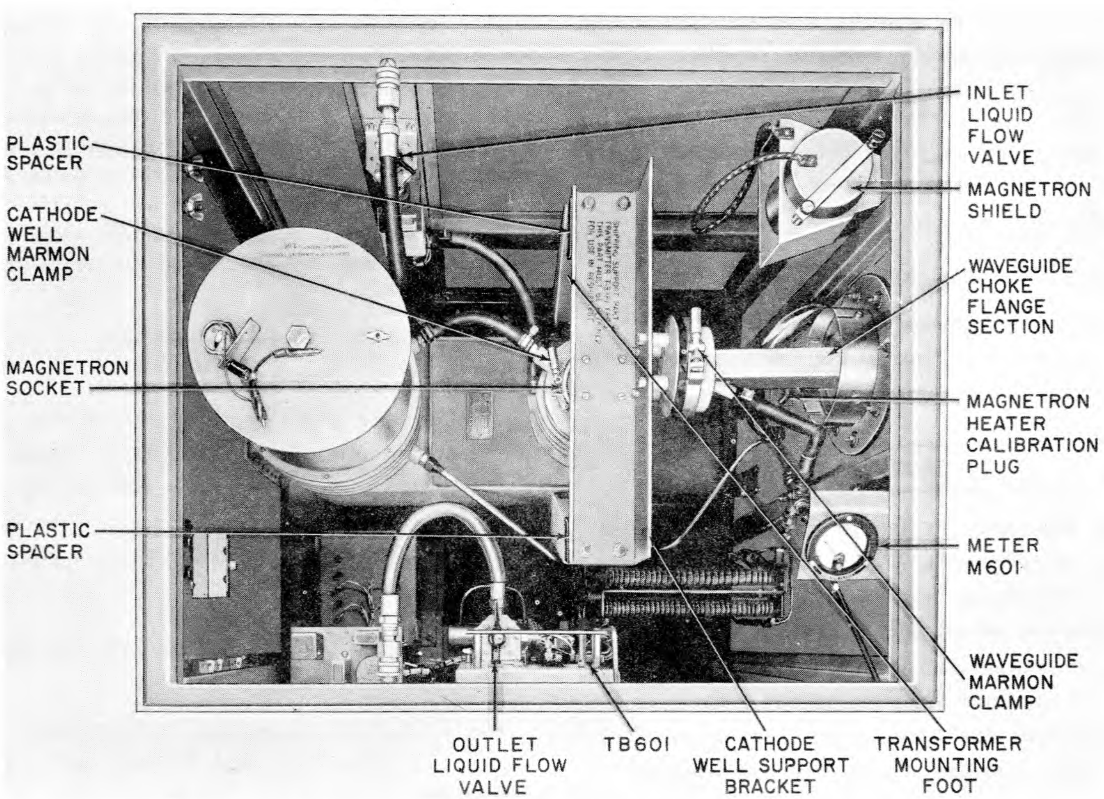


Figure 3–5. Magnetron Assembly for Radar Set AN/FPS-6A, Internal View of Removal of Cathode Well Support Bracket

f. Install isolator support under air-cooled ferrite isolator as follows:

(1) Back out three bolts (N157P2532) on flat mounting plate section (7213936) of isolator support until bolts are flush with surface of plate.

(2) Place mounting plate on A-frame with guide pins pointing up.

(3) Slide U-section (7744161) of isolator support onto plate until it is between fins and misses two tie rods that support fins on isolator.

(4) Move mounting plate and U-section until pins on plate rest against base of U-section to insure alinement of screws and plate with holes in base of U-section.

(5) Turn screws into mounting plate until weight of isolator rests on support.

g. Loosen eight screws that secure waveguide choke flange section of transmission line to wall of magnetron assembly cabinet, and remove four 10-32 cap screws from flange on waveguide section.

h. Remove three bolts that secure horizontal leg of hinge on isolator mounting bracket.

i. Disconnect air hose from waveguide section and slide ferrite isolator and waveguide section out of magnetron assembly cabinet.

j. Disconnect waveguide section from ferrite isolator.

k. Remove four bolts securing magnetron mounting brackets, using nonmagnetic wrenches supplied.

Note

Two men, one on either side of magnetron assembly, are required to remove the magnetron.

l. Lift magnetron straight out of cathode well.

m. Remove two Hanson fittings and pipe plugs installed in step c and replace in their storage mountings in magnetron assembly cabinet.

CAUTION

Use extreme care in handling magnetron; do not jar unnecessarily. Magnetron is an assembly of fragile and high-precision parts which are critically alined and is also an expensive piece of equipment. Avoid blows, jarring or shock of any kind. Keep magnetron away from ferromagnetic materials, such as tools, steel table tops, and steel floors. Use nonmagnetic box wrenches in magnetron assembly to install and remove magnetron. Do not set magnetron on thin metal cup protecting exhaust seal opposite high-voltage cathode bushing, or aluminum cup may be damaged under magnetron weight and exhaust seal tubulation impaired (figure 3–6).

n. Remove magnetron filament terminal adapter (figures 3–7 and 3–8).

o. Repack magnetron in its original shipping crate.

p. Place two plastic spacers on cathode well support and install cathode well support bracket with four bolts removed in step k.

q. Replace waveguide section in its original position and secure to cathode well support bracket with Marmon clamp removed in step e.

3–10. The procedure for removal of the magnetron from a magnetron assembly provided with liquid-cooled Ferrite Isolator CU-492/FPS-6A is identical to that outlined in paragraph 3–9, except as follows:

a. Disregard step f.

b. Liquid-cooled Ferrite Isolator CU-492/FPS-6A is not provided with an isolator support for use during installation or removal; therefore, this isolator must be held in place by some other means. Wooden blocks may be inserted between ferrite isolator and A-frame to support weight of isolator during removal.

3–11. DISASSEMBLY OF ANTENNA GROUPS OA-389/FPS-6 AND OA-2035/FPS-6A.

3–12. GENERAL. Disassembly of Antenna Groups OA-389/FPS-6 and OA-2035/FPS-6A is the reverse of the erection procedure described in the technical manual of installation instructions for this equipment. The gin pole of the erection equipment is used to disassemble the antenna. The components of the antenna are removed from the top platform of Tower AB-258/FPS-6 (temperate) with the antenna hoist and from the top platform of Tower AB-259/FPS-6 (arctic) with the gantry crane.

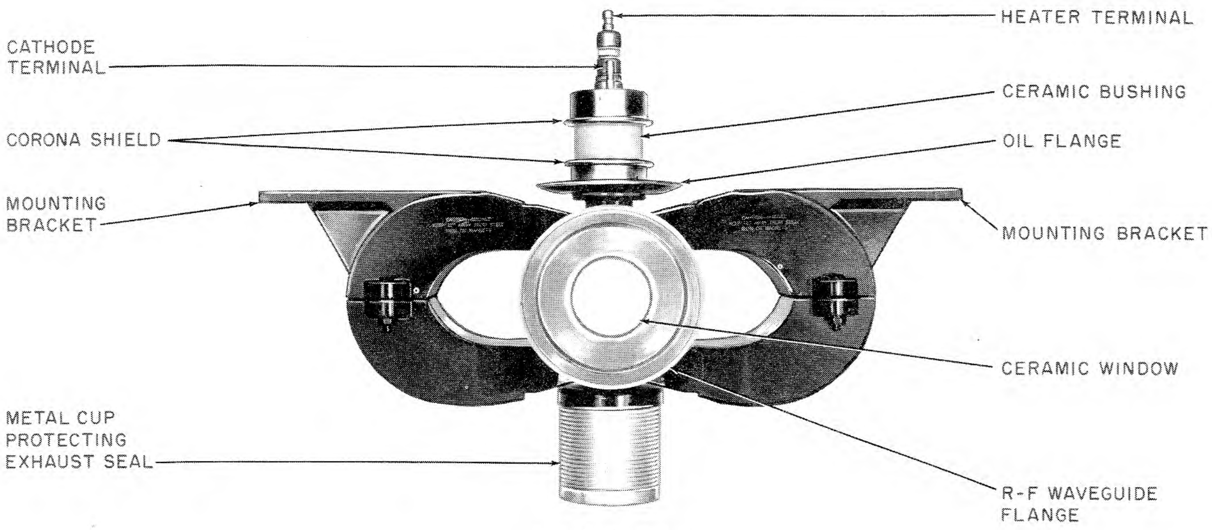
CAUTION

Use care when handling the antenna components; do not bump, bend, or mar them. Secure shipping covers to joint surfaces to prevent marring and entrance of foreign matter. Coat mounting flanges with corrosion-preventive compound.

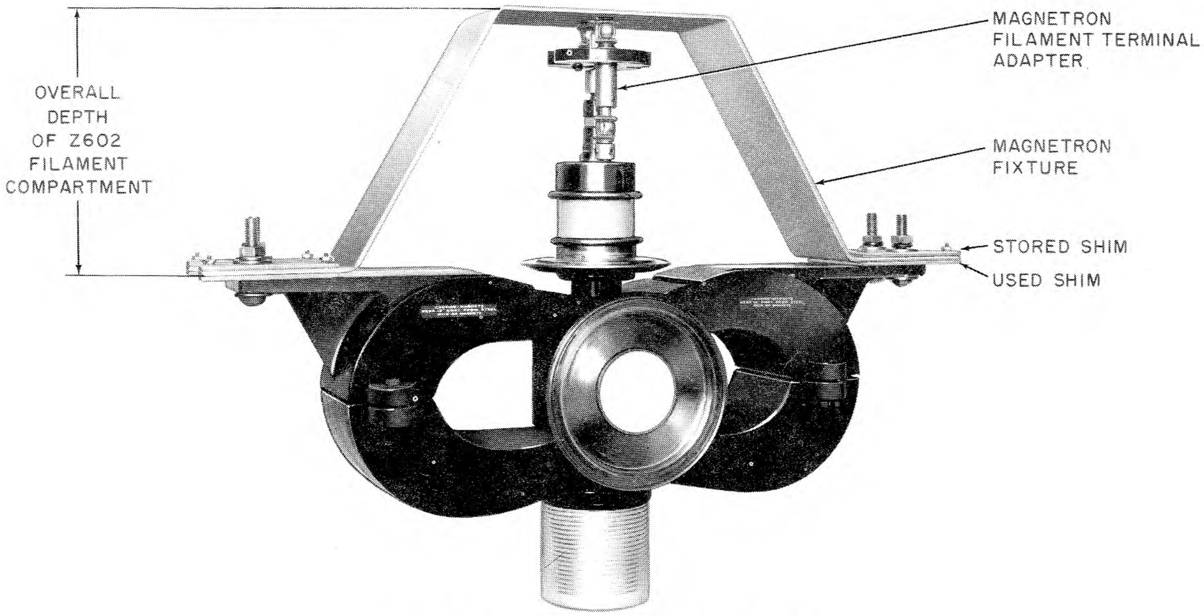
3–13. INTERCONNECTION CABLES. Disconnect the interconnection cables as follows:

a. Disconnect coaxial and multiconductor cables from girder junction box and bundle into shaft of cone assembly.

b. Disconnect interconnection cables (A7014263G1) from their receptacles and return to box 128.



MAGNETRON



MAGNETRON WITH FIXTURE IN USE

Figure 3–6. Magnetron and Magnetron Fixture

3–14. DIAL AND RING. Remove the dial and ring as follows:

a. Remove nameplate (NP117385), bracket (205A487P1), four clamps (205A488P1), four dial brackets (167B299P1), and dial and ring (145C547G1) from bottom of yoke hub of main girder assembly.

b. Return components to box 128 and hardware to package 32 of box 101.

3–15. AZIMUTH ROTATING JOINT. Remove the azimuth rotating joint as follows:

a. Remove bracket (174B668P1), two brackets (14C955G1), plate (174B670P1), azimuth rotating joint (519E476G1), and ring plate (174B669P1) from bottom flange of azimuth drive nut.

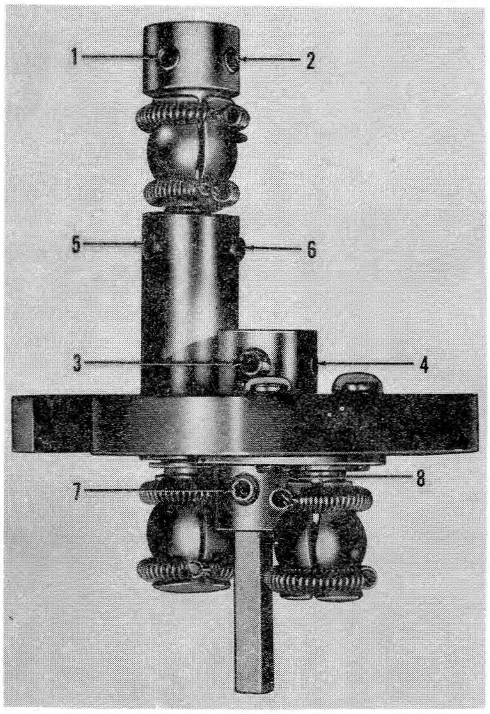


Figure 3–7. Magnetron Filament Terminal Adapter, Old Type

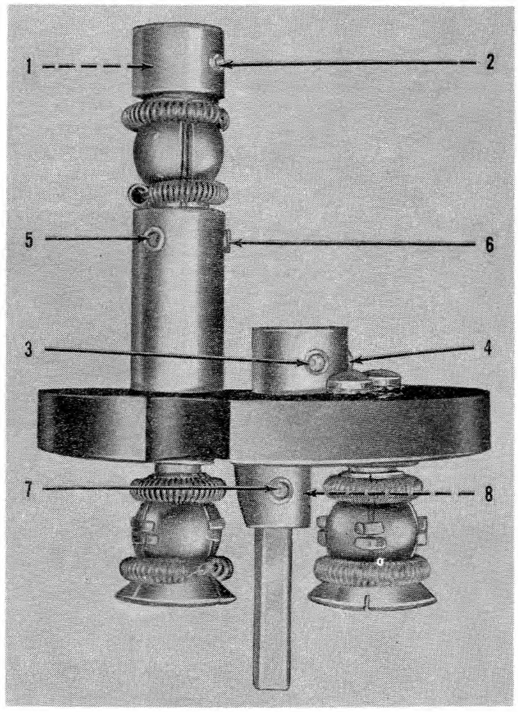


Figure 3–8. Magnetron Filament Terminal Adapter, New Type

b. Secure shipping cover to top flange of azimuth rotating joint.

c. Return components to box 127 and hardware to package 31 of box 101.

3–16. WAVEGUIDES. Remove the waveguides as follows:

a. Remove waveguide (169B704G1) from small end of waveguide (145C528G1).

b. Remove waveguide (145C528G1) and gasket (205A338P1) from bottom flange of azimuth drive unit.

c. Remove shims (202A793P1 through P6) and gaskets (202A786P1 and P2) from small end of waveguide.

d. Remove waveguide from girder junction box, cone assembly, and azimuth drive unit.

e. Remove waveguide support (9738647P1) and two straps (206A453P1) from left yoke section of main girder assembly.

f. Remove waveguide (145C811G1) from waveguide supports and straps on left yoke arm.

g. Remove one flexible waveguide (176B785G1) from fixed end of elevation rotating joint and one flexible waveguide (176B785G1) from waveguides (169B717G1 and 168B423G1).

h. Loosen half-clamps (169B365G1) and remove waveguide (169B717G1).

i. Remove support (169B379G1) and twist waveguide from mobile end of elevation rotating joint.

j. Remove clamp (145C851P1) from front face of left reflector hub.

k. Secure shipping covers to fixed and mobile ends of elevation rotating joint.

l. Remove waveguide (168B423G1) from horn assembly and secure shipping cover to input end of horn assembly.

m. Secure shipping covers to ends of waveguides.

n. Return components to box 125 and hardware to package 29 of box 101.

3–17. GIRDER JUNCTION BOX. Remove the girder junction box as follows:

a. Remove girder junction box (139D416G1) and D-shaped gasket (167B258P1) from yoke hub of main girder assembly.

b. Return components to box 126 and hardware to package 30 of box 101.

3–18. TIE ROD ASSEMBLY. Remove the tie rod assembly as follows:

a. Remove tie rod assembly (178B771G1) from right hub of center reflector section and right side of horn yoke.

b. Return components to box 123 and hardware to package 27 of box 101.

3-19. HORN ASSEMBLY. Remove the horn assembly as follows:

a. Remove captive bars from right side of horn yoke and slide out horn assembly (145C897G1).

b. Replace captive bars on horn yoke.

c. Return horn assembly and horn yoke (139D842G1) to box 124 and hardware to package 28 of box 101.

3-20. HORN-SUPPORTING MEMBERS. Remove the horn-supporting members as follows:

a. Remove horn-supporting assembly from front stiffeners of center reflector section and disassemble assembly.

b. Return bottom (979453P1) and top (979454P1) horn outriggers to box 123 and hardware to package 27 of box 101.

c. Return cross brace (139D812P1), two half-clamps (169B365P1), two braces (7414338P1), two braces (7414339P1), connector (169B376P1), and connector (169B376P2) to box 123 and hardware to package 27 of box 101.

d. Remove junctions (145C880P1 and 148C257P1), two braces (169B386P1), two braces (169B387P1), two braces (169B388P1), and four clamps (168B476P1) from front stiffeners of center reflector section.

e. Return components in step d to box 123 and hardware to package 27 of box 101.

3-21. BOTTOM REFLECTOR SECTION. Remove the bottom reflector section as follows:

a. Remove bottom reflector section (9076836P1), tag 6, from center reflector section.

b. Return component to box 121 and hardware to package 25 of box 101.

3-22. CONNECTING ROD. Remove the connecting rod as follows:

a. Remove connecting rod (7302613G1) from mounting bracket at rear of center reflector section and from crank of elevation motor.

b. Return component to box 122 and hardware to package 26 of box 101.

3-23. CENTER AND TOP REFLECTOR SECTIONS. Remove the center and top reflector sections as follows:

a. Remove center and top reflector section assembly from reflector mounting flanges of elevation selsyn and angle mark unit and elevation rotating joint.

b. Pivot elevation rotating joint to left and ease assembly from between reflector mounting flanges.

c. Remove top reflector section (9076835P1), tag 5, from center reflector section.

d. Return top reflector section to box 120 and hardware to package 25 of box 101.

e. Return center reflector section (9076834G2), tag 4, to box 119.

3-24. BRAKE ASSEMBLY. Remove the brake assembly as follows:

a. Remove brake assembly (139D861G2) from back of left yoke section of main girder assembly.

b. Return component to box 117 and hardware to package 23 of box 101.

3-25. ELEVATION MOTOR AND BRACKET. Remove the elevation motor and bracket as follows:

a. Remove elevation motor (506E111) from motor bracket.

b. Return elevation motor to box 118 and hardware to package 24 of box 101.

c. Remove motor bracket (7607107P1) from rear of left yoke section of main girder assembly.

d. Return motor bracket to package 117 and hardware to package 22 of box 101.

3-26. ELEVATION ROTATING JOINT. Remove the elevation rotating joint (519E480G1) as follows:

a. Prevent the reflector from moving during the following step by fastening a 1/2-inch diameter rope, approximately 60 feet long, to upper antenna supports above reflector junction and securing the center of the rope to a convenient place near the base of the antenna.

b. Disconnect upper segment of connecting rod assembly from lower segment by removing the four bolts and lockwashers and the eight washers and shock mounts which secure the upper and lower plates together.

c. Hold the reflector in place during the following steps by using a gin pole, crane, or traveling derrick.

d. Remove the rope securing the reflector in place.

e. Loosen seven screws and lockwashers securing the reflector mounting flange of the elevation rotating joint to the reflector hub.

f. Loosen four bolts and nuts securing elevation selsyn and angle mark unit to the right yoke arm.

g. Detach elevation rotating joint from left yoke arm by removing two bolts, two lockwashers, four plain washers, and two nuts from the front side and two bolts and nuts from the rear side.

h. Detach elevation rotating joint from reflector by removing seven screws and lockwashers securing the reflector mounting flange of the joint to the reflector hub.

i. Secure shipping cover to the bottom flange of the elevation rotating joint and return the joint to box 116.

j. Return hardware from the reflector mounting flange to the package of erection hardware for box 116 contained in box 102.

3-27. ELEVATION SELSYN AND ANGLE MARK UNIT. Remove the elevation selsyn and angle mark unit (7303266G2) as follows:

a. Perform steps a through d of paragraph 3-26.

b. Loosen eight screws securing the reflector mounting flange of the elevation selsyn and angle mark unit to the reflector hub.

c. Loosen the following hardware securing the elevation rotating joint to the left yoke arm: two bolts, two lockwashers, four plain washers, and two nuts from the front side and two bolts and nuts from the rear side.

d. Detach elevation selsyn and angle mark unit from the right yoke arm by removing four bolts and nuts.

e. Detach elevation selsyn and angle mark unit from the reflector hub by removing eight screws and lock-washers.

f. Secure shipping cover to the bottom flange of the unit and return the unit to box 115.

g. Return hardware from the reflector mounting flange to the package of erection hardware for box 115 contained in box 102.

3–28. YOKE ARMS. Remove the yoke arms as follows:

a. Remove waveguide supports (9720618P1 and 9738647G1) and three straps (206A453P1) from left yoke arm.

b. Return waveguide supports, straps, and hardware to box 125.

c. Remove left yoke arm (9797457P1) from left yoke section of main girder assembly.

d. Coat top and bottom flanges of left yoke arm with corrosion-preventive compound and return to box 114. Return hardware to package 20 of box 101.

e. Remove right yoke arm (9797457P10) from right yoke section of main girder assembly.

f. Coat top and bottom flanges of right yoke arm with corrosion-preventive compound and return to box 113. Return hardware to package 19 of box 101.

3–29. MAIN GIRDER ASSEMBLY. Remove the main girder assembly as follows:

a. Remove locknut (8AN132), lockwasher (W132), and ring (202A788P1) from threaded shaft of cone assembly and return to box 111.

b. Remove main girder assembly (145C508G1) from cone assembly.

c. Secure shipping cover to bottom flange of yoke hub.

d. Coat yoke arm mounting flanges with corrosion-preventive compound and return main girder assembly to box 112.

3–30. CONE ASSEMBLY. Remove the cone assembly as follows:

a. Disengage ring gear couplings of cone assembly (519E430G2) and azimuth drive unit and remove cone assembly.

b. Secure shipping covers to top and bottom flanges of cone assembly and return to box 111. Return hardware to package 18 of box 101.

3–31. AZIMUTH DRIVE UNIT AND MOTOR AND SELSYN UNIT. Remove the azimuth drive unit and the motor and selsyn unit as follows:

a. Remove azimuth drive unit (519E432G2), with motor and selsyn unit assembled to it, from mounting ring assembly.

b. Secure shipping covers to top and bottom flanges of azimuth drive unit and return to box 110.

3–32. MOUNTING RING ASSEMBLY. Remove the mounting ring assembly as follows:

a. Remove mounting ring assembly (7605550G1) from base ring.

b. Return component to box 109 and hardware to package 17 of box 101.

3–33. BASE RINGS. Remove the base rings as follows:

Note

Top base ring section (141D396P1), tag 2, is used only in temperate tower installations.

a. Remove top base ring section from bottom base ring.

b. Return top base ring section to box 102 and hardware to package 17 of box 101.

c. Remove bottom base ring section (149C574G1), tag 1, from top platform mounting pad and return to box 103. Leave hardware in pads.

3–34. DISASSEMBLY OF ANTENNA GROUP OA-2040/FPS-6B.

3–35. GENERAL. The procedure for disassembly of Antenna Group OA-2040/FPS-6B is the same as that given for Antenna Groups OA-389/FPS-6 and OA-2035/FPS-6A in paragraph 3–11. However, there are some units peculiar to Antenna Group OA-2040/FPS-6B and disassembly of these units is covered in the following paragraphs. It should be noted that the girder junction box, connecting rod, center reflector section, and the bracket for the elevation motor and brake of Antenna Group OA-2040/FPS-6B replace similar items in Antenna Groups OA-389/FPS-6 and OA-2035/FPS-6A. In addition, Antenna Group OA-2040/FPS-6B includes the variable-nod mechanism. Perform the disassembly of all items outlined in paragraphs 3–13 through 3–16, noting that waveguide (7708226G1) replaces waveguide (169B704G1).

3–36. ELEVATION TOWER ASSEMBLY. Remove the elevation tower assembly as follows:

a. Disconnect nod-amplitude shaft (7302607G1) mounted on elevation tower assembly (7302609G1) from universal joint of elevation motor pivot arm.

b. Disconnect yoke from lower end of connecting rod.

c. Remove elevation tower assembly and its bracket, with nod-amplitude shaft still assembled, from main girder.

d. Remove elevation gear case assembly (7302615G1) from elevation tower assembly and return to box 135.

e. Remove cone shaft assembly (7302607G1) from elevation tower assembly and return to box 133.

f. Return remainder of elevation tower assembly to box 134 and all hardware to box 101.

3–37. GIRDER JUNCTION BOX. Remove the girder junction box as follows:

a. Remove girder junction box (7607113G1) from main girder assembly.

b. Return girder junction box to box 126 and hardware to box 101.

3–38. PIVOT ARM ASSEMBLY. Remove the pivot arm assembly as follows:

a. Remove pivot arm assembly (7607104G1) from elevation motor shaft.

b. Return pivot arm assembly to box 122 and hardware to box 101.

3–39. ELEVATION MOTOR AND BRAKE ASSEMBLY. Remove the elevation motor and brake assembly as follows:

a. Remove elevation motor (506E111 or 662D612) from elevation motor and brake bracket.

b. Return elevation motor to box 118 and hardware to box 101.

c. Remove brake assembly (139D861G2) from elevation motor and brake bracket.

d. Return brake assembly to box 117 and hardware to box 101.

3–40. ELEVATION MOTOR AND BRAKE BRACKET. Remove the elevation motor and brake bracket as follows:

a. Remove elevation motor and brake bracket (7607107P1) from main girder assembly.

b. Return elevation motor and brake bracket to box 118 and hardware to box 101.

3–41. CONNECTING ROD ASSEMBLY. Remove the connecting rod assembly as follows:

a. Remove connecting rod assembly (7302613G1) from reflector drive tube.

b. Return connecting rod assembly to box 122 and hardware to box 101.

3–42. REFLECTOR DRIVE TUBE ASSEMBLY. Remove the reflector drive tube assembly as follows:

CAUTION

Adequate support must be provided for the reflector drive tube assembly during removal. Refer to the installation procedures for the reflector drive tube assembly in Section VI for the proper method of supporting the reflector drive tube with ropes.

a. Remove reflector drive tube assembly (7302621G1) and drive arms (7607115G1) from yoke hubs and center reflector section, being careful to avoid damaging drive arms or bolts.

b. Remove two reflector drive arms (7607115G1) from reflector drive tube.

c. Return entire assembly (including reflector drive tube, with short connecting rod and two drive arms) to box 132. Return hardware to box 101.

3–43. TIE ROD ASSEMBLY. Remove the tie rod assembly in accordance with the procedure outlined in paragraph 3–18.

3–44. HORN ASSEMBLY AND HORN-SUPPORTING MEMBERS. Remove the horn assembly and horn-supporting members as outlined in paragraphs 3–19 and 3–20, respectively.

3–45. REFLECTOR SECTIONS. Remove the bottom, center, and top reflector sections in accordance with the procedures given in paragraphs 3–21 and 3–23.

Note

The remainder of the antenna assembly should be disassembled as outlined in paragraphs 3–26 through 3–33.

3–46. SHIPPING UNPACKAGED EQUIPMENT.

3–47. When required, the units of Radar Set AN/FPS-6 can be shipped unpackaged under the following conditions:

a. Adequate strapping and cushioning is used

b. Trained personnel will handle the units

c. Units will not be damaged in transit

3–48. PACKAGING EQUIPMENT.

3–49. When trained personnel cannot accompany units in transit or be at both shipping and receiving points, the equipment must be packaged. Certain units are constructed so as not to require packaging for reshipment and can be shipped as they are, using adequate strapping and cushioning. Units originally shipped in special containers, noted as nonexpendable in the packing lists of Tower AB-258/FPS-6 (temperate), Tower AB-259/FPS-6 (arctic), and Antenna Group OA-389/FPS-6, can be packaged in their original containers. All other units should be packaged in accordance with Joint Army-Navy Packaging Instructions JPI-14A, Method II, which require a moisture- and vapor-proof package including a desiccant and, under certain conditions, a preservative. The containers for these units should be constructed according to the instructions of the Technical Orders listed in figure 3–9.

Technical Order Number	Title
00-35A-14	Marking of Supplies for Overseas Shipment
00-85-2	AAF Packaging Materials and Equipment
00-85-3	Corrosion Control for Packaging
00-85-4	Fiberboard Folding for Setup Cartons
00-85-5	Nailed Wood Boxes
00-85-5A	(Supplement)
00-85-6	Cleated Plywood Boxes
00-85-6A	(Supplement)
00-85-7	Crate Construction Manual
00-85-8	Interior Blocking, Bracing, and Cushioning
00-85-9	Preparation of Freight for Air Shipment
00-85-10	Metal Container Preservation and Packaging

Figure 3–9. Equipment Packaging Technical Orders

3–50. CABLE FABRICATION INSTRUCTIONS.

3–51. GENERAL.

3–52. All cables used to make interconnections between the component members of Radar Set AN/FPS-6, with the exception of the de-icing switch box power cables, are supplied by the manufacturer completely assembled and ready for use. The fabrication instructions given in the following paragraphs are included for use only when damage or failure requires repair or complete replacement of any cables. The procedures are arranged in numerical order by bulk cable nomenclature. Many cables use the same bulk cable and connector or lug terminations, which vary from each other only in length. Figure 3–10 is a list of these cables, cross-indexed with the bulk cable from which they are fabricated. Figures 3–11 and 3–12 tabulate the length, function, type of cable used, and other varied pertinent cable information.

Cable Symbol Number	Bulk Cable AN Nomenclature Code
W9401, W9402, W9403, W9404	CX-1968/U (ft in.)
W9405	CX-1971/U (ft in.)
W9406, W9412, W9415, W9419, W9420, W9422, W9425, W9428, W9432, W9436, W9437, W9454, W9455, W9458, W9459, W9461, W9462	CX-1163/U (ft in.)
W9407, W9410,W9411, W9416, W9433, W9434, W9435, W9438, W9439, W9440, W9441, W9442, W9443, W9444, W9445, W9452, W9453, W17006	CX-1158/U (ft in.)
W9408, W9409, W9414, W9417, W9418, W9421, W9423, W9424, W9426, W9429, W9431, W9446, W9447, W9463, W17009	CX-1970/U (ft in.)

Figure 3–10. Cable Fabrication Group List (Sheet 1 of 2)

Cable Symbol Number	Bulk Cable AN Nomenclature Code
W17010, W9413	CX-1159/U (ft in.)
W9427, W9430, W9448, W9449, W9456	CX-1156/U (ft in.)
W9450	CX-2084/U (ft in.)
W9451	CX-1156/U (ft in.)
W9501, W9502, W9503, W9504, W9505, W9506, W9510, W9511, W9512, W9517, W9518, W9519, W9520, W9521, W9522, W9523, W9524, W9534, W9535, W9536, W9537	CG-426A/U (ft in.)
W9507	CG-884A/U (ft in.)
W9508, W9509	CG-579/U (ft in.)
W9513, W9514, W9515	CG-927/U (ft in.)
W9516	CG-317/U (ft in.)
W9525, W9526, W9527	CG-426B/U (ft in.)
W17001	CX-1205/U (ft in.)
W17002, W17005, W17007	CX-1212/U (ft in.)
W17003, W17004	CX-1162/U (ft in.)
W17020	CX-2135/U (ft in.)
W17021, W17022, W17023, W17024, W17025, W17026, W17027, no symbol (power cable to de-icing switch box)	––
W17028, W17029, W17030, W17031, W17032, W17033, W17034, W17035, W17036	CX-1510/U (ft in.)
W17037	CX-1205/U (ft in.)
W9464	CX-4537

Figure 3–10. Cable Fabrication Group List (Sheet 2 of 2)

AN Nomenclature Code	Wire Used	Terminations: One End: Lug	One End: Plug	One End: Clamp or Cap and Chain	Other End: Clamp or Cap and Chain	Other End: Plug	Other End: Lug	Cable Symbol	Outside Diameter (inches)
CG-317/U (ft in.) Cord	RG-58A/U	—	7471378-2	—	—	7471378-2	—	W9516	0.805
CG-426A/U (ft in.) Cable Assembly, Radio Frequency	RG-59A/U	—	7468567-P1	7128111-1	7128111-1	7468567-P1	—	W9501 through W9506 W9510 W9511 W9512 W9517 W9518 through W9524 W9534 W9535 W9536 W9537	0.242
CG-426B/U (ft in.) Cord	RG-59A/U	—	7468567-P1	1 Weatherproofing grommet (701-3647-P1) and compression nut (7013646)	1 Weatherproofing grommet (701-3647-P1) and compression nut (7013646)	7468567-P1	—	W9525 W9526 W9527	0.242
CG-579/U (ft in.) Cable Assembly, Radio Frequency	RG-71/U	—	7468567-P1	7128111-1	7128111-1	7468567-P1	—	W9508 W9509	0.25
CG-884A/U (ft in.) Cable Assembly, Radio Frequency	CS-426	—	7408065	—	—	7408065	—	W9507	1.33
CG-927/U (ft in.) Cable Assembly, Radio Frequency	RG-59A/U	—	7468567-P1	7128111-1	1 Weatherproofing grommet (701-3647-P1) and compression nut (7013646)	7468567-P1	—	W9513 W9514 W9515	0.242
CX-1156/U (ft in.) Cable Assembly, Power	2#8 (CW-1198)	—	7408081-P1	7703729-P16	7703729-P16	7408081-P2	—	W9427 W9430 W9448 W9449 W9456	0.85
		#8(2)	—	—	7703729-P16	7408081-P2	—	W9451	—

Figure 3–11. Cable Nomenclature Index (Sheet 1 of 3)

AN Nomenclature Code	Wire Used	Terminations						Cable Symbol	Outside Diameter (inches)
		One End			Other End				
		Lug	Plug	Clamp or Cap and Chain	Clamp or Cap and Chain	Plug	Lug		
CX-1158/U (ft in.) Cable Assembly, Special Purpose	19#16 (CW-1196-19)	—	7408084-P2	7703729-P4	7703729-P4	7408086-P1	—	W9407 W9410 W9411 W9416 W9433 W9434 W9435 W9438 through W9445 W9452 W9453 W17006	0.97
CX-1159/U (ft in.) Cable Assembly, Special Purpose	8#16 shielded (CW-1195)	—	7408083-P2	7703729-P2	7703729-P2	7408083-P1		W9413	0.75
CX-1162/U (ft in.) Cable Assembly Power	4#6 (CW-1194)	—	7408082-P1	7703729-P11	—	—	#6$_{(1)}$	W17003 W17004	1.22
CX-1163/U (ft in.) Cable Assembly, Special Purpose	14#16 (CW-1196-14)	—	7408083-P2	7703729-P3	7703729-P3	7408083-P1	—	W9406 W9412 W9415 W9419 W9420 W9422 W9425 W9428 W9432 W9436 W9437 W9454 W9455 W9458 W9459 W9461 W9462	0.835
CX-1205/U (ft in.) Cable Assembly, Power	4#6 (CW-1194)	—	7408082-P2	7703729-P11	—	—	#6$_{(1)}$	W17001	1.22
		#6$_{(4)}$	—	—	7703729-P15	7408081-P1	—	W17037	1.22
CX-1212/U (ft in.) Cable Assembly, Special Purpose	4#16 (CW-1196-4)	—	7408082-P2	7703729-P15	—	—	#16$_1$	W17002 W17005 W17007	0.505

Figure 3–11. Cable Nomenclature Index (Sheet 2 of 3)

AN Nomenclature Code	Wire Used	Terminations: One End: Lug	One End: Plug	One End: Clamp or Cap and Chain	Other End: Clamp or Cap and Chain	Other End: Plug	Other End: Lug	Cable Symbol	Outside Diameter (inches)
CX-1510/U (ft in.) Cable Assembly, Power, Electrical	4#4 (CW-1210)	—	7408082-P1	7703729-P10	7703729-P10	7408082-P2	—	W17028 through W17036 (lamp blank cables)	1.49
CX-1968/U (ft in.) Lead, Electrical	1#3/0 (CW-1192)	—	$\#4/0_{(1)}$	—	—	—	$\#4/0_{(1)}$	W9401 through W9404	0.97
CX-1970/U (ft in.) Cable Assembly, Power, Electrical	4#6 (CW-1194)	—	7408082-P1	7703729-P11	7703729-P11	7408082-P2	—	W9408 W9409 W9414 W9417 W9418 W9421 W9423 W9424 W9426 W9429 W9431 W9446 W9447 W9463 W17009 W17010	1.22
CX-1971/U (ft in.) Cable Assembly, Power, Electrical	4#2 (CW-1197)	$\#2_{(1)}$	—	—	—	—	$\#2_1$	W9405	1.6
CX-2084/U (ft in.) Cable Assembly, Power, Electrical	4#16 (CW-1196-4)	—	7411335-P1	7703729-P15	7703729-P15	7408081-P1	—	W9450	0.505
CX-2135/U (ft in.) Lead, Electrical	1#4/0 (CW-1220)	—	$\#4/0_{(1)}$	—	—	—	$\#4/0_{(1)}$	W17020 through W17027 No symbol power cables to de-icing switch box)	1.14
CX-4537	2#16 (CW-1210)	—	7408081-P1	7703729-P15	7703729-P15	7408081-P2	—	W9464	—

Figure 3–11. Cable Nomenclature Index (Sheet 3 of 3)

Cable	One End: Jack or Terminal	One End: Unit	Other End: Jack or Terminal	Other End: Unit	Other End: Length (ft)	Function	AN Nomen-clature Code
W9401	—	Power source	TB6901 $_{\phi}$A	Control group assembly	275	Power	CX-1968/U
W9402	—	Power source	TB6901 $_{\phi}$B	Control group assembly	275	Power	CX-1968/U
W9403	—	Power source	TB6901 $_{\phi}$C	Control group assembly	275	Power	CX-1968/U
W9404	—	Power source	TB6901 NEP	Control group assembly	275	Power	CX-1968/U
W9405	—	Power source	TB6901 $_{\phi}$D	Control group assembly	275	Power	CX-1971/U
			TB6901 $_{\phi}$E				
			TB6901 $_{\phi}$F				
			TB6901 NAP				
W9406[1]	J9708	Junction box	J6910	Control group assembly	67	Control	CX-1163/U
W9407[1]	J9709	Junction box	J6909	Control group assembly	67	Power and control	CX-1158/U
W9406[2]	J6504	RHI Antenna control	J6910	Control group assembly	67	Control	CX-1163/U
W9407[2]	J6503	RHI Antenna control	J6909	Control group assembly	67	Power and control	CX-1158/U
W9408	J10302	Modulator high-voltage regulator	J6901	Control group assembly	360	Power	CX-1970/U
W9409	J2254	Modulator assembly	J6902	Control group assembly	365	Power	CX-1970/U
W9410	J2253	Modulator assembly	J6913	Control group assembly	365	Power	CX-1158/U
W9411	J928	R-f assembly	J6914	Control group assembly	350	Control	CX-1158/U
W9412	J920	R-f assembly	J6915	Control group assembly	350	Control	CX-1163/U
W9413	J921	R-f assembly	J6916	Control group assembly	350	Control	CX-1159/U
W9414	J925	R-f assembly	J6903	Control group assembly	350	Power	CX-1970/U
W9415	J3202	Azimuth drive motor and selsyn unit	J6905	Control group assembly	380	Control	CX-1163/U
W9416	J3304	Cone junction box	J6904	Control group assembly	380	Control	CX-1158/U
W9417	J3303	Cone junction box	J6907	Control group assembly	380	Power	CX-1970/U
W9418	J3302	Cone junction box	J6908	Control group assembly	380	Power	CX-1970/U
W9419	J3204	Azimuth drive motor	J6906	Control group assembly	380	Power and control	CX-1163/U

[1] For Radar Set AN/FPS-6 only
[2] For Radar Sets AN/FPS-6A and AN/FPS-6B

Figure 3–12. Cable Running List (Sheet 1 of 8)

Cable	One End		Other End			Function	AN Nomen-clature Code
	Jack or Terminal	Unit	Jack or Terminal	Unit	Length (ft)		
W9420	J3502	Amplidyne	J6911	Control group assembly	360	Power and control	CX-1163/U
W9421	J3501	Amplidyne	J6912	Control group assembly	360	Power	CX-1970/U
W9422	J916	R-f assembly	J2252	Modulator assembly	30	Power and control	CX-1163/U
W9423[1]	J923	R-f assembly	J1901	Magnetron heat exchanger	18	Power	CX-1970/U
W9423[2]	J923	R-f assembly	J2301	Ferrite isolator heat exchanger (CU-492/FPS-6A only)	18	Power	CX-1970/U
W9423[2]	J923	R-f assembly	J2351	Ferrite isolator blower assembly (CU-492A/FPS-6A only)	18	Power	CX-1970/U
W9424	J915	R-f assembly	J605	Magnetron cabinet assembly	12	Power	CX-1970/U
W9425	J913	R-f assembly	J603	Magnetron cabinet assembly	12	Power and control	CX-1163/U
W9426	J1801	Pressurizer and dehydrator	J924	R-f assembly	17	Power	CX-1970/U
W9427	J601	Magnetron cabinet assembly	J606	Magnetron cabinet assembly	5	Power	CX-1156/U
W9428	J10401	Modulator high-voltage power supply	J2251	Modulator assembly	19	Power and control	CX-1163/U
W9429	J10403	Modulator high-voltage power supply	J10301	Modulator high-voltage regulator	14	Power	CX-1970/U
W9430	J10404	Modulator high-voltage power supply	J10303	Modulator high-voltage regulator	14	Control	CX-1156/U
W9431	J3503	Amplidyne	J3203	Azimuth drive motor	12	Power	CX-1970/U
W9432	J3101	Safety box	J3305	Cone junction box	45	Control	CX-1163/U
W9433[1]	J9703	Junction box	J3901	Azimuth switch box	55	Control	CX-1158/U
W9434[1]	J9704	Junction box	J3902	Azimuth switch box	55	Control	CX-2397/U
W9433[2]	J9703	Junction box	J6501	RHI antenna control	55	Control	CX-1158/U
W9434[2]	J9704	Junction box	J6502	RHI antenna control	55	Control	CX-2397/U
W9435	J9710	Junction box	J3801	Time-sharing master control	56	Power and control	CX-1158/U
W9436[2]	J9705	Junction box	J4217	RHI No. 1	33	Power and control	CX-1163/U
W9437[1]	J9713	Junction box	J4217	RHI No. 2	53	Power and control	CX-1163/U
W9436[1]	J9705	Junction box	J22903	RHI No. 1	33	Power and control	CX-1163/U
W9437[2]	J9713	Junction box	J22903	RHI No. 2	53	Power and control	CX-1163/U

1 For Radar Set AN/FPS-6 only
2 For Radar Sets AN/FPS-6A and AN/FPS-6B

Figure 3–12. Cable Running List (Sheet 2 of 8)

Cable	One End: Jack or Terminal	One End: Unit	Other End: Jack or Terminal	Other End: Unit	Length (ft)	Function	AN Nomen-clature Code
W9438	J9714	Junction box	J3701	Remote height display	37	Power and control	CX-1158/U
W9439	J9715	Junction box	J3601	Azimuth control overlay	38	Power and control	CX-1158/U
W9440	J9711	Junction box	J3701	Remote height display	42	Power and control	CX-1158/U
W9441	J9712	Junction box	J3601	Azimuth control overlay	43	Power and control	CX-1158/U
W9442	J9706	Junction box	J3701	Remote height display	51	Power and control	CX-1158/U
W9443	J9707	Junction box	J3601	Azimuth control overlay	52	Power and control	CX-1158/U
W9444	J9701	Junction box	J3701	Remote height display	58	Power and control	CX-1158/U
W9445	J9702	Junction box	J3601	Azimuth control overlay	59	Power and control	CX-1158/U
W9446[1]	J3009	Girder junction box	J3004	Elevation drive motor	8	Power and control	CX-1970/U
W9446[2]	J3007	Girder junction box	J3004	Elevation drive motor	10	Power and control	CX-1970/U
W9447[1]	J3008	Girder junction box	J3005	Elevation drive motor	8	Power and control	CX-1970/U
W9447[2]	J3008	Girder junction box	J3005	Elevation drive motor	10	Power and control	CX-1970/U
W9448[1]	J3007	Girder junction box	J3006	Elevation drive interlock	8-1/2	Power and control	CX-1156/U
W9448[2]	J3007	Girder junction box	J3006	Elevation drive interlock	12-1/2	Power and control	CX-1156/U
W9449	J3301	Cone junction box	J3201	Azimuth drive interlock	7-1/2	Power and control	CX-1156/U
W9450	J18442 J19001	Pressure switch box (arctic tower) or Personnel hatch interlock (temperate tower)	J3308	Cone junction box	37	Power	CX-2084/U
W9451	—	Not used	—	—	—	—	—
W9452[2]	J6941	Control group assembly	J101	Azimuth blanker	25	Control	CX-1158/U
W9453[2]	J9709	Junction box	J6505	RHI antenna control	53	Control	CX-1158/U
W9454[2]	J9708	Junction box	J6506	RHI antenna control	53	Control	CX-1163/U
W9455[2]	J905	R-f cabinet assembly	J7601	Performance monitor	6	Power and control	CX-1163/U
W9456[2]	J22904	RHI No. 1	J23003	Raid size indicator	10	Power	CX-1156/U
W9458[2]	J3018	Girder junction box	J3021	Nod-position motor	7	Power and control	CX-1163/U

1 For Radar Set AN/FPS-6 only
2 For Radar Sets AN/FPS-6A and AN/FPS-6B

Figure 3–12. Cable Running List (Sheet 3 of 8)

Cable	One End: Jack or Terminal	One End: Unit	Other End: Jack or Terminal	Other End: Unit	Length (ft)	Function	AN Nomenclature Code
W9459[2]	J3019	Girder junction box	J3020	Nod-amplitude motor	13	Power and control	CX-1163/U
W9460	—	Not used	—	—	—	—	—
W9461[2]	J23601	Raid size remote unit	J23001	Raid size indicator	75	Control	CX-1163/U
W9455[2]	J905	R-f cabinet assembly	J7601	Performance monitor	6	Power and control	CX-1163/U
W9456[2]	J22904	RHI No. 1	J23003	Raid size indicator	10	Power	CX-1156/U
W9458[3]	J3018	Girder junction box	J3021	Nod-position motor	7	Power and control	CX-1163/U
W9459[3]	J3019	Girder junction box	J3020	Nod-amplitude motor	13	Power and control	CX-1163/U
W9460	—	Not used	—	—	—	—	—
W9461[2]	J23601	Raid size remote unit	J23001	Raid size indicator	75	Control	CX-1163/U
W8462[2]	J23602	Raid size remote unit	J23002	Raid size indicator	75	Control	CX-1163/U
W9462[2]	J2302	Heat exchanger (Ferrite Isolator CU-492/FPS-6A only)	J1901	Heat exchanger for magnetron	10	Power	CX-1970/U
W9463[3]	J2352	Ferrite isolator blower assembly (Ferrite Isolator CU-492A/FPS-6A only)	J1901	Heat exchanger for magnetron	10	Power	CX-1970/U
W9464[2]	J2303	Heat exchanger (Ferrite Isolator CU-492/FPS-6A only)	J610	Magnetron assembly	15	Control	CX-4537
(Replaces W9464)	E610 Adapter Plug	Magnetron assembly (Ferrite Isolator CU-492A/FPS-6A only)	J610	Magnetron assembly	15	Interlock short	—
W9465 through W9500	—	Not used	—	—	—	—	—
W9501[1]	J6923	Control group assembly	J4201	RHI No. 1	58	System trigger	CG-426A/U
W9502[1]	J6930	Control group assembly	J4202	RHI No. 1	58	Elevation data	CG-426A/U
W9503[1]	J6934	Control group assembly	J4203	RHI No. 1	58	Video	CG-426A/U
W9504[1]	J6927	Control group assembly	J4204	RHI No. 1	58	Angle marks	CG-426A/U
W9505[1]	J6925	Control group assembly	J4206	RHI No. 1	58	Range marks	CG-426A/U
W9501[2]	J6923	Control group assembly	J22007	RHI No. 1	58	System trigger	CG-426A/U
W9502[2]	J6930	Control group assembly	J22005	RHI No. 1	58	Elevation data	CG-426A/U

[1] For Radar Set AN/FPS-6 only
[2] For Radar Sets AN/FPS-6A and AN/FPS-6B
[3] For Radar Set AN/FPS-6B only

Figure 3–12. Cable Running List (Sheet 4 of 8)

Cable	One End: Jack or Terminal	One End: Unit	Other End: Jack or Terminal	Other End: Unit	Length (ft)	Function	AN Nomen-clature Code
W9503[2]	J6934	Control group assembly	J22003	RHI No. 1	58	Video	CG-426A/U
W9504[2]	J6927	Control group assembly	J22011	RHI No. 1	58	Angle marks	CG-426A/U
W9505[2]	J6925	Control group assembly	J22016	RHI No. 1	58	Range marks	CG-426A/U
W9506[2]	J102	Azimuth blanker	J2250	Modulator assembly	365	System trigger	CG-426A/U
W9506[1]	J6922	Control group assembly	J2250	Modulator assembly	365	System trigger	CG-426A/U
W9507	E601	Magnetron cabinet assembly	E2202	Modulator assembly	17	High-voltage pulse	CG-884A/U
W9508	J922	R-f assembly	J6918	Control group assembly	350	I-f pulse	CG-579/U
W9509	J919	R-f assembly	J6919	Control group assembly	350	STC and gain	CG-579/U
W9510	J602	Magnetron cabinet assembly	J6920	Control group assembly	350	Negative trigger	CG-426A/U
W9511	J6931	Control group assembly	—	Associated search radar	750	Blanking trigger in	CG-426A/U
W9512	J6932	Control group assembly	—	Associated search radar	750	Blanking trigger in	CG-426A/U
W9513	J3402	Cone junction box	J6926	Control group assembly	385	Angle marks	CG-927/U
W9514	J3404	Cone junction box	J6929	Control group assembly	385	Elevation S1	CG-927/U
W9515	J3403	Cone junction box	J6928	Control group assembly	385	Elevation R1	CG-927/U
W9516	J10402	Modulator high-voltage power supply	J2206	Modulator assembly	15	High voltage	CG-317/U
W9517[1]	J4201	RHI No. 2	J4209	RHI No. 1	32	System trigger	CG-426A/U
W9518[1]	J4202	RHI No. 2	J4210	RHI No. 1	32	Elevation data	CG-426A/U
W9519[1]	J4203	RHI No. 2	J4211	RHI No. 1	32	Video	CG-426A/U
W9520[1]	J4204	RHI No. 2	J4212	RHI No. 1	32	Angle marks	CG-426A/U
W9521[1]	J4206	RHI No. 2	J4214	RHI No. 1	32	Range marks	CG-426A/U
W9517[2]	J22007	RHI No. 2	J22008	RHI No. 1	32	System trigger	CG-426A/U
W9518[2]	J22005	RHI No. 2	J22006	RHI No. 1	32	Elevation data	CG-426A/U
W9519[2]	J22003	RHI No. 2	J22004	RHI No. 1	32	Video	CG-426A/U
W9520[2]	J22011	RHI No. 2	J22012	RHI No. 1	32	Angle marks	CG-426A/U
W9521[2]	J22016	RHI No. 2	J22015	RHI No. 1	32	Range marks	CG-426A/U
W9522	J6921	Control group assembly	—	Associated search radar	50	Sync trigger	CG-426A/U
W9523	J6935	Control group assembly	J930	R-f assembly	350	Video	CG-426A/U
W9524	J608	Magnetron cabinet assembly	J931	R-f assembly	12	Positive trigger	CG-426A/U

[1] For Radar Set AN/FPS-6 only

[2] For Radar Sets AN/FPS-6A and AN/FPS-6B

Figure 3–12. Cable Running List (Sheet 5 of 8)

Cable	One End: Jack or Terminal	One End: Unit	Other End: Jack or Terminal	Other End: Unit	Length (ft)	Function	AN Nomen-clature Code
W9525	J3001	Elevation selsyn and angle mark unit	J3010	Girder junction box	11	Elevation data	CG-426B/U
W9526	J3002	Elevation selsyn and angle mark unit	J3011	Girder junction box	11	Elevation data	CG-426B/U
W9527	J3003	Elevation selsyn and angle mark unit	J3012	Girder junction box	11-1/2	Angle marks	CG-426B/U
W9528[2]	J6922	Control group assembly	J102	Azimuth blanker	25	System trigger	CG426A/U
W9529[2]	J901	R-f assembly	J7602	Performance monitor	6	Forward power	CG-92D/U
W9530[2]	J902	R-f assembly	J7603	Performance monitor	6	Reverse power	CG-92D/U
W9531[2]	J903	R-f assembly	J7604	Performance monitor	6	Noise gate	CG-426A/U
W9532[2]	J906	R-f assembly	J7605	Performance monitor	6	Noise i-f signal	CG-579/U
W9533[2]	J2250	Modulator assembly	J7606	Performance monitor	35	System trigger	CG-426A/U
W9534[2]	J6936	Control group assembly	J22013	RHI No. 1	58	+275-volt ref	CG-426A/U
W9535[2]	J22014	RHI No. 1	J22013	RHI No. 2	32	+275-volt ref	CG-426A/U
W9536[2]	J22010	RHI No. 1	J23004	Raid size indicator	10	Strobe	CG-426A/U
W9537[2]	J22004	RHI No. 1	J23006	Raid size indicator	10	Video	CG-426A/U
W9538 through W17000	—	Not used	—	—	—	—	—
W17001	J18951	Blower No. 1 control selector	—	Power source	47	Power	CX-1205/U
W17002	J18405	Radome pressure control	TB18901	Blower No. 3 (100 cfm)	48	Power	CX-1212/U
W17003	J18406	Radome pressure control	TB18561	Blower No. 2 (1000 cfm)	15	Power	CX-1162/U
W17005	J18403	Blower No. 1 control selector	TB18501	Blower No. 1 (1000 cfm)	46	Power	CX-1162/U
W17005	J18403	Radome pressure control	TB18407	Anemometer	400	Control	CX-1212/U
W17006	J18404	Radome pressure control	J18441	Pressure switch box	4	Control	CX-1158/U
W17007	J18443	Pressure switch box	TB18551	Recirculation blower	15	Control	CX-1212/U
W17008	—	Not used	—	—	—	—	—
W17009	J18954	Blower No. 1 control selector	J18407	Radome pressure control	4	Power	CX-1970/U
W17010	J18952	Blower No. 1 control selector	J18401	Radome pressure control	5	Power	CX-1970/U
W17011 through W17019	—	Not used		—	—	—	—
W17020	—	De-icing switch box No. 1	—	Radome terminal box No. 1	27	Power	CX-2135/U (ft in.)

[2] For Radar Sets AN/FPS-6A and AN/FPS-6B

Figure 3–12. Cable Running List (Sheet 6 of 8)

Cable	One End		Other End		Length (ft)	Function	AN Nomen-clature Code
	Jack or Terminal	Unit	Jack or Terminal	Unit			
W17021	—	De-icing switch box No. 1	—	Radome terminal box No. 1	27	Power	CX-2135/U (ft in.)
W17022	—	De-icing switch box No. 1	—	Radome terminal box No. 1	27	Power	CX-2135/U (ft in.)
W17023	—	De-icing switch box No. 1	—	Radome terminal box No. 1	27	Power	CX-2135/U (ft in.)
W17024	—	De-icing switch box No. 2	—	Radome terminal box No. 2	46	Power	CX-2135/U (ft in.)
W17025	—	De-icing switch box No. 2	—	Radome terminal box No. 2	46	Power	CX-2135/U (ft in.)
W17026	—	De-icing switch box No. 2	—	Radome terminal box No. 2	46	Power	CX-2135/U (ft in.)
W17027	—	De-icing switch box No. 2	—	Radome terminal box No. 2	46	Power	CX-2135/U (ft in.)
W17028	J18461 through J18465	Radome terminal box No. 1	J18651 or J18601	Lamp bank No. 1	50	Power	CX-1510/U
W17029	J18461 through J18465	Radome terminal box No. 1	J18651 or J18601	Lamp bank No. 2	50	Power	CX-1510/U
W17030	J18461 through J18465	Radome terminal box No. 1	J18651 or J18601	Lamp bank No. 3	50	Power	CX-1510/U
W17031	J18461 through J18465	Radome terminal box No. 1	J18651 or J18601	Lamp bank No. 4	50	Power	CX-1510/U
W17032	J18461 through J18465	Radome terminal box No. 2	J18651 or J18601	Lamp bank No. 5	50	Power	CX-1510/U
W17033	J18461 through J18465	Radome terminal box No. 2	J18651 or J18601	Lamp bank No. 6	50	Power	CX-1510/U
W17034	J18461 through J18465	Radome terminal box No. 2	J18651 or J18601	Lamp bank No. 7	50	Power	CX-1510/U
W17035	J18461 through J18465	Radome terminal box No. 2	J18651 or J18601	Lamp bank No. 8	50	Power	CX-1510/U
W17036	J18461 through J18465	Radome terminal box No. 2	J18651 or J18601	Lamp bank No. 9	50	Power	CX-1510/U
No Symbol	—	De-icing switch box	—	120/208-volt, 3-phase, 60 cps, 200-kilowatt power source	8 cables cut to size in field (2400-ft. total)	Power	CX-2135/U (ft in.)
W17037	J18402	Radome pressure control	—	120/208-volt, 3-phase, 60-cps, 7.5-kilowatt power source	300	Power	CX-1205/U (ft in.)

Figure 3–12. Cable Running List (Sheet 7 of 8)

Cable	One End		Other End			Function	AN Nomenclature Code
	Jack or Terminal	Unit	Jack or Terminal	Unit	Length (ft)		
W17038 through W22000	—	Not used	—	—	—	—	—
W22001[2]	J22001	Oscilloscope of RHI No. 1	J22901	Power Supply of RHI No. 1	1 ft. 7-1/2 in.	Power	—
W22002[2]	J22002	Oscilloscope of RHI No. 2	J22902	Power Supply of RHI No. 2	1 ft. 7-1/2 in.	Power	—

[2] For Radar Sets AN/FPS-6A and AN/FPS-6B

Figure 3–12. Cable Running List (Sheet 8 of 8)

3–53. CABLE CG-317/U.

3–54. The details of the fabrication and assembly procedures for this single-conductor cable with connector terminations are given in figure 3–13. The length of this cable is provided in figure 3–12.

3–55. CABLES CG-462A/U, CG462B/U, CG-579/U, AND CG-927/U.

3–56. The details of the fabrication and assembly procedures for these single-conductor cables with connector terminations are given in figure 3–14. The lengths of these cables are provided in figure 3–12.

3–57. CABLE CG-884A/U.

3–58. The details of the fabrication and assembly procedures for this single-conductor cable with connector terminations are given in figure 3–15. The length of this cable is provided in figure 3–12.

3–59. CABLES CX-1156/U.

3–60. The details of the fabrication and assembly procedures for these multiconductor cables are given in figure 3–16. The connection diagram for the pin and socket inserts used in these cables is given in figure 3–17. The lengths of these cables are provided in figure 3–12.

3–61. CABLES CX-1158/U.

3–62. The details of the fabrication and assembly procedures for these multiconductor cables are given in figure 3–16. The connection diagram for the pin and socket inserts used in these cables is given in figure 3–18. The lengths of these cables are provided in figure 3–12.

3–63. CABLE CX-1159/U.

3–64. The details of the fabrication and assembly procedures for this multiconductor cable are given in figure 3–16. The connection diagram for the pin and socket inserts used in this cable is given in figure 3–19. The length of this cable is provided in figure 3–12.

3–65. CABLES CX-1162/U AND CX-1205/U.

3–66. These cables are multiconductor cables with connector terminations on one end and lug terminations on the other. The details of the fabrication and assembly procedures for the connector termination end are given in figure 3–16. The connection diagram for the pin or socket inserts used in this conductor is given in figure 3–20. The fabrication procedures for the lug termination end are as follows:

a. Cut cable to required length as specified in figure 3–12.

b. Square off end of cable and remove outer jacket for length sufficient to provide satisfactory free length of individual wires.

CAUTION

Be careful when performing step b to avoid damaging insulation of any enclosed conductors.

c. Strip sufficient insulation (approximately 1/2 inch) from end of each conductor to insure complete crimping of bared conductor in lug shank.

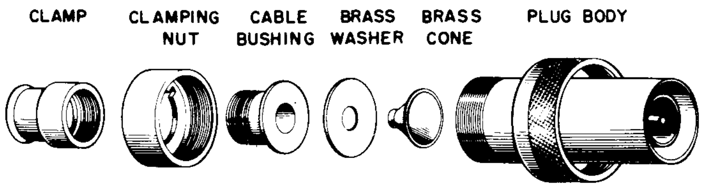
d. Insert bared end of conductor into shank of lug until insulation meets lug.

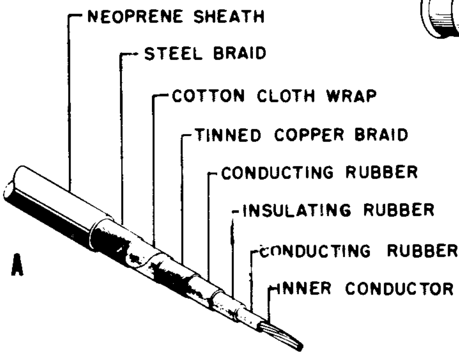
e. Crimp shank of lug, using appropriate crimping tool, so that there is good mechanical connection between lug and conductor.

f. Solder lug to conductor.

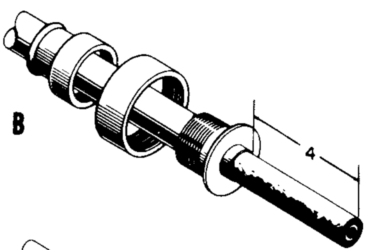
3–67. CABLES CX-1163/U.

3–68. The details of the fabrication and assembly procedures for these multiconductor cables with connector terminations are given in figure 3–16. The connection diagram for the pin and socket inserts used in these connectors is given in figure 3–21. The lengths of these cables are provided in figure 3–12.

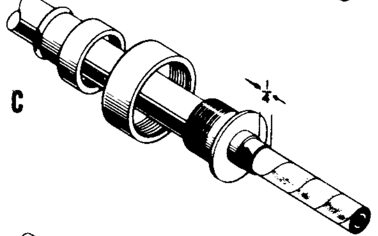




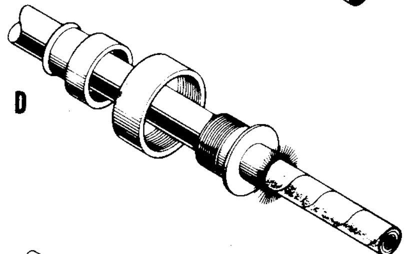
A THE CABLE USED IN THIS ASSEMBLY IS ARMY-NAVY TYPE RG-28/U AND IS CONSTRUCTED AS SHOWN IN FIGURE A.



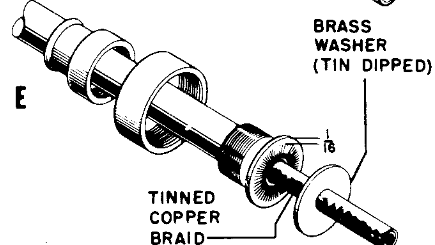
B SQUARE OFF THE END OF THE CABLE AND SLIP THE CLAMP, CLAMPING NUT, AND CABLE BUSHING (IN THIS ORDER) OVER THE CABLE.
REMOVE THE OUTER NEOPRENE SHEATH FOR A DISTANCE OF 4" FROM THE END OF THE CABLE, BEING CAREFUL NOT TO INJURE THE LAYER OF STEEL ARMOR BRAID BENEATH IT. NOTE: IN REMOVING ANY LAYER, IT IS VERY IMPORTANT NOT TO INJURE THE LAYER BENEATH IT. IF A KNIFE IS USED, ALWAYS CUT AWAY FROM THE CABLE, NEVER DOWN ON IT. A PAIR OF SCISSORS IS USEFUL IN REMOVING STEEL AND COPPER BRAID.



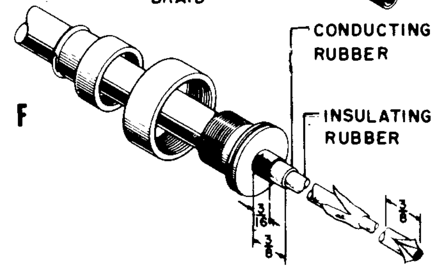
C REMOVE THE STEEL BRAID TO WITHIN 1/4" OF THE END OF THE OUTER NEOPRENE SHEATH.



D COMB OUT THE STEEL BRAID DOWN TO THE END OF THE OUTER SHEATH AND FAN OUT AT RIGHT ANGLES AS SHOWN.

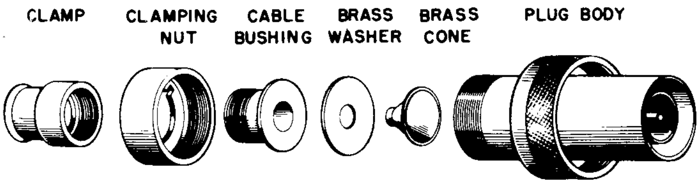


E SLIDE THE CABLE BUSHING INTO POSITION AGAINST THE STEEL WIRES, AND TRIM OFF THE STEEL STRANDS 1/16" BELOW THE OUTER DIAMETER OF THE FLANGE OF THE BUSHING.
REMOVE THE CLOTH COVERING OVER THE TINNED COPPER BRAID DOWN TO THE POINT WHERE THE STEEL BRAID STOPS.
TIN THE BRASS WASHER, AND SLIDE IT OVER THE TINNED COPPER BRAID UNTIL IT MEETS THE FANNED-OUT STEEL BRAID.

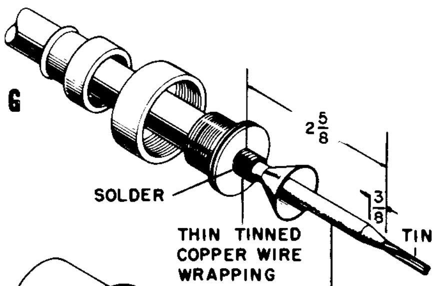


F REMOVE THE TINNED COPPER BRAID TO WITHIN 3/16" OF THE TINNED BRASS WASHER.
REMOVE THE CONDUCTING RUBBER LAYER TO A DISTANCE OF 3/8" FROM THE TINNED BRASS WASHER. NOTE: THE CONDUCTING RUBBER LAYER IS QUITE THIN, AND IS BEST REMOVED WITH A SHARP POINTED TOOL OR A KNIFE AS SHOWN IN THE TWO STAGES AT THE RIGHT OF FIGURE F. BY LIGHT PRESSURE OF THE TOOL OR KNIFE A FINE SLIT ABOUT 3/8" LONG IS MADE IN THE CONDUCTING RUBBER LAYER. THE LAYER THEN CAN BE FOLDED BACK ON ITSELF AND PULLED BACK FOR THE REQUIRED DISTANCE. CUT OFF CAREFULLY, AVOIDING LENGTHWISE TEARS IN THIS LAYER AND DAMAGE TO THE INSULATING RUBBER LAYER BENEATH. SCRAPE THE INSULATING RUBBER LAYER THUS EXPOSED TO REMOVE THE RESIDUE OF THE CONDUCTING RUBBER LAYER THAT MAY ADHERE TO IT.

Figure 3–13. Cable Fabrication, Single-conductor Cable CG-317/U (Sheet 1 of 2)

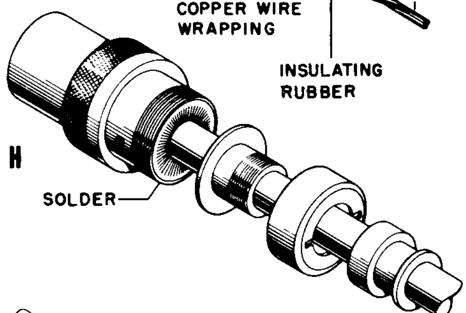


G



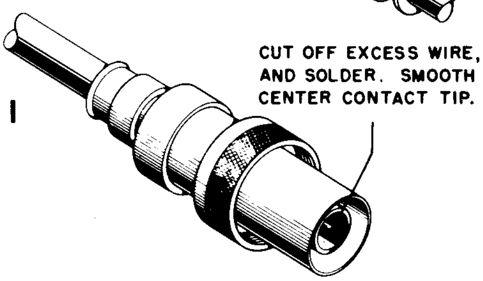
G SLIDE THE BRASS CONE OVER THE CONDUCTING RUBBER AND UNDER THE COPPER BRAID. THE STRAIGHT PART OF THE SMALL END OF THE CONE SHOULD SLIDE ABOUT $\frac{1}{16}$" INTO THE TINNED BRASS WASHER. WRAP THE TINNED COPPER BRAID WITH FINE TINNED COPPER WIRE TO HOLD IT IN PLACE FOR SOLDERING. SOLDER THE TINNED COPPER BRAID TO BOTH THE CONE AND THE TINNED BRASS WASHER. A FAIRLY LARGE IRON, ABOUT 150 TO 200 WATTS, IS REQUIRED FOR THIS OPERATION. BE CAREFUL NOT TO HOLD THE IRON IN ONE PLACE TOO LONG FOR THE RUBBER WILL BE BURNED. REMOVE THE INSULATING RUBBER TO WITHIN $2\frac{5}{8}$" FROM THE TINNED BRASS WASHER AND TAPER THE END AS SHOWN. TIN THE EXPOSED LENGTH OF THE CENTER CONDUCTOR.

H



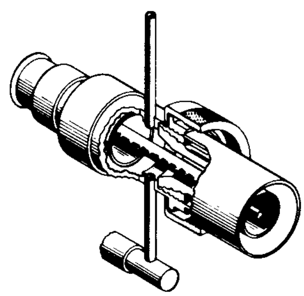
H INSERT THE CABLE ASSEMBLY INTO THE BACK END OF THE PLUG BODY, MAKING SURE THAT THE CENTER CONDUCTOR FITS INTO THE HOLE IN THE CENTER CONTACT.
SLIDE THE CABLE BUSHING BACK ALONG THE CABLE. SOLDER THE BRASS WASHER TO THE PLUG BODY. BE CAREFUL NOT TO ALLOW SOLDER TO FLOW ONTO THE THREADING.

I



I SLIDE THE CABLE BUSHING DOWN TO THE FANNED-OUT STEEL BRAID AND TINNED BRASS WASHER, AND SCREW ON THE CLAMPING NUT. THIS NUT SHOULD BE TIGHTENED SECURELY WITH A SPANNER WRENCH TO INSURE CLAMPING OF THE BUSHING TIGHTLY AGAINST THE STEEL BRAID, AND THUS TO PREVENT THE CABLE FROM TURNING IN THE PLUG. TO TIGHTEN THIS CLAMPING NUT, THE PLUG MUST BE KEPT FROM TURNING BY HOLOING IN A STRAP WRENCH WHICH WILL NOT MARK OR DISTORT THE PLUG. <u>A VISE MUST NOT BE USED</u> SINCE IT WILL BEND AND DISTORT THE PLUG BODY SO THAT THE PLUG WILL NOT FIT INTO A SOCKET.
CUT OFF THE EXCESS LENGTH OF WIRE PROTRUDING FROM THE HOLE IN THE CENTER CONTACT AND SOLDER THE WIRE TO THE CENTER CONDUCTOR USING ROSIN-CORE SOLDER. THE SOLDER SHOULD BE ALLOWED TO FLOW WELL DOWN INTO THE HOLE TO INSURE GOOD CONTACT. A DROP OF SOLDER SHOULD BE ALLOWED TO REMAIN ON THE TIP. SMOOTH OFF THE END OF THIS CENTER CONTACT WITH A SMALL FILE OR A SPECIAL TOOL SO THAT THE ROUNDEO END WILL PERMIT EASY ENGAGEMENT WITH A SOCKET. SCREW THE CLAMP ONTO THE PROTRUDING END OF THE CABLE BUSHING, AGAIN USING A STRAP WRENCH.

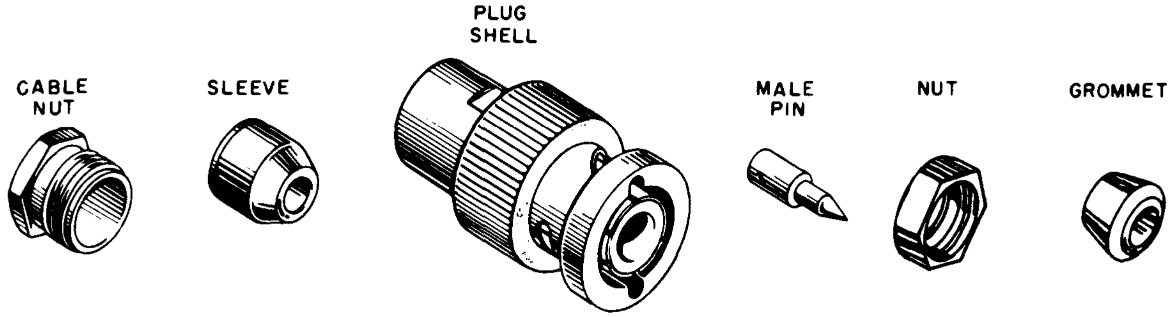
J

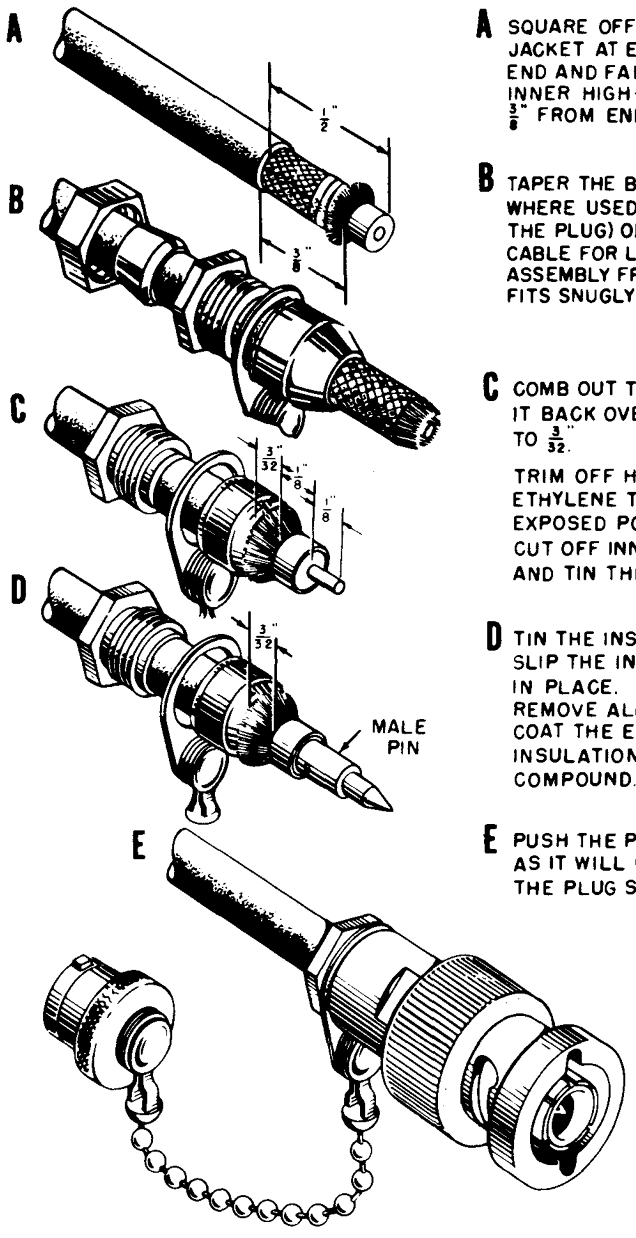


J THE AIR SPACES IN THE ASSEMBLED CONNECTOR ARE TO BE FILLED BY INJECTING DOW CORNING #4 IGNITION SEALING COMPOUND.
REMOVE THE TWO DIAMETRICALLY-OPPOSITE 10-32 SET-SCREWS IN THE REAR SECTION OF THE PLUG SHELL.
A GREASE GUN IS CONNECTED BY MEANS OF AN ADAPTER TO ONE OF THESE TAPPED SET-SCREW HOLES.
A BLEEDER TUBE IS SCREWED INTO THE OTHER HOLE.
THE FILLING OPERATION SHOULD BE CARRIED OUT WITH THE GREASE GUN AND ADAPTER BELOW THE CONNECTOR SO THAT THE FLOW OF COMPOUND IS THROUGH THE PLUG <u>AGAINST GRAVITY.</u>
TURN THE HANDLE OF THE GREASE GUN, FORCING THE COMPOUND INTO THE PLUG, UNTIL THE COMPOUND EMERGES CONTINUOUSLY FROM THE BLEEDER.
REMOVE THE BLEEDER, AND REPLACE THE SET-SCREW.
REMOVE THE GREASE GUN AND ADAPTER, AND REPLACE THE SECOND SET-SCREW.
STAKE BOTH SET-SCREWS.

K TEST THE ASSEMBLY BY APPLYING 25KV (PEAK), 60 cps FOR A PERIOD OF THREE MINUTES.
IF EACH END OF THE CABLE IS TERMINATED BY A PLUG, USE AN AIR-TO-AIR SOCKET ON EACH PLUG TO PREVENT FLASH-OVER TO THE SHELL.
IF A PLUG IS USED ON ONLY ONE END OF THE CABLE, A SOCKET IS TO BE USED ON THE PLUG, AND THE SHIELDING BRAIDS ON THE OTHER END ARE TO BE PEELED BACK TO PREVENT FLASH-DVER AT THAT END OF THE CABLE.

Figure 3–13. Cable Fabrication, Single-conductor Cable CG-317/U (Sheet 2 of 2)





A SQUARE OFF THE CABLE ENDS AND REMOVE $\frac{1}{2}$" OF VINYLITE OUTER JACKET AT ENDS, EXPOSING COPPER SHIELD BRAID. TAPE BRAID $\frac{3}{8}$" FROM END AND FAN OUT THE END OF THE BRAID TO PERMIT CUTTING OFF THE INNER HIGH-FREQUENCY INSULATION AND INNER CONDUCTOR $\frac{3}{8}$" FROM END OF VINYLITE OUTER JACKET. REMOVE TAPE.

B TAPER THE BRAID END. SLIDE COMPRESSION NUT AND GROMMET, WHERE USED,* OVER CABLE. SLIDE CABLE NUT (REMOVED FROM THE PLUG) ONTO THE CABLE. SLIDE CAP-AND-CHAIN LUG OVER CABLE FOR LATER ASSEMBLY AS SHOWN IN E. REMOVE SLEEVE ASSEMBLY FROM PLUG AND SLIDE IT OVER THE BRAID SO THAT IT FITS SNUGLY AGAINST THE VINYLITE JACKETSHOULDER.

C COMB OUT THE BRAID ALL THE WAY BACK TO THE SLEEVE, FOLD IT BACK OVER THE TAPERED END OF THE SLEEVE, AND TRIM TO $\frac{3}{32}$".

TRIM OFF HIGH-FREQUENCY INSULATION (INCLUDING POLY-ETHYLENE THREAD SUPPORT OF CABLE) AND LEAVE A $\frac{1}{8}$" EXPOSED PORTION.

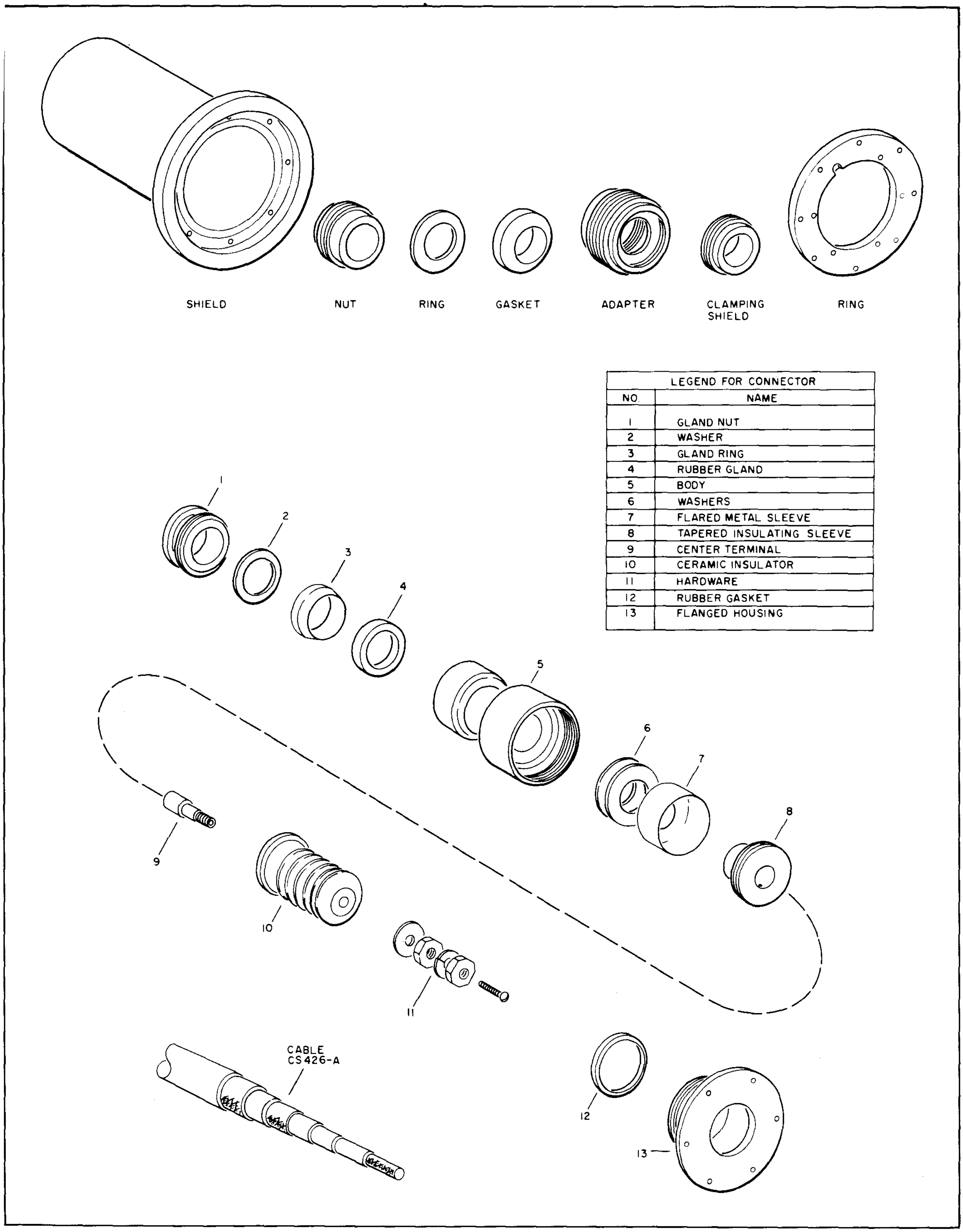
CUT OFF INNER CONDUCTOR TO $\frac{1}{8}$" FROM INSULATION SHOULDER AND TIN THE EXPOSED INNER CONDUCTOR END.

D TIN THE INSIDE OF THE MALE CONTACT PIN.
SLIP THE INNER CONDUCTOR INTO THE CONTACT PIN AND SOLDER IN PLACE.
REMOVE ALL EXCESS SOLDER.
COAT THE EXPOSED PORTION ($\frac{1}{8}$") OF THE HIGH-FREQUENCY INSULATION WITH A SMALL AMOUNT OF DOW-CORNING NO. 4 COMPOUND.

E PUSH THE PREPARED CABLE END INTO THE PLUG SHELL AS FAR AS IT WILL GO. SLIDE THE NUT FORWARD AND SCREW IT INTO THE PLUG SHELL. TIGHTEN SECURELY WITH A WRENCH.

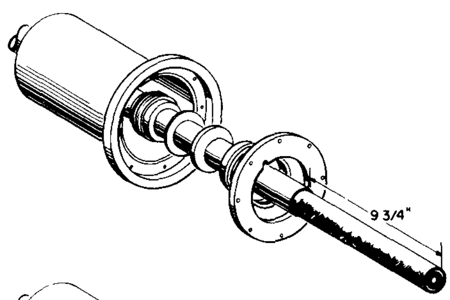
* USED ONLY IN FABRICATION OF CABLE CG-927/U

Figure 3–14. Cable Fabrication, Single-conductor Cables CG-462A/U, CG-462B/U, CG-579/U, and CG-927/U

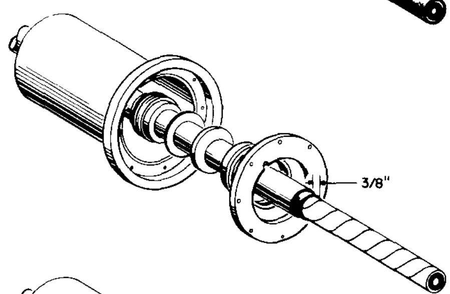


LEGEND FOR CONNECTOR	
NO.	NAME
1	GLAND NUT
2	WASHER
3	GLAND RING
4	RUBBER GLAND
5	BODY
6	WASHERS
7	FLARED METAL SLEEVE
8	TAPERED INSULATING SLEEVE
9	CENTER TERMINAL
10	CERAMIC INSULATOR
11	HARDWARE
12	RUBBER GASKET
13	FLANGED HOUSING

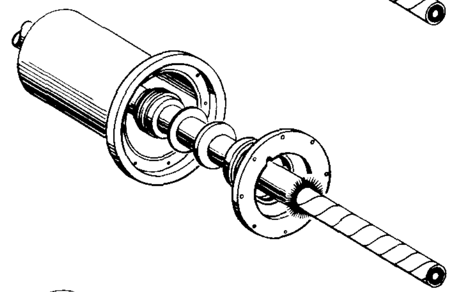
Figure 3–15. Cable Fabrication, Single-conductor Cable CG-884A/U (Sheet 1 of 3)



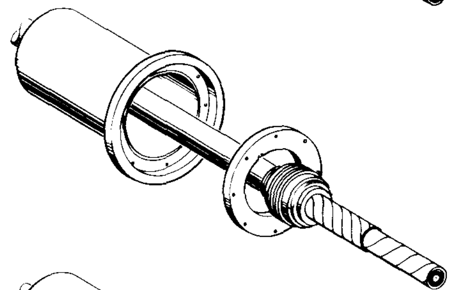
A SQUARE OFF THE END OF THE CABLE AND SLIP THE SHIELD, NUT, RING, GASKET, ADAPTER, AND RING (IN THIS ORDER) OVER THE CABLE. REMOVE THE OUTER RUBBER JACKET FOR A DISTANCE OF 9 3/4" FROM THE END OF THE CABLE, BEING CAREFUL NOT TO INJURE THE LAYER OF OUTER BRAID BENEATH IT. NOTE: IN REMOVING ANY LAYER, IT IS VERY IMPORTANT NOT TO INJURE THE LAYER BENEATH IT. IF A KNIFE IS USED, ALWAYS CUT AWAY FROM THE CABLE, NEVER DOWN ON IT. A PAIR OF SCISSORS IS USEFUL IN REMOVING STEEL AND COPPER BRAID.



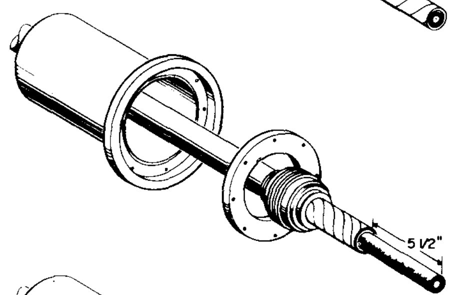
B REMOVE THE OUTER BRAID TO WITHIN 3/8" OF THE END OF THE OUTER RUBBER JACKET.



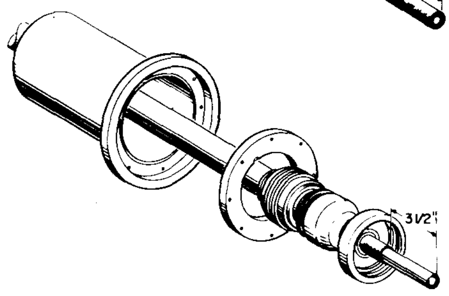
C COMB OUT THE REMAINING OUTER BRAID DOWN TO THE END OF THE OUTER RUBBER JACKET AND FAN OUT AT RIGHT ANGLES AS SHOWN. TRIM THE BRAID TO APPROXIMATELY 2" DIAMETER.



D WRAP THE INSULATION WITH TAPE (MINNESOTA MINING TYPE #33 OR EQUAL) STARTING AT THE FLARED BRAID, WORKING TOWARD THE END FOR APPROXIMATELY 5" USING A HALF-OVERLAP WRAP. SLIDE THE ADAPTER FORWARD UNTIL ITS INNER SURFACE IS JUST FLUSH WITH THE REAR OF THE FLARED BRAID AND ASSEMBLE THE CLAMPING SHIELD TURNING THE SHIELD WITH RESPECT TO THE ADAPTER AND CABLE. SLIDE THE GASKET AND RING FORWARD UNTIL SEATED AGAINST THE INNER FLANGE OF THE ADAPTER AND ASSEMBLE THE NUT TURNING THE NUT WITH RESPECT TO THE ADAPTER AND CABLE.



E REMOVE 5 1/2" OF THE TAPE AND INSULATION. DO NOT NICK OR DAMAGE THE EXPOSED DOUBLE-LAYER BRAID.



F SLIP THE GLAND NUT, WASHER, GLAND RING, RUBBER GLAND, BODY, AND 2 WASHERS (IN THIS ORDER) OF THE CONNECTOR OVER THE DOUBLE-LAYER BRAID. REMOVE 3 1/2" OF THE DOUBLE-LAYER BRAID.

Figure 3–15. Cable Fabrication, Single-conductor Cable CG-884A/U (Sheet 2 of 3)

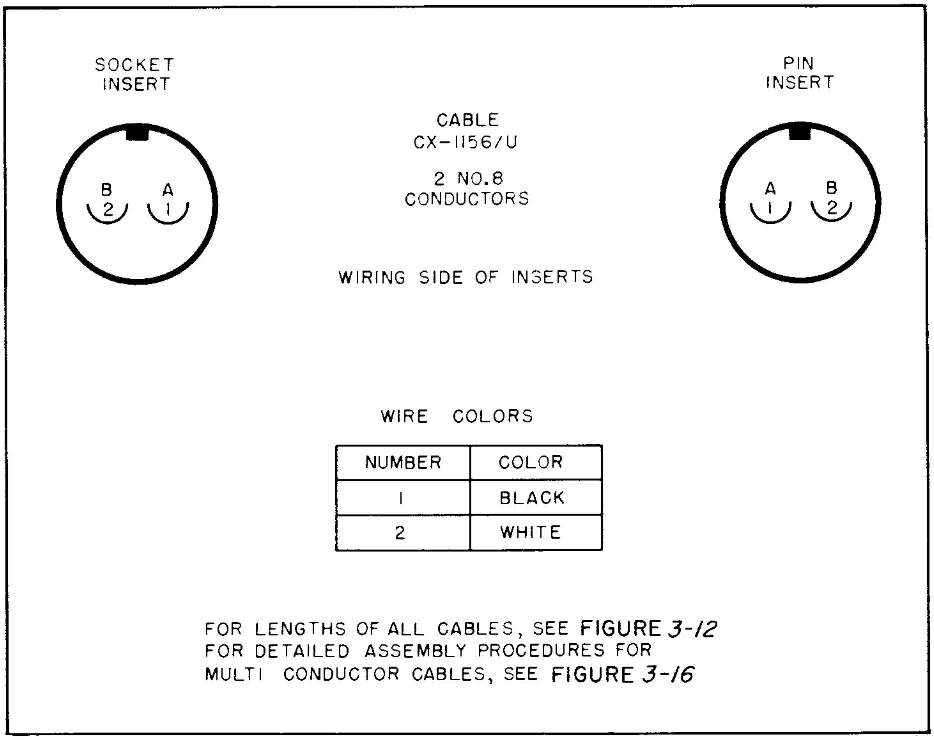


Figure 3–17. Cable Fabrication, Plug Connection Diagram for 22-1P and 22-1S Inserts, Using Cables CX-1156/U

3–69. CABLES CX-1212/U.

3–70. The details of the fabrication and assembly procedures for these cables are the same as those given in paragraph 3–66, except for the pin or socket insert connection diagram used in the connector termination end. The connection diagram for these cables is given in figure 3–22.

3–71. CABLES CX-1510/U.

3–72. The details of the fabrication and assembly procedures for these multiconductor cables with connector terminations are given in figure 3–16. The connection diagram for the pin and socket inserts used in these connectors is given in figure 3–23. The lengths of these cables are provided in figure 3–12.

3–73. CABLES CX-1968/U AND CX-2135/U.

3–74. The cables in this group are single-conductor cables with lug terminations. The lug termination diagram for these cables is given in figure 3–24. Cables CX-1968/U and CX-2135/U are fabricated according to the following procedure:

a. Cut cable to required length as specified in figure 3–12.

b. Remove all insulating material on cable far enough from each end to insure complete crimping of bared conductor in lug shank.

c. Insert bared end of conductor into shank of lug until insulation meets lug.

d. Crimp shank of lug, using appropriate crimping tool, so that there is good mechanical connection between lug and conductor.

e. Solder lug to conductor.

3–75. CABLES CX-1970/U.

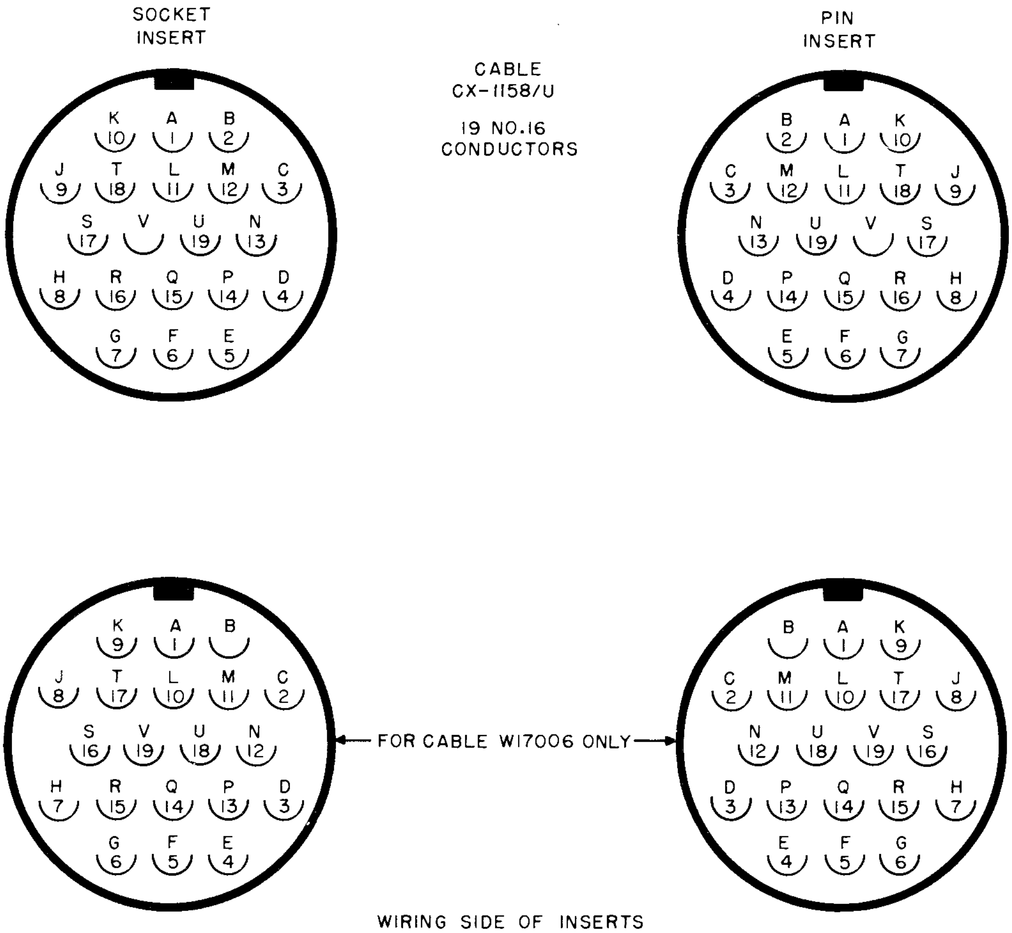
3–76. The details of the fabrication and assembly procedures for these multiconductor cables are given in figure 3–16. The connection diagram for the pin and socket inserts used in these cables is given in figure 3–20. The lengths of these cables are provided in figure 3–12.

3–77. CABLE CX-1971/U.

3–78. This cable is a multiconductor cable with lug terminations. The lug termination diagram for this cable is given in figure 3–25. Cable CX-1971/U is fabricated according to the procedure outlined in paragraph 3–66.

3–79. CABLE CX-2084/U.

3–80. The details of the fabrication and assembly procedures for this multiconductor cable are given in figure 3–16. The connection diagram for the pin and socket inserts used in this cable is given in figure 3–22. The length of this cable is provided in figure 3–12.



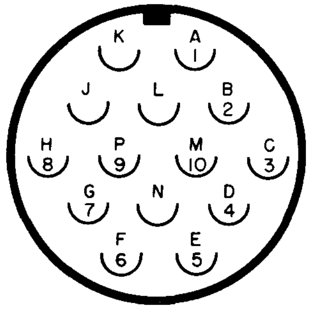
WIRE COLORS

NUMBER	COLOR	NUMBER	COLOR
1	BLACK	11	BLUE, BLACK TRACER
2	WHITE	12	BLACK, WHITE TRACER
3	RED	13	RED, WHITE TRACER
4	GREEN	14	GREEN, WHITE TRACER
5	ORANGE	15	BLUE, WHITE TRACER
6	BLUE	16	BLACK, RED TRACER
7	WHITE, BLACK TRACER	17	WHITE, RED TRACER
8	RED, BLACK TRACER	18	ORANGE, RED TRACER
9	GREEN, BLACK TRACER	19	BLUE, RED TRACER
10	ORANGE, BLACK TRACER		

FOR LENGTHS OF ALL CABLES, SEE FIGURE 3-12
FOR DETAILED ASSEMBLY PROCEDURES FOR MULTI CONDUCTOR CABLES, SEE FIGURE 3-16

Figure 3–18. Cable Fabrication, Plug Connection Diagram for 28-16P and 28-16S Inserts, Using Cables CX-1158/U

SOCKET
INSERT

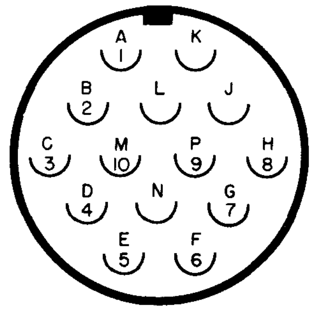


CABLE
CX-1159/U

8 NO.16 SHIELDED
CONDUCTORS

WIRING SIDE OF INSERTS

PIN
INSERT



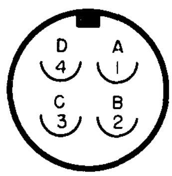
WIRE COLORS

NUMBER	COLOR		NUMBER	COLOR
1	BLACK		6	BLUE
2	WHITE		7	WHITE, BLACK TRACER
3	RED		8	RED, BLACK TRACER
4	GREEN		9	SHIELD
5	ORANGE		10	SHIELD

FOR LENGTHS OF ALL CABLES, SEE FIGURE 3-12
FOR DETAILED ASSEMBLY PROCEDURES FOR
MULTI CONDUCTOR CABLES, SEE FIGURE 3-16

Figure 3–19. Cable Fabrication, Plug Connection Diagram for 28-2P and 28-2S Inserts, Using Cable CX-1159/U

SOCKET
INSERT

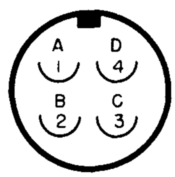


CABLE
CX-1162/U, CX-1205/U
AND CX-1970/U

4 NO.6
CONDUCTORS

WIRING SIDE OF INSERTS

PIN
INSERT



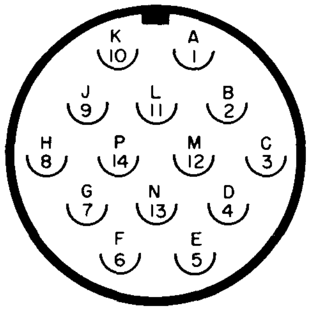
WIRE COLORS

NUMBER	COLOR
1	BLACK
2	WHITE
3	RED
4	GREEN

FOR LENGTHS OF ALL CABLES, SEE FIGURE 3-12
FOR DETAILED ASSEMBLY PROCEDURE FOR
MULTI CONDUCTOR CABLES, SEE FIGURE 3-16

Figure 3–20. Cable Fabrication, Plug Connection Diagram for 32-17P and 32-17S Inserts, Using Cables CX-1162/U, CX-1205/U, and CX-1970/U

SOCKET
INSERT

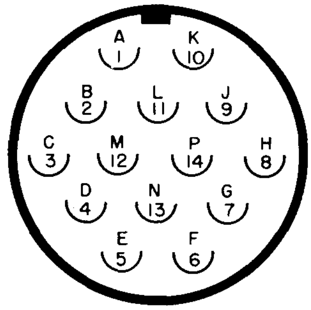


CABLE
CX-1163/U

14 NO.16
CONDUCTORS

WIRING SIDE OF INSERTS

PIN
INSERT



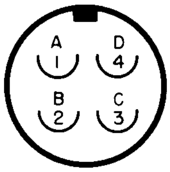
WIRE COLORS

NUMBER	COLOR	NUMBER	COLOR
1	BLACK	8	RED, BLACK TRACER
2	WHITE	9	GREEN, BLACK TRACER
3	RED	10	ORANGE, BLACK TRACER
4	GREEN	11	BLUE, BLACK TRACER
5	ORANGE	12	BLACK, WHITE TRACER
6	BLUE	13	RED, WHITE TRACER
7	WHITE, BLACK TRACER	14	GREEN, WHITE TRACER

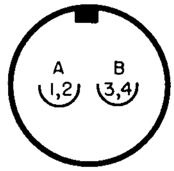
FOR LENGTHS OF ALL CABLES, SEE FIGURE 3-12
FOR DETAILED ASSEMBLY PROCEDURES FOR
MULTI CONDUCTOR CABLES, SEE FIGURE 3-16

Figure 3–21. Cable Fabrication, Plug Connection Diagram for 28-2P and 28-2S Inserts, Using Cables CX-1163/U

SOCKET INSERT



PIN INSERT



CABLE
CX-1212/U, CX-2084/U

4 NO.16
CONDUCTORS

WIRING SIDE OF INSERTS

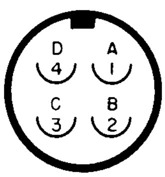
WIRE COLORS

NUMBER	COLOR
1	BLACK
2	WHITE
3	RED
4	GREEN

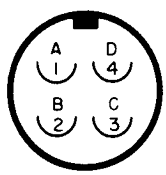
FOR LENGTHS OF ALL CABLES, SEE FIGURE 3-12
FOR DETAILED ASSEMBLY PROCEDURE FOR
MULTI CONDUCTOR CABLES, SEE FIGURE 3-16

Figure 3–22. Cable Fabrication, Plug Connection Diagram for 22-1P and 22-10P Inserts, Using Cables CX-1212/U and CX-2084/U

SOCKET INSERT



PIN INSERT



CABLE
CX-1510/U

4 NO. 4
CONDUCTORS

WIRING SIDE OF INSERTS

WIRE COLORS

NUMBER	COLOR
1	BLACK
2	WHITE
3	RED
4	GREEN

FOR LENGTHS OF ALL CABLES, SEE FIGURE 3-12 FOR DETAILED ASSEMBLY PROCEDURE FOR MULTI CONDUCTOR CABLES, SEE FIGURE 3-16

Figure 3–23. Cable Fabrication, Plug Connection Diagram for 32-17P and 32-17S Inserts, Using Cables CX-1510/U

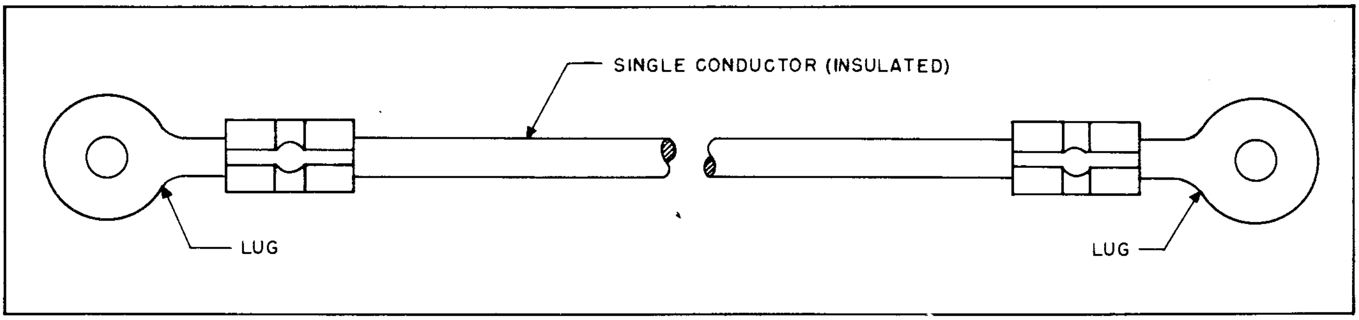


Figure 3–24. Cable Fabrication, Lug Termination Diagram for Cables CX-1968/U and CX-2135/U

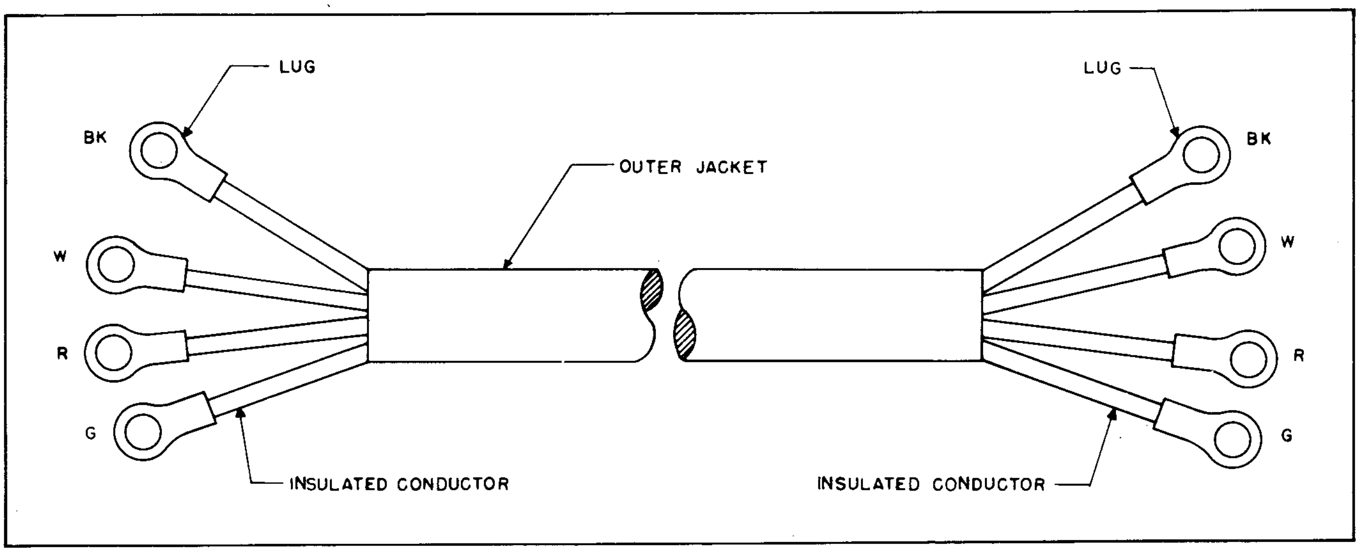


Figure 3–25. Cable Fabrication, Lug Termination Diagram for Cables CX-1162/U and CX-1971/U

SECTION IV
THEORY OF OPERATION

Note

Unless otherwise stated, all references to Radar Set AN/FPS-6 also apply to Radar Sets AN/FPS-6A, AN/FPS-6B and AN/FPS-90. Similarly, unless otherwise stated, all references to Radar Set AN/FPS-6A also apply to Radar Sets AN/FPS-6B and AN/FPS-90; and all references to Radar Set AN/FPS-6B, except for the variable-nod mechanism, also apply to Radar Set AN/FPS-90. Information applicable to Radar Set AN/MPS-14 is covered in Appendix A.

4–1. SCOPE.

4–2. This section is divided into three parts: general system operation, system block diagram analysis, and chassis theory. The discussion of general system operation (paragraph 4–3) covers tactical use of the equipment with emphasis on the signal flow between major systems. System block diagram analysis, which begins with paragraph 4–19, describes the interrelationships of major components. Chassis theory begins with paragraph 4-200. Each chassis is discussed first with the aid of a block diagram and then with simplified schematics.

4–3. GENERAL SYSTEM OPERATION.
(See figure 4–1.)

4–4. GENERAL.

4–5. The purpose of Radar Set AN/FPS-6 is to determine the height of targets designated by the operators of an associated search radar.

4–6. TARGET DESIGNATION.

4–7. Tactical considerations usually require that several plan position indicator (PPI) operators at a search radar be assigned to monitor the sky, with each operator responsible for a segment of the area under surveillance. These operators obtain the range and bearing of the target directly from the PPI display and obtain target height data from Radar Set AN/FPS-6. The height-finding facilities of Radar Set AN/FPS-6 are time-shared among a maximum of four search radar operators. Each PPI operator, in turn, is given 20 to 90 seconds in which to designate a target and receive height data on the target from Radar Set AN/FPS-6.

4–8. Each PPI operator has an azimuth control overlay (figure 1–25) which fits over his PPI display. A cursor on this overlay is rotated until it coincides with the target to be designated. The rotation of the cursor causes the simultaneous rotation of the rotors of a pair of selsyn control transformers. When the search radar PPI operator takes control of the height finder, these selsyn signals, representing the target bearing, are fed to Radar Set AN/FPS-6. When applied to the azimuth positioning servo system, the selsyn signals cause the antenna of Radar Set AN/FPS-6 to slew to that sector of the sky containing the designated target. The PPI operator also designates the target range by telephoning the information to the range-height indicator (RHI) operator or by causing a range line to appear on the RHI oscilloscope which intersects the designated target. This operation provides target range and bearing designation and points the antenna in the direction of the target area.

4–9. TRANSMISSION AND RECEPTION.

4–10. The transmitter-receiver system produces high-power r-f pulses for radiation by the antenna and converts the echo r-f pulses into video signals for display on the RHI oscilloscope. The transmitter-receiver system consists of a modulating system, a transmitting system, and a receiving system.

4–11. The modulating system produces the −65-kilovolt rectangular pulse which gates the transmitter. The magnetron of the transmitting system is fired by the modulating pulse and produces 2-microsecond, 5-megawatt r-f pulses at the pulse repetition frequency of the system trigger.

4–12. The r-f energy is shaped into a narrow beam by the antenna reflector and radiated into space. The nodding motion of the antenna sweeps the beam between +32 and −2 degrees relative to the horizon and the transmitted pulses travel outward into space until they strike some object. A portion of the radiated energy is then reflected back into the radar. The receiving system accepts the r-f echo pulses and converts them into video signals, which are fed to the RHI oscilloscope.

4–13. RHI DISPLAY.

4–14. Figure 1–8 shows a typical RHI display. Video signals appear as bright marks. The distance of the marks from the base line represents the height of the target in feet, while the distance from the left-hand edge of the display represents the range of the target in nautical miles. Angle, range, and height markers simplify the process of reading the display.

4–15. The range line on the RHI display is produced by intensification of a trigger sent by the search radar operator. The target intersected by this range line is that on which height data is desired. (Some installations do not use the range line. In these installations, the search operator telephones the range of the designated target to

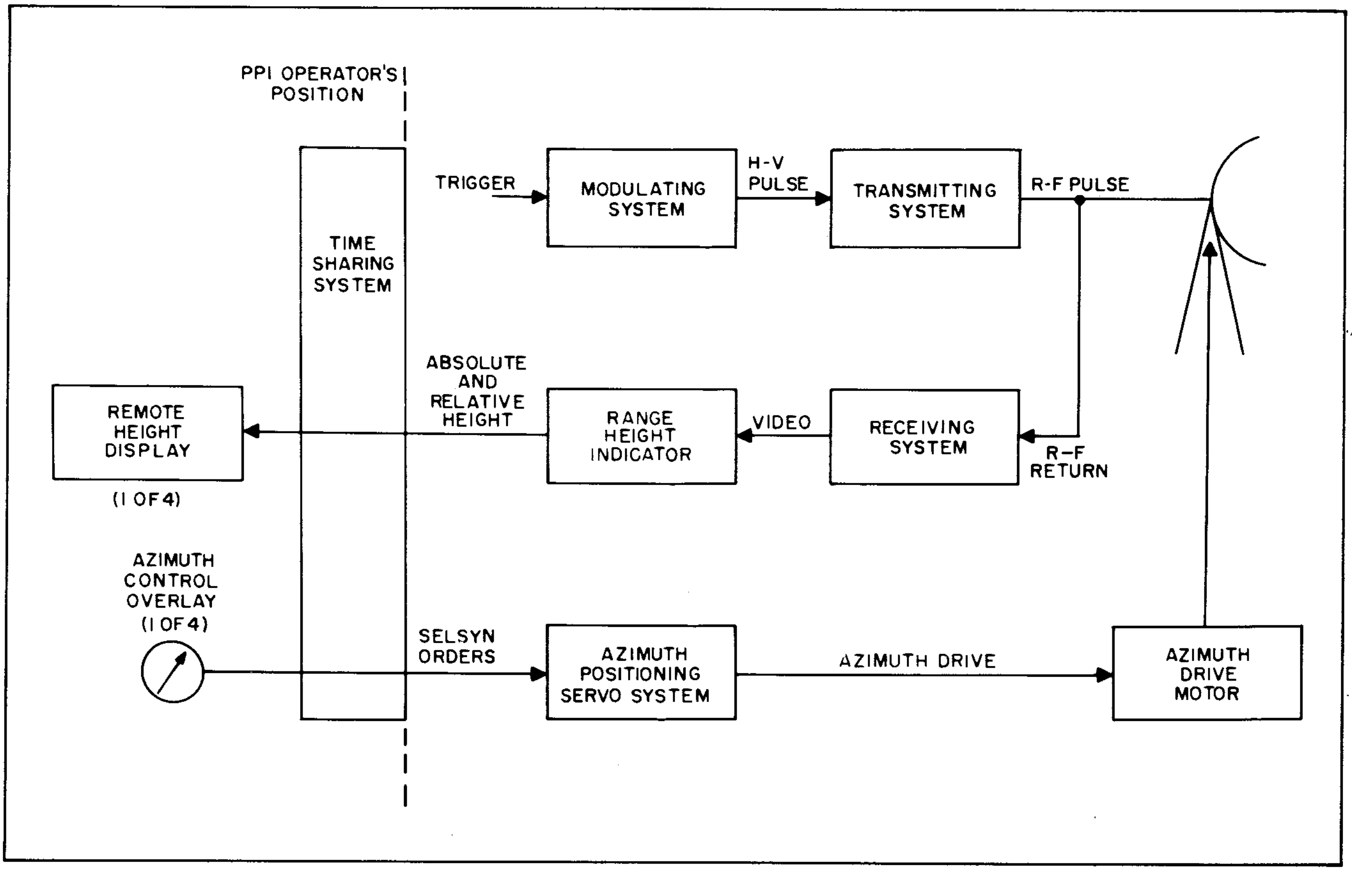


Figure 4–1. General System Operation

the RHI operator.) The RHI operator then rotates a handcrank which causes the height line to move vertically along the face of the display until it intersects the target. The handcrank rotation simultaneously causes a pair of selsyns in the RHI assembly to send out target height data in the form of selsyn signals to the remote height display (figure 1–26) mounted near the search radar operator.

4–16. REMOTE HEIGHT DISPLAY.

4–17. Absolute height of the target (target elevation taken with respect to the zero elevation axis of the antenna) is displayed on a Veeder-Root counter at the remote height display. This counter rotates in response to the selsyn signals from the RHI display. Once absolute height data has been transmitted, the RHI operator pushes in the height line handcrank, closing a circuit that lights the Veeder-Root counter at the remote height display.

4–18. If relative height (in most tactical operations, height of the target with respect to interceptor aircraft height) must be ascertained, the RHI operator turns the height line handcrank until the height line intersects the interceptor aircraft blip on the display. Selsyn signals are again sent out to the remote height display, causing a dial directly below the Veeder-Root counter to rotate until the relative height is indicated. Releasing the height line handcrank closes a circuit that lights the relative height dial. Both the absolute height counter and the relative height dial are locked until the PPI operator again takes control of the height-finding antenna.

4–19. TRANSMITTER-RECEIVER SYSTEM.

4–20. GENERAL.

4–21. The transmitter-receiver system is supplied with system trigger pulses by the range mark generator in the control group assembly and, in turn, feeds video signals to the RHI assembly. The overall operation of the transmitter-receiver system is the result of the combined functioning of the modulating, transmitting, and receiving systems. In addition, a performance monitor is incorporated into Radar Set AN/FPS-6A to permit a constant check of power output, voltage standing wave ratio (VSWR), and receiver noise figure. Refer to paragraph 4–102 for a description of the interrelationship of the receiving system, interference blanker, and the RHI assembly.

4–22. MODULATING SYSTEM. (See figure 4–2.)

4–23. FUNCTION. The modulating system receives a system trigger from the range mark generator at a pulse repetition frequency of 300 to 400 pps and

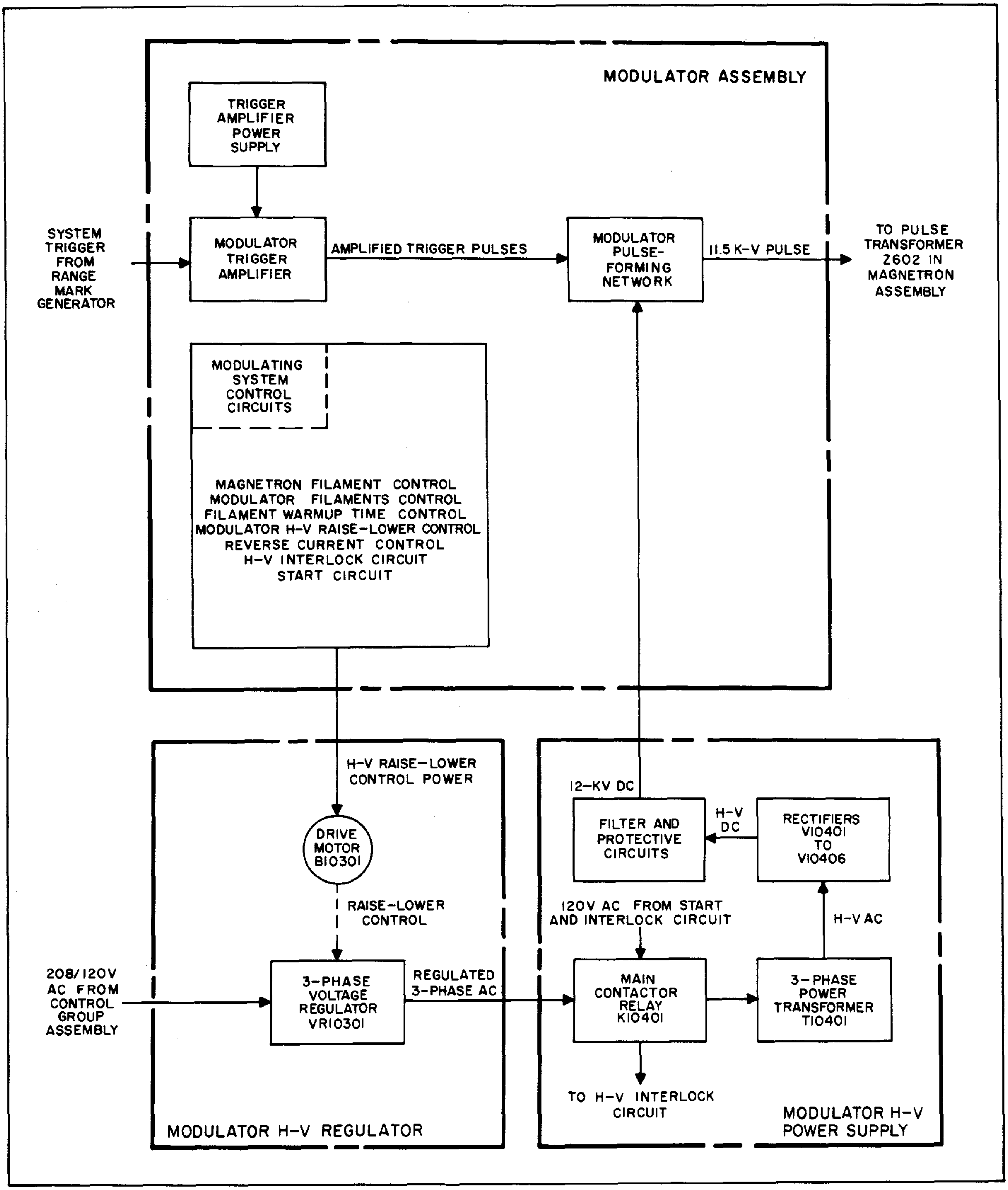


Figure 4–2. Modulating System, Block Diagram

shapes this trigger into a pulse 11.5 kilovolts in amplitude and 2 microseconds in duration. This pulse is then amplified to a —65-kilovolt pulse to fire the magnetron.

4–24. COMPONENTS. The modulating system includes the modulator high-voltage power supply, the modulator high-voltage regulator, and the modulator assembly. Each of these major units is a cabinet assembly containing smaller functional units and control circuits.

4–25. An azimuth blanker is provided with Radar Set AN/FPS-6A to turn off the transmitter when the antenna is pointing at an activity that would be harmed by r-f radiation (an aircraft refueling area, for example). If the antenna is slewed into a blanked azimuth sector, no video appears on the RHI display.

4–26. TRIGGER AMPLIFIER. The trigger amplifier is a subchassis within the modulator assembly. The system trigger received from the range mark generator is amplified sufficiently to fire the thyratron switch tube in the modulator.

4–27. MODULATOR PULSE-FORMING NETWORK. The 750-volt modulator trigger pulse causes the thyratron to ionize, completing the path for the discharge of the pulse-forming network through the primary of pulse transformer Z602 in the magnetron assembly. The rapid, but carefully controlled, discharge of the pulse-forming network produces a voltage pulse of 11.5 kilovolts (nominal value) across the primary of transformer Z602. The secondary of transformer Z602 steps up the pulse to the —65-kilovolt level (nominal value) and applies it to the cathode of the magnetron, which is then shocked into r-f oscillation.

4–28. MODULATOR HIGH-VOLTAGE REGULATOR. The energy to charge the pulse-forming network is obtained from a high-voltage power supply. The level of the high-voltage output is adjusted by the modulator high-voltage regulator, which consists principally of induction voltage regulator VR10301 and drive motor B10301. The induction voltage regulator is a three-phase transformer constructed so that the secondary windings can be rotated with respect to the primary windings. The phase-to-phase output voltage of the induction regulator is variable between 170 and 240 volts, depending upon the relative positions of the primary and secondary windings.

4–29. The drive motor is controlled by HV RAISE-LOWER switches at either the local control panel on the modulator assembly or the remote r-f control panel on the control group assembly. The drive motor is also controlled automatically by the high-voltage runback relay in the modulator control unit. This provision reduces the modulator output voltage in the event of magnetron arcing, thus decreasing the possibility of further arcing within the magnetron. In emergencies, the drive motor can be rotated by a handcrank.

4–30. MODULATOR HIGH-VOLTAGE POWER SUPPLY. The modulator high-voltage power supply provides the high-level d-c voltage used to charge the pulse-forming network in the modulator. When the RADIATE STOP & RESET control on the modulator or remote r-f control panel is placed in the RADIATE position while the high-voltage interlock circuit is closed, the following occurs: Main contactor relay K10401 closes and permits three-phase power from the modulator high-voltage regulator to pass to the primary of transformer T10401 in the modulator high-voltage power supply. The three-phase high-voltage a-c output of transformer T10401 is then fed to six rectifiers connected in a three-phase, full-wave rectifier circuit. The output of the rectifiers consists of high-voltage dc at a level substantially above 12 kilovolts. The rectified output is fed to a filter circuit which smooths out the ripple and drops the high voltage d-c output to a level of between 8.5 kilovolts (when the modulator high-voltage regulator is set at 170 volts, phase to phase) and 12 kilovolts (when the modulator high voltage regulator is set at 240 volts, phase to phase).

4–31. MODULATOR CONTROL CIRCUITS. The modulator filament control circuit maintains the filament voltage of the modulator tubes within 10 percent of rated values to conserve the emissive surface of the cathodes. The control circuit consists of a comparator circuit, a dual relay, and a motor driven autotransformer. Should the modulator filament voltage vary from the desired value, the comparator circuit will operate the dual relay, driving the motor on the autotransformer until the filament voltage is again normal. The magnetron filament power control circuit is similar to the circuit used in modulator filament power control except that it is the current drawn by the magnetron filament that is automatically adjusted. In addition, the magnetron filament power control circuit is set to maintain the magnetron filament current at a higher level when the radar is in standby than when it is radiating.

4–32. The filament warmup time control circuit prevents application of high voltage to the modulator for 15 minutes so that the magnetron and modulator tube filaments will have sufficient time to reach operating temperature.

4–33. The high-voltage interlock circuit removes high voltage from the magnetron under any of the following conditions: (1) component failure that could cause magnetron to overheat or receiver crystals to burn out, (2) receiver being tested, (3) transmitter-receiver drawer assembly withdrawn from cabinet and (4) HV SAFE-OPER switch on safety box (at antenna platform) in SAFE position. Operating in conjunction with the high-voltage interlock circuit are the modulator h-v RAISE-LOWER control and the start (RADIATE STOP & RESET) circuit which have been discussed in paragraphs 4–29 and 4–30.

4–34. The reverse current control circuit reduces power to the modulator high-voltage power supply when the magnetron arcs excessively. When the magnetron first

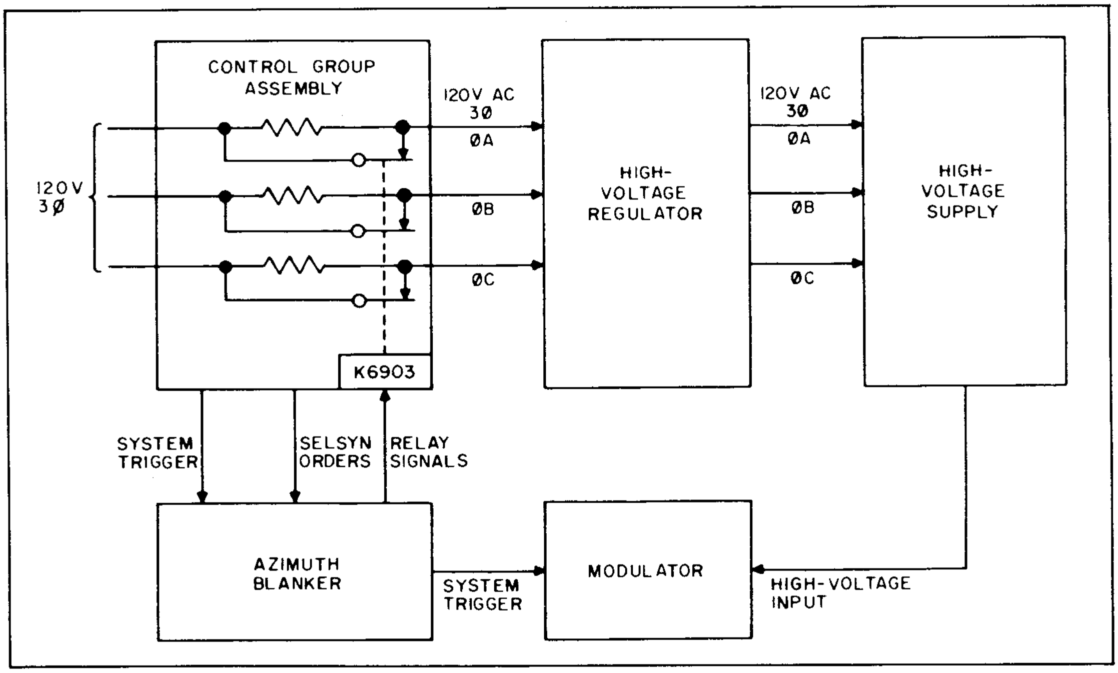


Figure 4–3. Azimuth Blanking, Block Diagram

arcs excessively, the control circuit turns on the drive motor in the modulator high-voltage regulator. This lowers the output of the modulator high-voltage regulator and causes a reduced output from the modulator high-voltage power supply. As a result, the modulating pulse is of lower amplitude. If reducing the amplitude of the modulating pulse is insufficient to stop excessive arcing, the reverse current control circuit opens the high-voltage interlock circuit. This interrupts power to the modulator high-voltage power supply and switches the radar to standby.

4–35. AZIMUTH BLANKER. (See figure 4–3.) The azimuth blanker is a component of Radar Set AN/FPS-6A. The blanker causes the magnetron to cease oscillation whenever the antenna points to a local activity that might be adversely affected by r-f radiation. The width of the azimuth sector blanked can be adjusted at the azimuth blanker from ±5 to ±45 degrees about the center, and the center can be continuously varied in azimuth.

4–36. The azimuth blanker receives selsyn orders representing antenna azimuth from the control group assembly. These selsyn orders are converted into relay action by the blanker. Relay action, in turn, supplies a control voltage to contactor K6903 in the control group assembly. Contactor K6903 is released when the antenna is in an azimuth sector where blanking is desired. Releasing the contactor places a 25-ohm resistor in each line of the 120-volt, 3-phase power supply to the high-voltage regulator. These dropping resistors reduce the voltage fed to the high-voltage power supply, lowering the high-voltage below the level required for magnetron oscillation. Once the antenna slews to the limit of the blanked sector, contactor K6903 operates, shorting out the three 25-ohm resistors and returning the high-voltage to its normal level.

4–37. Magnetron life is shortened by an extended period of reduced anode voltage. Accordingly, the azimuth blanker automatically slews the antenna out of a blanked sector after a lapse of 5 seconds and sounds a warning buzzer. If trouble in the azimuth positioning servo system makes it impossible to slew the antenna out of a blanked sector, the azimuth blanker removes the system trigger from the modulator. Without a system trigger, the magnetron cannot receive anode voltage.

4–38. TRANSMITTING SYSTEM. (See figure 4–4.)

4–39. FUNCTION. The transmitting system generates, guides, and radiates r-f pulses at a fixed frequency in the 2700- to 2900-megacycle band.

4–40. COMPONENTS. The components of the transmitting system are located in three major units: the magnetron assembly, the r-f assembly, and the antenna assembly. Two auxiliary units, the heat exchanger and the pressurizer and dehydrator, are also functional parts of the transmitting system.

4–41. In addition, Radar Set AN/FPS-6A uses a ferrite isolator and a ferrite isolator heat exchanger.

4–42. MAGNETRON ASSEMBLY. The modulating system applies a 2-microsecond, —11.5-kilovolt pulse across the primary of the pulse transformer in the magnetron assembly. The pulse transformer performs the dual function of stepping up the modulating pulse to —65 kilovolts in amplitude and matching the impedance of the magnetron with that of the modulator pulse-forming network. The —65-kilovolt output pulses are applied to the cathode of the magnetron (the

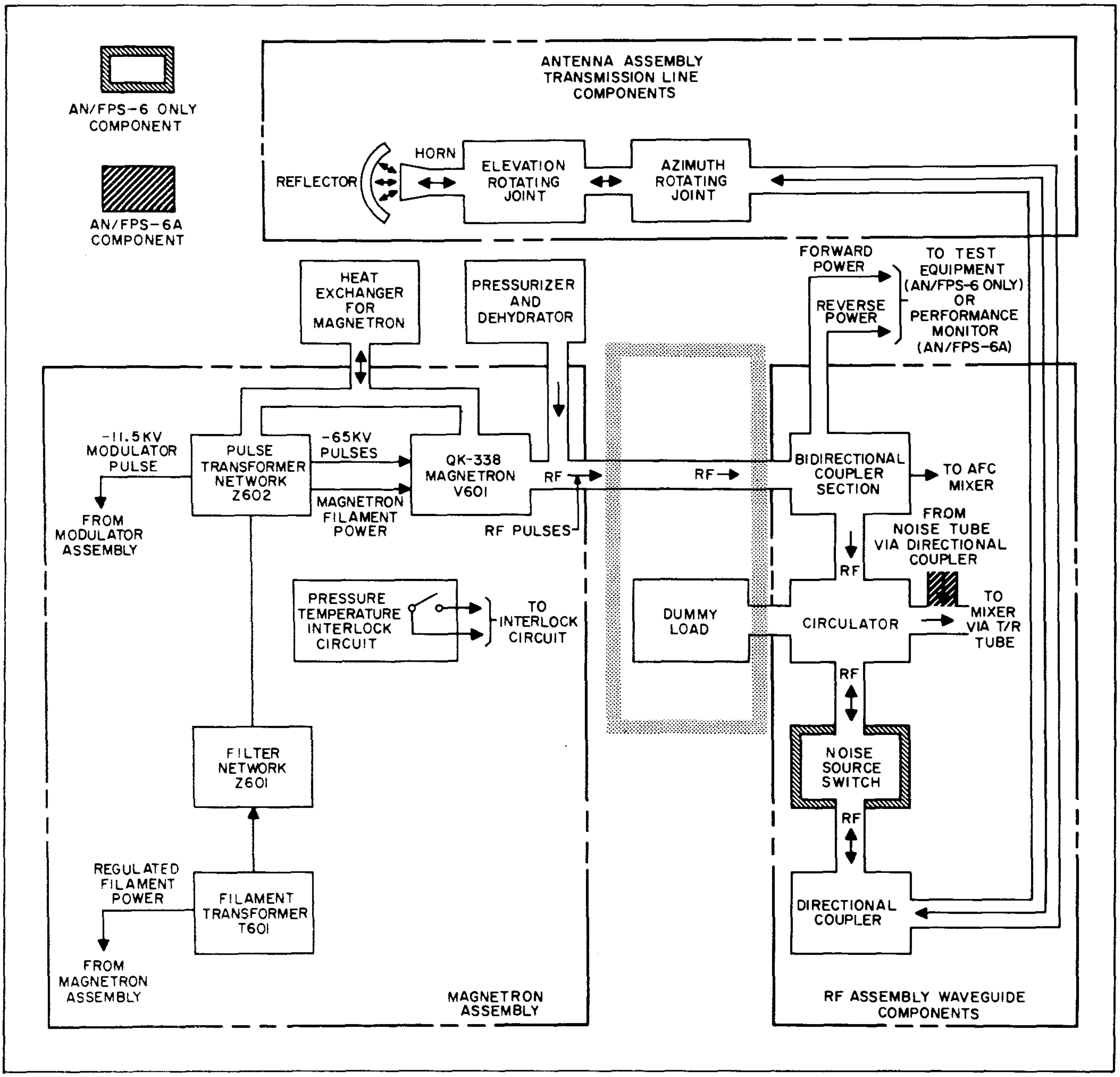


Figure 4–4. Transmitting System, Block Diagram

magnetron anode is grounded), causing the magnetron to oscillate. The output of the magnetron consists of r-f pulses at a fixed frequency in the 2700- to 2900-megacycle band. These r-f pulses have a duration of 2 microseconds and occur at a repetition rate of 300 to 400 pps (set by the pulse repetition frequency of the sync trigger provided by the associated search radar). The r-f pulses are coupled by waveguide components from the magnetron assembly to the r-f assembly.

4–43. Deleted.

4–44. R-F ASSEMBLY. Radio-frequency pulses from the magnetron assembly are fed to the bidirectional coupler, which consists of a main waveguide section, a top coupling section, and a bottom coupling section. The top and bottom coupling sections channel samples of radiated and reflected r-f power to test equipment. A small sample of the radiated energy is also fed to the automatic frequency control (AFC) mixer, where it is applied to circuits designed to maintain a stable intermediate frequency. An AFC attenuator limits the r-f sample to a relatively small fraction of the total transmitted energy. The main waveguide section of the bidirectional coupler transmits the r-f pulses to the duplexing section.

4-45. The duplexing section includes a ferrite circulator, a TR tube, a keep-alive power supply, and a third-harmonic filter. These units combine to perform the switching function which prevents the transmitted pulses from entering the receiving system, directs the transmitted pulses to the antenna, and directs echo pulses from the antenna to the mixer in the receiving system.

4-46. In Radar Set AN/FPS-6 only, r-f pulses to be radiated are fed from the main waveguide section of the bidirectional coupler, through the phase shifting circulator, to the noise source switch. The noise source switch (used with Radar Set AN/FPS-6 only) is a solenoid-operated waveguide switching device. During normal operation, the switch provides a continuous path between the duplexing section and the directional coupler for transmitted and received signals. During noise figure measurement, the noise source switch is energized and allows noise signals to pass into the receiving system. In Radar Set AN/FPS-6A, r-f signals pass from the duplexing system directly into the directional coupler.

4–47. Radio-frequency pulses pass through the directional coupler to the flexible waveguide which connects the r-f assembly to the antenna assembly. The directional coupler applies samples of the transmitted r-f energy to test equipment and also applies test signals into the receiving system.

4–48. ANTENNA ASSEMBLY. After passing through the flexible waveguide section between the r-f assembly and the antenna assembly, the r-f energy enters and passes through the azimuth rotating joint, through additional waveguides, and through the elevation rotating joint of the antenna assembly. From the elevation rotating joint, the r-f energy passes through waveguides to the antenna feedhorn, which feeds the r-f energy to the antenna reflector. The azimuth and elevation rotating joints permit the necessary rotation and scanning by the antenna without introducing appreciable reflections in the waveguide components. The antenna feedhorn is shaped so that a matching impedance is presented in the termination of the waveguide. The r-f energy from the horn is focused by the reflector into a flattened beam dimensionally greater in azimuth than in height and then radiated into space.

4–49. COOLING AND PRESSURIZING EQUIPMENT. Proper functioning of the transmitting system is aided by several auxiliary systems and circuits. These include the magnetron and pulse transformer cooling system, the waveguide pressurizing and dehydrating system, and associated interlock circuits.

4–50. The magnetron anode and the pulse transformer are cooled by a mixture of ethylene glycol and water from the heat exchanger. This coolant is transported through tubing from the heat exchanger to the magnetron assembly.

4–51. Deleted.

4–52. Arcing in the waveguide components is reduced to a minimum by pressurizing the magnetron output waveguide at 30 psi with dried and pressurized air supplied from the dehydrator and pressurizer, respectively.

4–53. The transmitting system is protected against failure of the cooling and pressurizing systems by the pressure-temperature interlock circuit, which is part of the modulator high-voltage interlock circuit. The pressure-temperature interlock circuit in the transmitting system includes three interlock switches which monitor the waveguide pressure, liquid coolant temperature, and liquid flow rate. If either the air pressure in the waveguide system or the liquid flow rate of the heat exchanger drops below preset levels, or if the cooling mixture temperature rises above a preset level, the proper interlock switch opens to cut off high voltage to the modulator, thereby causing the transmitting system to cease radiating.

4–54. RECEIVING SYSTEM. (See figure 4–5.)

4–55. FUNCTION. The receiving system converts r-f echoes into video signals which are amplified and used to intensity-modulate the cathode-ray tube (CRT) of the RHI oscilloscope.

4–56. COMPONENTS. Receiving system functions are performed by components located in the three major units: the antenna assembly, the r-f assembly, and the control group assembly.

4–57. ANTENNA ASSEMBLY. Radio-frequency echoes are received by the antenna and reflected into the feedhorn. Echoes then pass through the elevation rotating joint, the azimuth rotating joint, and the interconnecting waveguide sections of the antenna assembly transmission line components. All of these components function as part of the transmitting and receiving systems. After passing through the components, the received signals emerge at the flexible waveguide and are fed to the r-f assembly.

4–58. R-F ASSEMBLY. In the r-f assembly, the r-f echo signals pass through the directional coupler, the noise source switch (used with Radar Set AN/FPS-6 only), and the receiver arm of the circulator to the mixer. Within the mixer, the received r-f signals and

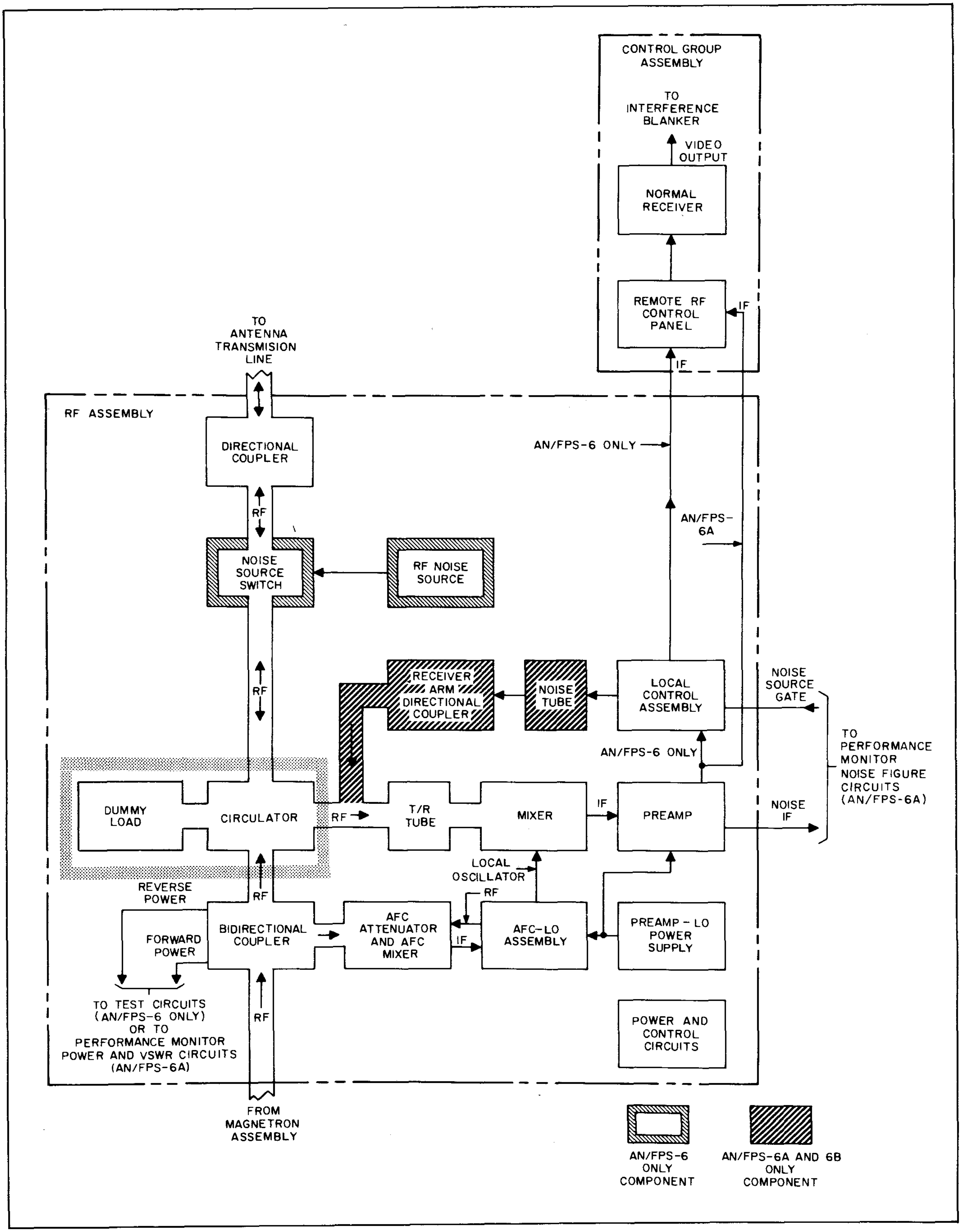


Figure 4–5. Receiving System, Block Diagram

.he local oscillator r-f signal, which is 30 megacycles lower than the frequency of the received signals, beat together. The output of the mixer consists of 30-megacycle i-f pulses. The frequency of the mixer output is maintained constant by the AFC circuits in the AFC-LO unit.

4–59. A sample of the transmitted pulse is coupled out of the bidirectional coupler and fed through the AFC attenuator to the AFC mixer. Part of the local oscillator output of the AFC-LO unit is also fed to the AFC mixer. The local oscillator is designed to oscillate at a frequency approximately 30 megacycles lower than that of the transmitted pulse. The transmitted pulse sample and the local oscillator signal beat together in the AFC mixer to produce an i-f output signal. This signal consists of pulses with a repetition frequency equal to that of the transmitted pulse, but with a carrier frequency of 30 megacycles. The i-f pulses from the AFC mixer are fed to the AFC circuits in the AFC-LO unit. The AFC circuits compensate for any change in the carrier frequency of the transmitted pulse or in the output frequency of the local oscillator which would tend to alter the 30-megacycle carrier frequency of the AFC mixer i-f output. The AFC circuits accomplish this action automatically and continually by adjusting the d-c voltage of the repeller anode of the klystron local oscillator. In this manner, the frequency of the local oscillator is maintained 30 megacycles below the carrier frequency of the transmitted pulse.

4–60. The 30-megacycle difference (r-f echo from local oscillator) represents the carrier frequency of the i-f signal. The 30-megacycle i-f output pulses from the mixer are amplified in the preamplifier and fed to the normal receiver in the control group assembly.

4–61. The electrical characteristics of the preamplifier and mixer used in the r-f assembly of Radar Set AN/FPS-6B differ from those of the units used in Radar Set AN/FPS-6 or AN/FPS-6A. However, both types perform the same function in the radar set.

4–62. NORMAL RECEIVER. The normal receiver amplifies and detects the i-f pulses. To compensate for unusual noise and interference conditions, special circuits are incorporated in the normal receiver to modify the video output of the receiver. Receiver gain is kept low by sensitivity time control (STC) action for the short period after the radiation of the transmitter pulse during which returns from nearby targets (strong signals) are expected. A fast time constant (FTC) circuit, used during jamming, can be employed on any large block of signal to differentiate broad jamming pulses into narrow spikes. These spikes appear on the RHI oscilloscope, but are much less objectionable than the original broad pulses. An automatic video noise limiting (AVNL) circuit sets the gain of the normal receiver in accordance with the prevailing noise level. The gain of the receiver is automatically set as high as the noise present in the receiver permits.

4–63. The video output of the normal receiver is fed to the interference blanker in the control group assembly. Refer to paragraph 4–102 for a description of the video path from this point.

4–64. The preamplifier-local oscillator power supply provides power for operation of the receiving system components in the r-f assembly. Similarly, the control group power supply supplies power for operation of the normal receiver and other components in the control group assembly.

4–65. The r-f noise source (used with Radar Set AN/FPS-6 only) provides signals which may be fed into the receiving system components to determine the receiver noise figure. In Radar Set AN/FPS-6A, this function is performed by the noise tube and receiver arm directional coupler. These components operate as part of the performance monitor (paragraph 4–66) supplied with Radar Set AN/FPS-6A.

4–66. PERFORMANCE MONITOR. (See figure 4–6.)

4–67. FUNCTION. The performance monitor is a component of Radar Set AN/FPS-6A. The three principal subsystems of the performance monitor are the power and VSWR monitor, the noise figure monitor, and the relative tuning indicator, which perform a constant check on the operation of the transmitter-receiver system. The power and VSWR monitor provides continuous measurement of transmitter power output and also permits measurement of transmission line VSWR. These measurements serve as overall checks on the operation of the transmitting system. An overall check on receiving system operation is provided by the noise figure monitor, which supplies continuous measurement of receiver noise. The relative tuning indicator continuously monitors the intermediate frequency.

4–68. COMPONENTS. The units of the performance monitor are located in three major components: the r-f assembly, the performance monitor cabinet, and the remote r-f control panel of the control group assembly.

4–69. POWER AND VSWR MONITOR. Bidirectional coupler E905 extracts samples of both forward (transmitted) and reflected r-f power from the main waveguide in the r-f assembly. The two r-f signals are then fed to the power and VSWR monitor in the performance monitor cabinet, where they are used to produce either a reading of forward power or a VSWR reading on a panel-mounted meter. The forward power reading represents the power output of the transmitter, while the VSWR reading represents the standing-wave ratio in the main waveguide. A meter in the remote r-f control panel provides a remote indication of forward power only.

4–70. NOISE FIGURE MONITOR. Noise figure is determined by comparing the noise in the receiving system (system noise) with a known quantity of noise (injected noise) generated by a noise tube. An increase in noise figure indicates that the signal-to-noise ratio of the receiving system has deteriorated. The noise figure gate generator receives system trigger pulses from the timing circuits of the radar and alternately generates noise-source-on and noise-source-off gates. These gates are generated during the 200-microsecond interval immediately preceding the firing of the transmitter by a system trigger. This 200-microsecond interval is the dead time between sweeps; that is, the time during which no video is displayed on the RHI oscilloscope. The noise source modulator, which is gated on for approximately 200 microseconds during every other sweep period by the gate generator, pulses neon discharge noise tube V918. The noise is fed through Directional Coupler CU-1375/FPS to the receiving system.

4–71. The preamplifier and mixer are part of the receiving system proper. Accordingly, the noise present during the period of the noise-source-off gate is the receiving system noise and that present during the period of the noise-source-on gate is the sum of the system noise and the injected noise. The output of the preamplifier and mixer is applied to the noise figure i-f amplifier, which raises the signal to a level that can be used in the noise

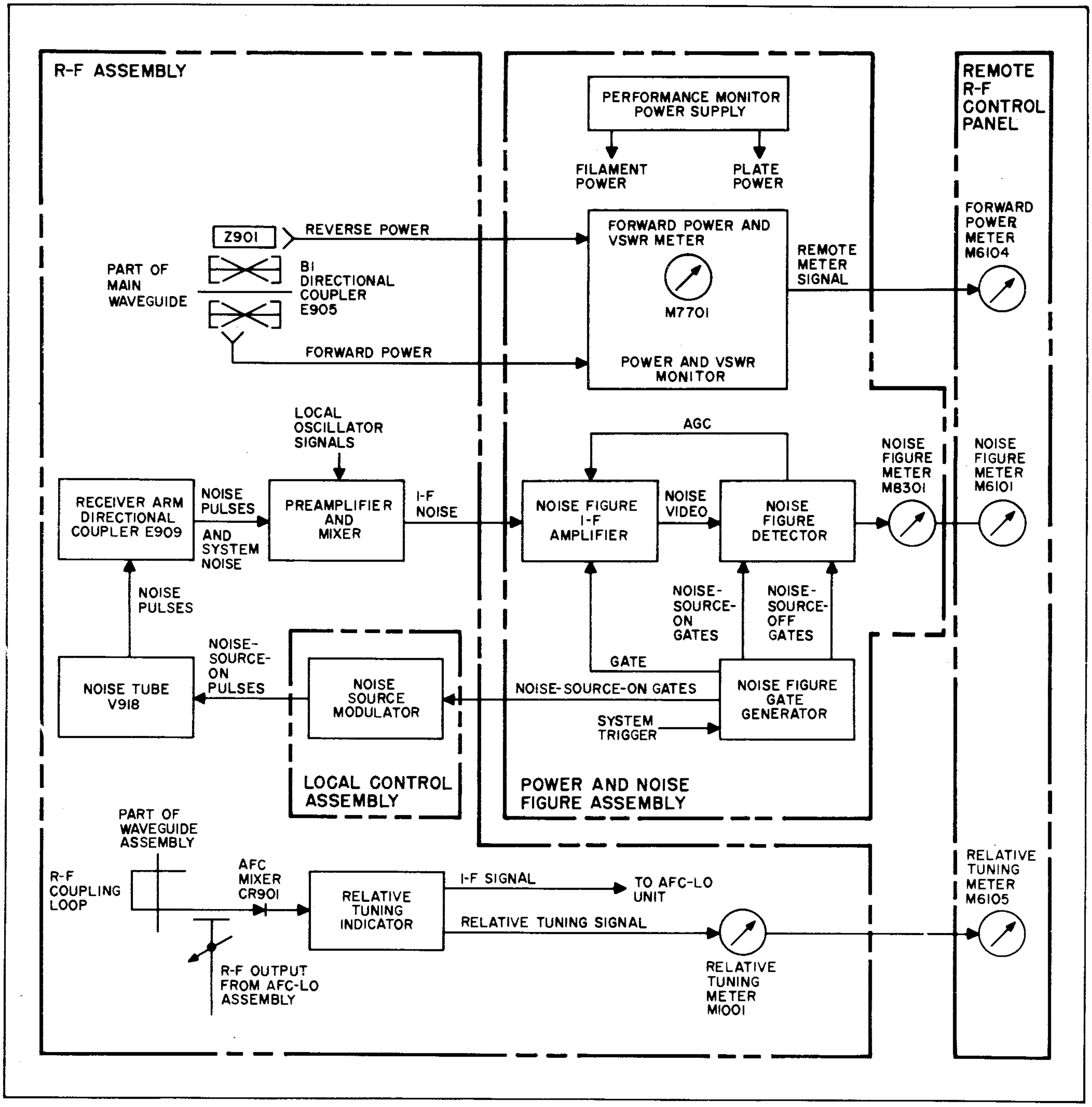


Figure 4–6. Performance Monitor, Block Diagram

figure detector. The noise-source-on and noise-source-off gates in the gate generator are fed to the i-f amplifier, keeping the amplifier cut off except during gated periods.

4–72. The noise figure detector is also gated. During the noise-source-on gate, the noise figure detector develops a signal which represents the sum of the system noise and the injected noise. During the noise-source-off gate, the noise figure detector output represents system noise alone. An automatic gain control (AGC) voltage, which is fed back to the noise figure i-f amplifier, keeps the system noise output at a constant level.

4–73. The outputs of the noise figure detector are fed to a metering circuit composed of an integrator, a chopper, and local and remote NOISE FIGURE meters. The metering circuit is arranged to read the ratio of total noise to system noise. Noise figure then is inversely proportional to the ratio of total (system plus injected) noise power to system noise power only. Assuming that the receiving system noise increases, AGC action reduces the gain of the noise figure i-f amplifier so that the amplitude of the system noise applied to the metering circuit remains the same. This AGC action also reduces the amplitude of the system plus injected noise output of the noise figure i-f amplifier. As a result, the amplitude of the system noise voltage applied to the metering circuit remains the same, while the amplitude of the system plus injected noise voltage decreases. Consequently, the ratio of total noise to system noise is less and the NOISE FIGURE meters indicate an increase in noise figure.

4–74. Conversely, if the receiving system noise decreases, AGC causes the amplitude of the system noise applied to the metering circuit to remain the same, while the amplitude of the injected noise applied to the metering circuit increases. Under these circumstances, the noise figure meters indicate a lower noise figure.

4–75. RELATIVE TUNING INDICATOR. The AFC mixer accepts a local oscillator signal from the AFC-LO assembly and a radar return signal from the r-f coupling loop in the main waveguide. The two signals are mixed and the resulting i-f signal is applied to the relative tuning indicator.

4–76. The relative tuning indicator has two outputs. One output is an amplified i-f signal which is applied to the AFC-LO unit, while the other output is a d-c signal with an amplitude proportional to the deviation of the i-f signal from its nominal value. The d-c signal is applied to local and remote RELATIVE TUNING meters, which are calibrated directly in frequency and are zero-centered around the nominal i-f value of 30 megacycles. These meters indicate any deviation in the i-f signal from its nominal setting. The local tuning meter, mounted on the local control panel, is a meter relay which can be set to light the DETUNING INDICATOR if the intermediate frequency deviates a preset amount above or below the nominal frequency. To turn off the DETUNING INDICATOR, the intermediate frequency must first be readjusted and then a RESET button depressed. The remote tuning meter, mounted on the remote r-f control panel, does not have the relay feature.

4–77. RANGE-HEIGHT PRESENTATION SYSTEM.

4–78. RHI DISPLAY.

4–79. GENERAL. The radar employs the RHI type of presentation. In this presentation, range is displayed along the horizontal axis and height along the vertical axis.

4–80. The RHI oscilloscope uses a 12-inch, long-persistence CRT. The actual viewing area is 7-1/2 inches in diagonal length. Range scales parallel the horizontal sides of the display and height scales parallel the vertical sides. Absolute and relative height dials indicate the height of the designated target. Focus, intensity, and centering controls are provided on the front panel in addition to potentiometers which adjust the intensity of the index markers.

4–81. PRESENTATION USED IN RADAR SET AN/FPS-6. Figure 1–8 shows a typical presentation on Radar Set AN/FPS-6. Range can be determined to a distance of 200 nautical miles and height to an altitude of 75,000 feet. The trace is synchronized with the nodding of the antenna as it scans between 32 degrees above and 2 degrees below the horizontal.

4–82. Electronically generated range, height, and angle markers enable the RHI operator to establish target position accurately. Range markers are provided at 10-mile increments out to 200 natuical miles, with every fifth marker intensified. Height markers are provided at altitude designations of 20,000, 40,000, and 60,000 feet. Angle markers, designating every 5-degree increment of antenna elevation, appear on the RHI oscilloscope as seven radii converging to a point at the lower left-hand corner of the display representing zero height and zero range. The angle markers are generated from triggers provided by a commutator geared to the antenna elevation motion.

4–83. The range line is a movable range marker actuated by a trigger from the associated search radar and is positioned so as to intersect the target being designated. The height line is a movable height marker positioned by turning the HEIGHT LINE handcrank. When the height line intersects the designated target, the absolute height dial indicates the height of the target with respect to the horizontal.

4–84. The front panel range selector switch provides a choice of three positions: 0 to 100 nautical miles, 0 to 200 nautical miles, or range delay. A range delay tape (moved by the RANGE DELAY handcrank) runs along beneath the display. The height selector switch has four positions: —5000 to +75,000 feet, —5000 to +25,000 feet, +20,000 to +50,000 feet, and +45,000 to +75,000 feet.

4–85. PRESENTATION USED IN RADAR SET AN/FPS-6A. Figure 1–9 shows a typical presentation on Radar Set AN/FPS-6A. Range can be determined to a distance of 300 nautical miles and height to an altitude of 100,000 feet. The trace is synchronized with the nodding of the antenna as it scans between 32 degrees above and 2 degrees below the horizontal.

4–86. Electronically generated range and angle markers enable the RHI operator to establish target position accurately. When ranges of less than 70 miles are selected, 10-mile markers appear on the CRT screen. When ranges of between 0 and 70 and between 0 and 150 miles are selected, 20-mile markers are seen on the screen. Selection of ranges of more than 150 miles causes 50-mile range markers to appear on the screen. Angle markers, designating every 5-degree increment of antenna elevation, appear on the RHI oscilloscope as seven radii converging to a point at the lower left-hand corner of the display representing zero height and zero range. The angle markers are generated from triggers produced by a commutator geared to the antenna elevation motion.

4–87. The range line is a movable range marker actuated by a trigger from the associated search radar and is positioned so as to intersect the target being designated. The height cursor is a short, intensified horizontal line which is positioned by moving a control stick. When the height cursor bisects the designated target, the absolute height dial indicates the height of the target with respect to the horizontal.

4–88. The front panel range control provides a continuous variation of sweep display from 50 to 300 nautical miles and indicates the selected range. The fixed height scale is calibrated from —5000 to +100,000 feet.

4–89. HORIZONTAL SWEEP SYSTEM. (See figure 4–7.)

4–90. FUNCTION. The horizontal sweep system deflects the CRT beam to the right as the radar pulse travels outward in space. The magnetic field causing the horizontal movement of the beam is produced by application of a sawtooth (linearly increasing) current applied to the horizontal sweep deflection coil. A voltage waveform of the proper current characteristics is obtained from the horizontal sweep circuit in the RHI assembly.

4–91. COMPONENTS. The horizontal sweep system consists of the synchronizing circuits in the range mark generator and the horizontal sweep circuit in the RHI assembly.

4–92. SYSTEM TRIGGER. Operation of the horizontal sweep circuit is initiated by a system trigger obtained from the range mark generator. This trigger is synchronized with the modulator trigger so that the horizontal sweep starts at the same time the transmitter fires.

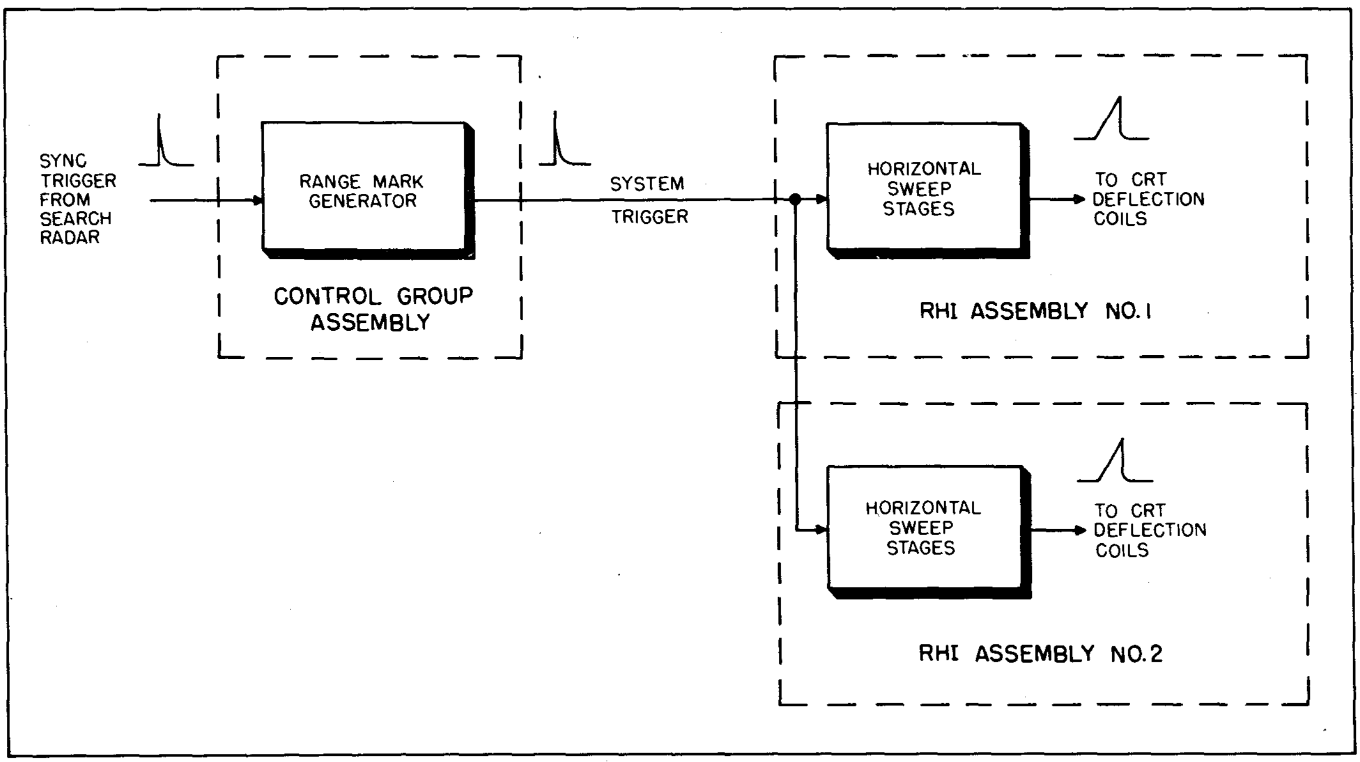


Figure 4–7. Horizontal Sweep System, Block Diagram

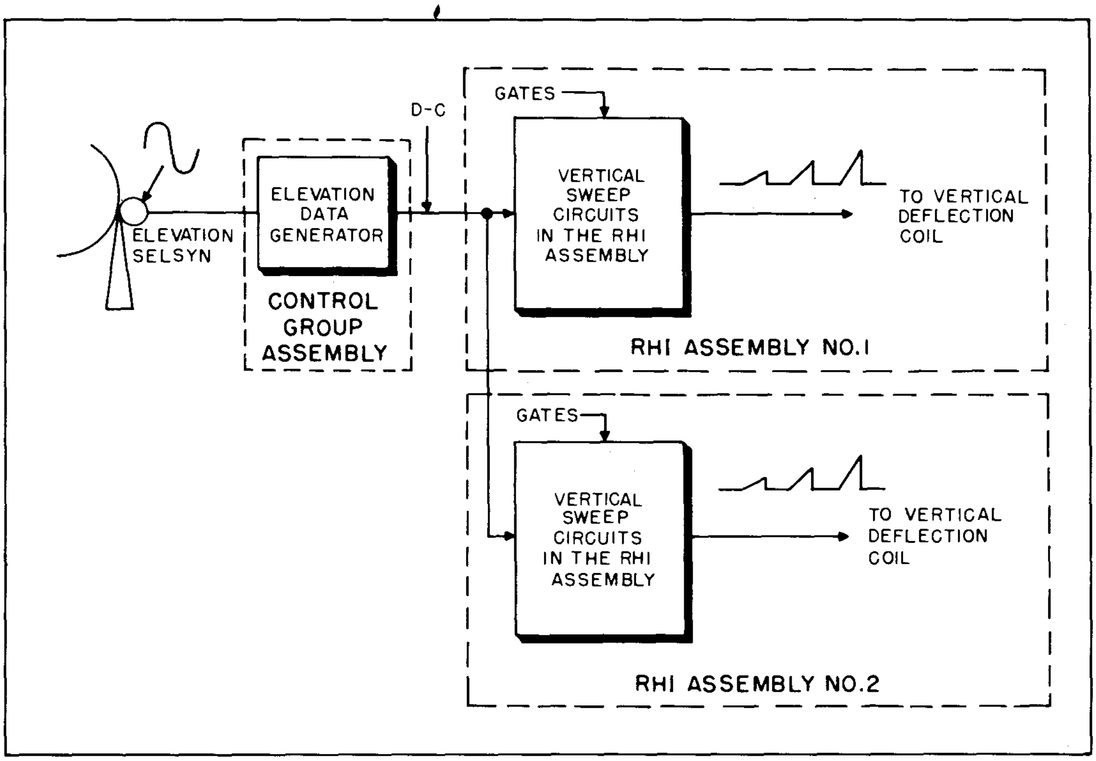


Figure 4–8. Vertical Sweep System, Block Diagram

4–93. HORIZONTAL SWEEP CIRCUIT. The horizontal sweep circuit transforms a d-c voltage reference (available within the RHI assembly) into a linearly increasing magnetic field in the CRT. For any given range, the rate of increase is proportional to d-c reference. The rate at which the magnetic field increases in magnitude determines the speed at which the beam moves horizontally across the screen.

4–94. The horizontal sweep can be delayed in time so that its starting point on the RHI oscilloscope screen represents any desired range from 0 to 180 nautical miles. Range delay permits expansion of the far end of the trace, thus enabling a detailed inspection of distant targets.

4–95. VERTICAL SWEEP SYSTEM. (See figure 4–8.)

4–96. FUNCTION. The vertical sweep system deflects the CRT beam vertically in synchronism with the nodding of the antenna. The trace is positioned on the screen of the RHI oscilloscope so that the perpendicular distance from the zero reference line to a target indication represents the height of the target.

4–97. COMPONENTS. The three components which produce the vertical sweep are the elevation selsyn (part of the elevation selsyn and angle mark unit), the elevation data generator (part of the control group assembly), and the vertical sweep stages in the RHI assembly.

4–98. ELEVATION SELSYN. The elevation selsyn is geared to the antenna motion and produces a sine wave whose amplitude and phase vary with the elevation angle. The selsyn is energized by a 1500-cps signal produced in the elevation data generator. The stator signal is a 1500-cps voltage in phase with the rotor signal when the antenna passes through positive elevation angles (above the horizontal axis of the antenna). The 1500-cps stator output is out of phase with the rotor voltage when the antenna passes through negative elevation angles (below the horizontal axis of the antenna).

4–99. ELEVATION DATA GENERATOR. The sinusoid produced in the elevation selsyn is applied to the elevation data generator and converted into a d-c voltage proportional to the sine of the antenna elevation angle. To understand the necessity for the sine function, it is first necessary to comprehend the relationship between target height and the angle of elevation of the radar antenna (figure 4–9). Angle θ represents the elevation angle of the antenna with respect to the horizontal. Assuming that a target exists at point X, a triangle is formed by the meeting of lines H, R, and S, where the length of line H represents the height of the target above the horizontal; line R represents the horizontal range of the target; and line S represents the slant range of the target. Applying trigonometry.

$$\text{Sine } \theta = \frac{\text{target height}}{\text{slant range}}$$

Transposing, target height $=$ sine $\theta \times$ slant range

4–100. In considering a group of targets at the same slant range but at different heights, it is necessary to

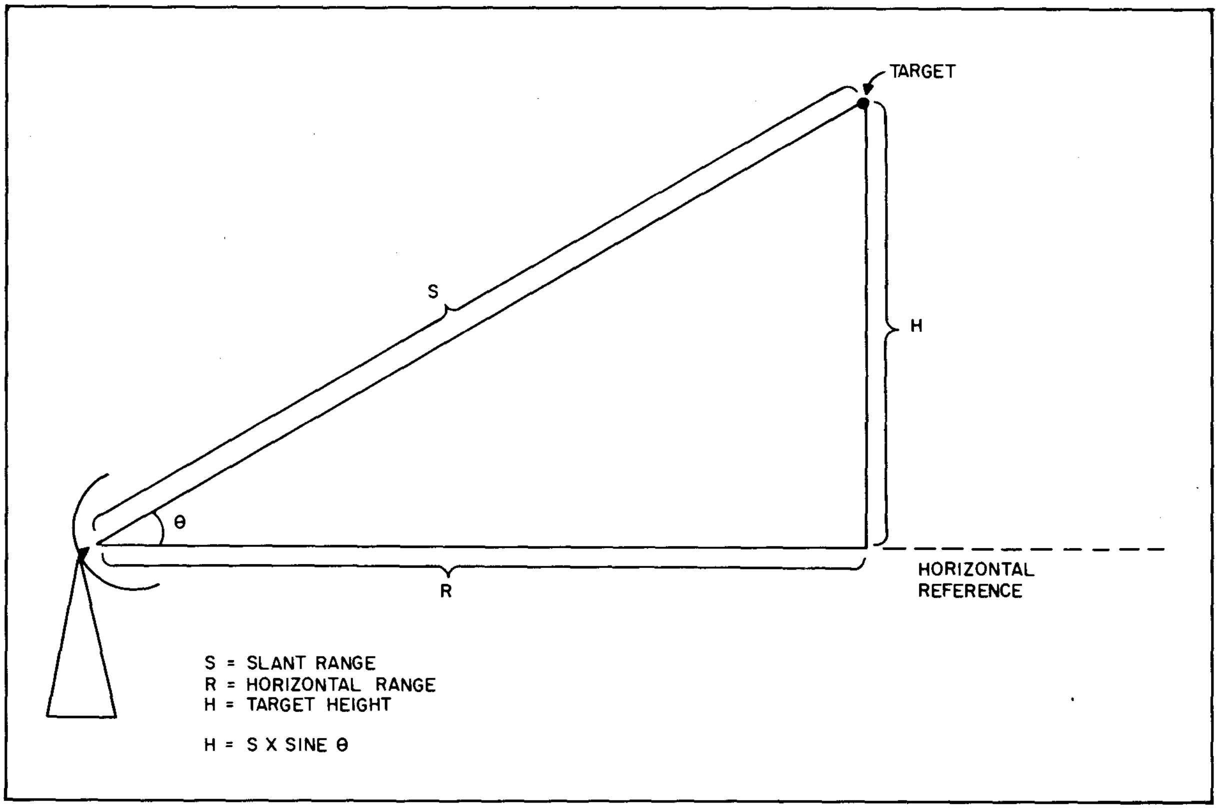


Figure 4–9. Relationship between Target Height and Antenna Elevation

bear in mind that the height of a target is proportional to sine θ. For this reason, the amplitude of the vertical sweep is made proportional to the sine of the elevation angle of the antenna. As the antenna scans from 0-degree elevation to a maximum of +32 degrees, the magnitude of the d-c voltage produced by the elevation data generator increases in a positive direction. Similarly, as the antenna nods downward, the d-c reference voltage decreases in magnitude. When the antenna points along the horizontal, no d-c elevation voltage is produced. When the antenna nods below the horizontal, the elevation data generator produces a negative voltage.

4–101. VERTICAL SWEEP STAGES IN RHI ASSEMBLY. The vertical sweep stages in the RHI assembly transform the d-c elevation voltage into a linearly increasing magnetic field with a rate of increase proportional to the amplitude of the d-c elevation voltage. As the antenna scans from 0-degree elevation to a maximum of +32 degrees, the amplitudes of the successive vertical sweeps increase. Similarly, the amplitude of each successive vertical sawtooth decreases as the antenna nods downward. No vertical sweep is generated at 0-degree elevation (the trace is produced solely by the range sweep). As the antenna nods below the horizontal reference, a negative sawtooth is produced which positions the trace below the zero reference line of the RHI oscilloscope.

4–102. VIDEO SYSTEM. (See figure 4–10.)

4–103. FUNCTION. The video system translates the r-f energy reflected by targets into voltage pulses for display on the range-height presentation.

4–104. COMPONENTS. The video system consists of the components of the receiving system, the interference blanker (a component of the control group assembly), and video stages within the RHI assembly.

4–105. RECEIVING SYSTEM. The receiving system converts the r-f energy gathered by the antenna into video pulses. The final component of the receiving system, the normal receiver, applies its output to the interference blanker.

4–106. INTERFERENCE BLANKER. When nearby radars fire, their r-f emissions are detected by the receiving system of the radar. Unless eliminated, these strong signals would be introduced into the video channel together with normal target responses and, consequently, would appear on the displays.

4–107. If the pulse repetition rates of the nearby radars were identical with that of the radar, the r-f transmitter pulses and the ground clutter they generated would always appear at the same point on the RHI oscilloscope. Since the recurrence rate of the interfering radars is

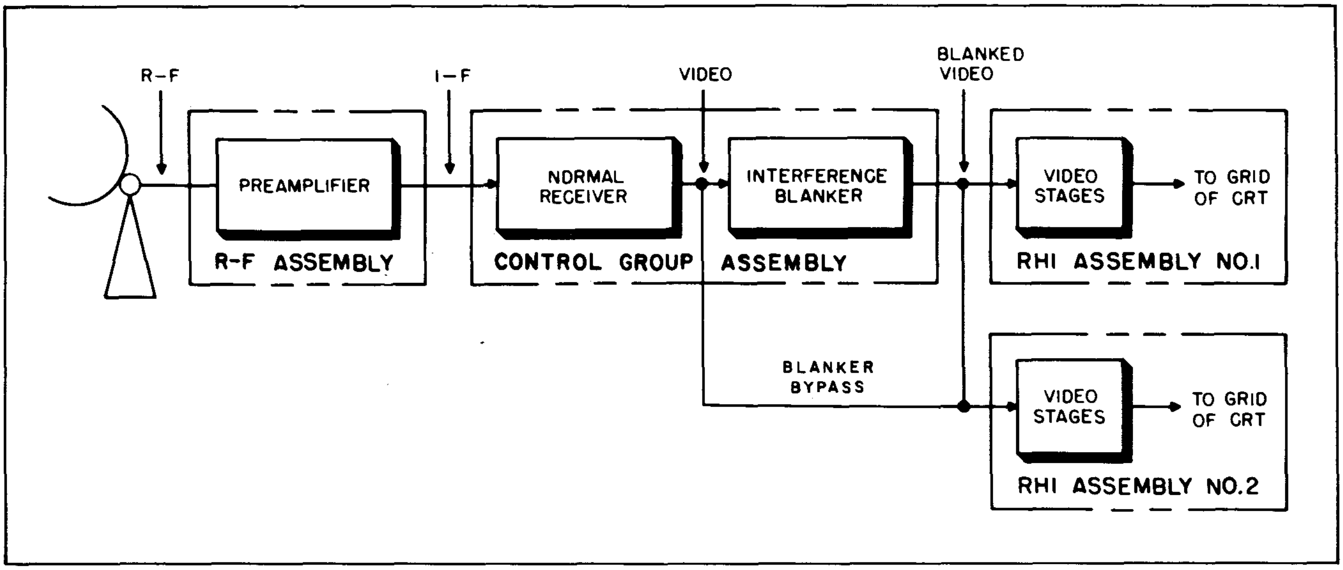


Figure 4–10. Video System, Block Diagram

generally not the same as that of the radar set, the undesired video from the interfering radars would appear at different points on the screen of the RHI oscilloscope. This would raise the background level of the display to a point where responses from weak targets would be obscured and difficult to distinguish. To prevent this phenomenon, the interference blanker blanks out the video between the normal receiver and the RHI assembly when a nearby radar fires. The blanking action is initiated by a trigger from the interfering radar, which is applied to the interference blanker at the instant the interfering radar transmits the disturbing r-f pulse. By generating a video blanking voltage, this trigger acts to prevent the undesirable r-f transmitter pulse video from appearing on the RHI oscilloscope. When blanking is not required, the blanker can be bypassed by the use of a switch.

4–108. VIDEO STAGES IN RHI ASSEMBLY. After emerging from the interference blanker, the video enters the video input of the RHI assembly. A video amplifier chain in the RHI assembly amplifies the video signals while preserving the signals against loss of low- and high-frequency components. The video, in the form of positive pulses, is applied to the grid of the CRT, which is normally cut off. The positive video pulses momentarily bring the display tube above cutoff, allowing the beam to strike the fluorescent screen. Each video pulse produces a small mark on the screen. The position of the mark with respect to the left-hand edge of the display and the zero elevation line indicates the range and height, respectively, of the target.

4–109. RANGE MARKER AND RANGE LINE SYSTEM. (See figures 4–11 and 4–12.)

4–110. FUNCTION. The range marker and range line system causes range markers to appear on the screen of the RHI oscilloscope and a variable marker (range line) to appear superimposed on the designated target.

4–111. In all radar systems, the length of time required for energy reflected from a target to return to the antenna is directly proportional to the target range. In this pulse radar, the energy is returned in the form of discrete echoes which are displayed on a CRT along a linear scale. The RHI operator determines target range by measuring the distance from the transmitter blip to the target echo. An approximate indication of target range could be obtained by measuring the distance with the aid of an etched scale placed over the screen of the RHI oscilloscope. A much more accurate method is used in this radar: the production of electronic range markers which appear as vertical lines spaced evenly along the horizontal axis of the CRT screen. When the distance in nautical miles between adjacent markers has been ascertained, the operator can determine target range by comparing the position of the echo with the known position of the range markers.

4–112. The range line appears superimposed upon one of the many targets displayed on the RHI oscilloscope. The RHI operator is thus informed that he must determine the height of this target and transmit the information to the associated search radar. (Where the range line does not intersect any target, height information is requested for all targets with ranges approximating that of the range line.)

4–113. COMPONENTS. The range markers and range line are produced on the face of the RHI oscilloscope by the combined functioning of three components of the radar: the range mark generator (physically a part of the control group assembly), the junction box (a part of the time-sharing system), and the range marker and range line stages in the RHI assembly.

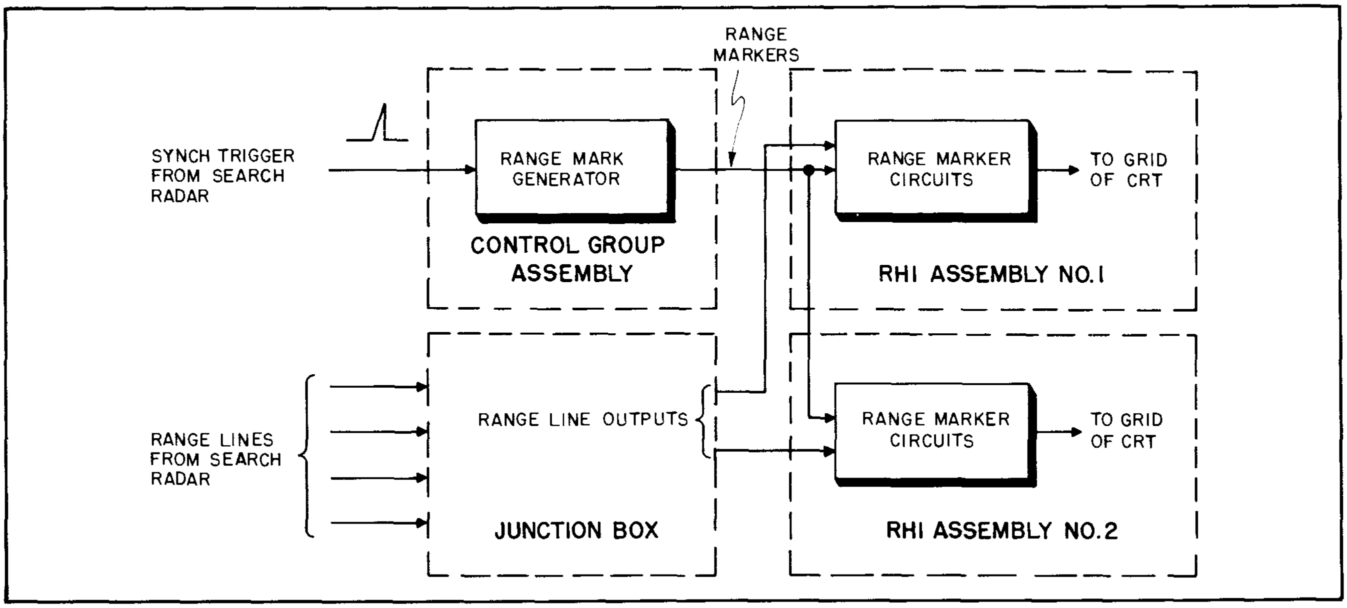


Figure 4–11. Range Marker and Range Line System of Radar Set AN/FPS-6, Block Diagram

4–114. CONTROL GROUP ASSEMBLY RANGE MARK GENERATOR. The first range marker produced should be 10 miles from the radiated transmitter pulse. Succeeding range markers should then appear at integral multiples of 10 miles from the first range marker. The desired spacing between the transmitter pulse and the first range marker is effected by deriving the initiating impulse for both the modulating system and the range markers from the same source; that is, the sync trigger. This sync trigger, generated by the associated search radar, is applied to the range mark generator. The sync trigger is sharpened by a blocking oscillator and applied, through isolating cathode followers, in the form of initiating impulses for the range marker gate circuit, the angle mark generator, the modulator, the interference blanker, and the sweep circuits in the RHI assembly. The range mark generator thus acts as a master synchronizer for the entire radar.

4–115. In Radar Set AN/FPS-6, the range mark generator produces range markers for the duration of one range sweep on alternate sweeps. Ten-mile markers are obtained at the output of the range mark generator. Every fifth marker is intensified to simplify reading of the RHI oscilloscope.

4–116. In Radar Set AN/FPS-6A, the range mark generator in the control group assembly supplies the RHI assembly with a synchronizing trigger only. While the range markers are cabled to the RHI assembly, they are used only in emergencies or for calibration.

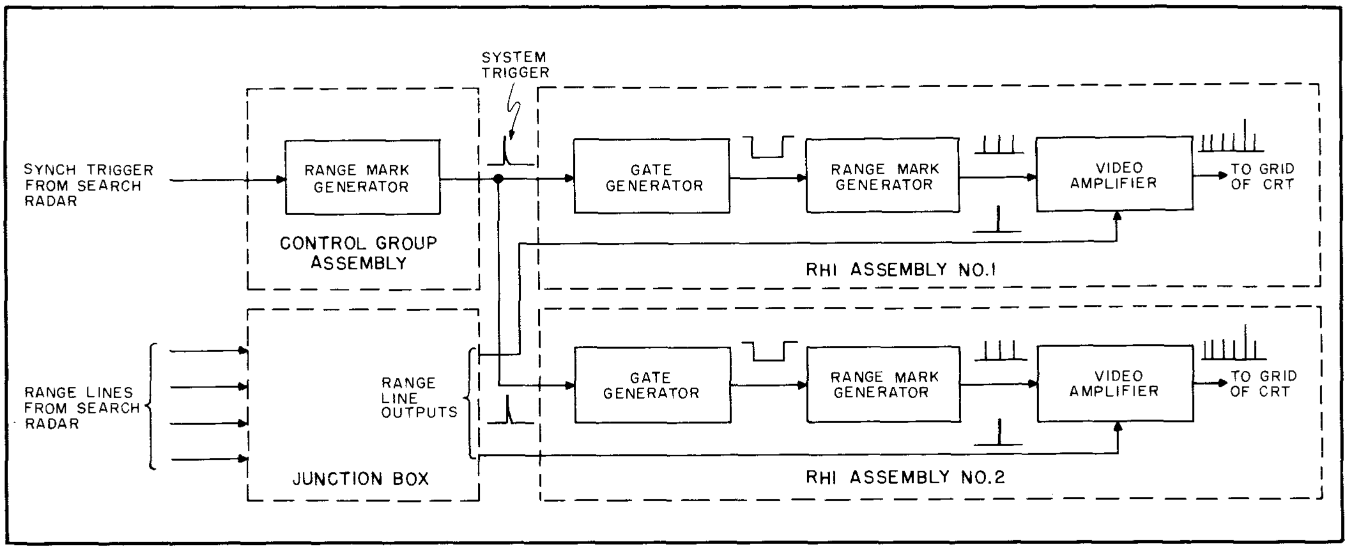


Figure 4–12. Range Marker and Range Line System of Radar Set AN/FPS-6A, Block Diagram

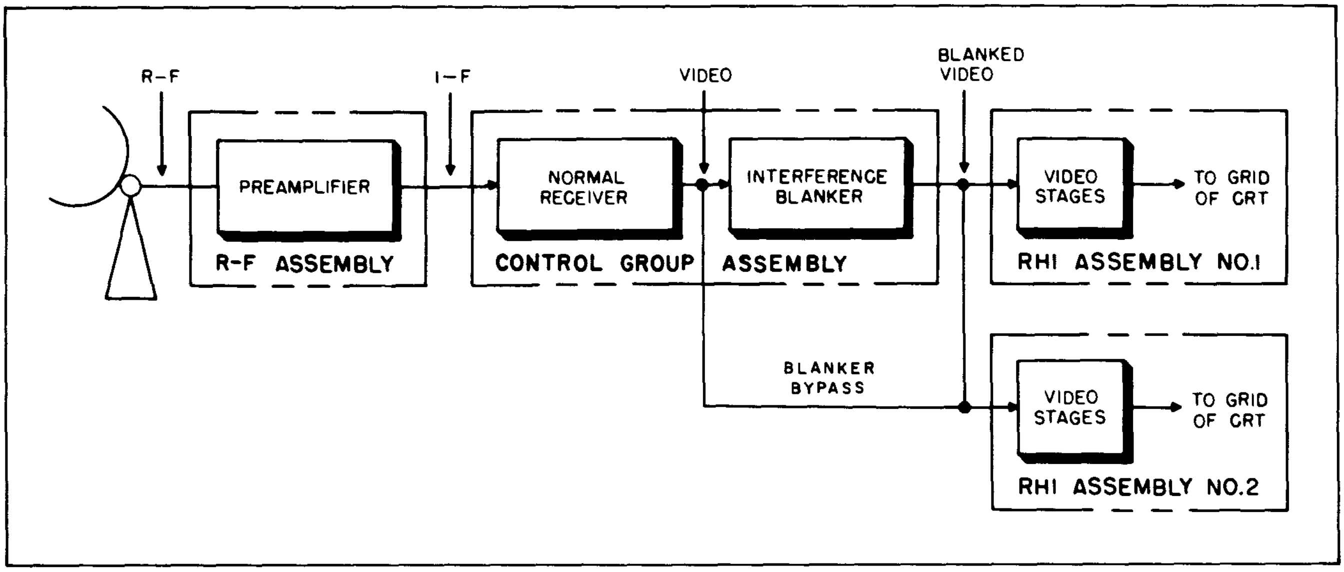


Figure 4–10. Video System, Block Diagram

generally not the same as that of the radar set, the undesired video from the interfering radars would appear at different points on the screen of the RHI oscilloscope. This would raise the background level of the display to a point where responses from weak targets would be obscured and difficult to distinguish. To prevent this phenomenon, the interference blanker blanks out the video between the normal receiver and the RHI assembly when a nearby radar fires. The blanking action is initiated by a trigger from the interfering radar, which is applied to the interference blanker at the instant the interfering radar transmits the disturbing r-f pulse. By generating a video blanking voltage, this trigger acts to prevent the undesirable r-f transmitter pulse video from appearing on the RHI oscilloscope. When blanking is not required, the blanker can be bypassed by the use of a switch.

4–108. VIDEO STAGES IN RHI ASSEMBLY. After emerging from the interference blanker, the video enters the video input of the RHI assembly. A video amplifier chain in the RHI assembly amplifies the video signals while preserving the signals against loss of low- and high-frequency components. The video, in the form of positive pulses, is applied to the grid of the CRT, which is normally cut off. The positive video pulses momentarily bring the display tube above cutoff, allowing the beam to strike the fluorescent screen. Each video pulse produces a small mark on the screen. The position of the mark with respect to the left-hand edge of the display and the zero elevation line indicates the range and height, respectively, of the target.

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4–113. COMPONENTS. The range markers and range line are produced on the face of the RHI oscilloscope by the combined functioning of three components of the radar: the range mark generator (physically a part of the control group assembly), the junction box (a part of the time-sharing system), and the range marker and range line stages in the RHI assembly.

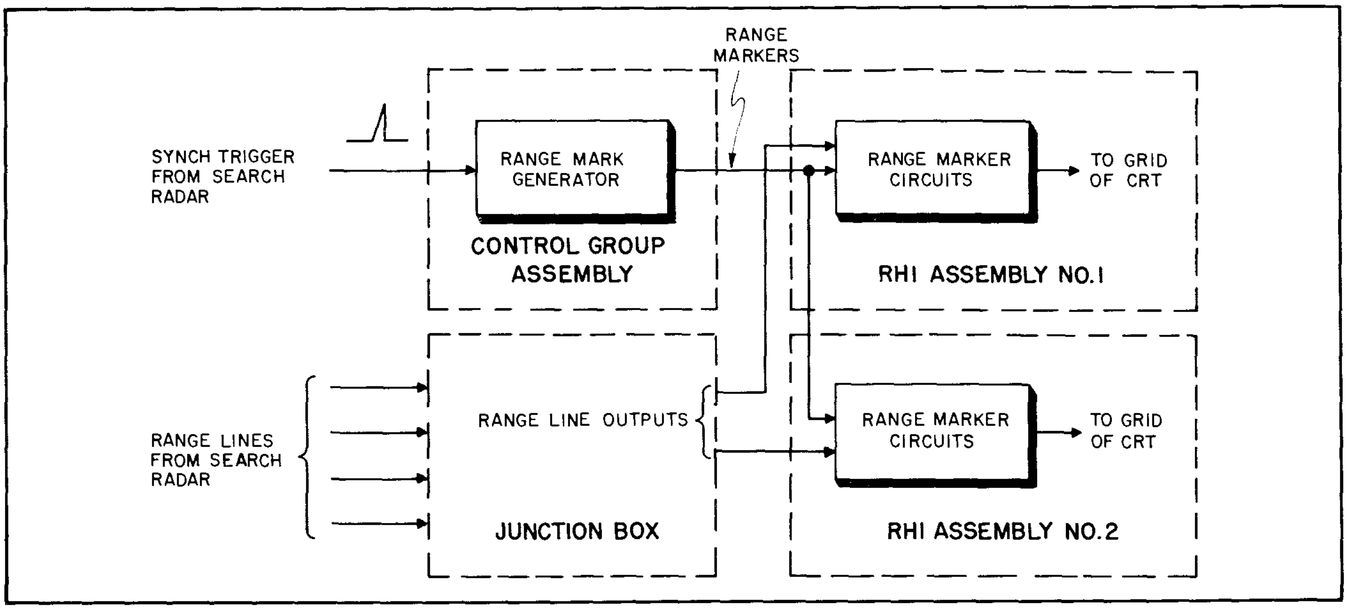

Figure 4–11. Range Marker and Range Line System of Radar Set AN/FPS-6, Block Diagram

4–114. CONTROL GROUP ASSEMBLY RANGE MARK GENERATOR. The first range marker produced should be 10 miles from the radiated transmitter pulse. Succeeding range markers should then appear at integral multiples of 10 miles from the first range marker. The desired spacing between the transmitter pulse and the first range marker is effected by deriving the initiating impulse for both the modulating system and the range markers from the same source; that is, the sync trigger. This sync trigger, generated by the associated search radar, is applied to the range mark generator. The sync trigger is sharpened by a blocking oscillator and applied, through isolating cathode followers, in the form of initiating impulses for the range marker gate circuit, the angle mark generator, the modulator, the interference blanker, and the sweep circuits in the RHI assembly. The range mark generator thus acts as a master synchronizer for the entire radar.

4–115. In Radar Set AN/FPS-6, the range mark generator produces range markers for the duration of one range sweep on alternate sweeps. Ten-mile markers are obtained at the output of the range mark generator. Every fifth marker is intensified to simplify reading of the RHI oscilloscope.

4–116. In Radar Set AN/FPS-6A, the range mark generator in the control group assembly supplies the RHI assembly with a synchronizing trigger only. While the range markers are cabled to the RHI assembly, they are used only in emergencies or for calibration.

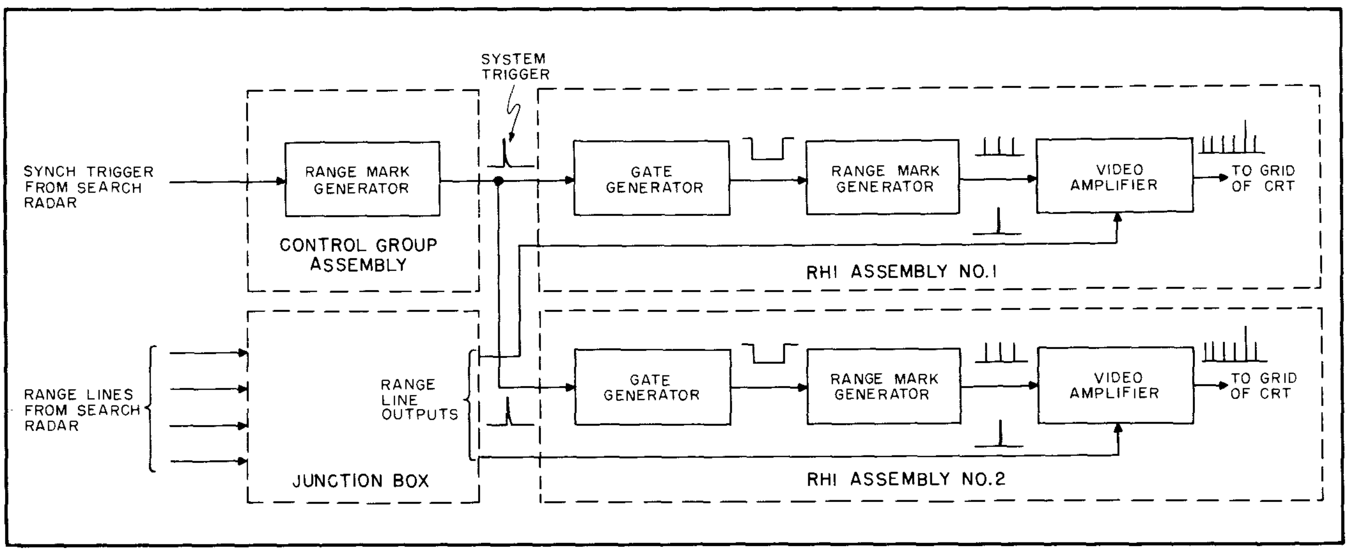

Figure 4–12. Range Marker and Range Line System of Radar Set AN/FPS-6A, Block Diagram

4–117. JUNCTION BOX. The range line trigger from the PPI display of the associated search radar (generated by the positioning of the PPI display marker) is fed through relays in the junction box to the RHI assembly. As many as four PPI operators can supply range line triggers to the junction box. The time-sharing system insures that only one of the range line triggers can reach the RHI assembly at any given instant.

4–118. RANGE MARKER AND RANGE LINE CIRCUITS IN RHI ASSEMBLY OF RADAR SET AN/FPS-6 ONLY. Stages in the RHI assembly of Radar Set AN/FPS-6 mix the range markers and the range line trigger, amplify the combined signal, and apply the resulting sequence of positive pulses to the grid of the CRT. The range markers then brighten the CRT at intervals corresponding to 10 nautical miles of target range. The range line brightens the display at the same time that the video return from the designated target is received.

4–119. RANGE MARKER AND RANGE LINE CIRCUITS IN RHI ASSEMBLY OF RADAR SET AN/FPS-6A. The system trigger from the control group assembly is used to start a gate circuit which allows the RHI range mark generator to produce range markers for the duration of one range sweep. A 2:1 frequency divider in the range mark generator counts down the applied gates so that range markers are produced on alternate sweeps. The output of the range mark generator consists of 10-, 20-, or 50-mile range markers, as determined by the position of the front panel RANGE control. Stages in the RHI video amplifier mix the range markers and the range line trigger, amplify the combined signal, and apply the resulting sequence of positive pulses to the grid of the CRT. The range markers then brighten the CRT at regular intervals. The range line brightens the display at the same time that the video return from the designated target is received.

4–120. HEIGHT MARKER AND HEIGHT LINE SYSTEM.

4–121. The height markers and the height line are generated by circuits located entirely within the RHI assembly.

4–122. ANGLE MARKER SYSTEM. (See figure 4–13.)

4–123. FUNCTION. The angle marker system provides an angle marker for every 5-degree increment of antenna elevation. The angle markers are fed to the cathode of the CRT and appear on the indicator screen as radii converging to a focal point representing zero height and zero range.

4–124. COMPONENTS. Angle markers are produced by the combined functioning of three units: the angle mark commutator (a part of the elevation selsyn and angle mark unit) geared to the antenna elevation motion, the angle mark generator (physically a part of the control group assembly), and several stages in the RHI assembly.

4–125. ANGLE MARK COMMUTATOR. A commutator mounted on the antenna assembly produces marker pulses at the instant the antenna passes through elevation angles of 0, 5, 10, 15, 20, 25, and 30 degrees. The commutator contains two connected rings, each in contact with one carbon brush. One of these rings has a conducting segment 360 degrees wide, and the other a conducting segment 5.5 degrees wide. The commutator is geared to the nodding motion of the reflector so that the 5.5-degree-wide segment is in contact with its brush once every 5 degrees of antenna elevation,

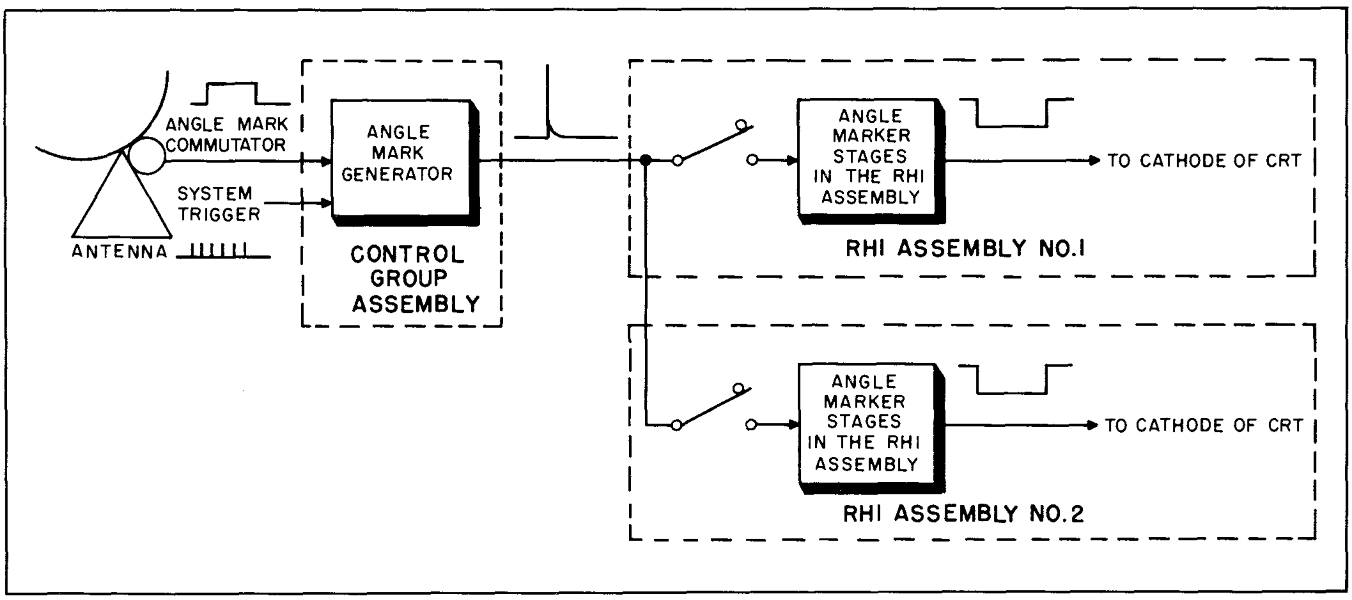

Figure 4–13. Angle Marker System, Block Diagram

thus completing a circuit to the grid of the angle mark generator tube once every 5 degrees.

4–126.The angle mark commutator used in Radar Set AN/FPS-6A differs from that of Radar Set AN/FPS-6 only in that for Radar Set AN/FPS-6A two brushes are used on the commutator ring with the 5.5-degree wide conducting segment. If a single brush were used, the angle mark generated on the upswing of the antenna would be out of coincidence with the angle mark generated on the downswing. The use of two brushes minimizes this difficulty because the spacing between them is slightly narrower than the width of the conducting segment, and the circuit to the angle mark generator tube is complete only when the segment is in contact with both brushes. Certain AN/FPS-6 systems can also be equipped with this type of angle mark commutator.

4–127. ANGLE MARK GENERATOR. The pulses produced by the angle mark commutator are relatively broad and vary in length with the speed of elevation scanning. In addition, the leading edge of the pulse seldom coincides with the start of the sweep. The angle mark generator converts the broad pulses obtained from the commutator into discrete triggers synchronized with the pulse repetition rate of the radar. The commutator pulse initiates a cycle of multivibrator operation which is terminated by the arrival of a system trigger from the range mark generator. The lagging edge of the multivibrator pulse, which coincides in time with the system trigger, is used to fire a blocking oscillator. Thus, the output of the angle mark generator is a narrow pulse produced simultaneously with the system trigger. Since the system trigger initiates the generation of the sweeps, the angle mark trigger is also synchronized with the start of the sweeps.

4–128. ANGLE MARKER STAGES IN RHI ASSEMBLY. The angle mark triggers are expanded to one sweep length by a multivibrator in the RHI assembly. The gates thus produced intensity-modulate the CRT for this interval. A switch on the front panel of the RHI assembly permits the operator to turn off the angle markers.

4–129. RAID SIZE INDICATION SYSTEM. (See figure 4–14.)

4–130. FUNCTION. The raid size indication system is supplied with Radar Set AN/FPS-6A. This system allows the RHI operator to make a close examination of a designated distant target to determine the number of aircraft in the raid, the type of formation, and the spacing between aircraft. The information thus obtained is then sent to the search radar PPI operator who initiated the request.

4–131. COMPONENTS. The raid size indication system consists of a raid size indicator (RSI), mounted on the antenna control unit, and a raid size remote unit (RSRU), located near one of the PPI operators.

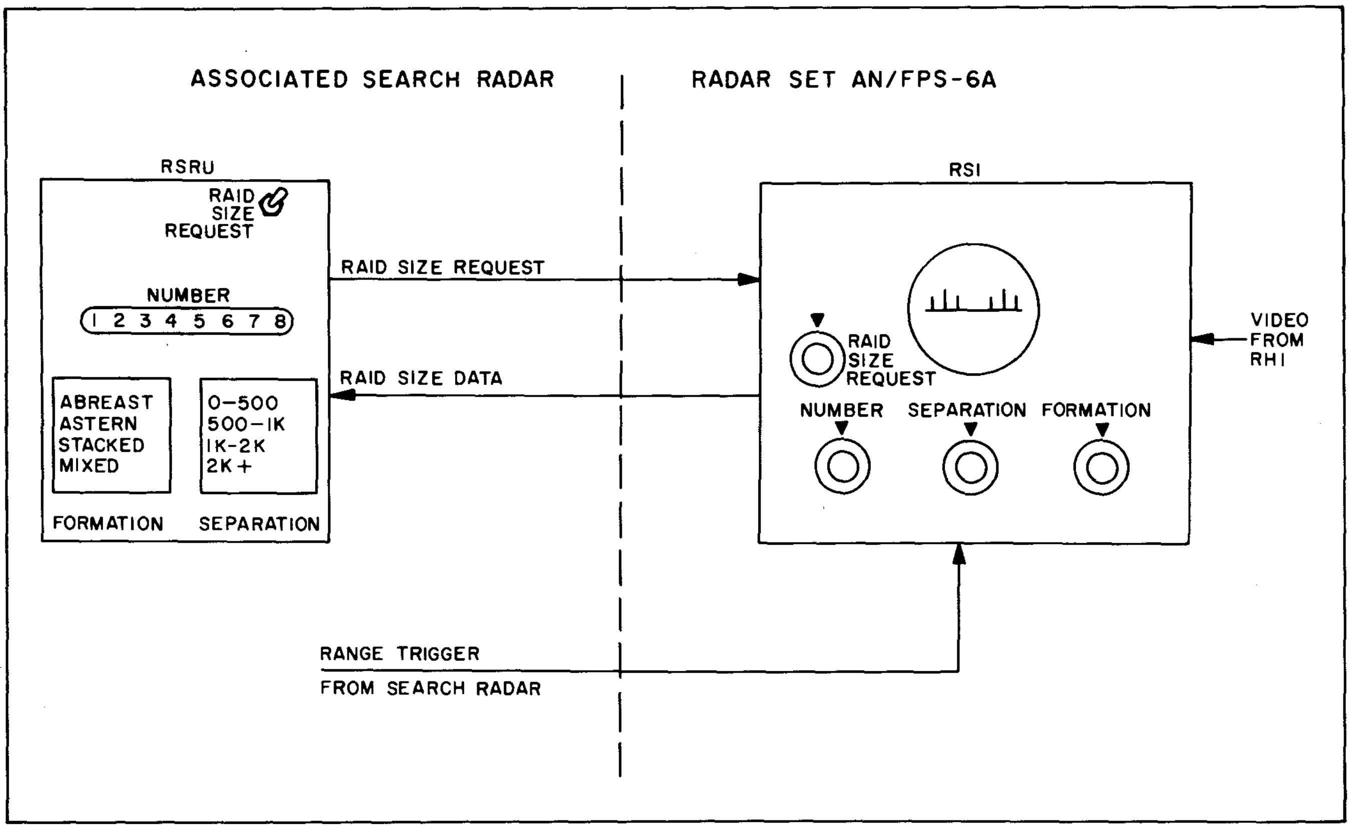

Figure 4–14. Raid Size Indication System

4-132 RAID SIZE INDICATOR. The appearance of a distant target on the search radar PPI display may actually indicate a group of aircraft. If the PPI operator suspects that this is the case, he can throw a switch on his RSRU which requests that the operator at the RSI examine the target and report the number of aircraft included in the target. The PPI operator must also supply the range-delayed trigger to the RSI. The RSI receives the same video sent to the RHI oscilloscope. At the RSI, however, the video is displayed on an A-scope whose entire trace represents only 5 nautical miles. The RSI operator examines the target (or group of targets) on the 5-mile sweep or switches to a 2-1/2-mile sweep for closer inspection. In answering a request for information concerning the target, the RSI operator manually operates switches that send raid size data to front panel indicators on the RSRU.

4–133. RAID SIZE REMOTE UNIT. The RSRU indicators indicate the number of aircraft in the raid and the distance between aircraft: 0 to 500, 500 to 1000, 1000 to 2000, or more than 2000 feet. These indicators also designate the type of formation: abreast, astern, stacked, or mixed.

4–134. TIME-SHARING AND ANTENNA CONTROL SYSTEM.

4–135. TIME-SHARING SYSTEM. (See figure 4–15.)

4–136. FUNCTION. The time-sharing equipment enables four PPI operators at an associated search radar to share the height-finding facility of Radar Set AN/FPS-6. Through the time-sharing equipment, search radar personnel designate targets to the RHI operator of Radar Set AN/FPS-6. This equipment also serves as the channel through which height data from the RHI assembly is transmitted to the proper remote height display so that it can be read by the PPI operator.

4–137. COMPONENTS. The time-sharing system includes the following components: four azimuth control overlays, four remote height displays, the azimuth switch box, the time-sharing master control, and the junction box. In Radar Set AN/FPS-6A, the RHI antenna control is used in place of the azimuth switch box.

4–138. Each azimuth control overlay is mounted over the face of a PPI display at the search radar. One remote height display is mounted near each azimuth control overlay. Although the azimuth control overlays and remote height displays are used by search radar personnel, they are supplied as components of Radar Set AN/FPS-6. In some installations, the azimuth control overlay and remote height display are integral parts of the PPI console.

4–139. The time-sharing master control is mounted on the desk used by the time-sharing control officer. This desk is usually located in the operations room of the associated search radar and positioned so that the time-sharing control officer can survey all four PPI displays. The junction box is mounted near the RHI assembly.

4–140. The azimuth switch box of Radar Set AN/FPS-6 (or the RHI antenna control of Radar Set AN/FPS-6A) is mounted close to the RHI assembly. This unit allows the RHI operator to disable the time-sharing equipment and to position the antenna in azimuth by rotating the selsyns within the unit.

4–141. TIME-SHARING MASTER CONTROL. The time-sharing master control is a master synchronizing device which allots each PPI operator sufficient time to designate a target and receive height information from the height-finding radar. The time-sharing master control places PPI operator No. 1 in contact with the height-finding radar by providing a 28-volt d-c signal to energize a group of relays in the junction box. The blue indicator on the front panel of each remote height display lights to inform all the operators that operator No. 1 has azimuth control of the height-finding antenna and that he will soon receive height data on his designated targets. The selsyn signals from azimuth control overlay No. 1 are fed to the azimuth positioning servo system. The height-finding antenna, in response to the servo system, swings around to the designated azimuth, showing the RHI operator the sector of the area under surveillance which contains the designated target. Since there may be many targets in this sector, the designated target must also be identified in range. Therefore, the PPI operator sends out the range line trigger (essentially, a movable range marker whose position corresponds to the range of the target to be designated). This trigger causes a range line to intersect the designated target on the screen of the RHI oscilloscope. (The range line is not available in some installations. When this is the case, the search radar operator designates target range by telephone.)

4–142. The RHI operator sends out information on the absolute height of the designated target and PPI operator No. 1 sees the absolute height counter on his remote height display light. After a short pause, the lower dial of the remote height display also lights, allowing the PPI operator to read the relative target height. The time-sharing master control then removes the 28-volt d-c signal from the PPI No. 1 relay group in the junction box, causing the blue indicator on each remote height display to go off. Almost instantly, the amber indicator lights, informing all operators that PPI operator No. 2 has been given azimuth control and will receive height data from the RHI operator. PPI operator No. 2 retains azimuth control as long as the time-sharing master control maintains a second group of relays in the junction box energized.

4–143. Switching from one PPI operator to the next is accomplished by the time-sharing master control. In addition to supplying a switching voltage, the time-sharing master control also performs the following functions:

a. Determines the length of time that an operator remains in control. This control period may be fixed at any point between 20 and 90 seconds at the discretion of the time-sharing control officer.

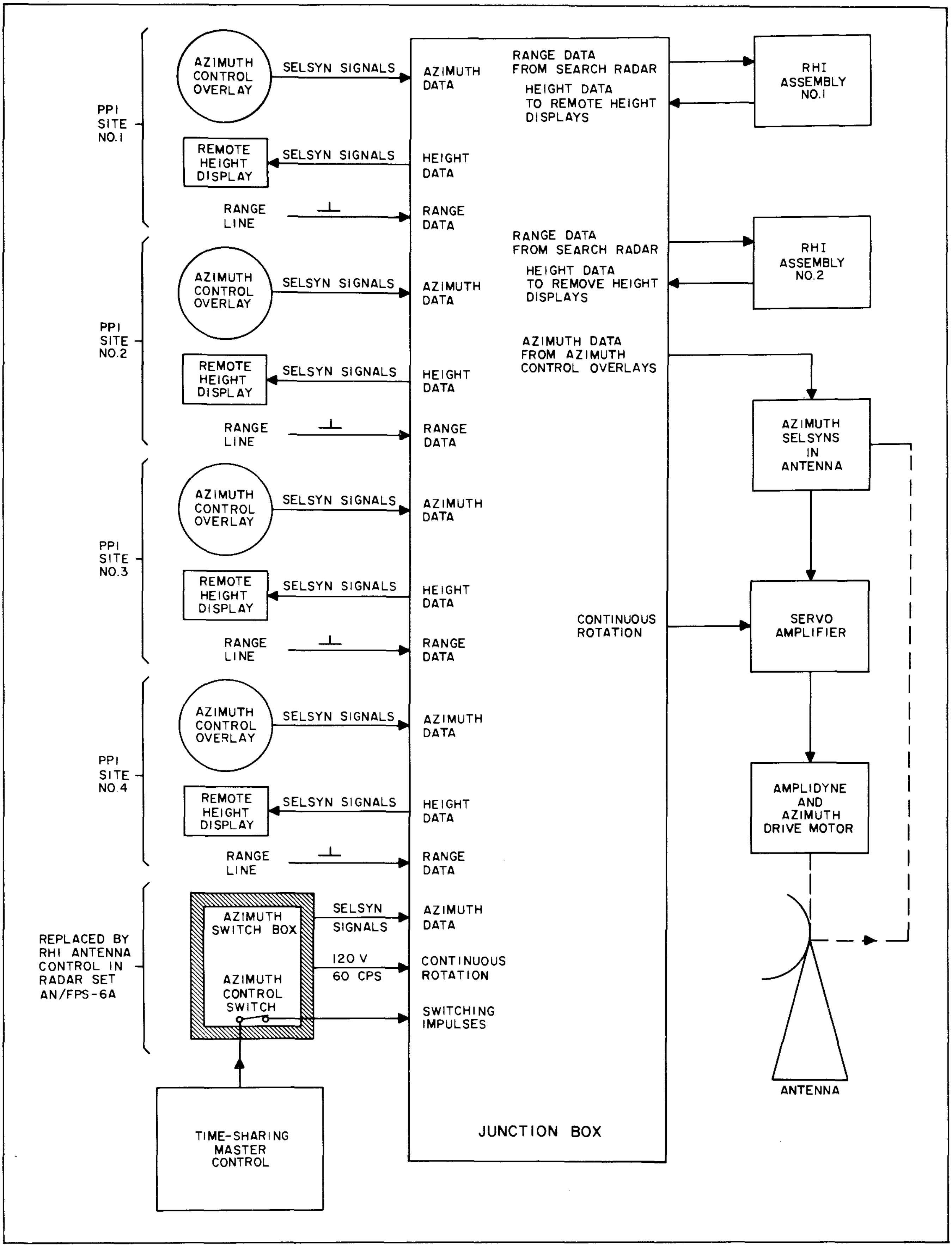

Figure 4–15. Time-sharing System, Block Diagram

b. Determines the sequence in which the PPI operators receive control. Normally, operator No. 1 is placed in control first, followed by operators No. 2, 3, and 4. However, any sequence of the four operators can be established.

c. Allows the time-sharing control officer to disable the automatic circuits and assign control manually.

d. Allows the time-sharing control officer to interrupt the time-sharing sequence at any point and return control to the first operator in the sequence.

e. Allows the time-sharing control officer to warn an operator that his period of control is running out and to extend the period of control, if necessary, to permit the operator to obtain all his height data.

f. Allows the time-sharing control officer to bypass a PPI site.

4–144. Four color-coded indicators on the front panel of the time-sharing master control indicate which of the four PPI sites has been granted a period of azimuth control. Each color-coded indicator is permanently connected in parallel with the indicators of the same color on the four remote height displays. For example, the blue indicators (one on the time-sharing master control and one on each of the four remote height displays) light each time PPI site No. 1 is given azimuth control.

4–145. JUNCTION BOX. All of the connections necessary to place a PPI operator in contact with the height-finding radar are made through the junction box. There are four groups of relays in the junction box, one for each PPI operator. Only one group can be energized at any one time. The particular group energized is determined by the time-sharing master control, which supplies the necessary 28-volt energizing signal.

4–146. Assuming that the PPI No. 1 relay group is energized, the stators of the antenna selsyns are connected to the stators of the selsyns in azimuth control overlay No. 1. In addition, the rotors of the selsyns in azimuth control overlay No. 1 are connected to the 1- and 36-speed inputs to the azimuth positioning servo system and the range line trigger is fed to the RHI assembly. In this manner, target bearing and range are indicated to the height-finding radar. A 6.3-volt signal is also fed to the red control indicator on azimuth control overlay No. 1 to inform the operator that he has been given a period of azimuth control.

4–147. Remove height display No. 1 receives height data and the necesssary switching signals each time the PPI No. 1 relay group is energized. The stators of the absolute height selsyns in the RHI assembly are connected to the stators of the selsyn control transformers in remote height display No. 1. The stators of the relative height selsyn in the RHI assembly are connected to the stators of the relative height selsyn receiver in remote height display No. 1. The rotor of the relative height selsyn in remote height display No. 1 receives 120 volts ac. The absolute-relative height relay in remote height display No. 1 is connected to one side of the absolute-relative height microswitch in the RHI assembly. This relay is energized by a 28-volt signal when the HEIGHT LINE hand crank on the RHI assembly of Radar Set AN/FPS-6 is pushed in. (In Radar Set AN/FPS-6A, this relay is energized by placing the ABSOLUTE RELATIVE switch on the RHI assembly in the RELATIVE position.) When energized, the relay locks the absolute height dial and also lights it. Finally, energizing the absolute-relative height relay in the remote height display removes the 28-volt signal supplied by the junction box to the relative height brake. The brake is then released, permitting the relative height selsyn to respond to relative height stator signals.

4–148. The junction box also supplies the time-sharing master control with 28 volts dc for relay operation and 120 volts ac for timer operation. The control group assembly supplies 120 volts ac to the filament transformer in the junction box. The 6.3 volts ac produced is used to operate the control indicators on the azimuth control overlays.

4–149. The time-sharing system is automatically disabled when an azimuth switch box of Radar Set AN/FPS-6 (or the RHI antenna control of Radar Set AN/FPS-6A) is placed in azimuth control of the height-finding antenna. Although two switch boxes may be supplied in some installations (normal installations are supplied with one), the relays in the junction box are interconnected so that only one azimuth switch box can be in control at any one time.

4–150. Two RHI assemblies are supplied with Radar Set AN/FPS-6. If both assemblies are manned, it is possible to team each PPI position with one of the two RHI assemblies. RHI selector switches in the junction box permit this teaming.

4–151. AZIMUTH CONTROL OVERLAYS. The bearing of the designated target is transmitted from the azimuth control overlay of the azimuth servo positioning system of the height-finding radar. Each of the four azimuth control overlays is mounted on the face of a PPI display by four thumbscrews. Basically, the azimuth control overlay consists of a lucite cover plate with an etched cursor. The cover plate can be rotated by a small handcrank. Rotation of the handcrank and cover plate also turns the rotors of a 1-speed selsyn control transformer and a 36-speed selsyn control transformer in the azimuth control overlay. The PPI operator rotates the cursor (and the selsyn rotors) until it is alined with the target he wishes to designate.

4–152. When the operator's period of azimuth control arrives, the control indicator on the overlay lights. Simultaneously, relays in the junction box connect the stators of the selsyn generators in the antenna assembly to the stators of the two selsyn control transformers in the azimuth control overlay. If the antenna is not pointing in the direction specified by the cursor of the azimuth control overlay, there is a difference between the angular position of the rotors of the antenna assembly selsyns and that of the rotors of the azimuth control overlay selsyns. An error signal then appears across the rotors of the selsyn control transformers in the azimuth control overlay. The 1- and 36-speed selsyns in the azimuth control overlay transmit their error signals through the junction box to the azimuth positioning servo amplifier. Thus, a servo loop is completed which causes the height-finding antenna to rotate until it points in the direction indicated by the azimuth control overlay cursor.

4–153. REMOTE HEIGHT DISPLAYS. The remote height display indicates absolute and, if required, relative height of the target on a Veeder-Root counter and a dial, respectively. Absolute height is transmitted by the RHI operator who rotates the HEIGHT LINE handcrank on the RHI assembly of Radar Set AN/FPS-6 until the height line is moved into coincidence with the designated target. (In Radar Set AN/FPS-6A, a control stick is operated until the height cursor is moved into coincidence with the designated target.) Selsyns geared to the HEIGHT LINE handcrank (or control stick drive mechanism in Radar Set AN/FPS-6A) transmit the height data through the junction box to the remote height display.

4–154. The absolute height selsyn orders are fed through the junction box to a pair of selsyn control transformers in the remote height display. The output of these selsyn control transformers is then fed to the servo amplifier in the remote height display (not to be confused with the servo amplifier in the azimuth positioning servo system). The amplified a-c selsyn signals are applied to the control field of the two-phase a-c drive motor, which rotates both the Veeder-Root counter and the rotors of two absolute height selsyn control transformers. Rotation continues until the angular position of the selsyn rotors in the remote height display corresponds to the angular position of the selsyn rotors in the RHI assembly. When all rotors are in correspondence, the height data signal ceases, the drive motor in the remote height display ceases its rotation, and the Veeder-Root counter is stopped. The number indicated on the Veeder-Root counter represents absolute target height in thousands of feet.

4–155. The RHI operator of Radar Set AN/FPS-6 pushes in the HEIGHT LINE handcrank after he has transmitted absolute height data. (The RHI operator of Radar Set AN/FPS-6A places the RELATIVE- ABSOLUTE switch in the RELATIVE position.) This sends a 28-volt d-c signal to relays in the remote height display. The relays lock the Veeder-Root counter in place and light the counter dial, advising the PPI operator that absolute height data is available in final form.

4–156. If relative height data is to be sent, the RHI operator of Radar Set AN/FPS-6 rotates the HEIGHT LINE handcrank until it intersects a video return whose height is to be compared with that of the designated target. (The RHI operator of Radar Set AN/FPS-6A manipulates the control stick until the height cursor intersects this second return. Tactically, this return represents the height of interceptor aircraft.

4–157. The relative height selsyn signal is fed to a receiver selsyn in the remote height display. The receiver selsyn drives the relative height dial directly. After relative height data has been transmitted, the RHI operator of Radar Set AN/FPS-6 releases the HEIGHT LINE handcrank. (The RHI operator of Radar Set AN/FPS-6A returns the RELATIVE-ABSOLUTE switch to the ABSOLUTE position.) The 28-volt d-c signal is then removed from the relays within the remote height display. This lights the relative height dial and releases a brake which is pressed against the dial, locking it in place. Both the absolute and relative height indicators remain locked and lighted until the next period in which the time-sharing system allows an interchange of information between that PPI operator and the RHI operator.

4–158. Four color-coded indicators on the front panel of the remote height display indicate which of the four PPI sites has azimuth control. Each color-coded indicator is permanently connected in parallel with indicators of the same color on the time-sharing master control and on the other remote height displays. For example, the blue indicators (one on the time-sharing master control and one on each of the four remote height displays) light each time PPI site No. 1 has been given azimuth control. The amber indicators indicate control at PPI site No. 2; the green indicators, control at PPI site No. 3; and the white indicators, control at PPI site No. 4.

4–159. AZIMUTH SWITCH BOX (RADAR SET AN/FPS-6) OR RHI ANTENNA CONTROL (RADAR SET AN/FPS-6A). If the target designation system is not functioning properly, the RHI operator of Radar Set AN/FPS-6 can throw a switch on the azimuth switch box and assume azimuth positioning control of the height-finding antenna. (The RHI antenna control of Radar Set AN/FPS-6A replaces the azimuth switch box of Radar Set AN/FPS-6.) When antenna control is achieved, the time-sharing master control, the azimuth control overlays, and the remote height displays are disabled. The azimuth positioning servo system then responds to azimuth orders received from 1- and 36-speed selsyns in the azimuth switch box.

4–160. Two switch boxes may be supplied in some installations. The azimuth switch boxes are wired through the junction box in such a manner that only one box can assume control at a time.

4–161. AZIMUTH DRIVE AND CONTROL SYSTEM. (See figure 4–16.)

Note

Refer to paragraph 4–135 before proceeding with the discussion of the azimuth drive and control system.

4–162. FUNCTION. The azimuth positioning servo system provides for remote controlled positioning of the antenna to any desired azimuth. The antenna is usually positioned from one of the four azimuth control overlays. When azimuth control is placed in one of the azimuth control overlays, the height-finding antenna is always pointed toward the target designated by the search radar personnel.

4–163. COMPONENTS. The azimuth positioning servo system normally consists of four azimuth control overlays, an azimuth switch box, the junction box, the antenna control panel (part of the control group assembly), and the power distribution panel (part of the control group assembly). This servo system also includes the servo amplifier (part of the control group assembly), the amplidyne generator set, the azimuth drive motor (part of the antenna assembly), and the azimuth selsyn gear unit (part of the antenna assembly).

4–164. Two azimuth switch boxes are supplied in some installations of Radar Set AN/FPS-6. However, this discussion assumes a standard installation with one azimuth switch box. In Radar Set AN/FPS-6A, the RHI antenna control is substituted for the azimuth switch box.

4–165. ANTENNA POWER CONTROL. The azimuth drive motor receives power through an amplidyne generator and an exciter generator. Both of these units are rotated by the amplidyne drive motor. The required three-phase power is made available by turning on the ANTENNA POWER circuit breaker at the power distribution panel and pressing the AZIMUTH DRIVE START button at the antenna control panel. This applies three-phase power to the amplidyne drive motor. The amplidyne drive motor receives excitation from the servo amplifier; however, a time delay in the 500-volt servo amplifier plate supply withholds this voltage to permit the filaments in the amplifier to reach a stable opening temperature. When the AZIMUTH DRIVE STOP button is pressed, the amplidyne motor is turned off, disabling the azimuth drive.

4–166. AZIMUTH POSITIONING SERVO SYSTEM. The motor drive of the reflector in azimuth is controlled by the closed-loop azimuth positioning servo system shown in figure 4–16. Each azimuth control overlay and each azimuth switch box contains a 1-speed and a 36-speed selsyn. The rotors of these selsyns are geared to a handwheel. For purposes of clarity in this discussion, it is assumed that the time-sharing system interconnects the rotors of the selsyn control transformers in azimuth control overlay No. 4 through circuits in the junction box to the input of the servo amplifier. The stators of the control transformers are connected through the junction box to the stators of corresponding 1- and 36-speed selsyn generators (azimuth selsyns) in the azimuth selsyn gear unit. These selsyn generators are geared to the azimuth motion of the reflector and their rotors are excited by 60-cps power. The position of the rotors of these selsyns corresponds in azimuth at all times to the position of the reflector.

4–167. If the handwheel on azimuth control overlay No. 4 has been turned so that the rotors of the control transformers are in a position corresponding with that of the rotors of the azimuth selsyns, the 60-cps output of the control transformers is zero. Under these conditions, the servo amplifier receives zero input, so that its output is zero. Thus, the excitation of the amplidyne generator is zero and the amplidyne output is zero. The azimuth drive motor receives no power and the reflector does not move. The reflector is then considered synchronized (in correspondence).

4–168. If the handwheel on azimuth control overlay No. 4 is turned, the rotors of the control transformers are moved from their position of correspondence with the rotors of the azimuth selsyns. The control transformers then immediately produce a 60-cps error signal. The amplitude of this signal indicates the amount of disparity in the positions of the rotors and the phase of the signal indicates the direction of the disparity. This error signal is applied to the servo amplifier and produces an output which excites the amplidyne. The amplidyne feeds d-c power, whose magnitude and polarity depend upon the amplitude and phase of the error signal, to the armature of the azimuth drive motor. This motor then drives the reflector in azimuth in a direction which requires the smallest distance of reflector travel to reduce the error signal to zero. The error signal is reduced to zero because, as the reflector turns, so do the rotors of the azimuth selsyns. As these rotors turn, they reach a new position of correspondence with the rotors of the control transformers and the error signal becomes zero. At this position of the reflector, the azimuth drive motor stops, since the output of the amplidyne has become zero in accordance with the reduction of the servo amplifier output to zero. The antenna is then again synchronized.

4–169. STABILIZATION CIRCUITS. An object as massive as the reflector and its rotating support has a great deal of inertia; that is, once put into motion, the reflector tends to continue in motion. Therefore, instead of coming to rest at the new position of correspondence mentioned in paragraph 4–168, the reflector tends to overshoot this position. If the reflector does overshoot, the selsyns develop an error signal which indicates that the reflector has swung too far. This error signal produces motor drive which causes the reflector to swing back toward the position of correspondence. The reflector then again tends to overshoot (this time in the opposite direction) and is again swung back, only to overshoot once more. Thus, a mechanical oscillation of the reflector occurs about the desired position of correspondence. This condition, called "hunting", is undesirable and is prevented by employing negative feedback (antihunt feedback) to nullify the effects of mechanical inertia.

4–170. Three different sources of antihunt feedback are used in the servo system: velocity feedback, quadrature feedback, and current feedback. Velocity feedback is obtained from the tachometer in the azimuth selsyn gear unit. The tachometer is a small d-c generator whose voltage output depends upon the instantaneous velocity of the azimuth motion of the reflector. Quadrature feedback is developed in a special winding in the amplidyne

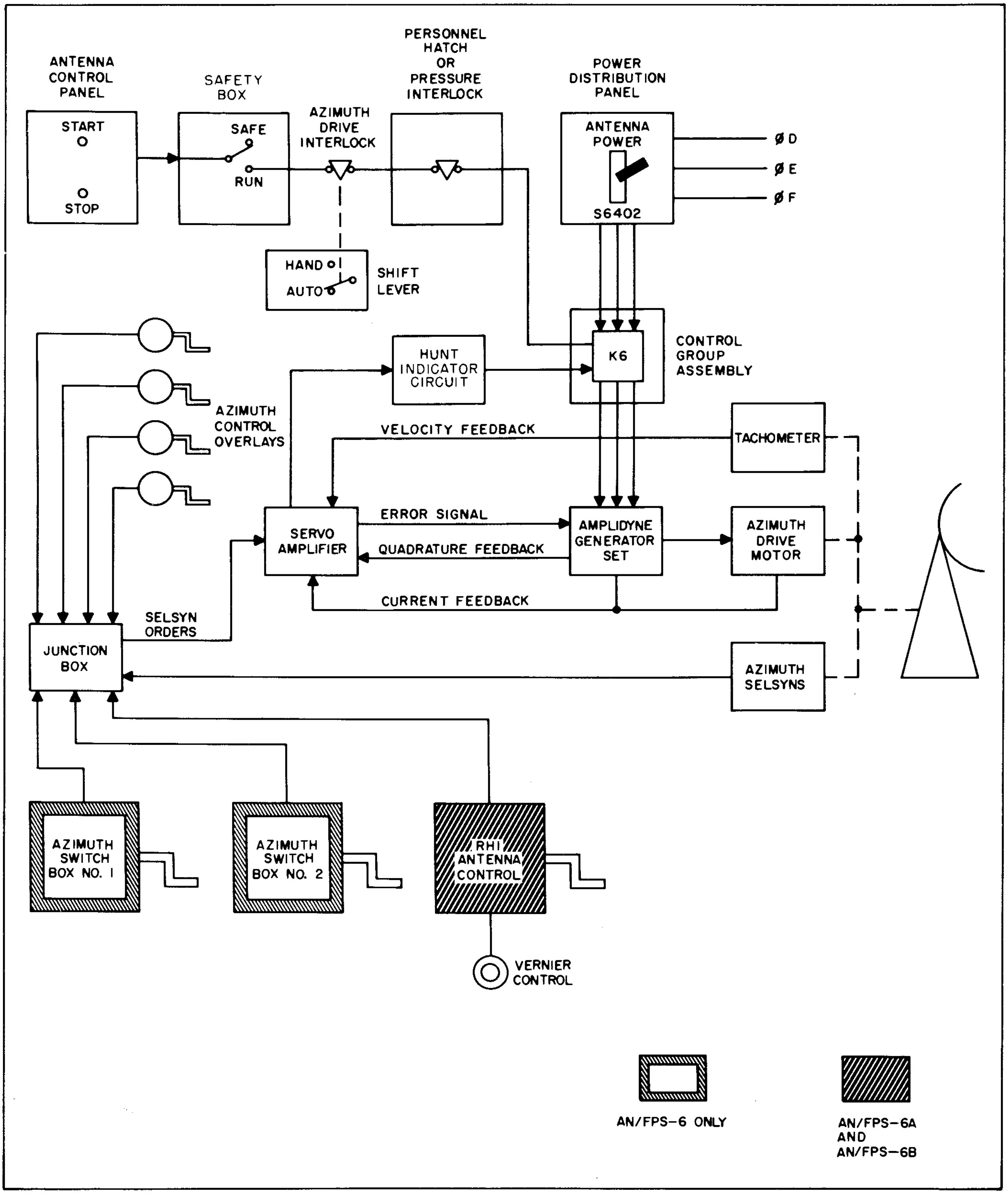

Figure 4–16. Azimuth Drive and Control System, Block Diagram

generator and current feedback is taken from the armature circuit of the amplidyne and the azimuth drive motor.

4–171. The maximum velocity at which the amplidyne can cause the azimuth drive motor to rotate the antenna is limited by the velocity feedback. Similarly, the maximum torque which the amplidyne can cause the drive motor to exert upon the antenna is limited by the current feedback. High-frequency hunting of the antenna about the position of correspondence is minimized by the quadrature feedback.

4–172. When the antenna starts hunting, two amber indicators on the antenna control panel light alternately each time the servo amplifier signals the azimuth drive direction. If hunting persists, the hunt circuit automatically de-energizes the amplidyne circuit, lighting a red indicator light and sounding a buzzer. Upon operation of the RESET SWITCH, the red indicator light goes off and the buzzer stops. Drive power can be restored by pressing the START button.

4–173. VERNIER CONTROL. A slight adjustment of antenna azimuth is sometimes necessary to obtain the maximum return signal from a target. The RHI operator of Radar Set AN/FPS-6A can change the azimuth to which the PPI operator has slewed the height-finding antenna by ±4.5 degrees. This is accomplished at the RHI antenna control by adjusting a differential selsyn connected between the 36-speed selsyn in the azimuth control overlay and the selsyn geared to the antenna azimuth drive. The differential selsyn, which is restricted to 330 degrees of rotation, can modify the antenna position by 330/36, or approximately 9 degrees (±4.5 degrees about the zero point).

4–174. CONTINUOUS ROTATION. When continuous slewing of the reflector is desired, a switch on the azimuth switch box is placed in either the CW or CCW position. (The corresponding switch on the RHI antenna control is placed in either the CW ROT or CCW ROT position.) When the switch is actuated, it disconnects the rotors of the control transformers from the input of the servo amplifier and simultaneously feeds a 60-cps signal of constant voltage to the input of the servo amplifier. This voltage simulates a continuing, constant error signal and thus causes continuous slewing at a speed limited by the velocity feedback. When the switch is in the CW position, the a-c voltage to the input of the servo amplifier is of a certain phase. When the switch is in the CCW position, the phase is reversed, causing a reversed direction of slewing. It should be noted that continuous slewing of the reflector is not desired and is thus avoided during normal operation. However, provision is made for such slewing so that Radar Set AN/FPS-6 can be used as a search radar.

4–175. SECTOR SCAN. To cause the reflector of Radar Set AN/FPS-6A to sector scan in azimuth, the MODE switch on the RHI antenna control is turned to the SECTOR SCAN position. When this switch is actuated, it disconnects the rotors of the antenna control transformers from the servo amplifier and simultaneously feeds a 60-cps signal of constant voltage to the input of the servo amplifier. This voltage simulates a continuing, constant error signal and thus causes continuous slewing at a speed limited by the velocity feedback. Periodically, relay action causes a voltage of reversed phase to be applied to the servo amplifier, thus reversing the direction of antenna rotation. The point at which the phase switching relays operate determine the width of the sector. A maximum sector width of 120 degrees is possible.

4–176. AZIMUTH DRIVE INTERLOCK CIRCUIT. Several interlocks are provided to protect maintenance personnel working near the antenna. The azimuth drive interlock is opened when the azimuth drive handcrank is shifted from the AUTO to the HAND position. The safety box contains a master SAFE-RUN switch which disables both the elevation and azimuth drives when placed in the SAFE position. The tower interlock in temperate tower installations disables the elevation and azimuth drives when the personnel hatch is opened. In arctic installations using a radome, the tower interlock disables the antenna when radome pressure becomes insufficient to keep the radome properly inflated. In addition, the control group assembly is interlocked so that the antenna cannot be rotated when any of the drawer assemblies in the control group cabinet are pulled forward.

4–177. MANUAL ANTENNA ROTATION. During maintenance operations, the technician may find it convenient to disable the servo system and position the antenna manually. To do this, the HAND-AUTO lever on the antenna assembly is shifted to the HAND position. This opens the azimuth drive interlock while engaging the azimuth drive handcrank with the gears in the azimuth drive unit. Opening the azimuth drive interlock switch disables the azimuth drive motor by removing power from the drive motor of the amplidyne generator set. The antenna can then be rotated by turning the azimuth handcrank.

4–178. ELEVATION DRIVE AND CONTROL SYSTEM. (See figure 4–17.)

4–179. FUNCTION. The elevation drive causes the antenna to nod at 20 or 30 cpm, depending upon whether the drive is set for slow or fast scan. The drive can be controlled from three units: the safety box, the antenna control panel, and either the azimuth switch box of Radar Set AN/FPS-6 or the RHI antenna control of Radar Set AN/FPS-6A. The safety box controls permit the maintenance technician to set antenna nodding at the desired rate of speed during troubleshooting and maintenance procedures. The antenna control panel permits search radar personnel to control the elevation scan of the height finder and the azimuth switch box (RHI antenna control) allows the RHI operator to control elevation scan. The three sets of controls are interconnected so that the antenna can be set for fast or slow elevation scan or can be stopped from any position. Interlock switches and overload relays are also supplied for the protection of personnel and equipment. In addition, Radar Set AN/FPS-6B contains controls for adjusting the amplitude and center position of the nodding arc.

4–180. COMPONENTS. The components of the elevation drive and control system normally installed include the tower interlock switch; the elevation drive interlock switch on the brake assembly of the antenna assembly; and the elevation drive motor, girder junction box, and cone junction box in the antenna assembly. Additional system components in a normal installation also include the safety box, the antenna control panel and line contactor relays in the control group assembly, the junction box, and the azimuth switch box.

4–181. In Radar Set AN/FPS-6A, the RHI antenna control is used instead of the azimuth switch box.

4–182. ELEVATION DRIVE. The elevation drive motor receives three-phase power from a line contactor relay in the control group assembly. The required three-phase power is made available by turning on the ANTENNA POWER circuit breaker at the power distribution panel. The elevation drive motor can then be turned on and off and switched from one speed to the other from the safety box located near the antenna. The motor can also be controlled in this manner from the antenna control panel in the control group assembly as well as from the azimuth switch box (or RHI antenna control) located near the RHI assembly. The 3-phase, 208-volt, 60-cps power from the control group assembly enters the cone assembly and is fed into the cone junction box inside of the cone assembly. The power then

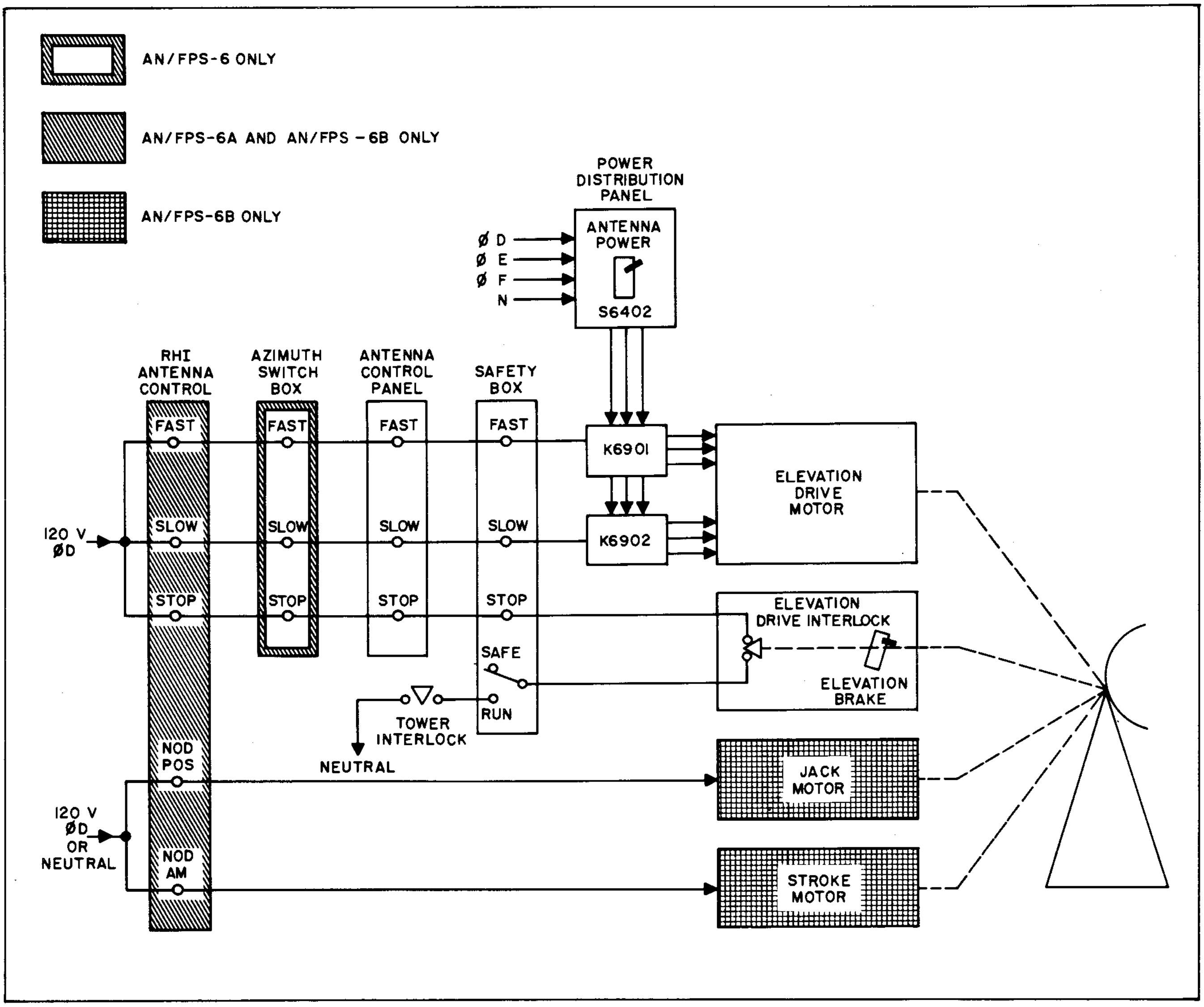

Figure 4–17. Elevation Drive and Control System, Block Diagram

passes through slip rings in the cone junction box to the girder junction box and is applied to the slow or fast speed winding of elevation drive motor B3002.

4–183. The mechanical power output of the elevation drive motor is connected through integral gears to a crank on the motor shaft. The crank drives a connecting rod fastened to the reflector. Power applied to the slow winding of the motor causes the reflector to nod in elevation at a rate of 20 cpm. Power applied to the fast winding causes nodding at 30 cpm. The amplitude of the nod is limited to the angles of —2 and +32 degrees from the horizontal.

4–184. VARIABLE-NOD MECHANISM. The variable-nod mechanism is part of the antenna assembly in Radar Set AN/FPS-6B only. This mechanism permits the elevation scan angle to be continuously variable from a maximum of 34 degrees (—2 to + 32 degrees) to a minimum of 1 degree. The center of this nodding arc is also variable. The variable-nod mechanism of Radar Set AN/FPS-6B replaces the connecting rod and elevation crank arm of Radar Set AN/FPS-6.

4–185. The variable-nod mechanism is controlled from the RHI antenna control. Operating the NOD AM switch applies power to the stroke motor, which varies the effective length of the connecting rod and therefore, the length of the nodding arc. Operating the NOD POS switch applies power to the jack motor, which, by positioning of the effective base of the connecting rod, determines the center of the nodding arc.

4–186. ELEVATION DRIVE INTERLOCK CIRCUIT. Power is withheld from the elevation drive motor whenever any of several interlock switches are opened. The elevation brake interlock switch opens when the elevation brake is clamped on. The personnel hatch interlock switch opens when the personnel hatch leading to the roof of the temperate tower is opened. The pressure interlock switch opens when the air pressure which supports the radome in the arctic tower installation decreases below a safe value. (In mobile installations, the tower interlock switch is shorted by means of a jumper.)

4–187. In addition to the interlock switches mentioned in paragraph 4–186, there is the SAFE-RUN switch on the safety box. When this switch is operated to the SAFE position, it withholds power from both the elevation and azimuth drive motors, thus preventing all electrically powered motion of the reflector. The SAFE-RUN switch is intended as a safety device for the protection of maintenance personnel working on the antenna system.

4–188. ELEVATION BRAKE. The elevation brake enables the reflector to be locked in any angle of elevation between —2 and +32 degrees. When the elevation brake is positioned properly, a brake shoe presses against the rim of the flywheel mounted on the shaft of the elevation drive motor. The friction between the brake shoe and the flywheel locks the reflector in position in elevation. When the brake is locked, the elevation brake interlock switch is automatically opened.

4–189. POWER DISTRIBUTION.
(See figure 4–18.)

4–190. A-C POWER.

4–191. GENERAL. The radar is designed to permit operation from two sources of 3-phase, 208/120-volt a-c power. One source supplies all of the power required for the electronic components, while the second source provides the power required by the antenna drives and the amplidyne. When two sources of power are available, the surge of current that accompanies the starting of either drive is isolated from the electronic components. In some installations, however, one power source can be used if it is of sufficient capacity. Primary power is connected to the control group.

4–192. MODULATOR POWER. Phases A, B, and C are supplied to the modulator high-voltage regulator, which is an induction type regulator whose three-phase output feeds the modulator high-voltage power supply. The 12-kilowatt output of the high-voltage supply provides the source for the modulator pulse. Phases A, B, and C are also fed directly into the modulator. Phase A is used in the magnetron filament control circuit to maintain a constant magnetron filament voltage, while phase B is utilized in circuits designed to maintain a constant modulator filament voltage. Phase C is used in modulator control circuits which start or stop the generation of the modulating pulse, raise or lower the output of the modulator high-voltage regulator, and guard against faulty operation of the transmitter-receiver system.

4–193. RHI ASSEMBLY POWER. Phase B power is applied through the junction box to the RHI power supply convenience outlets and the rotors of the height selsyns.

4–194. CONTROL GROUP ASSEMBLY POWER. Phase A supplies power for the blower which cools the control group assembly cabinet. Phase B is the selsyn-energizing voltage which is fed through a time-delay relay to the azimuth selsyns. This is designed to insure that the servo amplifier has warmed up and is in operating condition before the selsyns can send any order signals into the servo loop. Phase C is a control voltage which is applied through the remote r-f control panel to the noise source. Phase C is also applied to the power supply which generates the d-c voltages for the anode, bias, and filament circuits required by the control group assembly units.

4–195. TRANSMITTER-RECEIVER POWER. Phases A, B, and C enter the r-f assembly cabinet and are fed to the heat exchanger and to the pressurizer and dehydrator to operate three-phase motors. Phases B and C are fed to the magnetron assembly cabinet. Phase B supplies power to the convenience outlets. Phase C is used in the r-f assembly cabinet control circuits, in

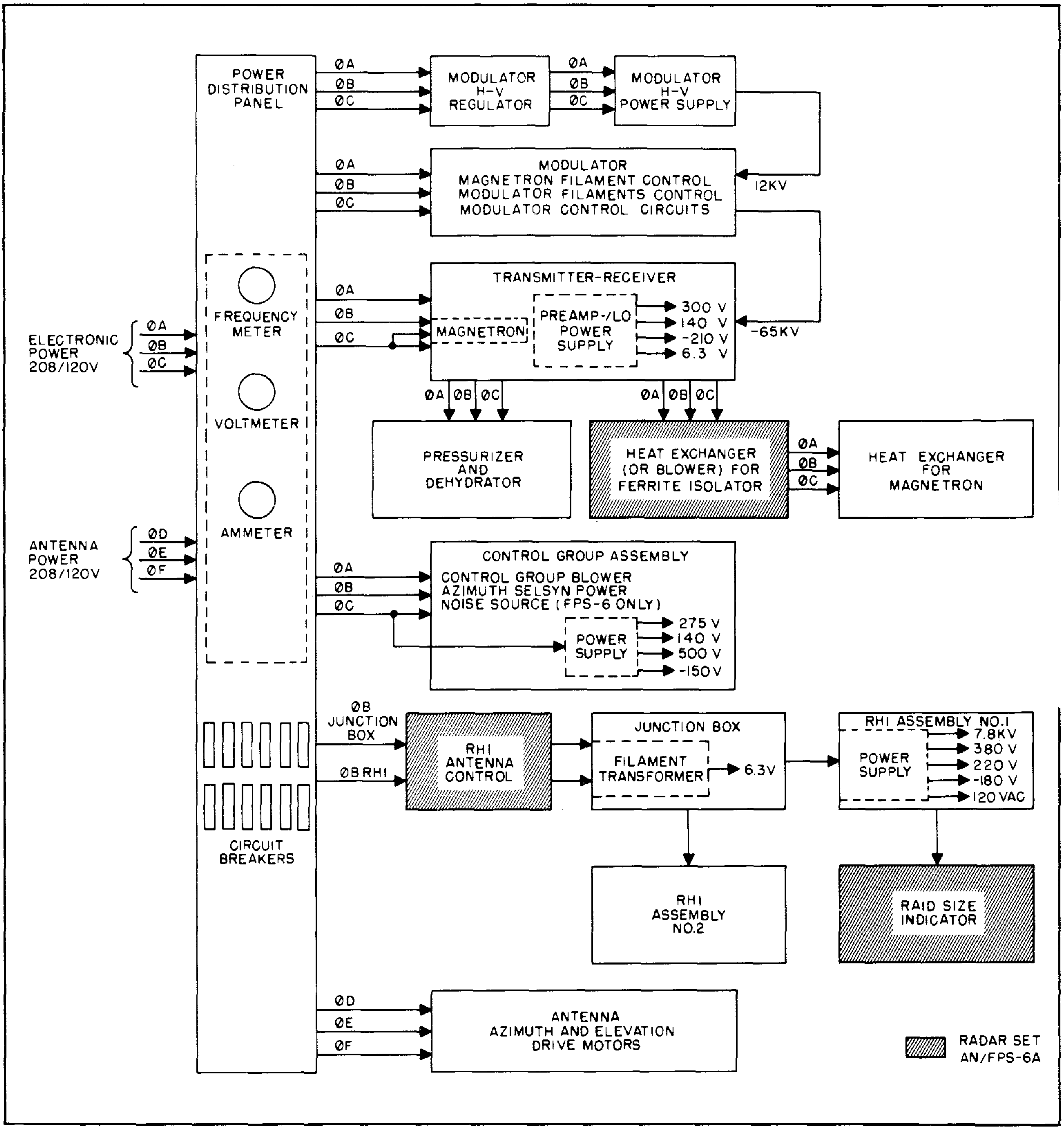

Figure 4–18. Power Distribution, Block Diagram

the noise source chassis, and in the keep-alive power supply chassis. Phase C is also fed to the preamplifier-local oscillator power supply chassis, which feeds power to the receiving system units in the r-f assembly.

4–196. JUNCTION BOX POWER. The junction box receives phase B, which is then applied to a stepdown transformer to obtain the filament voltage that operates indicator lamps in the time-sharing system. Phase B is also fed through the junction box to the RHI assemblies, to the time-sharing master control, and to the indicator lamp voltage transformers in the remote height displays.

4–197. ANTENNA POWER. Phases D, E, and F are applied to the antenna assembly. These phases supply the power to operate the amplidyne and the azimuth and elevation drive motors as well as the heating, deicing, and ventilating equipment in the radome.

4–198. D-C POWER.

4–199. Direct-current power supplies within the various components of the radar convert the a-c power into plate, bias, and high-voltage supplies. These power supplies also provide the 6.3-volt a-c filament voltages required.

4–200. MODULATOR TRIGGER AMPLIFIER (AMPLIFIER, TRIGGER AM-654/FPS-6).

4–201. BLOCK DIAGRAM. (See figure 4–19.)

4–202. The modulator trigger amplifier uses the 30-volt system trigger to develop a 750-volt modulator trigger. The system trigger is coupled by cathode follower V2001A to blocking oscillator V2001B and V2002A. Cathode follower V2001A acts as a buffer to prevent the blocking oscillator from affecting the preceding circuit. The blocking oscillator produces a 280-volt pulse each time a system trigger input is received. Cathode follower V2002B, located at the output of the blocking oscillator, provides the oscillator with a high-impedance load while matching the output to the low input impedance of ionized 3C45 thyratron switch V2003.

4–203. In the interval between successive system trigger pulses, the capacitance in pulse-forming network Z2001 is charged through charging reactor L2001. The charging reactor resonates with the network capacitance to obtain the 500-volt charge.

4–204. The ionization of thyratron switch V2003 by the blocking oscillator pulse initiates the discharge of the pulse-forming network capacitor through the primary of pulse transformer T2001. The pulse transformer voltage ratio is 1:3 when properly loaded. With half of the 500-volt charge of pulse-forming network Z2001 appearing across the primary of transformer T2001 during discharge, the output pulse is 750 volts in amplitude. This 750-volt pulse is fed to thyratron switch V2201 of the modulator.

4–205. A power supply unit, built onto the modulator trigger amplifier chassis, supplies 260 volts dc to the plate circuits of the blocking oscillator, cathode followers, and modulator control units. A second full-wave rectifier supplies 450 volts dc to the thyratron switch.

4–206. CIRCUIT ANALYSIS OF MODULATOR TRIGGER AMPLIFIER.

4–207. BLOCKING OSCILLATOR. (See figure 4–20.) The positive system trigger is applied at jack J2001 to cathode follower V2001A, which is used to isolate blocking oscillator V2001B and V2002A from the input circuits. A 68-ohm resistor, R2001, matches the input impedance of the amplifier to the 72-ohm coaxial cable to prevent reflections. Since the gain of cathode follower V2001A is less than unity, a slightly diminished system trigger is fed to the input grid of the blocking oscillator.

4–208. A voltage divider composed of resistor R2005 in series with the parallel combination of resistors R2008 and R2009 holds the cathodes of blocking oscillator V2001B and V2002A at a potential of 25 volts above ground. Thus, both triodes remain cut off. Capacitor C2005 is the cathode bypass capacitor for the blocking oscillator. Resistor R2003 and capacitor C2002 form an

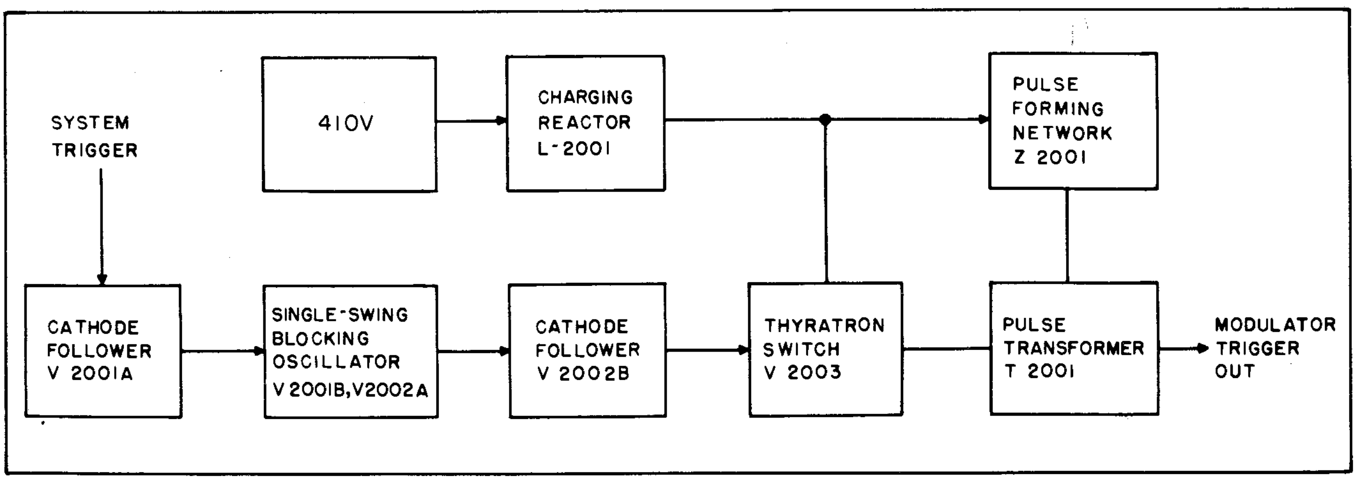

Figure 4–19. Modulator Trigger Amplifier, Block Diagram

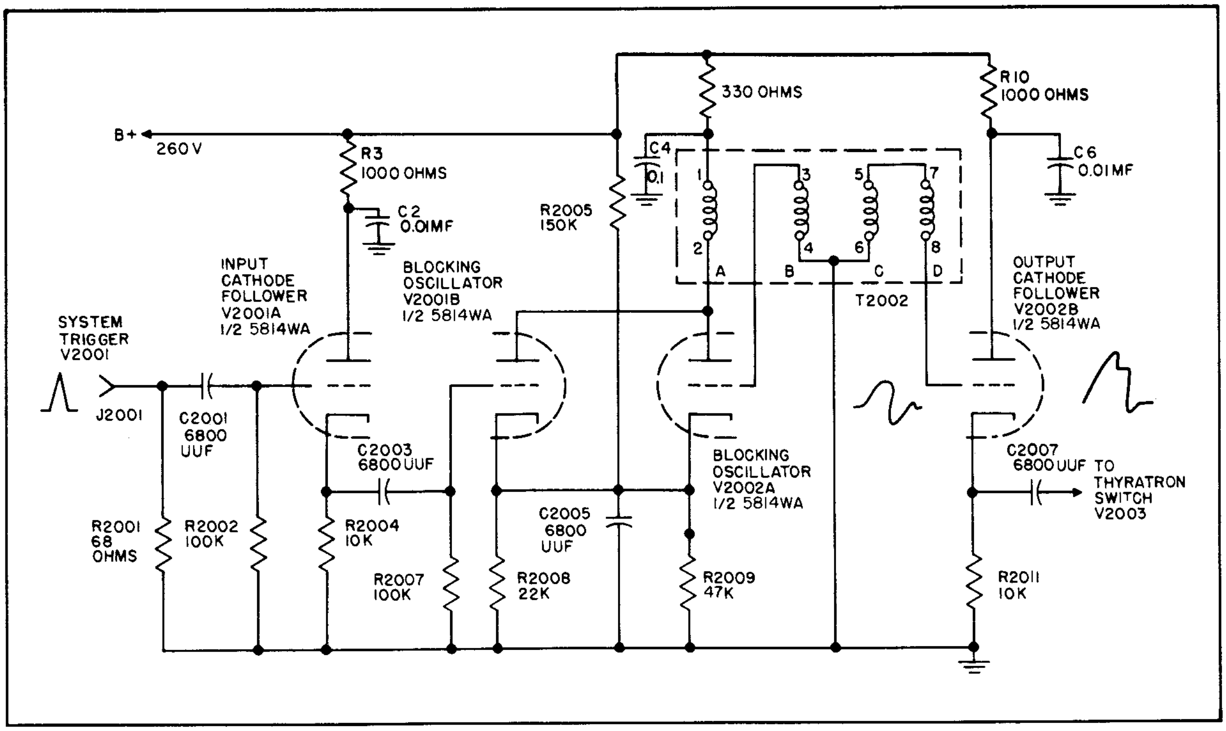

Figure 4–20. Modulator Trigger Amplifier, Simplified Schematic Diagram

RC filter in the plate circuit of cathode follower V2001A to prevent interaction between the plate circuits of the various tubes.

4–209. The arrival of the positive system trigger at the grid of tube V2001B causes this tube to conduct, allowing current to flow through coil A (the primary) of transformer T2002. This pulse is then magnetically transferred to coil B (the secondary) of the transformer. The secondary is wound with respect to primary so that the upper end, terminal 3, is placed at a positive potential. The grid of tube V2002A is then sufficiently above ground to overcome the cathode bias and this section conducts. The plate current of tube V2002A must also pass through coil A, further expanding the magnetic field. A regenerative condition has thus been established wherein an increase of current through coil A induces a positive voltage in coil B. Tube V2002A then conducts more heavily, drawing more current through coil A, inducing a greater positive potential at the grid of tube V2002A, and further increasing the conduction of this section.

4–210. The voltage at the grid of tube V2002A builds up rapidly until the heavy current drawn through coil A nears the core saturation point. As transformer T2002 approaches core saturation, energy is not coupled to the secondary as efficiently. Thus, the grid of tube V2002A continues to build up a positive potential, but at a slower rate. As a result, the increase of current through tube V2002A is slowed down. Eventually, a point is reached where the increase of current through coil A is not sufficient to compensate for the coupling losses between the two coils. At this point, the potential at the grid of tube V2002A stops building up. When this occurs, the current through coil A and the magnetic field around coil A become stationary. In the absence of relative motion between the magnetic field and coil B, no voltage is induced in coil B. The current through coil B starts to decrease and the field around coil B starts to collapse. Coil B then self-induces a voltage opposite in polarity to the previous voltage and the potential at the grid of tube V2002A begins to increase in the negative direction, causing a decrease in plate current. A drop in the current drawn through coil A causes the primary magnetic field to collapse, inducing a voltage in coil B that reinforces the negative buildup at the grid of tube V2002A. This rapid regenerative action continues until both tubes V2001B and V2002A are cut off. The circuit then remains quiescent until the next trigger pulse. Coils C and D of transformer T2002 function as a tertiary winding to couple the blocking oscillator pulse to the grid of tube V2002B.

4–211. The output waveshape from blocking oscillator V2001B and V2002A shows a positive alternation approximately 250 volts in amplitude and a negative alternation of approximately 75 volts. Cathode follower V2002B functions to isolate the blocking oscillator from the thyratron switch and to supply a pulse from a low-impedance source to the thyratron grid. Since the cathode load is not bypassed, the more positive the grid becomes, the greater is the current drawn through resistor R2011. The greater the voltage drop across resistor R2011, the greater the bias on the stage. Thus, the input impedance of the stage remains high despite the 250-volt signal placed on the grid during pulse intervals. In addition, the blocking oscillator pulse is passed by cathode follower V2002B to the thyratron switch with only a slight decrease. During the negative pulse, however, cathode follower V2002B cuts off when the grid signal reaches approximately —27 volts. Thus, the output from this section, when viewed through capacitor C2007, is a positive pulse of approximately 250 volts in amplitude, followed by a negative swing of 27 volts.

4-212. TRIGGER AMPLIFIER PULSE-FORMING CIRCUIT. (See figure 4-21.) In the trigger amplifier pulse-forming circuit, the capacitance in pulse-forming network Z2001 is discharged through the primary of the pulse transformer. The resulting output is a steep-sided, 750-volt, 2-microsecond modulator trigger pulse.

4-213. A series-resonant circuit, consisting of charging reactor L2001 and the capacitance of pulse-forming network Z2001, is connected across the d-c source of 450 volts. Reactor L2001 represents the principal inductance in the charging circuit. The inductance in pulse-forming network Z2001 and in the primary of pulse transformer T2001 is negligible in comparison. As a result, the voltage drops across the inductors in the pulse-forming network and the voltages in the primary of pulse transformer T2001 are relatively small in comparison to the voltages appearing across the charging reactor.

4-214. If f_r is the resonant frequency of the charging circuit, $1/f_r$ represents the time required for the capacitance to reach some maximum charge and then to completely discharge. At the instant the voltage is applied, there is very low voltage across the capacitor, while practically all of the voltage is across the reactor (B, figure 4-21).

4-215. As the capacitor charges, the voltage across the choke decreases, since, at any instant, the sum of the voltage drops must equal the applied voltage. At the end of $1/4f_r$ second, the capacitor has attained a charge of 450 volts. The current through the choke is then at a maximum, the voltage across the choke is at some minimum value, and the magnetic field has expanded to its greatest extent (C, figure 4-21).

4-216. With the capacitor charged to the source voltage, current flow in the circuit tends to decrease, and the magnetic field collapses. The collapsing field induces a voltage in the choke which attempts to maintain current flowing in the original direction. This current flow continues to charge the capacitor until at $t = 1/2f_r$ seconds, the capacitor has reached a charge much greater than the original d-c source voltage.

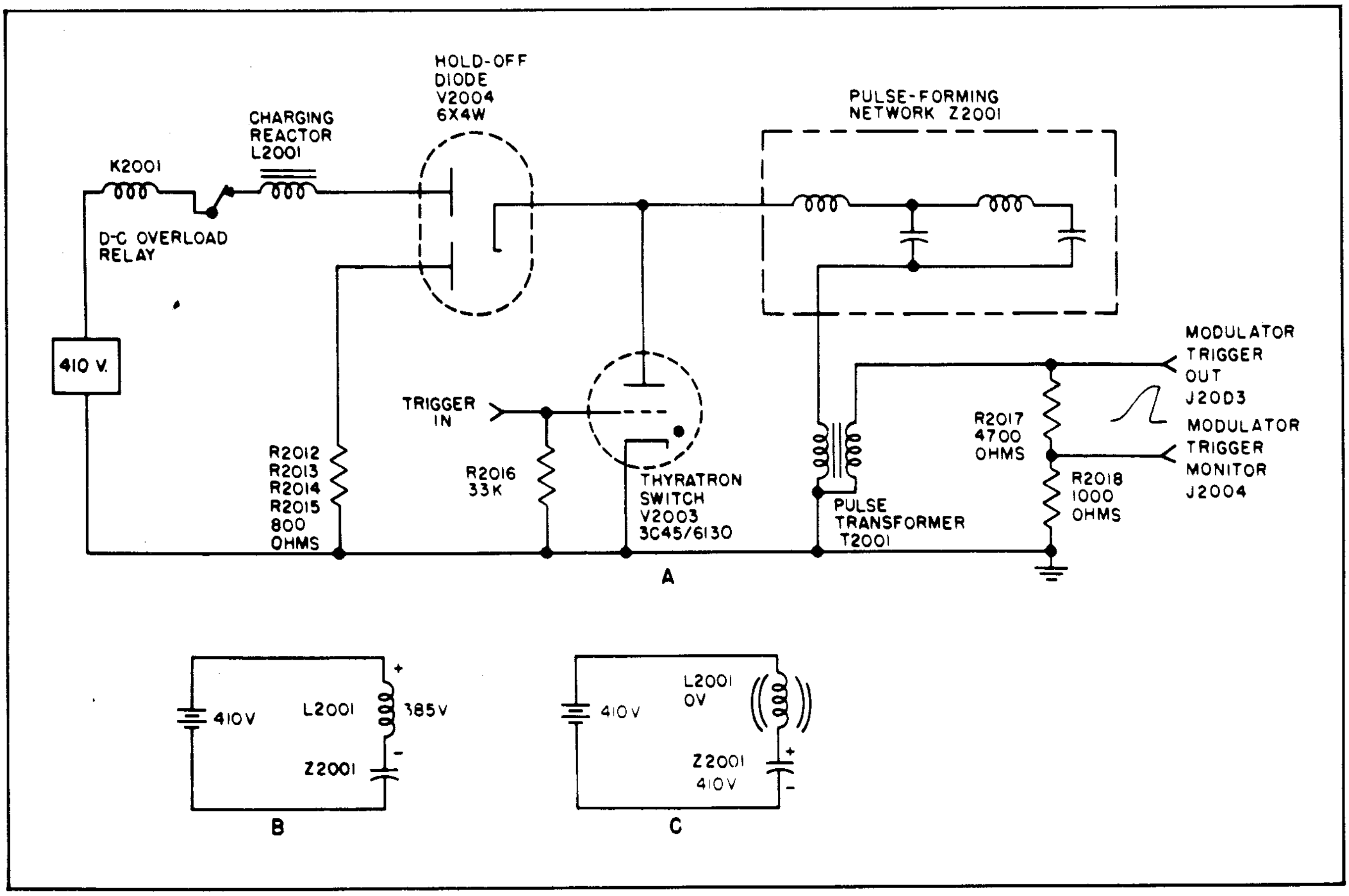

Figure 4-21. Modulator Trigger Amplifier Pulse-forming Circuit, Simplified Schematic Diagram

Holdoff diode V2004 maintains the increased charge of approximately 600 volts on the capacitor by blocking the flow of discharge current. Thus, the capacitor remains fully charged until the thyratron switch tube is fired (A, figure 4–21).

4–217. DISCHARGE CIRCUIT. A type 3C45 thyratron, placed across the series combination of the pulse-forming network and the pulse-transformer primary, provides a low-impedance path for the discharge of the network capacitance. Prior to the trigger from the blocking oscillator, the grid of the thyratron is at ground potential and the gas is not ionized. Upon the arrival of a pulse from the blocking oscillator, the gas ionizes rapidly and the tube conducts heavily. The network then discharges through the pulse transformer and the thyratron switch. The transformer steps up the amplitude of the pulse and inverts the polarity. The output obtained across the transformer secondary consists of a +750-volt pulse used to trigger the modulator pulse-forming circuit.

4–218. The modulator trigger can be monitored at jack J2004. The pulse obtained across the secondary of transformer T2001, when using a 225-ohm resistor as the load is shown in A of figure 4–22. The almost rectangular pulse indicates that a substantially constant current flows in the transformer for the duration of the pulse. The steep, trailing edge indicates that maximum transfer of power is obtained and the pulse-forming network is fully discharged at the conclusion of the pulse.

4–219. The pulse actually obtained at jack J2004 during normal operation is shown in B of figure 4–22. The grid of thyratron V2201 functions as the load on the secondary of pulse transformer T2001. Before ionization, the grid impedance of thyratron V2201 is quite high. The leading edge of the thyratron then rises rapidly until thyratron V2201 ionizes at point t. The plateau represents the very low impedance of the thyratron grid circuit while the tube conducts. Time t usually occurs at some potential between 100 and 700 volts. At the end of each pulse, a negative voltage appears across the output terminals of the pulse-forming network. Diode section 6–7 of holdoff diode V2004 and resistors R2012 through R2015 provide a path to ground to dissipate this current, removing any residual energy that may have been present in the network.

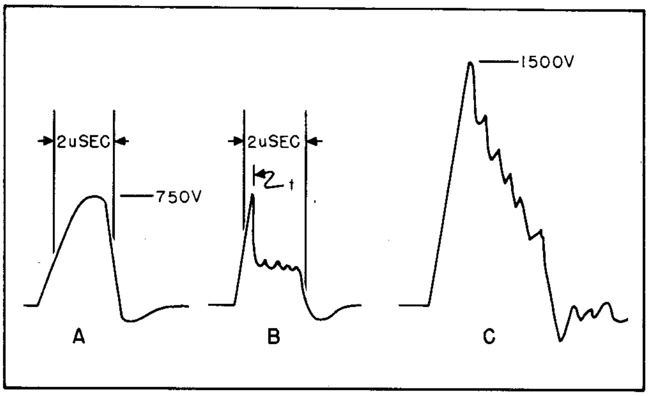

Figure 4–22. Effect of Transformer Load on Pulse Shape

4–220. The waveshape shown in C of figure 4–22 is of particular interest to maintenance personnel. This waveform is obtained when the grid of thyratron V2201 does not fire. A high impedance is then reflected into the primary and almost the entire voltage stored in pulse-forming network Z2001 appears across transformer T2001. The wave rises to almost 1500 volts. (The wave at output jack J2003 rises to this potential; approximately 1/6 of this voltage may be measured at monitor jack J2004.) The wide and jagged trailing edge can be understood by considering that the impedance of the primary is now many times the impedance of pulse-forming network Z2001. Since the impedances do not match, power cannot be removed efficiently from the network. The energy is reflected back and forth in pulse-forming networks Z2001 as a wave motion, gradually discharging into the primary inductance of pulse transformer T2001. This discharge is slower than the pulse length, but faster than the interpulse period. As pulse transformer T2001 approaches saturation, the transformer short circuits the load end of the pulse-forming network. The network termination then exhibits a negative voltage which is removed by reverse-current diode 1/2 6X4.

4–221. Occasionally, the gas in the type 3C45 thyratron does not de–ionize soon enough. The excessive current drawn at that time causes relay K2001 to open, interrupting the 450-volt supply long enough to allow the gas to de-ionize. The relay then closes again, restoring power to the trigger amplifier pulse-forming circuit.

4–222. MODULATOR TRIGGER AMPLIFIER POWER SUPPLY. (See figure 7–58.) The modulator trigger amplifier has a self-contained power supply which furnishes plate and filament voltages to the modulator trigger amplifier and plate voltage to the modulating system control circuits. The input to transformers T2003 and T2004 is 120 volts ac from phase C.

4–223. This power supply provides 450 volts dc for the thyratron switch only and 260-volt d-c plate power for tubes V2001 and V2002 and for all tubes in the modulator control unit. To reduce the heater-to-cathode potential of tubes V2005 and V2006, the filament winding is tied to +260 volts. Thus, the possibility of arc-over between the two elements is reduced.

4–224. MODULATOR PULSE-FORMING CIRCUIT (CABINET, ELECTRICAL EQUIPMENT CY-1138/FPS-6).

4–225. BLOCK DIAGRAM. (See figure 4–23.)

4–226. The 750-volt input trigger causes the modulator pulse-forming circuit to place −11.5 kilovolts across

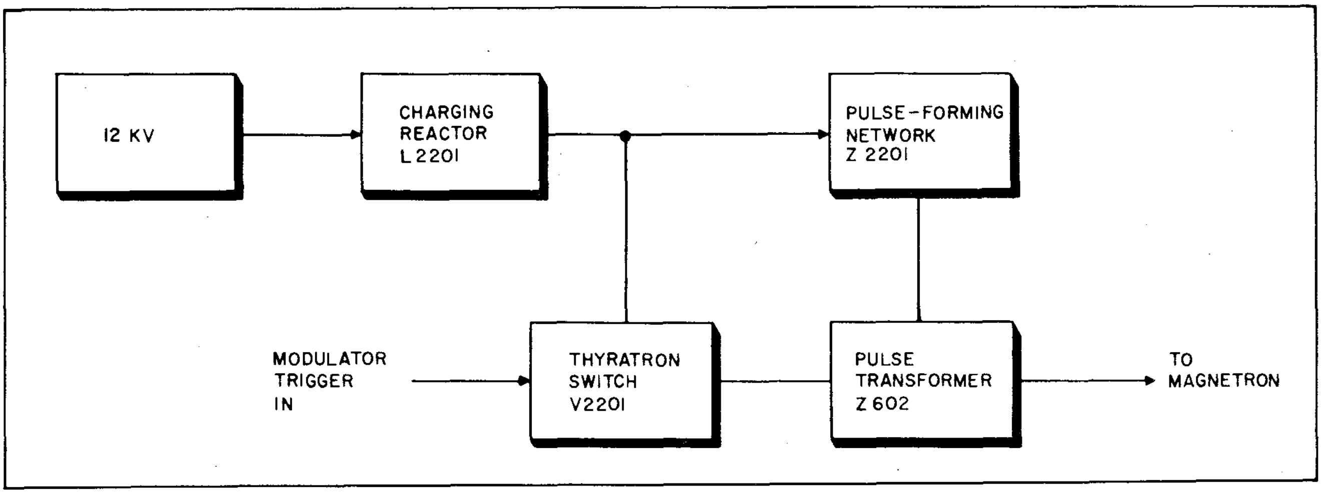

Figure 4–23. Modulator Pulse-forming Circuit, Block Diagram

the primary of pulse transformer Z602 in the magnetron assembly. This voltage remains across the primary for the duration of the input trigger.

4–227. The capacitance of pulse-forming network Z2201 charges through reactor L2201. After the network capacitance has been charged to the supply voltage of 12 kilovolts, the magnetic field around the reactor collapses, inducing an emf in such a direction as to charge the network to twice the supply voltage. During discharge, the reactor prevents current drain by isolating the power supply from the conducting thyratron switch.

4–228. The thyratron switch is a heavy-duty, hydrogen-filled type. When ionized by the 750-volt modulator trigger, the thyratron switch provides a low-impedance path for network discharge. A reservoir at the base of the tube contains a small hydrogen generator which tends to maintain a predetermined gas pressure within the tube and allows readjustment of the gas pressure by reservoir control transformer T2203. Reservoir filament voltage is a critical quantity and must be adjustable. An aluminum shield is mounted on the front edge of the cradle to protect personnel from X-ray radiation.

4–229. When the modulator trigger causes the gas in the thyratron to ionize, the capacitance of the pulse-forming network is discharged through the primary of pulse transformer Z602. The pulse-forming network is designed to match the impedance of the primary of pulse transformer Z602 and to discharge the capacitance in 2 microseconds. When properly terminated, no energy remains in the pulse-forming network following the discharge period. Maximum power is transferred through the pulse transformer to the magnetron.

4-230. The current flowing through the primary of pulse transformer Z602 during the network discharge develops the modulating pulse across the secondary. This pulse is −65 kilovolts in amplitude and 2 microseconds wide and is fed directly to the magnetron cathode. An RC network shunts the primary at all times to remove the spike from the leading edge of the modulator pulse. The secondary of transformer Z602 is designed to match the impedance of the oscillating magnetron; the primary impedance matches the characteristic impedance of the pulse-forming network. Magnetron arcing loads the pulse transformer, reducing the primary impedance of the transformer below the value required to match the characteristic impedance of the pulse-forming network. Under these conditions, a reverse-current signal is produced to actuate warning and protective circuits.

4-231. CIRCUIT ANALYSIS OF MODULATOR PULSE-FORMING CIRCUIT.

4–232. CHARGING MODULATOR PULSE-FORMING CIRCUIT. (See figure 4–24.) A maximum d-c voltage of 12 kilovolts can be obtained from the modulator high-voltage power supply to charge pulse-forming network Z2201 through reactor L2201 and the primary of pulse transformer Z602. Capacitor C2201 and reactor L2204 filter out the noise voltages produced by sudden changes in voltage levels during charge and discharge. The capacitance of the pulse-forming network is charged to approximately twice the d-c source voltage. The charging wave, which can be monitored at jack J2204, is similar in appearance to the waveform shown in B of figure 4–24. The reactance in the charge path has been chosen so that the network capacitance can just reach a 24-kilovolt charge during the interval between modulator triggers. A holdoff diode is therefore unnecessary.

4–233. ELECTRICAL CHARACTERISTICS OF PULSE-FORMING NETWORK Z2201. A parallel-wire transmission line possesses inductance due to the action of the magnetic field about the copper wire. In addition, the transmission line possesses capacitance because of the existence of an electrostatic field between the wires. A combination of a coil and a capacitor can be used to produce a network with electrical behavior closely approximating that of an open two-wire line, particularly with respect to the important attributes of delay time and characteristic impedance. In this manner,

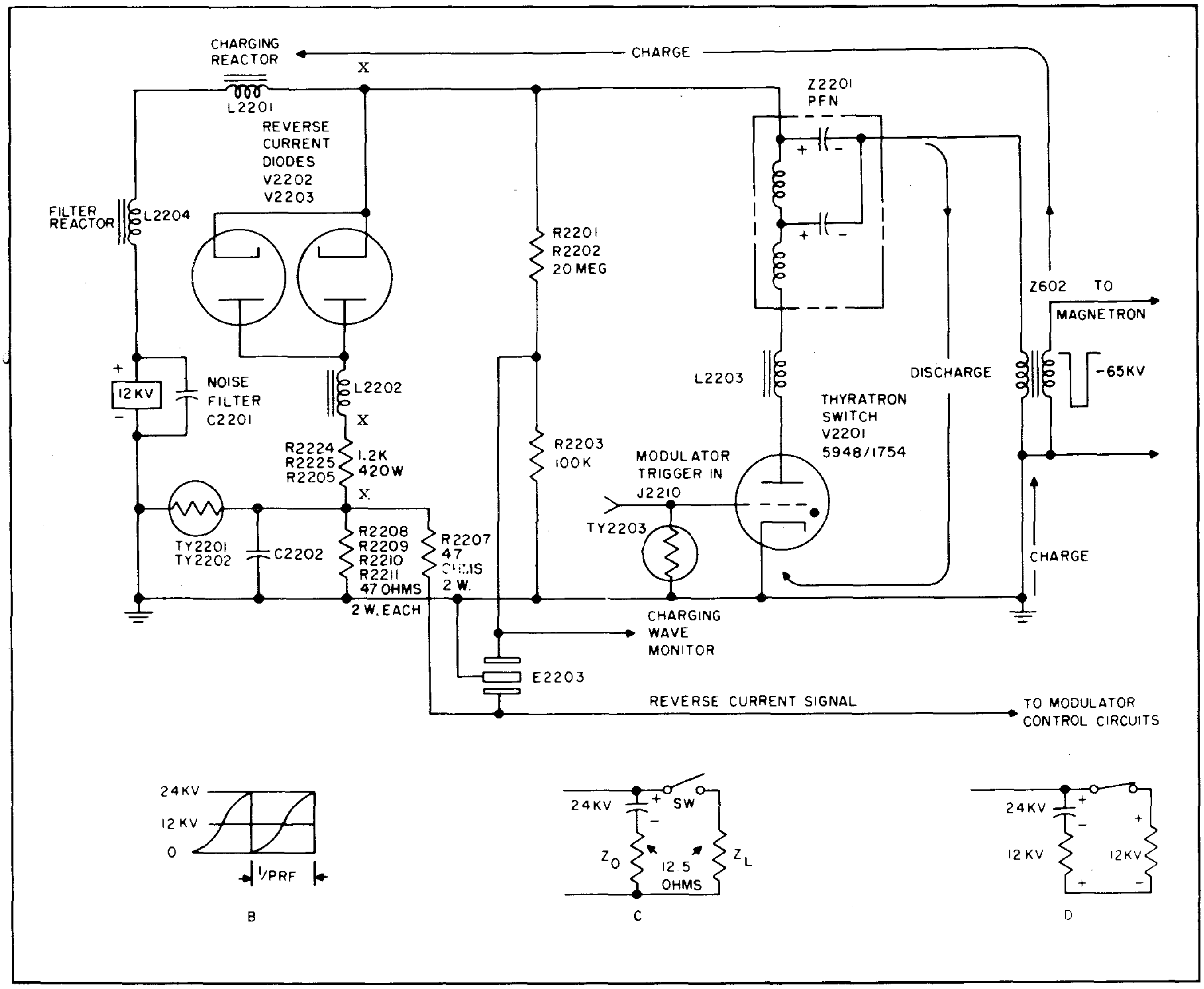

Figure 4–24. Modulator Pulse-forming Circuit, Simplified Schematic Diagram

a transmission line of cumbersome length can be reduced to essential circuit elements.

4–234. If a d-c source is connected across one end of a parallel-wire line, an electrical impulse travels along the line as a wave of electromagnetic and electrostatic energy. The time required for the energy to reach the other end of the line is called the delay time. In an artificial transmission line, such as in pulse-forming network Z2201, the delay is proportional to the number of sections of which the line is composed, and to the square root of the product of inductance and capacitance. Network Z2201 is designed so that energy requires 1 microsecond to complete the journey from one end to the other.

4–235. In the actual pulse-forming circuit, the charging takes place through reactor L2201, which is in series with the d-c supply and the network. Since the inductance of the charging choke is so much greater than the network inductance, pulse-forming network Z2201 is effectively a simple capacitor during the charging period. However, the pulse-forming network does behave as a transmission line during the discharge period. During discharge, energy travels down the line as a wave motion.

4–236. If a parallel-wire line is terminated in a reactance, energy reaching the load is stored for an interval in the form of an electromagnetic or an electrostatic field, and then reflected toward the source. No power can be absorbed by a reactive load. If the line is terminated in a pure resistance, the ratio of reflected to absorbed power is a function of the magnitude of the resistance. Experiments show that at one particular value of resistance, no reflected energy is discernible, and maximum power is absorbed by the load. This critical value of resistance is always equal to the characteristic impedance, Z_0, of the line. An artificial line, such as the pulse-forming network, also has a characteristic impedance proportional to the square root of the ratio of inductance to capacitance. Adding sections to the line does not change the ratio of L/C, and consequently does not alter the characteristic impedance.

4–237. A line terminated in a resistance equal to the characteristic impedance displays the traits of a pure resistance: voltage and current travel down the line in phase, current flow is maintained at a constant level, and maximum power is transferred from line to load. Finally, in this ideal case, all the energy is absorbed by the resistive load and none is reflected.

4–238. Pulse-forming network Z2201 has two L-sections in cascade and possesses a characteristic impedance of 12.5 ohms and a delay time of 0.5 microsecond per section. The network produces a pulse 2 microseconds in duration.

4–239. MODULATOR PULSE TRANSFORMER. The primary of pulse transformer Z602 is designed to work into a 12.5-ohm load; the secondary requires a 500-ohm load. The impedance of the oscillating magnetron constitutes the necessary 500-ohm load on the secondary of the pulse transformer. The impedance ratio of pulse transformer Z602 is 40:1, so that 12.5 ohms are reflected into the primary. The operating impedance of the transformer primary equals the characteristic impedance of the pulse-forming network.

4–240. DISCHARGING MODULATOR PULSE-FORMING CIRCUIT. (See figure 4–24.) The pulse-forming network is charged to 24 kilovolts during the interval between trigger pulses. Network discharge commences when the modulator trigger fires the JAN 5948 thyratron, causing the primary of pulse transformer Z602 to be placed across pulse-forming network Z2201. In C of figure 4–24, the pulse-forming network is shown as a capacitor charged to 24 kilovolts, in series with a 12.5-ohm resistance, Z_0, representing the characteristic impedance of the network and another 12.5-ohm resistance, Z_1, representing the impedance reflected into the primary of the pulse transformer. The thyratron is diagramed as an SPST switch. Ionizing the thyratron is equivalent to closing the switch, completing the discharge circuit. Since the load impedance matches the internal impedance of the pulse-forming network, the network voltage is divided equally between Z_0 and Z_1, as shown in D of figure 4–24. The voltage dropped across the internal impedance, while equal to the potential difference across Z_1, is of negative polarity. The −12 kilovolts are propagated down the line as a traveling wave, bringing the potential of each point passed down to 12 kilovolts. By the time the wave reaches the open end, 12 kilovolts exist at any point on the line. The open end corresponds to a capacitive load. This reactive termination is unable to absorb any of the energy and therefore reflects the wave with no change in polarity. As the wave retraces its steps, the potential at each point passed is reduced to zero. When the wave reaches the resistive end of the line, the potential across the load is reduced to zero and the pulse is ended. Since the delay time of the line is 0.5 microsecond per section, 1 microsecond is required for the wave to journey down the line and 1 microsecond for the return trip, producing a 2-microsecond pulse.

4–241. Charging reactor L2201 isolates the thyratron switch from the modulator high-voltage power supply during the pulse to minimize the current drawn by the thyratron. Reactor L2201 also allows the switch tube to de-ionize by isolating the thyratron from the power supply for a period of time following the pulse.

4–242. Discharge current must flow through the network inductance and the external resistance; that is, through the transformer primary. The rate of network discharge is determined by the value of the external resistance. As the discharge begins, heavy current flows and a magnetic field builds up rapidly about the network inductance. As the network capacitance discharges further, network current decreases momentarily. Coincidentally, the magnetic field collapses slightly, inducing a counter emf in the network coils and tending to compensate for the decreased discharge current. As the discharge current decreases still further, the current produced by the counter emf increases just rapidly enough to maintain a constant current through the transformer primary. Thus, the network capacitance, which tends to cause an exponential decay of current during discharge, is counterbalanced by the inductance. For this reason, the shape of the pulse is determined primarily by the pulse-forming network.

4–243. Although the network voltage was divided equally between the load and the line, almost all of the energy (I^2R) is absorbed by the load when the returning wave reaches Z_L. This condition is produced because the line is composed of reactive elements and cannot absorb power. If the termination did not match the characteristic impedance of the load, a portion of the returning energy would have been reflected down the line for a second round trip. In the modulator pulse-forming circuit, the impedances are matched fairly closely. Approximately 75 percent of the energy originally stored in the pulse-forming network is delivered to the magnetron. The 25-percent loss is due to dielectric and eddy current losses in the switch tube and losses in the pulse transformer.

4–244. The pulse transformer thus functions to provide a terminating impedance of the correct value to match the Z_0 of the pulse-forming network and also amplifies the pulse. The output across the secondary is a negative pulse, approximately rectangular in shape, −65 kilovolts in amplitude and 2 microseconds in duration.

4–245. Thyrite resistor TY2203, located between the grid and ground of thyratron V2201, appears as a high resistance under ordinary operating voltage (nominal 750-volt pulse). If thyratron V2201 flashes through, because of a faulty thyratron or misadjustment of the capsule voltage, the voltage on the grid rises appreciably above normal. Since the resistance of the thyrite decreases as the voltage across it increases, the potential is prevented from rising to a level which could destroy pulse transformer Z2001 or connecting cables.

4–246. RESISTIVE LOADING. (See figure 7–57.) Resistors R2218 through R2223 constitute a constant resistive load across the primary of the pulse transformer. Thus, these resistors reduce the input impedance of the pulse-transformer primary circuit to a value which more nearly matches the output impedance of the pulse-forming network.

4–247. DESPIKING NETWORK. (See figure 7–57.) A despiking network, composed of the parallel combination of 80-ohm resistors R2212 through R2217 in series with capacitor C2204, shunts the primary of pulse transformer Z602. To appreciate the utility of the network, the operation of the pulse transformer must be considered without the network. An impedance of 12.5 ohms is reflected into the primary of pulse transformer Z602 if the secondary works into a 500-ohm load. Ordinarily, the anode impedance of the oscillating magnetron loads the secondary with the required resistance. However, there is a fraction of time between the arrival of the pulse on the magnetron cathode and the start of the oscillation. During this time, the anode circuit reflects a high impedance into the primary. Without the despiking network, the primary circuit impedance would be approximately 120 ohms (the impedance of the resistive loading), or 10 times the characteristic impedance of the pulse-forming network. Under these conditions, almost the entire 24 kilovolts of the pulse-forming network capacitance would be seen across the primary at the first instant; after the start of oscillations, the primary voltage would decrease to a normal 12 kilovolts. Thus, a 24-kilovolt spike would appear at the leading edge of the modulating pulse. This effect would be undesirable because the frequency stability of the magnetron is contingent upon a flat-topped pulse.

4–248. To filter out the spike, an RC circuit with 12.5 ohms of resistance in series with 0.005 microfarad of capacitance is placed across the primary. When the thyratron fires, heavy current flows through this despiking network and capacitor C2204 starts to charge. At that instant, the impedance of the capacitance is effectively zero. The despiking network resistance, in parallel with the transformer primary, presents 12.5 ohms to the pulse-forming network so that a matching termination is effected. The 24 kilovolts then divide equally between the primary and the pulse-forming network, as required. The time-constant of the despiking network is quite short, so that the despiking capacitance is fully charged by the time the magnetron goes into oscillation. The despiking network then presents an infinite impedance since no current can flow in the network with the capacitors fully charged. By this time, however, the anode circuit of the oscillating magnetron reflects the proper impedance into the transformer primary to maintain a matched termination across the pulse-forming network.

4–249. REVERSE CURRENT. (See figure 4–25.) The discussion of the discharge of pulse-forming network Z2201 assumes matched impedances at all times. However, when the magnetron arcs over, a short circuit is reflected into the primary of the pulse transformer and the entire 24 kilovolts appears across the internal impedance of the network as shown in A of figure 4–25. A 24-kilovolt traveling wave is then propagated down the line, reducing the potential of each point passed to zero. By the time the wave reaches the open end, the line has been completely discharged. The open end then is unable to absorb any of the energy and reflects the wave with no change in polarity. As the wave retraces its steps, the line is charged to a potential of −24 kilovolts.

4–250. Heavy undermatching produces several undesirable effects. No energy is transferred to the magnetron when arcing in the magnetron reflects a short circuit to the primary of the pulse transformer. The high negative voltage on the plate of the thyratron attracts positive ions which bombard the anode with sufficient force to damage the surface. However, the most serious effects result from the cumulative nature of the heavily undermatched condition as shown in B of figure 4–25. The period from t_0 to t_1 represents the normal charge curve of the network. The pulse-forming network is completely discharged at time t_1, the end of the pulse. During the period from t_1 to t_2, the network charges through the charging choke to a potential approximately twice that of the source voltage.

4–251. At time t_2, the magnetron arcs over and the network charges to −24 kilovolts. The −24-kilovolt

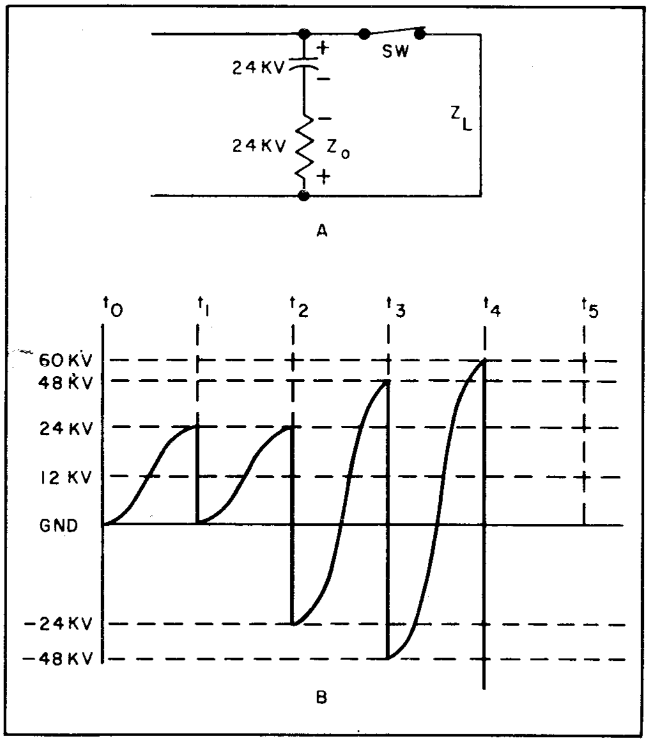

Figure 4–25. Reverse Current

potential is in such a direction as to add to the source potential when the network is charging normally. The network then sees a d-c source of 36 kilovolts instead of 12 kilovolts and charges through the charging choke to a point 72 kilovolts above the level to which the network was charged at the end of the previous pulse. Since the network had been charged to —24 kilovolts and sees a source potential of 36 kilovolts, d-c resonant charging brings the potential to 72 kilovolts above this level, or to 48 kilovolts above ground, assuming no losses.

4–252. Since a high-Q choke is used with d-c resonant charging, the pulse should first increase in amplitude at an arithmetic rate; that is, 24 kilovolts, 48 kilovolts, 72 kilovolts, etc. This increase would occur if the charging path remained a high-Q, d-c resonant circuit. However, the Q of charging reactor L2201, while approximately 30 under normal operating conditions, decreases rapidly as the current through the coil approaches saturation. The Q continues to decrease as the network voltage continues to build up and the magnetic field of the coil plays practically no part in the charging process until after the eighth pulse. Approximately half of the energy that would ordinarily be fed into the pulse-forming network is dissipated by the internal resistance of the saturated charging reactor.

4–253. Since, at time t_3, the network is charged to a voltage twice that of the normal value, a strong possibility exists that the magnetron will arc over again on the succeeding pulse. If arc-over does occur, a —48-kilovolt charge remains in the network. A —48-kilovolt potential across the thyratron could cause arc-over. The network could charge to approximately 60 kilovolts during the interval between pulses. However, the reverse-current diodes prevent the network from charging to a voltage high enough to cause destructive arc-over in the thyratron.

4–254. REVERSE-CURRENT DIODES. (See A, of figure 4–24.) Reverse-current diodes V2202 and V2203 conduct very slightly during normal operation of the pulse line. However, immediately after each magnetron arc-over, a negative voltage appears across the output of the pulse-forming network, allowing the diodes to conduct heavily. The diodes conduct the reverse current through the circuit to ground, thus discharging the network and protecting the thyratron against too great a negative plate voltage and destruction by arc-over. Capacitor C2202 filters out high-frequency oscillations.

4–255. A magnetic field is built up around inductor L2202 by current flow through the reverse-current diodes. This field collapses at the expiration of reverse-current flow and induces a voltage which charges the network to approximately 15 percent of the normal charge. The network then charges to a level of approximately 87 percent of normal through inductor L2201. The magnetron is thus discouraged from arcing by lowering of the anode voltage during the next pulse. A voltage is developed across resistors R2208 through R2211 during the flow of reverse current. This voltage would be proportional to the magnitude of reverse current if not for resistors (thyrites) TY2201 and TY2202. These thyrites are voltage-sensitive resistors which act as voltage regulators by decreasing resistance as the voltage across them increases. Thus, approximately 50 volts is produced at jack J2208 when the magnetron is arcing, regardless of the magnitude of reverse current. This 50-volt, 280-microsecond pulse is used to operate the warning and protective devices in the modulator control unit.

4–256. Arrestor E2203 protects the charging-wave monitor and reverse-current signal circuits against high voltage. Under normal conditions, the voltage applied to arrestor E2203 is insufficient to break down the gaps. If any of the points marked x in A of figure 4–24 were to open, the voltage on the monitor lines would rise to the 24 kilovolts to which the lines are returned. Under these conditions, the gaps would arc over and ground the monitor line affected, protecting the monitor devices against the high voltage.

4–257. MODULATOR FILAMENT CIRCUIT. (See figure 4–26.) Transformers T2201 through T2204 are located in the modulator and provide the proper filament voltages for operation of the vacuum tubes in the modulator pulse-forming circuit. A regulated 120-volt input from the modulator filament control circuit is applied across the primary terminals of transformers T2201 through T2203. The secondary of transformer T2201 supplies the filament voltage for reverse-current diodes V2202 and V2203. Transformers T2201, T2203, and T2204 form a filament supply circuit for the JAN 5948 hydrogen thyratron, V2201.

4–258. Thyratron V2201 has two filaments, one for the cathode and one for the hydrogen reservoir heater. Transformer T2201 supplies the voltage for the cathode filament, while transformer T2203 is an adjustable autotransformer which permits control of the reservoir heater voltage by controlling the input to transformer T2204. Meter M2201 is placed across the secondary of transformer T2204 and indicates the reservoir voltage. Capacitor C2203 is a 0.1-microfarad capacitor which acts as a meter bypass.

4–259. MODULATOR HIGH-VOLTAGE REGULATOR (VOLTAGE REGULATOR CN-93/CPS-6B). (See figure 7-126.)

4–260. The modulator high-voltage regulator is a three-phase transformer with secondary windings that can be rotated with respect to the primary windings. One side of each secondary is coupled to one side of its respective primary so that the voltage induced in each secondary varies in magnitude and polarity in accordance with its position. The output voltage of the regulator is the algebraic sum of the primary and secondary voltages. The position of the secondaries is varied by motor B10301, which is controlled by the high-voltage raise-lower circuit discussed in paragraph 4–328. The output is controlled automatically by the magnetron anode-current control circuit or manually by the HV RAISE-

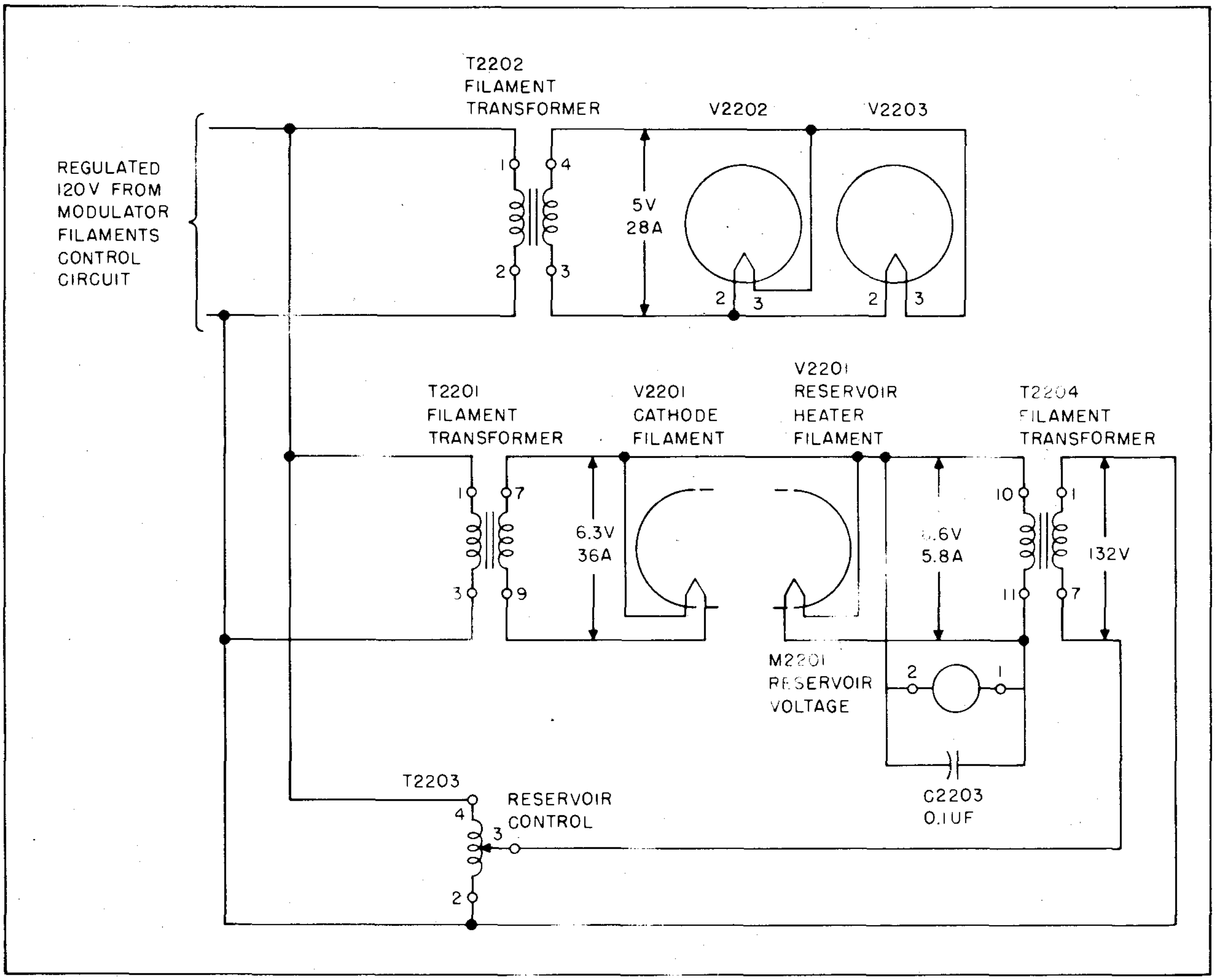

Figure 4–26. Modulator Filament Circuit. Simplified Schematic Diagram

HV LOWER switch on either the modulator or remote control panel. The drive motor operates between limits set by limit switches S10301 and S10302. The output voltage can be varied between 170 and 240 volts line-to-line.

4–261. MODULATOR HIGH-VOLTAGE POWER SUPPLY (POWER SUPPLY PP-783/FPS-6).

4–262. BLOCK DIAGRAM. (See figure 4–27.)

4–263. The power supply consists of a three-phase power supply, six 371B rectifier tubes, a filter, two filament transformers, and a blower. Three-phase, full-wave rectification is used because of low-ripple requirements. The filament transformer provides filament power for the rectifier tubes, which are cooled by the blower. The cabinet door is equipped with interlock switches because of high voltages involved.

4–264. Three-phase a-c power from the modulator high-voltage regulator is fed to the power transformer as shown in figure 4–27. The three-phase, high voltage output is then converted by the six rectifier tubes into high-voltage d-c power, which is applied through the filter and an associated protective circuit to the modulator. The filter protective circuit prevents high-current surges to filter capacitor when power is turned on, and discharges the filter capacitor when power is turned off. The voltage to the modulator is contingent upon value of input supply from modulator high-voltage regulator and can be varied between 8.4 and 12 kilovolts.

WARNING

Potential 15KV will remain in capacitor C-10401 if bleeding resistors are open. Always use shorting bar to discharge C-10401 when working in immediate area.

4–265. CIRCUIT ANALYSIS OF MODULATOR HIGH-VOLTAGE POWER SUPPLY. (See figure 4-28.)

4–266. The coil and one set of contacts of relay K10401 are in the high-voltage interlock circuit. To energize the coil, the other contacts in the interlock circuit must be closed. Then, by operating the RADIATE-STOP & RESET switch on either the modulator or remote control panel to the RADIATE position, start relay K2108 is energized, contacts 2 and 4 close, power is fed to the

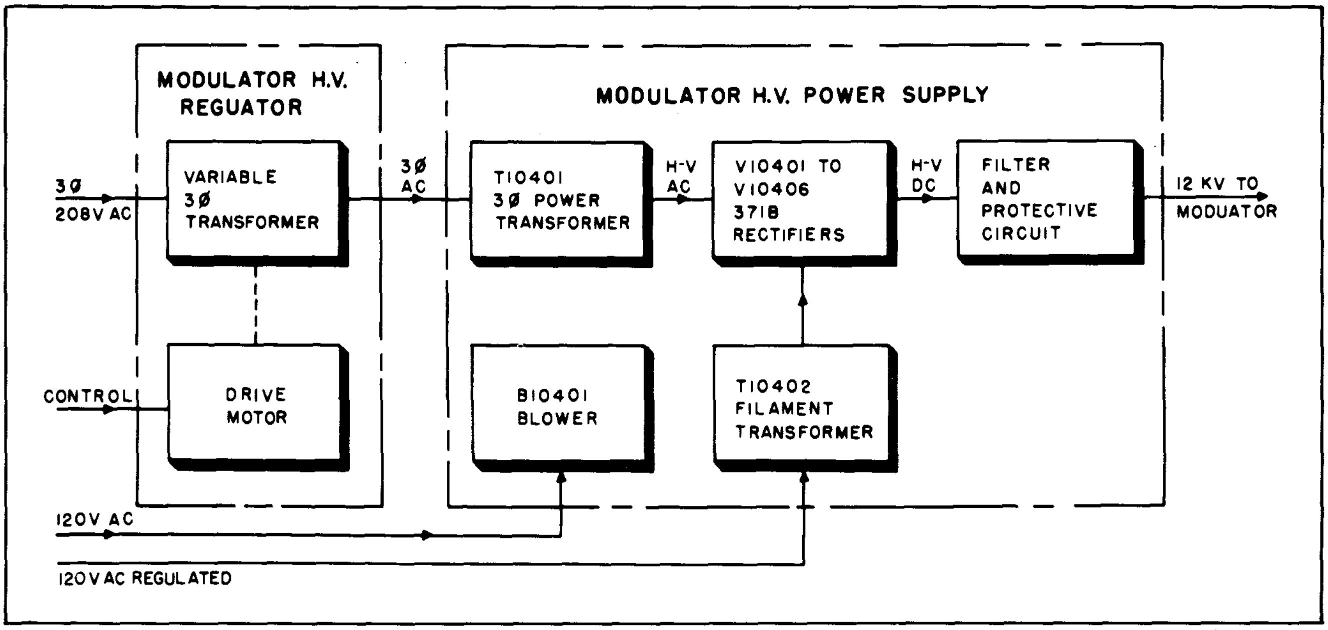

Figure 4–27. Modulator High-voltage Regulator and Modulator High-voltage Power Supply, Block Diagram

coil of relay K10401 and its contacts are closed. The interlock circuit is then complete and three-phase power from the modulator high-voltage regulator is applied to the delta-connected primary of transformer T10401. The Y-connected secondary of transformer T10401 develops approximately 13 kilovolts (maximum) across output terminals A and B, B and C, or C and A. Six high-voltage 371B diode-rectifier tubes, connected in series-parallel, provide full-wave rectification. Choke coil L10401 and capacitor C10401 comprise a filter that removes the a-c component of the rectified current. The high-voltage d-c output is fed to the modulator.

Note

Capacitor C2201, the high-voltage noise filter (figure 4–24), is connected between the high-voltage input jack in the modulator assembly and ground.

4–267. Multiplier resistors R10401 through R10404 are in series with HV meter M2103 and limit the meter current to the proper operating level. Spark gap E10401 shunts meter M2103. If the voltage across the meter becomes too high, the spark gap fires and shorts out the meter. Capacitor C2103 is a 0.01-microfarad capacitor which acts as a bypass across the meter.

4–268. The negative side of the power supply is grounded through solenoid 11-12 of d-c overload relay K2250 and HV CURRENT meter M2104 in the modulator assembly. Relay K2250 has a pair of normally closed contacts in the high-voltage interlock circuit (paragraph 4–337). While the power is off, or during periods of normal current drain, the contacts remain together. If the modulator high-voltage power supply is shorted, or under any other high current drain condition, the field about solenoid 11-12 of relay K2250 becomes strong enough to cause the contacts to spring apart, interrupting the high-voltage interlock circuit and cutting off input power to the modulator high-voltage power supply. The interlock circuit contacts of relay K2250 can be reset by operating switch S2101 (modulator control panel) or switch S6101 (remote control panel) to the STOP & RESET position. For a complete description of the high-voltage interlock circuit, refer to paragraph 4–337.

4–269. HV CURRENT meter M2104 on the modulator control panel indicates the current drain from the modulator high-voltage power supply. Capacitor C2104 acts as a meter bypass.

4–270. Resistors R10405 and R10406, in combination with relays K10402 and K10403, comprise a protective circuit that limits the current surge into capacitor C10401 when the modulator high-voltage power supply is turned on or off. Relays K10401 and K10402 are energized in parallel and operate at the same time. Since relay K10403 operates after relay K10401 has closed, capacitor C10401 remains in series with resistor R10406 across the high-voltage rectifier output for the fraction of a second between operation of relay K10401 and relay K10403. During this interval, resistor R10406 limits the current surge to capacitor C10401. When relay K10403 operates, its normally open contacts short out resistor R10406, leaving capacitor C10401 directly across the high-voltage output. When relay K10401 is de-energized in order to remove high voltage from the modulator, relays K10402 and K10403 are de-energized. Capacitor C10401 then discharges through resistors R10405 and R10406 and the normally closed contacts of relay K10402.

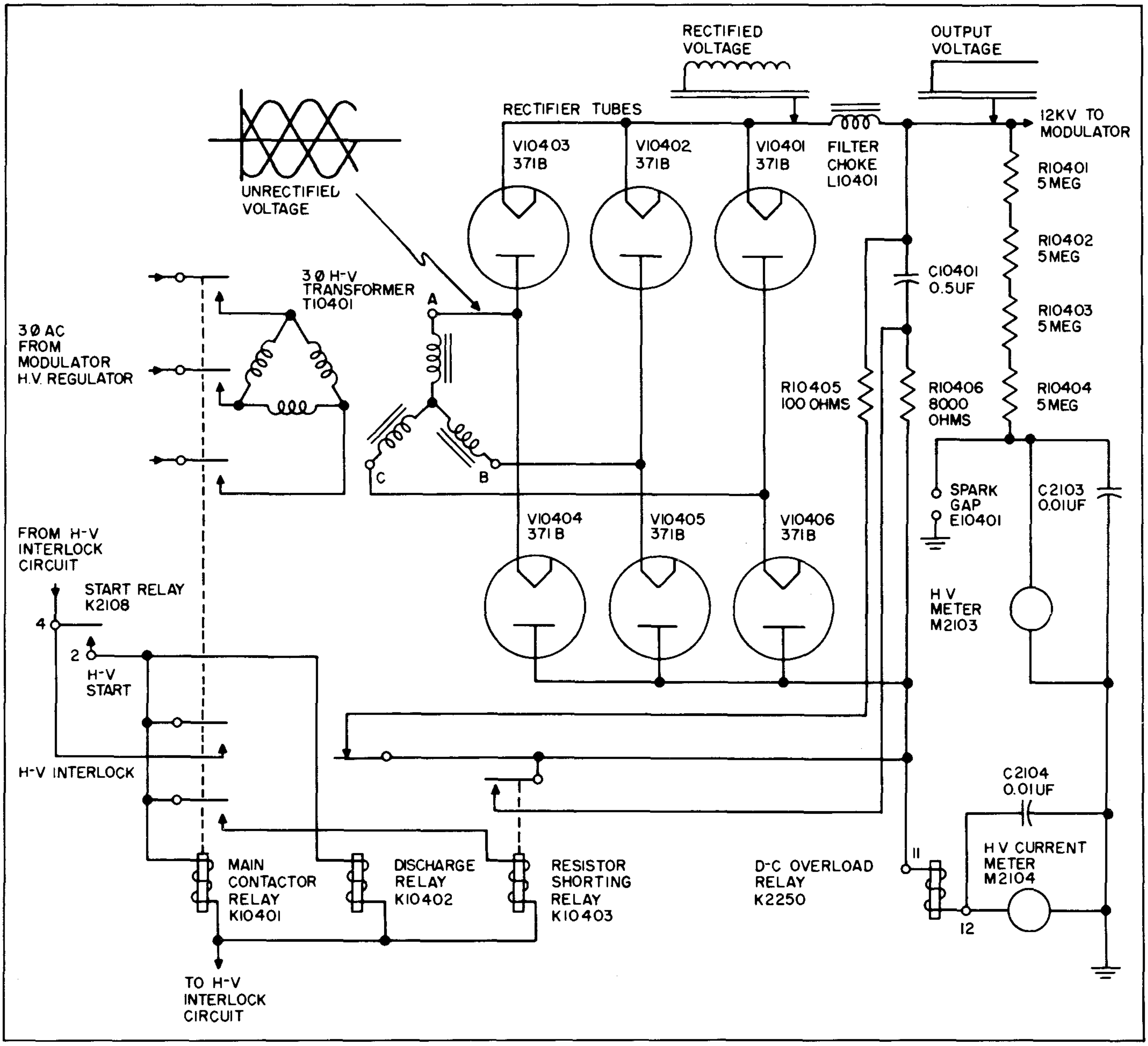

Figure 4–28. Modulator High-voltage Power Supply, Simplified Schematic Diagram

4–271. Filament transformers T10402 and T10403, blower B10401, door interlocks S10401 and S10403, and interlock shorting switch S10402 are shown in the complete schematic for the modulator high-voltage power supply (figure 7–127). Each filament transformer receives a regulated 120-volt supply from the wiper arm of modulator filament powerstat T2250. The secondaries supply the rectifier tubes with 5 volts ac. Blower B10401 cools the rectifier tubes. The blower consists of a single-phase, 120-volt a-c motor of the split-phase type and a cooling fan. The input to the blower is phase C power from the modulator control unit. Door interlocks S10401 and S10403 prevent the operation of the modulator high-voltage power supply while the power supply cabinet door is open. Interlock shorting switch S10402 is used as an emergency device to short out door interlocks S10401 and S10403 to allow the power supply to be serviced under battle conditions. These switches are functional units in the high-voltage interlock circuit.

WARNING

Interlock shorting switch S10402 permits entry into the modulator high-voltage power supply while high-voltage circuits are energized. Operate this switch only when emergency repairs must be made under battle conditions, exercising extreme caution.

4–272. MODULATOR CONTROL UNITS (REGULATOR, CURRENT AND VOLTAGE CN-187/FPS-6).

4–273. BLOCK DIAGRAM. (See figure 4–29.)

4–274. This discussion covers the theory of operation of the circuits which control the operation of the modulating system. These control circuits involve elements in all major components of the modulating system as well as in other components of the radar. The symbol number, name, and function of the modulator front panel controls and indicators located in each unit are provided in figure 1–69.

4–275. POWER INPUT. The modulating system control circuits are divided into four electromechanical loops: magnetron filament control, modulator filaments control, modulator control, and magnetron anode-current control. Each loop is supplied with one phase of a 3-phase, 4-wire, 208/120-volt, 60-cps power supply. This power input arrangement yields 208 volts line-to-line or 120 volts line-to-neutral.

4–276. FUSE CIRCUITS. (See figure 7–55.) Each phase of the power input is fused separately. Neon indicators, located on the modulator control panel and labeled MAGNETRON FILAMENT, MODULATOR FILAMENTS, and MODULATOR CONTROL, light in the event of fuse failure. Each fuse shorts out the series combination of an NE-51 indicator and a 150-kilohm current-limiting resistor. If the fuse blows, power is applied to the limiting resistor and indicator, lighting the indicator.

4–277. MODULATOR FILAMENT VOLTAGE CONTROL. (See B of figure 4–29.) Phase B of the unregulated three-phase supply feeds the controls for the modulator filaments. A potential of 120 volts is developed across the input terminals of modulator filament powerstat T2250. At the output, a motor-driven wiper arm is adjusted to tap off 120 volts. This regulated voltage is fed to the various filament transformers in the modulating system, to the 15-minute time-delay circuit (C, figure 4–29), and to filament control transformer T2103.

4–278. The rectified and regulated filament output is applied to the B-section of dual-triode comparator tube V2103 and compared against a fixed potential maintained on the grid of the A-section by voltage-regulator (V-R) tube V2104. Both sections of tube V2103 conduct equally when the regulated output from the powerstat equals some preset level. If the output becomes other than the preset value, in this equipment 120 volts, the sections of tube V2103 conduct unequally, producing an error voltage which energizes one section of relay K2105. Phase B power then passes through the closed contacts of relay K2105 to the drive motor. Depending upon which set of contacts of relay K2105 are closed, the drive motor operates to raise or lower the wiper arm until a regulated output of 120 volts is again available.

4–279. MAGNETRON FILAMENT CURRENT CONTROL. (See A of figure 4–29.) Phase A of the unregulated three-phase supply is the power source for the control circuit which supplies regulated current to the magnetron filament. The control system incorporates elements similar to those in the modulator filament voltage control system described in the foregoing paragraphs. In addition, the magnetron filament power controls maintain the current flow to the magnetron filament at a higher level when the radar is in the ready condition and at a lower level when the radar is in the radiate condition. The downward adjustment in magnetron filament current during radiate periods compensates for the increased heating of the magnetron cathode, which occurs when high-voltage modulator pulses are applied and r-f oscillations produced.

4–280. An undercurrent relay in the magnetron filament circuit cuts off high voltage to the modulator whenever the magnetron filament current drops below a preset value.

4–281. MODULATOR CONTROL. (See C of figure 4–29.) The modulator and magnetron filaments are allowed 15 minutes to warm up before phase C power is applied to the modulator controls to turn on high voltage. At the expiration of the warm-up period, the READY indicators on the modulator and remote control panels light and power is fed to the high-voltage interlock circuit.

4–282. The high-voltage interlocks consist of various switches, relays, and contacts, wired in series, to form a protective circuit for the transmitter-receiver system. All of the interlocks must be closed before high-voltage power can be applied to the modulator.

4–283. To energize the start circuit, the RADIATE-STOP & RESET switch on either the modulator or remote control panel must be placed in the RADIATE position. The start circuit remains energized for a moment only, since once the RADIATE-STOP & RESET switch is released the contacts return to their normally open position. The function of the start circuit is to energize main contactor relay K10401. When this has been accomplished, the start circuit can be de-energized because the hold-in contacts of relay K10401 are then closed. Regulated three-phase ac from the modulator high-voltage regulator passes through the closed contacts of relay K10401 to the modulator high-voltage power supply, where the ac is converted to high-voltage dc and applied to the modulator. Simultaneously, the RADIATE indicators light and the READY indicators go off.

4–284. High-voltage power to the modulator is cut off and the system stops radiating when any of the high-voltage interlocks are opened. The RADIATE indicators then go off and the READY indicators light, indicating that the system is in a ready (standby) condition. High voltage cannot be reapplied to the modulator until the high-voltage interlock circuit is

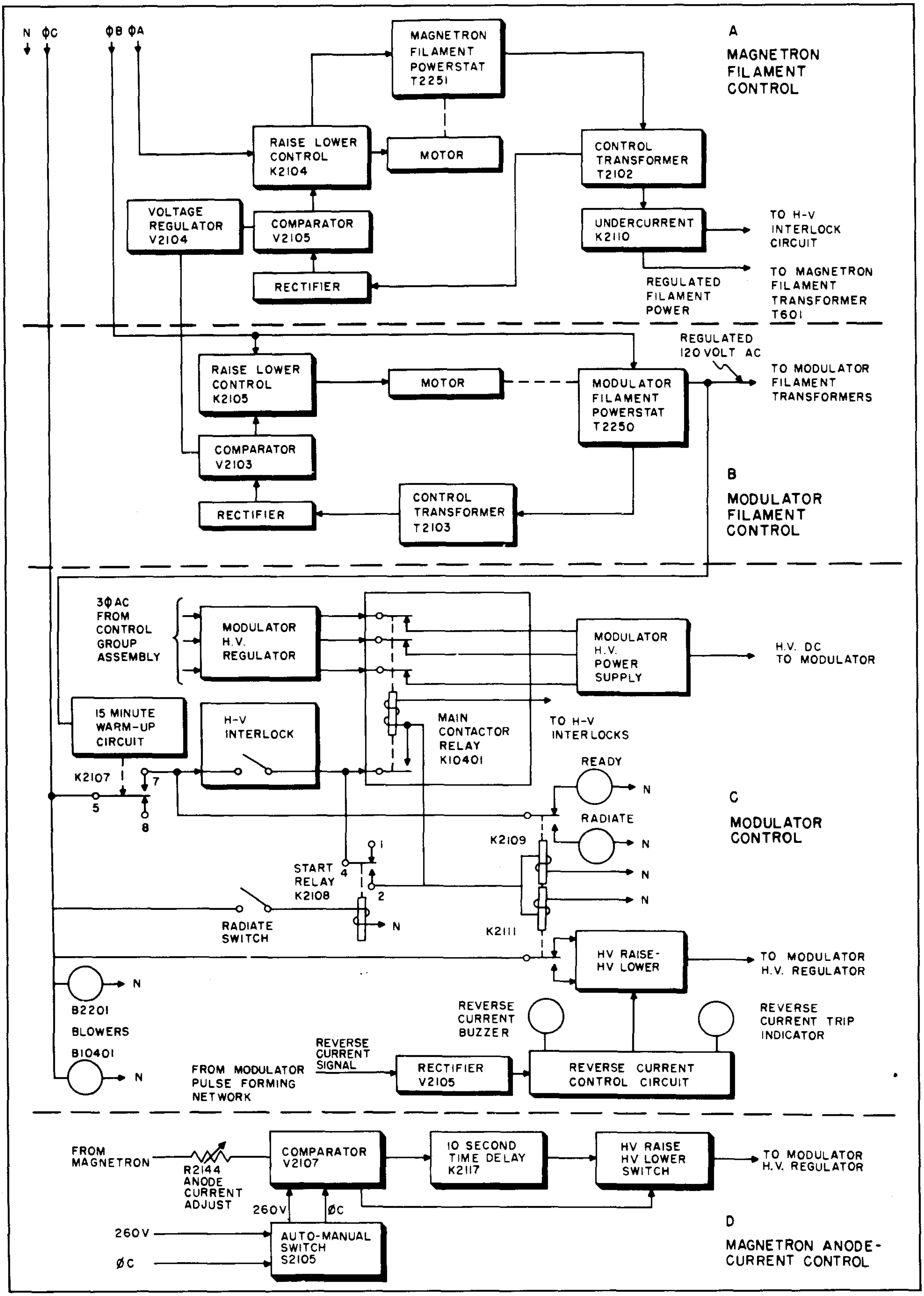

Figure 4–29. Modulating System Controls

closed and the RADIATE-STOP & RESET switch momentarily placed in the RADIATE position.

4–285. The high-voltage raise-high-voltage lower circuit is adjusted automatically to lower the modulator high-voltage regulator output during ready periods. When in radiate, the regulator output is controlled manually by the HV RAISE-HV LOWER switch on the modulator or remote control panel, or automatically by the magnetron anode current control circuit.

4–286. To prevent damage to the emissive surface of the magnetron, excessive arcing must be avoided. If the magnetron arcs excessively, reverse current flows in the modulator reverse-current control circuit. The rectified reverse-current signal then trips the high-voltage runback relay, energizing the high-voltage raise – high voltage lower circuit to lower the high-voltage output until arc-over stops. Buzzers wired in with the high-voltage runback relay inform the operator of this temporary arc-over condition.

4–287. Ten seconds after arc-over stops, the magnetron anode-current control circuit (paragraph 4–289) automatically returns the high voltage to its former level. At the same time, the reverse-current control circuit is released.

4–288. If magnetron arc-over does not stop within 8 seconds after the high voltage has been reduced, the high-voltage interlock circuit is opened, turning off the high voltage. The RADIATE indicators then go off and the READY and REVERSE CURRENT TRIP indicators light.

4–289. MAGNETRON ANODE-CURRENT CONTROL. (See D of figure 4–29.) The magnetron anode-current control circuit operates whenever the AUTO-MANUAL switch is in the AUTO position. If the magnetron anode current departs from the preset level by more than 2 milliamperes, comparator V2107 produces an error voltage which closes one set of contacts of relay K2117. Depending upon which set of contacts of relay K2117 has closed, the drive motor operates to raise or lower the output of the modulator high-voltage regulator until the magnetron anode current is again at the preset level.

4–290. Time-delay relay K2116, in series with the raise lead from relay K2117, provides a 10-second delay between the closing of relay K2117 and the application of phase C voltage to the raise side of the drive motor. This 10-second delay is necessitated by the operation of the reverse-current circuit. After the reverse-current circuit has lowered the high-voltage output, the magnetron is allowed to operate at reduced voltage for 10 seconds in the expectation that this will clear up the cause of arc-over.

4–291. CIRCUIT ANALYSIS OF MODULATING SYSTEM CONTROLS.

4–292. MODULATOR FILAMENT CONTROL CIRCUIT. (See figure 4–30.) Modulator filament powerstat T2250, is a variable output autotransformer using a motor-driven adjustment control. The input voltage is applied across the part of the winding between terminals 2 and 1, while the output is taken between terminal 3, the wiper arm, and terminal 1. The position of the wiper, which is set by the drive motor, determines the amplitude of the output. Limit switches prevent the drive motor from raising or lowering the wiper arm beyond preset points.

4–293. Under normal conditions, a regulated output of 120 volts is obtained with an unregulated input of 110 to 130 volts. The regulated output voltage is applied to filament transformers T10402 and T10403 in the modulator high-voltage power supply, to filament transformers T2201 and T2202 and reservoir control transformer T2203 in the modulator cabinet assembly, and to the 15-minute filament warmup circuit.

4–294. Regulated Phase B power is also applied across the primary of modulator filament power control transformer T2103 as shown in figure 4–30. Transformer T2103 is a 1:1 transformer through which a portion of the output voltage is applied to the comparator circuit. The value of the output voltage is indicated on MOD FIL SUPPLY meter M2107 on the modulator control panel. Capacitor C2107 is a bypass capacitor in the meter circuit.

4–295. The portion of the regulated output voltage fed through filament power control transformer T2103 is rectified by rectifier CR2102 and filtered by resistor R2106 and capacitor C2109. Additional smoothing is afforded by resistor R2118. The d-c signal injected at the grid of section B of comparator V2103 is compared with the reference voltage established at the grid of section A. Gas regulator tube V2104, in series with current-limiting resistors R2107 and R2108, maintains a constant potential of 105 volts at the cathode of comparator V2103. FILAMENT VOLTAGE SENSITIVITY potentiometer R2116 is adjusted so that the grid of tube V2103A is a few volts negative with respect to its cathode. FILAMENT VOLTAGE potentiometer R2106 is similarly adjusted so that, with 120 volts across transformer T2103, the bias on tube V2103B equals that established for the other section. With a regulated output of 120 volts, the sections conduct equally.

4–296. Relay K2105 has two solenoids, one placed in series with the plate circuit of each half of comparator tube V2103. When the sections conduct equally, each solenoid attracts the armature with equal force, with the result that the armature remains stationary. If the regulated filament voltage were to increase, a more positive potential would appear at the grid of tube V2103B and this section would conduct more heavily. Solenoid 5-6 would then exert the stronger attractive force, pulling the armature over to contact 3, thus applying 120 volts to operate the drive motor which lowers the wiper arm until the regulated filament voltage is reduced to 120 volts.

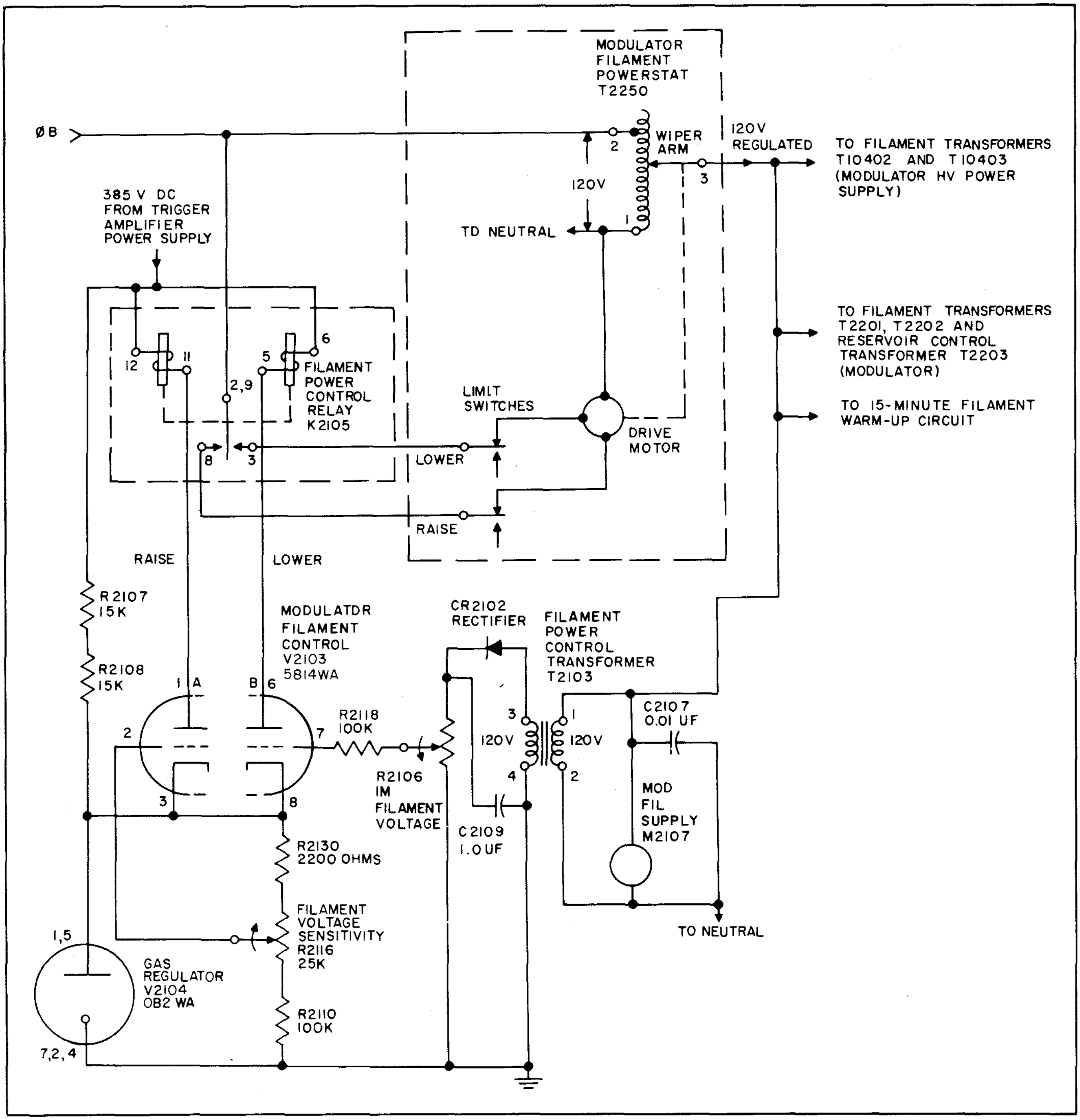

Figure 4–30. Modulator Filament Control Circuit, Simplified Schematic Diagram

4–297. If the regulated voltage were to fall below 120 volts, tube V2103A would conduct more heavily and solenoid 11-12 would attract the armature to contact 8, causing the drive motor to rotate so as to raise the wiper to a point where the output voltage is again 120 volts.

4–298. MAGNETRON FILAMENT CONTROL CIRCUIT. (See figure 4–31.) The magnetron filament control circuit is similar but not identical to the modulator filament control circuit described in the previous paragraphs. It should be noted that 120 volts is first applied through contacts 4 and 1 of relay K2106 to the lower circuit of the drive motor. The drive motor then rotates to a position determined by its lower limit switch, driving the wiper arm on the powerstat to its lowest position. At this point, the powerstat microswitch closes, energizing relay K2106 and placing 120 volts across the input terminals of the powerstat. Since the wiper arm is at its lowest position, the output voltage is low. Thus, the magnetron filament, initially cold

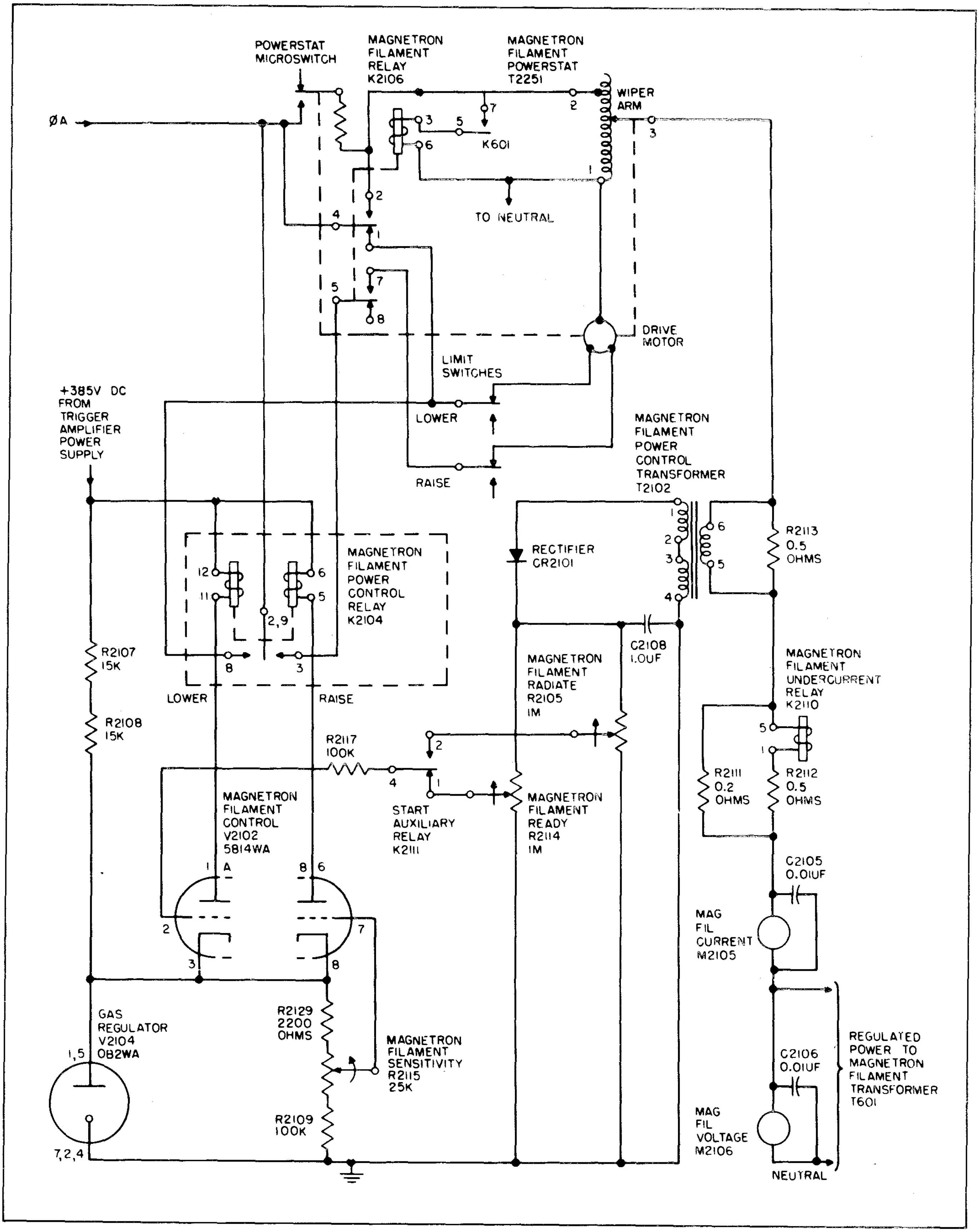

Figure 4–31. Magnetron Filament Control Circuit, Simplified Schematic Diagram

and therefore having a low resistance, is protected against overheating and burnout.

4–299. The low output voltage is maintained for a moment. Since relay K2106 is energized, contacts 2 and 4 and 5 and 7 are closed and power is removed from the lower drive motor circuit. The position of the wiper arm is then controlled by the comparator circuit and filament power control relay K2104. Initially, the comparator circuit attempts to raise the output voltage as described in the following paragraphs. As the drive motor is operated to raise the voltage, the powerstat microswitch opens and input power can now bypass the microswitch by passing through closed contacts 2 and 4 of relay K2106.

4–300. The comparator circuit maintains one of two preset output voltages. If the modulator and magnetron filaments are being warmed up, or if the system is in the ready condition, the magnetron filament voltage is maintained higher than when the system is in the radiate condition. This is designed to prevent overheating of the magnetron cathode. Start auxiliary relay K2111 is energized only when the system is radiating (paragraph 4–311). The relay acts as a magnetron filament potential selector. Thus, contacts 1 and 4 are closed during warm-up or ready periods and contacts 2 and 4 are closed during radiate periods.

4–301. The comparator circuit is energized by having the magnetron filament regulating circuit current flow through the series-connected primary of magnetron filament power control transformer T2102. The output of transformer T2102 is rectified by rectifier CR2101 and filtered by potentiometers R2105 and R2114 and capacitor C2108. Additional smoothing is afforded by resistor R2117. The d-c signal is applied to the grid of tube V2102A and compared with the fixed potential maintained on the grid of tube V2102B by gas regulator V2104. Regulator V2104, in series with current-limiting resistors R2107 and R2108, maintains a constant potential of 105 volts at the cathode of the comparator tube. MAGNETRON FILAMENT SENSITIVITY potentiometer R2115 is adjusted to keep the grid of tube V2102B a few volts negative with respect to its cathode. MAGNETRON FILAMENT READY potentiometer R2114 is in the grid circuit of tube V2102A during warm-up or ready periods. Potentiometer R2114 is adjusted so that with standby current flowing through the magnetron filament regulating circuit, the bias on tube V2102 equals that established for tube V2102B. MAGNETRON FILAMENT RADIATE potentiometer R2105 is in the grid circuit of tube V2102A during radiate periods. Potentiometer R2105 is adjusted so that with radiate current flowing through the magnetron filament regulating circuit, the bias on tube V2102A again equals that established for tube V2102B. Figure 4–32 shows the meter M2105 reading with various pulse transformers to obtain the correct magnetron heater current. This figure is to be used only if the transformer ratio for the system has not been established by direct calibration.

Pulse Transformer	Ratio	QK338		QK338A	
		Radiate	Standby	Radiate	Standby
Moloney	11.05	7.42	7.70	6.87	7.15
GE Types A and B	10.75	7.63	7.90	7.07	7.34
GE Types C and D	10.00	8.20	8.50	7.60	7.90

Figure 4–32. Pulse Transformer Ratios

4–302. It has already been shown that initially, at the start of the ready period, the voltage to the magnetron filament is low. The low current in the magnetron filament regulating circuit is reflected into the comparator circuit as a low output voltage from control transformer T2102. This voltage is rectified, filtered, and fed through potentiometer R2114 and contacts 1 and 4 of relay K2111 to the grid of tube V2102A, where it is compared with the fixed potential maintained on tube V2102B. The voltage appearing on tube V2102A is therefore lower than the voltage on tube V2102B. Thus tube V2102B conducts more heavily and solenoid 5-6 of relay K2104 exerts the stronger attractive force, pulling the armature over to contact 3. Phase A power is then applied to the raise circuit of the drive motor, raising the wiper arm until the current in the magnetron filament regulating circuit is the preset standby current. The comparator circuit maintains the current in the magnetron filament circuit by reacting to changes in the output voltage of its control transformer in the same manner as in the modulator filament comparator circuit.

4–303. When the system starts radiating, relay K2111 is energized and the grid of tube V2102A is connected to potentiometer R2105. The comparator circuit then functions to maintain a constant current in the magnetron filament regulating circuit. If, for any reason, high voltage must be removed from the modulator, the system is placed in the ready condition, relay K2111 is de-energized and the grid of tube V2102A is connected to potentiometer R2114 to maintain a higher magnetron filament regulating circuit current. The higher filament current is maintained until the high voltage is restored to the modulator.

4–304. Resistor R2113 shunts the primary of control transformer T2102 and serves to establish the voltage drop across the primary of transformer T2102. The drop across resistor R2113, and therefore the input to the comparator circuit, varies with the current in the magnetron filament regulating circuit.

4–305. Under normal operating conditions, the magnetron cathode is heated sufficiently by the filament to boil off electrons. The emitted electrons are replaced by others drawn from the modulator high-voltage power supply during the pulse. However, should the filament be cool at the time of the pulse, the excessively high potential existing between cathode and anode will rip the emissive surface from the cathode, irreparably damaging the tube. For this reason, the warm-up and ready voltage is set high enough to preheat the magnetron filament before the radiate period begins. As another safeguard, undercurrent relay K2110 is placed in series with the output to the magnetron filament. Resistors R2111 and R2112 act to limit the current flow through relay K2110 to its proper operating value. If the filament current should decrease below a safe operating level, relay K2110 is de-energized and its contacts in the high-voltage interlock circuit are opened. High-voltage power to the modulator and magnetron is then cut off and the system cannot radiate until relay K2110 is energized.

4–306. MAG FIL CURRENT meter M2105 and MAG FIL VOLTAGE meter M2106 on the modulator control panel indicate the value of the output current and voltage to magnetron filament transformer T601. Capacitors C2105 and C2106 act as high-frequency bypass capacitors in the meter circuits.

4–307. FILAMENT WARM-UP TIME. (See figure 4–33.) The modulator and magnetron filaments are allowed 15 minutes to warm up by the time-delay circuit shown in figure 4–33. High voltage cannot be applied to the modulator until the expiration of the warm-up period. Momentary power failure after the initial warm-up, however, necessitates merely a 5-minute warm-up before radiation.

4–308. Relays K2101, K2102, K2103, and K2118 each contain a bimetallic strip which, when heated, moves to close the relay contacts. The contacts of time-delay relay K2118 have the additional characteristic of remaining closed for 2-1/2 minutes after a-c excitation is removed. The regulated 120-volt a-c power supply from the modulator filament control circuit (figure 4–30) is applied to the heater element of relay K2101. The other side of this element is returned to neutral through normally closed contacts 1 and 4 of time-delay auxiliary relay K2107. After 5 minutes, the thermal element of relay K2101 moves sufficiently to close contacts 5 and 7, connecting the element of relay K2102 to the 120-volt a-c supply. Five minutes later, the closing of the contacts of relay K2102 feeds the energizing voltage to the elements of both relays K2103 and K2118. Five minutes later, contacts 5 and 7 of relays K2103 and K2118 close. Neutral is applied, through contacts 5 and 7 of relay K2103 to the coil of relay K2107, energizing this relay. Relay K2107 remains energized through hold-in contacts 4 and 2. Simulatenously, neutral is removed from time-delay relays K2101, K2102, and K2103. Contacts 5 and 7 of relay K2107 close, feeding the phase C supply to the indicator circuits of the modulator and remote control panel and to the high-voltage interlock circuit. Relay K2118 remains energized, since its heater element is directly connected to neutral. Thus, 15 minutes must elapse before time-delay auxiliary relay K2107 is energized, after which both relays K2107 and K2118 remain energized.

4–309. Relay K2118 serves an important function in the filament warm-up circuit. If, for any reason, phase C excitation is removed for a brief period of time (2-1/2 minutes or less), relay K2118 reduces the delay time to 5 minutes. When a-c power is removed from relay K2118, its contacts remain closed. If a-c power is reapplied within 2-1/2 minutes, it is routed through closed contacts 7 and 5 of relay K2118 to contact 3 of relay K2103. Five minutes later, contacts 5 and 7 of relay K2103 close and relay K2107 is energized. Since the filament circuit has not completely cooled, the short time delay is not detrimental to operation.

4–310. The phase C supply is fed through contacts 1 and 4 of start auxiliary relay K2109, lighting amber READY indicators I2106 (modulator control panel) and I6103 (remote control panel). The voltage is also channeled through contacts 1 and 9 of integrator relay K2113, lighting blue REV CURRENT indicators I2107 (modulator control panel) and I6102 (remote control panel). Finally, the voltage is fed to RADIATE-STOP & RESET switch S2101B, energizing the high-voltage interlock circuit. The system is now in the ready (standby) condition.

4–311. START CIRCUIT. (See figure 4–33.) The phase C voltage is also applied to RADIATE-STOP & RESET switches S2101A (modulator control panel) and S6101A (remote control panel). These switches are normally open and are closed only while the operator keeps them closed; that is, keeps them in the RADIATE position. Upon releasing the switch, the contacts return to the normal position. Since the switches are in parallel, operating either one to the RADIATE position momentarily energizes start relay K2108. If the interlocks are closed, power passes through contacts 4 and 2 of relay K2108 and energizes main contactor relay K10401 and starts auxiliary relays K2109 and K2111. The hold-in contacts of relay K10401 then close. Relay K2108 is de-energized upon release of the start switch, opening contacts 2 and 4; however, the hold-in contacts keep relay K10401 and the start auxiliary relays energized.

4–312. Since relay K10401 is energized, the contacts through which power is fed from the modulator high-voltage regulator to the modulator high-voltage power supply are closed. High voltage is then fed to the modulator, the magnetron oscillates, and the system starts radiating.

4–313. Since relay K2109 is energized, contacts 2 and 4 close. The amber READY indicators then go off and red RADIATE indicators I2105 (modulator control panel) and I6104 (remote control panel) light. The RADIATE TOTAL HRS meter is energized and records the amount of time (in hours) that the high voltage is on. Capacitor C2101 acts as a high-frequency bypass in the meter circuit.

4–314. Since relay K2111 is energized, power is fed through high-voltage runback relay K2112 to the armatures of the HV RAISE-HV LOWER switches. Thus, the modulator high-voltage regulator output can be controlled. Contacts 2 and 4 of relay K2111 also close, lowering the magnetron filament voltage during radiate periods.

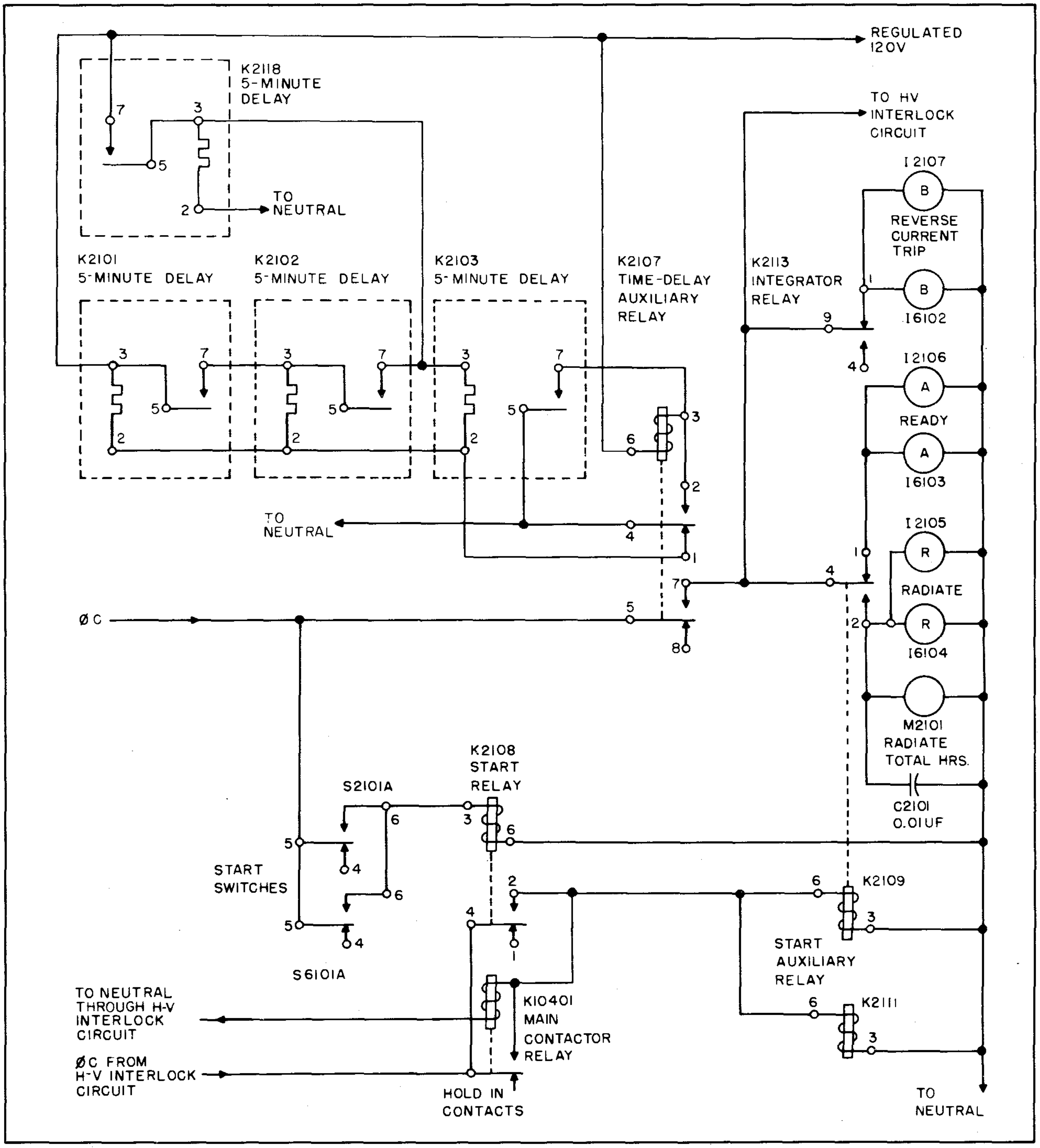

Figure 4–33. Filament Warm-up Control and Start Circuit, Simplified Schematic Diagram

4–315. Integrator relay K2113 is in the reverse-current circuit and is energized while the system is radiating properly. Thus, during radiate periods, the blue REV CURRENT indicators are off. The reverse-current control circuit is covered in detail in the following paragraphs.

4–316. REVERSE-CURRENT CONTROL CIRCUIT. (See figure 4–34.) Arc-over between cathode and anode, which is a difficulty common to all high-power magnetrons, is undesirable because of the formation of positive ions which bombard the cathode and tend to remove the emissive surface. Some arc-over can be tolerated; however, excessive arcing must be prevented. Reverse current generated in pulse-forming network Z2201 during arc-over feeds an electromechanical loop which operates to protect the magnetron. It should be noted that arc-over can occur and reverse current can flow only during radiate periods.

4–317. When the radar is first placed in the radiate condition, start relay K2108 is energized momentarily, closing contacts 5 and 7. Resistor R2128 is shorted out of the cathode circuit of tube V2101B. At the same time, the grid of tube V2101B is at ground potential prior to the arrival of reverse current, so that tube V2101B conducts heavily. The solenoid of integrator relay K2113 is energized by the plate current of tube V2101B. When relay K2108 is de-energized, opening contacts 5 and 7, resistor R2128 remains shorted, since contacts 5 and 10 of relay K2113 are then closed.

4–318. Prior to the flow of reverse current, grid 2 of tube V2106 is at positive potential. Therefore, tube V2106A conducts heavily and relay K2114 is operated. Contacts 5 and 10 of relay K2114 ground grid 2 of tube V2101 so that tube V2101A conducts and relay K2112 is operated. Relays K2112, K2113, and K2114 remain energized until the arrival of the reverse-current signal. It should be noted that a complete path for the flow of reverse current from the plate of tube V2105B to the grid of tube V2101B does not exist while relay K2112 is energized.

4–319. During magnetron arc-over reverse voltage is developed in the pulse-forming circuit and is applied to jack J2101. The value of the input to reverse-current rectifier V2105B is determined by the setting of potentiometer R2207 (figure 4–24). The value of the input to reverse-current rectifier V2105A is determined by the setting of potentiometers R2207 and R2119. Potentiometer R2207 is adjusted to provide proper runback time before high voltage is cut off. Potentiometer R2119 is then adjusted to provide proper starting of the runback operation.

4–320. During magnetron arc-over, the reverse-current signal is rectified by tube V2105A and filtered by capacitors C2111 and C2112 and resistor R2121. Capacitor C2112 is charged negatively with respect to ground. Tube V2106A is cut off when capacitor C2112 accumulates a charge of approximately —10 volts, which de-energizes

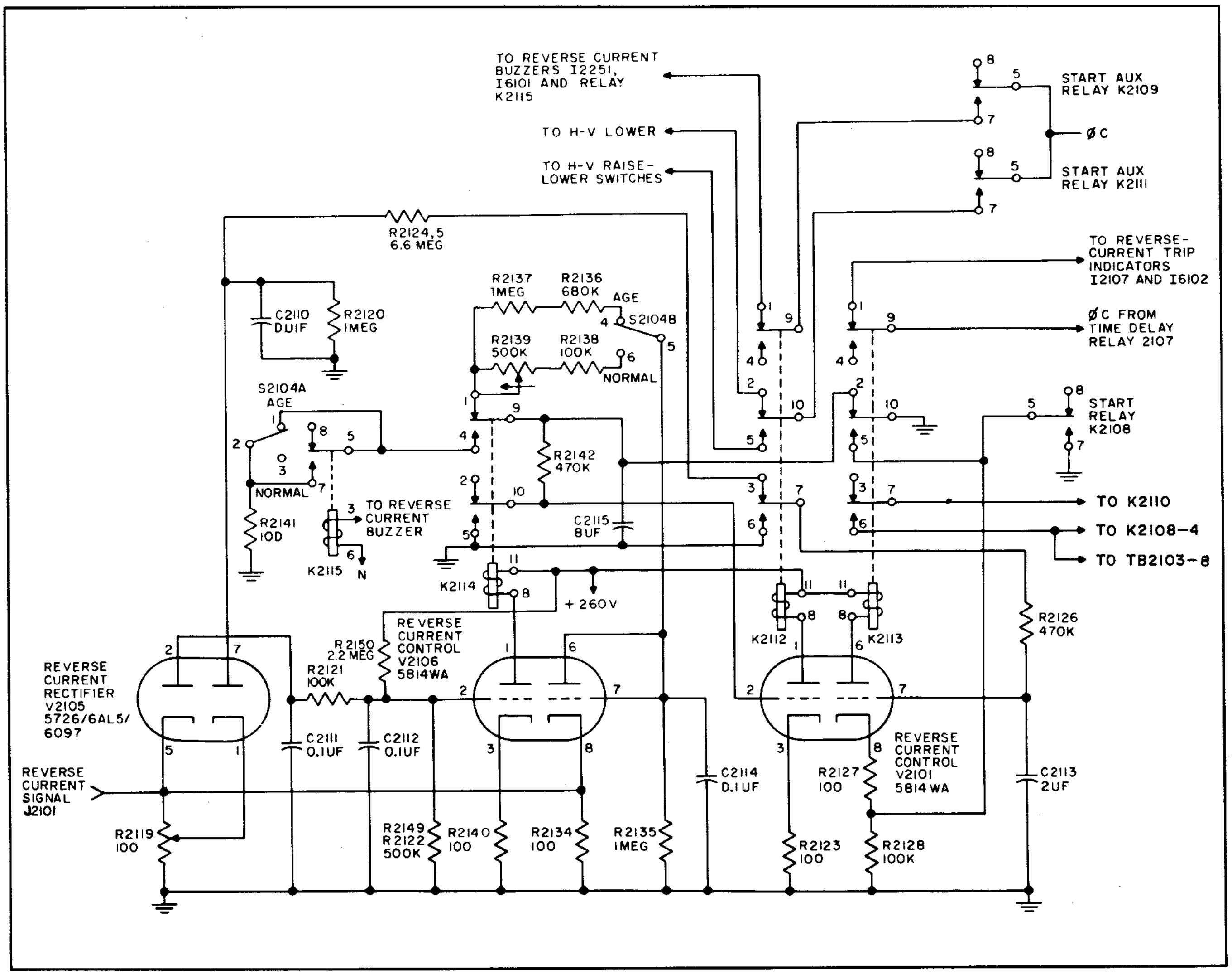

Figure 4–34. Reverse-current Control Circuit, Simplified Schematic Diagram

relay K2114. Contacts 5 and 10 of relay K2114 open, removing ground from the grid of tube V2101A. At the same time, contacts 1 and 9 close, completing the circuit between the plate of tube V2106B and the grid of tube V2101A.

4–321. Reverse current is also rectified by tube V2106B and filtered by resistor R2135 and capacitor C2114. The filtered output is applied to the grid of tube V2101A through a time-constant circuit consisting of resistor R2138, potentiometer R2139, and capacitor C2115. Capacitor C2115 is charged negatively with respect to ground. Tube V2101A is cut off when capacitor C2115 accumulates a charge of approximately —10 volts. Potentiometer R2139 is adjusted so that capacitor C2115 requires 1 second to reach a —10 volt charge, thus providing a delay between the start of reverse-current flow and the beginning of the runback cycle. The purpose of this 1-second delay is to prevent the runback circuit from responding to momentary bursts of reverse current. The runback cycle starts when tube V2101A is cut off, allowing relay K2112 to de-energize.

4–322. When relay K2112 is de-energized, phase C power is fed through contacts 9 and 1 of relay K2112 to turn on reverse-current buzzers I2251 (in the modulator assembly) and I1601 (in the remote control asembly). Relay K2115 is connected across the reverse-current buzzers and is energized at the same time. As long as reverse current continues, relay K2115 has no effect. However, should reverse current stop after a short interval, tube V2106A will conduct, relay K2114 will operate, and contacts 4 and 9 will close. Contacts 5 and 7 of relay K2115 will then place resistor R2141 in parallel with capacitor C2115. This action will discharge capacitor C2115, allowing tube V2101A to again conduct and relay K2112 to operate, causing the reverse current buzzers to stop. Thus, the action of relay K2115 stops the runback cycle almost instantly if reverse current should stop. However, if reverse current continues, relay K2112 remains de-energized and the runback cycle continues.

4–323. When relay K2112 is de-energized, phase C power is also applied through contacts 5 and 7 of start auxiliary relay K2111 and contacts 2 and 10 of relay K2112 to the lower drive-motor circuit of the modulator high-voltage regulator. The drive motor operates to decrease the magnetron anode voltage. If reducing the anode voltage stops arc-over, reverse current will cease and, after a short delay occasioned by the discharge of capacitor C2112 and C2115, tubes V2101A and V2106A will again conduct. Relays K2112 and K2114 will be re-energized, the reverse-current buzzers will go off, and operation will be resumed at a lower anode voltage. If arc-over persists, then reverse current will flow through tube V2105B and contacts 3 and 7 of relay K2112 to charge integrating capacitor C2113.

4–324. The rectified output from tube V2105B is filtered by capacitor C2110 and resistor R2120 before being applied to the integrating circuit. An unusually long RC time constant, consisting of 7.07 megohms of resistance (resistors R2124, R2125, and R2126) in series with 2.0-microfarad capacitor C2113, constitutes the integrating circuit. As determined by the setting of resistor R2207, between 7 and 9 seconds are required to charge the integrating capacitor sufficiently to cut off tube V2101B and de-energize integrator relay K2113.

4–325. When relay K2113 releases, contacts 1 and 9 close, lighting the blue REV CURRENT indicators (figure 4–33). Contacts 5 and 10 then open, removing the short across resistor R2128, and thereby maintaining the cathode of tube V2101B at a high cutoff potential. Contacts 6 and 7 open, breaking the high-voltage interlock circuit to de-energize main contactor relay K10401 and start auxiliary relays K2109 and K2111 (figure 4–33). The contacts of relay K10401 in the modulator high-voltage power supply spring apart, removing high voltage from the modulator. Contacts 2 and 4 of relay K2109 open, extinguishing the RADIATE indicators, while contacts 1 and 4 are made, lighting the READY indicators. Contacts 5 and 8 of relay K2111 feed 120 volts to the drive motor in the modulator high-voltage regulator to set the high-voltage supply to its lowest value before power is reapplied. Resistor R2114 is switched into the grid circuit of tube V2102A (figure 4–31) to set the magnetron filament current at some higher value during this ready period. While arc-over persists, the radar will not remain in the radiate condition. The radar can again be placed in the radiate condition by placing the RADIATE-STOP & RESET switch in the STOP & RESET position and then in the RADIATE position.

4–326. AGE-NORMAL SWITCH S2104. Certain gases in a new magnetron cause it to arc over frequently. Allowing arc-over to continue will age (break in) the magnetron by burning out these gases so that subsequent operation is quite stable. When AGE-NORMAL switch S2104 is placed in the AGE position, the runback circuit will operate less frequently, making possible the prolonged periods of arc-over that are required for burning out these gases.

4–327. Switch S2104 has two sections. When placed in the AGE position, section B of the switch connects a longer time constant (resistors R2136 and R2137) into the grid of tube V2101A. As a result, tube V2101A requires 5 seconds before cutting off, allowing this additional time before runback is started. (In the NORMAL position of the switch, runback is started 1 second after arc-over occurs.) At the same time, section A of the switch shorts out contacts 5 and 7 of relay K2115. This places resistor R2141 across capacitor C2115 whenever relay K2114 is operated (relay K2114 operates when reverse current stops), thus discharging capacitor C2115 after each burst of reverse current. In this manner, capacitor C2115 is prevented from building up a charge during serveral bursts of reverse current and then tripping the runback circuit. When the magnetron is being aged, runback cannot be started until arc-over has persisted uninterrupted for 5 seconds.

4–328. MAGNETRON ANODE-CURRENT CONTROL CIRCUIT. (See figure 4–35.) Magnetron anode current can be controlled by controlling the amplitude of the high voltage applied to the modulator. The output from the modulator high-voltage regulator, and therefore the high-voltage output from the modulator high-voltage power supply depends upon the relative positions of the primaries and secondaries of voltage regulator VR10301 in the modulator high-voltage regulator. Drive motor B10301 controls the position of the secondaries and therefore controls the output voltage (paragraph 4–259).

4–329. Prior to starting the radar (during ready periods), relay K2111 is not energized and phase C power passes through contacts 5 and 8 to the lower circuit of the drive motor. Thus, when the system is started, the high-voltage output is low enough to prevent damage to the magnetron.

4–330. During radiate periods, the high-voltage output can be adjusted manually or automatically. To adjust the output manually, AUTO-MANUAL switch S2105 is placed in the MANUAL position and then the HV RAISE-HV LOWER switch on the modulator control panel (S2102) or its duplicate on the remote control panel (S6102) is operated to the HV RAISE or HV LOWER position. Power reaches the armature of these switches through contacts 5 and 7 of relay K2111 and contacts 5 and 10 of relay K2112. By operating either of these switches, the drive motor is energized and rotates the secondaries of the voltage regulator to either raise or lower the output voltage.

4–331. During arc-over periods, as described in paragraph 4–320, relay K2112 is de-energized and power passes through contacts 5 and 7 of relay K2111 and contacts 2 and 10 of relay K2112 to energize the lower circuit of the drive motor. Thus, the anode voltage is reduced. If arc-over does not stop, the radar goes into a ready peroid.

4–332. To adjust the output automatically, the AUTO-MANUAL switch is set to the AUTO position, placing the modulator high-voltage regulator output under the control of comparator stage V2107. The comparator circuit automatically adjusts the high voltage so as to maintain the magnetron anode current at some fixed, predetermined level. The comparator circuit performs one other function: after relay K2112 has lowered the anode voltage during arc-over, as described in paragraph 4–320, the comparator raises this voltage to the desired predetermined level 10 seconds after reverse current stops. The 10-second delay permits the magnetron to

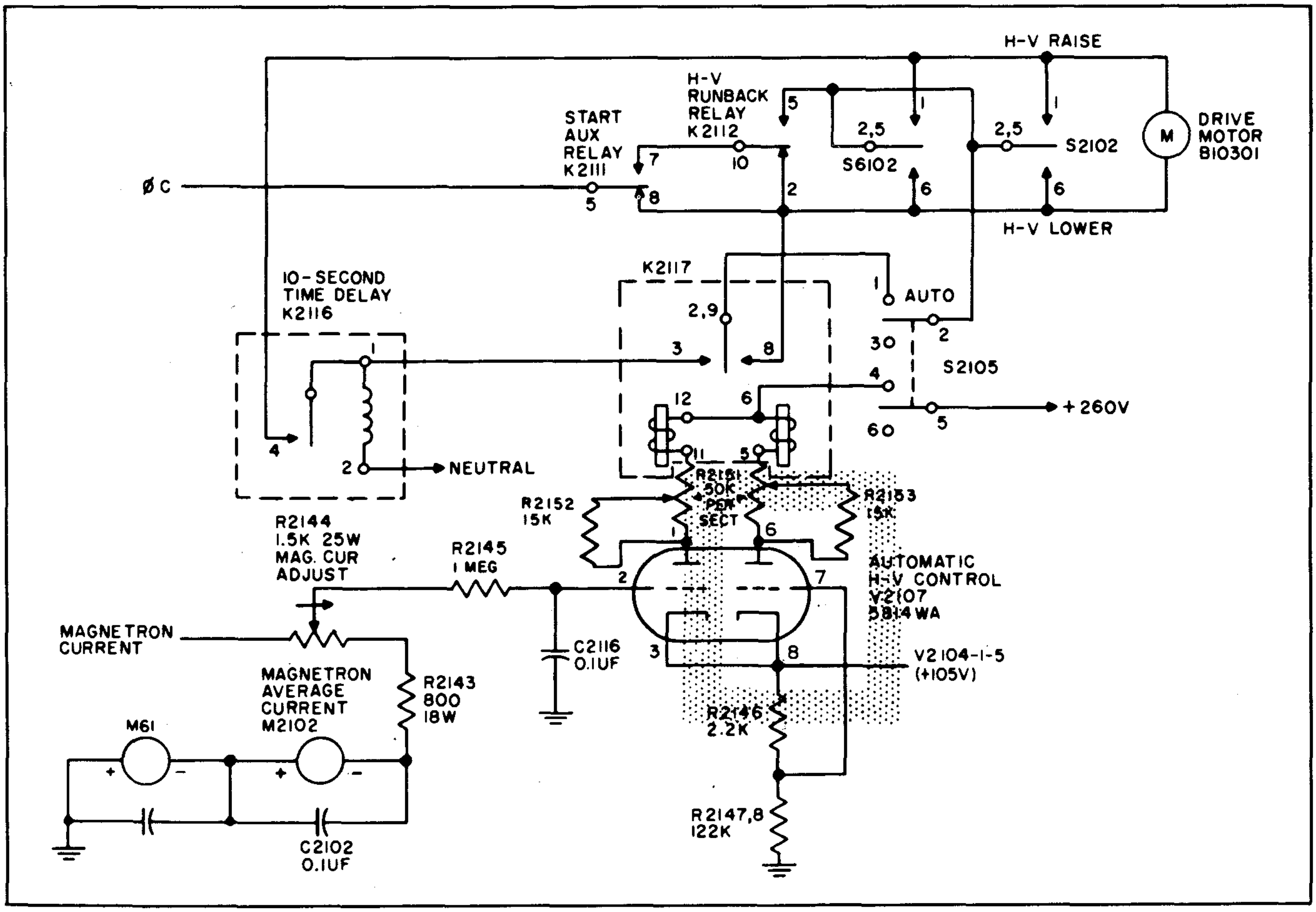

Figure 4–35. Magnetron Anode High Current Control Circuit, Simplified Schematic Diagram

operate at low voltage for a short time to remedy the causes of arc-over.

4–333. When the AUTO-MANUAL switch is placed in the AUTO position, a +260-volt plate supply is applied to dual triode V2107 through contacts 4 and 5 of the switch. Simultaneously, phase C voltage from contacts 5 and 10 of the switch is applied to the armature of relay K2117. Each plate circuit of dual triode V2107 contains one of the two solenoids of relay K2117. When the circuit is properly adjusted, and the magnetron anode current is at the desired level, the two triode sections of dual triode V2107 conduct equally. Potentiometer R2151 serves a dual purpose: it compensates for slight unbalances in the two halves of the comparator circuit and it sets the sensitivity of the comparator circuit. With equal current passing through the two solenoids of relay K2117, equal and opposite forces are exerted on the armature of this relay and it remains midway between contacts 3 and 8.

4–334. When operation of the magnetron at a higher anode current is desired, MAG. CUR. ADJ. control R2144 is turned clockwise, increasing the voltage at grid 2 of dual triode V2107. Greater current then passes through solenoid 11–12 of relay K2117 than through solenoid 5–6. As a result, the armature of relay K2117 is pulled over to contact 3. Phase C voltage is then applied through contacts 5 and 7 of relay K2111 (closed when the high voltage was applied), through contacts 5 and 10 of relay K2112 (energized except during runback), through contacts 1 and 2 of switch S2105 (closed in the AUTO position), and through contacts 2 and 3 of relay K2117 to terminal 1 of 10-second time-delay relay K2116. After 10 seconds, this relay closes and phase C voltage passes through contacts 1 and 4 of this relay to the raise circuit of drive motor B10301. This causes the drive motor to raise the high-voltage output until the magnetron anode current has reached the desired level. At this point, the voltage applied to grid 2 of tube V2107 is equal to that applied to grid 7; both sections of the tube conduct equally, the armature returns to the point midway between the two solenoids, and drive motor B10301 comes to rest.

4–335. Circuit operation is very similar after the runback circuit has lowered the high voltage during arc-over. The comparator circuit is again unbalanced because runback reduced the high voltage below the normal operating level. In addition, section A of tube V2107 is conducting more heavily than section B, and therefore the armature of relay K2117 has been pulled over to contact 3. However, the path to terminal 1 of relay K2116 is not complete until arc-over ceases. Relay K2112 energizes and its contacts 5 and 10 close. After a 10-second delay to allow relay K2116 to energize, phase C voltage is applied to the raise circuit of drive motor B10301 to bring the high voltage up to the preset level.

4–336. If the magnetron anode current rises above the preset level, the comparator circuit automatically reduces the high-voltage output. The circuit operation is then similar to that described previously, except that in this instance, solenoid 5-6 of relay K2117 receives more current than solenoid 11-12. Thus, the path for phase C voltage is through the armature and contact 8 of relay K2117 to the lower circuit of drive motor B10301.

4–337. HIGH-VOLTAGE INTERLOCK CIRCUIT. (See figure 4–36.) The high-voltage interlock circuit is a series-connected circuit containing various switches, relays, and contacts. An open at any point in the circuit causes main contactor relay K10401 in the modulator high-voltage power supply to de-energize, opening the contacts through which regulated three-phase power is applied to the modulator high-voltage power supply circuit. Thus, power to the modulator is cut off, the magnetron cannot oscillate, and the system cannot radiate until the high-voltage interlock circuit is once again closed and the radar is started.

Note

The elements in the high-voltage interlock circuit are located in the various units which comprise the transmitter-receiver system.

4–338. Time-delay auxiliary relay K2107 prevents the application of high voltage to the modulator until the expiration of the 15-minute filament warm-up period (paragraph 4–307). After the 15 minutes have expired, the solenoid of relay K2107 is energized, closing contacts 5 and 7. The phase C supply is then fed to RADIATE-STOP & RESET switch S2101B on the modulator control unit and then to RADIATE-STOP & RESET switch S6101B on the remote control unit.

4–339. These series-connected, momentary contact switches are normally in the position shown in figure 4–36. The flow of power through the interlock circuit, and therefore the flow of high voltage to the modulator, can be stopped by placing switch S2101B or S6101B in the STOP & RESET position. It should be noted that in this position, 120 volts is applied across the high-voltage d-c overload reset relay, solenoid 10-9 of relay K2250. This automatically resets (closes) contacts 6 and 8 of relay K2250. When the STOP & RESET switch is released, the contacts of relay K2250 return to their normal position.

4–340. The high-voltage d-c overload relay, solenoid 11-12 of relay K2250, is energized and forces contacts 6 and 8 to open when the high-voltage current output from the modulator high-voltage power supply becomes dangerously high. To close the contacts, the reset solenoid of relay K2250 must be energized. This is accomplished by placing switch S2101B or S6101B in the STOP & RESET position.

4–341. In considering the operation of main contactor relay K10401, it should be assumed that the other interlocks are to be closed and the radar is ready to be started. When either of the momentary contact start switches, S2101A or S6101A, are placed in the RADIATE position, start relay K2108 is energized, momentarily clos-

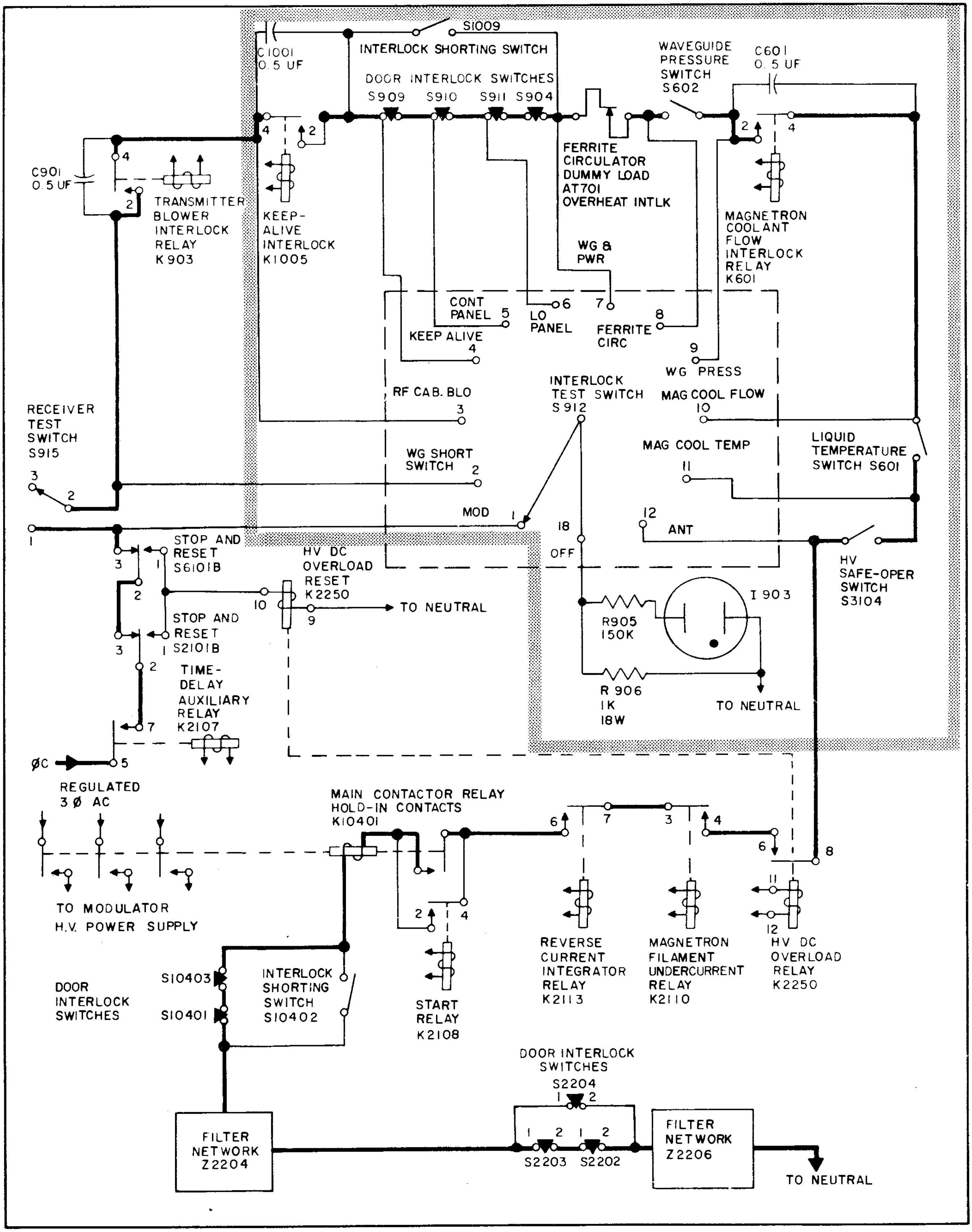

Figure 4–36. High-voltage Interlock Circuit for Radar Set AN/FPS-6 Only

ing contacts 2 and 4. Power then passes through the contacts and energizes relay K10401. After the starting operation has activated relay K10401, 120 volts is maintaned on the coil by its hold-in contacts. Thus, regulated three-phase ac from the modulator high-voltage regulator passes through the closed contacts of relay K10401 to the modulator high-voltage power supply and the system starts radiating. If any of the interlocks open, relay K10401 is de-energized, cutting off power to the modulator high-voltage power supply. The radar then goes into a ready (standby) condition until the interlocks are once again closed, and the starting operation is repeated.

4–342. The symbol numbers, name, and function of each element in the high-voltage interlock circuit are listed in figure 4–37. This figure is arranged in a power-flow sequence and can therefore be used directly with figure 4–36 in analyzing the circuit.

WARNING

Interlock shorting switches S1009, S10402, and S2251 permit entry into units while high-voltage circuits are energized. These switches should be operated only when emergency repairs must be made under battle conditions, exercising extreme caution.

4–343. INTERLOCK TEST SWITCH. (See figure 4–36.) INTERLOCK TEST switch S912 is located on the indicator and test panel of the r-f assembly and is used to locate a break in the high-voltage interlock circuit The test circuit includes switch S912, voltage-dropping resistor R905, and neon indicator I903. Shunt resistor R906 is added to prevent false indications of indicator I903.

Symbol	Element	Function
K2107	Time-delay auxiliary relay; contacts 5 and 7	Prevents application of power to interlocks until expiration of 15-minute filament warm-up period.
S2101B	RADIATE–STOP & RESET switch (modulator control panel)	Manually operated to cut off high-voltage power and reset high-voltage d-c overload relay contacts.
S6101B	RADIATE–STOP & RESET switch (remote control panel)	Manually operated to cut off high-voltage power and reset high-voltage d-c overload relay contacts.
K2250	High-voltage d-c overload reset; solenoid 10-9	Energized when switch S2101B or S6101B is in STOP & RESET position. Resets (closes) high-voltage d-c overload relay contacts.
S915	WAVEGUIDE SHORTING SWITCH BYPASS	Opens high-voltage interlock circuit to prevent equipment from radiating during certain receiver test procedures.
K903	Transmitter blower interlock relay; contacts 2 and 4	Closed when blower B901 reaches operating speed.
C901	Capacitor (0.5 microfarad)	Suppresses sparks across contacts 2 and 4 of relay K903.
K1005	Keep-alive interlock relay; contacts 4 and 2	Closed when TR tube receives proper keep-alive voltage.
C1001	Capacitor (0.5 microfarad)	Suppresses sparks across contacts 4 and 2 of relay K1005.
S904 and S909 through S911	Door interlock switches	Open if r-f assembly waveguide components door or any r-f assembly drawers are opened.

Figure 4–37. Elements Located in High-Voltage Interlock Circuit (Sheet 1 of 3)

Symbol	Element	Function
S1009	INTERLOCK SHORT switch	Emergency switch used to short switches S911, S910, S909, and S904 to allow servicing under battle conditions.
S901A	Noise source interlock switch	Relay K901 energized when noise source is in use, opening switch S901, preventing radiation.
S602	Waveguide pressure switch	Prevents application of high voltage until waveguide is pressurized at 30 psi.
S3104	HV SAFE-OPER switch	Used by technician to turn off r-f power when working near antenna.
K601	Magnetron coolant flow interlock relay; contacts 2 and 4	Closes when liquid flow switch S603 operates.
C601	Capacitor (0.5 microfarad)	Suppresses sparks across contacts 4 and 2 of relay K601.
S603	Liquid flow switch (heat exchanger for magnetron)	Closes and energizes relay K601 when flow of coolant in magnetron assembly reaches 2 gpm.
S601	Liquid temperature switch (heat exchanger for magnetron)	Thermostatic switch which prevents application of high voltage if temperature of coolant in magnetron assembly is excessive.
S2302	Liquid temperature switch (heat exchanger for ferrite isolator)	Thermostatic switch which prevents application of high voltage if temperature of coolant is excessive.
S2303	Liquid flow switch (heat exchanger for ferrite isolator)	Closes and energizes relay K601 when coolant flow rate reaches 0.8 gpm.
K2250	High-voltage d-c overload relay solenoid 11-12; contacts 8 and 6	Opens when high-voltage power supply output becomes dangerously high. Resets (closes) when switch S2101B or switch S6101B is operated to STOP & RESET position, energizing solenoid 10-9 of relay K2250.
K2110	Magnetron filament undercurrent relay; contacts 4 and 3	Prevents application of high voltage while magnetron filament curent is below safe operating level.
K2113	Reverse current integrator relay; contacts 7 and 6	Prevents application of high voltage while magnetron arcs excessively.
K2108	Start relay; contacts 4 and 2	Momentarily closes when radar is started. Energizes relay K10401.
K10401	Main contactor relay	Solenoid closes contacts through which three-phase ac from modulator high-voltage regulator is fed to modulator high-voltage power supply. Hold-in contacts maintain 120 volts on solenoid after relay K2108 is de-energized.
S10401 S10403	Door interlock switches	Opens if modulator high-voltage power supply doors are opened.
S10402	Interlock shorting switch	Emergency switch used to short switches S10401 and S10403 to allow servicing under battle conditions.
Z2204	Filter network	Isolates r-f noise generated in lower compartment of modulator cabinet from rest of circuit.

Figure 4–37. Elements Located in High-Voltage Interlock Circuit (Sheet 2 of 3)

Symbol	Element	Function
S2202 and S2203	Door interlock switches	Opens if modulator assembly trigger amplifier or thyratron compartment doors are opened.
S2204	Door interlock switch	Door Interlock Switch can be used to bypass switches S2202 and S2203.
Z2206	Filter network	Isolates r-f noise generated in lower compartment of modulator cabinet from rest of system.
S912	INTERLOCK TEST switch	Operated to locate break in high-voltage interlock circuit.

Figure 4–37. Elements Located in High-Voltage Interlock Circuit (Sheet 3 of 3)

4–344. The high-voltage interlock circuit used in Radar Set AN/FPS-6A (figure 4–38) includes the ferrite-isolator heat exchanger interlock. The r-f switch test positions have been relocated and the seal blower and the noise source switch have been eliminated. The names of the interlock test positions have been changed to indicate the functions performed more accurately.

4–345. Leads from each of the first 11 positions of switch S912 are connected to the neutral sides of the various interlocks to be tested. As the switch arm is rotated clockwise to each position, indicator I903 lights when the interlock is closed and does not light when the interlock is open.

4–346. MAGNETRON ASSEMBLY (TRANSMITTER, RADAR T-338/FPS-6).

4–347. BLOCK DIAGRAM. (See figure 4–39.)

4–348. The —11.5-kilovolt pulse from the modulator is applied to the primary of the pulse transformer through a special pulse cable. The pulse transformer has two important functions: it increases the amplitude of the —11.5-kilovolt pulse to —65-kilovolts and it matches the impedance of the magnetron to that of the pulse-forming network in the modulator. The pulse transformer has a bifilar secondary winding which is designed so that there are two parallel secondary windings. The high-voltage pulse in each of these windings is induced between ground and cathode. A tertiary winding in the pulse transformer network provides pulse output signals for test and trigger purposes.

4–349. A regulated a-c voltage from the magnetron filament control circuit in the modulator control unit is applied across the primary of the filament transformer. This voltage is higher during ready than during radiate periods. The output of the filament transformer is connected between the two low-voltage ends of the parallel secondary windings of the pulse transformer. As far as the filament circuit is concerned, the two secondaries are in series opposition and the induced high-voltage pulses cancel each other. Thus, the only potential difference existing between these windings is the filament supply voltage. As an added precaution, a filter network is connected between the pulse and filament transformers to prevent the presence of r-f potentials in the filament supply circuit.

4–350. Magnetron QK338 or QK338A operates at a frequency within the band of 2750 to 2860 megacycles. The magnetron is a powerful high-frequency oscillator designed for pulse modulation and has good frequency stability. Using the —65-kilocycle pulses from the pulse transformer, the magnetron generates r-f pulses which are coupled directly to a waveguide section and fed to the waveguide components in the r-f assembly. The resonant cavities which sustain the oscillation are internal parts of the magnetron. A magnetic field across the tube is required so that oscillation can occur. This field is supplied by a permanent magnet whose poles are mounted snugly against the case of the magnetron. Typical normal operating conditions for the magnetron are as follows:

a. Filament resistance (cold): 0.008 ohm

b. Filament voltage: 7.3 to 9.3 volts

c. Minimum preheat time: 3 minutes

d. Filament current (preheat) for magnetron QK338: 85 amperes ±3.5 percent

e. Filament current (preheat) for magnetron QK338A: 79 amperes ±3.5 percent (exact value stamped on magnetron)

f. Filament current (operate) for magnetron QK338: 82 amperes

g. Filament current (operate) for magnetron QK338A: 76 amperes (exact value stamped on magnetron)

h. Pulse duration: 2 microseconds

i. Peak anode voltage: 72 kilovolts

j. Peak anode current: 130 amperes

k. Peak power output (useful range) :3.0 to 4.8 megawatts

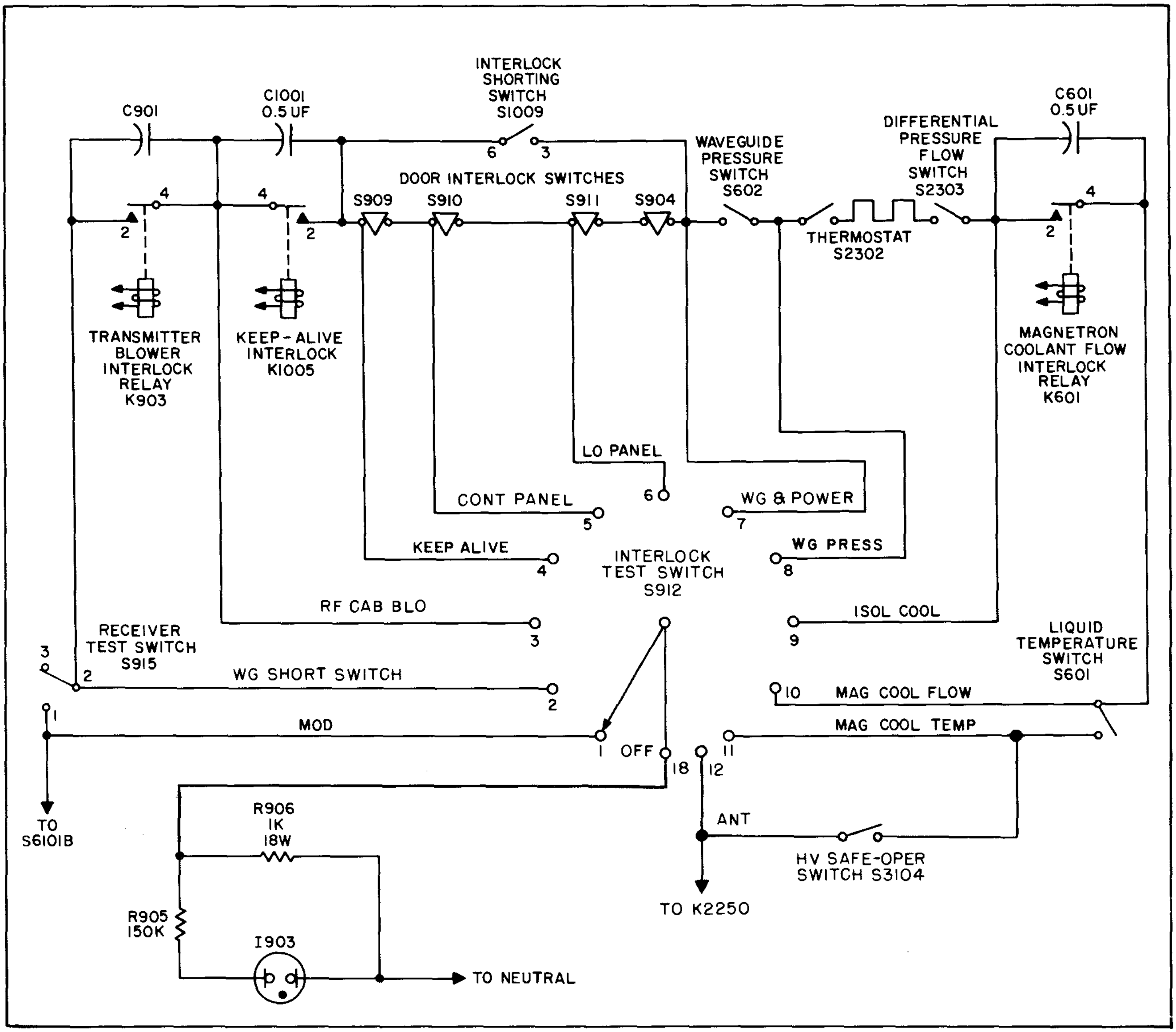

Figure 4-38. High-voltage Interlock Circuit for Radar Set AN/FPS-6A

l. Life (SWR of 1.1): 250 hours

m. Average anode current (useful range):

(1) 300 pps: 54 to 78 milliamperes dc

(2) 360 pps: 64 to 93.5 milliamperes dc

(3) 400 pps: 72 to 104 milliamperes dc

Note

Average anode current can be read on MAG CURRENT meters on modulator and remote control panels.

4-351. The pressure-temperature control components are in the high-voltage interlock circuit. If the magnetron is not being cooled sufficiently, or if the pressure in the waveguide is below the proper operating level, the high-voltage interlock circuit is opened and high voltage to the modulator is cut off.

4-352. CIRCUIT ANALYSIS OF MAGNETRON ASSEMBLY COMPONENTS.

4-353. PULSE-TRANSFORMER NETWORK. (See figure 4-40). The development of the modulating pulse and a preliminary analysis covering the application of the modulating pulse to the pulse transformer has been discussed in the theory of operation of the modulating system. The input to filament transformer T601 has been covered in paragraph 4-298. Both the modulating pulse and the filament supply must pass through pulse-transformer network Z602 before reaching the magnetron. This discussion covers the pulse-transformer network and its associated circuits.

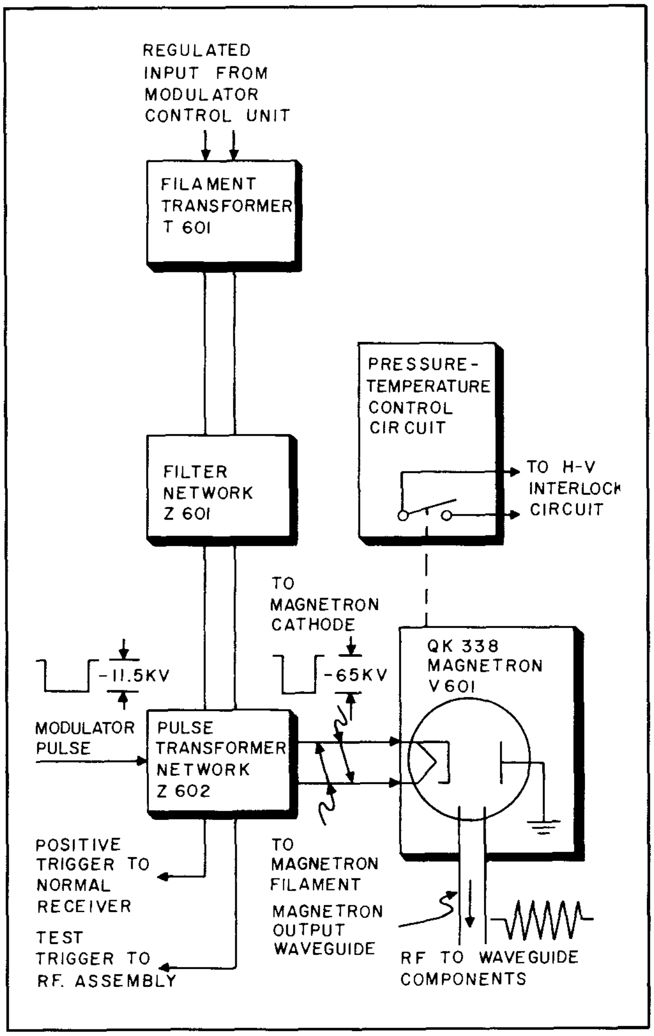

Figure 4–39. Magnetron Assembly Components, Block Diagram

4–354. Pulse-transformer network Z602 consists of three transformers. Windings A, B, C, and D constitute the actual pulse transformer. Winding A is the modulator pulse input winding, winding D is used to supply test and trigger pulses to other components in the transmitter-receiver system, and windings E and F constitute a stepdown filament transformer.

4–355. The —11.5-kilovolt modulating pulse is applied across winding A. The secondary of the pulse transformer consists of windings B and C in parallel. The turns ratio for the pulse transformer is approximately 5.65:1. Thus, the voltage induced in each secondary winding is 65 kilovolts. The pulse transformer has another important function: impedance matching to effect maximum power transfer. While the magnetron is oscillating, its impedance is 400 ohms. The impedance of the pulse-forming network is 12.5 ohms. Since the impedance ratio for the pulse transformer is approximately 32:1 (the square of the turns ratio), the impedance reflected back to the modulator pulse-forming network is 12.5 ohms. Thus, the impedance of the magnetron and of the modulator pulse-forming network are matched.

4–356. The 65-kilovolt pulses induced in windings B and C have the polarity shown in figure 4–40. For the high-voltage pulse, the positive ends of these windings are effectively at ground potential. Capacitor C603, in parallel with section A of filter network Z601, grounds the positive end of winding B. Similarly, capacitor C602, in parallel with section B of network Z601, grounds the positive end of winding C. Thus, —65-kilovolt pulses are applied to the magnetron cathode to start oscillations.

4–357. The only potential difference between windings B and C is the filament supply voltage. During radiate periods, regulated power is applied to the primary of filament transformer T601. The voltage stepup ratio of the transformer is 2:1. Filter network Z601 and capacitors C603 and C602 prevent surges of magnetron plate current from being reflected into the 120-volt a-c supply system. The potential difference between windings B and C of the pulse transformer is at the 240-volt level and is applied across winding E of the pulse-transformer network. As mentioned previously, windings E and F constitute a stepdown filament transformer. The output from winding F is applied to the magnetron filament.

4–358. The —11.5-kilovolt modulating pulse induces a 1200-volt pulse in winding D of the pulse-transformer network. Resistors R602 through R605 and resistor R601 constitute a voltage divider through which a 100-volt positive trigger is fed to the normal receiver. Resistors R610 through R613 and resistor R609 comprise an additional voltage divider through which a test trigger is fed to the r-f assembly.

4–359. The magnetron plate current can be read on MAG CURRENT meters M2102 (modulator control panel) and M6101 (remote control panel). Capacitor C2102 is an r-f bypass for meter M2102. Spark gap E602, in series with resistor R608, protects the meters against high-voltage surges. When the voltage across the spark gap becomes excessive, the spark gap breaks down and bypasses the high voltage to ground.

4–360. DETAILED FUNCTIONING OF MAGNETRON. (See figure 4–41.) At the instant before the application of the modulating pulse to the magnetron cathode, a space charge of emitted electrons exists in the space between the cathode and the anode block. Immediately after the application of this pulse, these electrons, under the influence of the magnetic field of the external magnet and the electrostatic d-c field produced by the modulating pulse, start moving along curved paths toward the anode. The direction of this motion is determined by that of the external magnetic field. Random initial concentrations of electrons in the vicinity of an anode segment produce an instantaneous charge-displacement current in the anode block, as indicated in figure 4–41. This places a positive charge on

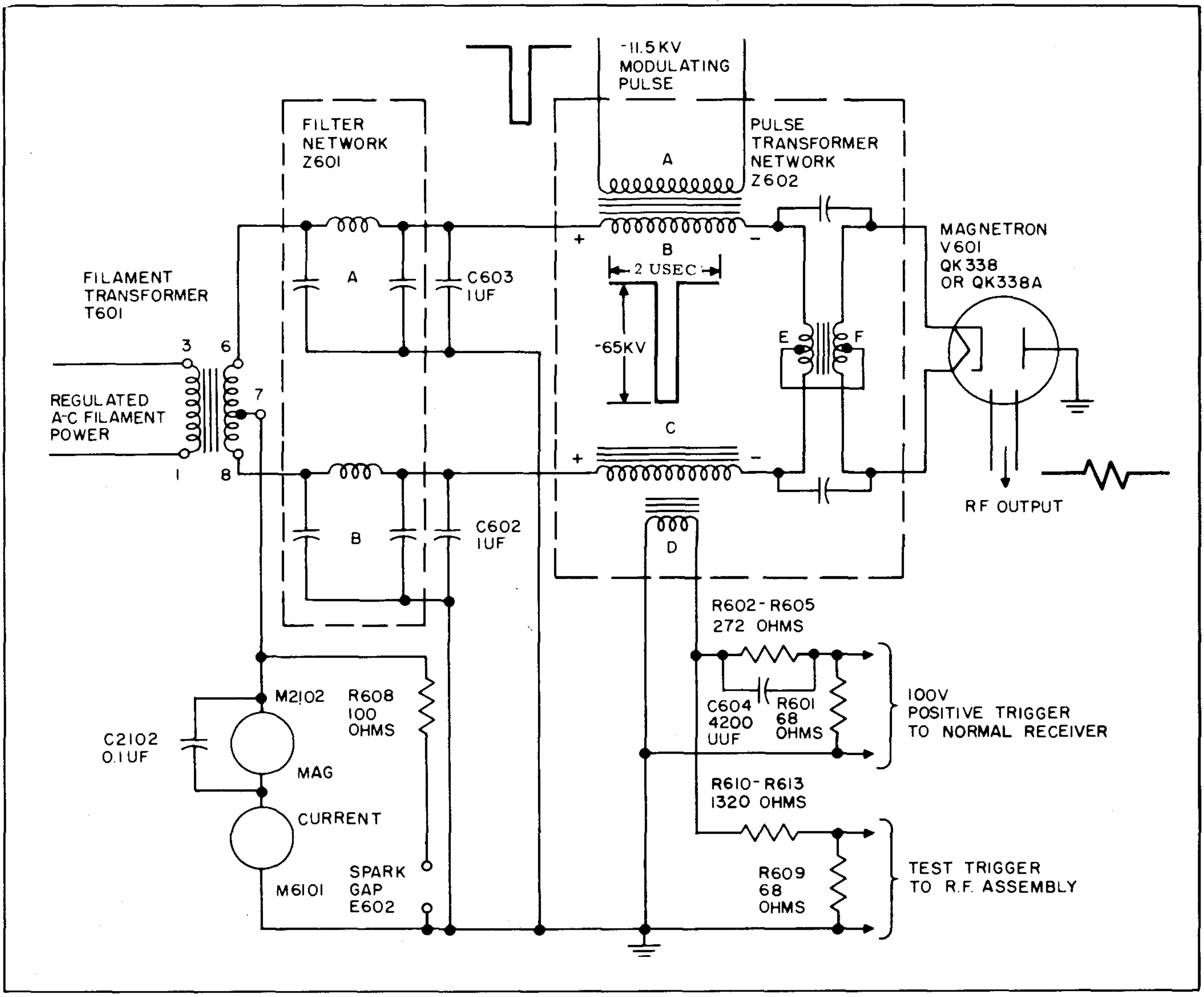

Figure 4–40. Pulse-transformer Network, Simplified Schematic Diagram

the segment and a negative charge on each of the adjacent segments. The displacement current flowing around a cavity produces a magnetic field that couples the cavity through both end spaces to the two adjacent cavities. Because all cavities are resonant and coupled together, r-f oscillations start. The electrons of the space charge are then under the influence of an electrostatic r-f field produced by the displaced charges as well as the magnetic and the d-c fields.

4–361. The configuration of the r-f field at an instant of peak voltage across the cavities in the anode block is shown in figure 4–41. The interaction space between the cathode and anode block is shown divided into sectors, one in front of each numbered cavity. Those electrons within the sectors in front of odd-numbered cavities are accelerated by the d-c field as well as the r-f field within these sectors, so that the radii of curvature of their paths decrease. A typical path for such electrons is shown by the heavy curved line between point A and the cathode in figure 4–41. Because of this acceleration, these electrons absorb some energy from the r-f field, are removed from the space charge, driven back to the cathode, and generate heat. Thus, the electrons cease contributing to the process of transferring energy from the d-c field to the electromagnetic field of the cavities.

4–362. Those electrons within the sectors in front of even-numbered cavities are accelerated by the d-c field, but decelerated by the r-f field within these sectors. The radii of curvature of the paths of these electrons increase and they spiral toward the anode, as shown by the heavy line from point B to the anode in figure 4–41. Because of this deceleration, these electrons sustain oscillations by giving the energy acquired from the d-c field to the r-f field. When these electrons enter the r-f field of the adjacent odd-numbered sector, they are further decelerated because this adjacent field has reversed its polarity during the time taken by the electrons

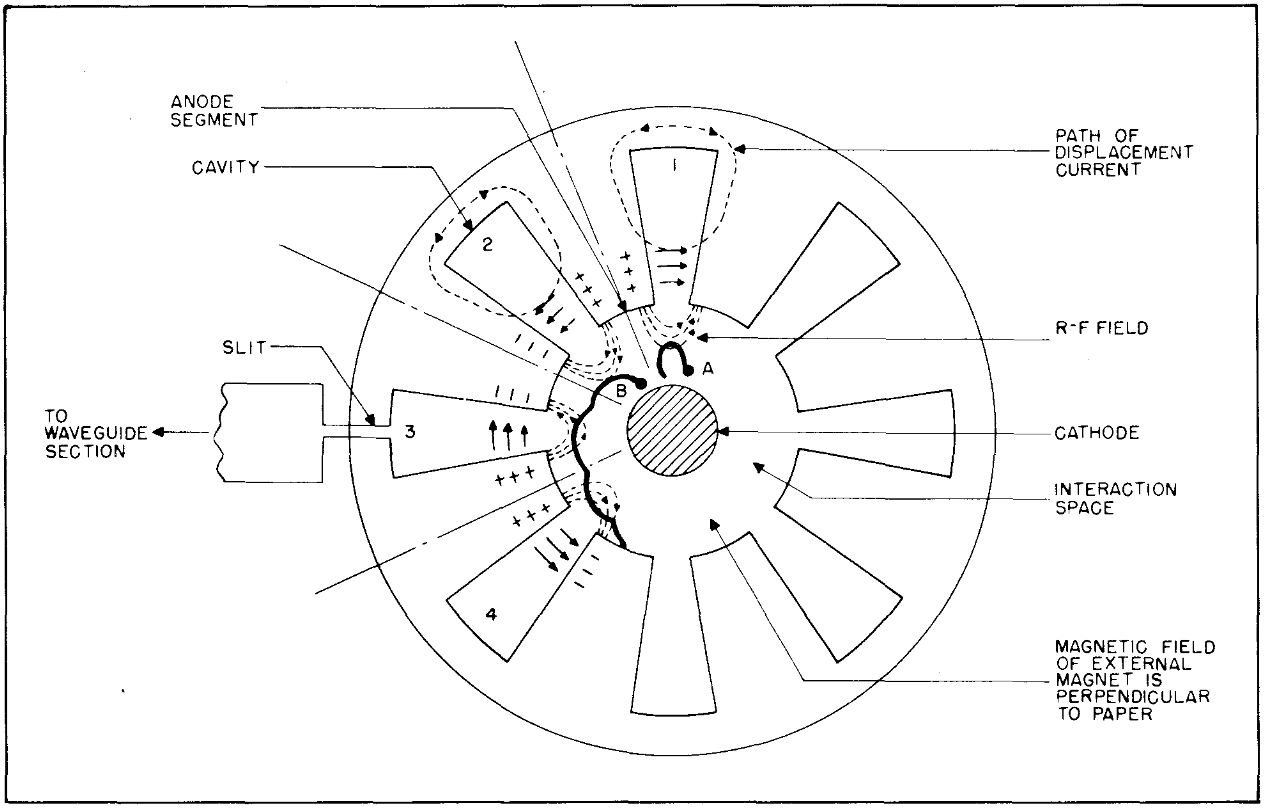

Figure 4–41. Paths of Electrons in an Oscillating Magnetron

to reach it. During their passage through regions of weak or zero r-f field strength, these electrons are accelerated at the expense of energy from the d-c field. The electrons then give up more energy to the r-f field, and, because they are in step with the r-f field alternations, this process is repeated until the electrons strike the anode.

4–363. The plate current of the magnetron is composed of those electrons that reach the anode. Energy acquired by the electrons from the d-c field is transferred to the electromagnetic field of the cavities. The energy is extracted from the back of one of these cavities by means of a slit which connects the cavity to a waveguide section. Since all cavities are coupled together, energy from all contributes to the total output of approximately 5 megawatts for the 2-microsecond pulse duration.

4–364. During magnetron operation, the cathode is bombarded by positive ions as well as by electrons. This bombardment causes secondary emission from the cathode and also generates heat. The power dissipated in the process comes from the modulating pulse and is equivalent to the power supplied by the magnetron filament power supply. In effect, this cathode bombardment is an additional source of power for cathode heating. To prevent overheating, the amount of power supplied to the cathode filaments by the filament power supply is lowered automatically during radiate periods.

4–365. MAGNETRON PRESSURE-TEMPERATURE CONTROL CIRCUIT. The magnetron pressure-temperature control circuit interrupts the operate path of relay K601. Thus, the modulator high-voltage interlock circuit (figure 4–36) opens whenever the temperature of the magnetron assembly components or the pressure in the waveguide components is not at a safe operating level. When the interlock circuit opens, high-voltage pulses cannot be applied to the magnetron.

4–366. The magnetron pressure-temperature control circuit contains switches S601 through S603 and relay K601 (figure 4–36). Liquid temperature switch S601 is mounted on the cooling duct near the magnetron anode. When the temperature of the cooling liquid becomes excessive, thermostatic action opens the normally closed switch contacts in the high-voltage interlock circuit. Waveguide pressure switch S602 is mounted on the sidewall of the magnetron cabinet and is connected to the waveguide pressure system by 1/4-inch copper tubing. When air pressure in the waveguide falls below the normal pressurized level of 30 psi, air pressure on a bellows is insufficient to hold the switch closed. These contacts then open, interrupting the high-voltage interlock circuit.

4–367. Liquid flow switch S603, mounted on the cooling liquid duct in the magnetron cabinet (figure 7–37), is actuated by the flow of liquid against a diaphragm. When the liquid flow in the duct reaches that necessary to cool the magnetron anode (2 gallons per minute), the diaphragm forces the switch to close, thereby closing relay K601. Contacts 2 and 4 of this relay then close and, since they are in the high-voltage interlock circuit, pulses can be applied to the magnetron only when these contacts are closed. Contacts 7 and 8 of relay K601 prevent application of heater power except when normal coolant flow is provided.

4–368. MAGNETRON HEATER CALIBRATOR. The magnetron assembly for Radar Set AN/FPS-6A is equipped with a heater calibrator (figure 4–42) composed of ten 16-watt, 1-ohm load resistors, isolation transformer T602, and MAGNETRON FILAMENT meter M601. The magnetron heater calibrator is employed to determine the current drawn by the magnetron filament circuit during ready and radiate conditions and this information is used during alinement and testing of the magnetron and modulator.

Note

Magnetron heater circuit calibration is performed on a new modulator or a new magnetron assembly, or after components of the magnetron heater circuit have been changed. When a new magnetron is installed, the calibration is performed only if the new magnetron filament requirements differ from those for the old unit.

4–369. In use, the magnetron heater calibrator is plugged into magnetron socket Z602 and, with the radar in the radiate condition, MAGNETRON FILAMENT READY control R2114 is adjusted until MAGNETRON FILAMENT meter M601 reads the normal 85 amperes (QK338 magnetron) or the value stamped on the tube (QK338A magnetron). The reading of the MAG FIL CURRENT meter on the modulator control unit is recorded at this time (on the nameplate below the meter) as the ready current. Then, with the radar in the radiate condition, MAGNETRON FILAMENT RADIATE control R2105 is adjusted until MAGNETRON FILAMENT meter M601 reads 82 amperes (QK338 magnetron) or the value stamped on the tube (QK338A magnetron). The reading of the MAG FIL CURRENT meter on the modulator control unit is recorded on the meter nameplate as the radiate current.

4–370. R-F ASSEMBLY (CABINET, ELECTRICAL EQUIPMENT CY-1108/FPS-6).

4–371. FUNCTIONING OF WAVEGUIDE CHOKE JOINTS. (See figure 4–43.)

4–372. A waveguide choke joint connects the r-f input section to the bidirectional coupler, and similar choke joints connect all waveguide sections in the waveguide assembly. The choke joint facilitates the removal of waveguide sections for purposes of maintenance and portability, and also affords a good electrical connection between the sections with a minimum of power loss.

4–373. A cross-sectional view of a choke joint through the center of the wide dimension of the waveguide is shown in figure 4–43. For waveguides excited in the $TE_{0,1}$ mode, the electric field is most intense in the region of the waveguide corresponding to the cross section shown. The r-f slot is effectively a one-quarter wavelength transmission line terminated at its outer end (area B) by an infinite impedance. The r-f slot reflects this infinite impedance to area A as an effective r-f short between the waveguide ends.

4–374. The impedance at area B is effectively infinite because it is composed of the r-f slot impedance in

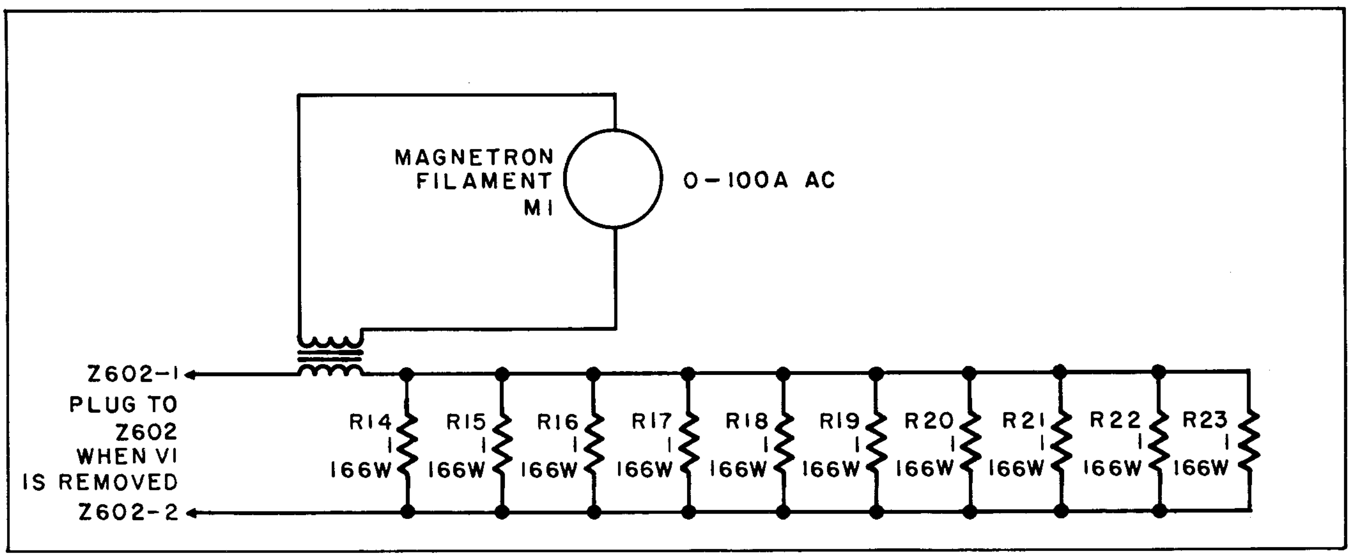

Figure 4–42. Magnetron Heater Calibrator Circuit

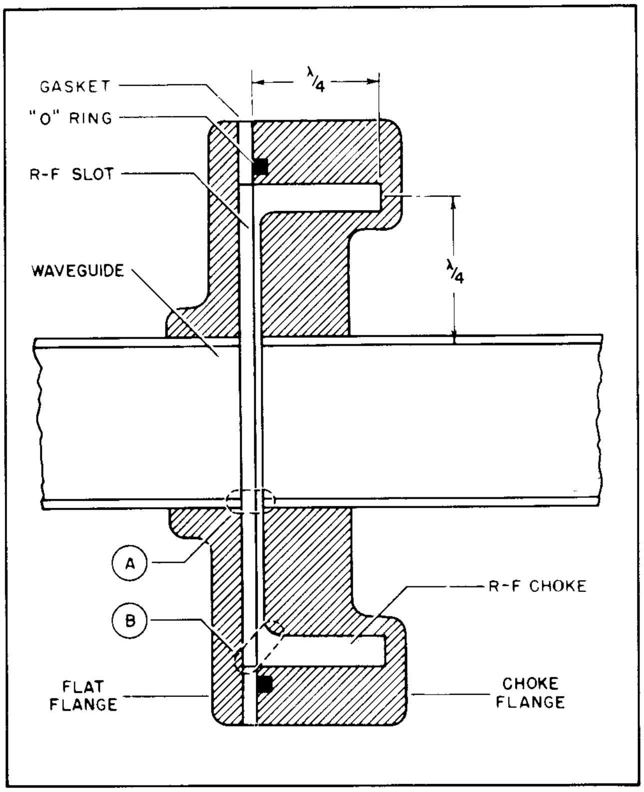

Figure 4–43. Choke Joint, Cross-sectional View

series with the impedance of the r-f choke. The r-f slot impedance is a variable, since its value depends upon the thickness of the O-ring and the tightness of the flange-securing bolts. The r-f choke impedance is infinite because it is one-quarter wavelength long and shorted at its end; therefore, the sum of the impedances at area B is infinite.

4–375. The r-f slot is one-quarter wavelength long only in the region opposite the center of the wide side of the waveguide. This choke point makes an effective r-f short because the electrostatic field strength decreases considerably toward the narrow side of the waveguide

4–376. FUNCTIONING OF FERRITE ISOLATOR.

4–377. Ferrites are magnetic particles which are ceramic in nature and principally composed of oxides of metals, such as iron, nickel, cobalt, magnesium, manganese, and aluminum. These ferrites possess two properties not found in conventional magnetic materials: nonconductivity and low hysteresis loss at microwave frequencies.

4–378. The ferrite isolator (CU-492/FPS-6A) is a nonreciprocal attenuating device connected between the transmitter (magnetron) and the load (antenna). The isolator offers low attenuation to r-f power transmitted in the forward direction and (from the magnetron) high attenuation to r-f power traveling in the reverse direction (reflected from the antenna). The isolator thus isolates the magnetron from the antenna with negligible insertion loss and provides a matched load for the magnetron. The matched load improves magnetron stability and prolongs magnetron life.

4–379. The ferrite isolator consists of ferrite strips and an external permanent magnet. Upon interaction with an r-f magnetic field, the electrons within the ferrite material spin about their axes. The spinning electrons simulate a current flowing through a coil, thereby producing a magnetic field (figure 4–44) about the electron axes. The electron-produced magnetic field tends to be alined with the applied r-f magnetic field, but is revolved about the r-f magnetic field at a rate determined by r-f field strength. When the rate of revolution of the electron-produced magnetic field is equal to the applied r-f frequency, a resonance is produced which causes absorption of the reflected r-f signal.

4–380. Early models of the ferrite isolator employed in Radar Sets AN/FPS-6A and AN/FPS-6B used water cooling. Subsequent models used in Radar Set AN/FPS-6B incorporate air cooling.

4–381. FUNCTIONING OF BIDIRECTIONAL COUPLER SECTION.

4–382. GENERAL. (See figure 4–45.) The AFC attenuator couples out a small fraction of the transmitted power from the bidirectional coupler, attenuates it to a level that will not damage the AFC crystal mixer, and feeds the sample through an r-f coupling loop to the AFC mixer. Detailed functioning of the AFC mixer is covered in paragraph 4–445. Although the mixer is mounted on the bidirectional coupler, it is a functional unit in the receiving system and is therefore described with the other components of that system.

4–383. The main waveguide section of the bidirectional coupler guides the r-f power to the duplexer. In Radar

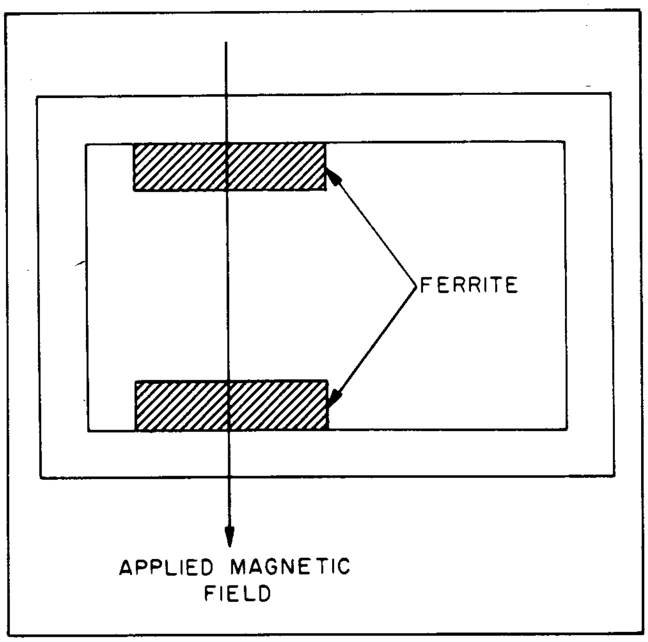

Figure 4–44. Ferrite Isolator Internal Construction

Set AN/FPS-6, the probe in the top coupling section couples samples of the transmitted power to coaxial switch S905. The probe in the bottom coupling section couples samples of the reflected power to the same switch. Coaxial switch S905 connects either the power radiated or the power reflected to the POWER MEASURE jack on the indicator and test panel of the r-f assembly. In Radar Set AN/FPS-6A, the samples of both transmitted and reflected power are fed to the power and VSWR monitor in the performance monitor cabinet, where they are used to produce a reading of forward power or VSWR on a panel-mounted meter. Coaxial switch S905 and the POWER MEASURE jack are therefore eliminated on the AN/FPS-6A indicator and test panel. There is also a meter in the remote r-f control panel which provides a remote indication of forward power.

4–384. AFC ATTENUATOR. The AFC attenuator is a short, circular waveguide section operating at lower than its cutoff frequency at the fundamental output frequencies of the magnetron. Thus, these frequencies are highly attenuated in passing through the attenuator. However, the magnetron output contains higher order harmonics of the fundamental magnetron output frequencies which are dissipated in the resistive card contained in the attenuator. The power level at all frequencies is further reduced by weak coupling between the attenuator section and the main r-f waveguide. The power that is finally fed to the AFC mixer is limited to a level that is insufficient to damage the mixer crystal.

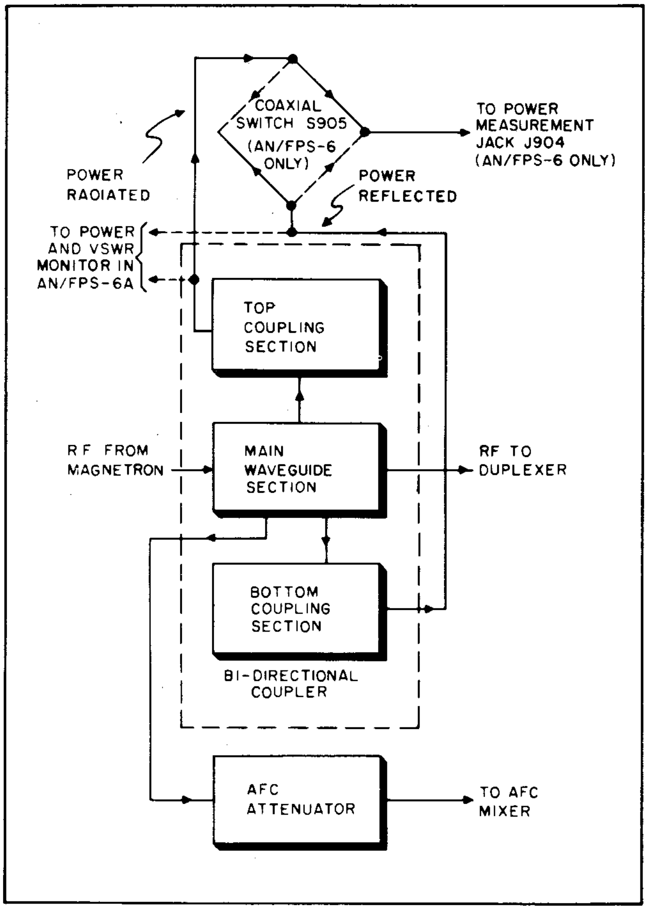

Figure 4–45. Bidirectional Coupler Section, Block Diagram

4–385. BIDIRECTIONAL COUPLER. (See figure 4–46.) Each of the two coupling sections contains five holes which permit the entry of samples of r-f power from the main waveguide. Some of the power is dissipated and, in Radar Set AN/FPS-6, some is picked up by the probes and coupled to coaxial switch S905. The r-f power traveling in the main waveguide may be the transmitted or reflected power. The coupling sections isolate samples of this power for separate power measurements. In Radar Set AN/FPS-6A, the transmitted and reflected power samples picked up in the bidirectional coupler are fed to the power and VSWR monitor in the performance monitor.

4–386. The transmitted wave traveling through the bidirectional coupler is shown in A of figure 4–46. Samples of this wave enter the top and bottom coupling sections through coupling holes 1.46 inches apart. The length of the wave in the main waveguide is approximately 5.8 inches. Therefore, five samples of the transmitted wave enter the top coupling section one-quarter wavelength apart and five samples of the wave enter the bottom coupling section one-quarter wavelength apart.

4–387. In the top coupling section, the five samples of the transmitted wave arrive at the probe in phase, since they travel equal paths. For example, sample 3 travels one-quarter wavelength more than sample 2 in the main waveguide, but travels one-quarter wavelength less in the top coupling section. Therefore, the transmitted wave produces an indication on the measuring device connected to the probe in the top section. The portion of the wave that is not picked up by the probe is dissipated in the resistive strip at the other end of the coupling section.

4–388. In the bottom coupling section, the five samples of the transmitted wave arrive at the probe out of phase since they travel different distances. This out-of-phase relationship causes cancellation of most of the transmitted wave at the probe. The portion of the wave that is not cancelled is dissipated in the resistive strip. Therefore, the transmitted wave produces no indication on the measuring device connected to the probe in the bottom coupling section.

4–389. The reflected wave traveling through the bidirectional coupler is shown in B of figure 4–46. This case is similar to that of the transmitted wave, except that the reflected wave travels in an opposite direction. The portions of the wave reaching the probe in the bottom coupling section are in phase, while those reaching the probe in the top coupling section are out of phase. Therefore, the reflected wave produces an indication on the measuring device connected to the bot-

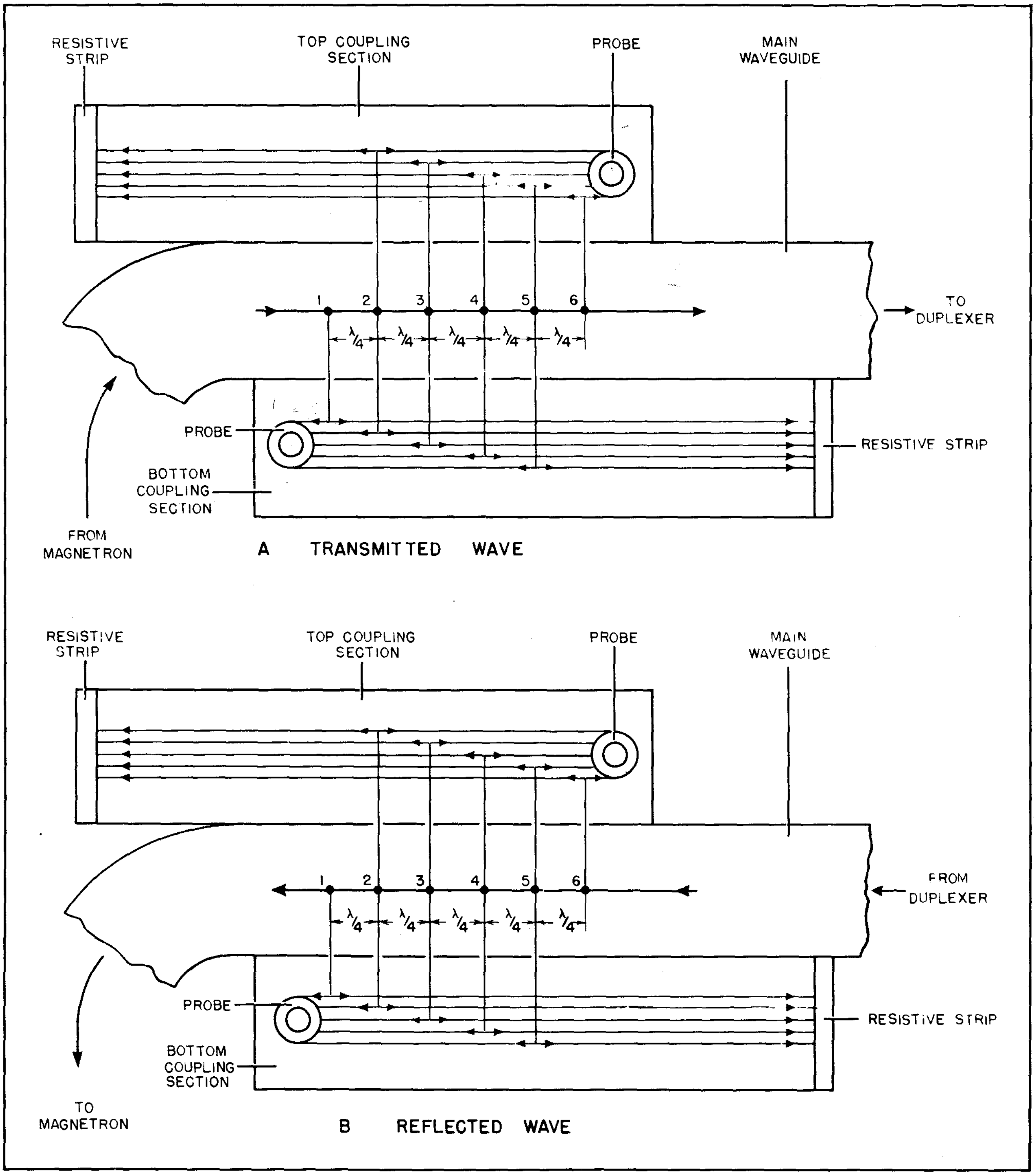

Figure 4–46. Bidirectional Coupler Circuits

tom coupling section, but produces no indication on the measuring device connected to the top coupling section.

4–390. POWER AND VSWR MEASUREMENT FOR RADAR SET AN/FPS-6. (See figure 4–45.) Both transmitted (radiated) and reflected power are measured at POWER MEASURE jack J904 and used to compute the VSWR. The VSWR indicates how well the transmission line is matched. If the line is matched, the average reflected power is relatively small as compared to the average radiated power. Then, the VSWR is a number close to unity. If there is a mismatch in the line, the average reflected power is increased and the VSWR is a number greater than unity. For the transmission line in Radar Set AN/FPS-6, the VSWR should not exceed 1.40.

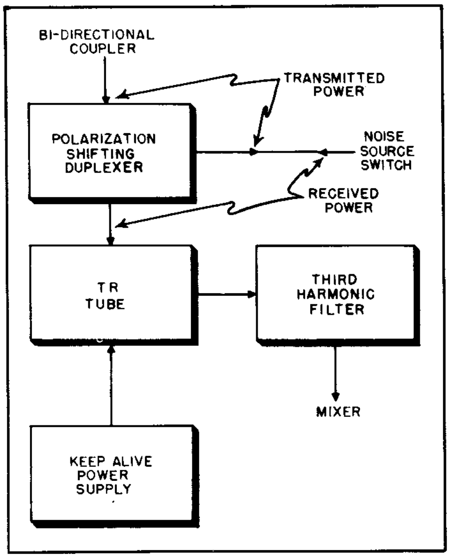

Figure 4–47. Duplexing Section Components, Block Diagram

4–391. POWER AND VSWR MEASUREMENT FOR RADAR SET AN/FPS-6A. The performance monitor of Radar Set AN/FPS-6A provides direct reading of forward power on VSWR. Refer to paragraphs 4–615 through 4–697 for information regarding these measurements.

4–392. FUNCTIONING OF DUPLEXING SECTION COMPONENTS.

4–393. GENERAL. (See figure 4–47.) The duplexing section includes the polarization-shifting duplexer, TR tube, keep-alive power supply, and the third harmonic filter. Figure 4–47 shows the signal flow through these components.

4–394. The duplexing section permits use of the same antenna and waveguide for both transmitting and receiving. This section is, in effect, a fast-acting electronic switch which provides a path from the magnetron to the antenna during transmission, and from the antenna to the signal mixer during reception. Transmitted power travels through the polarization-shifting duplexer without entering the receiver arm. Received power enters the receiver station through the TR tube.

4–395. A keep-alive power supply provides approximately —300 volts (loaded) to the keep-alive electrode in the TR tube. This voltage keeps the gas in the tube partially ionized. A metering circuit indicates the keep-alive current through the TR tube. Contacts in the high-voltage interlock circuit open and cut off power to the modulator when the input voltage to the keep-alive power suply is cut off.

4–396. The waveguide switch is connected at opposite ends to the TR tube and the signal mixer. This switch places an r-f open circuit in the waveguide before the mixer when the equipment is not radiating or test signals are not being introduced into the receiving system. This protects the sensitive mixer from r-f signals entering the antenna from nearby radar sets and also serves as a low-pass filter, preventing harmonic radiation of the magnetron from reaching the crystals.

4–397. DUPLEXING CIRCUIT DURING TRANSMISSION. (See figure 4–48.) Transmitted power enters the duplexer excited in the $TE_{0,1}$ mode. For this mode, in a rectangular waveguide, the E-vector is always parallel to the narrow dimension of the waveguide cross section. Transition to the circular section of the duplexer is accomplied by a gradual taper exciting the $TE_{1,1}$ mode.

4–398. The receiver arm of the duplexer is oriented with its H-plane parallel to the axis of the circular section and its E-plane parallel to the H-plane of the transmitted wave. Theoretically, no energy can be coupled into the receiver arm when this condition is met. Actually, however, some of the transmitted power will leak into the receiver arm. The crystal in the mixer is protected from this leakage power by the TR tube.

4–399. Within a small fraction of a microsecond after the leakage power enters the TR tube, the rise in voltage across one of the spark gaps causes an arc-over. The gas within the TR tube is maintained in a partially ionized condition by a keep-alive voltage. Therefore, the length of time between the entry of this power and arcing is held to a minimum. When the spark gap arcs over, the adjacent resonant gaps (or the adjacent resonant gap and resonant window), which are one-quarter wavelength apart, are at high-voltage points and therefore arc over. The end result of firing of the gaps is to place the resonant window at the input end of the TR tube at a high-impedance, high-voltage point in the voltage standing wave of the TR tube. This resonant window arcs over and the transmitted power then has a continuous path past the receiver arm to the polarization-shifting quartz tubes in the duplexer.

4–400. A small amount of leakage power maintains the TR tube discharge. As long as the TR tube is operating properly and is properly ionized by the keep-alive voltage, the amount of transmitted power that passes through the tube is not sufficient to damage the crystal in the mixer.

4–401. After the transmitted wave has passed the receiver arm, it encounters the first of 16 gas-filled quartz tubes which span the circular section of the duplexer. The first two tubes are perpendicular to the E-vector of the transmitted wave and serve to maintain polarization in the immediate region of the receiver arm. The third tube is rotated approximately 6.4 degrees from the first two. Each successive tube is rotated an equal amount from the preceding one. The sixteenth tube is at 90 degrees to the first two. Newer units have only 15 tubes. The first tube (figure 4–48) is eliminated, therefore only one is perpendicular to the E-vector.

4–402. The high-powered level of the input to the circular polarization-shifting section causes the quartz tubes to ionize; consequently, they are good conductors during transmission. The E-vector cannot have a component parallel to the conducting tube, so that the third tube, and each successive tube thereafter, causes a 6.4-degree rotation of the E-vector. In this manner, the transmited wave is shifted 90 degrees in polarization as it travels through the circular section.

4–403. Conversion back to a rectangular waveguide is accomplished by a tapered section oriented at right angles to the tapered section at the transmitter end of the duplexer. Similarly, the waveguide carrying power out of the duplexer is oriented at right angles to the waveguide carrying power into the duplexer.

4–404. DUPLEXING CIRCUIT DURING RECEPTION. (See figure 4–48.) In the TR tube, the time of

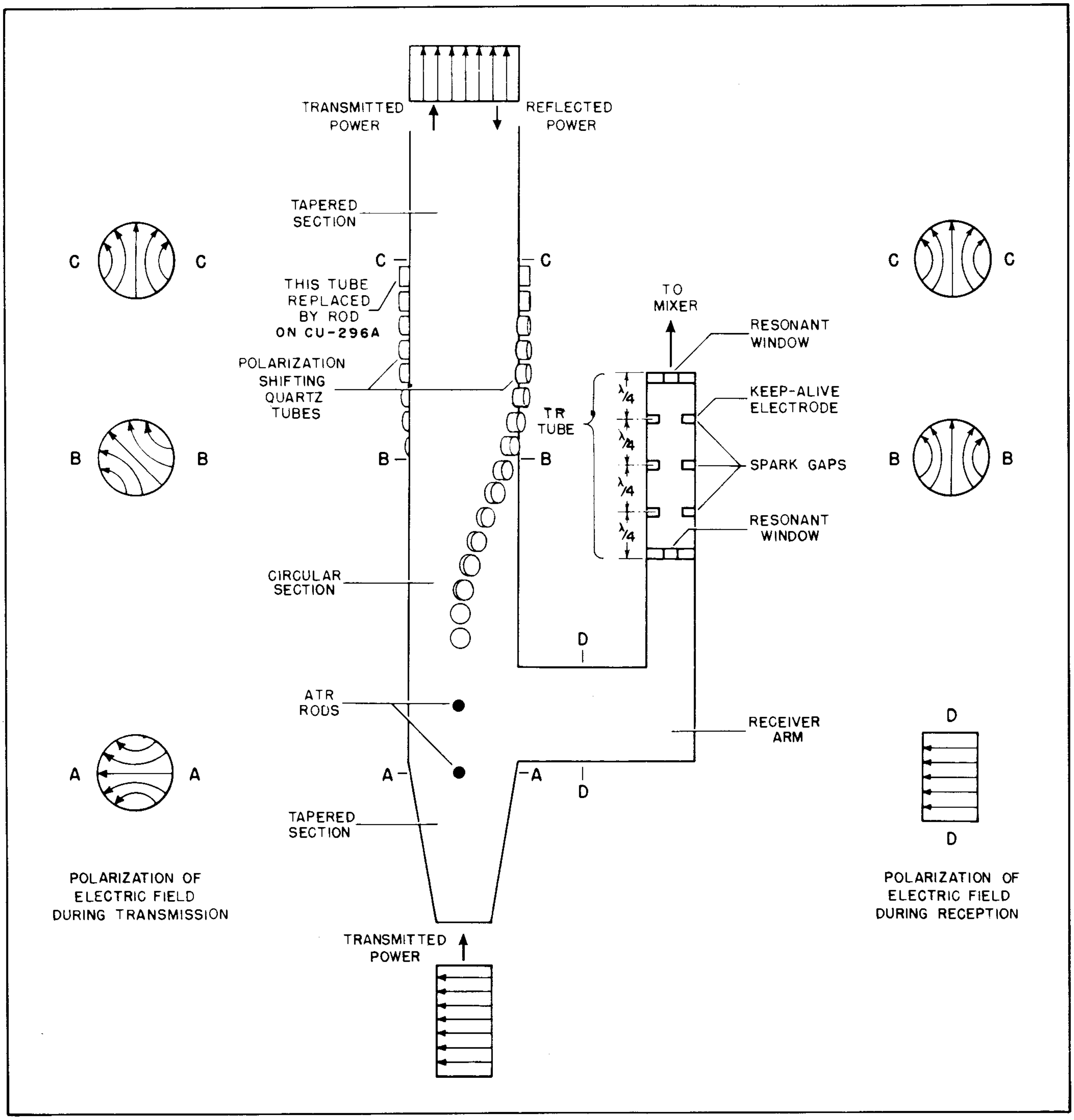

Figure 4–48. Duplexing Circuits

4-405. As discussed in paragraph 4-403 above, high power transient signals created by antenna mismatch will also cause the TR tube to fire. This causes the high power signals to be reflected back into the E-arm of the hybrid tee. Here, the reflected energy is split into two components of equal amplitude which are 180 degress out of phase. These components emerge from the dual arms of the tee. The phase section (see par. 4-399) introduces an additional shift in phase of 90 degrees between these two components so that when they enter the short slot hybrid they are out of phase by 270 degrees. These components will split in the short slot hybrid coupler and an additional 90 degrees of phase shift is introduced to one part of each signal. Due to the phase relationship between these components, they arrive at the antenna port 180 degrees out of phase and, hence, they cancel one another avoiding the radiation of spurious signals.

4-406. The signals arriving at the dummy load port, however, are in phase and recombine. This energy passes into the dummy load arm in which a matched termination AT-901 absorbs the r-f energy, converting it to heat. A thermal switch AT-901 OVERHEAT INTLK is incorporated into the high voltage interlock circuit which protects the load from overheating.

4-407. A small amount of leakage power maintains the TR tube discharge. As long as the TR tube is operating properly and is properly ionized by the keep-alive voltage, the amount of transmitted power that passes through the tube is not sufficient to damage the crystal in the mixer.

4–408. KEEP-ALIVE POWER SUPPLY CIRCUITS. (See figure 4–49.) A 120-volt, 60-cps input to transformer T401 is stepped up to 750 volts and rectified by selenium rectifier CR401. This voltage is applied to filtering capacitor C401 and its associated network composed of filter resistors R401, R405, and R406 and filter capacitor C402. Resistors R402 and R403 are bleeders. A —550-volt d-c output from the filter is supplied to ballast resistor R904, which is connected to the keep-alive electrode. Resistor R904 reduces the voltage to approximately —300 volts at the keep-alive electrode. The setting of CUR. ADJ potentiometer R407 determines the value of TR tube current.

4–409. A reading corresponding to the TR tube current can be taken while the supply is loaded. The metering circuit in either the remote or local control unit is placed across resistor R404, which is in the filter return circuit of the keep-alive power supply. When control is remote, local-remote relay K1001 is not activated and contacts 14 and 9 are connected as shown in figure 4–49. When RECEIVER TEST switch S6111 is in the TR CUR position (position 1), meter M6103 measures the TR tube current. When control is at the local control unit, relay K1001 is activated and contacts 14 and 8 are connected. When RECEIVER TEST switch S1004 is in the TR CUR position (position 1), meter M1002 measures the TR tube current.

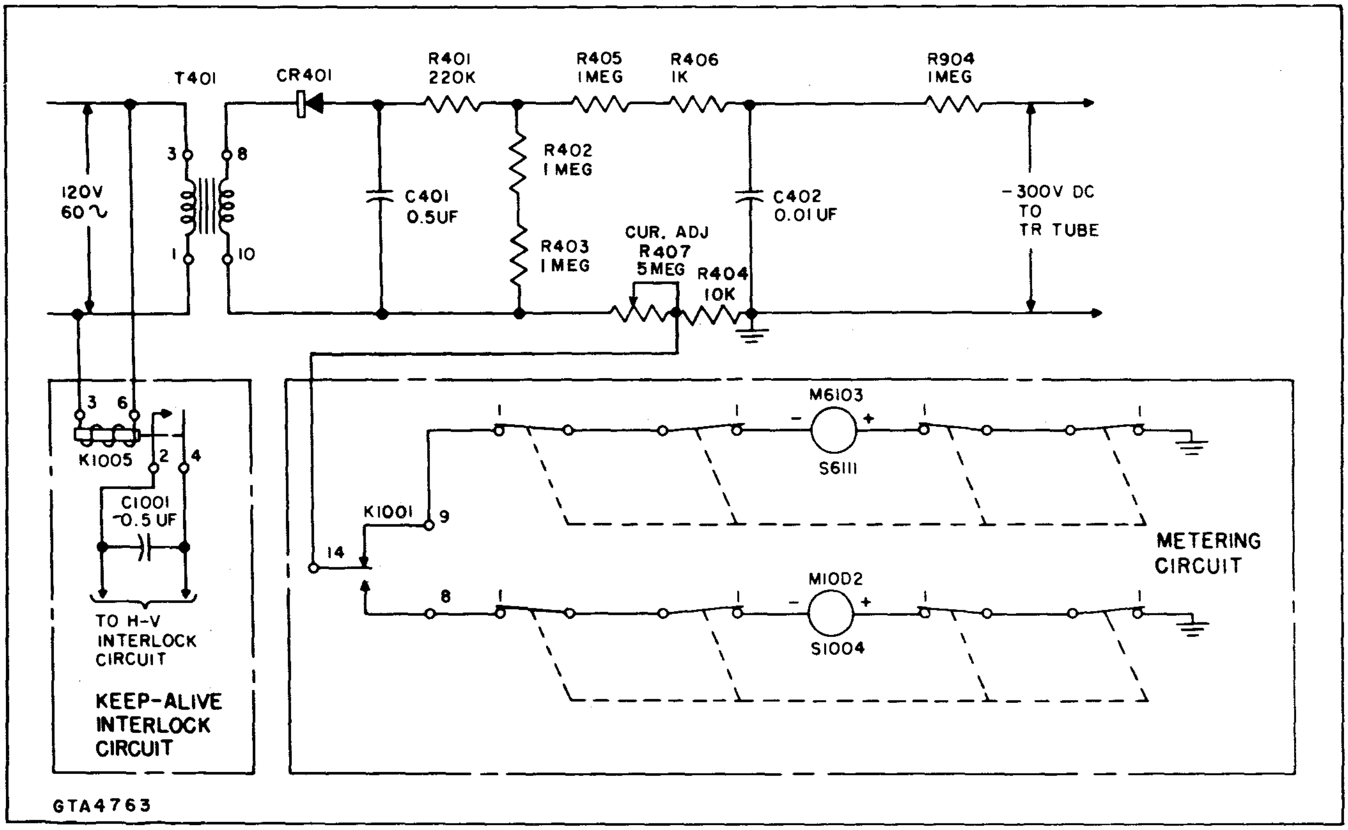

Figure 4–49. Keep-alive Power Supply Circuits, Simplified Schematic Diagram

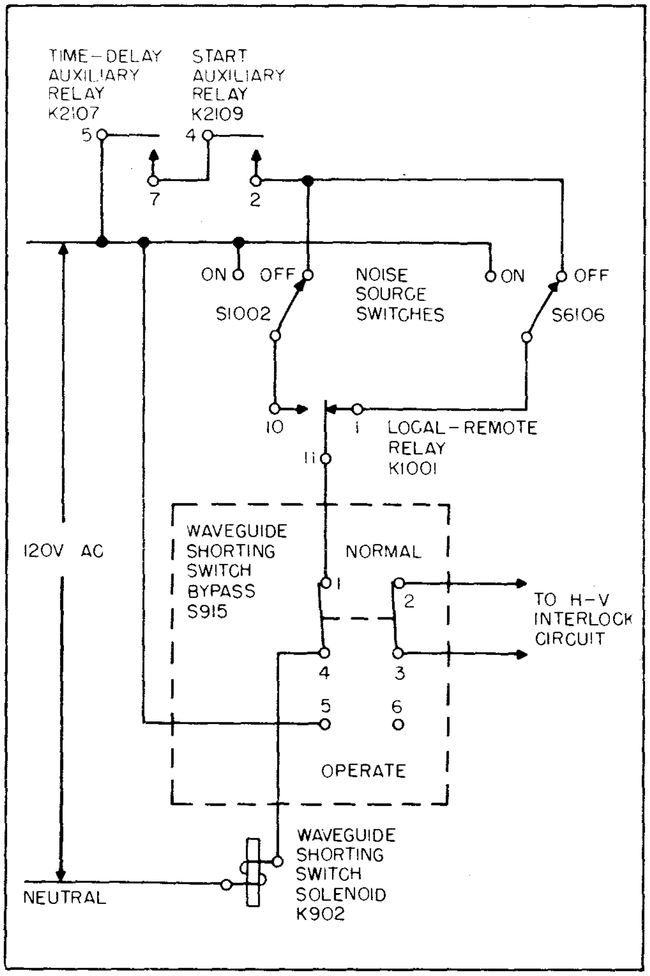

Figure 4–50. Waveguide Shorting Switch Control, Simplified Schematic Diagram

4–410. Keep-alive interlock relay K1005 in the local control unit is connected across the 120-volt, 60-cps input to the primary of transformer T401. When power is supplied to transformer T401, relay K1005 is activated and contacts 2 and 4 in the high-voltage interlock circuit are connected. If the input to transformer T401 is interrupted, contacts 2 and 4 open and power is cut off to the modulator. Capacitor C1001 serves as a spark suppressor for the relay. The complete high-voltage interlock circuit is described in paragraph 4–337.

4–411. WAVEGUIDE SHORTING SWITCH AND HARMONIC FILTER. There is a certain amount of third harmonic radiation generated by magnetrons. This is not blocked by the TR tube as is the fundamental frequency (paragraph 4–399), thus it may find its way to the mixer crystals and damage them. To prevent this, a low-pass filter is installed just ahead of the mixer. This filter consists essentially of two waveguide-to-coaxial transition sections with the coaxial stubs connected together. The stubs are of such length that coupling is possible at the fundamental frequency but not at the third harmonic. When the system is not radiating (relay K902 not energized), the probes lie approximately parallel to the long dimension of the waveguide. With relay K902 energized, the probes rotate 90 degrees and are in a position to couple the fundamental from one waveguide section to the other.

4–412. WAVEGUIDE SHORTING SWITCH CONTROL CIRCUIT. (See figure 4–50.) Solenoid K902, a part of waveguide switch and harmonic filter E901, is energized to maintain the r-f probes in position to pass the fundamental frequency when the radar is radiating. Solenoid K902 also serves the same purpose when noise source test signals are introduced into the receiving system and test equipment signals are introduced into the receiving system through the directional coupler.

4–413. During radiate periods, time-delay auxiliary relay K2107 and start auxiliary relay K2109 are energized. Power passes through closed contacts 5 and 7 of relay K2107 and contacts 4 and 2 of relay K2109 to the OFF contacts of NOISE SOURCE switches S1002 (local control panel) and S6106 (remote control panel). The noise source must be off during radiate periods. If the noise source were on, noise source interlock switch S901 would be open (figure 4–51) and the radar could not radiate. Contacts 1 and 11 of local-remote relay K1001 are closed when control of the radar is at the remote control unit (relay K1001 is not energized); contacts 10 and 11 are closed when control is at the local control unit (relay K1001 is energized). Thus, one pair of contacts is always closed and power passes to WAVEGUIDE SHORTING SWITCH BYPASS switch S915 in the waveguide compartment of the r-f assembly. During radiate periods, switch S915 must be in the position shown in figure 4–50. If switch S915 were operated, the interlock circuit would be open and the radar could not radiate. Power passes through terminals 1 and 4 of switch S915, applying 120 volts across solenoid K902. Thus, the solenoid is energized and the probes positioned to pass power, allowing echo signals to pass through the receiver arm to the mixer. The probes remain in this position as long as the radar remains in the radiate condition.

4–414. When noise source signals are to be introduced into the receiving system for test purposes, switch S1002 or S6106 must be in the ON position. If control is at the remote control unit, power passes through the ON terminal of switch S6106 and contacts 1 and 11 of relay K1001 to switch S915. Similarly, if control is at the local control unit, power passes through the ON terminal of switch S1002 and contacts 10 and 11 of relay K1001 to switch S915, which may be in either the normal or operate position. If switch S915 is in the normal position, power is fed to solenoid K902 through terminals 1 and 4 of switch S915. If this switch is in the operate position, power passes through terminals 5 and 4 to solenoid K902. In either case, solenoid K902 is energized and the waveguide shutter is opened, allowing noise source signals to pass through the receiver arm to the mixer.

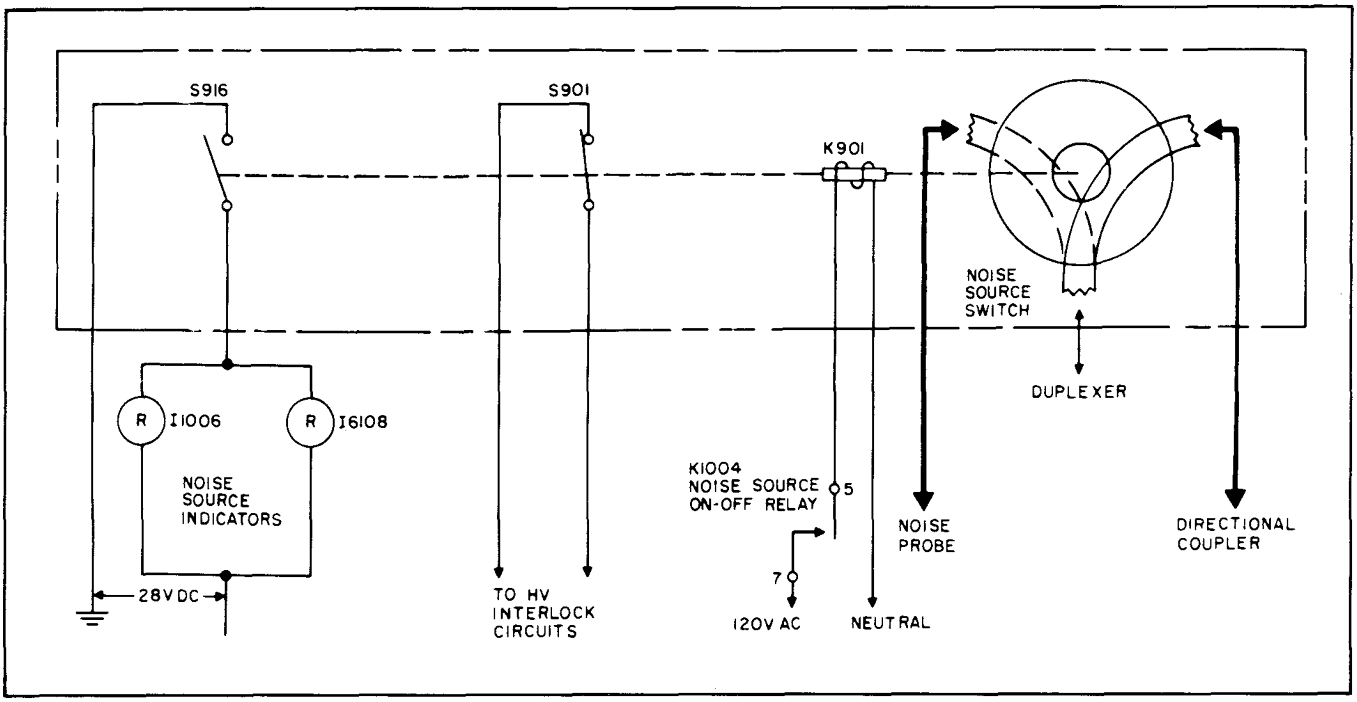

Figure 4–51. Noise Source Switch and Indicator Circuits for Radar Set AN/FPS-6 Only

4–415. When test signals are introduced into the receiving system through the directional coupler, switch S915 must be in the operate position. Power passes through contacts 5 and 4 of switch S915 and 120 volts is applied across relay K902. Thus, the solenoid is energized and the waveguide shutter is opened, allowing test signals to pass through the receiver arm to the signal mixer.

4–416. FUNCTIONING OF NOISE SOURCE SWITCH (RADAR SET AN/FPS-6 ONLY). (See figure 4–51.)

4–417. GENERAL. The noise source switch is a solenoid-operated waveguide switching device. In the normal position, this switch provides a continuous path between the duplexer and the directional coupler for transmitted and received signals. Solenoid K901 is energized when noise source signals are to be introduced into the receiver section. A drum which contains a 120-degree waveguide bend is then rotated to the noise source position and noise source signals are introduced through a noise probe (paragraph 4–422). The operation of the noise source itself is covered in paragraph 4–566 with the other components of the receiving system.

4–418. Choke joints provide a continuous path for the r-f power past the waveguide junctions (paragraph 4–370). An interlock circuit cuts off power to the magnetron when the switch is in the noise source position. Indicators on the remote and local control panels light when the switch is in the noise source position.

4–419. ENERGIZING CIRCUIT. Noise source on-off relay K1004 is energized when the noise source is on. Contacts 7 and 5 close and 120-volt a-c power energizes solenoid K901. When the solenoid is energized, a plunger moves upward, causing rotation of the drum which contains the 120-degree waveguide bend. The drum then rotates to the noise source position, where its waveguide section connects with the waveguide section from the noise probe. Thus, the circuit between the noise probe and the duplexer is completed. When the noise source is off, contacts 7 and 5 break and the noise source switch returns to its normal position.

4–420. INTERLOCK CIRCUIT. Switch S901 is normally closed. When relay K901 is energized, switch S901 opens, breaking the high-voltage interlock circuit and cutting off power to the modulator. The high-voltage interlock circuit prevents magnetron power from reaching the sensitive noise source when the noise source switch is in the noise source position. For a description of the complete high-voltage interlock circuit, refer to paragraph 4–337.

4–421. INDICATOR CIRCUIT. Switch S916 is normally open. When solenoid K901 is energized, switch S916 closes. Both the remote and local NOISE SOURCE indicators light when switch S916 is closed, indicating that the noise source is on.

4–422. FUNCTIONING OF R-F NOISE PROBE. (See figure 4–52.)

4–423. The r-f noise probe is a coaxial line-to-waveguide transition section. A cross-sectional view of the

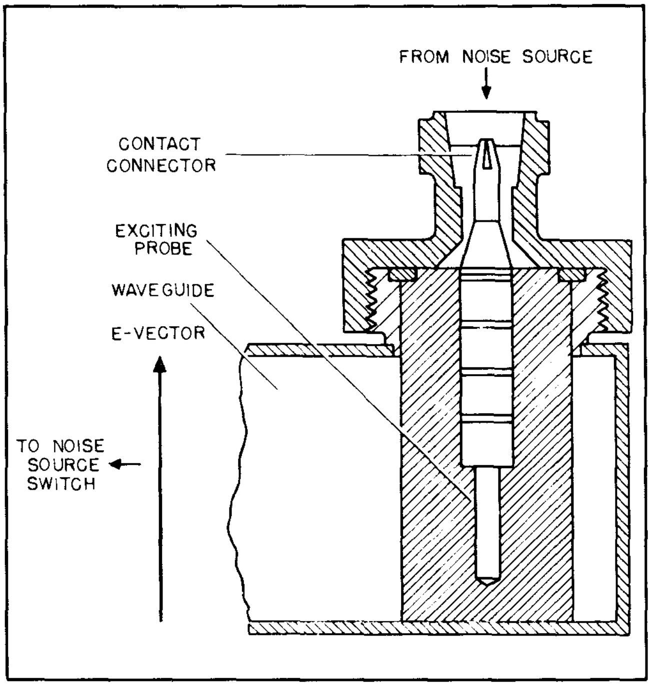

Figure 4–52. R-f Noise Probe, Cross-sectional View

probe through the center of the wide dimension of the waveguide is shown in figure 4–52.

4–424. The output signal from the noise source is fed to the contact connector of the noise probe by coaxial cable. The center conductor of the noise probe forms a small radiating antenna or exciting probe. This probe excites a wave whose E-vector is parallel to the direction of the probe. A short section of waveguide feeds the signal into the noise source switch. A choke joint connects the waveguide sections of the noise probe and the noise source switch.

4–425. FUNCTIONING OF DIRECTIONAL COUPLER. (See figure 4–53.)

4–426. The main waveguide section of the directional coupler guides the r-f power traveling between the noise source switch and the antenna transmission line components. Samples of this power enter the coupling section through five coupling holes. A probe in the coupling section picks up the samples of the wave traveling toward the antenna and couples these samples to test equipment. The samples of the wave from the antenna are dissipated in the coupling section. Conversely, test signals can be introducted into the main waveguide through the coupling holes to test the receiver section.

4–427. The theory of operation of the directional coupler is similar to that of the bidirectional coupler covered in paragraph 4–385. However, the directional coupler has only one coupling section, which corresponds to the top coupling position of the bidirectional coupler.

4–428. Considering the top coupling section only in figure 4–46, the five samples of the wave traveling toward the antenna arrive at the probe in phase (A, figure 4–46). The five samples of the wave from the antenna, however, arrive at the probe out of phase and are dissipated in the resistive strip. Therefore, for the directional coupler, samples of output power are transmitted to the test equipment through DIRECTIONAL COUPLER jack J936 on the front panel of the r-f assembly.

4–429. Test signals are introduced into the receiver section through DIRECTIONAL COUPLER jack J936. These signals are fed to the probe and coupled into the main waveguide. The signals traveling toward the receiver section are in phase, while those traveling toward the antenna are out of phase and are dissipated in the main waveguide.

4–430. Before introducing test equipment signals into the receiver section, the waveguide shorting switch shutter must be opened. As described in paragraph 4–414, placing switch S915 in the operate position energizes the waveguide shorting switch solenoid and opens the shutter.

4–431. RECEIVER ARM DIRECTIONAL COUPLER.

4–432. The receiver arm directional coupler (figure 4–54) has been incorporated into Radar Sets AN/FPS-6A and AN/FPS-6B to facilitate injection of noise from the continuous noise monitor into the receiving system. This coupler is inserted between the receiver arm of the duplexer and the TR tube and provides a nominal coupling factor of 18 db between the noise tube and the receiver with a minimum directivity of 15 db. The coupling factor and directivity permit the noise signals to be injected into the receiving system without degradation of system performance.

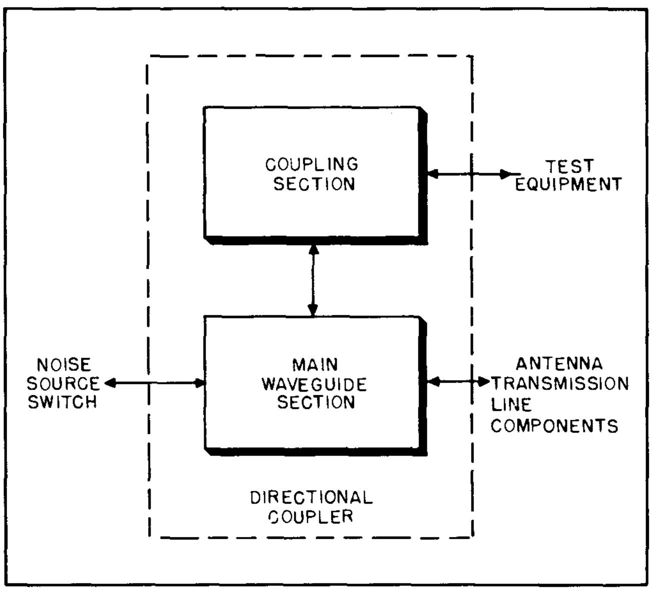

Figure 4–53. Directional Coupler, Block Diagram

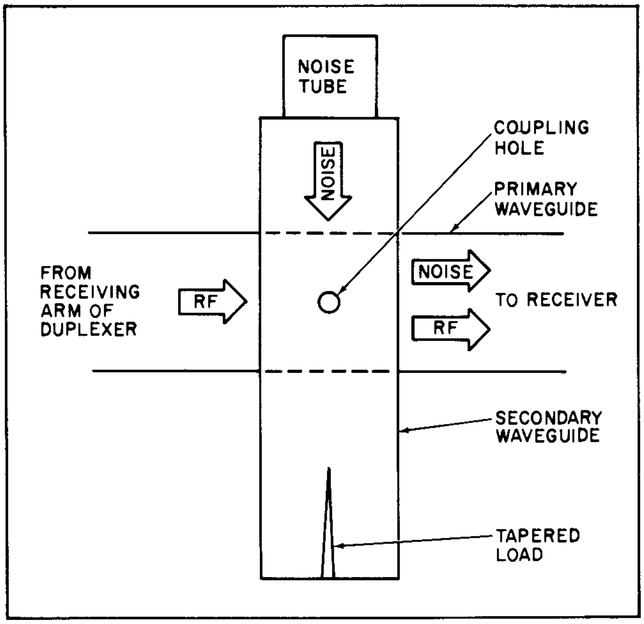

Figure 4–54. Receiver Arm Directional Coupler, Simplified Operation Diagram

4–433. The receiver arm directional coupler consists of primary and secondary waveguides, with a single hole providing coupling between waveguides (figure 4–54). The noise tube is attached to the secondary waveguide, which is terminated in a tapered load. An r-f signal from the receiving arm of the duplexer is guided through the primary waveguide into the receiving system. Noise introduced into the secondary waveguide is coupled into the primary waveguide through the coupling hole. Coupler directivity prevents noise from traveling toward the duplexer. Noise traveling toward the receiver is transmitted to the receiver together with the r-f signal.

4–434. ANTENNA TRANSMISSION LINE. (See figure 4–55.)

4–435. The antenna transmission line components carry the transmitted and received signals through the antenna assembly. These components include the azimuth rotating joint, the elevation rotating joint, a 90-degree twist waveguide section, the horn, and the reflector. Also included are 1-1/2-inch by 3-inch rectangular waveguide sections, some straight and some with various degrees of bend, used to interconnect the components. Waveguide choke joints of the type described in paragraph 4–371 couple the components to prevent leakage of r-f power from the transmission line.

4–436. This discussion of the antenna transmission line components is concerned only with the paths of the transmitted and received signals through the antenna assembly. Figure 4–55 shows the path of the transmitted wave. The path of the received wave is in a direction opposite to that of the transmitted wave.

4–437. AZIMUTH ROTATING JOINT. Information relative to the construction of the antenna assembly is contained in paragraph 4–1776. The azimuth rotating joint allows the antenna to rotate 360 degrees in azimuth (figure 4–56) with respect to the fixed waveguide. Radio-frequency power from the waveguide components in the r-f assembly is brought in at the bottom of the joint through a rectangular waveguide which operates in the $TE_{0,1}$ mode. The center section of the joint is a circular waveguide which operates in the $TM_{0,1}$ mode. Power is taken from the rectangular waveguide and coupled into the circular waveguide section. Filters at the top and bottom of the circular waveguide section suppress the radially asymmetrical $TE_{1,1}$ mode which is present in some degree.

4–438. The electrical and magnetic fields in the circular waveguide are symmetrical about the axis. As a result of this symmetry, the rotation of one portion of the cylinder about its axis with respect to another portion of the cylinder has no effect on the polarization of the field in the complete cylinder. A rotating choke joint separates the rotating and stationary parts of the cylinder. The portion of the cylinder above the rotating choke joint rotates about its axis. The polarization of the field remains the same in both the rotating and stationary portions of the cylinder. The choke joint prevents r-f leakage at the junction.

4–439. At the top of the rotating cylinder, energy is taken out of the circular guide in the same fashion as it is fed at the bottom.

4–440. ELEVATION ROTATING JOINT. The theory of operation of the elevation rotating joint is identical to that of the azimuth rotating joint described in paragraph 4–437. However, the functions of the two joints differ. The elevation rotating joint allows scanning by the antenna from −2 to +32 degrees in elevation (figure 4–56). The rate of scanning can be set at either 20 or 30 cps.

4–441. TWIST WAVEGUIDE. The polarization of the wave leaving the elevation rotating joint is horizontal (parallel to the shorter side of the waveguide cross section). By using a waveguide section with a 90-degree twist, the polarization of the wave is changed to vertical (again parallel to the shorter side of the waveguide cross section) and this vertically polarized wave is transmitted to the horn.

4–442. HORN AND REFLECTOR. The antenna transmission line terminates in a horn, which is flared in its wide dimension, and a parabolic reflector. The horn is at the focus of the reflector and directs the vertically polarized r-f power into the reflector. When the radar set is in operation, the horn moves with the reflector in azimuth (360) degrees) and in elevation (−2 to +32 degrees) so that the horn is always at the focus of the reflector. The general shape of the beam and its method of scanning is shown in figure 4–56.

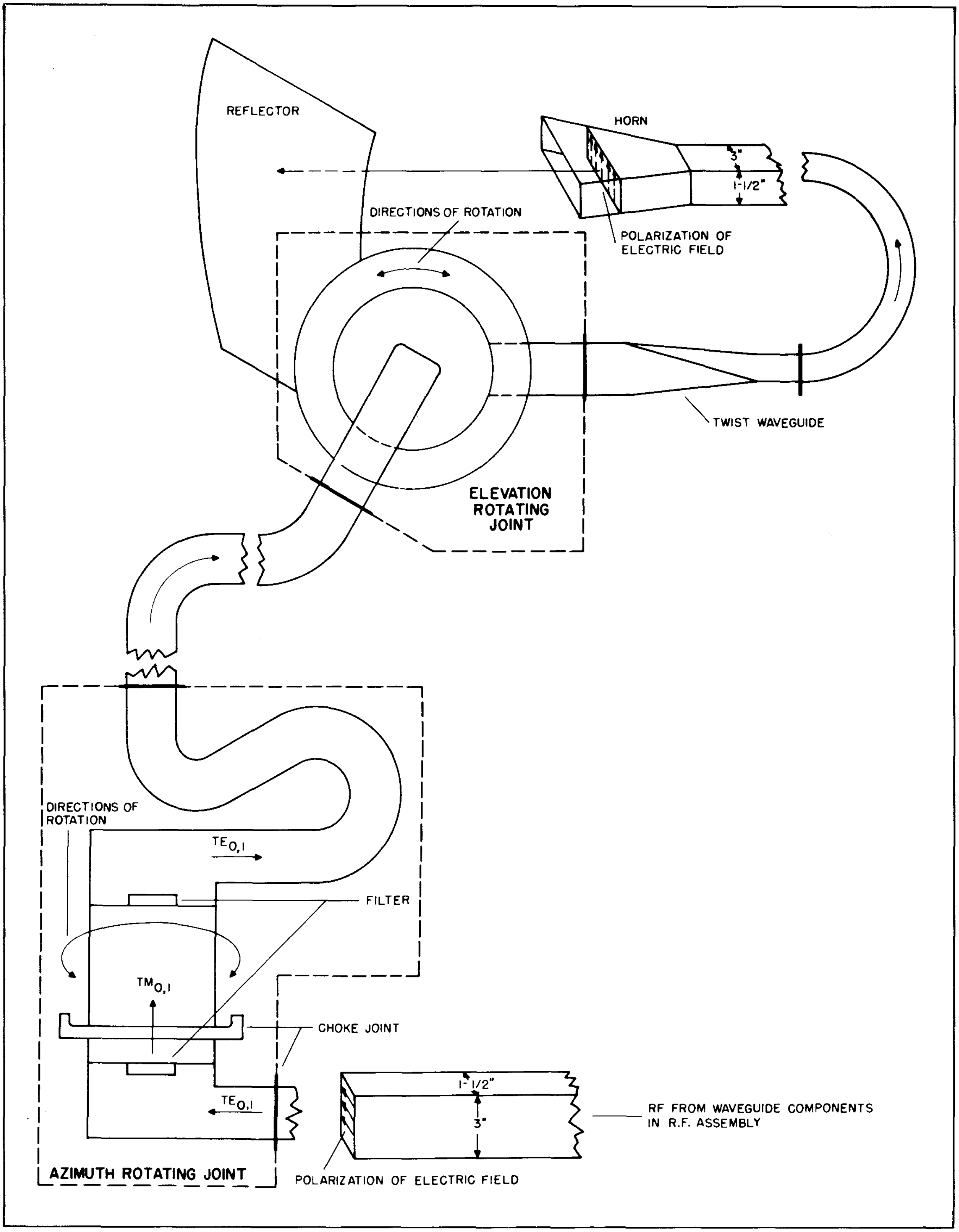

Figure 4–55. Antenna Transmission Line Components

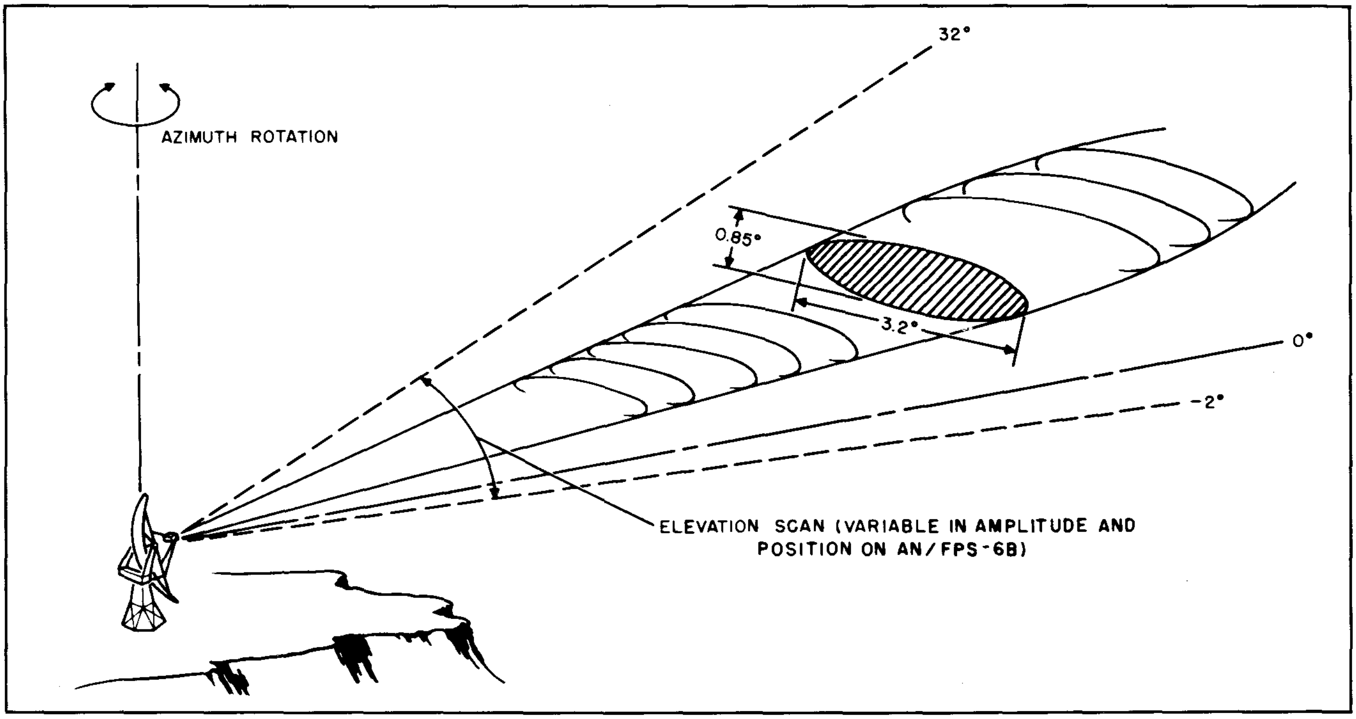

Figure 4–56. Radar Set AN/FPS-6 Scanning Pattern

4–443. The combination of a flared horn and vertically positioned parabolic reflector produces a beam which is highly directive in the vertical plane (elevation) and broad in the horizontal plane (azimuth). The flared horn not only controls the directivity of the radiation, but also serves as an impedance-matching device between the impedance encountered by the wave in the guide and the impedance encountered by the wave in free space. The flare results in a gradual change in the guide impedance, so that the impedance at the mouth of the horn is virtually the same as that offered by free space. Impedance-matching keeps the standing wave ratio in the waveguide close to unity.

4–444. RECEIVED SIGNAL. Conversely, the received signal is picked up by the reflector, focused to the horn, passed through the antenna transmission line components, and fed to the waveguide components in the r-f assembly. The discussion covering the transmitted pulse is also applicable for the received signal.

4–445. AFC MIXER.

4–446. GENERAL.

4–447. When the application of two different frequencies, f_1 and f_2, into a circuit will distort the waveform of whatever signal is applied to it (that is, a nonlinear circuit), there results at the output of such a circuit four main frequencies. These four frequencies are f_1 and f_2 (the original frequencies), a frequency which is the sum of f_1 and f_2, and a frequency which is the difference between f_1 and f_2. By the use of a suitable filter system, the frequency f_1 minus f_2 can be selected from these four frequencies. In Radar Set AN/FPS-6, f_1 is the sample of the transmitter pulse from the AFC attenuator, while f_2 is the local oscillator signal. These signals are mixed in a crystal detector (the nonlinear element) and a 30-megacycle difference frequency is produced. This 30-megacycle frequency is low enough to be amplified efficiently.

4–448. CIRCUIT ANALYSIS OF AFC MIXER. (See figures 4–57 and 4–58.)

4–449. Figure 4–57 is a schematic diagram of the AFC mixer and figure 4–58 is an equivalent circuit diagram of the AFC mixer. Refer to these two figures in the following analysis of the AFC mixer circuit.

4–450. A c-w signal from the local oscillator is coupled into a coaxial arm of the AFC mixer where it initially encounters a terminating resistive disk. This disk acts to terminate the coaxial line from the local oscillator in the proper impedance (50 ohms). In addition, the resistance of the disk is much lower than the impedance of the remainder of the mixer circuit, considered as a load in parallel with the resistive disk. Therefore, changes in the power drawn by the mixer, exclusive of the resistive disk, have a negligible effect on the impedance seen by the local oscillator and, consequently,

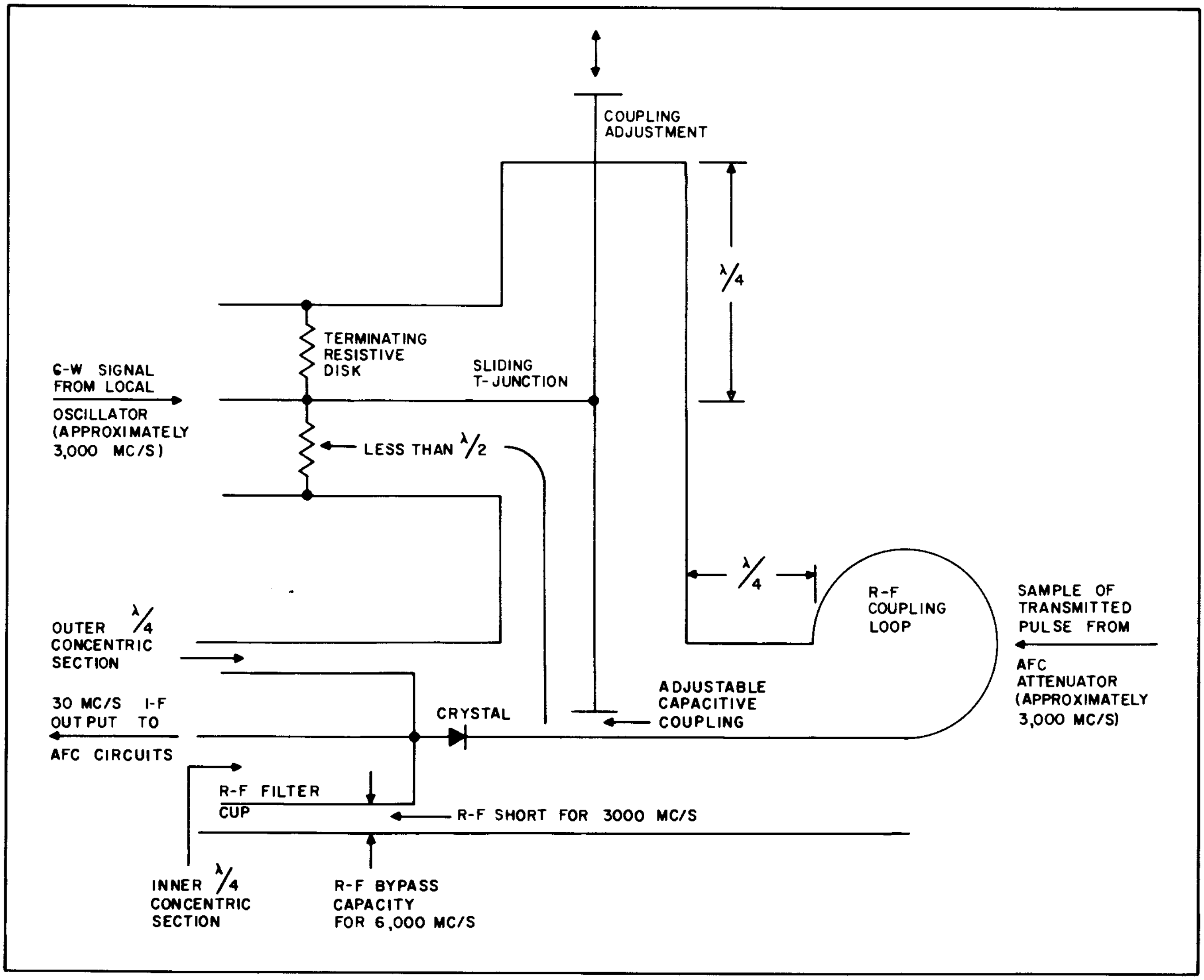

Figure 4–57. AFC Mixer, Simplified Schematic Diagram

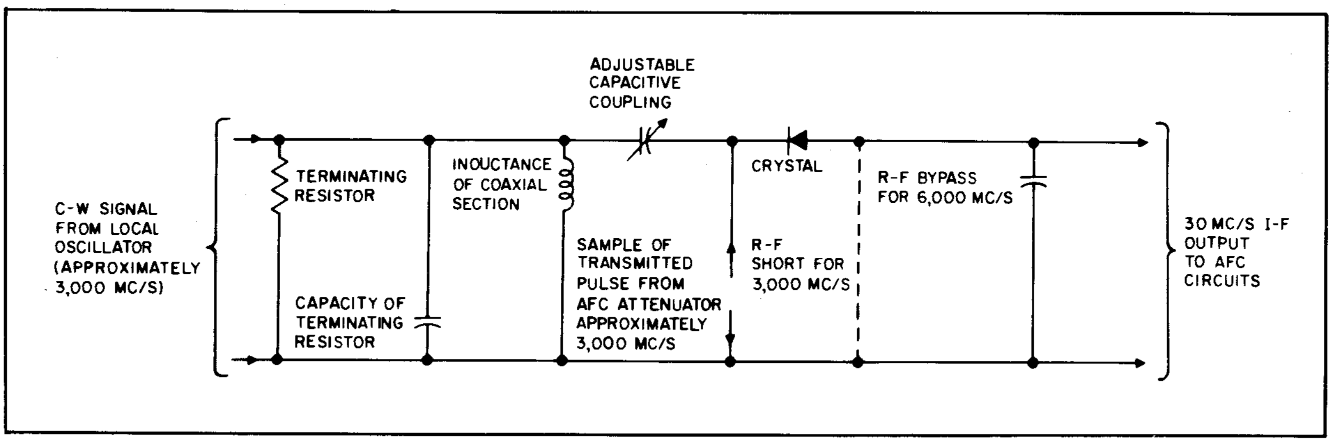

Figure 4–58. Equivalent Circuit of AFC Mixer

a negligible effect on the performance of the local oscillator. The impedance presented to the local oscillator by the terminating resistive disk is not purely resistive, but has a capacitive component due to its bakelite dielectric. This capacitive component of impedance is cancelled out by the coaxial section in the mixer, which the local oscillator signal encounters as it approaches the crystal. The coaxial section is slightly less than one-half wavelength long at 2800 megacycles and therefore acts as an inductance. This inductance is of a magnitude just sufficient to cancel the capacitive component.

4–451. The local oscillator signal is coupled to the coaxial section containing the crystal by an adjustable capacitive coupling arrangement using a sliding-T junction. The signal is prevented from proceeding toward the r-f coupling loop because the distance between the capacitive coupling point and the r-f coupling loop is one-quarter wavelength, shorted at the far end by the r-f loop, and therefore presents an infinite impedance to the local oscillator signal.

4–452. A sample of the transmitted pulse, picked up from the AFC attenuator by the r-f coupling loop, arrives at the crystal in parallel with the input from the local oscillator. These two signals beat together in the crystal detector. Four frequencies leave the crystal, namely: the sample of the transmitted pulse, the local oscillator signal, the sum of these frequencies, and the difference of these frequencies. The difference frequency, 30 megacycles, is the i–f signal which is passed through the filter cup arrangement to the frequency control circuits. The sum frequency, of the order of 6000 megacycles, is bypassed by the capacity between the filter cup and the outer wall of the mixer, which acts as a bypass capacitor. The frequency of the local oscillator and the frequency of the sample of the transmitted pulse, each on the order of 3000 megacycles, are prevented from passing through the filter cup arrangement because, at 3000 megacycles, the filter cup, viewed from the crystal, consists of a half wavelength coaxial line folded back upon itself and terminated at its far end in a short circuit. The first quarter wavelength of this line consists of the filter cup, acting as a "fat" center conductor of a coaxial liner; the outer wall of the mixer being its outer conductor. The second quarter wavelength, folded back inside the first quarter wavelength, consists of the center conductor of the mixer as the center conductor of the line, with the inside wall of the filter cup as its outer conductor. In figure 4–57, these quarter wavelength sections are marked respectively, outer $\lambda/4$ concentric section and inner $\lambda/4$ concentric section. Since the far end of this half wavelength line is shorted (by the base of the filter cup), the 3000-megacycle signal, looking at the filter cup from the crystal, sees a short circuit. Only frequencies of the order of 30 megacycles can emerge from the filter cup arrangement.

4–453. AFC-LO UNIT (OSCILLATOR, RADIO FREQUENCY O-166/CPS-6B).

4–454. BLOCK DIAGRAM. (See figure 4–59.)

4–455. The output signal from the AFC crystal mixer is in the form of the transmitted pulse at an intermediate frequency whose value is the difference between the actual transmitted carrier frequency and the frequency of the local oscillator. This signal is fed to i-f amplifier V21301. The amplified i-f pulse is then applied to a Weiss discriminator which detects the i-f signal, yielding an output of video pulses whose amplitude and polarity depend upon the frequency of the i-f pulses. When the i-f output is exactly 30.2 megacycles, the amplitude of the output pulses from the discriminator is zero. When the i-f output is higher than 30.2 megacycles, the output pulses are positive, and when the i-f output is lower than 30.2 megacycles, the pulses are negative. The greater the frequency separation between the i-f output and 30.2 megacycles, the greater the amplitude of the pulses. These pulses are fed to video amplifier V21303A, which inverts the polarity of the pulses and amplifies them. The output of this amplifier is fed to sweep stopper diode V21303B.

4–456. The circuit described thus far may have three different outputs. When the i-f signal produced by beating the local oscillator signal with the sample of the transmitted pulse is exactly 30.2 megacycles, the signal fed to sweep stopper V21303B is practically zero. When the local oscillator is operating at a frequency higher than desired, the i-f output is lower than 30.2 megacycles and the signal fed to the sweep stopper is a series of video pulses of positive polarity. When the local oscillator frequency is too low, the i-f output is higher than 30.2 megacycles and the pulses at the sweep stopper are negative. The desired intermediate frequency is 30 megacycles. However, to obtain an error signal which will cause the AFC circuit to lock in at 30 megacycles, it is necessary to tune the discriminator to produce a small negative output at 30 megacycles or zero output at 30.2 megacycles.

4–457. The sweep stopper converts any positive pulses fed to it into a negative bias for phantastron sweep generator V21304. The phantastron sweep generator circuit has two separate and distinct modes of operation: it acts either as a free-running sawtooth sweep voltage generator or as a d-c amplifier, depending upon the bias placed on it.

4–458. If this bias is sufficiently negative, the circuit acts as a d-c amplifier; if the bias is not sufficiently negative, the circuit acts as a free-runing sawtooth generator. When the AFC system is locked in, which is to say that the AFC system is maintaining the local oscillator at a frequency proper for the production of an i-f output of 30 megacycles, the Weiss discriminator produces a small negative pulse output. This output is amplified and inverted by the video amplifier so that the sweep stopper receives a positive pulse. The

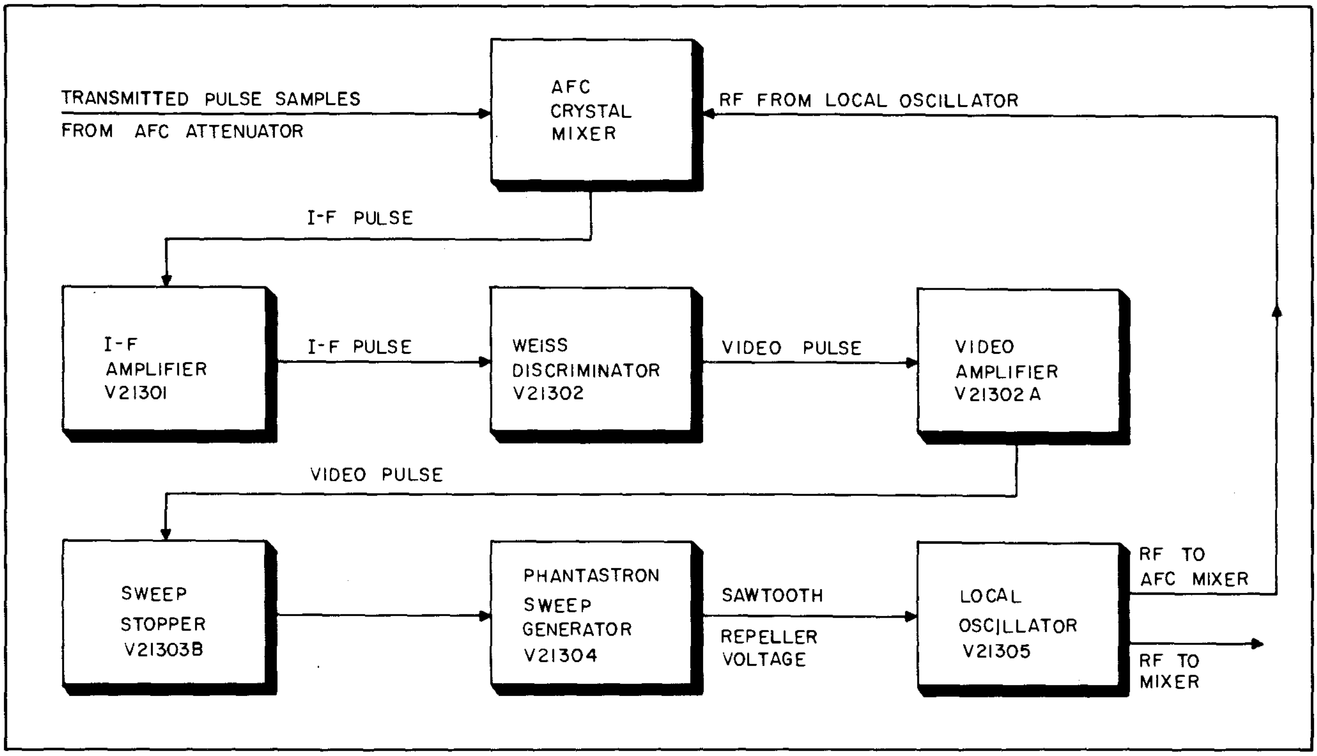

Figure 4–59. AFC-LO Unit, Block Diagram

sweep stopper then produces a negative bias for the phantastron, which operates as a d-c amplifier to control the repeller voltage of the klystron local oscillator. More negative bias at the phantastron lowers the frequency of the local oscillator.

4–459. If the local oscillator frequency or the frequency of the transmitted carrier then varies in a direction which makes the i-f output a little lower than its previous value of 30 megacycles, the output of the discriminator becomes more negative. In addition, the output of the video amplifier becomes more positive, the sweep stopper produces more negative bias on the phantastron, and the frequency of the local oscillator is lowered, thereby raising the intermediate frequency. The reverse process will occur if the i-f output goes higher than its previous value of 30 megacycles.

4–460. When the AFC system is not locked in, then there are either no pulses or there are negative pulses at the sweep stopper, resulting in insufficient negative bias at the grid of the phantastron. The phantastron immediately begins to operate as a sawtooth generator, which causes the repeller voltage of the klystron local oscillator to execute sawtooth-shaped excursions. This results in sawtooth-shaped excursions of the frequency of the local oscillator, sweeping from low to high frequency. At the instant during an excursion that the i-f output becomes slightly higher than 30.2 megacycles, positive pulses once more appear at the sweep stopper, sufficient bias is produced for the phantastron, and the phantastron commences operation as a d-c amplifier. The AFC system will then lock on.

4–461. CIRCUIT ANALYSIS OF AFC-LO UNIT.

4–462. I-F AMPLIFIER V21301. (See figure 4–60.) In Radar Set AN/FPS-6, the i-f signal is obtained from the AFC mixer; in Radar Set AN/FPS-6A, the i-f signal is obtained from the relative tuning indicator. In either case, the i-f signal is fed into the primary of transformer L21305, which is tuned to 30 megacycles through capacitor C21301 and bypassed to ground through capacitor C21302. The d-c crystal current of the crystal detector in the AFC mixer passes through the primary of transformer L21305 and is led through r-f choke L21304 to the receiver metering circuits in the remote or local control unit. If control is at the remote control panel, the AFC crystal current is read on meter M6103 (figure 4–59). If control is at the local control panel, the AFC crystal current is read on meter M1002.

4–463. The secondary of transformer L21305 is connected between ground and the grid of conventional i-f amplifier V21301. Capacitor C21303 is the cathode bypass capacitor, capacitor C21304 is both a screen bypass and decoupling filter capacitor, resistor R21317 is the cathode resistor which develops class A bias for the tube, and inductor L21301 is the plate load impedance for the tube. Resistor R21302, in conjunc-

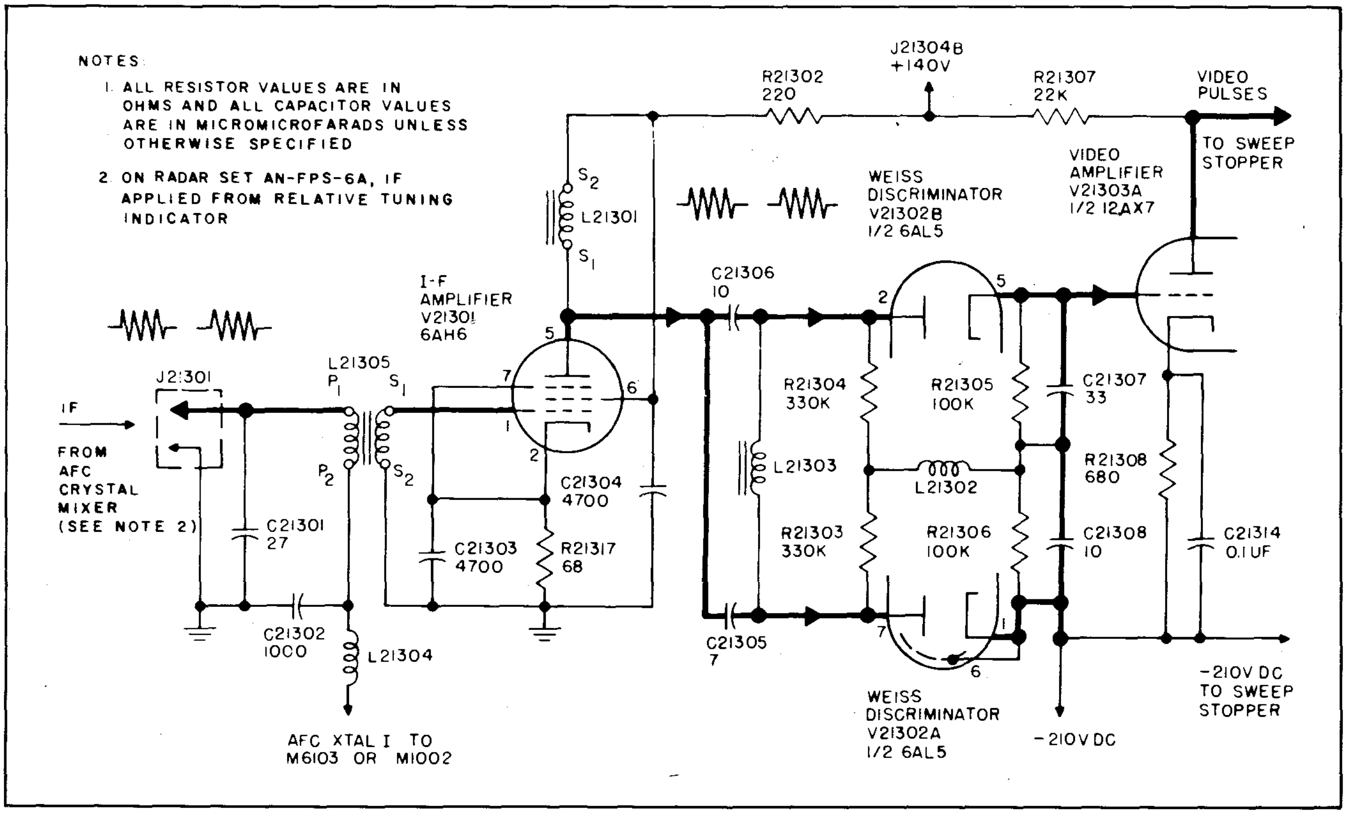

Figure 4–60. I-f Amplifier V21301, Weiss Discriminator V21302, and Video Amplifier V21303A, Simplified Schematic Diagram

tion with capacitor C21304, serves as a decoupling filter for the plate power supply. The output is taken at the plate.

4–464. WEISS DISCRIMINATOR V21302. Figure 4–61 shows the Weiss discriminator circuit and two equivalent circuits. In A of figure 4–61, E is the i-f output from i-f amplifier V21301. The output of amplifier V21301 appears across the discriminator between the junction of capacitors C21305 and C21306 and the —210-volt terminal, which is effectively at signal ground through the coupling action of filter capacitor C1113 in the preamplifier-local oscillator supply. Capacitor C1113 is connected between —210 volts dc and d-c ground. Capacitors C21305 and C21306, together with inductor L21303, comprise a tuned circuit that determines E_1, the portion of voltage E that will be applied across amplifier V21302A, and E_2, the portion of voltage E that will be applied across amplifier V21302B. Once the magnitude of voltage E has been fixed, the i-f voltage appearing across either diode section of the discriminator depends only upon the frequency of E.

4–465. Diode V21302A rectifies E_1, the direct current flowing from cathode to plate, through resistor R21303, inductor L21302, and cathode load resistor R21306. The d-c voltage drop across resistor R21306 is positive at its cathode end. Diode V21302B rectifies E_2, the direct current flowing from cathode to plate, through resistor R21304, inductor L21302, and cathode load resistor R21305. The d-c voltage drop across resistor R21305 is positive at its cathode end. When E_1 equals E_2, the d-c voltages across resistors R21305 and R21306 are equal. Since these voltages are oppositely polarized, the total cathode-to-cathode voltage, which is the output voltage of the discriminator, is zero. The circuit is arranged so that this condition occurs when the i-f signal is exactly 29.8 megacycles. At an i-f output higher than 29.8 megacycles, E_2 is larger than E_1. Then, the voltage across resistor R21305 is larger than that across resistor R21306, so that the output voltage of the discriminator is positive with respect to the cathode of diode V21302A. At an i-f output lower than 29.8 megacycles E_1 is larger than E_2. Then, the voltage across resistor R21306 is larger than that across resistor R21305, so that the output voltage is negative with respect to the cathode of diode V21302A.

4–466. An equivalent circuit for the i-f paths in the discriminator is shown in B of figure 4–61. The capacitances of diodes V21302A and V21302B, respectively, are C_A and C_B. The circuit is shown connected across E, at one end by connection to the plate of the previous circuit and at the other end by the coupling effect of capacitor C1113. E_1 and E_2 are shown across C_A and C_B, respectively.

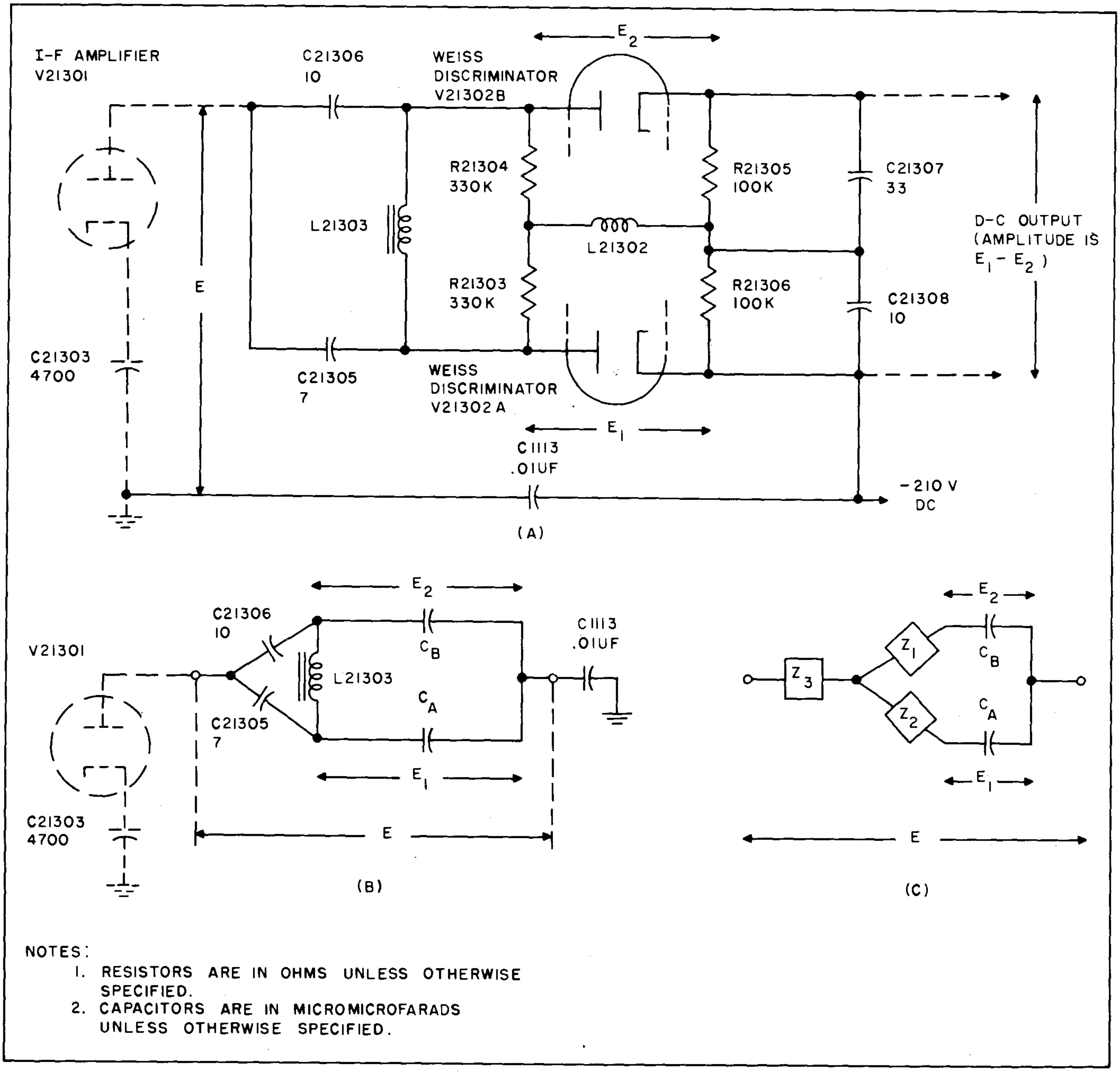

Figure 4–61. Weiss Discriminator, Schematic and Equivalent Circuits

4–467. When two capacitances and an inductor are connected in triangular fashion, as are capacitors C21305 and C21306 and inductor L21303, the arrangement is called a pi-network. In order to analyze the action of a pi-network, it is necessary to convert it into an equivalent T-network as shown in C of figure 4–61. The procedure by which this transformation is performed is beyond the scope of this technical manual. However, the following should be observed: When the i-f signal entering the T-network is approximately 30.8 megacycles, Z_1 behaves like an inductance of a size which will series-resonate with C_B, so that the impedance of the upper branch is virtually zero, making E_2 very large and E_1 almost zero. When the i-f signal entering the T-network is approximately 28.8 megacycles, Z_2 behaves like an inductance of a size which will series-resonate with C_A, so that the impedance of the lower branch is virtually zero, making E_1 very large and E_2 almost zero. When the i-f signal is exactly 29.8 megacycles, the impedances of Z_1 and Z_2 are equal in magnitude, making the currents in both branches equal, so that E_1 equals E_2. Figure 4–62 is the Weiss discriminator response curve. This curve illustrates how the output of the discriminator varies with the frequency of the input.

4–468. In figure 4–60 it can be seen that inductor L21302 is an r-f choke which is self-resonant at about

30 megacycles. This inductor prevents the passage of i-f potentials from the plate side of the diodes to the cathode side of the diodes. It should also be noted that bypass capacitors C21307 and C21308 are of two different values. This arrangement is necessary in order to compensate for slight differences in the magnitude of the i-f voltages which would otherwise appear across the diodes at exactly 29.8 megacycles. The action of the pi-network, referred to in paragraph 4–467, cannot cause precisely equal voltages to appear across the diodes at 29.8 magacycles without this compensation.

4–469. The cathode of diode V21302A is not returned to ground but to a —210-volt line brought in from the preamplifier-local oscillator supply. This same line is used as the d-c return, instead of ground, for the other stages in the local oscillator unit with the exception of the klystron local oscillator and i-f amplifier V21301. The output of the discriminator is connected directly to the grid of video amplifier V21303A.

4–470. VIDEO AMPLIFIER V21303A. (See figure 4–60.) The video amplifier is a conventional, class A amplifier whose bias is derived from cathode bias resistor R21308, bypassed by cathode bypass capacitor C21314. Resistor R21307 is the plate load resistor. The output is taken from the plate and fed to diode-connected sweep stopper V21303B.

4–471. SWEEP STOPPER V21303B. (See figure 4–63.) When a positive pulse is fed to sweep stopper V21303B from the preceding video amplifier, the sweep stopper conducts and capacitor C21309 charges through the tube to the peak value of the pulse. The time constant for this charging circuit is very short and is determined by capacitor C21309 and the resistance of the diode. In the intervals between pulses, capacitor C21309 discharges slowly through resistor R21309, producing a voltage across resistor R21309 which is negative at the plate end. Thus, the diode cannot conduct during the discharge of capacitor C21309 and the discharge time constant is long, being the product of capacitor C21309 and resistor R21309. The long discharge time constant maintains the voltage across resistor R21309 essentially constant between successive pulses at the sweep stopper. This direct voltage is applied through resistor R21310 to the phantastron sweep generator as a negative bias. If it is assumed that the phantastron is, at the moment, operating as a d-c amplifier (that is, the AFC system is locked in), the voltage that the phantastron applies to the repeller of the klystron local oscillator V21305 depends upon the amount of bias produced across resistor R21309 by the sweep stopper. Therefore, if the frequency of the klystron changes, or if the output frequency of the magnetron changes, the bias voltage across resistor R21309 also changes. This causes the magnitude of the pulses appearing at the sweep stopper

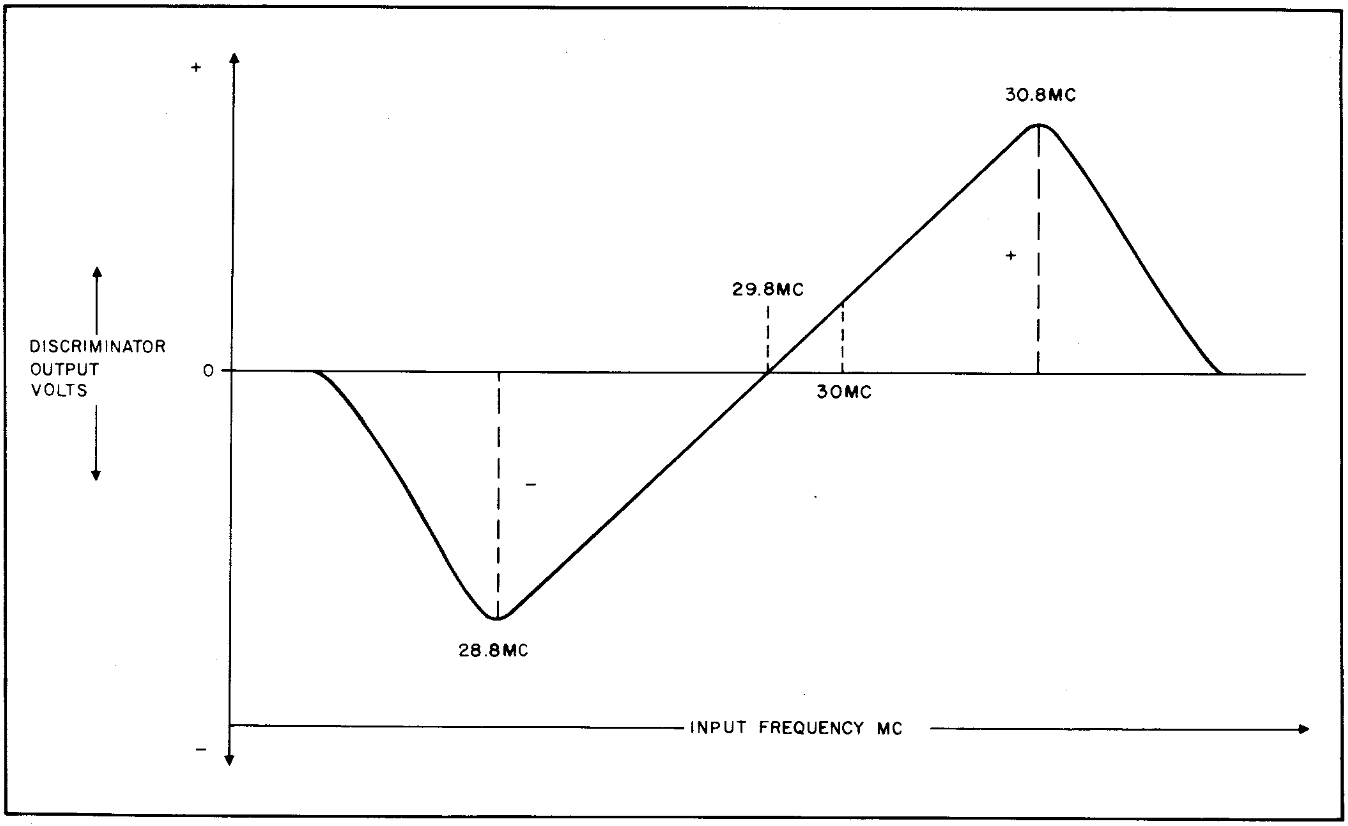

Figure 4–62. Weiss Discriminator Response Curve

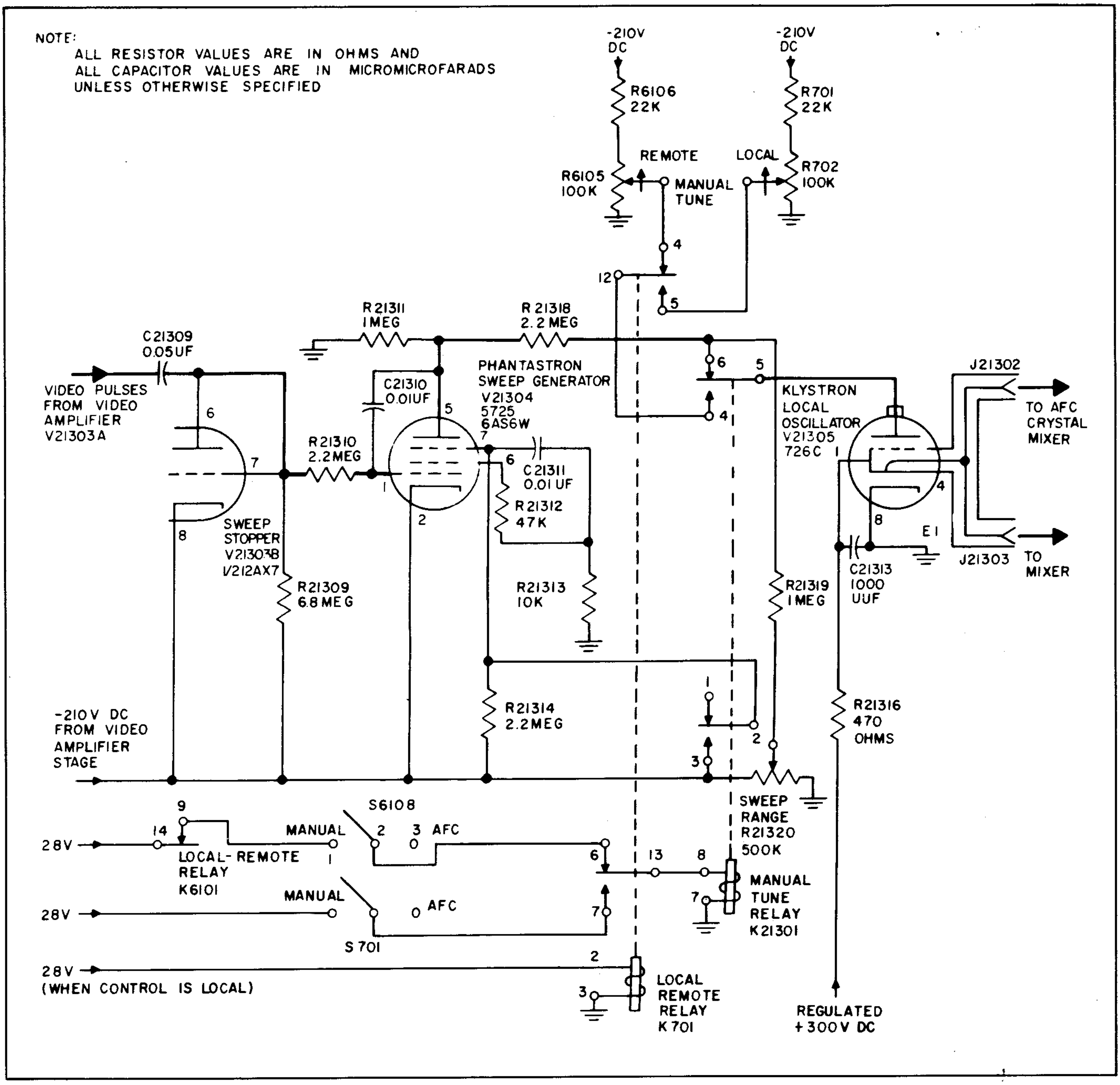

Figure 4–63. Sweep Stopper V21303B, Phantastron Sweep Generator V21304, Manual Tune Control and Klystron Local Oscillator V21305, Simplified Schematic Diagram

to be altered, which, in turn, alters the bias at the grid of the phantastron. The klystron repeller voltage is then altered, changing the klystron frequency. This action is always in such a direction as to attempt to maintain the i-f output at exacly 30 megacycles.

4–472. When the pulses at the sweep stopper are negative, capacitor C21309 cannot charge through the diode sweep stopper, since such charging would require that electrons flow from the plate to the cathode of the diode. In addition, the time constant of capacitor C21309 and resistor R21309, the only possible remaining charge path for capacitor C21309, is long. Thus, no considerable charging of capacitor C21309 can occur, and therefore no bias is fed from the sweep stopper to the phantastron, which commences to act as a sawtooth generator. The same process commences when no pulses appear at the sweep stopper, which occurs when the i-f output is exactly 30.2 megacycles. Therefore, the normal operating condition of the AFC system, when locked in, is with the intermediate frequency at 30 megacycles. At this frequency, small positive pulses appear at the sweep stopper and sufficient bias is produced by the sweep stopper to cause the phantastron to act as a d-c amplifier.

4–473. PHANTASTRON SWEEP GENERATOR V21304. (See figure 4–63.) Phantastron sweep generator V21304 is initially considered at a time when its mode of operation is that of a free-running sawtooth generator. It is assumed that for some reason no positive pulses are reaching the sweep stopper and that therefore no bias for the phantastron is being supplied by the sweep stopper. This condition could be realized, for example, by removing discriminator tube V21302 from its socket. When this is done, the phantastron starts producing a sawtooth wave of voltage at its plate. This sawtooth starts at about −25 volts with respect to ground and downsweeps to about −200 volts with respect to ground. The downsweep is virtually linear, except for an abrupt decrease of about 35 volts at the beginning of the downsweep. The sawtooth endures for a period of about 2 seconds. In order to analyze this sawtooth-generating action, the cycle is entered at the instant when the plate voltage commences its linear downward swing (B, figure 4–64).

4–474. As shown in figures 4–63 and 4–64, the approximate conditions at this point in the cycle are as follows: The plate supply is 210 volts and the drop across plate load resistor R21311 is 35 volts. The plate current is less than 1.0 milliampere and the screen grid current is a few microamperes, producing a negligible drop across resistors R21312 and R21313, so that the screen grid voltage is 210 volts. In addition, the suppressor grid is at a positive potential and the control grid voltage is −10 volts, nearly cut off. It should be noted that these voltages are referred to cathode, not ground.

4–475. The high negative bias on the control grid is caused by the fact that capacitor C21310 is charged to approximately 175 volts at the instant the downsweep commences. This capacitor discharges through resistors R21310 and R21309, producing the control grid bias. As the discharge of capacitor C21310 proceeds, the discharge current decreases and the voltage drop across resistors R21310 and R21309 decreases, causing the control grid voltage to change in the positive direction. However, because of the high transconductance of the tube and the large value of plate load resistor R21311, a small change in grid voltage produces a large change in plate voltage. Thus, as the grid voltage becomes less negative, the plate voltage falls toward the cathode potential A times as fast (where A is the gain of the stage). This drop in plate voltage slows the discharge rate of capacitor C21310 from the usual exponential rate given by the time constant of capacitor C21310 and resistors R21309, R21310, and R21311 to a rate that is virtually linear. This fact, coupled with the fact that the tube has a high transconductance, means that the grid cannot be changing more than a few volts during the entire linear downsweep. Therefore, the voltage drop across capacitor C21310 falls in a linear fashion and it is the potential at the plate end of capacitor C21310 which falls in this linear fashion, because the voltage at the grid end is essentially fixed.

4–476. This process continues until, as the plate voltage approaches the end of its downsweep (C, figure 4–64), the plate voltage falls so far below the screen voltage that more and more electrons from the space current in the tube are attracted to the screen and fewer and fewer to the plate. The screen current, which flows through resistors R21312 and R21313, increases to a large value and the screen voltage falls. As this occurs, the voltage drop across resistor R21313 rises and the potential at the end of capacitor C21311 connected to resistor R21313 rises. When this potential rises, the voltage across capacitor C21311, which was charged to the full screen voltage of 210 volts, falls and capacitor C21311 commences to discharge through resistor R21314.

4–477. The discharge current through resistor R21314 places a negative bias on the suppressor grid, further increasing the screen current by decreasing the plate current. This process is regenerative, so that the plate current is rapidly cut off and the plate voltage rises sharply. With the rise in plate voltage, capacitor C21310 begins to charge through resistors R21309, R21310, and R21311, rapidly making the voltage on the control grid positive. At this point, capacitor C21310 continues its charging at a much higher rate through the low cathode-to-grid resistance and resistor R21311. The low screen voltage and the negative bias on the suppressor grid combine to keep the plate current decreasing until, at point A in figure 4–64, no plate current flows. By this time, sufficient charge has leaked off capacitor C21311 through resistor R21314 to bring the suppressor grid near cathode potential. When this occurs, plate current begins to flow, dropping the plate voltage. This causes capacitor C21310 to start discharging through resistors R21310 and R21309, placing the control grid bias at nearly cutoff. This lowers the screen current to a very small value and causes the voltage at the junction of resistors R21312 and R21313 to return to 210 volts. Simultaneously, capacitor C21311 starts to charge to this voltage through resistor R21314, causing a positive suppressor grid bias across this resistor which further speeds the sharp drop of plate voltage from 175 to 165 volts. At this point, the slow downward sweep of plate voltage begins and the cycle is complete.

4–478. The sawtooth output voltage is applied to the repeller anode of klystron local oscillator V21305 through a voltage-divider network. A simplified schematic of this circuit is shown in figure 4–65. In this figure, the voltages appearing across various parts of the network at the time when the sawtooth is at its maximum (A, figure 4–64), are shown with solid arrows. The voltages appearing across the same parts of the network when the sawtooth is at its minimum (C, figure 4–64) are shown with dotted arrows. Vary-

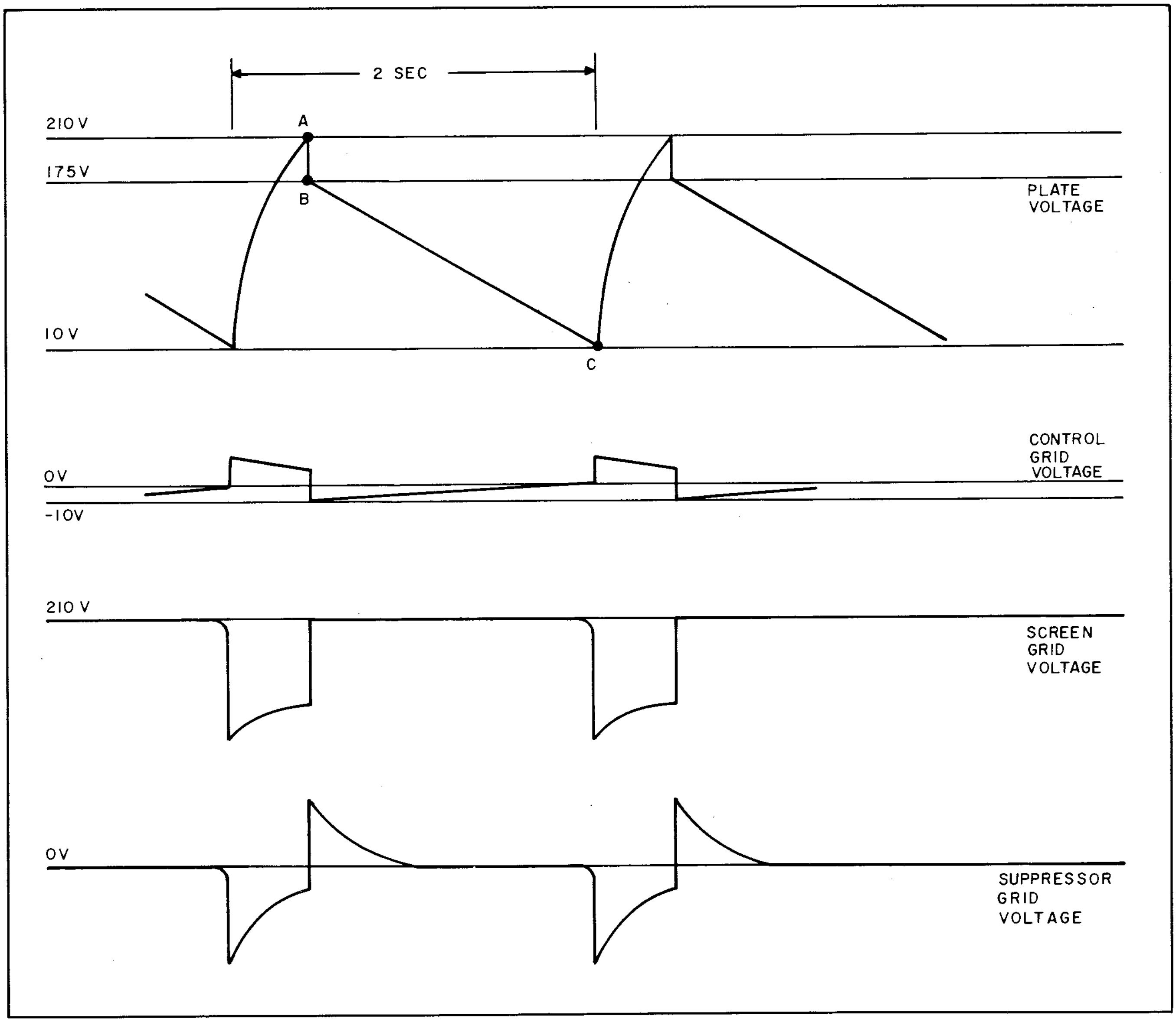

Figure 4–64. Phantastron Sweep Generator Waveforms

ing the position of the center arm of SWEEP RANGE potentiometer R21320 changes the amplitude of the sawtooth sweep applied between the repeller anode and the cathode of klystron V21305. Figure 4–65 shows the range of amplitude of the repeller voltage at its nominal setting for the operation of this circuit: a range of 110 to 180 volts, negative with respect to its cathode.

4–479. In considering the phantastron when its mode of operation is that of a d-c amplifier, it is assumed that the equipment has just been energized, that it has warmed up, and that the entire AFC system is in proper operating condition. The AFC system is not yet locked in, so that the phantastron is generating sawtooth waves and the sawtooth is about to start its downswing.

4–480. At the top of the downswing, the voltage on the repeller anode of the klystron is —110 volts, so that the klystron frequency is very low, producing an intermediate frequency which is higher than the range of frequencies that will produce an output at the Weiss discriminator (figure 4–62). Therefore, no pulses arrive at the sweep stopper, the sweep stopper does not affect the phantastron operation, and the downsweep proceeds. The frequency of the klystron then increases, decreasing the intermediate frequency entering the discriminator. As the intermediate frequency decreases below 29.8 megacycles, the discriminator begins to yield negative pulses. These negative pulses appear at the sweep stopper as positive pulses, since the discriminator output is inverted as well as amplified by the video amplifier. The sweep stopper then begins to produce a negative bias across resistor R21309 (figure 4–63). While the intermediate frequency is in the vicinity of 30 megacycles, this bias is adequate to prevent the discharge of capacitor C21310 and thus to prevent the phantastron from acting as a sawtooth generator. The phantastron therefore acts simply as a d-c amplifier. Any small change of voltage at the control grid alters the d-c drop across resistor R21311, thus adjusting the repeller voltage in such a direction as to maintain the intermediate frequency at 30 megacycles.

4–481. If the frequency of the klystron or that of the transmitted pulses varies to a point where the intermediate frequency rises above 29.8 megacycles, the bias produced by the sweep stopper rapidly disappears. The phantastron then starts a sawtooth sweep, changing the intermediate frequency to a value lower than 30.2 megacycles, and bias is again produced by the sweep stopper.

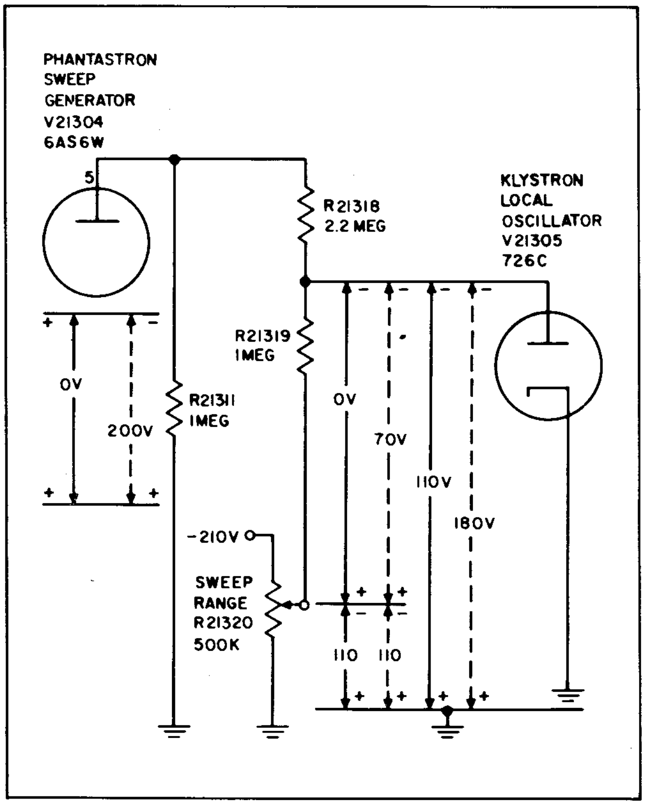

Figure 4–65. Phantastron Output Circuit, Simplified Schematic Diagram

4–482. MANUAL TUNE CONTROL. (See figure 4–63.) When control is local, manual tune relay K21301 can be actuated from the local oscillator assembly panel by placing AFC-MANUAL switch S701 in the MANUAL position. When control is remote, relay K21301 is energized from the remote control panel by placing AFC-MANUAL switch S6108 in the MANUAL position. Contacts 14 and 9 of local-remote relay K6101 are closed during remote operation. Local-remote relay K701 is energized during local operation, closing contacts 2 and 3 and 5 and 12.

4–483. When relay K21301 is energized, the output of the phantastron sweep generator, and therefore the frequency control circuits of the AFC system, are removed from the repeller anode of the klystron. Simultaneously, a negative voltage is fed to the repeller anode through contacts 4 and 5 of relay K21301. The amplitude of the voltage is adjustable at the local oscillator assembly panel or remote control panel, depending upon which unit has control, by means of MANUAL TUNE potentiometer R702 or R6105. Adjustment of this voltage permits manual adjustment of the frequency of the klystron.

4–484. Energizing relay K21301 also causes resistor R21414 in the suppressor grid circuit of the phantastron sweep generator to be shorted out by contacts 2 and 3 of relay K21301. As a result, the phantastron is prevented from operating as a sawtooth generator during manual adjustment of the klystron frequency or when failure of the AFC circuit occurs.

4–485. KLYSTRON LOCAL OSCILLATOR V21305. (See figure 4–63.) Klystron local oscillator V21305 is a conventional reflex oscillator which feeds local oscillator signals to the AFC crystal mixer from jack J21302 and to the signal crystal mixer from jack J21303. The frequency of the klystron oscillator is tuned to 30 megacycles lower than the magnetron frequency by varying the size of the resonant cavity. A tuning screw is provided for this purpose.

4–486. A 300-volt d-c accelerator voltage is supplied by the preamplifier-local oscillator power supply to the accelerator grid in the klystron through a decoupling network composed of resistor R21316 and capacitor C21313. When either AFC-MANUAL switch S701 on the local oscillator assembly panel or switch S6108 on the remote control panel is in the AFC position, the negative voltage between the repeller anode and the cathode is adjusted automatically by the frequency control circuits described previously. A more negative repeller voltage causes a higher klystron frequency, while a less negative repeller voltage causes a lower klystron frequency. When either AFC-MANUAL switch S701 on the local oscillator assembly panel or switch S6108 on the remote control panel is in the MANUAL position, the repeller voltage is adjusted by the MANUAL TUNE potentiometers described in paragraph 4–482.

4–487. MIXER AND PREAMPLIFIER (MIXER STAGE, FREQUENCY CV-218/CPS-6B AND PREAMPLIFIER AM-623/CPS-6B).

4–488. BLOCK DIAGRAM.

4–489. Local oscillator signals from the klystron local oscillator and echo signals from the waveguide assembly components are fed into the mixer (figure 4–66). These frequencies are maintained at a difference of 30 megacycles by the action of the AFC system. The frequencies are mixed in the mixer and the difference frequency of the 30-megacycle i-f signal is fed into the first i-f amplifier, V21501. The i-f signal is then fed from this amplifier to a second i-f amplifier, V21502, for further amplification. The second i-f amplifier feeds two different channels: the normal i-f channel and the moving target indicator (MTI) i-f channel.

4–490. The normal i-f channel consists of a third i-f amplifier, V21503, which feeds a fourth i-f amplifier, V21505. The fourth i-f amplifier, in turn, feeds i-f cathode follower V21506A. The output of this cathode follower is then coupled to the normal receiver.

4–491. The MTI channel consists of i-f amplifier V21504, which feeds MTI cathode follower V21506B. The MTI channel is not used in Radar Set AN/FPS-6, since this radar does not contain an MTI system. In Radar Set AN/FPS-6A, however, this channel is used as part of noise figure monitoring.

4–492. Radar Set AN/FPS-6 is required to detect targets at long distances. Thus, the radar set is given a large peak power output and a narrow i-f bandwidth. Cutting down the i-f bandwidth lowers the noise figure of the receiver. Noise limits the range of detection of a radar just as does the power output of the radar transmitter. Less transmitted power or more noise, in the form of a higher noise figure, lowers the signal-to-noise ratio of a given target. Therefore, emphasis has been placed upon obtaining as low a receiver noise figure as is practicable.

4–493. Noise is held to a minimum by using an optimum i-f bandwidth. For Radar Set AN/FPS-6, this bandwidth is 0.6 megacycle at the half-power points with the i-f output down to 3 db. In addition, the noise generated at the input to the first one or two i-f amplifiers is kept to a minimum by proper design. Since noise generated in or fed to these stages receives the most amplification, these stages are particularly important in achieving a low noise figure for the radar receiver. Another source of noise, which may be eliminated, is noise entering the mixer along with the local oscillator signal. This noise is eliminated to a large degree by the dual-crystal and dual-output-coupling arrangement used in the mixer. This arrangement, called a balanced mixer, causes cancellation of local oscillator noise between the two crystals.

4–494. CIRCUIT ANALYSIS OF MIXER AND PREAMPLIFIER.

4–495. MIXER. (See figure 4–67.) Received r-f echo pulses pass through the waveguide shorting switch and enter the mixer at E. The received r-f pulses excite coupling loops A and B in the mixer, from which the received r-f pulse energy is transmitted to mixer crystals CR21501 and CR21502. Simultaneously, c-w local

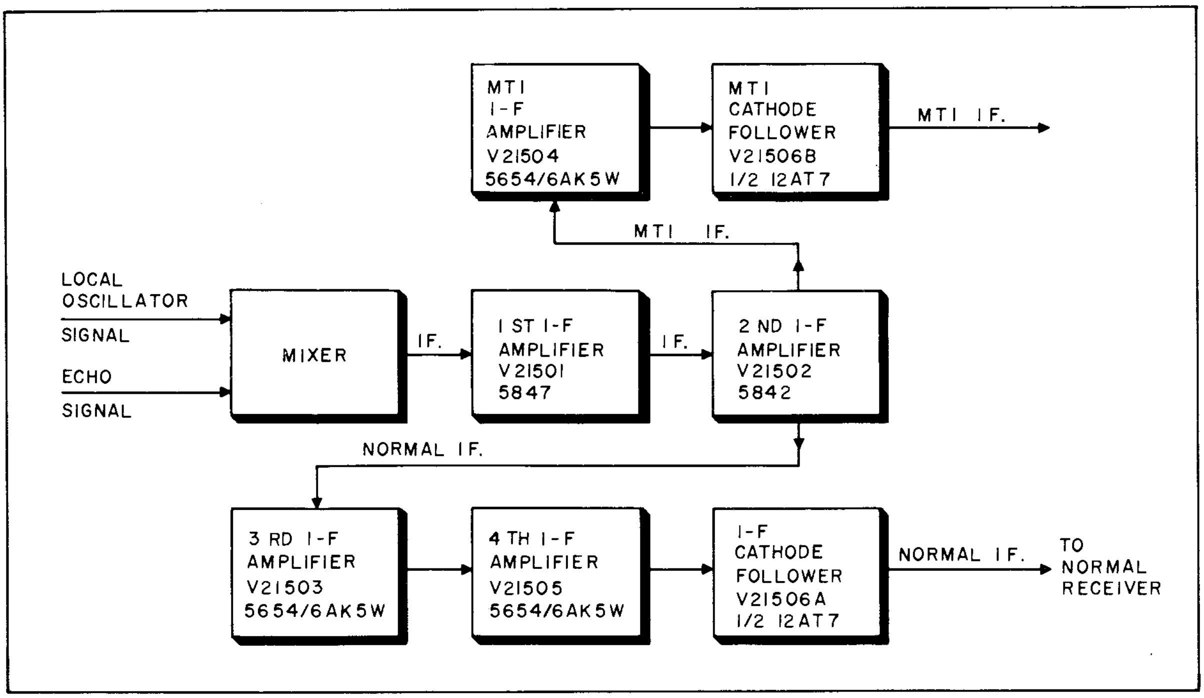

Figure 4–66. Mixer and Preamplifier, Block Diagram

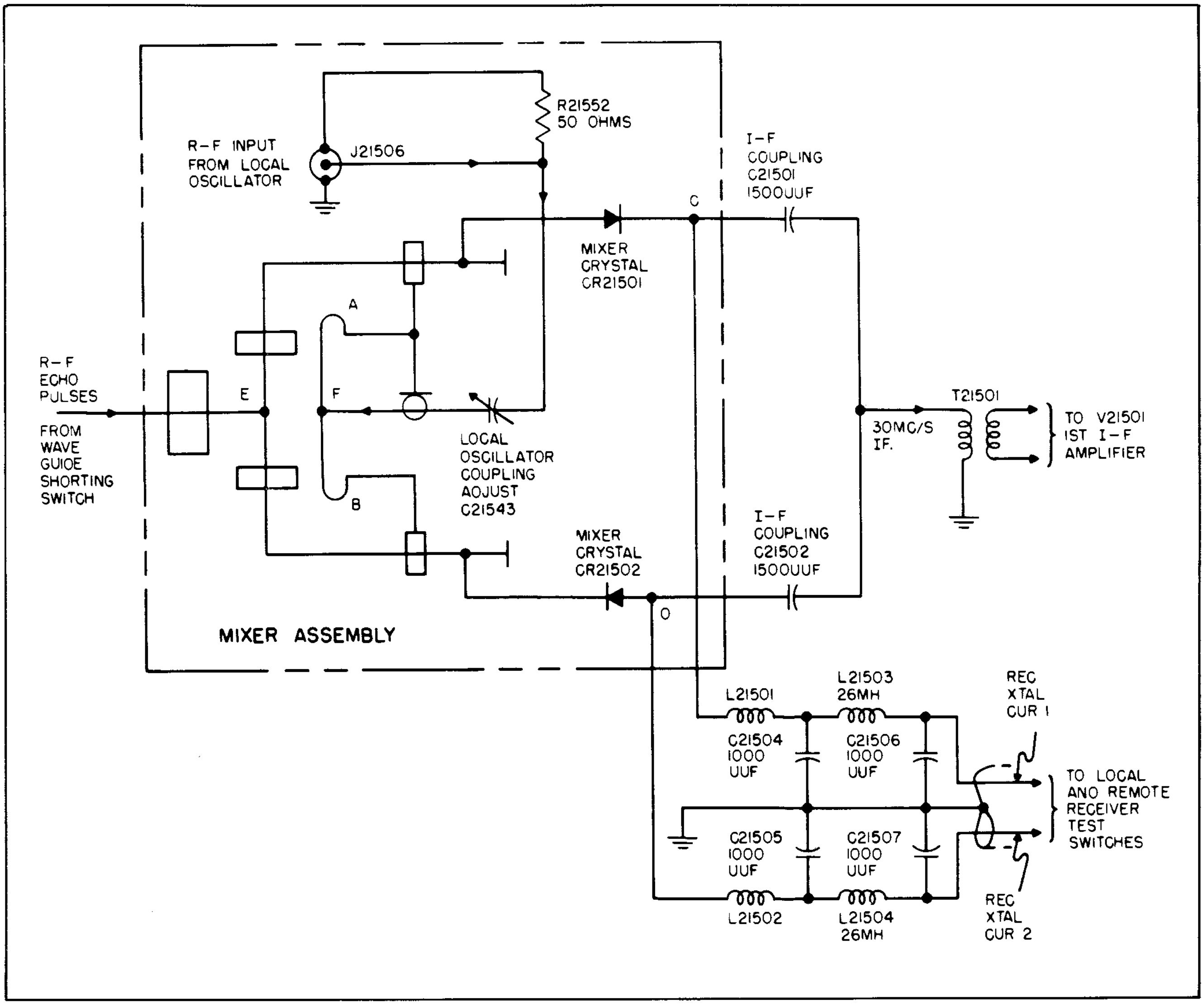

Figure 4–67. Mixer, Simplified Schematic Diagram

oscillator r-f energy, at a frequency 30 megacycles lower than the received signal frequency, is fed to the coupling loop circuits at F and from there to mixer crystals CR21501 and CR21502. Radio-frequency energy from the local oscillator enters the mixer at jack J21506. Impedance matching resistor R21522 is connected across jack J21506. Local oscillator coupling adjustment capacitor C21543 is used to regulate the amount of local oscillator r-f power which enters the mixer.

4–496. Pulsed energy at the radar carrier frequency and c-w energy at the 30-megacycle lower local-oscillator frequency are fed to each mixer crystal. Since the output circuits of the mixer crystals are tuned to the difference frequency of 30 megacycles, the output of the mixer circuit fed to transformer T21501 consists of i-f pulses, with an a-c component at the difference frequency of 30 megacycles superimposed on a d-c component. Capacitors C21501 and C21502 couple the a-c component of the mixer output to transformer T21501. The balanced arrangement of crystals CR21501 and CR21502 results in the attenuation of any noise components accompanying the local oscillator r-f input without appreciably attenuating the 30-megacycle i-f output of the mixer. The output of transformer T21501 is fed to the input circuit of i-f amplifier V21501 in the preamplifier.

4–497. The outputs of mixer crystals CR21501 and CR21502 are also tapped off at points C and D and fed to a filter network. This network attenuates the r-f and i-f components of the outputs of the mixer crystals and transmits the d-c components of the outputs of the mixer crystals to the crystal current metering circuits. The filter network consists of inductors L21501 through L21504 and capacitors C21504 through C21507.

4–498. Inductors L21501 and L21502 are self-resonant at 30 megacycles and present a high impedance to the 30-megacycle i-f components of the outputs of the two mixer crystals. Capacitors C21504 and C21505 are r-f bypass capacitors. Inductors L21503 and L21504 are 26-millihenry chokes and present a high impedance to any r-f energy which may not have been sufficiently attenuated by the preceeding network. Capacitors C21506 and C21507 are also r-f bypass capacitors. The outputs of the filter network, consisting of the filtered d-c components of the outputs of mixer crystals CR21501 and CR21502, are fed to two positions on local and remote RECEIVER TEST switches S1004 and S6111.

4–499. FIRST AND SECOND I-F AMPLIFIERS V21501 AND V21502 OF PREAMPLIFIER AM-263/CPS-6 FOR RADAR SETS AN/FPS-6 AND AN/FPS-6A. (See figure 4–68.) The first i-f amplifier, V21501, is a triode-connected, grounded cathode (conventional) amplifier which drives the cathode of a grounded grid second i-f amplifier, V21502. The i-f signal appearing across the secondary of coupling transformer T21501 is connected to the grid of i-f amplifier V21501 through parasitic suppressor L21505. This suppressor offers little impedance to a 30-megacycle signal, but very high impedance to any high-frequency oscillation appearing in this grid circuit. Resistor R21501, together with any d-c resistance belonging to the secondary of transformer T21501 and to inductor L21506, is the cathode bias resistor for i-f amplifier V21502. Capacitor C21508 bypasses resistor R21501. Resistor R21502 is the cathode bias resistor for i-f amplifier V21501 and capacitor C21510 is the cathode bypass for this tube. Tunable inductor L21508, which is self-resonant in the vicinity of 30 megacycles, is the plate load impedance for amplifier V21501. The output of amplifier V21501 drives the cathode of amplifier V21502.

4–500. Because of the grounded grid connection of amplifier V21502, the input impedance of this amplifier is relatively low. Therefore, amplifier V21502 loads amplifier V21501 heavily, causing the voltage gain of amplifier V21501 to be very low, approaching unity. Thus, neutralization of amplifier V21501 is not necessary for the stability of the first stage. Nevertheless, amplifier V21501 is neutralized by the addition of inductive feedback through inductor L21506, which resonates with the grid-plate interelectrode capacity of amplifier V21501. The addition of neutralization improves the noise figure of this stage. The power gain and the output impedance of amplifier V21501 are high, providing a good noise figure to the second i-f amplifier stage.

4–501. Tunable inductor L21510 is self-resonant in the vicinity of 30 megacycles and is the plate load impedance of amplifier V21502. Resistor R21505 loads inductor L21510 for the proper bandpass characteristic. Inductor L21508, in the plate circuit of amplifier V21501, is adequately loaded by the input impedance of amplifier

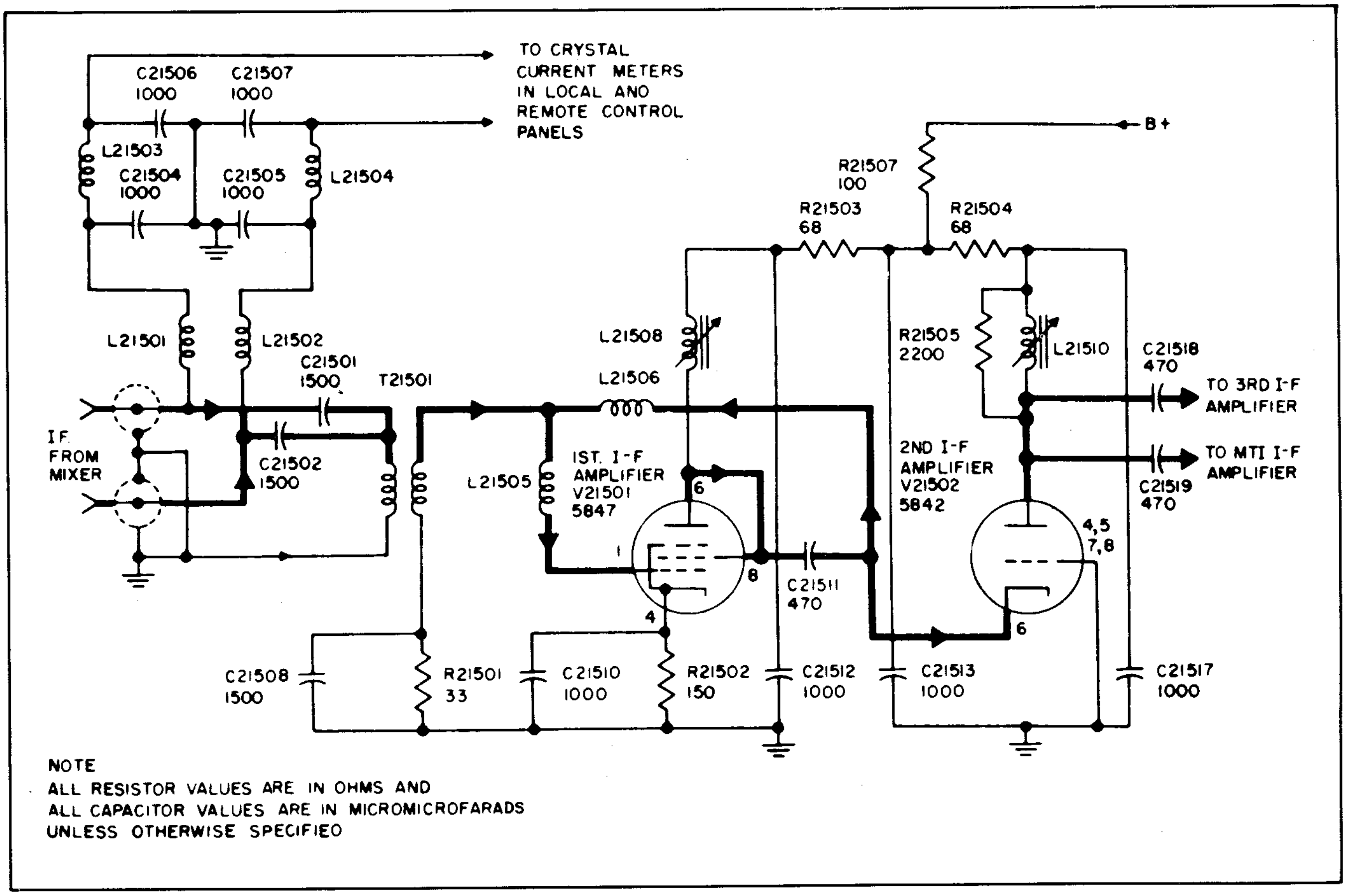

Figure 4–68. Mixer Output Coupling and First and Second I-f Amplifiers, Simplified Schematic Diagram

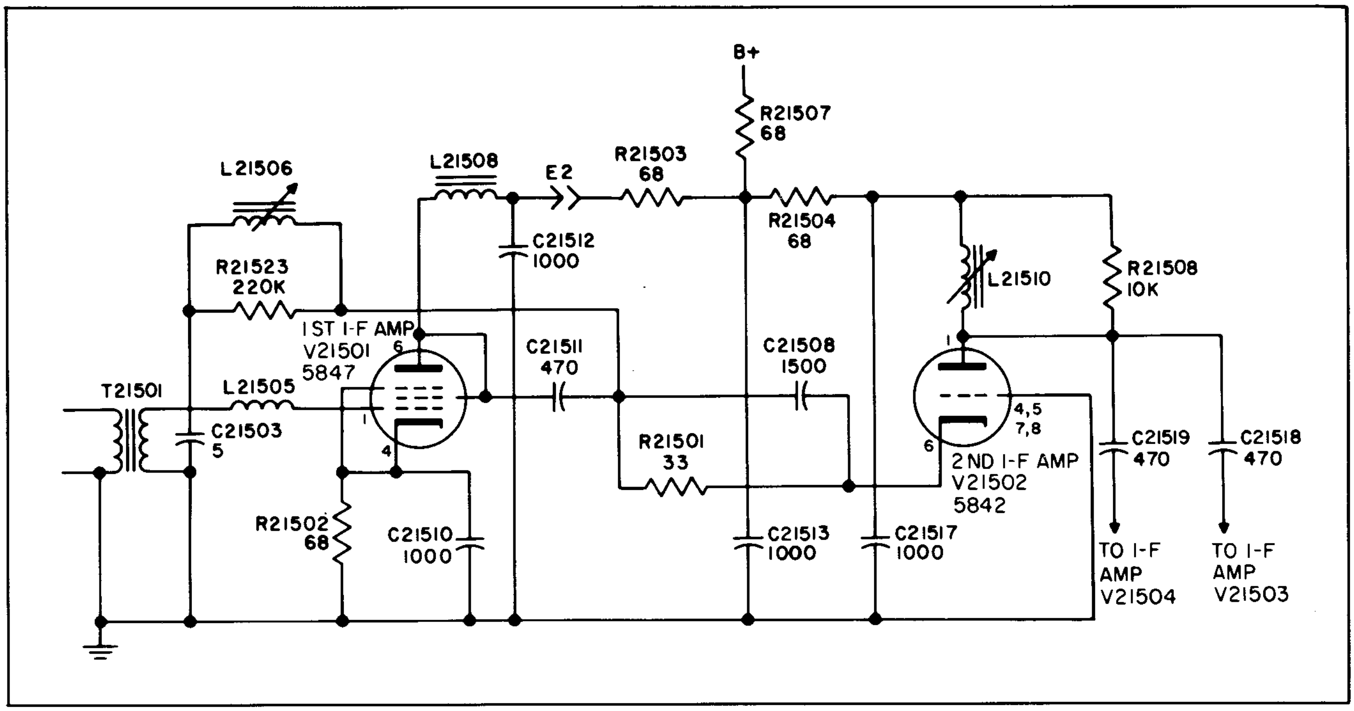

Figure 4–69. First and Second I-f Stages, Intermediate Amplifier AM-1820/CPS-6B, Simplified Schematic Diagram

V21502. Thus, no loading resistor is required. The cathode-to-plate interelectrode capacitance of amplifier V21502, which is the tube capacity that determines plate-circuit-to-grid-circuit feedback in a grounded grid amplifier, is 1.8 micromicrofarads. This capacity is small enough so that neutralization is not required. The output amplifier V21502 is fed to the third i-f amplifier and to the moving target indicator i-f amplifier through coupling capacitors C21518 and C21519, respectively. Resistors R21507, R21503, and R21504 and capacitors C21512, C21513, and C21517 form decoupling networks which prevent interaction of the various circuits through plate power leads.

4–502. FIRST AND SECOND STAGES OF PREAMPLIFIER AM-1820/CPS-6B FOR RADAR SET AN/FPS-6B. (See figure 4–69.) As in the case of Preamplifier AM-263/CPS-6 (paragraph 4–499), the first amplifier, V21501, is a conventional, grounded cathode triode stage. This stage is followed by a grounded grid stage using amplifier V21502. Preamplifier AM-1820/CPS-6B is designed for use with IN21E crystals rather than IN21C crystals. The most satisfactory noise figure can be obtained only with the IN21E crystals. Capacitor C21503, together with tube and circuit capacitance, tunes the secondary of transformer T21501 to 30 megacycles. The signal appearing across the secondary of transformer T21501 is connected to the grid of amplifier V21501 through parasitic suppressor L21505. This suppressor offers little impedance to a 30-megacycle signal, but very high impedance to any high-frequency oscillation appearing in this grid circuit. Resistor R21502 is the cathode bias resistor for amplifier V21501 and capacitor C21510 is the cathode bypass for this tube. Inductor L2108, which is resonant to 30 megacycles, is the plate load impedance for amplifier V21501.

4-503. The output of amplifier V21501 drives the cathode of amplifier V21502 through capacitors C21511 and C21508. This cathode circuit loads the output of amplifier V21501 sufficiently to make a loading resistor unnecessary. Resistor R21501, the d-c resistance of inductor L21506, and the d-c resistance of the secondary of transformer T21501 develop the bias for amplifier V21502. Inductor L21506 is the neutralizing inductance for amplifier V21501. This inductance is used to balance out any output voltage fed to the input circuit of the stage through tube interelectrode capacitance. Resistor R21523 makes the bandwidth of the neutralizing circuit broad enough to be effective over the bandwidth of the preamplifier. Spark gap E21502 removes plate voltage from amplifier V21501 when the stage is being neutralized. Tunable inductor L21501, which is self-resonant in the vicinity of 30 megacycles, is the plate load for amplifier V21502. Resistor R21505 loads the resonant circuit to provide sufficient bandwidth.

4–504. The cathode-to-plate interelectrode capacitance of amplifier V21502, which is the tube capacity that determines plate-circuit-to-grid-circuit feedback in a grounded grid amplifier, is small enough (1.8 micromicrofarads) not to require neutralization. The output of amplifier V21502 is fed to the third amplifier and to the moving target indicator i-f amplifier through coupling capacitors C21518 and C21519, respectively. Resistors R21507, R21503, and R21504 and capacitors

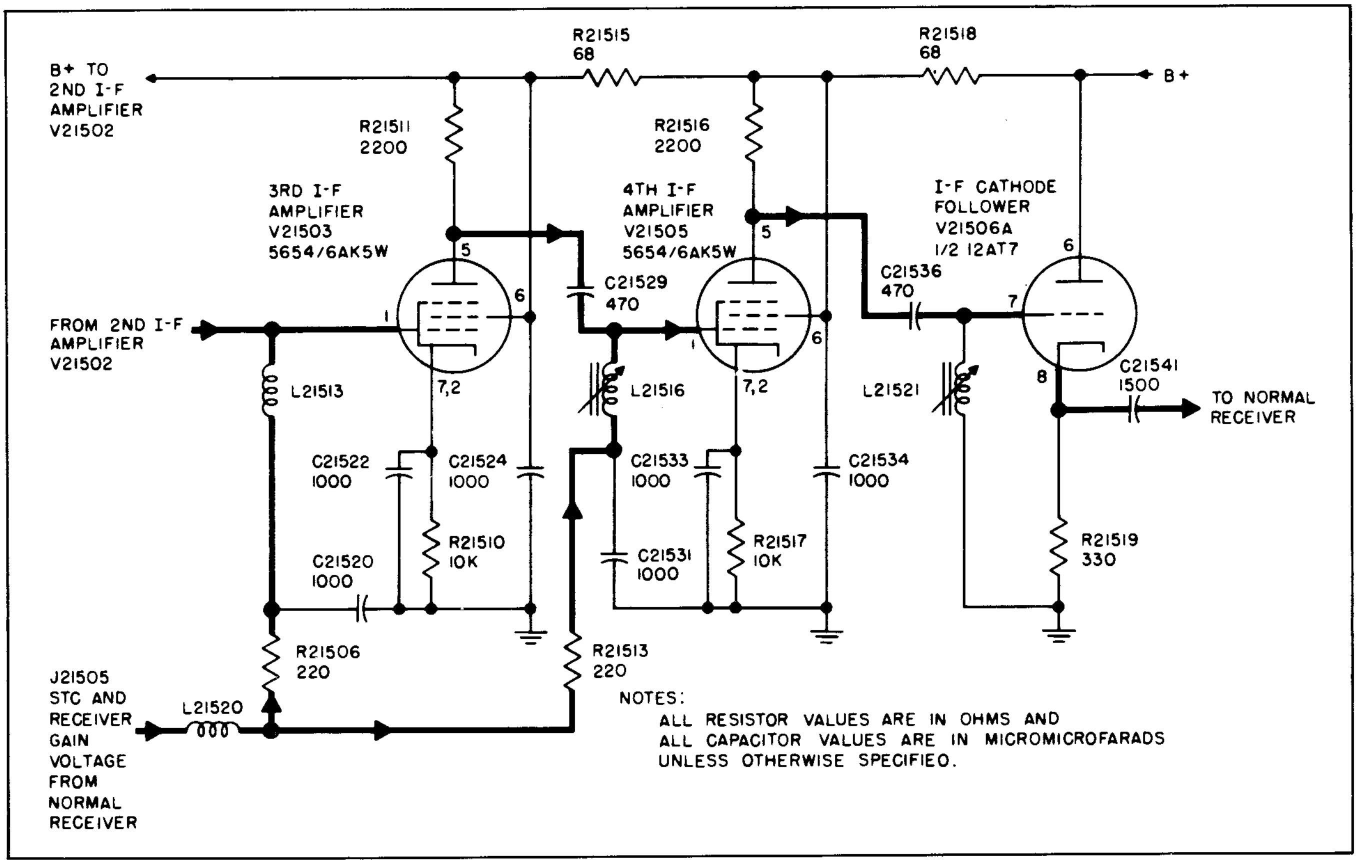

Figure 4–70. Third and Fourth I-f Amplifiers and I-f Cathode Follower, Simplified Schematic Diagram

C21512, C21513, and C21517 form decoupling networks which prevent interaction of the various circuits through plate power leads.

4–505. THIRD AND FOURTH I-F AMPLIFIERS V21503 AND V21505 AND CATHODE FOLLOWER V21506A. (See figure 4–70.) The third and fourth i-f amplifier circuits are similar. The principal difference between these circuits is that the d-c grid return of amplifier V21503 is through untuned inductor L21513, while the return of amplifier V21505 is through self-resonant tunable inductor L21516, which resonates in the vicinity of 30 megacycles. Both d-c grid returns pass through decoupling networks composed of resistor R21506 and capacitor C21520 and resistor R21513 and capacitor C21531, respectively. The grid returns then pass through choke L21520, terminating at jack J21505. At this jack, a sensitivity time control (STC) and gain voltage from the normal receiver is fed into the preamplifier. The gain of the 6AK5 tube varies as the bias voltage varies, becoming smaller as the bias becomes less positive. Thus, as the d-c voltage provided by the STC and gain system varies, the gain of the third and fourth i-f amplifers varies.

4–506. Amplifier V21503 is capacitively coupled to amplifier V21505 by capacitor C21529. Resistors R21510 and R21517 are cathode bias resistors and capacitors C21522 and C21533, respectively, are their bypass capacitors. Resistors R21511 and R21516 are plate load resistors. Capacitors C21524 and C21534, serving as screen bypass capacitors, form decoupling networks in the plate power line in conjunction with resistors R21515 and R21518.

4–507. The output from the plate of amplifier V21505 is fed through coupling capacitors C21536 to cathode follower V21506A. The cathode follower contains a self-resonant inductor, L21521, in its grid circuit which enables the cathode follower to be tuned to 30 megacycles. Resistor R21519 is the cathode load resistor. The output from the cathode of cathode follower V21506A is fed through coupling capacitor C21541 to a long cable which connects the preamplifier chassis to the normal receiver. Because of the long distance between the two chassis, the very low output impedance of a cathode follower is desired.

4–508. MOVING TARGET INDICATOR I-F AMPLIFIER V21504 AND CATHODE FOLLOWER V21506B. (See figure 4–71.) The moving target indicator i-f channel is used for the noise figure monitor in Radar Set AN/FPS-6A. Amplifier V21504 is a conventional pentode i-f amplifier which derives class A bias from cath-

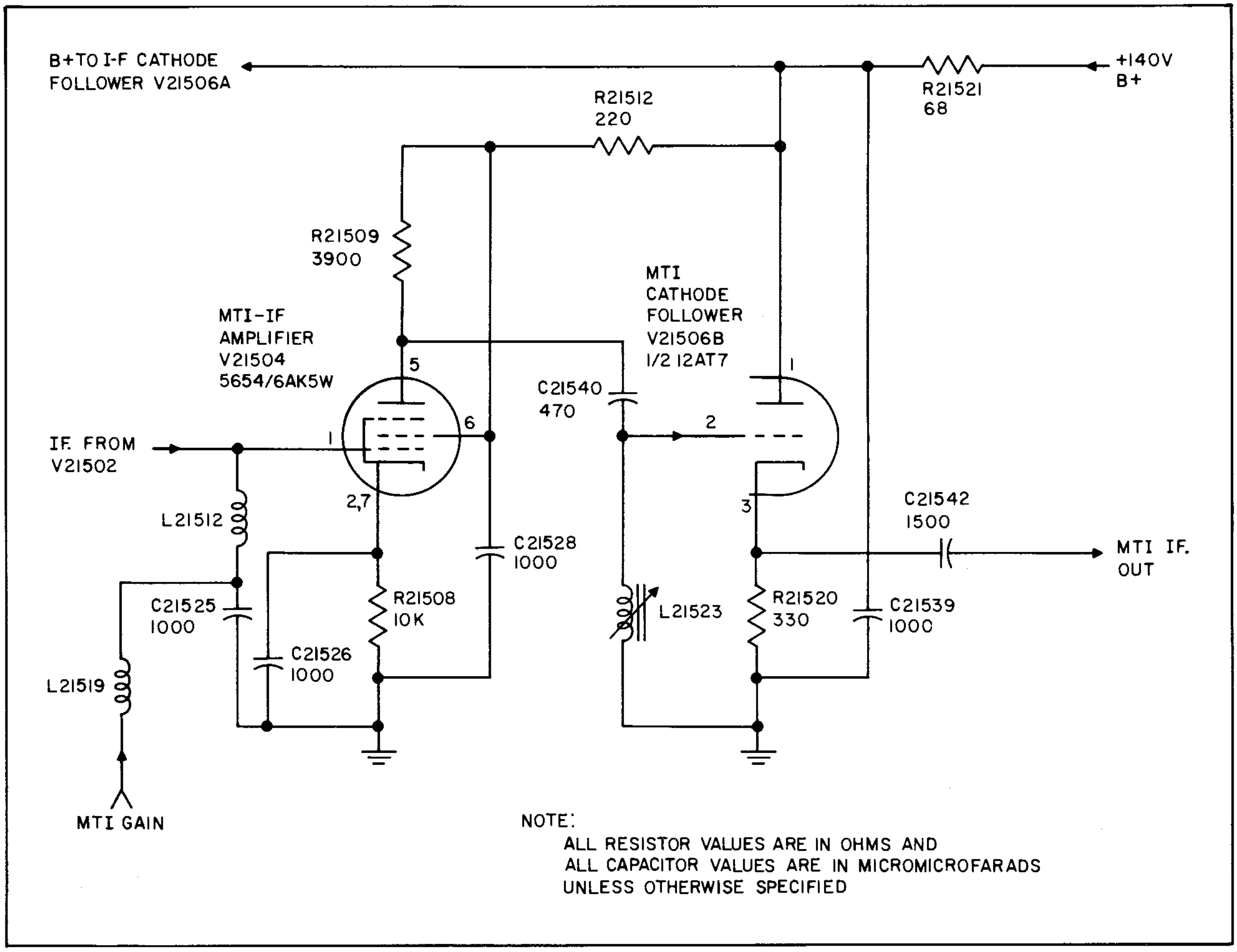

Figure 4–71. Moving Target Indicator I-f Amplifier and Cathode Follower, Simplified Schematic Diagram

ode resistor R21508. Capacitor C21526 bypasses resistor R21508. Capacitor C21528 serves as the screen bypass and forms a decoupling network in the plate power line in conjunction with resistor R21512. The d-c return from the grid is made through chokes L21512 and L21519 to MTI GAIN jack J21504. At this jack, a variable positive d-c voltage is supplied by the associated search radar to control the gain of the moving target indicator i-f amplifier. Resistor R21509 is the plate load resistor.

4–509. The output taken from the plate of amplifier V21504 is fed through coupling capacitor C21540 to cathode follower V21506B. The cathode follower contains self-resonant inductor L21523 in its grid circuit which enables the cathode follower to be tuned to 30 megacycles. Resistor R21520 is the cathode load resistor. The output from the cathode of cathode follower V21506B is coupled through capacitor C21542 to MTI IF OUT jack J21503. Resistor R21521 and capacitor C21539 form a decoupling network in the plate power lead. The cathode follower is used because of the likelihood that a long cable will be used to connect jack J21503 to the MTI receiver. Therefore, the very low output impedance of a cathode follower is desired.

4–510. NORMAL RECEIVER (AMPLIFIER, INTERMEDIATE FREQUENCY AM-622/CPS-6B).

4–511. BLOCK DIAGRAM. (See figure 4–72.)

4–512. Intermediate signals from the preamplifier are fed into the normal receiver and applied to the grid of the fifth i-f amplifier, V21701. Two variable bias voltages are also applied to the grid of amplifier V21701 in order to vary the gain of the stage, and therefore the gain of the normal receiver. The first of these bias voltages is the i-f gain voltage. Manual control of this voltage is provided by the RECEIVER GAIN potentiometers in the local and remote control units. The second bias voltage is that produced by the STC circuits in the normal receiver. This voltage automatically and continuously adjusts the gain of the receiver during the

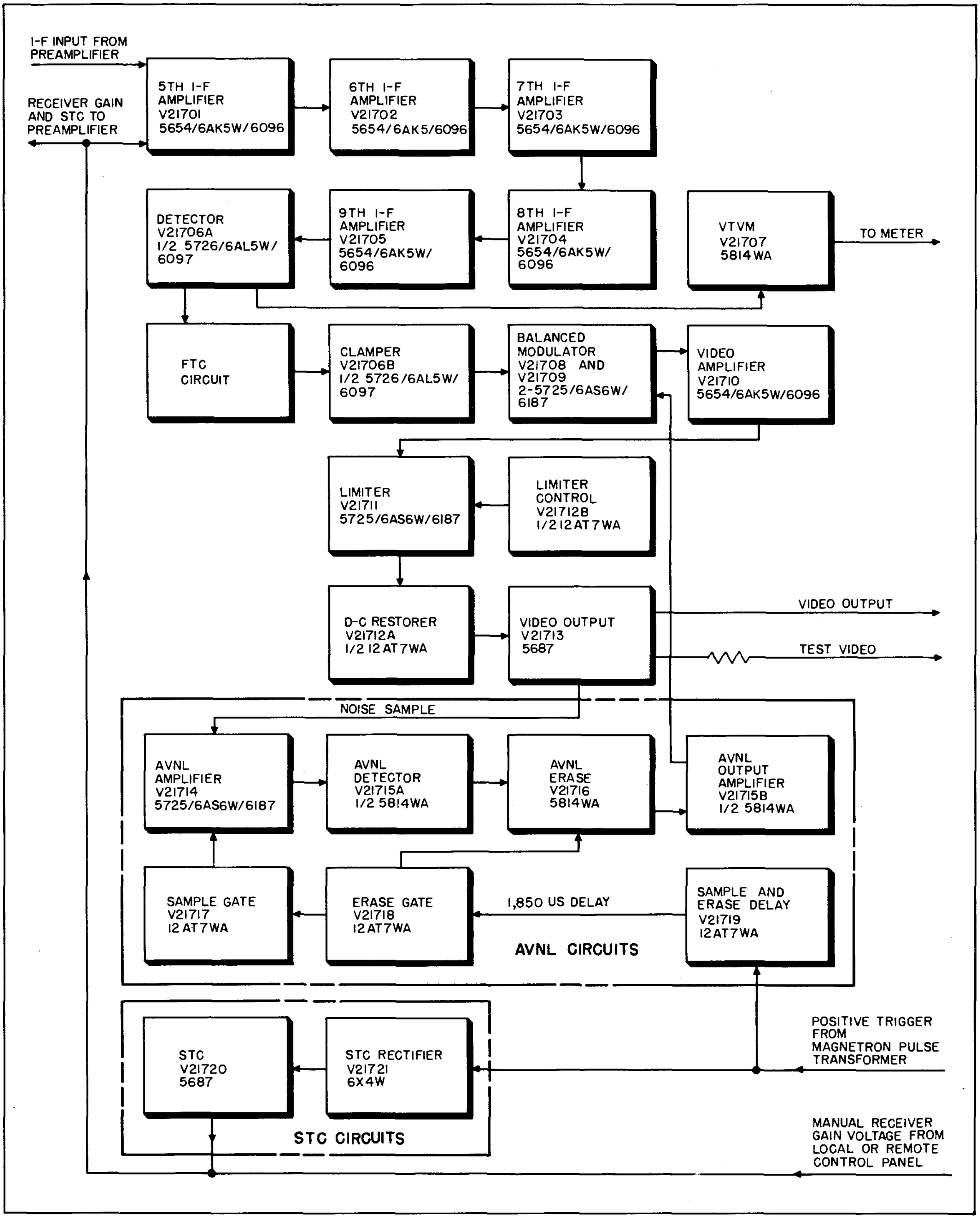

Figure 4–72. Normal Receiver, Block Diagram

period between pulses. When echoes are returning from nearby targets, and are therefore powerful signals, the gain of the receiver is reduced by the STC action. When echoes are returning from distant targets, and thus are weak, STC action increases the receiver gain. Since control of the fifth i-f amplifier alone does not produce sufficient change in gain, the receiver gain voltage and the STC voltage are also fed to the third and fourth i-f amplifiers in the preamplifier (figure 4–70).

4–513. After amplification by the fifth i-f amplifier, the i-f signal is amplified successively by the sixth, seventh, eighth, and ninth i-f amplifiers, V21702, V21703, V21704, and V21705, respectively. The ninth amplifier feeds detector V21706A, which rectifies the i-f signal, filters out the 30-megacycle component of the rectified i-f signal, and delivers the resulting video pulses to the fast time constant (FTC) circuit. A part of the video pulse voltage is applied to vacuum tube voltmeter (VTVM) V21707. The VTVM can be connected to a milliammeter with a range of 0 to 1 milliamperes on the remote control panel or to a similar milliammeter on the local control panel. The VTVM measures the magnitude of the video voltage at the detector for test purposes.

4–514. The FTC circuit is an arrangement offering a choice of two different RC coupling networks to the next stage, clamper V21706B. The first RC network is used when good receiving conditions prevail. This network has a long time constant compared to the time of duration of the video pulses, thus the video pulses pass through to the clamper without distortion. The second RC network has a short (fast) time constant and differentiates the video pulses before passing them on to the clamper. This differentiating action is used under conditions of jamming or severe nonjamming interference and eliminates a great deal of such interference. The video pulses applied to the FTC circuit are negative-going, and the function of the clamper is to maintain the output of the FTC circuit as a series of negative pulses clamped to 0 volt as a reference level. The negative video pulses from the clamper are applied to balanced modulator V21708 and V21709. The FTC circuits can be disabled by setting the FTC switch on the remote control panel to the OFF position.

4–515. The balanced modulator contains an amplifier for the video pulses coming from the clamper. The gain of this amplifier is controlled during the period between pulses by a voltage dependent upon the amount of noise entering the receiver. This control voltage is produced by the automatic video noise limiting (AVNL) circuits. The AVNL control voltage is applied intermittently to the amplifier and, in addition to varying its gain, causes pulses in the amplifier output. These pulses, if allowed to pass through the remainder of the normal receiver, would cause the appearance of a false target on the radar presentation. Therefore, the pulses must be removed. The additional tube, V21708, in the balanced modulator is a compensating device to which the control voltage from the AVNL circuit is also applied. The compensating tube produces pulses in its output which cancel the pulses produced in the amplifier tube. The combination of amplifier tube and compensating tube is the balanced modulator. The amplifier video output is fed to and amplified by video amplifier V21710. The output from amplifier V21710 is applied to limiter V21711.

4–516. Limiter V21711 is a video amplifier operated near the saturation point on its characteristic curve, so that large signals produce little more output than small signals. This limiting action prevents the passage of very large signals which would block the grids of subsequent video amplifiers. The screen voltage of the limiter, which is critical for proper limiting action, is set by limiter control tube V21712B. The output of the limiter drives d-c restorer V21712A. The d-c restorer clamps the video pulses from the limiter to a negative bias voltage reference line and feeds video output amplifier V21713. The video output is fed to a coaxial cable leading to the interference blanker. A portion of the video output is also fed to AVNL amplifier V21714.

4–517. The AVNL circuits set the gain of the entire normal receiver in accordance with the prevailing noise conditions so that, during a period between transmitted pulses, the gain of the receiver is as high as the noise present in the receiver will permit. The AVNL circuits can be disabled by placing the AVNL switch on the remote control panel in the OFF position.

4–518. AVNL amplifier V21714 amplifies the noise present in the video output and feeds it to AVNL detector V21715A. The detector produces a d-c voltage in accordance with the amplitude of the noise. This voltage is applied to AVNL output amplifier V21715B. The output from amplifier V21715B is applied to the balanced modulator, controlling its gain, and thus controlling the gain of the normal receiver.

4–519. Sample and erase delay V21719, erase gate V21718, and sample gate V21717 act together to allow the AVNL circuit to take a fresh sample of noise conditions during each period between transmitted pulses. In order to accurately sample the amount of noise, a sampling time is selected when a target return is least likely; that is, as far out in range as is practicable. This is the interval of range sweep between approximately 150 and 200 nautical miles. A positive trigger pulse from the magnetron pulse transformer, synchronized with the main bang, enters the sample and erase delay circuit. The sample and erase delay circuit produces a positive pulse at the input to the erase gate approximately 1850 microseconds later (150 miles of range). The erase gate actuates the AVNL erase circuit so that the previous sample of noise in the AVNL detector is erased. This erasure continues for 90 microseconds. Then, when the range sweep is at 157 miles, the erase gate delivers a positive pulse at the input to the sample gate. The positive pulse turns on the AVNL amplifier for 525 microseconds and then turns it off. During this interval, corresponding to the passage of the range sweep from 157 miles to 200 miles, the AVNL amplifier takes a fresh noise sample and passes it on to the AVNL detector.

4–520. The positive trigger pulses from the magnetron pulse transformer also trigger the action of the STC circuit composed of STC rectifier V21721 and STC tube V21720. The STC circuit produces a voltage in series with the receiver gain voltage and of such a waveform that the gain of the normal receiver is lowered during the interval of the range sweep corresponding to nearby targets, and is increased progressively as the sweep moves out to more and more distant ranges. This reduction of gain at short ranges reduces clutter, which is the appearance of extremely intense target indications on the radar indicator at short ranges. Clutter is caused by the great strength of echo signals from objects (like the ground, trees, etc.) located at short distances from the radar. Clutter masks true target indications and is therefore undesirable. The STC circuits can be disabled by operating the STC switch on the remote control panel to the "OFF" position.

4–521. CIRCUIT ANALYSIS OF NORMAL RECEIVER.

4–522. FIFTH I-F AMPLIFIER V21701. (See figure 4–73.) The i-f signal from the preamplifier is applied to the grid of fifth i-f amplifier V21701 through coupling capacitor C21701 and across self-resonant, tunable inductor L21715 (tuned to 30 megacycles). Resistors R21701 and R21702 in parallel terminate the coaxial line from the preamplifier in its surge impedance value (93 ohms). The positive receiver gain and STC voltage is applied to the grid through inductor L21715. Capacitor C21702 functions as a bypass capacitor. The value of the receiver gain voltage is determined by the setting of RECEIVER GAIN potentiometer R6103 on the remote control panel or RECIEVER GAIN potentiometer R1003 on the local control panel. The STC circuits are covered in paragraph 4–552. Cathode resistor R21703, bypassed by capacitor C21703, provides a negative grid bias. The d-c grid return is through the STC circuit. Capacitor C21704 is the screen bypass and forms a decoupling network in the plate supply (B+) line in conjunction with resistor R21705. Resistor R21704 is the plate load resistor. The amplified i-f signal is coupled to the next stage through capacitor C21705.

4–523. SIXTH I-F AMPLIFIER V21702. (See figure 4–73.) The i-f signal from the previous stage is applied to the grid of sixth i-f amplifier V21702 across the tuned circuit composed of inductor L21702 and capacitor C21702 (tuned to 30 megacycles). Cathode resistor R21707, bypassed by capacitor C21708, develops a very high negative bias. The grid return is through inductor L21701 to the STC circuit. The total of the cathode bias and the bias voltage from the receiver gain and STC circuits has a considerable effect on the gain of the stage. The use of a very high cathode resistance enables this stage to provide a certain amount of limiting action in the presence of very strong i-f signals. Such signals tend to drive the grid positive, thus increasing the plate current and the grid bias. This increase in grid bias lowers the mu of the tube, and therefore the gain of the stage. Capacitor C21709 is the screen bypass and, together with resistor R21709, also provides decoupling in the B+ line. Resistor R21708 is the plate load resistor. The amplified i-f output is coupled to the next stage through capacitor C21710.

4–524. SEVENTH, EIGHTH, AND NINTH I-F AMPLIFIERS V21703, V21704, AND V21705. (See figure 4–73.) These stages are similar to sixth i-f amplifier V21702, except that a voltage divider composed of resistors R21725, R21726, and R21727 provides additional bias for the grids of the eighth and ninth i-f amplifiers, V21704 and V21705. Additional bias for the grid of seventh i-f amplifier V21703 is provided by the RECEIVER GAIN and STC control circuits through inductor L21701 and resistor R21710. The action of the seventh i-f amplifier is therefore similar to that of the sixth i-f amplifier in that its bias level causes a reduction in gain when strong i-f signals are introduced. The output from the plate of the ninth i-f amplifier is coupled through capacitor C21725 to detector V21706A.

4–525. DETECTOR V21706A. (See figure 4–74). The i-f output from the ninth i-f amplifier is applied across the diode detector V21706A. The detector is in parallel with the tuned circuit composed of inductor L21706 and capacitor C21726 (resonant at 30 megacycles). The negative-going half of the i-f signal causes the diode to conduct, so that the negative half of the i-f signal is reproduced across load resistor R21722. The 30-megacycle component of this signal, however, is bypassed by capacitor C21728 and is further prevented from reaching resistor R21722 by the action of inductor L21707. This inductor is both self- and parallel-resonant at 30 megacycles and therefore presents a very high impedance to this frequency. The resulting signal across resistor R21722 is the negative half of the modulation envelope of the i-f signal, a series of video pulses plus any interfering signals, and noise.

4–526. VACUUM TUBE VOLTMETER (VTVM) V21707. (See figure 4–74.) The two triode sections of tube V21707 are connected in a bridge-type VTVM circuit. The cathodes of tube V21707 can be connected to the milliammeter on the local or remote control panel. (Polarity is indicated on the figure.) When the voltage drop across cathode resistor R21723 is equal to that across parallel combination cathode resistors R21724 and R21800, there is a zero voltage across the milliammeter, which reads zero. The grid of tube V21707B is returned to ground through METER ZERO ADJUST potentiometer R21790. The grid of tube V21707A is returned to ground through resistor R21722, across which the signal output from the detector appears. When such a signal appears, the grid of tube V21707A becomes more negative than previ-

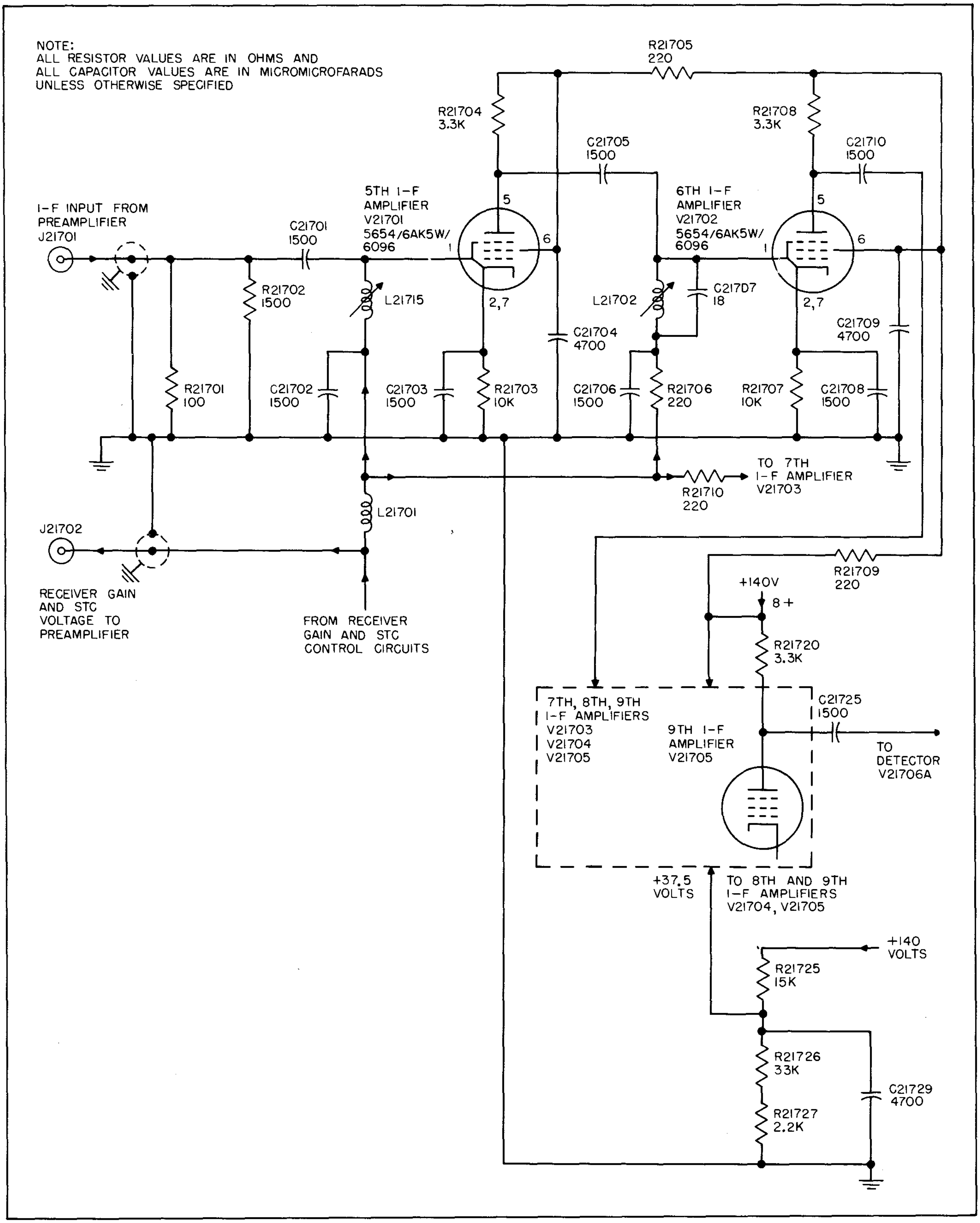

Figure 4–73. Normal Receiver I-f Amplifier, Simplified Schematic Diagram

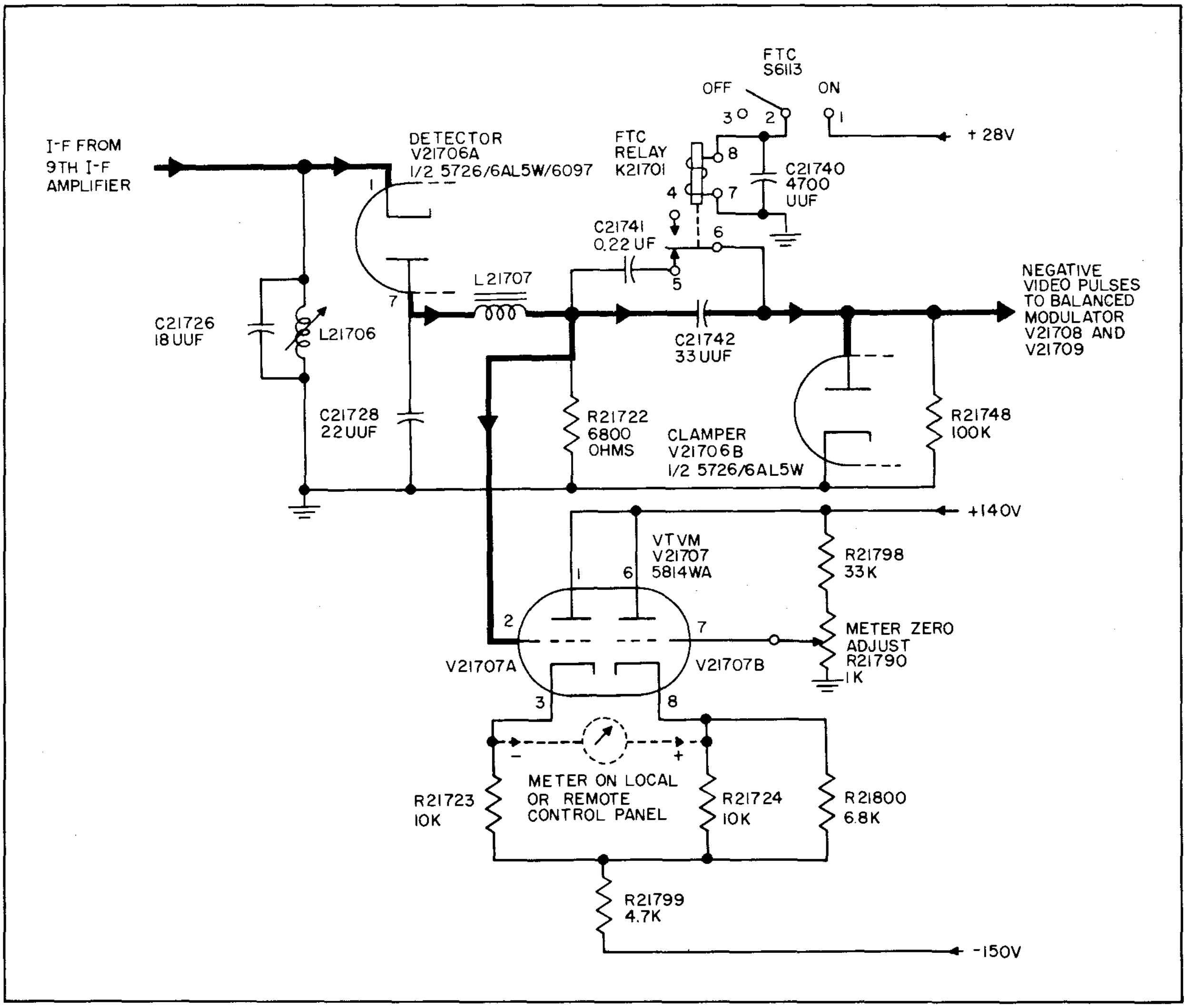

Figure 4–74. Detector, FTC, Clamper, and VTVM, Simplified Schematic Diagram

ously and the current through cathode resistor R21723 decreases, lowering the voltage drop across the resistor. This places the potential of the cathode of tube V21707B, causing the meter to read. The VTVM allows a reading of the relative magnitude of the detector output for test purposes. The meter zero can be set by adjusting METER ZERO ADJUST potentiometer R21790.

4–527. FAST TIME CONSTANT (FTC). (See figure 4–74.) FTC relay K21701 is actuated by placing FTC-ON-OFF switch S6113 on the remote control panel in the ON position. When this relay is in its de-energized position (FTC OFF), video signals appearing across resistor R21722 are coupled to the next stage, clamper V21706B, through the parallel combination of capacitors C21741 and C21742, and appear across resistor R21748. The time constant of the parallel combination of these capacitors with resistor R21748 is long compared with the video signals. Thus, the video signals pass through without being differentiated or distorted. When relay K21701 is energized (FTC ON), capacitor C21741 is removed from the circuit. The time constant of the coupling circuit is then very short, approximately 3.3 microseconds. Thus, signals with a longer duration than 3.3 microseconds are differentiated as they are transmitted through the coupling circuit. The FTC coupling circuit is used in the presence of jamming or excessive ground clutter. The 2-microsecond echo signals pass through the differentiating network unaltered, whereas jamming signals of long duration are converted into brief pulses with little ability to mask the desired echo signals. Clutter, which behaves somewhat like a lengthy pulse, is also greatly reduced by the differentiating action.

4–528. CLAMPER V21706B. (See figure 4–74.) Negative pulses from the FTC circuit are applied across diode clamper V21706B. These negative pulses drive the plate of the diode more negative than the cathode, so that clamper V21706B does not conduct, and therefore has no effect upon the circuit. However, capacitors

C21742 and C21741 accumulate a charge during the passage of long signals or blocks of signals. When this charge discharges through resistor R21748, a large positive voltage is produced which tends to mask any small negative pulses. This positive voltage is removed by the diode clamper, which conducts and discharges the coupling capacitors rapidly through its low cathode-to-plate resistance.

4–529. BALANCED MODULATOR V21708 AND V21709. (See figure 4–75.) Tube V21709 functions as a low gain video amplifier, with its gain controlled during the period between transmitted pulses by a d-c voltage on the suppressor grid. This voltage is the AVNL voltage derived from the AVNL circuit. Tube V21708 functions as a compensating device which prevents a change in the total plate current of tube V21709 as the result of a change in the AVNL voltage. Compensation of this kind is necessary because the AVNL voltage is gated off and on. The suppressor grid of tube V21709 is kept negative by the AVNL voltage during most of the period between transmitted pulses by an amount depending upon noise conditions in the received signal. However, the AVNL voltage is gated off for a 90-microsecond interval in each period between transmitted pulses, returning the suppressor grid to zero voltage. When the negative suppressor grid voltage is again gated on, the voltage at the plate of tube V21709 rises suddenly. If allowed to reach the radar indicating circuits, this voltage pulse would cause the appearance of a false target. However, at the same time that this positive pulse of voltage is appearing at the plate of tube V21709, the gated AVNL voltage is also being applied to the suppressor grid of tube V21708. The AVNL voltage causes the screen current of tube V21708 to rise, since fewer electrons can reach the plate due to the negative suppressor grid. The increased screen current then flows through resistor R21796, the plate load resistor for tube V21709, lowering the plate voltage of this tube. If the cathode bias of tube V21708, obtained across resistor R21797 and MOD BAL resistor R21747, is properly adjusted, the increase in the voltage at the plate of tube V21708 (due to the negative suppressor grid voltage pulse at tube V21709) is exactly offset by the decrease in plate voltage at tube V21709 (due to the increased screen current of tube V21708).

4–530. MOD BAL control R21747 is provided to allow adjustment of the cathode bias. Resistor 21744 is a plate-dropping resistor for both modulator tubes. Capacitor C21739 acts to maintain a constant voltage at the junction of resistor R21744 and resistors R21796 and R21746. Resistor R21746 is the plate load resistor for tube V21708. Resistor R21743 is a screen-dropping resistor and capacitor C21737 is the screen bypass.

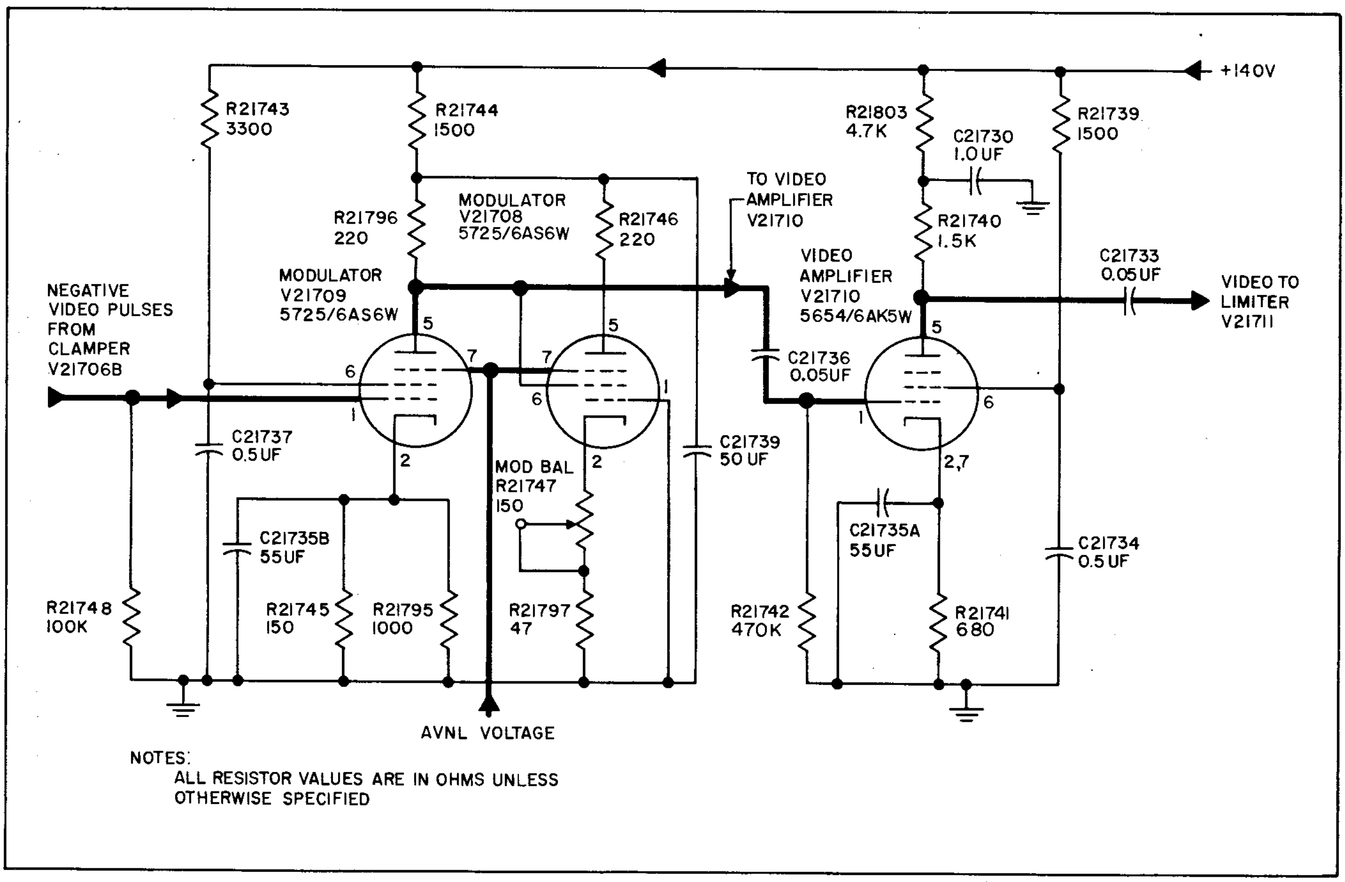

Figure 4–75. Balanced Modulator and Video Amplifier, Simplified Schematic Diagram

Cathode bias for tube V21709 is obtained across the parallel combination of resistors R21745 and R21795, bypassed by capacitor C21735B.

4–531. During the time that the AVNL voltage is gated on, so that the voltage at the suppressor grid of tube V21709 is negative, the gain of tube V21709 is reduced below its optimum value. The gain is reduced because the negative suppressor-grid voltage diverts electrons from the plate to the screen, reducing the plate current. Thus, changes in plate current, caused by the video signals at the control grid of tube V21709, are smaller than these changes would be with the suppressor grid at zero potential. The AVNL voltage is gated on during the entire interpulse interval, except when the range sweep is between 150 and 157 miles. A fresh noise sample is taken each time the range sweep goes from 157 to 200 miles. The noise sample controls the receiver gain until the range sweep again reaches 150 miles in the next interpulse period. More noise causes smaller normal receiver gain, while less noise causes more gain. As the range sweep goes from 150 to 157 miles, the old noise sample is erased, and the positive-going video pulse output is taken from the plate of tube V21709 and fed to video amplifier V21710.

4–532. VIDEO AMPLIFIER V21710 (See figure 4–75.) Tube V21710 is connected in a standard video amplifier circuit. Cathode bias is obtained across resistor R21741, bypassed by capacitor C21735A. Resistor R21739 is the screen-dropping resistor and the screen bypass is capacitor C21734. Coupling from the previous stage is through capacitor C21736. Resistor R21742 is the grid return. The negative-going video pulse output is taken from the plate and coupled to limiter V21711 through capacitor C21733. Capacitor C21730, and resistor R21803 in series with plate load resistor R21740, provide decoupling in the plate circuit of amplifier V21710.

4–533. LIMITER V21711. (See figure 4–76.) The negative-going video pulses arriving at the grid of limiter V21711 vary in amplitude from those which are approximately at noise level to those which are of very large amplitude. The weakest pulses must be amplified to a level sufficient to actuate the RHI circuits without allowing the stronger signals to block the grids of subsequent video amplifiers. The limiter operates as a video amplifier at or near the cutoff point of its characteristic curve, so that the output of the limiter, for either small or large signals, is nearly constant. The dynamic range of this output, which is the difference between the amplitudes of the largest and the smallest signal outputs, can be adjusted by varying the screen voltage of the limiter. A change in screen voltage moves the operating point on the limiter characteristic curve either closer to (smaller dynamic range) or farther from (larger dynamic range) the saturation point. Setting the dynamic range also sets the limit level (the level of signal at which the limiter will start to limit). Self-adjusting bias is derived from grid-leak resistor R21738. Capacitor C21732 is the screen bypass and resistor R21737 is the plate load resistor. A positive-going pulse is fed through coupling capacitor C21731 to d-c restorer V21712A and to video output tube V21713A.

4–534. LIMITER CONTROL V21712B. (See figure 4–76.) Limiter control V21712B is connected as a cathode follower. Cathode load resistor R21733 serves as a source of voltage for the screen of limiter V21711 and this screen voltage is controlled by varying the d-c voltage at the grid of the limiter control. Resistor R21734, LIMIT LEVEL control potentiometer R21735,

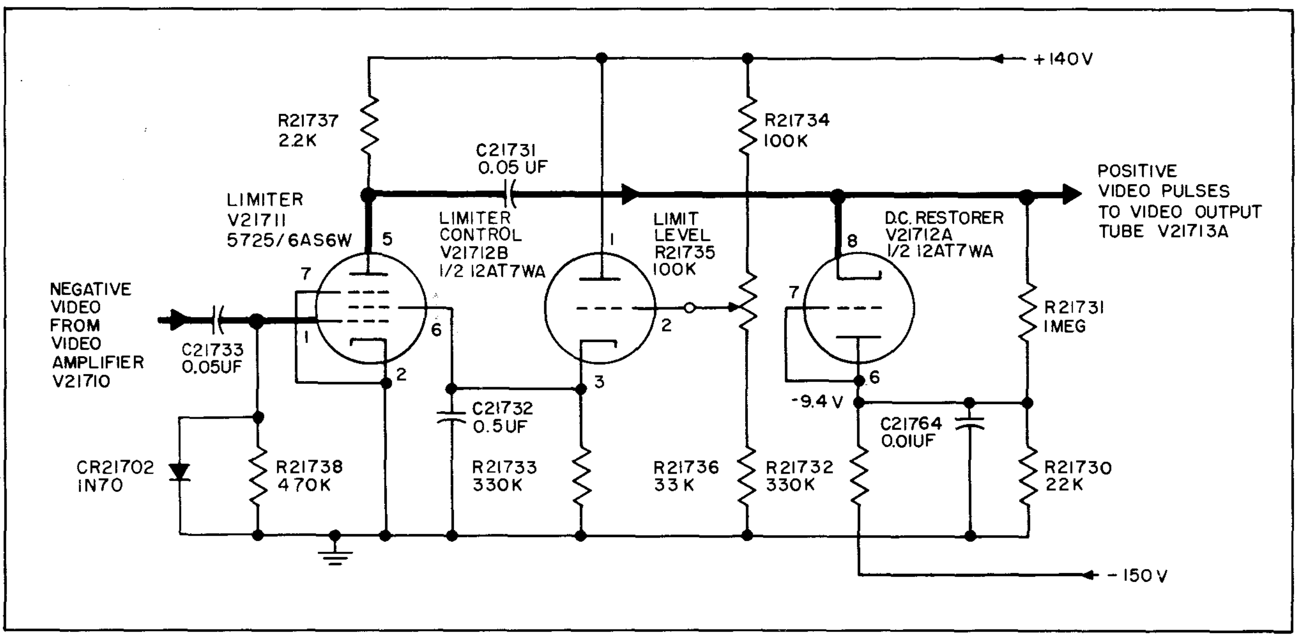

Figure 4–76. Limiter, Limiter Control, and D-c Restorer, Simplified Schematic Diagram

and resistor R21736 form a voltage divider from which this grid voltage is taken. Adjustment of the LIMIT LEVEL control sets the screen voltage of the limiter, thus setting the dynamic range and the limit level of the limiter.

4–535. D-C RESTORER V21712A. (See figure 4–76.) Positive-going video pulses from the limiter are coupled through capacitor C21731 to the cathode of diode-connected tube V21712A and to the grid of tube V21713A, the video output. Resistors R21732 and R21730 form a voltage divider which provides a 9.4-volt negative bias to the plate of the d-c restorer and, through resistor R21731, to the cathode of the d-c restorer. This bias also appears at the grid of tube V21713A. Capacitor C21764 acts to maintain a constant bias.

4–536. When positive pulses appear at the cathode of d-c restorer V21712A, they drive the cathode more positive than the plate, so that tube V21712A does not conduct and has no effect on the circuit. However, capacitor C21731 accumulates a charge during the passage of signals by charging through resistors R21730 and R21731. This charge, when discharged through resistors R21730 and R21731 after the positive pulses subside, would tend to drive the grid of tube V21713A very negative, perhaps masking small signals which might immediately follow. The d-c restorer prevents this occurrence by conducting when the discharge voltage appears across resistors R21730 and R21731, thus shorting this voltage and rapidly discharging capacitor C21731 through d-c restorer V21712A and resistor R21730.

4–537. VIDEO OUTPUT TUBE V21713A. (See figure 4–77.) Video output tube V21713A is connected as a cathode follower. This tube provides a video output of positive-going pulses to video output jack J21703 and a video test output through resistor R21801 to TEST VIDEO jack J21706. Tube V21713A is also cathode-coupled to amplifier V21713B, which drives AVNL amplifier V21714. Resistors R21730 and R21731 are the grid return for tube V21713A and tube R21729 is the cathode-load resistor for this tube. Resistor R21729 acts as an unbypassed cathode resistor for amplifier V21713B and provides cathode coupling. When the grid of the cathode follower is driven in the positive direction, the voltage across resistor R21729 increases, causing the voltage at the grid of amplifier V21713B to become more negative with respect to its cathode. When the signal at the grid of the cathode follower goes in the negative direction, the grid of amplifier V21713B is effectively driven in the positive direction. Because of the high value of plateload resistor R21728 and other design features, the amplifier circuit of tube V21713B has poor low-frequency response, and therefore differentiates the video pulses which enter it. This amplifier, like the AVNL amplifier which it drives through coupling capacitor C21743, is not designed to produce amplification of video pulses, but rather is designed to amplify any noise which enters tube V21713A and to differentiate the video pulses.

4–538. AVNL AMPLIFIER V21714. (See figure 4–78.) Noise signals from video output tube V21713 are applied to the grid of AVNL amplifier V21714 through coupling capacitor C21743. Bias is derived from a voltage divider connected between —150 volts and ground.

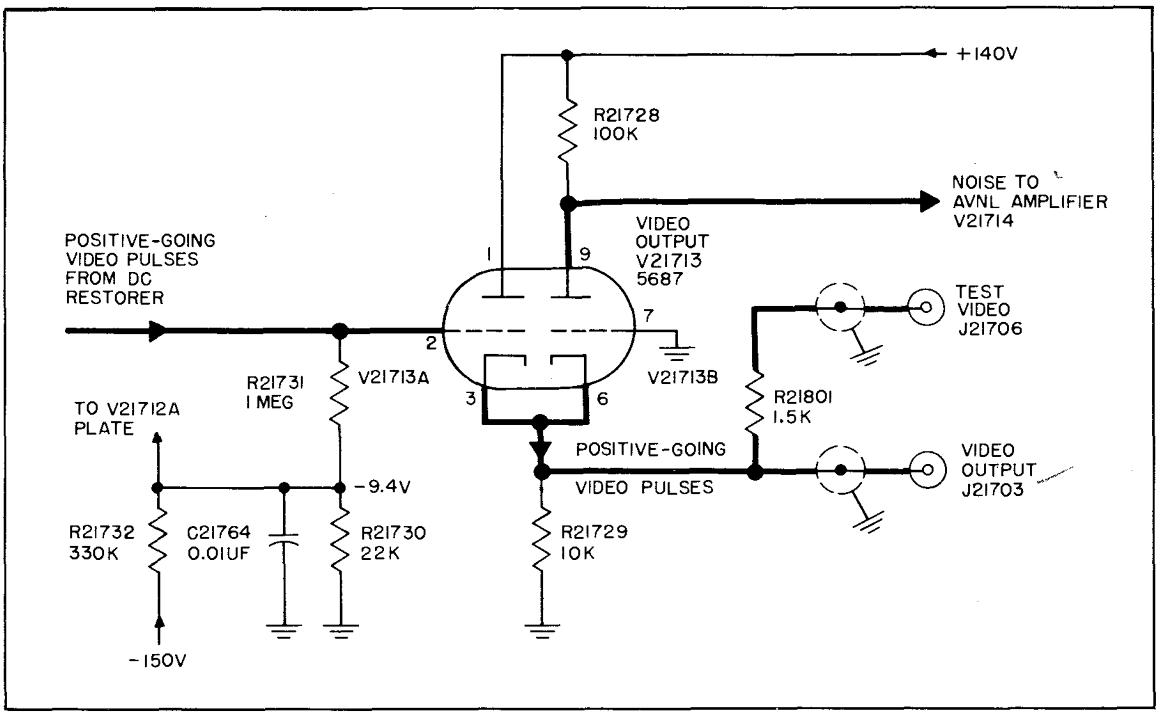

Figure 4–77. Video Output Circuit, Simplified Schematic Diagram

This voltage divider is composed of resistors R21750, R21751, and R21752. Resistor R21753 is the grid return and resistor R21754 is the plate load resistor. Capacitor C21744 is the screen bypass and resistor R21755 is the screen-dropping resistor. Suppressor grid voltage is obtained from a voltage divider, composed of resistors R21756 and R21757, connected between the output of sample gate V21717B and —150 volts. The positive pulse from the sample gate acts in conjunction with the —150-volt suppressor grid bias to maintain the suppressor grid at —20 volts at all times, except for a 525-microsecond interval during which the range sweep is between 157 and 200 miles. In this interval, the suppressor grid voltage is 8 volts. The waveform is indicated on figure 4–78 and can be compared with the waveform of the output of the sample gate.

4–539. While the suppressor grid remains at —20 volts, the AVNL amplifier is unable to pass noise signals, since its plate current is cut off by the negative suppressor grid. However, during the 525-microsecond interval when the suppressor grid is at 8 volts, the AVNL amplifier does pass noise signals to AVNL detector V21715A. The design of the AVNL amplifier is such that it has poor low-frequency response and tends to differentiate any video pulses that enter it. Thus, its output is almost entirely noise.

4–540. AVNL DETECTOR V21715A. (See figure 4–78.) During the 525-microsecond interval when the AVNL amplifier produces a noise signal output, the signal is coupled through capacitor C21745 to the cathode of AVNL detector V21715A. The negative-going half of the noise signal causes the plate of the diode-connected detector tube to be more positive than the cathode, and the diode conducts. The current flowing in the diode charges capacitor C21746 negatively. At the end of the 525-microsecond interval, capacitor C21746 is charged to a voltage whose magnitude depends upon that of the noise signal produced by the AVNL amplifier. The magnitude of the noise signal, in turn, depends upon the amount of noise entering the receiver during the interval. In this interval, the range sweep goes from 157 to 200 miles. The voltage to which capacitor C21746 is charged is the AVNL voltage, which is applied to the AVNL output tube across AVNL erase tube V21716.

4–541. AVNL ERASE TUBE V21716. (See figure 4–78.) The two triode sections of AVNL erase tube V21716 are connected in parallel so that this tube is effectively one triode. The cathode-to-plate d-c resistance of tube V21716 is connected in parallel with capacitor C21746 in the AVNL detector. When the grid voltage of the tube is more negative than cutoff, this cathode-to-plate resistance is virtually infinite and capacitor C21746 is unaffected. However, when the grid of AVNL erase tube V21716 is made slightly positive, the resistance of the triode is very small, and rapidly discharges capacitor C21746, making the AVNL voltage

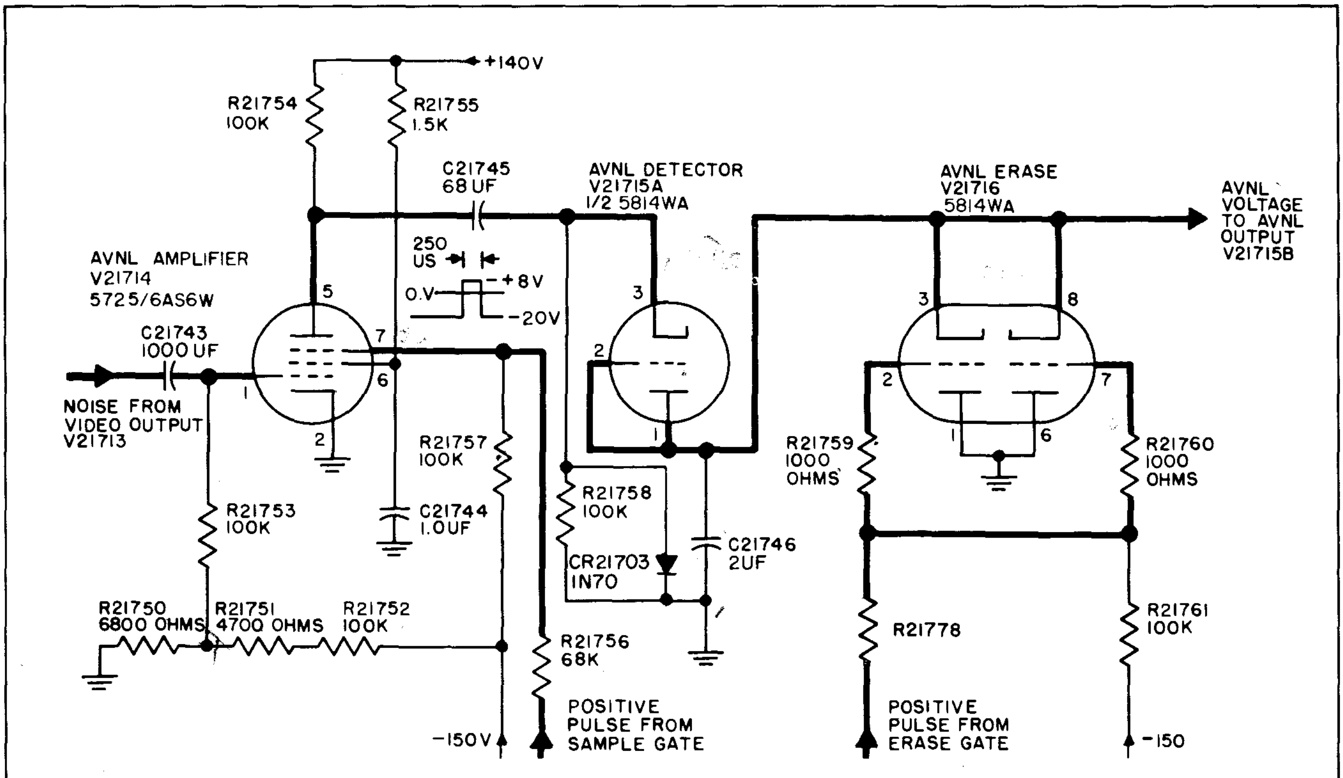

Figure 4–78. AVNL Amplifier, AVNL Detector, and AVNL Erase Circuit, Simplified Schematic Diagram

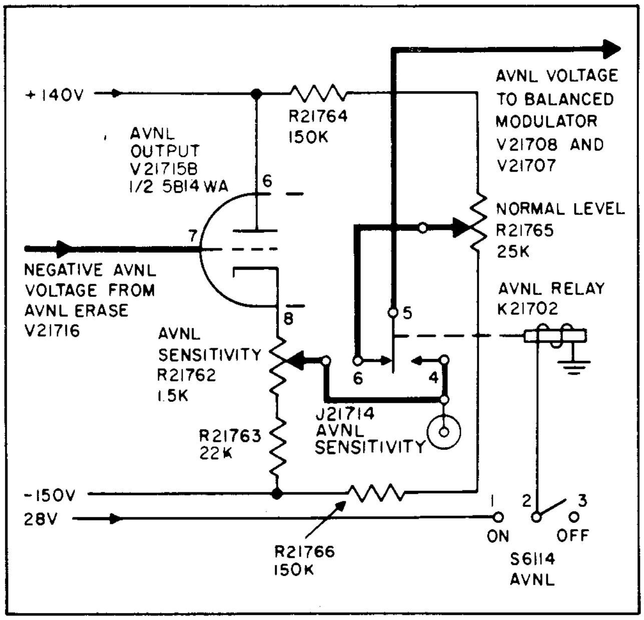

Figure 4–79. AVNL Output Circuit, Simplified Schematic Diagram

zero. This action erases the AVNL voltage. Bias for the grid of the AVNL erase tube is obtained from a voltage divider, composed of resistors R21778 and R21761, connected between —150 volts and the output of erase gate V21718B.

4–542. The positive pulse from the erase gate acts in conjunction with the —150 volts to maintain the grid of the erase tube at approximately —27 volts during the entire period between transmitted pulses, except for a 90-microsecond interval during which the range sweep goes from 150 to 157 miles. During this interval, the grid voltage of the AVNL erase tube is made approximately +1 volt. Therefore, as the range sweep goes from 150 to 157 miles, the AVNL erase discharges capacitor C21746 in the AVNL detector. This erases the AVNL voltage caused by the noise sample taken in the 157- to 200-mile range sweep of the previous interpulse period. Then, as the range sweep goes from 157 to 200 miles, the AVNL amplifier passes a new noise sample to the AVNL detector, and capacitor C21746 is recharged.

4–543. AVNL OUTPUT TUBE V21715B. (See figure 4–79.) AVNL output tube V21715B is a cathode follower whose plate is connected directly to the +140 volts and whose cathode is connected to —150 volts through AVNL SENSITIVITY control potentiometer R21762 and resistor R21763. The AVNL voltage from AVNL erase tube V21716 is applied to the grid of tube V21715B. When AVNL relay K21702 is energized, the voltage taken between ground and the center arm of potentiometer R21762 is applied through contacts 4 and 5 of relay K21702 to balanced modulator V21708 and V21709. Relay K21702 is energized by placing AVNL switch S6114 on the remote control panel in the ON position. For a given magnitude of AVNL voltage input to tube V21715B, the amount of negative voltage that is applied to the balanced modulator is varied by adjusting AVNL SENSITIVITY control R21762. When disabling of the AVNL circuits is desired relay K21702 is de-energized by placing AVNL switch S6114 in the OFF position. A fixed negative voltage for the balanced modulator is then taken through contacts 5 and 6 of relay K21702 from the voltage divider composed of resistors R21764, R21765, and R21766 connected between +140 and —150 volts. The magnitude of this voltage can be varied by adjusting NORMAL LEVEL control R21765.

4–544. SAMPLE AND ERASE DELAY V21719, ERASE GATE V21718, AND SAMPLE GATE V21717. (See figures 4–80 and 4–81.) Figure 4–80 is a simplified schematic diagram of the sample and erase delay, the erase gate, and the sample gate, while figure 4–81 shows the waveforms at the indicated points on the schematic diagram. The time axis of the waveform diagram is distorted where necessary, for convenience of presentation.

4–545. Sample and erase delay V21719 is a one-shot, cathode-coupled multivibrator which produces a negative 1850-microsecond pulse each time a trigger pulse appears at the grid of tube V21719A. Before the trigger pulse enters the grid, tube V21719A is cut off by the bias voltage across cathode resistor R21781. This bias returns to the grid of tube V21719A through grid return diode CR21704. The large bias across the cathode resistor is caused by the fact that tube V21719B has a positive grid return through resistor R21780 and DELAY GATE control R21779. Thus, the grid of tube V21719B is maintained at slightly more than 0 volt with respect to its cathode, and heavy current flows through resistor R21781 and tube V21719B. Since tube V21719A is cut off, the voltage at its plate is 140 volts and capacitor C21751 is charged to the difference between the plate voltage of tube V21719A and the grid voltage of tube V21719B, which is approximately 140 volts.

4–546. A 2-microsecond, 50-volt positive pulse, synchronized with the main bang and derived from the magnetron pulse transformer, is applied to the grid of tube V21719A through coupling capacitor C21755 and across diode CR21704 and capacitor C21766. This circuit reduces the pulse in amplitude, producing the waveform shown at B in figure 4–81. The positive pulse at B, coinciding with the leading edge of the trigger pulse from the magnetron pulse transformer, drives the grid of tube V21719A positive. The voltage at the plate of tube V21719A immediately drops to a low value, sharply reducing the voltage across capacitor C21751. This capacitor immediately begins to discharge through resistors R21780 and R21784 and potentiometer R21779. The discharge current flowing through resistor R21780 and potentiometer R21779 produces a large negative voltage which drives the grid of tube V21719B to cut-off.

4–547. When the discharge of capacitor C21751 has reached the point at which tube V21719B just begins to

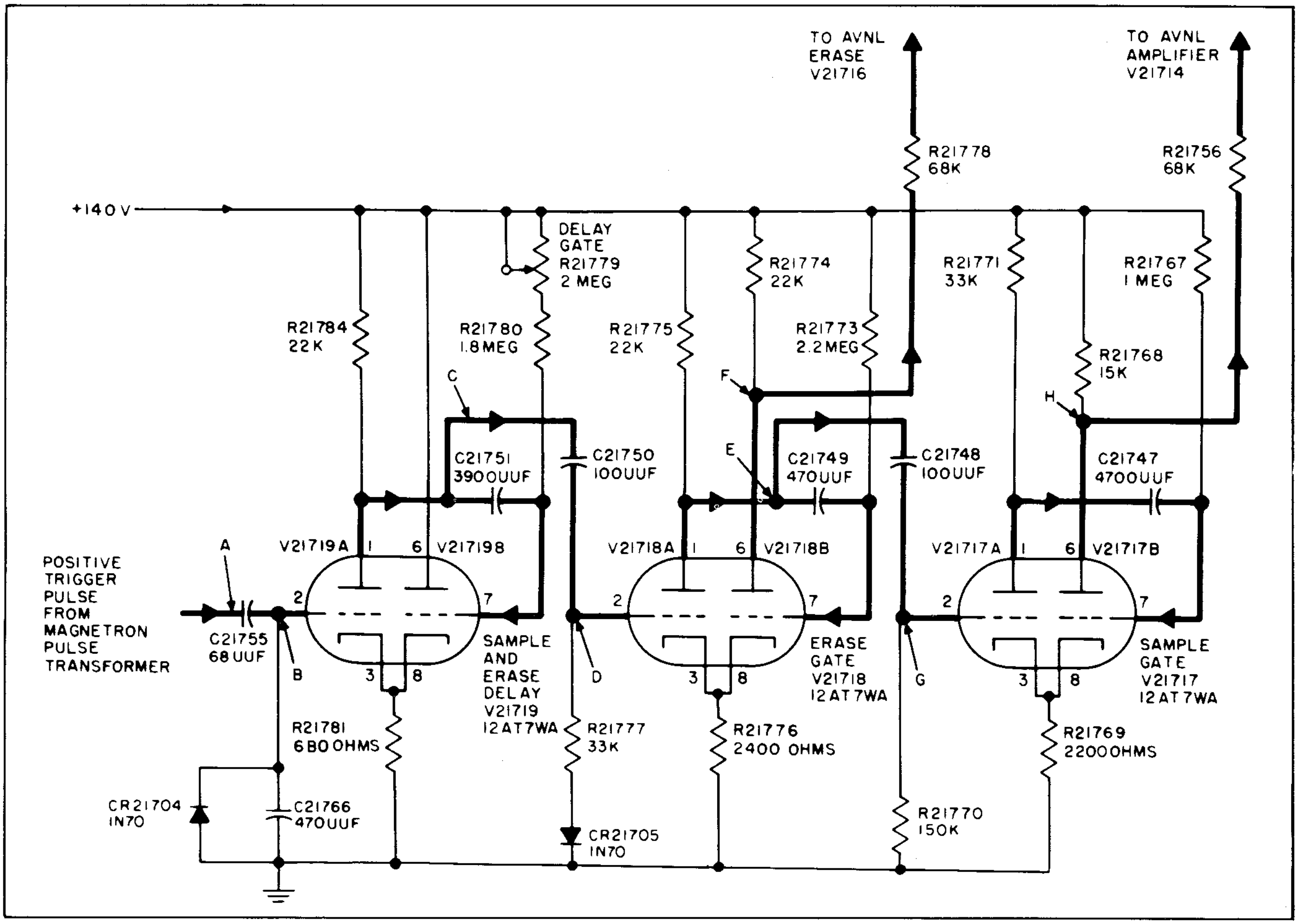

Figure 4–80. Sample and Erase Delay, Erase Gate, and Sample Gate Circuits, Simplified Schematic Diagram

draw plate current, the bias across the cathode resistor increases, raising the plate voltage of tube V21719A. Capacitor C21751 then seeks to charge and the grid of tube V21719B is driven positive, rapidly causing tube V21719A to cutoff. The plate voltage of tube V21719A rises to 140 volts, ending the negative pulse at C of figure 4–80. Capacitor C21751 quickly charges through the cathode resistor, the grid circuit of tube V21719B, and resistor R21784, and tube V21719A awaits another positive pulse to trigger it.

4–548. The duration of the negative output pulse depends upon the time required for capacitor C21751 to discharge through potentiometer R21779 and resistors R21780 and R21784. This time may be varied and therefore the duration of the output pulse can be adjusted by varying DELAY GATE control R21779. The duration is nominally 1850 microseconds, corresponding to a passage of the range sweep from 0 to 150 miles.

4–549. The 1850-microsecond negative-going pulse from the sample and erase delay is coupled to erase gate V21718 through capacitor C21750 and across grid return resistor R21777 and diode CR21705. In passing through this RC coupling network, the pulse is differentiated, producing a negative pulse synchronized with the main bang at D of figure 4–80 and also a positive pulse 1850 microseconds later. The erase gate operates in precisely the same manner as the sample and erase delay, except that the time constant of resistors R21773 and R21775, with capacitor C21749, is short. Thus, the negative-going output pulse at E of figure 4–80 is of 90 microseconds duration only. The short negative-going pulse that results from the differentiation of the leading edge of the 1850-microsecond pulse is applied to the grid of tube V21718A. However, this negative-going pulse has no effect, since tube V21718A is already cut off. The differentiation of the trailing edge of the 1850-microsecond pulse produces a brief positive pulse. The arrival of this positive pulse at the grid of tube V21718A triggers the erase gate, producing the 90-microsecond negative-going output pulse at E of figure 4–80. Since tube V21718A is cut off when tube V21718B is conducting, and vice versa, the pulse at F of figure 4–80 is of the same form as that at E, but is positive-going. This positive-going pulse controls the AVNL erase as described in paragraph 4–541.

4–550. The negative-going pulse at E of figure 4–80 is coupled to the sample gate through capacitor C21748 and across resistor R21770. In passing through this RC

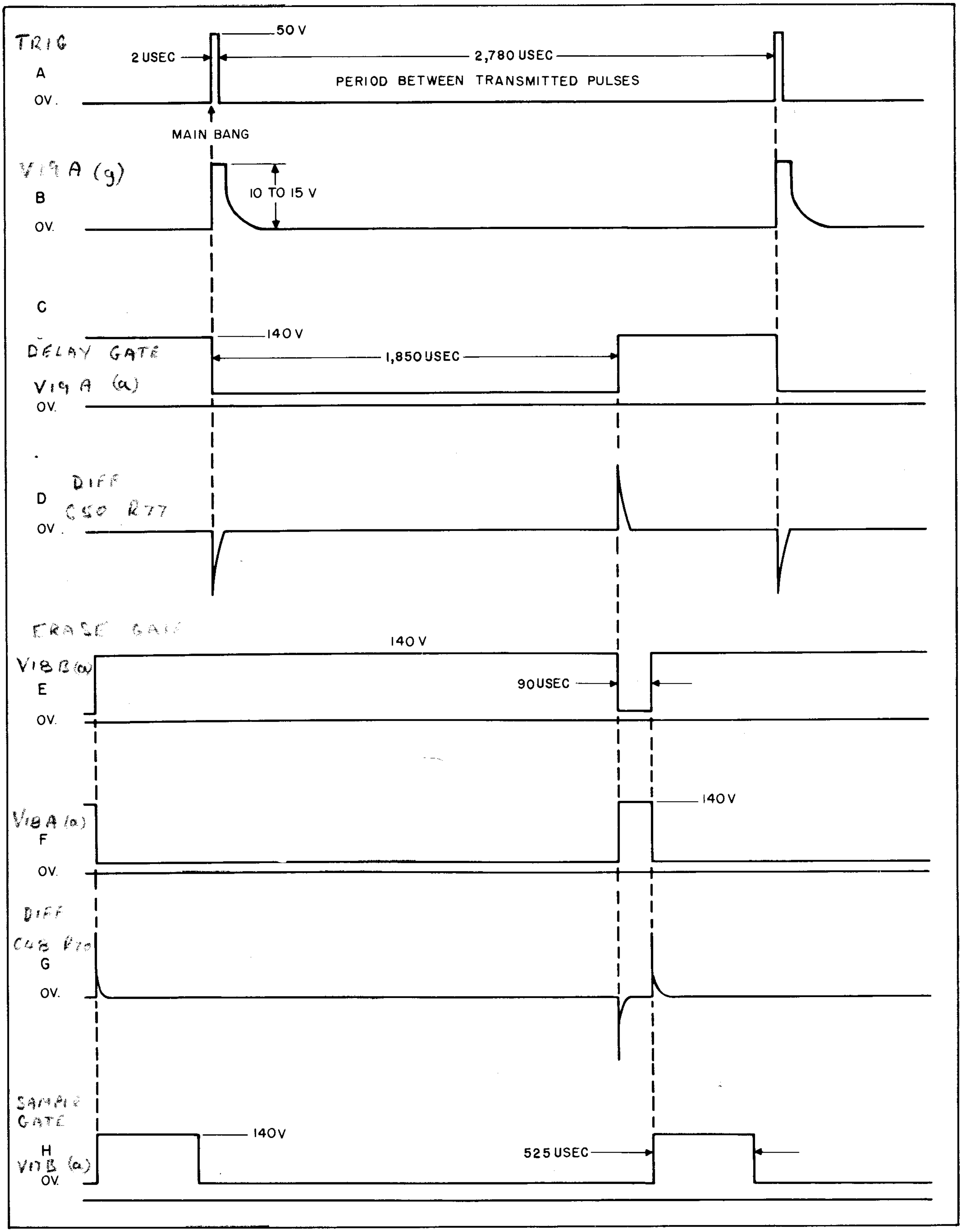

Figure 4–81. Waveforms at Designated Points in Figure 4–80

tiated, producing a brief negative-going pulse synchro- coupling network, the 90-microsecond pulse is differen- nized with its leading edge at G of figure 4–80 and, 90 microseconds later, a brief positive-going pulse synchronized with its trailing edge. The sample gate operates in the same manner as the sample and erase delay and the erase gate, except that the time constant of capacitor C21747, with resistors R21767 and R21771, is such that the sample gate produces a 525-microsecond output pulse at H of figure 4–80. As in the case of the erase gate, the grid of tube V21717A is cut off before the arrival of either the negative, or positive-going short pulses resulting from the differentiation of the 90-microsecond pulse from the previous stage. The negative-going pulse has no effect on tube V21717A, whereas the positive-going pulses triggers this tube. The positive-going output pulse at H of figure 4–80 controls the AVNL amplifier as described in paragraph 4–538.

4–551. Since a radar signal requires approximately 12.36 microseconds for a round trip to and from a target 1 nautical mile away, the erase gate produces a 90-microsecond pulse at F of figure 4–80 whose period of duration corresponds to the passage of the range sweep from approximately 150 to 157 miles. The sample gate produces a 525-microsecond pulse at H of figure 4–80. The period of duration of this pulse corresponds to the passage of the range sweep from approximately 157 to 200 miles. Thus, as the range sweep goes from 150 to 157 miles, the erase gate causes the AVNL erase to erase the noise sample which the AVNL detector stores. As the range sweep goes from 157 to 200 miles, the sample gate causes the AVNL amplifier to pass a new noise sample to the AVNL detector.

4–552. STC RECTIFIER V21721 AND STC V21720. (See figure 4–82.) STC relay K21703 is actuated when STC switch S6112 on the remote control panel is placed in the ON position. The STC circuits then act to produce an output voltage of the waveform shown in figure 4–83. This positive STC voltage is applied in series with the manually controlled positive receiver gain voltage to the grids of the fifth, sixth, and seventh i-f amplifiers in the normal receiver. This voltage is also applied to

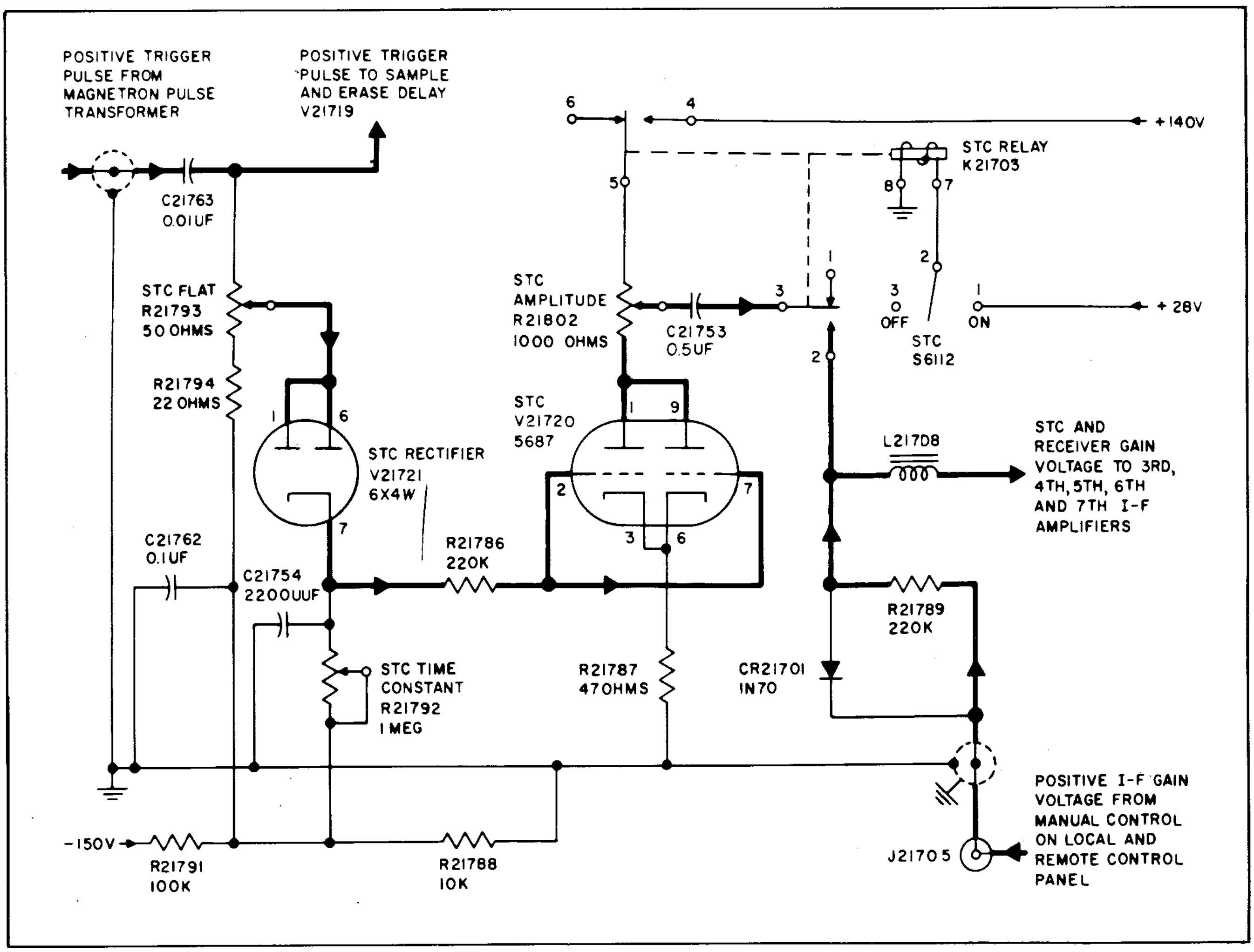

Figure 4–82. STC Circuits, Simplified Schematic Diagram

the grids of the third and fourth i-f amplifiers in the preamplifier. As the voltage becomes less positive, the mu of the i-f amplifiers becomes smaller, reducing the voltage gain of these amplifiers. Rectifier CR21701 is introduced as a stabilizing element and prevents excessive gain reduction. Thus, the STC voltage serves to make the gain of the normal receiver channel small at the beginning of each interpulse period when powerful echoes are being received from nearby targets. This action reduces ground clutter.

4–553. The positive trigger pulse from the magnetron pulse transformer is fed through coupling capacitor C21763 and across STC FLAT control R21793 and resistor R21794. The bottom of resistor R21794 is bypassed to ground through capacitor C21762. In the absence of a trigger pulse, the plates and cathode of STC rectifier V21721 are provided with negative bias by a voltage divider connected between —150 volts and ground. Resistors R21791 and R21788 form this divider. The negative bias at the cathode of STC rectifier V21721 is applied through current-limiting resistor R21786 to the grids of STC tube V21720. Both triode sections of tube V21720 are connected in parallel to form a single triode. This grid bias is sufficient to maintain tube V21720 beyond cutoff. STC AMPLITUDE control R21802 is the plate load resistor for this tube. Because of the cutoff bias, the plate voltage is 140 volts. Capacitor C21753 couples any change in voltage at the plate of tube V21720 to decoupling inductor L21708. The bottom of resistor R21789 is returned to the manual receiver gain voltage. Thus, any output coupled through capacitor C21753 from tube V21720 is developed across resistor R21789, which is in series with the receiver gain voltage. Rectifier CR21701 and resistor R21789, in parallel, form a unidirectional coupling circuit. This circuit permits the receiver gain voltage to act in series with the STC voltage, but prevents the STC output from affecting the manually controlled receiver gain potential.

4–554. At the beginning of a period between transmitted pulses, a 2-microsecond positive trigger pulse appears at the input to the STC rectifier and drives the plates positive. Capacitor C21754 then charges through STC rectifier V21721 to a voltage determined by the setting of potentiometer R21793. Immediately following the pulse, capacitor C21754 begins to discharge through resistors R21788 and R21792, causing a large positive voltage across these resistors. This voltage drives the grid of tube V21720 positive and the plate current of this tube immediately goes to saturation, causing the plate voltage to fall. The fall of potential is coupled through capacitor C21753 as shown in A of figure 4–83. After the interval shown in B of this illustration, the discharge of capacitor C21754 reaches a point where the positive voltage at the grid of tube V21720 decreases from the value producing saturation current. The plate current then begins to rise toward its full value. The interval shown in C of figure 4–83 depends upon the time constant of the discharge path of capacitor C21754. This time constant can be changed by adjusting STC TIME CONSTANT control R21792. The length and amplitude of the flat portion of the STC voltage waveform shown in B of figure 4–83 depends upon the magnitude of the voltage to which capacitor C21754 is charged by the trigger pulse as well as location of the saturation point on the dynamic characteristic curve of tube V21720. STC flat, STC amplitude, and STC time constant are adjusted at the radar site to meet the particular requirements of the site.

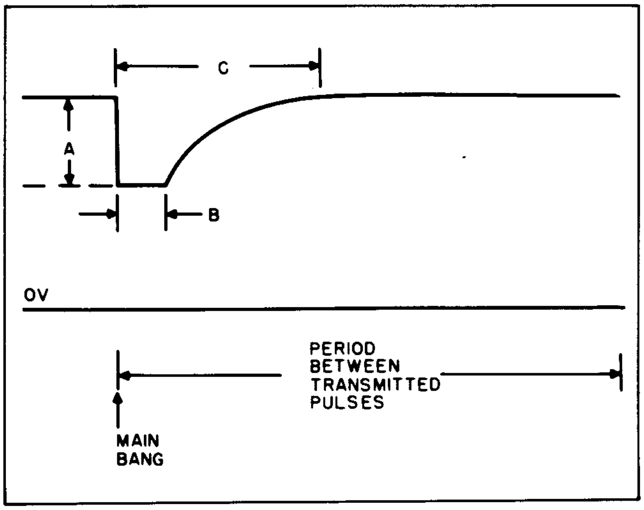

Figure 4–83. Typical STC Voltage Waveform

4–555. PREAMPLIFIER-LOCAL OSCILLATOR POWER SUPPLY (POWER SUPPLY PP-755/FPS-6).

4–556. BLOCK DIAGRAM. (See figure 4–84.)

4–557. GENERAL. The preamplifier-local oscillator power supply delivers regulated d-c power and filament power to various units of the transmitter-receiver system. The units supplied include the AFC-LO unit, the preamplifier, the local control assembly, the r-f noise source, and the remote r-f control assembly. The regulated d-c power is supplied at potentials of +140, —210, +375, and +300 volts. Filament power is provided at a potential of 6.3 volts ac.

4–558. Phase C of the 3-phase, 208/120-volt a-c supply is fed to five transformers in the preamplifier-local oscillator power supply. These transformers include high-voltage power transformer T1101 and filament transformers T1102, T1107, T1105, and T1106.

4–559. High-voltage power transformer T1101 includes a multitapped high-voltage secondary winding and two heater voltage secondary windings. The multitapped, high-voltage secondary supplies high-voltage a-c power to the rectifiers which deliver regulated d-c power at potentials of +140, —210, +375, and +300 volts. The filament voltage secondary windings of transformer

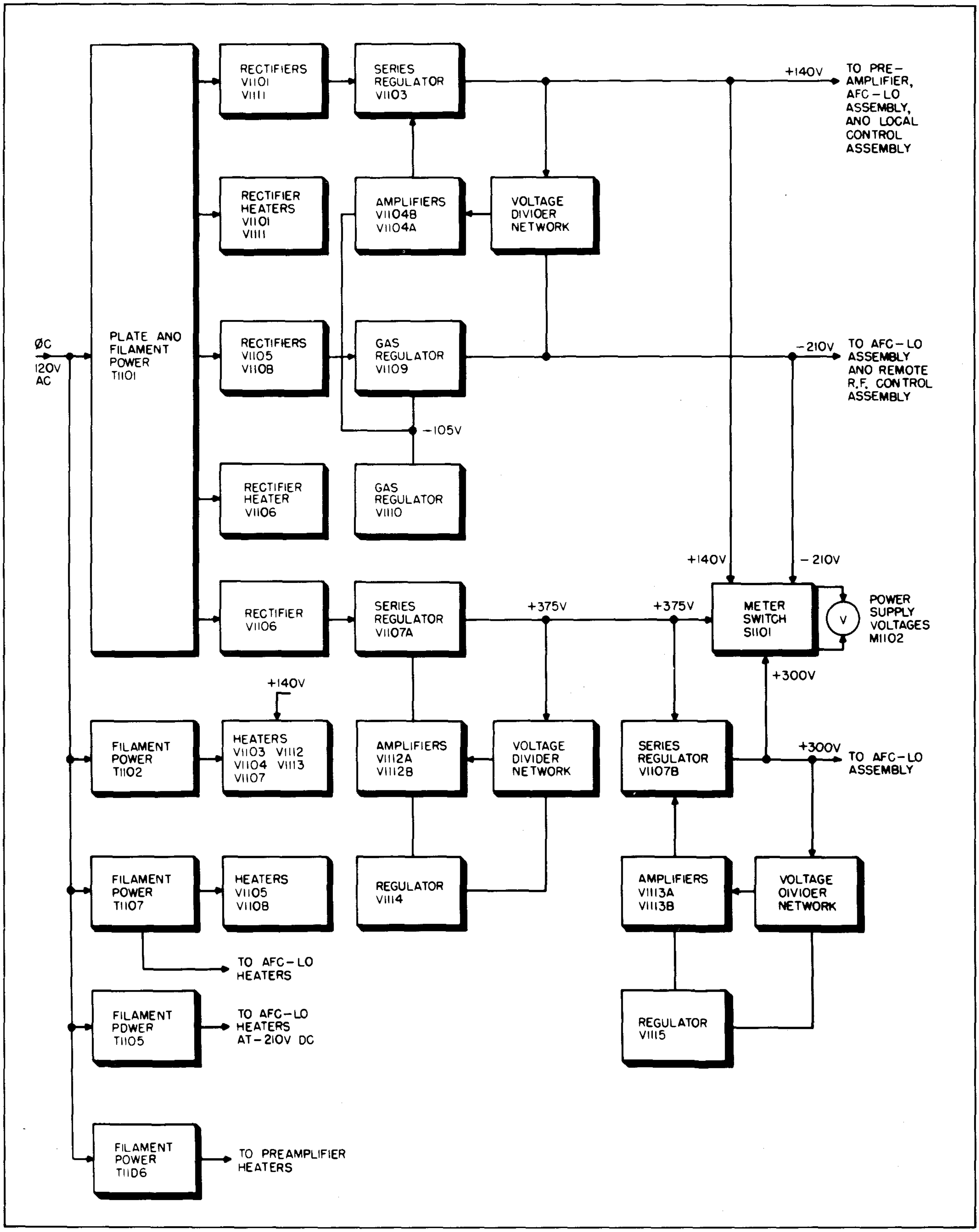

Figure 4–84. Preamplifier-Local Oscillator Power Supply, Block Diagram

T1101 supply filament power to rectifiers V1101, V1106, and V1111 in the preamplifier-local oscillator power supply.

4–560. Filament transformers T1102, T1107, T1105, and T1106 step down the 120-volt a-c input to 6.3 volts ac. The 6.3-volt a-c outputs are fed to heater circuits in the preamplifier-local oscillator power supply, the AFC-LO unit, and the preamplifier. The heater input to three tubes of the AFC-LO unit is introduced at a level of −210 volts dc, while the heater input to five tubes of the preamplifier-local oscillator power supply is introduced at a level of +140 volts dc. Both arrangements are necessary to avoid exceeding the rated heater-to-cathode potentials in the respective tubes.

4–561. REGULATED +140-VOLT D-C SUPPLY. The regulated +140-volt d-c supply circuit includes rectifiers V1101 and V1111, series regulator V1103, and amplifiers V1104B and V1104A. A voltage divider network is connected between the regulated +140-volt output and a regulated reference potential of −210 volts dc. Feedback potentials are tapped off the voltage divider and fed to amplifiers V1104A and V1104B. Amplifier V1104A is connected to a −105-volt tap on the regulated −210-volt supply. The output of amplifier V1140B is an amplified version of the input from the voltage which is fed to series regulator V1103. The current and potential changes of series regulator V1103, in response to the feedback signal from amplifier V1104B, are in such a direction as to maintain the regulated +140-volt supply within ±1.0 volt despite normal load fluctuations. The regulated +140-volt output is fed to circuits in the preamplifier, AFC-LO assembly, local control assembly, and to the meter switch.

4–562. REGULATED −210-VOLT D-C SUPPLY. Rectifiers V1105 and V1108 are connected across the secondary of transformer T1101. Gas regulator tubes V1109 and V1110 are connected across the output of the rectifiers and produce a regulated potential of −210 volts. A regulated d-c potential of −105 volts to ground is available at the connection between regulated tubes V1109 and V1110. The d-c potential is used as a regulated reference potential for the amplifiers in the regulated +140-volt supply. The regulated −210-volt output supplies circuits in the AFC-LO assembly and the remote r-f control assembly and is also fed to the meter switch.

4–563. REGULATED +375-VOLT D-C SUPPLY. The regulated +375-volt d-c supply circuit includes rectifier V1106, series regulator V1107A, amplifiers V1112A and V1112B, and gas regulator V1114. A voltage divider network is connected between the regulated +375-volt output and ground. Feedback potentials are tapped off the voltage divider and fed to amplifiers V1112A and V1112B. The feedback potential changes are proportional to changes in the +375-volt output level. The output of amplifier V1112B is an amplified version of the input from the voltage divider and is fed to series regulator V1107A. The current and potential changes of series regulator V1107A, in response to the signal from amplifier V1112B, are in such a direction as to maintain the regulated +375-volt supply level within ±1.0 volt despite normal load fluctuations. The regulated +375-volt output is fed to another regulating circuit and to meter swich S1101. The second regulating circuit is adjusted to maintain an output of +300 volts dc.

4–564. REGULATED +300-VOLT D-C SUPPLY. The regulated +300-volt d-c supply circuit includes series regulator V1107B, amplifiers V1113A and V1113B, and gas regulator V1115. The input to the circuit is the output of the regulated +375-volt supply. The +300-volt output is sampled by a voltage divider which feeds proportionate potential changes to amplifiers V1113A and V1113B. The output of amplifier V1113B is fed to series regulator V1107B. The current and potential changes of series regulator V1107B, in response to the signal from amplifier V1113B, are in such a direction as to maintain the regulator +300-volt supply level within ±1.0 volt despite normal fluctuations. The output of the regulated +300-volt d-c supply is fed to circuits in the AFC-LO assembly and to meter switch S1101 in the preamplifier-local oscillator power supply.

4–565. R-F NOISE SOURCE (GENERATOR, INTERFERENCE SG-62/FPS-6).

4–566. BLOCK DIAGRAM.

4–567. The r-f noise source (figure 4–85) generates shot-noise at frequencies in the 3000-megacycle band for the purpose of measuring the noise figure of the receiver of Radar Set AN/FPS–6. The r-f noise source consists of motor-tuned type 2K41 klystron V1401 and associated power, control, measuring, and indicator circuits.

4–568. The application of power to the r-f noise source is controlled by local and remote NOISE SOURCE switches S1002 and S6106, local-remote relay K1003, and noise-source power-control relay K1004. Phase C of the three-phase electronic power input supplies 120 volts ac to the inputs of the klystron power and amplitude control circuits. Phase C is also fed at the option of manually-operated, frequency-control switching circuits through either the raise or lower control circuits to klystron tuning motor B1401. These circuits control the direction of rotation of the tuning motor.

4–569. Anode and filament power for klystron V1401 is supplied by circuits which receive input power from transformer T1402. The amplitude of the noise output power of the r-f noise source is established by the output of the klystron control grid bias supply, which receives input power from transformer T1401. The input to bias supply transformer T1401 can be varied manually by local or remote NOISE AMPLITUDE control potentiometers R1009 and R6104. The amplitude of the noise output of the r-f noise source is measured by NOISE AMPLITUDE meters M1001 and M6102.

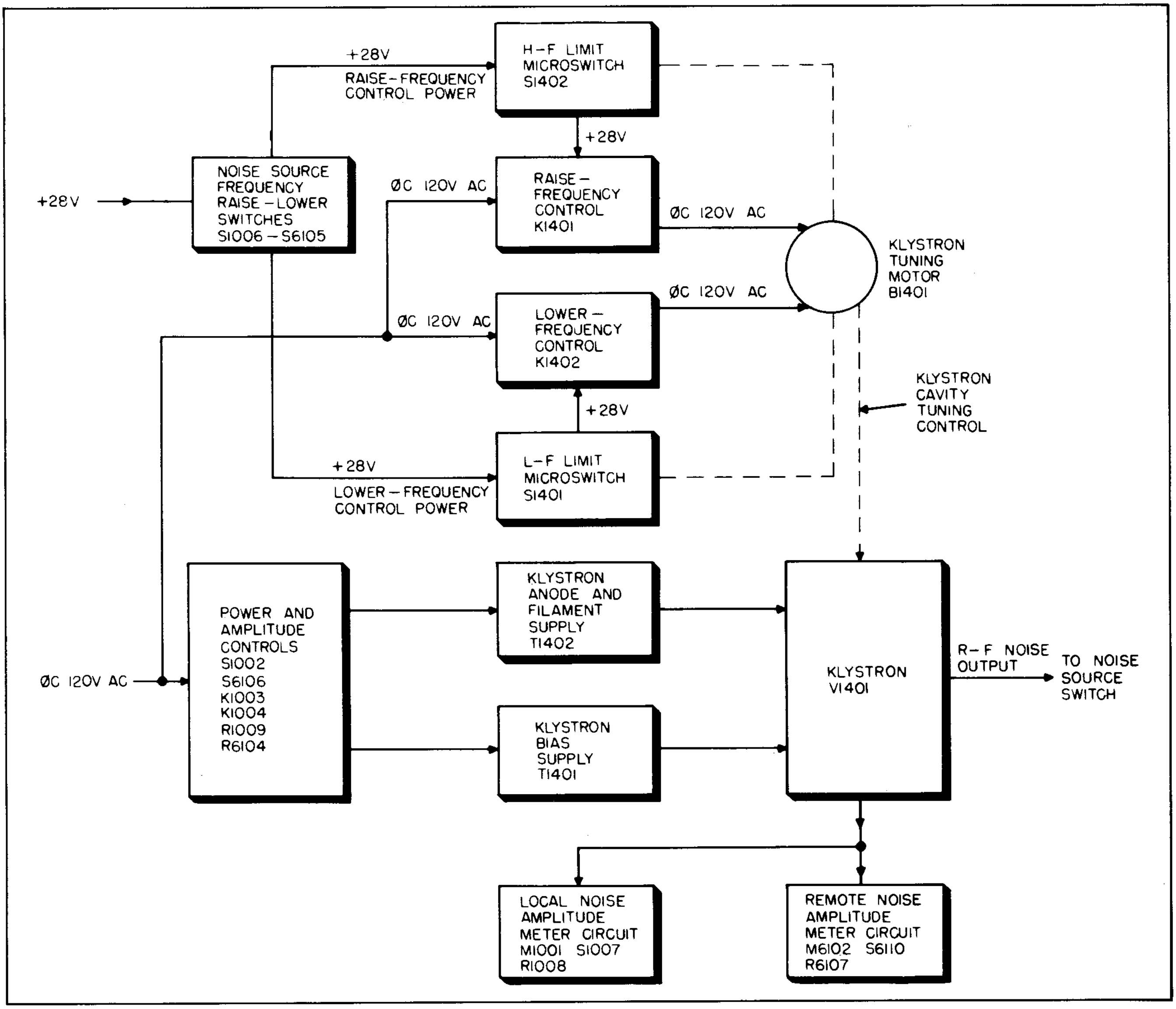

Figure 4–85. Noise Source for Radar Set AN/FPS-6, Block Diagram

4–570. In order to calibrate the r-f noise source to determine the noise figure of the receiver, the frequency of the output of noise klystron C1401 must be adjustable within narrow limits. The noise output frequency of klystron V1401 is varied by the klystron cavity tuning control, which is mechanically coupled to klystron tuning motor B1401. The tuning adjustment limits are determined by the settings of high-frequency limit microswitch S1402 and low-frequency limit microswitch S1401. These switches are operated by klystron tuning motor B1401 and cut off power to the motor when it has rotated the klystron cavity tuning control to either of the present high- or low-frequency limit settings. The switches are set to cut off power to the klystron tuning motor before the motion of the cavity tuning control is brought to a stop. The control is halted in the lowest or highest frequency position by mechanical stops on the klystron. This arrangement is necessary to avoid destruction of the reduction gear assembly which couples tuning motor B1401 to the klystron cavity tuning control. The direction of rotation of the tuning control on the klystron determines whether the klystron noise output frequency is raised or lowered. The direction of rotation of the control is determined by the direction of rotation of the tuning motor, which in turn depends on whether the raise or lower control circuit has been energized.

4–571. The noise source output frequency can be raised or lowered by operating local or remote NOISE SOURCE FREQUENCY RAISE-LOWER switch S1006 or S6105. Switches S1006 or S6105 feed +28 volts dc to raise-frequency control relay K1401 or lower-frequency control relay K1402. When switch S1006 or S6105 is operated to the RAISE position, relay K1401 is energized. Power is then fed through the contacts of the relay to the field windings of tuning motor B1401. As a result, the motor rotates in such a direction as to cause the cavity tuning control to raise the noise output frequency of klystron V1401. When switch S1006 or S6105 is operated to the LOWER position, relay K1402 is energized and power is fed through the contacts of the relay to the field windings of tuning motor B1401. The motor then rotates in such a direction as to cause the cavity tuning control to lower the noise output frequency of klystron V1401.

4–572. When +28-volt power is fed from either the local or remote NOISE SOURCE FREQUENCY RAISE-LOWER switch to raise-frequency control relay K1401, the power must first pass through high-frequency limit microswitch S1402. Switch S1402 then opens and cuts off +28-volt d-c power to raise-frequency control relay K1401 whenever klystron tuning motor B1401 rotates to its highest preset frequency position. When de-energized, relay K1401 cuts off 120-volt a-c power to the field windings of tuning motor B1401 and stops the rotation of the motor. Raise-frequency control relay K1401 can be de-energized before tuning motor B1401 reaches the high-frequency limit position. The relay is de-energized by allowing the particular NOISE SOURCE FREQUENCY RAISE-LOWER switch in operation to spring back from the RAISE position to neutral.

4-573. When +28-volt power is fed from either the local or remote NOISE SOURCE FREQUENCY RAISE-LOWER switch to lower-frequency control relay K1402, the power must first pass through low-frequency limit microswitch S1401. Switch S1401 then opens and cuts off +28-volt d-c power to lower-frequency control relay K1402 whenever klystron tuning motor B1401 rotates to the lowest preset frequency position. When de-energized, relay K1402 cuts off 120-volt a-c power to the field windings of tuning motor B1401 and stops the rotation of the motor. Lower-frequency control relay K1402 can be de-energized before tuning motor B1401 reaches the low-frequency limit position. The relay is de-energized by allowing the particular NOISE SOURCE FREQUENCY RAISE-LOWER switch in operation to spring back from the LOWER position to neutral.

4–574. The noise output of klystron V1401 is fed through jack J1401 to a transmission cable which finally couples the noise power to the noise source switch.

4–575. CIRCUIT ANALYSIS OF R-F NOISE SOURCE.

4–576. NOISE KLYSTRON OPERATION. (See figure 4–86.) The r-f noise source is a shot-noise source, as distinguished from a thermal or crystal noise source. Shot noise is generated by random variations in the movement of electrons through a vacuum tube. Shot-noise voltages are defined as voltages induced in the load resistance of a vacuum tube as a result of random changes in the flow of electrons from the cathode to the plate. The number of electrons which reach the plate per unit of time (plate current) varies slightly, though continually, in a random manner. These random variations in plate current are caused by irregularities in emission rate and other factors. Each random fluctuation in the plate current of the tube produces a corresponding random pulse of voltage across the load of the tube. These small load-voltage fluctuations, attributable to the causes outlined, are refered to as shot noise. The shot-noise output level of a tube is proportional to the average amplitude of the noise-voltage pulses.

4–577. If the vacuum tube in which the current fluctuations are produced includes a resonant cavity, the current fluctuations excite the cavity to produce random, low-level r-f pulses at frequencies predominantly within the passband of the resonant cavity. This process is true of 2K41 klystron V1401, which acts as the noise generator tube of the r-f noise source. The repeller plate of klystron V1401 is connected to the cavity grids. As a result, no retarding or bunching of the electron beam occurs. These effects would be produced if the repeller were maintained at a negative potential with respect to the cavity grids. In other words, with klystron V1401 connected as shown in figure 4–86, any variations in electron flow through the tube are due to random causes (shot-noise). The actual noise output consists of random, low-level r-f pulses in the 3000-megacycle frequency range.

4–578. NOISE KLYSTRON ANODE POWER SUPPLY. (See figure 4–86.) The flow of electrons through noise klystron V1401 is produced as follows. The klystron repeller plate and cavity grids are connected to ground. The noise klystron anode power supply maintains the cathode of the klystron at a potential of −1200 volts dc with respect to ground. The noise klystron anode power supply consists of the high-voltage secondary of transformer T1402, rectifier CR1401, filter capacitor C1402, and bleeder resistors R1402 through R1404. The high-voltage secondary of transformer T1402 steps up the 120-volt a-c primary input to a level of 1100 volts ac. The high-voltage secondary, in series with rectifier CR1401, constitutes a half-wave rectifier power supply. In conjunction with filter capacitor C1402 and the bleeder network of resistors R1402 through R1404, the power supply establishes a potential of −1200 volts dc at the cathode of klystron V1401. The low-voltage secondary of transformer T1402 supplies power to the filament of noise klystron V1401 at a potential of 6.3 volts ac and a current of 1.8 amperes.

4–579. NOISE KLYSTRON BIAS SUPPLY. (See figure 4–86.) The amplitude of the output of the r-f noise source is varied by controlling the plate current of noise klystron V1401. This is accomplished by establishing a variable d-c bias between the control grid and cathode of the klystron. Transformer T1401 is the klystron bias supply transformer. The input to the primary of transformer T1401 is variable and can be controlled at either the local control panel of the r-f assembly or the remote control panel of the control group assembly. Figure 4–86 includes a simplified presentation of the noise amplitude control circuit of the local control panel. This control circuit contains a voltage divider connected across the

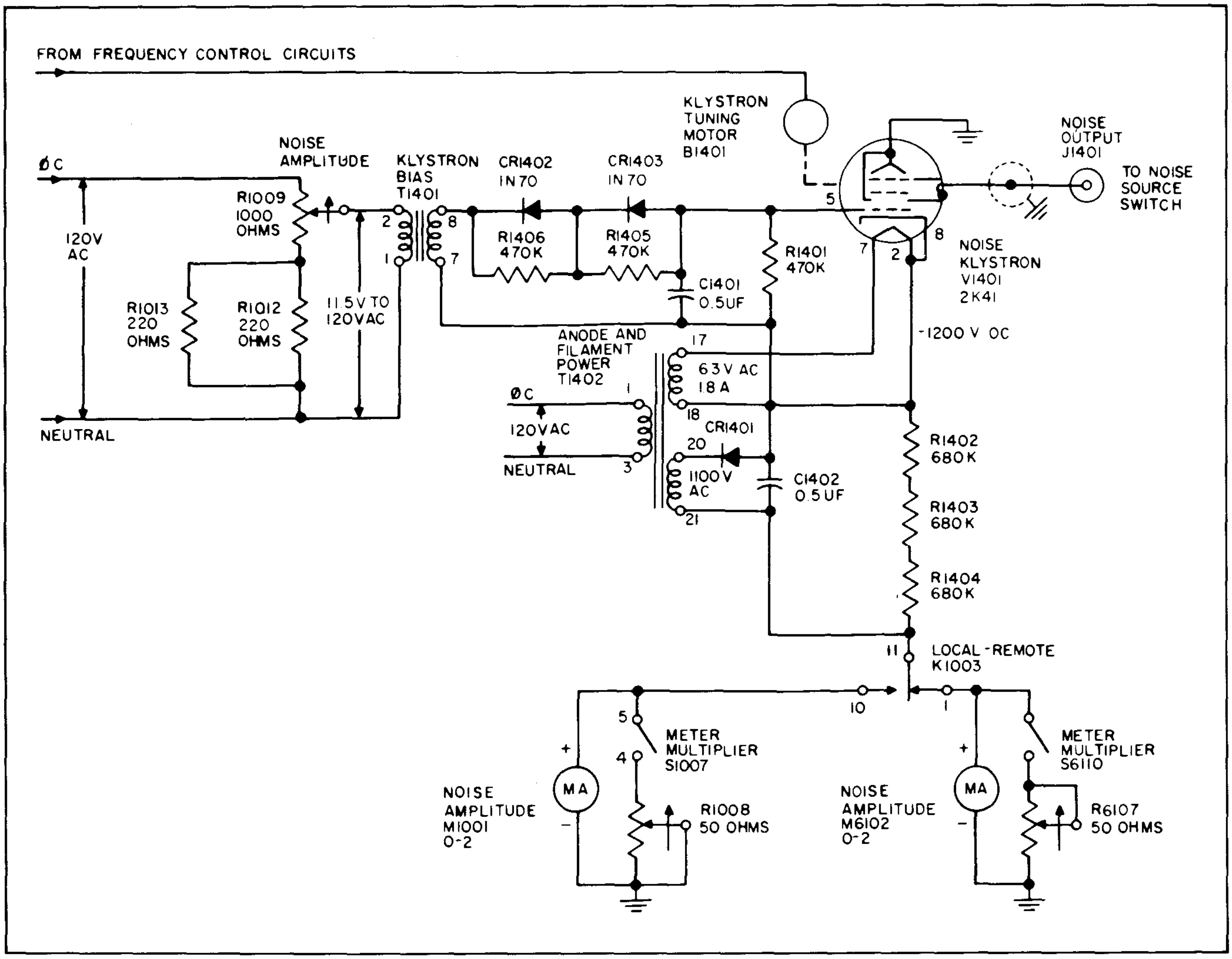

Figure 4–86. R-f Noise Source, Klystron and Supply Circuits for Radar Set AN/FPS-6, Simplified Schematic Diagram

120-volt a-c input to the primary of bias supply transformer T1401. The voltage divider includes NOISE AMPLITUDE control potentiometer R1009, which is connected in series with the parallel combination of resistors R1012 and R1013. With this arrangement, potentiometer R1009 can be used to vary the input to the primary of transformer T1401 from 11.5 to 120 volts rms, which causes a corresponding but stepped-down variation in the output of the secondary. The variable output of the secondary of bias supply transformer T1401 is rectified by series-connected rectifiers CR1402 and CR1403, and the rectified output is filtered by capacitor C1401 and applied as a variable bias between the control grid and cathode of noise klystron V1401. Resistor R1401 is the grid return for klystron V1401. Resistors R1405 and R1406 constitute a bleeder network for rectifiers CR1402 and CR1403. The amplitude of the noise output of klystron V1401 increases as the bias on the control grid becomes less negative.

4–580. NOISE AMPLITUDE METER CIRCUITS. (See figure 4–86.) Variations in the amplitude of the output of the r-f noise source are directly proportional to variations in the amplitude of the cathode current of noise klystron V1401. Either of two meter circuits can be switched into the cathode circuit of klystron V1401 through contacts of local-remote relay K1003. When control is local, NOISE AMPLITUDE meter M1001, calibrated at 0 to 2 milliamperes dc, is connected in series with the cathode circuit of klystron V1401 through contacts 10 and 11 of local-remote relay K1003. METER MULTIPLIER switch S1007 and resistor R1008, in series, constitute a local control circuit which is used to double the current range of the meter circuit whenever the tube current of klystron V1401 exceeds 2 milliamperes. When control is remote, NOISE AMPLITUDE meter M6102, calibrated at 0 to 2 milliamperes dc, is connected in series with the cathode circuit of klystron V1401 through contacts 1 and 11 of local-remote relay

K1003. METER MULTIPLIER switch S6110 and resistor R6107, in series, constitute a remote control circuit. This circuit is used to double the current range of the meter circuit whenever the cathode current of klystron V1401 exceeds 2 milliamperes.

4–581. The range of the locally controlled NOISE AMPLITUDE meter circuit is doubled by closing METER MULTIPLIER switch S1007. Similarly, the range of the remote controlled NOISE AMPLITUDE meter circuit is doubled by closing METER MULTIPLIER switch S6110. When either the local or remote NOISE AMPLITUDE control is varied, the change in the control grid bias of klystron V1401 produces a corresponding change in the cathode current which is measured by the corresponding NOISE AMPLITUDE meter. Any change in the cathode current of klystron V1401 produces a corresponding change in the r-f noise output level. The output of the r-f noise source is fed through jack J1401 and type RG–21/U transmission cable to the r-f noise probe, which then feeds the noise signal to the noise source switch.

4–582. POWER AND AMPLITUDE CONTROL CIRCUITS. (See figure 4–87.) The transmission of supply power to the r-f noise source and the amplitude of the r-f noise source output can be controlled from either the local control panel or the remote r-f control panel. When local control is in effect, local-remote relay K1003 is energized and 120-volt a-c power is fed to the coil of noise source control relay K1004 through NOISE SOURCE switch S1002 and contacts 7 and 13 of local-remote relay K1003. When remote control is in effect, local-remote relay K1003 is de-energized. The 120-volt a-c power is then fed through the coil of noise source control relay K1004 through NOISE SOURCE switch S6106B and contacts 6 and 13 of local-remote relay K1003. When noise source control relay K1004 is energized through either the local or remote control circuits, contacts 2 and 4 of relay K1004 close and 120-volt a-c power is fed to the noise source klystron anode and filament supply transformer T1402.

4–583. When local control is in effect, 120-volt a-c power is also fed through contacts 2 and 4 of relay K1004 to the local noise amplitude control circuit. This circuit consists of NOISE AMPLITUDE control potentiometer R1009 in series with the parallel combination of resistors R1012 and R1013. The output of the local noise amplitude control circuit is fed through contacts 8 and 14 of local-remote relay K1003 to klystron bias supply transformer T1401. Relay K1003 is energized when control is local.

4–584. When control is remote, 120-volt a-c power is fed through remote NOISE SOURCE switch S6106 to the remote noise-amplitude control circuit. This circuit consists of NOISE AMPLITUDE control potentiometer R6104 in series with the parallel combination of resistors R6111 and R6112. The output of the remote noise-amplitude control circuit is fed through contacts 9 and 14 of local-remote relay K1003 to klystron bias supply transformer T1401. Relay K1003 is de-energized when control is remote.

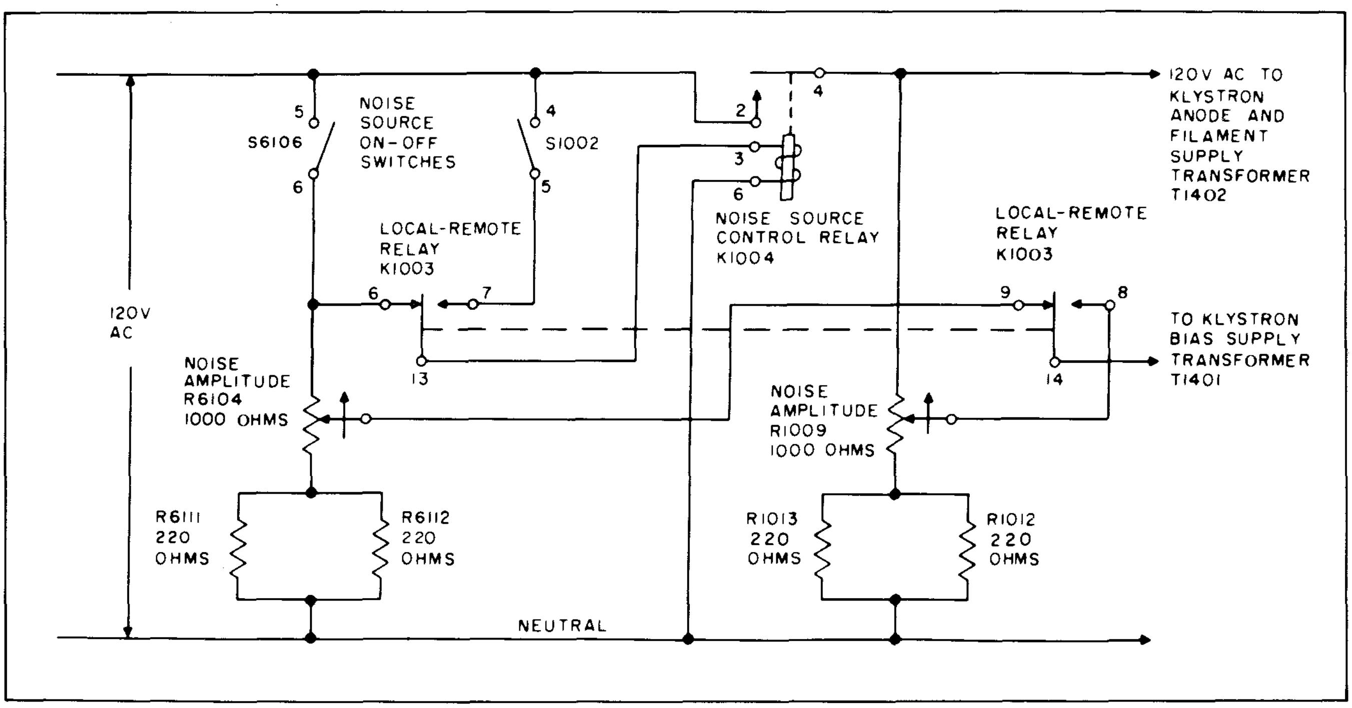

Figure 4–87. R-f Noise Source, Power and Noise Amplitude Controls for Radar Set AN/FPS-6, Simplified Schematic Diagram

4–585. TUNING AND INDICATOR CONTROL CIRCUITS. (See figure 4–88.) The frequency of the output of noise klystron V1401 is raised or lowered by control circuits at the local and remote r-f control panels. When local control is in effect, local-remote relays K6101 and K1001 through K1003 are energized and the frequency of the r-f noise source output is controlled by local NOISE SOURCE FREQUENCY RAISE LOWER switch S1006.

4–586. When switch S1006 is placed in the RAISE position, contacts 2 and 3 of this switch close. Since local-remote relay K1001 is energized, +28-volt d-c power is fed through contacts 13 and 7 of relay K1001, contacts 2 and 3 of switch S1006, and contacts 2 and 3 of microswitch S1402 to the coil of raise-frequency control relay K1401.

4–587. When relay K1401 is energized, the three sets of contacts of this relay close and power is fed to both the normal and phase-shifting windings of klystron tuning motor B1401. The motor then rotates the klystron cavity tuning control in the raise-frequency direction. The 120-volt a-c power is fed through contacts 2 and 1 to the parallel combination of capacitors C1403 and C1404, which are in series with winding A of tuning motor B1401. Capacitors C1403 and C1404 are phase-shifting capacitors in the field-winding circuit of motor B1401, which requires two-phase power for its operation. In addition, 120-volt a-c power is fed through contacts

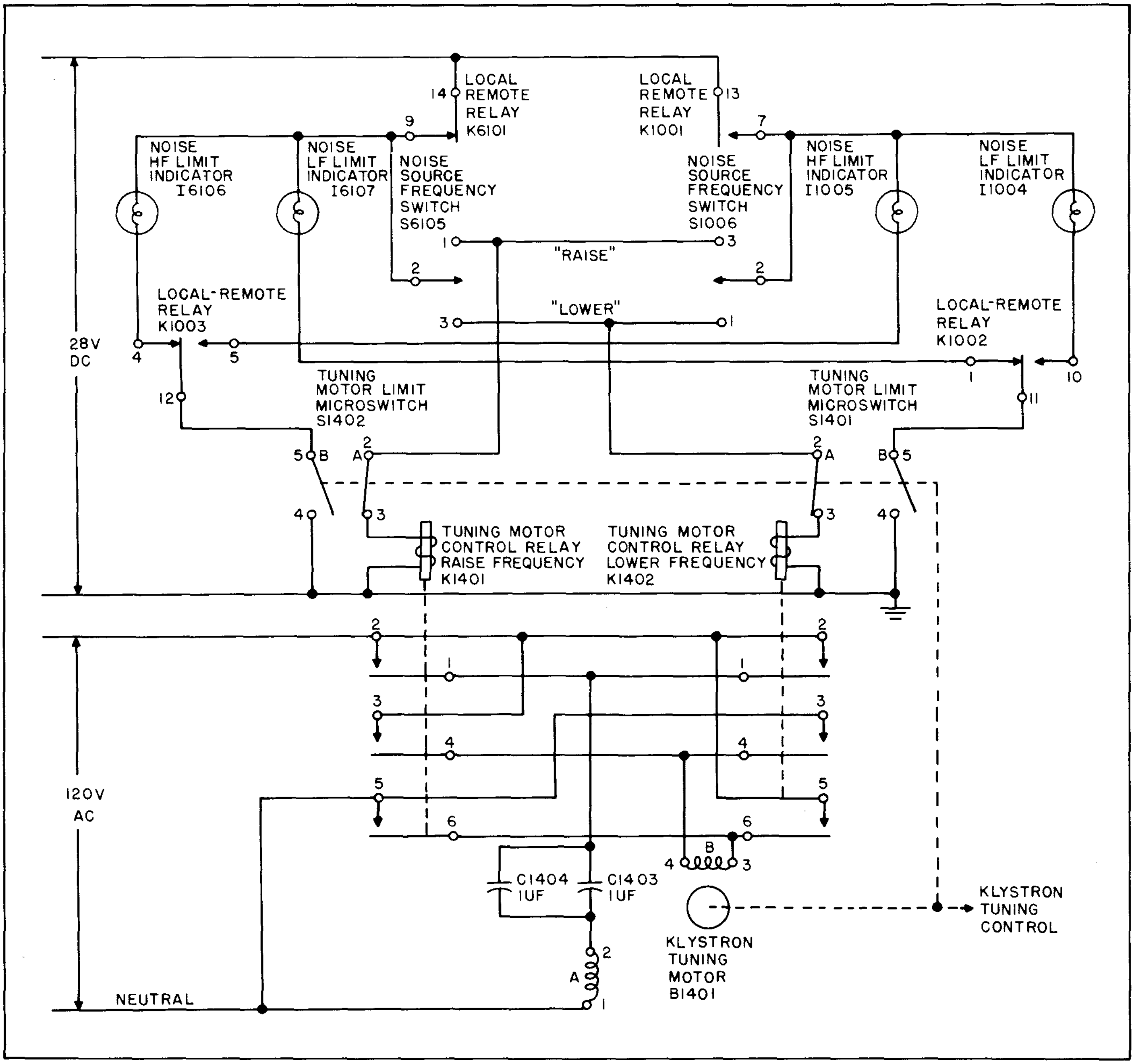

Figure 4–88. R-f Noise Source, Tuning and Indicator Control Circuit for Radar Set AN/FPS-6, Simplified Schematic Diagram

3 and 4 of relay K1401 to terminal 4 of winding B. Terminal 3 of winding B is connected to neutral through contacts 5 and 6 of relay K1401. To reverse the direction of rotation of motor B1401, the connections of the 120-volt a-c input power to the terminals of winding B are reversed. The reversal takes place when lower-frequency control relay K1402 is energized.

4–588. With switch S1006 in the RAISE position, raise-frequency control relay K1401 remains energized and tuning motor B1401 rotates in the raise-frequency direction until either of the following two actions occurs: If switch S1006 is returned from the RAISE position to neutral, contacts 2 and 3 of this switch open, cutting off 28 volts dc to the coil of relay K1401. When the coil of relay K1401 is de-energized, its three pairs of contacts open and cut off 120-volt a-c power to the field winding of motor B1401, which stops the motor. The frequency of the output of noise klystron V1401 will then have increased in accordance with the change in the setting of the klystron cavity tuning control. However, if switch S1006 is held in the RAISE position, raise-frequency control relay K1401 remains energized. Motor B1401 then continues to rotate in the raise-frequency direction until it reaches a preset position and trips high-frequency limit microswitch S1402.

4–589. When microswitch S1402 is tripped, contacts 2 and 3 of this switch open and contacts 5 and 4 close. When contacts 2 and 3 open, the coil of relay K1401 is de-energized and tuning motor B1401 stops. Simultaneously, local noise frequency HIGH LIMIT indicator I1005 lights, since contacts 5 and 4 of switch S1402 close to provide a continuous circuit to ground. When control is local, indicator I1005 is connected to 28 volts dc through contacts 7 and 13 of local-remote relay K1001. Indicator I1005 is connected to ground through contacts 5 and 12 of local-remote relay K1003 and contacts 5 and 4 of high-frequency limit microswitch S1402 whenever tuning motor B1401 is rotated to the position in which switch S1402 is tripped. Indicator I1005 remains lit as long as local control is in effect and tuning motor B1401 remains in the preset high-frequency limiting position in which switch S1402 is tripped. When motor B1401 rotates in the lower frequency direction, away from the high-frequency limit position, switch S1402 reverts to the nontripped position, closing contacts 2 and 3 and opening contacts 5 and 4. As a result, the connection of indicator I1005 to ground is interrupted.

4–590. When control is local, the frequency of the output of the r-f noise source is lowered by placing local NOISE SOURCE FREQUENCY RAISE LOWER switch S1006 in the LOWER position. When switch S1006 is in the LOWER position, contacts 2 and 1 of this switch close. Since local-remote relay K1001 is energized, +28 volts dc is fed through contacts 13 and 7 of relay K1001, contacts 2 and 1 of switch S1006, and contacts 2 and 3 of microswitch S1401, to the coil of lower-frequency control relay K1402.

4–591. When relay K1402 is energized, the three pairs of contacts of this relay close and 120-volt a-c power is fed to windings A and B of tuning motor B1401. The 120-volt a-c power is fed through contacts 2 and 1 of relay K1402 to phase-shifting capacitors C1403 and C1404, in series with winding A. Power is also fed through contacts 5 and 6 of relay K1402 to terminal 3 of winding B, while terminal 4 of winding B is connected to neutral through contacts 3 and 4 of relay K1402. Since terminal 3 of winding B is connected to the 120-volt a-c power input and terminal 4 connected to neutral, tuning motor B1401 rotates in the lower frequency direction, which is opposite to that in which the motor rotates when relay K1401 is energized.

4–592. With switch S1006 in the LOWER position, lower-frequency control relay K1402 remains energized and tuning motor B1401 rotates in the lower-frequency direction until either of the following two actions occurs: If switch S1006 is returned from the LOWER position to neutral, contacts 2 and 1 of this switch open, cutting off 28 volts dc to the coil of relay K1402. When the coil of relay K1402 is de-energized, its three pairs of contacts open and cut off 120-volt a-c power to the field windings of motor B1401, which stops the motor. The frequency of the output of noise klystron V1401 will then have decreased in accordance with the change in the setting of the klystron cavity tuning control. However, if switch S1006 is held in the LOWER position, lower-frequency control relay K1402 remains energized. Motor B1401 then continues to rotate in the lower-frequency direction until it reaches a repeat position and trips low-frequency microswitch S1401. When switch S1401 is tripped, contacts 2 and 3 of this switch open and contacts 5 and 4 close. When contacts 2 and 3 open, the coil of relay K1402 is de-energized and motor B1401 stops. Since contacts 5 and 4 of switch S1401 close at the same time that contacts 2 and 3 open, local LOW LIMIT indicator I1004 lights.

4–593. When control is local, LOW LIMIT indicator I1004 is connected to +28 volts dc through contacts 7 and 13 of local-remote relay K1001. Indicator I1004 is connected to ground through contacts 10 and 11 of local-remote relay K1002 and contacts 5 and 4 of low-frequency limit microswitch S1401. This switch is tripped whenever tuning motor B1401 reaches its preset low-frequency limit position. Indicator I1004 remains lit as long as local control is in effect and motor B1401 remains in the preset low-frequency limit position. When motor B1401 rotates in the raise-frequency direction, away from the low-frequency limit position, switch S1401 reverts to the nontripped position, closing contacts 2 and 3 and opening contacts 5 and 4. Indicator I1004 then goes off.

4–594. When remote control is in effect, local-remote relays K6101, K1001, K1002, and K1003 are de-energized. The frequency of the r-f noise source output is then controlled by remote NOISE SOURCE FREQUENCY switch S6105.

4–595. When NOISE SOURCE FREQUENCY switch S6105 is placed in the RAISE position, contacts 2 and 1 of this switch close. Since local-remote relay K6101 is de-energized and contacts 14 and 9 of relay K6101 are normally closed when relay K6101 is de-energized, +28-volt d-c power is fed through contacts 14 and 9 of relay K6101, contacts 2 and 1 of switch S6105, and contacts 2 and 3 of microswitch S1402 to the coil of raise-frequency control relay K1401. From this point, the functioning of relay K1401 and tuning motor B1401 is identical to that described in paragraph 4–587.

4–596. With switch S6105 in the RAISE position, raise-frequency control relay K1401 remains energized and tuning motor B1401 rotates in the raise-frequency direction until either of the following two actions occurs: If switch S6105 is returned from the RAISE position to neutral, contacts 1 and 2 of this switch open, cutting off 28 volts dc to the coil of relay K1401. When the coil of relay K1401 is de-energized, its three pairs of contacts open and cut off 120-volt a-c power to the field windings of motor B1401, which stops the motor. However, if switch S6105 is held in the RAISE position, raise-frequency control relay K1401 remains energized and motor B1401 continues to rotate in the raise-frequency direction until the motor reaches a preset position and trips high-frequency limit microswitch S1402.

4–597. When microswitch S1402 is tripped, contacts 2 and 3 of this switch open and contacts 5 and 4 close. When contacts 2 and 3 open, the coil of relay K1401 is de-energized and tuning motor B1401 stops. Simultaneously, remote noise frequency HIGH LIMIT indicator I6106 lights, since contacts 5 and 4 of switch S1402 close to provide a continuous circuit to ground. When control is remote, indicator I6106 is connected to +28 volts dc through contacts 9 and 14 of local-remote relay K6101. Indicator I6106 is connected to ground through contacts 4 and 12 of local-remote relay K1003 and contacts 5 and 4 of switch S1402 whenever motor B1401 trips switch S1402. Indicator I6106 remains lit as long as remote control is in effect and motor B1401 remains in the preset high-frequency limiting position in which switch S1402 is tripped. When motor B1401 rotates in the lower-frequency direction, away from the high-frequency limit position, switch S1402 reverts to the non-tripped position. Contacts 2 and 3 then close and contacts 5 and 4 open, interrupting the connection to ground of indicator I6106.

4–598. When control is remote, the frequency of the output of the r-f noise source is lowered by placing remote NOISE SOURCE FREQUENCY switch S6105 in the LOWER position. When switch S6105 is operated to the lower position, contacts 2 and 3 of switch S6105 close. Since local-remote relay K6101 is de-energized, +28 volts dc is fed through normally closed contacts 14 and 9 of relay K6101, contacts 2 and 3 of switch S6105, and contacts 2 and 3 of microswitch S1401 to the coil of lower-frequency control relay K1402. From this point, the functioning of relay K1402 and tuning motor B1401 is identical to that described in paragraph 4–591.

4–599. With switch S6105 in the LOWER position, lower-frequency control relay K1402 remains energized and tuning motor B1401 rotates in the lower-frequency direction until either of the following two actions occurs: If switch S6105 is returned from the LOWER position to neutral, contacts 2 and 3 of this switch open, cutting off 28 volts dc to the coil of relay K1402. When the coil of relay K1402 is de-energized, its three pairs of contacts open and cut off 120-volt a-c power to the field windings of motor B1401, which stops the motor. The frequency of the output of noise klystron V1401 will then have decreased in accordance with the change in the setting of the klystron cavity tuning control. However, if switch S6105 is held in the LOWER position, lower-frequency control relay K1402 remains energized. Motor B1401 then continues to rotate in the lower-frequency direction until it reaches a preset position and trips low-frequency limit microswitch S1401. When switch S1401 is tripped, contacts 2 and 3 of this switch open and contacts 5 and 4 close. When contacts 2 and 3 open, the coil of relay K1402 is de-energized and tuning motor B1401 stops. Since contacts 5 and 4 of switch S1401 close at the same time that contacts 2 and 3 open, remote LOW LIMIT indicator I6107 lights.

4–600. When remote control is in effect, LOW LIMIT indicator I6107 is connected to +28 volts dc through contacts 9 and 14 of local-remote relay K6101. Indicator I6107 is connected to ground through contacts 1 and 11 of local-remote relay K1002 and contacts 5 and 4 of microswitch S1401. Switch S1401 is tripped whenever tuning motor B1401 reaches its preset low-frequency limit position. Remote LOW LIMIT indicator I6107 remains lit as long as remote control is in effect and motor B1401 remains in the preset low-frequency limit position. When motor B1401 rotates in the raise-frequency direction, away from the low-frequency limit position, switch S1401 reverts to the nontripped position, contacts 2 and 3 close, contacts 5 and 4 open, and indicator I6107 goes off.

4–601. FUNCTIONING OF POWER DISTRIBUTION AND CONTROL SYSTEM.

4–602. GENERAL. Distribution and control of the 120-volt a-c and 28-volt d-c power in the receiving system is covered in the following paragraphs. The units discussed are the receiving system components located in the r-f assembly and the components in the control group assembly (remote control assembly). Since control of the receiving system is in many respects functionally related to control of the transmitting system, various transmitting system components located in the r-f assembly are also discussed.

4–603. 120-VOLT A-C POWER DISTRIBUTION AND CONTROL. (See figure 4–89.) POWER switch S1008 controls the flow of power to the other units in the r-f assembly. This switch opens automatically when the current drain becomes excessively high. Indicator I1008 lights to indicate that switch S1008 is closed.

4–604. In Radar Set AN/FPS-6 only, the power distribution to the noise source and waveguide shorting switch local and remote control circuits is as follows. When control is local, remote-local relays K1001, K1002, and K1003 are energized and NOISE SOURCE switch S1002 controls the application of power to the noise source, noise source controls, noise source switch controls, and to the waveguide shorting switch controls.

4–605. When switch S1002 is in the OFF position, noise source control relay K1004 is not energized. Thus, the noise source is off and the noise source switch is in its normal position. If the radar is not transmitting, the waveguide shorting switch solenoid remains de-energized and the shorting switch probes are in their decoupled positions. If the radar is transmitting, 120 volts ac is fed through contacts 3 and 2 of switch S1002 and contacts 10 and 11 of relay K1001 to energize the waveguide shorting switch solenoid and couple the signal to the receiver. This may also be accomplished by operating WAVEGUIDE SHORTING SWITCH BYPASS switch S915 on the r-f assembly of Radar Set AN/FPS-6 only.

4–606. When switch S1002 is in the ON position, power flows through contacts 1 and 2 of switch S1002 and contacts 10 and 11 of relay K1001, energizing the waveguide shorting switch solenoid. Noise source control relay K1004 is energized through contacts 4 and 5 of switch S1002 and contacts 7 and 13 of relay K1003. Power is fed through contacts 7 and 5 of relay K1004 to the noise source switch solenoid to rotate the switch to the noise source position. Power is also fed through contacts 2 and 4 of relay K1004 to the noise source chassis and to the noise amplitude control circuit in the local control unit. The noise amplitude control output is fed through contacts 8 and 14 of relay K1003 to the noise source.

4–607. When control is remote, the remote-local relays are not energized and NOISE ON-OFF switch S6106 controls the application of power to the noise source, noise source controls, noise source switch controls, and waveguide shorting switch controls. Phase C of the 3-phase, 4-wire, 208/120-volt a-c supply is fed through the power distribution panel to the remote control panel. The power is then fed to contacts 3 and 5 of switch S6106 through fuse F6101. Neon glow indicator I6111 lights to indicate failure of fuse F6101. Resistor R6110 is a current-limiting resistor.

4–608. When switch S6106 is in the OFF position and the radar is transmitting, 120 volts ac is fed through contacts 1 and 2 of switch S6106 and contacts 1 and 11 of relay K1001 to energize the waveguide shorting switch control circuit. When switch S6106 is in the ON position, power is fed through contacts 3 and 2 of switch S6106 and contacts 1 and 11 of relay K1001 to energize the waveguide shorting switch control circuit and through contacts 5 and 6 of switch S6106 and contacts 6 and 13 of relay K1003 to energize noise source control relay K1004. Thus, power is fed to the noise source switch control circuit and to the noise source chassis. The noise amplitude is then controlled at the remote control panel.

4–609. In Radar Set AN/FPS-6A, the 120-volt a-c remote and local power and control circuits for the noise source generators and waveguide shorting switch have been eliminated (figure 4–90). These circuits have been replaced by a 120-volt a-c power and control circuit for the noise figure modulator. Phase C of the 120 volts ac from the power distribution panel is applied to the noise figure modulator through POWER switch S7801 and PLATE switch S7803 in the performance monitor power supply.

4–610. 28-VOLT D-C POWER DISTRIBUTION AND CONTROL. (See figure 4–91.) The 28-volt d-c power is taken from the control group power supply and fed to the local and remote control panels. This supply is used primarily to energize control relays at the local and remote control positions. Control can be at either the local or remote control position; both positions cannot have control at the same time.

4–611. Switches S1001 and S6109 are the REMOTE-LOCAL CONTROL switches. If the switches are in the position shown in figure 4–91, control is remote. If the position of one of the switches is changed, control is changed to local. If the position of one of the switches is changed again, control is returned to the remote position. When control is local, 28 volts dc is fed to remote-local relays K1001, K1002, and K1003 in the local control panel, to relay K701 in the local oscillator assembly, and to relay K6101 in the remote control panel. When control is remote, these relays are not energized. LOCAL indicators I1002 and I6110 light when control is local; REMOTE indicators I1001 and I6109 light when control is remote.

4–612. In Radar Set AN/FPS–6, noise source tuning controls are provided at the local and remote control positions. MANUAL-AFC switches S701 and S6108 are used to select manual or AFC operation of the local oscillator. If control is local and switch S701 is in the MANUAL position, 28 volts is fed through switch S701 and contacts 7 and 13 of relay K701 to relay K21301 of the AFC-LO unit, disabling the AFC circuits. If control is in the MANUAL position, 28 volts is fed through contacts 14 and 9 of relay K6101, contacts 1 and 2 of switch S6108, and contacts 6 and 13 of relay K701 to relay K21301 of the AFC-LO unit, disabling the AFC circuits.

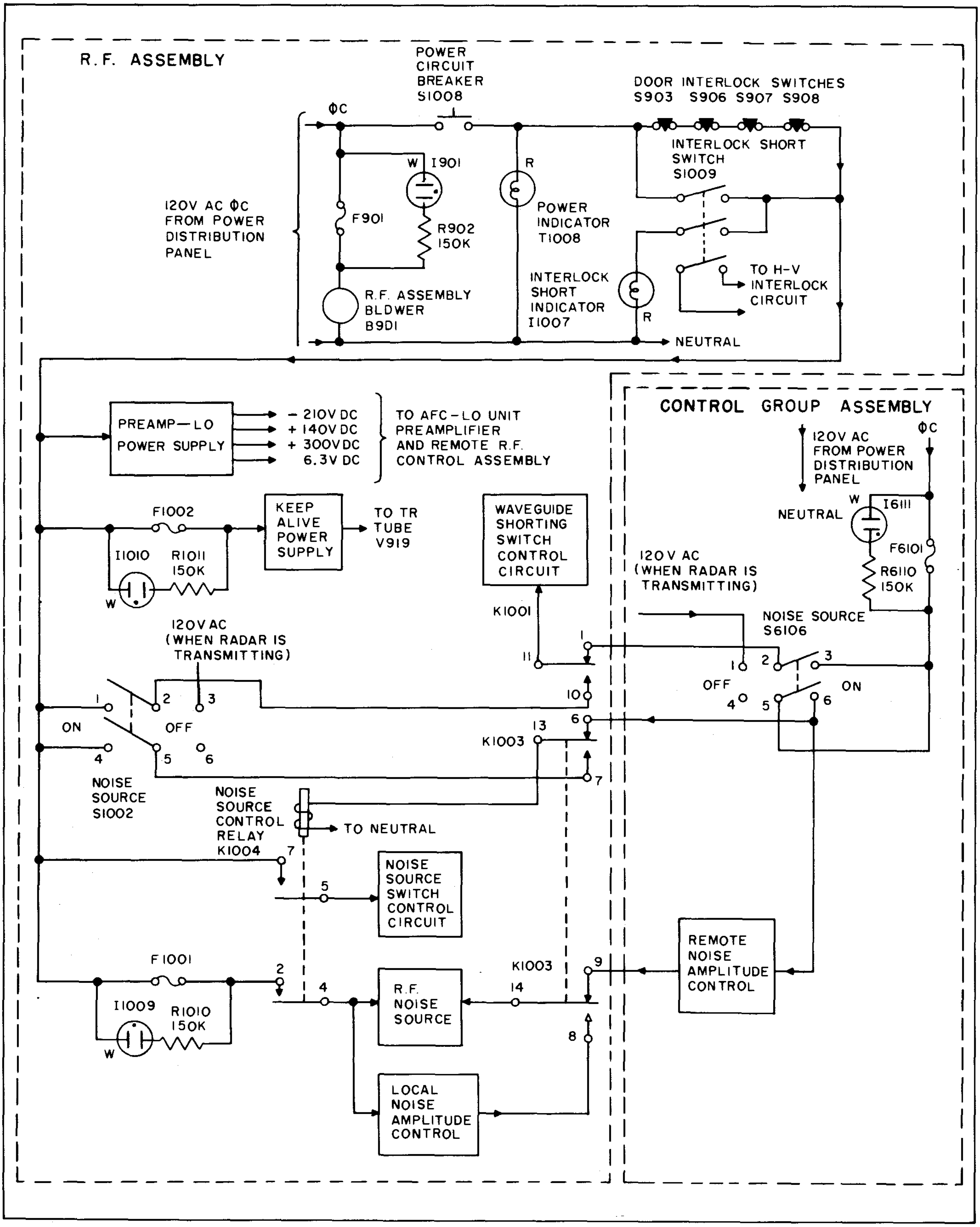

Figure 4–89. Receiving System 120-volt A-c Power and Control Diagram for Radar Set AN/FPS-6

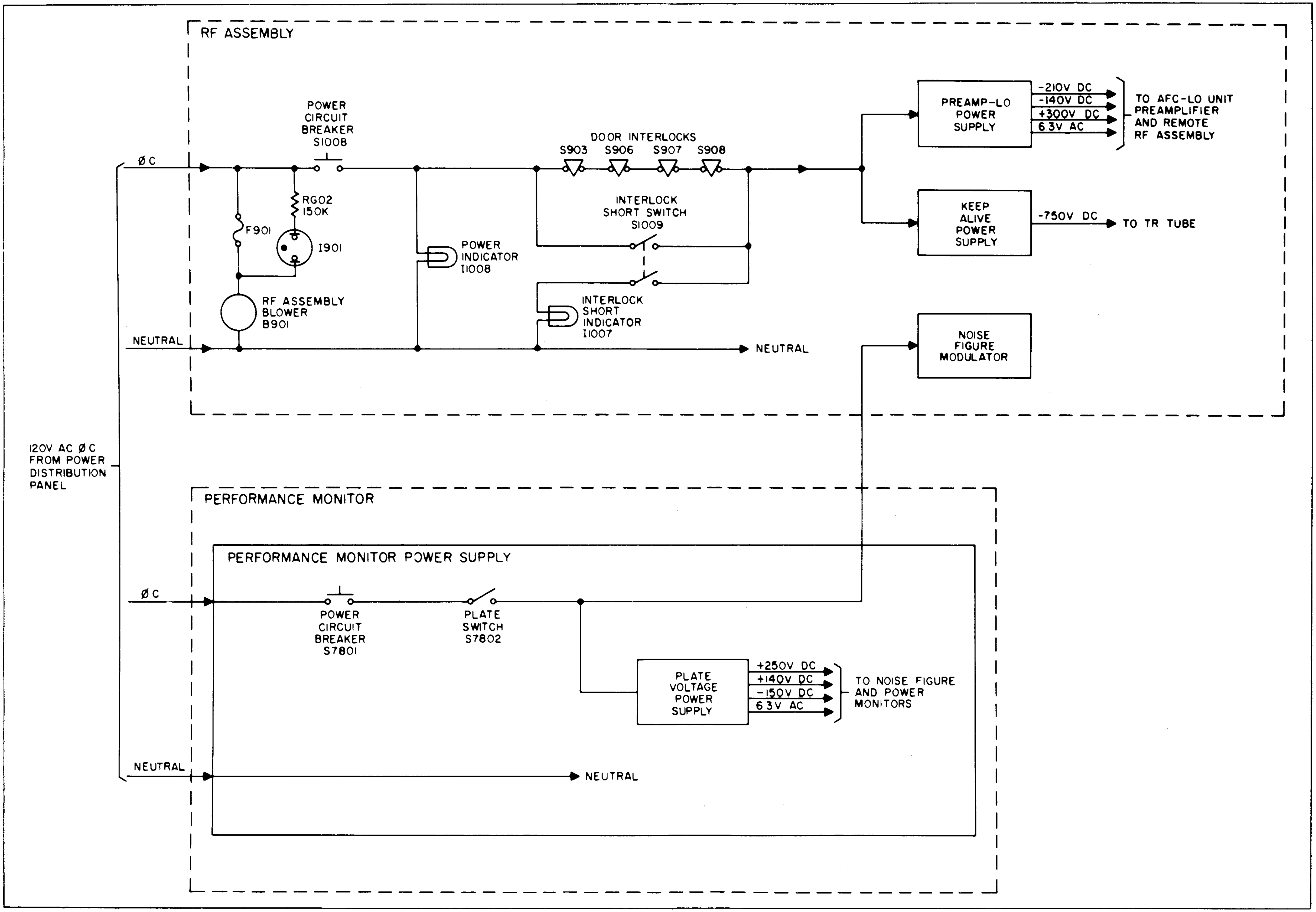

Figure 4-90. Receiving System 120-volt A-c Power and Control Diagram for Radar Set AN/FPS-6A

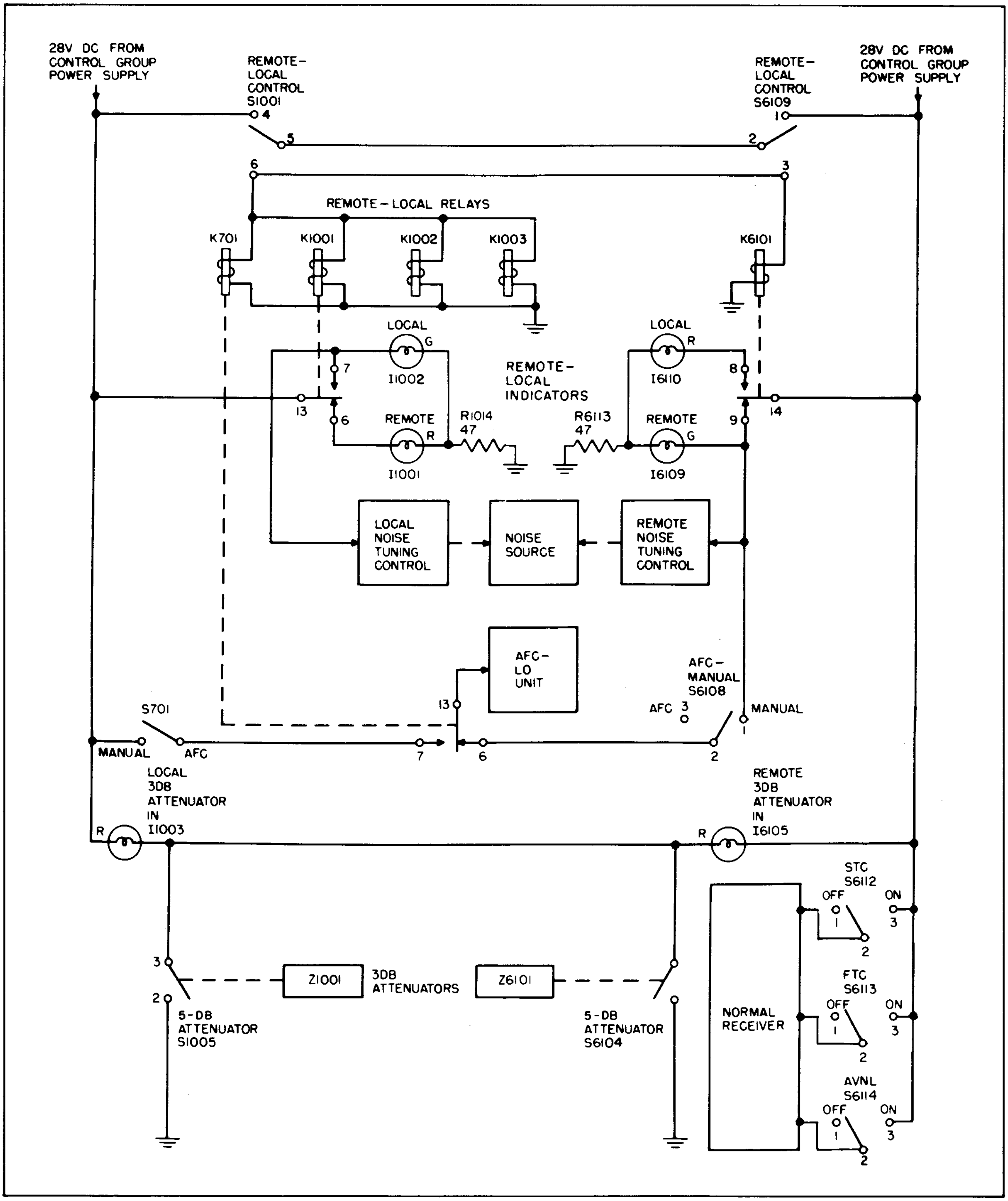

Figure 4–91. Receiving System 28-volt D-c Power and Control Diagram for Radar set AN/FPS-6 Only

4–613. ATTENUATOR 3 DB switches S1005 and S6104 are mechanically ganged to local 3-db attenuator Z1001 and remote 3-db attenuator Z6101, respectively. Operating either switch to the closed position introduces the corresponding attenuator into the 30-megacycle i-f circuit. At the same time, the closed switch provides a continuous path to ground for both local and remote ATTENUATOR IN indicators. Both indicators light as long as either attenuator is in the i-f circuit. Indicators I1003 and I6105 are the local and remote ATTENUATOR IN indicators, respectively.

4–614. The STC, FTC, and AVNL control circuits in the normal receiver are turned ON or OFF by operating switch S6112, S6113, or S6114, respectively. In the ON position, 28 volts pass through the switch to energize a control relay in the normal receiver. In the OFF position, the relay is de-energized.

4–615. INDICATOR AND TEST PANEL. The purpose of all controls, indicators, and jacks on the indicator and test panel are given in figures 1–61 and 1–62. These elements are described as parts of the functional circuits to which they belong. The schematic diagram of the indicator and test panel is included in the schematic of the r-f assembly cabinet (figures 7–41 and 7–42).

4–616. The indicator and test panel used in Radar Set AN/FPS-6A (figure 1–62) does not contain coaxial switch S905 and POWER MEASURE jack J904. In addition, 120V AC OUTLET power receptacles J926 and J934 have been replaced by dual 120V AC OUTLETS power receptacle J926. The positions of INTERLOCK TEST switch S912 have been redesignated for inclusion of the ISOL COOL position (ferrite isolator coolant interlock).

4–617. NOISE FIGURE GATE GENERATOR (GATE, ELECTRONIC TD-176/GPA-40).

4–618. BLOCK DIAGRAM. (See figure 4–92.)

4–619. System trigger pulses (A, figure 4–92) are applied to trigger delay tubes V8001 and V8002A. These tubes are arranged in the form of a phantastron oscillator and produce the basic timing signal (B, figure 4–92). The duration of the positive-going portion of this signal is adjusted to 200 microseconds. The lagging edge of each such pulse is coincident with a system trigger pulse. Inverter V8003 serves as the trigger for flip-flop V8004, which delivers its out-of-phase square wave outputs (C and C′, figure 4–92) to inverters V8005 and V8007, respectively.

4–620. Inverter V8005 serves as the trigger for gate generator V8006, which delivers negative-going 200-microsecond pulses (D, figure 4–92) to cathode follower V8002B and positive-going pulses (D′, figure 4–92) to cathode follower V8009B. Both of these pulses are generated simultaneously every other period; the lagging edge of each pulse is coincident with a corresponding system trigger pulse. The inverted pulse outputs of cathode followers V8002B and V8009B are the noise-source-on gates cabled to the noise source modulator and noise figure detector, respectively.

4–621. Inverter V8007, driven by the inverted output (C′, figure 4–92) of flip-flop V8004, serves as the trigger for gate generator V8008. The latter delivers positive-going 200-microsecond pulses (E, figure 4–92) to cathode follower V8009A during the retrace intervals of those periods in which the noise-source-on gates are not generated. The output of cathode follower V8009A is a series of noise-source-off gates which are cabled to the noise figure detector.

4–622. Mixer V8010 is a dual triode whose A-section receives the noise-source-on gate while the B-section receives the noise-source-off gate. The combined output, obtained from the cathode, consists of both gates, one on each sweep (F, figure 4–92). The mixer output is fed from jack J8005 to the i-f amplifier.

4–623. CIRCUIT ANALYSIS OF NOISE FIGURE GATE GENERATOR. (See figure 7–118.)

4–624. PHANTASTRON V8001 AND V8002A. (See figure 4–93.) Trigger delay V8001 and cathode follower V8002A form a phantastron circuit. In the pretrigger condition, trigger delay V8001 is cut off and cathode follower V8002 is conducting. A voltage divider composed of resistors R8004 through R8006, connected between +140 and −150 volts, applies a negative voltage to the suppressor grid of trigger delay V8001, cutting off plate current.

4–625. Although no plate current flows in trigger delay V8001, grid current flows from ground to +140 volts through resistors R8010 and R8011. This voltage divider action places the grid of trigger delay V8001 at a slightly positive voltage level, charging capacitors C8004 and C8005.

4–626. When a positive trigger pulse (A, figure 4–93) from jack J8001 is applied to the suppressor grid, plate current begins to flow in trigger delay V8001 and there is an immediate drop in plate potential. This causes a corresponding drop in the cathode potential of cathode follower V8002A, which in turn causes capacitors C8004 and C8005 to discharge through resistor R8011. The descending plate potential of trigger delay V8001 controls the discharge of capacitors C8004 and C8005 in such a manner that the capacitors discharge linearly. The sudden conductance of trigger delay V8001 and the linear discharge of capacitors C8004 and C8005 produce a negative-going trapezoidal waveform (B, figure 4–93) which is sensed at the cathode of cathode follower V8002A. As the capacitors discharge, plate current decreases until a switching action occurs. The plate current of trigger delay V8001 then ceases and the rising plate voltage causes capacitors C8004 and C8005 to charge instantly through trigger delay V8001 and cathode follower V8002A. The short time constant which cathode V8002A presents to the capacitors produces the steep trailing edge of the

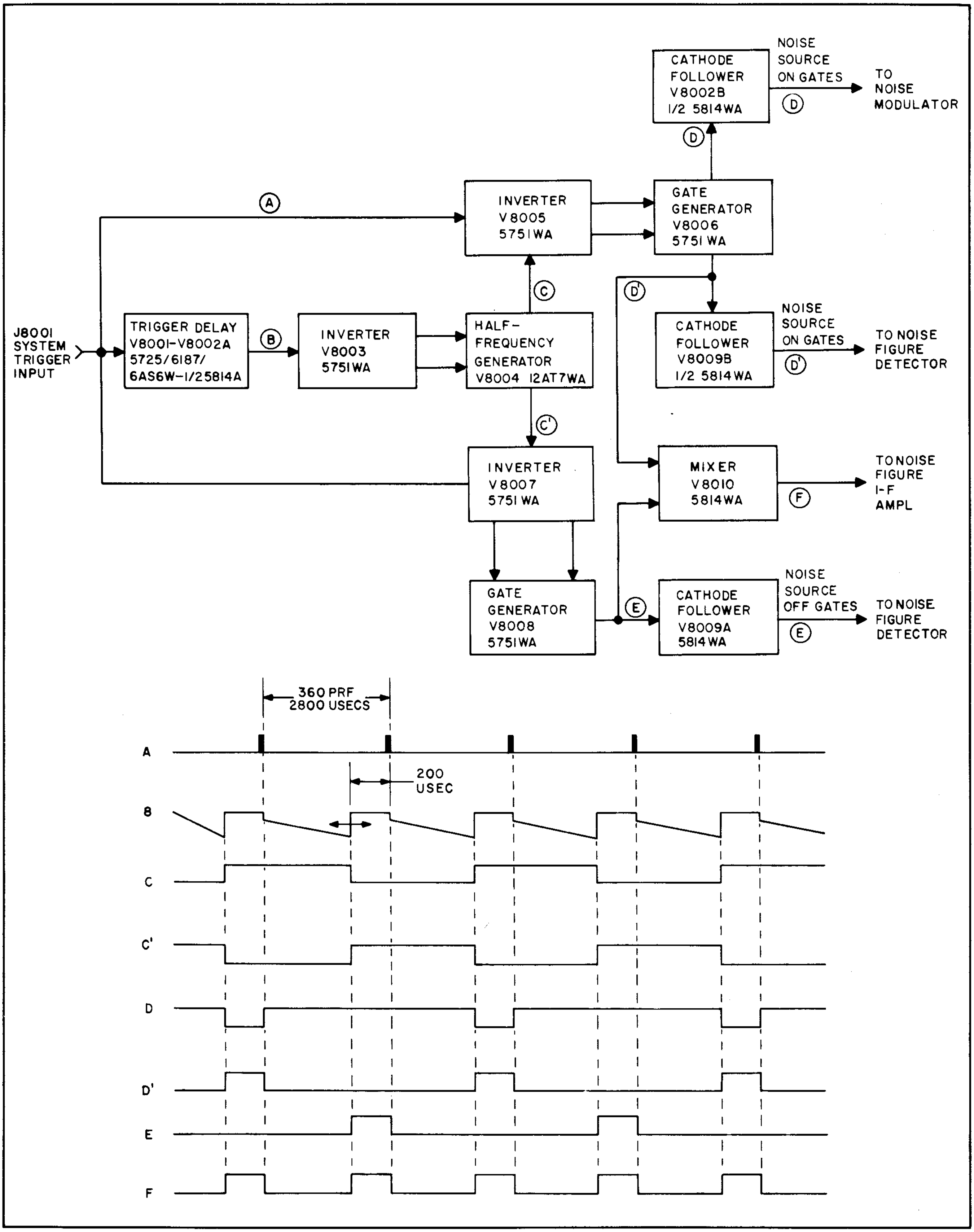

Figure 4–92. Noise Figure Gate Generator, Block Diagram

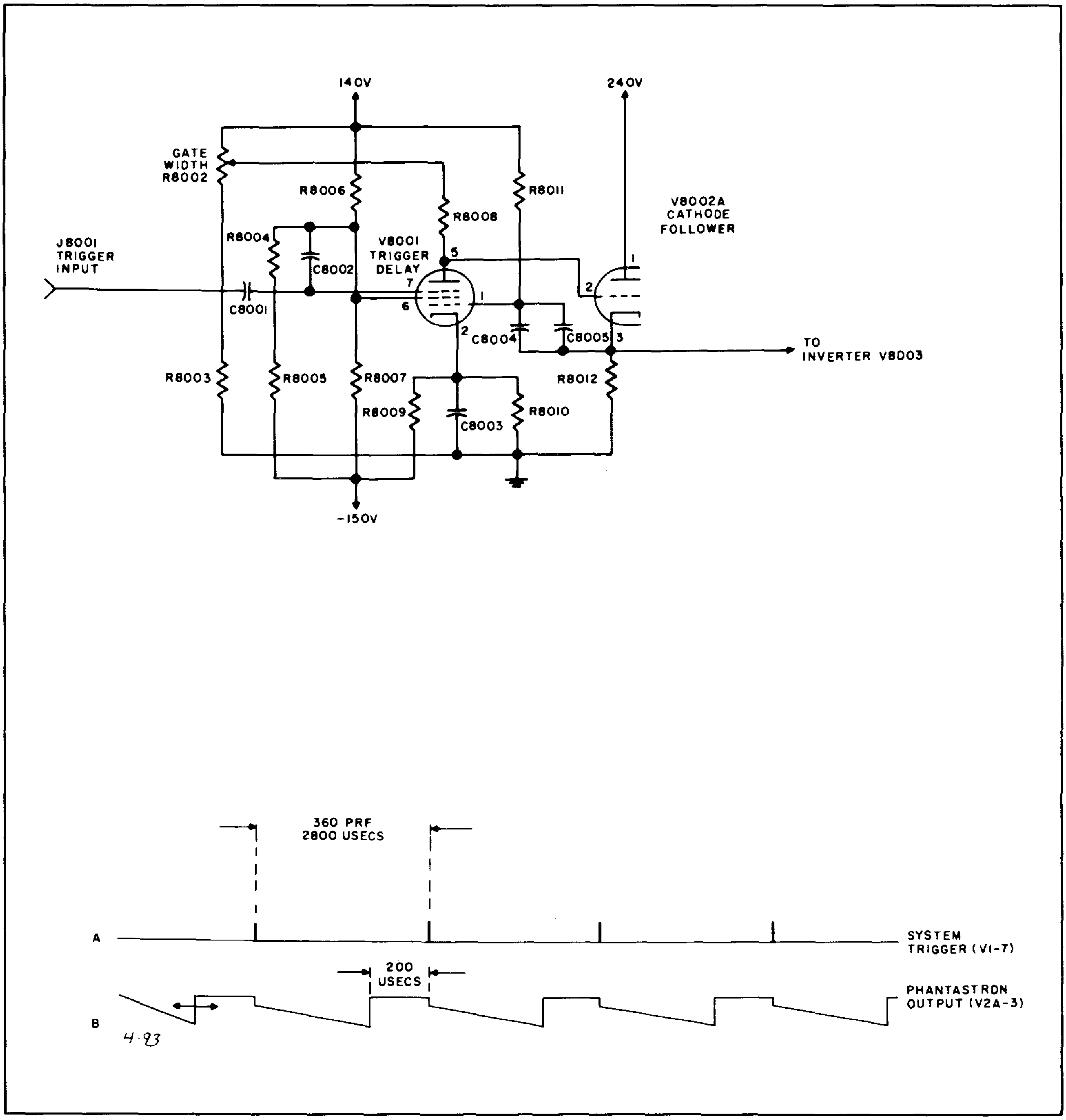

Figure 4-93. Phantastron, Simplified Schematic Diagram

trapezoidal waveform developed across resistor R8012. GATE WIDTH potentiometer R8002 adjusts the width of the trapezoidal waveform by controlling the plate voltage of trigger delay V8001.

4-627. INVERTER V8003. (See figure 4-94.) The trapezoidal waveform (B, figure 4-94) is differentiated by capacitor C8006 and resistors R8014 and R8016 and the resulting trigger (C, figure 4-94) applied to inverter V8003. A voltage divider composed of resistors R8013, R8015, and R8016 and capacitor C8007 produces the bias voltage for this stage. The negative amplified outputs at the plates of inverter V8003 are fed to the plate circuits of half-frequency generator V8004.

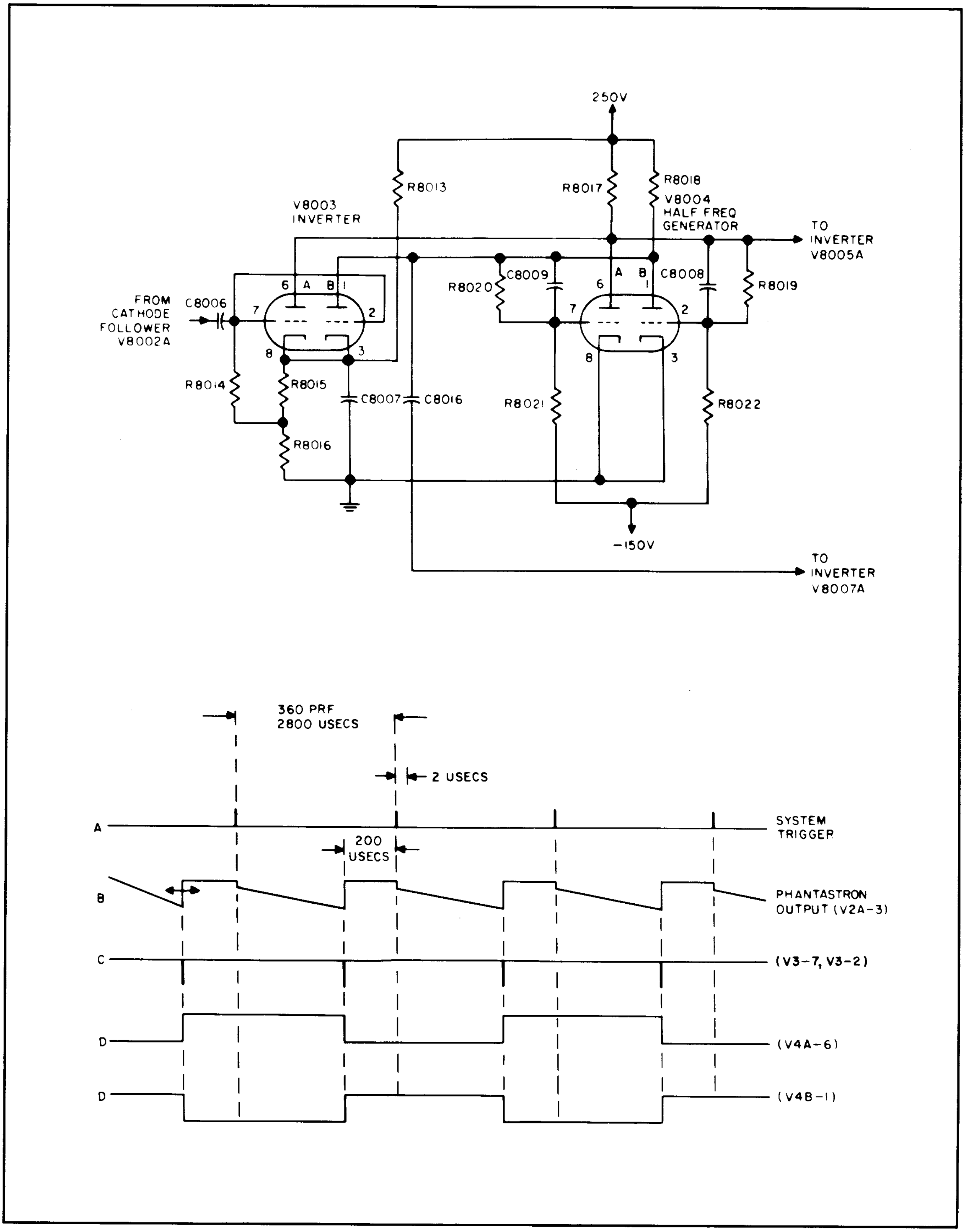

Figure 4–94. Inverter and Half-frequency Generator, Simplified Schematic Diagram

4–628. HALF-FREQUENCY GENERATOR V8004. (See figure 4–94.) Half-frequency generator V8004 is basically a multivibrator with two stable states. Assuming that in the pretrigger condition generator V8004A is conducting and generator V8004B is cut off, the plate voltage of generator V8004A is low and the plate voltage of generator V8004B is high. A switching action occurs when the negative triggers from inverter V8003 are applied simultaneously to generator V8004. A negative trigger applied to the plate of tube V8004A has no effect, since plate voltage is already low; however, a negative trigger applied to the plate of tube V8004B is felt at the grid of tube V8004A. Tube V8004A then conducts less heavily and its rising plate voltage brings the grid of tube V8004B above cutoff. Tube V8004B starts to conduct and the descending plate voltage, coupled to the grid of tube V8004A by capacitor C8009 and resistors R8020 and R8021, causes tube V8004A to cut off. During the next switching action, tube V8004B is cut off and tube V8004A starts to conduct. Thus, for every two trigger pulses applied, half-frequency generator V8004 produces one output pulse (D and D′, figure 4–94). The rising plate voltage of tube V8004A is applied to inverter V8005A. When the next switching action occurs, the rising plate voltage of tube V8004B is applied to inverter V8007A.

4–629. INVERTER V8005. (See figure 4–95.) The rising plate voltage from generator V8004A (B, figure 4–95) is differentiated by capacitor C8010 and resistors R8023 and R8026 and is applied as a positive trigger (C, figure 4–95) to the grid of inverter V8005A. The negative trigger, developed in the plate circuit of inverter V8005A, is applied to the plate of gate generator V8006A.

4–630. GATE GENERATOR V8006. (See figure 4–95.) The negative trigger applied to the plate of gate generator V8006A is coupled to the grid of gate generator V8006B by capacitor C8014, producing a positive waveform in the plate circuit. This positive pulse is coupled to the grid of generator V8006A by capacitor C8015, producing a negative waveform at the plate of this section. This negative waveform continues until a positive trigger pulse (A, figure 4–95), applied from jack J8001 to the grid of inverter V8005B by capacitor C8013, causes a drop in the plate potential of inverter V8005B. The drop in plate voltage is fed simultaneously to two places: to the grid of generator V8006A, causing its plate voltage to increase and thereby producing the lagging edge of the 200-microsecond, negative-going pulse (D, figure 4–95); and to the plate of generator V8006B, producing the lagging edge of the 200-microsecond, positive going pulse (E, figure 4–95).

4–631. However, the next trigger pulse sent to apply a negative voltage to the grid of generator V8006A has no affect on its plate current, since the plate voltage of inverter V8005B, and therefore the grid voltage of generator V8006A, are then at the low point because of the reversal of the output of tube V8005. Consequently, every other trigger pulse from jack J8001 produces positive- and negative-going pulses at the plates of generator V8006. The negative pulses are coupled to cathode follower V8002B, while the positive pulses are coupled to output stage V8009B.

4–632. OUTPUT STAGES V8002B AND V8009. The output at the cathode of cathode follower V8002B is applied to jack J8002, which feeds the negative noise-source-on gate signal to the noise figure modulator. The positive-going pulses from the plate of generator V8006B raise the voltage at the grid of stage V8009B, producing a positive-going pulse at the cathode of stage V8009B. This output is applied to jack J8003, which feeds the positive noise-source-on gate signal to the noise figure detector.

4–633. The low plate voltage of generator V8004B is also fed to the grid of inverter V8007A. The operation of inverter V8007, gate generator V8008, and cathode follower V8009A is identical to that of inverter V8005, generator V8006, and stage V8009B, except that at this time the alternate portion of the half-frequency generator output is being used. Consequently, the positive output of cathode follower V8009A (F, figure 4–94) is produced on alternate sweeps from the positive output of stage V8009B. The output pulse is applied to jack J8004, which feeds the positive noise-source-off gate to the noise figure detector.

4–634. MIXER V8010. Mixer V8010 combines the noise-source-on and noise-source-off gates into one signal. The noise-source-on gate from the plate of generator V8006B is coupled to the grid of mixer V8010A by resistors R8056 and R8057, while the noise-source-off gate from the plate of generator V8008B is coupled to the grid of mixer V8010B by resistors R8058 and R8059. The output at the cathode of mixer V8010B (G, figure 4–94), which is a positive 200-microsecond gate produced on each sweep just prior to the arrival of the system trigger is applied through jack J8005 to the noise figure i-f amplifier.

4–635. NOISE FIGURE MODULATOR (GENERATOR, PULSE SG-222/GPA-40 AND NOISE TUBE V918).

4–636. BLOCK DIAGRAM. (See figure 4–96.)

4–637. The negative-going, 200-microsecond noise-source-on gate is applied to both amplifier V8101 and inverter-cathode follower V8104. Power amplifier V8101 has an inductance as its plate load. Prior to application of the gate, the stage conducts heavily. The noise-source-on gate then cuts off amplifier V8101 and the magnetic field about the inductor collapses, producing a large, positive-going pulse at the output. Clipper V8102 clips off the overshoot at the lagging edge of the pulse. The high-amplitude, positive pulse generated by amplifier V8101 is fed to the anode of noise tube V918.

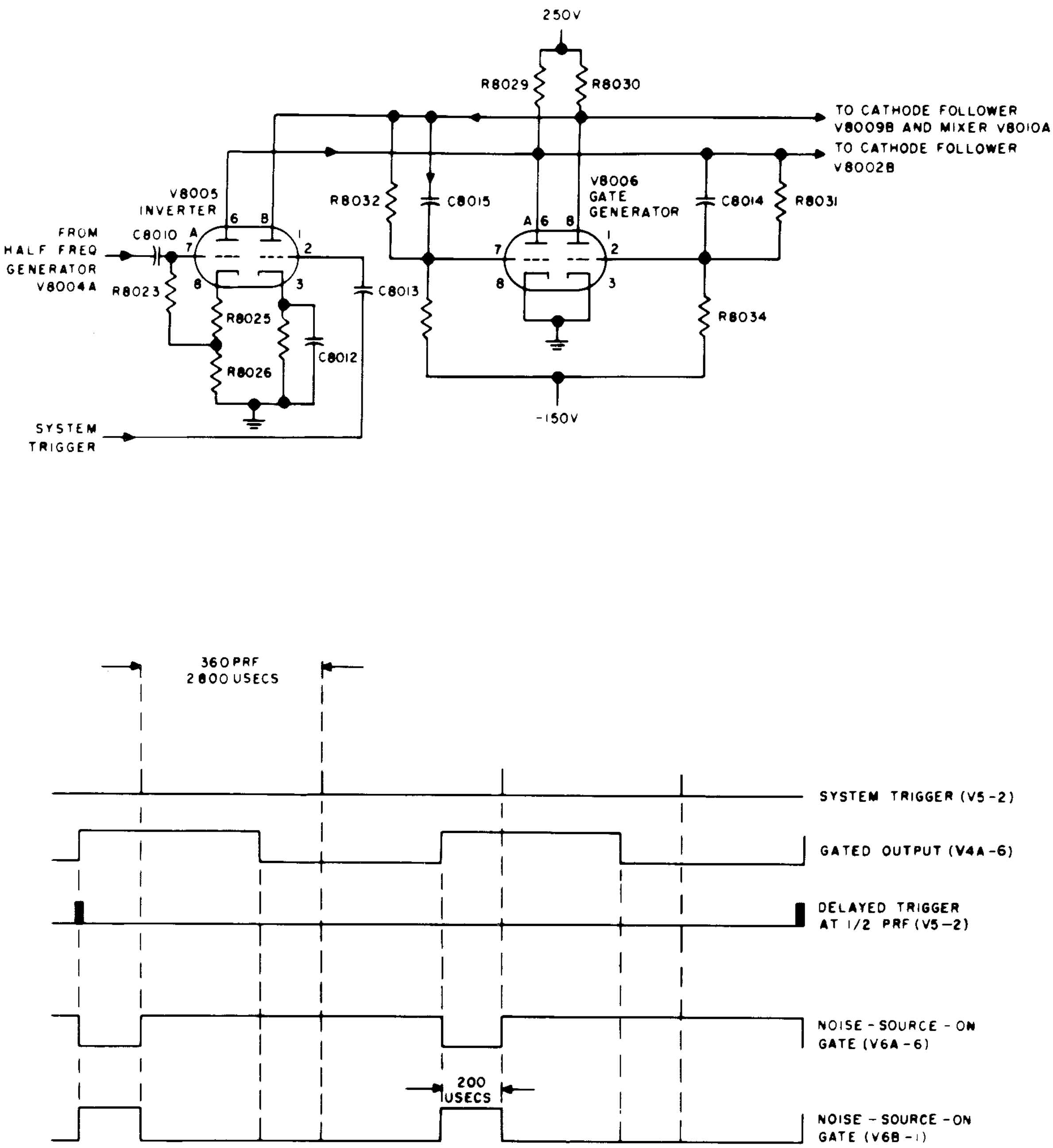

Figure 4–95. Inverter and Gate Generator, Simplified Schematic Diagram

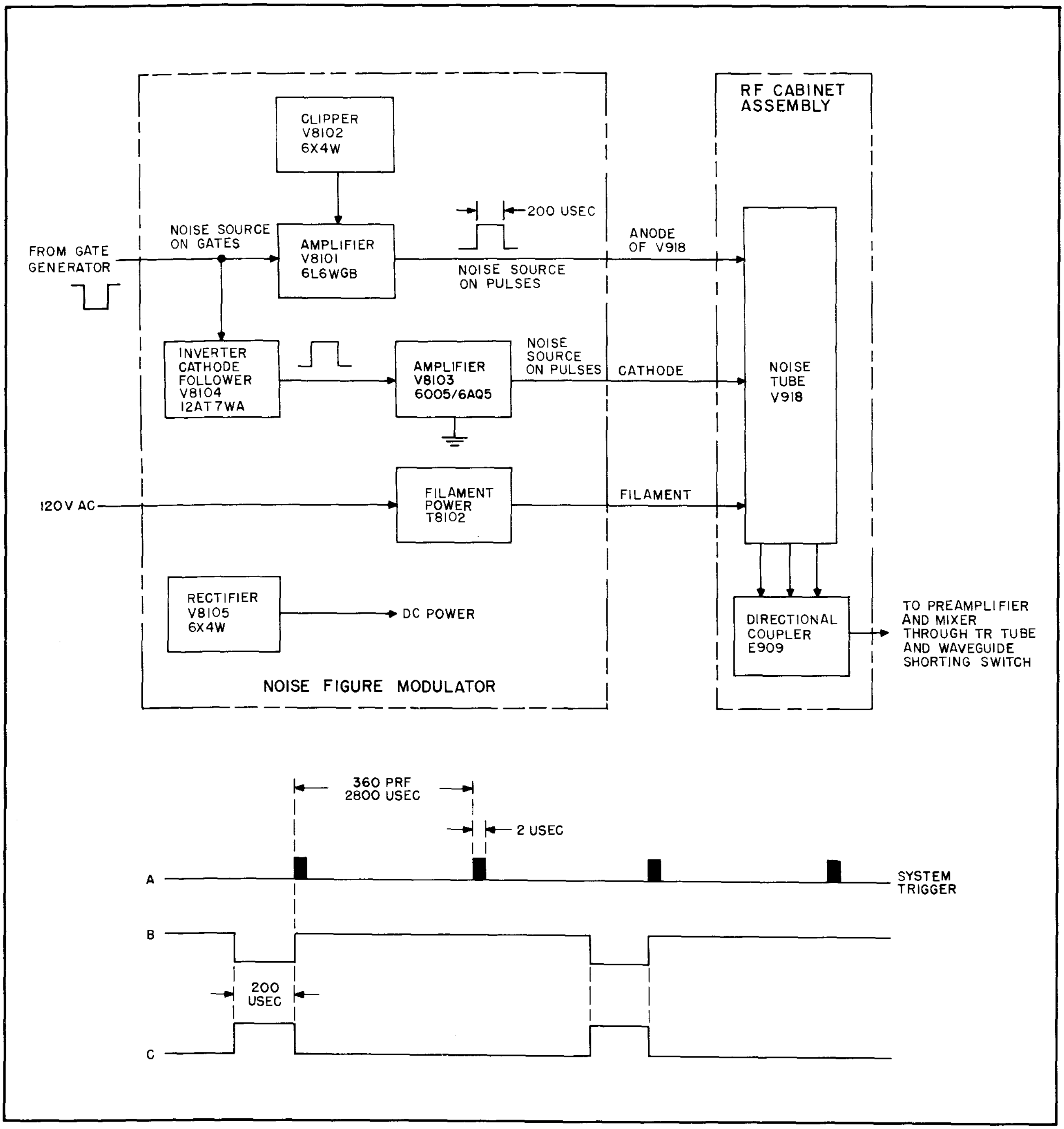

Figure 4–96. Noise Figure Modulator and Noise Source, Block Diagram

4–638. Simultaneously, inverter-cathode follower V8104 feeds a positive-going, 200-microsecond pulse to amplifier V8103, which is connected between the cathode of noise tube V918 and ground. The positive pulse causes amplifier V8103 to conduct heavily, grounding the cathode of the noise tube.

4–639. Under these conditions, noise tube V918 fires into directional coupler E909. The coupler noise output is fed into the waveguide structure. From the waveguide, the noise voltage is fed to the preamplifier and mixer. At the conclusion of the noise-source-on gate, amplifier V8103 is cut off by its grid signal. This opens the cathode circuit of the noise tube and turns off the pulse. The pulse is also removed from the plate of the noise tube.

4–640. CIRCUIT ANALYSIS OF NOISE FIGURE MODULATOR. (See figure 4–96.)

4–641. VIDEO AMPLIFIER V8101. The 200-microsecond, negative-going pulse from the noise figure gate generator is applied to video amplifier V8101 through jack J8101. The grid of amplifier V8101 is at ground potential prior to the arrival of the pulse and the tube conducts heavily. The negative-going pulse cuts off amplifier V8101, producing a 200-microsecond, positive-going pulse at the plate. Inductor L8102 insures a steep rise in the leading edge of the pulse. The plate voltage of amplifier V8101 falls rapidly when the input pulse ends after 200 microseconds.

4–642. CLIPPER V8102. A train of damped oscillations is generated at the output of video amplifier V8101 as the magnetice field about inductor L8102 collapses at the end of the pulse. Damping diode V8102, connected across inductor L8102 and resistor R8104, then conducts, preventing the overshoot from appearing at jack J8103. The positive pulse at jack J8103 is applied to the anode of the noise source tube in the r-f cabinet assembly. The cathode of damping diode V8102 is connected to the secondary filament winding of transformer T8101 to prevent arc-over between the filament and cathode of this stage.

4–643. PULSE AMPLIFIER V8104. The grid of pulse amplifier V8104 is returned to B+ so that this stage normally conducts heavily in the absence of an input. The 200-microsecond, negative-going pulse from jack J8101 produces a positive output at the plate of amplifier V8104A which is coupled to cathode follower V8104B. This positive pulse is then fed to the grid of output amplifier V8103.

4–644. OUTPUT AMPLIFIER V8103. The positive output from cathode follower V8104B is applied to the grid of amplifier V8103. The cathode of noise source tube V918 is effectively placed at ground potential by this action, since it is connected to the plate of amplifier V8103 through terminal 5 of terminal board TB8101. The filament supply voltage for the noise source tube at transformer T8102 is also tied to the cathode through terminals 5 and 6 of terminal board TB8101.

4–645. POWER SUPPLY V8105. A 120-volt potential from terminals 3 and 4 of terminal board TB8101 is applied to the primary winding of transformer T8101. The stepped-up voltage from the high-voltage winding of transformer T8101 is then applied to the plates of rectifier V8105. This voltage is rectified by full-wave rectifier V8105, filtered by a pi-network composed of capacitors C8101 and C8102 and indicator L8101, and supplied as plate and bias voltage. Filament voltage for the circuit is taken from the low-voltage winding of transformer T8101. A separate secondary winding of transformer T8101 provides filament voltage for damping diode V8102.

4–646. MIXER AND PREAMPLIFIER. (See figure 4–96.) During 200-microsecond noise-on gate intervals, the noise output of directional coupler E909 is fed to the mixer assembly of the mixer and preamplifier. The mixer assembly also receives the local oscillator signal from the klystron. Since the noise frequencies extend through the normal frequency range of the radar, the mixer assembly delivers a 30-megacycle noise signal suitable for application to the i-f amplifiers. The noise signal level is raised by i-f amplifiers V21501, V21502, and V21504 and is then applied through cathode follower V21506B to the noise figure i-f amplifier. It should be noted that the mixer assembly and the first two i-f amplifiers are common to the normal signal path; i-f amplifier V21504 and cathode follower V21506, previously provided in Radar Set AN/FPS-6 for use with MTI circuits, are used in the noise figure circuits of Radar Set AN/FPS–6A to increase the gain of the noise figure i-f channel. Although the normal i-f channel also receives the noise i-f signal, operation is not affected, since noise signals are gated only during the dead time of the radar indicator.

4–647. NOISE FIGURE I-F AMPLIFIER (AMPLIFIER-CONVERTER AM-1619/GPA-40).

4–648. BLOCK DIAGRAM. (See figure 4–97.)

4–649. The noise figure i-f amplifier raises the level of the noise signal to that required by the noise figure detector. Amplifiers V7901 through V7905 are tuned to a center frequency of 30 megacycles. The gain of amplifiers V7903, V7904, and V7905 is controlled by an AGC voltage cabled from the noise figure detector. The amplified i-f output of amplifier V7905 is detected by diode CR7901 and applied through cathode follower V7906A to inverter V7906B. The noise video output of cathode follower V7906A is amplified by amplifier V7907A and applied through cathode follower V7907B to the noise figure detector. Clamper CR7902 prevents the video output from going positive with respect to ground. The

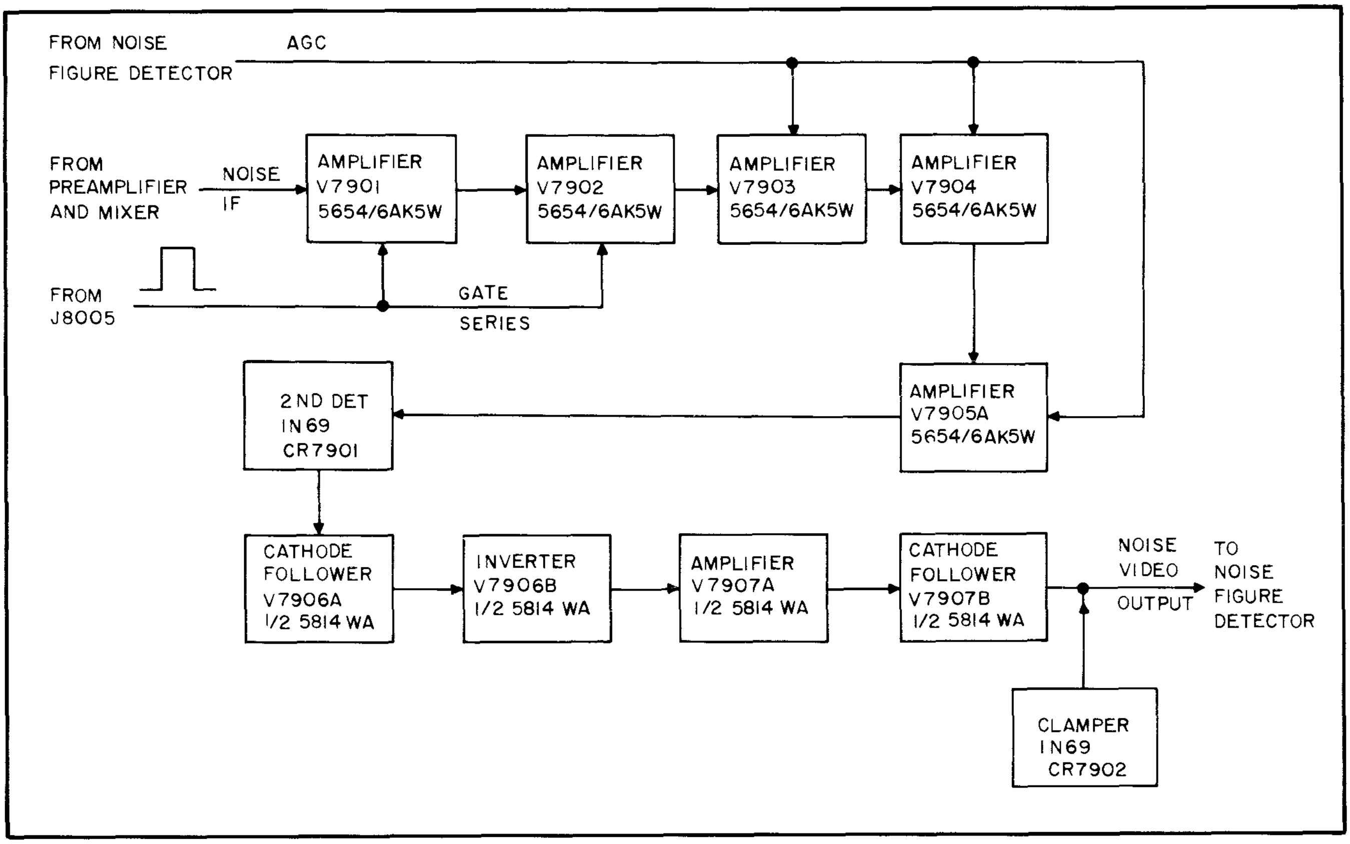

Figure 4–97. Noise Figure I-f Amplifier, Block Diagram

noise-source-on and -off gates from jack J8005 in the gate generator are fed to the screens of tubes V7901 and V7902, keeping the i-f amplifier cut off except during the gated periods.

4–650. CIRCUIT ANALYSIS OF NOISE FIGURE I-F AMPLIFIER.

4–651. FIRST COINCIDENCE AMPLIFIER V7901. Two signals are applied to amplifier V7901: one to the control grid through jack J7901 and the other to the screen grid through jack J7905. Both inputs must be present at the same time to produce a plate output. The grid return resistor is R7927 and the impedance match to the coaxial cable is resistor R7901. Inductors L7913 and L7914 prevent i-f oscillations from entering the gate circuit through jack J7905. Capacitor C7930 provides a positive feedback path from screen to cathode to reinforce the switching action when the gate begins.

4–652. The noise signal (B, figure 4–98) from the noise figure mixer and preamplifier is applied to jack J7901, and the 200-microsecond positive gate (C, figure 4–98) from the noise figure gate generator is applied to jack J7905. During the period of coincidence, the output waveform appears as shown in D of figure 4–98. It should be noted that there are two periods of coincidence: between t_0 and t_1 the output represents an amplified version of the system noise only signal; be-

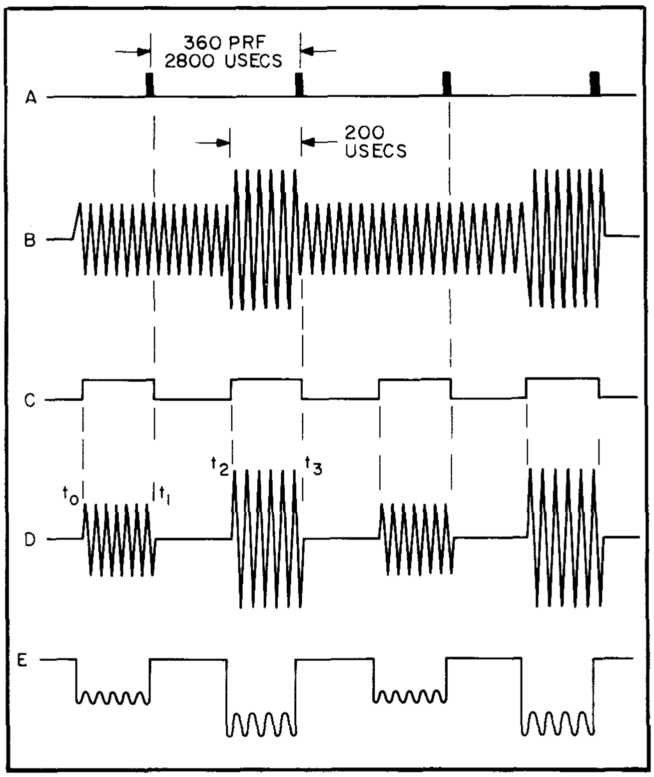

Figure 4–98. Noise Figure I-f Amplifier Waveforms

tween t_2 and t_3 the output represents the system noise plus the injected noise signal.

4–653. SECOND COINCIDENCE AMPLIFIER V7902. The i-f signal is coupled to the grid of amplifier V7902 through capacitor C7902 and inductor L7901. Variable inductor L7901, in conjunction with the stray capacitance across the input to amplifier V7902, forms a parallel-resonant circuit tuned to 30 megacycles. The gate pulse from jack J7905 is also applied to the screen grid of amplifier V7902, so that the amplifier i-f output will not appear at the plate circuit except when coincidence occurs between the screen and control grid inputs.

4–654. I-F AMPLIFIERS V7903 THROUGH V7905. Three i-f amplifiers step up the 30-megacycle signal (D, figure 4–98). Inductors L7902 through L7904 tune the stages to the center intermediate frequency. The gain of these stages is controlled by an AGC voltage from the noise figure detector which is fed to the control grids through terminal 2 of terminal board TB7901. The AGC voltage keeps the level of the system noise constant.

4–655. VIDEO DETECTOR CR7901. The 30-megacycle i-f signal is fed to crystal rectifier CR7901, which eliminates the positive portion of the waveform. Inductor L7906, capacitor C7914, and resistor R7912 filter out the r-f component of the signal, providing a train of video pulses about 200 microseconds wide (E, figure 4–98) to the grid of cathode follower V7906A. Detector bias potentiometer R7936, in conjunction with resistors R7912 and R7928, forms a voltage divider which biases rectifier CR7901.

4–656. AMPLIFIERS V7906 and V7907. The negative waveform from the cathode of amplifier V7906A is amplified by amplifiers V7906B and V7907A and applied to cathode follower V7907B. Input cathode follower V7906A isolates the diode from the loading effects of the amplifier stages. Output cathode follower V7907B matches the output to the coaxial line. Crystal diode CR7902 clamps the positive portion of the waveform. The output signal is a negative 200-microsecond noise sample applied through jack J7902 to the noise figure detector.

4–657. NOISE FIGURE DETECTOR (DETECTOR, VIDEO SIGNAL RF-65/GPA-40).

4–658. BLOCK DIAGRAM. (See figure 4–99.)

4–659. The noise video signal developed at the output of the noise figure i-f amplifier is connected to two bridge detectors in the noise figure detector. Each bridge detector is pulsed by a noise gate. The upper detector (figure 4–99) is gated by noise-source-off gates during periods in which the noise source is off. The lower detector is gated simultaneously with the pulsing of the noise source. The application of a gate permits the corresponding bridge detector to conduct. The output of the upper channel, gated on when the noise source is off, represents system noise. The lower channel, gated on in synchronism with the noise source, represents system noise plus injected noise. An integrating network at the output of each bridge detector produces a d-c level proportional to the average noise derived from the associated detector and maintains the level between gated intervals. Each integrating network feeds its output into a chopper which delivers the two switched levels to amplifier V8205. The latter drives noise-figure meters M8301 and M6101 in the performance monitor cabinet and the remote r-f panel, respectively.

4–660. The integrated system noise output of the upper channel is amplified by amplifier V8206 and applied to cathode follower V8207B. The cathode follower output is an AGC voltage which is applied to the controlled i-f stages in the noise figure i-f amplifier. Clamper V8207A is used during the initial warmup to prevent the controlled i-f amplifier grids from going positive. The clamper accomplishes this by clamping the grid of cathode follower V8207B at some slightly negative voltage. The cathode output is then slightly negative during warmup and this slight bias is fed to the grids of the controlled i-f stages, preventing them from drawing current during warmup.

4–661. CIRCUIT ANALYSIS OF NOISE FIGURE DETECTOR. (See figures 4–100 and 4–101.)

4–662. GENERAL. The video signal detector is divided into an upper channel which operates during the noise-source-off period and a lower channel which functions during the noise-source-on period. The channels are identical, therefore only the lower channel is described.

4–663. LOWER BRIDGE DETECTOR V8203 AND V8204. The lower end of the bridge detector is connected to the −150-volt supply through resistor R8239 and the upper end is connected to the 140-volt supply through resistor R8238. Before the gates are applied, current flow through section A and B of detector V8203 equals the flow through sections A and B of detector V8204. BALANCE ADJUST control R8223 is adjusted to obtain equal integrator outputs from both the upper and lower channels during the noise-source-off period (noise tube not being fired).

4–664. Assume that a positive 200-microsecond gate (B, figure 4–100) is applied to jack J8203 at the same time negative video, 200 microseconds in duration, is applied to jack J8202. The positive gate pulse is coupled to the plate of diode V8203A while the negative video signal is coupled to the cathode of diode V8203A and the plate of diode V8203B. Diode V8203A tends to conduct more while diode V8203B tends to conduct less at this time. The result unbalances the bridge, causing negative video to exist at the junction of resistors R8224 and R8222.

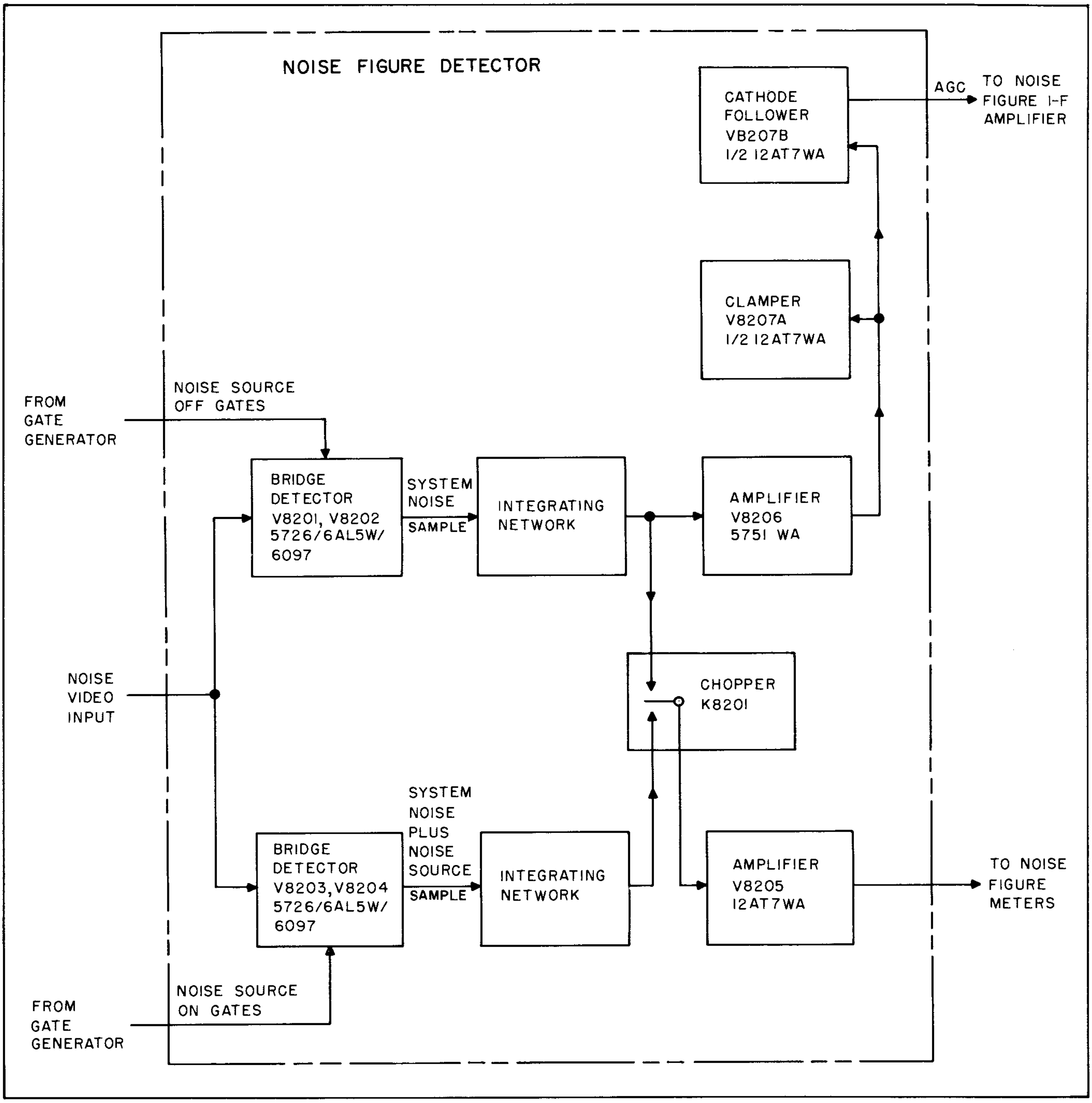

Figure 4–99. Noise Figure Detector, Block Diagram

4–665. Capacitor C8204 and resistor R8203 maintain a constant voltage at the plates of detectors V8203 and V8204 during the 200-microsecond gate period. The voltages across the bridge begin to shift as the varying video signal is applied at jack J8202. Capacitor C8206 attempts to follow the voltage variations, but the long time constant of capacitor C8206 and resistor R8204 keeps the capacitor voltage substantially constant. The capacitor voltage is applied to chopper K8201. The voltage level across capacitor C8206 represents the average level of system noise plus injected noise.

4–666. The function of the upper bridge detector is identical to that of the lower bridge detector, except that the upper detector is gated by the noise-source-off gate (C, figure 4–100) and its output waveform is taken from capacitor C8205. The voltage level across capacitor C8205 represents the average level of system noise only.

4–667. Electronic chopper K8201 is powered by 6.3 volts ac. The output voltage of capacitor C8205 is applied to the grid of amplifier V8205A through pins 6 and 7 of relay K8201 during the noise-source-off period. The out-

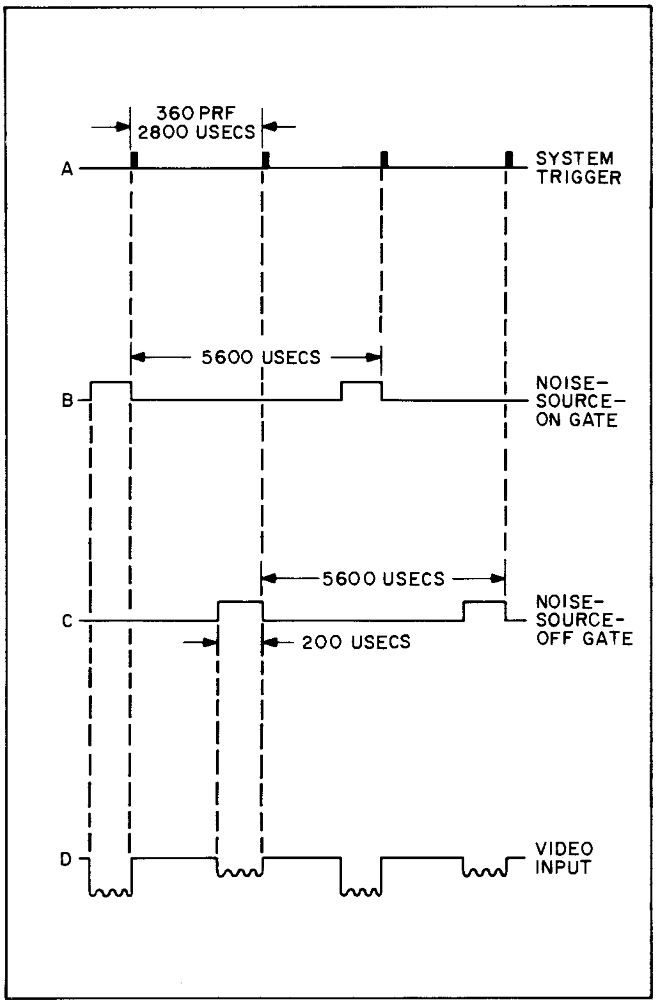

Figure 4–100. Noise Figure Detector Waveforms

put voltage of capacitor C8206 is applied to the grid of amplifier V8205A by pins 1 and 7 of the chopper during the noise-source-on period.

4–668. METER VOLTAGE AMPLIFIERS V8205A AND V8205B. Chopper K8201 applies the bridge detector outputs alternately to relay K8205A. The detector outputs are amplified by amplifiers V8205A and V8205B. The positive portions of the amplified output are clipped by diodes CR8201 and CR8202, and the result is fed through pin 7 of terminal board TB8201 to the noise figure meter.

4–669. The ganged arms of CALIBRATE OPERATE switch S8201 are depressed only during test and calibration of the meter voltage circuit. This removes the outputs of capacitors C8205 and C8206 from amplifier V8205A, substituting NOISE OFF REF and NOISE ON REF potentiometers R8219 and R8220. Current flowing from the −150-volt supply to ground through these potentiometers provides reference voltages for use in meter calibration. METER CALIBRATE potentiometer R8225 in the cathode of amplifier V8205A is adjusted for a predetermined amount of plate current with the reference voltage inputs.

4–670. AGC CIRCUIT V8206 AND V8207. A negative AGC voltage, required for operation of the noise figure i-f amplifier, is developed from the output level of capacitor C8205. If the system noise increases, the charge on capacitor C8205 increases. Therefore, a more negative AGC voltage is applied to the noise figure i-f amplifiers, changing the gain until the charge on capacitor C8205 returns to its original value.

4–671. Clamper V8207A and the setting of AGC LOCK ON potentiometer R8244 provide a negative voltage for the i-f amplifier grids during warmup time. The grids

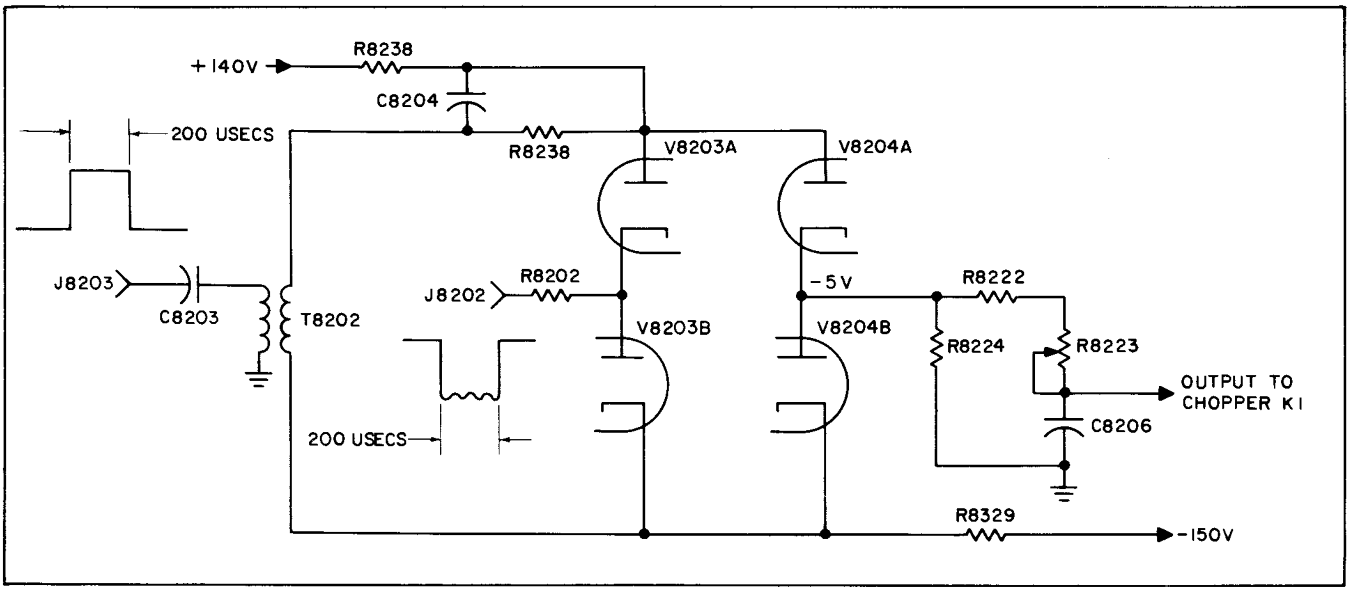

Figure 4–101. Bridge Detector in Noise-source-on Channel, Simplified Schematic Diagram

are thereby prevented from becoming positive and drawing current during the time that power is being applied to the circuit.

4–672. POWER AND VSWR MONITOR (PANEL, MONITOR SB-691/GPA-40).

4–673. BLOCK DIAGRAM. (See figure 4–102.)

4–674. POWER MONITOR. Thermistors RT7701 and RT7702 are the basic measuring elements in the power monitor. Power dissipated in a thermistor causes an increase in thermistor temperature and a corresponding decrease in its resistance. The change in resistance depends only on power dissipation and not on the frequency of the applied power. Thus, r-f power can be measured by determining the audio-frequency or d-c power required to produce the same resistance change. Each of the two thermistors is initially heavily biased with 10-kilocycle audio power. When r-f power is added, the reduction in audio power necessary to maintain the initial thermistor resistance is used as a measure of r-f power. This reduction in audio power is automatic because the thermistors are in the bridge feedback network of an audio oscillator.

4–675. The basic circuit consists of a Wein bridge oscillator and an a-c voltmeter. The combination of the Wein bridge, differential amplifier V7701, amplifier V7702, and cathode follower V7703 (with positive feedback applied from the output of cathode follower V7703 to the bridge network) produces oscillation at approximately 10 kilocycles. Initially, a predetermined audio-frequency power level is applied to the bridge and meter M7701 is set to zero by adjusting the d-c power impressed across the terminals of the bridge network. When r-f power is subsequently applied to the bridge, the resulting reduction in audio-frequency power produces a corresponding increase in the reading of meter M7701. The RADIATED POWER CHART mounted on the panel permits the operator to convert quickly from average power in kilowatts (the meter reading) to peak power in megawatts (radiated power). Due allowance is made for the pulse repetition frequency of the radar transmitter.

4–676. The output of amplifier V7705 is also applied through a rectifier circuit to a power meter in the remote r-f control panel. The remote indicator, which reads forward power only, is connected in the circuit when mode switch S7702 is in the FORWARD POWER READ position. Forward power can be read from the remote indicator when the normalizing attenuator is set to a normal value of 8.3 db and the POWER READ indicator is on.

4–677. VSWR MONITOR. Transmission line standing-wave ratio is measured by comparing forward and reflected power and displaying the result on a meter calibrated from 1.0 to 1.6. Initially, forward power is applied to the VSWR meter and the normalizing attenuator is adjusted until the meter reads full scale. Then, reflected power is applied to the meter bridge circuit and VSWR is read directly. If reflected power equals the forward power used in calibrating the meter, the meter reads full scale (1.6). If the reflected power is zero, the meter reads minimum (1.0).

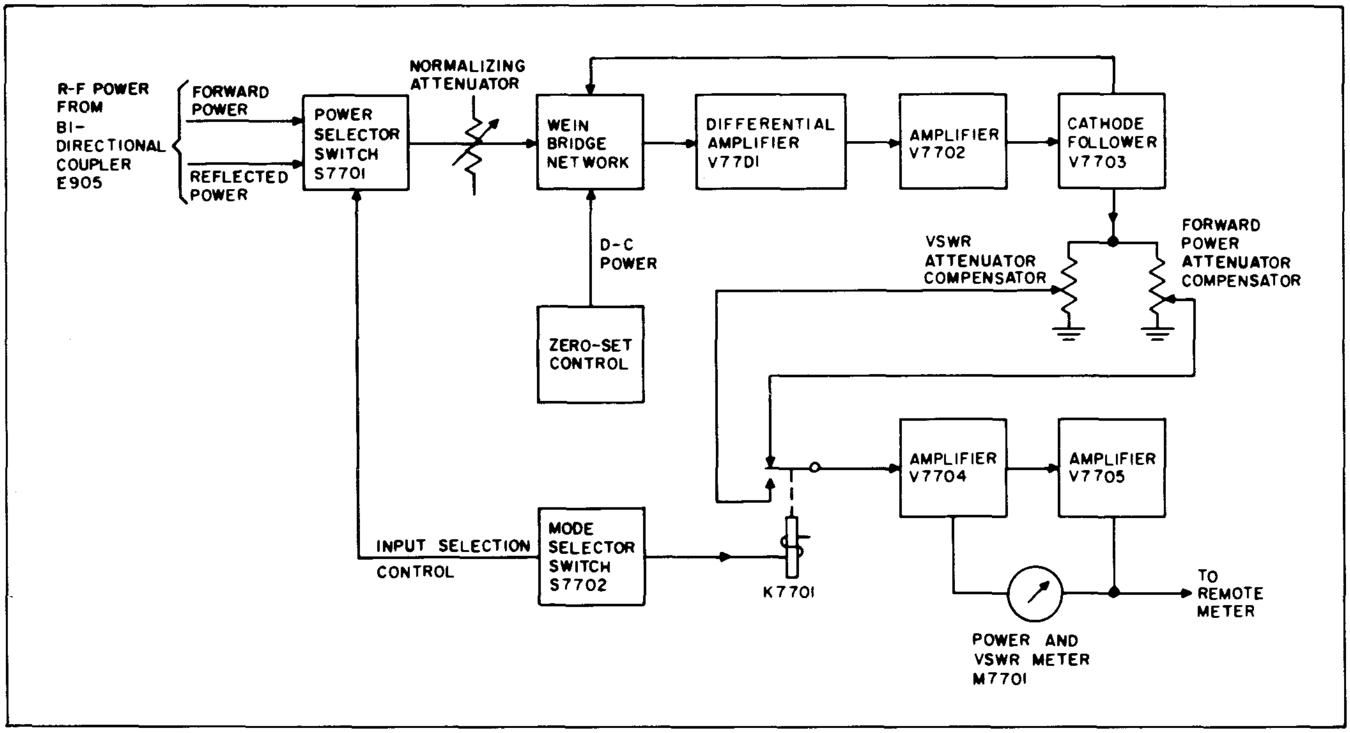

Figure 4–102. Power and VSWR Monitor, Block Diagram

4-678. SWITCHING CIRCUITS. Mode selector switch S7701, controlled by signals from mode switch S7702, selects the proper input signal from the bridge network. Relay K7701 is also controlled by mode switch S7702 and switches either of two attenuator compensators between the output of the oscillator and the metering circuits. The compensators correct for any change in the attenuation of bidirectional coupler E905. In addition, the compensators permit the flexibility of using different cables between coupler E905 and the performance monitor.

4-679. CIRCUIT ANALYSIS OF POWER AND VSWR MONITOR.

4-680. SELF-BALANCING BRIDGE. (See figure 4-103.) The self-balancing bridge consists of a bridge network, differential amplifier V7701, amplifier V7702, and cathode follower V7703 which operate as a 10-kilocycle Wein bridge oscillator. The positive feedback necessary to sustain oscillation is developed in the following manner: A push-pull voltage variation appearing between points A and B of the bridge network is applied to the grids of differential amplifier V7701. This produces an error voltage which is applied to amplifier V7702. The amplified error voltage is applied between points C and D of the bridge network through cathode follower V7703, providing the feedback voltage required for oscillation.

4-681. The positive feedback would keep the circuit oscillating even if the bridge were removed. However, the bridge is designed to filter out all feedback voltages except those with the desired frequency. The frequency of oscillation is determined by capacitors C7701 and C7702 and the setting of frequency adjust potentiometers R7701A and R7701B.

4-682. A fixed level output of 10 kilocycles is required for precise measurement of power and VSWR. Accordingly, ZERO SET-FINE potentiometer R7754 and ZERO-SET COARSE switch S7705 establish a d-c level for the bridge, and therefore the level of output oscillation. In practice, mode switch S7702 is set to either ZERO-SET FORWARD POWER or ZERO SET-VSWR so that mode selector switch S7701 connects termination E7701 to the input line. ZERO SET switch S7705 and potentiometer R7754 are then adjusted until 1.57 volts is read between jack J7703 and ground. The resistance of thermistor RT7703 varies with changes in current, therefore this thermistor maintains a constant voltage input to the bridge.

4-683. When forward power is to be measured, mode switch S7702 is placed in the FORWARD POWER-READ position. This causes mode selector switch S7701 to connect the forward power r-f signal from jack J7701 to the junction of thermistors RT7701 and RT7702. NORMALIZING ATTENUATOR AT7701 is turned counterclockwise for an attenuation of 8.3 db. When this attenuation is reached, a stop prevents further counterclockwise rotation of the attenuator and limit switch S7703 closes, completing the circuit for POWER READ indicator DS7701. The lighting of indicator DS7701 informs the operator that the attenuator is properly set.

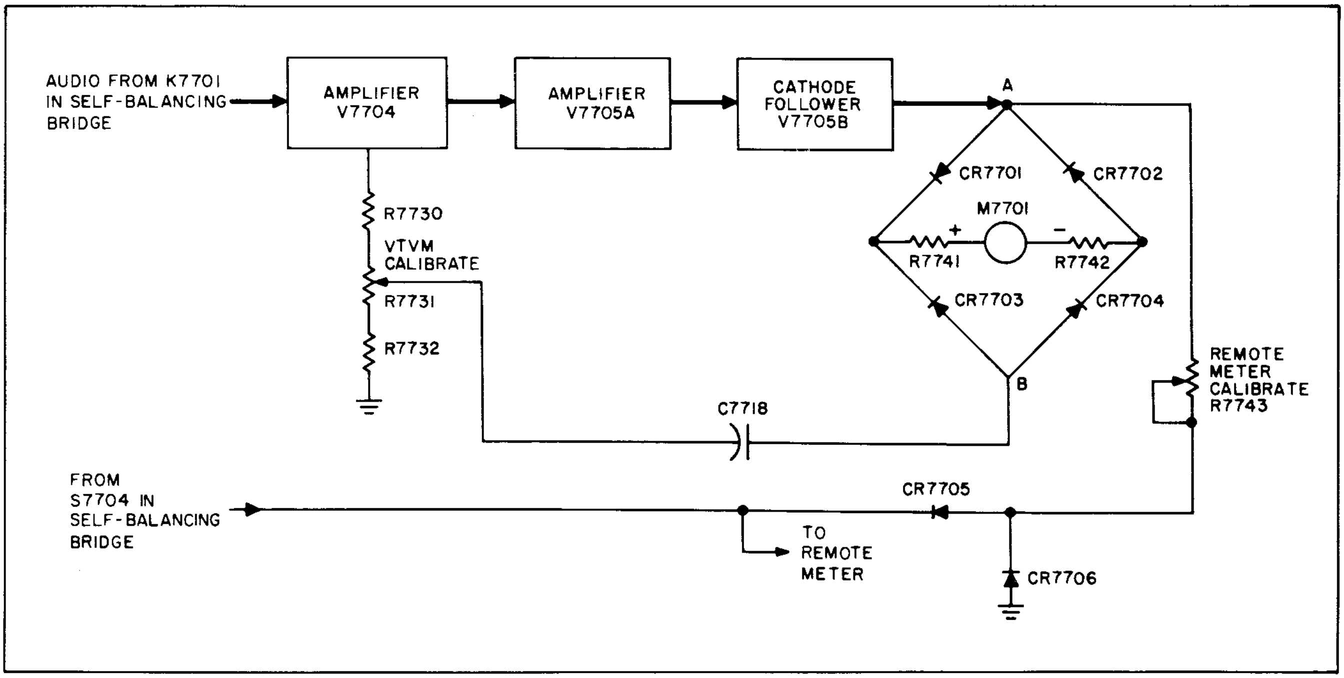

Figure 4-103. Power Monitor Self-balancing Bridge, Partial Schematic Diagram

4–684. Thermistors RT7701 and RT7702 are the basic power-measuring elements in the self-balancing bridge. Power dissipated in a thermistor causes an increase in thermistor temperature and a corresponding decrease in its resistance. The resistance change depends only on power dissipation and not on the frequency of the applied power. Application of radio frequency to the junction of thermistors RT7701 and RT7702 causes a decrease in thermistor resistance which unbalances the bridge network and produces a corresponding increase in push-pull audio voltage between points A and B. The positive and negative portions of the push-pull audio voltage are applied to differential amplifier V7701 and produce an error signal which is amplified by amplifier V7702. The amplified error signal is applied between point C and ground of the bridge network through cathode follower V7703 to unbalance the bridge. In addition, the amplified error signal, which is equal in magnitude to the applied r-f signal, is applied through relay K7701 to the panel-mounted VTVM. The same signal is also applied to the remote power meter.

4–685. Assuming that VSWR is to be measured, with mode switch S7702 still in the FORWARD POWER-READ position, NORMALIZING ATTENUATOR AT7701 is turned clockwise until the panel meter reads full scale. This opens limit switch S7703 so that the POWER READ indicator goes off and closes switch S7704 so that the remote meter is shorted. Turning mode switch S7702 to the VSWR-READ position connects reflected r-f power from jack J7702 to the self-balancing bridge and energizes relay K7701 so that the output signal goes to the panel meter through resistor R7727, VSWR CALIBRATE control R7725, and VSWR ATTENUATOR COMPENSATOR E7703. Attenuators E7702 and E7703 compensate for differences in the amount of attenuation caused by signals between the forward and reflected channels of the receiver-arm directional coupler.

4–686. VACUUM-TUBE VOLTMETER. (See figure 4–104.) The 10-kilocycle signals from the Wein bridge oscillator are full-wave rectified by diodes CR7701 through CR7706 before being applied to panel meter M7701. Diodes CR7705 and CR7706 rectify the audio voltage used for calibrating the remote meter. The selected audio signal appearing at the arm of relay K7701 is amplified by tubes V7704 and V7705A and applied to point A of the bridge rectifier through tube V7705B. A d-c voltage proportional to the applied audio voltage is indicated on meter M7701. VTVM CALIBRATE potentiometer R7731 is adjusted for meter zero during calibration. A feedback voltage from the wiper arm of VTVM CALIBRATE potentiometer R7731 is applied to point B of the bridge rectifier through capacitor C7718. REMOTE METER CAL potentiometer R7743 adjusts the audio voltage applied to diodes CR7705 and CR7706 to calibrate the remote meter.

4–687. PERFORMANCE MONITOR POWER SUPPLY (POWER SUPPLY PP-1690/GPA-40). (See figure 4–105.)

4–688. The performance monitor power supply delivers regulated d-c power and filament power to components of the power and noise figure assembly. The regulated d-c power is supplied at potentials of +250, +140, and −150 volts. Filament power is supplied at a potential of 6.3 volts ac.

4–689. A voltage of 120 volts ac is fed to four transformers in the power supply. These include plate and filament power transformers T7801 and T7802 and filament transformers T7803 and T7804.

4–690. The high-voltage secondary winding of transformer T7801 delivers high-voltage a-c power to rectifier V7801. The high d-c output of rectifier V7801 is controlled by a standard type series regulator circuit composed of series regulator V7801, amplifier V7803, gas regulator V7804, and a voltage divider network. The circuit arrangement produces regulated +250 volts dc which is cabled to components of the noise figure monitor.

4–691. The regulated 250-volt supply is applied to the input of another series regulator (series regulator V7806, amplifier V7805, and a voltage divider). This regulator delivers regulated +140 volts dc to components of the noise figure monitor and the power monitor.

4–692. The high-voltage secondary winding of transformer T7802 delivers a-c power to rectifier V7807, with the circuit arranged to produce a negative d-c output. A series regulator circuit composed of series regulator V7808, amplifier V7810, gas regulator V7809, and a voltage divider produces −150 volts regulated dc which is cabled to components of the noise figure monitor.

4–693. The three d-c outputs are also connected to meter switch S7805. This switch, in conjunction with meter switch S7801, provides the means of monitoring each of the d-c supply voltages.

4–694. RELATIVE TUNING INDICATOR (INDICATOR, FREQUENCY SEPARATION ID-606/GPA-40).

4–695. BLOCK DIAGRAM. (See figure 4–106.)

4–696. The i-f signal developed at the output of the AFC mixer is amplified by amplifier V501. This amplifier has two outputs; one applied through cathode follower V507 to the AFC-LO unit, and the other applied to an i-f strip composed of tubes V502, V503, and V504. The amplified i-f output of tube V504 is applied to discriminator V505, which produces a d-c output. The amplitude of this output is proportional to the frequency deviation of the input signal from the nominal 30-megacycle center value. The polarity of the d-c signal is determined by the direction of the deviation (above or below the center frequency). Difference amplifier V506 then produces a tuning indication for the local and remote relative tuning meters.

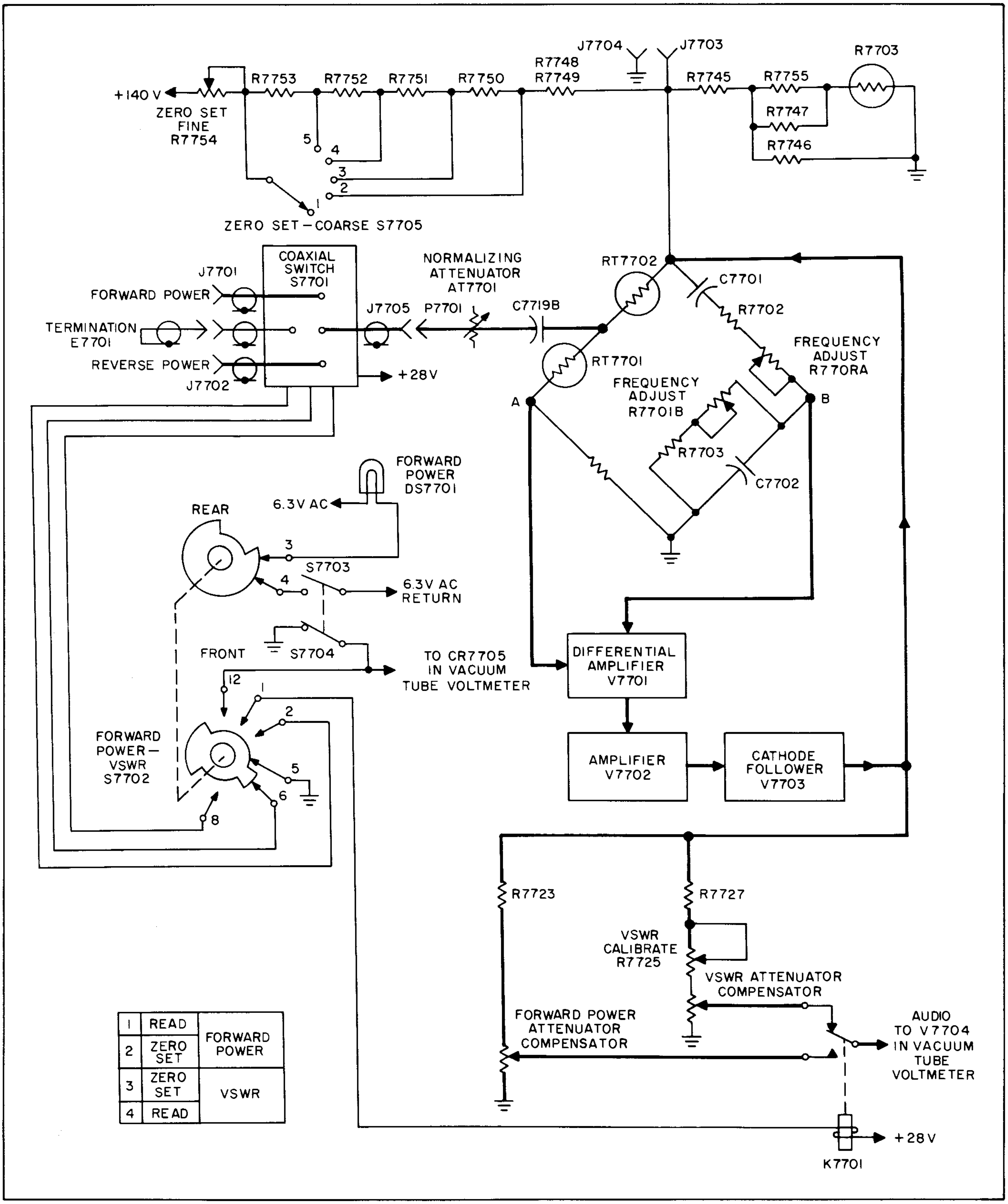

Figure 4–104. Power Monitor VTVM, Partial Schematic Diagram

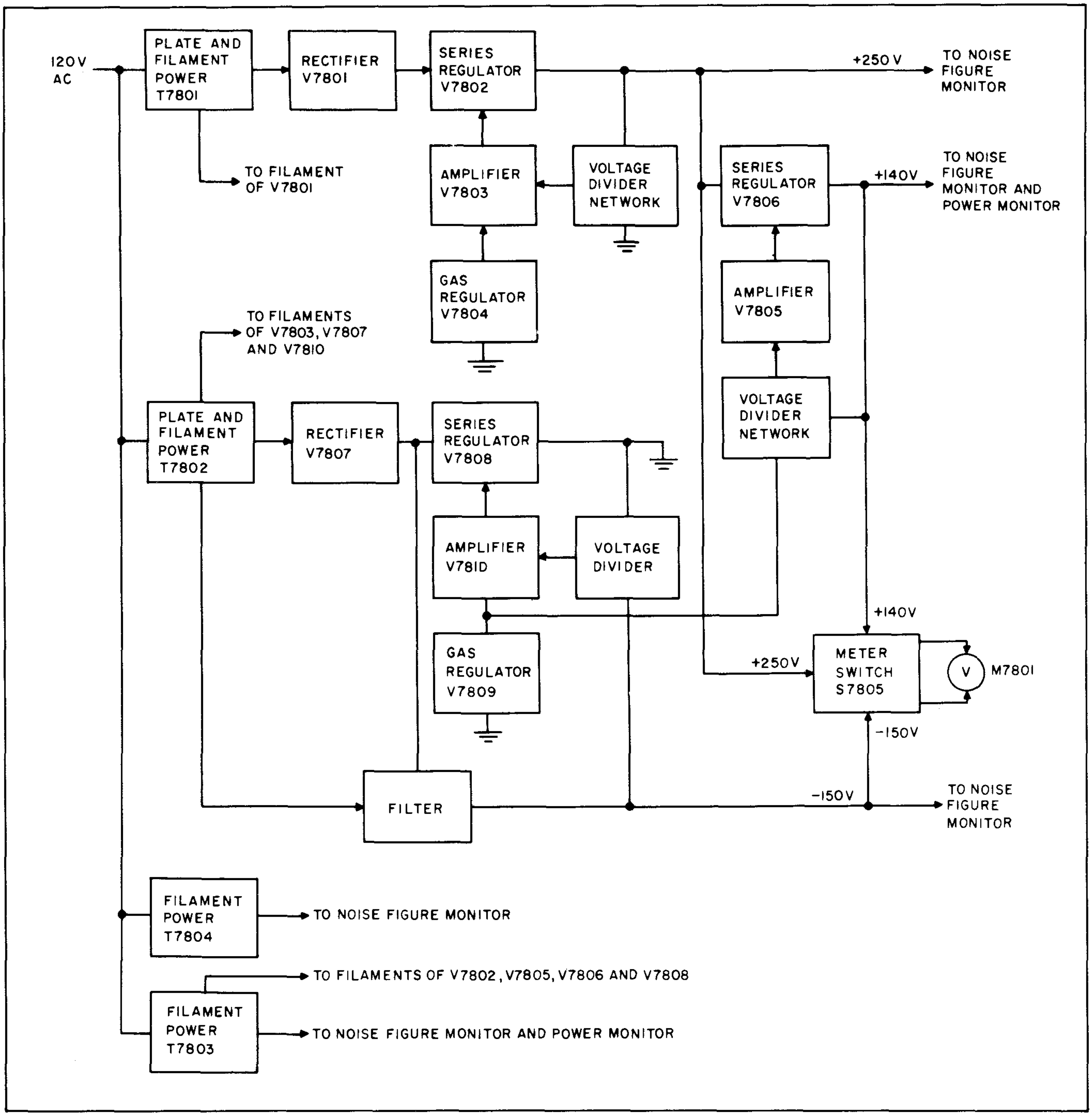

Figure 4–105. Performance Monitor Power Supply, Block Diagram

4–697. Relative tuning meter M1005 is equipped with a lockup relay type coil and contacts; that is, the meter relay. When the frequency deviation from 30 megacycles reaches either of two preset limits (one below and the other above 30 megacycles), a pair of contacts close and lock up the associated coil. A path is then completed to local and remote tuning alarm indicators I1003 and I6105. The indicators light and remain lit until the frequency deviation is reduced and either a local or remote reset switch is actuated. The automatic alarm circuit thus warns operating personnel of excessive frequency deviation.

4–698. CIRCUIT ANALYSIS OF RELATIVE TUNING INDICATOR. (See figure 7–35.)

4–699. I-F AMPLIFIERS V501 THROUGH V504 AND CATHODE FOLLOWER V507. The i-f output of the AFC mixer is fed through jack J501 and variable transformer L501 to the control grid of i-f amplifier

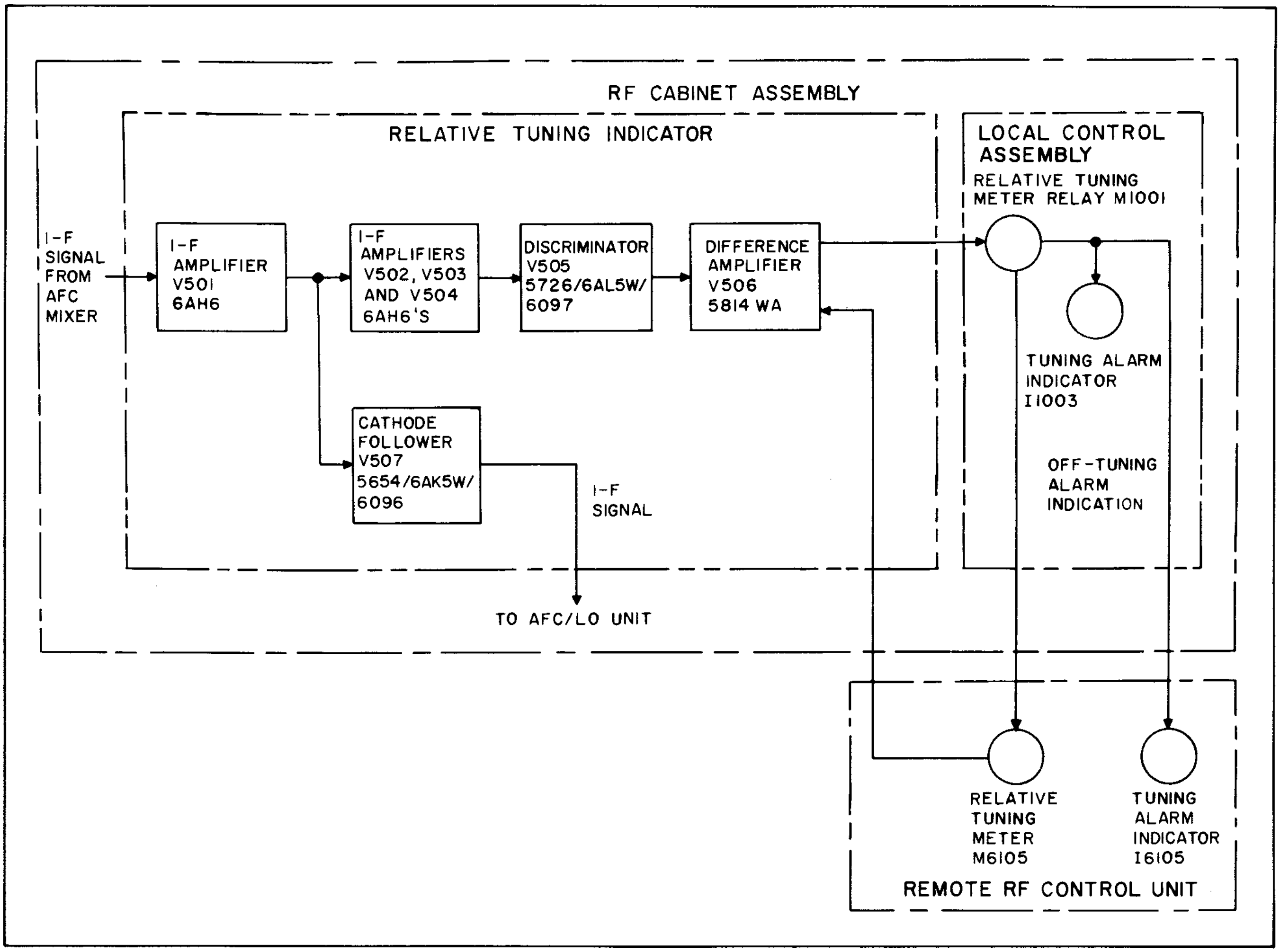

Figure 4–106. Relative Tuning Indicator, Block Diagram

V501. Amplifiers V501 through V504 are conventional, cathode-biased i-f amplifiers tuned to 30 megacycles by variable transformer L501 and variable inductors L502 through L505. Inductor L508 and capacitor C517 are components of a 30-megacycle filter. The 30-megacycle intermediate frequency is fed out to the AFC-LO unit through jack J502 at the cathode of cathode follower V507. Capacitor C501 acts as an a-c ground to undesired frequencies. The d-c crystal current of the crystal detector in the AFC mixer passes through the primary of variable transformer L501 through r-f choke L508 to the RECEIVER metering circuits.

4–700. WEISS DISCRIMINATOR V505. The 30-megacycle i-f signal is also fed to a Weiss discriminator. As shown in figure 4–107, the basic discriminator consists of two series-tuned circuits. It is assumed that after variable inductor L506 is adjusted, one tuned circuit resonates at 29.5 megacycles and the other at 30.5 megacycles.

4–701. The configuration of the circuit when the incoming signal is at the center intermediate frequency of 30 megacycles is shown in A of figure 4–107. The two circuits are then detuned from the center frequency by an equal amount, one above and the other below 30 megacycles. Rectifiers V505A and V505B conduct equally during the positive alternations of the input signal, charging capacitors C515 and C516 to equal voltages of opposite polarity. The discriminator output is taken across both capacitors. Thus, when the incoming signal is 30 megacycles, the net discriminator output is zero.

4–702. The configuration of the circuit when the incoming signal is 30.5 megacycles is shown in B of figure 4–107. Inductor L506 and capacitor C513 form a series resonant circuit tuned to this frequency. The total voltage across the resonant circuit is minimum (E_{min}) at this time, since the voltage dropped across the capacitor is equal and opposite to that dropped across the inductor. The total voltage (E_{min}) dropped across i-f amplifier V504 must be, for all practical purposes, the voltage dropped across resistor R512, rectifier V505B, inductor L507, resistor R514, and capacitor C516. During the positive alternation of the i-f input, diode V505B conducts more heavily than diode V505A, since maximum current flows in a circuit at resonance. At this time, capacitor C516 charges to the polarity shown through

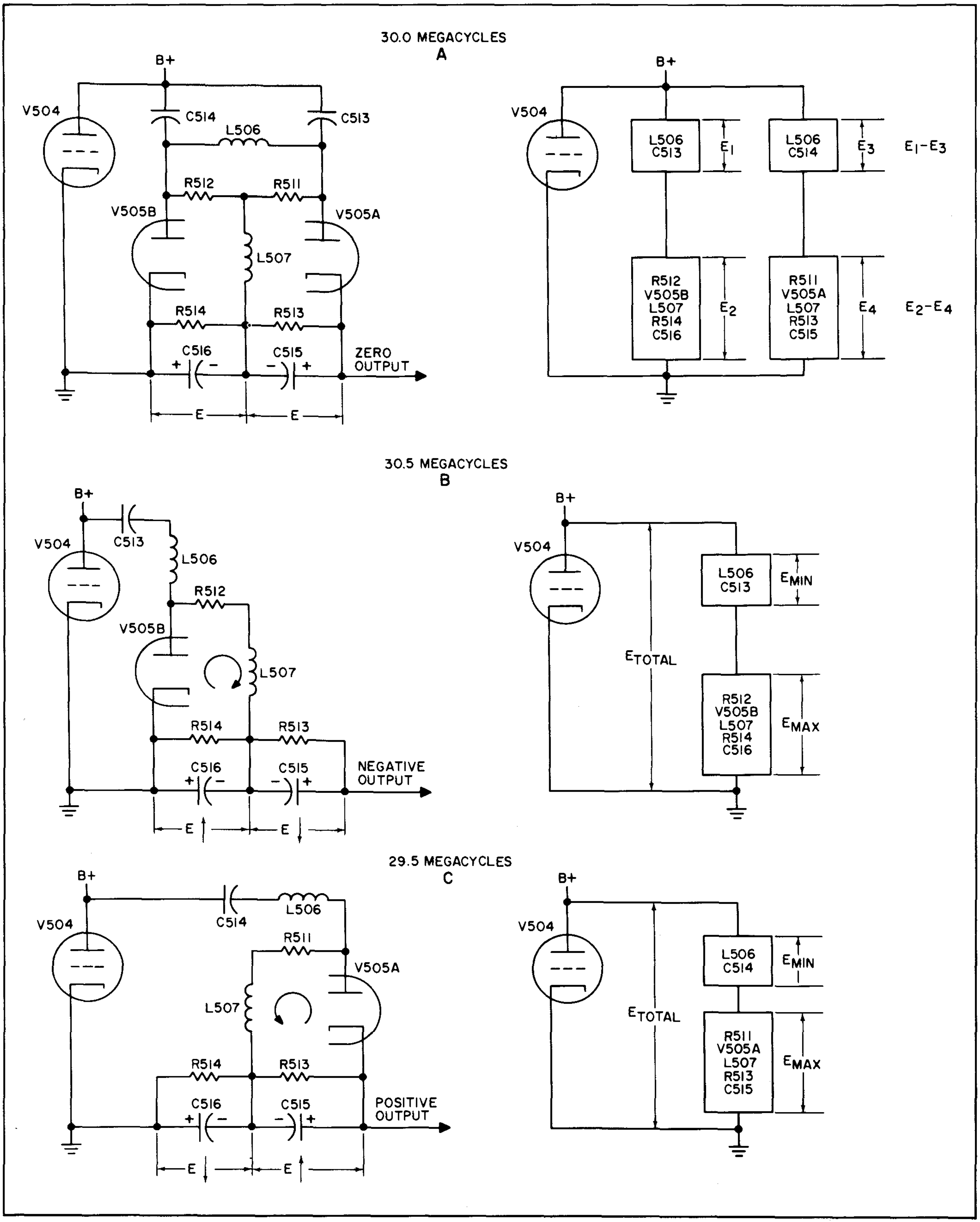

Figure 4–107. Weiss Discriminator, Simplified Schematic Diagram and Equivalent Circuit

rectifier V505B, resistor R516, and inductor L507. (The capacitor attempts to discharge during the negative portion of the i-f input, but is prevented from doing so by the long time constant of resistor R514. This keeps the capacitor charged during both alternations.) Therefore, when the incoming signal is above 30 megacycles, the net discriminator output is a negative voltage.

4–703. The configuration of the circuit when the incoming signal is 29.5 megacycles is shown in C of figure 4–107. Inductor L506 and capacitor C514 form the series resonant circuit tuned to this frequency. Capacitor C515 charges to the polarity shown through rectifier V505A during the positive alternation of the i-f input. Thus, when the incoming signal is below 30 megacycles, the net discriminator output is a positive voltage.

4–704. DIFFERENCE AMPLIFIER V506. The output of discriminator V505 is applied to the grid of difference amplifier V506. The other grid or difference amplifier V506 is grounded. When the i-f input is 30 megacycles, the discriminator output is zero. At this time both grids of difference amplifier V506 are effectively at ground potential and the plate voltages of each section are equal. Two zero-center meters, one in the local control panel and one on the remote r-f control panel, are connected between the plates of difference amplifier V506. When the plates have equal voltages, as occurs when the i-f input is at center frequency, the meter needle does not deviate from center. If a change occurs in the intermediate frequency, the discriminator output causes the meter to deviate in the direction of the change.

4–705. CALIBRATION CONTROLS. When OPERATE-CALIBRATE switch S501 is in the CALIBRATE position, it effectively grounds the top of resistor R515, applying ground to grid 7 of difference amplifier V506. The relative tuning meter should then indicate 30 megacycles (center position). If it does not, METER ZERO control R520 is adjusted to balance the currents in the two halves of difference amplifier V506. METER CALIBRATE rheostat R528 is a sensitivity control set to provide maximum deflection of the relative tuning indicator meter for a small amount of frequency deviation. This control is set with OPERATE-CALIBRATE switch S501 in the OPERATE position and the local oscillator manually detuned for maximum discriminator output.

4–706. RANGE MARK GENERATOR (CALIBRATOR, RANGE TS-735/FPS-6).

4–707. BLOCK DIAGRAM ANALYSIS OF RANGE MARK GENERATOR. (See figure 4–108.)

4–708. The range mark generator performs three functions. It produces a series of synchronizing triggers which initiate the operation of other components of the radar and generates range markers at intervals of 10 nautical miles. The range mark generator also produces crystal-controlled markers for use in alining the unit. The following paragraphs describe how the first two functions are performed.

4–709. Associated equipment supplies an external sync-trigger which arrives at the range mark generator in a distorted form due to the effects of long coaxial lines. Therefore, only the lower portion of the leading edge of the sync trigger is used to fire a blocking oscillator. The system trigger obtained from the blocking oscillator is applied to several circuits in the radar and through dual diode V5209 to the half-frequency multivibrator.

4–710. The half-frequency multivibrator produces one complete output cycle for each pair of input triggers. The negative portion of the square-wave output gates the 10-mile marker oscillator and allows the oscillator to generate marks during the entire interpulse interval, regardless of the repetition rate of the sync trigger. Although this arrangement requires the marker oscillator to cease operation during alternate interpulse intervals, the presistence of the phosphor on the indicator screen is sufficient to maintain the range markers at acceptable intensity until the next group of range markers is produced.

4–711. The negative portion of waveform C of figure 4–108 is applied to the grid of the 10-mile oscillator, which generates oscillations at a frequency of 80.867 kilocycles. The period of one cycle equals the time required for a pulse of radar energy to travel 10 nautical miles to a target and return to the antenna.

4–172. The positive portions of the 10-mile oscillations are removed by the clipper. A series of positive alternations, obtained from the plate of the clipper tube, is fed to the clamper. The input to the clamper is a slightly reduced version of the half-frequency multivibrator output waveform. When this gating signal goes positive, the clamper stage conducts heavily, shorting any output from the clipper. By this means, any oscillations generated after the conclusion of the negative gate are kept from the 10-mile blocking oscillator. A differentiating network at the output of the clamper tube sharpens the alternations for application to the 10-mile blocking oscillator.

4–713. Each positive pulse from the clamper tube triggers the 10-mile blocking oscillator to produce a train of spikes at a repetition rate of 80.867 kilocycles.

4–714. The 50-mile blocking oscillator is kept beyond cutoff by high cathode bias. The capacitor of an RC network in the grid circuit is charged when the oscillator is triggered by a 10-mile marker. The RC network holds the stage below cutoff while the capacitor discharges. By the time the fifth subsequent 10-mile marker arrives, the RC network capacitance has discharged sufficiently to allow the marker to trigger the stage. As a result, the 50-mile blocking oscillator generates one narrow output spike for each five input pulses.

4–715. The 10- and 50-mile markers are fed into the mixer. Coincidence between the 10- and 50-mile markers causes the mixer to conduct more heavily at that instant. The 50-mile markers are thus intensified. The output of the range mark circuit as shown in F of figure 4–108.

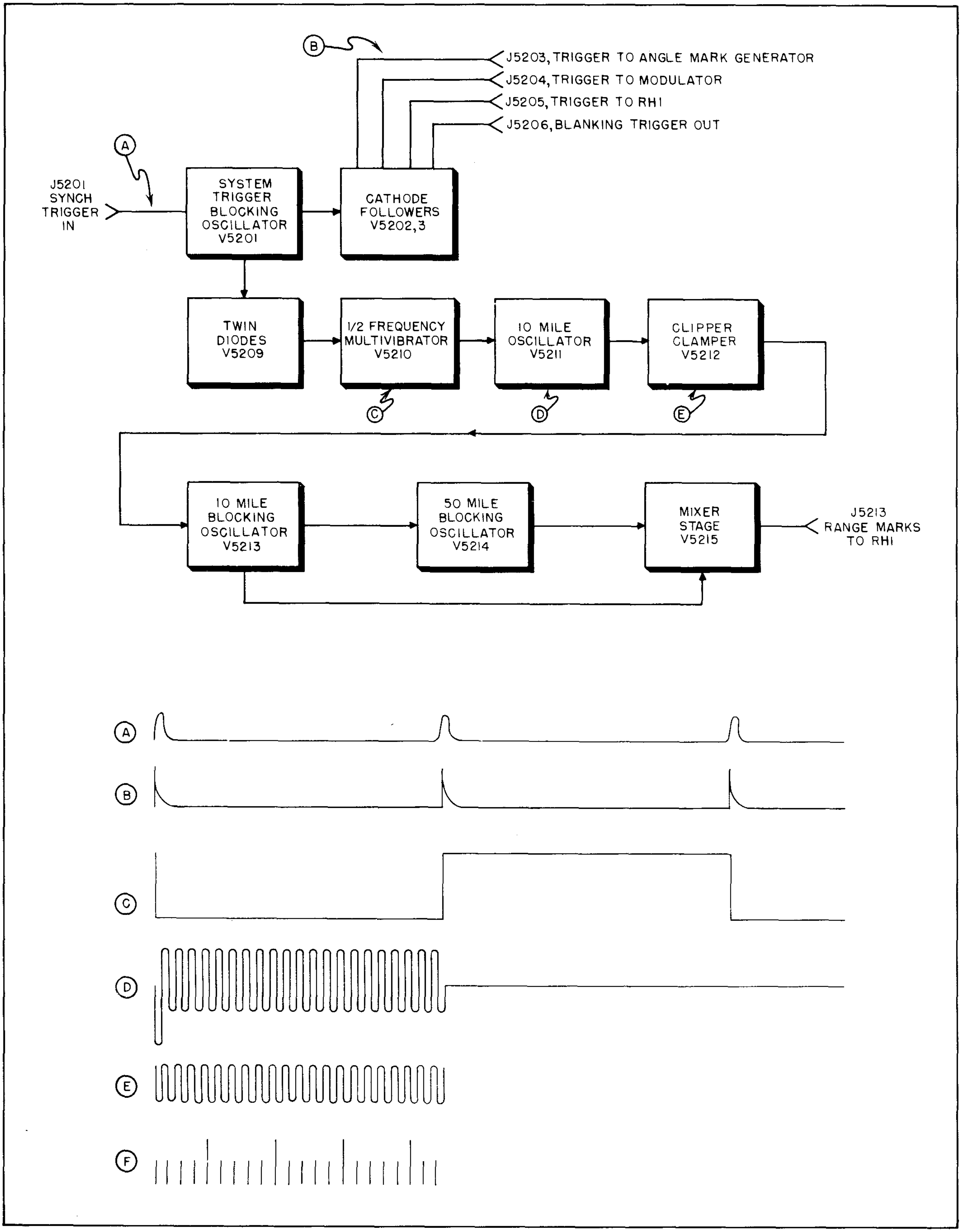

Figure 4–108. Range Mark Generator, Block Diagram

4–716. CIRCUIT ANALYSIS OF RANGE MARK GENERATOR.

4–717. BLOCKING OSCILLATOR V5201. (See figure 4–109.) Negative voltage tapped from the voltage divider composed of resistors R5201 through R5203 keeps section A of blocking oscillator V5201 cut off. Bypass capacitor C5201 effectively grounds resistor R5204 during the input pulse, thus maintaining a constant input impedance and decoupling the bias supply from the input pulse.

4–718. The arrival of the positive sync trigger at the grid of oscillator section V5201A causes that section to conduct. The flow of plate current through oscillator section V5201A results in a voltage drop at the plate of the section. This drop is coupled across transformer T5201 and appears as a positive potential at the input to oscillator section V5201B. The grid of oscillator section V5201B is then sufficiently above ground to overcome the bias placed on capacitor C5204 during the previous cycle and this section conducts. It should be noted that the plate current of oscillator section V5201B must also pass through coil A, further expanding the magnetic field. Thus, a regenerative condition is established whereby an increase of current through coil A induces a positive voltage in coil B. This causes oscillator section V5201B to conduct more heavily, drawing more current through coil A, inducing a greater positive potential at the grid of oscillator section V5201B, and further increasing the conduction of this section. During this period of heavy conduction, capacitor C5204 charges negatively through the grid circuit of oscillator section V5201B.

4–719. The voltage at the grid of oscillator section V5201B builds up rapidly until the heavy current drawn through the section nears the current saturation point. As the section approaches saturation, it does not amplify as efficiently. Thus, the grid of oscillator section V5201B continues to build up a positive potential, but at a slower rate. As a result, the increase of current through

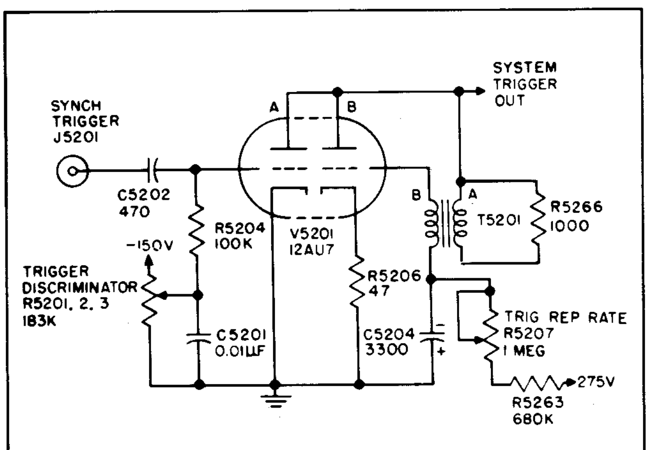

Figure 4–109. System Trigger, Blocking Oscillator, Range Mark Generator, Simplified Schematic Diagram

oscillator section V5201B is slowed down. Eventually, a point is reached where the increase of current through coil A is not sufficient to compensate for the coupling losses between the two coils. At this point, the grid of oscillator section V5201B stops building up. When this occurs, the current through coil A remains stationary for a moment and the magnetic field about the primary also becomes stationary. In the absence of relative motion between the magnetic field and coil B, the field about the secondary starts to collapse. Coil B then self-induces a voltage opposite in polarity to the previous voltage, and capacitor C5204 starts to discharge through resistor R5207. The potential at the grid of oscillator section V5201B then begins to increase in the negative direction, while the plate current decreases. A drop in the current drawn through coil A causes the primary magnetic field to collapse, inducing a voltage in coil B that reinforces the negative buildup at the grid of oscillator section V5201B. This rapid regenerative action continues until both oscillator sections are cut off. Section V5201A remains cut off until the next trigger. Section V5201B remains cut off until capacitor C5204 has discharged sufficiently to reduce the bias below the cutoff point. In practice, section V5201B is just ready to break into conduction when the next trigger arrives.

4–720. The time constants of potentiometer R5207 and capacitor C5204 determine the length of time that oscillator section V5201B remains cut off. Increasing the value of the resistance increases the time required for the capacitor to discharge. In the absence of a sync trigger, the blocking oscillator runs freely at a repetition rate determined by the setting of potentiometer R5207.

4–721. CLIPPING DIODE V5209. The plate waveform of oscillator section V5201B shows, in addition to the desired negative pulse, a positive alternation, produced by shock excitation of the primary of transformer T5201 at the instant the blocking oscillator stage cuts off. Dual diode V5209 clips the positive alternation and also provides some degree of isolation between the blocking oscillator and the half-frequency multivibrator.

4–722. HALF-FREQUENCY MULTIVIBRATOR V5210. (See figure 4–110.) The two sections of half-frequency multivibrator V5210 form a triggered multivibrator of the Eccles-Jordan type whose frequency of oscillation depends on the pulse recurrence frequency of the set. The negative-going input trigger pulse is applied to the plates of both sections of multivibrator V5210. Since the plate of multivibrator section V5210A is connected to the grid of multivibrator section V5210B through resistor R5238, and the plate of multivibrator section V5210B is connected to the grid of multivibrator section V5210A through resistor R5235, the input trigger is effectively applied to both grids of the multivibrator.

4–723. In this paragraph, the action of the multivibrator circuit is discussed without considering the application of the triggering pulses. The cathodes of both sections of multivibrator V4210 are grounded directly, and, since the grid circuits of the sections have duplicate components, the two sections of the multivibrator theoretically conduct equally. The plate-to-ground potential of multivibrator section V5210A is divided between resistors R5238 and R5239. Similarly, the plate-to-ground potential of diode V5209B appears across a voltage divider composed of resistors R5235 and R5236. This regenerative interstage coupling amplifies any random current fluctuation. For instance, a slight increase in current through the first section of the multivibrator decreases the plate potential of that section so that a smaller drop appears across resistor R5239. The bias on multivibrator section V5210B is determined by the algebraic sum of the voltage drops across resistor R5239 and the −150-volt supply to which the grids are returned (figure 4–110). A decrease in the potential difference across resistor R5239 is equivalent to an increase in bias. As a result, the current flow through multivibrator section V5210B decreases, thereby raising the plate voltage of the section. This increase drives the grid of multivibrator section V5210A more positive through resistor R5235. These actions are additive until multivibrator section V5210A becomes fully conductive while maintaining multivibrator section V4210B at cutoff.

4–724. Consider the equivalent circuit consisting of resistors R5238 and R5239 in series with the −150-volt supply to which the grids are returned, and the 145 volts existing across multivibrator section V5210A while it conducts (figure 4–110). Since the two voltage sources are in series adding, a total of 295 volts is divided between the resistors. Two-fiths of the total source voltage, or 118 volts, appears across resistor R5239, the grid resistor of multivibrator section V5210B. This voltage is in series opposition to the −150-volt supply, leaving −31 volts between the grid and cathode to maintain the multivibrator beyond cutoff. The grid-to-cathode impedance is infinite at this time, so that this quantity can be safely ignored.

4–725. Another equivalent circuit can be drawn to show how the bias is established on multivibrator section V5210A (figure 4–110). Approximately 265 volts (not quite the full plate supply voltage, because of slight conduction through resistor R5233) appears across multivibrator section V5210B while it is cut off. The total source voltage is 415 volts. Two-fifths of the total source voltage, or 166 volts, appears across resistors R5236, leaving 16 volts between grid and cathode. However, since section A conducts at this time, the grid-to-cathode impedance is less than infinite and exerts a loading effect upon resistor R5236. Consequently, approximately 150 volts appears across the grid resistor so that zero bias is maintained on this section. The multivibrator is then in a position of stable equilibrium and remains in this condition until disturbed by a trigger pulse.

4–726. In this paragraph, the action of the multivibrator in concurrence with the application of the triggering pulses is discussed. The negative triggering pulse applied to the grid of multivibrator section V5210B has no effect on this triode, since the section is already at cutoff. The negative pulse applied to the grid of multivibrator section V5210A causes the plate voltage of this section to rise. A fraction of this increase is transferred to resistor R5239 and is sufficient to overcome the bias

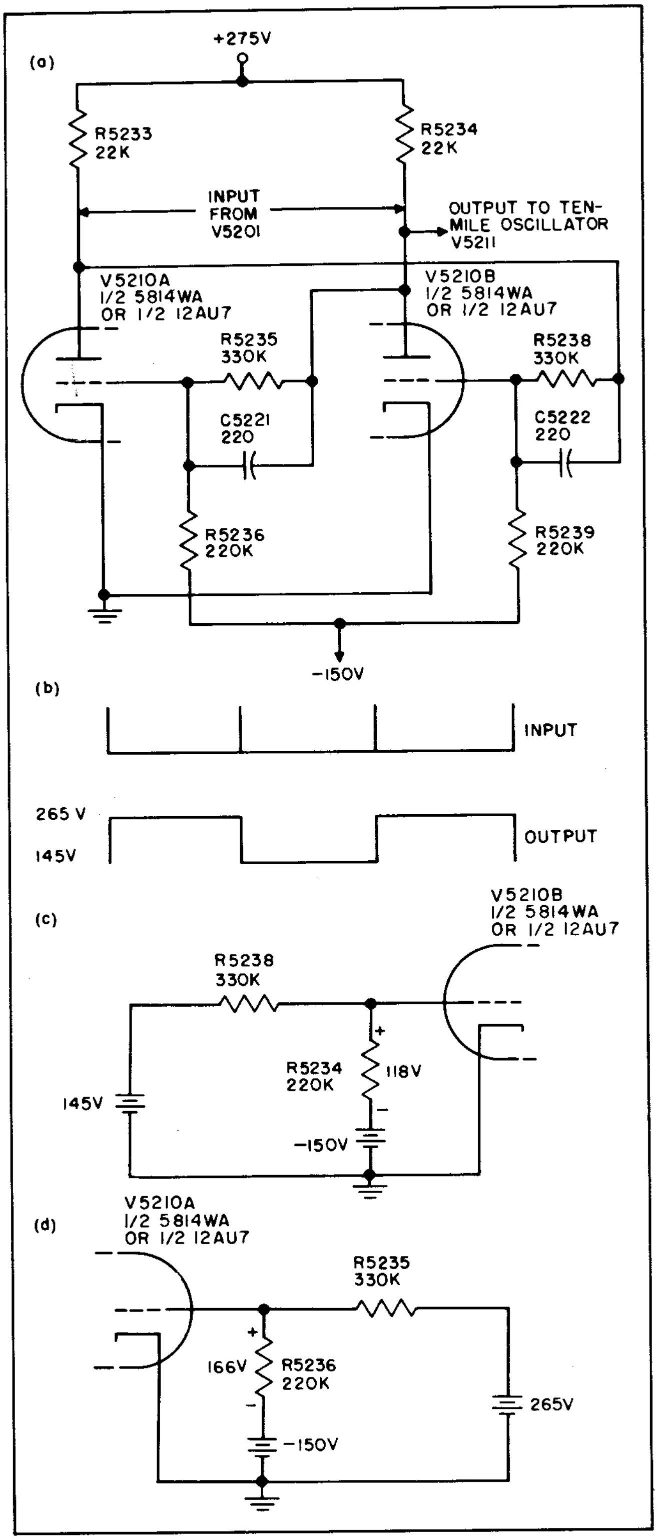

Figure 4–110. Half-frequency Multi-vibrator, Range Mark Generator, Simplified Schematic Diagram

on multivibrator section V5210B. When multivibrator section V5210B goes into conduction, its plate voltage decreases, reducing the potential difference across resistor R5236. The regenerative action which has thus been initiated ceases when multivibrator section V5210A is cut off while multivibrator section V5210B is conducting heavily. A switching action occurs each time a trigger is received. In this way, a square wave is produced at the plate of each section at a frequency which is exactly half the pulse recurrence frequency.

4–727. TEN-MILE OSCILLATOR V5211. (See figure 4–111). The square-wave output from half-frequency multivibrator V5210 is coupled through the parallel RC combination of capacitor C5223 and resistor R5237, a low-phase-shift network, to the grid of 10-mile oscillator section V5211A. During the positive portion of the square-wave gate, the first section of oscillator V5211 conducts heavily. The low plate impedance of the triode section at this time effectively shunts the cathode tuned circuit, damping out all oscillation. During the negative portion of the input, the triode is cut off, in effect removing the damping impedance from the tank circuit. The magnetic field about the coil then collapses, and oscillations are produced at a frequency of 8.0867 kilocycles. The first alternation, generated during the period that oscillator section V5211A is held at cutoff, is of negative polarity. Since this first negative alternation occurs simultaneously with the radiation of the transmitter pulse, it is masked by the transmitter blip on the indicator screen. The time between initiations of successive negative half cycles is equal to the time required for a radar pulse to reach a target 10 nautical miles distant and return to the antenna. The remaining 22 negative alternations can therefore be used to produce 10-mile range markers on the indicator screen, up to a maximum of 220 nautical miles (for a pulse repetition frequency of 360). Positive feedback, sufficient to overcome the losses inherent in the tank circuit, is supplied through oscillator section V5211B. Feedback control R5244 is adjusted until all the 10-mile range markers are of equal amplitude.

4–728. CLIPPER V5212A. Oscillations obtained across inductor L5202 are fed through capacitor C5226 to the grid of the first section of clipper-clamper V5212. Since the cathode of this section is grounded, grid current limiting eliminates all the positive alternations. The negative alternations are amplified and inverted in the usual manner. Capacitor C5227, in conjunction with grid leak resistor R5247 of trigger stage V5213A, sharpens the positive alternations into spikes useful for triggering the 10-mile blocking oscillator.

4–729. CLAMPER V5212B. When the input to 10-mile oscillator V5211 goes positive, plate current drawn through the tank circuit should theoretically damp out all oscillation. Practically, several highly damped oscillations are produced following the application of the positive portion of the gate. The clamper, operating when the 10-mile oscillator is turned off, shorts out unwanted, spurious oscillations.

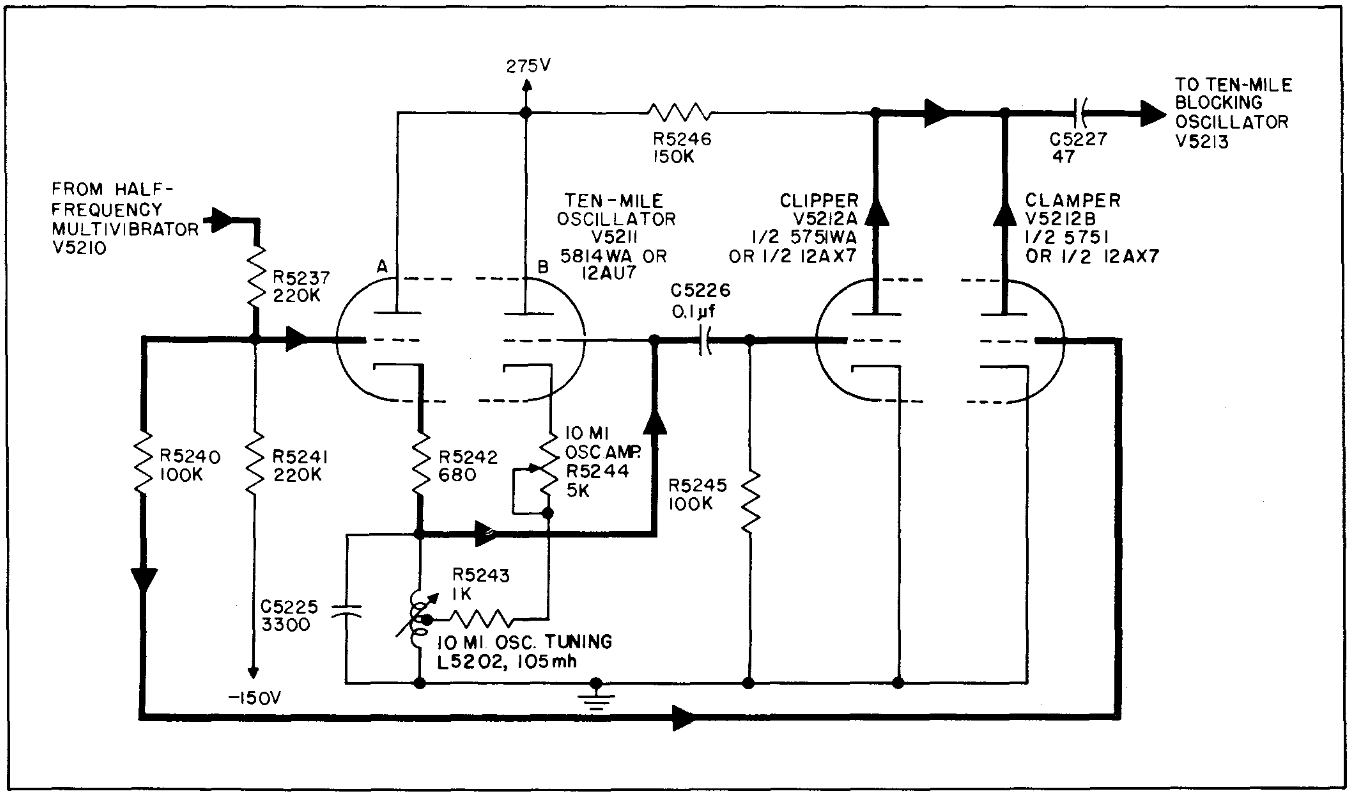

Figure 4–111. 10-mile Oscillator, Range Mark Generator, Simplified Schematic Diagram

4–730. The clamper stage derives its input from the same source as the 10-mile oscillator. When the signal gating the 10-mile oscillator goes positive, clamper V5212B conducts heavily, shorting the plate of the clipper stage to ground. Therefore, any spurious oscillations are shorted out by the clamper. During negative gate signals, the clamp is effectively an open circuit.

4–731. TEN-MILE BLOCKING OSCILLATOR V5213. (See figure 7–85.) The positive pulses from the plate of clipper V5212A trigger 10-mile blocking oscillator V5213. One output pulse from the blocking oscillator is produced for each input trigger. Refer to paragraph 4–717 for a detailed circuit analysis of blocking oscillator operation. The amplitude of the 10-mile markers can be varied by adjusting potentiometer R5251.

4–732. FIFTY-MILE BLOCKING OSCILLATOR V5214. A voltage divider consisting of resistors R5256, R5257, and R5258 maintains a fixed bias on the cathode of 50-mile blocking oscillator stage V5214B. This bias is sufficient to keep the stage far beyond cutoff. When oscillator stage V5214B fires, capacitor V5231 charges through the grid circuit so that its upper plate acquires a negative potential with respect to ground. Five input pulses are accepted before capacitor C5231 discharges sufficiently to allow oscillator stage V5214B to fire again. In this manner, the 50-mile blocking oscillator generates one output pulse for every five input triggers. Refer to paragraph 4–717 for a detailed circuit analysis of blocking oscillator operation.

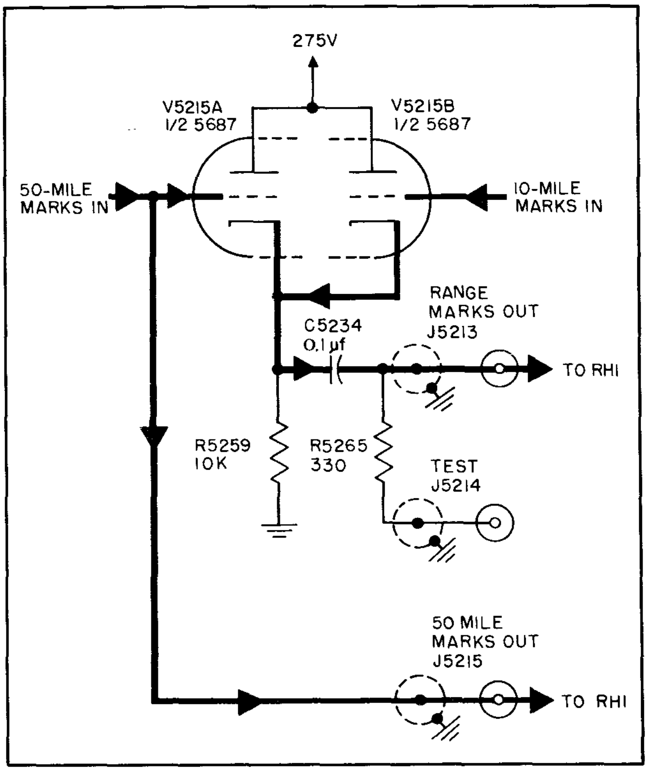

Figure 4–112. Mixer, Range Mark Generator, Simplified Schematic Diagram

4–733. The rate of discharge of capacitor C5231 can be adjusted by potentiometer R5254. As this resistance is decreased, the discharge time of capacitor C5231 is reduced, thus decreasing the number of pulses accepted before capacitor C5231 discharges sufficiently to allow triggering. In practice, potentiometer R5254 is set for a counting ratio of 5:1.

4–734. MIXER V5215. (See figure 4–112.) The 10-mile and 50-mile range markers are mixed in mixer V5215. The 50-mile markers are applied as positive pulses to the grid of mixer stage V5215A, while the positive 10-mile markers are applied to the grid of mixer stage V5215B. The combined output is sent to the RHI assembly from jack J5213. Every fifth mark is of larger amplitude because of the increased conduction through common cathode resistor R5259 during coincidence between the 10- and 50-mile markers. Monitor jack J5214, located on the front panel, allows the operator or technician to secure a reduced version of the combined range marker output for test purposes.

4–735. BLOCK DIAGRAM ANALYSIS OF RANGE MARK CALIBRATOR. (See figure 4–113.)

4–736. The range mark calibrator generates 5-mile range marks and mixes these with the 10-mile marks obtained from the range mark generator. The 5-mile marks, developed in a crystal-controlled circuit, serve as a precision signal against which the range marker circuits can be calibrated.

4–737. Sync trigger pulses are applied to a half-frequency multivibrator (an Eccles-Jordan flip-flop circuit) to produce one complete multivibrator cycle for each pair of input triggers. The two grid outputs gate opposing suppressor grids of the switch tubes.

4–738. The sync trigger also initiates a cycle of blanking multivibrator operation (a one-shot multivibrator circuit). It should be noted that this multivibrator produces one complete cycle during each alternation of the half-frequency multivibrator. The blanking signal is fed to the control grids of both switch tubes.

4–739. The 1-mile oscillator is a crystal-controlled oscillator which operates at a frequency of 80.867 kilocycles. A period of one cycle at this frequency is equal to the period required for electromagnetic energy to complete the journey to a target 1 nautical mile distant and return to the antenna.

4–740. The 5-mile blocking oscillator is synchronized by the 80.867-kilocycle oscillations. The time constant of an RC network in the grid circuit of the blocking oscillator is adjusted so that the fifth positive alternation of this synchronizing signal initiates a cycle of blocking oscillator operation. Thus, the blocking oscillator converts the 80.867-kilocycle sinusoids into discrete pulses spaced 5 miles apart.

4–741. Switch tubes V5206 and V5207 are dual-gated amplifiers which switch alternately from 5- to 10-mile mark outputs. The 5-mile marks are fed to the control

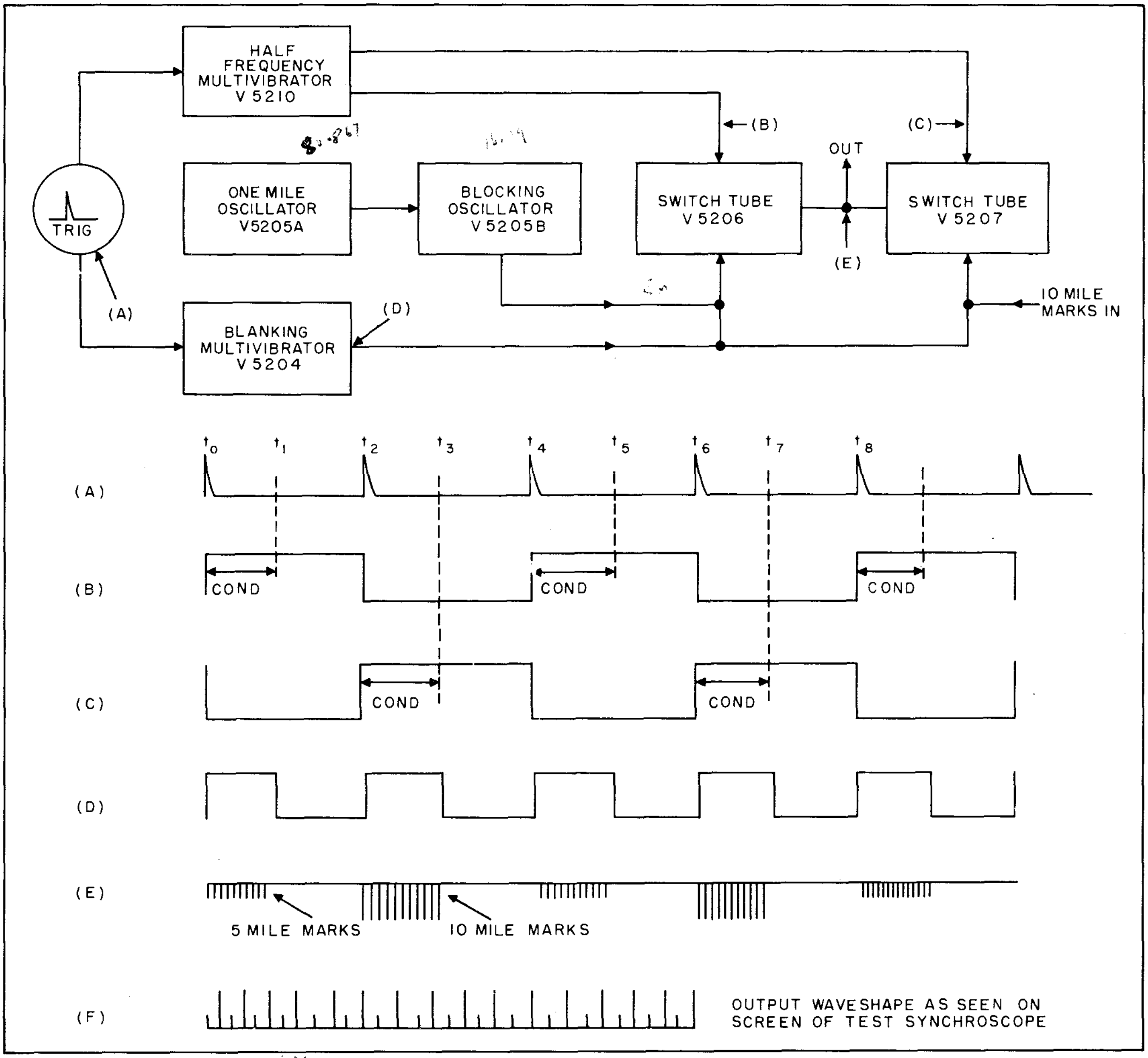

Figure 4–113. Range Mark Calibrator, Range Mark Generator, Block Diagram

grid of amplifier V5206, while the 10-mile marks are applied to the control grid of amplifier V5207. The blanking signal (waveform D) is applied to both control grids simultaneously. The suppressor grids are gated by opposing waveforms from the half-frequency generator (waveforms B and C).

4–742. No output can be obtained from a dual-gated amplifier unless positive-going signals are applied simultaneously to suppressor and control grids. Switch tubes V5206 and V5207 are synchronized so that both stages are cut off during the negative-going portion of the blanking signal, and only one tube can conduct during each positive-going portion of the blanking signal. Switch tube V5206 conducts during each alternate positive-going portions of the blanking signals (that is, t_0-t_1, t_4-t_5), producing amplified 5-mile marks at the output in these intervals. Switch tube V5207 conducts during the remaining positive-going portions of the blanking signal (that is, t_2-t_3, t_6-t_7), producing amplified 10-mile marks in these intervals. The combined output resembles waveform E.

4–743. A pulse amplifier of conventional design (not shown in figure 4–113) amplifies and inverts the switch-tube output, and the succeeding cathode follower couples the signal to a low-impedance coaxial cable. The output seen on the screen of a test synchroscope should resemble waveform F. The 5- and 10-mile marks appear superimposed because the synchroscope is triggered by the 5- and 10-mile marks on alternate sweeps.

4–744. CIRCUIT ANALYSIS OF RANGE MARK CALIBRATOR.

4–745. BLANKING MULTIVIBRATOR V5204. (See figure 4–114.) Under static conditions, blanking multivibrator section V5204A is held beyond cutoff by the −150-volts to which its grid is returned, while the positive grid return of multivibrator section V5204B keeps that section in heavy conduction. The plate of multivibrator section V5204A is at the level of the plate supply voltage at this time, while the grid of the conducting section is at zero potential. Capacitor C5211, connected between these two points, charges to the level of the plate supply voltage through the grid circuit of multivibrator section V5204B.

4–746. The plate of multivibrator section V5204B is at 150 volts. This potential is divided equally between resistors R5213 and R5214. The bias on multivibrator section V5204A, determined by the 75 volts dropped across resistor R5213 and by the −150-volt bias supply, is −75 volts, as shown in figure 4–114.

4–747. A negative trigger, obtained from the plate of system trigger blocking oscillator V5201 (paragraph 4–717), is applied to the grid of multivibrator section V5204B through capacitor C5211. This cuts off multivibrator section V5204B for the duration of the trigger, raising its plate potential to the level of the plate supply voltage. The plate supply voltage is divided equally between resistors R5213 and R5214, placing approximately 135 volts across resistor R5213. The bias on section A is now 135 −150 volts, or −15 volts. Section A then begins to conduct, reducing the potential at the plate of this section, and capacitor C5211 discharges through grid return resistor R5216. The potential difference, measured between the upper end of resistor R5216 and ground, always equals 275 volts. While section B conducts heavily, the grid-to-ground potential is zero. Therefore, the full 275-volt plate supply voltage can be read across resistor R5216. When capacitor C5211 discharges through resistor R5216, the voltage dropped across the resistor is in excess of 275 volts. Therefore, if the voltage between the upper end of resistor R5216 and ground is to equal 275 volts, the grid-to-ground potential must be some negative quantity. This is in fact the case.

4–748. The regenerative connection of the multivibrator sections acts to reinforce the situation described in paragraph 4–747. The voltage at the grid of multivibrator section V5204B becomes more negative, holding that section cut off; multivibrator section V5204A conducts heavily.

4–749. Capacitor C5211 continues to discharge. At first, heavy discharge current flows through resistor R5216, so that the potential difference across this component is considerably in excess of 275 volts. Since the rate of discharge of a capacitor is an exponential function, discharge current rapidly dwindles and the voltage across resistor R4216 decreases accordingly. When the potential from the grid of multivibrator section V5204B to ground reaches the cutoff value, this section begins to conduct. A second switching action then occurs, again due to the regenerative connection between the sections. At the conclusion of this action, the circuit is restored to the original condition and remains quiescent until the next trigger.

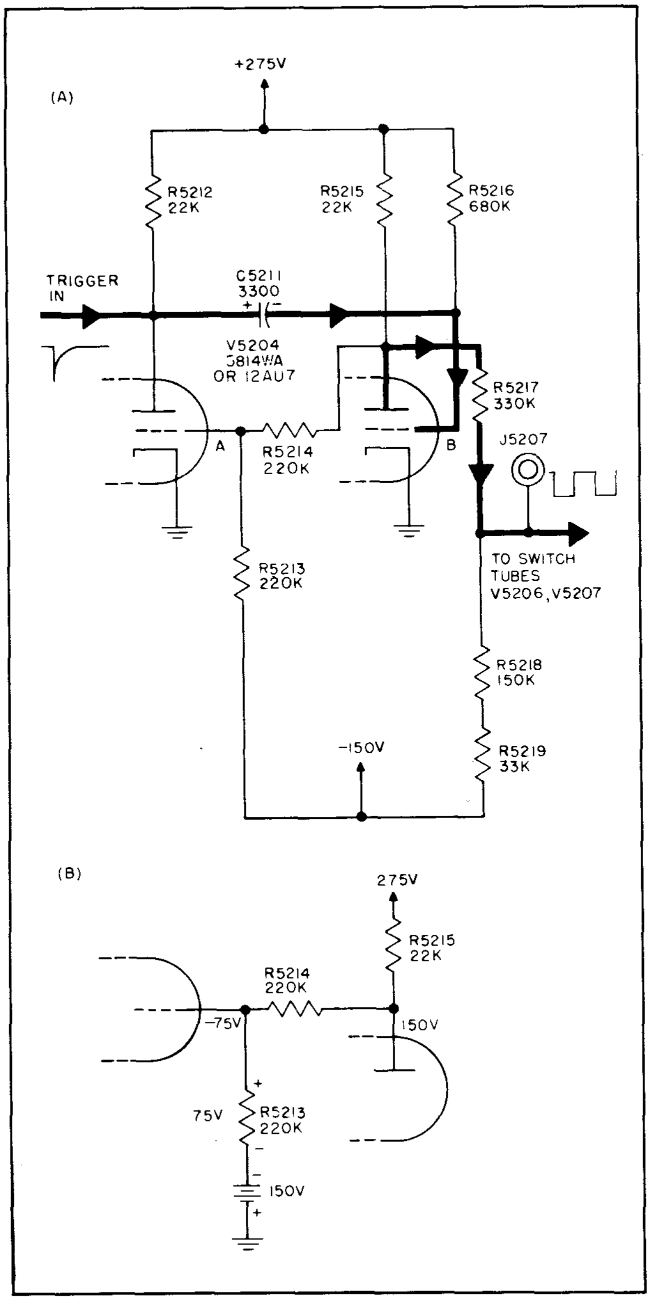

Figure 4–114. Blanking Multivibrator, Range Mark Generator, Simplified Schematic Diagram

4–750. The output waveform is shown in figure 4–114. The frequency of this blanking signal is the same as the repetition rate of the trigger pulse (normally 360 pps). The signal is applied simultaneously to both grids of the switch tubes.

4–751. ONE-MILE OSCILLATOR V5205A. (See figure 7–85.) This crystal-controlled oscillator is the primary timing standard of the radar. The period of its oscillations, 12.4 microseconds, is the equivalent in time of 4054 yards, or 2 nautical miles (1 mile out to the target and 1 mile back).

4–752. Essentially, 1-mile oscillator V5205A is a tuned-plate, tuned-grid oscillator, with the crystal acting as the grid tank circuit. The tuned tank circuit of oscillator V5205A consits of inductor L5201 and capacitor C5212. Feedback in a tuned-plate, tuned-grid oscillator is accomplished through the medium of grid-to-plate capacitance. Resistor R5223 and capacitor C5215 constitute a power supply decoupling network. Plate circuit oscillations developed across winding of 3–6 of transformer T5205 are coupled to the 5-mile blocking oscillator.

4–753. FIVE-MILE BLOCKING OSCILLATOR V5205B. This is a free-running type of oscillator whose pulse repetition frequency can be adjusted by variable grid resistor R5222. Capacitor C5214, resistor R5222, and protective resistor R5264 determine the counting rate of the blocking oscillator (normally 5:1). The 1-mile oscillations act as a synchronizing signal. The first four cycles of this synchronizing voltage cannot affect the blocking oscillator, since it is far beyond cutoff during this time. The positive alternation of the fifth cycle arrives just as the grid voltage reaches cutoff and acts to bring the oscillator into conduction.

4–754. The magnetic field around winding 1–4 of transformer T5202 builds up rapidly as 5-mile blocking oscillator V5205B starts to conduct. Expanding lines of force cutting winding 3–6 induce a positive voltage at the grid of oscillator V5205B. Capacitor C5214 charges negatively with respect to ground through the grid circuit. Conduction through the triode increases until plate current saturates section 1–4 of the transformer. Then, the field collapses about winding 3–6, inducing a negative voltage at the grid of oscillator V5205B. At the same time, capacitor C5214 discharges through the shunting resistance. The stage remains cut off until capacitor C5214 has discharged far enough so that the combination of the reduced negative potential at the grid of oscillator V5205B and the positive alternation of the synchronizing signal drives the stage into conduction.

4–755. The output signal, consisting of a series of positive spikes spaced 5 miles apart, is developed across cathode potentiometer R5224. A portion of this signal is tapped off and fed to the control grid of switch tube V5206 through capacitor C5216.

4–756. SWITCH TUBES V5206 AND V5207. (See figures 4–113 and 4–115.) Pentode switch tubes V5206 and V5207 utilize common plate load resistor R5226, as shown in figure 4–115. The 5-mile markers are fed to the control grid of tube V5206, while the 10-mile markers are applied to the control grid of tube V5207. The blanking signal is applied to both control grids simultaneously. The suppressor grids are gated by opposing waveforms from the half-frequency multivibrator (B and C, figure 4–113). During the period from t_0 to t_1, tube V5206 conducts, since both its suppressor and its control grid have positive-going voltages (B and D,

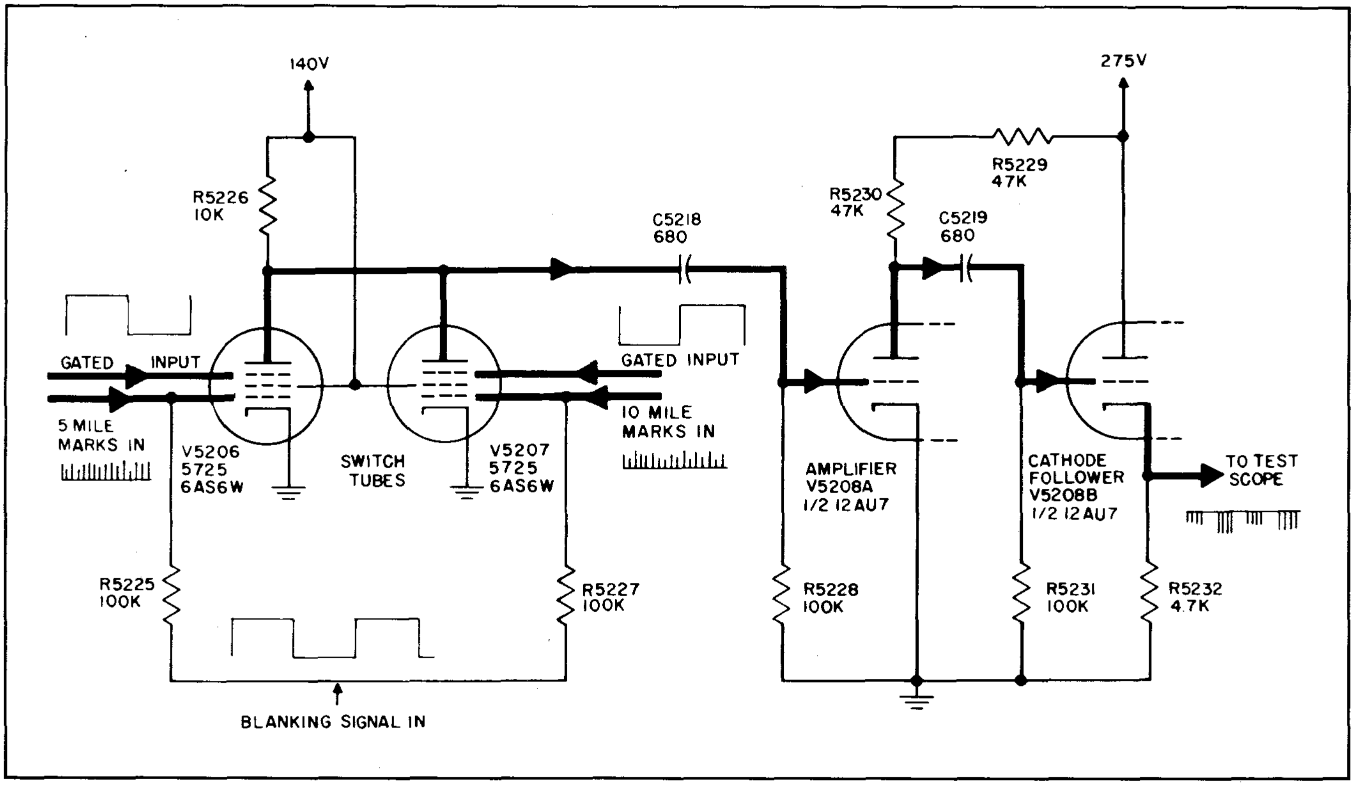

Figure 4–115. Switch Tubes and Amplifier, Range Mark Generator, Simplified Schematic Diagram

figure 4–113). During this interval, the negative going voltage at the control grid of tube V5207 (C, figure 4–113) keeps this tube cut off. During the period from t_1 to t_2, both tubes are cut off by the negative-going portion of the blanking voltage. From t_2 to t_3, tube V5207 conducts because of coincidence between the positive-going portions of waveforms C and D, but tube V5206 is cut off by the negative-going alternation of waveform B. The output resembles waveform E. When viewed on a test synchroscope, the 5- and 10-mile markers are superimposed as shown in F of figure 4–113.

4–757. Resistors R5225 and R5227 provide some measure of isolation between the marker oscillators and the blanking multivibrator. Potentiometer R5224 in the cathode circuit of the 5-mile blocking oscillator is set so that the amplitude of the 5-mile markers is lower than that of the 10-mile makers. Alternate 5-mile markers should be alined with the 10-mile markers on the synchroscope presentation.

4–758. AMPLIFIER AND CATHODE FOLLOWER V5208. The switch tube output is amplified and inverted by a conventional voltage amplifier, V5208A. The output obtained at the plate of amplifier V5208A is fed to cathode follower V5208B. The output of the cathode follower is conveyed to the front panel through jacks J5210 and J5211 for connection to the test synchroscope.

4–759. ANGLE MARK GENERATOR (CALIBRATOR, ELEVATION TS-736/FPS-6).

4–760. BLOCK DIAGRAM. (See figure 4–116.)

4–761. The inputs to the angle mark generator produced during periods of coincidence between the angle mark commutators are rectangular in shape. The width of these inputs is dependent upon the rate at which the antenna nods (B, figure 4–116).

4–762. The width of the commutator pulse greatly exceeds one sweep length, as shown in B of figure 4–116. Were a pulse of this width allowed to intensity-modulate the indicator, the resulting angle mark would be broad enough to obscure targets. In addition, the leading edge of the commutator pulse does not coincide in time with the beginning of the trace; that is, the pulse edge does not coincide with the trigger pips (A, figure 4–116). Such a pulse would produce a jagged angle mark.

4–763. The angle mark generator converts the commutator pulse of waveform B into a narrow trigger (F, figure 4–116), generated simultaneously with the arrival of a system trigger pulse (A, figure 4–116). The resulting angle mark output is shown in F of figure 4–116.

4–764. The system trigger inputs from the range mark generator are amplified by trigger amplifier V5301A and applied to one grid of synchronizing multivibrator V5303. The commutator pulse from the antenna is amplified, differentiated, and clipped by trigger amplifier V5301B, and the remaining negative spike is applied to the grid of the synchronizing multivibrator. Since the synchronizing multivibrator is an Eccles-Jordan circuit, the presence of blocking diodes V5302A and V5302B is necessary to isolate the stage and protect it agains spurious triggering.

4–765. The negative triggers (A, figure 4–116) keep one-half of synchronizing multivibrator V5303 cut off. The arrival of the differentiated commutator pulse at the opposite grid initiates a multivibrator change cycle producing the output shown in D of figure 4–116. Waveform D is differentiated and used to trigger blocking oscillator V5304. It should be noted that the trigger output (F, figure 4–116) coincides in time with one of the trigger inputs (A, figure 4–116).

4–766. CIRCUIT ANALYSIS OF ANGLE MARK GENERATOR.

4–767. TRIGGER AMPLIFIER V5301A AND BLOCKING DIODE V5302A. (See figure 7–87.) Resistor R5301 terminates the coaxial input line in its characteristic impedance, preventing reflections which could cause spurious triggering. Grid resistor R5304 is returned to a point 27 volts below ground on a voltage divider composed of resistors R5302 and R5303. Bypass capacitor C5302 decouples the bias supply from the trigger. The system trigger from the range mark generator drives the tube into conduction and an amplified and inverted version of the narrow trigger appears at the plate. The output is coupled through blocking diode V5302A to the grid of synchronizing multivibrator section V5303B.

4–768. COMMUTATOR PULSE AMPLIFIER V5301B AND BLOCKING DIODE V5302B. Commutator pulse amplifier V5301B is normally cut off because its grid is connected to a point 25 volts below ground at the junction of a voltage-divider composed of resistors R5307 and R5323. At the coincidence between the angle mark commutators geared to the antenna elevation motion, the upper end of resistor R5306 is placed at ground potential and in parallel with resistor R5323. The bias on the stage decreases to a fraction of a volt. This situation prevails for the length of time that the commutators coincide, or approximately 10,000 microseconds. This time varies with the nodding speed of the antenna.

4–769. Commutator pulse amplifier V5301B conducts heavily during the coincident period, developing a negative-going rectangular pulse in the plate circuit. Capacitor C5304 and resistor R5310 differentiate the waveform. When the blocking diode conducts, an additional capacitance charge path is provided through resistor R5314. The blocking diode isolates the grid of the synchronizing multivibrator and eliminates the positive portion of the differentiated commutator pulse. The negative spike of voltage is fed from the amplifier stage to the synchronizing multivibrator through the blocking diode.

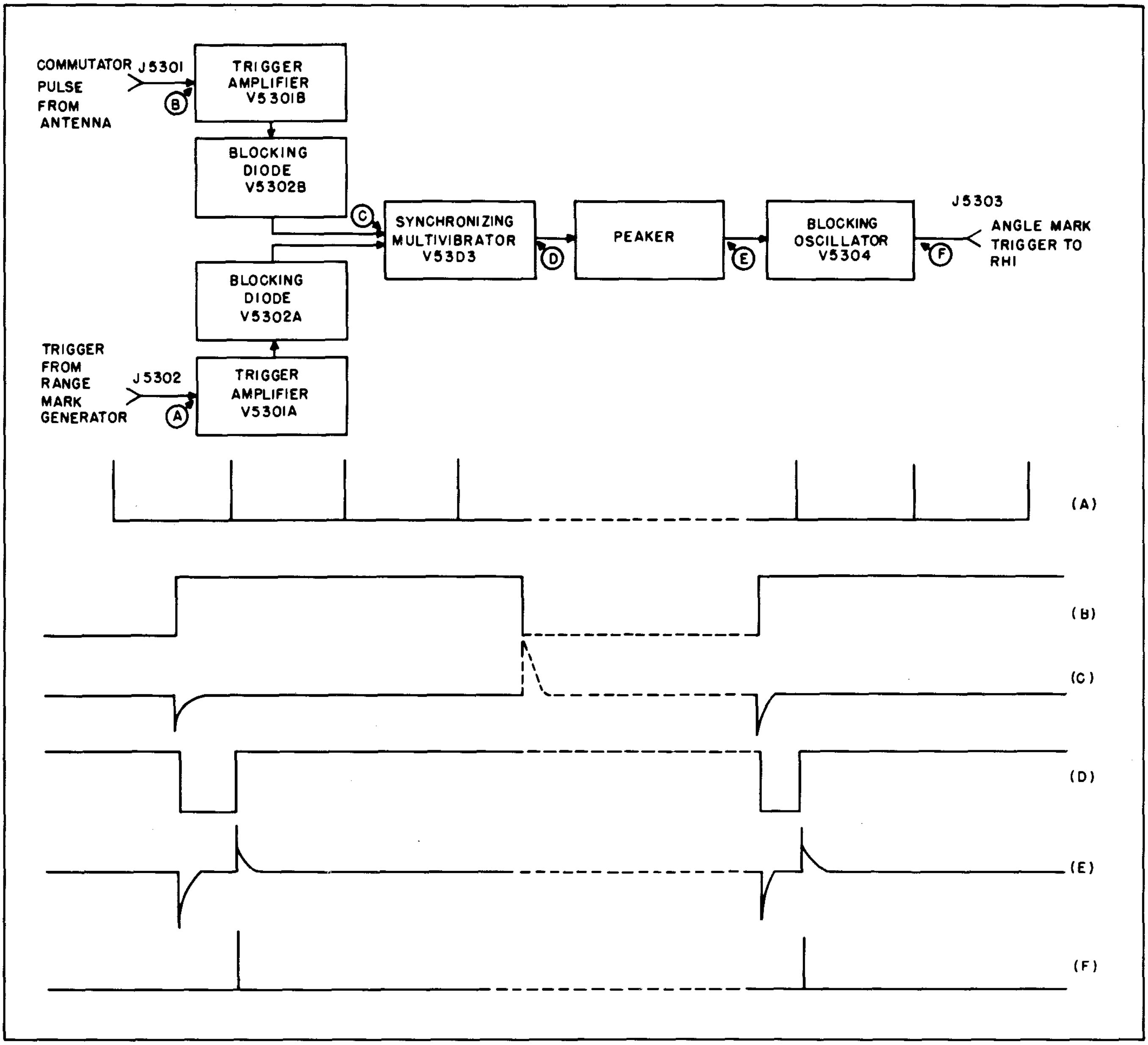

Figure 4–116. Angle Mark Generator, Block Diagram

4–770. SYNCHRONIZING MULTIVIBRATOR V5303. This multivibrator is a modified Eccles-Jordan trigger circuit possessing two conditions of stable equilibrium. One of these conditions exists when section V5303A is conducting and section V5303B is cut off. The other condition is in effect when section V5303A is cut off and section V5303B is conducting. The circuit remains in one or the other of these conditions until the occurrence of some action, such as a trigger, which causes the nonconducting section to conduct. The sections then reverse their functions, remaining in the new condition as long as no plate current flows in the section that is cut off. Because of the sudden shift from one state of equilibrium to another, this circuit is often called a flip–flop circuit.

4–771. Resistors R5311 and R5314 function as the plate loads for sections V5303A and V5303B, respectively. This circuit is quite similar to half-frequency multivibrator V5210. Refer to paragraph 4–723 for an analysis of the operation of the multivibrator circuit prior to the application of the triggering pulses.

4–772. In synchronizing V5303, the input circuits are isolated from any positive pulses or transients by the blocking diodes. Trigger pulses from the range mark generator are coupled through blocking diode V5301A to the grid of section B of multivibrator V5303. If the multivibrator has previously alined itself with section B cut off, the trigger can have no effect. If, however, section B of the multivibrator is conducting, the negative trigger initiates a switching action. The negative trigger causes the potential at the plate of section B to rise, and a portion of this increased potential is applied to the grid of section A as a positive voltage sufficient to overcome the bias. Section A then conducts and its plate voltage falls. Since the plate voltage of section A is proportioned between resistors R5312 and R5316, when this voltage decreases, the drop across resistor R5316 is reduced correspondingly. This regenerative action is cumulative until the condition of stable equilibrium is reached wherein section V5303A conducts and section V5303B is cut off.

4–773. The commutator pulse, converted to a negative spike by the differentiating action of resistor R5310 and capacitor C5304, is applied to the grid of section V5303A. This spike sets off another regenerative sequence which flips the multivibrator to the alternate condition of stable equilibrium. The output pulse is shown as D of figure 4–116.

4–774. BLOCKING OSCILLATOR V5304. An RC network composed of capacitor C5307 and resistor R5317 differentiates the multivibrator output and applies the resulting peaks (E, figure 4–116) to amplifier V5304A. The positive peaks are inverted twice: once by the amplifier, and a second time in passing from winding 3–6 to winding 2–5 of transformer T5301. Thus, the grid winding receives a positive trigger which is in phase with the positive peak of waveform E.

4–775. Section V5304B is held at cutoff by the action of the voltage divider consisting of resistors R5319, R5320, and R5321. The negative peaks appearing across winding 2–5 of transformer T5301 can have no effect, since the section is already cut off. The positive peak, however, is of sufficient amplitude to overcome the cathode bias, so that a rush of plate current passes through winding 1–4. A magnetic field expands rapidly, inducing a voltage in winding 2–5 which accentuates the positive potential already there. The stage then conducts more heavily, the magnetic field about winding 1–4 expands further, and the voltage induced in winding 2–5 drives the grid more positive. Plate current buildup continues until winding 1–4 remains stationary for an instant. The field about winding 2–5 then collapses, inducing a negative potential on the grid. Plate current then decreases, and the magnetic field about winding 1–4 collapses. This collapsing field induces a voltage in winding 2–5 which drives the grid more negative. In this manner, the stage is rapidly returned to the cutoff condition.

4–776. A 1-microsecond pulse is developed across resistor R5320 during the short interval in which the stage conducts. This output, which is the angle mark trigger, is fed from jack J5303 to the RHI assembly.

4–777. ELEVATION DATA GENERATOR FOR RADAR SET AN/FPS-6 (CONTROL, INDICATOR C-993/FPS-6).

4–778. BLOCK DIAGRAM. (See figure 4–117.)

4–779. The elevation data generator contains the 1500-cps oscillator used for excitation of the elevation selsyn on the antenna. The generator also includes the resolver circuit, employed for the formation of a d-c height voltage proportional to the sine of the elevation angle, for use in the RHI oscilloscope.

4–780. The rotor of the selsyn mounted in the elevation selsyn and angle mark unit is part of the tank

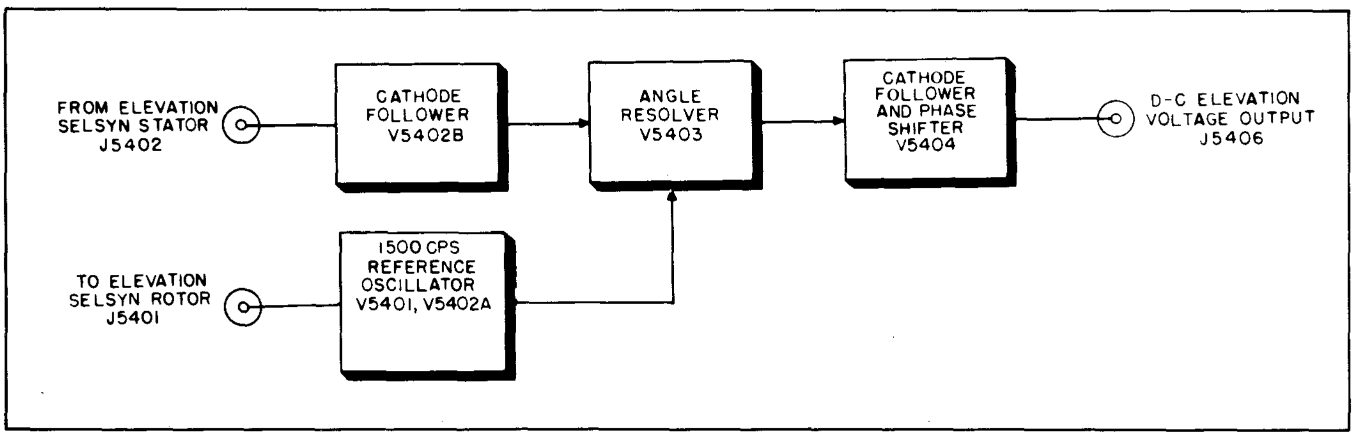

Figure 4–117. Elevation Data Generator for Radar Set AN/FPS-6, Block Diagram

circuit of the 1500-cps reference oscillator. This oscillator generates a slightly distorted sinusoidal voltage which excites the elevation selsyn and also serves as the reference signal for the resolver.

4–781. The 1500-cps voltage induced in the stator of the elevation selsyn is returned to the elevation data generator through the input cathode follower which isolates the resolver circuit from the selsyn. The cathode follower output is transformer-coupled to the resolver circuit.

4–782. The resolver circuit compares the 1500-cps voltage received from the elevation selsyn with the 1500-cps reference voltage generated by the oscillator and produces a d-c voltage which varies in amplitude and polarity with the elevation angle of the antenna. The ZERO SET potentiometers are adjusted for a zero output voltage when the elevation angle is zero.

4–783. The d-c output from the resolver is fed through a d-c cathode follower to the RHI assembly. A PHASE SHIFT control at the input to the cathode follower allows for exact synchronization between the output voltage and the antenna movement.

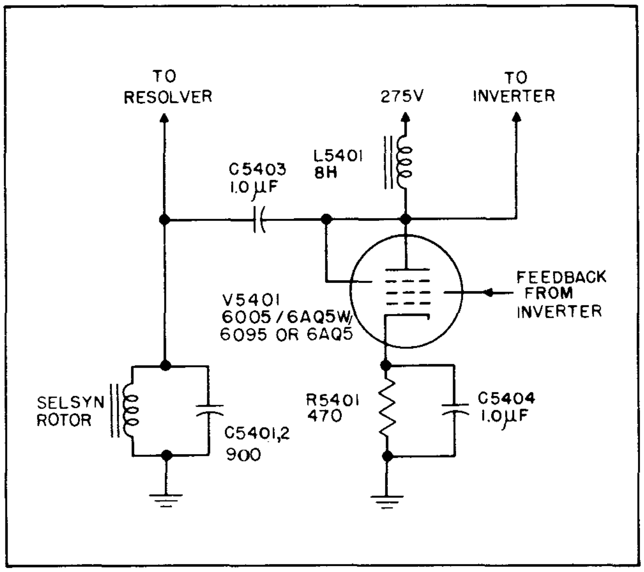

Figure 4–118. 1500-cps Oscillator, Elevation Data Generator for Radar Set AN/FPS-6, Simplified Schematic Diagram

4–784. CIRCUIT ANALYSIS OF ELEVATION DATA GENERATOR FOR RADAR SET AN/FPS-6.

4–785. 1500-CPS OSCILLATOR V5401. (See figure 4–118.) The 1500-cps oscillator utilizes two stages: a pentode (the oscillator tube) to provide sufficient amplification to maintain oscillation, and a triode (the phase inverter) to supply the regenerative feedback necessary for sustained oscillation. Capacitors C5401 and C5402, in parallel with the rotor of the elevation selsyn, comprise a tuned circuit designed to resonate at 1500 cps. The tank shunts oscillator tube V5401. Any fluctuation in the plate voltage of the oscillator tube is coupled into the tank through capacitor C5403 and oscillations start. The oscillatory voltage is fed from the plate of oscillator tube V5401 to the grid of phase inverter V5402A. An amplified and inverted version of this signal is obtained from the plate of phase inverter V5402A and fed back to the grid of the oscillator tube in correct phase to maintain oscillation. The feedback signal is amplified by oscillator tube V5401. Choke L5401 is used as the plate load of the oscillator, since this reactive component acts as an a-c load without appreciably lowering the d-c plate voltage. Oscillations are fed from the plate of tube V5401 to the resolver as a reference signal; the 1500-cps voltage in the tank circuit excites the rotor of the elevation selsyn. A sample of the 1500-cps signal for test purposes can be obtained at jack J5404.

4–786. ELEVATION SELSYN B3001 AND INPUT CATHODE FOLLOWER V5402B. The 1500-cps signal supplied to the rotor of elevation selsyn B3001 induces corresponding voltages in the stator windings. The magnitude and phase of the stator outputs are functions of the antenna elevation angle. A summation network at the selsyn combines the three stator voltages into a single voltage proportional to the sine of the elevation angle. The selsyn is adjusted so that the output voltage of the network is zero when the antenna is pointing horizontally. This network output is fed through jack J5402 to the grid of input cathode follower V5402B. The output load of this cathode follower consists of two parts (figure 4–119), resistor R5409 and the primary of transformer T5401. The resistor limits tube current to a safe value; the useful output is developed across the secondary of transformer T5401.

4–787. RESOLVER CIRCUIT V5403. A 1500-cps data voltage, in phase with the reference signal (figure 4–119), appears across the secondary of transformer T5401 when the antenna elevation angle is a positive quantity. A voltage 180 degrees out of phase with the reference signal appears across the secondary when the elevation angle is negative. The magnitude of the a-c data voltage is proportional to the sine of the antenna elevation angle. No output appears if the antenna is set at zero elevation.

4–788. The resolver includes two triodes, the two sections of tube V5403 which operate as grid-controlled rectifiers. The grids are driven in phase by the relatively high-amplitude 1500-cps reference voltage. Bias is developed by the charges on capacitors C5410 and C5411 leaking off through the grid-leak resistors. The grid voltages allow the flow of plate current through the tubes only during a small portion of the input cycle.

4–789. In the absence of a data voltage, there is no voltage applied to resolver V5403 from the secondary of transformer T5401, so that neither half of the tube conducts. A zero output voltage then occurs when the antenna is pointing horizontally.

4–790. When a sinusoidal data voltage is of the same polarity as the reference voltage, the flow of current through tube V5403B is intensified by the grid swinging positive. Tube V5403A carries very little or no current under these conditions, which occur at all positive elevation angles. A positive rectified output of a magnitude directly proportional to the amplitude of the a-c data voltage is delivered at the cathode of tube V5403B. When the antenna elevation angle is negative (that is, below the horizon), tube V5403B carries very little or no current while tube V5403A conducts heavily. A negative rectified output is obtained from the plate of tube V5403A.

4–791. The rectified outputs are smoothed by filter capacitor C5412. However, the time required by filter capacitor C5412 to charge and discharge causes the output voltage to lag the antenna position. In addition, since the filter capacitor charges through tube V5403B during the upsweep of the antenna and discharges through resistors R5415, R5416, and R5417 on the downsweep, the charging path is shorter than the discharge path. As a result, the output voltage lag is more pronounced on the downsweep. To compensate for this, a portion of the output waveform is coupled through capacitor C5409 and potentiometer R5414 to the grid of triode V5404B. This triode receives a positive voltage on the upsweep of the antenna, producing a relatively large signal at the arm of potentiometer R5410. This signal is fed back to pin 7 of transformer T5401 as resolver bias. On the downsweep, a negative signal is applied to triode V5404B and a smaller feedback signal is taken from potentiometer R5410. Compensating the output voltage assures that the angle markers seen on the RHI display are in coincidence on the up and down sweeps of the trace. Potentiometer R5414 is adjusted to provide a single coincident picture on the RHI display when the elevation drive is on slow. When the fast nodding rate is selected, relay K5401 switches potentiometer R5419 into the circuit in place of potentiometer R5414.

4–792. OUTPUT CATHODE FOLLOWER V5404A. (See figure 4–119.) Vacuum tube V5404A is used as a cathode follower. The d-c signal voltages are fed to the grid of tube V5404A from the phase-shifting network discussed previously and are taken from the cathode of the tube to be applied to the RHI assembly. The cathode potential at zero elevation is set at zero by the adjustment of the ZERO SET potentiometer. This control varies the zero point by changing the bias on the resolver tubes. Potentiometer R5410 zeroes the elevation data generator for slow nodding of the antenna; potentiometer R5418 is used during fast nodding. The output of the cathode follower is approximately 125 volts at +32 degrees elevation and −8 volts at −2 degrees.

4–793. ELEVATION DATA GENERATOR FOR RADAR SET AN/FPS-6A (CALIBRATOR, ELEVATION TD-170/FPS-6).

4–794. BLOCK DIAGRAM. (See figure 4–120.)

4–795. GENERAL. The two major parts of the elevation data generator are the 1500-cps oscillator chain and the resolver chain. The 1500-cps oscillator chain develops the excitation voltage for the elevation selsyn on the

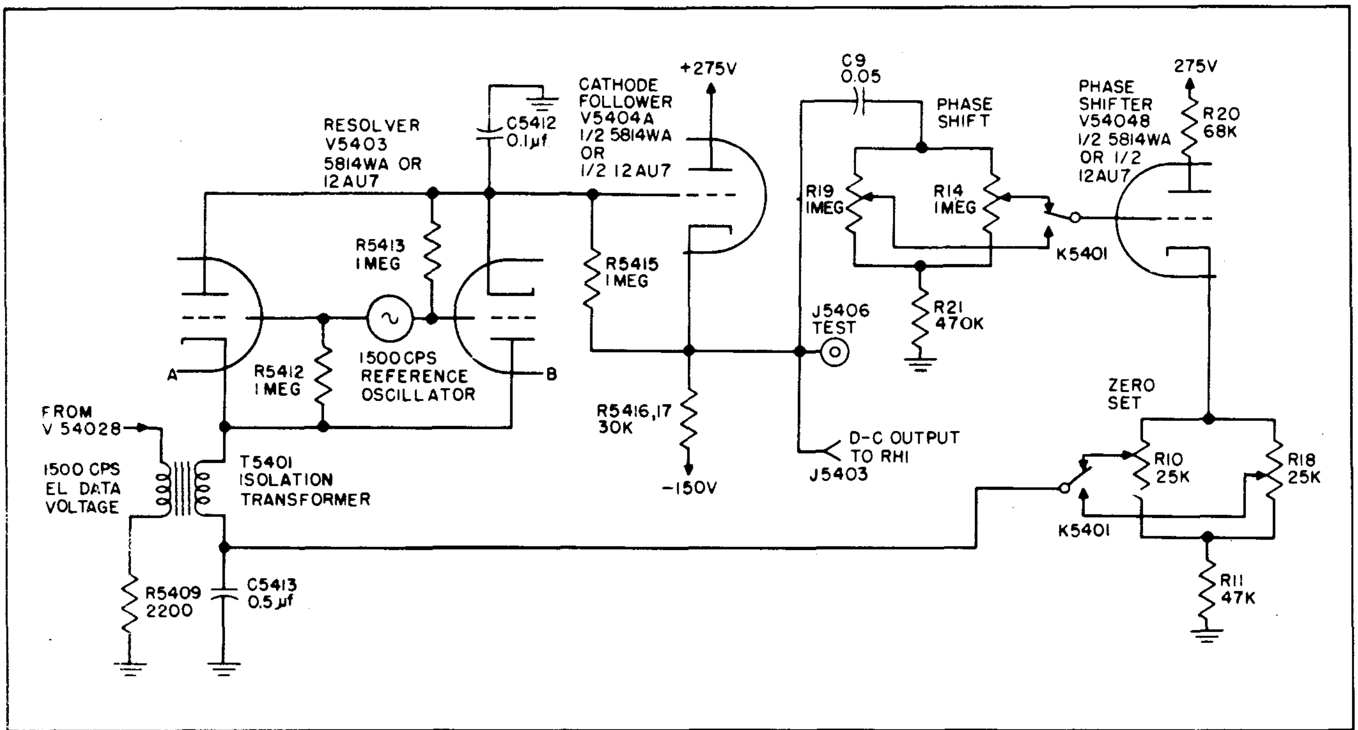

Figure 4–119. Elevation Angle Resolver, Elevation Data Generator for Radar Set AN/FPS-6, Simplified Schematic Diagram

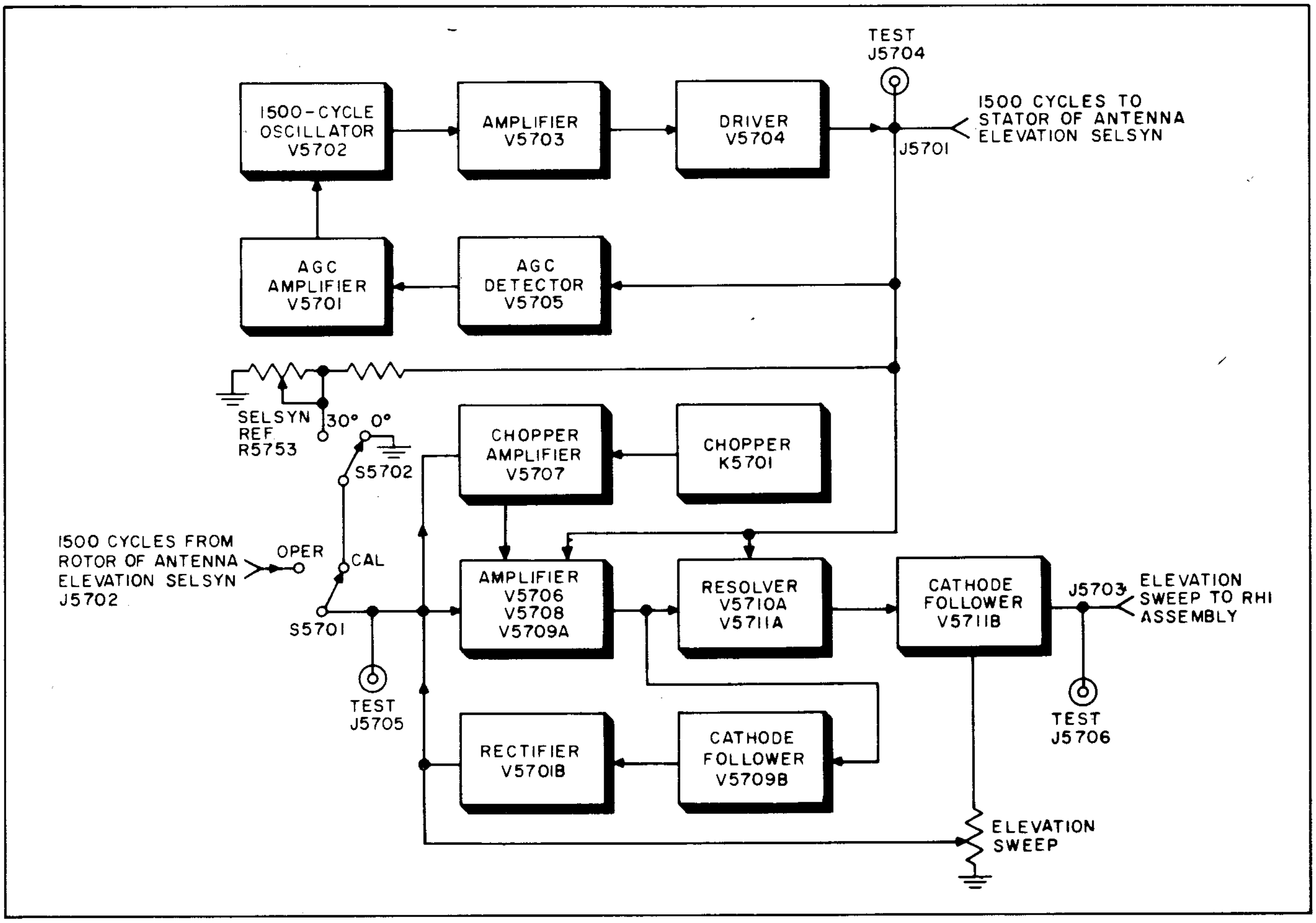

Figure 4–120. Elevation Data Generator for Radar Set AN/FPS-6A, Block Diagram

antenna. The resolver chain converts selsyn orders representing the antenna elevation angle into a d-c height voltage proportional to the sine of the elevation angle.

Note

A different type of elevation synchro, the 5SCT type, must be used as selsyn B3001 in the elevation selsyn and angle mark unit in conjunction with the elevation data generator for Radar Set AN/FPS-6. Some Radar Set AN/FPS-6 systems are fitted with this newer elevation data generator and, therefore, require the use of the 5SCT type synchro.

4–796. OSCILLATOR CHAIN. The oscillator chain consists of tubes V5701 through V5705. A Hartley oscillator, V5702B, generates the 1500-cps signal. This signal is amplified by buffer amplifier V5703 and applied to the stator of the elevation selsyn through pentode driver V5704.

4–797. An AGC circuit keeps the amplitude of the oscillator output constant. This is essential if the elevation data voltage output is to be an accurate indication of the angle of elevation of the antenna. The AGC circuit consists of detector V5705, d-c amplifier V5701, and triode control tube V5702A. The detector rectifies a portion of the 1500-cps output. The d-c amplifier takes this rectified sample and applies it to the triode control tube. Acting in response to the AGC signal, the triode control tube adjusts the plate supply voltage of the 1500-cps oscillator so that the amplitude of the oscillations is held at a constant level.

4–798. RESOLVER CHAIN. The resolver chain consists of tubes V5706 through V5711. The input to the resolver chain is obtained from the rotor of the antenna selsyn. The rotor signal consists of a 1500-cps voltage whose amplitude is proportional to the angle of elevation of the antenna.

4-799. Tubes V5706, V5708, and V5709A are direct-coupled amplifiers which amplify the 1500 cps signal before it is detected in the resolver stage. The amplifiers are direct-coupled for minimum phase shift and good low-frequency response. Since the resolver is phase sensitive, it is necessary to keep the phase of the rotor signal intact, or the resolver output will not accurately reflect the angle of elevation of the antenna. The low-frequency response is essential to preserve the 1/3-cps component induced in the rotor signal by the nodding of the antenna at 20 nods per minute.

4–800. The resolver circuit, composed of triodes V5710-A and V5711A and their associated components, compares the 1500-cps voltage receiver from the elevation selsyn with the 1500-cps reference generated by the oscillator. The resolver produces a d-c voltage which varies in amplitude and polarity with the elevation angle of the antenna.

4–801. Three feedback loops stabilize the action of the resolver circuit. One feedback loop, consisting of chopper relay K5701 and chopper amplifier V5707, maintains the input at zero reference level.

4–802. A second feedback loop, consisting of cathode follower V5709B and rectifier V5710B, takes a sample of the 1500-cps output of the amplifier chain, rectifies it, and applies the resulting d-c signal as a bias to the early stages of the chain. This AGC circuit keeps the gain of the d-c amplifier chain constant despite aging of the tubes and components.

4–803. A third feedback loop takes a sample of the d-c output and feeds it back to the input. This overall feedback serves to correct any deviations in performance in any portion of the resolver chain.

4–804. CIRCUIT ANALYSIS OF ELEVATION DATA GENERATOR FOR RADAR SET AN/FPS-6A.

4–805. 1500-CPS HARTLEY OSCILLATOR V5702B. (See figure 4–121.) Oscillator V5702B is connected as a conventional Hartley oscillator. The tank circuit consists of coil L5701 and capacitors C5702 and C5703 and is tuned to a frequency of approximately 1500 cps. When the power is turned on, electrical energy flows through the tank circuit and oscillations begin. To sustain the oscillations, and to maintain them at the same amplitude, a source of feedback is required which will provide the tank circuit with an amount of energy equivalent to that dissipated in the circuit by resistive losses. The feedback in this circuit is supplied by connecting the grid and plate to opposite ends of the tank circuit, while connecting the cathode to the center tap on the coil.

4–806. When, at a given instant in the oscillatory cycle, the top of coil L5701 is positive with respect to the other end, the grid of oscillator V5702B is connected to a positive signal. Simultaneously, the plate of oscillator V5702B is connected through capacitor C5705 to the lower end of coil L5701, which is negative. The signal at the lower end of the coil is in phase with the plate voltage, which is inverted from the negative signal on the grid. Thus, the feedback is positive and maintains the oscillation. The tap on coil L5701 has been selected so that the feedback is sufficient to maintain the oscillation. Grid limiting resistor R5712 prevents overdriving the grid and distorting the sine wave output. Limiting resistor R5711 prevents overdriving the cathode.

4–807. BUFFER AMPLIFIER V5703. Buffer amplifier V5703 is used to amplify the 1500-cps signal without loading the oscillator or causing the oscillator frequency to change. Resistors R5713 and R5717 are parasitic suppressors. The screen grid is maintained at some d-c voltage above the cathode, but below the plate level, by connecting it to the junction of resistors R5715 and R5716.

4–808. DRIVER AMPLIFIER V5704. A pentode driver stage, V5704, is used as the output of the oscillator chain. The signal from buffer amplifier V5703 is RC-coupled by capacitor C5706 and resistor R5720 to the grid of amplifier V5704. Reactor L5702 is used as the plate impedance. The reactor has a low d-c resistance so that plate voltage on the output stage can be higher. Resistors R5721 and R5724 are parasitic suppressors. Resistor R5722 and capacitor C5707 decouple the 1500-cps signal from the power supply.

4–809. Deleted.

4–810. DETECTOR V5705. A portion of the 1500-cps output is applied to the input of detector V5705. The detector is located at the end of a voltage divider chain composed of precision resistors R5701, R5702, and R5703. In effect, detector V5705 is a d-c generator between the bottom of the voltage divider and ground. The d-c output (a negative voltage) is used in an AGC circuit that keeps the frequency and amplitude of the 1500-cps oscillations constant.

4–811. AGC AMPLIFIER V5701 AND V5702A. Tube V5701 is a difference amplifier, with its B section serving as the reference section and its A section receiving the AGC signal Tube V5702A is a control tube that adjusts the plate voltage for oscillator stage V5702B. The rectified sample of the AGC voltage is applied to tube V5701A; bias for tube V5701A is provided by the cathode follower action of tube V5701B. (While resistor R5705 appears to be the plate resistor for tube V5701B, it actually is part of a voltage divider composed of resistors R5705 and R5709 which determines the plate supply voltage for cathode follower V5701B.) For example, if the plate supply voltage decreases, so does the voltage at the junction of resistors R5705 and R5709. The lower plate voltage of tube V5701B causes it to draw less current through cathode resistor R5706. This means less bias for tube V5701A, which still conducts the same amount of plate current as before the plate supply voltage changed.

4–812. The AGC voltage from detector V5705 is a negative-going d-c signal. Capacitor C5701 tends to charge negative with respect to ground as a result of the AGC voltage.

4–813. A typical example of AGC action follows. For this example, it is assumed that the amplitude of the 1500-cps oscillations increase. A larger 1500-cps signal is then fed back from the output of driver amplifier

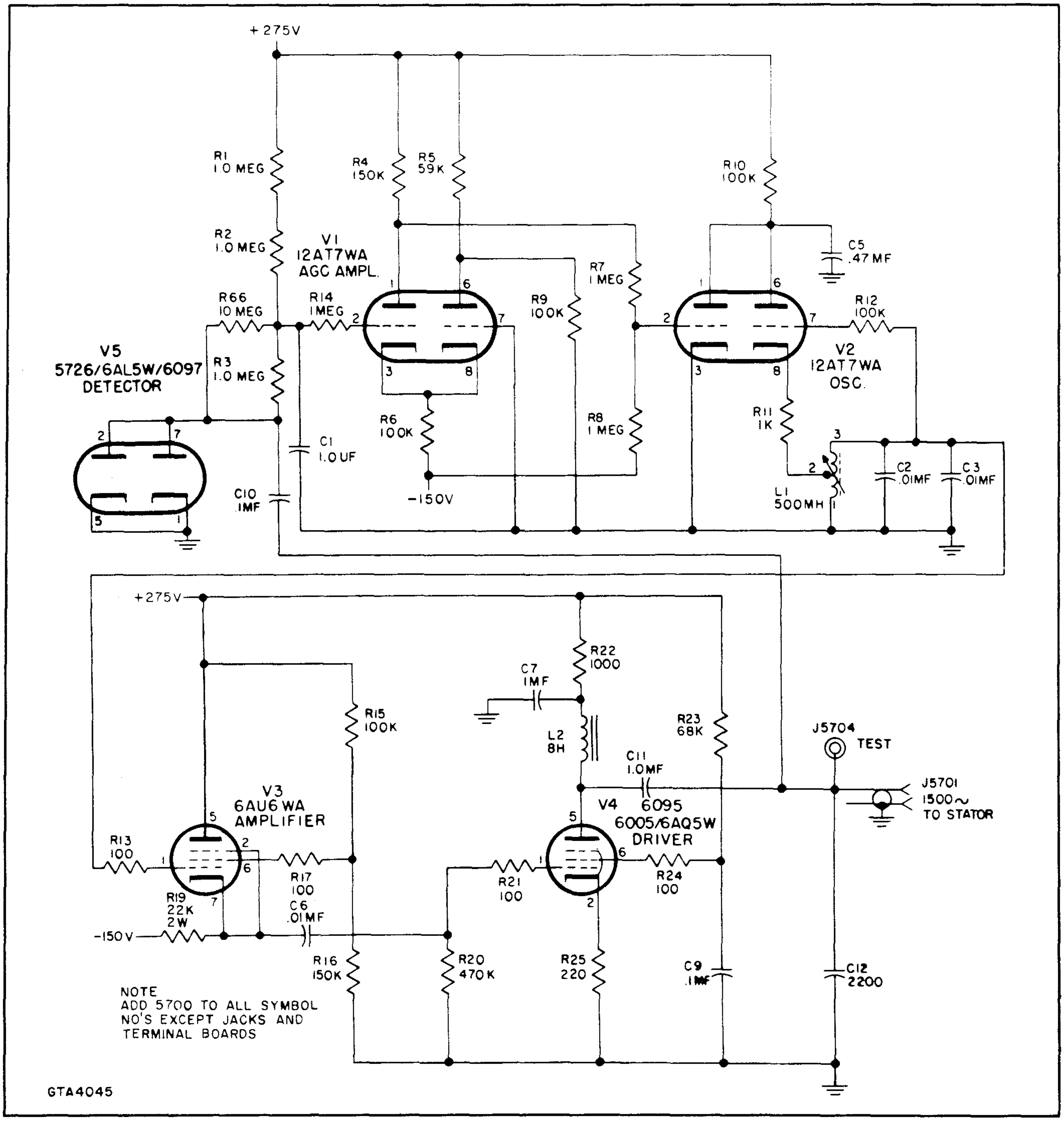

Figure 4-121. 1500-cps Oscillator, Elevation Data Generator for Radar Set AN/FPS-6A, Simplified Schematic Diagram

V5704 through capacitor C5710 to detector V5705. The negative signal appearing at the grid of tube V5701A is then larger, and this tube conducts less and its plate voltage rises. The voltage at the grid of control tube V5702A goes in a positive direction and this tube conducts more heavily. The voltage at the plate of oscillator V5702B then decreases. With a smaller voltage at the plate of oscillator V5702B, the amplitude of oscillation decreases. The circuit is, of course, adjusted so that the amount of correction is just sufficient to restore the amplitude of oscillations to the normal level.

4-814. RESOLVER AMPLIFIER V5706, V5708, AND V5709A. (See figure 4-122.) The 1500-cps elevation signal (R1) from the antenna synchro is connected to jack J5702 and is amplified by direct-coupled amplifiers

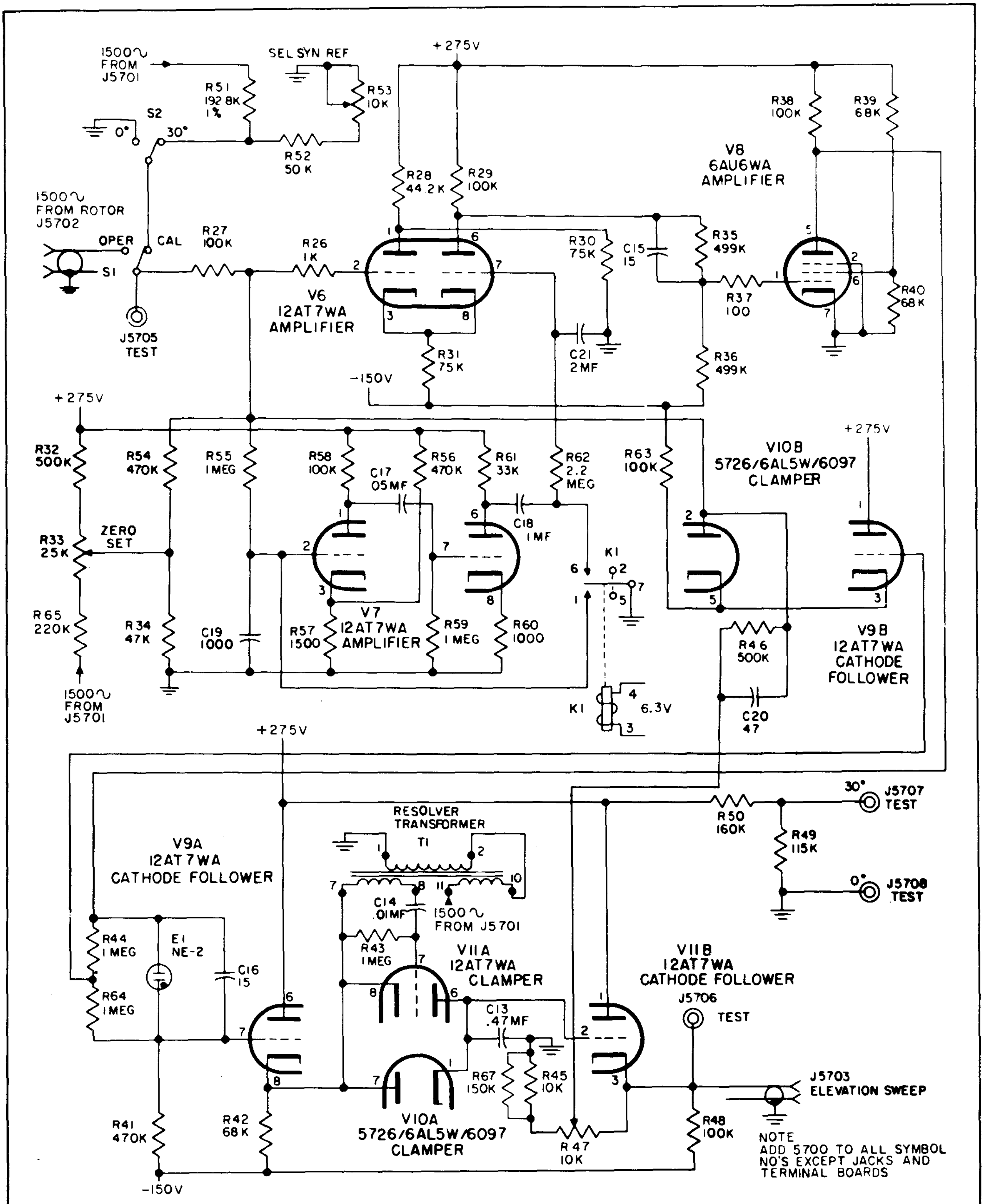

Figure 4–122. Elevation Angle Resolver, Elevation Data Generator for Radar Set AN/FPS-6A, Simplified Schematic Diagram

V5706, V5708, and V5709A for conversion to a d-c elevation sweep voltage by the resolver circuit. The amplitude and phase of the elevation signal are directly proportional to the sine of the elevation angle of the antenna. When the antenna is pointing above the horizontal, the elevation signal is in phase with the reference signal (S1), which is applied to the stator of the antenna synchro. When the antenna is pointing below the horizontal, the elevation signal is 180 degrees out of phase with the reference signal.

4–815. Because the resolver circuit is phase sensitive, it is necessary to have the signal applied to it always in phase with the reference signal. For this reason, the reference signal voltage from jack J5701 is also applied to the grid amplifier V5706A through resistors R65, R33, and R54 and through resistors R5765, R5733, R5754, and R5726.

4–816. The voltage of the reference signal is always greater than the maximum out-of-phase voltage of the elevation signal produced when the antenna is at its maximum point of sweep below the horizontal. Consequently, the combined signal applied to the grid of amplifier V5706A is always in phase with the reference signal.

4–817. The combined signal is amplified by amplifier V5706A and direct-coupled to amplifier V5706B by common cathode resistor R5731. Isolation between the elevation signal and the reference signal circuits is provided by resistor R5727, and resistor R5726 limits the grid current. The output of amplifier V5706B is applied to the grid of pentode amplifier V5708 through a network composed of resistor R5735 and capacitor C5715, the constants of which are chosen to introduce the minimum phase shift at 1500 cps.

4–818. The output of amplifier V5708 is coupled to amplifier V5709A through a network that includes indicator E5701. This indicator introduces a constant difference in potential between the plate of amplifier V5708 and the grid of amplifier V5709, maintaining the correct bias on amplifier V5709A and providing a form of coupling between the plate of amplifier V5708 and the grid of amplifier V5709A that does not introduce distortion or phase shift. The output of amplifier V5709A appears across cathode follower R5742 and is applied directly to the resolver circuit.

4–819. RESOLVER CIRCUIT. Diode V5710A and triode V5711A form the resolver circuit, which converts the amplified elevation signal (R1) to a varying d-c voltage for application to the elevation sweep circuits in the RHI. The 1500-cps elevation signal from amplifier V5709A is applied to the plate of diode V5710A and to the cathode of triode V5711A. In addition, a 1500-cps reference signal (S1) from transformer T5701 is applied between the cathode and grid of triode V5711A. As explained previously, this reference signal is always in phase with the elevation signal.

4–820. Resolver action takes place only during the positive half cycles of the applied signals. During the negative half cycles, the plate of diode V5710A is negative with respect to its cathode and triode V5711A is cut off by the negative voltage applied to its grid by the reference signal. During the positive half cycles, diode V5710A conducts, charging capacitor C5713, only when the elevation signal is increasing, and triode V5711A conducts only when the signal is decreasing.

4–821. To understand this action, it should be assumed that the antenna is starting to rise from its lowest position. The small, 1500-cps, a-c signal from the rotor of the antenna synchro is then applied to the resolver. On the positive half cycle, the plate of diode V5710A is raised to a higher potential than its cathode and the diode conducts, placing a positive charge on capacitor C5713. As the antenna continues to rise, each succeeding positive half cycle rises to a higher voltage than that of the previous half cycle, and diode V5710A conducts when the applied voltage is greater than the charge already built up across capacitor C5713. Thus, the voltage across capacitor C5713 steadily increases as the antenna elevation increases.

4–822. When the antenna reaches maximum elevation and starts to descend, each succeeding positive half cycle becomes lower in voltage than the previous half cycle, and the voltage applied to the plate of diode V5710 becomes lower than the charge built up across capacitor C5713, making diode V5710A unable to conduct. At this time, however, the voltage on the cathode of triode V5711A is lower than that on the plate and the reference signal is applied in phase to the grid, making the grid positive. Triode V5711A therefore conducts and discharges capacitor C5713 to the voltage of the applied elevation signal.

4–823. It should be noted that even though the difference in potential between the plate and cathode of triode V5711A is relatively small, the internal resistance of triode V5711A is made even lower by the positive bias on the grid. This enables capacitor C5713 to discharge at a linear rate and keeps the charge across the capacitor directly proportional to the amplitude of the elevation signal. Capacitor C5714 and resistor R5743 provide grid leak bias for triode V5711A.

4–824. CATHODE FOLLOWER V5711B. The output from the resolver stage is applied to the grid of tube V5711B, which is connected as a cathode follower. The elevation sweep voltage for the RHI is developed across cathode load resistors R5745 and R5747 and applied to output jack J5703. Test jack J5706 is connected in parallel with jack J5703 to permit measuring the output voltage.

4–825. CATHODE FOLLOWER V5709B AND CLAMPER V5710B. A portion of the d-c output from cathode follower V5711B is tapped off ELEVATION SWEEP potentiometer R5747 and fed back to the grid of amplifier V5706A. This feedback loop compensates for changes in the overall gain of the amplifier resulting from aging tubes or from changes in the levels from diode V5710A and triode V5711A.

4–826. Neither diode V5710A nor triode V5711A conduct during negative half cycles of the 1500-cps signal applied to the resolver circuit. To maintain the feedback voltage at the correct level during negative half cycles, a portion of the output from amplifier V5708 is applied to the grid of cathode follower V5709B.

4–827. Clamper V5710B is cathode-coupled to cathode follower V5709B; consequently, the voltage on the cathode of cathode follower V5709B is depressed during negative half cycles. Clamper V5710B produces a voltage drop across resistor R5746, thus maintaining the feedback voltage at a level proportional to the amplitude of the negative half cycles. During positive half cycles, clamper V5710B is cut off and the feedback voltage is determined by the output of the resolver circuit.

4–828. CHOPPER AMPLIFIER V5707. The sum of the d-c voltages at the junction of resistors R5726 and R5727 (that is, the bias voltage on the grid of amplifier V5706A) is normally zero. Drifts from this value change the reference level of the entire circuit and cause inaccuracies in the elevation sweep voltage. Chopper K5701 and chopper amplifier V5707 counteract the tendency of the bias voltage to drift.

4–829. The coil of chopper K5701 is energized by 60-cycles ac and alternately grounds contacts 1 and 7 at a rate of 60 times per second. When contact 1 is open, the bias voltage for amplifier V5706A is applied through resistor R5755 to the grid of chopper amplifier V5707A; when contact 1 is grounded, the grid of chopper amplifier V5707A is at ground potential.

4–830. If the bias voltage for amplifier V5706A is zero, no effect is produced on chopper amplifier V5707A. However, if the bias voltage drifts from zero, a square wave is applied to the grid of chopper amplifier V5707A by the chopper action. If the bias voltage drifts in the positive direction, a positive-going square wave with its lower edge at ground potential is applied to the grid of chopper amplifier V5707A. If the drift is in the negative direction, a negative-going square wave with its upper edge at ground potential is generated.

4–831. To understand the action of the chopper amplifier, it should be assumed that the bias voltage for amplifier V5706A rises to some positive value. The resulting square wave is then applied to the grid of chopper amplifier V5707A, where it is amplified and inverted twice by chopper amplifiers V5707A and V5707B and finally made to appear at the junction of capacitor C5718 and resistor R5762. It should be noted that from time t_1 to time t_2, contact 1 of relay K5701 is open and contact 7 is grounded and that, consequently, a positive-going wave at the grid of chopper amplifier V5707A appears as a negative-going wave at the junction of capacitor C5718 and resistor R5762. This output is applied across capacitor C5721 through resistor R5762, and the negative charge built up across capacitor C5721 is applied to the grid of amplifier V5706B.

4–832. The reverse action takes place if the bias on amplifier V5706A drifts in a negative direction. It should be noted that the polarity of the charge built up across capacitor C5721 is opposite to the polarity of the drift voltage. The voltage built up across capacitor C5721 is amplified by amplifiers V5706B and V5708 and cathode follower V5709B and is finally fed back to the grid of amplifier V5706A in opposition to the original direction of drift, thus driving the bias voltage back to the zero level.

4–833. INTERFERENCE BLANKER (BLANKER, INTERFERENCE MX-1316/FPS-6).

4–834. BLOCK DIAGRAM. (See figure 4–123.)

4–835. As many as three radars may be interconnected with this set. The interference blanker blanks the video in the video channel of Radar Set AN/FPS-6 whenever a disturbing radar fires. This prevents the r-f transmitter pulse and most of the ground clutter it generates from reaching the Radar Set AN/FPS-6 indicators, thus maintaining the quality and contrast of the displays.

4–836. Each interfering radar is connected to a separate trigger amplifier. Separate trigger amplifiers V5501A, V5501B, and V5502A are used to handle triggers of from 10 to 150 volts in amplitude. The three amplifiers use a common plate load so that all three of the possible trigger inputs can be mixed.

4–837. The inverted trigger input is applied to the normally conducting section of gating mutlivibrator V5503, producing a negative gate 7 to 13 microseconds wide, as determined by the setting of potentiometer R5517. The duration of the blanking period is determined by the width of the negative gate output. The blanking gate width control should be set for a pulse of sufficient width to blank out triggers from other radar sets. The gate pulse is fed out at jack J5512 through a cathode follower when an associated moving-target indicator (MTI) radar is used.

4–838. The gate pulse is also fed to the suppressor grid of blanking stage V5505. The video signals are applied to the control grid. Video inputs to the blanking stage can be delayed by a delay line for a fixed period of 1 microsecond. The delay compensates for trigger delay caused by long lines between Radar Set AN/FPS-6 and the search radar. A switch is provided to bypass the video around the interference blanker. This switch is used when blanking is not required.

4–839. The blanked video is amplified by amplifier V5506A and applied to output cathode follower V5507A. A d-c restorer, V5506B, connected across the input to the cathode follower, clamps the lower portion of the waveform to the zero axis. The blanker video is applied to the RHI assembly. The test video signal is

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4–838. The gate pulse is also fed to the suppressor grid of blanking stage V5505. The video signals are applied to the control grid. Video inputs to the blanking stage can be delayed by a delay line for a fixed period of 1 microsecond. The delay compensates for trigger delay caused by long lines between Radar Set AN/FPS-6 and the search radar. A switch is provided to bypass the video around the interference blanker. This switch is used when blanking is not required.

4–839. The blanked video is amplified by amplifier V5506A and applied to output cathode follower V5507A. A d-c restorer, V5506B, connected across the input to the cathode follower, clamps the lower portion of the waveform to the zero axis. The blanker video is applied to the RHI assembly. The test video signal is

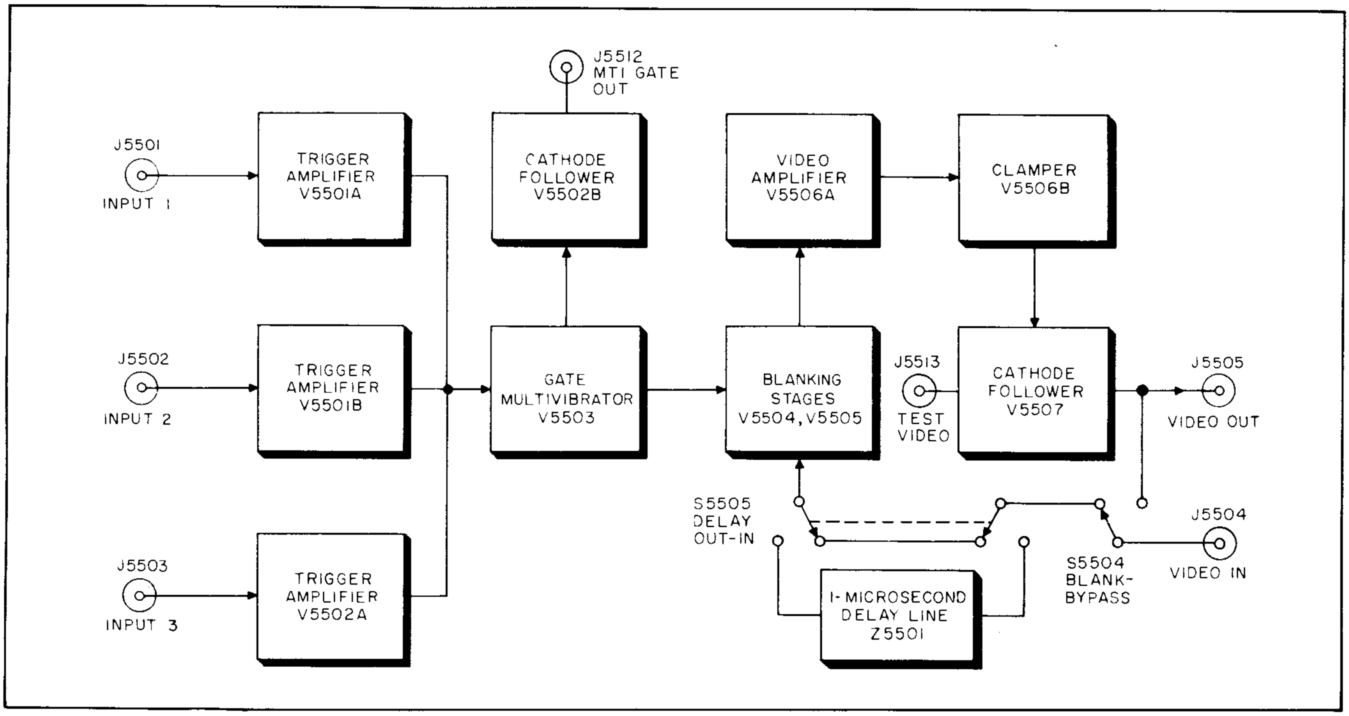


Figure 4–123. Interference Blanker, Block Diagram

used at the transmitter cabinet for alining the AFC-LO unit and preamplifier components.

4–840. CIRCUIT ANALYSIS OF INTERFERENCE BLANKER.

4–841. TRIGGER AMPLIFIERS V5501A, V5501B, AND V5502A. The functions and operating characteristics of trigger amplifiers V5501A, V5501B, and V5502A are the same; therefore, only trigger amplifier V5501A is discussed (figure 4–124). The input to the trigger amplifier consists of the blanking trigger from the interfering radar. The trigger amplifier permits a range of input trigger amplitudes of 10 to 150 volts.

4–842. To prevent the input trigger pulse to the amplifier from being reflected back into the transmission line and causing spurious triggering, a 68-ohm resistor, R5501, can be connected in parallel with the line by closing coaxial cable termination switch S5501. Since this provides proper impedance termination, reflections are now prevented. TRIGGER GAIN control R5510 adjusts the bias on the stage and capacitor C5504 decouples the bias supply from the input trigger.

4–843. GATING MULTIVIBRATOR V5503. (See figure 4–124.) One-shot multivibrator V5503 generates the blanking gate pulse. In its quiescent state, section A of multivibrator V5503 is held at cutoff by the negative voltage to which the grid is returned. Section B conducts heavily because its grid is returned to the plate supply voltage through resistors R5517 and R5518. Capacitor C5508 has charged through the grid circuit of tube V5503B to the plate supply voltage. The negative trigger from amplifier stage V5501A is applied to the grid of tube V5503B, reducing the plate current and increasing the plate potential of the section. The increase in the plate potential of tube V5503B is coupled to section A through capacitor C5507 and resistor R5515. This positive-going voltage drives section A into conduction. The plate potential of section A falls, releasing the pressure on capacitor C5508. The capacitor then discharges through grid return resistors R5517 and R5518, creating a potential difference across these resistors which is much larger than the plate supply voltage of 275 volts.

4–844. Since the voltage measured from the upper end of resistor R5517 to ground must read 275 volts at all times, and the voltage drop across the resistors exceeds this value, the grid-to-ground potential of tube V5503B is then sufficient to cut off the section. The current in the discharge circuit of capacitor C5508 decreases exponentially as the capacitor discharges. Similarly, the voltage across grid return resistors R5517 and R5518 decreases exponentially while the grid-to-ground voltage increases. After an interval determined principally by the time constant of the capacitor and the grid return resistors, the grid-to-ground voltage reaches a value slightly above cutoff. Tube V5503B then resumes conduction. The falling plate potential of tube V5503B is coupled through capacitor C5507 and resistor R5515 to the grid of tube V5503A, initiating a regenerative action that ends with section A cut off. Capacitor C5508 then charges through the grid circuit of tube V5503B to 275 volts, which is the plate voltage of tube V5503A. Once capacitor C5508 has charged, grid circuit current ceases

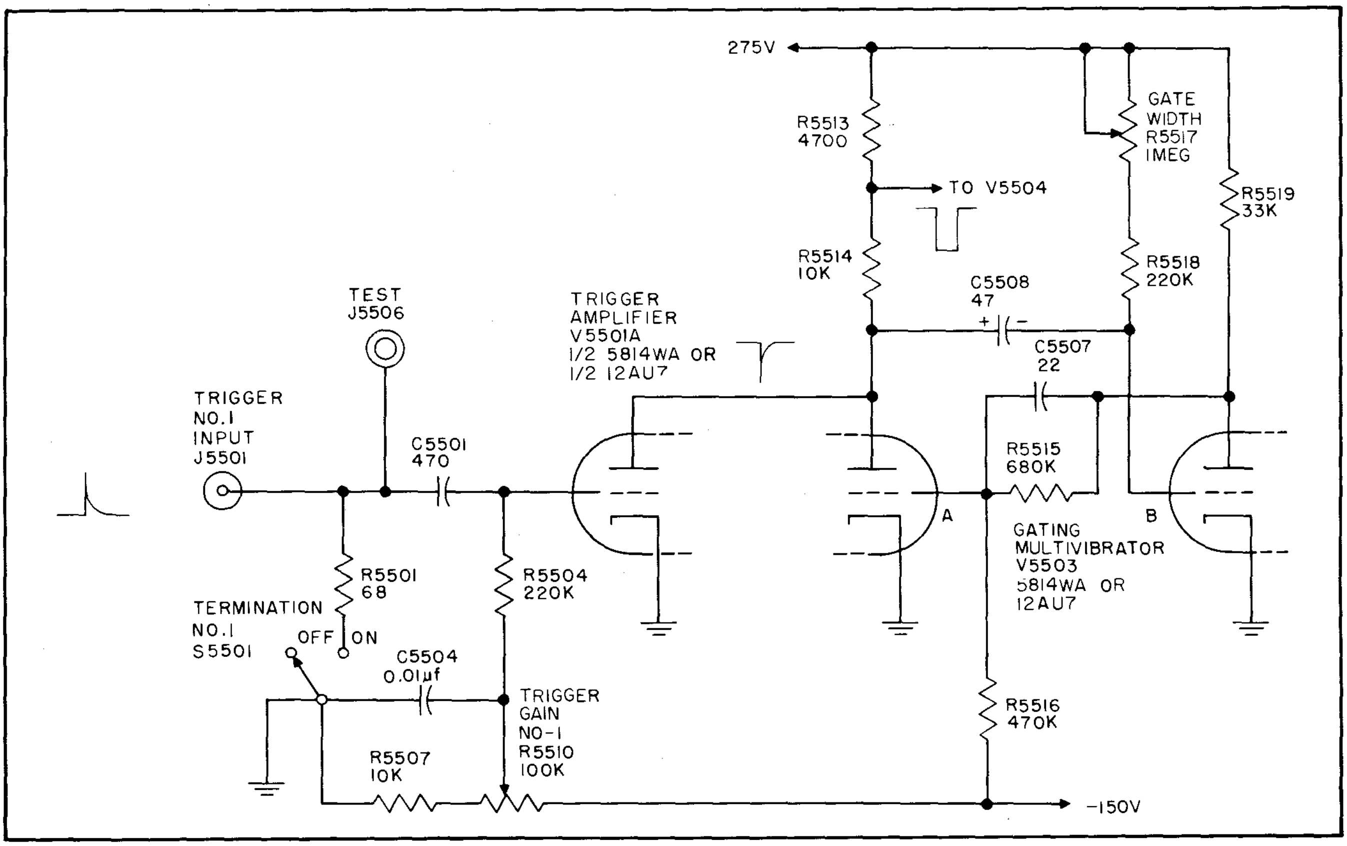


Figure 4–124. Trigger Amplifier and Gating Multivibrator, Interference Blanker, Simplified Schematic Diagram

and zero bias is maintained on this section. Section A is held at cutoff by the negative 150-volt supply. These quiescent conditions prevail until the next trigger input.

4–845. A negative output pulse is obtained at the plate of tube V5503A while this section conducts. Tube V5503B remains cut off during this interval. Resistor R5517 determines the discharge time of capacitor C5508 and therefore the length of time section B remains cut off. Resistor R5517 must be set so that the output pulse is slightly wider than the pulse transmitted by the interfering radar if all ground clutter is to be blanked.

4–846. MTI CATHODE FOLLOWER V5502B. A positive pulse, obtained at the plate of tube V5503B, can be applied to the associated MTI radar through cathode follower V5502B and jack J5512.

4–847. CONTROL STAGE V5504 AND BLANKING STAGE V5505. (See figure 4–125.) Without control stage V5504, the waveform at the plate of blanking tube V5505 would resemble that shown in figure 4–125. The residual gate would be produced when the gating pulse, in cutting off the blanking tube, raised its plate potential to the level of the plate supply voltage.

4–848. The control stage, V5504, prevents the formation of a residual gate. The screen of control tube V5504 and the plate of blanking tube V5505 are tied to the lower end of resistor R5526. The blanking pulse, applied to the suppressor grids of both tubes simultaneously, cuts off the plate current of blanking tube V5505 while increasing the screen current of control tube V5504. By adjusting potentiometer R5523, the increase in the screen current of control tube V5504 can be made exactly equal to the decrease in the plate current of blanking tube V5505. If potentiometer R5523 is adjusted properly, the voltage at the plate of blanking tube V5505 during blanking equals the operating plate potential of the stage while it conducts. The blanked output at the plate of blanking tube V5505 should resemble the waveform of figure 7–91.

4–849. VIDEO AMPLIFIER V5506A. (See figure 7–91.) Video amplifier V5506A contains 100-microhenry coil L5501 in the plate circuit to compensate for the degrading effects of interelectrode capacitance. With the 1-microsecond delay network switched into the circuit, the bandwidth should be wide enough to pass signals of from 60 cps to 2.5 megacycles.

4–850. CLAMPER V5506B AND OUTPUT CATHODE FOLLOWER V5507. A negative clamper, composed of the triode section of V5506B connected as a diode, clamps the lower portion of the video signal to the zero reference line. The output to the RHI assembly is obtained across the cathode of cathode follower

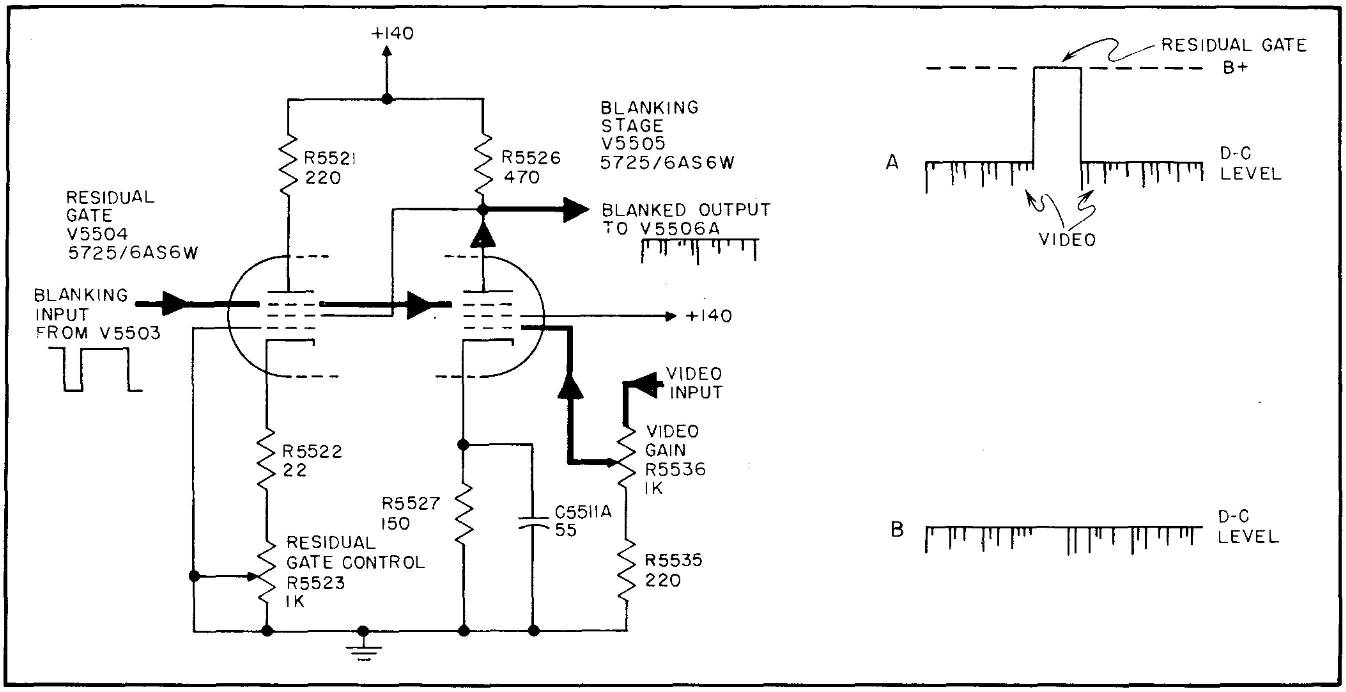


Figure 4–125. Effect of Eliminating Control Stage V5504, Interference Blanker, Simplified Schematic Diagram

V5507. When depressed, switch S5504 bypasses the interference blanker circuit and couples the video directly from the video channel to the RHI assembly. A sample of the video can be obtained at jack J5513 across the cathode of cathode follower V5507B.

4–851. REMOTE R-F CONTROL PANEL (CONTROL, RADAR SET C-992/FPS-6, C-2653/FPS-6A, AND C-2655/FPS-6B).

4–852. Figures 1–42 and 1–43 list the controls and indicators of the remote r-f control panel with a short statement concerning the function of each element. The circuit analysis of the remote r-f control panel is presented in paragraph 4–601.

4–853. ANTENNA CONTROL PANEL (CONTROL, ANTENNA C-991/FPS-6).

4–854. Figure 1–41 lists the controls and indicators of the antenna control panel with a short statement of the function of each element. A hunt-indicator circuit built into the panel is discussed in paragraph 4–895. The circuit analysis of the antenna control panel is given in paragraph 4–1706.

4–855. SERVO AMPLIFIER (AMPLIFIER CONTROL AM-646/FPS-6).

4–856. BLOCK DIAGRAM. (See figure 4–126.)

4–857. The servo amplifier is part of an amplidyne control system which positions the radar antenna in azimuth. The function of the servo amplifier is to supply two control field currents, F1-F3 and F2-F4, for the amplidyne generator. These currents vary in accordance with changes in the error signal obtained from the azimuth control overlay. When the error signal is zero, the two control currents must be equal. When the error signal calls for movement of the antenna in one direction, one control current must increase and the other must decrease. When the antenna is to move in the opposite direction, the unbalance in the control currents must be reversed.

4–858. PHASE DETECTOR. In the servo amplifier, the phase relation between the error signal and the selsyn reference voltage provides the necessary indication to distinguish between clockwise and counterclockwise rotation signals. Phase detector V6003 and V6004 converts the reference and order signals into a d-c voltage whose amplitude indicates the arc through which the antenna is required to rotate and whose polarity indicates the direction of rotation.

4–859. PUSH-PULL AMPLIFIER. The phase detector output is applied to phase inverter V6008, which produces outputs of equal amplitude but opposite phase. These outputs are applied to cathode followers V6009A and V6009B and then to power amplifiers V6010 and V6011. The control fields of the amplidyne generator are electrically located in the plate circuits of the power amplifiers. When the error signal is zero, equal currents flow through fields F1-F3 and F2-F4. At all other times, either one field or the other predominates and the antenna is driven accordingly.

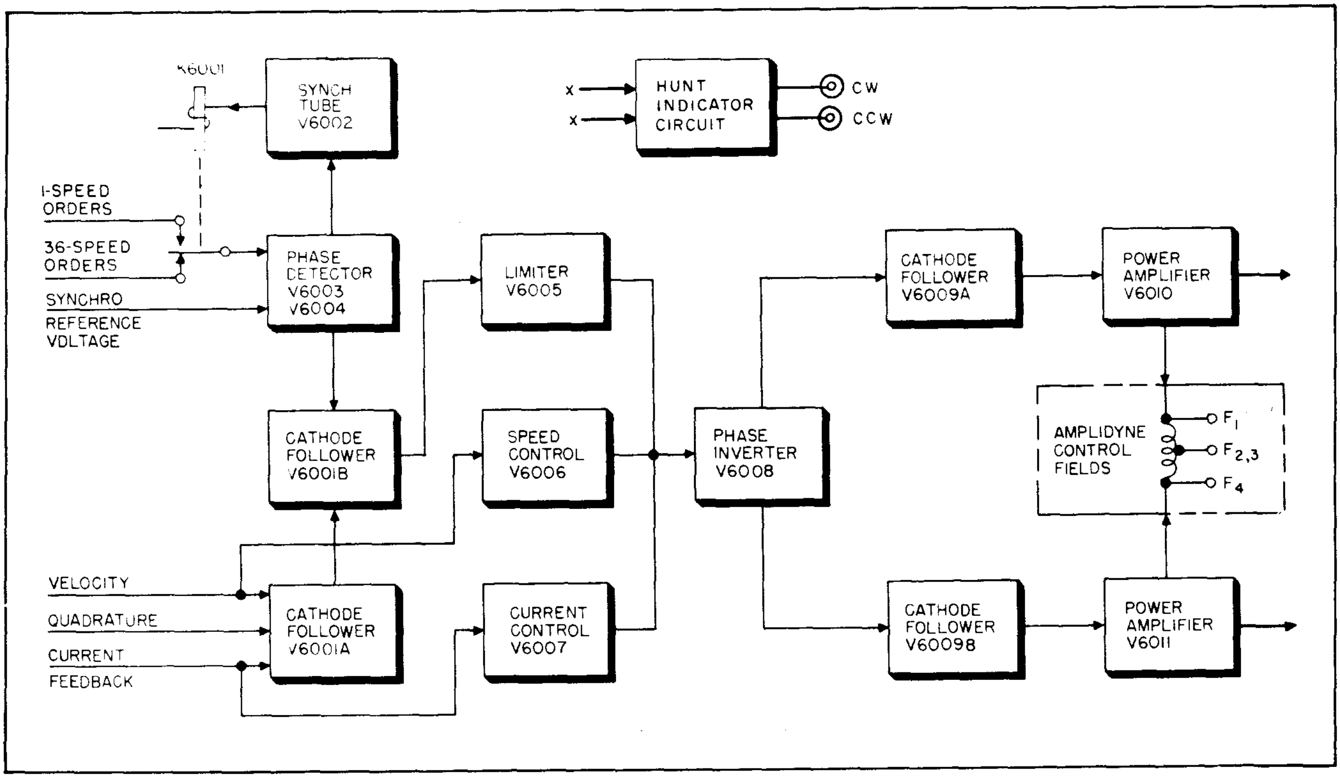


Figure 4–126. Servo Amplifier, Block Diagram

4–860. STABILIZATION. Speed current, and quadrature stabilizing voltages modify the effects of the error signal to prevent hunting. The stabilizing voltages are discussed in paragraph 4–166. The principal purpose of the speed and current stabilizing voltages is to prevent hunting. However, these two voltages also serve to limit the operation of the system to safe levels. Current control tube V6007 receives a current feedback signal and then functions to prevent the current drawn from the amplidyne generator from exceeding a certain value. Speed control tube V6006 receives an input from the velocity feedback line and then acts to prevent the antenna from rotating faster than a fixed speed. Limiter tube V6005 limits amplifier output voltages to safe operating levels.

4–861. HUNT INDICATOR CIRCUIT. When the antenna accelerates, either the amber AZIMUTH SERVO CW or the amber AZIMUTH SERVO CCW indicators (I6207 or I6208) on the antenna control panel lights, indicating the duration and direction of the acceleration. If this condition persists, as in hunting, time-delay relay K6207 opens the azimuth control power circuit, thereby causing the antenna to cease all motion in azimuth. Red LOCKOUT indicator I6206 lights and LOCKOUT buzzer sounds and will continue to do so until RESET SWITCH S6206 is operated, closing the azimuth control circuit. The azimuth drive machinery can then be started again by pressing the START button on the antenna control panel. A detailed circuit analysis of the hunt indicator circuit is presented in paragraph 4–895.

4–862. SYNCHRONIZING. The principal disadvantage of the 36-speed system is that the 36-speed selsyn rotates through electrical zero 36 times each time the antenna or the azimuth control overlay passes through 0 degree. As a result, it is possible that the azimuth control overlay and the antenna can be out of alinement by some multiple of 10 degrees (360/36). To prevent misalinement, the azimuth control overlay and antenna are first synchronized approximately with the 1-speed signal. Once approximate synchronization has been accomplished, the 1-speed signal is disconnected and the 36-speed orders picked up. If, at any time during operation of the antenna, the azimuth control overlay and antenna drop out of synchronization, current through the synchronization tube increases sufficiently to energize relay K6001. The 1-speed orders then replace the 36-speed orders until the system is again approximately alined and the 36-speed orders come into control.

4–863. PHASE DETECTOR CIRCUIT. (See figure 4–127.)

4–864. RECTIFIERS V6003 AND V6004. The phase detector is primarily a rectifier circuit in which two d-c voltages are produced. The relative magnitude of these voltages is controlled by the error signal, with one voltage being greater for a clockwise rotation signal and the other for counterclockwise rotation. One of these voltages is then subtracted from the other to provide a control voltage for the later stages in which the control field currents for the amplidyne generator are produced. Since the polarity of the control voltage depends upon which of the two original voltages is greater, the polarity provides a means of discriminating between clockwise and counterclockwise rotation signals in later stages. Operation of the phase detector is modified by auxiliary circuits used in synchronizing. Only the effect of the 36-speed error signal is considered in this discussion.

4–865. As shown in figure 4–127, the 36-speed error signal reaches the primary winding of transformer T6001 through the normally closed contacts of synchronizing relay K6001. Capacitor C6009 (across the primary of transformer T6001) removes sharp peaks from the error signal caused by sparking of the relay contacts. The end taps of the secondary windings of transformer T6001 are connected to the plates of rectifiers V6003 and V6004. The cathodes of these rectifiers are connected to the end taps of the secondary of transformer T6002, whose primary receives the 120-volt a-c reference voltage. The reference voltage determines which of the rectifier tubes will pass current during a given half cycle. Simultaneously, the error signal voltage determines which half of the firing tube will pass the greater current.

4–866. Plus and minus signs at transformer T6002 indicate the polarities for one half cycle. Since the cathodes of rectifier V6003 are connected to a negative transformer tap, the cathodes are negative with respect to the plates and rectifier V6003 therefore draws current. The cathodes of rectifier V6004 are connected to positive taps and rectifier V6004 therefore does not conduct, since the reference voltage is greater than any possible signal voltage. On the opposite half cycle, the conditions are reversed: rectifier V6004 draws current and rectifier V6003 does not conduct.

4–867. When the antenna is in correspondence with the 36-speed azimuth orders, there is no error signal voltage, and both plates of firing tube V6003 have the same potential. The two plates then draw equal current: the upper plate through resistor R6036 and the lower plate through resistor R6029. Since current flow is in the opposite direction in each resistor, the voltage drop in one cancels the voltage drop in the other, and the net voltage difference across resistors R6029 and R6036 is zero. This voltage difference constitutes the output of the phase detector, which is applied through filter resistors R6037 through R6042 across resistor R6045 and R6048 in the grid circuit of cathode follower V6001B. Thus, for a zero error signal, the output of the first stage is a zero voltage difference across resistors R6045 and R6048.

4–868. CLOCKWISE ROTATION SIGNAL. An error signal calling for clockwise rotation affects the polarity of the taps of transformer T6001, as indicated by the plus and minus signs for the half cycle in which rectifier V6003 is firing. (See figure 4–132 in paragraph 4–899.) Plus and minus signs at the taps of transformer T6002 show polarities for the same half cycle. The clockwise rotation signal changes the potential of the upper plate

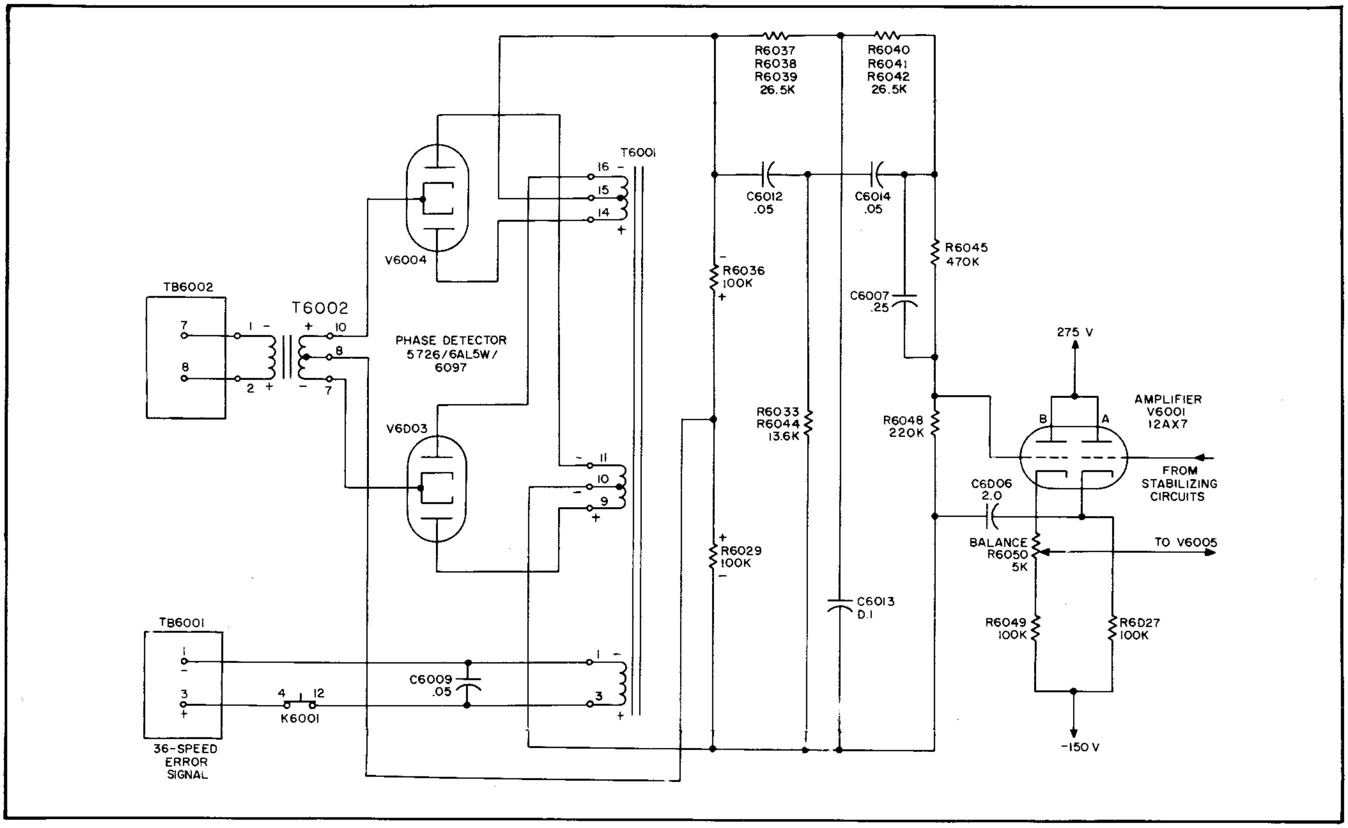


Figure 4–127. Phase Detector, Servo Amplifier, Simplified Schematic Diagram

of firing tube V6003 in a negative direction, and the tube therefore draws less current through resistor R6036. The lower plate voltage then changes in a positive direction, and current in resistor R6029 is increased. The voltage drop in resistor R6029 is then greater than in resistor R6036 and the upper end of resistor R6036 becomes positive with respect to the lower end of resistor R6029. The voltages across resistors R6045 and R6048 have the same polarity, thus, when a clockwise rotation signal occurs, the grid voltage of cathode follower V6001B changes in a positive direction.

4–869. For the second half cycle, all alternating current polarities in transformers T6001 and T6002 are reversed and rectifier V6004 becomes the firing tube. For a clockwise rotation signal, the upper plate of rectifier V6004, which is connected to a minus transformer tap, draws a light current through resistor R6036. The lower plate of the rectifier is connected to a plus tap and draws heavy current through resistor R6029. Thus, the result of a clockwise rotation signal is the same for both half cycles.

4–870. COUNTERCLOCKWISE ROTATION SIGNAL. For a counterclockwise error signal, the polarities in transformer T6001 are reversed from those shown in figure 4–127, while those in transformer T6002 remain the same. Since the changes in plate voltage have the opposite sense, the upper plate of rectifier V6003 on the half cycle shown in the figure draws heavy current through resistor R6036, while the lower plate draws less current through resistor R6029. On the second half cycle, the upper and lower plates of rectifier V6004 follow suit. The voltage drop in resistor R6036 is then greater than that in resistor R6029, and the upper end of resistor R6036 becomes negative with respect to the lower end of resistor R6029. The result of a counterclockwise rotation signal, then, is to change the grid voltage of cathode follower V6001B in a negative direction.

4–871. COUPLING TO CATHODE FOLLOWER V6001B. When the servo amplifier is under 1-speed control, the output of the first stage is a d-c voltage across resistors R6029 and R6036 applied across resistors R6047 and R6048 in the grid circuit of cathode follower V6001B. When the servo amplifier is under 36-speed control, the d-c output voltage is applied across resistors R6045 and R6048. Inserted between the two pairs of resistors is an RC filter, comprising resistors R6037 through R6042 and capacitors C6012, C6013, and C6014, which eliminates the 120-cps ripple from the output of rectifiers V6003 and V6004.

4–872. The grid circuit of cathode follower V6001B also includes resistor R6028, which is fed by resistor R6027 in the cathode of tube V6001A. Tube V6001A is a cathode follower, controlled by the stabilizing circuits (paragraph 4–879), which introduces stabilizing corrections through changes in current flow in resistor R6027.

4–873. Cathode follower V6001B performs the usual function of coupling two stages while permitting independent design of both. The output of tube V6001B is a d-c voltage across resistors R6049 and R6050 which is applied to phase inverter V6008 resistors through R6053, R6057, and R6070. This voltage varies with the phase-detector output impressed on the grid, changing in a positive direction for a clockwise rotation signal and in a negative direction for a counterclockwise rotation signal. Resistors R6053, R6057, and R6070 perform functions in the limiter circuits described in paragraph 4–884.

4–874. PUSH-PULL AMPLIFIER. (See figure 4–128.)

4–875. PHASE INVERTER V6008. The left side of phase inverter V6008 is connected as a conventional amplifier controlled by the output of cathode follower V6001B. The output of this side, taken from the plate, is applied to the grid of cathode follower V6009B through resistors R6081 and R6082. Since a clockwise rotation signal changes the voltage at the grid of phase inverter V6008A in a positive direction, it increases current flow through the plate, reduces the plate voltage, and results in a negative change of voltage at the grid of cathode follower V6009B. A counterclockwise rotation signal has the opposite effect.

4–876. The other half of phase inverter V6008 is connected as an amplifier with a grounded grid and a variable cathode voltage. Resistors R6060 and R6075 and potentiometer R6024 comprise a bleeder circuit. Since the two cathodes are connected together, the cathode potential in the right side depends upon current flow in the left side. An increase of current through inverter V6008A (clockwise rotation) changes the cathode potential in a positive direction. In the right side of tube V6008A, this change has the same effect as a negative change in grid voltage, and thus reduces the current through phase inverter V6008B. Similarly, a decrease in current through phase inverter V6008A (counterclockwise rotation) increases current through inverter V6008B. An output voltage is taken from inverter V6008B through grid resistors R6076 and R6077 and applied to the grid of tube V6009A. Since a clockwise rotation signal decreases current in inverter V6008B, it results in a change of voltage in a positive direction at the grid of tube V6009A. A counterclockwise rotation signal has the opposite effect.

4–877. POWER AMPLIFIERS V6010 AND V6011. Tubes V6010 and V6011 are connected as conventional push-pull amplifiers, with tube V6010 supplying current to the F1-F3 control field of the amplidyne and tube V6011 supplying current to the F2-F4 control field. As explained previously, a clockwise rotation signal changes the control grid voltage of amplifier V6010 in a negative direction and that of amplifier V6011 in a positive direction. The clockwise rotation signal thus results in light current for the F1-F3 field and heavy current for the F2-F4 field. A counterclockwise rotation signal has the opposite effect.

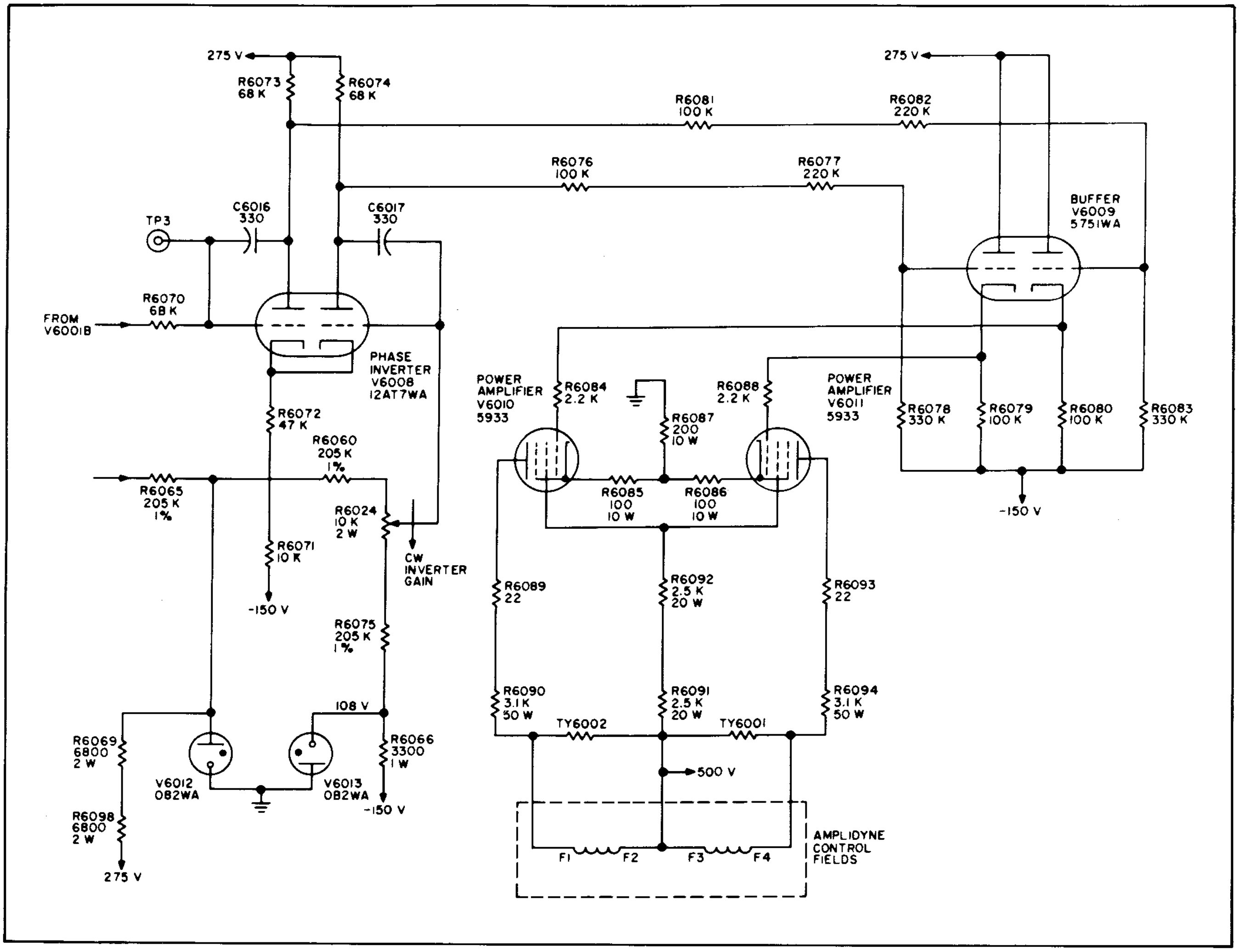


Figure 4–128. Push-pull Amplifier, Servo Amplier, Simplified Schematic Diagram

4–878. In the power stage, resistors R6089 and R6093 prevent parasitic oscillations in the outputs of amplifiers V6010 and V6011. Thyrite resistors TY6001 and TY6002 provide current paths in parallel with the amplidyne control fields. These resistors have the characteristic of a reduced resistance at high voltage, and therefore provide a certain amount of overload protection for the control fields as well as protection against undesirable transients. Screen grid voltage for amplifiers V6010 and V6011 is taken from a voltage divider composed of resistors R6091, R6092, and R6058.

4–879. STABILIZING AND LIMITING CIRCUITS.

4–880. STABILIZATION DURING 36-SPEED OPERATION. A fraction of each of the three stabilizing voltages is taken from the input voltage dividers, and the sum of these fractions applies a voltage through relay K6001 across a filter comprising capacitors C6004 and C6005 and resistors R6025 and R6026. The filter output is applied by cathode follower V6001A through filter capacitor C6006 and resistor R6028 to the phase detector. The voltage is only applied to the filter during 36-speed operation to prevent the capacitors from taking a charge during 1-speed control and thus causing high transients when the system switches to 36-speed control.

4–881. As long as the system is not hunting, the stabilizing voltage is a pulsating direct current and the filter blocks the flow of current in the stabilizing circuit. If the system is hunting, the polarity of the stabilizing voltage changes with each swing of the load. The voltage then becomes true alternating current, with the same frequency as the hunting. The RC phase lead network permits large feedback at the higher frequencies (at which the system is likely to oscillate), yet high gain (and high accuracy) at low or zero frequencies.

4–882. Plus and minus signs in figure 4–129 at the stabilizing tachometer, quadrature field, and compensating field indicate the polarities of the stabilizing inputs when the antenna is moving toward correspondence under the influence of a clockwise rotation error signal. For the purposes of explanation, it is assumed that the antenna has previously overshot the

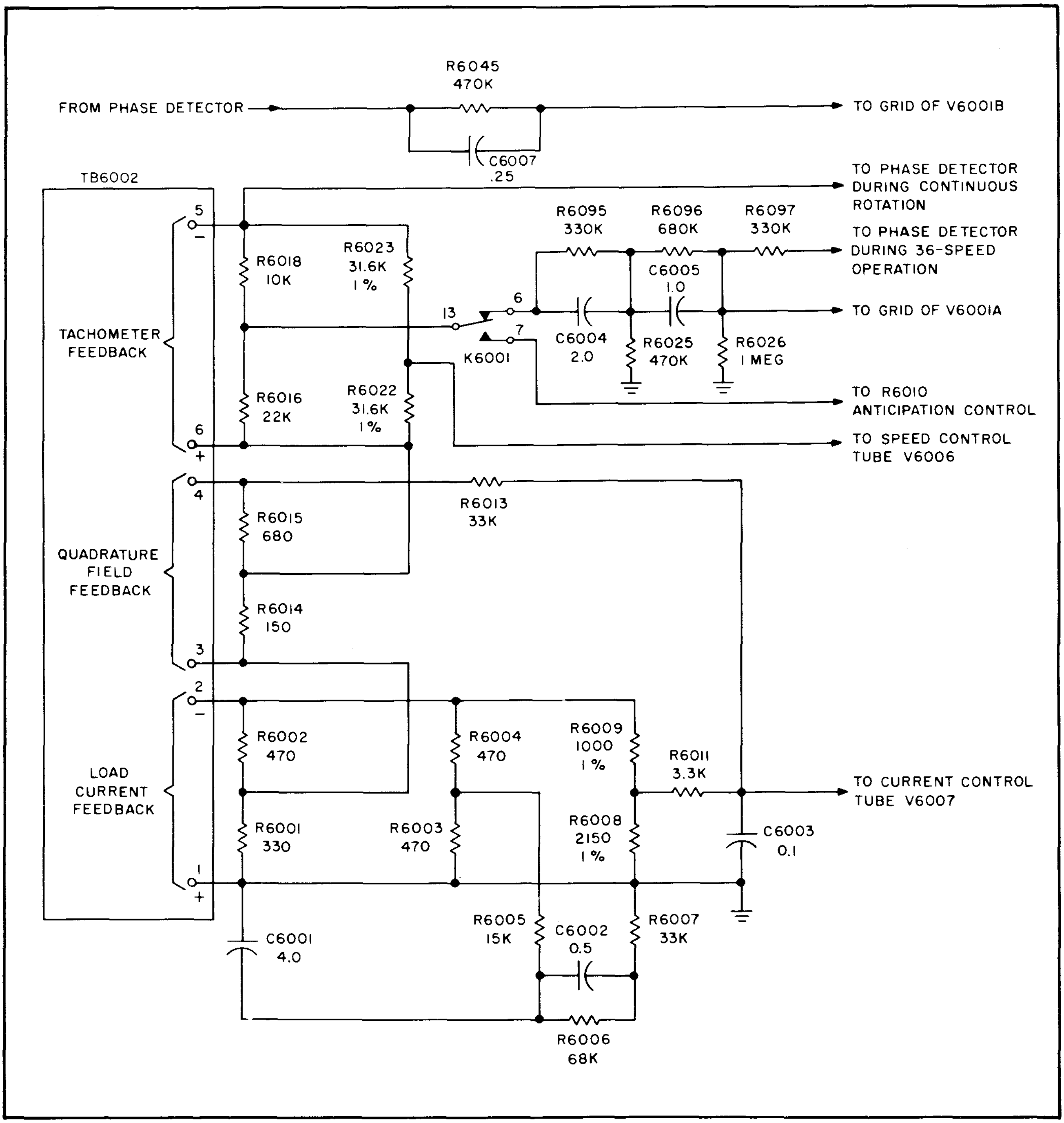


Figure 4-129. Stabilizing Network Inputs, Servo Amplifier (Continuous Rotation or 36-speed Operation), Simplified Schematic Diagram

correspondence point and is in the process of hunting. Consequently, the stabilizing voltage is alternating current of a frequency high enough to pass capacitors C6004 and C6005. Current then flows through the filter resistors. Since the grid of cathode follower V6001A is connected to the upper end of resistor R6026, the grid voltage changes in a negative direction as a result of the signal under discussion. This negative change of voltage is coupled to the grid of cathode follower V6001B and thus reduces the positive effect of the clockwise rotation error signal which is introduced into the same grid circuit by the output of tubes V6003 and V6004 (the phase detector). Since the effect of the stabilizing voltage is to reduce the effect of the error signal as the antenna approaches correspondence, it reduces the speed of travel and therefore shortens the next overswing.

4–883. When the antenna passes the correspondence point and starts to swing back under the influence of the counterclockwise rotation signal, the stabilizing voltage is reversed and its effect opposes that of the counterclockwise rotation signal. Thus, an opposing force is applied to the load in either direction of rotation, with the result that hunting is effectively stopped.

4–884. SIGNAL LIMITER CIRCUIT. (See figure 4–130.) Limiter tube V6005 prevents excessive error signals from reaching phase inverter V6008. This permits the use of high amplifier gain (great sensitivity to small inputs) and yet protects the azimuth drive system from the effects of unsafe inputs. Plate 2 and cathode 1 of limiter V6005 are connected to the line leading to the grid of phase inverter V6008A. For a zero error signal, this line is at zero potential with respect to ground. This potential increases for a clockwise rotation signal and decreases for counterclockwise rotation. Cathode 5 of limiter V6005 is connected to a point on a voltage divider composed of resistors R605 and R6052 which has a positive potential. Therefore, this side of the tube can fire only when there is a clockwise rotation signal sufficiently large (4 volts) to make the plate terminal greater than that of the cathode. When this occurs, limiter V6005 draws current through resistor R6053 from the cathode of cathode follower V6001B, and the resulting voltage drop in this resistor prevents any appreciable further increase in the voltage at plate 2.

4–885. On the other side of limiter V6005, plate 7 is connected to a point the same amount below ground that plate 2 is above ground. This side of the tube can fire only when there is a counterclockwise rotation signal sufficiently large (4 volts) to make cathode 1

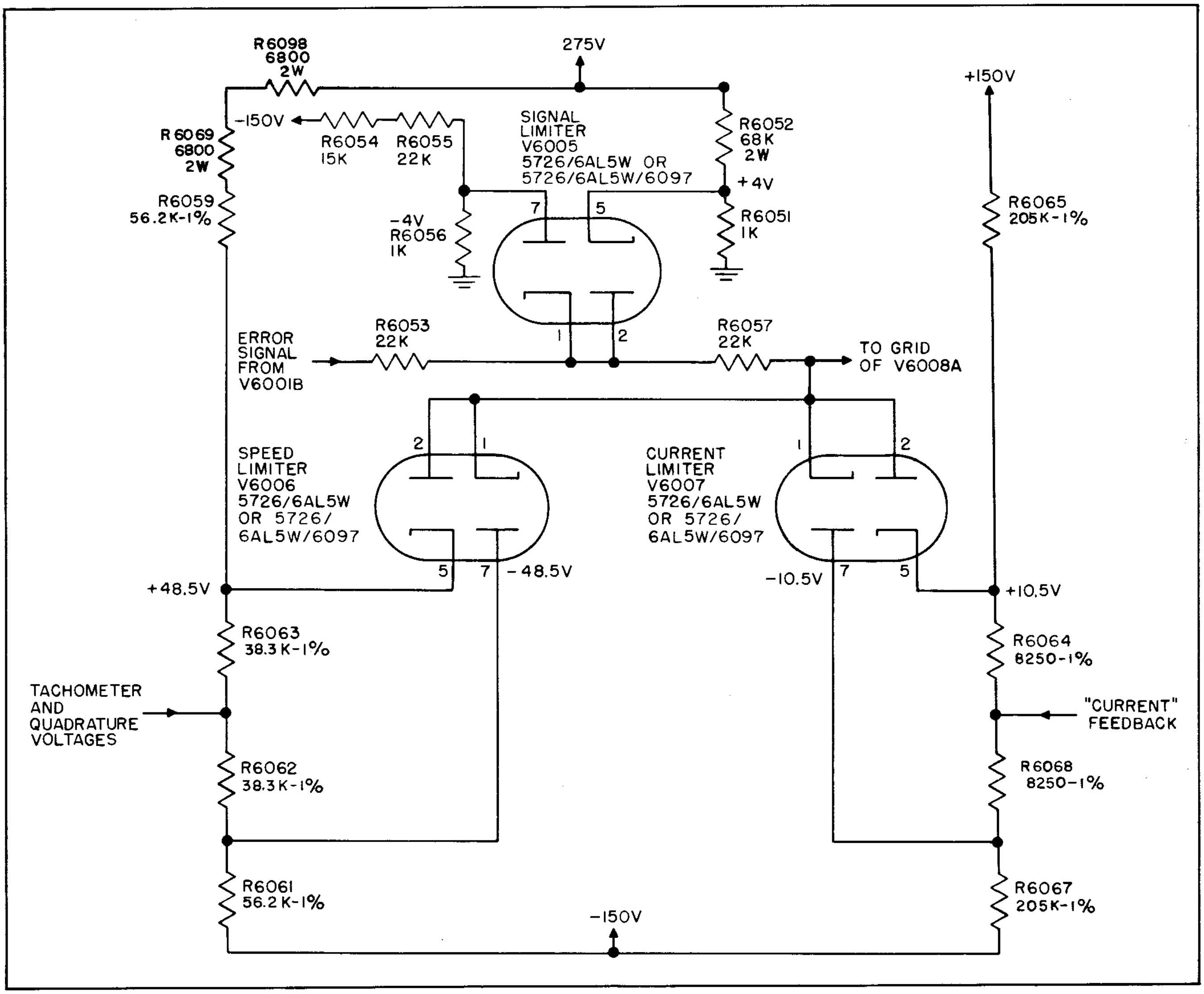


Figure 4–130. Current and Speed Limiting Circuits, Servo Amplifier, Simplified Schematic Diagram

negative with respect to the plate. When this occurs, current drawn by tube V6005 through resistor R6053 flows in the opposite direction and has the opposite effect to that drawn in clockwise rotation. The voltage at cathode 1 is thus prevented from going appreciably farther in the negative direction. Thus, tube V6005 sets a positive limit for clockwise rotation and a negative limit for counterclockwise rotation on the potential of the point between resistors R6053 and R6057 in the line leading to phase inverter V6008.

4–886. SPEED LIMITING CIRCUITS. (See figure 4–130.) Tube V6006 is the speed limiter. The condition of the speed limiting circuits with the antenna mount in the standstill condition is first considered. A voltage divider consisting of resistors R6059 and R6061 through R6063 is inserted across the regulated voltage supplied by gaseous regulators V6012 and V6013. An input from the stabilizing tachometer is applied to the voltage divider at a point between resistors R6062 and R6063.

4–887. Cathode 5 of speed limiter V6006 is tied to a point of relatively high positive potential on the voltage divider. Plate 2 of speed limiter V6006 is tied to the line to the grid of phase inverter V6008, which is at zero potential. For the standstill conditions just described, the cathode is positive with respect to the plate, and thus this section of the tube is cut off.

4–888. The other half of speed limiter V6006 is now considered. With the antenna mount at standstill, the point between resistors R6063 and R6062 has pratically ground potential. There is no voltage from the stabilizing tachometer and the voltages from the compensating field and the quadrature field are negligible. Plate 7 is tied to the junction of resistors R6061 and R6062, which is actually negative with respect to ground. Cathode 1 is tied to the line leading to the grid of phase inverter V6008, which is at zero potential. Plate 7 is then negative with respect to cathode 1 and no current can pass.

4–889. When the antenna rotates clockwise, the stabilizing tachometer introduces a negative voltage at the point between resistors R6062 and R6063. The potentials at all points in the voltage divider then shift in the negative direction. Since the tachometer voltage is proportional to antenna mount speed, the shift increases with an increase of speed. If the error signal calls for a speed greater than the desired limiting speed, the negative shift at the point between resistors R6059 and R6063 soon becomes sufficient to make cathode 5 of speed limiter V6006 negative with respect to plate 2. The tube then draws current through resistor R6057, and the resulting voltage drop in that resistor decreases the effect of the clockwise rotation signal on the grid of phase inverter V6008A. This limitation of the signal at phase inverter V6008A prevents the antenna from following at excessive speed.

4–890. The speed limit operation for counterclockwise rotation is similar in principle to that for clockwise rotation, but it occurs in response to signals of the opposite polarity. The stabilizing tachometer introduces a positive voltage into the voltage divider and thus shifts the potential at plate 7 of phase inverter V6006 in a positive direction. As the limiting speed is approached, plate 7 becomes positive with respect to cathode 1 and draws current through resistor R6057. Since resistor R6057 is now a cathode resistor, the current flow results in a positive change of potential at the grid of phase inverter V6008A to oppose the negative effect of the counterclockwise rotation signal and thus to limit further increase of speed.

4–891. CURRENT LIMITING CIRCUITS. (See figure 4–130.) Current flow between the amplidyne generator and the drive motor in response to a clockwise rotation signal causes a d-c voltage to appear across the compensating field windings. This voltage reaches terminals 1 and 2 of terminal board TB6002 at the input to the servo amplifier with the polarity shown by the signs in figure 4–129. A fraction of this voltage is combined with the voltage from the quadrature field. The combined output is applied to the junction of resistors R6064 and R6068. Resistors R6064, R6065, R6067, and R6068 form a voltage divider across the voltage-regulated supply provided by gas tube regulators V6012 and V6013.

4–892. For clockwise rotation, the voltage from the compensating field introduced at terminals 1 and 2 is negative with respect to ground and drives all points in the voltage divider in a negative direction. For counterclockwise rotation, this voltage has the opposite effect. The values of the resistors in the voltage divider are selected so that, with the system at rest, cathode 5 of current limiter V6007 is positive with respect to plate 2, and plate 7 of current limiter V6007 is negative with respect to cathode 1.

4–893. When the antenna mount is moving in the clockwise direction, the voltage from the compensating field drives cathode 5 of current limiter V6007 in a negative direction. At the same time, the clockwise error signal drives plate 2 in a positive direction. If the motor current exceeds the allowable limit, cathode 5 of current limiter V6007 becomes negative with respect to plate 2 and the left half of the tube draws current. When the tube passes current, the positive potential of plate 2 decreases and the positive effect of the error signal on the grid of phase inverter V6008A is diminished. The rate of acceleration of the antenna is then limited. Thus, current limiter V6007 limits motor current in the same manner that speed limiter 7 of current limiter V6007 becomes positive with respect to cathode 1 at the limiting value of motor current. Current drawn through this side of the tube then has a similar effect in limiting motor current.

4–894. Capacitor C6003 is used to remove a-c voltages of undesired frequencies from the current limit signal.

4-895. HUNT INDICATOR CIRCUIT. (See figure 4-131.)

4-896. When the antenna hunts, it swings back and forth through the null position and power amplifiers V6010 and V6011 alternately conduct larger and smaller amounts of currents, depending upon the amplitude and polarity of the control voltage. The voltages across the cathode resistors are directly proportional to the respective currents. Therefore, for a clockwise acceleration signal, the lighter current through amplifier V6010 produces a smaller voltage drop across resistor R6085 as compared to the voltage drop across resistor R6086 due to the heavier current through amplifier V6011. For a counterclockwise acceleration signal, this condition is reversed. The resulting potential difference between the cathodes of V6010 and V6011 varies at the hunting frequency, since the antenna is swinging back and forth about zero position. This variation signal is applied to a filter network composed of sensitivity control resistor R6203, current limiting resistor R6204, and capacitors C6202 and C6203.

4-897. The a-c signal caused by hunting activates polarized relay K6206. The polarity of this voltage changes with the input signal in the push-pull amplifier and determines the direction of current flow through polarized relay K6206. When a clockwise signal is applied, this relay closes contacts 4 and 5 and amber AZIMUTH SERVO CW indicator I6207 lights. When a counterclockwise signal is applied, relay K6206 closes contacts 6 and 7 and amber AZIMUTH SERVO CCW indicator I6208 lights. With either signal (clockwise or counterclockwise), 120 volts ac is applied to time-delay relay K6207 through contacts 3 and 8 of relay K6206. Resistor R6208 and capacitor C6204 protect the contacts of relay K6206. If hunting persists, relay K6207 closes contacts 5 and 7, activating relay K6208. Resistor R6203 is a sensitivity control and adjusts the interval between the beginning of hunting and lockout of the antenna.

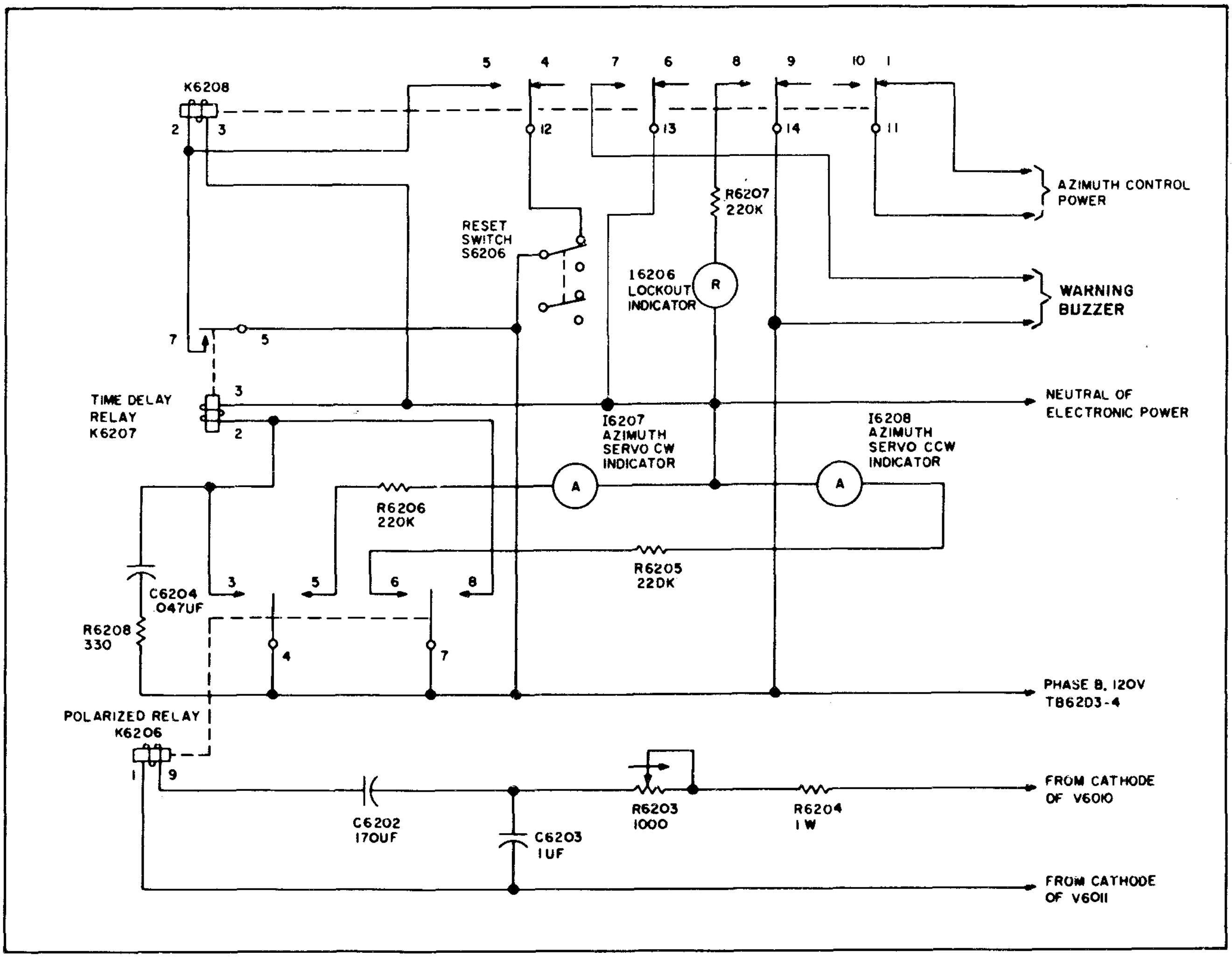


Figure 4-131. Hunt Indicator Circuit, Simplified Schematic Diagram

4–898. Relay K6208 closes contacts 5 and 12, which keeps the relay energized, and breaks contacts 1 and 11, which opens the azimuth control drive power circuit and removes antenna control power. This relay also closes contacts 8 and 14, 7 and 13. Contacts 8 and 4 cause the red LOCKOUT indicator to light, contacts 7 and 13 cause the LOCKOUT buzzer to sound. Prior to restarting antenna rotation, relay K6208 must be deenergized by means of RESET SWITCH S6206, thereby closing the azimuth control power circuit and switching off the LOCKOUT indicating devices. The antenna drive mechanism can then be started in the usual manner by depressing the START button on the antenna control panel. This cycle is repeated if the cause of hunting is not removed.

4–899. SYNCHRONIZING CIRCUITS.
(See figure 4–132.)

4–900. The synchronizing circuits operate when the antenna is more than about 2-1/2 degrees out of correspondence with the 1-speed azimuth order signals. At

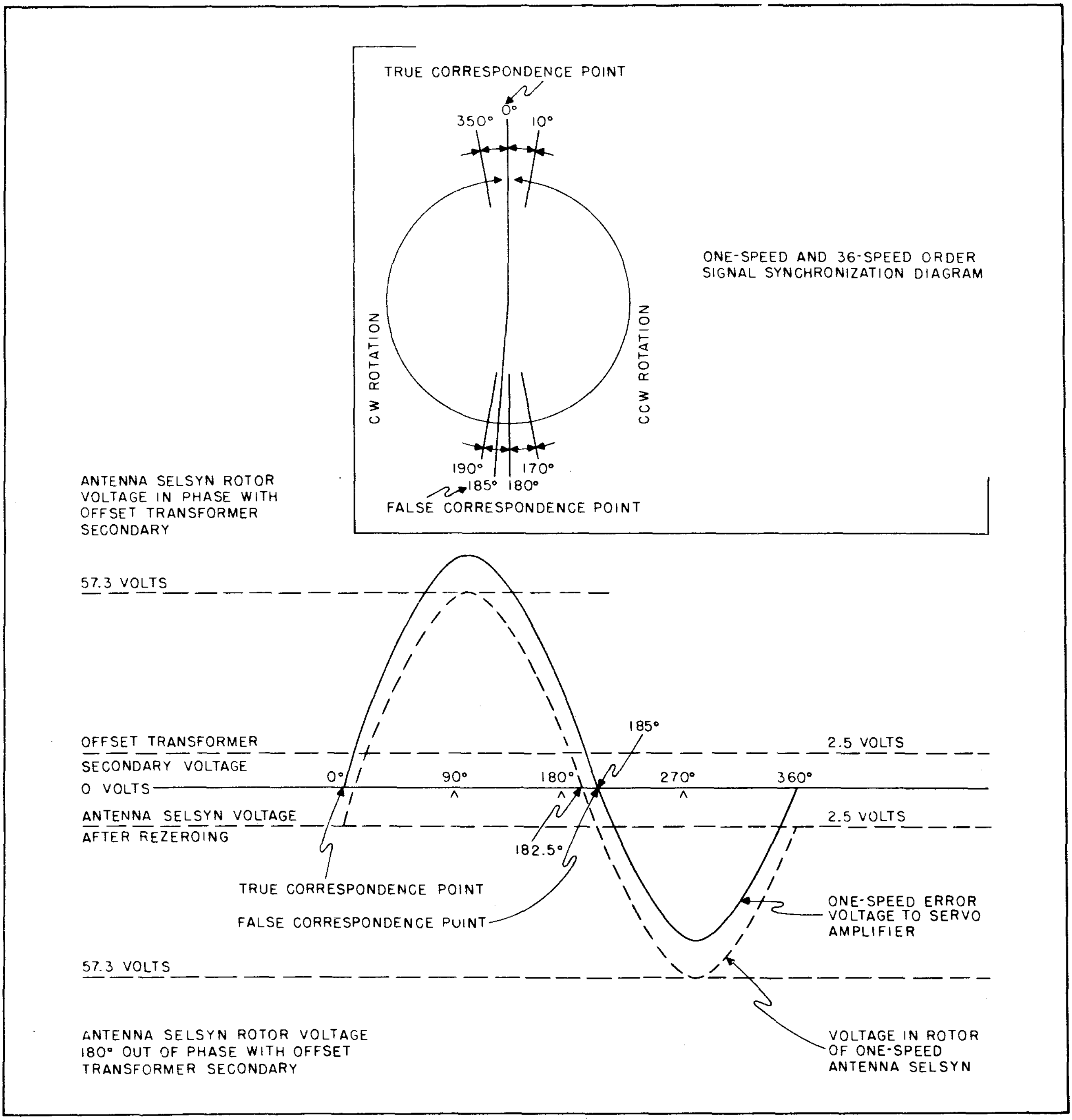


Figure 4–132. Modification of 1-speed Order Signal, Servo Amplifier

this point, the 1-speed error signal reaches such a magnitude that the synchronizing relay picks up and connects the 1-speed error signal in place of the 36-speed error signal in the servo amplifier circuits.

4–901. When the antenna is not at the position ordered by the 1-speed signal, an error signal is induced in the rotor windings of the selsyn in the azimuth control overlay or in the azimuth switch box. This error signal is applied to terminals 1 and 2 of terminal board TB6001 at the input to the servo amplifier.

4–902. The 1-speed error signal, however, cannot be used directly, since it has a false correspondence point 180 degrees from the true correspondence. At this point, the synchro rotor is at right angles to the magnetic field and the induced error signal voltage is zero, just as it is at true correspondence. For a small distance at each side of the false correspondence point, there is a dead space in which the 1-speed error signal is too weak to actuate the synchronizing relay. With the antenna mount in this dead space, the 36-speed signal would run it to the false correspondence point and hold it there.

4–903. To avoid this difficulty, the error signal is modified by a 2-1/2-volt stickoff voltage and the 1-speed antenna selsyn is zeroed in such a manner that the false correspondence point is shifted about 5 degrees. The result is shown in the insert diagram of figure 4–132 by the outer arrows. These arrows indicate the direction of movement called for by the modified 1-speed signal, and the small inner arrows indicate the same for the 36-speed signal. With the false correspondence point 185 degrees from true correspondence, the 36-speed signal runs the system out of the dead space (instead of centering it in the dead space), after which synchronizing relay K6001 switches over to 1-speed operation to bring the system into correspondence.

4–904. It should be noted that the 36-speed error signal also has a false correspondence point 180 degrees from the true correspondence point. But at 180 degrees, the 1-speed and stickoff voltages are in control. These voltages take the system out of false null and start it in the clockwise direction.

4–905. The 1-speed error signal is modified by adding to it a voltage from the secondary winding of offset transformer T6003. As shown in figure 4–133, the secondary winding of the offset transformer is inserted in series with the R1 lead of the 1-speed antenna selsyn. The a-c potential in the transformer secondary winding is equivalent to a signal calling for about 2-1/2 degrees of clockwise rotation. Consequently, in order that the error signal voltage at servo amplifier terminals TB6001-1 and TB6001-2 can drop to zero when the antenna is in correspondence with the 1-speed order signal, the stator of the 1-speed selsyn in either the azimuth control overlay or azimuth switch box must be shifted 2-1/2 degrees. The direction of shift must be such that an error signal voltage is induced in the rotor windings calling for 2-1/2 degrees of counterclockwise rotation.

4–906. Rezeroing the 1-speed selsyn shifts the false correspondence point about 5 degrees. The addition of the offset transformer voltage moved the false correspondence point 2-1/2 degrees, and the rezeroing of the 1-speed selsyn shifted it another 2-1/2 degrees in the same direction, making a total shift of 5 degrees. The voltage curves of figure 4–132 explain how this shift of the false correspondence point is accomplished. It should be noticed that the zero axis of the sine curve representing the error signal voltage at terminals 1 and 2 of terminal board TB6001 is shifted from the 0-volt line to the 2.5-volt line by the addition of the offset transformer secondary voltage. Consequently, the error signal voltage curve intersects the 0-volt line at two points separated by 5 degrees more than 180 degrees on the ascending half and by two points separated by 5 degrees less than 180 degrees on the descending half.

4–907. Resistor R6035 is inserted to shift the phase of the voltage on the secondary of offset transformer T6003 (figure 4–133). The phase shift is necessary to compensate for the phase shift occurring in the selsyn circuits, and thus insure that the voltage in the antenna selsyn rotor is either exactly in phase or exactly 180 degrees out of phase with the voltage in the secondary of the offset transformer.

4–908. As shown in figure 4–133, the 1-speed error signal is modified in the secondary winding of transformer T6003. The secondary of transformer T6003 controls the voltage at the grid of tube V6002A.

4–909. In the absence of an error signal, the grid and cathode of tube V6002A are both at ground potential and the tube draws a definite amount of plate current. An error signal, either clockwise or counterclockwise rotation, impresses an a-c voltage on the grid, raising the grid slightly above zero on alternate half cycles. During the positive half cycles, the grid collects electrons emitted by the cathode. The resistance of resistor R6030 is relatively large (470,000 ohms) and the grid-leak current is therefore relatively small after the first few cycles. As a result, an excess of electrons collects as a negative charge on the side of capacitor C6010 nearest the grid; this condition drives the average grid voltage in a negative direction. With the lower average grid voltage, the grid is positive with respect to the cathode during only a part of the positive half cycle, and thus collects fewer electrons. At the same time, the change in grid voltage increases the rate of electron flow through resistor R6030. The average grid voltage then becomes stabilized at a point at which the rate of electron flow through the resistor balances the rate at which electrons are collected by the grid. A large error signal results in a larger negative shift in grid voltage than a small one, but the shift is always in a negative direction for either clockwise or counterclockwise rotation signals.

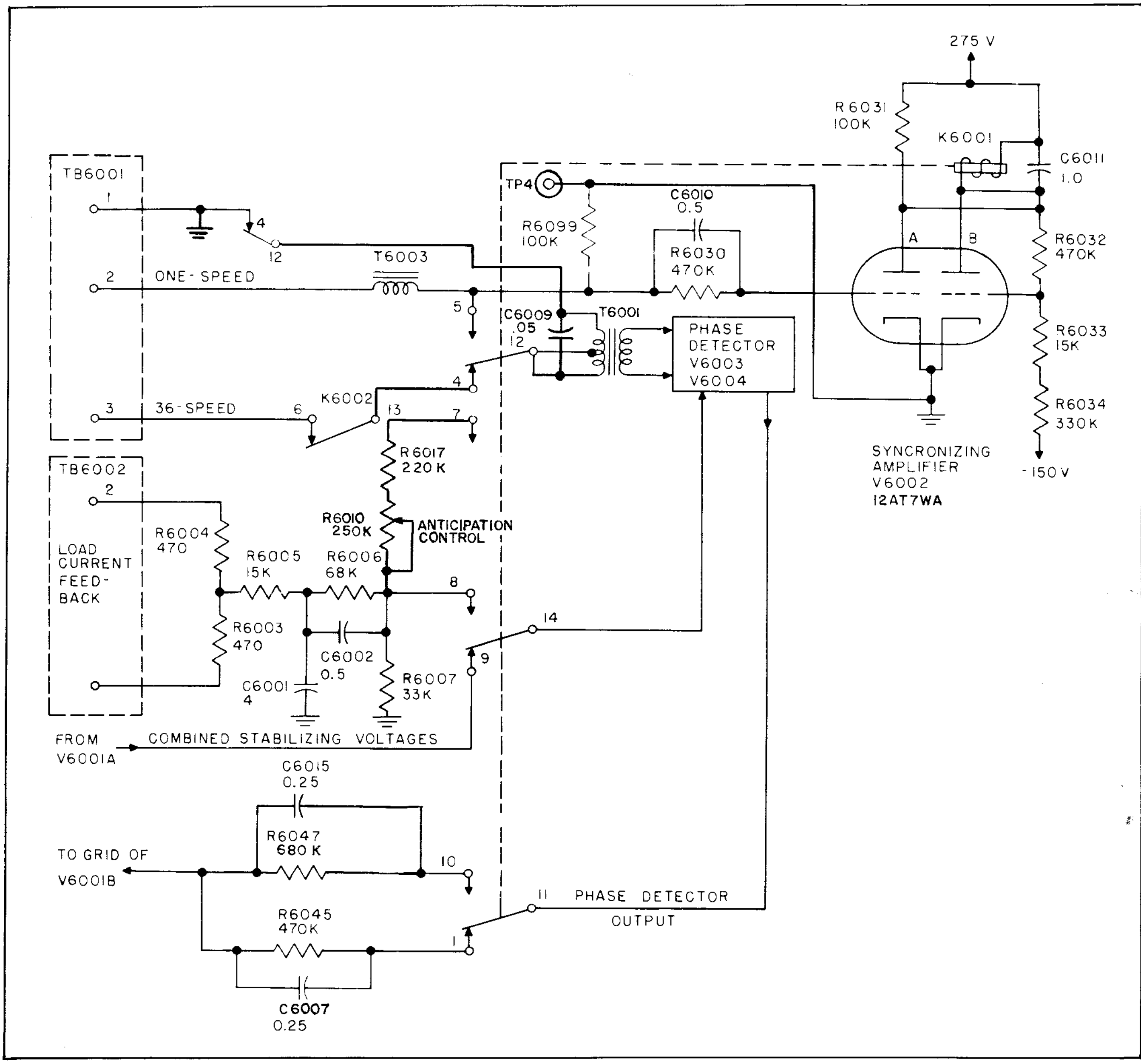


Figure 4–133. Synchronizing Circuits, Servo Amplifier, Simplified Schematic Diagram

4–910. Since the effect of the error signal on the grid voltage of tube V6002A is in a negative direction, it reduces the plate current in the tube and consequently the voltage drop across plate resistor R6031. Accordingly, the positive potential of the plate is increased. The plate of tube V6002A is connected through resistor R6032 to the grid of amplifier V6002B. Therefore, as the positive potential on the plate of tube V6002A increases, amplifier V6002B passes more current and increases current flow through the coil of synchronizing relay K6001. If the 1-speed error signal is strong enough, the increase in current flow actuates relay K6001. Capacitor C6011 is connected in parallel with the relay coil to prevent the relay from chattering during slight variations in the output of amplifier V6002B. Resistors R6032, R6033, and R6034 form a voltage divider to apply only a fraction of the output of tube V6002A as the signal to the grid of amplifier V6002B.

4–911. When synchronizing relay K6001 is actuated, contacts 4 and 12 are opened, while contacts 5 and 12 are closed. This has the effect of disconnecting the 36-speed error signal from the primary of transformer T6001 and applying the 1-speed error signal in its place. Consequently, the 1-speed error signal is introduced into the amplifier circuits and the antenna follows this signal until approximate correspondence is reached.

4–912. Again referring to figure 4–133, the 1-speed error signal applied to transformer T6003 becomes smaller as the antenna approaches correspondence. The charge on capacitor C6010 then leaks off faster than electrons are accumulated on the grid of tube V6002A, and the grid voltage shifts in a positive direction. This positive shift results in an increase in current in tube V6002A and a corresponding decrease in current in amplifier V6002B, which eventually releases relay K6001. Since less current is required to hold a relay than to pick it up, the antenna passes the 2-1/2-degree point before the relay opens. The 36-speed error signal assumes control once the relay opens and accurately positions the antenna.

4–913. STABILIZATION OF SYNCHRONIZING CIRCUITS. Since the synchronizing operation usually consists of a high-speed run to a fixed correspondence point, and since accuracy in following a 1-speed signal is not important in synchronizing, the stabilization requirements of the 1-speed system are different from those of the 36-speed system. Therefore, a separate stabilizing system is provided for the synchronizing operation. The change from one system to the other is brought about through the operation of relay K6001. Contacts 9 and 14 and contacts 13 and 6 are opened when relay K6001 is actuated, removing the normal effect of the tachometer voltage, compensating field voltage, and quadrature voltage used in stabilizing the 36-speed system. At the same time, contacts 8 and 14 and contacts 7 and 13 are closed and new stabilizing effects are introduced as described in the following paragraphs. When relay K6001 is actuated into 1-speed control, it also opens contacts 13 and 6 and closes contacts 13 and 7. This adds a portion of the tachometer feedback voltage to the current feedback voltage in the 1-speed loop. The amount of tachometer feedback is determined by the setting of resistor R6010. This is done so that the proper amount of anticipation or decelerating torque is applied to eliminate overshoot at correspondence.

4–914. A voltage proportional to the current drawn by the armature of the azimuth drive motor is tapped from the compensating fields of the amplidyne and drive motor and applied across resistors R6003 and R6004 as shown in figure 4–133. This is the same stabilizing voltage applied to resistors R6001 and R6002 in the 36-speed operation, but, since a different percentage is needed for 1-speed stabilization, separate voltage dividers are used. When relay K6001 is actuated, contacts 9 and 14 are opened and contacts 8 and 14 are connected. One-half of the stabilizing voltage is applied to the phase detector, opposing the error voltage.

4–915. Resistors R6005, R6006, and R6007 with capacitor C6002 from a network which acts as a frequency-selector circuit. This network has no effect on the high and low frequencies fed into the servo amplifier; it affects only the middle range of frequencies in which the servo system might become unstable. Using such a network to attenuate the unstable middle frequencies, makes possible high gain at low frequency (meaning high accuracy) and high gain at high frequency (meaning fast response time).

4–916. A further stabilizing effect in synchronizing is produced by the operation of contacts 1, 10, and 11 of relay K6001 in the grid circuit of cathode follower V6001B. It it desirable to build up the antenna speed quickly to 60 degrees per second to start the antenna toward correspondence, to reduce the speed as correspondence is approached, and to apply a reversing voltage to the antenna just before correspondence is reached. In this manner, the antenna gets underway promptly, but the number and amplitude of the overswings at correspondence is greatly reduced.

4–917. The operation of synchronizing relay K6001 transfers the phase detector output connection to cathode follower V6001B through resistor R6047, where only a fraction of the net output voltage of the phase detector is available. However, resistors R6047 and R6048 and capacitor C6015 form a lead network which puts out maximum voltage to start the antenna. As the antenna nears correspondence, the lead network produces a rapidly decreasing voltage to decelerate the antenna. A voltage of opposing polarity is produced by the lead network when the antenna swings into the correspondence point.

4–918. Capacitor C6015 has previously discharged through the resistor. At the moment relay K6001 picks up, there is a sudden inrush of current to charge capacitor C6015. This charging current, passing through resistor R6048 in the grid return of cathode follower V6001B, increases the voltage drop in that resistor so that momentarily the voltage at the grid of cathode follower V6001B is nearly equivalent to the full output voltage of the phase detector. Thus, practically the full effect of the 1-speed error signal is available to start the antenna toward correspondence. When capacitor C6015 becomes fully charged, the effect of the charging current is removed and only a fraction of the output voltage of the phase detector reaches the grid of cathode follower V6001B. This causes the antenna to begin to slow down approximately 30 degrees from correspondence.

4–919. As the antenna approaches correspondence, the error signal becomes progressively smaller and the voltage across capacitor C6015 and resistor R6048 is correspondingly decreased. The decreased voltage causes the capacitor to discharge. The resulting discharge current has the opposite effect to that of the original charging current and opposes the effect of the phase detector output. The voltage across the grid return resistor of cathode follower V6001B reaches zero before the error signal reaches zero and has the opposite polarity when the correspondence point is reached. In this manner, the effect of the error signal is cancelled and reversed just before the antenna arrives at the correspondence point.

4–920. ANTICIPATION CONTROL POTENTIOMETER R6010. (See figure 4–134.) An anticipation or decelerating torque is supplied by the limiting circuits in order to eliminate overshooting of the antenna at corresponce. Because of the higher velocity of the antenna in 1-speed operation, this opposing torque or limiting voltage must be larger in 1-speed operation than in 36-speed operation. Therefore, in 1-speed operation, a portion of the tachometer feedback voltage is added to the current feedback voltage to provide the proper amount of anticipation or decelerating torque. The setting of anticipation control potentiometer R6010 regulates the amount of tachometer feedback voltage applied to the 1-speed loop.

4–921. Anticipation control potentiometer R6010 should be so adjusted that a smooth transfer from 1-speed to 36-speed operation is effected in minimum transfer time. Potentiometer R6010 is preset at the factory and normally should not require any readjustment. If adjustment becomes necessary, however, it should only be performed after allowing the antenna to slew for about 30 minutes.

4–922. SPEED CONTROL. Speed control tube V6006 is essentially a limiter designed to conduct whenever the tachometer voltage reaches a predetermined level. Since the tachometer voltage is proportional to the speed of antenna rotation, this limiting voltage represents a certain speed of rotation. A voltage divider composed of resistors R6022 and R6023 feeds approximately two-thirds of the tachometer voltage to the speed control tube.

4–923. CURRENT CONTROL. Current control tube V6007 is essentially a limiter designed to conduct whenever the azimuth drive motor draws a certain amount of current from the amplidyne generator. Since this current is proportional to the loading of the antenna, the limiting value of current represents a certain load condition. A voltage divider composed of resistors R6008 and R6009 feeds approximately two-thirds of the current stabilizing voltage through resistor R6011 to the current control tube.

4–924. PHASE DETECTOR OUTPUT COMPENSATION. (See figure 4–133.) The antenna swings about sharply in response to the selsyn orders until it is synchronized with the azimuth control overlay. Two separate lead networks are provided to slow down the antenna as it approaches correspondence. The lead network for 36-speed operation consists of resistor R6045 and capacitor C6007. When relay K6001 is actuated to place the servo amplifier under 1-speed control, relay contacts 1 and 11 are open and contacts 10 and 11 are closed. The lead network for 1-speed operation, composed of resistor R6047 and capacitor C6015, then causes the antenna to slow down before reaching correspondence or the 36-speed switching point. This is necessary because the antenna has a high velocity as it approaches correspondence.

4–925. CONTINUOUS ROTATION. (See figure 4–135.)

4–926. GENERAL. The continuous rotation voltage is composed of a 120-volt a-c signal which is fed both to the phase detector of the servo amplifier and the solenoid of continuous rotation relay K6002. As long as the a-c signal is fed into the servo amplifier, a voltage is produced at the control fields of the amplidyne generator which causes the antenna to rotate at a constant 1/6 rpm. If a jumper is connected between pins 6 and 7 of terminal board TB6001, a top speed of 1/4 rpm is possible. In this respect, the continuous rotation voltage differs from the 36-speed error signal, which decreases to zero once the antenna has turned to the designated azimuth.

4–927. CONTINUOUS ROTATION RELAY K6002. The 120-volt signal is fed to the relay solenoid through terminals 4 and 5 of terminal board TB6001. Contacts 4 and 12 and contacts 6 and 13 are pulled apart by the energized solenoid, opening the 36-speed input lines. Simultaneously, contacts 10 and 11 close to apply the proper stabilizing input to the system. The continuous rotation a-c voltages are applied through terminals 4 and 5 of terminal board TB6001. Contacts 5 and 12 and contacts 7 and 13 close, completing a path from terminals 4 and 5 to the phase detector.

4–928. CONTINUOUS ROTATION VOLTAGE. The hot side of the 120-volt a-c signal which rotates the antenna continually in a clockwise direction is fed in at terminal 5 of terminal board TB6001, while the neutral line is brought to terminal 4. The signal is applied through contacts 5 and 12 of K6002 to the phase detector. The hot side of the counterclockwise rotation signal is fed in at terminal 4 of terminal board TB6001, while the neutral line is brought to terminal 5. The counterclockwise signal is applied to the phase detector through contacts 7 and 13 and contacts 5 and 12 of relay K6002. The 180-degree phase reversal takes place in the azimuth switch box, as explained in paragraph 4–1130. The phase detector compares the continuous rotation voltage against the reference voltage and a d-c voltage is produced at the output. The polarity of the d-c voltage indicates the desired direction of rotation and the amplitude of this voltage is sufficient to rotate the antenna at a fixed speed.

4–929. The operation of the push-pull amplifier is the same for continuous rotation as for normal operation.

4–930. STABILIZING INPUTS IN CONTINUOUS ROTATION. During normal operation, the stabilizing voltages are applied to the output of the phase detector through tube V6001A. However, during continuous rotation, the feedback signals are d-c voltages of relatively constant value. Capacitors C6004 and C6005 block this d-c voltage from tube V6001A; therefore, tube V6001A is bypassed during continuous rotation and the feedback voltages are added to the output of the phase detector directly through contacts 10 and 11 of relay K6002.

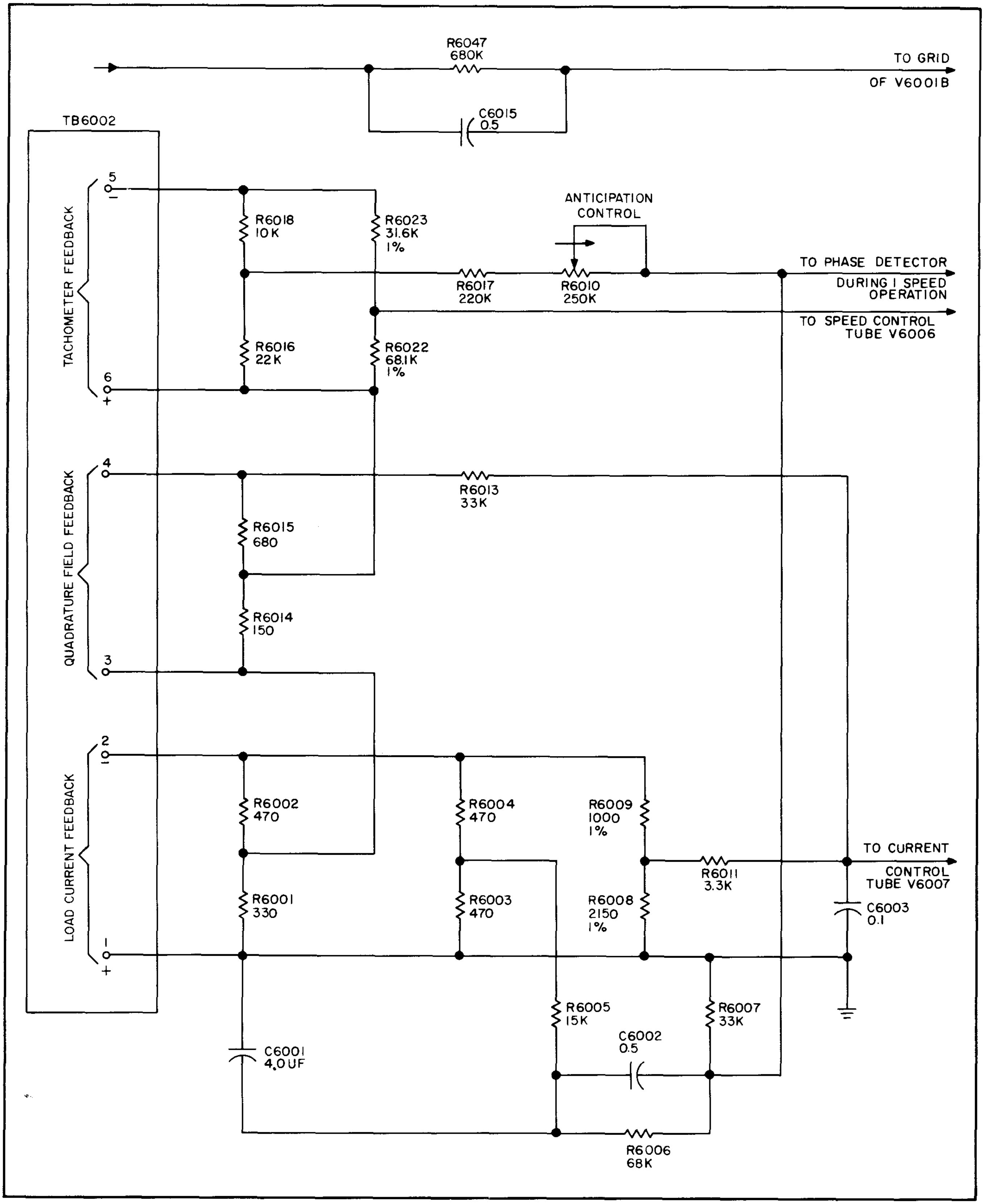


Figure 4–134. Stabilizing Network Inputs, Servo Amplifier (1-speed Operation), Simplified Schematic Diagram

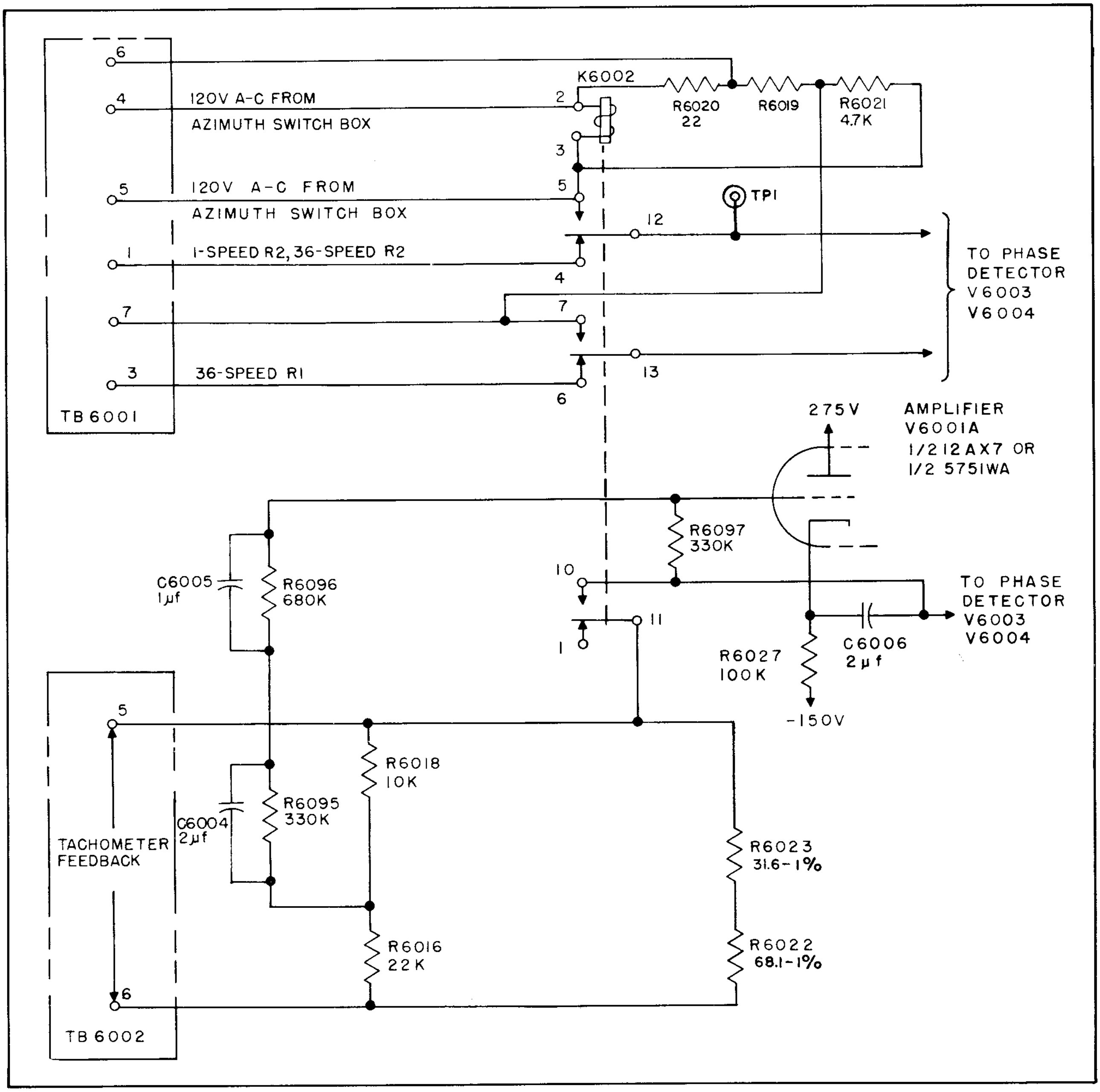


Figure 4–135. Continuous Rotation Circuit, Servo Amplifier, Simplified Schematic Diagram

During continuous rotation, the feedback voltages function to prevent variations in antenna speed caused by variations in wind loading. Since the antenna turns at a slower rate than during normal operation, a larger tachometer output is required for stabilization. For this reason, the entire tachometer output is used during continuous rotation.

4–931. CONTROL GROUP POWER SUPPLY (POWER SUPPLY PP-757/FPS-6).

4–932. BLOCK DIAGRAM. (See figure 4–136.)

4–933. This unit satisfies the power requirements of all the component chassis of the control group assembly. The control group power supply consists of two sections. One section contains the 28-volt d-c unregulated and the 6.3-volt a-c filament supplies, while the second contains the 500-volt d-c unregulated supply and the regulated 275-volt, 140-volt, and —150-volt d-c supplies. Suitable facilities are provided to fuse and meter the output lines.

4–934. SWITCHES AND INDICATORS. (See figure 4–137.)

4–935. POWER SWITCHES. Switch S5601, the main circuit breaker for the control group power supply, is wired in series with the hot side of the 120-volt a-c line. Green indicator I5622 lights when the a-c line is complete. This indicator is wired between the control group

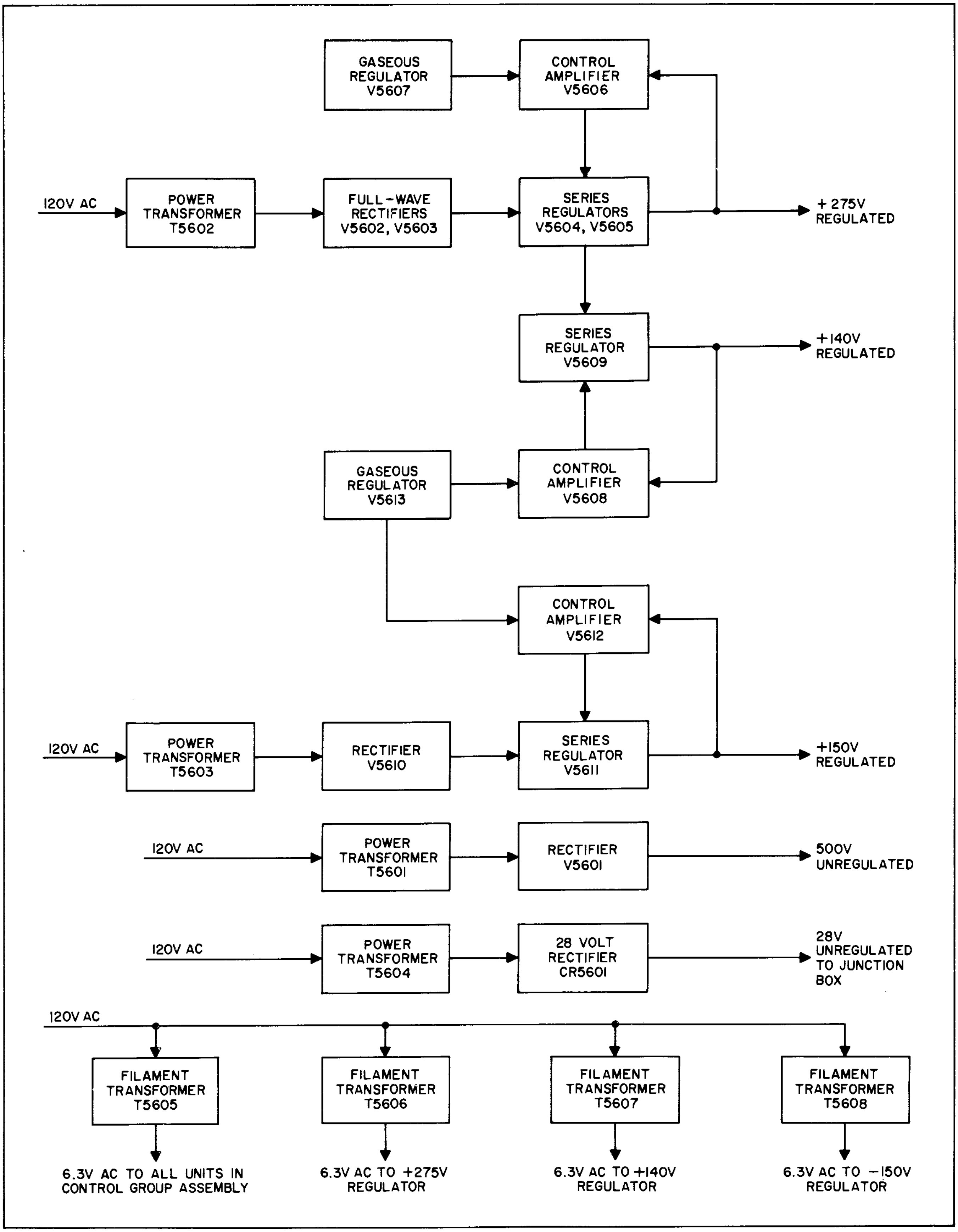


Figure 4–136. Control Group Power Supply, Block Diagram

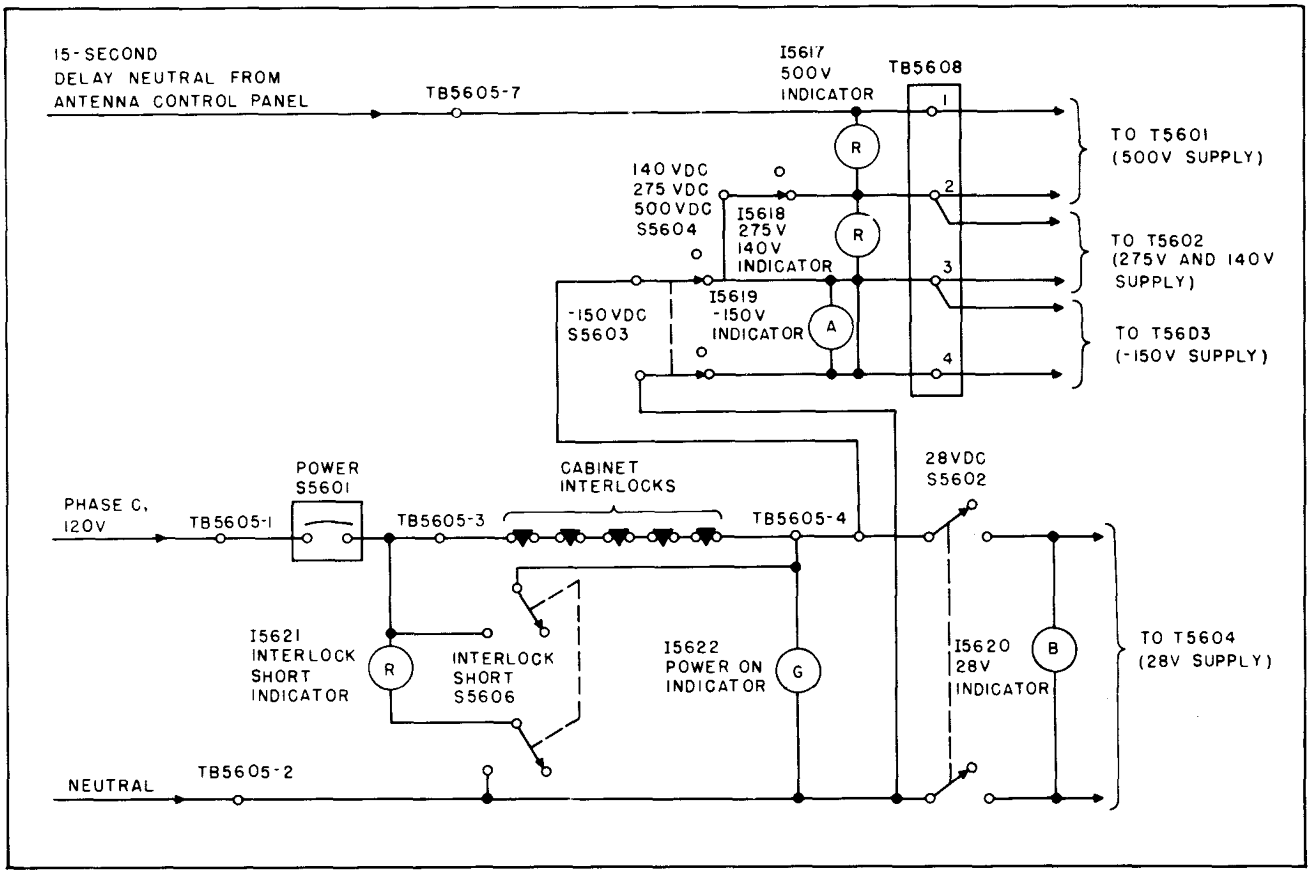


Figure 4–137. Switches and Indicators, Control Group Power Supply, Simplified Schematic Diagram

interlock line (terminal 4 of terminal board TB5605) and neutral.

4–936. Switch S5602 is in series with the primary of transformer T5604. Blue indicator I5620 lights to indicate that the 28-volt line is on. Switch S5603 turns on the —150-volt supply and is wired between the primary sides of transformer T5603. Amber indicator I5619 indicates that this supply has been energized. It should be noted that the 275- and 500-volt supplies cannot be energized unless the bias supply is energized, since current must flow through switch S5603 before reaching switch S5604. This protects the circuits against the excessive current drain that would occur in the absence of proper biasing. Switch S5604 turns on the 275-, 140-, and 500-volt supplies. Red indicator I5618 lights when the 275- and 140-volt supplies have been turned on. Another red indicator, I5617, lights when the unregulated 500-volt supply has been turned on.

4–937. Plate current is withheld from the servo amplifier until the filaments have warmed up. This is accomplished by a thermal relay in the antenna control panel. Once the thermal relay has closed, the neutral line to the 500-volt supply is completed and the servo amplifier can receive plate voltage.

4–938. INTERLOCKS. Interlocks turn off the power supply if any of the doors leading to the remote r-f control panel, the power supplies, the antenna control panel, or the generator-blanker assembly are opened. The interlocks can be shorted by closing switch S5606 when performing maintenance operations on the equipment. Indicator I5621 lights to indicate that the interlocks are shorted.

WARNING

Personnel are exposed to voltages dangerous to life when the interlocks are shorted. INTERLOCK SHORT switch S5606 should be closed only when it is necessary to perform maintenance operations on the equipment. Once the maintenance work has been completed, switch S5606 should be opened.

4–939. VOLTMETER. (See figure 7–95.) Voltmeter M5601 and rotary switch S5605 allow operating personnel to read the output voltages from the 275-, 140-, or —150-volt lines. When reading the positive voltage supplies, one side of the meter is grounded through switch S5605. The other side of the meter is grounded through the switch when reading the bias supply voltage.

4–940. POWER DISTRIBUTION PANEL (PANEL, POWER DISTRIBUTION SB-225/FPS-6).

4–941. POWER REQUIREMENTS.

4–942. GENERAL. Radar Set AN/FPS-6 requires 208-volt, 3-phase power at 60 cps. The power is supplied on a four-wire system. Each of three of the wires supplies one of the phases, while the fourth is the neutral. The three phases are 120 electrical degrees apart. A voltmeter placed across any two of the three phases would read 208 volts. A measurement taken between one of the phase lines and neutral would show 120 volts.

4–943. POWER INPUTS. The power is generated externally and fed into the control group cabinet at terminal board TB6901. Two three-phase supplies are used in most installations. One supply provides power for the electronic components of the radar, while the other provides power for the antenna drive system. The electronic power load of approximately 35 kilowatts maximum is fed into terminal board TB6901 on terminals ϕA, ϕB, and ϕC and the neutral ties into terminal NEP (neutral, electronic power). The phase rotation is ABC.

4–944. The antenna power load of approximately 10 kilowatts maximum is fed into terminal board TB6901 on terminals ϕD, ϕE, and ϕF and the neutral ties into terminal NAP (neutral, antenna power). The phase rotation is DEF. Two separate loads are used because of the heavy surges of current drawn by the antenna azimuth drive system at the start of rotation. However, a single, heavy-duty power source can be used in some installations.

4–945. GROUNDING. In general, if the neutrals are not grounded at the power source, they should be grounded at the control group cabinet. The antenna power neutral is grounded by running the ground strap from terminal NAP on terminal board TB6901 to terminal 3 of terminal board TB6906, while the electronic power neutral is grounded by running the ground strap from terminal NEP on terminal board TB6901 to terminal 4 on terminal board TB6906. If the grounds are not desired, then the ground straps should be doubled back on themselves and fastened to terminals NEP and NAP of terminal board TB6901.

4–946. CIRCUIT BREAKERS AND FUSES. (See figure 7–106.)

4–947. The magnetic circuit breakers have the external appearance of flush-mounted toggle switches of the type used to turn on the lights in a home. These circuit breakers are operated to the upper position to turn on the circuit. An internal electromagnet is energized by the circuit current. If the current increases to the overload point, the strength of the electromagnet becomes sufficient to pull the switch handle downward and to open the switch. The circuit breakers can be reset by operating the handles to the upper position. Unlike fuses, there is no element to replace.

4–948. As shown in figure 7–106, circuit breakers are provided for the main power lines, the antenna power lines, the output to the modulator high-voltage regulator, the modulator, transmitter-receiver group, the control group assembly, the RHI, and the junction box. Circuit breakers S6409 through S6412 are spares provided for future modifications.

4–949. Two cartridge fuses are provided. Fuse F6401 protects convenience outlet jacks J6401 and J6402. Fuse F6402 protects the line to the blower located in the control group assembly power supply.

4–950. INDICATORS. (See figure 7–106.)

4–951. All fuses and circuit breakers are provided with neon indicators which indicate whether the circuit is complete. Neon indicators I6401, I6402, and I6403, connected between the phase A, B, and C lines, respectively, and neutral, light to indicate that the circuit from terminal board TB6901 to the power source is complete. Neon indicator I6420, connected between the load side of main power circuit breaker S6401 and neutral, lights at all times unless the circuit breaker goes off.

4–952. Similarly, antenna power circuit breaker S6402 has a trio of indicators at the line side and a single indicator, I6417, at the load side. All the other circuit breakers have a single indicator, connected from one of their lines to the neutral, which lights unless the circuit has been interrupted.

4–953. The neon indicators which indicate blown fuses function in a slightly different fashion. These indicators remain off (they are shorted by the fuse) if the fuse is whole. If the fuse is ruptured, a fraction of the line voltage is applied to the neon indicator through a dropping resistor and the indicator then lights to indicate the open circuit. Indicator I6418 indicates the failure of fuse F6401, while indicator I6419 lights if fuse F6402 fails.

4–954. MOTOR-STARTER RELAYS K6901 AND K6902.

4–955. Motor-starter relays K6901 and K6902 are mounted on the wall behind the power distribution panel. Relay K6901, which controls the operation of the elevation drive motor, is described as part of the elevation drive and control system in paragraph 4–1737. Relay K6902, which controls the operation of the amplidyne drive motor, is part of the azimuth positioning servo system and is described in paragraph 4–1710.

4–956. The relays have separate actuating and overload coils. When the actuating circuit is closed, the magnetic field built up around the actuating coil becomes sufficient to close the relay contacts. When current through an overload coil becomes excessive, a pair of overload contacts open, breaking the actuating circuit.

4–957. The relays usually reset automatically after an overload, although provision is made for manual reset. A wire lever to the right of each of the red reset buttons determines whether the reset is automatic or manual. When the lever is in the upper notch, reset occurs automatically after 5 seconds. When the lever is set to the lower notch, the relay must be reset manually by pressing the red reset button after 1 minute.

4–958. GENERATOR-BLANKER PANEL (GENERATOR, PULSE TD-73/FPS-6 AND TD-243/FPS-6A).

4–959. The input lines for the generator-blanker panel are picked up from the line side of the main circuit breaker and the antenna power circuit breaker at the power distribution panel. Terminals 5 through 8 connect the generator-blanker panel to the phase A through C lines and the neutral electronic power (NEP). Terminals 1 through 4 connect the generator-blanker panel to the phase D through F lines and the antenna power neutral (NAP).

4–960. Switch S6301 is a rotary type which can connect to each of the six input phases in turn. Meter M6301 is a voltmeter calibrated from 0 to 150 volts. One terminal of meter M6301 is connected to the wiper arm of the A section of switch S6301, while the other is connected through the wiper arm of switch S6301B to one of the neutrals. Meter M6302 is a vibrating-reed type of frequency meter, calibrated from 55 to 65 cycles, which reads the frequency of the line while meter M6301 reads the voltage. A third meter, M6303, measures the amount of on-time of the main breaker, S6401, at the power distribution panel. Meter M6303 is connected from phase A to neutral.

4–961. AZIMUTH CONTROL OVERLAY (CONTROL, ANTENNA C-1050/FPS-6). (See figure 7–65.)

4–962. SERVO LOOP ELEMENTS.

4–963. SELSYN CONTROL TRANSFORMERS. Control transformers B3601 and B3602 are geared to the cursor ring gear, which is in turn geared to the handcrank (figure 4–138). Transformer B3601 is a 1-speed (coarse) selsyn, which means that it completes one revolution for each revolution made by the cursor. Transformer B3602 is a 36-speed (fine) selsyn which completes 36 revolutions for each revolution of the cursor. The two control transformers are electrically identical. These selsyns form a part of the two-speed antenna positioning servo system which is discussed in detail in paragraphs 4-161 through 4-177. A two-speed servo system is used because of its higher accuracy.

4–964. Figure 4–139 is a functional block diagram of the azimuth positioning servo system. The stator leads of the selsyns are marked S1, S2, and S3, and the rotor leads are marked R1, and R2.

4–965. The stators of the overlay control transformers are connected through the junction box to the stators of the antenna selsyn generators. The rotors of these generators are excited with 120 volts, 60 cps, which induces stator signals in the generator stators corresponding to the antenna position. These stator signals are sent to the control transformer stators of the overlay in control.

4–966. If the antenna position does not correspond to that of the cursor, the stator signals received from the antenna selsyns induce an error voltage in the overlay control transformer rotors. The error voltage is applied to the azimuth servo amplifier and the output of the amplifier drives the antenna to the cursor position. At this point, the error voltage from the control transformer becomes effectively zero and the antenna comes to rest.

4–967. FLYWHEEL. There is a flywheel geared to the cursor to smooth out its action. The flywheel is located adjacent to the control transformers.

4–968. CONTROLS AND INDICATORS.

4–969. PASS-ON-OFF SWITCH S3601. The time-sharing master control periodically assigns azimuth control to each overlay. If switch S3601 (figure 7–65) is in the ON position, the overlay receives and uses this control. If the switch is in the OFF position, the overlay receives this control but does not use it. If the switch is in the PASS position, the overlay does not receive control.

4–970. Switch S3601 accomplishes the functions outlined in paragraph 4–969 by controlling time-sharing relay circuits in the junction box. In the ON position, the switch completes the relay circuit through terminals N and P of receptacle J3601. In the OFF position, the switch interrupts this circuit. In the PASS position, the switch passes the relay signal through terminals L and M of receptacle J3601 and back through the junction box to the time-sharing master control. Control is then shifted to the next overlay in the time-sharing sequence.

4–971. CONTROL INDICATOR I3601. The control indicator lights when the time-sharing master control assigns azimuth control to the overlay and when the PASS-ON-OFF switch is in the ON position. This indicator (figure 7–65) is located at the upper left edge of the cursor window and is a red bullseye pilot indicator which receives 6.3 volts ac from terminals Q and S of receptacle J3601. Simultaneously, one of the four pilot indicators at each of the remote height displays lights, indicating which of the overlays is in control.

4–972. CURSOR ILLUMINATION. Indicators I3602 through I3606 are equally spaced about the perimeter of the lucite cursor window and provide edge-lighting to illuminate the etched cursor. DIMMER rheostat R3601, in series with these indicators, controls the intensity of this illumination. The indicators are supplied with

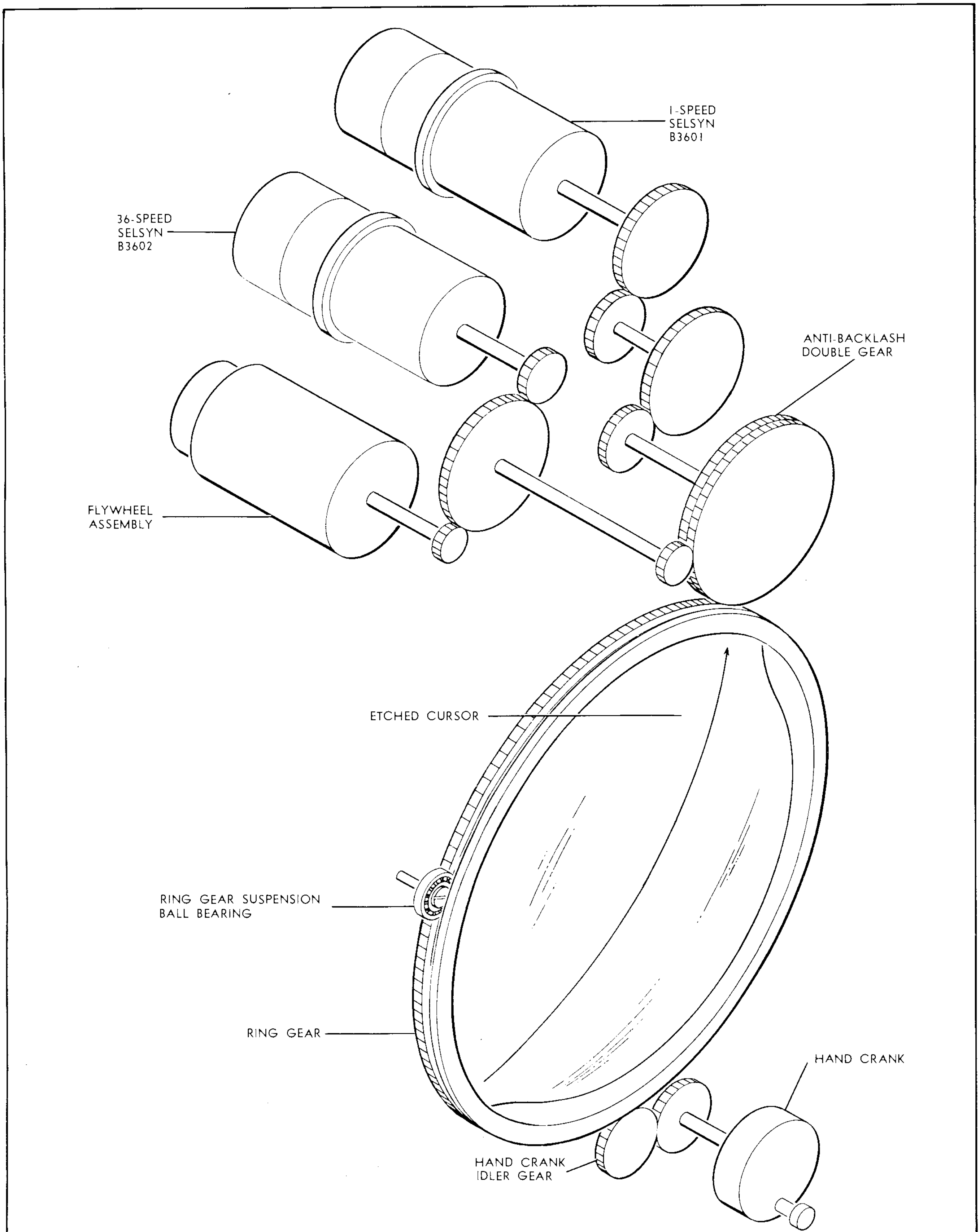


Figure 4–138. Azimuth Control Overlay, Mechanical Schematic Diagram

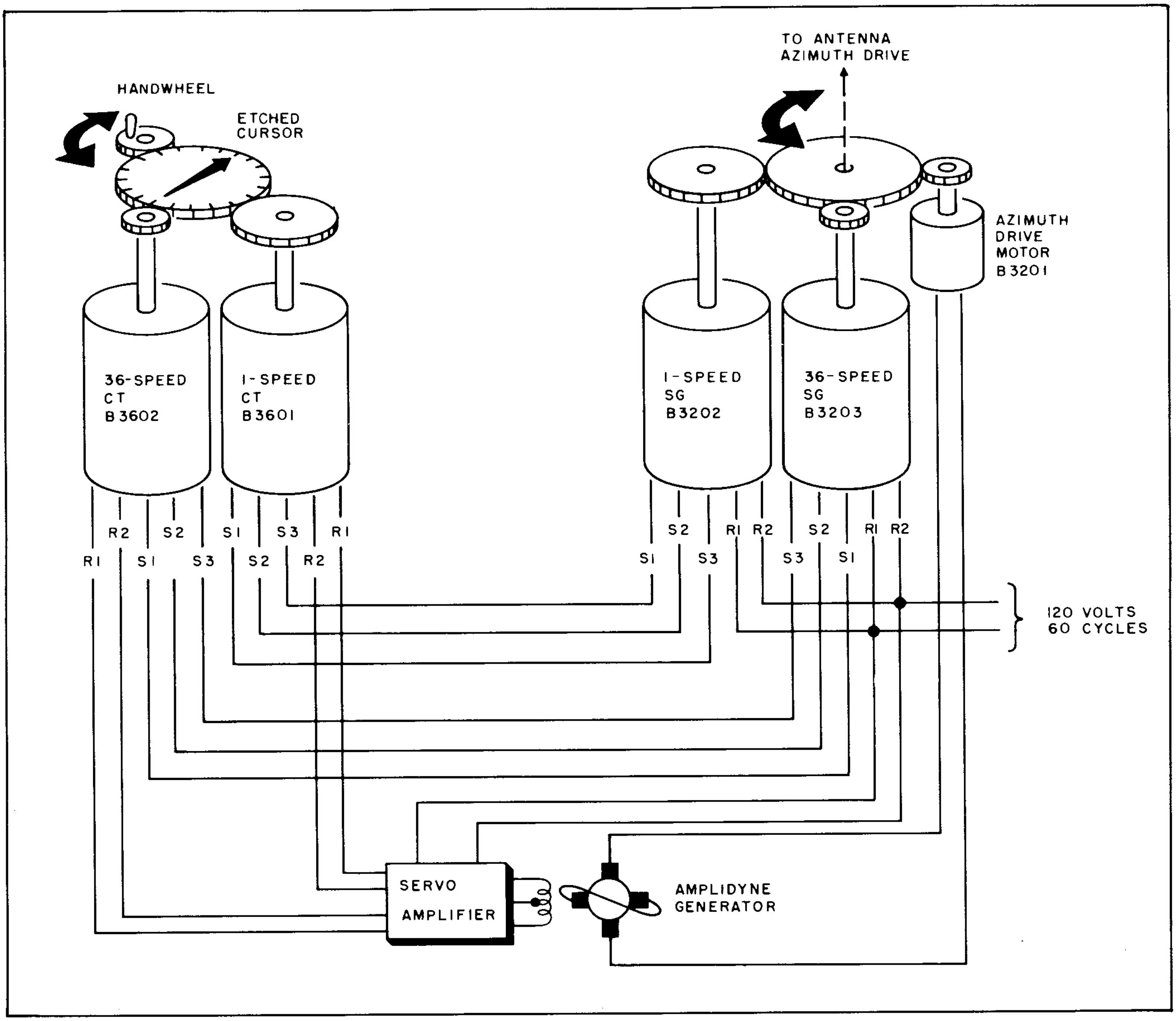


Figure 4–139. Azimuth Control Servo System, Block Diagram

6.3 volts ac through terminals Q and R of receptacle J3601. The DIMMER knob is located on the right-hand side of the selsyn housing.

4–973. HEIGHT DISPLAY (INDICATOR, HEIGHT ID-331/FPS-6).

4–974. BLOCK DIAGRAM. (See figure 4–140.)

4–975. ABSOLUTE HEIGHT. Absolute height of the target is displayed by a Veeder-Root counter located on the front panel of the remote height display (RHD). This counter is positioned by a handcrank on the RHI. The RHI operator sends both absolute and relative height signals to the RHD with this handcrank. The absolute height counter is positioned by a 2-speed servo system which responds to absolute height selsyn stator signals (figure 4–141).

4–976. RELATIVE HEIGHT. Relative height is displayed by a dial on the front panel of the RHD. The dial is positioned by a single selsyn follower which receives relative height selsyn stator signals from a selsyn generator in the RHI. This generator is geared to the RHI height handcrank when the crank is pushed in to transmit relative height.

4–977. RELATIVE HEIGHT BRAKE. When the RHI operator completes his relative height transmission, the operator releases his handcrank. A series of relaying operations applies electromagnetic brake E3701 to the relative height dial, locking the dial until the next transmission or until clearing by switch S3701. The relay sequence is outlined in paragraph 4–1019.

4–978. CONTROL INDICATORS. There are four pilot indicators on the front panel of the RHD. Each

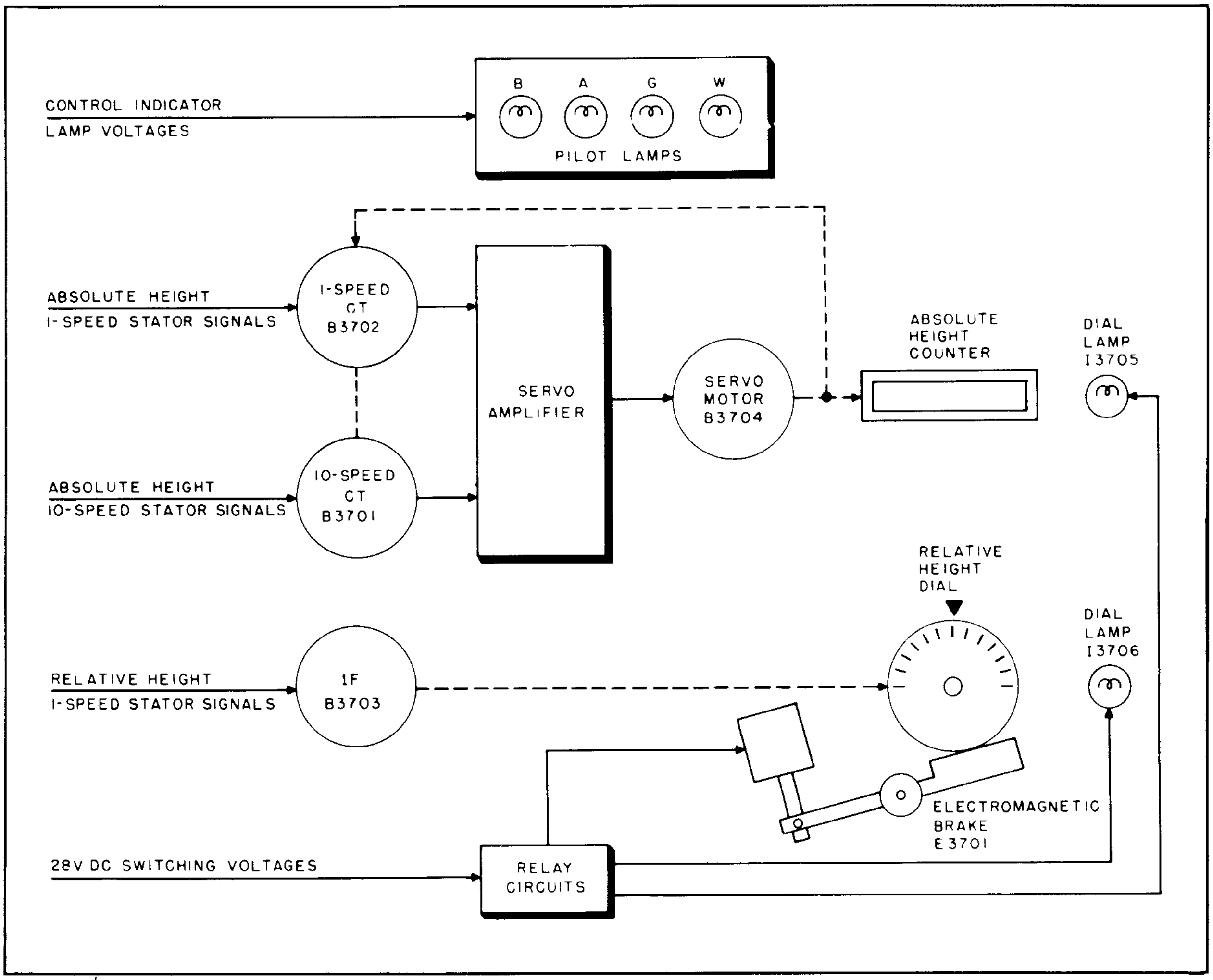


Figure 4–140. Remote Height Display, Block Diagram

indicator represents one of the four PPI positions and, when lighted, each indicates when its respective PPI position has azimuth control of the height-finding radar antenna by means of its overlay. These indicators are supplied with 6.3 volts ac at the proper time by relays in the time-sharing master control. The operation of these relays is covered in paragraph 4–1019.

4–979. ABSOLUTE HEIGHT SERVO CIRCUIT. (See figure 4–142.)

4–980. GENERAL. The absolute height servo consists of control transformers B3701 and B3702, servo motor B3704, and a Veeder-Root counter. The control transformer rotors are geared to the motor and counter. RHI selsyn generator voltages, representing target height, are applied to the control transformer stators. Error voltages, induced in the control transformer rotors, are fed to the servo amplifier. The output of the servo amplifier is applied to the control field of motor B3704, which drives the absolute height counter and the control transformer rotors. When the rotor positions correspond to the positions of the RHI generator rotors, the error voltages fall to zero and the system comes to rest.

4–981. ADVANTAGES OF 2-SPEED SERVO. Greater positioning accuracy is available from a 2-speed system than from a 1-speed system. A 2-speed system contains two control transformers instead of one. The control transformers are fed selsyn stator signals from two selsyn generators and are geared to each other so that one completes several revolutions while the other completes one revolution (figure 4–141). The RHD utilizes a 1- and 10-speed system. The 1-speed control transformer completes one revolution while the 10-speed control transformer completes 10 revolutions.

4–982. Assume there is an error in the position of the absolute height counter sufficient to displace the 1-

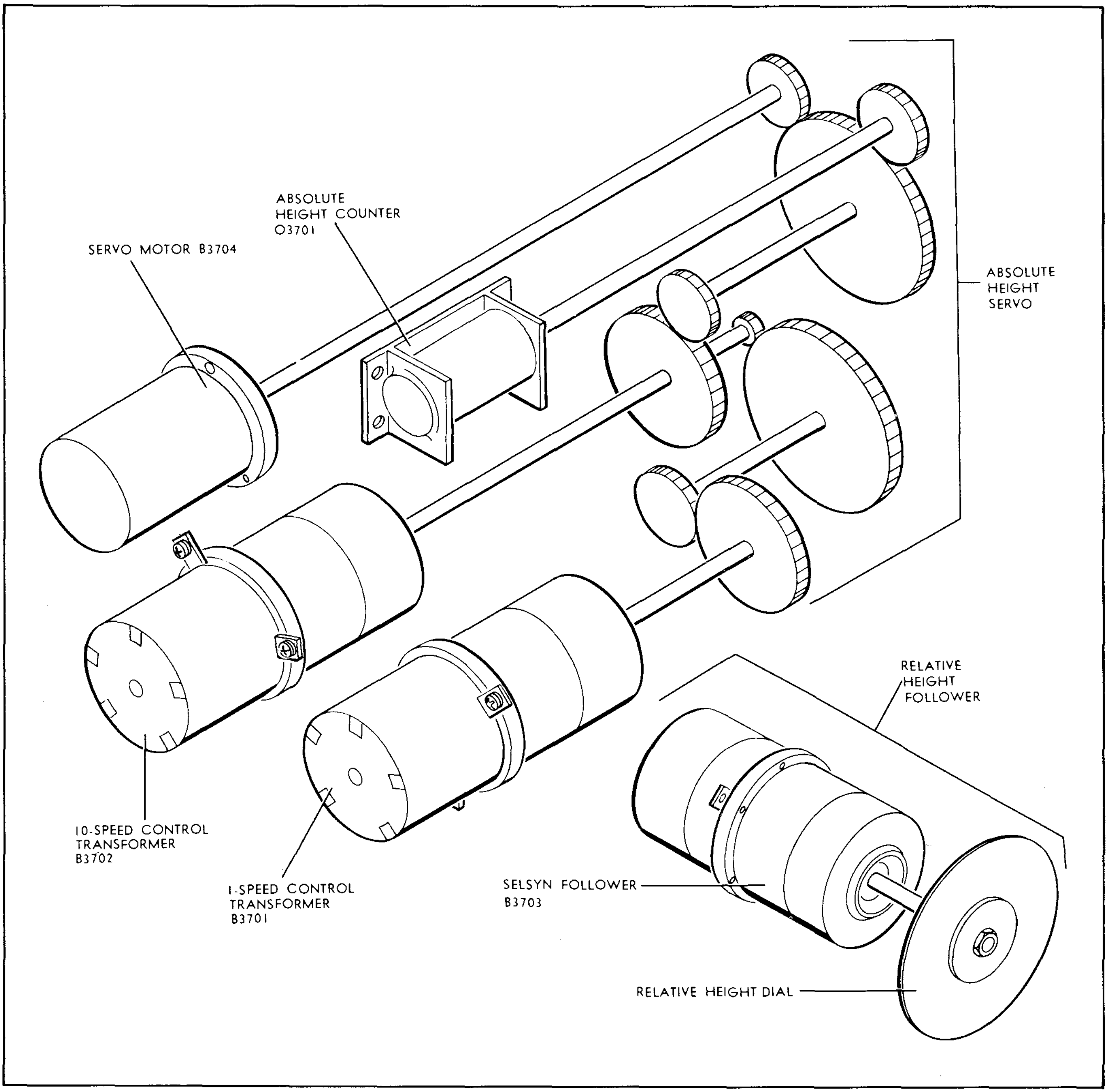


Figure 4–141. Remote Height Display, Mechanical Schematic Diagram

speed control transformer 1/2 degree from its null position. This is a rather small displacement and the error produced in the rotor is relatively small. In fact, it may not be sufficient to cause the servo amplifier to correct the position error. If this were the case, a 1-speed servo system could allow a 1/2 degree error.

4–983. In a 1- and 10-speed system, however, the 10-speed control transformer would be displaced 10 times one-half, or 5 degrees from its null. The control transformer error voltage at this position is considerable and drives the amplifier to correct the counter position. If the 10-speed control transformer is then 1/2 degree in error, the 1-speed control transformer is in error by only 1/20 of a degree and the error in the counter is reduced proportionately.

4–984. It would appear that the error in a 1- and 10-speed system would be reduced by a factor of 1/10. This is not actually the case, however, since it is necessary to reduce the error voltage from the 10-speed control transformer to 1/3 of its normal value, as explained in paragraph 4–990. The reduction in high-speed error signal means that the servo position error is actually

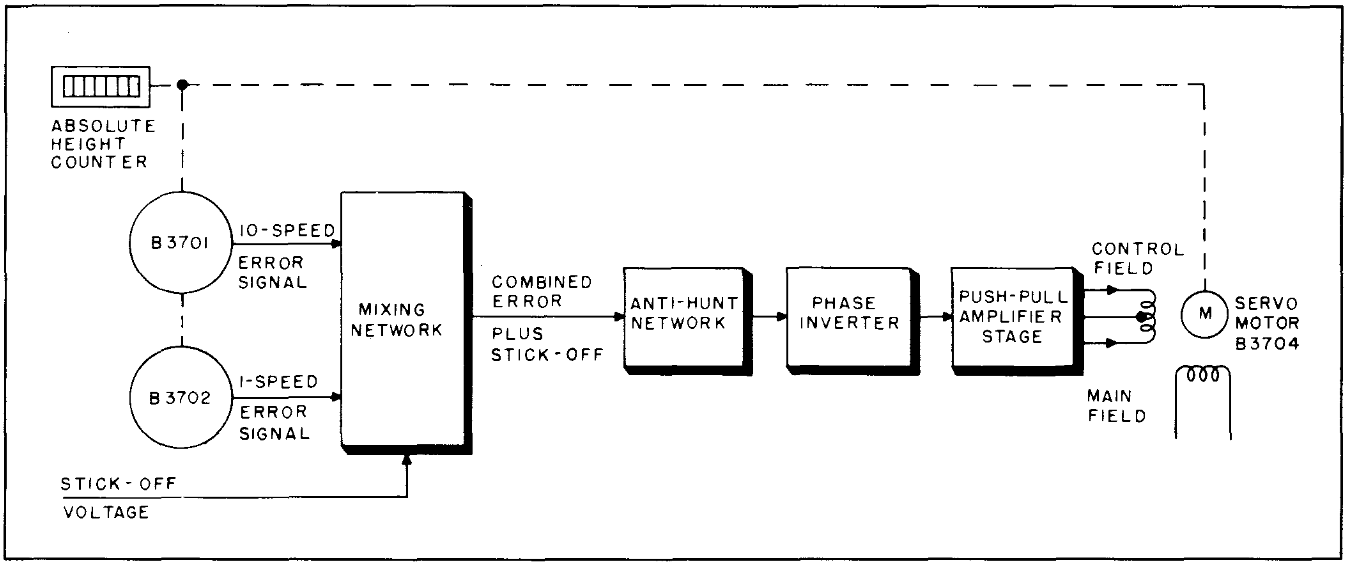


Figure 4–142. Absolute Height Servo, Remote Height Display, Block Diagram

reduced by a factor of 3/10 and, obviously, this is still a considerable improvement.

4–985. PROBLEMS ARISING FROM 2-SPEED SERVO SYSTEM. The 2-speed system has some inherent faults which must be corrected. These are hangup and hunting. Hunting is a problem common to both 1- and 2-speed systems. These faults and the means of correction are discussed individually in succeeding paragraphs.

4–986. HANGUP. A servo is said to hang up when it drives to a position other than the correct one and stays there in a stable condition. A servo that is hung up drives to its correct position only when forcibly moved some distance from its hangup position. In a 1- and 10-speed servo, the most common hangup points are near 30 degrees and at 180 degrees. Hangup is possible even though the selsyns are properly zeroed.

4–987. Figures 4–143 and 4–144 are plots of error signal versus system position in degrees. The dotted lines shown in figure 4–143 represent the individual outputs of the two control transformers. The solid line represents the sum of these two error signals. Portions of the curves that are above the axis are of positive phase; that is, in phase with the reference voltage, in this case, the excitation to the selsyn generator rotors. Portions of the curve that are below the axis are of negative phase, or 180 degrees out of phase with the reference voltage. It should be noted that the curve represents voltage as a function of system position, and not of time. As long as this is kept in mind, the curves should not be confusing.

4–988. It is now possible to state the conditions for a stable null in terms of the voltage curves in figure 4–143. A stable null occurs if the curve representing amplifier input plotted against system position has a positive slope; that is, the curve slants up to the right at a point where it passes through the axis.

4–989. The result of what occurs when the input to the amplifier is a simple series addition of the two rotor error signals is shown in A of figure 4–143. As can be seen in this figure, there are several hangup points on this curve as defined in paragraphs 4–986 and 4–988.

4–990. ELIMINATION OF HANGUP. All but one of the hangups are eliminated in B of figure 4–143 by simply reducing the magnitude of the high-speed error signal to one-third of its full value with a voltage divider before adding it to the low-speed error voltage. This step produces the curve in B of figure 4–143 which has a single hangup point at 180 degrees. The voltage divider is a part of the mixing circuit in the input section of the servo amplifier.

4–991. The 180-degree hangup is eliminated by the application of a stickoff voltage developed across resistor R3 in the circuit shown in A of figure 4–144. This voltage is added in series with the error signals and amounts to about 7 volts ac. The stickoff voltage is in phase with the reference voltage mentioned in paragraph 4–987 and is therefore positive and above the axis on the graphs. Figure 4–144 shows the solid curve of figure 4–143 as a dotted line. The horizontal dotted line represents the stickoff voltage and the solid curve represents the sum of the two dotted curves.

4–992. The addition of the stickoff voltage has the effect of raising the curve shown in B of figure 4–143 to the position shown in A of figure 4–144. The 180-degree hangup point has been raised so that it no longer crosses the axis and is therefore no longer a hangup point as defined in paragraphs 4–986 and 4–988.

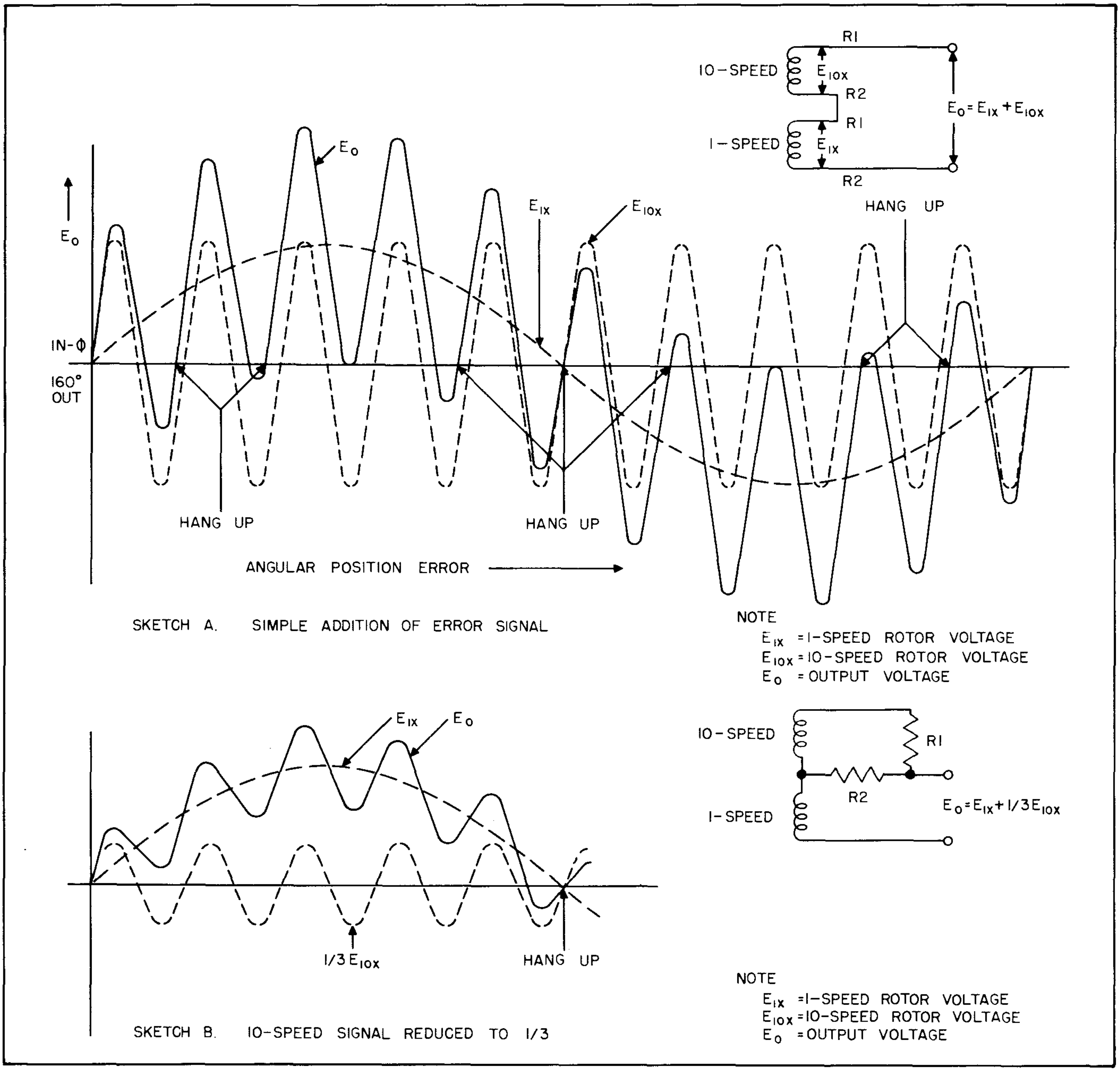


Figure 4–143. Reduction of High-speed Error Signal to Avoid Hangup

4–993. The point on the new curve of A of figure 4–144 that crosses the axis near 180 degrees has a negative (down to the right) slope and is therefore not a hangup point.

4–994. To summarize, all of the hangup points are eliminated by two steps: By reduction of the high-speed error signal to one-third of the magnitude of the low-speed error signal, and by application of a stickoff voltage in series with the control transformer rotors.

4–995. A further adjustment must now be made. The stickoff voltage has changed the position of the true null point from 0 degree to a position a few degrees from 0. This effect is counteracted by rotating the case of the low-speed control transformer, which moves the curve representing low-speed output to the right. This curve is shown as a dotted line in B of figure 4–143 and in A of figure 4–144. The effect on the solid curve is to change its shape negligibly and to shift it to the right so that its true null is at 0 degree. The resulting curve is shown in B of figure 4–144 by the solid line. This curve represents the signal fed to the antihunt network in the servo amplifier.

4–996. HUNTING. Hunting is the mechanical oscillation of a servomechanism about its null position. It is

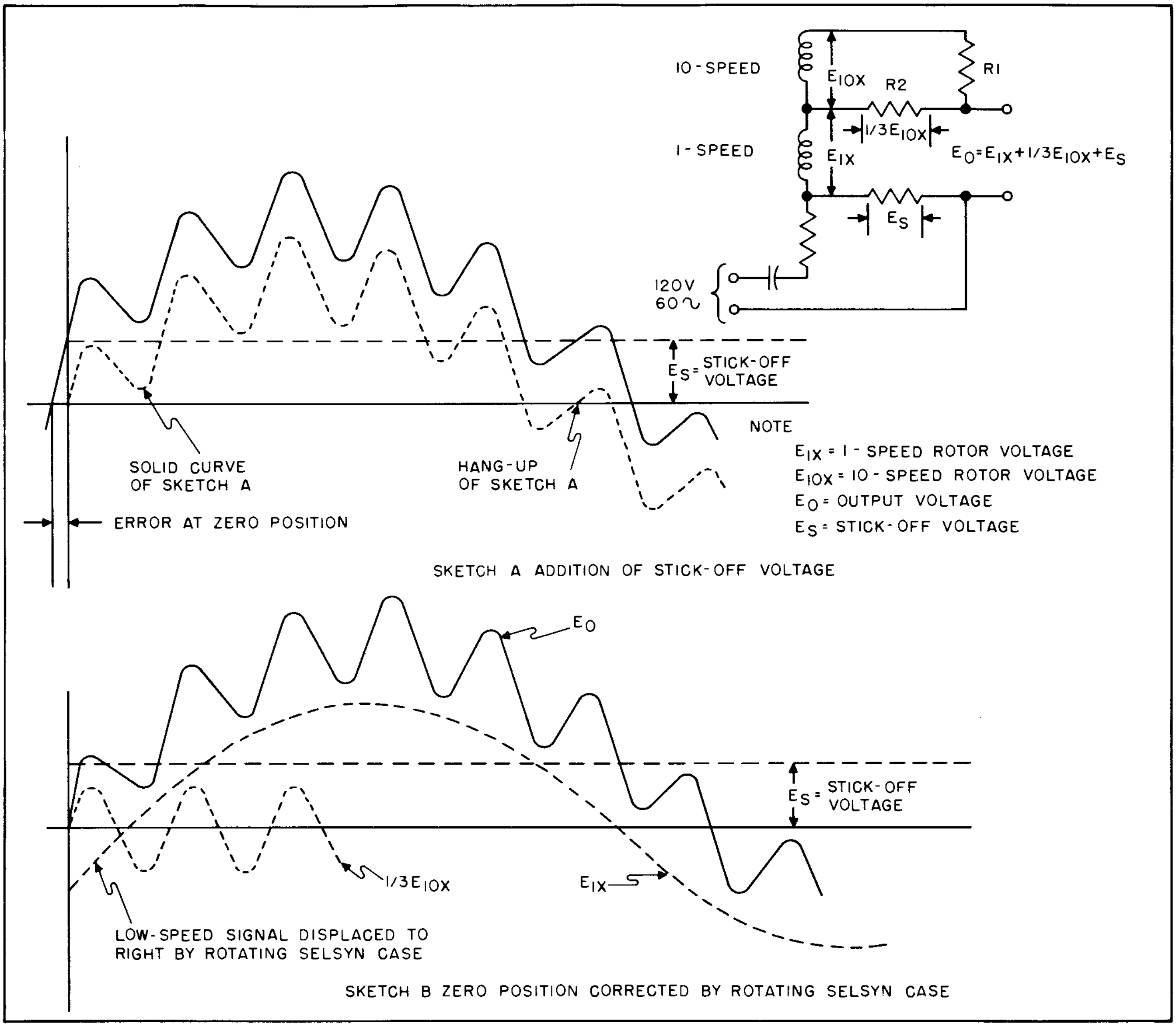


Figure 4–144. Addition of Stickoff Voltage to Prevent Hangup at 180 Degrees

caused basically by the mechanical inertia of the system and the properties of its feedback devices.

4–997. When a servo is displaced from its null and allowed to drive back to that position, it has a tendency to overshoot its mark. A new error signal is then set up in the control transformer by this overshoot which pulls the servo back toward the proper null position. However, it may overshoot now in the other direction. Under certain conditions, the servo will continue to oscillate about the null position, resulting in a chattering of the gear train and absolute height counter. In addition to causing unnecessary wear in the system, hunting prevents accurate positioning of the servomechanism.

4–998. When the servo is oscillating about its null position, the control transformer rotor output curve has the appearance of that shown in figure 4–145. For purposes of simplicity, a 1-speed system is considered, although the discussion is equivalent to that for a 1- and 10-speed system. This control transformer error voltage amounts to a 60-cps carrier which is amplitude-modulated with the frequency of the hunting.

4–999. Any modulated signal of this type is actually composed of two frequencies equal to the sum and dif-

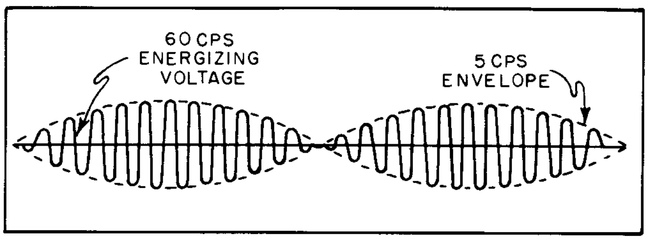


Figure 4–145. Waveform of Error Signal when Servo is Hunting at 5 CPS

ference between the frequencies of the carrier and of the modulating signal. For example, if the control transformer excitation frequency is 60 cps and the system is hunting at 5 cps, the servo amplifier receives two signals, one at 55 and one at 65 cps.

4–1000. REQUIREMENTS FOR SYSTEM STABILITY. Hunting can be prevented by operating on these side-band frequencies in such a way that the frequencies are relatively ineffective in the servo amplifier and motor. If the effectiveness of these frequencies can be considerably reduced, they will be unable to sustain the hunting oscillations and the hunting will die out after a few cycles.

4–1001. ANTIHUNT NETWORK. The antihunt network in the absolute height servo discriminates against the side-band frequencies in the error signal by shifting their phase. Their effect on the servo motor is thereby reduced. The circuit used is commonly termed a bridged-T network.

4–1002. The bridged-T network is shown in figure 4–146. The characteristics of the network are shown by curves of phase shift and attenuation versus frequency. Figure 4–146 also shows the network circuit with the components labeled as they actually appear in the amplifier. As shown by the attenuation curve of the bridged-T network, 60-cps signals suffer minimum attenuation. Pure 60-cps signals exist only in the absence of hunting. When the servo system hunts, the low-frequency signal (approximately 5 cps) impressed on the carrier causes difference frequencies of approximately 55 and 65 cps to be produced. The bridged-T network attenuates these signals and, since the signals associated with hunting cannot pass through the bridged-T network, hunting is quickly damped. The system's tendency toward dynamic oscillation or hunting is thus reduced by the antihunt network.

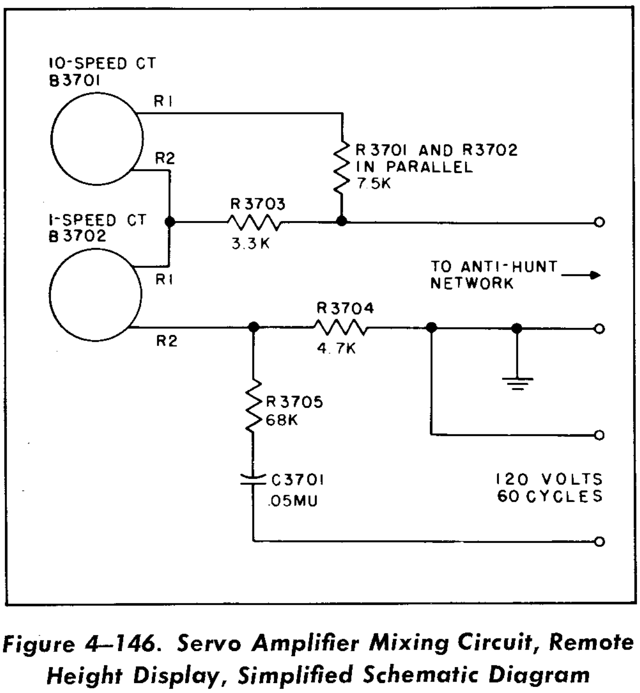


Figure 4–146. Servo Amplifier Mixing Circuit, Remote Height Display, Simplified Schematic Diagram

4–1003. The antihunt network does not interfere with the positioning ability of the servo when it is not hunting. In the absence of hunting, the 60-cps control transformer rotor voltage is not modulated with a hunting frequency. Therefore, if there is a position error, the rotor voltage is essentially a pure 60-cps signal. The antihunt network will not shift the phase of this steady-state error signal.

4–1004. SERVO AMPLIFIER.

4–1005. The servo amplifier consists of a mixing circuit, antihunt network, phase inverter, push-pull amplifier, and d-c power supply. Each of these sections is shown on the block diagram and are discussed separately in the following paragraphs.

4–1006. A schematic diagram of the servo amplifier is presented in figure 7–66. Figure 4–142 is a functional block diagram.

4–1007. MIXING CIRCUIT. The mixing network (figure 4–146) combines the error signals from the two control transformers with the stickoff voltage to form the single modified error signal. This signal is presented to the antihunt network and then proceeds to the phase inverter.

4–1008. The 10-speed signal from control transformer B3701 is applied to a resistance voltage divider consisting of resistors R3701 and R3702 in parallel, and with both in series with resistors R3703. About one-third of the 10-speed signal appears across resistor R3703. Resistors R3704 and R3705, together with capacitor C3701, form a combination voltage divider and phase-shifting network which is placed across the 120-volt a-c source. It develops the stickoff voltage of about 9 volts and of proper phase across resistor R3704. The purpose of the stickoff voltage is explained in paragraphs 4–991 through 4–993. Briefly, its function is to prevent hangups.

4–1009. The 1-speed signal from control transformer B3702 is applied in series-aiding with the voltages across resistors R3703 and R3704. The result is the modified error signal which is applied to the antihunt network. The value of this signal equals the sum of the 1-speed signal, plus one-third of the 10-speed signal, plus the stickoff voltage.

4–1010. ANTIHUNT NETWORK. The antihunt network receives the modifier error signal from the mixing network and damps it. The operation of this network is discussed in paragraphs 4–1001 through 4–1003. It is a bridged-T network and its circuit is developed in figure 4–147.

4–1011. PHASE INVERTER. The function of the phase inverter is to supply a driving signal to each of the two tubes in the push-pull amplifier. These two driving

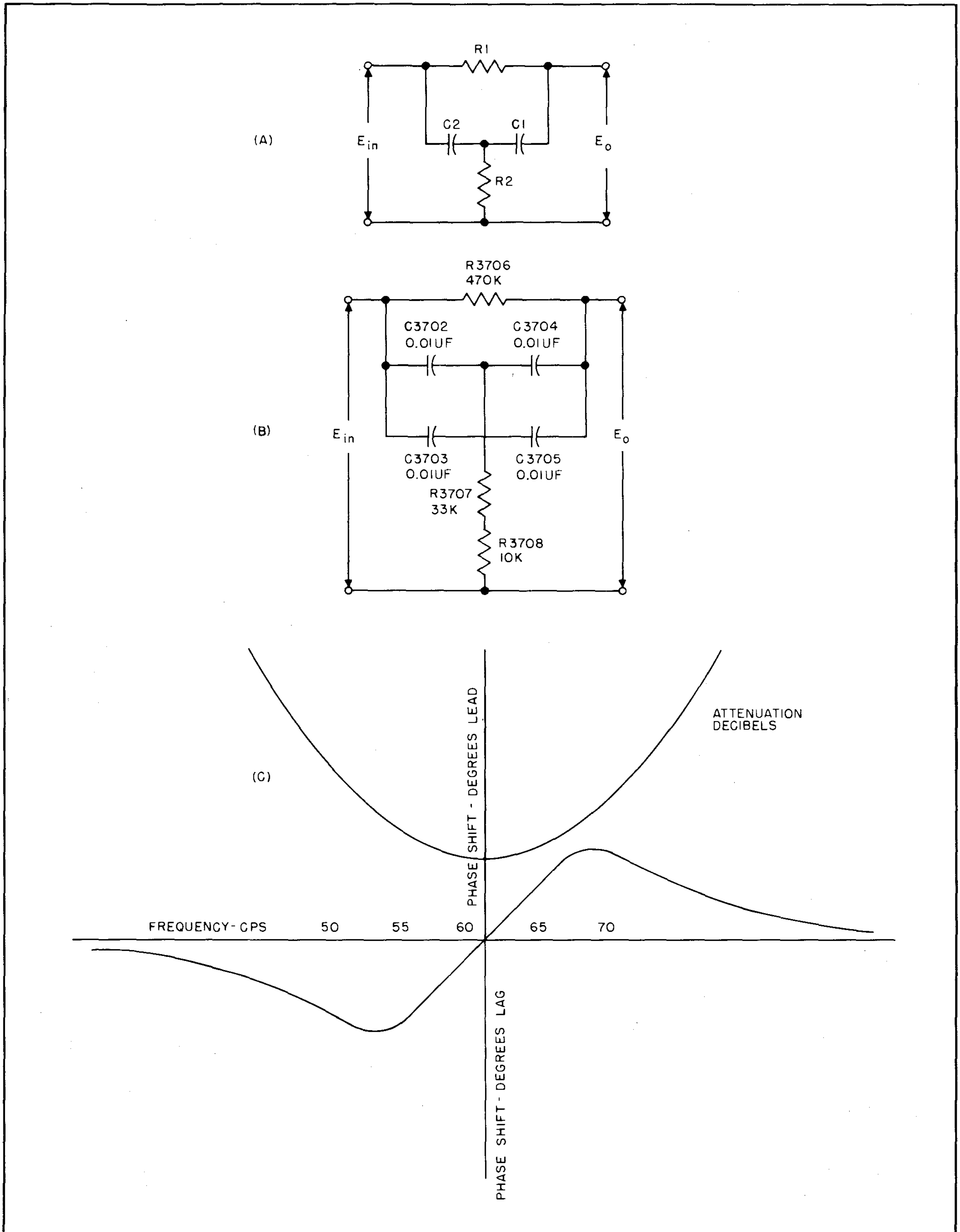


Figure 4–147. Antihunt Network and Network Phase Characteristics

signals are required to be of equal amplitude and 180 degrees out of phase with each other. The input to the phase inverter is the modifier and damped error signal from the antihunt network. Twin triode V3701 functions as the phase inverter. The upper and lower halves of this tube will be referred to. These terms apply to the positions of the tube halves as shown in the schematic of figure 7–66.

4–1012. The error signal from the antihunt network is applied to the grid of the upper triode at pin 2. Resistor R3712 is the plate load resistor for this triode and C3706 is its coupling capacitor. Resistors R3715 and R3716 form part of the grid circuit resistance for one of the push-pull, beam power tubes, V3702, as well as forming a voltage divider to supply grid excitation to the lower triode of tube V3701. Resistor R3713 is the plate load for the lower triode and capacitor C3707 is its coupling capacitor. Resistors R3717 and R3716 form part of the grid resistance for the other beam power push-pull tube V3703. It should be noted that resistor R3716 is common to the grid circuits of both push-pull tubes.

4–1013. If the outputs of the two triodes of the phase inverter are exactly equal and 180 degrees out of phase with each other, as is true in the ideal case, the signal across resistor R3716 is zero becaust the triode outputs cancel there. However, if one triode tends to produce more signal than the other, the outputs will not exactly cancel across resistor R3716 and a small signal appears across this resistor, representing the difference between the two triode outputs. This difference is applied to the grid of the lower triode and amplified through this triode in such a way as to balance the circuit. Actually, the circuit is never exactly balanced because a small signal is required to drive the lower triode. Since this unbalance is very small, the signals supplied to the grids of the push-pull tubes are essentially equal.

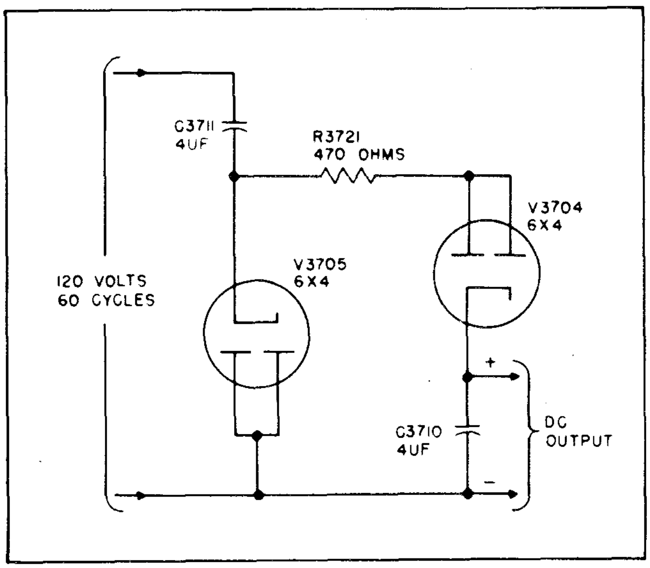


Figure 4–148. Voltage Doubler Circuit, Remote Height Display, Simplified Schematic Diagram

4–1014. PUSH-PULL AMPLIFIER. Tubes V3702 and V3703 are beam power amplifiers. These tubes are arranged in a conventional push-pull circuit with the centertapped control field of the selsyn motor as their load. Resistor R3719 furnishes cathode bias to the two tubes, while resistors R3714 and R3718 limit grid current in the output tubes. Capacitor C3708, in parallel with the motor control winding, forms the proper load impedance for the output tubes. Jacks J3702 and J3703 are test jacks which may be used to measure the signals at the push-pull grids or to supply such drive signals from an external source.

4–1015. D-C POWER SUPPLY. The plate voltage in the servo amplifier are supplied by a half-wave doubler circuit. Resistor R3720 and capacitor C3709 form a conventional decoupling network which prevents coupling between the amplifier stages caused by a common power supply impedance.

4–1016. The doubler circuit consists of two diodes, each used as a half-wave rectifier. A simplified schematic of this circuit is shown in figure 4–148.

4–1017. Diode V3705 sees capacitor C3711 as its load impedance. This diode conducts during every other half cycle and maintains a charge on capacitor C3711 that is nearly equal to the line voltage. Diode V3704 conducts during the half cycle that diode V3705 does not conduct. When diode V3704 conducts, it maintains a charge on capacitor C3710. It should be noted that capacitor C3711 is in series-aiding with the line voltage during this half cycle and its charge provides the effect of an additional line voltage source. The result is a source voltage nearly twice the line voltage. Capacitor C3710 is therefore charged to nearly twice the line voltage.

4–1018. When charged in the manner described in paragraph 4–1017, capacitor C3710 acts as the d-c power source. The amplifiers drain the charge and the voltage doubler diodes replenish it. The d-c voltage output under load conditions is about 135 volts.

4–1019. RELAY CIRCUITS.

4–1020. The relay circuits are shown schematically in figure 4–149. The operations of these circuits are outlined on a step-by-step basis in figure 4–150.

4–1021. TIME-SHARING MASTER CONTROL (CONTROL, ANTENNA C-1049/FPS-6).

4–1022. GENERAL. (See figure 7-68.)

4–1023. The time-sharing master control directs the switching functions of the four PPI relay groups in the junction box. This control energizes the relay groups individually by means of 28-volt switching signals. There is one switching outlet for each PPI relay group in the junction box.

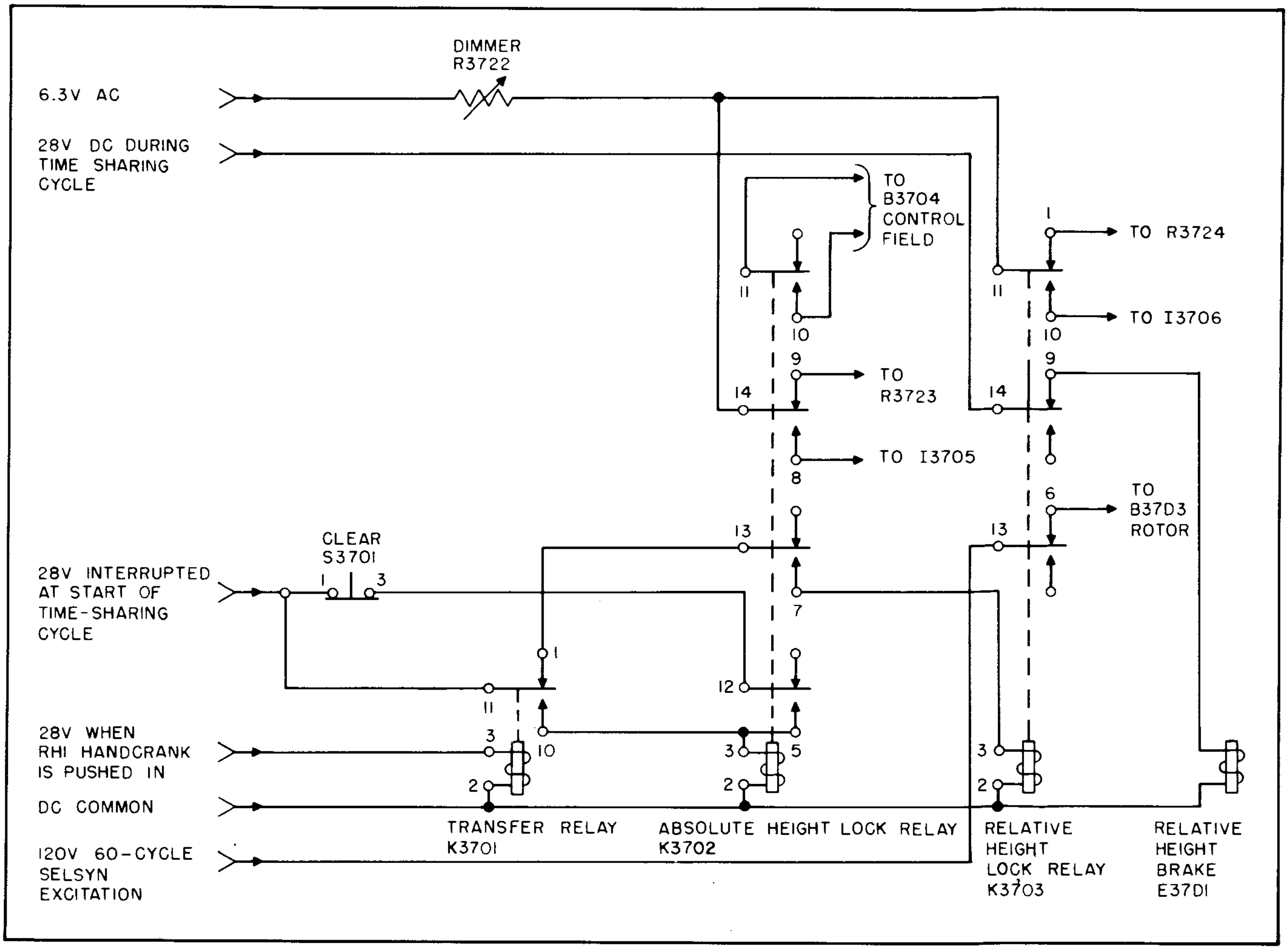


Figure 4–149. Relay Circuits, Remote Height Display

4–1024. Terminal P of jack J3801 carries the switching signal for the PPI No. 1 relay group. The signals for the PPI No. 2, 3, and 4 relay groups appear at terminals Q, R, and S, respectively, of jack J3801. When a 28-volt d-c switching signal appears at terminal P of jack J3801, the PPI No. 1 relay group energizes, making height-finding radar information available to the PPI No. 1 operator.

4–1025. Control can be given to the PPI operators either automatically or manually. When MANUAL SELECT switch S3801 is in the PPI 1 position, the PPI No. 1 operator has control of the height-finding radar for as long as the switch is in that position. The equivalent is true for the PPI 2, PPI 3, and PPI 4 positions of the switch. If the MANUAL SELECT switch is placed in the AUTO position, control is automatically assigned to each of the four PPI operators in a sequence determined by the settings of sequence switches S3802 through S3805. The duration of the control periods is adjusted by the INTERVAL SECS. control on the front panel of the time-sharing master control.

4–1026. The four color-coded indicators on the front panel indicate which PPI operate has control. Terminals H, J, K, and L of jack J3801 provide 6.3-volt a-c outputs which are in parallel with the four indicators on the front panel. These indicator voltage outputs go through the junction box to the four remote height displays (RHD's). There is a similar set of four colored indicators on the front panel of each RHD. All five blue indicators light whenever the PPI No. 1 operator has control. All five amber indicators light whenever the PPI No. 2 operator has control. Lighting of the green indicators indicate that the PPI No. 3 operator has control, and lighting of the white indicators indicate control by the PPI No. 4 operator.

4–1027. Consider a typical case of time-sharing master control operation. Assume the MANUAL SELECT switch to be in the AUTO position, the SEQUENCE 1 switch in the PPI 3 position, the SEQUENCE 2 switch in the PPI 1 position, the SEQUENCE 3 switch in the PPI 2 position, the SEQUENCE 4 switch in the PPI 4 position, and the INTERVAL SECS. switch in the 40 position. When START switch S3806 is placed in the down position, 28 volts dc appears at terminal R of jack J3801. This voltage energizes the PPI No. 3 relay group in the junction box and gives control to the PPI No. 3

Step No.	Action	28 Volts Dc	Results
1	Time-sharing assigns control to to this PPI position.	Applied to pin S of jack J3701 and through contacts 14 and 9 of relay K3703 (de-energized). Momentarily interrupts 28 volts at pin T.	Brake solenoid E3701 energized; releases brake. Clears circuit by de-energizing any closed relays.
2	RHI operator transmits absolute height data.		No relay action.
3	RHI operator pushes in his handcrank to transmit relative height information, closing switch S4205 attached to RHI height handcrank.	Applied through switch S4205 in RHI to pin U of jack J3701.	Energizes solenoid of relay K3701.
4	Relay K3701 energized by step 3.	Applied through contacts 11 and 10 of relay K3701 to relay K3702.	Energizes relay K3702, which is held by its own contacts (12 and 5) and normally closed switch S3701. Contacts 10 and 11 of relay K3702 short out servo amplifier output, disabling absolute height counter. Contacts 14 and 8 illuminate ABSOLUTE HEIGHT dial with indicator I3703.
5	RHI operator releases height handcrank after completing relative height transmission.	Removed from pin U by opening switch S4205 in RHI.	Relay K3701 releases.
6	Relay K3701 released by step 5.	Applied through contacts 11 and 1 of relay K3701 (de-energized) and contacts 13 and 7 of relay K3702 (energized).	Relay K3703 energizes. Contacts 13 and 6 open, removing 110 volts ac from rotor of relative height selsyn follower B3703. Contacts 9 and 14 open, disconnecting brake solenoid E3701 from line S. This de-energizes solenoid and brake is applied by spring pressure. Contacts 11 and 10 close, illuminating RELATIVE HEIGHT dial within rotor I3706.
7	Time-sharing takes away control.	Removed from pin S.	No action.
8	PPI operator operates CLEAR switch S3701.	Relay K3702 holding contacts 5 and 12 momentarily disconnected from line T.	Relay K3702 de-energizes. Contacts 7 and 13 open, causing relay K3703 to de-energize. All dial indicators go off and absolute height servo operation is restored. Relative height selsyn rotor is energized, de-energizing all relays.
9	Time-sharing again assigns control to this PPI position. This is a repetition of step 1 and initiates a new cycle.	Momentarily interrupted at pin T.	If PPI operator has not operated CLEAR switch, this will result in the same function as step 8. This prepares RHD for reception of new height data.

Figure 4–150. Sequence of Relay Operation in Remote Height Display

operator. The green indicator on the front panel of the time-sharing master control then lights and 6.3 volts ac appears at terminal K of jack J3801. This voltage lights the green indicators on all four RHD's notifying all operators that PPI No. 3 has control. These conditions prevail for 40 seconds.

4–1028. When the 40-second period ends, the 28 volts dc disappears from terminal R of jack J3801 and appears immediately at terminal P. This de-energizes the PPI No. 3 relay group in the junction box and energizes the PPI No. 1 relay group. Control thereby passes from the PPI No. 3 operator to the PPI No. 1 operator. All green indicators then go off and all blue indicators light. At the end of another 40-second period, control similarly passes from the PPI No. 1 operator to the PPI No. 2 operator. The blue indicators then go off and the amber indicators light. In another 40 seconds, control passes from the PPI No. 2 operator to the PPI No. 4 operator. At the end of this control period, control reverts to PPI No. 3, and the sequence repeats.

4–1029. It is possible to interrupt this sequence at any time by placing the START switch in the down position. This causes a reset action which immediately returns control to the PPI operator designated by the SEQUENCE 1 switch. All the sequence switches can be set to any of the PPI positions. Two or more switches can be set to the same PPI position. The PPI operator thus designated receives more than one control period during each sequencing cycle. The PPI operator designated by the SEQUENCE 1 switch is the one to whom control reverts whenever the START switch is placed in the down position.

4–1030. Each of the four sequence switches has a PASS position. When a switch is placed in this position, the associated sequence is bypassed. Assume that the SEQUENCE 2 switch is in the PASS position and that all other switches are in the positions described in paragraph 4–1027. When the PPI No. 3 operator (assigned to sequence No. 1) has been granted 40 seconds of control time, control does not pass to PPI No. 1 but rather immediately to the PPI No. 2 operator. Thus, the second control sequence is bypassed. It is also possible for any PPI operator to bypass himself, regardless of the settings of the sequence switches on the time-sharing master control. The PPI operator accomplishes this function by placing azimuth control switch S3601 (on his azimuth control overlay) in the PASS position. As long as the switch remains in this position, the PPI operator is bypassed each time his control period arrives.

4–1031. AUTO-WARN switch S3807, on the front panel of the time-sharing master control, is normally in the AUTO position. If the time-sharing master controller desires to extend the control period of any PPI operator, he throws switch S3807 to the WARN position. This causes the colored indicators on the time-sharing master control, and the RHD's which signify the particular PPI position, to flash, notifying all associated personnel that the designated PPI operator has been granted extended control time.

4–1032. There are three ways by which an extended control period can be terminated. The usual method requires that the PPI operator with extended control place his azimuth control switch (on his azimuth control overlay) in the PASS position. The extended control period then ends and control immediately passes to the PPI operator assigned to the following sequence. When the time-sharing master controller is notified by his colored indicators that the extended control period has ended, he should return the AUTO-WARN switch to the AUTO position; otherwise, the PPI operator next in sequence would also be granted extended control. When the time-sharing master controller desires to end an extended control period, he determines which sequence switch is allotted to the PPI operator with extended control and places the switch in the PASS position. He then returns the AUTO-WARN switch to the AUTO position and the sequence switch from PASS to its former position. It is also possible to end the extended control period by merely returning the AUTO-WARN switch to the AUTO position. However, action may be delayed, since control ends with the next pulse from the timer circuit.

4–1033. Figure 4–151 lists the principal components of the time-sharing master control as well as their functions. This figure also provides the technician with a useful reference and will serve as an aid in reading this section. Figure 7–68 is a schematic diagram of the time-sharing master control.

Element	Title	Function
I3801	"PPI 4" indicator (white)	Lights when PPI No. 4 operator is given azimuth control of antenna.
I3802	"PPI 3" indicator (green)	Lights when PPI No. 3 operator is given azimuth control of antenna.
I3803	"PPI 2" indicator (amber)	Lights when PPI No. 2 operator is given azimuth control of antenna.
I3804	"PPI 1" indicator (blue)	Lights when PPI No. 1 operator is given azimuth control of antenna.
I3805	"TIMER" indicator (red)	Lights when a-c power is applied.
K3801	Slave relay	Shortens timing pulse so that azimuth control can be transferred only once for each closing of timer relay contacts.

Figure 4–151. Elements of Time-sharing Master Control (Sheet 1 of 4)

Element	Title	Function
K3802	Transfer relay No. 1	When energized, feeds 28-volt d-c switching signal and 6.3-volt a-c indicator voltage to "SEQUENCE 1" switch S3802, and then to PPI relay group (in junction box) designated by SEQUENCE 1" switch.
K3803	Transfer relay No. 2	When energized, feeds 28-volt d-c switching signal and 6.3-volt a-c indicator voltage to "SEQUENCE 2" switch S3803, and then to PPI relay group (in junction box) designated by "SEQUENCE 2" switch.
K3804	Transfer relay No. 3	When energized, feeds 28-volt d-c switching signal and 6.3-volt a-c indicator voltage to "SEQUENCE 3" switch S3804, and then to PPI relay group (in junction box) designated by "SEQUENCE 3" switch.
K3805	Transfer relay No. 4	When energized, feeds 28-volt d-c switching signal and 6.3-volt a-c indicator voltage to "SEQUENCE 4" switch S3805, and then to PPI relay group (in junction box) designated by "SEQUENCE 4" switch.
K3806	Slave relay	Functions in conjunction with relay K3801.
K3807	Auxiliary relay No. 1	When energized, applies 28 volts dc to solenoid of transfer relay No. 1 and to holding contact 4 of auxiliary relay No. 4.
K3808	Auxiliary relay No. 2	When energized, applies 28 volts dc to solenoid of transfer relay No. 2 and to holding contact 4 of auxiliary relay No. 1.
K3809	Auxiliary relay No. 3	When energized, applies 28 volts dc to solenoid of transfer relay No. 3 and to holding contact 4 of auxiliary relay No. 2.
K3810	Auxiliary relay No. 4	When energized, applies 28 volts dc to solenoid of transfer relay No. 4 and to holding contact 4 of auxiliary relay No. 3.
K3811	Bypass relay	When energized, bypasses PPI operator next in sequence.
K3812	Normal control relay	Energized whenever "AUTO-WARN" switch is in "AUTO" position. Feeds timing pulse from timer circuit to slave relays, and then to transfer and auxiliary relays.

Figure 4–151. Elements of Time-sharing Master Control (Sheet 2 of 4)

Element	Title	Function
K3813	Extended control relay	Energized by blinker relay K3814 during timing pulse immediately following placement of "AUTO-WARN" switch S3807 in "WARN" position. Remains energized until bypass action energizes bypass relay K3814 or switch S3807 is returned to "AUTO" position, whichever occurs sooner. Places 110K shunt across timing capacitor C3803, increasing pulse rate of timer circuit.
K3814	Blinker relay	Energized during each timing pulse from timer relay K3815. Interrupts indicator circuit, causing control indicators on front panel and on all RHD's to flash. Initially energizes extended control relay K3813 after switch S3807 is thrown to "WARN" position.
K3815	Timer relay	Energized momentarily at intervals determined by adjustment of "INTERVAL SECS." control R3803, producing short d-c timing pulses. These pulses initiate switching cycles in automatic transfer circuit.
R3803	"INTERVAL SECS." control	Determines interval (variable between 20 and 90 seconds) between timing pulses produced by timer circuit and timer relay K3815.
S3801	"MANUAL SELECT" switch	Transfers control manually to any of four PPI operators. When placed in "AUTO" position, allows time-sharing master control to transfer control automatically after "START' switch has been placed in down position.
S3802	"SEQUENCE 1" switch	Determines which PPI operator is to have control during time-sharing sequence No. 1. Can also be set to bypass this sequence, immediately turning over control to sequence No. 2.
S3803	"SEQUENCE 2" switch	Determines which PPI operator is to have control during time-sharing sequence No. 2. Can also be set to bypass this sequence, immediately turning over control to sequence No. 3.

Figure 4–151. Elements of Time-sharing Master Control (Sheet 3 of 4)

Element	Title	Function
S3804	"SEQUENCE 3" switch	Determines which PPI operator is to have control during time-sharing sequence No. 3. Can also be set to bypass this sequence, immediately turning over control to sequence No. 4.
S3805	"SEQUENCE 4" switch	Determines which PPI operator is to have control during time-sharing sequence No. 4. Can also be set to bypass this sequence, immediately turning over control to sequence No. 1.
S3806	"START" switch	Must be momentarily placed in down position to start automatic switching action. Also used as reset switch. If placed in down position while automatic transfer is progressing, immediately switches control to time-sharing sequence No. 1.
S3807	"AUTO-WARN" switch	When in "AUTO" position, allows automatic sequencing to proceed without interruption. When in "WARN" position, holds up automatic sequencing, giving extended time to PPI operator in control after his time has expired. Causes control indicators on time-sharing master control and RHD's to flash during extended control period.
S3808	"TIMER" switch	Applies 120 volts ac to timer relay K3815 solenoid and to filament transformer T3801.
T3801	Filament transformer	Applies 6.3 volts ac to filaments of timer tubes V3801 and V3802.
V3801	Rectifier	Rectifies 120 volts ac to provide dc for timer tubes and relay K3815.
V3802	Timer and relay cutoff	Timer tube V3802A supplies discharge path for timing capacitor C3803. Relay cutoff tube V3802B controls current through timer relay K3815.
C3803	Timing capacitor	Acts with tube V3802A and resistors R3803 and R3805 to form RC timing network. Controls conduction of relay cutoff tube V3802B.

Figure 4–151. Elements of Time-sharing Master Control (Sheet 4 of 4)

4–1034. MANUAL SELECTION. Four PPI positions and an AUTO position are available in setting MANUAL SELECT switch S3801. When the switch is placed in one of the PPI positions, the designated PPI operator has azimuth control of the height-finding antenna for as long as the switch remains in that position. When the switch is placed in the AUTO position, control is automatically transferred from one PPI operator to another, in the order determined by the setting of sequence switches S3802 through S3805.

4–1035. MANUAL SELECT switch S3801 is shown in figure 4–152. Contact 21, one of the two rotors of the switch, is connected to the 28-volt d-c height indicator cutout line (paragraph 4–1084). When the switch is placed in the PPI position, 28 volts dc is fed through closed contacts 21 and 23 of switch S3801 and through terminal P of jack J3801 to the PPI No. 1 relay group in the junction box. This relay group energizes, giving azimuth control to the PPI No. 1 operator. Contacts 11 and 13 of switch S3801 also close, feeding 6.3 volts ac to blue indicator I3804 ,and then through the junction box to the blue indicators on all four RHD's. The lighting of the indicators informs all PPI operators and the time-sharing master controller that the PPI No. 1 operator has azimuth control.

4–1036. When MANUAL SELECT switch S3801 is in the PPI 2 position, 28 volts dc passes through contacts 21 and 24 of switch S3801 to the PPI No. 2 relay group in the junction box. Contacts 11 and 14 of switch S3801 feed 6.3 volts ac to the amber indicators at the RHD's and to amber indicator I3803 on the time-sharing master control. Similar functions are executed when the MANUAL SELECT switch is placed in the PPI 3 and PPI 4 positions.

4–1037.When the MANUAL SELECT switch is placed in the AUTO position, 28 volts from the height indicator cutout line is furnished to the transfer relays 3
through contacts 21 and 22 of MANUAL SELECT switch S3801. Contacts 11 and 12 of switch S3801 feed 6.3 volts ac to the transfer relays which accomplish automatic sequencing.

4–1038. When control is being assigned manually, it is not necessary to turn the TIMER switch on. It may be advisable to do so, however, so that the filaments in the timer circuit are warmed up if it is necessary to change quickly to automatic sequencing operation.

4–1039. AUTOMATIC SEQUENCING. (See figure 4–153.)

4–1040. GENERAL. The automatic sequencing circuit consists of four sequence switches, four transfer relays, four auxiliary relays, two slave relays, START switch S3806, and a timer circuit.

4–1041. The timer circuit produces 28-volt trigger pulses at intervals which can be varied from 20 to 90 seconds by INTERVAL SECS. control R3803. Each pulse

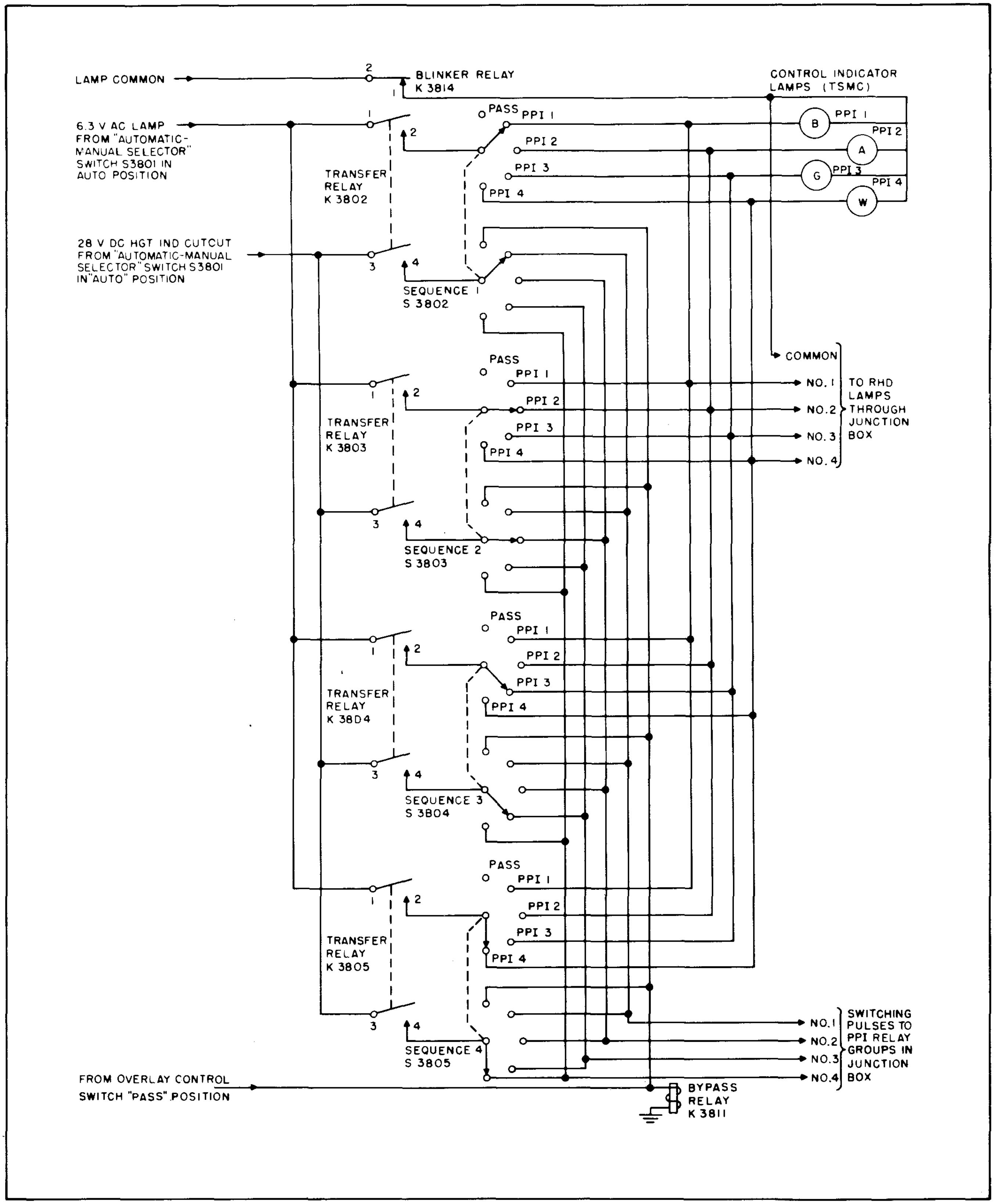


Figure 4–152. Indicators and Sequence Switches, Time-sharing Master Control, Simplified Schematic Diagram

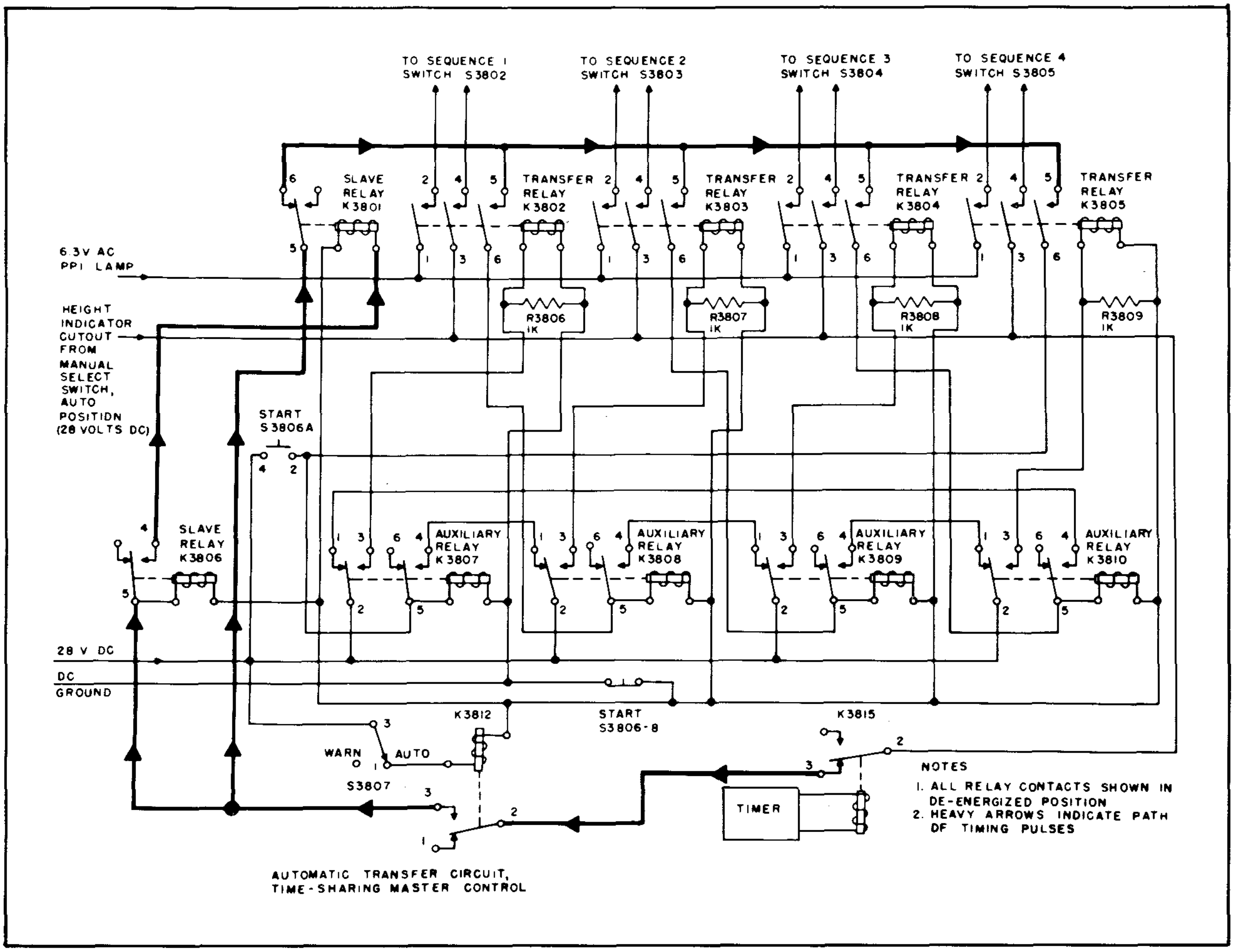


Figure 4–153. Automatic Transfer Circuit, Time-sharing Master Control, Simplified Schematic Diagram

is a fraction of a second in duration. The pulses are generated by the closing of contacts 2 and 3 of timer relay K3815. During normal sequencing, normal control relay K3812 is energized. Each timing pulse travels through closed contacts 2 and 3 of normal control relay K3812 to slave relays K3801 and K3806, and then to the transfer and auxiliary relays. The timing pulse triggers one of the auxiliary relays (paragraph 4–1044), causing the associated transfer relay to produce a d-c switching signal until the next timing pulse occurs. The switching pulse thus produced passes through the associated sequence switch to a PPI relay group in the junction box.

4–1042. TRANSFER AND AUXILIARY RELAYS. Each control sequence has one transfer relay and one auxiliary relay. Transfer relay No. 1 (relay K3802) and auxiliary relay No. 1 (relay K3807) are associated with sequence No. 1. When these two relays are energized, the PPI operator assigned to sequence No. 1 by SEQUENCE 1 switch S3801 has azimuth control of the height-finding antenna. Similarly, sequence No. 2 is in control when transfer relay No. 2 (relay K3803) and auxiliary relay No. 2 (relay K3808) are energized.

4–1043. Each transfer relay is energized by an auxiliary relay. Assume that auxiliary relay No. 1 has become energized. Its contacts 2 and 3 close, applying 28 volts dc to the solenoid of transfer relay No. 1. Whenever a transfer relay is energized, its contacts 3 and 4 close, sending a 28-volt switching signal to its associated sequence switch; its contacts 1 and 2 close, sending 6.3 volts ac to the associated sequence switch; and its contacts 5 and 6 close, connecting the solenoid of the auxiliary relay in the next sequence to the timing pulse line from the slave relays.

4–1044. Before any auxiliary relay can become energized, the transfer relay of the preceding sequence must be energized. Assume that transfer relay No. 2 is energized. The next timing pulse passes through closed contacts 5 and 6 of transfer relay No. 2 to the solenoid of auxiliary relay No. 3. Contacts 1 and 2 of auxiliary relay No. 3 open, allowing auxiliary relay No. 2 to drop out. Transfer relay No. 2 is thereby released and transfer relay No. 3 is energized through contacts 2 and 3 of auxiliary relay No. 3.

4–1045. Auxiliary relay No. 3 remains energized, through its holding contacts 4 and 5 and through the normally closed contacts of auxiliary relay No. 4, until auxiliary relay No. 4 is energized by the next timing pulse. The next timing pulse passes through closed contacts 5 and 6 of transfer relay No. 3 to the solenoid of auxiliary relay No. 4. Auxiliary and transfer relays No. 3 drop out, and transfer relay No. 4 is held in until the following timing pulse energizes the auxiliary relay of the sequence following the one in control, thus automatically transferring control from one sequence to another.

4–1046. INITIATION OF AUTOMATIC SEQUENCING. Before any auxiliary relay can become energized by a timing pulse, one of the transfer relays must be energized. For this reason, the sequencing cycle must be initiated manually whenever the time-sharing master control has been disconnected from the 28-volt d-c supply. Sequencing need not be initiated manually after the height indicator cutout voltage (paragraph 4–1084) has been interrupted.

4–1047. START switch S3806 is a momentary-action, double-pole, single-throw toggle switch. When placed in the down position, contacts 2 and 4 of this switch close, applying 28 volts dc to the solenoid of auxiliary relay No. 1. This energizes transfer relay No. 1. With transfer relay No. 1 energized, the next timing pulse can energize auxiliary relay No. 2, and the sequencing cycle is thus initiated. The relays continue to be energized and de-energized with each timing pulse. It should be noted that the setting of the MANUAL SELECT switch does not affect the operation of the transfer and auxiliary relays. Once sequencing is started, the operator hears these relays clicking periodically for as long as the timer is turned on, regardless of the setting of the MANUAL SELECT switch.

4–1048. RESETTING. Switch S3806 can be used to interrupt the sequencing cycle at any point and to return control to sequence No. 1. Normally closed contacts 3 and 5 of switch S3806 are in the d-c return circuit for the solenoids of all relays except auxiliary relay No. 1, transfer relay No. 1, and timer relay K3815. Therefore, if the START switch is placed in the down position during any sequence other than No. 1, the energized auxiliary and transfer relays are de-energized. Auxiliary relay No. 1 and transfer relay No. 1 are then energized, giving control to sequence No. 1.

4–1049. After the sequencing has been reset, sequence No. 1 retains control only until the next timing pulse. The timer circuit is not affected by START switch S3806. Assume that the START switch is placed in the down position after sequence No. 3 has had control for 30 seconds. If the INTERVAL SECS. control is set to the 40 position, sequence No. 1 has control for only 10 seconds before another timing pulse advances control to sequence No. 2.

4–1050. SLAVE RELAYS. Slave relays K3801 and K3806 shorten the timing pulses before they reach the auxiliary relays. The duration of a timing pulse must be shorter than the time delay between the start of the timing pulse and the closing of a transfer relay. If the timing pulse is not terminated before a transfer relay closes, the end of the pulse reaches the next auxiliary relay and causes a second automatic transfer. Thus, if the timing pulses are too long, each one can transfer control two, three, or more times.

4–1051. After a timing pulse passes through normally closed contacts 2 and 3 of normal control relay K3812 (figure 4–153), it passes through closed contacts 5 and 6 of slave relay K3801 to the auxiliary relays. At the same time, the pulse energizes the solenoid of relay K3806, the other slave relay. Contacts 4 and 5 of relay K3806 then close, exposing the solenoid of slave relay K3801 to the timing pulse. This energizes relay K3801, removing the remainder of the timing pulse from the auxiliary relays. In this way, the duration of the timing pulse is clipped before it reaches the auxiliary relay circuit.

4–1052. SEQUENCE SWITCHES. Figure 4–152 shows the four sequence switches (switches S3802 through S3805). Each is a two-section switch. A section consists of a rotating contact and five stationary contacts. Rotating contact 21 of each switch receives a switching signal from its associated transfer relay. Each switch can channel its switching signal to any one of the four PPI relay groups in the junction box, or back to bypass relay K3811 in the time-sharing master control. The latter action causes the sequence to be bypassed, as described in paragraph 4–1070. If the switching signal is directed to one of the PPI relay groups in the junction box, the associated PPI operator receives control of the height-finding radar.

4–1053. The other section of each sequence switch, consisting of rotary contact 11 and stationary contacts 12 through 16, receives 6.3-volt a-c indicator voltage from contact 2 of the associated transfer relay. The switch channels the voltage to one of the four RHD's unless it is in the PASS position.

4–1054. The sequence switches can be set to assign control to the PPI operators in any order desired during automatic sequencing. Any sequence switch can be set to bypass its sequence. This feature is useful when the radar system is used with a reduced complement of PPI operators, or when activity is not evenly divided between the sectors monitored by each PPI operator.

4–1055. EXTENDED CONTROL CIRCUIT. (See figure 4–154.)

4–1056. INITIATION. It may become necessary for a particular PPI operator to retain use of the height-finding radar after his regularly assigned time has expired. Such a situation may arise when his sector of the sky contains several targets. Under these conditions, the time-sharing master controller can delay the automatic sequencing by placing AUTO-WARN switch S3807 in the WARN position. The PPI operator then retains control until he places antenna control switch S3601 (on his azimuth control overlay) in the PASS position, or until the time-sharing master controller places the proper sequence switch in the PASS position. The lighted indicators on the time-sharing master control and on all RHD's flash for the duration of the extended control time.

4–1057. AUTO-WARN switch S3807 (figure 4–154) is a double-pole, double-throw toggle switch which is normally placed in the AUTO position. When switch S3807 is set for automatic sequencing, its contacts 1 and 3 are closed, supplying 28 volts dc to the solenoid of normal control relay K3812. When this relay is energized, its contacts 2 and 3 close, carrying timing pulses from timer relay K3815 to slave relays K3801 and K3806.

4–1058. Placing AUTO-WARN switch S3807 in the WARN position grants extended control time to the PPI operator already in control. Contacts 1 and 3 of switch S3807 then open, de-energizing normal control relay K3812. (It should be noted that if the switch is thrown during a timing pulse, the normal control relay is held in for the duration of the pulse. Blinker relay contacts 4 and 5, which are closed during each timing pulse, send 28 volts dc through closed contacts 4 and 5 of normal control relay K3812. The normal control relay is held in until the disappearance of the timing pulse allows blinker relay K3814 to be de-energized).

4–1059. When normal control relay K3812 is de-energized, its contacts 2 and 3 open, disconnecting slave relays K3801 and K3806 from timer relay K3815. No

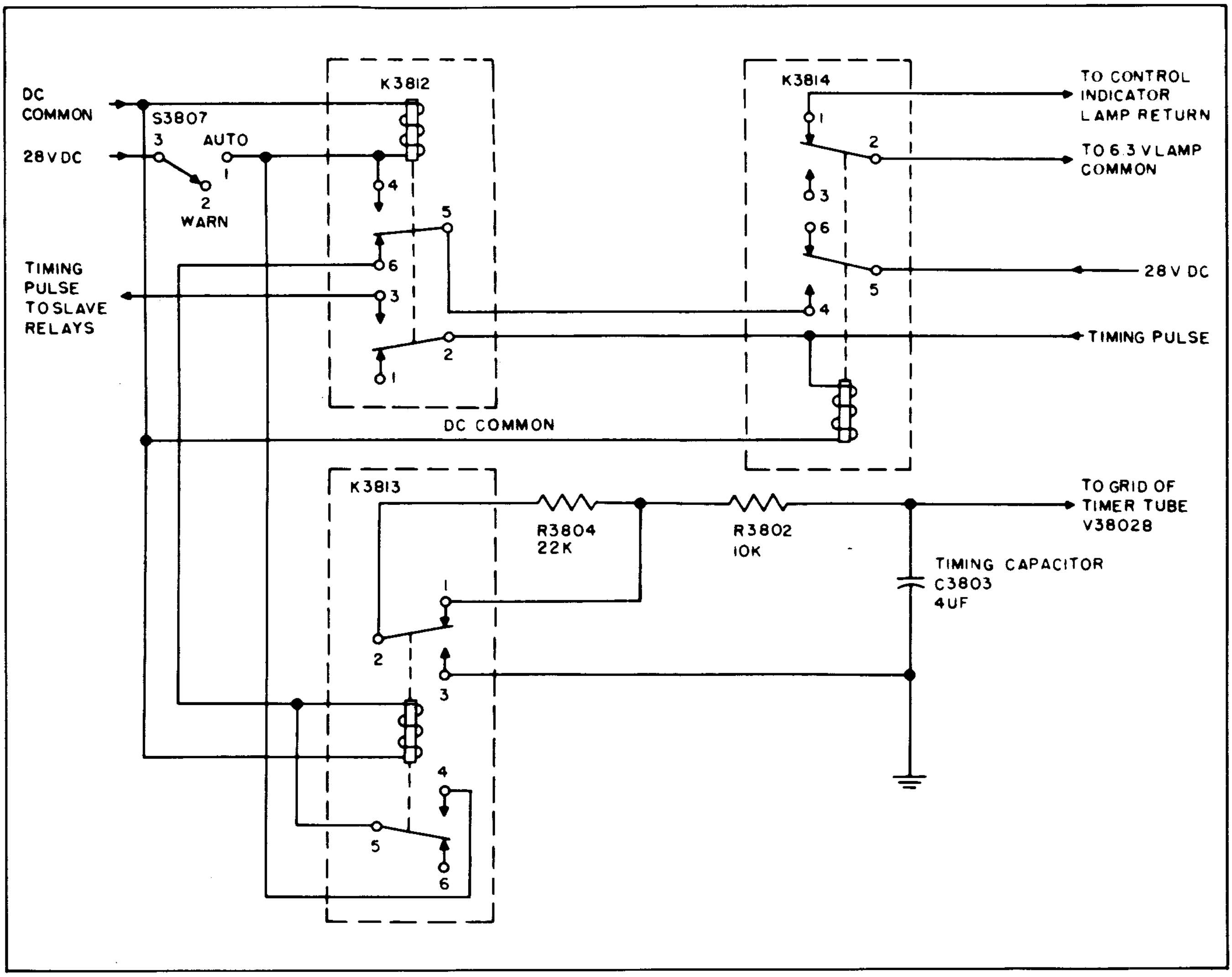


Figure 4–154. Extended Control Circuit, Time-sharing Master Control, Simplified Schematic Diagram

automatic sequencing can then occur, because timing pulses are withheld from the transfer and auxiliary relays. Contacts 5 and 6 of normal control relay K3812 close, so that when contacts 4 and 5 of blinker relay K3814 close during the next timing pulse, 28 volts dc is applied to the solenoid of extended control relay K3813.

4–1060. Contacts 4 and 5 of extended control relay K3813 close when the timing pulse is applied to the relay solenoid. Hold-in voltage, fed through contacts 4 and 6 of AUTO-WARN switch S3807 to contact 4 of relay K3813, holds the extended control relay closed. The hold-in voltage can be interrupted either by returning AUTO-WARN switch S3807 to the AUTO position or by energizing bypass relay K3811 (paragraph 4–1070).

4–1061. When extended control relay K3813 is energized, its contacts 2 and 3 close, placing a 110-kilohm shunt across timing capacitor C3803. The shunt consists of resistors R3802 and R3804 in series. Shunting the timing capacitor in this way (paragraph 4–1083) causes the timer to produce timing pulses at a rapid rate. These pulses do not reach the auxiliary relays, because contacts 2 and 3 of normal control relay K3812 are open (paragraph 4–1058). However, the pulses energize blinker relay K3814 as usual, causing its contacts 1 and 2 to open and close rapidly. These contacts are in the indicator return circuit for all control indicators on the time-sharing master control and RHD front panels. All lighted indicators then flash for the duration of the extended control period.

4–1062. In summary of the operation of the extended control circuits, consider a typical case. The time-sharing master control is set for automatic operation, with a 50-second control period. The sequence switches are set to give control to PPI's No. 1, No. 4, No. 2, and No. 3, in that order. The PPI No. 2 operator has had control for 30 seconds when he discovers that a 50-second control period is not sufficient to allow him to find the height of all targets in his sector of the sky. He signals this fact to the time-sharing master controller, who places the AUTO-WARN switch in the AUTO position. There are then 20 seconds remaining in the normal control period.

4–1063. Normal control relay K3812 is immediately de-energized and nothing more occurs until the 20 seconds remaining in the normal control period have elapsed. At the end of the 20-second period, timer relay K3815 produces a normal timing pulse. This pulse cannot reach the auxiliary relays because normal control relay K3812 is de-energized. However, the pulse energizes blinker relay K3814. This action energizes extended control relay K3813, which remains energized by the hold-in voltage. Closing extended control relay K3813 places a 110-kilohm shunt across timing capacitor C3803. The timer circuit then produces timing pulses at a rapid rate and each of these pulses momentarily energizes blinker relay K3814 and causes the amber indicators on all the RHD's and the time-sharing master control to flash. The flashing amber indicators inform all the PPI operators and the time-sharing master controller that the PPI No. 2 operator has been granted an extended period of azimuth control.

4–1064. Whenever normal control relay K3812 is energized, the time-sharing master control is in a normal control condition. Whenever extended control relay K3813 is energized, the time-sharing master control is in an extended control condition. Both relays cannot be energized at the same time.

4–1065. TERMINATION. There are three ways to end the extended control period. All three methods cause extended control relay K3813 to drop out and normal control relay K3812 to be energized.

4–1066. Normally, the PPI operator is the first person to know that he needs no further extended control time. This operator then throws antenna control switch S3601 (on his azimuth control overlay) to the PASS position. The extended control period ends immediately, and control is passed to the PPI operator next in sequence. The operation of the bypass circuit is described in paragraph 4–1070.

4–1067. A second method for ending an extended control period is to turn the relevant sequence switch to the PASS position. For example, assume that the PPI No. 4 operator, assigned to sequence No. 2, has extended control. If the SEQUENCE 2 switch is placed in the PASS position, control is immediately transferred to the PPI operator assigned to sequence No. 3. Either method of bypassing the PPI operator with extended control immediately ends the extended control period.

4–1068. It is possible to end the extended control period simply by returning AUTO-WARN switch S3807 to the AUTO position. In this case, there is a short delay before the extended control period is terminated. Figure 4–154 shows that returning switch S3807 to the AUTO position opens its contacts 4 and 6, removing the hold-in voltage from contact 4 of extended control relay K3813. The extended control relay then drops out. At the same time, contacts 1 and 3 of AUTO-WARN switch S3807 close, energizing normal control relay K3812. Control is transferred to the next sequence when the next timing pulse occurs. Because extended control relay K3813 is de-energized by placement of switch S3807 in the AUTO position, the shunt (paragraph 4-1061) is removed from timing capacitor C3803, and the timer pulse rate returns to its slower value. Since it is impossible at this point to determine the charge left on timing capacitor C3803 at the time that the AUTO-WARN switch was placed in the AUTO position, it is impossible to predict the time remaining before the next timing pulse occurs. The delay between the return of switch S3807 to the AUTO position and the transfer of control to the next sequence varies from almost none to the period designated by

INTERVAL SECS. control R3803. During this delay, the control indicators cease to flash, remaining lighted until control is transferred.

4–1069. BYPASS CIRCUIT. (See figure 4–155.)

4–1070. The bypass circuit performs two functions: exclusion of a particular PPI operator or operators from the time-sharing cycle, and termination of an extended control period. As an example of the first function, assume that the search radar is to be operated with a reduced complement of PPI operators and that the PPI No. 1 site is not to be used. Any one of the sequence switches can be placed in the PASS position and the remaining three switches set to the three applicable PPI positions. In such a case, each time-sharing cycle consists of only three sequences instead of the usual four. The same results can be accomplished by placing antenna control switch S3601 (on azimuth control overlay No. 1) in the PASS position.

4–1071. Assume that sequence No. 1 is in control and that it has delegated that control to the PPI No. 1 operator. The switching signal from transfer relay No. 1 (relay K3802) passes through contacts 21 and 23 of SEQUENCE 1 switch S3802 to the PPI No. 1 relay group in the junction box. If antenna control switch S3601 (on azimuth control overlay No. 1) is then placed in the PASS position, the ground return circuit for the PPI No. 1 relay group is interrupted by open contacts 4 and 6 of switch S3601. The PPI No. 1 relay group is de-energized, removing control from the PPI No. 1 operator. At the same time, the switching signal from SEQUENCE 1 switch S3802 passes through closed contacts 1 and 3 of antenna control switch S3601 on the azimuth control overlay to the solenoid of bypass relay K3811, energizing this relay.

4–1072. Bypass relay K3811 can also be energized by placing SEQUENCE 1 switch S3802 in the PASS position (figure 4–155). Contacts 21 and 22 of switch

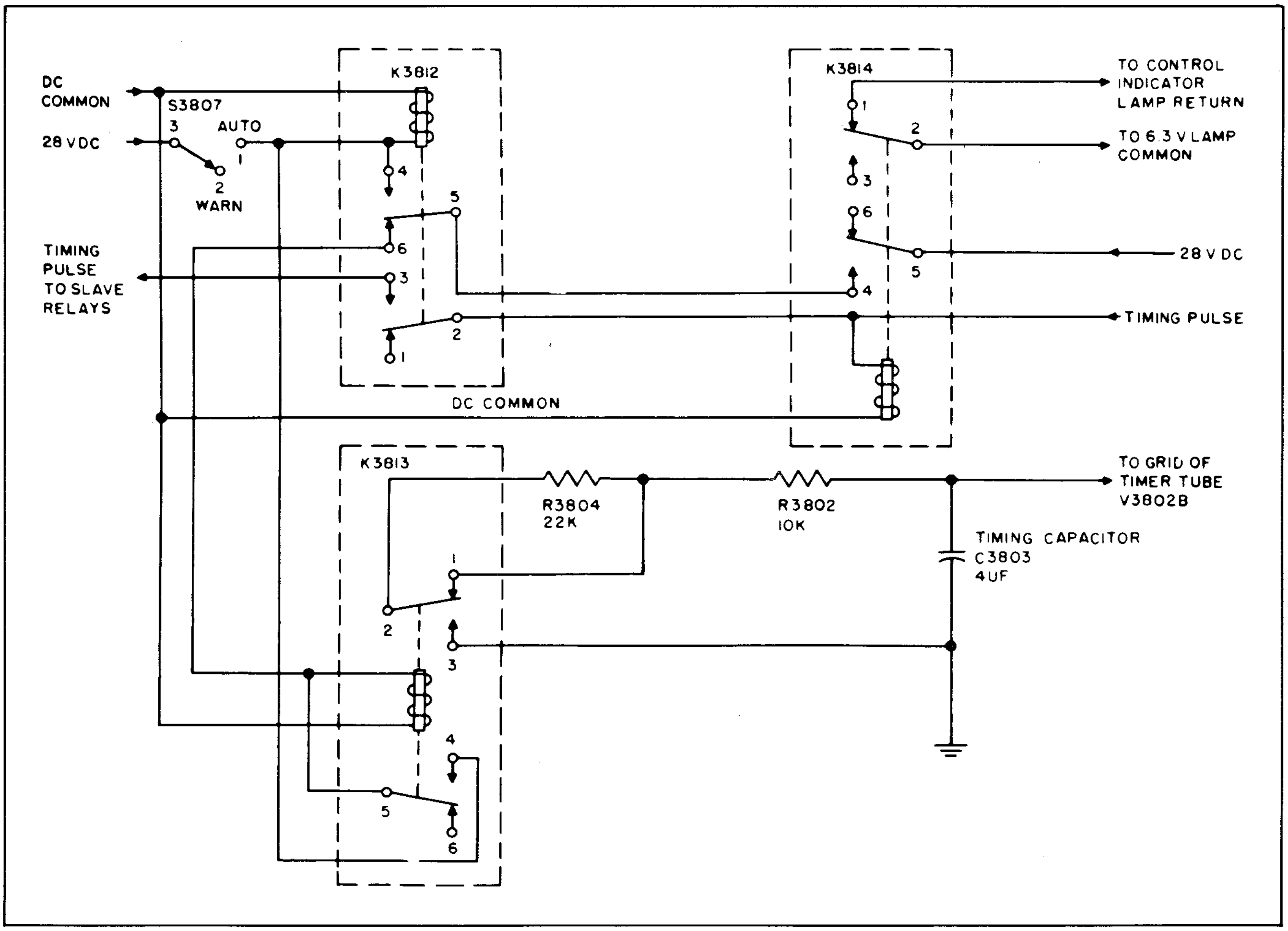


Figure 4–155. Bypass Circuit, Time-sharing Master Control, Simplified Schematic Diagram

S3802 then close, sending the switching signal directly to the solenoid of bypass relay K3811. If either switch S3601 or switch S3802 is closed before sequence No. 1 is given control, relay K3811 becomes energized as soon as transfer relay No. 1 (relay K3802) is energized. In this case, the PPI No. 1 operator does not receive control at all, since bypassing occurs immediately.

4–1073. After bypass relay K3811 has been energized, operation of the bypass circuit depends on the setting of AUTO-WARN switch S3807. With the switch in the AUTO position, normal control relay K3812 is energized and extended control relay K3813 is de-energized. When bypass relay K3811 becomes energized, its contacts 2 and 3 close, placing 10-kilohm resistor R3802 across timing capacitor C3803. The timing capacitor discharges very rapidly, causing a new timing pulse to be generated by the timer circuit (paragraph 4–1080). The new timing pulse travels through closed contacts 2 and 3 of normal control relay K3812 to slave relays K3801 and K3806. The pulse causes the auxiliary and transfer relays to advance control to the next sequence. Bypassing is thus accomplished.

4–1074. If AUTO-WARN switch S3807 is in the WARN position when a sequence switch is in the PASS position, extended control relay K3813 is energized and normal control relay K3812 is de-energized. When bypass relay K3811 is energized by the method described in paragraph 4-1071 or that described in paragraph 4–1072, its contacts 5 and 6 open, removing hold-in voltage from extended control relay K3813. Relay K3813 then drops out and contacts 4 and 5 of bypass relay K3811 close, energizing normal control relay K3812. Contacts 2 and 3 of bypass relay K3811 close, rapidly discharging timing capacitor C3803 as described in paragraph 4–1073. A new timing pulse is thereby produced which travels through closed contacts of normal control relay K3812 to the slave relays, and then to the transfer and auxiliary relays. The timing pulse causes control to be transferred to the next sequence.

4–1075. As soon as control has been transferred, the switching signal is removed from the sequence switch of the sequence just bypassed. This removes energizing voltage from the solenoid of bypass relay K3811. When the bypass relay drops out, its contacts 4 and 5 open and is energized. Thus, the circuit is returned to an extended S3807 in the WARN position, normal control relay K3812 is de-energized and extended control relay K3813 is energized. Thus the circuit is returned to an extended control condition. For this reason, it is generally desirable to return the AUTO-WARN switch to the AUTO position after an extended control period has been terminated by bypassing the PPI operator with extended control. Otherwise, the next sequence would also be granted extended control at the end of the normal control period.

4–1076. TIMER CIRCUIT. (See figure 4–156.)

4–1077. When TIMER switch S3808 is closed (figure 4–156), 120 volts ac is applied across the series combination of the solenoid of timer relay K3815, rectifier V3801B, and relay cutoff tube V3802B. Current flows through these elements during alternate half cycles of the 120 volts ac, energizing timer relay K3815. Contacts 4 and 5 of relay K3815 then close, applying 120 volts ac to the series combination of rectifier V3801A, resistor R3801, and timing capacitor C3803. The timing capacitor charges rapidly, with its charging current limited to a safe value by resistor R3801. The current flowing through timer tube V3802A during the charging period is negligible.

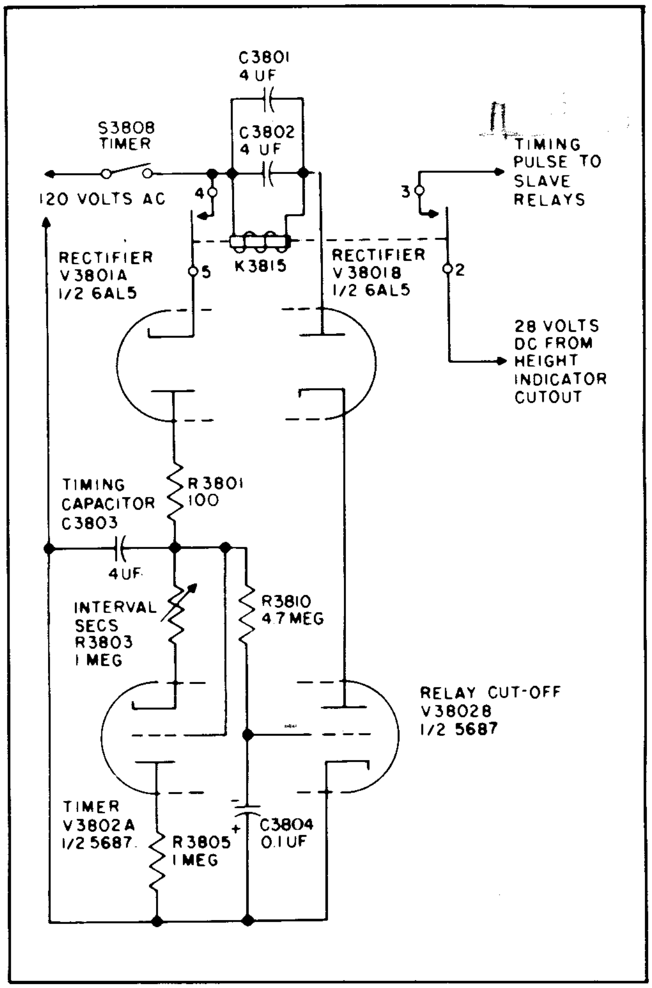


Figure 4–156. Timer Circuit, Time-sharing Master Control, Simplified Schematic Diagram

4–1078. Timing capacitor C3803 is in the grid circuit of relay cutoff tube V3802B. When the charge on the timing capacitor reaches the cutoff bias value for tube V3802B, the tube stops conducting. If it were not for delay capacitors C3801 and C3802, the timer relay would immediately be de-energized when the cutoff tube stopped conducting. However, while relay cutoff tube V3802B is conducting, delay capacitors C3801 and C3802 build up a charge. When relay cutoff tube V3802B stops conducting, the delay capacitors discharge through the solenoid of timer relay K3815, keeping it energized for about 40 milliseconds longer. During the 40-millisecond delay, timer capacitor C3803 continues to build up its charge to a value far in excess of the cutoff value for tube V3802B.

4–1079. When delay capacitors C3801 and C3802 become discharged, timer relay K3815 is de-energized, removing 120 volts ac from rectifier V3801A and timing capacitor C3803. The timing capacitor then begins to discharge slowly through timer tube V3802A, resistor R3805, and INTERVAL SECS. control R3803. The discharge rate of the timing capacitor is varied by adjusting INTERVAL SECS. control R3803.

4–1080. As timing capacitor C3803 discharges, its voltage eventually drops to a value which allows relay cutoff tube V3802B to start conducting again. When this tube conducts, it energizes timer relay K3815 again, timing capacitor C3803 begins to charge, and the sequence outlined in paragraphs 4–1077 through 4–1079 is repeated.

4–1081. The timer circuit causes timing relay K3815 to be energized for about 40 milliseconds every 20 to 90 seconds. Each time the relay is energized, its contacts 2 and 3 close, generating a short 28-volt d-c timing pulse which, during normal control periods, goes through the slave relays to the transfer and auxiliary relays to trigger a sequencing action.

4–1082. The interval between timing pulses is varied from 20 to 90 seconds by manipulating INTERVAL SECS. control R3803 to adjust the conductivity of timer tube V3802A. The INTERVAL SECS. control is a cathode bias resistor for tube V3802A.

4–1083. Under conditions of extended control or bypassing, other resistors are shunted across timing capacitor C3803. During extended control (paragraph 4–1061), resistors R3802 and R3804 are placed across the timing capacitor by extended control relay K3813. These resistors decrease the time constant of the discharge circuit and make the timer circuit go through its cycle at a much faster rate. The purpose of the accelerated pulse rate is to cause control indicators to flash by means of blinker relay K3814. When bypass relay K3811 is energized as described in paragraph 4–1071, its contacts 2 and 3 close, shunting 10-kilohm resistor R3802 across timing capacitor C3803. The shunt discharges capacitor C3803 almost immediately, causing a new timing pulse to be generated without delay. The shunt is removed as soon as the pulse has been delivered to the transfer relays.

4–1084. HEIGHT INDICATOR CUTOUT CIRCUIT.

4–1085. There are two sources of d-c voltage for the time-sharing master control. Terminal E of receptacle J3801 receives 28 volts dc from the control group assembly through the junction box. This voltage passes through the junction box without interference except for fuse F9714. The voltage operates most of the relays in the time-sharing master control; the remaining relays are operated by height indicator cutout voltage.

4–1086. Height indicator cutout voltage is 28 volts dc. This voltage enters the time-sharing master control through terminal F of receptacle J3801 and is controlled by height indicator cutout relay K9701 in the junction box (paragraph 4–1113). When either RHI operator takes azimuth control by closing AZIMUTH CONTROL switch S3904 on his azimuth switch box, height indicator cutout relay K9701 is energized. Contacts 1 and 2 of relay K9701 then open, disconnecting the height indicator cutout line to the time-sharing master control from the 28-volt d-c supply in the control group assembly.

4–1087. When height indicator cutout voltage is cut off, contacts 4 and 5 of timer relay K3815 (figure 4–153) can produce no timing pulses, even when the contacts are closed by the timer circuit. The transfer relays cannot become energized because there are no timing pulses. However, the transfer and auxiliary relays already energized (before height indicator cutout voltage is removed) are held in. MANUAL SELECT switch S3801 cannot energize any PPI relay groups in the junction box.

4–1088. When an RHI operator takes control with his azimuth switch box, the time-sharing master control is effectively disabled. If the time-sharing master control is in the automatic sequencing condition when the RHI operator takes control, the time-sharing master control returns control to the PPI operator last holding it as soon as height indicator cutout voltage is restored. Since the timer circuit remains in operation even with height indicator cutout voltage removed, the PPI operator to whom control is returned has an undetermined period of control which ends with the next timing pulse.

4–1089. INDICATOR OPERATION.

4–1090. There are five indicators on the front panel of the time-sharing master control. Indicators I3801 through I3804 are control indicators, each of a different color. Each control indicator signifies a particular PPI operator and lights when that operator has azimuth control. If the operator is granted extended control by the time-sharing master control, the indicator signifying that operator flashes for the duration of the extended control period. Each RHD has four similar indicators on its front panel. When an indicator on the time-sharing master control panel lights, its mate on each of the four RHD panels lights. The five blue indicators (one on the time-sharing master control and one on each RHD) are in parallel and light when the PPI No. 1 operator has control. The five amber indicators are in parallel and light when the PPI No. 2 operator has control. The green indicators light when the PPI No. 3 operator has control, and the white indicators light when the PPI No. 4 operator has control. This is true whether control is assigned automatically or manually.

4–1091. Indicator I3805 is the red TIMER indicator and lights whenever 120 volts ac is applied to the timer circuit. This indicator is in parallel with the filaments of the timer tubes and receives 6.3 volts ac from transformer T3801.

4–1092. The control indicator circuits are shown in figure 4–152. These circuits receive 6.3 volts ac either from MANUAL SELECT switch S3801 or from the sequence switches, depending on whether manual control or automatic sequencing is being used. When MANUAL SELECT switch S3801 is in the PPI 3 position, 6.3 volts ac travels from terminal N of receptacle J3801, through contacts 11 and 15 of MANUAL SELECT switch S3801, to green indicator I3802, signifying that the PPI No. 3 operator has control. The indicator voltage is also applied to terminal K of receptacle J3801, and thence to the green indicators on all RHD's (through the junction box).

4–1093. When MANUAL SELECT switch S3801 is in the AUTO position, 6.3 volts from terminal N of receptacle J3801 travels through closed contacts 11 and 12 of switch S3801 to contacts 1 of transfer relays K3802 through K3805. Each transfer relay energized sends this voltage through its contacts 1 and 2 to contact 11 of its associated sequence switch. The sequence switch sends the voltage to one of the control indicators on the front panel and to the corresponding indicator on each RHD (through the junction box).

4–1094. The return circuit for all the control indicators passes through normally closed contacts 1 and 2 of blinker relay K3814. The blinker relay is alternately energized and de-energized rapidly when the time-sharing master control is in the extended control condition (paragraph 4–1061). This causes the indicators receiving voltage from their sequence switches to flash rapidly, advising all operators that a particular PPI operator has extended control.

4–1095. JUNCTION BOX (TERMINAL BOX J-470/FPS-6 AND J-910/FPS-6B).

4–1096. GENERAL.

4–1097. The junction box is a distribution center for the azimuth, range, and height information of the radar. The junction box contains a total of 27 relays arranged in seven groups. Figure 4–157 identifies the member relays of each group and lists the functions of each group. The junction box also contains four RHI selector switches, one for each of four PPI positions, as well as ASB switch S9705.

4–1098. One relay group controls each PPI position. The function of the relay group (figure 4–157) is to connect the azimuth control overlay of the PPI position into the antenna azimuth servo system. The relay group also connects the RHD of each PPI position to the RHI of the height-finding radar and clears the RHD height dials at the beginning of the control period. Each PPI relay group is energized by a 28-volt d-c switching signal from the time-sharing master control.

4–1099. Height indicator cutout relay K9701 disables the time-sharing master control whenever an azimuth switch box takes over azimuth control. The relay is energized through one-half of the AZIMUTH CONTROL switch on each azimuth switch box and supplies 28 volts dc to the other half of the AZIMUTH CONTROL switch on each azimuth switch box so that either can energize the associated azimuth switch box relay group.

4–1100. Each azimuth switch box relay group can be energized by one-half of the AZIMUTH CONTROL switch of the respective azimuth switch box. Each of these relay groups connects the respective azimuth switch box into the antenna azimuth servo system.

Group	Relays	Function
PPI No. 1	K9712, K9713,	Channel azimuth stator signals from antenna selsyns to selsyns in overlay No. 1.
	K9714	Channel azimuth error signals from rotors of overlay selsyns to servo amplifier in control group assembly.
		Channel absolute and relative height selsyn stator signals from selsyn generators in RHI to control transformers in RHD No. 1.
		Channel absolute-relative relay voltage from RHI to RHD No. 1 height relay.
	K9710, K9711	Acting together, momentarily interrupt 28 volts dc on height data lock line going to RHD No. 1. Interruption clears height relays in RHD No. 1.
		Channel range data from PPI No. 1 to RHI.
		Provide 28 volts dc for relative height brake in RHD No. 1.
		Channel 6.3 volts ac to control indicator bullseye on overlay No. 1.
PPI No. 2	K9715, K9716, K9717	Same as relays K9712 through K9714 in PPI position No. 2.
	K9708, K9709	Same as relays K9710 and K9711 in PPI position No. 2.
PPI No. 3	K9718, K9719	Same as PPI No. 1 group in PPI position No. 3.
	K9720, K9706, K9707	
PPI No. 4	K9721, K9722, K9723	Same as PPI No. 1 group in PPI position No. 4.
	K9704, K9705	

Figure 4–157. Junction Box Relays (Sheet 1 of 2)

Group	Relays	Function
Height cutout	K9701	Removes 28 volts dc (height indicator cutout) from time-sharing master control. As a result, no PPI position can obtain azimuth control when relay K9701 is energized.
		Removes 6.3 volts ac from time-sharing master control for PPI indicators.
		Supplies 28 volts dc to both switch boxes to energize one or the other set of azimuth switch box relay groups.
Azimuth switch box No. 1	K9703	Disables azimuth switch box No. 2 relay group.
		Supplies 120-volt a-c slewing voltage to azimuth switch box No. 1.
	K9724, K9725	Channel azimuth stator signals from antenna selsyn stators to overlay switch box No. 1 control transformer stators.
		Channel azimuth error signals from switch box control transformer rotors to azimuth servo amplifier in control group assembly.
		Channel 6.3 volts ac to AZIMUTH CONTROL indicator on switch box No. 1.
Azimuth switch box No. 2	K9702	Same as switch box No. 1 relay group in switch box No. 2.
	K9726, K9727	

Figure 4–157. Junction Box Relays (Sheet 2 of 2)

4–1101. Radar Set AN/FPS-6 normally operates with one RHI and one azimuth switch box. However, since there are two azimuth switch box relay groups, two RHI's and two azimuth switch boxes can be used with the system, if desired. The ASB switch adapts the junction box for either mode of operation. If only one azimuth switch box is to be used, the ASB switch must be placed in the ASB 1 position and the azimuth switch box connected to receptacles J9703 and J9704 of the junction box. If two switch boxes are to be used, the switch is placed in the ASB 1 & 2 position and the second azimuth switch box is connected to receptacles J9716 and J9717.

4–1102. The RHI selector switches, S9701 through S9704, are covered in detail later in this discussion. If two RHI's are used with Radar Set AN/FPS-6, the selector switches team each of the PPI operators with one or the other of the two RHI operators.

4–1103. PPI RELAY GROUPS.

4–1104. GENERAL. Figure 4–158 shows the PPI No. 1 relay group. The other three PPI relay groups are functionally identical. The PPI No. 1 relay group must

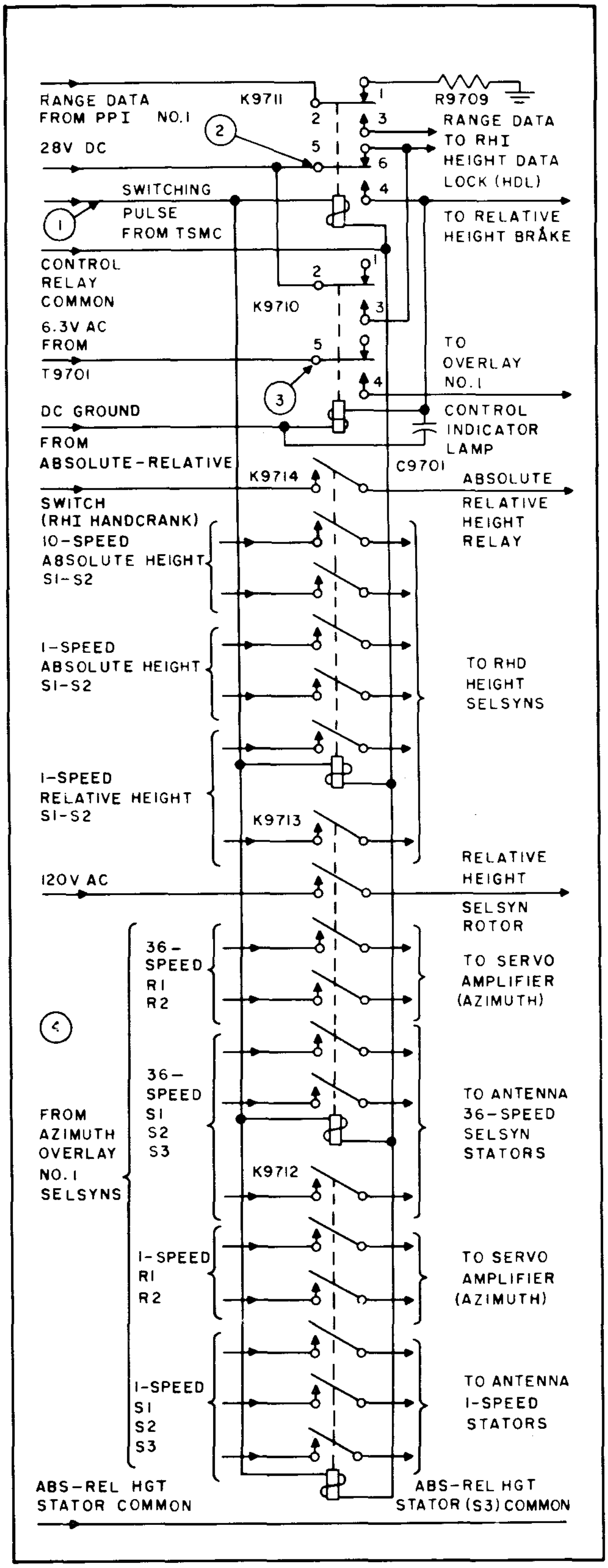


Figure 4–158. PPI No. 1 Relay Group, Junction Box, Simplified Schematic Diagram

be energized in order that the PPI No. 1 operator can have use of the height-finding radar. Similarly, the PPI No. 2 relay group must be energized in order that the PPI No. 2 operator can have control, and so on for the PPI No. 3 and 4 relay groups. Only one of these relay groups can be energized at any one time.

4–1105. Each PPI relay group is energized by a 28-volt d-c switching signal from the time-sharing master control. The switching signal for the PPI No. 1 relay group enters the junction box through terminal P of receptacle J9710. Similarly, the switching signal for the PPI No. 2 relay group enters through terminal Q; for the PPI No. 3 relay group, through terminal R; and for the PPI No. 4 relay group, through terminal S. All of these terminals are on receptacle J9710. The return path for these switching signals is through overlay pass switches to d-c ground of terminal D of receptacle J3810.

4–1106. AZIMUTH CONTROL BY PPI OPERATORS. Each PPI relay group gives each PPI operator azimuth control of the height-finding antenna as shown in figures 4–158 and 7–26. The 1- and 36-speed stator signals from the selsyn generators at the antenna are channeled through closed contacts of relays K9712 and K9713 to the stators of the control transformers of azimuth control overlay No. 1. The 1- and 36-speed error signals from the rotors of the azimuth control overlay control transformer are channeled through contacts of relays K9712 and K9713 to the servo amplifier in the control group assembly. The output of the servo amplifier is applied to the control winding of an amplidyne generator, and the output of this generator is fed to the azimuth drive motor. The motor positions the antenna in azimuth to correspond to the position of the overlay or switch box selsyns in control.

4–1107. RANGE DATA TRANSMISSION. There are four range strobe inputs, one from each PPI. When energized, a PPI relay group channels the associated range strobe to the RHI. When the PPI No. 1 relay group is energized, the range strobe from PPI No. 1 passes through closed contacts 2 and 3 of relay K9711 to the RHI. When the PPI No. 1 relay group is de-energized, the range strobe passes through closed contacts 1 and 2 of relay K9711 to resistor K9709. This resistor terminates the coaxial cable with the proper terminal impedance, thereby preventing reflections in the coaxial line which might interfere with the pattern on the PPI screen.

4–1108. HEIGHT DATA TRANSMISSION. When a PPI relay group is energized, the absolute and relative height selsyn stator signals are channeled from the RHI to the RHD of the PPI position associated with that relay group (figures 4–158 and 7–24). If PPI No. 1 is in control, the height data passes through the closed contacts of relays K9713 and K9714. The absolute height stator signals position a servomechanism as described in paragraph 4–973, while the relative height stator signals position a selsyn follower in the RHD. Contacts 10 and 14 of relay K9713 provide 120 volts ac to excite the rotor of the selsyn follower when the PPI No. 1 relay group is energized.

4–1109. RHD HEIGHT RELAY CONTROL. Details of the operation of the relay circuits in the RHD are given in paragraph 4–973.

4–1110. When the RHI operator pushes in his hand crank to transmit relative height data, a switch is automatically closed in the RHI. This switch applies 28 volts dc to terminal U of receptacle K9701 in the junction box. The absolute-relative height switching signal passes through contacts 10 and 14 of relay K9714 when the PPI No. 1 relay group is energized (figure 4–158). The signal then goes to the RHD at PPI No. 1 and energizes the absolute-relative height relay in the RHD. This locks the absolute height display and prepares the RHD to receive relative height information. When the RHI operator releases his handcrank, the 28 volts is removed and the absolute-relative height relay in the RHD is de-energized. The relative height dial then locks and the absolute height dial remains locked.

4–1111. If an RHD receives height information during a previous control period, the dials of the RHD are locked. These dials must be cleared before new height information can be received. When a PPI relay group energizes, the group automatically clears the associated RHD height dials by momentarily interrupting the 28 volts dc at the height data lock line shown in figure 4–158. When the PPI No. 1 relay group is energized, contacts 5 and 6 of relay K9711 open, removing 28 volts dc from the height data lock line. This voltage is applied through contacts 4 and 5 of relay K9711 to the solenoid of relay K9710. After a short delay caused by the charging of capacitor C9701, relay K9710 energizes. Contacts 2 and 3 of relay K9710 then close, returning 28 volts dc to the height data lock line. This brief interruption allows all relays in the RHD to drop out, unlocking both height displays.

4–1112. CONTROL INDICATORS. Each azimuth control overlay has a control indicator which lights when the overlay has azimuth control. When the PPI No. 1 relay group is energized 6.3 volts ac is fed through contacts 4 and 5 of relay K9710 to the overlay at the PPI No. 1 position. Equivalent relays perform the same function for the other PPI positions when the associated relay groups are energized. The control indicators on the RHD's receive voltages from the time-sharing master control. These voltages pass through the junction box, but are not controlled by any junction box relays.

4–1113. HEIGHT INDICATOR CUTOUT RELAY. (See figure 4–159.)

4–1114. Height indicator cutout relay K9701 serves two purposes. When energized by either of the azimuth

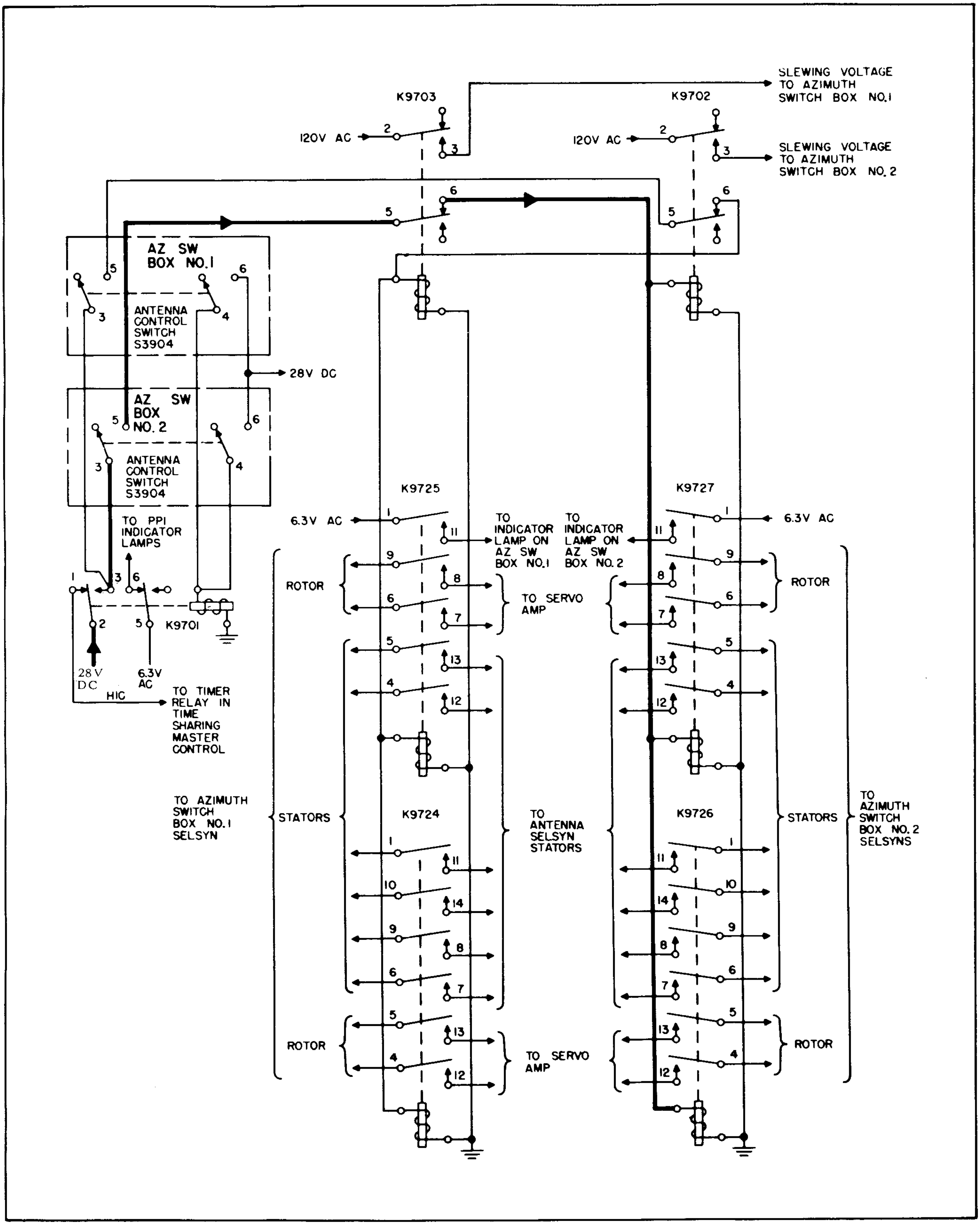


Figure 4–159. Azimuth Control by RHI Operator in Radar Set AN/FPS-6, Simplified Schematic Diagram

switch boxes, the relay disables the time-sharing master control by removing the 28-volt d-c height indicator cutout voltage, thereby reserving azimuth control for either of the azimuth switch boxes. Relay K9701 also removes the 6.3-volt a-c indicator voltage from the time-sharing master control so that none of the control indicators on the RHD's or on the time-sharing master control can light.

4–1115. Relay K9701 is energized whenever AZIMUTH CONTROL switch S3904 in either azimuth switch box is closed. Contacts 4 and 6 of switch S3904 in azimuth switch box No. 1 are in parallel with the same contacts in azimuth switch box No. 2. When either switch is closed, 28 volts dc is fed through contacts 4 and 6 of switch S3904 to the junction box, energizing relay K9701. Contacts 1 and 2 of relay K9701 open, removing 28 volts dc from the height indicator cutout line (figure 4–159). This voltage is then fed through contacts 2 and 3 of relay K9701 and back to contact 3 of the AZIMUTH CONTROL switch in both azimuth boxes. As a result, each azimuth switch box is provided with a voltage to energize the associated relay group.

4–1116. Normally closed contacts 5 and 6 of relay K9701 carry the voltages for the control indicators in the time-sharing master control and the four RHD's. When relay K9701 is energized, these contacts open, opening the indicator circuits.

4–1117. Figure 4–159 shows both azimuth switch box relay groups. Each group consists of two relays, as shown in figure 4–157. When energized, either group connects the selsyns of the associated azimuth switch box into the antenna servo loop in the same way that the PPI relay groups connect the azimuth control overlay selsyns into the loop. Figure 7–26 shows the detailed circuits of this operation. With the selsyns connected into the antenna servo system, the azimuth switch box has control of the antenna in azimuth.

4–1118. When energized, each relay group feeds 6.3 volts ac to the azimuth switch box, lighting a control indicator on the switch box front panel (figure 4–159). Each group also feeds 120 volts ac to the azimuth switch box to be used as continuous rotation, or slewing voltage when the CONT. ROT. switch is closed. Continuous rotation is discussed in paragraph 4–1138.

4–1119. Only one of the azimuth switch box relay groups can be energized at any one time. If one group is energized, the other group cannot be energized until the first is de-energized.

4–1120. When AZIMUTH CONTROL switch S3904 of azimuth switch box No. 1 is closed, contacts 3 and 5 of the switch send 28 volts dc to the solenoids of relay K9724 and K9725. Reference to figure 4–159 shows that this voltage must pass through normally closed contacts 5 and 6 of relay K9727. As a result, if relay K9727 of relay group No. 2 is energized, group No. 1 cannot be energized. If switch S3904 of azimuth switch box No. 2 is closed, contacts 3 and 5 apply 28 volts dc to azimuth switch box No. 2 relay group, provided that the No. 1 group is not energized.

4–1121. PROVISION FOR AZIMUTH SWITCH BOX NO. 2

4–1122. ASB switch S9705 (figure 4–160) is a two-position wafer switch. This switch functions to adapt the junction box for operation with either one or two azimuth switch boxes.

4–1123. Normal operation of the Radar Set AN/FPS-6 system requires only one azimuth switch box; therefore, only one of these components is furnished with each installation. The junction box circuit, however, provides for operation with two azimuth switch boxes, when desired.

4–1124. When only one azimuth switch box is used, this box must be connected to receptacles J9703 and J9704 and ASB switch S9705 placed in the ASB 1 position. This switch completes elevation control circuits which are normally completed by contacts of switches S3901, S3902, and S3905 in the second azimuth switch box. These elevation control circuits must be completed for the antenna to scan in elevation.

4–1125. When two azimuth switch boxes are used, the second is connected to receptacles J9716 and J9717 of the junction box. ASB switch S9705 must then be placed in the ASB 1&2 position.

4–1126. RHI SELECTOR SWITCHES. (See figure 4–161.)

4–1127. Normal operation of Radar Set AN/FPS-6 calls for two RHI's which are furnished with each installation. Under certain circumstances, the use of only one RHI may be desirable and feasible.

4–1128. RHI selector switches S9701 through S9704 team each PPI position with either of the two RHI's, when two are used. Figures 4–161 and 7–24 show the circuit details of these switches. Each switch contains two wafers, each consisting of four segments which are single-pole, double-throw switches. The moving contact of each switch segment is connected to an RHD: switch S9701 to RHD No. 1, switch S9702 to RHD No. 2, and so on. One stationary contact of each switch segment is connected to RHI No. 1; the other stationary contact of each switch segment is connected to RHI No. 2.

4–1129. If PPI No. 1 is to be teamed with RHI No. 1, switch S9701 is placed in the position shown in figure 4–161. The range strobe from PPI No. 1 passes through contacts 2 and 12 of switch S9701A to RHI No. 1. Absolute-relative height relay voltage from the hand-crank switch in RHI No. 1 passes through contacts 3 and 5 of switch S9701A to RHD No. 1. Absolute and relative height stator signals from the height selsyns in RHI No. 1 pass through switch sections A and B to RHD No. 1. All of these signals, including the

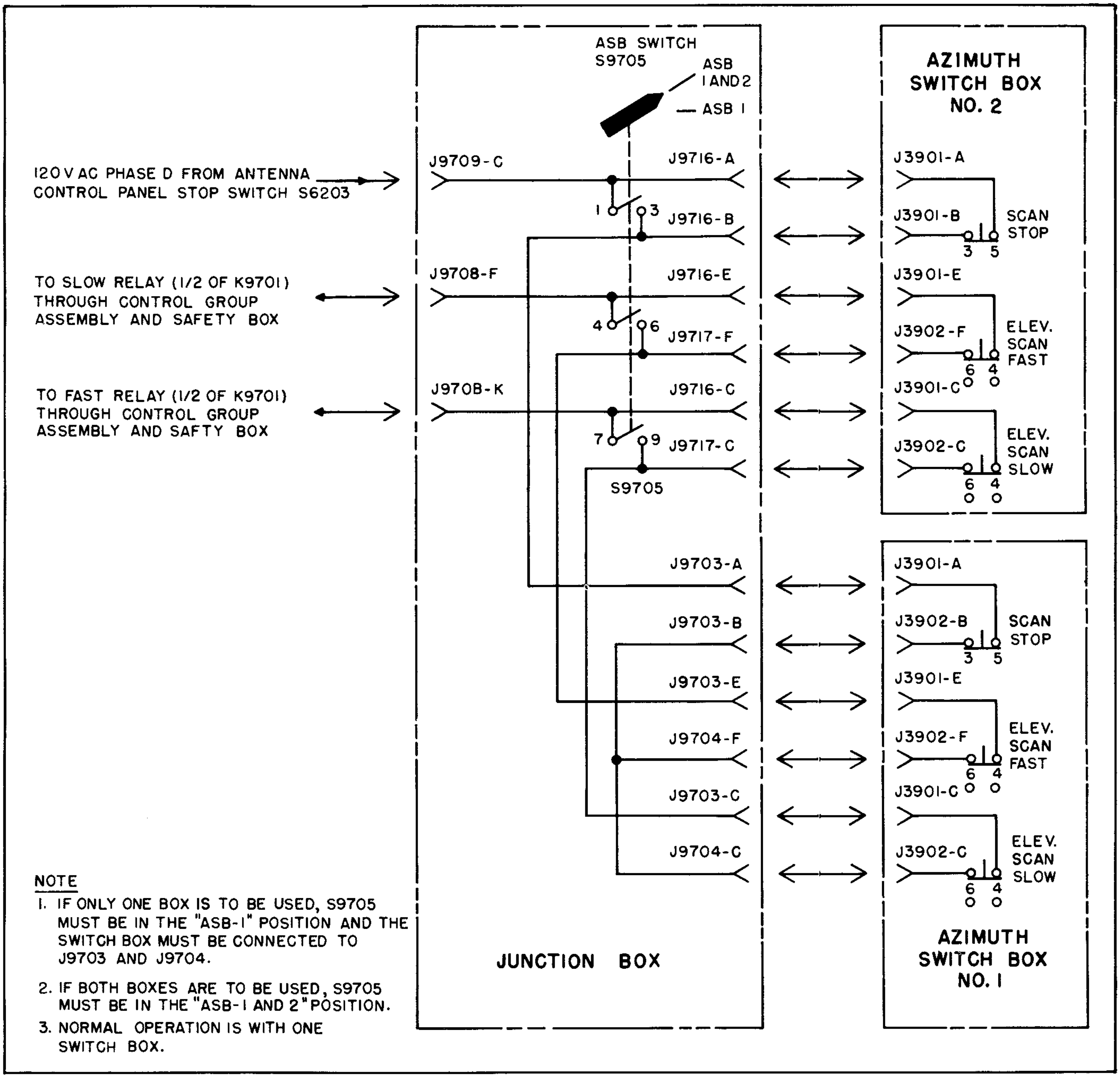


Figure 4–160. Azimuth Switch Box No. 2 Cutout, Simplified Schematic Diagram

range strobe and relay voltage, pass through contacts of the PPI No. 1 relay group before reaching RHD No. 1, with the exception of the S3 stator leads. The S3 leads of all height selsyns are connected together and are called stator common S3.

4–1130. AZIMUTH SWITCH BOX (CONTROL, ANTENNA C-1048/FPS-6).

4–1131. GENERAL. (See figures 4–162 and 4–163.)

4–1132. The azimuth switch box provides the RHI operator with elevation control of the height-finding antenna at all times as well as with the option of assuming azimuth control, if desired. The elevation controls allow the RHI operator to place the antenna in either slow or fast nodding, or to stop the elevation scan entirely. These controls duplicate the controls available to the maintenance personnel and the operating crew of the associated search radar by means of azimuth control overlays and an antenna control panel. Indicators show whether the antenna is nodding at the slow or fast rate.

4–1133. AZIMUTH CONTROL. (See figure 7–125.)

4–1134. AZIMUTH CONTROL SWITCH S3904. The RHI operator can take over control of the antenna by

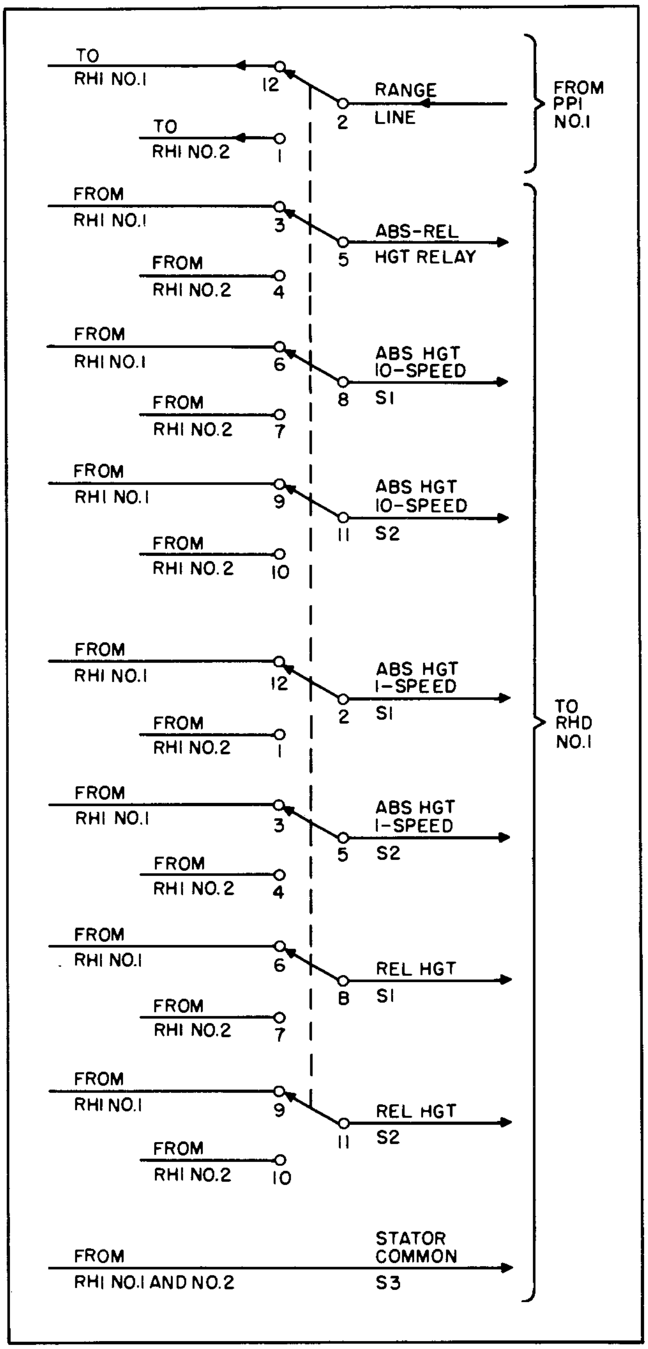


Figure 4–161. RHI Selector Switch, Junction Box, Simplified Schematic Diagram

placing AZIMUTH CONTROL switch S3904 in the ON position. Contacts 4 and 6 of switch S3904 then close, applying 28 volts dc to the solenoid of height indicator cutout relay K9701 in the junction box. This relay energizes, removing height indicator cutout voltage (28 volts dc) from the time-sharing master control and applying 28 volts dc to contact 3 of AZIMUTH CONTROL switch S3904 in both azimuth switch boxes.

4–1135. With height indicator cutout voltage removed, the time-sharing master control is disabled. As a result, no PPI operator is able to obtain azimuth control when the AZIMUTH CONTROL switch on either azimuth switch box is in the ON position. Contacts 5 and 6 of height indicator cutout relay K9701 open when the relay is energized. Thus, 6.3 volts ac is removed from the time-sharing master control so that none of the control indicators on the time-sharing master control or the RHD's can light.

Element	Title	Function
B3901	1-speed selsyn control transformer	Feeds coarse azimuth error signal to servo amplifier when switch S3904 is closed.
B3902	36-speed selsyn control transformer	Feeds vernier azimuth error signal to servo amplifier when switch S3904 is closed.
I3901	ELEV. SCAN SLOW indicator	Lights when antenna is in slow elevation scan.
I3902	ELEV. SCAN FAST indicator	Lights when antenna is in fast elevation scan.
I3903	Dial lamp	Lights AZIMUTH dial.
I3904	AZIMUTH CONTROL indicator	Lights when RHI operator assumes azimuth control.
S3901	ELEV. SCAN SLOW switch	When depressed, places antenna in slow elevation scan.
S3902	ELEV. SCAN FAST switch	When depressed, places antenna in fast elevation scan.
S3903	CONT. ROTATION switch	In CW position, antenna rotates clockwise at a constant 90 degrees per minute. In CCW position, antenna rotates counterclockwise at a constant 90 degrees per minute. Center position is OFF.
S3904	AZIMUTH CONTROL switch	In ON position gives RHI operator azimuth control of antenna.
S3905	SCAN STOP switch	When depressed, causes antenna nodding to cease.

Figure 4–162. Elements of Azimuth Switch Box

4–1136. The AZIMUTH CONTROL switch that is turned to the ON position energizes height indicator cutout relay K9701. This relay applies 28 volts dc, through closed contacts 3 and 5 of AZIMUTH CONTROL switch S3904, to the corresponding azimuth switch box relay group in the junction box (figure 4–159). An azimuth switch box gains control of the height-finding antenna in azimuth when the box energizes the associated relay group.

4–1137. MANUAL AZIMUTH CONTROL. With AZIMUTH CONTROL switch S3904 in the ON position, the RHI operator has manual control of the antenna. By turning the handcrank on the azimuth switch box, the operator can rotate the antenna to any desired azimuth. The azimuth is indicated by a counter on the

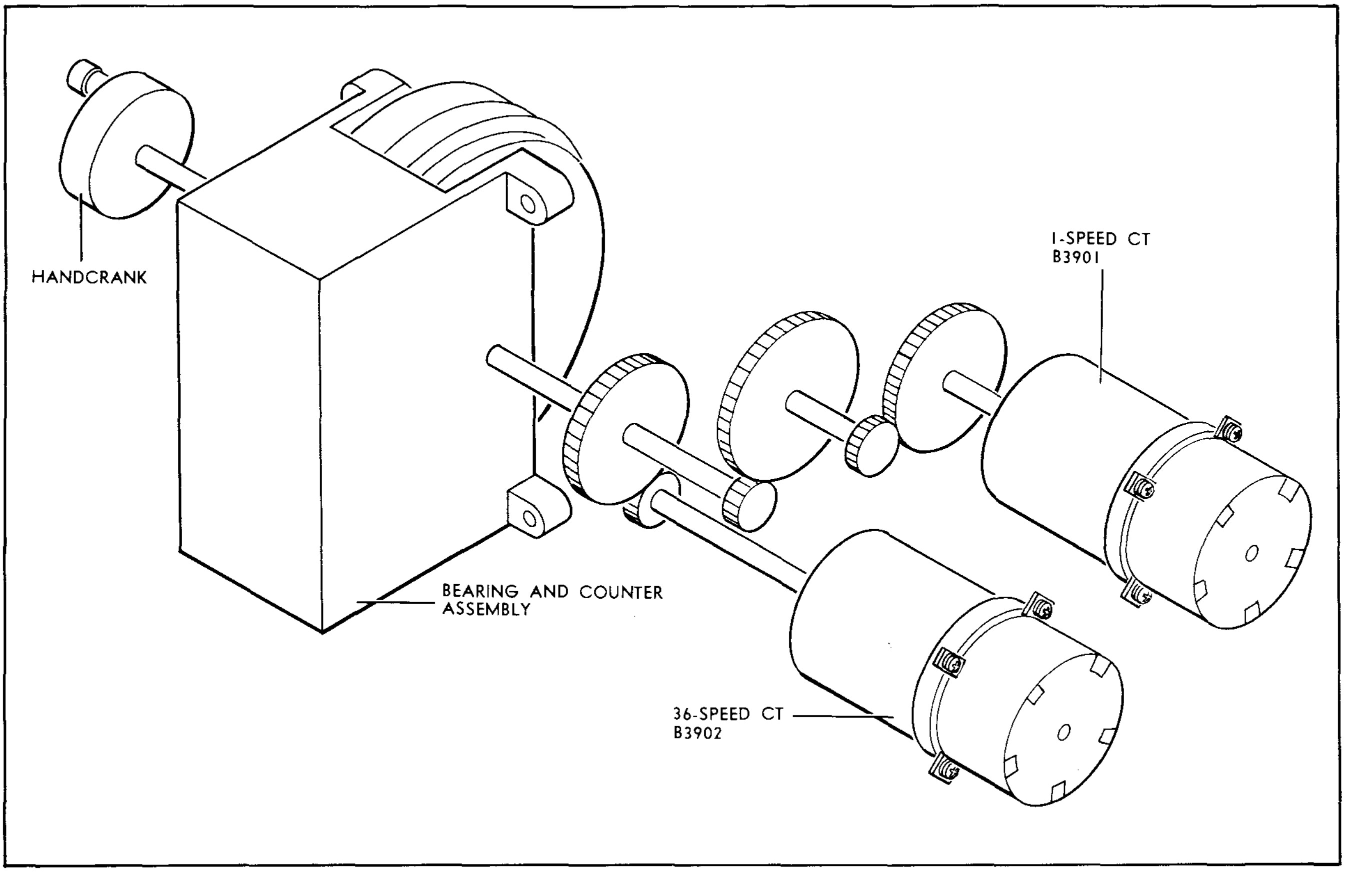


Figure 4–163. Azimuth Switch Box, Mechanical Schematic Diagram

front panel which is illuminated when the operator has control. The handcrank is geared to two selsyn control transformers. These selsyns are identical to those in the azimuth control overlays. When an azimuth switch box relay group in the junction box is energized, the selsyns of the corresponding azimuth switch box are placed into the antenna servo system. Figure 4–159 shows the relay groups.

4–1138. CONTINUOUS ROTATION. (See figure 4–164.) The RHI operator can cause the height-finding antenna to rotate continuously in azimuth in either direction. The operator accomplishes this by placing AZIMUTH CONTROL switch S3904 in the ON position and CONT. ROTATION switch S3903 in either the CW or CCW position. The antenna rotates a constant speed of either 60 or 90 degrees per minute, depending on whether a jumper is placed across terminals 6 and 7 of terminal board TB6001 in the servo amplifier. If switch S3903 is placed in the CW position, the antenna rotates clockwise; if the switch is placed in the CCW position, the antenna rotates counterclockwise.

4–1139. When AZIMUTH CONTROL switch S3904 is placed in the ON position, the corresponding azimuth switch box relay group is energized. This relay group then sends 120 volts ac to the azimuth switch box. The voltage is applied to terminals 3 and 4 of CONT ROTATION switch S3903.

4–1140. If the RHI No. 1 operator desires the antenna to rotate continuously clockwise, he places AZIMUTH CONTROL switch S3904 in the ON position and turns CONT ROTATION switch S3903 to the CW position. This energizes relay K9703 in the azimuth switch box No. 1 relay group located in the junction box. Contacts 2 and 3 of relay K9703 then close, channeling 120 volts ac to terminal 3 of CONT ROTATION switch S3903 in azimuth switch box No. 1. Terminal 4 of this switch is connected to the 120-volt a-c neutral. When switch S3903 is placed in the CW position, contacts 3 and 5 and contacts 4 and 6 of switch S3903 close. This applies 120 volts ac to the servo amplifier in the control group assembly through the junction box. Relay K6002 in the servo amplifier energizes, disconnecting the azimuth switch box selsyns from the amplifier and applying the 120 volts ac to the amplifier. The amplifier then becomes saturated, causing the antenna to rotate at a constant speed.

4–1141. If CONT ROTATION switch S3903 is placed in the CCW position, the operation described in paragraph 4–1140 occurs. However, the 120 volts ac is applied to the servo amplifier 180 degrees out of phase from that applied with the switch in the CW position. Switch S3903 performs a reversing function.

4–1142. The center position of CONT. ROTATION switch S3903 is the off position. The switch is a double-pole, double-throw toggle switch.

4–1143. ELEVATION CONTROL.

4–1144. The three elevation controls include ELEV. SCAN SLOW switch S3901, ELEV. SCAN FAST switch S3902, and ELEV SCAN STOP switch S3905. These three switches are functionally identical to the controls on the antenna control panel in the control group assembly. Refer to paragraph 4–1706 for a detailed analysis of the elevation control circuits.

4–1145. INDICATORS.

4–1146. There are three indicators on the front panel of the azimuth switch box. AZIMUTH CONTROL indicator I3804 receives 6.3 volts ac from contact 11 of relay K9725 in the junction box (azimuth switch box No. 1) or from contact 11 of relay K9727 in the junction box (azimuth switch box No. 2). The dial illumination indicator, I3903, for the azimuth counter is lighted by the same voltage. The intensity of indicator I3903 is varied by DIMMER control R3903. When AZIMUTH CONTROL switch S3904 is turned

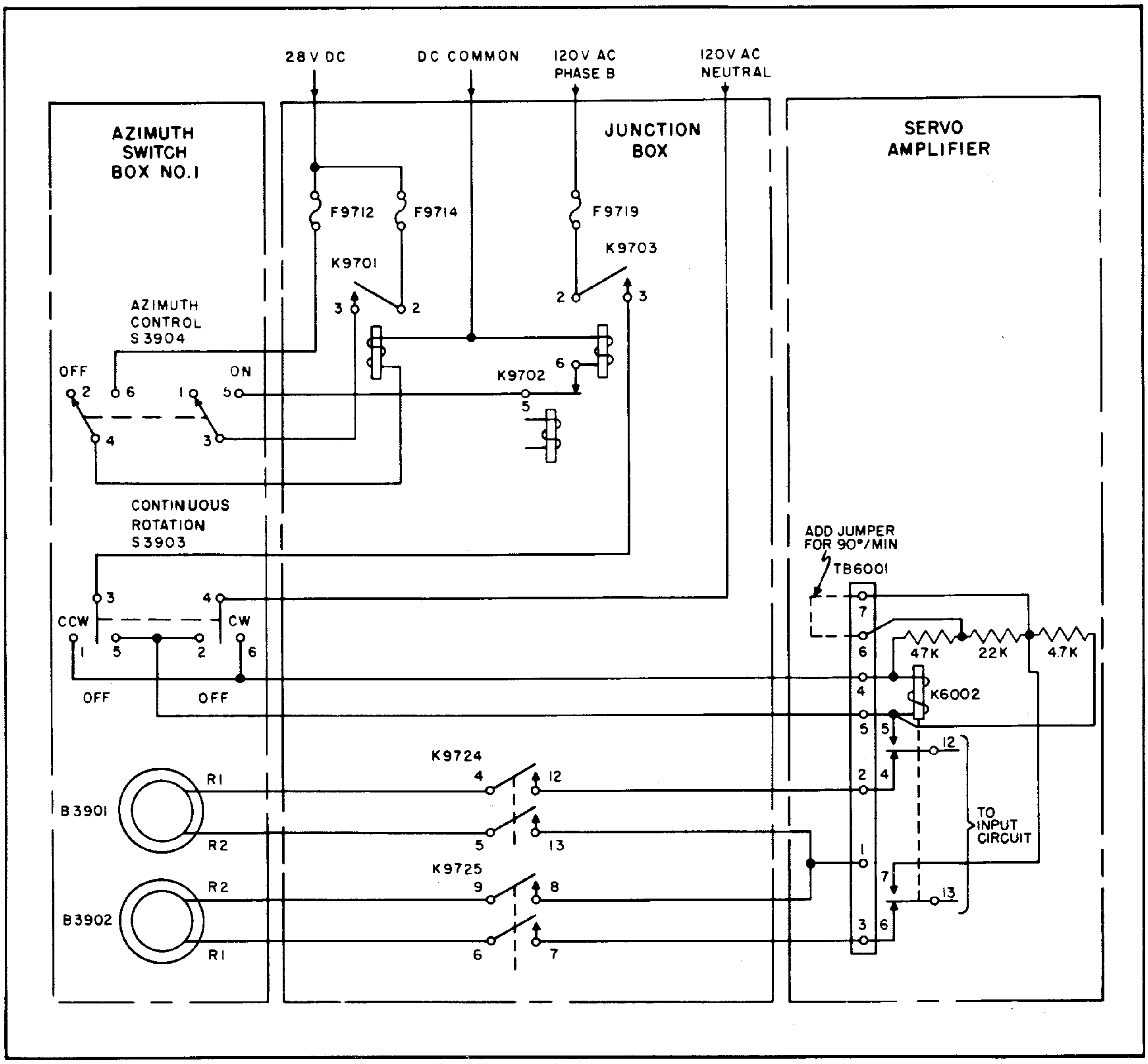


Figure 4–164. Slewing Controls, Azimuth Switch Box, Simplified Schematic Diagram

to the ON position, both the AZIMUTH CONTROL indicator and the counter illumination indicator light.

4–1147. ELEV SCAN FAST indicator I3902 lights when ELEV SCAN FAST switch S3902 is pushed. Contacts 1 and 3 of switch S3902 close, applying 120 volts ac to indicator I3902 through resistor R3902. This causes the fast relay in the control group assembly to energize and remain energized. The fast relay sends 120 volts ac through terminal D of receptacle J3902 to indicator I3902 to keep it lit.

4–1148. ELEV SCAN SLOW indicator I3901 is lighted by ELEV SCAN SLOW switch S3901 and by the slow relay in the control group assembly in the same manner that indicator I3902 is lighted (paragraph 4–1147).

4–1149. AZIMUTH BLANKER (BLANKER, INTERFERENCE MX-1739A/FPS-6).

4–1150. GENERAL.

Note

Radar Set AN/FPS-6A contains two chassis that perform blanking operations. The interference blanker (Blanker, Interference MX-1316/FPS-6) is used with both Radar Sets AN/FPS-6 and AN/FPS-6A. Functionally, the interference blanker is part of the video system. The azimuth blanker (Blanker, Interference MX-1739A/FPS-6) is used with Radar Set AN/FPS-6 only. Functionally, the azimuth blanker is a part of the azimuth positioning system.

4–1151. The azimuth blanker prevents the radar from transmitting whenever the antenna enters an azimuth where r-f radiation could disturb a local activity. Blanking may be necessary, for example, to prevent radiation on aircraft refueling facilities, to prevent interference between Radar Set AN/FPS-6A and adjacent radars, or to prevent interference with microwave communications. The width of the blanked sector can be adjusted from ±5 to ±45 degrees about the center. The center is continuously variable in azimuth and can be set by a front panel control.

4–1152. Operators are advised of the blanked sectors and do not request the heights of targets in these sectors. However, the antenna often passes through a blanked sector in rotating to some other azimuth. When the antenna enters a sector in which blanking is desired, the high voltage is lowered to a level at which the magnetron no longer oscillates. Lowering the high voltage prevents radiation in the sector. Since a prolonged period of reduced voltage can damage the magnetron, the antenna is given a maximum of 5 seconds to travel through the sector. If the antenna stays in the blanked sector for more than 5 seconds, a buzzer sounds and the antenna is driven from the sector automatically.

4–1153. The buzzer continues to sound after the antenna has been automatically rotated out of the blanked sector. Continued sounding of the buzzer is a reminder that the PPI overlay in control must be set to some azimuth outside of the blanked sector and that the CLEAR switch on the azimuth blanker must be pressed. The buzzer then stops, the antenna rotates to the newly selected azimuth, and operation returns to normal.

4–1154. Servo system failure would make it impossible for the automatic circuits to drive the antenna from the blanked sector. Therefore, if the antenna remains in the blanked sector for more than 30 seconds, a red indicator lights, indicating servo failure, and the system trigger is removed from the modulator. Removal of the system trigger protects the magnetron by stopping the generation of the high-voltage modulating pulse. The radar set then does not radiate and the magnetron is not subject to the reduced high voltage. The radar set must now be placed in standby and the servo troubles corrected.

4–1155. Figure 4–165 lists the principal elements in the azimuth blanker with a short statement of the function of each element.

Element	Title	Function
B101	SECTOR AZIMUTH POSITION differential generator	Determines center of sector to be blanked.
E101	Warning buzzer	Sounds when antenna remains in blanked sector for more than 5 seconds.
I101	Blown fuse indicator	Lights when fuse F101 blows.
I102	BLANK indicator	Lights when antenna is in a blanked sector.
I103	ANT. DRIVE FAILURE indicator	Lights when antenna remains in a blanked sector for more than 25 seconds, indicating failure in azimuth drive system.
I104	BYPASS indicator	Lights when interference blanker is bypassed by throwing switch S101 to BYPASS position.
K101	Sector control relay	When releases, magnetron ceases to oscillate, blanking out radar.
K102	Ambiguity control relay	Operates to prevent an ambiguous blanked sector 180 degrees from desired sector.
K103	Sector control auxiliary	Operates when 101 releases, removing the system trigger from the modulator, causing the magnetron to cease oscillation.

Figure 4–165. Elements of Azimuth Blanker (Sheet 1 of 2)

Element	Title	Function
K104	Timing relay (5-second delay)	Begins timing when antenna enters blanked sector. Contacts close after antenna has been in blanked sector 5 seconds.
K105	Antenna slewing relay	Operates when antenna remains in blanked sector for 5 seconds, causing azimuth drive system to slew antenna out of sector.
K106	Timing relay (20-second delay)	Operates when antenna remains in blanked sector for 25 seconds after operation of relay K104.
K107	Deleted.	
S101	BLANKER BY-PASS switch	In BYPASS position, applies 120 volts to relay K103. Blanking cannot occur while relay K103 is energized.
S102	CLEAR switch	When depressed, breaks holding path of relay K105, restoring circuit to normal after automatic slewing action has occurred.

Figure 4–165. Elements of Azimuth Blanker (Sheet 2 of 2)

4–1156. SECTOR BLANKING

4–1157. INPUT SIGNALS. Selsyn signals representing antenna azimuth are sent to the azimuth blanker from the antenna azimuth selsyn generator. These selsyn signals are fed to the stator winding of differential generator B101 (figure 4–165). The differential generator is similar to a selsyn generator, except that it has a rotor composed of three wye-connected windings.

4–1158. When the differential generator is zeroed, the output developed across the R1-R3 winding is as shown by the solid curve in A of figure 4–166. When the antenna is at zero, no output is developed across the R1-R3 winding. When the antenna has rotated to 90 degrees azimuth, the voltage across the R1-R3 winding is a 60-cps, 90-volt sine wave that is in phase with the excitation voltage. (The antenna selsyn has a 60-cps excitation applied across the rotor.) At 270 degrees azimuth, the voltage across the R1-R3 winding is a 60-cps, 90-volt sine wave that is 180 degrees out of phase with the excitation voltage.

4–1159. If the differential generator is rotated to 90 degrees for example, the zero points shift as shown by the dotted curve in A of figure 4–166. Zero voltage then exists across the R1-R3 winding when the antenna passes through 90 degrees and 270 degrees, with the maximum voltage across the R1-R3 winding when the antenna passes through 180 degrees and 360 degrees. Although this example illustrates the effect on the voltage across the R1-R3 winding when the differential generator is turned 90 degrees, the differential generator can be rotated so that the zero point will fall anywhere between the limits of 0 and 360 degrees. Therefore, it would be possible by rotating the differential generator dial until it reads 40 degrees to have 0 volt across the R1-R3 winding at 40 and 220 degrees. It should be noted that there is always a second zero point 180 degrees away from the dial setting.

4–1160. CONVERTING SELSYN SIGNALS INTO RELAY ACTION. The function of the circuit shown in figure 4–166 is to convert the output from winding R1-R3 into a relay action which will initiate the blanking sector. Blanking starts when relay K101 is released.

4–1161. The signal from winding R1-R3 is converted to a d-c voltage by isolation transformer T101, a full-wave crystal rectifier (CR101 through CR104), and filter capacitor C102. This d-c signal is applied to the upper end of relay K101. A 120-volt a-c signal is converted to a d-c voltage by isolation transformer T102, a full-wave crystal rectifier (CR105 through CR108), and filter capacitor C103. This d-c signal is applied to the lower end of relay K101.

4–1162. Relay K101 is energized as long as the voltage at the upper end of relay K101 is at least 0.5 volt more positive than the voltage at the lower end. However when the voltage from winding R1-R3 starts to decrease as the zero point is reached, the voltage at the upper end of relay K101 is not sufficient to keep the relay energized. Blanking starts as soon as relay K101 releases. The exact relay contacts that operate to cause blanking are covered later in this discussion.

4–1163. The waveform around the zero point is shown in B of figure 4–166. When SECTOR WIDTH control R107 is set so that the voltage across capacitor C103 is at a maximum, relay K101 remains released for the length of time shown as the maximum blanking sector. When potentiometer R107 is set at maximum, the relay is released for just the short length of time shown as the minimum blanking sector.

4–1164. MIN SECTOR ADJ. control R106 and MAX. SECTOR ADJ. control R108 set the limits through which the SECTOR WIDTH control can operate. For example, if control R106 is set for ±10 degrees (10 degrees on each side of the center of the sector) and control R108 is set for ±45 degrees, then the SECTOR WIDTH control can vary sector width from a maximum of 90 degrees to a minimum of 20 degrees.

4–1165. CONTACT NETWORK FOR BLANKING. The relay paths for blanking circuit operation are shown in figure 4–167. When blanking starts, relay K101 releases and contacts 4 and 5 open the operate path of relay K103. When relay K103 releases, contacts 10 and

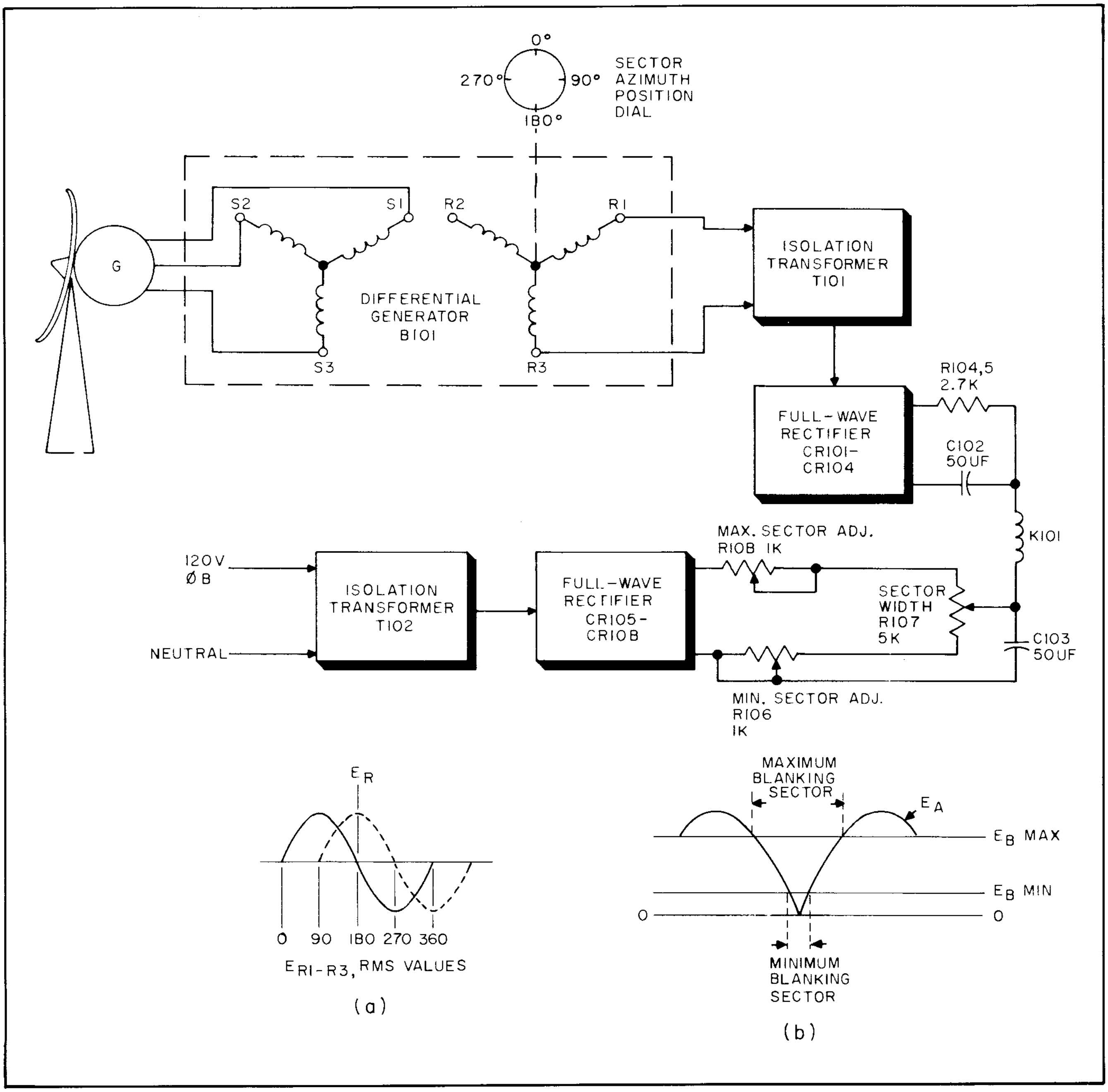


Figure 4–166. Azimuth Blanker, Sector Blanking Circuit

11 open, removing 120 volts from relay K6903 in the control group assembly. The release of relay K6903 places a 25-ohm resistor in each line leading to the modulator high-voltage regulator. This reduces the amount of high voltage available for the magnetron anode. The magnetron is then unable to oscillate with this reduced high voltage and the radar is blanked. At the start of the blanking sector, BLANK indicator I102 lights when 120 volts is applied to it through contacts 9 and 14 of relay K103.

4–1166. When the blanking period is over, relay K101 operates and applies 120 volts through contacts 4 and 5 to the coil of relay K103. When relay K103 operates, the "BLANK" indicator goes off and 120 volts is applied through contacts 10 and 11 to relay K6903 in the control group assembly. When relay K6903 operates, it shorts out the three 25-ohm resistors in the lines leading to the modulator high-voltage regulator. This restores the magnetron anode voltage to its normal value, permitting oscillation to resume.

4–1167. AMBIGUITY CONTROL. As explained previously, there are two azimuths at which the voltage across the R1-R3 winding becomes zero. One is the desired azimuth and the other is 180 degrees away from

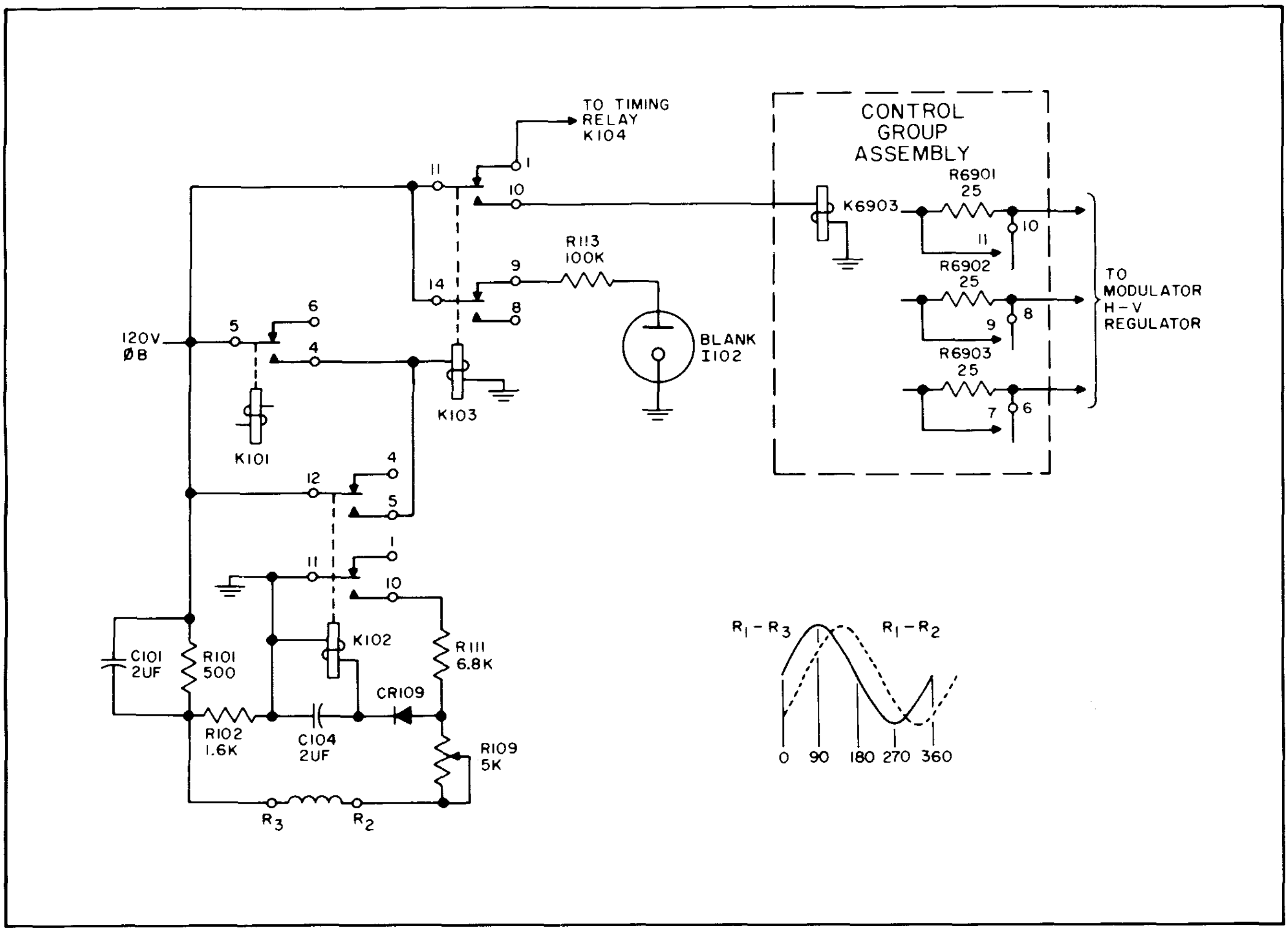


Figure 4–167. Azimuth Blanker, Relay Paths for Blanking

it. Relay K102 is designed to prevent blanking from occurring during the false zero point (figure 4–167). The circuit receives the voltage from the R2-R3 winding of the differential generator rotor. This voltage lags that of winding R1-R3 by 60 degrees. (See the dotted waveform in figure 4–167.) Mixed with the voltage of winding R1-R2 is a percentage of the 120-volt, phase B voltage. When the voltage of winding R1-R2 is shown as a positive signal, it is in phase with the 120-volt, phase B voltage. When the voltage of winding R1-R2 is shown below the reference line, it is 180 degrees out of phase with the phase B voltage.

4–1168. Assume that the differential generator is set at 0 degree, which means that the center of the blanked sector is 0 degree. The 120-volt signal and the voltage of winding R1-R2 are then out of phase. As a result, the voltage reaching relay K102 is not sufficient to energize this relay. Therefore, relay K102 has no effect on circuit operation during the desired blanking sector.

4–1169. Circuit operation when the false null is reached is next considered. This null occurs at an azimuth of 180 degrees when the differential generator is set at zero. As shown in figure 4–167, the voltage of winding R1-R2 is in phase with the 120-volt, phase B voltage. Therefore, the two voltages add and are thus sufficient to energize relay K102. When relay K102 is energized, contacts 5 and 12 close, applying 120 volts to relay K103. Energizing relay K103 prevents blanking at this time. Relay K102 remains energized for a fairly wide sector to assure that blanking cannot occur during even a wide false null.

4–1170. AUTOMATIC SLEWOUT.

4–1171. GENERAL. To protect the magnetron against an extended period of reduced anode voltage, steps must be taken to assure that the antenna does not stay in the blanked sector too long. The circuit shown in A of figure 4–168 slews the antenna out of the blanked sector after 5 seconds. In brief, relay K103 indicates whether the antenna is in the blanked sector, relay K104 provides a 5-second timing interval, and relay K105 provides the voltage that automatically slews the antenna out of the blanked sector. The detailed operation of the circuit is given in the following paragraphs.

4–1172. Relay K103 is released when the antenna is in the blank sector. Contacts 12 and 5 of this relay then open removing the system trigger from the modulator. The high voltage modulating pulse is not generated. Consequently, the radar set does not radiate and the magnetron does not receive high voltage. Contacts 1 and 11 of this relay then close, applying 120 volts to the thermal element of time-delay relay K104. If the antenna remains in the blanked sector for more than 5 seconds; that is, if relay K103 remains released for more than 5 seconds, contacts 5 and 7 of relay K104 close, applying 120 volts to buzzer E101 and relay K105. Contacts 10 and 11 of relay K105 then close to hold in the relay.

4–1173. When relay K105 is operated; transfer contacts 12 and 13 remove the error voltage from the servo amplifier and substitute a control voltage derived from differential generator B101. The substitute control voltage, fed into the 1-speed input of the servo amplifier, causes the antenna to slew out of the blanked sector. At the same time, contacts 8 and 14 of relay K105 close, grounding the grid of tube V6002A in the azimuth servo amplifier. This energizes synchronizing relay K6001, transferring the servo amplifier from the 36- to the 1-speed input.

4–1174. Relay K104 is released when the antenna slews out of the blanked sector; however, relay K105 is still held in. To restore operation to normal, the PPI operator must set his overlay to a new antenna position outside the blanked sector. CLEAR switch S102 is then pressed to break the holding path for relay K105. This stops buzzer E101 and the antenna proceeds to the newly selected azimuth.

4–1175. TWENTY-SECOND DELAY. The azimuth servo system may fail making it impossible to slew the antenna out of the blanked sector. Therefore, some protection must be provided against this possibility. The circuit shown in B of figure 4–168 permanently removes the high voltage from the magnetron if the antenna remains in the blanked sector for more than 30 seconds.

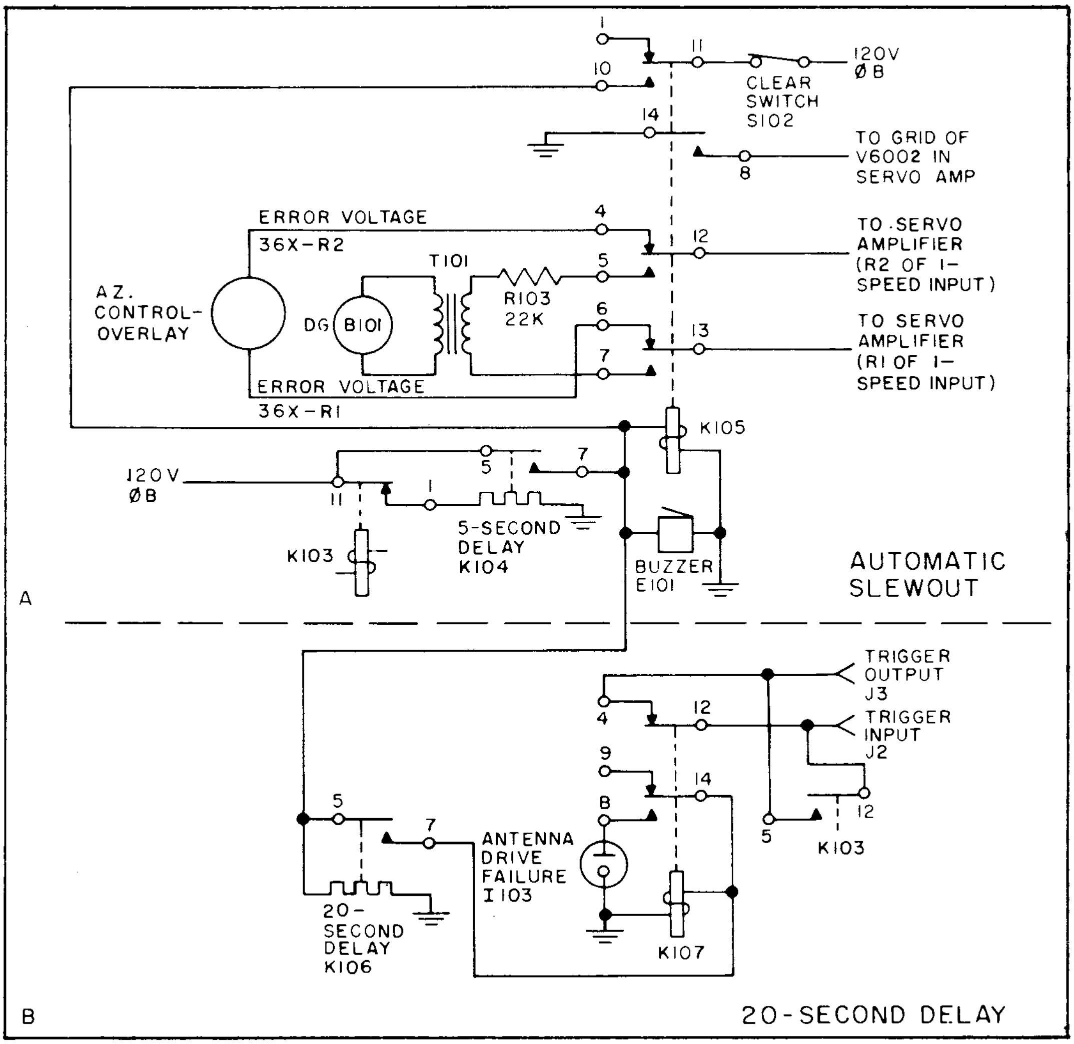


Figure 4–168. Azimuth Blanker, 5-and 20-second Delay Circuits

In brief, after 5-second delay relay K104 has operated, 20-second delay relay K106 starts its timing cycle. If the antenna is still in the blanked sector 20 seconds later, relay K106 operates.

4–1176. The 20-second delay relay, K106, receives its operating power through contacts 1 and 11 of relay K103 (released) and through contacts 5 and 7 of relay K104 (operated). As long as the antenna stays in the blanked sector, relay K103 remains released, keeping relay K104 operated and contacts 5 and 7 of relay K104 closed. If the antenna remains for a total of 25 seconds (5 seconds due to the action of relay K104 and 20 seconds due to relay K106), relay K106 operates, closing contacts 5 and 7, and lighting ANTENNA DRIVE FAILURE indicator I 103.

4–1177. Deleted.

4–1178. The radar should then be placed in the standby condition until the antenna drive difficulties are corrected. If the antenna is removed from the blanked sector (manually or otherwise), contacts 5 and 12 of relay K103 close, reapplying the trigger to the modulator. Initially, reduced voltage is applied to the magnetron. After 90 milliseconds, however, contactor K6903 operates and full high voltage is applied to the magnetron.

4–1179. BLANKER BYPASS. When the interference blanker is in use, BLANKER BYPASS switch S101 is in the ON position. Should discontinuance of the blanker be necessary, the switch is thrown to the BYPASS condition. As shown in figure 4–169, when switch S101 is in the BYPASS position, contacts 4 and 5 are closed, applying 120 volts to BYPASS indicator I104. At the same time, contacts 1 and 2 of the switch are closed, applying 120 volts to relay K103. As explained in the preceding paragraphs, blanking cannot occur when relay K103 is energized.

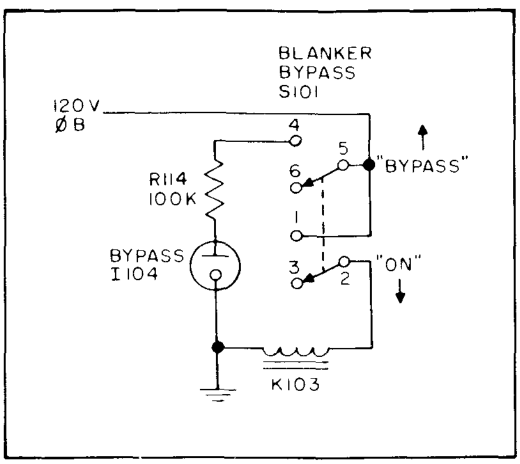


Figure 4–169. Azimuth Blanker, Blanker Bypass Circuit

4–1180. RHI ANTENNA CONTROL (CONTROL, ANTENNA C-1830/GPS).

4–1181. GENERAL.

4–1182. FUNCTION. The RHI antenna control provides the RHI operation with elevation control of the height-finding antenna at all times. In addition, this control also permits the RHI operator the option of assuming azimuth control, if desired.

4–1183. ELEVATION CONTROLS. The elevation controls allow the RHI operator to place the antenna in either slow or fast nodding, or to stop the elevation scan entirely. These controls duplicate those available to the maintenance personnel and the operating crew of the associated search radar at the antenna control panel and antenna safety box. Indicators denote whether the antenna is nodding at the slow or fast rate.

4–1184. Two controls are provided to allow the RHI operator to adjust the elevation nod angle. One control adjusts the amplitude of the elevation scan from 1 to 34 degrees of arc while the other control adjusts the center of the nodding arc.

4–1185. AZIMUTH CONTROLS. If the RHI opertor desires to exercise azimuth control of the antenna, he turns MODE switch S6501 from PPI CONTROL to one of four other positions. This cuts out the azimuth control overlays by energizing height indicator cutout relay K9701 in the junction box. When the MODE switch is in the RHI CONTROL position, the antenna can be positioned to any azimuth. A handwheel on the front panel of the RHI antenna control allows the operator to rotate selsyn control transformers B6501 and B6502, which feed azimuth error signals to the servo amplifier and thus position the antenna.

4–1186. To rotate the antenna clockwise at a continuous 60 degrees per minute (or 90 degrees per minute when using fast elevation scan), the MODE switch is placed in the CW ROTATION position. Continuous counterclockwise rotation at the same speeds is possible by selecting the CCW ROTATION mode. To cause the antenna to scan a particular sector of azimuth, the SECTOR SCAN mode is selected at MODE switch S6501. The center of the sector is selected by rotating the SECTOR SCAN dial to the desired position; the width of the sector is set by rotating SECTOR WIDTH potentiometer R6517. Sector width can be varied from 10 to 120 degrees. Potentiometer R6526 can be used to obtain scan widths narrower than 10 degrees.

4–1187. The ANTENNA AZIMUTH POSITION dial indicates the azimuth of the antenna when the azimuth servo system is energized. When the RHI CONTROL mode is in use, the dial is positioned by the handwheel. During any other mode, synchros B6501 and B6502 act as follower selsyns, picking up the azimuth synchro orders from the selsyn generators mounted on the antenna. Synchros B6501 and B6502 then drive the ANTENNA AZIMUTH POSITION dial through a built-in servo amplifier.

4–1188. The RHI operator can move the antenna in azimuth a slight amount from the setting determined by the PPI operator to optimize the return presented on the RHI. This is accomplished by setting the MODE switch to the PPI CONTROL position and rotating the VERNIER CONTROL dial, which permits adjustment of the antenna up to ±4-1/2 degrees in azimuth.

4–1189. ELEMENTS OF RHI ANTENNA CONTROL. Figure 4–170 lists the principal components of the RHI antenna control and the function of each. This figure will serve as a useful reference for the technician in reading this section. Figure 7–107 is a schematic of the RHI antenna control.

4–1190. ELEVATION CONTROLS.

4–1191. The ELEV. SCAN SLOW, ELEV. SCAN FAST, and ELEV. SCAN STOP controls duplicate those on the antenna control panel of the control group assembly. These controls and the elevation nod angle controls, NOD AM. and NOD POS., are described in paragraph 4–1706.

4–1192. AZIMUTH CONTROL BY RHI OPERATOR.

4–1193. To gain azimuth control of the antenna of Radar Set AN/FPS-6, the RHI operator turns MODE switch S6501 to the RHI CONTROL position. In this position (figure 4–171), contacts 2 and 12 of switch S6501C are closed, applying 28 volts dc to LOCAL CONTROL indicator I6503 and to the solenoid of relay K9701 in the junction box. Energizing relay K9701 opens its contacts 1 and 2, removing 28 volts from the time-sharing master control, thus disabling the unit. With the time-sharing master control inoperative, none of the PPI overlays can gain azimuth control of the antenna of Radar Set AN/FPS-6.

4–1194. Energizing relay K9701 closes its contacts 2 and 3, causing 28 volts to be applied to the solenoids of relays K9724 and K9725. When relay K9724 is energized, its contacts 4 and 12 and contacts 5 and 13 close. This completes the path between the rotor of 1-speed synchro B6501 and the azimuth servo amplifier. As shown in figure 4–171, the path for the R1 signal is through closed contacts 2 and 12 of switch S6501A (these contacts are closed in the RHI CONTROL position of the MODE switch) and through contacts 4 and 12 of relay K9724. Similar paths are completed for the R2 signal from synchro B6501 and for the rotor signals of synchro B6502.

Element	Title	Function
B6501	1-speed synchro	Feeds 1-speed antenna synchro orders to azimuth servo amplifier in control group assembly when RHI control mode is selected; feeds 1-speed antenna synchro orders to indicator servo amplifier in RHI antenna control in all other modes.
B6502	36-speed synchro	Feeds 36-speed antenna synchro orders to azimuth servo amplifier in control group assembly when RHI control mode is selected; feeds 36-speed antenna synchro orders to indicator servo amplifier in RHI antenna control in all other modes.
B6503	Vernier synchro	36-speed differential generator which modifies antenna position up to 4-1/2 degrees from that selected by PPI operator.
B6504	Sector scan synchro	1-speed control transformer used in circuit which converts antenna position to relay operation.
B6505	Azimuth indicator servo motor	Drives ANTENNA AZIMUTH INDICATOR dial under control of servo amplifier in RHI antenna control panel.
I6501	ELEV. SCAN SLOW indicator	Lights when ELEV. SCAN SLOW switch on RHI antenna control is operated.
I6502	ELEV. SCAN FAST indicator	Lights when ELEV. SCAN FAST switch on RHI antenna control is operated.
I6503	LOCAL CONTROL indicator	Lights when MODE switch is in any position but PPI CONTROL. Indicates that RHI operator has taken antenna control from PPI operator.
I6504	CIR. POL. indicator	Not used at present.
K6501	Sector control relay No. 1	When energized, operates relay K6903 and causes antenna to reverse direction of rotation and move clockwise.
K6502	Sector control relay No. 2	When energized, operates relay K6904 and causes antenna to reverse direction of rotation and move counterclockwise.
K6503	Clockwise rotation relay	When energized, causes antenna to rotate in a clockwise direction. Energized during sector scan.

Figure 4–170. Elements of RHI Antenna Control (Sheet 1 of 3)

Element	Title	Function
K6504	Counterclockwise rotation relay	When energized, causes antenna to rotate in a counterclockwise direction. Energized during sector scan.
O6501	ANTENNA AZIMUTH INDICATOR dial	Indicates azimuth of antenna of Radar Set AN/FPS-6 at any instant.
O6502	SECTOR SCAN dial	Set by RHI operator to center of desired azimuth sector.
O6503	VERNIER CONTROL dial	Connected to shaft of vernier control synchro B6503; rotated to modify position of antenna up to ±4-1/2 degrees.
R6502	SELSYN MIXING control	Controls amplitude of 36-speed rotor voltage mixed with 1-speed error voltage.
R6508	DISCRIMINATOR BALANCE control	Balances discriminator V6501 so that zero output appears at terminals of magnetic amplifier when error signal is zero.
R6510	FEEDBACK control	Stabilizes indicator servo loop by controlling amount of feedback from output to input of servo amplifier.
R6513	1-speed error cancel control	Balances out 1-speed error voltage during vernier control.
R6517	SECTOR WIDTH control	Controls width of azimuth sector during SECTOR SCAN mode.
R6518	SECTOR SCAN BALANCE control	Adjusts current through relays K6501 and K6502 so that each relay operates when antenna reaches same number of degrees from center of sector.
R6521	DIMMER control	Adjust intensity of illumination around front panel dials.
R6526	SCAN ADJUST control	Provides smaller range of sector width, if required, under special tactical situations. Normally set for a range of 10 to 120 degrees.
S6501	MODE switch	In PPI CONTROL mode position, antenna is controlled by PPI operator through azimuth control overlay. In RHI CONTROL mode position, positioning control is taken by RHI operator. In SECTOR SCAN mode position, antenna slews between two points up to 120 degrees apart.

Figure 4–170. Elements of RHI Antenna Control (Sheet 2 of 3)

Element	Title	Function
		In CW ROTATION mode position, antenna rotates continuously at either 60 or 90 degrees per minute in clockwise direction. In CCW ROTATION mode position, antenna rotates continuously at either 60 or 90 degrees per minute in counterclockwise direction.
S6502	ELEV. SCAN STOP switch	Stops elevation scan.
S6503	ELEV. SCAN SLOW switch	Causes antenna to nod at 20 cycles per minute.
S6504	ELEV. SCAN FAST switch	Causes antenna to nod at 30 cycles per minute.
S6505	Vernier control brake release	Releases brake on VERNIER CONTROL dial and synchro. Operated when VERNIER CONTROL dial is pressed.
S6506	SECTOR SCAN START switch	Operates relay K6503 to start antenna sectoring in azimuth.
S6507	CIR. POL. switch	Not used at present.
S6508	NOD AM. switch	Controls amplitude of antenna nodding.
S6509	NOD POS. switch	Controls center of nodding sector.
S6510	Clutch actuator	When pressed, energizes clutch E6504, coupling handwheel to 1- and 36-speed synchros B6501 and B6502.

Figure 4–170. Elements of RHI Antenna Control (Sheet 3 of 3)

4–1195. To position the antenna once he has secured control, the RHI operator presses the handwheel and turns it. Pressing the handwheel pushes it against switch S6510 (figure 7–107), closing the switch and applying 28 volts dc to clutch B6504. The energized clutch couples the handwheel to synchros B6501 and B6502 and to the ANTENNA AZIMUTH INDICATOR dial. When the operator now turns the handcrank, the antenna assumes the position indicated by the ANTENNA AZIMUTH POSITION dial.

4–1196. VERNIER CONTROL.

4–1197. Figure 4–172 shows the circuit that provides vernier control. The RHI operator presses the VERNIER CONTROL dial, closing switch S6505 and applying 28 volts dc to the dial brake. This releases the brake,

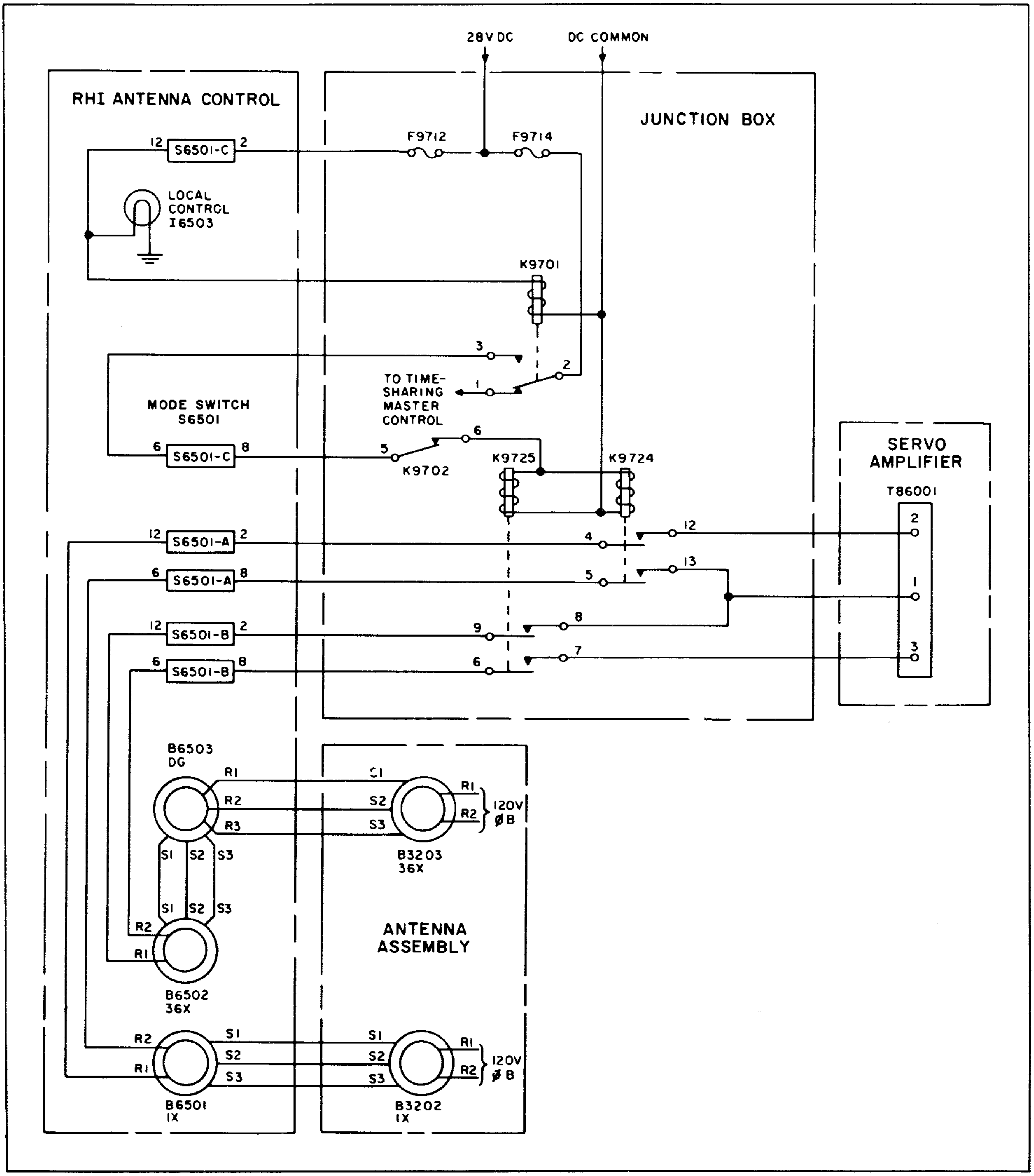


Figure 4–171. Azimuth Control by RHI Operator in Radar Set AN/FPS-6A, Simplified Schematic Diagram

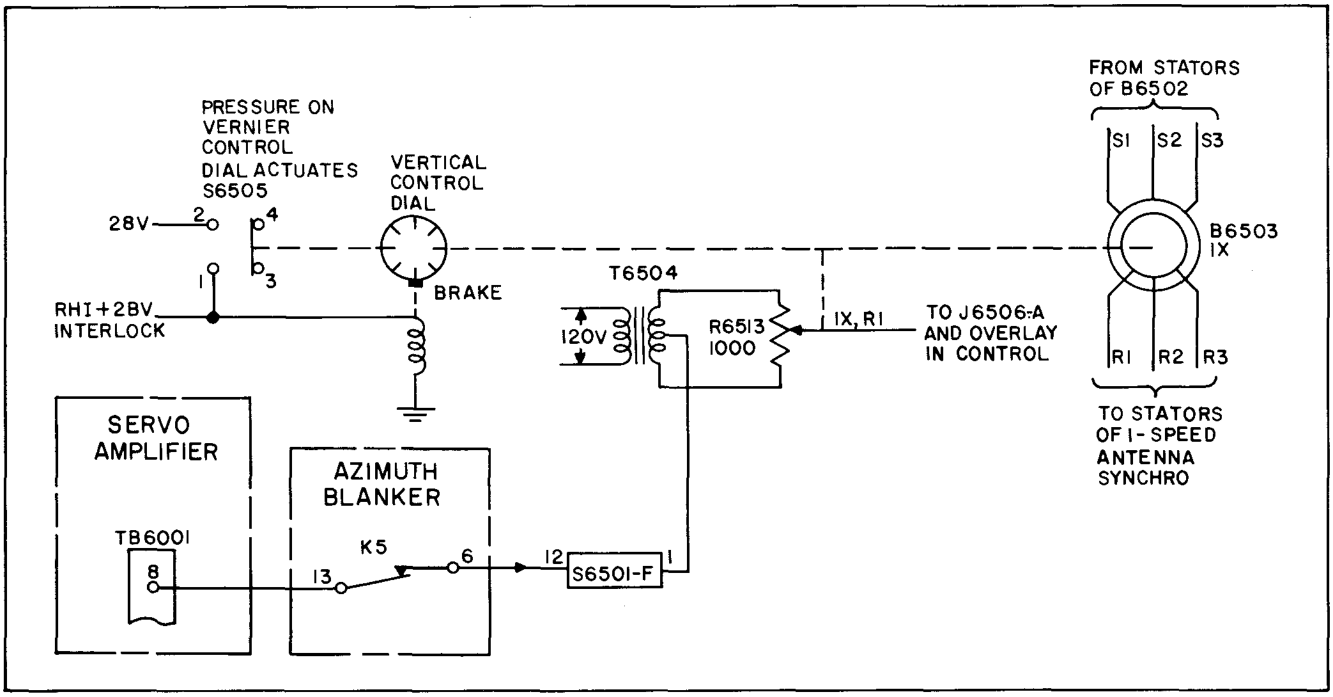


Figure 4–172. Vernier Control, Simplified Schematic Diagram

making it possible to turn the dial. The dial is geared to differential generator B6503 in a 36:1 ratio; that is, the dial turns 1 revolution for each 10 degrees of rotation of the differential generator. This permits extremely precise positioning of the antenna.

4–1198. The differential generator is connected between the stator of the antenna synchro and the stator of the 36-speed synchro in the PPI overlay in control. The function of the differential generator is to produce an angular difference between input and output, depending upon the setting of the generator rotor. For example, if the rotor is moved 144 degrees from electrical zero, there will be a difference of $144/36 = 4$ degrees.

4–1199. Thus, the antenna, under the influence of the 36-speed error signal produced by the differential generator, is moved from the position designated by the PPI operator. As the antenna moves from this designated position, however, the 1-speed error signal begins to build up at the rate of 1 volt per degree of rotation. If this 1-speed error signal reaches 2.5 volts in amplitude, it will trip a switching relay in the servo amplifier, disconnecting the 36-speed signal and substituting the 1-speed signal. A cancel voltage, developed across potentiometer R6513 during vernier control, prevents this from happening. The cancel circuit consists of tapped transformer T6504, phasing capacitor C6505, and potentiometer R6513, geared to the rotor of differential generator R6503. The voltage across potentiometer R6513 is built up at the rate of 1 volt per degree in polarity opposing the 1-speed error signal.

4–1200. SECTOR SCAN.

4–1201. SECTOR SCAN OPERATING PROCEDURE. The procedure for setting up the sector scan mode by the RHI operator is as follows:

a. Set MODE switch S6501 to RHI CONTROL position and set antenna to center of desired sector. For example, if a sector from 40 to 90 degrees is desired, set antenna at 65 degrees.

b. Set MODE switch S6501 to SECTOR SCAN position.

c. Set SECTOR SCAN dial to center of desired sector. In the example given in step a, dial would be set to 65 degrees.

d. Set SECTOR WIDTH potentiometer to angular width of desired sector. In the example given in step a, this control would be set to 50 degrees.

e. Depress SECTOR SCAN START switch.

4–1202. SECTOR SCAN START-UP. When SECTOR SCAN START switch S6506 (figure 4–173) is depressed, 120 volts is applied to the solenoid of relay K6503, energizing the relay. To hold in relay K6503, 120 volts is applied through contacts 6 and 13 of relay K6504 and through contacts 5 and 12 of relay K6503 to the solenoid.

4–1203. When relay K6503 is energized, 120 volts is fed out through contacts 8 and 14, contacts 3 and 13 of switch S6501E, to terminal board TB6001-5 in the

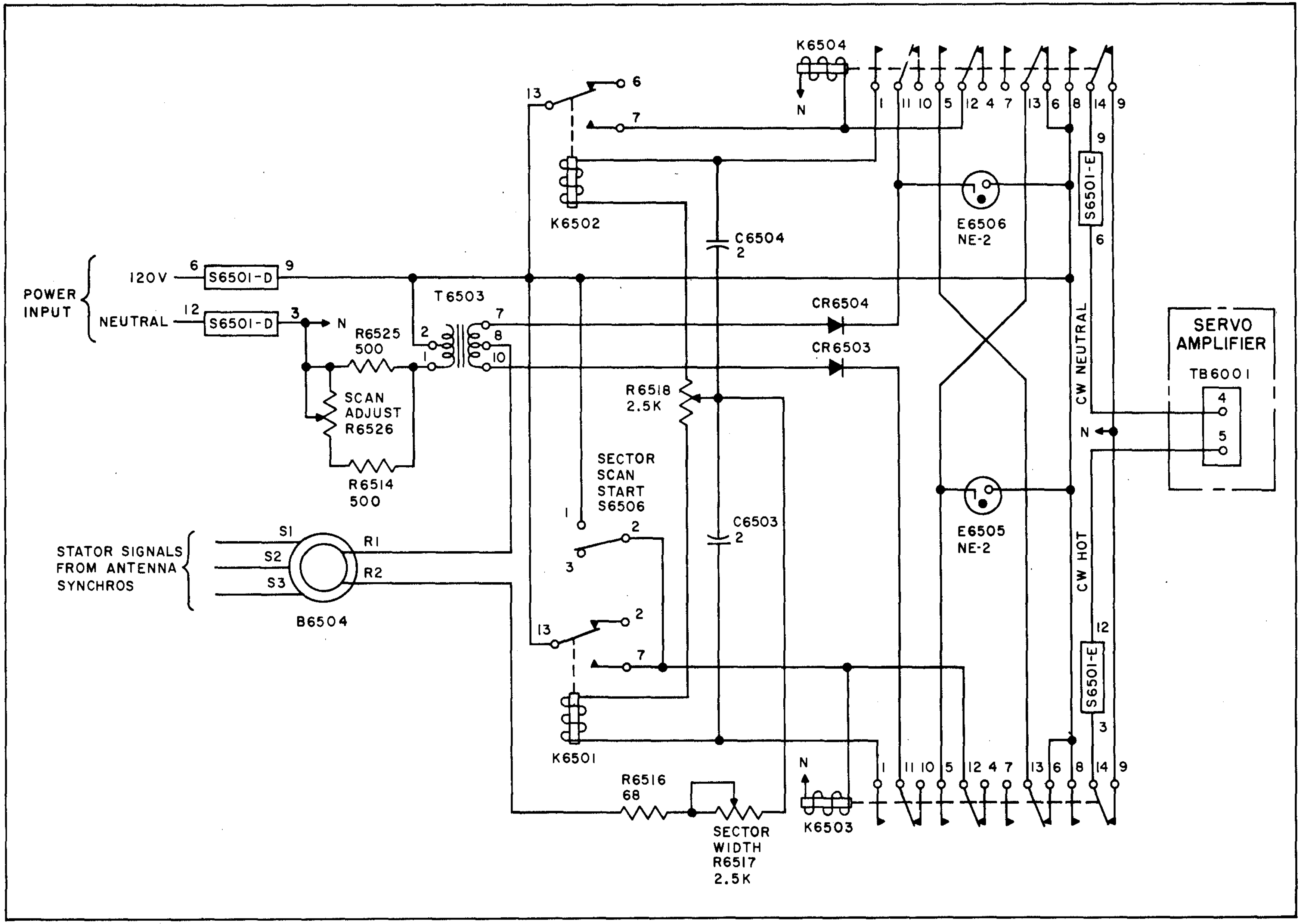


Figure 4–173. Sector Scan Operation, Simplified Schematic Diagram

servo amplifier. At the same time, relay K6504 is deenergized and the neutral side of the 120-volt line is fed through contacts 9 and 14 of relay K6504 to terminal board TB6001-4 in the servo amplifier. With this input, the antenna rotates in a clockwise direction.

4–1204. CLOCKWISE SECTOR SCAN. Relay K6503 remains operated during the clockwise sweep of the antenna through the sector. With relay K6503 operated, its contacts 1 and 11 open, breaking the operate path of relay K6501. Therefore, it is impossible to energize relay K6501 during clockwise antenna rotation.

4–1205. The stator leads of synchro B6504 are tied to the corresponding leads of the 1-speed antenna synchro. The RHI operator has already turned the rotor of the synchro to the center of the desired sector in step c of paragraph 4–1201. When the antenna and the rotor are in the same position, no output appears across the rotor windings of synchro B6504. However, as the difference between the rotor position and that of the antenna increases, an increasing a-c voltage appears across the rotor winding.

4–1206. The rotor voltage is added to the 60-volt a-c signal across terminals 8 and 10 of transformer T6503 and the sum is applied to relay K6502. This relay is a marginal relay; that is, it does not operate until the current through its coil reaches a predetermined value. The azimuth at which the relay operates is determined by SECTOR SCAN WIDTH control R6517, which is in series with the R2 rotor lead. Thus, relay K6502 operates at the end of the clockwise travel of the antenna.

4–1207. When relay K6502 operates, 120 volts is applied through contacts 7 and 13 to operate relay K6504. Contacts 6 and 13 of relay K6504 open, breaking the holding path to relay K6503. Relay K6503 then releases. To hold in relay K6504, 120 volts is applied through contacts 6 and 13 of relay K6503 and through contacts 5 and 12 of relay K6504 to the solenoid. Type NE-2 neon indicators E6505 and E6506 minimize sparking across the relay contacts.

4–1208. When relay K6504 is energized, 120 volts is fed out through contacts 8 and 14 and contacts 6 and 9 of switch S6501E to terminal board TB6001-4 in the servo amplifier. At the same time, relay K6503 is deenergized and the neutral side of the 120-volt line is fed through contacts 9 and 14 of relay K6503 to terminal board TB6001-5 in the servo amplifier. With this input, the antenna rotates in a counterclockwise direction.

4–1209. COUNTERCLOCKWISE SECTOR SCAN. Relay K6504 remains operated during the counterclockwise sweep of the antenna through the sector. With relay K6504 operated, its contacts 1 and 11 open, breaking the operate path of relay K6502. Thus, it is impossible to energize relay K6502 during counterclockwise antenna rotation.

4–1210. The release of relay K6503 allows its contacts 1 and 11 to close, completing the operate path for relay K6501. However, relay K6501 does not operate at this time, since the rotor voltage and the voltage across terminals 7 and 8 of transformer T6503 are out of phase and very low voltage is applied to relay K6501.

4–1211. As the antenna sweeps past the center of the sector, there is a phase reversal in the rotor voltage and it goes into phase with the voltage between terminals 7 and 8 of transformer T6503. The sum of these two voltages continues to build up until it is sufficient to operate relay K6501. The azimuth at which relay K6501 operates is controlled by the setting of SECTOR WIDTH control R6517. Operation of relay K6501 then initiates the same chain of events that pressing the SECTOR SCAN START button did and the cycle begins again.

4–1212. SECTOR SCAN ADJUSTMENT CONTROLS. SECTOR SCAN BALANCE control R6518 equalizes the operate points of relays K6501 and K6502. Because of manufacturing tolerances, it is very difficult to build two relays that will operate at exactly the same current level. Therefore, if resistor R6518 were not in the circuit, one relay might operate (again referring to the example in paragraph 4–1201) at approximately 89 degrees while the other might operate at 35 degrees (that is, +24 degrees and –30 degrees from the center position). Potentiometer R6518 is therefore adjusted so that, if one relay requires a slightly higher level of current to operate it, then that relay will have slightly less resistance in its path than the other.

4–1213. SCAN ADJUST potentiometer R6526 is used to set up sectors from 3 to 10 degrees in width. (Sector widths below 3 degrees are not recommended because of the danger of generating resonance in the antenna structure.) Increasing the voltage applied to transformer T6503 through potentiometer R6526 decreases the width of the sector, since the rotor (which depends on sector rotation) then has to supply a much smaller voltage.

4–1214. CONTINUOUS ROTATION.

4–1215. To rotate the antenna in a clockwise direction at a steady 60 degrees per minute, the RHI operator selects the CW ROTATION mode. Counterclockwise rotation is possible by selecting the CCW ROTATION mode. If the elevation scan is set to 30 nods per minute (fast scan), then a rotational speed of 90 degrees per minute is required for full coverage of the sky. Switching to the speed of 90 degrees per minute is performed at the servo amplifier.

4–1216. In either the CW ROTATION or CCW ROTATION position of the mode switch, the RHI operator assumes control of the antenna from the PPI operator. In the CW ROTATION mode (A, figure 4–174), 28 volts dc is fed through fuse F9712 and contacts 4 and 12 of switch S6501-C to relay K9701. This energizes relay K9701 and contacts 1 and 2 of this relay open,

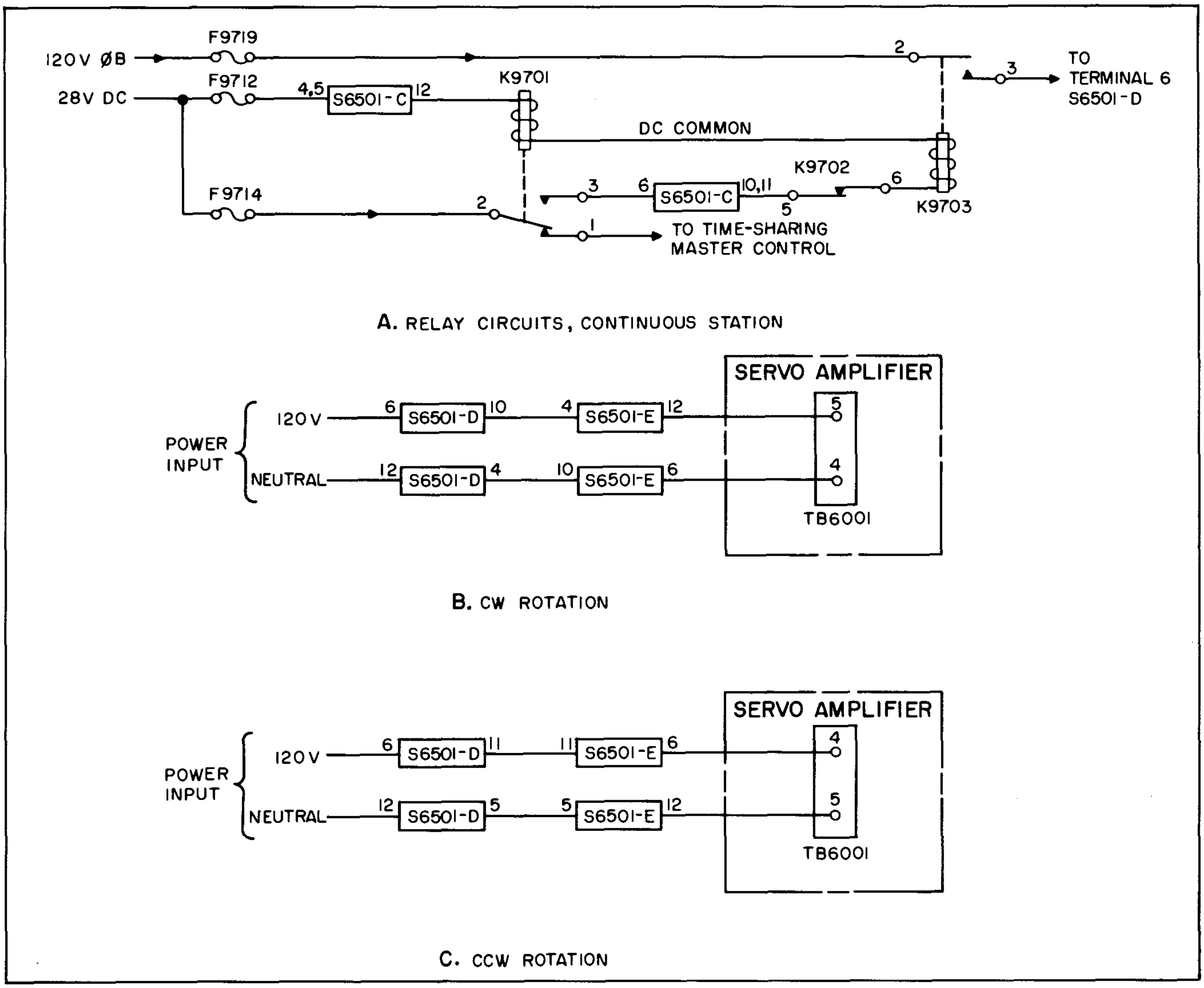


Figure 4–174. Continuous Rotation, Simplified Schematic Diagram

removing 28 volts from the time-sharing master control. In this manner, the time-sharing master control is disabled and the azimuth control overlays lose control of the antenna. Energizing relay K9701 also closes its contacts 2 and 3. This applies 28 volts through these contacts of relay K9701, contacts 6 and 10 of switch S6501-C, and contacts 5 and 6 of relay K9702, energizing relay K9703. Contacts 2 and 3 of relay K9703 then close, completing the path for 120 volts ac from the junction box, through fuse F9719, to MODE switch S6501 in the RHI antenna control.

4–1217. Relay operation is essentially the same for the CCW ROTATION mode, except that contacts 5 and 12 of switch S6501-C complete the operate path for relay K9701 while contacts 6 and 11 of switch S6501-C complete the operate path for relay K9703.

4–1218. For clockwise rotation (B, figure 4–174), 120 volts is fed through contacts 6 and 10 of switch S6501-D and contacts 4 and 12 of switch S6501-E to terminal board TB6001-5 in the servo amplifier. The neutral side is completed through contacts 12 and 4 of switch S6501-D and contacts 10 and 6 of switch S6501-E to terminal board TB6001-4 in the servo amplifier. With this input to the servo amplifier; that is, 120 volts on terminal 5 of terminal board TB6001 and the neutral on terminal 4 of terminal board TB6001, the antenna rotates continuously in a clockwise direction.

4–1219. For counterclockwise rotation, the switches reverse the polarity of the input to terminal board TB6001 in the servo amplifier. With this input; that is, 120 volts on terminal 4 of terminal board TB6001 and the neutral on terminal 5 of terminal board TB6001, the antenna operates continuously in a counterclockwise direction.

4–1220. ANTENNA AZIMUTH INDICATOR.

4–1221. GENERAL. The antenna azimuth indicator displays the azimuth of the antenna in degrees on the ANTENNA AZIMUTH POSITION dial. The dial is either manually operated or servo driven, depending upon the position of MODE switch S6501. During the RHI CONTROL mode, the dial is geared directly to the azimuth handcrank. In any other mode, the dial is positioned in response to servo orders received from the antenna synchros. The remainder of this discussion is devoted to an explanation of the servo system.

4–1222. SUMMARY OF SERVO OPERATION. The servo system receives antenna position information in the form of stator signals from the azimuth synchros geared to the antenna motion. Synchros B6501 and B6502 use this information and act as control transformers in this application. The stators act as the primary of a transformer; the rotors act as the secondary. No signal appears across the servo rotors if they are in the same relative position as the rotors of the synchros in the antenna. However, if the rotors are not in the same position as the antenna synchro rotors an error voltage appears across the rotors of synchros B6501 and B6502.

4-1223. The error voltages and the stickoff voltage are fed to the mixing network. The stickoff voltage has the effect of eliminating the tendency of the servo to hang up at a false zero point. Refer to paragraphs 4–981 through 4–995 for an explanation of hangup. The output of the mixing network is a single error voltage.

4–1224. The error voltage is amplified by amplifier V6501 and magnetic amplifier E6501. The output of the magnetic amplifier is used to drive servo motor B6505, which drives AZIMUTH POSITION dial O6501 and the synchro rotors. When the rotor positions correspond to the positions of the antenna synchro rotors, the error voltage falls to zero and the system comes to rest.

4–1225. MIXING NETWORK. (See figure 4–175.) All of the rotor signals are fed to a T-shaped mixing network composed of resistors R6501 through R6503 and thyrite resistor TY6501. Resistor R6502 determines the amount of 36-speed signal that will be mixed with the 1-speed signal and resistors R6501 and R6503 isolate the rotor windings of synchros B6501 and B6502. Thyrite resistor TY6501 operates as a shunt limiter to clip the 36-speed signal at 15 volts peak to peak. The clipping action is the result of the variation of thyrite resistance with voltage; as applied voltage increases the resistance of thyrite TY6501 decreases. This clipping action, which reduces the amplitude of the 36-speed signal, eliminates all but one of the hangup points. (Refer to paragraphs 4–981 through 4–995 for a discussion of hangup.) The remaining hangup at the 180-degree point is eliminated by the 2.2-volt stickoff voltage developed across the secondary of transformer T6501. As shown in the simplified schematic of figure 4–175, the secondary of transformer T6501 is in series with the R1 signal from synchro B6501. The combined signal appears across the primary of transformer T6502.

4–1226. DISCRIMINATOR V6501. Dual triode V6501 operates as a grid-controlled rectifier. The plate supply for this tube is the 120-volt a-c line voltage applied between the plate and cathode leads through the magnetic amplifier control windings. Since tube V6501 conducts only when its plate is positive with respect to its cathode, current flows in the control windings only during negative half cycles of the 120-volt plate supply. Potentiometer R6508 in the cathode circuit is adjusted so that, with no error signal input to the grids, there is no output from the servo amplifier to servo motor B6505. This potentiometer thus balances out any variations in the magnetic amplifier circuit.

4–1227. The error signal is applied to the grid through transformer T6502 and grid-limiting resistors R6506 and R6507. The grids are connected to opposite ends of the secondary of transformer T6502, therefore they are driven out of phase. When the grid of the left-hand section sees a positive-going signal, the grid of the right-hand section sees a negative-going signal.

4–1228. Assume that the signal on the top side of the secondary of transformer T6502 is in phase with the 120-volt a-c plate supply. Since current flows during negative alternations of the 120-volt plate supply, and since the left-hand grid is negative at that time, the left-hand section of the tube then conducts very lightly and the right-hand section conducts heavily. Thus, when the signal on the top side of the secondary of transformer T6502 is in phase with the plate supply, most of the current flows through winding A-D of the magnetic amplifier. The amplitude of this current depends on the amplitude of the error signal.

4–1229. When the signal on the bottom side of the secondary of transformer T6502 is in phase with the 120-volt plate supply, the left-hand section of discriminator V6501 conducts heavily and most of the current flows through winding H-L of the magnetic amplifier. The intensity of this current flow depends upon the amplitude of the error signal.

4–1230. MAGNETIC AMPLIFIER. The magnetic amplifier converts the rectified error voltage at the output of discriminator V6501 into a pulsating current that drives servo motor B6505. Physically, the magnetic amplifier consists of two toroids: A and B, each with a separate primary and secondary. In turn, each primary and each secondary is divided into two sections. The four primary sections (two sections each from toroids A and B) make up the control windings of the magnetic amplifier. The four secondary sections (two sections each from toroids A and B) make up the gate windings of the magnetic amplifier.

4–1231. The control windings are located electrically in the plate circuits of discriminator V6501. When the discriminator conducts (during the negative half cycle of the 120-volt input), the control windings set up a magnetization level in the torrid cores. This process is

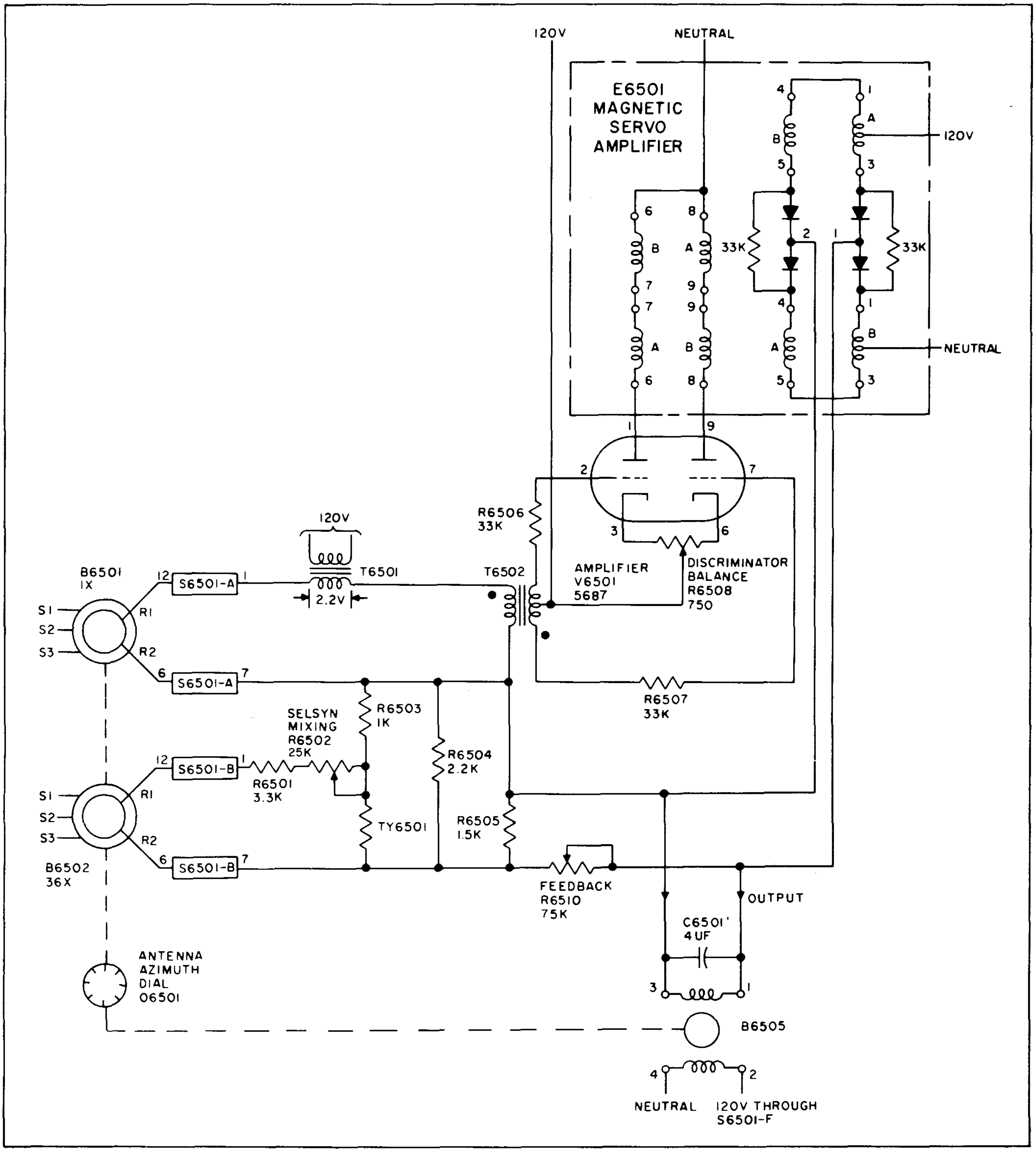


Figure 4–175. Azimuth Indicator Servo Amplifier, Simplified Schematic Diagram

called premagnetization. During the positive half cycle, the lines of force set up during premagnetization control the action of the gate windings. In this way, the servo is able to respond to changes in input level or load within one half cycle.

4–1232. The gate windings are arranged as a bridge circuit at the output side of the magnetic amplifier. The essential point to bear in mind about the gate windings is that the amount of current these windings transfer to the load depends upon the number of lines of flux in the core and the direction of the lines of flux. During the negative half cycle of the 120-volt input, the control windings premagnetize the two cores, setting up a certain number of magnetic lines with a certain direction. During the positive half cycle, the line current flowing through the gate windings generates additional lines of force; the direction of these lines of force is said to be in the positive direction. If the premagnetization flux lines are also positive, the flux produced during the positive half cycle adds to the existing lines. The greater the number of positive premagnetization lines in existence, the sooner the lines generated during the positive half cycle saturate the core and allow current to flow to the load. Therefore, when a high level of positive premagnetization exists in the core, the gate remains open for almost the entire positive half cycle and heavy current flows to the load. Conversely, with a high negative premagnetization, the gate opens for just a short period of time at the end of the half cycle. In this case, a small current flows to the load.

4–1233. Circuit action in the absence of an error voltage is now considered. At this time, both grids of discriminator V6501 are at ground potential. During the premagnetization half cycle, the two triode sections conduct equally. By tracing the circuit shown in figure 4–175, it can be seen that current flows in opposite directions in the two primary sections of toroid A. Current flows from terminal 6 to 7 in one section and from terminal 9 to 8 in the other section. The same relative current flow exists in the two primary sections of toroid B. With equal and opposing currents flowing, the total lines of force in the core due to the control windings is zero.

4–1234. At the same time, a small amount of line current flows through the secondary sections of both toroids. (This current is small because it must flow through the 33-kilohm resistors rather than the crystal rectifiers). Since this action occurs during the negative half cycle of the 120-volt input, the lines of force thus generated are oriented in a negative direction. No current flows to the load at this time because the impedances of all the gate windings are equal and the bridge circuit is balanced. On the positive half cycle of the 120-volt a-c input, the discriminator cannot conduct. The line current flowing through the gate windings is then small because both cores contain lines of flux alined in the negative direction, therefore the toroids present an extremely high impedance to the current attempting to flow in the positive direction. Again, no current is fed to the load because the impedance of all secondary sections is the same and the bridge is balanced.

4–1235. Circuit action with an error signal is next considered. During the premagnetization half cycle, the two triodes of discriminator V6501 conduct unequally. Assume that the phase of the error signal is such that the number of positive flux lines produced in the core of toroid A increases. At the same time, a large increase in the number of negative flux lines occurs in core B. During the positive half cycle, the discriminator cannot conduct. As the a-c line voltage goes positive, core A soon reaches positive saturation and its reactance falls to its residual value. However, core B never does reach positive saturation and its reactance is very high. With this difference in the reactance of toroids A and B, the gate-winding bridge circuit becomes unbalanced. Output current therefore flows from terminal 1 to 2 and the motor turns in the direction corresponding to this combination of phasing.

4–1236. Upon a reversal of the phase of the error signal, phase current in core A ceases and core B conducts. The current to the load is then from terminal 2 to terminate 1 and the motor reverses direction.

4–1237. SERVO MOTOR B6505. Servo motor B6505 has two fields. The control field, 1-3, receives the servo amplifier output. The excitation field, 2-4, receives 120-volt, phase B voltage. The servo amplifier output is a half wave, rectified a-c voltage. Capacitor C6501 charges during reception of the alternation of rectified voltage and discharges during the period between voltage inputs. In this fashion, the half wave input to the motor is converted into a signal that resembles a sine wave in appearance and effect.

4–1238. The speed at which the motor rotates depends upon the amplitude of the magnetic amplifier output which, in turn, is dependent upon the magnitude of the error voltage. The direction in which the motor rotates depends upon whether the control field input is in phase or out of phase with the excitation field. This is also contingent upon the error voltage. Thus, the servo motor, acting in response to the error voltage, drives dial O6501 and synchros B6501 and B6502 simultaneously. When the rotors of the synchros correspond to the rotors of the antenna synchros, the error voltage drops to zero, the servo amplifier output also drops, and the servo motor stops. The position of the dial then indicates the azimuth of the antenna.

4–1239. ANTIHUNT FEEDBACK. Hunting is the mechanical oscillation of a servomechanism about its null position. To prevent this oscillation, a feedback voltage taken from the control field of servo motor B6505 is fed back to the input to transformer T6502. The feedback voltage is proportional to the speed of the motor and, since it is negative feedback, it is 180 degrees out of phase with the error signal. When the motor starts to position the dial, the amplitude of the feedback voltage is considerably smaller than the amplitude of the error signal and thus has little effect at this time. As the motor builds up speed, the feedback voltage increases in amplitude until, approximately 10 degrees from the null point, the feedback signal is greater than the error signal and the motor begins to slow down. Ideally, feedback slows the motor so that it will coast into the null position with no overshoot and no hunting.

4–1240. When the servo motor is hunting, the control voltage is maximum as it passes through the null point. Therefore, the feedback voltage is able to exert its greatest effect on damping the motor when the motor passes through the null point. In a properly alined circuit, the feedback stops the motor in the null position with either no or very few oscillations.

4–1241. RHI ASSEMBLY FOR RADAR SET AN/FPS-6 (RADAR SET GROUP OA-270/FPS-6).

4–1242. OVERALL BLOCK DIAGRAM. (See figure 4–176.)

4–1243. GATE CIRCUIT. The gate circuit produces positive and negative rectangular waves. These waves initiate the operation of the horizontal sweep generator, the intensifier and intensity compensation circuit, and the vertical sweep generator. Both positive and negative gates are started by the system trigger pulses received from the control group assembly. These trigger pulses, occurring at the same time as the transmitted radar pulse, are the zero time reference for the RHI. The length of both the positive and the negative gates is determined by the amplitude of either the horizontal or vertical sweep voltages.

4–1244. HORIZONTAL SWEEP GENERATOR. The horizontal sweep generator produces the horizontal component of the CRT trace. Both positive and negative gates from the gate circuit are used to unclamp the horizontal charging capacitor in the first stage. The d-c charging voltage is obtained internally. A bootstrap feedback circuit is used to obtain a linear sweep voltage. With different ranges, changes in sweep speed are obtained by varying the amount of degenerative feedback in the six-tube output amplifier stage. Range delay is produced by changing the input bias to the first stage of this amplifier.

4–1245. A horizontal sweep voltage is fed to the intensity compensation circuit. This voltage provides a means for keeping the intensity of the CRT trace constant with different sweep speeds. The sweep voltage is also used for gating the intensifier circuit when delayed presentation is used.

4–1246. A horizontal sweep voltage is applied to the vertical sweep generator circuit to provide corrections for the earth's curvature and for atmospheric refraction of the radar beam. A horizontal sweep voltage is also used to cut off the gate when the antenna is positioned at lower elevation angles. This cutoff voltage determines the right-hand edge of the display.

4–1247. INTENSIFIER AND INTENSITY COMPENSATION CIRCUIT. In the intensifier, a negative gate is applied to the cathode of the CRT to unblank it for the duration of the sweep. This prevents burning of the CRT and removes distracting displays during the interval between the radar trigger and the start of the delayed presentation. Unblanking can be delayed when delayed presentation is used to eliminate undesirable brightness on the viewing screen at the start of the trace. This initial brightness is the result of the high beam intensity before the horizontal sweep starts sweeping the beam horizontally.

4–1248. Horizontal sweep voltages are applied to a network in the intensity compensation circuit to keep the intensity of the trace constant with different range settings. The intensity compensation circuit also eliminates changes in intensity that would occur with changes in pulse repetition frequency and elevation angle.

4–1249. VERTICAL SWEEP CIRCUIT. The vertical sweep circuit produces the vertical component of the CRT trace. A vertical sweep voltage is also returned to the gate circuit to cut off the gate when the antenna is positioned at higher elevation angles. This voltage determines the upper edge of the display. Both the positive and negative gates are used to unclamp the vertical charging capacitor. The charging voltage is obtained externally from the elevation data generator in the control group assembly. A bootstrap feedback circuit is used to obtain a linear sweep voltage. With different height expansions, changes in sweep speed are obtained by varying the amount of degenerative feedback in the five-tube output amplifier. Vertical delay is brought about by changing the input bias to the first stage of this amplifier.

4–1250. Corrections for earth's curvature and atmospheric refraction are applied from the horizontal sweep circuit as an additional reference voltage for charging the vertical sweep capacitor. These corrections become appreciable at longer ranges and give the proper upward curve to the vertical sweep voltage.

4–1251. HEIGHT MARKER GENERATOR. The height marker generator produces a series of altitude markers on the viewing screen. This circuit is triggered by the vertical sweep voltage. The voltage at which triggering occurs is set by means of three potentiometers. These potentiometers determine the vertical position of the three height markers which normally appear at the 20,000-, 40,000-, and 60,000-foot heights.

4–1252. HEIGHT LINE GENERATOR. The height line generator produces a single altitude marker on the viewing screen. This circuit is triggered by the vertical sweep voltage. The voltage at which triggering occurs is set by the HEIGHT LINE handcrank. This setting determines the vertical position of the height line.

4–1253. The height line is mixed with the height markers in the video channel, is amplified, and is then applied to the CRT grid. With the antenna nodding in elevation, the markers appear as bright lines across the viewing screen.

4–1254. The HEIGHT LINE handcrank is geared to a mechanical counter which indicates at all times the height in feet represented by the height line. This handcrank is also geared to selsyns which transmit the height data to remote height displays located at an associated search radar.

4–1255. RANGE MARKER CIRCUIT. The range markers are generated in the range mark generator located in the control group assembly. The markers are

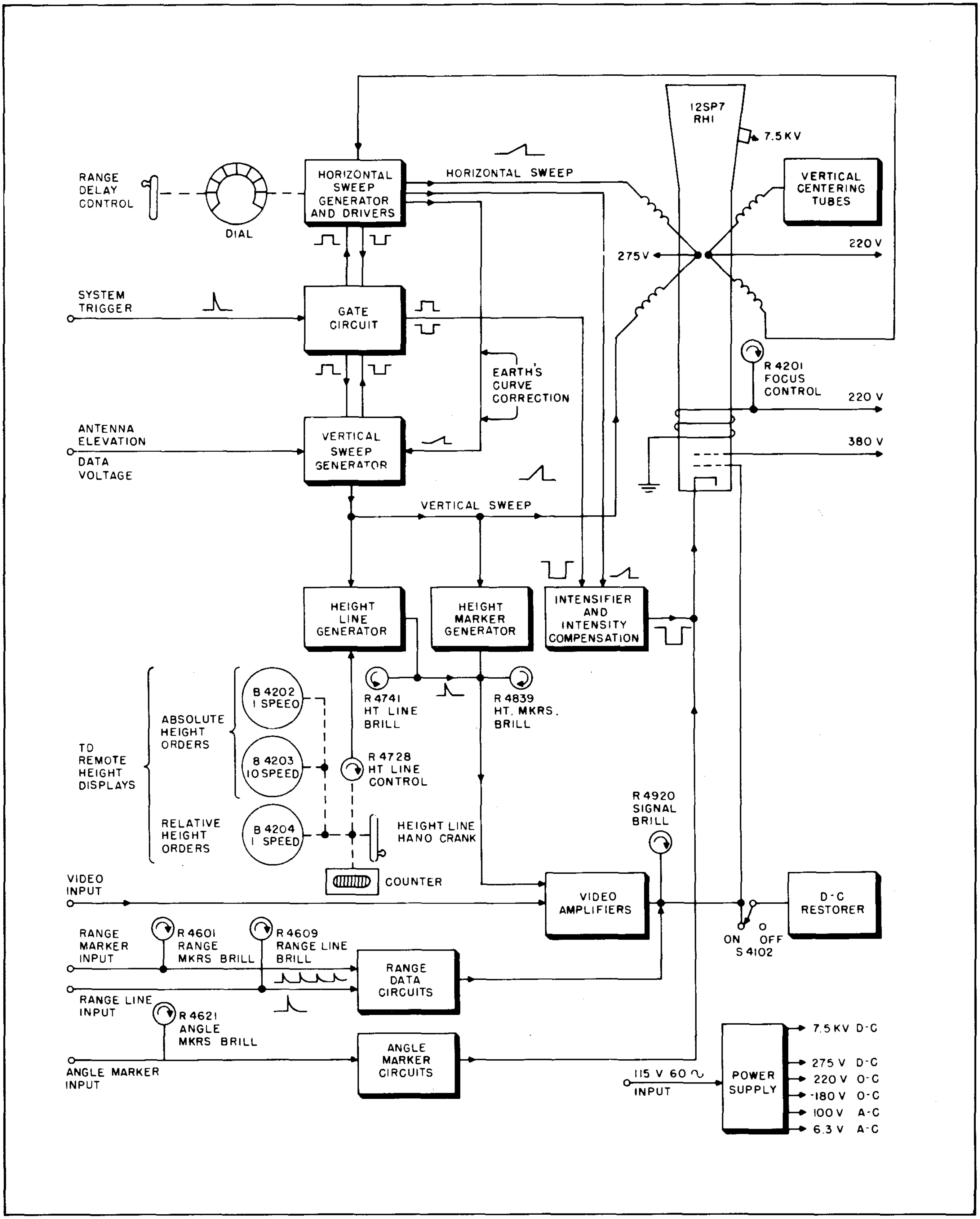


Figure 4-176. RHI Assembly for Radar Set AN/FPS-6, Block Diagram

spaced at intervals of 10 nautical miles, with every fifth marker intensified. In the RHI, these markers are amplified and mixed with the range line. After amplification and mixing, the combined range data signal is fed to the video amplifier chain for application to the grid of the CRT.

4–1256. RANGE LINE. The range line consists of a single trigger positioned in time by an operator at the associated search radar. This trigger causes a vertical line to appear on the viewing screen which intersects the target about which the search radar operator desires height information. In the RHI, the range line trigger is amplified and mixed with the range markers. The combined signal is then fed to the video amplifier for application to the CRT.

4–1257. ANGLE MARKER CIRCUIT. Commutators located on the antenna assembly produce pulses at every 5 degrees of antenna elevation. These pulses are synchronized with the system trigger and converted into narrow spikes by the angle mark generator located in the control group assembly. The spikes are applied to the angle marker circuits in the RHI where they initiate a cycle of multivibrator action. The width of the multivibrator output corresponds to one sweep length. Thus, the trace is brightened for the duration of one sweep when the antenna passes through every 5 degrees of elevation. The markers, appearing as bright lines on the display, originate in the lower left-hand corner.

4–1258. VIDEO AMPLIFIER. The video amplifier amplifies the target signals supplied by the radar receiver sufficiently to produce spots of the proper intensity on the viewing screen. The video channel also receives the height line signal, height markers, range markers, and range line. These signals are mixed, amplified, and fed to the grid of the CRT.

4–1259. RHI POWER SUPPLY. The RHI power supply is located on a separate chassis below the main chassis. The circuits contained therein supply the following voltages:

a. Regulated 220 volts positive (adjustable)

b. Regulated 180 volts negative (adjustable)

c. Regulated 275 volts positive (not adjustable)

d. Regulated 7,500 volts positive (not adjustable)

e. 100 volts ac

f. 6.3 volts ac

4–1260. FUNCTIONING OF CRT. (See figure 4–177.)

4–1261. GENERAL. The CRT used is a conventional magnetic type 12SP7. The numeral 12 signifies a 12-inch diameter screen (10-inch viewing area). The code P7 denotes a long-persistence phosphor (screen coating) with an amber glow, while the letter S distinguishes this tube from others of the same diameter and phosphor.

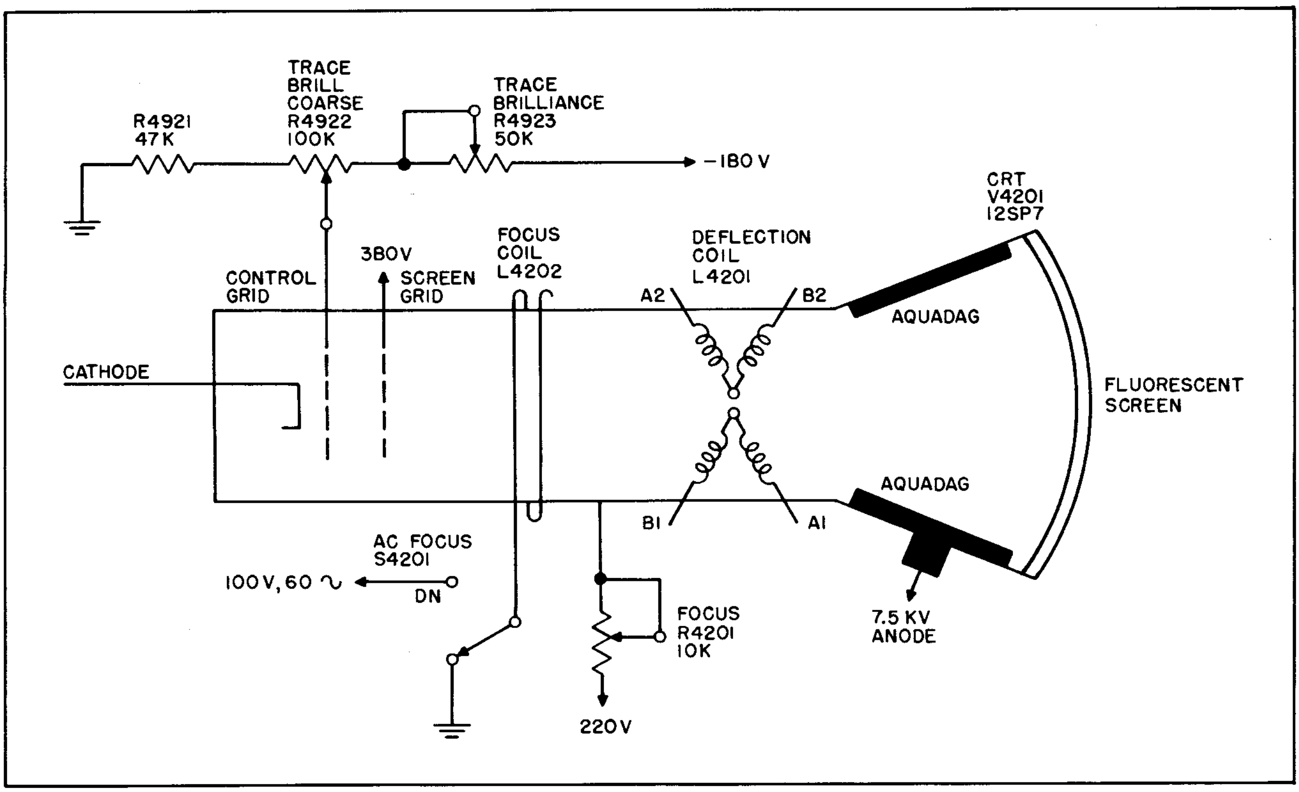


Figure 4–177. CRT Elements and Controls of RHI Assembly for Radar Set AN/FPS-6, Simplified Schematic Diagram

Essentially, the tube contains the electron gun and the fluorescent screen. The focus and deflection coils fit around the neck of the CRT.

4–1262. BRILLIANCE CONTROLS. Resistors R4921, R4922, and R4923 constitute a voltage divider between the negative power supply and ground. Voltage tapped off at the wiper arm of TRACE BRILL. COARSE potentiometer R4922, the largest of the three resistors, determines the bias applied to the grid of the CRT. This control is set so that the grid-cathode potential is approximately that required for cutoff. The positive input signals bring the CRT grid out of cutoff and allow electrons to pass through the grid. A luminous spot is thus produced on the screen, provided the tube is not blanked at this time.

4–1263. TRACE BRILLIANCE control R4923 is connected as a rheostat and can vary the current flowing through the voltage divider. As a result, rotating the arm of this control allows a fine adjustment of the trace brilliance.

4–1264. The grid of the CRT can be clamped at the bias level set by the two brilliance controls by throwing "DC RESTORER" switch S4902 to the "ON" position. For a circuit analysis of this stage, refer to paragraph 4–1411.

4–1265. FOCUS CONTROL. Focusing the electron beam is accomplished by first centering the beam by adjusting the position of the precentering magnet at the base of the tube. The strength of the magnetic field produced by the focus coil is then adjusted for best trace definition. When the strength and the physical alinement of the magnetic field are properly adjusted with respect to the CRT axis, the focusing field causes the electrons to converge at a common point on the fluorescent screen.

4–1266. The precentering magnet consists of a circular permanent magnet around the neck of the tube, partially shunted by a soft iron sleeve. The amount of shunting, and therefore the strength of the magnetic field, can be varied by sliding the magnet with respect to the sleeve. The direction of the field can be changed by rotating the magnet. When the magnet is adjusted, the beam can be directed down the center of the focus coil.

4–1267. With switch S4201 in the AC FOCUS position, a 60-cps a-c voltage is applied to focus coil L4202 to facilitate adjustment of the precentering magnet and positioning of the coil. The a-c current flowing through the focus coil produces a crescent-shaped pattern on the screen. This pattern shows the technician when the axes of the tube coincide with the magnetic field.

Note

Normally, adjustment of the precentering magnet and use of the a-c focus control is necessary only upon installation of the radar set or when the CRT is replaced.

4–1268. Switch S4201 is normally connected to ground. In this position, the other end of the focus coil is connected to the 220-volt d-c supply through resistor R4201, the FOCUS control. The strength of the magnetic field is adjusted by varying the current flowing through the focus coil. As shown in figure 4–177, FOCUS control R4201 is connected as a rheostat in series with the 220-volt supply and determines the current flowing through the focus coil.

4–1269. SWEEP DEFLECTION. The CRT beam should be deflected to the right as the radar pulse travels outward in space. A linear sawtooth voltage applied to the horizontal deflection winding produces the necessary magnetic field for this purpose. The vertical motion of the CRT beam should be synchronized with the antenna nodding. A linear sawtooth voltage of variable amplitude, applied to the vertical winding of the deflection coil, can be used to satisfy this requirement.

4–1270. When the antenna points along the horizontal (zero elevation), there is no output from the elevation data generator. The capacitor in the vertical sweep generator does not charge, and no vertical sweep is produced. During this time, however, a horizontal sweep is generated. The CRT beam is then moved from left to right along the zero line under the sole influence of the horizontal sawtooth (figure 4–178).

4–1271. The elevation data generator produces a positive output as the antenna scans upward. The vertical sawtooth is produced by the action of the vertical sweep capacitor in attempting to charge to this elevation data voltage. Two forces are then acting upon the CRT beam: the horizontal force of the horizontal sweep and the vertical force of the vertical sweep. As a result of these two forces acting perpendicular to each other, the beam is moved along a diagonal path.

4–1272. As the elevation angle increases, the magnitude of the elevation data voltage also increases. The data voltage reaches a maximum positive amplitude when the antenna points to 32 degrees, which is the upper limit of its arc. The vertical sweep produced at this time is of an amplitude so much greater than the horizontal sweep, that the electron beam is pulled up almost vertically with the result shown in figure 4–178.

4–1273. The elevation data generator supplies a negative voltage to the sweep capacitor when the antenna points below the horizontal. As a result, a negative-going sawtooth is developed by the vertical sweep circuits. The combination of horizontal and vertical sweep signals causes the beam to trace a diagonal path below the zero line.

4–1274. At first glance the range markers may seem to curve around with the trace motion, since the sweep takes on the appearance of a rotating radius. However, in practice the range markers appear on the indicator as straight, vertical lines.

4–1275. Figure 4–178 shows how the 50-mile range marker would appear on the trace at 0 degree and 15 degrees of antenna elevation. This marker is always produced 618 microseconds (50 x 12.36) after the start of the sweep. It should be noted that distance x is greater than distance y. Since the trace covers a greater distance in the same period of time, the trace must be moving faster at the higher elevation angles. This increased speed is logical because of the increased force applied to the electron beam by the larger vertical sweep sawtooth. Therefore, although the sweep appears to rotate, the fact that the electron beam is moving faster at the higher

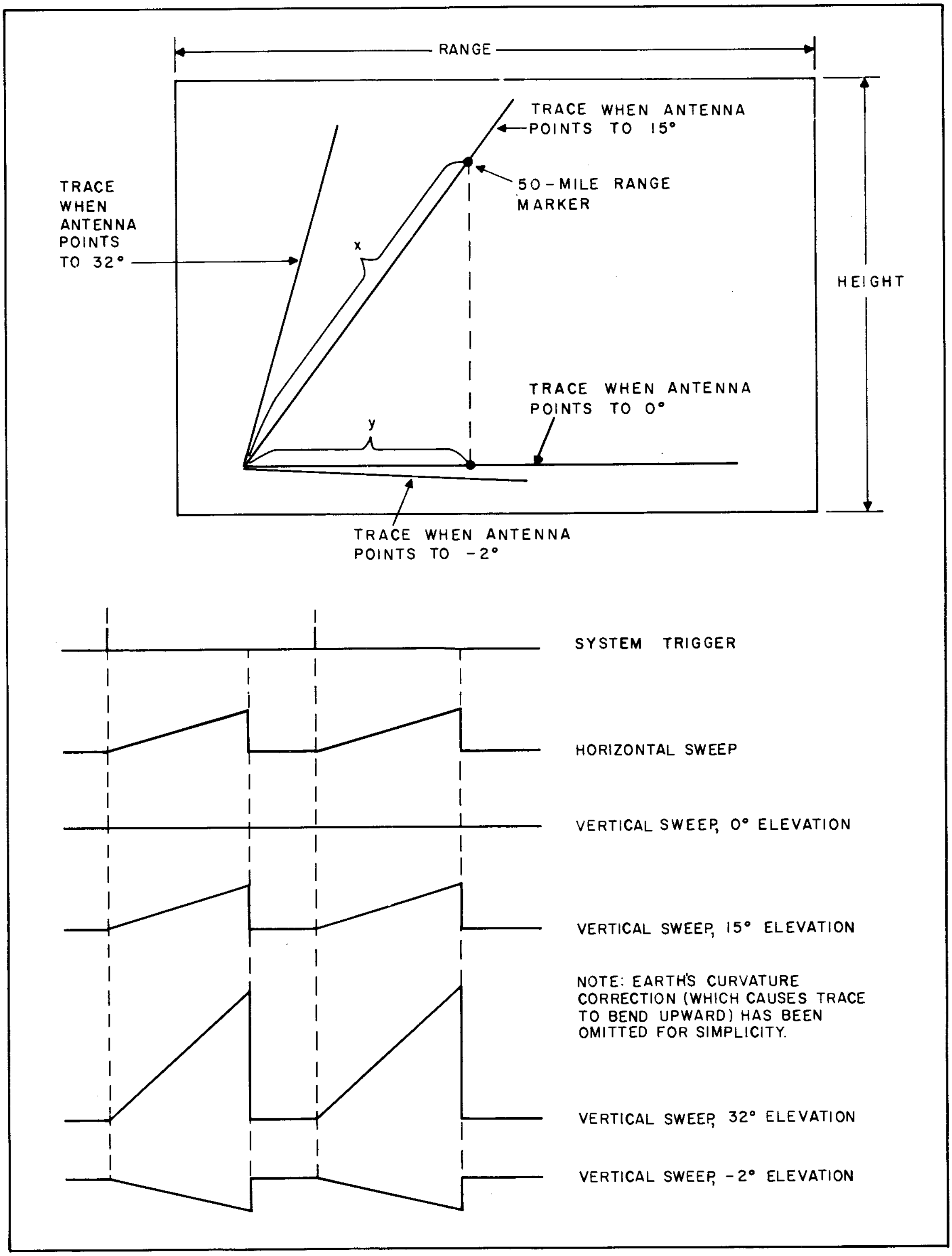


Figure 4–178. Sweep Deflection

elevation angles allows the range markers to remain at the same perpendicular distance from the left-hand edge of the display. The result is a succession of bright dots which trace out a series of straight, vertical lines as the trace rotates through 90 degrees.

4–1276. VERTICAL CENTERING. As shown in figure 4–179, vertical centering tubes V4007 through V4009 draw current through a winding of the deflection coil. The magnetic field about the winding moves the CRT beam in a vertical direction. The vertical centering adjustment, which determines the amount of current drawn by the centering tubes, is used to move the sweep starting point up or down on the CRT screen. The two vertical centering potentiometers are VERT. CENT. 25,000 FT. potentiometer R4031 and VERT. CENT. 75,000 FT. potentiometer R4032. Potentiometer R4031 is switched into the circuit when HEIGHT SELECTOR switch S4501B is in the –5–25 position. In all other positions of the selector switch, potentiometer R4032 is in the circuit.

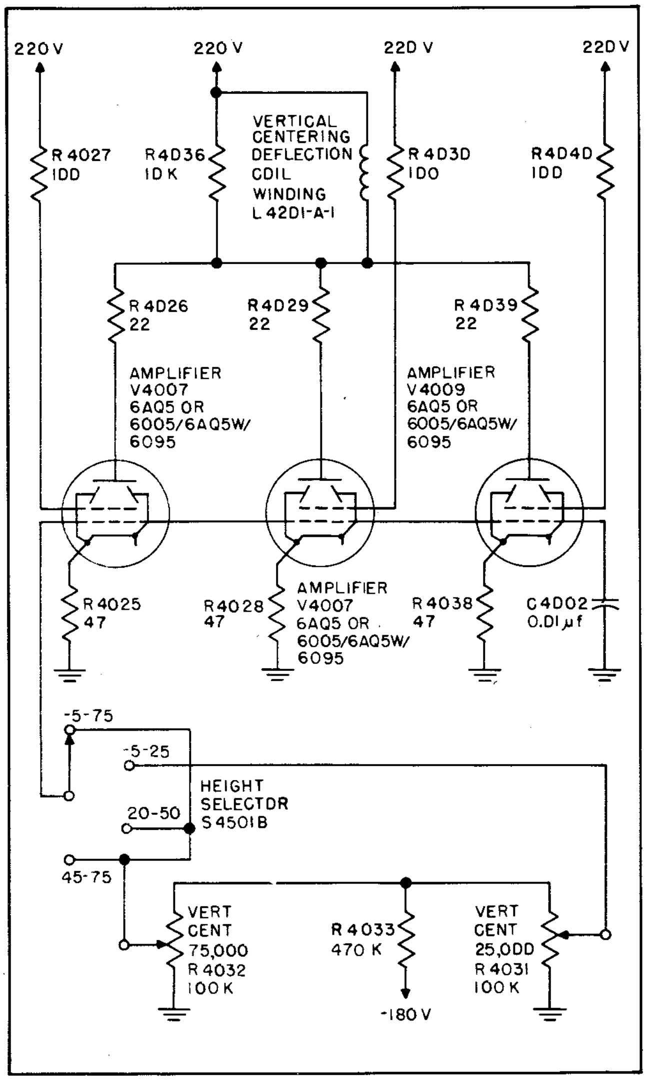


Figure 4–179. Vertical Centering Circuit, Simplified Schematic Diagram

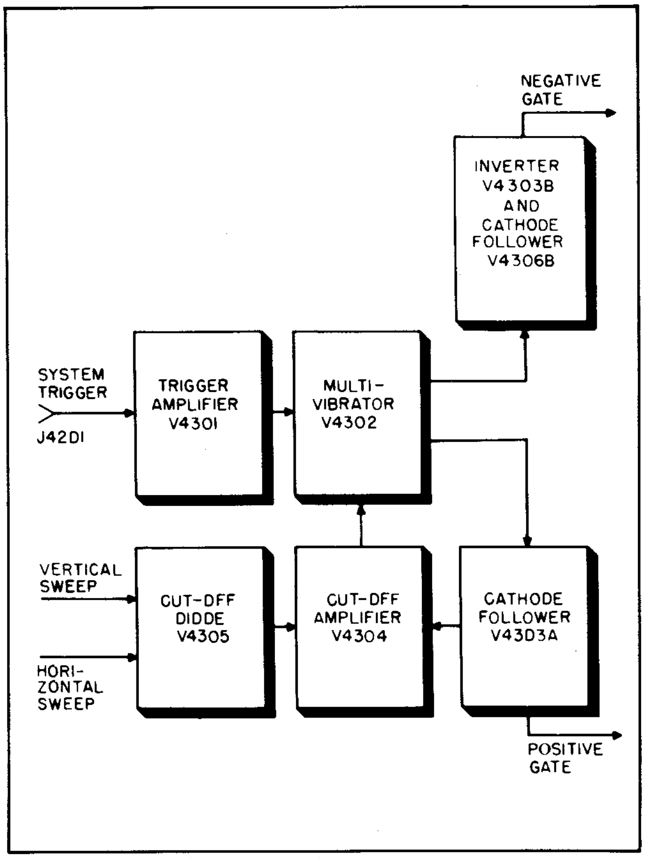


Figure 4–180. Gate Circuit, Block Diagram

4–1277. Three tubes are required to handle the current requirements. Beam-power stages are used because these stages are constant-current devices. For a given grid voltage, the beam-power stages pass a substantially steady current despite fluctuations in the plate voltage. The combination of the beam-power stages and filter capacitor C4002 acts to regulate the centering current.

4–1278. Resistors R4025, R4028, and R4038 limit current to a safe value at the maximum setting (0 volt) of the vertical centering potentiometer. The three 22-ohm plate resistors suppress parasitic oscillations. The 100-ohm resistors in the screen grid circuits also act to squelch parasitic oscillations. Resistor R4036 shunts the deflection coil to damp out shock-excited oscillations caused by the sudden application and removal of the sweep voltages.

4–1279. BLOCK DIAGRAM OF GATE CIRCUIT. (See figure 4–180.)

4–1280. POSITIVE AND NEGATIVE GATES. The gate circuit is a master synchronizer which produces the rectangular pulses to turn on the various circuits in the RHI. The outputs of the gate circuit are fed to the horizontal sweep, vertical sweep, and intensifier circuits.

4–1281. The system trigger from the associated search radar is amplified in trigger amplifier V4301. This amplified trigger is used to fire a multivibrator. The multivibrator output is inverted by inverter V4303B to produce the negative gate. The positive gate is applied to the external circuits through cathode follower V4303A.

4–1282. REGENERATIVE GATE CUTOFF. The width of the gate pulses and the amplitude of the sweep voltages are interdependent. As in most sweep circuits, the wider the gate the longer the period of time the sweep capacitor has to charge and the greater the amplitude of the sweep voltage. However, the regenerative cutoff circuit feeds a portion of the sweep voltage output back to the gate circuit. When the sweep voltages reach a predetermined amplitude, the gate circuit is cut off, turning off both sweep generators.

4–1283. The cathodes of duo-diode V4305 are tied together and connected to the grid of the normally cutoff section of cutoff amplifier V4304. The horizontal and vertical sweep voltages are fed into the plates of duo-diode V4305. As the sweep voltages rise in amplitude, the voltage rises at the junction of the diode cathodes and at the normally cutoff grid of cutoff amplifier V4304. When one of the sweep voltages reaches the predetermined amplitude, the cutoff section of cutoff amplifier V4304 is driven to conduction. When this section conducts, the plate voltage falls. This negative-going voltage is applied to the conducting section of multivibrator V4302. The negative-going voltage brings the multivibrator action to an end, cutting off the gate circuit and turning off both sweep generators.

4–1284. The positive gate pulse is applied to the normally conducting section of cutoff amplifier V4304. As a result, the potential at the common cathode of cutoff amplifier V4304 is raised to a value that holds tube V4304A cut off until the next cycle of the regenerative gate cutoff circuit.

4–1285. CIRCUIT ANALYSIS OF POSITIVE AND NEGATIVE GATE GENERATION. (See figure 4–181.)

4–1286. TRIGGER AMPLIFIER V4301. The 30-volt system trigger from the range mark generator initiates the gate and thus determines the time at which these circuits start operating. Because this trigger and the transmitted pulse occur almost simultaneously, accurate ranging and height measuring are possible.

4–1287. Tube V4301 is the trigger amplifier stage. The grids of both sections are returned to a point on a negative voltage divider so that the tube is cut off in the absence of the trigger. This arrangement prevents noise voltages from being amplified in the stage and then triggering the multivibrator.

4–1288. GATE MULTIVIBRATOR V4302. The grid of multivibrator V4302B is normally held at 0 volt by grid current through resistors R4305 and R4304, causing the tube to conduct heavily. The grid of multivibrator V4302A is normally biased beyond cutoff by the voltage divider action of resistors R4307, R4308, and R4309.

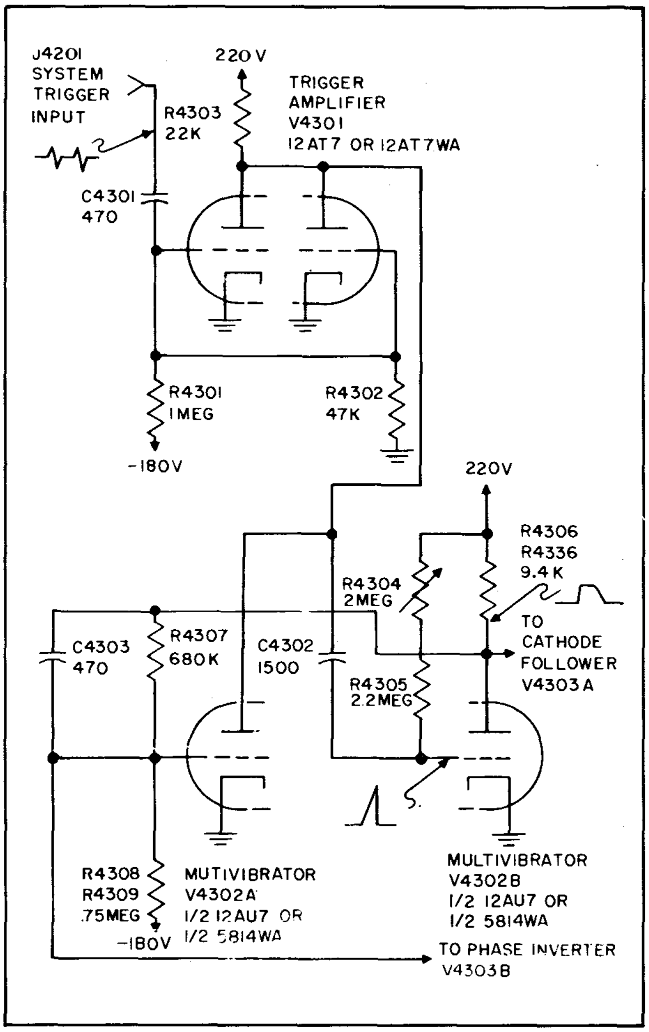


Figure 4–181. Gate Multivibrator, Simplified Schematic Diagram

Capacitor C4303 and the voltage divider resistors form a coupling network so that the grid of multivibrator V4302A can follow rapid changes in the plate voltage of multivibrator V4302B. These quiescent conditions exist before the arrival of the input trigger.

4–1289. The amplified trigger pulse from trigger amplifier V4301 drives the grid of multivibrator V4302B sharply negative. The plate voltage of multivibrator V4302B then rises steeply and this rise is coupled to the grid of multivibrator V4302A. The increase in grid voltage causes multivibrator V4302A to conduct and the plate voltage to fall. The decrease in the plate voltage of multivibrator V4302A is coupled to the grid of multivibrator V4302B and this decrease causes a further rise in the plate voltage of multivibrator V4302B. This regenerative action continues until multivibrator V4302A conducts heavily and multivibrator V4302B is cut off.

4–1290. The grid voltage of multivibrator V4302B is held below cutoff by the charge of capacitor C4302, which leaks off through resistors R4304 and R4305. A positive-going rectangular pulse is then produced at the plate of multivibrator V4302B and applied to inverter V4303B. The width of the gate is normally determined by the gate cutoff circuit. In the absence of regenerative gate cutoff, the output from the plate of multivibrator V4302B would be 250 radar miles in width.

4–1291. NEGATIVE GATE OUTPUT. The positive pulse from the plate of multivibrator V4302B is applied to the grid of inverter V4303B. A negative gate is produced at the plate of this inverter and applied to cathode follower V4306B. The output from the cathode follower is the negative gate which is applied to the horizontal and vertical sweep generators.

4–1292. POSITIVE GATE OUTPUT. A positive gate is produced at the plate of multivibrator V4302B and applied to cathode follower V4303A. The output from the cathode follower is taken across resistor R4318 and applied to the cutoff diodes and the clamps of the horizontal and vertical sweep generators.

4–1293. CIRCUIT ANALYSIS OF REGENERATIVE GATE CUTOFF.
(See figure 4–182.)

4–1294. During intervals between gates, the grid of gate cutoff amplifier V4304B is held at +4 volts by a voltage divider network composed of resistors R4319 through R4321. The self-biasing action of amplifier V4304B holds the cathode at about +4.8 volts and the amplifier therefore conducts with a bias of about 0.8 volt. The grid of amplifier V4304A is held at ground potential by resistor R4310. Since the cathode voltage of amplifier V4304A is then high and the grid voltage low, the tube is cut off. The plate voltage of amplifier V4304A is low because of heavy conduction through multivibrator V4302B.

4–1295. At the start of the gate, the plate voltage of multivibrator V4302B rises as the tube is cut off. This sharply rising voltage is coupled through cathode follower V4303A to the grid of amplifier V4304B. The cathode of amplifier V4304B follows this rise. At the same time, the plate voltage of amplifier V4304A rises sharply to nearly 220 volts. Despite the increase in plate voltage, amplifier V4304A remains cut off because of a highly positive cathode potential, and remains cut off until its grid voltage rises sufficiently to allow conduction.

4–1296. During the period of the gate, a vertical sweep voltage is applied to one plate of gate cutoff diode V4305A and a horizontal sweep voltage to the other plate. Conduction of the diode through resistor R4310 and the charging of capacitor C4304 causes the higher of these rising sweep voltages to appear at the grid of amplifier V4304A. When the conduction point of amplifier V4304A is reached, its plate voltage drops.

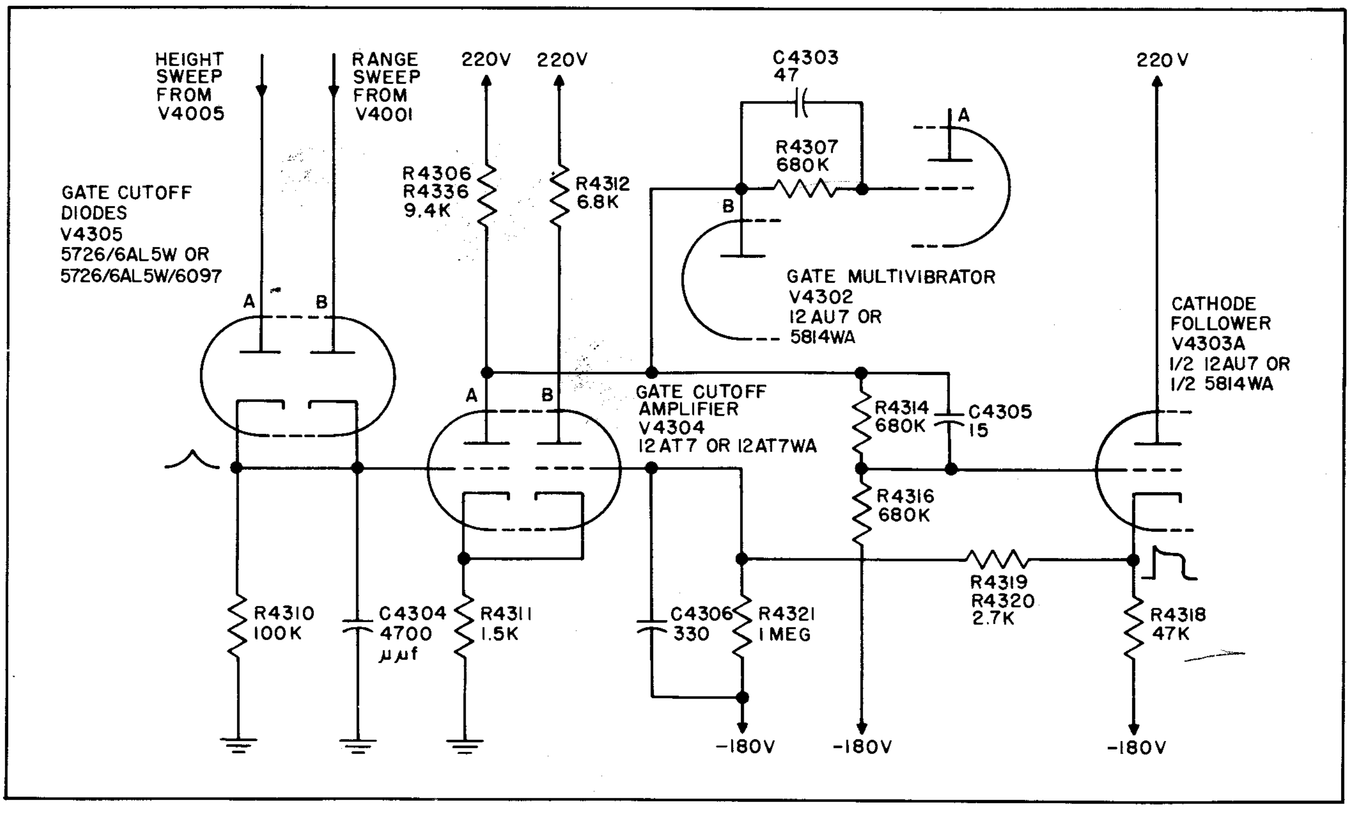


Figure 4–182. Gate Cutoff, Simplified Schematic Diagram

This drop in voltage is coupled to the grid of cathode follower V4303A. The cathode voltage of cathode follower V4303A then drops and this drop is applied to the grid of amplifier V4304B. This causes a decrease of voltage at the common cathode of amplifier V4304, resulting in a decrease in bias for amplifier V4304A and, consequently, a further decrease in its plate voltage.

4–1297. This regenerative action quickly lowers the grid voltage of multivibrator V4302A sufficiently to cause a rise in plate voltage that raises the grid of multivibrator V4302B to its conduction point. Normal multivibrator regeneration then takes place. This leaves multivibrator V4302B conducting and cathode follower V4303A and inverter V4303B cut off. The circuit remains in this condition until the next trigger occurs. A positive rectangular wave is produced at the cathode of cathode follower V4303A.

4–1298. BLOCK DIAGRAM OF HORIZONTAL SWEEP CIRCUIT.
(See figure 4–183.)

4–1299. The horizontal sweep circuits can be divided into four functional groupings: the gated clamp and sweep generator, sweep amplifier chain, sweep inverter, and sweep drivers. The sweep generator consists of a diode clamp, a triode clamp with a capacitor and resistor connected between the plate and ground, and a multistage feedback amplifier. The capacitor tends to charge exponentially during the period of the negative gate. The sweep amplifier chain provides an inverse feedback loop to convert the capacitor charge curve from an exponential to a linear sawtooth. The gain of the amplifier chain, and therefore the amount of feedback, is adjustable.

4–1300. The sweep amplifier chain consists of several amplifiers in cascade, finally leading into a power amplifier. The sweep signal is inverted in the sweep inverter and fed into the opposing power amplifier to provide push-pull power output. The current through the deflection coil increases in a linear manner. The linear increase causes the magnetic field about the deflection coil to expand at a constant rate, and in turn to exert a steadily increasing force on the electron beam to sweep it across the face of the CRT at a constant rate.

4–1301. CIRCUIT ANALYSIS OF HORIZONTAL SWEEP GENERATOR.

4–1302. GATED CLAMPS V4401 AND V4402A. (See figure 4–184.) Clamp tubes V4401 and V4402A are essentially electronically-operated switches. A positive voltage exists at the plates of clamp tube V4401 prior to the arrival of the negative gate. During this ungated interval, clamp tube V4401 conducts and shorts sweep capacitor C4401 to ground. Clamp tube V4402A also conducts in the absence of the positive gate and keeps the sweep capacitor from charging. The sweep starts when the clamp tubes are cut off by the arrival of the gate pulses. The voltage at the plate of clamp tube V4402A rises as rapidly as the charging of capacitor C4401 permits. Sweep capacitor C4401 attempts to charge to the voltage existing at the junction of resistors R4403 and R4405.

4–1303. Since capacitor C4401 cannot charge instantly, the entire voltage change is seen across the charging circuit resistor at the first instant. The interelectrode capacitances of the sweep amplifier stages charge to the voltage across resistor R4402. Charging the interelectrode capacitances before the sweep voltage is developed effectively prevents these capacitances from

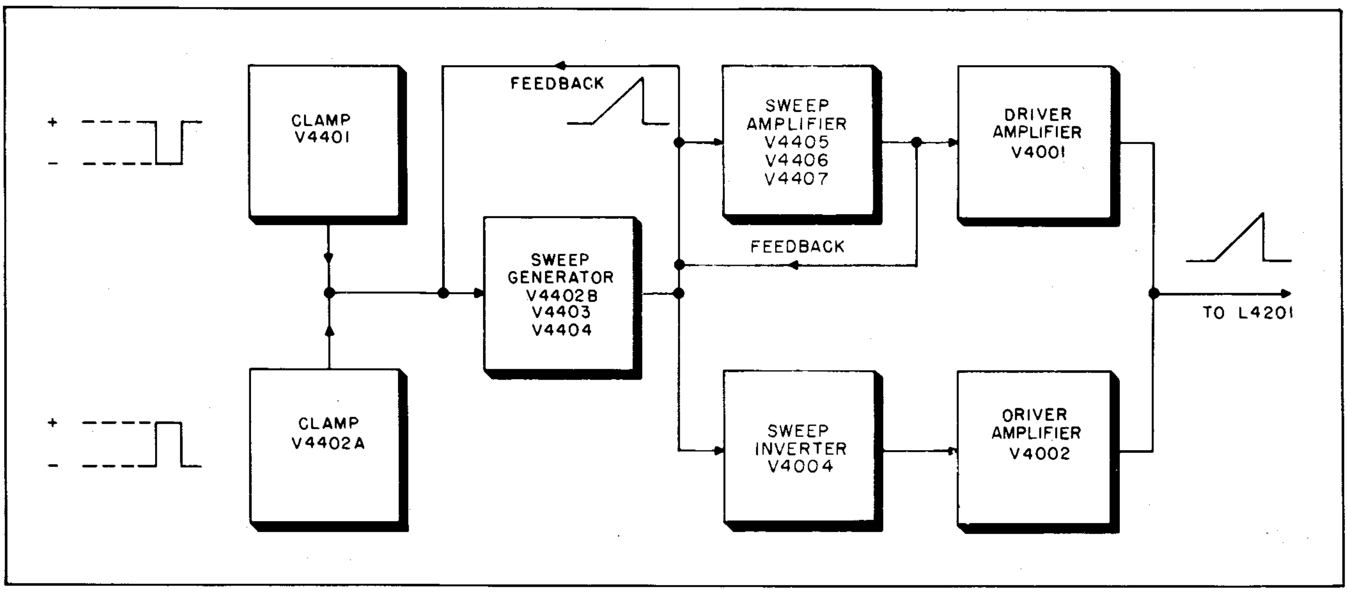


Figure 4–183. Horizontal Sweep Circuit, Block Diagram

interfering with the sweep generator operation, since a charged capacitor is functionally an open circuit.

4–1304. The voltage across resistor R4402 decreases as the capacitor charges. The principal charging path is from ground, through resistor R4402, capacitor C4401, and resistors R4406 and R4403 to the B+ supply. One feedback path exists from ground through resistor R4402, capacitor C4401, and resistor R4407 to the output of the feedback amplifier. The other path exists from the cathode of amplifier V4402B through resistor R4414 to the output of the bootstrap amplifier. If only a single charging path was provided, the capacitor would charge in the familiar exponential fashion. The current charging capacitor C4401 is the sum of the currents through the principal charging path and the feedback path. As the capacitor approaches full charge, the current flow in the principal path decreases. However, the current in the feedback path increases (the feedback loop produces an output current in inverse ratio to the intensity of the input current). The result is that the current charging capacitor C4401 remains constant. Since the charging current does not diminish, the charging wave does not taper off exponentially. The constant charging current produces a linear sawtooth voltage.

4–1305. The sweep capacitor discharges rapidly through clamp tube V4401 or V4402A at the conclusion of the gate pulse. When switch S4401 is placed in the CAL. position, the plate of clamp tube V4402A is grounded

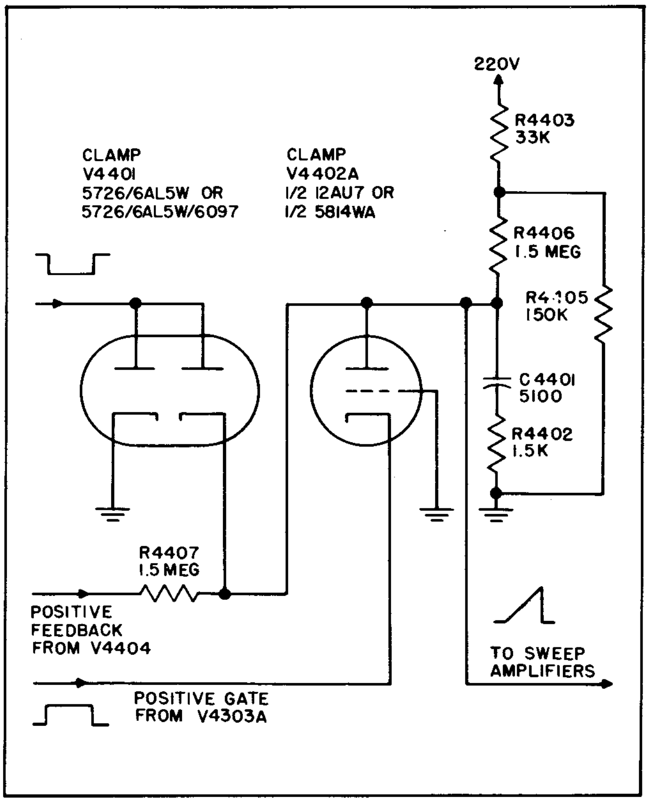


Figure 4–184. Clamp and Sweep Generator, Simplified Schematic Diagram

through resistor R4406 so that the sweep capacitor cannot charge. HOR. SWEEP GEN. ZERO potentiometer R4435 is then adjusted until a low amplitude square wave appears at jack J4402. Switch S4401 is normally left in the OPER. position.

4–1306. AMPLIFIER V4402B. (See figure 4–185.) The sawtooth signal from the horizontal sweep generator is amplified in amplifier V4402B. Fixed bias for this stage is obtained from the junction of resistors R4409 and R4415 in a voltage divider composed of these resistors and HOR. SWEEP GEN. LIN. potentiometer R4437. Although potentiometer R4437 constitutes a part of the voltage divider, the setting of this potentiometer has relatively little effect on the bias of the stage. However, the signal developed across the output cathode follower is tapped off at the junction of resistors R4414 and R4415 and fed back to the input of the sweep amplifier chain at the cathode of amplifier V4402B. The setting of potentiometer R4437 determines the amount of feedback and also the gain of the sweep amplifier chain. Just enough feedback must be provided to straighten out the sawtooth. The input sawtooth has been made linear by the action of the feedback signal supplied to the grid of the sweep generator. Another inverse feedback loop is required to cancel sweep amplifier distortion. The signal fed back to the cathode of amplifier V4402B is in the same phase as the signal on the grid. However, a positive signal on the cathode is equivalent to a negative signal on the grid, so that effectively the signal fed back is in inverse polarity. When mixed with the original signal, the inverse wave cancels any nonlinearities generated within the stages encompassed by the feedback loop, namely, sweep generator tubes V4402B, V4403, and V4404.

4–1307. AMPLIFIER-CATHODE FOLLOWER V4403. The A section of amplifier-cathode follower V4403 is connected as a conventional amplifier, while the B section is used as a cathode follower. The grid of the B section is connected to HOR. SWEEP GEN. ZERO potentiometer R4435, which is part of a negative voltage divider. This potentiometer determines the bias current through common cathode resistor R4412 and is adjusted for a low amplitude, rectangular wave at the cathode of cathode follower V4404.

4–1308. CATHODE FOLLOWER V4404. Tube V4404 is operated as a conventional cathode follower. The output signal is obtained at the junction of resistors R4414 and R4416 and is fed to three circuits. These circuits are the delay circuit, the height sweep circuit (as the earth's curvature correction voltage), and the sawtooth feedback circuit. The latter circuit assures that the current charging the sweep capacitor is constant.

4–1309. HORIZONTAL SWEEP DRIVERS. (See figure 4–186.) The linear sweep voltage from the cathode of cathode follower V4404A is amplified by sweep amplifiers V4405 and V4406. The amplified sweep is then applied to amplifier V4001 through cathode follower V4407. The linearly increasing current through

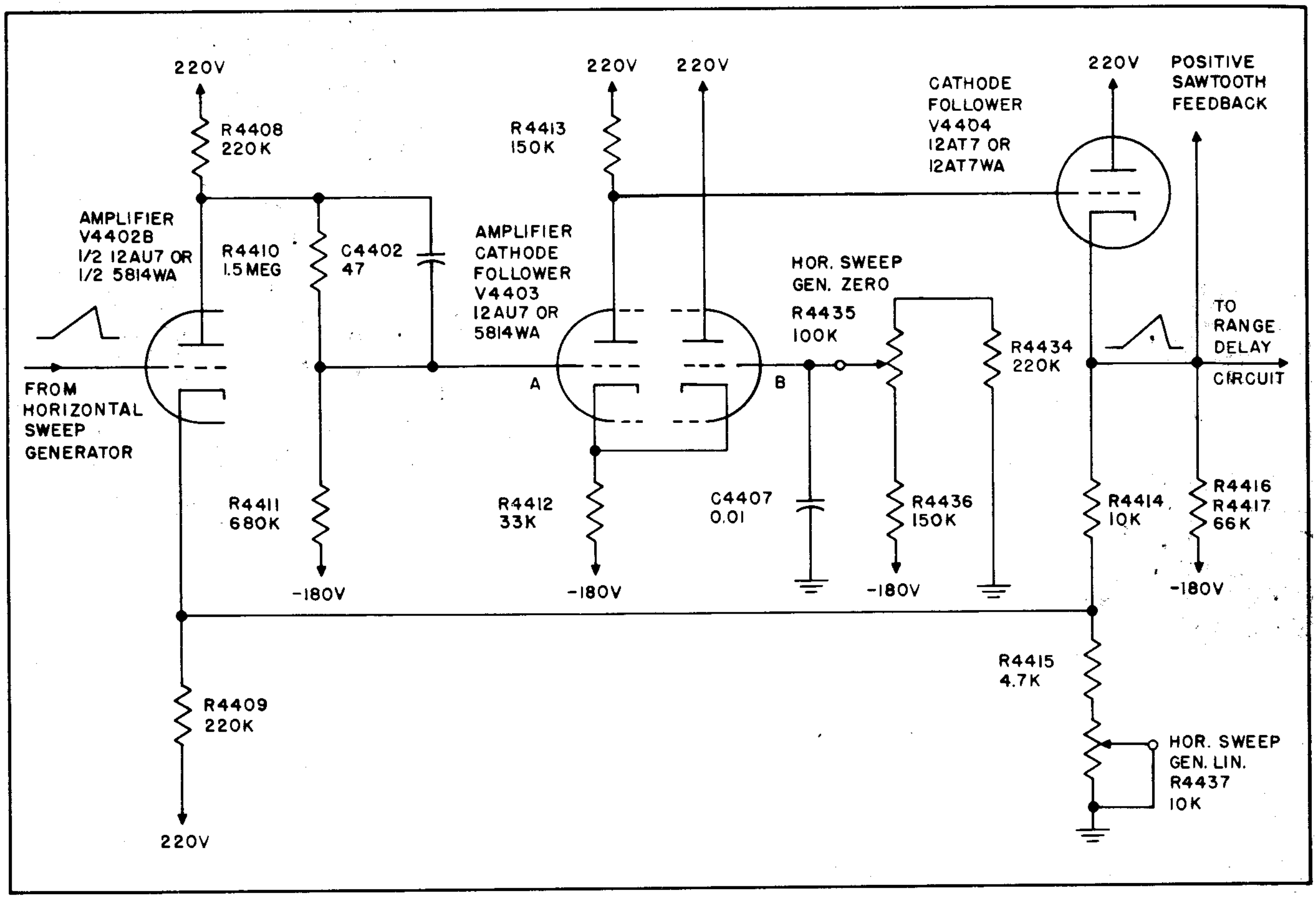


Figure 4–185. Horizontal Sweep Amplifier, Simplified Schematic Diagram

the deflection coil winding in the plate of amplifier V4001 produces part of the variation in the magnetic field which sweeps the CRT beam horizontally.

4–1310. A feedback signal is taken from the cathode of amplifier V4001 and fed back to the grid of cathode follower V4405B. In this manner, distortion introduced by the final amplifier stage is held to a minimum. A high-frequency feedback signal is taken from the output of cathode follower V4407 and fed back through filter capacitor C4406 to the plate of amplifier V4405. The capacitor passes only the high frequencies.

4–1311. The sweep voltage from the cathode of amplifier V4001 is fed through resistor R4007 to the grid of inverter amplifier V4004. The output of amplifier V4004 drives opposing output amplifier V4002 so that its current decreases as the current through amplifier V4001 increases. Because of the push-pull connections of the deflection coil, the range sweep on the CRT is thereby increased. A feedback voltage is taken from the cathode of amplifier V4002 and applied to the grid of amplifier V4004 so that the sweep current in amplifier V4002 is linear, with equal and opposite magnitude to that in amplifier V4001.

4–1312. RANGE DELAY.

4–1313. RANGE DELAY control R4443 (figure 4–187) permits the sweep to be delayed in time so that the starting point on the screen represents any desired range from 0 to 150 nautical miles. Sweep delay is accomplished by varying the bias on the grid of amplifier V4405A. Increasing the bias voltage at the grid of amplifier V4405A by means of the RANGE DELAY control cuts off the amplifier. As the positive sawtooth sweep voltage increases in amplitude, the grid of amplifier V4405A reaches the proper point for resumption of conduction. At this point, the sweep is initiated in the amplifier. The length of time that elapses between the start of the original sweep and the start of the delayed sweep thus depends upon the setting of the RANGE DELAY control. Waveforms depicting the delay action are shown in figure 4–188. HOR. DELAY ZERO control R4442 (figure 4–187) and HOR. DELAY RATE control R4444 are provided for adjusting the limits of the range delay potentiometer.

4–1314. Since the range depicted on the display depends upon the speed of the trace, changes in range are brought about by changing the rate of increase of the range sweep current. This is accomplished by varying

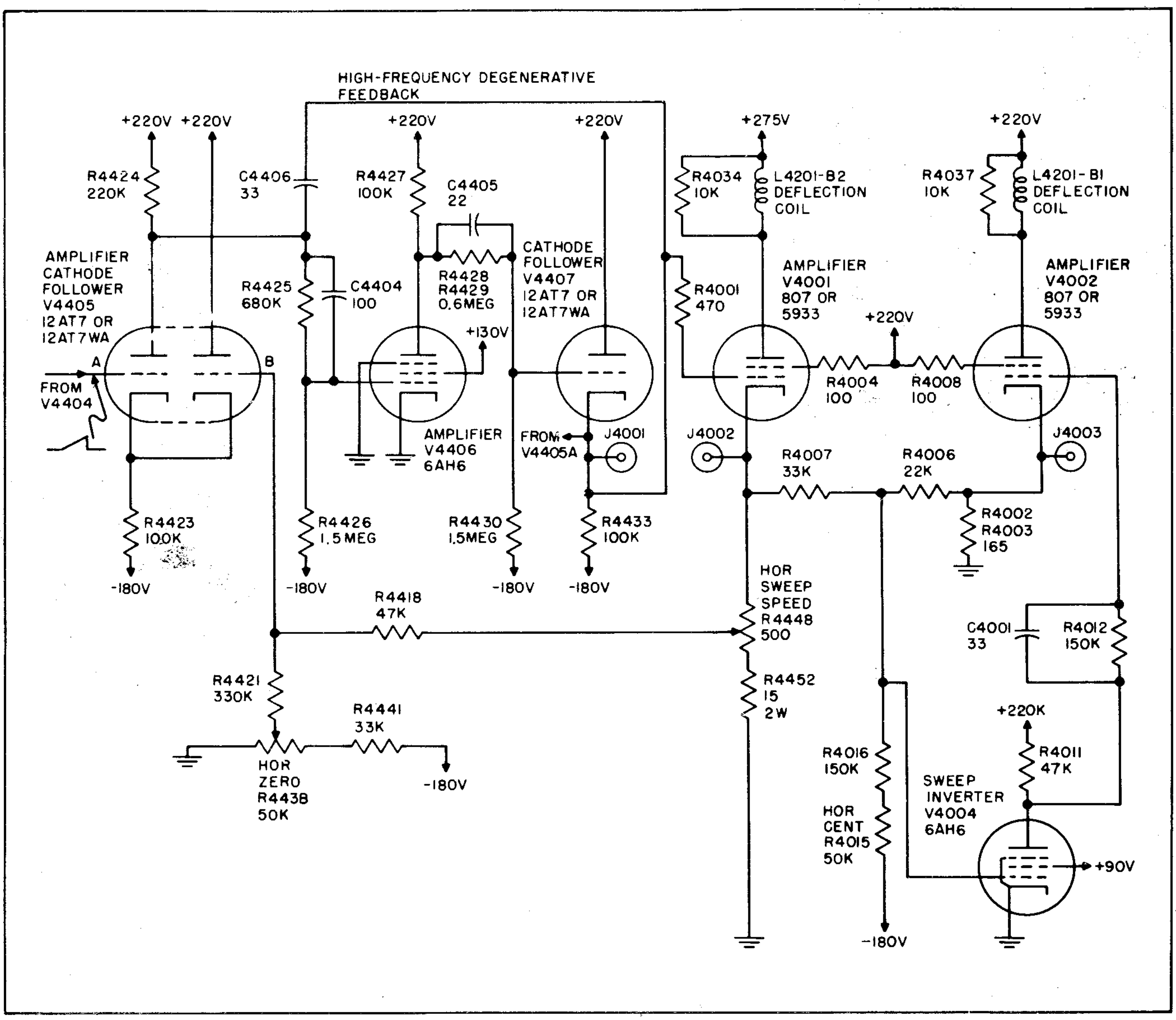


Figure 4–186. Horizontal Sweep Driver, Simplified Schematic Diagram

the overall gain of the amplifier through the introduction of a variable amount of degeneration. As shown in figure 4–186, the degenerative positive sweep voltage is fed from the cathode of sweep amplifier V4001. HOR. SWEEP SPEED control R4448 determines the amount of degenerative voltage applied to the grid of cathode follower V4405B. A greater amount of degeneration results in a smaller effective signal applied to cathode follower V4405B, since the feedback signal is 180 degrees out of phase with the original. The smaller the gain, the smaller the sweep signal, and the shorter the range represented on the display. The HOR SWEEP SPEED control should be set for a sweep of 100 miles on the 0- to 100-mile range and a sweep of 200 miles on the 0- to 200-mile range. However, the control should be set for a 50 mile sweep when using range delay. The HOR. SWEEP SPEED control normally requires readjustment each time a component of the sweep amplifier circuit is replaced.

4–1315. Figure 4–187 shows the first section of RANGE SELECTOR switch S4402A. This switch determines the bias on amplifier V4405A. In the 100 position, a 100-mile sweep is obtained; in the 200 position, the sweep voltage is attenuated so that the electron beam sweeps across the CRT face in 200 miles. In the DELAY position, the sweep amplitude is such that a 50-mile sweep deflects the trace across the CRT. RANGE DELAY control R4443 adds a bias to this sweep so that as much as 150 miles of sweep is required to start the deflection, but it still takes 50 miles more to display the sweep. HOR. DELAY RATE control R4444 calibrates the RANGE DELAY handwheel dial. HOR. SWEEP ZERO control R4438 (figure 4–186) sets the starting current

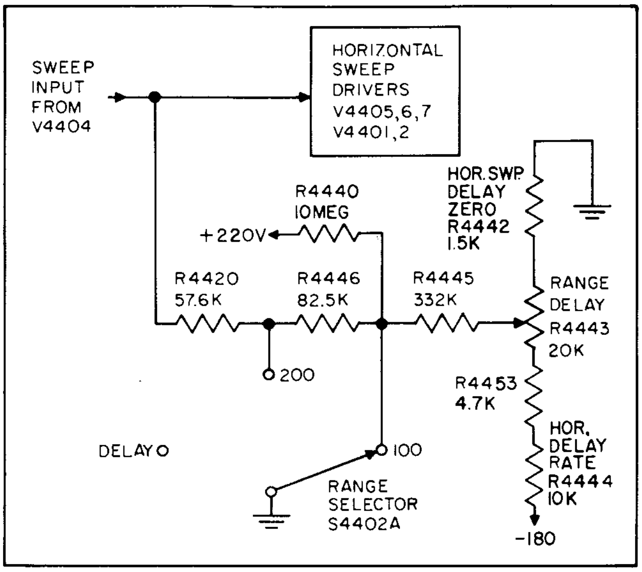


Figure 4–187. Range Delay Circuit, Simplified Schematic Diagram

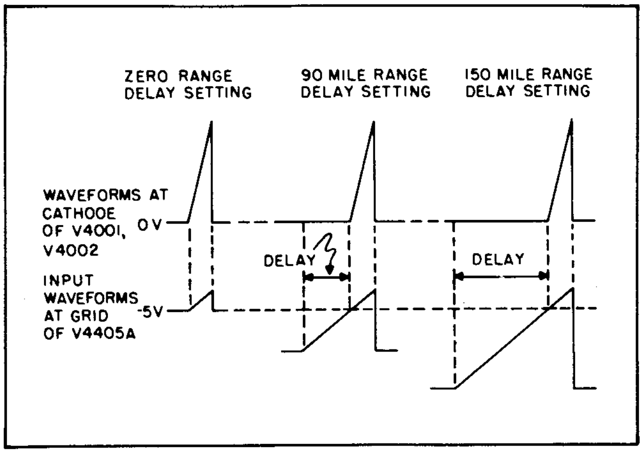


Figure 4–188. Range Delay Waveforms

in the sweep driver. HORIZ. CENT. control R4015 (figure 4–186) positions the start of the sweep at the proper point on the display.

4–1316. The horizontal sweep circuit supplies signals to several other circuits. The earth's curvature correction has already been mentioned and is discussed in detail in paragraph 4–1331. The output from the cathode circuit of gated clamp V4001 has already been discussed in the theory of the gate circuit cutoff. Two sweep outputs are fed to the intensifier and intensity compensation circuit, one taken from the grid of cathode follower V4405B and the other from the cathode of amplifier V4001. The uses of these voltages are discussed in connecton with the intensity compensation circuit.

4–1317. INTENSIFIER. (See figure 4–189.)

4–1318. During the intervals between gates on delayed presentation, amplifiers V4306A and V4307A are both conducting at zero bias. The resulting low plate voltage produces a negative voltage at the junction of resistors R4330 and R4331, holding amplifier V4307B cut off. At zero bias, the plate current from either amplifier V4306A or V4307A keeps amplifier V4307B cut off. The voltage at the grid of cathode follower V4309A is held at a high value by the action of a voltage divider composed of resistors R4332, R4340, and R4341 in the grid circuit. The CRT is held cut off by the resulting high cathode voltage.

4–1319. A negative square wave from the gate circuit cuts off amplifier V4306A. Current from amplifier V4307A still keeps the plate voltage at a low level. At the same instant, if there is no delay, or after the delay period, a range sweep input from amplifier V4001 is applied to the cathode of amplifier V4307A. The rising voltage on this cathode produces an amplified positive rising sweep at the plate. The amplified sweep voltage from amplifier V4307A appearing on the grid of amplifier V4307B drives the grid to zero bias in a short interval. The sweep is amplified and inverted at the plate of amplifier V4307B. The two-stage amplification of the sweep is the gate wave front. This sharply dropping voltage is applied to cathode follower V4309A, lowering the voltage on the cathode of the CRT to the point where signals become visible on the screen. A delay in the unblanking occurs because the drop in cathode voltage is not instantaneous; the CRT reaching the conduction point a short time after the start of the gate. The intensity of the signals appearing on the screen is determined by the setting of the intensity controls in the grid circuit of the CRT and by the action of the intensity compensation circuit. The CRT remains unblanked until the range sweep is again cut off and the cathode of amplifier V4307A returns to 0 volt. Heavy conduction then occurs, dropping the plate voltage of amplifier V4307A. The plate voltage of amplifier V4307B rises and, as the grid of cathode follower V4309A goes positive, cathode follower V4309A conducts, producing a cathode voltage rise which cuts off the CRT. For undelayed operation, there is no need for the sweep intensifier action and amplifier V4307A remains permanently cut off with about 60 volts on its grid.

4–1320. INTENSITY COMPENSATION CIRCUIT. (See figures 4–190 and 4–191.)

4–1321. Intensity compensation is produced by automatic variation of the d-c voltage on the cathode of the CRT with changes in range, pulse repetition frequency, or elevation angle. The variation is brought about by a changing d-c voltage on the grid of cathode follower V4309B. This d-c voltage should be higher for long ranges, high pulse repetition frequencies, and low elevation angles. Conversely, the voltage should be lower for short ranges, low pulse repetition frequencies, and high elevation angles.

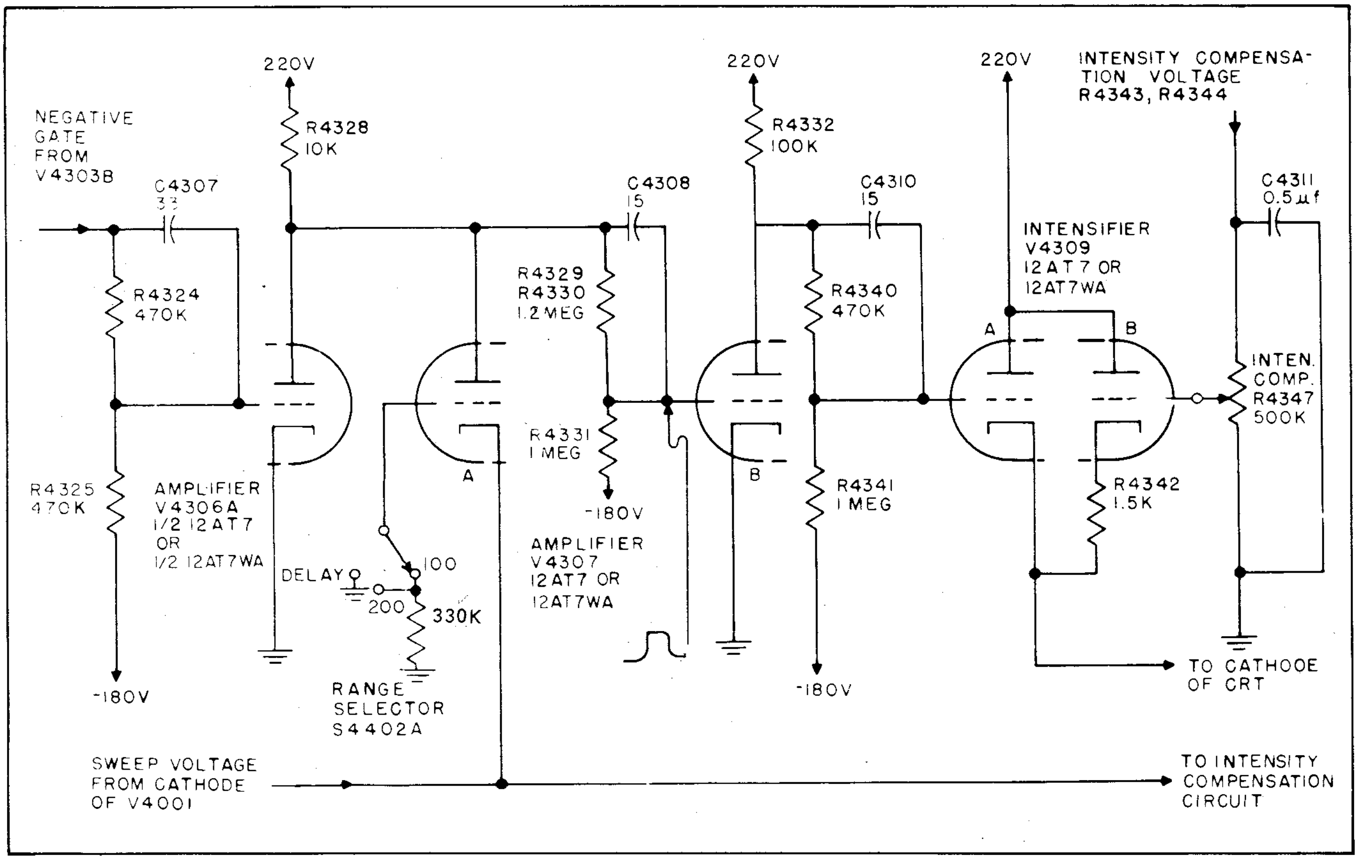


Figure 4–189. Intensifier Circuit, Simplified Schematic Diagram

4–1322. The input to the compensation circuit consists of a sweep voltage from the horizontal sweep circuit. This voltage is applied through resistor R4343 and filtered by capacitor C4311. The capacitor filters this sweep and the resulting d-c voltage at the junction is equal in magnitude to the average d-c voltage of the composite sweep. A portion of this d-c voltage is picked off by potentiometer R4347 and applied to the grid of cathode follower V4309B. Changes in this d-c voltage reduce or increase the intensity of signals appearing on the CRT screen.

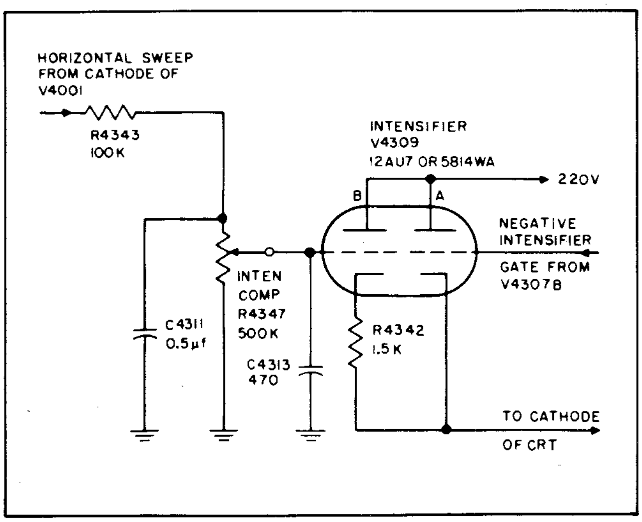


Figure 4–190. Intensity Compensation Circuit, Simplified Schematic Diagram

4–1323. The changes in the d-c intensity compensation voltage that result from different range settings are shown graphically in A and B of figure 4–191. In this illustration, a comparison of d-c average is made. The d-c average of the sweeps applied to resistor R4343 are shown for both 50- and 100-mile ranges. The amplitude of the resulting d-c voltage is seen to decrease markedly as the range shortens. The lower d-c voltage provides the required compensation of intensity for the faster sweep.

4–1324. The changes in the intensity of the display that would result from changes in pulse repetition frequency are compensated for in this circuit as illustrated in C and D of figure 4–191. The d-c level at the grid of cathode follower V4309B is shown to depend upon the number of sweep voltages occurring during any given interval of time. With fewer sweeps (a lower pulse repetition frequency), the d-c voltage at the CRT cathode is lower.

4–1325. This circuit compensates for changes in intensity that would occur with different elevation angles,

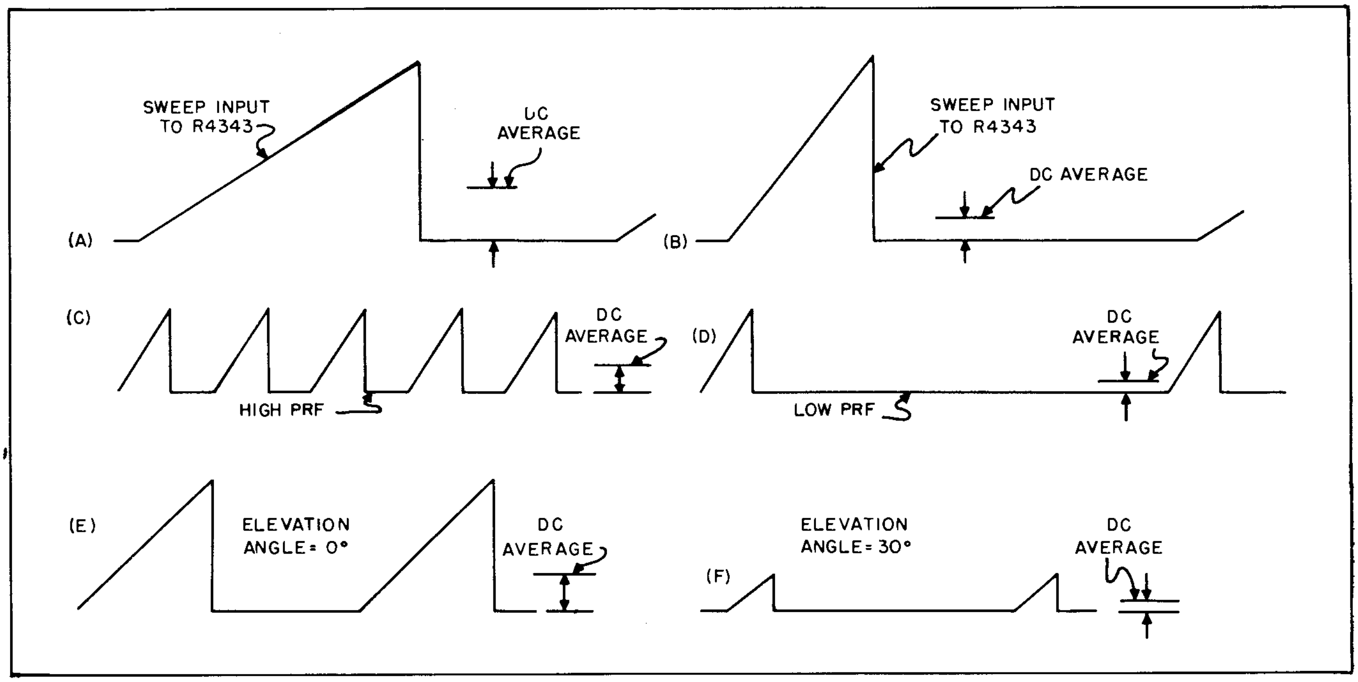


Figure 4–191. Intensity Compensation Waveforms

since at the higher angles the gating time is shorter, and the horizontal sweeps do not reach the voltage required for full deflection as shown in E of figure 4–191. The d-c average of these voltages at the CRT cathode is lower at the higher elevation angles, as required.

4–1326. BLOCK DIAGRAM OF VERTICAL SWEEP CIRCUITS. (See figure 4–192.)

4–1327. The vertical sweep circuits in the RHI can be divided into three functional groups: the gated clamp and sweep generator, the sweep amplifier chain, and the sweep drivers. The sweep generator contains a diode clamp, a triode clamp with a capacitor and resistor connected between the plate and ground, and a bootstrap amplifier to insure sweep linearity. The capacitor tends to charge exponentially during the period of the gate pulses. The bootstrap amplifier chain provides an inverse feedback loop to convert the capacitor charge curve from an exponential to a linear sawtooth. The gain of the amplifier chain, and therefore the amount of feedback, is adjustable. The sweep am-

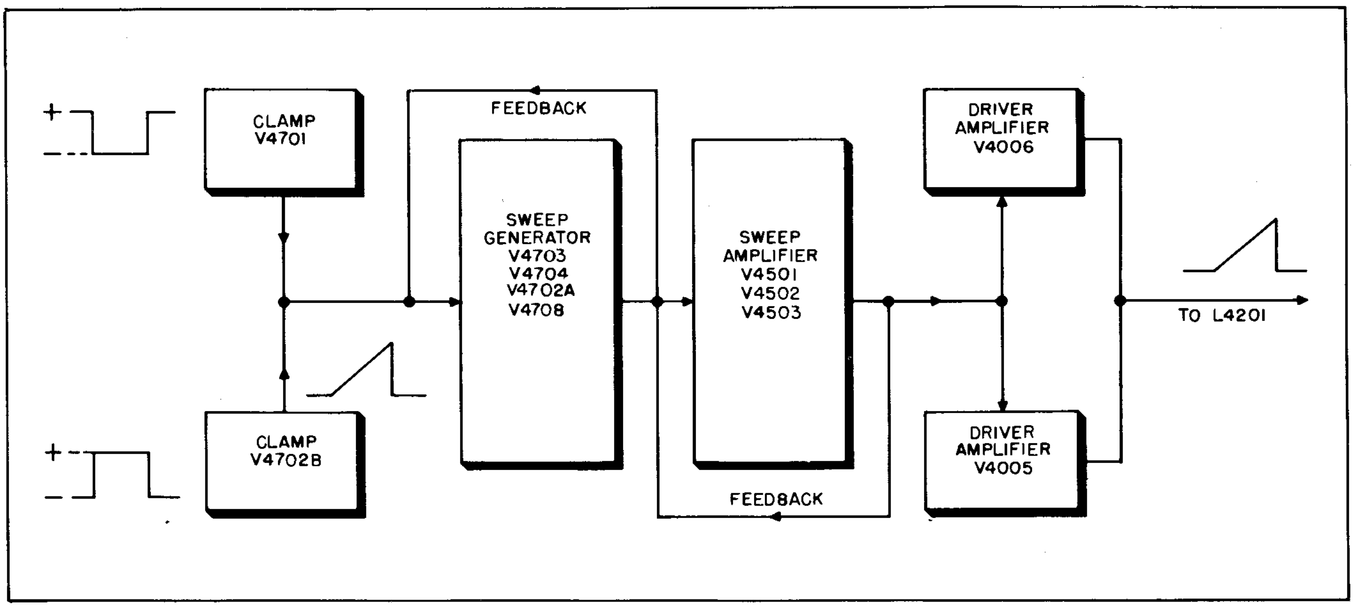


Figure 4–192. Vertical Sweep Circuit, Block Diagram

plifier chain consists of several amplifiers in cascade, finally leading into a pair of power amplifiers. The deflection coil is located in the plate circuits of the power stages. Current through the deflection coil increases in a linear manner. The linear increase causes the magnetic field about the deflection coil to expand at a constant rate, and in turn exert a steadily increasing force on the electron beam to sweep it vertically along the face of the CRT at a constant rate.

4–1328. The amount of vertical force exerted upon the electron beam depends upon the amplitude of the vertical sweep sawtooth. This amplitude is a function of the d-c voltage supplied by the elevation data generator and is proportional to the sine of the antenna elevation angle. The elevation data generator, a component of the control group assembly, is described in paragraph 4–777.

4–1329. CIRCUIT ANALYSIS OF VERTICAL SWEEP GENERATOR.

4–1330. GATING CLAMPS V4701 and V4702B. (See figure 4–193.) Clamp tubes V4701 and V4702B are essentially electronically operated switches. A positive voltage exists at the plate of clamp tube V4701 prior to the arrival of the negative gate. During this ungated interval, clamp tubes V4701 and V4702B conduct and hold sweep capacitor C4701 near ground potential. The positive gate is applied to the cathode of clamp tube V4702 and the negative gate to the plates of clamp tube V4701. The gates cut off these tubes, permitting sweep capacitor C4701 to attempt to charge to the value of the d-c elevation voltage. At the end of the gating period, clamp tubes V4701 and V4702B again conduct, providing a pair of discharge paths for the capacitor. The discharge occurs through clamp tube V4702B if the sweep voltage is positive, for positive elevation angles, and through clamp tube V4701 when the sweep is negative, for negative elevation angles. Resistor R4705 produces an initial jump or pedestal at the base of the sweep, since it is necessary to charge the distributed capacitances of the deflection coil and the amplifier circuit at the beginning of the sweep.

4–1331. CORRECTING FOR EARTH'S CURVATURE AND ATMOSPHERIC REFRACTION. An additional source of charging current for the vertical sweep capacitor is obtained from inverter amplifier V4404. This voltage is the horizontal sweep, which increases in amplitude as the radar pulse travels outward into space. The voltage rise causes more and more charging current for sweep capacitor C4701. The additional current supplements the linear charging system to produce an upward curving vertical sweep voltage, and thereby corrects for the curvature of the earth and the bending (refraction) of the radar beam by the atmosphere. Potentiometer R4703 permits coarse adjustment of the amount of earth's curvature correction voltage supplied to the vertical sweep generator. Potentiometer R4451 permits feeding either more or

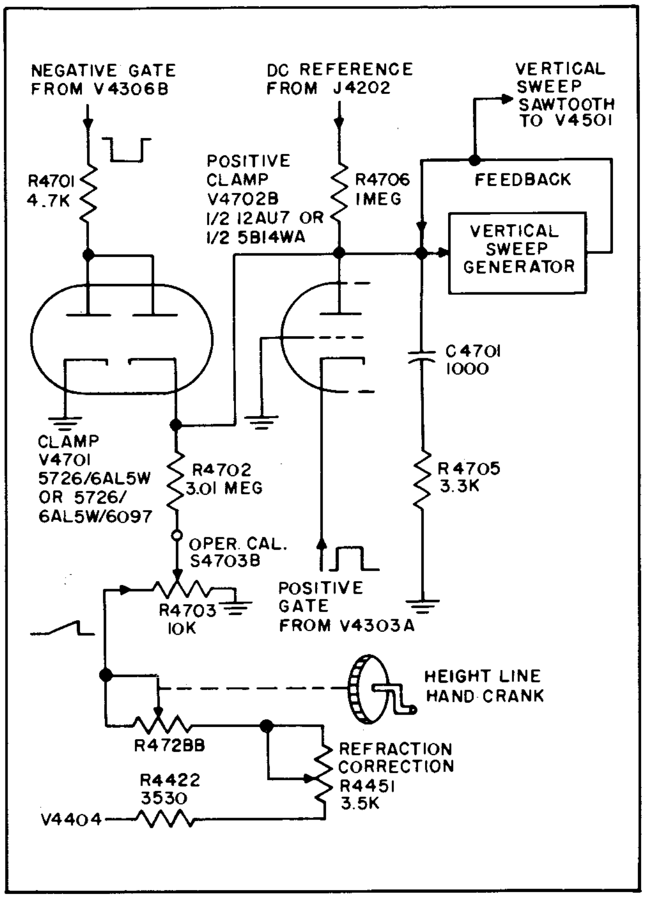


Figure 4–193. Vertical Sweep Generator, Simplified Schematic Diagram

less of the correction voltage to the sweep generator, depending upon whether the radar beam is refracted upward or downward from the standard correction. Finally, since the refractive effect becomes most pronounced at the higher altitudes for a given range, potentiometer R4728B (geared to the HEIGHT LINE handcrank) increases the amount of correction voltage when reading targets at the upper end of the height scale.

4–1332. SWEEP GENERATOR AMPLIFIERS V4702A, V4703, V4704, AND V4708. (See figure 4–194.) The sweep voltage across sweep capacitor C4701 is amplified and made linear through the use of negative feedback in a manner similar to that employed in the horizontal sweep circuit. VERT. SWEEP LIN. control R4708 determines the amount of the inverted signal from the cathode of amplifier V4704B that will be applied to the grid of amplifier V4703A. In addition to supplying sufficient feedback to straighten the sawtooth, VERT. SWEEP LIN. control R4708, in combination with resistors R4707 and R4710, also determines the gain of amplifiers V4703 and V4704. The greater the amount of feedback, the lower the gain.

4–1333. Cathode follower V4702A applies a bias voltage to amplifier V4703A so that the sawtooth begins

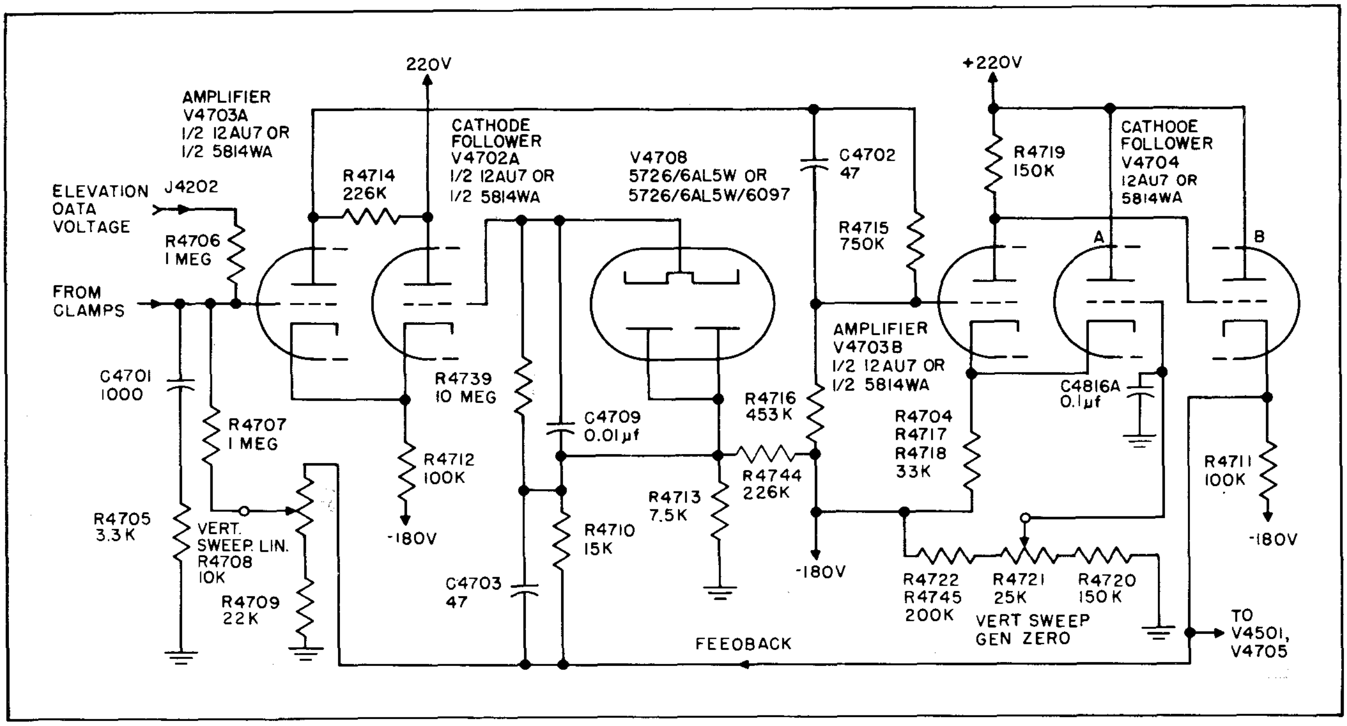


Figure 4–194. Vertical Sweep Amplifier, Simplified Schematic Diagram

its rise from a voltage level sufficient to position the origin of the sweep trace on the zero height line of the display. However, variations in filament supply voltage change both the conduction through cathode follower V4702A and the bias level of amplifier V4703A. Diode V4708 minimizes changes in zero level caused by filament supply fluctuation. For example, an increase in filament voltage causes the diode to conduct more heavily. The diode then draws a greater current through resistor R4713, making the top of this resistor more negative with respect to ground. The grid of cathode follower V4702A, which is returned to this more negative point through resistor R4739, consequently draws less current and returns the zero level of amplifier V4703A to normal.

4–1334. Cathode follower V4704A sets the bias level of amplifier V4703B. This level is set during RHI alinement by means of VERT. SWEEP GEN. ZERO control R4721.

4–1335. SWEEP DRIVER CHAIN V4501, V4502, V4503, V4005, AND V4006. (See figures 4–195 and 4–196.) Sweep drivers V4501 and V4502 and cathode follower V4503 provide the high amount of amplification that makes the output closely match the input in this kind of degenerative circuit. Cathode follower V4503 is provided to drive the type 807 output tubes, V4005 and V4006. Degeneration is obtained by feeding a signal from the resistor network in the cathode of output tubes V4005 and V4006 to the cathode of cathode follower V4501B. As a result, the cathode of amplifier V4501A rises and opposes the rise in voltage at the grid.

4–1336. The amount of output sweep fed back to the cathode of amplifier V4501A determines the gain of the degenerative amplifier. When more signal is fed back, there is greater degeneration and corresponding decrease in gain. The percentage of signal fed back is determined by the setting of potentiometer R4525.

4–1337. VERT. SWEEP SPEED CONTROL R4525. (See figure 4–190.) VERT. SWEEP SPEED control R4525, by determining the amplifier's effective gain, provides a fine control for adjusting the sweep speed (figure 4–196). The base of the sweep signal is determined by the setting of VERT. SWEEP GEN. ZERO control R4721, while the height of the sweep is fixed by the action of the sweep cutoff circuit. The speed of the sweep depends upon the time required for the sawtooth to rise from the base line to the cutoff voltage. The higher the gain of the amplifier, the faster the rise of the sawtooth. Current increases through the deflection coil in the plate circuit of output tubes V4005 and V4006 at a speed proportional to the rate of rise of the sawtooth. A rapid current rise through the deflection coil, in turn, causes the magnetic field which exerts the vertical force on the electron beam to expand rapidly.

4–1338. HEIGHT SELECTOR SWITCH S4501. (See figures 4–195 and 4–196.) The HEIGHT SELECTOR switch provides a choice of four positions: –5-75, –5-25, 20-50, and 45-75. These designations are in thousands of feet and are taken with respect to the horizontal reference line, or the line traced by the radar beam when the antenna is pointing at zero elevation. If the radar were mounted on high land, it is quite possible that

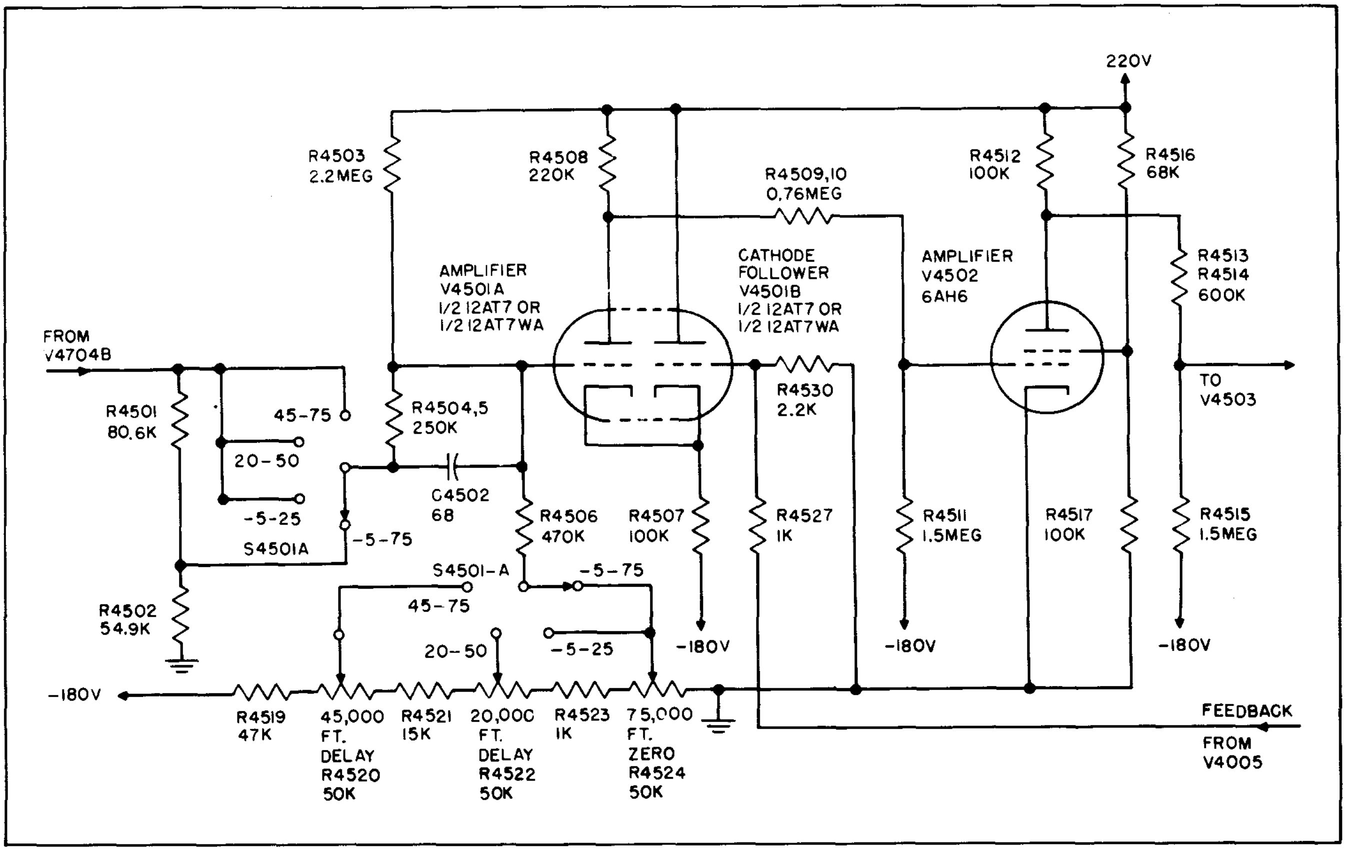


Figure 4–195. Vertical Sweep Driver Circuit, Simplified Schematic Diagram

targets with absolute altitudes below that of the radar would be intercepted. These targets are considered to be at negative heights and can be read on the RHI up to a maximum of —5000 feet.

4–1339. One section of switch S4501A (figure 4–195) compensates for the excessive length of the —5-75 sweep. When the —5-75 position is selected, a sweep 80,000 feet in length must be produced; all the other sweep positions require only 30,000 feet. Since the longer sweep requires a sawtooth that rises slowly (paragraph 4–1337), a voltage divider composed of resistors R4501 and R4502 divides the amplitude of the signal by 30/75. The lower amplitude sawtooth requires a longe time to rise from the zero base line to the cutoff voltage, producing the required longer sweep.

4–1340. The other section of HEIGHT SELECTOR switch S4501A (figure 4–195) provides the delay necessary for the 20-50 and 45-75 ranges, and uses circuits similar to that employed in obtaining range delay. Potentiometers R4520 and R4522 set the bias on amplifier stage V4501A so that the tube is well beyond cutoff. As the positive sweep is applied, the grid is raised above cutoff into the conducting region. At this point, of course, the amplifier action begins again. The length of time that elapses between the start of the original sweep and that of the delayed sweep thus depends upon the setting of the vertical delay controls. Potentiometer R4520 is set for a 45,000-foot delay and is used when the height selector switch is in the 45-75 position. Potentiometer R4522 is set for a 20,000-foot delay and is used when the height selector switch is in the 20-50 position. 75,000 FT. ZERO control R4524 is used for adjusting the input bias of the amplifier when on the undelayed presentations.

4–1341. One section of HEIGHT SELECTOR switch S4501B (figure 4–179) changes the vertical centering for the —5,000- to 25,000-foot presentation.

4–1342. The other section of HEIGHT SELECTOR switch S4501B (figure 4–196) changes the vertical cutoff point for the —5,000- to 25,000-foot presentation. This change is necessary because a different centering potentiometer is used with this presentation.

4–1343. Switch S4501C (figure 4–197) places the correct bias at the grid of vertical intensifier V4308A for each of the four height sweep ranges. The intensifier circuit cuts off the CRT beam when it reaches the lower edge of the screen. This action prevents a bright flare from appearing just off the bottom of the screen on delayed presentations and when the sweep goes beyond —5,000 feet. Vertical sweep from tubes V4005 and V4006 is amplified by amplifier V4308B and fed to the grid amplifier of vertical intensifier V4308A. The amplified

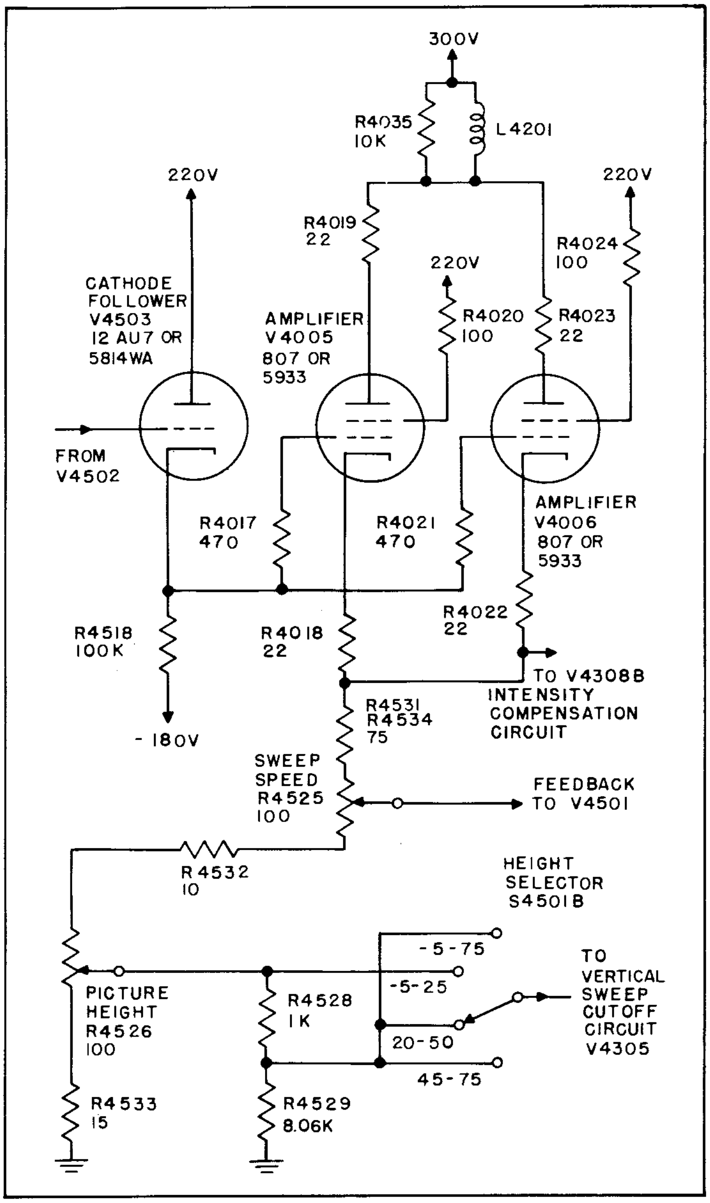


Figure 4–196. Vertical Sweep Output Circuit, Simplified Schematic Diagram

sawtooth from the plate of amplifier V4308B turns on vertical intensifier V4308A when the trace sweeps below the bottom edge of the presentation. The plate voltage of vertical intensifier V4308A falls sufficiently to hold the grid of amplifier V4307B beyond cutoff. The high plate voltage of amplifier V4307B is coupled to cathode follower V4309 for application to the cathode of the CRT. The high cathode voltage biases the CRT beyond cutoff and turns off the beam. VERT. DELAY INT. control R4335 adjusts the lower cutoff limit for all ranges. During the upsweep of the trace, the amplified sawtooth from the plate of amplifier V4308B turns off vertical intensifier V4308A, allowing the grid of amplifier V4307B to rise. This lowers the cathode potential of the CRT and turns on the beam.

4–1344. BLOCK DIAGRAM OF RANGE DATA STAGES.
(See figure 4–198.)

4–1345. The range line is combined with the range marks in dual-triode mixer V4601. The combined signal is amplified by amplifier V4602A and coupled through cathode follower V4602B to the grid of the CRT. Potentiometers are provided to adjust the amplitude of the range marks and the range line independently. In addition, a test jack is supplied to monitor the input to the CRT. If desired, the RHI operator can turn off the range marks and the range line individually by operating switches S4601 and S4602, respectively.

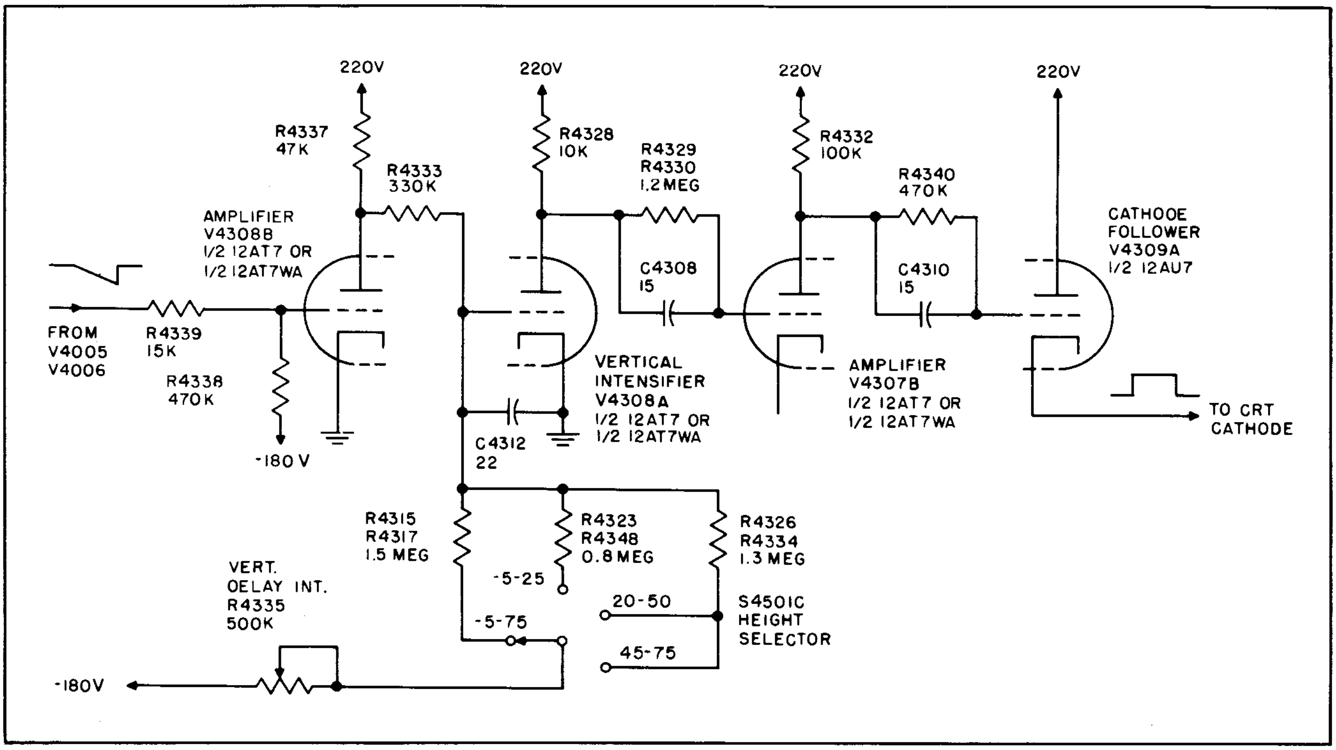


Figure 4–197. Vertical Intensifier, Simplified Schematic Diagram

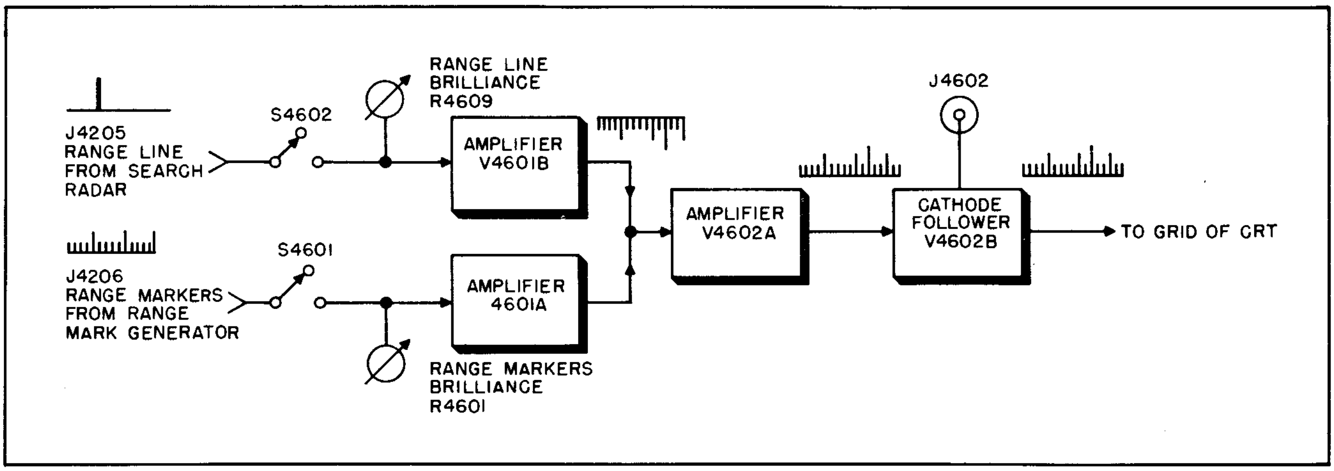


Figure 4–198. Range Marker Circuits, Block Diagram

4–1346. DETAILED ANALYSIS OF RANGE DATA CIRCUITS.

4–1347. AMPLIFIER V4601B. (See figure 4–199.) The range line obtained from the search radar is fed through jack J4205 to the resistive element of RANGE LINE brilliance control R4609. A portion of the signal is taped off by the wiper arm of this potentiometer and fed through capacitor C4604 to the grid of amplifier stage V4610B. Resistor R4610 normally returns the grid to the —180-volt supply and keeps the stage cut off unless switch S4602 is set to the ON position. When the range line is desired, switch S4602 is closed, returning the grid to ground through resistor R4611. The stage then functions as an amplifier.

4–1348. AMPLIFIER V4601A. Range markers from the range mark generator are fed through jack J4206 to one end of the resistive element of RANGE MARKERS brilliance control R4601. A portion of the signal is

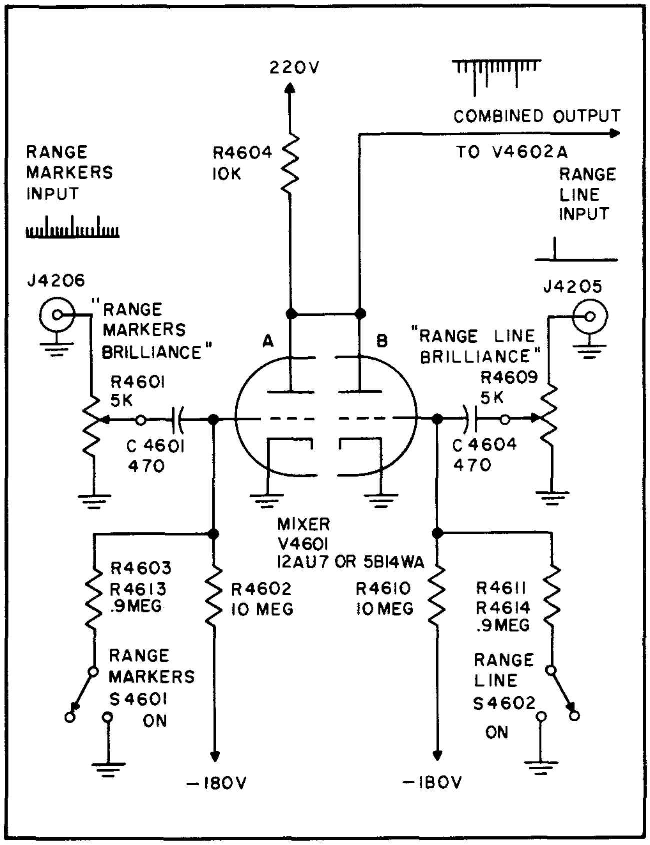


Figure 4–199. Range Marker and Range Line Mixer, Simplified Schematic Diagram

tapped off by the wiper arm and applied to the grid of amplifier section V4601A. Resistor R4602 normally returns the grid to the —180-volt supply, thus keeping the stage cut off. When range markers are desired, switch S4601 is closed, returning the grid to ground through resistor R4603 and allowing the stage to function as an amplifier.

4–1349. The output from both sections of stage V4601 is developed across a common plate load, resistor R4604. In this manner, the range line is mixed with the range markers.

4–1350. AMPLIFIER V4602A. (See figure 7–26.) The signal developed at the plates of stage V4601 is applied to amplifier V4602A. The output from amplifier V4602A, in an amplified and inverted form, is fed to cathode follower V4602B.

4–1351. CATHODE FOLLOWER V4602B. The cathode impedance of cathode follower V4903, the final stage of the video amplifier chain, also serves as the load impedance of cathode follower V4602B. In this manner, the range markers and range line are combined with the video signal and sent to the grid of the display tube. Test jack J4602 permits the technician to check the combined signal at the output of cathode follower V4602B.

4–1352. BLOCK DIAGRAM OF HEIGHT MARKER CIRCUIT. (See figure 4–200.)

4–1353. A height marker is produced at 20,000 feet, at 40,000 feet, and at 60,000 feet. The markers appear on the RHI as three equidistant parallel lines.

4–1354. The undelayed height sweep sawtooth (including earth's curvature correction) from cathode follower V4705 serves as the common input to regenerative amplifiers V4801, V4803, and V4804. Each regenerative amplifier consists of two triodes interconnected so as to constitute a positive feedback loop. One section of each regenerative amplifier conducts heavily, while sections V4801A, V4803A, and V4804A are biased beyond cutoff by 20,000 FT. HT. MARKER control R4841, 40,000 FT. HT. MARKER control R4843, and 60,000 FT. HT. MARKER control R4845, respectively.

4–1355. The positive-going sawtooth is applied to the grids of the cutoff sections. The bias determines how high the sawtooth must rise before it can bring the section into conduction and initiate the regenerative action (figure 4–200). Regenerative amplifier V4801 is triggered at point x on the input sawtooth and produces the pulse shown as waveform B. Regenerative amplifier V4803 produces a pulse at point y as shown in waveform C, while regenerative amplifier V4804 conducts at point z on the input sawtooth and produces the waveform shown in D.

4–1356. The regenerative amplifier output pulses are unsuitable for application to the display because they are to broad and of varying widths. The three pulses are differentiated and mixed in amplifiers V4802A, V4802B, and V4805A before application to blocking oscillator V4805B. The blocking oscillator then converts these pulses into narrow spikes which can be applied to video amplifier V4902 of the video amplifier chain. After amplification, the narrow triggers intensity-modulate the CRT, resulting in bright, fine lines on the display; broad markers might obliterate targets. Potentiometer R4839 determines the brilliance of the height markers.

4–1357. DETAILED ANALYSIS OF HEIGHT MARKER CIRCUIT. (See figure 4–201.)

4–1358. REGENERATIVE AMPLIFIER V4801. Potentiometer R4841 places a negative potential at the grid of stage V4801A sufficient to cut off the stage during no-signal periods. The grid of stage V4801B is connected to a positive potential at the junction of resistors R4803 and R4807 so that the B section conducts prior to the arrival of the signal input. The sawtooth input voltage is a positive signal applied to the grid of the normally cutoff stage V4801A. When this signal reaches a value determined by the setting of 20,000 FT. HT. MARKER potentiometer R4841, stage V4801A conducts. The plate voltage of the A section then falls. This decreasing voltage, coupled to the grid of the B section as a negative-going potential, cuts off this half of the tube. As stage V4801B cuts off, current through the tube lessens, resulting in a decrease in the voltage across cathode re-

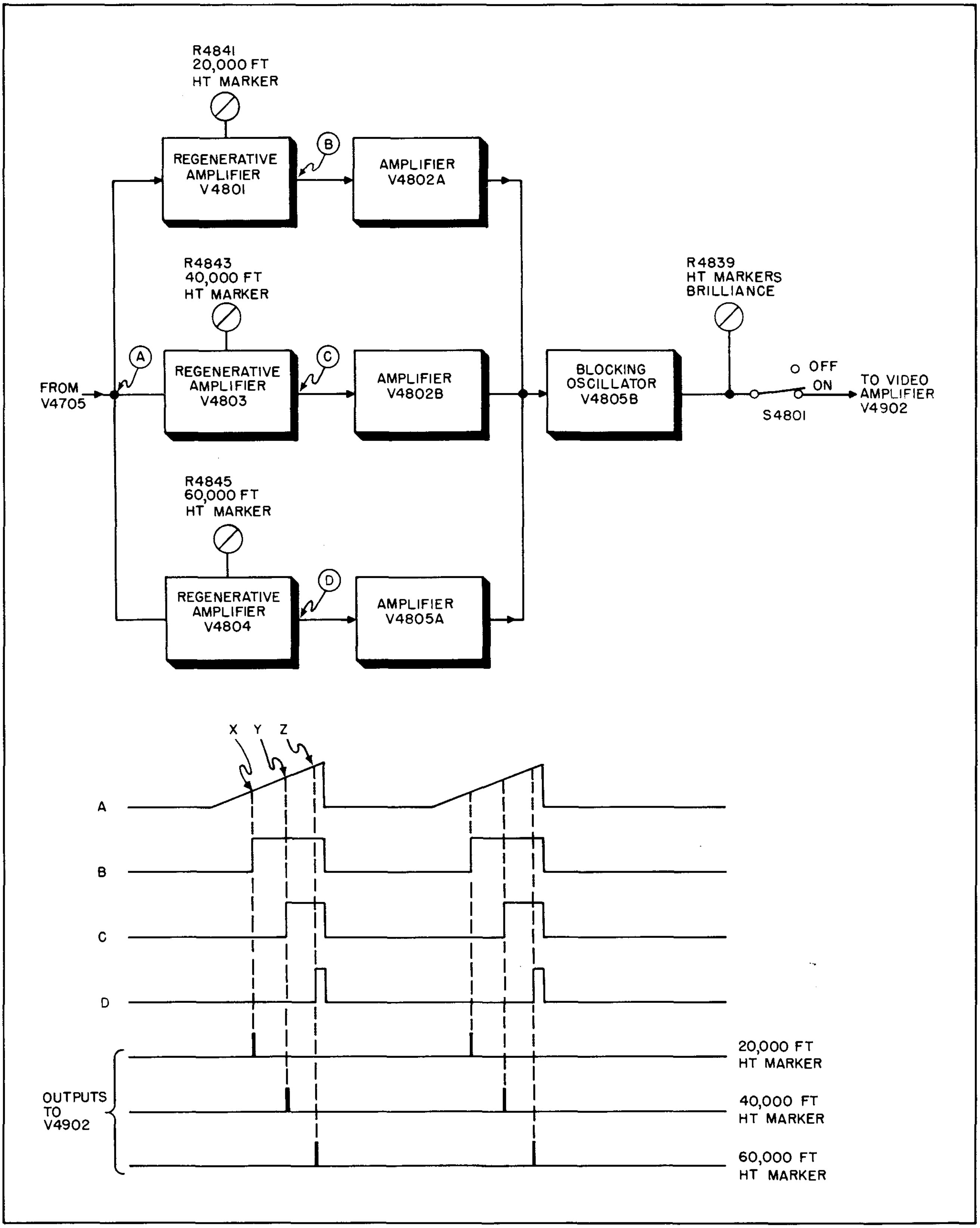


Figure 4–200. Height Marker ~~Circuit~~, Block Diagram

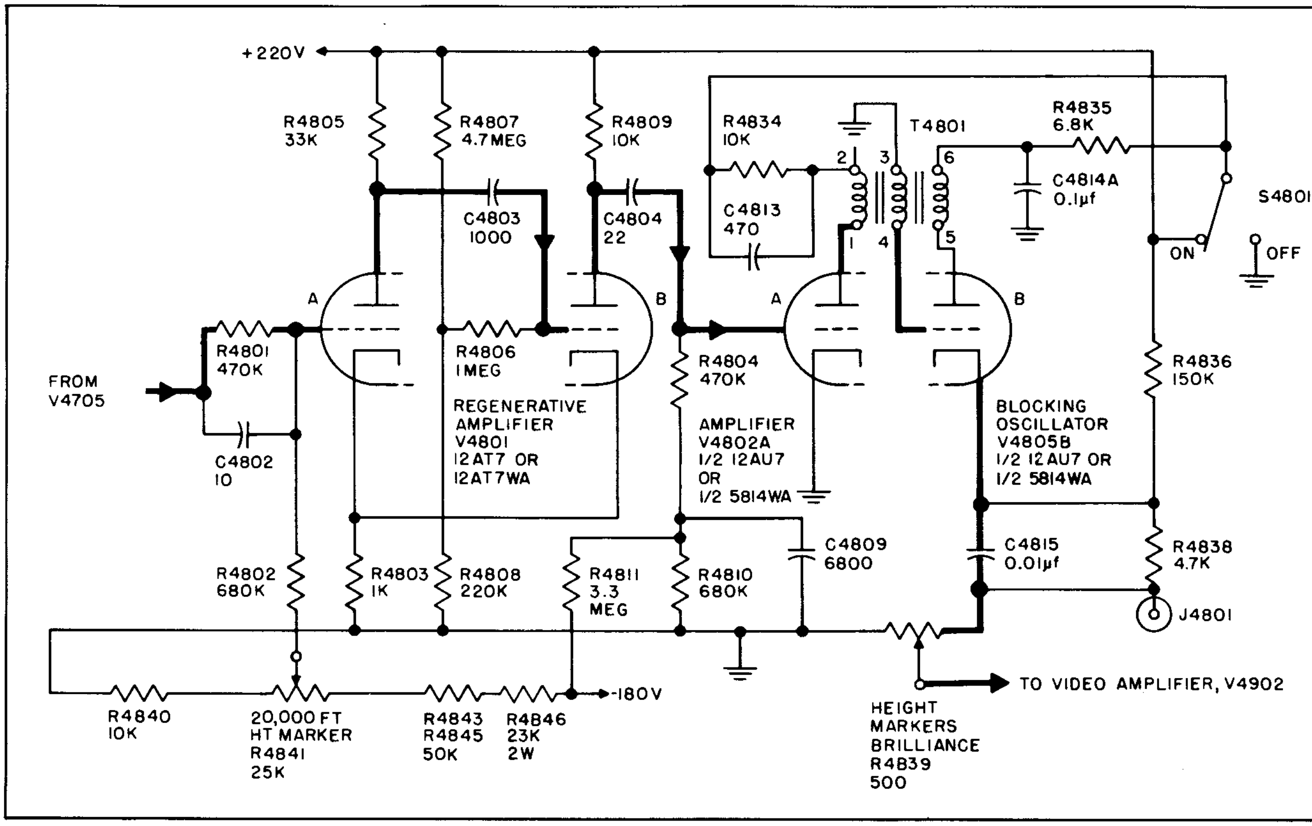


Figure 4–201. Height Marker Circuit, Simplified Schematic Diagram

sistor R4803. The voltage change across resistor R4803 is coupled to the cathode of stage V4801A as a decrease in bias. Stage V4801A then conducts more heavily and its plate voltage falls. The negative-going voltage at the plate of stage V4801A is coupled to the grid of stage V4801B, causing the B section to conduct even less. This regenerative action builds up very quickly and ends with stage V4801A conducting and stage V4801B cut off. Stage V4801B remains cut off until stage C4803 discharges or until the end of the sawtooth, whichever occurs first.

4–1359. The grid of the A section returns to its cutoff condition at the conclusion of the sawtooth input, causing the plate voltage of stage V4801A to rise. This rise in voltage, coupled to the grid of stage V4801B, drives the B section into conduction. The amplifier then remains in this condition, with the B section conducting and the A section cut off, until the next sawtooth input.

4–1360. The plate voltage of stage V4801B is high once stage V4801A has been driven into conduction by the input, and remains high until the conclusion of the input signal. The output from the plate of stage V4801B then is a wide positive pulse.

4–1361. AMPLIFIER V4802A. The positive pulse from stage V4801B is differentiated by capacitor C4804 and resistor R4804. Prior to the arrival of the pulse at the grid of amplifier V4802A, this stage is biased beyond cutoff, since it is returned to a point of negative potential at the junction of resistors R4810 and R4811. The arrival of the positive spike on the grid of the stage brings the tube into conduction and sends plate current through the tube to winding 1-2 of pulse transformer T4801. This pulse of current through the transformer initiates the blocking oscillator action.

4–1362. BLOCKING OSCILLATOR V4805B. Blocking oscillator stage V4850B is normally held beyond cutoff by the positive voltage to which the cathode is returned at the junction of resistor R4836 and R4838. The pulse of current through winding 1-2 of transformer T4801 creates a magnetic field which induces a positive voltage across winding 3-4. This positive voltage at the grid of blocking oscillator V4805B causes the stage to go into conduction and current rushes through winding 5-6 of the transformer. This current produces a magnetic field which induces a voltage across winding 3-4 of such a polarity as to make the grid of blocking oscillator

V4805B more positive. More current is then drawn by blocking oscillator V4805B, the current through winding 5-6 increases further, and an even stronger positive voltage is induced at the grid of blocking oscillator V4805B. This buildup of current continues until the transformer core approaches the saturation point. When a transformer begins to saturate, it cannot efficiently induce voltage into an adjacent winding. As a result, although the voltage at the grid of blocking oscillator V4805B continues to build up, it does so at a slower rate. Eventually, the voltage induced in winding 3-4 is not sufficient to overcome the losses in the grid circuit. The grid voltage then begins to decrease, reducing the current through winding 5-6.

4–1363. As soon as the current in winding 5-6 of transformer T4801 starts to decrease, a second cumulative action sets in which keeps reducing the current until blocking oscillator V4805B is cut off. Tube V4805B remains cut off by the positive voltage divider in the cathode composed of resistors R4838, R4836, and R4839. The output pulse is approximately 1 microsecond in duration with an amplitude determined by the setting of HEIGHT MARKERS brilliance control R4839.

4–1364. CIRCUITS FOR 40,000- AND 60,000-FOOT HEIGHT MARKERS. Except for the settings of potentiometers R4843 and R4845, the 40,000- and 60,000-foot height marker circuits are identical to the 20,000-foot height marker circuit. Switch S4801 is closed when turning off of the height markers is desired. This action grounds the plate of the blocking oscillator and the amplifier tubes.

4–1365. BLOCK DIAGRAM OF HEIGHT LINE CIRCUIT. (See figure 4–202.)

4–1366. Rotating the height handcrank on the front panel of the RHI causes the height line, a variable height marker which appears as a horizontal line, to move vertically along the face of the indicator.

4–1367. In the height line circuit, a sweep voltage, corrected for earth's curvature and atmospheric refraction, controls the triggering of a marker generator. The output of the marker generator is amplified in the video circuit and applied to the CRT control grid.

4–1368. EARTH'S CURVATURE CORRECTION. The display shows each target at a height above or below a horizontal plane through the antenna. This plane is represented by the horizontal or zero elevation line of the picture. If the height line were obtained using the height sweep without correction for earth's curvature, it would be parallel to the zero elevation line and would measure the height above the horizontal plane. In order to measure true height above sea level, the curvature of the earth requires a correction which is a function of the square of the range. This correction is obtained by using the range sweep voltage as one of the reference voltages to which the height sweep capacitor attempts to charge.

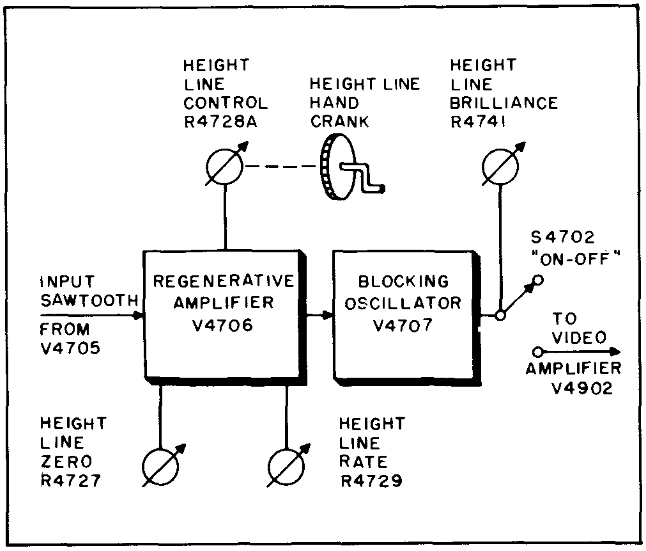


Figure 4–202. Height Line Circuit, Block Diagram

4–1369. ATMOSPHERIC REFRACTION CORRECTION. The atmosphere causes the radar beam to bend (refract); unless corrected, this refraction could result in inaccurate height readings. Like the earth's curvature error, the magnitude of the refractive error increases with range; refraction correction is achieved by varying the amount of earth's curvature correction applied to the vertical sweep circuit (figure 4–193).

4–1370. REGENERATIVE AMPLIFIER V4706. The compensated height sweep sawtooth is applied to regenerative amplifier V4706. The regenerative amplifier consists of two triodes interconnected to form a positive feedback loop. One section of the regenerative amplifier normally conducts heavily, while the other section is biased beyond cutoff by potentiometers R4727, R4728A, and R4729. The most important of these controls is R4728A, which is mechanically linked with the height handcrank.

4–1371. The positive-going sawtooth is applied to the grid of the cutoff section. The bias determines how high the sawtooth must rise before it can bring the section into conduction and initiate the regenerative action.

4–1372. BLOCKING OSCILLATOR V4707. The regenerative amplifier output pulses are unsuitable for application to the display because they are too broad. The blocking oscillator converts these pulses into narrow spikes which can be applied to video amplifier V4902 of the video amplifier chain. After amplification, the narrow triggers intensity-modulate the CRT, resulting in a bright, fine line on the display; a thick line might obliterate targets. Potentiometer R4741 determines the brilliance of the height line. The height line circuits can be disconnected by means of switch S4702.

4–1373. DETAILED ANALYSIS HEIGHT LINE CIRCUIT. (See figure 4–203.)

4–1374. REGENERATIVE AMPLIFIER V4706. The height line circuit consists of a regenerative amplifier and a blocking oscillator. The regenerative amplifier is formed by stages V4706A and V4706B. The resistor network in the grid of stage V4706A provides sufficient negative bias to keep this tube cut off. With stage V4706A cut off, the grid of stage V4706B is positive enough to cause grid limiting and zero bias.

4–1375. When a height sweep is produced in the sweep generator, it appears slightly attenuated at the grid of stage V4706A. This positive sweep mixes with the d-c bias. When the sweep brings the voltage at the grid to the cutoff level, stage V4706A starts to conduct. Conduction drops the plate voltage of stage V4706A and the grid voltage of stage V4706B, causing V4706B to conduct less strongly. As the cathode current of stage V4706B decreases, the voltage drop across resistors R4730 and R4731, and therefore the bias on stage V4706A, decreases correspondingly. This causes more plate current and a lower plate voltage drop for stage V4706A, and a regenerative cycle takes place which leaves stage V4706A conducting and V4706B stage cut off. This condition continues until, with the end of the sweep, the grid voltage of stage V4706A returns to the negative level determined by HEIGHT LINE control R4728A. This cuts off stage V4706A and allows stage V4706B to conduct again.

4–1376. BLOCKING OSCILLATOR V4707. In the blocking oscillator circuit, oscillator V4707 is normally kept cut off by the positive cathode bias resulting from a resistor network. This network is composed of resistors R4738, R4740, and R4741.

4–1377. The quick rise in plate voltage caused by the regenerative cutting off of stage V4706B is transformer-coupled by transformer T4701 to the grid of stage V4707 as a positive pulse. This causes blocking oscillator V4707 to conduct; the increasing plate current through the winding of transformer T4701 produces an even more positive voltage at the grid of blocking oscillator V4707, effectively causing a further increasing in plate current.

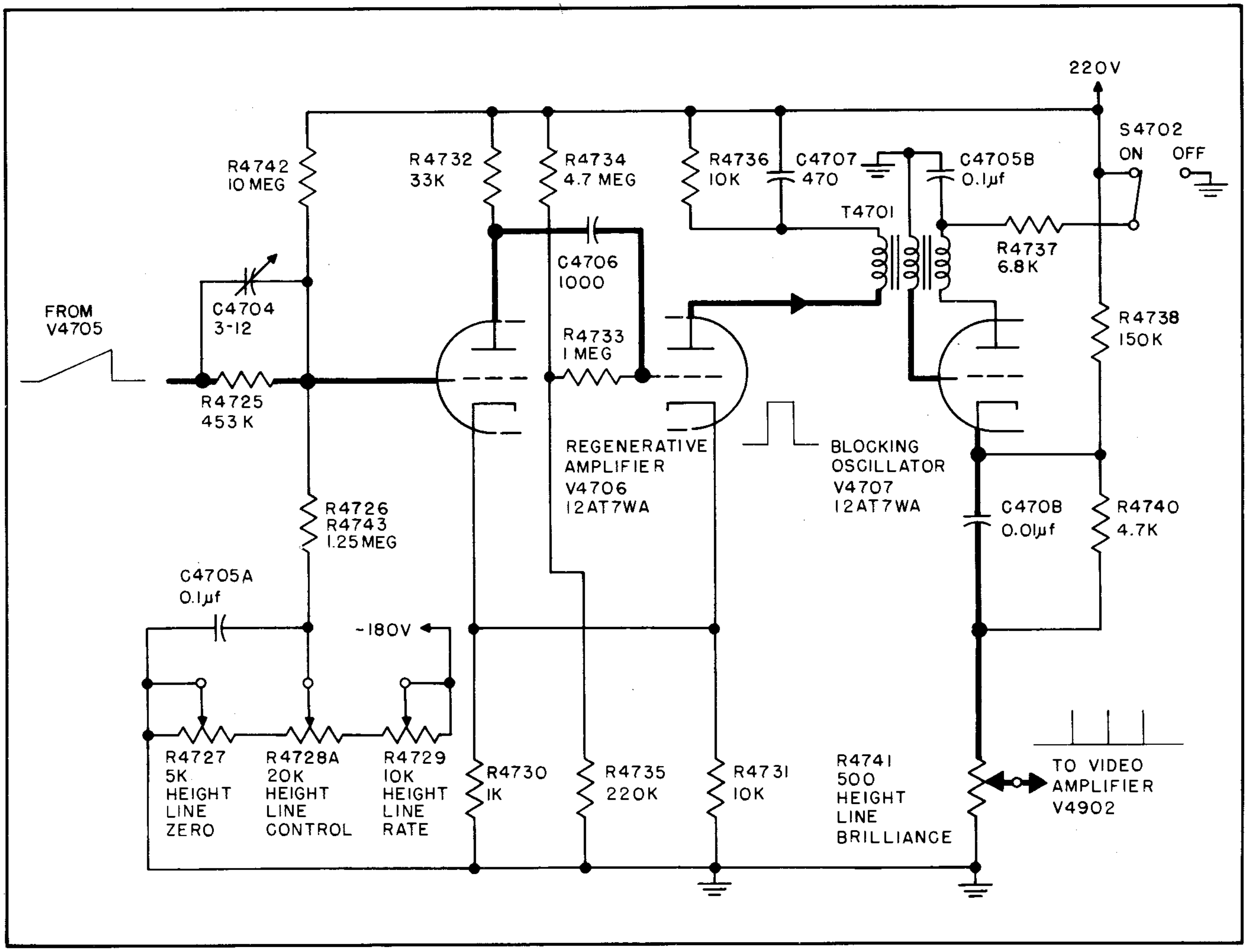


Figure 4–203. Height Line Circuit, Simplified Schematic Diagram

When transformer core saturation is approached, the increase in grid voltage diminishes, and a reverse action takes place. The decreasing plate current produces a negative voltage at the grid which, in turn, brings about a further decrease in plate current and the circuit quickly returns to its normal condition.

4–1378. As a result of the action described in paragraph 4–1377, a positive pulse of short duration appears across potentiometer R4741. A part of this pulse is selected by potentiometer R4741, the HEIGHT LINE brilliance control, and fed to video amplifier V4902.

4–1379. The decoupling network composed of resistor R4736 and capacitor C4707 provides a d-c load for the plate circuit of stage V4706B. The current from the pulse comes largely from capacitor C4707, which recharges through resistor R4736 during the time between pulses. Capacitor C4708 is a cathode bypass for resistor R4740, which means that effectively the entire voltage rise of the pulse occurs across resistor R4741.

4–1380. ON SWITCH S4701. Switch S4701, a front panel control, is closed to turn off the height line. This action grounds the plate of the blocking oscillator and the amplifier tubes.

4–1381. HEIGHT SELSYNS. (See figure 7–71.)

4–1382. GENERAL. Three physically identical selsyn generators are provided for height transmission. Two of these selsyns are for absolute height transmission, while the third is employed for relative height transmission.

4–1383. ABSOLUTE HEIGHT TRANSMISSION. The HEIGHT LINE handcrank is connected to the input shafts of absolute height selsyns B4202 and B4203. Selsyn B4203 is a 10-speed unit used for accuracy of transmission. Selsyn B4202, a 1-speed unit, is used for synchronizing the servo loop in the remote height display (RHD).

4–1384. The HEIGHT LINE handcrank is rotated until the height line intersects the designated target. This action also rotates the rotors of the absolute height selsyns and causes them to send out 1- and 10-speed orders to the RHD. The height thus transmitted can be read on the ABSOLUTE HEIGHT counter on the front panel of the RHI assembly. This counter is geared to the HEIGHT LINE handcrank.

4–1385. RELATIVE HEIGHT TRANSMISSION. After transmitting absolute height, the RHI operator pushes in his height handcrank. This closes microswitch S4205, which permits 28 volts dc from terminal J of jack J4217 to pass through the switch and out terminal H to the junction box and then to an RHD. The 28-volt signal actuates a relay in the RHD which locks the absolute height dial and allows relative height information to be sent.

4–1386. Pushing in the height handcranks also engages relative height selsyn B4204 and the RELATIVE HEIGHT dial on the RHI. The handcrank is then rotated until the height line intersects a second traget. The relative height of the second target; that is, the height with respect to the first target, appears on the RHD (due to 1-speed orders from the relative height selsyn) and on the RELATIVE HEIGHT dial on the RHI. In addition, the absolute height of the second target appears on the ABSOLUTE HEIGHT counter on the RHI. When the height handcrank is pulled out, it is disengaged from the relative height selsyn and dial. A helical spring then returns the relative height selsyn and dial to the zero position.

4–1387. BLOCK DIAGRAM OF ANGLE MARKER CIRCUITS. (See figure 4–204.)

4–1388. The positive angle mark trigger derived from the angle mark generator chassis is amplified and inverted by amplifier V4603A. In addition to providing a

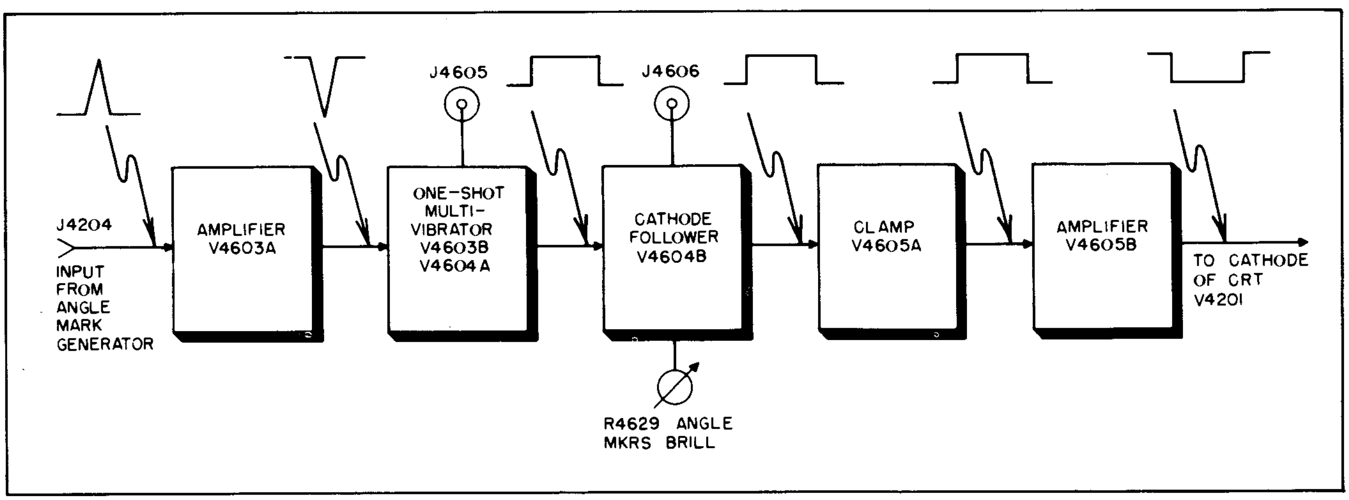


Figure 4–204. Angle Marker Circuits, Block Diagram

pulse of suitable amplitude and polarity to trigger the succeeding stage, this circuit provides some measure of isolation between the blocking oscillator of the angle mark generator and the multivibrator in the RHI. A switch in the plate circuit disconnects B+ from the stage when turning off of the angle markers is desired. This switch is located on the front panel.

4-1389. Triode sections V4603B and V4604A constitute a one-shot multivibrator. A negative trigger from the input amplifier initiates a cycle of one-shot multivibrator action. The duration of the positive alternation of the multivibrator output is equal to that of one sweep when the RHI is set for the maximum 200-mile range. The output can be monitored at test jack J4605.

4-1390. Cathode follower V4604B matches the high output impedance of the one-shot multivibrator to the low input impedance of the clamp and gain control. The output can be monitored at test jack J4606.

4-1391. Clamp V4605A places the base of the waveform on the −180-volt level. This insures that the angle markers will only be visible during the positive-going portion of the output from the one-shot multivibrator.

4-1392. Amplifier V4605B is used primarily as an isolating circuit. This amplifier couples the voltage across the clamp to the cathode of the CRT. The circuit also effectively inverts the input. The angle marker, which is a negative gate one sweep length in duration, is fed directly to the cathode of the display tube.

4-1393. DETAILED ANALYSIS OF ANGLE MARKER CIRCUITS.

4-1394. AMPLIFIER V4603A. (See figure 4-205.) The angle mark trigger developed in the angle mark generator chassis is applied through jack J4204 and coupling capacitor C4620 to the grid of amplifier stage V4603A. The stage is normally cut off because the grid is returned to the −180-volt supply through resistors R4620 and R4621. The arrival of the positive angle mark trigger brings the stage into conduction. A negative trigger is obtained at the plate for appli-

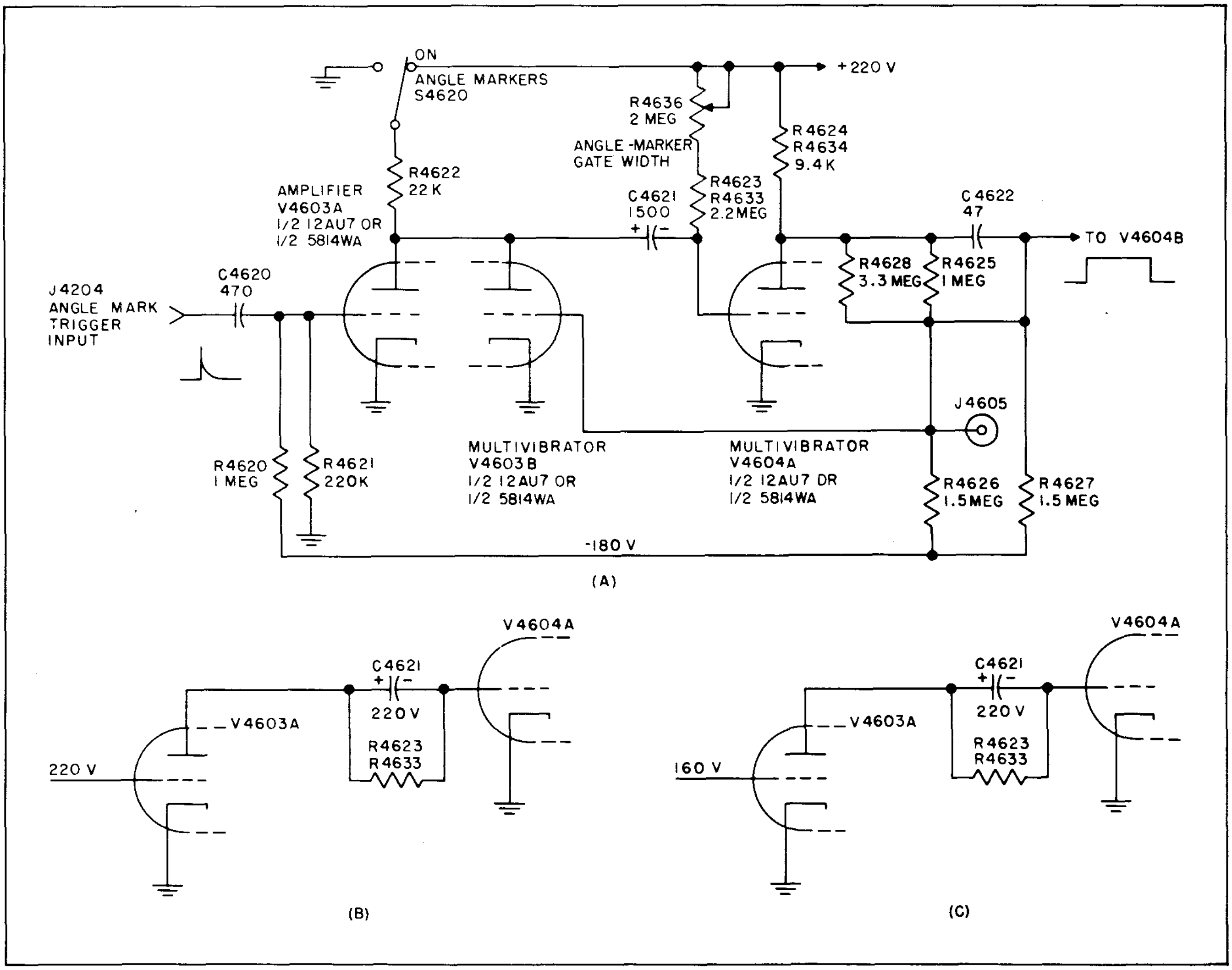


Figure 4-205. Amplifier and Multivibrator, Angle Marker Circuits, Simplified Schematic Diagram

cation to the multivibrator stage. Switch S4620, located in the plate circuit of the amplifier, is in series with the B+ supply. The switch is placed in the ON position when angle markers are desired. In this OFF position, the switch opens the B+ line and grounds the plate circuit, thus removing the angle markers from the display.

4–1395. MULTIVIBRATOR V4603B AND V4604A. (See A, figure 4–205.) Sections V4603B and V4604A are coupled in a one-shot multivibrator. The grid of section V4603B is held at a negative voltage by the resistive divider so that this section is normally cut off. The grid of section V4604A is returned to B+ through resistors R4623, R4633, and R4636 so that this section normally conducts heavily. Capacitor C4621 charges through the grid circuit of section V4604A to approximately the potential at the plate of amplifier V4603A, or 220 volts. The capacitor is charged in the polarity shown in B of figure 4–205. The plate supply voltage and the charge on the capacitor are in series-opposition, with the result that the grid-cathode potential is zero.

4–1396. The negative trigger from the amplifier stage is applied to the grid of section V4604A, cutting off this section. The plate voltage of section V4604A then rises abruptly to B+. A portion of this rise is tapped off across a voltage divider, consisting of the parallel combination of resistors R4628 and R4625 in series with resistors R4626 and R4627, and fed back to the grid of section V4603B as a positive-going potential. This allows the grid of section V4603B to rise above cutoff and brings the stage into conduction. The plate voltage of section V4603B falls, holding the grid of section V4604A beyond cutoff.

4–1397. Capacitor C4621 then begins to discharge through resistors R4623 and R4633. At the first instant of discharge, practically the entire B+ potential appears across these resistors. At this time, the grid-cathode circuit of section V4604A sees —220 volts across resistors R4623 and R4633 and approximately 160 volts at the plate of section V4603A (C, figure 4–205). The grid-cathode potential of section V4604A is then 160--220, or 60 volts. This is considerably beyond cutoff, of course. As the capacitor discharges further, the flow of discharge current decays in exponential fashion. When the difference between the potential at the plate of section V4603A and the voltage across resistors R4623 and R4633 reaches a value equal to cutoff, section V4604A begins to conduct again and its plate voltage falls. The lowering of the plate voltage of section V4604A reduces the drop across resistors R4626 and R4627 to the point where section V4603B cuts off. The multivibrator is then restored to the static condition and remains in this condition until the next angle mark trigger.

4–1398. The output from the stage is a positive-going pulse taken from the plate of section V4604A. The time-constant resistors R4623 and R4633 and capacitor C4621 is selected so that section V4604A remains cut off for 2,650 microseconds, the equivalent of 214 nautical miles. During this time, the plate voltage of section V4604A is high and it is this 2,650-microsecond gate that intensity-modulates the cathode of the display tube after suitable inversion.

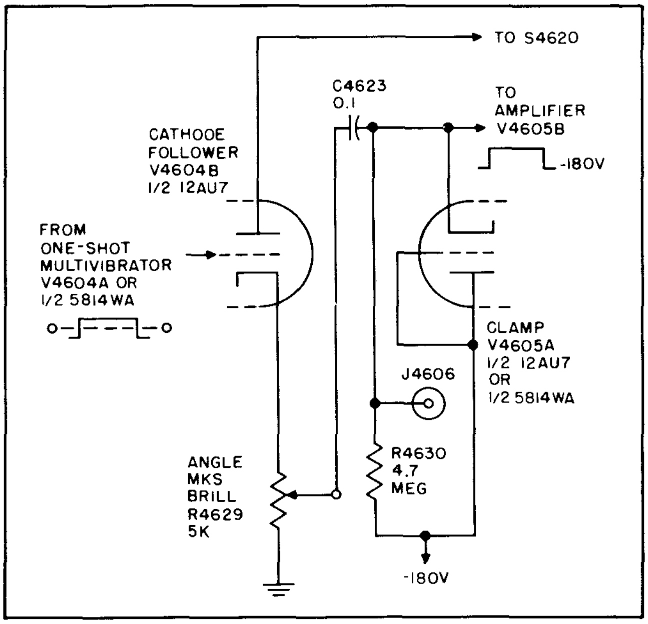


Figure 4–206. Cathode Follower and Clamp, Angle Marker Circuits, Simplified Schematic Diagram

4–1399. CATHODE FOLLOWER V4604B. (See figure 4–206.) The output from the multivibrator stage is fed to cathode follower V4604B, which matches the high output impedance of the multivibrator to the low input impedance of the clamp and gain control R4629 while the diode is conducting. Potentiometer R4629 adjusts the amplitude of the angle markers. Since the angle markers intensity-modulate the CRT, the greater the amplitude of the markers, the brighter they will appear on the display.

4–1400. CLAMP V4605A. (See figure 4–206.) Clamp V4605A is wired as a d-c resistor which clamps the lower level of the signal on the —180-volt line. If the signal starts to go below the —180-volt line, the d-c restorer tube conducts, shorting the signal to the negative supply. The signal can be observed for test purposes at jack J4606.

4–1401. AMPLIFIER V4605B. (See figure 4–207.) Amplifier V4605B isolates the CRT from the d-c restorer. As shown in figure 4–207, the plate current of the cathode follower forms part of the beam current of the CRT. This amplifier can be considered as a variable impedance. When the positive pulse arrives, the plate voltage of the amplifier decreases and lowers the cathode voltage of the CRT, permitting a greater beam current to flow.

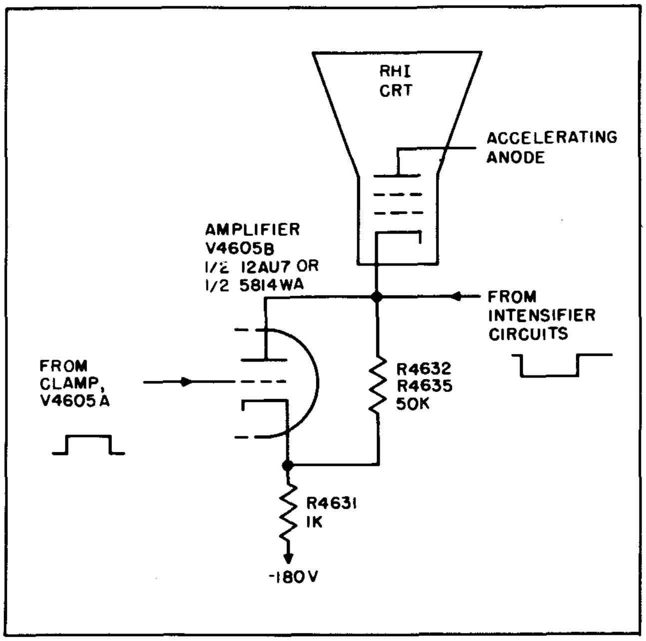


Figure 4–207. Cathode Follower, Angle Marker Circuits, Simplified Schematic Diagram

4–1402. The trace is brightened for 2650 microseconds, or the duration of one complete sweep, when the RHI is set for the maximum range.

4–1403. BLOCK DIAGRAM OF VIDEO CIRCUITS. (See figure 4–208.)

4–1404. Video from the interference blanker is fed into the RHI at jack J4203. Compensating inductances extend the range of video amplifiers V4901 and V4902 to include the full bandwidth of frequency components likely to be found in the video signals. When open, switch S4901 removes the SIGNAL BRILLIANCE control from the circuit and substitutes a —180-volt bias to the stage, thus turning off this stage. Cathode follower V4903 isolates the video amplifier chain from the CRT and furnishes a low-impedance input to the grid circuit of the CRT to minimize pickup of extraneous signals. Height markers and the height line are mixed with video at the second video stage, V4902. D-c restorer stage V4904A can be switched in at the CRT grid, if necessary, to clamp the signals at a level set by the TRACE BRILLANCE control. This maintains the normal grid bias voltage of the CRT at a constant level and permits signals to rise only in a positive direction from this level. By preventing variations in the bias due to large blocks of strong signals or jamming, the clamper prevents signals of small amplitude from being lost, and maintains a constant signal intensity on the CRT screen. Range markers and the range line are mixed with video at the output of video cathode follower V4903.

4–1405. The video signals are approximately 2 microseconds in width and, ideally, rectangular in shape. Mathematical analysis shows that a rectangular video pulse contains a fundamental frequency component and harmonics, or frequencies at integral multiples of the fundamental. In this case, the fundamental frequency is $\frac{10^6}{2}$ seconds, or 500 kilocycles. To preserve the shape of the pulse, the fundamental and, as a rough approximation, the first three higher order odd harmonics (that is, the third, fifth, and seventh) must be passed by the video amplifier. The maximum frequency to be amplified, then, is 500 kilocycles x 7, or 3.5 megacycles. In most amplifiers, the capacitance of the tube limits the frequency range over which the stage can operate. In video amplifiers, a compensating inductance is added to cancel the effects of the interelectrode capacitance.

4–1406. DETAILED ANALYSIS OF VIDEO CIRCUITS.

4–1407. VIDEO AMPLIFIER V4901. (See figure 4–209.) Video from the interference blanker chassis is applied

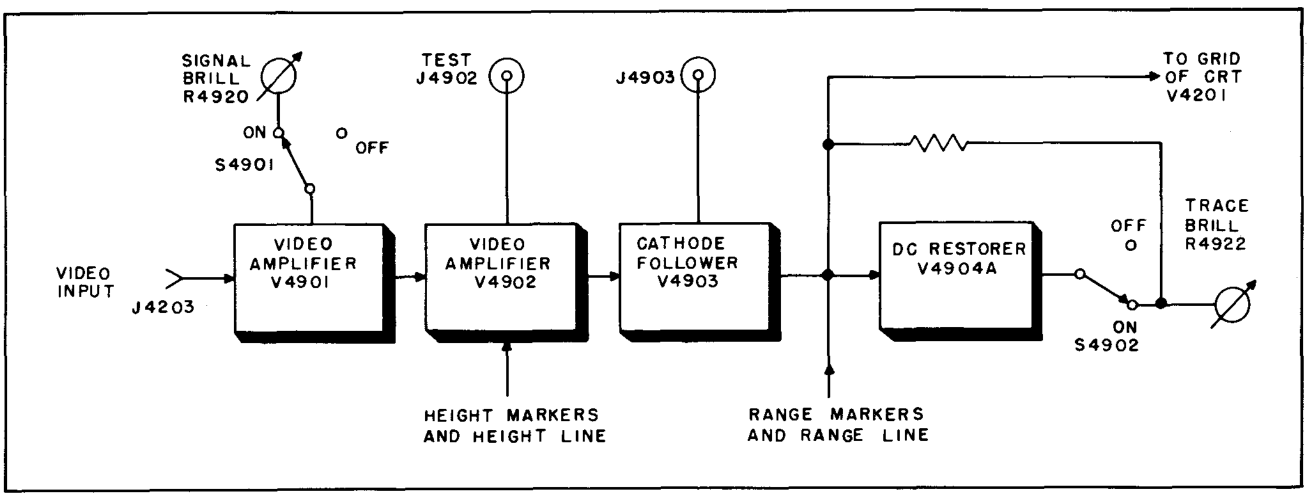


Figure 4–208. Video Circuits, Block Diagram

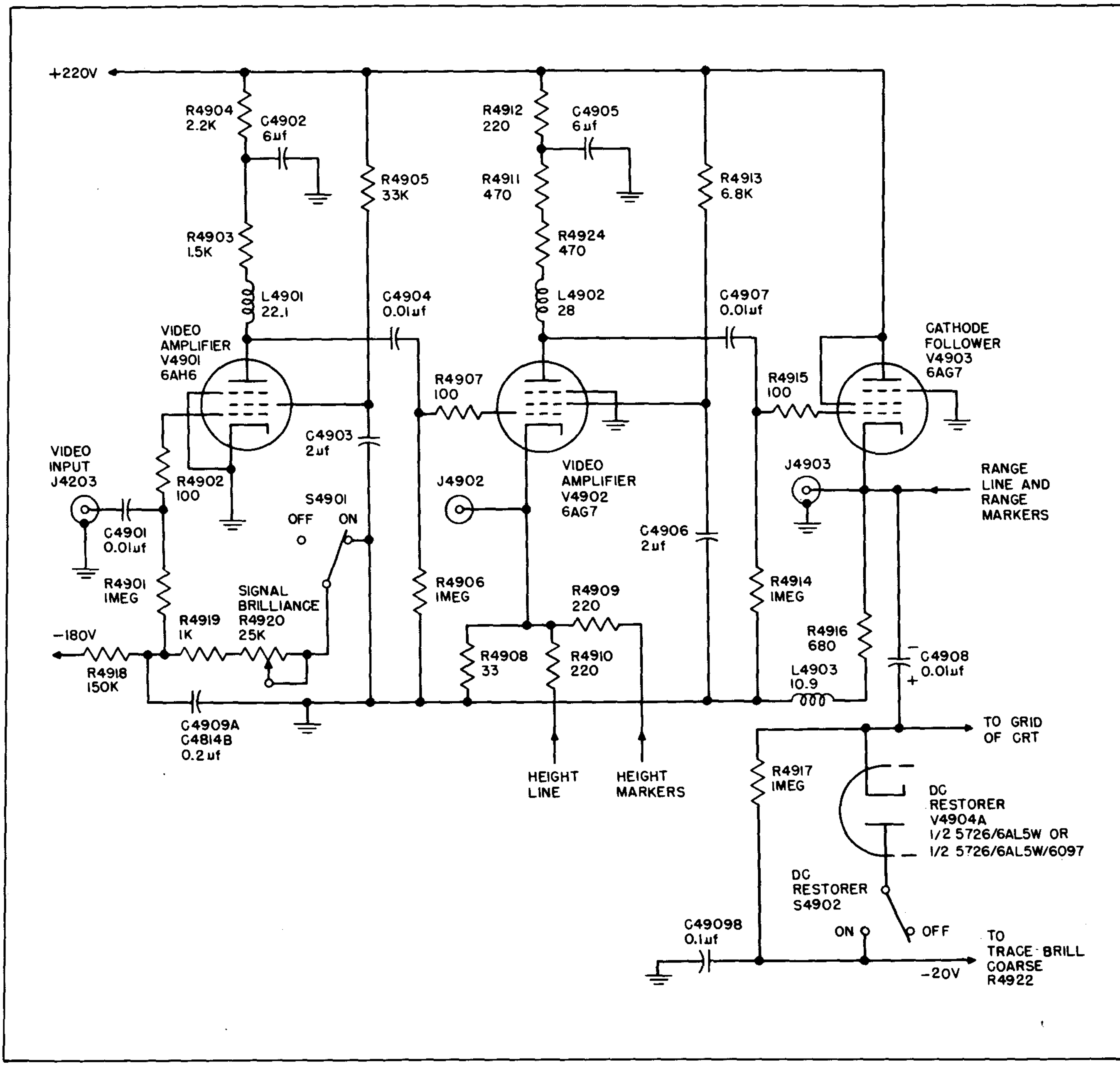


Figure 4–209. Video Circuits, Simplified Schematic Diagram

to the control grid of video amplifier V4901 through jack J4203 and blocking capacitor C4901. Resistor R4901 functions as the grid load. Resistor R4902 serves the dual function of limiting the current drawn by the grid during large input signals and suppressing parasitic oscillations. If switch S4901 is open, resistors R4901 and R4918 supply a —180-volt bias to the grid of the stage. With switch S4901 closed, the bias is determined by a voltage divider consisting of resistors R4918, R4919 and R4920. Adjusting SIGNAL BRILLANCE potentiometer R4920 varies the bias on the stage. Since a pentrode is used as the video amplifier, the operating point of tube V4901 also determines the amplification of the stage. Capacitors C4909A and C4814B filter out bias supply ripple. Screen grid ripple is removed by filter capacitor C4903 and resistor R4905.

4–1408. Resistor R4903 serves as the plate load of video amplifier V4901. Inductor L4901 compensates for the tendency of the tube to de-emphasize the high frequency components of the input due to the interelectrode capacitance. Resistor R4904 and capacitor C4902 constitute a decoupling network to prevent undesirable feedback oscillations and to filter ripple from the 220-volt supply. The output is taken from the plate circuit and fed to a second video amplifier, V4902.

4–1409. VIDEO AMPLIFIER V4902. Amplified video from video amplifier V4901 is coupled through capacitor

C4904 to the grid of video amplifier V4902, providing a second stage of video amplification. Two additional inputs, the height line and the height markers, are fed in at the cathode through 220-ohm isolating resistors R4909 and R4910. The video signals applied to video amplifier V4902 are of negative polarity, while the height line and height markers are positive in polarity and of considerably larger amplitude than the video. The output consists of positive signals with video, height line, and height markers mixed. Test jack J4902 is provided across the cathode load. Inductor L4902 functions as the compensating impedance. The output is taken from the plate circuit and applied to cathode follower V4903.

4–1410. CATHODE FOLLOWER V4903. Video height line, and height markers are coupled through capacitor C4907 to the grid of cathode follower V4903. High-frequency losses are minimized by compensating inductor L4903 in the cathode circuit of cathode follower V4903. The output is taken from the cathode, mixed with the range markers, and applied to the grid of the CRT through coupling capacitor C4908. Resistor R4917 serves as the grid load of the CRT. Capacitor C4909B filters out ripple in the bias supply to which the TRACE BRILLANCE potentiometer is returned.

4–1411. D-C RESTORER V4904A. The grid bias for the CRT is determined by the setting of the TRACE BRILLANCE potentiometer. With DC RESTORER switch S4902 open, the video rides above and below this bias. Closing the DC RESTORER switch clamps the video signals to the level of the voltage existing at the arm of the TRACE BRILLANCE potentiometer. This level is normally just suffiiciently negative to place the tube at cutoff.

4–1412. If the TRACE BRILLANCE potentiometer is set for —40 volts, then the plate of the clamper is placed at that potential. Whenever the video signal starts to go below this value, the cathode is at a negative potential with respect to the plate and the diode conducts. The conducting diode connects the grid of the CRT directly to the —40-volt bias, and also allows capacitor C4908 to charge so as to oppose the grid potential going below —40 volts (figure 4–209).

4–1413. RHI POWER SUPPLY (POWER SUPPLY PP-795/FPS-6).

4–1414. BLOCK DIAGRAM. (See figure 4–210.)

4–1415. The RHI power supply consists primarily of the regulated plate and bias supplies, the high-voltage and filament supplies, and metering and indicator light circuits.

4–1416. A full-wave rectifier circuit furnishes 390 volts which is regulated for 400- and 220-volt plate supplies. The bias supply rectifier supplies an ungrounded 230 volts for the regulated —180-volt supply. The self-regulating high-voltage oscillator operates at a frequency near 4800 cps and supplies a-c power for the 7500- and 380-volt CRT supplies. As a protective measure, plate voltage for the high-voltage series regulator is furnished by the 220-volt supply; consequently failure of the 220-volt supply cuts off the high-voltage supply.

4–1417. HIGH-VOLTAGE POWER SUPPLY. (See figure 4–211.)

4–1418. The high-voltage power supply furnishes the 380- and 7500-volt potentials required for the type 12SP7 cathode-ray tube. An audio oscillator converts the 220-volt d-c voltage into 4800 cycles a-c for application to high-voltage transformer T4150. A group of selenium rectifier and filter capacitors located across the secondary of the transformer rectifies and filters the stepped-up voltage. A sample of the output is fed to voltage regulator V4151, which maintains the d-c high-voltage output at a relatively constant level by changing the screen voltage of oscillator V4150. The 380-volt d-c supply is obtained from the junction of a selenium rectifier and a capacitor which shunt the plate of the oscillator tube.

4–1419. OSCILLATOR V4150. The capacitance of capacitor C4150 and the reflected capacitance of transformer T4150 combine with the inductance at the primary winding (taps 1 and 2) to form a low-Q tank circuit resonant at 4800 cps. Oscillator V4150 is a type 6L6GA amplifier tube which provides the amplification necessary to sustain oscillations. Windings 1-2 and 3-4 of transformer T4150 constitute the regenerative feed back loop which feeds a portion of the oscillatory energy from the tank into the grid of oscillator V4150. The oscillations are then amplified in the plate to compensate for losses due to resistance in the tank.

4–1420. The a-c feedback signal across winding 3-4 of transformer T4150 is limited at the grid of oscillator V4150 when that tube draws grid current. Consequently, the waveform at the plate of tube V4150 is distorted and partially clipped on the negative side of the cycle. The distortion persists throughout the entire circuit and does not permit flywheel correction of waveform irregularities. Because of this condition, the connections to the secondary winding of transformer T4150 cannot be reversed without sacrificing high-voltage rectifier output and stable regulator action.

4–1421. REGULATOR V4151. The output of the tank is taken from winding 1-2 and coupled through the secondary of transformer T4150 to the grid of voltage regulator V4151. Capacitor C4152 filters the voltage at the grid of voltage regulator V4151. Any changes in the 7500-volt output line are also felt across the grid-load resistor R4153. The amplifier action of voltage regulator V4151 causes a change in the opposite direction to appear at the plate.

4–1422. The output of regulator V4151 is taken at the junction of resistors R4154 and R4156 and fed through rheostat R4155 to the screen grid of oscillator

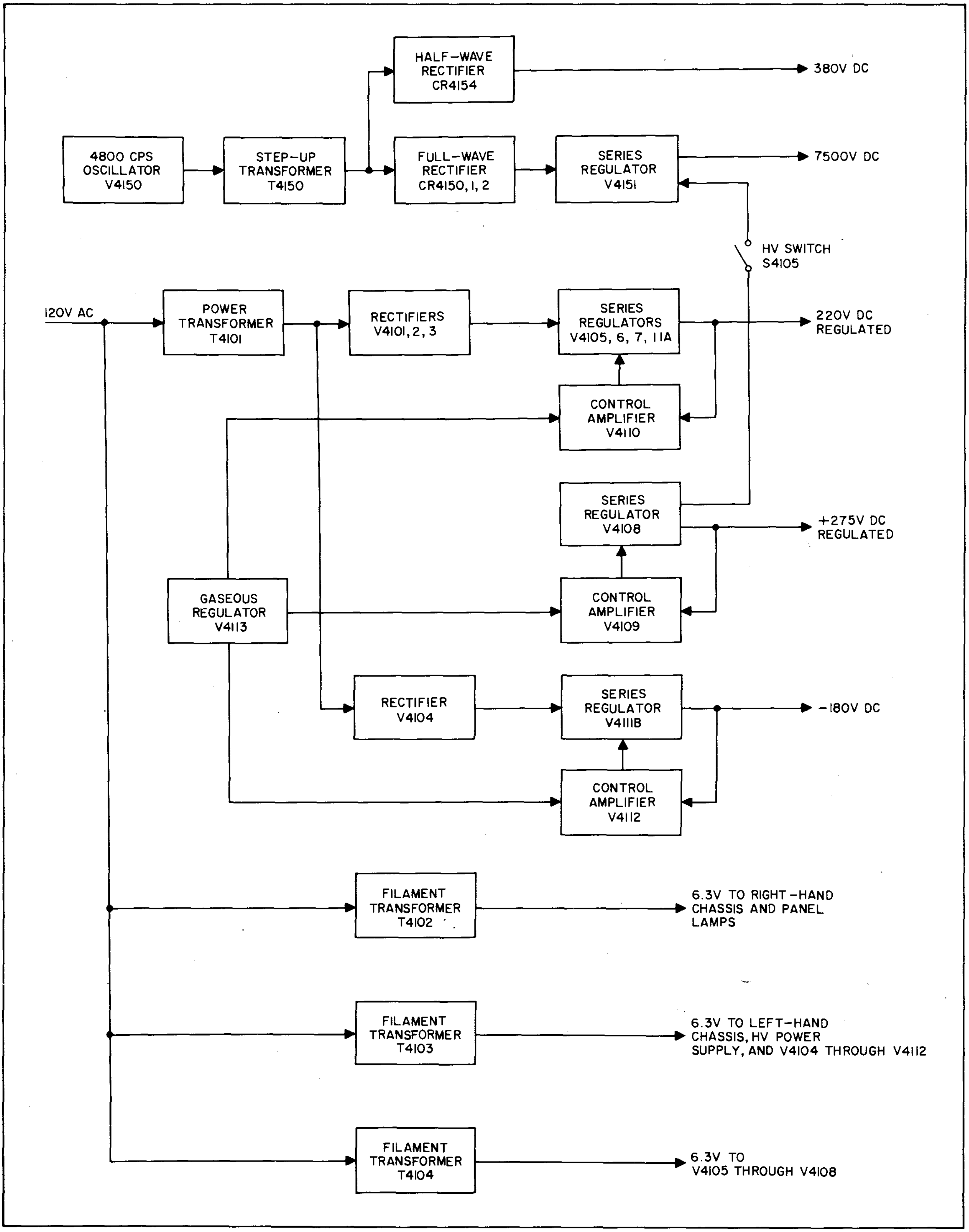


Figure 4–210. RHI Power Supply (Power Supply PP-795/FPS-6), Block Diagram

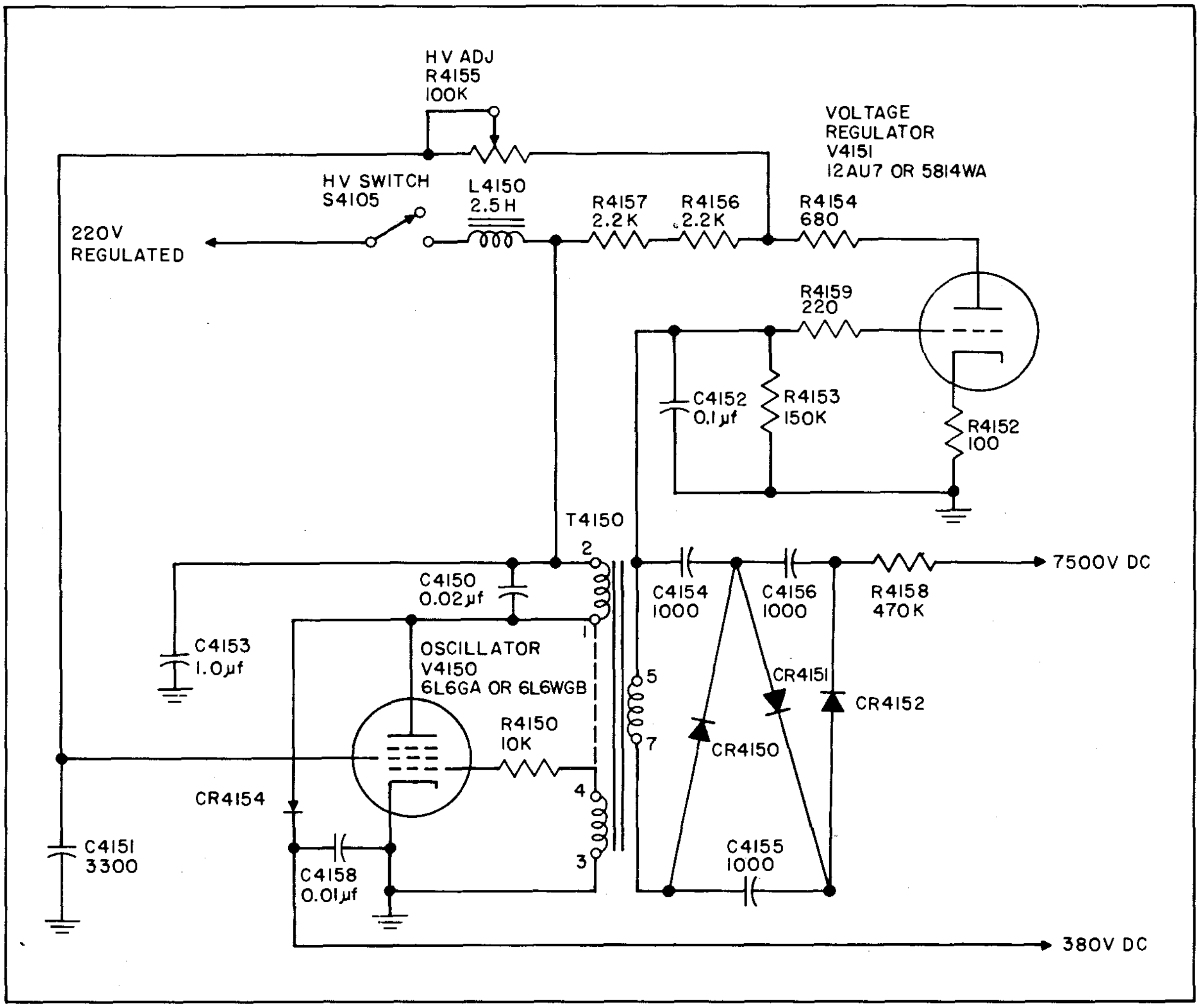


Figure 4–211. CRT High-Voltage Supply, Simplified Schematic Diagram

V4150. This feedback line attempts to maintain oscillations at a constant amplitude by controlling the voltage on the screen grid of oscillator V4150.

4–1423. As an example of the action of the high voltage, assume that the output voltage falls below the 7500-volt level. A part of this voltage decrease then appears at the grid of regulator V4151, causing the plate voltage of this tube to rise. The increase in the plate voltage of the regulator is fed to the screen grid of this tube. The higher screen voltage provides greater driving power for the tank circuit and the oscillations therefore increase in amplitude. If the regulatory circuit is correctly adjusted, this increase is just sufficient to bring the amplitude of the oscillations up to a normal level. H.V. ADJ. control R4155 sets the high-voltage output under normal load conditions by controlling the operating voltage at the oscillator screen grid.

4–1424. FILTER AND RECTIFIER FOR 380-VOLT OUTPUT. The oscillations are rectified and filtered by the series combination of crystal rectifier CR4154 and capacitor C4158 which shunts oscillator V4150. Capacitor C4158 provides sufficient filtering due to the light load and the presence of CRT deflection coil L4201 in the load.

4–1425. HIGH-VOLTAGE OUTPUT. An a-c voltage of 2500 volts appears across winding 5-7 of transformer T4150. Crystal rectifiers CR4150, CR4151, and CR4152, with capacitors C4154, C4155, and C4156, act as a voltage tripler to produce 7500 volts dc at the output.

4–1426. SWITCHES AND INDICATORS. (See figure 4–212.)

4–1427. No power can be applied unless FILAMENTS circuit breaker S4101 is closed. (The emissive surface can be removed from a cold cathode if the plate supply is turned on before the tube has warmed up.) BIAS switch S4103 can then be closed, applying 114-volts to both the plate supply and bias supply rectifiers. The 220-volt plate supply is activated by closing PLATE switch S4104, which applies the unregulated rectifier output to the 220-volt regulator tubes. The high-voltage

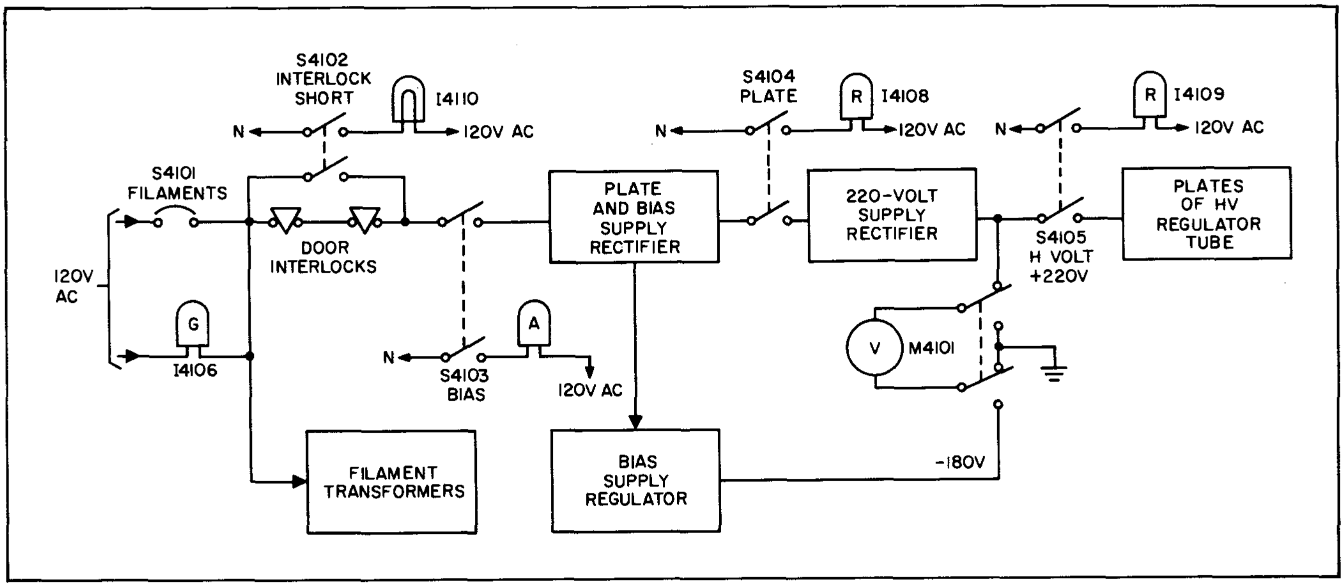


Figure 4–212. RHI Power Supply, Switches and Indicators, for Radar Set AN/FPS-6

supply is activated by closing H. VOLT switch S4105, which applies regulated 220 volts to the plates of the regulator stages in the high-voltage supply. Failure of the 220-volt supply automatically turns off the high voltage. Were this not done, failure of the 220-volt supply would remove the sweep voltages, allowing the stationary CRT beam to burn the fluorescent coating of the CRT.

4–1428. Panel-mounted voltmeter M4101 measures the output of either the 220- or —180-volt supply, depending upon the position of polarity-reversing switch S4106.

4–1429. RHI ASSEMBLY FOR RADAR SET AN/FPS-6A (INDICATOR GROUP OA-929/FPS-6A).

4–1430. BLOCK DIAGRAM. (See figure 4–213.)

4–1431. GATE GENERATOR. The gate generator controls the timing of all signals produced within the RHI. The output positive and negative gates are iniated by positive triggers from the range mark generator in the control group assembly at a rate of 300 to 400 cps. The length of these gates is controlled by inputs from the range sweep generator, range sweep driver, height sweep generator, and height sweep driver. As a result, the duration of the positive and negative gates is a function of the setting of the RHI front panel RANGE control and of the AN/FPS-6A antenna elevation angle. The positive gates are applied to the video amplifier and to the range sweep, height sweep, and range mark generators. The negative gates are applied to the time-share gate and height sweep generators and to the video amplifier.

4–1432. TIME-SHARE GATE GENERATOR. The time-share gate generator produces four timing gates which control the display of the cursor. The cursor display is produced between the end of one sweep and the start of the next, and occurs at a rate of 20 cps. A negative gate from the gate generator is applied to a frequency divider in the time-share gate generator. This divider synchronizes the time-share gate generator with the end of the negative gate at a rate of 20 cps. The time-share gate generator produces the positive and negative 250-microsecond time-share gates. These two gates are applied to the range and height sweep drivers and permit cursor positioning information to be conveyed to the drivers. A 375-microsecond gate is also initiated by the end of the counted-down gates. Mixing of the 250- and 375-microsecond gates provides cursor intensity and video blanking gates.

4–1433. RANGE SWEEP GENERATOR. The range sweep generator produces horizontal deflection sawtooth voltages. The duration of these voltages is controlled by the applied positive gate from the generator. The output sawtooth voltage is applied to the range sweep driver to produce horizontal deflection. The same output is applied to the gate generator as one of the signals which terminate the positive and negative gates. In addition, the sawtooth voltage is applied to the earth curvature circuit within the height sweep generator to compensate for the curvature of the earth as the range increases.

4–1434. RANGE SWEEP DRIVER. The range sweep driver supplies the current necessary for horizontal deflection of the sweep and for range positioning of the cursor. When an input from the range sweep generator is applied to the range sweep driver, horizontal sweep deflection is produced. However, when the two time-share gates are applied, the range sweep driver

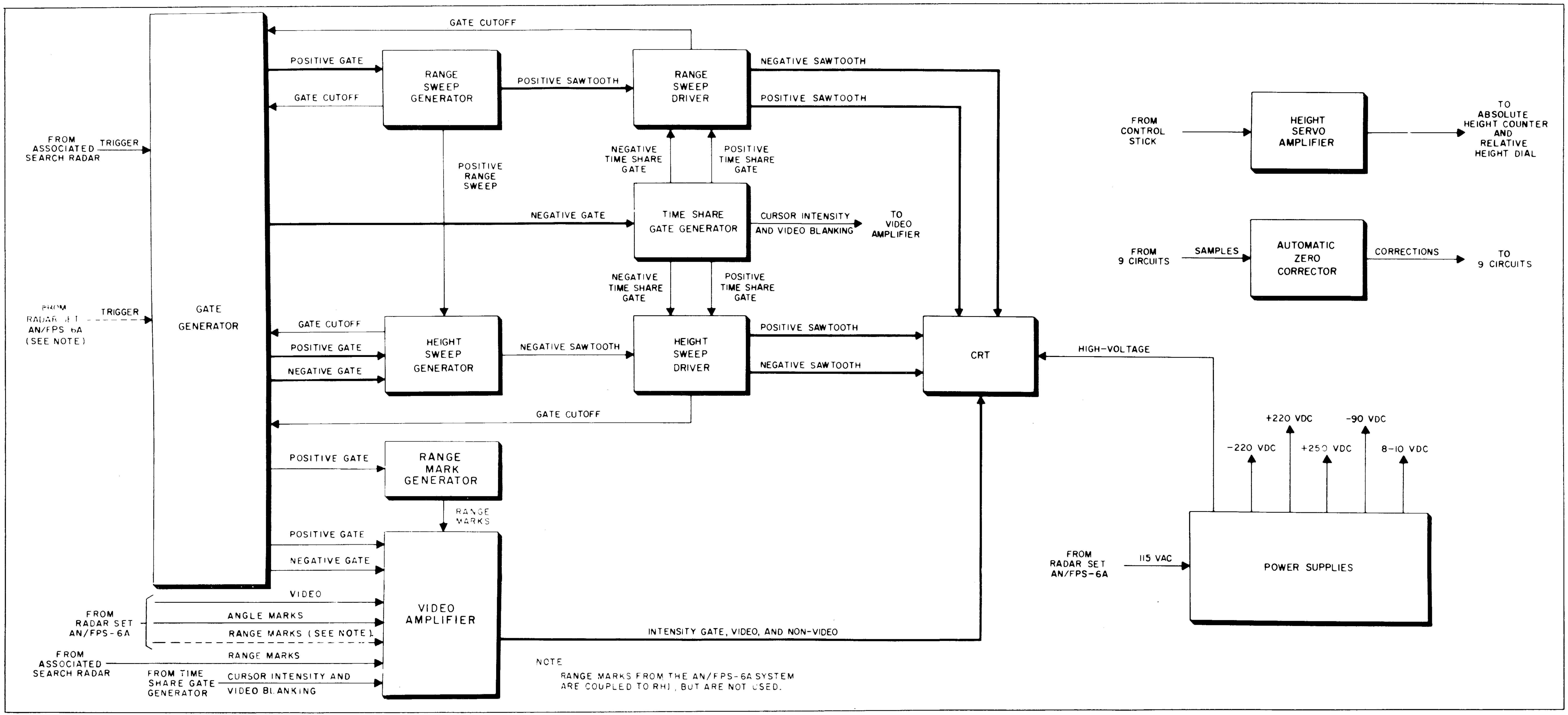


Figure 4–213. RHI Assembly for Radar Set AN/FPS-6A, Block Diagram

provides cursor range positioning (controlled by the cursor d-c level inputs). The outputs for horizontal sweep deflection and cursor range positioning are two current sawtooth pulses of equal amplitude but opposite polartiy. These sawtooth pulses are applied to the left and right deflection coils of the CRT. A sawtooth voltage output from the range sweep driver is applied to the gate generator to control the duration of the positive and negative gates.

4–1435. HEIGHT SWEEP GENERATOR. The height sweep generator produces a sawtooth voltage for vertical deflection. This circuit operates in a manner similar to the range sweep generator. The main difference is that the height sweep generator produces both positive and negative outputs because the antenna radiates at both positive and negative angles, whereas the range sweep generator outputs are always positive. In order to produce height sweep voltages of either polarity, both positive and negative gates from the gate generator are applied to the height sweep generator. An input from the range sweep generator is used to correct the height sweep generator output for earth curvature with respect to range. One output from the height sweep generator is applied to the height sweep driver to produce vertical deflection, while the second output is applied to the gate generator to control the duration of the positive and negative gates.

4–1436. HEIGHT SWEEP DRIVER. The height sweep driver is similar to the range sweep driver. The height sweep driver supplies the current necessary for vertical deflection of the sweep and for height positioning of the cursor. When an input from the height sweep generator is applied to the height sweep driver, vertical sweep deflection is produced. However, when the two time-share gates are applied, the height sweep driver provides cursor height positioning as determined by the cursor d-c level inputs. The outputs for vertical sweep deflection and cursor height positioning are two current sawtooth pulses of equal amplitude but opposite polarity. These sawtooth pulses are applied to the upper and lower deflection coils of the CRT. A sawtooth voltage output from the height sweep driver is applied to the gate generator to control the duration of the positive and negative gates.

4–1437. HEIGHT SERVO AMPLIFIER. The height servo amplifier supplies the power to drive a common motor for the ABSOLUTE and RELATIVE height counters. In addition, the common drive motor controls one of the cursor height-positioning voltages. The height servo amplifier receives a 60-cycle a-c signal input whenever the front panel control stick is moved. A feedback voltage from the height gear train cancels the drive voltage when the counter readings correspond to the position of the control stick.

4–1438. RANGE MARK GENERATOR. The range mark generator produces 10-, 20-, or 50-nautical mile range marks as determined by the position of the front panel RANGE control. Positive gates are applied to the range mark generator from the gate generator. A frequency divider with the range mark generator counts down the applied gates at a ratio of 2;1, so that range marks are produced for every other sweep. Range marks from the Range Mark Generator in the Control Group Assembly are cabled into the RHI and are used for calibration purpose only.

4–1439. VIDEO AMPLIFIER. The video amplifier controls all information displayed on the CRT. All outputs from the video amplifier are applied to the CRT control grid. A positive gate from the gate generator is used to intensify the CRT display when horizontal and vertical deflection voltages are generated. The video blanking gate and the cursor intensity gate from the time-share gate generator (which occur at the end of a sweep) prevent sweep information from being displayed on the CRT and permit the display of the cursor. A compensation circuit within the video amplifier provides equal trace intensity for all displayed ranges. In addition, video and nonvideo signals are applied to the video amplifier. Video signals are target returns received from Radar Set AN/FPS-6A. Nonvideo signals are range marks, range lines, and angle marks which aid the operator in interpreting the CRT display. The angle mark trigger from Radar Set AN/FPS-6A activates a circuit within the video amplifier which produces an intensification level for sweeps occuring each 5 degrees of antenna elevation. Video and nonvideo information is mixed and amplified within the video amplifier and then applied to the CRT.

4–1440. POWER SUPPLY. When 115 volts, 60 cycles ac is applied to the RHI assembly, the power supply produces the following voltages:

a. −220 volts regulated dc (adjustable)

b. +220 volts regulated dc (not adjustable)

c. −90 volts regulated dc (not adjustable)

d. +250 volts unregulated dc (not adjustable)

e. +10 kilovolts unregulated dc (adjustable)

f. 115 volts, 60 cps unregulated ac (not adjustable)

g. 6.3 volts, 60 cps unregulated ac (not adjustable)

4–1441. AUTOMATIC ZERO CORRECTOR. The automatic zero corrector maintains a constant 0 d-c reference voltage level within the most important functional components of the equipment. The circuits concerned are sampled for a 0-volt reference level by the automatic zero corrector through the sampling switch. When the reference level is incorrect, a correction voltage is applied to the sampled circuit, thus returning its reference level to 0 volt.

4–1442. SYSTEM TIMING. (See figure 4–214.)

4–1443. SWEEP DISPLAY TIMING. The positive input triggers from the range mark generator in the control group assembly are applied to the gate generator at a rate of 360 pps. Each input trigger starts the generation of a sweep display by initiating the positive and negative gates (A, figure 4–214). The positive gate is applied to the range sweep generator, which produces a range sweep sawtooth voltage waveform. This waveform is used by the range sweep driver to generate two sawtooth current waveforms of the same duration but of opposite polarity, for range or horizontal sweep deflection. The positive gate is also applied to the range mark generator, which produces 10-, 20-, or 50-nautical mile range marks for every alternate range sweep. Selection of the appropriate range marks is accomplished when the range is manually selected by means of front panel RANGE control R61.

4–1444. Both positive and negative gate are supplied to the height sweep generator to produce a negative height sweep sawtooth voltage waveform when the antenna radiates at a positive elevation angle. Two height sweep sawtooth current waveforms of equal amplitude but opposite polarity are generated by the height sweep driver. When the antenna elevation angle is between 0 and −2 degrees, the output waveforms of the height sweep generator and height sweep driver are as shown in B of figure 4–214. The distortion of these waveforms, shown by dotted lines, indicates that earth curvature correction has been introduced.

4–1445. The positive and negative gates can be terminated in one of two ways: by recovery time limitations, or by the termination of one or a combination of the waveforms from the range and sweep generators and/or the positive waveforms from the range and height sweep drivers.

4–1445. CURSOR DISPLAY TIMING. The time-share gate generator produces the positive and negative time-share gates which are initiated by the trailing edge of the negative gate (A, figure 4–214). This generator also produces the cursor intensity gate and the video blanking gate at the same time. The 250-microsecond time-share gates are used for RHD suppression. The trailing edge of the positive time-share gate produces the negative-going step in the cursor intensity gate, thus permitting cursor display during a 125-microsecond interval. The 375-microsecond video blanking gate at the video amplifier inhibits the display of video information for the duration of the applied gate.

4–1447. VIDEO AND NONVIDEO INFORMATION. The output waveform from the video amplifier shows the time relationship of video and nonvideo information displayed during the sweep as well as the display of the cursor following the sweep. The duration of the video intensity gate is equal to that of the positive gate, or equal in time to the range and height sweep sawtooth waveforms. Video signals, angle and range marks, and a range line are all coincidentally displayed during this interval. The angle mark level is applied to sweeps at every 5 degrees of the elevation angle of the AN/FPS-6A antenna. The position where the range line appears on the video intensity gate is determined by a PPI operator or another external source to inform the operator that height information is requested for a target appearing at the specified range. After the video information has been displayed, it is suppressed for 375 microseconds. A 125-microsecond cursor intensity gate, produced during this interval, intensifies the CRT beam at a position determined by the d-c cursor levels applied to the sweep drivers. Under certain conditions (C, figure 4–214), when the cursor is being displayed coincidentally with the arrival of a system trigger pulse from the range mark generator in the control group assembly) approximately 20 miles of the following range sweep is blanked at the origin.

4–1448. FUNCTIONING OF CRT. (See figure 4–215.)

4–1449. GENERAL. The type 12ABP7-A cathode-ray tube employs magnetic deflection and electrostatic focusing. The number 12 signifies a 12-inch-diameter screen and the code designation P7 denotes a long-persistence phosphor coating with an amber glow. The letters AB distinguish the CRT from others of the same diameter and phosphor.

4–1450. The CRT is provided with controls which permit adjustment of the sweep intensity and the focusing of display information. Calibration panel AUX INTENSITY potentiometer R148 and front panel SWEEP potentiometer R54 vary the intensity of the CRT display, while the percentering magnet and FOCUS control R174 vary the focal point of the electron beam.

4–1451. SWEEP INTENSITY ADJUSTMENTS. AUX INTENSITY potentiometer R148 is a coarse control for adjusting the intensity of the sweep. SWEEP potentiometer R54 is the fine intensity control. Potentiometer R148 controls the static bias present on the ground grid of the CRT. This control is adjusted to produce a display on the face of the CRT which is barely visible when potentiometer R54 is in its center position. Therefore, potentiometer R148 controls the range of intensity which can be produced with potentiometer R54. Potentiometer R54 varies the d-c level of the intensity gate applied to the control grid of the CRT. When potentiometer R148 is properly adjusted, varying potentiometer R54 from one extreme to the other produces a display whose intensity varies from complete cutoff to intense brightness.

4–1452. FOCUS ADJUSTMENTS. Focusing of the electron beam is accomplished with the precentering magnet and FOCUS control R174. When the electron beam is improperly focused, any stationary point on the CRT display has a halo of light surrounding it and is not centered within the halo. The precentering magnet and control R174 are normally adjusted alternately to eliminate the halo or to center the stationary

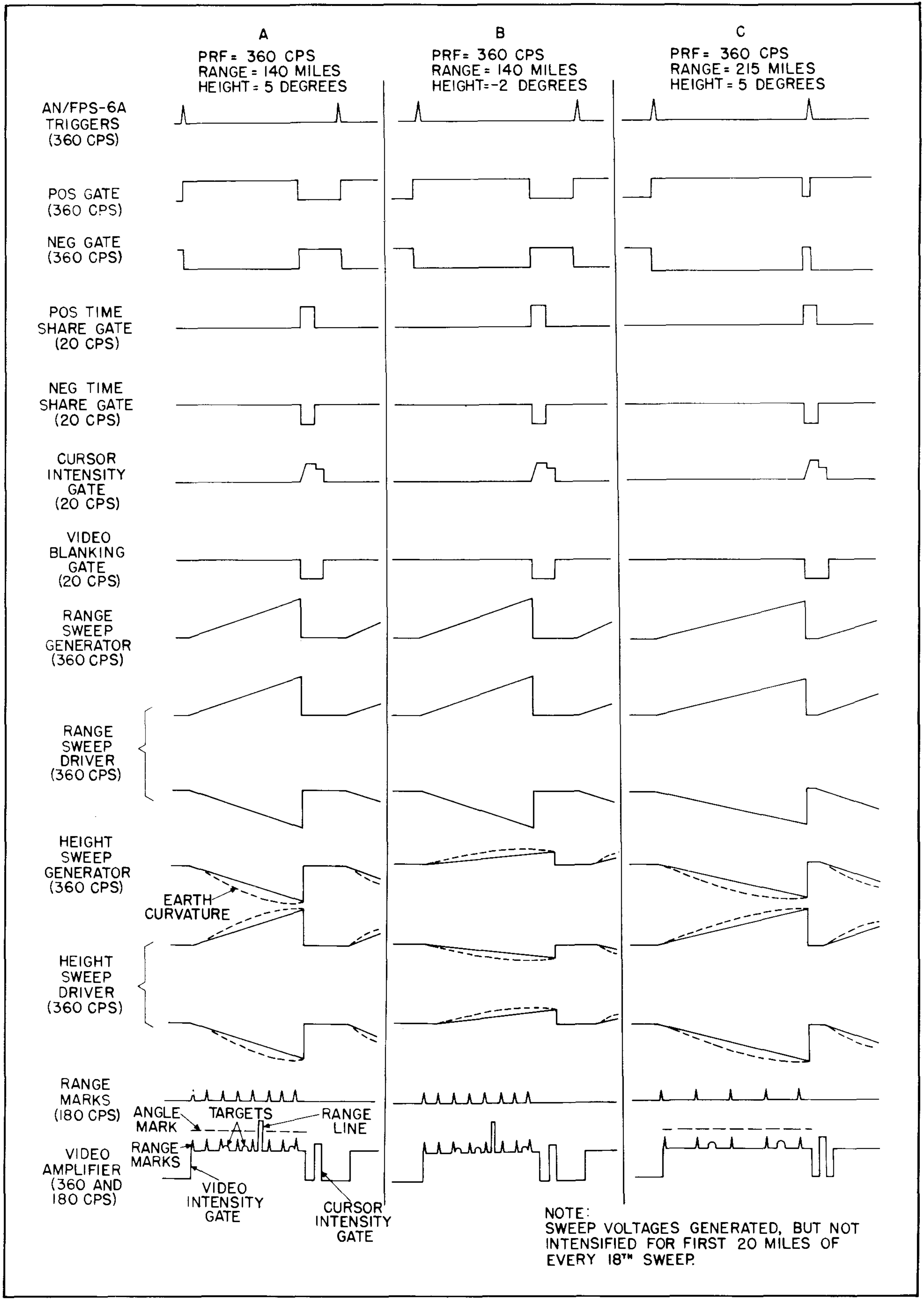


Figure 4–214. System Timing Chart

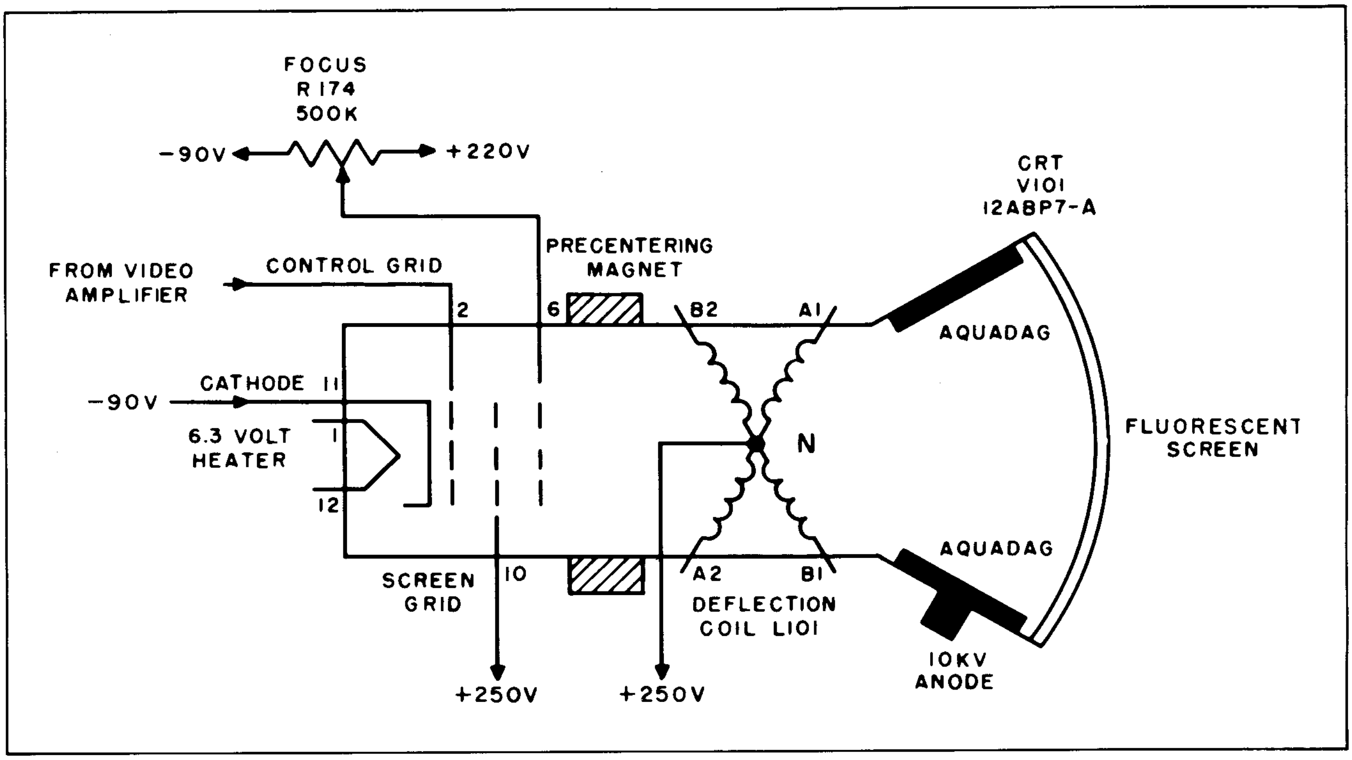


Figure 4–215. CRT Elements and Controls of RHI Assembly for Radar Set AN/FPS-6A, Simplified Schematic Diagram

point within the halo. Adjustment of the precentering magnet in conjunction with control R174 is necessary only upon installation of the RHI or when a CRT is replaced. Thereafter, focusing adjustments are made with FOCUS control R174 alone.

4–1453. The precentering magnet is a circular permanent magnet around the neck of the CRT. A soft iron sleeve located between the neck of the CRT and the magnet itselff partially shunts the effect of the magnet. The strength of the magnetic field produced by the magnet is varied by sliding the magnet axially with respect to the CRT. The direction of the field is changed by rotating the magnet around the neck of the CRT.

4–1454. DEFLECTION AND CENTERING. The position of the beam at any instant is determined by the voltages impressed upon the four windings of deflection coil L101. The four windings of coil L101 are joined together at a common point (point N), which is connected to a +300-volt source. Windings B1-N and B2-N are the horizontal, push-pull sweep windings which are driven by the range sweep driver. Windings A1-N and A2-N are the vertical, push-pull sweep windings which are driven by the height sweep driver. The horizontal and vertical deflection windings provide the off-centering current necessary to locate the sweep origin in the lower left-hand corner of the display. This is accomplished by controlling the d-c current flowing through coil L101 from the height and range sweep drivers through adjustment of HORZ ORIGIN control R112 and VERT ORIGIN control R125 in the sweep driver circuit. The sawtooth vertical (height) and horizontal (range) sweep voltages are initiated by positive and negative gates. These sweep voltages cause the trace to assume the appearance of a rotating radius whose fixed end is located at the lower left-hand corner of the display and which rotates through one quadrant.

4–1455. REQUIREMENTS FOR BEAM DEFLECTION. The velocity of the CRT electron beam from left to right is equal to one-half the velocity of the transmitted radar pulse. Linear sawtooth voltages applied to the horizontal deflection winding produce magnetic fields which move the electron beam to the right at the proper velocity. The vertical component of the CRT trace is determined by the antenna elevation angle. Linear sawtooth voltages whose amplitude is a function of the antenna elevation angle are applied to the vertical windings of the deflection coil.

4–1456. EFFECT OF SWEEP SIGNALS. When the antenna points along the horizontal (zero elevation), no elevation voltage is applied to the height sweep generator. Therefore, there is no vertical sweep. During this time, however, a horizontal sweep is generated. The CRT beam is then moved from left to right along the zero line under the sole influence of the horizontal sawtooth.

4–1457. RESULT OF VERTICAL AND HORIZONTAL FORCES. The elevation data is positive as the antenna scans upward and there are then two forces acting upon the CRT beam. These forces are the horizontal deflection and the vertical deflection voltages. As a result of these two forces acting perpendicular to each other, the beam is moved along a diagonal path. The position of the beam at any given instant is a function of range and elevation angle. The horizontal displacement of the beam from the left-hand edge indicates the range, while the perpendicular displacement of the beam from the zero line indicates the height.

4–1458. BLOCK DIAGRAM OF GATE GENERATOR. (See figure 4–216.)

4–1459. The gate generator produces both positive and negative output gates for each applied trigger. The positive output gate is applied to the range sweep generator, height sweep generator, video amplifier, and range mark generator. The negative output gate is applied to the time-share gate generator, height sweep generator, and video amplifier. The gate generator is composed of the positive and negative gate generator circuit, gate cutoff amplifier circuit, automatic recovery circuit, and test trigger generator circuit.

4–1460. The positive and negative gate generator circuit produces positive and negative output gates. These gates are initiated by a positive trigger applied to the gate multivibrator from either Radar Set AN/FPS-6A or the test trigger generator. Termination of the gates is controlled by the application of a negative trigger to the gate multivibrator from the gate cutoff amplifier circuit. The gate multivibrator is composed of limiter V501B, gate multivibrator V502, and gate cathode followers V503A and V503B.

4–1461. The gate cutoff amplifier circuit generates the negative trigger which terminates the positive and negative gates. This circuit is composed of three normally cutoff amplifiers (V504B, V506A, and V506B), isolation diode V505B, amplifier V504A, and trigger amplifier V501A. The following inputs, either singly or in combination, control the generation of the negative output trigger:

a. Range sweep generator sawtooth

b. Range sweep driver sawtooth

c. Height sweep driver sawtooth

d. Negative height sweep generator sawtooth

e. Automatic recovery circuit trigger

4–1462. Each of the five input voltages controls the cutoff amplifier for a specific condition.. When RANGE control R61 is at maximum range (300 nautical miles), the sawtooth voltage from the range sweep generator controls the duration of the positive and negative gates. At minimum range (50 nautical miles), the range sweep driver sawtooth voltage controls the duration of the gates. When the elevation angle of the antenna of Radar Set AN/FPS-6A is large, the sawtooth voltage from the height sweep driver determines the duration

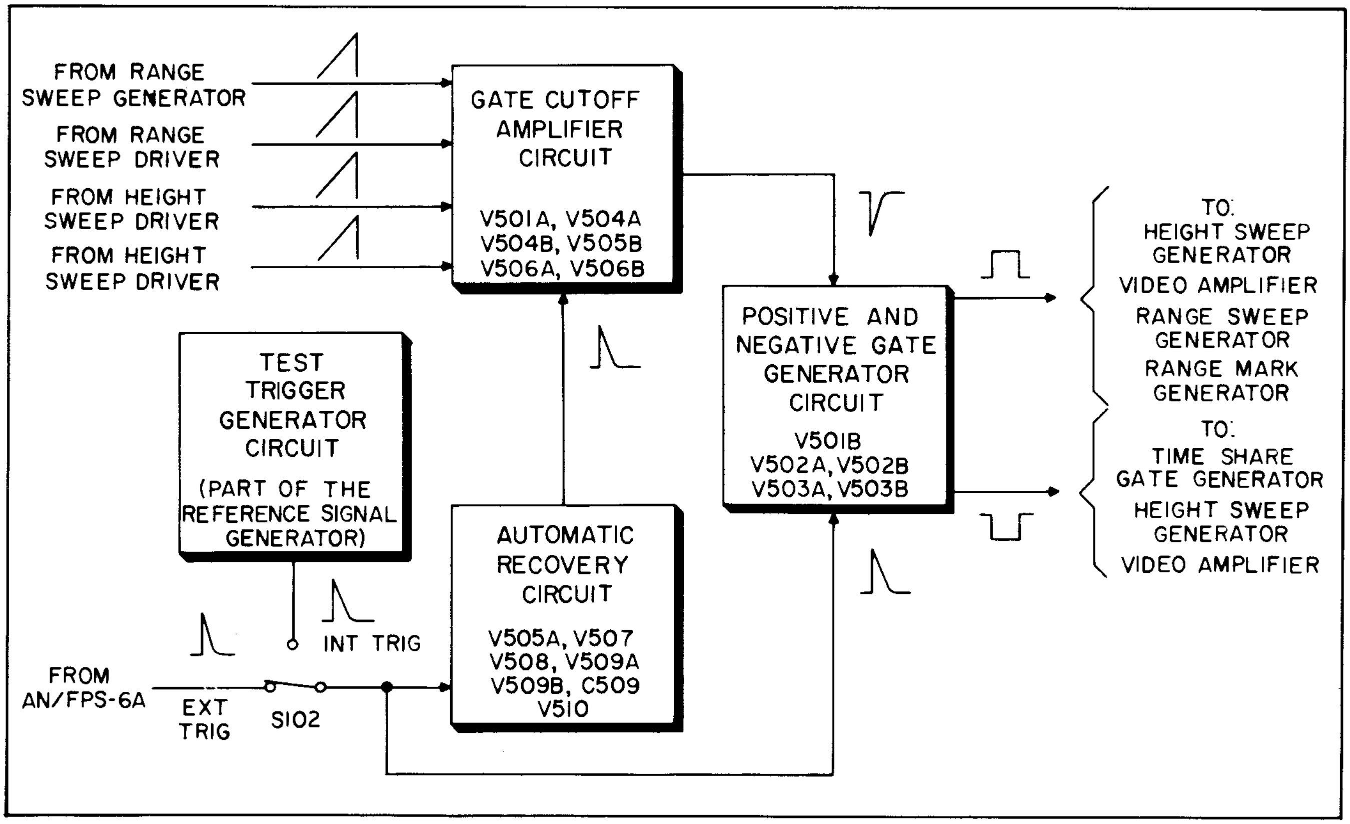


Figure 4–216. Gate Generator, Block Diagram

of the gates. When the antenna is radiating below the horizon (through negative elevation angles), the sawtooth voltage from the height sweep generator controls the length of the gates. When the input pulse repetition frequency is high, the positive pulse from the automatic recovery circuit determines the duration of the output gates.

4–1463. The automatic recovery circuit generates a positive pulse which controls the cutoff amplifier when the pulse repetition frequency is high. In addition, if all four sawtooth inputs to the cutoff amplifier fail to terminate the gates, the positive pulse determines the duration of the output gates. The positive output pulse from the automatic recovery circuit is initiated by a positive input trigger from either Radar Set AN/FPS-6A or the test trigger generator. The automatic recovery circuit is composed of limiter V509A, recovery gate multivibrator V507, sweep clamp V505A, sweep amplifier V508, sweep cathode follower V509B, peak detector V510, and calibration panel RECOVERY TIME potentiometer R104. The test trigger generator (part of the reference signal generator) produces positive triggers at a calibration rate of 260 cps. These triggers are used during servicing and calibration of the equipment. The test trigger generator circuit consists of a modified self-pulsing blocking oscillator (oscillator V652A) and calibration panel EXT TRIG-INT TRIG switch S102.

4–1464. CIRCUIT ANALYSIS OF GATE GENERATOR.

4–1465. POSITIVE AND NEGATIVE GATE GENERATOR CIRCUIT. A positive 5- to 50-volt system trigger is applied to the grid of limiter V501B in the positive and negative gate generator circuit (figure 7–143). This limiter is driven into saturation when the input trigger exceeds 5 volts, resulting in uniform negative triggers at the plate of limiter V501B. These triggers are then applied to the grid of tube V502B (part of the gate multivibrator).

4–1466. Bistable gate multivibrator V502 is composed of tubes V502B and V502A. In the first state, tube V502B is conducting at saturation and tube V502A is cut off. In the second state, tube V520B is cut off and tube V502A conducts at saturation. A negative trigger applied to the grid of tube V502B from the plate of limiter V501B initiates the second state. Multivibrator V502 remains in the second state until a negative trigger is applied to the grid of tube V502A from the gate cutoff amplifier circuit. With the multivibrator in the second state, positive and negative gates are produced at the plates of tubes V502B and V502A, respectively. The positive gate developed at the plate of tube V502B is applied to the range sweep generator, height sweep generator, video amplifier, and range mark generator through cathode follower V503B. The negative gate developed at the plate of tube V502A is applied to the time-share gate generator, height sweep generator, and video amplifier through cathode follower V503A. The duration of the generated gates is determined by the arrival time of the trigger applied to the grid of tube V502A from the gate cutoff amplifier circuit (paragraph 4–1467).

4–1467. GATE CUTOFF AMPLIFIER CIRCUIT. The sawtooth and trigger input signals are applied to the normally nonconducting amplifiers (amplifiers V504B, V506A, and V506B) of the gate cutoff amplifier circuit (figure 7–143). The common cathode voltage for amplifiers V504A, V504B, V506A, and V506B is maintained at zero because of the plate and grid currents of amplifier V504A. Since the control grids of amplifiers V504B, V506A, and V506B are maintained at negative levels, the three normally cutoff amplifiers conduct only when the applied sawtooth voltages to their respective grids overcome this bias. When the amplitude of the input signals, singly or in combination, is sufficient to cause conduction of one of these amplifiers, heavily conducting amplifier V504A is cut off. Conduction of any of the normally nonconducting amplifiers increases the current through common cathode resistor R520 The current increase through resistor R520 increases the cathode bias on amplifier V504A This increased bias cuts off the amplifier and increases the voltage at the plate. This voltage is then applied to the grid of amplifier V501A. The conduction of amplifier V501A increases sharply, resulting in a negative-going voltage at the plate of amplifier V501A. This drop in plate voltage is the negative trigger applied to the grid of tube V502A (part of the gate multivibrator). The negative trigger cuts off tube V502A, terminates the gates, and returns gate multivibrator V502 to the first condition of conduction (paragraph 4–1465).

4–1468. When the input triggers occur at a low pulse repetition frequency and RANGE control R61 is at maximum range (300 nautical miles), the positive sawtooth input from the range sweep generator assumes primary control of gate cutoff amplifier V504B (figure 4–217). The application of this sawtooth voltage to the grid of amplifier V504B gradually overcomes the static bias of this amplifier. When amplifier V504B conducts through resistor R520, the increased cathode bias on amplifier V504A cuts off amplifier V504A, producing a postitive pulse at the plate of amplifier V504A. The circuit operation then proceeds to completion as described in paragraph 4–1467.

4–1469 When RANGE control R61 is at minimum range (50 miles), the positive sawtooth input from the range sweep driver controls the duration of the gate generator. Selection of a low range applies the same amplitude signal to the grid of amplifier V506B as does selection of a longer range (figure 4–217). However, conduction of amplifier V506B occurs earlier at the 50-mile range than at the 300-mile range, because the amplitude that the amplifier reaches is earlier in time. When amplifier V506B starts conducting, the increased current flow through resistor R520 produces the same effect as for the range sweep generator input to amplifier V504B (paragraph 4–1468).

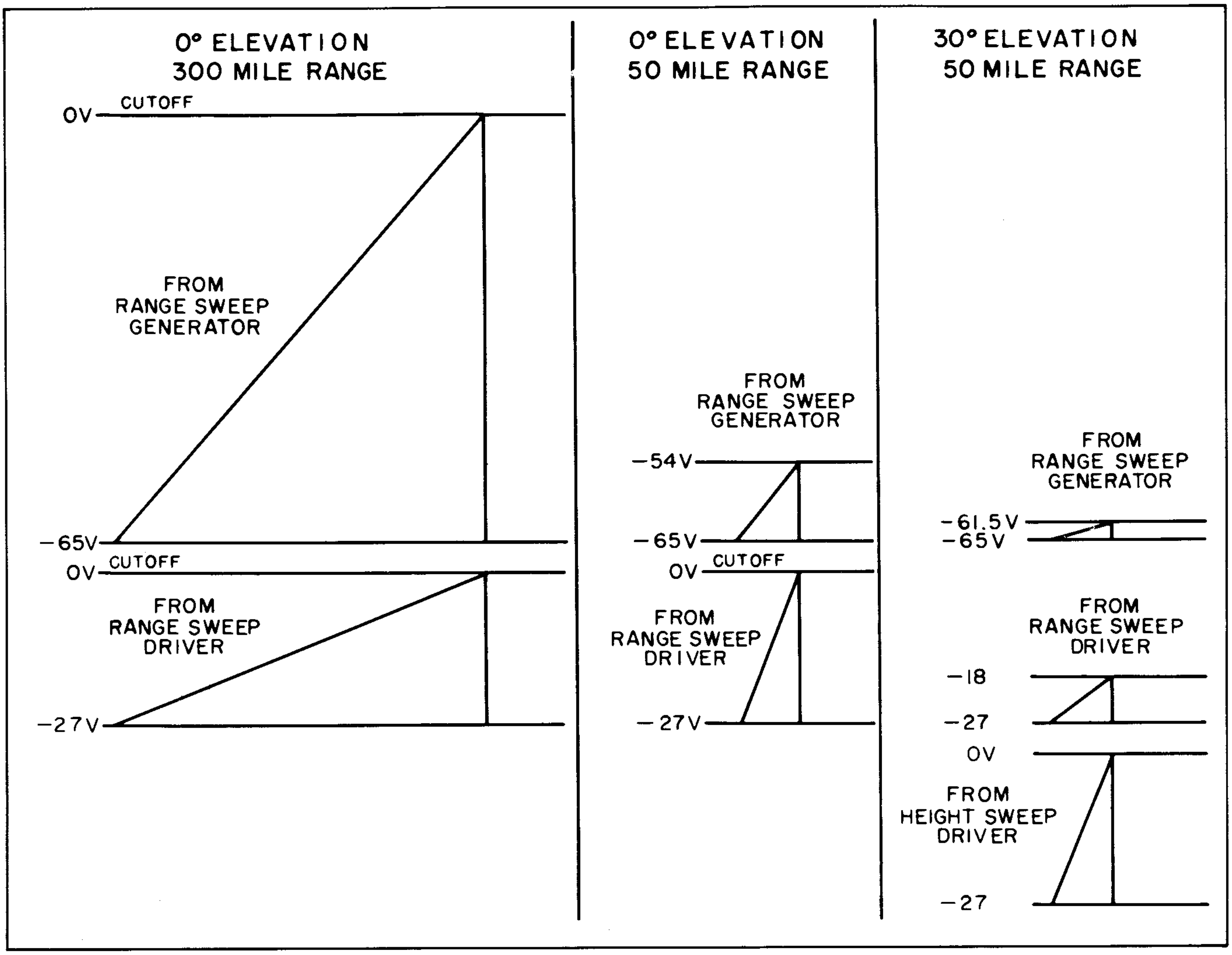


Figure 4–217. Gate Cutoff Amplifier, Timing Chart

4–1470. When the antenna of Radar Set AN/FPS-6A nods through a large elevation angle, the sawtooth input from the height sweep driver exerts primary control over the gate duration of the multivibrator. This sawtooth voltage is applied to the grid of amplifier V506A. When the amplitude of the sawtooth voltage overcomes the static bias and results in conduction of amplifier V506A, the increased current flow through resistor R520 biases amplifier V504A beyond cutoff. Consequently, a positive pulse is developed at the plate of amplifier V504A which is amplified and inverted through amplifier V501A and then applied to the grid of tube V502A as a negative trigger to terminate the gate and return the multivibrator to its first state.

4–1471. The method of cutoff described in paragraph 4–1470 is effective only during calibrate conditions when the height sweep has no earth curvature. When the antenna radiates below the horizon, the positive sawtooth from the negative height sweep generator circuit controls the gate duration of multivibrator V502. This sawtooth is applied to the grid of amplifier V504B through isolation diode V505B. When amplifier V504B conducts through resistor R520, the increased current flow through this resistor increases the cathode bias of amplifier V504A. The increased cathode bias cuts off amplifier V504A, producing a positive pulse at the plate of amplifier V504A. This positive pulse is subsequently amplified and inverted through amplifier V501A and then applied as a negative trigger to the grid of tube V502A, cutting off tube V502A.

4–1472. AUTOMATIC RECOVERY CIRCUIT. Any pulse repetition frequency greater than 270 pps does not permit sufficient time for a 300-mile range sweep. The automatic recovery circuit (figure 4–218) provides a trigger which terminates the positive and negative gates 125 microseconds before the next radar trigger is received.

4–1473. The positive trigger from Radar Set AN/FPS-6A is applied to the grid of limiter V509A. This limiter serves the same function as limiter V501B in the positive and negative gate generator circuit (paragraph 4–1465).

4–1474. The negative trigger from the plate of limiter V509A is applied through capacitor C507 to the grid of tube V507B (part of the recovery gate multivibrator). The recovery gate multivibrator is a one-shot multivibrator, with tube V507B conducting and tube V507A cut off. The negative trigger applied to the grid of tube V507B cuts off this section and permits tube V507A to start conducting. The gate duration of the recovery multivibrator is 560 microseconds. A positive square wave from the cathode of tube V507A is applied to the plate of sweep clamp V505A.

4–1475. When the recovery gate multivibrator is not producing a positive square wave output at the cathode of tube V507A, the recovery sweep generator produces positive sawtooth voltages. When tube V507A is cut off, its negative cathode voltage is applied to the plate of sweep clamp V505A, holding the clamp at cutoff. When clamp V505A is cut off, the grid voltage of sweep amplifier V508 begins to go negative because of the charging of sweep capacitor C509 through resistor R536. However, the grid voltage of amplifier V508 is inverted and amplified through amplifier V508 and the cathode follower-coupled back to the control grid. Thus, the grid potential of amplifier V508 remains constant during the charging period of capacitor C509. The positive sawtooth on the cathode of cathode follower V509B is applied to peak detector V510.

4–1476. When the input trigger cuts off tube V507B in the recovery gate multivibrator, sweep capacitor C509 discharges through sweep clamp V505A. Capacitor C509 fully discharges during the 560-microsecond gate duration of the recovery gate multivibrator. When the multivibrator returns to its static condition, capacitor C509 begins to recharge.

4–1477. The combination of tubes V510A and V510B acts as a peak detector because of the grid leak bias developed by resistor R543 and capacitor C510. Immediately following the application of power, the positive voltage on the grid of tube V510B causes heavy conduction of this tube, while the voltage developed across calibration panel RECOVERY TIME potentiometer R104 biases tube V510A slightly negative. The positive sawtooth input from the automatic recovery circuit results in greater conduction of tube V510B. As the input voltage continues to rise, the control grid of tube V501B draws current and charges capacitor C510. The charge on capacitor C510 increases as each successive sawtooth is applied to the grid of tube V510B. The negative side of capacitor C510 eventually drives tube V501B to cutoff, and tube V510A conducts. The discharge time for capacitor C510 is long in comparison with the 560-microsecond recovery gate, during which the capacitor has time to discharge. Thus, this charge is the d-c grid voltage of tube V510B on which the sawtooth voltages are impressed. A portion of each sawtooth overcomes the negative bias and causes tube V510B to conduct. The accumulation of charge by capacitor C510 and the consequent shifting of the grid voltage level of tube V510B cause this tube to begin conduction at a progressively later point as each sweep is applied. The stage finally reaches a static state where the charge on the capacitor is stable for a given pulse repetition frequency. Once stable operation of the circuit for a given pulse repetition frequency has been achieved, the sawtooth inputs overcome this static grid leak bias at the same point in time for each input, and tube V510B conducts. The plate voltage then drops sharply and is coupled to the grid of tube V510A, cutting off this tube while tube V510B conducts. With tube V510A cut off, the plate voltage on tube V510A rises sharply and is applied to the cutoff amplifier circuit. It is this rapid change in voltage that is used to return gate multivibrator V502 to its original state (paragraph 4–1466).

4–1478. The purpose of capacitor C510 is to vary the d-c grid voltage of tube V510B as the pulse repetition frequency varies. This is done to insure that a positive pulse is produced at the plate of tube V510A during the last 125 microseconds of each interval between successive trigger pulses, regardless of the pulse repetition frequency employed. A decrease or increase in pulse repetition frequency causes the charge across capacitor C510 to increase or decrease accordingly. The static cathode potential of tube V510, together with the slope of the linear rise of the sawtooth waveform developed by the recovery sweep generator, remains the same when the pulse repetition frequency is changed. However, the width of the sawtooth pulse is longer, and consequently greater in amplitude, for a slower pulse repetition frequency than for a higher frequency. When the pulse repetition frequency is decreased, the charge across capacitor C510 is increased sufficiently so that all of the amplitude of each sawtooth pulse, except for the last 125 microseconds, is required to overcome the negative bias of tube V510B. Similarly, when the pulse repetition frequency is increased, the charge of capacitor C510 is decreased sufficiently to enable only the amplitude of the last 125 microseconds of each sawtooth pulse to drive tube V510B into conduction.

4–1479. When the first trigger pulse is received a:ter the pulse repetition frequency is decreased, the charge across capacitor C510 is still at the level required for the higher frequency (figure 4–219). Thus, the amplitude of the first sawtooth of the new, lower pulse repetition frequency overcomes the negative bias of tube V510, leaving much more time than just 125 microseconds remaining. Tube V510B conducts for this longer period. During the conduction of tube V510B, its grid draws current and, because this tube then conducts for a longer interval, the charge across capacitor C510 is increased. The timing chart shown in figure 4–219 illustrates how the change in d-c grid potential corresponding to a change in pulse repetition frequency prevents tube V510B from conducting except during the last 125 microseconds of each sweep. The timing chart also shows that the proper grid level of tube V510B is obtained for the lower pulse repetition frequency after the first trigger pulse is received. Actually, this is not correct because several pulses are received

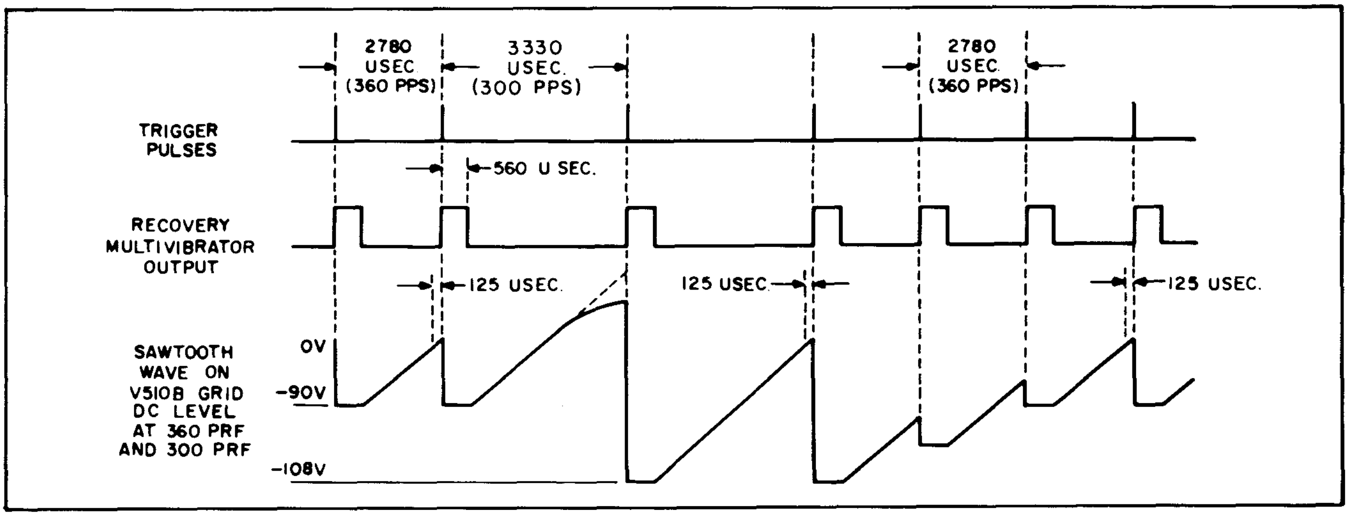


Figure 4–219. Automatic Recovery Circuit, Timing Chart

before the proper level is developed. (For simplicity of this discussion, only one trigger pulse of the lower pulse repetition frequency is shown.) The upper part of the sawtooth, which causes tube V510B to conduct for longer than 125 microseconds, is shown curved to illustrate the effect of grid current upon the waveform. In addition, the waveforms are not drawn to scale.

4–1480. Normally, any discharge of capacitor C510 during the 560-microsecond interval between sawtooth pulses is compensated for during the 125-microsecond conduction period of tube V510B at the end of each sawtooth. Assume that the pulse repetition frequency increases from 300 to 360 pps. When the first trigger pulse of the higher frequency is received, the d-c grid potential of tube V510B is at the lower frequency level. Before the first sawtooth of the new pulse repetition frequency has time to raise the d-c level above cutoff, the next trigger pulse is received, thus terminating the sawtooth. Any reduction in the charge across capacitor C510 during the preceding 560-microsecond interval cannot be compensated for and additional discharging occurs during the next interval between sawtooth pulses. As shown in figure 4–219, the discharge of capacitor C510 continues in this manner until a d-c level is reached which can be overcome by the sawtooth pulses, leaving 125 microseconds remaining during which tube V510B can conduct.

4–1481. The cathode bias for peak detector V510 is established by RECOVERY TIME potentiometer R104. The cathode bias on peak detector V510 is varied by the movable arm on potentiometer R104. Decreasing the resistance of potentiometer R104 reduces the cathode bias on peak detector V510. Thus, the time required for the sawtooth input to cause conduction of peak detector V510 is reduced, and the detector conducts sooner. When peak detector V510 conducts sooner, it initiates the positive output pulse earlier. Similarly, increasing the resistance of potentiometer R104 increases the time required for the sawtooth input to overcome the increased cathode bias on peak detector V510, which delays generation of the positive pulse.

4–1482. TEST TRIGGER GENERATOR CIRCUIT. The test trigger generator circuit (figure 7–145) is composed of a modified, self-pulsing blocking oscillator (oscillator V652A) and EXT TRIG-INT TRIG switch S102. When the equipment is initially energized, current flows through oscillator V652A. A part of the plate current flows through windings 1-5 and 6-2 of transformer T651, making terminals 5 and 2 negative. A voltage is also induced in winding 3-7 of transformer T651 that is 180 degrees out of phase with the voltage in the other two windings of the transformer. The voltage at the control grid of oscillator V652A is positive, and therefore a greater current flows through the oscillator. As the oscillator current increases, the control grid draws current and capacitor C651 charges with the grid side negative. When plate current saturation is reached, there is no longer any voltage induced in transformer T651. The negative charge of capacitor C651 is then applied to the control grid, and oscillator V652A cuts off. The discharge time of capacitor C651 through resistor R657 controls the repetition rate of the oscillator by determining the time that it takes to return the oscillator to a conducting state. Since the output is taken from the cathode, positive triggers are applied to EXT TRIG-INT TRIG switch S102. When this switch is in the INT TRIG position, the test triggers are applied as the input to the gate generator.

4–1483. BLOCK DIAGRAM OF TIME-SHARE GATE GENERATOR. (See figure 4–220.)

4–1484. The time-share gate generator receives a negative gate from the gate generator and produces positive and negative time-share gates (250 microseconds). These gates are applied to the range and height sweep drivers. A cursor intensity gate and a video blanking gate (375 microseconds) are also produced and simultaneously applied to the video amplifier. The video blanking gate at the video amplifier prevents the display of video

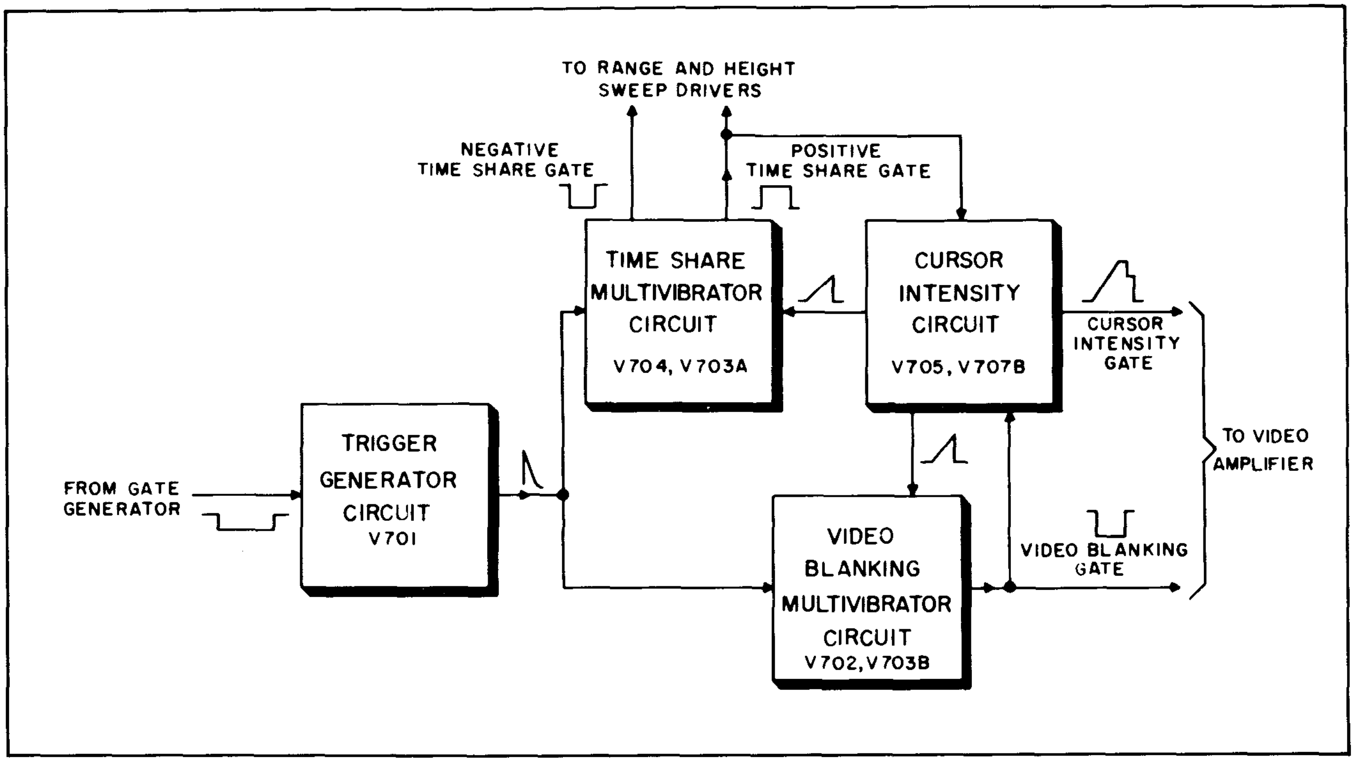


Figure 4–220. Time-share Gate Generator, Block Diagram

information, while the cursor intensity gate permits the cursor marker to be displayed.

4–1485. The trigger generator circuit is composed of blocking oscillator V701A, amplifier V701B, a differentiating network comprising capacitor C702 and resistor R703, and TIME SHARE FREQ control R101. The differentiated negative gate input to the trigger generator circuit results in the generation of a positive trigger pulse. This pulse simultaneously triggers the time-share and video blanking multivibrator circuits. The trigger generator also reduces the pulse repetition frequency of the output trigger to 20 pps.

4–1486. The time-share multivibrator circuit is composed of bistable multivibrator V704 and cutoff amplifier V703A. The generation of positive and negative time-share gates is initiated when a positive trigger is applied from the trigger generator. The positive sawtooth signal from the cursor intensity gate terminates the positive and negative gates, thus establishing the gate duration at 250 microseconds.

4–1487. The video blanking multivibrator circuit consists of bistable multivibrator V702 and cutoff amplifier V703B. This circuit is initiated by the same positive trigger used to trigger the time-share multivibrator circuit. The leading edge of the video blanking gate is applied to the video amplifier to begin video blanking. Simultaneously, the leading edge is applied to the cursor intensity circuit to start the generation of the cursor intensity gate and the positive sawtooth feedback signal. The positive sawtooth voltage from the cursor intensity gate terminates the video blanking gate 375 microseconds after initiation.

4–1488. The cursor intensity gate circuit is composed of gating tube V705B, sweep cathode follower V705A, and sweep capacitor C708. The video blanking gate applied to the cursor intensity circuit causes the generation of the cursor intensity gate. After 250 microseconds, the negative-going trailing edge of the positive time-share gate produces the negative step in the cursor intensity gate. The positive sawtooth generated and applied to the time-share multivibrator circuit is of larger amplitude than the sawtooth signal sent to the video blanking multivibrator circuit. Consequently, the video blanking gate is terminated 125 microseconds after the positive and negative time-share gates. As a result, the video blanking gate is of 375-microsecond duration, while the two time-share gates are of 250-microsecond duration.

4–1489. CIRCUIT ANALYSIS OF TIME-SHARE GATE GENERATOR.

4–1490. TRIGGER GENERATOR CIRCUIT. A negative gate from the gate generator is applied to a differentiating network composed of capacitor C702 and resistor R703 in the trigger generator circuit (figure 4–221). The differentiated waveform is applied to the control grid of trigger amplifier V701B. Amplifier V701B is biased close to cutoff and then driven into cutoff by a negative, differentiated trigger. When the positive trigger is applied to the control grid of amplifier V701B, a positive voltage from transformer T701 is present at the control grid of blocking oscillator V701A. This oscillator is thus triggered, and a positive pulse from the cathode of blocking oscillator V701A is simultaneously applied to the time-share and video blanking multivibrator circuits. When trigger amplifier V701B is cut off by the negative, differentiated pulse, a small voltage change is produced in winding 5 and 1 of transformer T701. In addition, a voltage of opposite polarity is induced in winding 2-6, permitting conduction of rectifiers CR706 and CR707. The induced voltage in winding 2-6 is thus damped by rectifier CR706 and CR707.

4–1491. During the time that the blocking oscillator is conducting, capacitor C704 is negatively charged on the grid side because of the current drawn by the control grid. The resulting RC charging curve counts down the input pulse repetition frequency of 360 pps to 20 pps at the output of blocking oscillator V701A. This action is accomplished by applying a series of input triggers on the RC charging curve of capacitor C704 and resistor R705, thus triggering blocking oscillator V701A. The voltage to which capacitor C704 discharges, and therefore the discharge rate, is controlled by TIME SHARE FREQ control R101. Raising this potential in a positive direction at the arm of control R101 permits capacitor C704 to discharge more rapidly, resulting in an increase of output pulse repetition frequency. Control R101 is adjusted to produce a time-share gate of 20 cps, and therefore must be readjusted to compensate for changes in components due to aging.

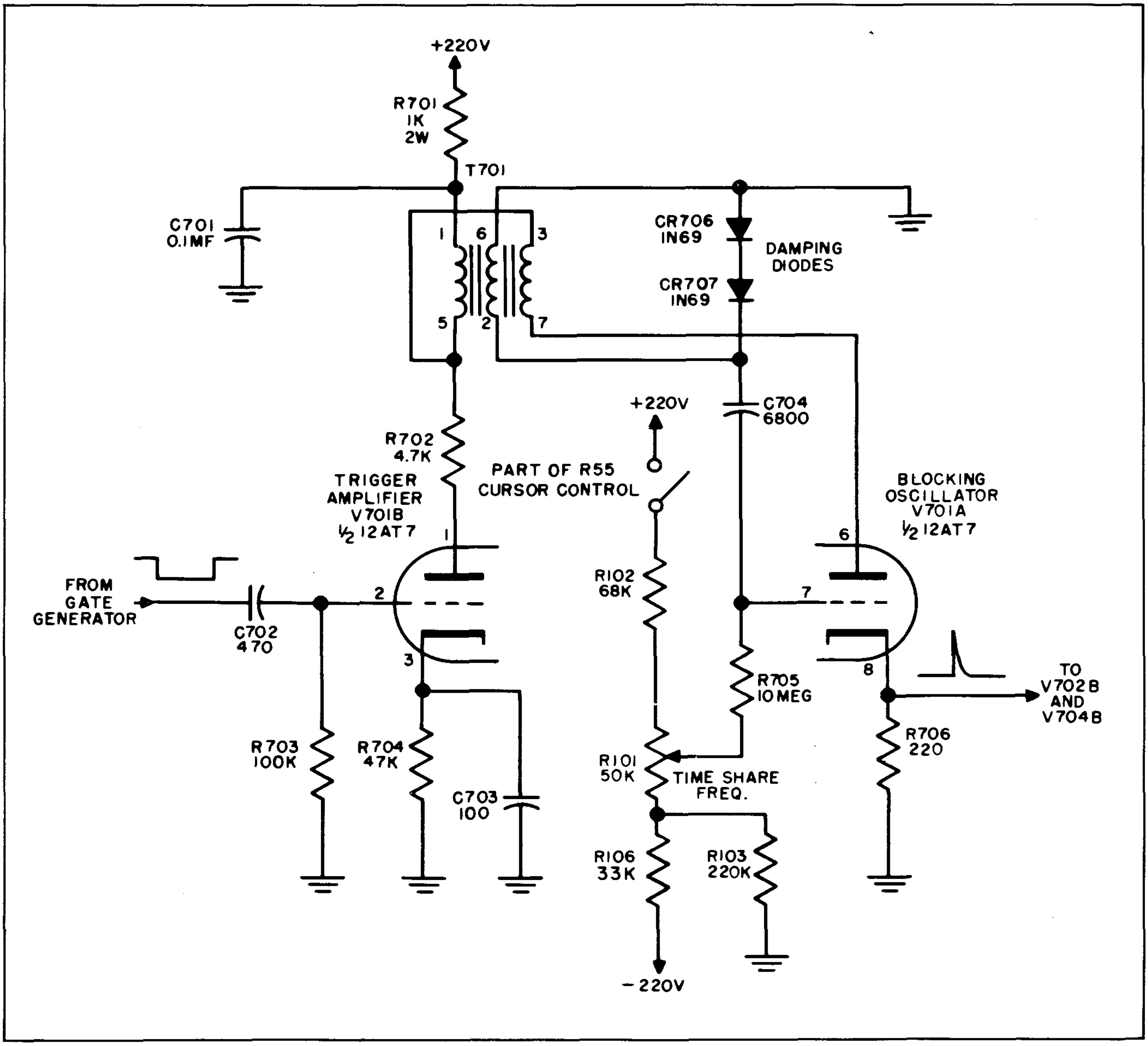


Figure 4–221. Time-share Trigger Generator, Simplified Schematic Diagram

4–1492. TIME-SHARE AND VIDEO BLANKING MULTIVIBRATOR CIRCUITS. Video blanking multivibrator V702 (figure 7–146) is also actuated by a negative trigger from the cathode of blocking oscillator V701. The trigger is applied to the cathode of multivibrator V702, which is the normally conducting section of the multivibrator. The return of the multivibrator to a steady state condition is controlled by the output of cutoff amplifier V703. A sawtooth voltage is applied to the control grid of amplifier V703 from the cursor intensity circuits (paragraph 4–1495). The relationship between the bias on amplifier V703 and the input sawtooth produces a negative-going signal at the plate of amplifier V703 at an interval of 375 microseconds after the video blanking multivibrator is triggered. The 375-microsecond negative gate to the cursor and video intensity circuits is developed at the cathode of multivibrator V702.

4–1493. A positive trigger from the cathode of blocking oscillator V701A is applied to the cathode of multivibrator V704B, the normally conducting section of the time-share multivibrator. This trigger causes tube V704B to cut off and permits tube V704A to conduct. The time-share multivibrator remains in this state until a negative-going voltage from the plate of amplifier V703A is applied to the control grid of time-share multivibrator V704A. Cutoff amplifier V703A is biased well into cutoff, so that a voltage sawtooth applied to the control grid from the video intensity circuit produces a negative-going signal at the plate 250 microseconds after the time-share multivibrator is triggered. Thus, the duration of the time-share gates is also 250 microseconds. The positive and negative time-share gates are developed at the cathodes of tubes V704A and V704B, respectively. Both gates are applied to the range and height sweep driver circuits. In addition, a positive time-share gate is applied to the video intensity circuit.

4–1494. CURSOR INTENSITY CIRCUIT. The negative 375-microsecond gate from the cathode of multivibrator V702 is applied to the control grid of gating tube V705B (figure 7–146). The negative gate drives gating tube V705B to cutoff and sweep capacitor C708 begins to charge toward +220 volts. The sawtooth voltage rise on the control grid of sweep cathode follower V705A is coupled from the cathode of cathode follower V705A through bootstrap capacitor C707 to the junction of resistors R719 and R720. The positive rise is applied to sweep capacitor C708 through resistor R720. The regenerative feedback to the positive side of the sweep capacitor raises the voltage to which capacitor C708 charges and produces a more linear voltage rise which is applied to the control grid sweep cathode follower V705A.

4–1495. The voltage sawtooth developed at the cathode of cathode follower V705A is used to cut off both the time-share and video blanking multivibrators. The signal applied to the time-share multivibrator is the entire cathode voltage. The sawtooth applied to the video blanking multivibrator is approximately two-thirds of the cathode voltage. The ratio of voltage applied to the time-share multivibrator, as compared to the video blanking multivibrator, is 1:1-1/2. Since the cutoff amplifiers for both multivibrators operate at the same bias, the time-share gate is ended earlier than the video blanking gate. The duration of the time-share gate is 250 microseconds, while the duration of the video blanking gate is 375 microseconds or 1-1/2 times as long as the time-share gate.

4–1496. Any change in the cathode voltage of cathode follower V705A at the junction of resistors R721 and R722 and the cathode of clamp V707B is coupled to output jack J704. Thus, the rising sawtooth on the cathode of cathode follower V705A is applied to jack J704. However, rectifier CR702 clamps the upper limit of the applied signal at ground, and rectifier CR701 mixes the end of the time-share gate with the resulting limited sawtooth.

4–1497. As the voltage sawtooth at the cathode of clamp V707B rises from a negative potential (approximately −40 volts), the signal is immediately felt at output jack J704. The sawtooth at output jack J704 reaches 0 volt approximately 125 microseconds after the start of the sweep. Rectifier CR702 then begins to conduct, thereby limiting the output voltage to 0 volt. The 0-volt level is maintained until the end of the time-share gate. Clamp V707B isolates this limiting level from the cathode of cathode follower V705A, since the plate potential is negative with respect to the voltage at the cathode. The end of the time-share gate occurs 125 microseconds after the limiting action of rectifier CR702. The trailing edge of the positive time-share gate from the cathode of tube V704A, which drops to approximately −10 volts, is coupled through rectifier CR701 to jack J704. Rectifier CR701 then conducts, clamping the voltage at jack J704 to the potential at the cathode of tube V704A. Rectifier CR702 is cut off because the plate voltage is more negative than the cathode voltage. The effect of applying the end of the positive time-share gate to jack J704 is the production of a negative step in the output waveform. When the negative step is accomplished, this level is maintained until the end of the sweep.

4–1498. At the end of the video blanking gate, gating tube V705B conducts and rapidly discharges sweep capacitor C708. The sharp trailing edge of the sawtooth is coupled to output jack J704 through clamp V707B. The entire time duration of the cursor intensity gate is 375 microseconds, or the length of the video blanking gate.

4–1499. BLOCK DIAGRAM OF RANGE SWEEP GENERATOR. (See figure 4–222.)

4–1500. The range sweep generator receives a positive gate from the gate generator and produces a positive sawtooth output. This output is applied to the range sweep driver for sweep generation, to the gate generator to initiate sweep termination, and to the earth curvature circuit for height correction.

4–1501. The sawtooth generator circuit composed of cathode follower V801A, gate inverter V802A, range sweep clamp V803A, parallel-connected sweep capacitors C802, C803, and C814, and charging resistor R810. This circuit generates a negative sawtooth voltage when a positive gate is applied and transfers the sawtooth output to the linearity amplifier. The duration of the negative sawtooth sweep signal is established by the duration of the applied positive gate. A positive sawtooth feedback from the linearity amplifier is employed within the sawtooth generator to produce a linear sweep voltage by maintaining a constant charging rate on the sweep capacitor. A clamp correction signal from the sweep discharge clamp circuit insures that each sawtooth generated begins at the same d-c level.

4–1502. The linearity amplifier circuit is a high-gain amplifier composed of amplifier-comparator V804, amplifier V805, and cathode follower V807B. The negative sawtooth from the sawtooth generator is applied to the linearity amplifier. The negative sawtooth voltage is amplified and inverted; then the positive sawtooth output is applied to the range sweep driver, the gate generator, and to the earth curvature circuit. The positive sawtooth output is also returned as feedback to the sawtooth generator during sweep generation. The linearity amplifier is therefore capable of compensating for any component or signal variation occurring at the output of the sawtooth generator.

4–1503. The sweep discharge clamp circuit consists of cathode follower V810B, amplifiers V802B and V807A, amplifier-comparator V806, and rectifier CR801. The sweep discharge clamp does not produce an output during the generation of a sweep. However, when the sweep capacitors discharge, a clamp correction signal is generated and supplied to the sawtooth generator to maintain the sweep output voltage at a constant level. Each sawtooth sweep is thus initiated at a specific d-c level.

4–1504. CIRCUIT ANALYSIS OF RANGE SWEEP GENERATOR.

4–1505. SAWTOOTH GENERATOR AND LINEARITY AMPLIFIER CIRCUITS. A positive square wave from the gate generator is applied to the control grid of gate inverter V802A, which is normally cut off (figure 7–148). Inverter V802A conducts for the duration of the input signal. The negative gate developed at the plate of inverter V802A is applied through cathode follower V801A to the plate of range sweep clamp V803A. When the negative gate is applied to the plate of clamp V803A, this tube is cut off and sweep capacitors C802, C803, and C814 begin to charge through resistor R810 and generate a sweep. As the capacitors begin to charge, a negative sawtooth is generated at the control grid of amplifier-comparator V804A.

4–1506. The control grid of amplifier-comparator V804A is maintained at a constant 0 d-c potential with no signal input, and a sample of the steady state voltage is applied to the automatic zero corrector. If the voltage at the control grid of amplifier-comparator V804A is not 0 volt, an input to the control grid of tube V804B is supplied by the automatic zero corrector. This input is cathode-coupled to amplifier-comparator V804A and the control grid voltage of amplifier-comparator V804A returns to 0 volt. Refer to paragraph 4–1652 for a detailed discussion of the automatic zero corrector.

4–1507. The combination of tubes V804A, V805A, and V805B produces a high-gain, direct-coupled amplifier which produces a positive output with a negative signal input. Cathode follower V807B isolates the amplifier output from the input circuit and developes the output signal. The negative sawtooth applied to the control grid of tube V804A is amplified and inverted by tube V804A, V805A, and V805B. The positive sawtooth applied to the control grid of cathode follower V807B is taken from the cathode and applied to the range sweep driver, the gate generator, and to the earth curvature circuit.

4–1508. In addition, the positive sawtooth output of cathode follower V807B is coupled back to sweep capacitors C802, C803, and C814. This positive feedback voltage is of opposite polarity to the negative voltage generated by capacitors C802 and C803 and resistor R810. Thus, the resulting voltage change at the control grid of amplifier-comparator V804A is minute, or approximately equal to the output voltage divided by the gain of the amplifier. The small change in voltage at the grid of amplifier-comparator V804A permits a constant current flow through resistor R810. The constant current through resistor R810 results in a highly linear sawtooth applied to the grid of amplifier-comparator V804A as well as a highly linear output at the cathode of cathode follower V807B.

4–1509. SWEEP DISCHARGE CLAMP CIRCUIT. The sweep discharge clamp circuit maintains a 0-volt d-c level at the cathode of cathode follower V807B when a sweep voltage is not being generated. The control grid of amplifier-comparator V806A is maintained at a constant 0 d-c potential, with no signal input, by the automatic zero corrector (paragraph 4–1652). Amplifier-comparator V806 does not invert an applied signal because this tube is coupled from the control grid of tube V806A to the common cathode and to the plate of tube V806B. The cathode of amplifier-comparator V806 is prevented from going below ground potential by rectifier CR801. Amplifier V807A and cathode follower V801B complete the negative feedback loop to the control grid of amplifier-comparator V806A through clamp V803B.

4–1510. When the sweep is generated, a positive sawtooth is applied to the plate of clamp V803B and the control grid of amplifier-comparator V806A. The signal is amplified by tube V806A, further amplified and inverted by tube V807B, and developed as a negative sig-

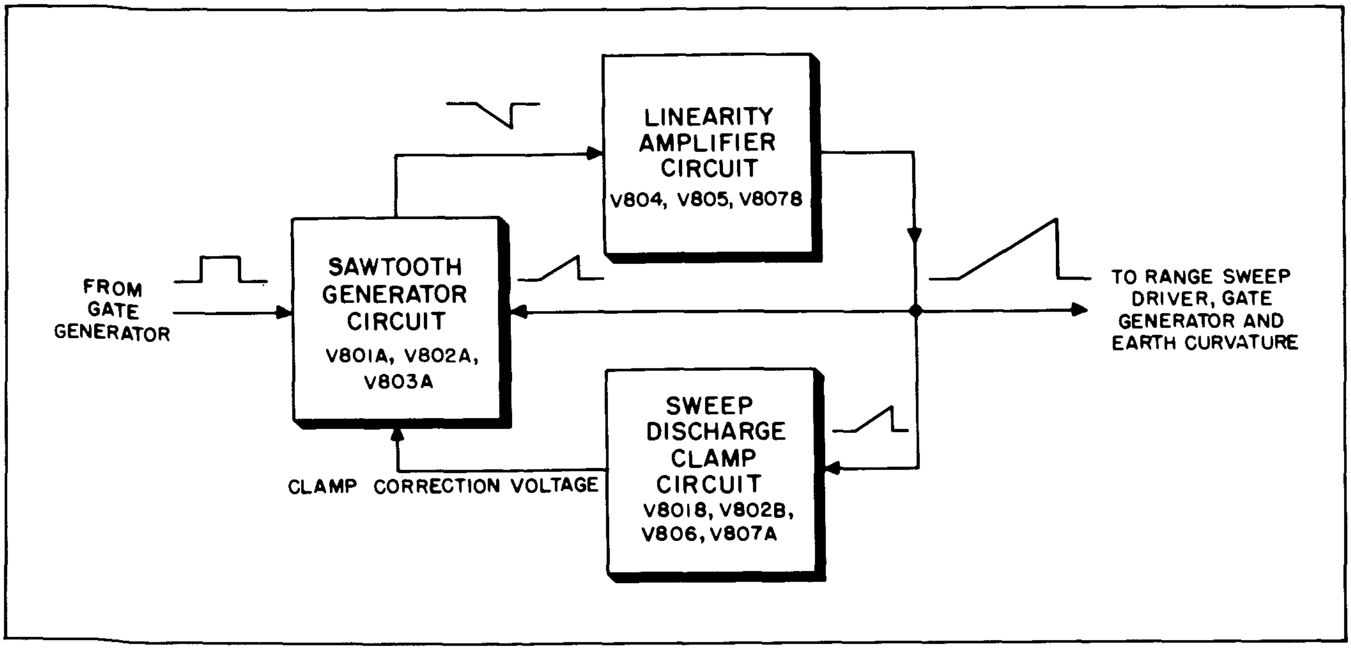


Figure 4–222. Range Sweep Generator, Block Diagram

nal at the cathode of cathode follower V801B. The negative signal produced by the amplifier at the cathode of clamp V803B, and the positive signal on the plate of clamp V803B, cause the clamp to conduct and produce a complete cancellation of both signals at the control grid of amplifier-comparator V806A. However, when the sweep capacitors are discharged, the gating voltage causes the capacitors to accumulate a charge in the reverse direction.

4–1511. When the positive gate is removed from the grid of gate inverter V802A, the voltage applied to the plate of discharge diode V803A becomes positive. After sweep capacitors C802 and C803 are completely discharged, the capacitors begin to change to the positive level at the plate of diode V803A. As a result, a negative level is produced at the cathode of cathode follower V807B. This negative signal is applied to the control grid of amplifier-comparator V806A and to the plate of clamp V803B, resulting in a positive output at the cathode of cathode follower V801B. The combination of the negative voltage applied to the plate of clamp V803B and the positive voltage applied to the cathode of the clamp cuts off clamp V803B and breaks the feedback loop. The positive signal at the cathode of cathode follower V801B is then applied to amplifier V802B, which amplifies and inverts the applied positive signal. The negative signal from the plate of amplifier V802B is applied through cathode follower V801A to the plate of diode V803A. This signal modifies the plate voltage of diode V803A and returns the cathode of cathode follower V807B to 0 volt. When the sweep capacitors return to a steady state condition of no charge, no further signal is developed at the control grid of amplifier-comparator V806A.

4–1512. BLOCK DIAGRAM OF RANGE SWEEP DRIVER. (See figure 4–223.)

4–1513. When the range sweep driver receives a positive sawtooth voltage input, two sawtooth sweep currents of opposite polarity are produced. The negative sawtooth sweep current is applied to the left deflection coil, while the positive sawtooth sweep current is simultaneously applied to the right deflection coil for range sweep display. When the time-share gates are present, the range cursor inputs position the cursor marker in range.

4–1514. The input circuit is composed of diode clamps V301, V302, and V309A, origin balance adjust control R341, frequency compensation adjust control C301, RANGE ZERO control R108, and the range section of control stick R73A. This circuit couples the positive range sweep sawtooth voltage from the range sweep generator to the left deflection circuit. When the time-share gates are present, the cursor range position inputs are coupled to the left deflection circuit.

4–1515. The left deflection circuit consists of amplifier-comparator V303, sweep voltage amplifier V304, sweep driver V305, RANGE control R61, and HORZ ORIGIN control R112. The positive sawtooth range sweep voltage applied to the left deflection circuit initiates the generation of a decreasing sawtooth current through the left deflection coil. The feedback from RANGE control R61 adjusts the sawtooth deflection current to correspond to the selected range. A negative sawtooth voltage is applied to the video amplifier for intensity compensation. When time-share gates are generated, the cursor inputs to the left deflection circuit position and modulate the cursor marker at the desired range.

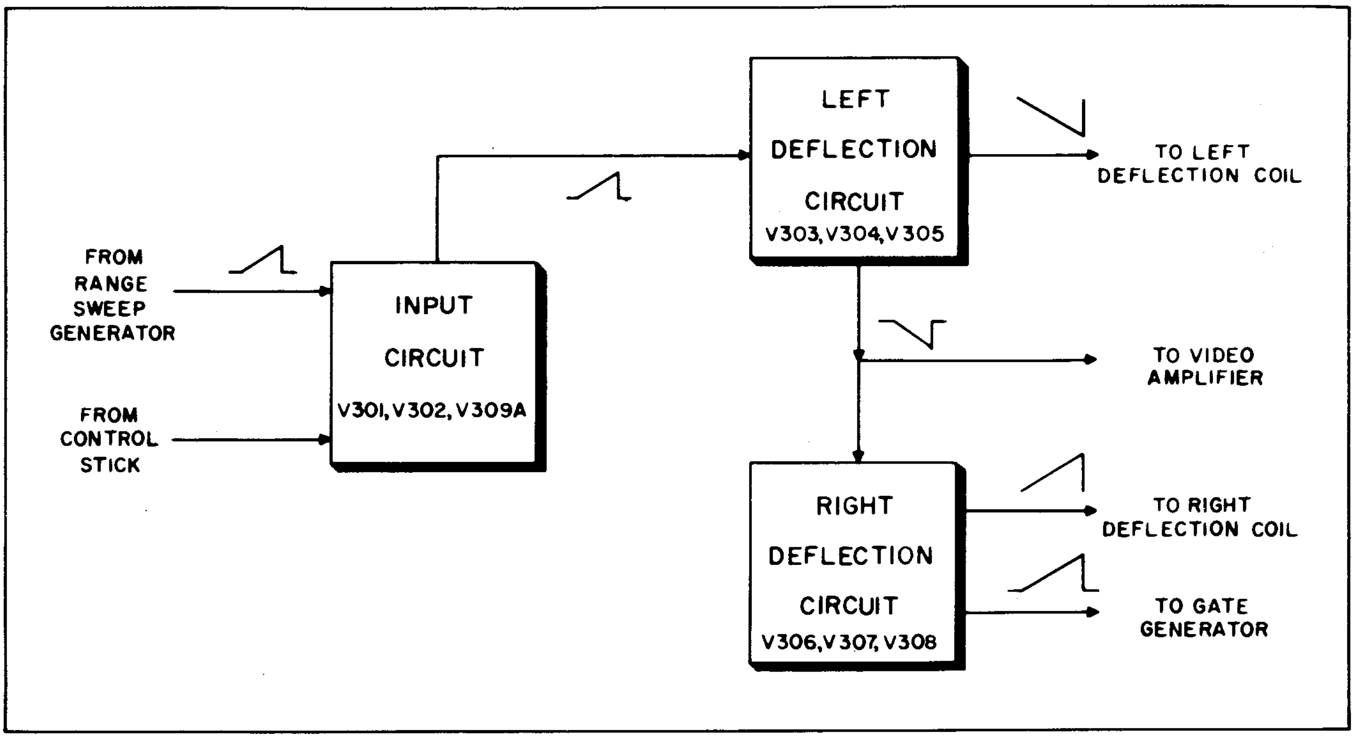


Figure 4–223. Range Sweep Driver, Block Diagram

4–1516. The right deflection circuit is composed of sweep amplifier V306 and V307, sweep driver V308, and HORZ SWP SPEED control R114. A negative sawtooth voltage from the left deflection circuit initiates the generation of an increasing sawtooth current through the right deflection coil to produce the movement of the electron beam. A positive sawtooth voltage is then developed and sent to the gate generator. This sawtooth voltage is applied to the gate generator to control the duration of the positive and negative gates.

4–1517. CIRCUIT ANALYSIS OF RANGE SWEEP DRIVER.

4–1518. INPUT CIRCUIT. A positive sawtooth from the output of the range sweep generator (figure 4–224) is applied to the plate of diode clamp V302A across resistor R301 and capacitor C301. Diode V302A conducts to the sawtooth voltage applied to the plate of the diode and the cathode voltage rises to this value. The signal applied to the left circuit is developed at the grid of amplifier-comparator V303A. Gating diode V301A is cut off during the sweep, since the upper level of the negative time-share gate is always greater than the applied voltage to the plate. Gating diode V301B normally conducts when the sweep is applied because the lower level at the positive time-share gate is negative. This negative d-c potential is present at the plate of diode V301B and holds diode clamp V302B at cutoff. Driving diode clamp V302B to cutoff prevents application of the cursor range, cursor modulator, and range zero inputs to the left deflection circuit during range sweep generation.

4–1519. When the time-share gates are applied to the input circuit of the range sweep driver, the cursor information is coupled to the left deflection amplifier and the sweep voltage is blocked. A negative time share from the time-share gate generator is applied to the cathode of gating diode V301A. Diode V301A then conducts and places a negative voltage level from its cathode to the plate of diode V302A. The negative voltage on the plate of diode V302A drives the diode to cutoff and prevents any range sweep information from affecting the input circuit. A positive time-share gate is applied to the cathode of diode V301B and cuts off this tube. Diode V302B conducts to the combination of the inputs from the cursor modulator, control stick range resistor R73A, and RANGE ZERO potentiometer R108. The signal is developed at the grid of amplifier-comparator V303A.

4–1520. Diode V309A functions only when the cursor range setting exceeds the setting of RANGE control R61. Under these conditions, the feedback voltage developed by the left deflection amplifier is insufficient to hold the input voltage to the amplifier at zero, thus activating the automatic zero corrector circuit. Diode V309A prevents the voltage to the deflection amplifier from exceeding 1 volt, which is a safe level.

4–1521. To maintain the sweep origin at the same fixed position on the CRT for both minimum and maximum settings of RANGE control R61, the cathode potential of sweep driver V305 must be held at a constant voltage of zero. The voltage is maintained by means of origin balance adjust control R341. A po-

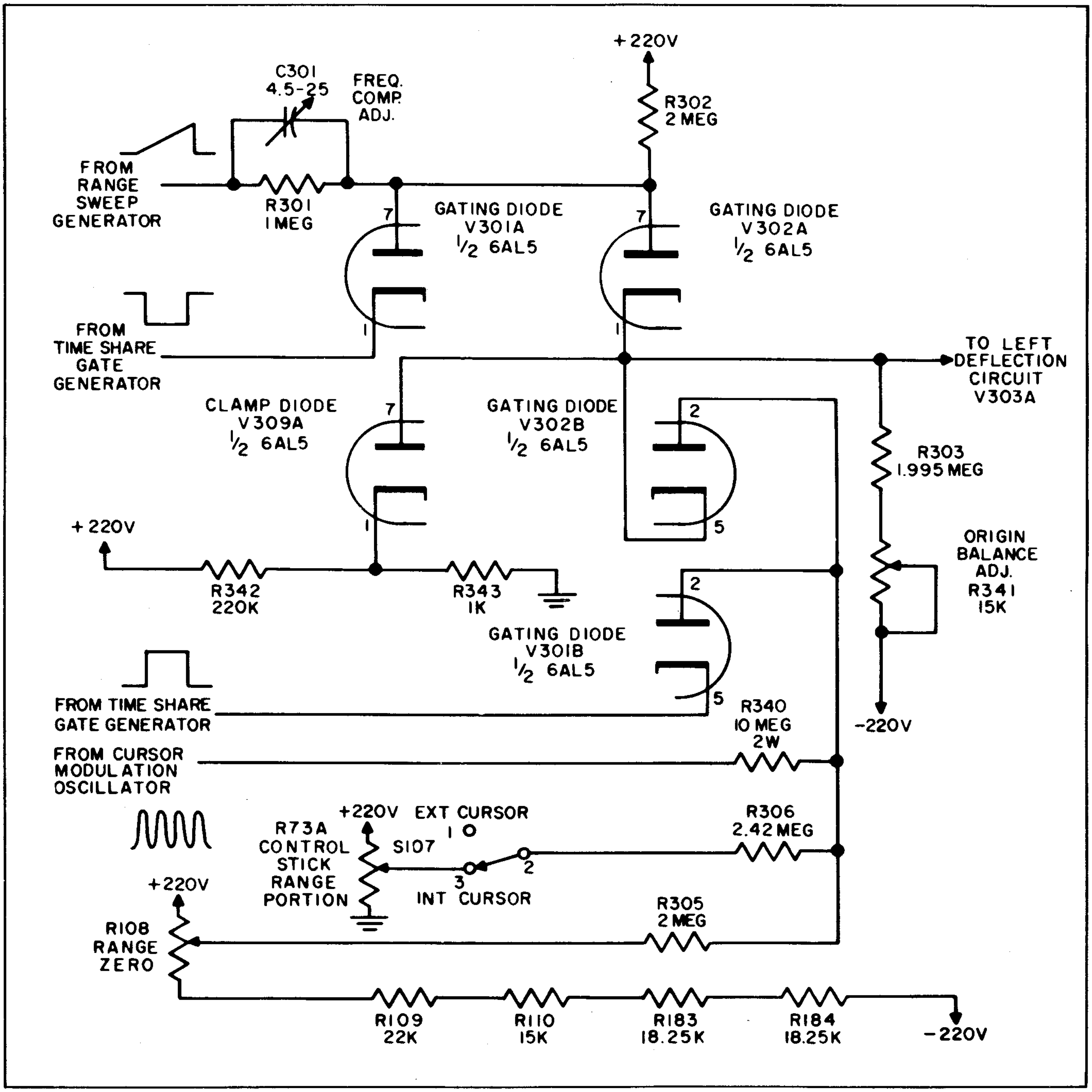


Figure 4–224. Range Sweep Driver Input Circuit, Simplified Schematic Diagram

tential of other than 0 volt normally results at the cathode of sweep driver V305 from RANGE control R61 and associated voltage divider resistors R117 through R119, and R62. As a result origin balance adjust control R341 is adjusted to create a compensating potential to override this unbalanced cathode potential.

The cathode of sweep driver V305 is thus maintained at 0 volt, permitting the sweep origin to occur repeatedly at the same point on the CRT.

4–1522. LEFT DEFLECTION CIRCUIT. A positive range sweep or cursor voltage is applied to the control grid of amplifier-comparator V303A (figure 4–225). The control grid of amplifier-comparator V303A is maintained at a constant 0-volt d-c potential, with no signal input, by the automatic zero corrector (paragraph 4–1652). Amplifier-comparator V303 amplifies, but does not invert, the applied signal. The positive signal at the plate of tube V303B is coupled to the control grid of sweep voltage amplifier V304. The negative signal from

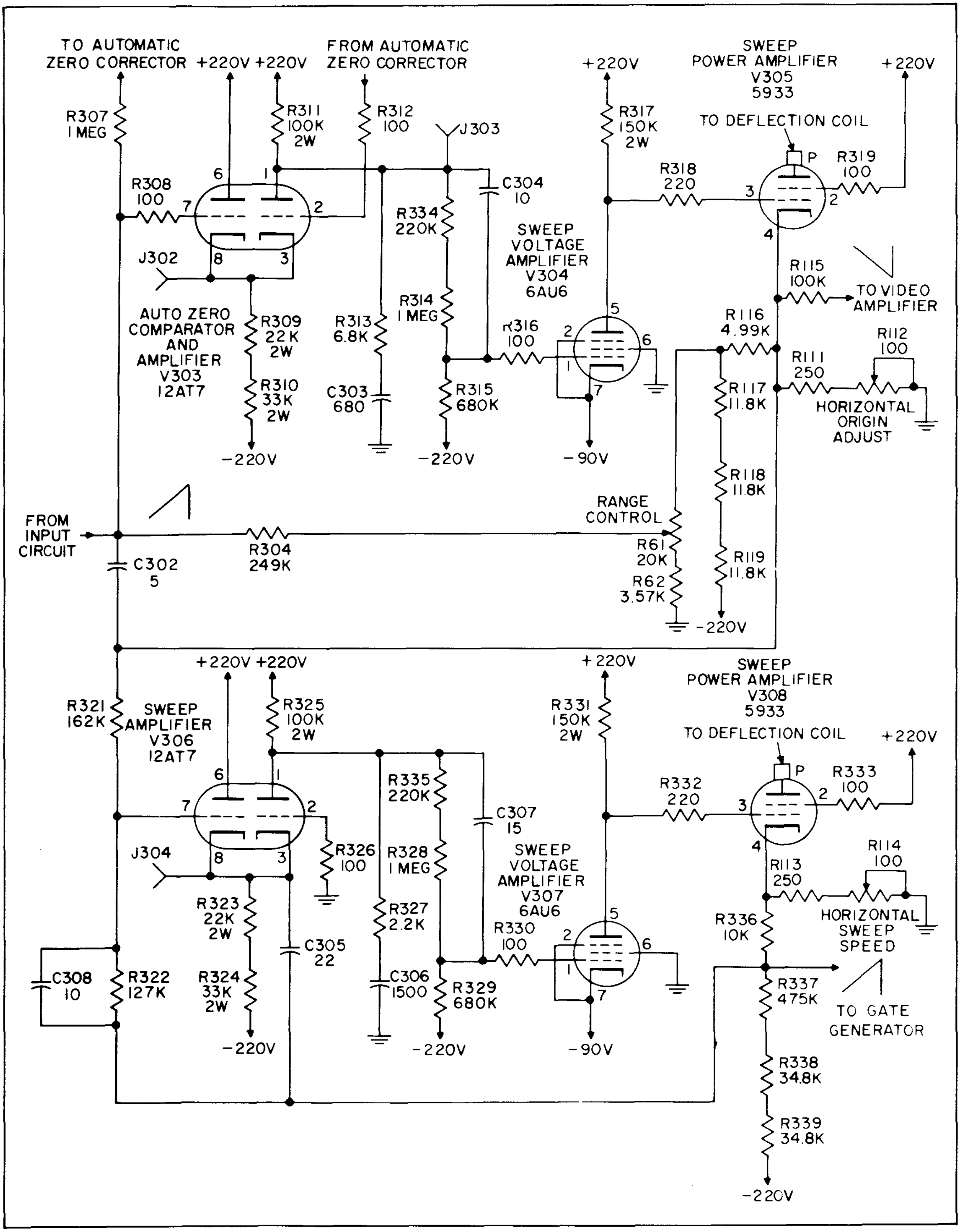


Figure 4–225. Left and Right Deflection Circuits, Simplified Schematic Diagram

the plate of amplifier V304 is applied to the control grid of sweep driver V305. This negative signal reduces current flow through sweep driver V305 and the left deflection coil of the CRT. The negative sawtooth current through the deflection coil starts the electron beam moving toward the right. HORZ ORIGIN potentiometer R112 control the static current through sweep driver V305, which in turn determines the starting position of the sweep on the face of the CRT.

4–1523. Two negative sawtooth voltage outputs proceed from the cathode of sweep driver V305. One output is applied as an input signal to the right deflection circuit, while the other is transferred to the intensity compensation circuit in the video amplifier (paragraph 4–1618).

4–1524. Two feedback circuits are employed within the left deflection circuit as linearity and amplitude controls. An a-c feedback is provided from sweep driver V305 to the control grid of amplifier-comparator V303 by means of capacitor C302. This feedback compensates for amplifier phase shift and prevents circuit oscillation. The d-c feedback is adjusted by front panel RANGE control R61.

4–1525. When control R61 is set to the maximum range of 300 miles, the arm is positioned at the top of the potentiometer and a maximum feedback signal is developed at this arm. Under these conditions, the amplifier closed loop gain is a minimum and the voltage developed at the cathode of sweep driver V305 is also a minimum for any specific input voltage. When control R61 is set to its minimum range of 50 miles, the closed loop gain is higher by a factor of 6:1, causing the output voltage to exceed that developed under minimum gain conditions by a factor of 6:1.

4–1526. Resistors R116 through R119, together with resistors R161 and R162, form a voltage divider which provides a static d-c feedback voltage of 0 volt to the amplifier input. When the sweep is applied to the range sweep driver, the d-c feedback voltage at the grid of amplifier-comparator V303 cancels the applied signal to the extent that only a small voltage change is applied to the grid of tube V303. This minute voltage change at the grid of tube V303 produces a linear current change through the deflection coil. When the 300-mile range is selected, the time required to develop a voltage of sufficient amplitude to drive the electron beam across the face of the CRT is 3708 microseconds. However, when the 50-mile range is selected, the feedback to amplifier-comparator V303 is relatively small and the voltage for complete deflection of the electron beam is reached in 18 microseconds.

4–1527. RIGHT DEFLECTION CIRCUIT. A negative sawtooth from the cathode of sweep driver V305 in the left deflection circuit is applied to the control grid of sweep amplifier V306A (figure 4–225). The negative output signal is developed at the plate of sweep amplifier V306. The signal is then amplified and inverted by sweep amplifier V307 and applied as a positive sawtooth to the control grid of sweep driver V308. This positive signal causes an increase in current through the right deflection coil of the CRT and moves the electron beam to the right. HORZ SWP SPEED potentiometer R114 controls the current through sweep driver V308, which in turn determines the velocity of the electron beam from left to right.

4–1528. The positive sawtooth developed at the cathode of sweep driver V308 is applied to the gate generator and fed back to both the common cathode of sweep amplifier V306 and to the control grid of sweep amplifier V306. The signal to the gate generator controls the period of the gate multivibrator when a low range is selected. The degenerative feedback to the input circuit corrects for any distortion introduced into the input signal by component variations within the right deflection circuit.

4–1529. BLOCK DIAGRAM OF HEIGHT SWEEP GENERATOR.

4–1530. The height sweep generator is similar to the range sweep generator (figure 4–222). In addition to the negative gate input, the height sweep generator receives from the elevation data generator a d-c voltage proportional to the sine of the antenna angle of elevation, an earth curvature correction voltage, and a positive gate. The height sweep generator differs from the range sweep generator in that the output signals are either positive or negative, as determined by the position of the antenna of Radar Set AN/FPS-6A. When the antenna is radiating below the horizon, a positive sweep is produced and the waveforms are similar to those shown in figure 4–222. However, when the antenna is radiating above the horizon, the polarity of the waveforms is reversed and a negative output is produced.

4–1531. The sawtooth generator circuit consists of gate cathode follower V601A, diode clamps V602A and V602B, and calibration panel controls SWEEP CURVATURE switch S103 and EARTH CURVATURE potentiometer R126. This circuit generates sawtooth voltages of a polarity and amplitude determined by the polarity and intensity of the elevation data voltage. These sawtooth voltages are applied to the linearity amplifier circuit. The earth correction voltage is mixed with the antenna voltage to produce a sawtooth output which includes compensation for the curvature of the earth. The positive and negative gates are used to initiate the generation of height sweep sawtooth waveforms as well as to control the discharge of the sweep capacitor.

4–1532. The linearity amplifier circuit is a high-gain amplifier composed of amplifier-comparator V604, amplifiers V605A and V605B, and cathode follower V603B. The output voltage from the linearity amplifier circuit is applied to both the height sweep driver and the gate generator. When the antenna is radiating below the horizon, the input to the gate generator controls the uration of the gate multivibrator (paragraph 4–1471). 'he input to the height sweep driver is always used to roduce the vertical component of a trace on the CRT. 'wo feedbacks are taken from the linearity amplifier ircuit. The first feedback is applied to the sawtooth oltage, while the second is employed to disable the weep discharge clamp circuit during the time when a weep is generated.

–1533. The sweep discharge clamp circuit is com- ›osed of amplifier-comparitor V607, amplifier V606A, athode follower V606B, diode clamps V608A and '608B, sweep discharge amplifier V603A, and sweep ischarge cathode follower V601B. During the gener- tion of a height sweep, the sweep discharge clamp ircuit does not produce any output. However, if the sweep capacitor tends to charge in the reverse direction during the discharge time, this circuit varies the voltage which controls the discharge of the capacitor. Thus, this circuit insures that the sweep capacitor has no effective charge when a new sweep is initiated.

4–1534. CIRCUIT ANALYSIS OF HEIGHT SWEEP GENERATOR.

4–1535. SAWTOOTH GENERATOR CIRCUIT. A gate is applied to the control grid of gate cathode follower V601A in the sawtooth generator circuit (figure 4–226) from the gate generator. The positive signal on the cathode of cathode follower V601A drives diode clamp V602B to cutoff. A negative gate is applied directly to the plate of diode clamp V602A, and this

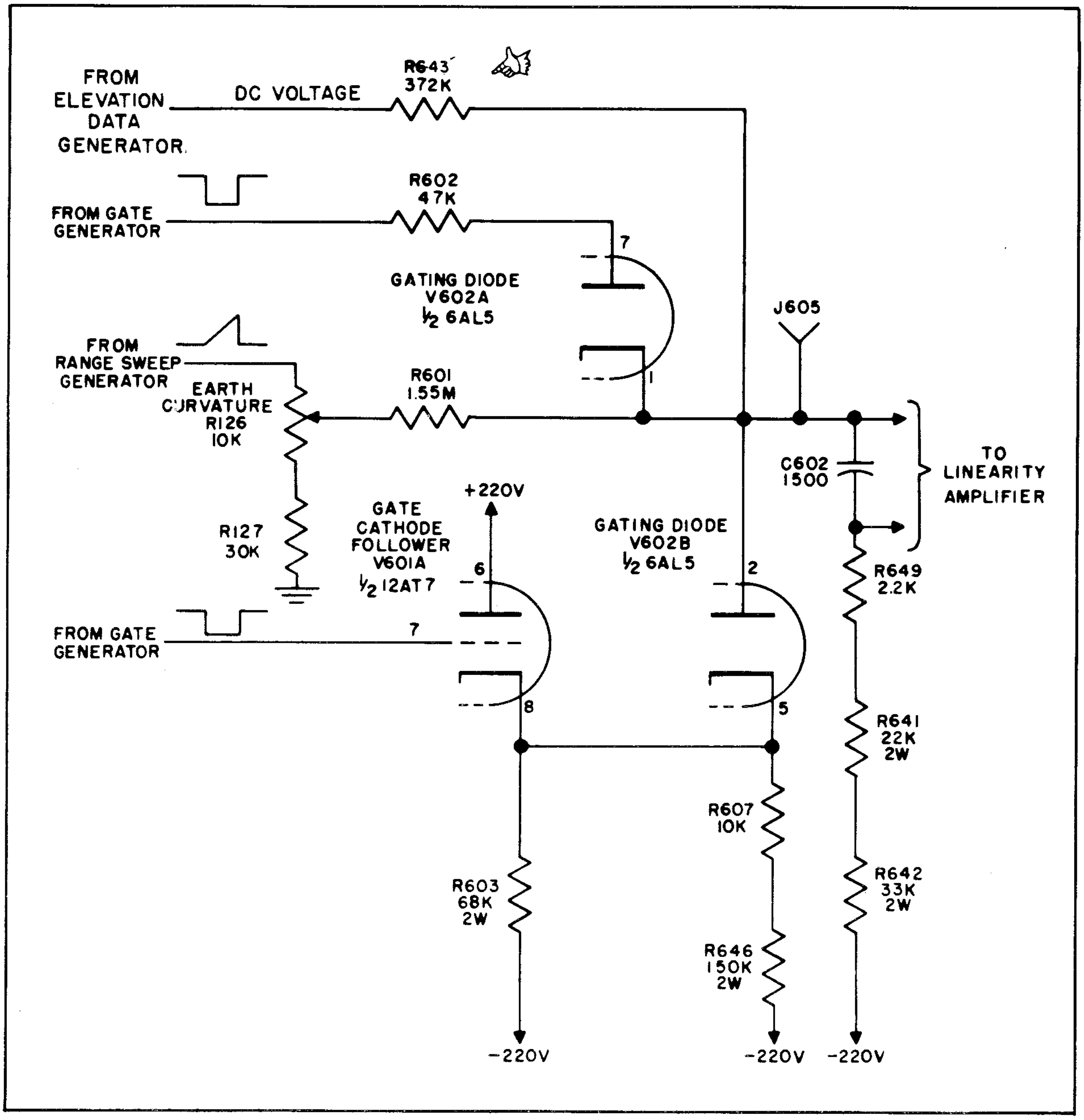


Figure 4–226. Height Sweep Sawtooth Generator, Simplified Schematic Diagram

diode is also driven to cutoff. The charge of sweep capacitor C602 is largely controlled by the instantaneous potential of the antenna reference voltage from Radar Set AN/FPS-6A. A sample of the output from the range sweep driver is developed across EARTH CURVATURE potentiometer R126. When SWEEP CURVATURE switch S103 is in the ON position, this input is also applied to the sawtooth generator circuit. This input adds to, and subtracts from, the antenna voltage to produce a voltage which determines the charge of capacitor C602. As the antenna radiates above the horizon, a positive signal is applied to the linearity amplifier circuit. When the antenna is radiating below the horizon, a negative signal is applied to the linearity amplifier circuit. Sweep capacitor C602 is discharged through either diode clamp V602A or V602B when the the antenna voltage is negative or positive, respectively.

4–1536. LINEARITY AMPLIFIER CIRCUIT. A signal applied to the control grid of amplifier-comparator V604A from the sawtooth generator circuit is successively amplified and inverted by amplifiers V604A, V605A, and V605B. The output of the linearity amplifier circuit (figure 7–144) is developed at the cathode of cathode follower V603B. A constant 0-volt d-c potential is maintained at the control grid amplifier-comparator V604A with no signal input by the automatic zero corrector (paragraph 4–1652) and the feedback from the cathode of cathode follower V603B. The output voltage at the cathode of cathode follower V603B is applied to the height sweep driver, the gate generator, and to the sweep discharge clamp circuit. The degenerative feedback to sweep capacitor C602 corrects for signal variations of components as a result of aging and maintains the 0-volt d-c level with no signal input.

4–1537. SWEEP DISCHARGE CLAMP CIRCUIT. The sweep discharge clamp circuit (figure 7–144) provides a rapid discharge path for capacitor C602. In addition, this circuit insures that the output potential at jack J603 is held at 0 volt between the generation of sawtooth waves after capacitor C602 has completely discharged. This action causes each successively generated sawtooth wave to be initiated at the same starting point and occurs after either a positive or negative sawtooth wave has been generated. The function of the sweep discharge clamp circuit is accomplished by preventing capacitor C602 from charging in the opposite direction after discharge, which results in the capacitor having no charge between the generation sawtooth waves. This circuit also keeps the grid potential of amplifier V607A at 0 volt during the development of each sawtooth wave.

4–1538. During the generation of either a negative or positive sawtooth wave at jack J603, the grid potential of amplifier V607A varies with the sawtooth wave. Because of the actions of amplifiers V607B and V606A, the voltage produced at one side of resistor R647 is equal in amplitude and opposite in polarity to the grid voltage of amplifier V607A.

4–1539. When the grid voltage of amplifier V607A is positive, a negative voltage equal in amplitude and opposite in polarity is developed at the end of resistor R647. This resistor is directly connected to the cathode of feedback diode V608B. The negative voltage on the cathode of diode V608B causes this tube to conduct if the difference in potential between its cathode and plate exceeds 7 volts. The plate of diode V608B is directly connected to the grid of amplifier V607A. When the grid voltage reaches an amplitude resulting in a 7-volt difference between the cathode and plate of amplifier V607A, this tube conducts. The plate voltage of amplifier V607A is then algebraically added to the cathode voltage of this tube. The grid voltage of amplifier V607A is equal in amplitude and opposite in polarity to the cathode voltage of diode V608B; therefore, the resulting grid voltage of amplifier V607A is 0 volt. This voltage is maintained at the 0-volt level during each positive sawtooth wave.

4–1540. When the grid voltage of amplifier V607A goes negative, a voltage equal in amplitude and opposite in polarity is developed at the junction of resistors R647 and R639. This point is directly connected to the plate of feedback diode V608A, whose plate is directly connected to the grid of amplifier V607A. Feedback diode V608A conducts when the potential difference exceeds 7 volts and the resulting grid voltage of amplifier V607A is 0 volt (paragraph 4–1539). The grid of amplifier V607A is held at 0 volt during the generation of negative sawtooth waves.

4–1541. The actions described in paragraphs 4–1539 and 4–1540 occur only during the generation of a sawtooth wave. These paragraphs do not describe the connection between the cathode of feedback diode V608B and resistor R608, which is connected to the grid of sweep discharge amplifier V603A. This connection was not covered because amplifier V603A functions only during the discharge of capacitor C602, which occurs at the end of each sawtooth wave.

4–1542. The gate generator applies negative gates to the plate of gating diode V602A and positive gates to the control grid of gate cathode follower V601A. These gates are generated simultaneously by the gate generator, so that the gates start and end together. During a negative gate, the plate voltage of gating diode V602A is negative, holding the tube at cutoff. Simultaneously, because of the presence of a positive gate, gate cathode follower V601A conducts and its resulting cathode voltage is positive. When the cathode of cathode follower V601A is conducting, cathode follower V601B and gating diode V602B are joined together so that all have a common cathode potential. Thus, during a positive gate, the positive cathode potential developed by gate cathode follower V601A holds gating diode V602B and sweep discharge cathode follower V601B cut off. Consequently, as a result of the application of a negative gate to gating diode V602A and a positive gate to gate cathode follower V601A, gating diodes V602A and

V602B are cut off. These diodes are maintained in this state until the termination of the gates.

4–1543. At the simultaneous termination of the positive and negative gates, the plate voltage of gating diode V602A rises and the grid voltage of gate cathode follower V601A falls. Diode V602A can conduct if the cathode of this tube is negative. The cathode of diode V602A is directly connected to one side of capacitor V602, and the potential on the cathode is therefore dependent upon the direction in which capacitor C602 is charged. During the generation of negative sawtooth waves, the side of capacitor C602 connected to the cathode of diode V602A is positive; during positive sawtooth waves, the side of this capacitor is negative. The cathode of gating diode V602A is also directly connected to the plate of gating diode V602B, whose cathode is in turn directly connected to the cathodes of gate cathode follower V601A and sweep discharge cathode follower V601B.

4–1544. Following the fall of the positive gate, cathode follower V601A is cut off. The common cathode voltage developed across resistor R603 for tubes V601A, V601B, and V602B is then controlled by sweep discharge cathode follower V601B. The grid voltage of cathode follower V601B is controlled by the plate voltage of sweep discharge amplifier V603A. In turn, the conduction of amplifier V603A can be varied by a change in voltage at the cathode of sweep clamp cathode follower V606B. During the static condition, amplifier V603A develops a plate voltage which permits cathode follower V601B to produce a slightly negative common cathode voltage. This negative voltage allows gating diode V602B to conduct if the plate of the tube is positive. The plate of diode V602B is connected to both the cathode of gating diode V602A and to one side of capacitor C602.

4–1545. As mentioned previously, the polarity of the potential at this point is dependent upon the direction in which capacitor C602 is charged during the presence of the positive and negative gates. If the potential at the side of capacitor C602 connected to the cathode of gating diode V602A and the plate of gating diode V602B is negative upon termination of the gates (a positive sawtooth is generated), the rapid discharge path for capacitor C602 is provided by gating diode V602A. When this potential is positive (a negative sawtooth is generated), the rapid discharge path for capacitor C602 is supplied by gating diode V602B.

4–1546. When capacitor C602 is completely discharged, the path formed by either gating diode V602A or V602B is still present. Consequently, capacitor C602 starts to charge in the opposite direction. When capacitor C602 is completely discharged, the rise in potential at one side of the capacitor indicates recharging. The grid of amplifier V607A is connected through resistor R609 to one side of capacitor C602. Thus, any change in potential at this side of the capacitor is reflected at the grid of amplifier V607A. As capacitor C602 tends to recharge (regardless of direction), the increase of potential at the side of capacitor C602 coupled to amplifier V607A results in the development of a voltage equal in amplitude and opposite in polarity at the cathode of sweep clamp cathode follower V606B. This voltage charge is slight and of sufficient amplitude to cause feedback diode V608B to conduct. However, the drop or rise in voltage is felt at the grid of sweep discharge amplifier V603A, causing a rise or fall in its plate voltage. This variation of the plate voltage of amplifier V603A increases or decreases the common cathode voltage of tubes V601A, V601B, and V602B.

4–1547. If the rise in voltage at the grid of amplifier V607A is positive, a positive voltage can be produced at the side of capacitor C602 by establishing a charge path for the capacitor through gating diode V602B. As a result of the application of a positive voltage to amplifier V607A, a negative voltage is felt at the grid of amplifier V603A, a positive voltage at the grid of cathode follower V601B, and a positive voltage at the cathode of diode V602B. The positive cathode voltage cuts off diode V602B and prevents capacitor C602 from charging through this diode. Again the charge across capacitor C602 is removed and diode V602A tends to recharge capacitor C602. The side of capacitor C602 coupled to amplifier V607A then rises negatively. As a result of the application of a negative voltage to amplifier V607A, a positive voltage is felt at the grid of amplifier V603A, a negative voltage at the grid of cathode follower V601B, and a negative voltage at the cathode of diode V602B. Gating diode V602B is again driven into conduction and opposes the charging of capacitor C602 by diode V602A. The counteractions of diodes V602A and V602B continue during the interval between gates and the effective charge of capacitor C602 is maintained at approximately 0 volt.

4–1548. BLOCK DIAGRAM OF HEIGHT SWEEP DRIVER.

4–1549. The height sweep driver, which is similar to the range sweep driver (figure 4–223), is composed of the input, upper deflection, and lower deflection circuits. When the height sweep driver receives a positive or negative (corresponding to the elevation angle of the antenna) sawtooth voltage input from the height sweep generator, two sawtooth height sweep currents of opposite polarity are produced. The sawtooth voltage input is positive when the elevation angle of the antenna is 0 to −2 degrees and negative when the angle is 0 to +32 degrees. The sawtooth height sweep currents are simultaneously applied to the upper and lower deflection coils to provide a vertical height sweep component. When the height sweep terminates, three height cursor inputs are present at the height sweep driver. These cursor inputs affect the vertical display of the cursor marker in height. In the following discussion, height sweep generation is presented first, followed by height cursor generation.

4–1550. The input circuit is composed of gating diodes V201 and V202, refraction potentiometer R63A, strobe position potentiometer R63B, control stick (range section) R73B, RANGE ZERO control R108, STATION HEIGHT control R110, SWP CURVATURE control R131, HGT SWP CAL control R158, and frequency compensation adjust control C201. This circuit supplies a negative or positive sawtooth voltage input from the height sweep generator or the upper deflection circuit. When the time-share gates are applied to the upper deflection circuit, the input circuit produces a composite cursor input voltage which corresponds to the height position where the cursor marker is to be displayed. This composite voltage is applied to the upper deflection circuit.

4–1551. The upper deflection circuit comprises amplifier-comparator V203, sweep voltage amplifier V204, sweep driver V205, and VERT SWP SPEED control R123. The negative or positive sawtooth height sweep voltage applied to the upper deflection circuit initiates the generation of a negative or positive sawtooth height sweep current to the upper deflection coil. The VERT SWP SPEED control adjusts the current through the deflection coil to produce the desired deflection. A sawtooth voltage from the upper deflection circuit is also produced and applied to the lower deflection circuit. This sawtooth voltage initiates the generation of the vertical sawtooth sweep current applied to the low deflection coil. A sawtooth voltage output is sent to the gate generator which controls the positive gate. During the period when the time-share gates are applied, the height cursor inputs are applied to the upper deflection circuit. These cursor inputs cause the upper deflection circuit to produce a positioning current for the cursor marker. A voltage output is also obtained and supplied to the lower deflection circuit for cursor positioning.

4–1552. The lower deflection circuit consists of amplifier-comparator V206, sweep voltage amplifier V207, sweep driver V208, and VERT ORIGIN control R125. A positive or negative sawtooth height sweep voltage from the upper deflection circuit is applied to the lower deflection circuit. This sawtooth input causes the generation of a positive or negative sawtooth deflection current to the lower deflection coil. The VERT ORIGIN control determines the sweep origin by controlling the static current through the deflection coil. A height cursor voltage is obtained from the upper deflection circuit when the time-share gates are present and is applied to the lower deflection circuit. This height cursor input results in the generation of a current which is used to position the cursor marker in height.

4–1553. CIRCUIT ANALYSIS OF HEIGHT SWEEP DRIVER.

4–1554. INPUT CIRCUIT. A negative sawtooth height sweep input is applied to the common cathode of gating diodes V202A and V202B through resistor R206 and capacitor C201 (figure 4–227). The positive time-share gate is not present at the plate of diode V202A; therefore, this tube is held at cutoff. The applied negative sawtooth voltage drives diode V202B into conduction, resulting in a negative sawtooth at the plate. The sawtooth voltage from the plate of diode V202B is coupled to the upper deflection circuit. Gating diode V201A prevents the height cursor inputs from reaching the upper deflection circuit during height sweep generation. The absence of the negative time-share gate at the plate of diode V201A permits this tube to conduct, thereby holding diode V201B at cutoff by placing a positive potential on the cathode. The height cursor inputs are thus isolated from the upper deflection circuit.

4–1555. When the positive and negative time-share gates are present, gating diode V201A is driven to cutoff and diode V201B conducts. Conduction through diode V202A places a positive potential at the cathode of diode V202B, thereby removing the height sweep saw-tooth input from the upper deflection circuit. The negative time-share gate applied to the plate of gating diode V201A drives the tube to cutoff. Gating diode V201B is then permitted to conduct, since the height cursor input is applied to the cathode of diode V201B. The height cursor input consists of a composite d-c potential of negative polarity for cursor height positioning. This composite d-c potential is determined by the position of control stick range portion R73B, refraction correction control R63, SWP CURVATURE control R131, and STATION HEIGHT control R110 (figure 4–227). The negative height cursor input signal from the plate of diode V201B is coupled to the upper deflection circuit.

4–1556. UPPER DEFLECTION CIRCUIT. A negative height sweep is applied to the control grid of comparator V203A (figure 4–228). The control grid of comparator V203A is held at a constant 0-volt d-c potential with no signal input by the automatic zero corrector circuit (paragraph 4–1652). The control grid of amplifier V203B receives an automatic zero correction signal to stabilize any d-c voltage variation at the control grid of comparator V203A. The cathode of comparator V203A follows the voltage excursion taken by the control grid when the height sweep sawtooth is applied. The cathode of comparator V203A is directly coupled to the cathode of amplifier V203B; therefore, a negative sawtooth from comparator V203A is present at the cathode of amplifier V203B, producing an amplified negative sawtooth at the plate. This negative sawtooth plate swing is applied to the control grid of sweep voltage amplifier V204, driving toward cutoff. A positive sawtooth is thus produced at the plate of amplifier V204 and coupled to the control grid of sweep driver V205. The current through sweep driver V205 is then increased, developing a positive height sweep sawtooth current which is applied to the upper deflection coil. VERT SWP SPEED control R123 establishes the current through sweep driver V205, producing the desired deflection for a particular input voltage. This deflection current controls the vertical sweep speed by determining the rate of change of the sawtooth current.

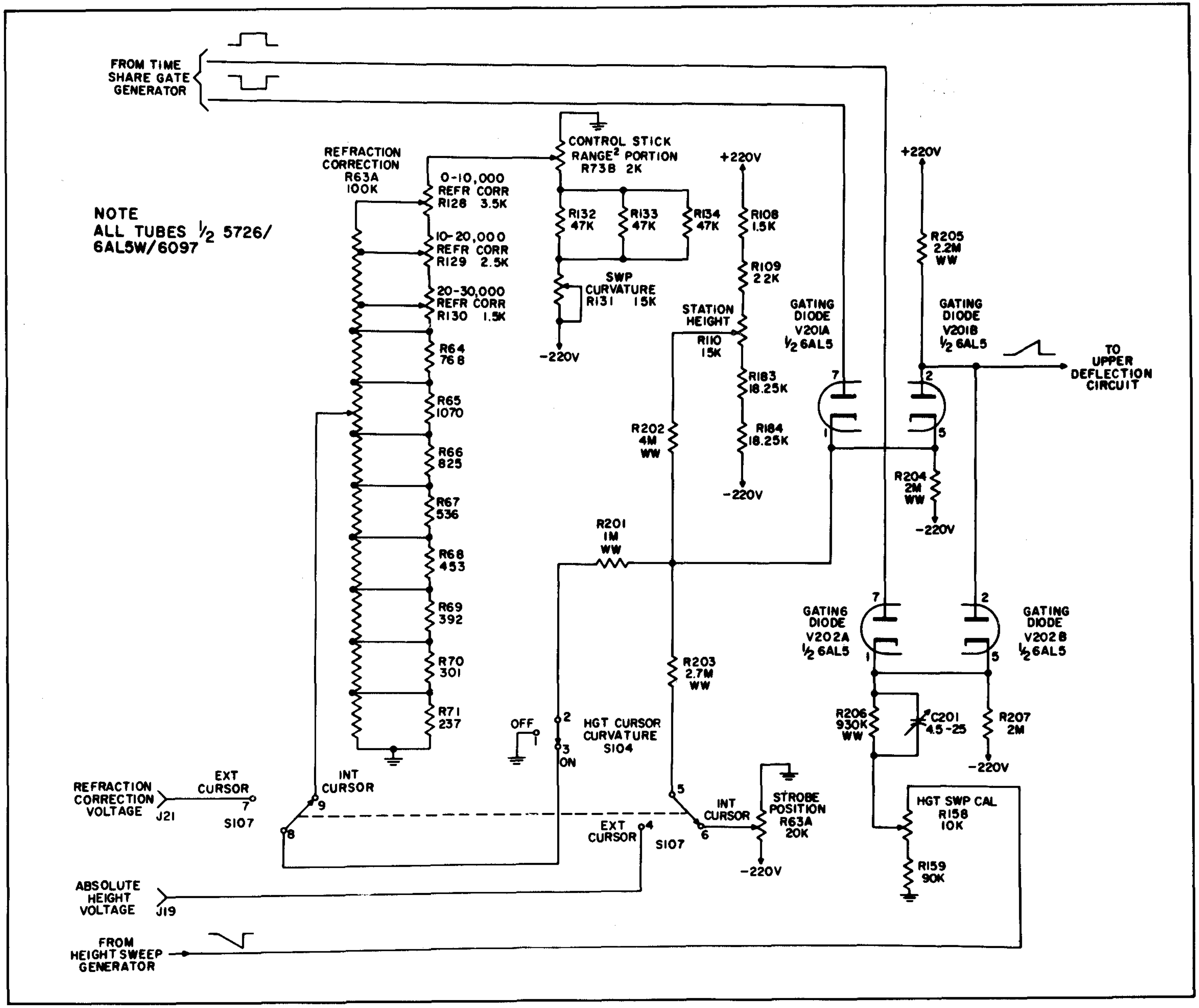


Figure 4–227. Height Sweep Driver Input Circuit, Simplified Schematic Diagram

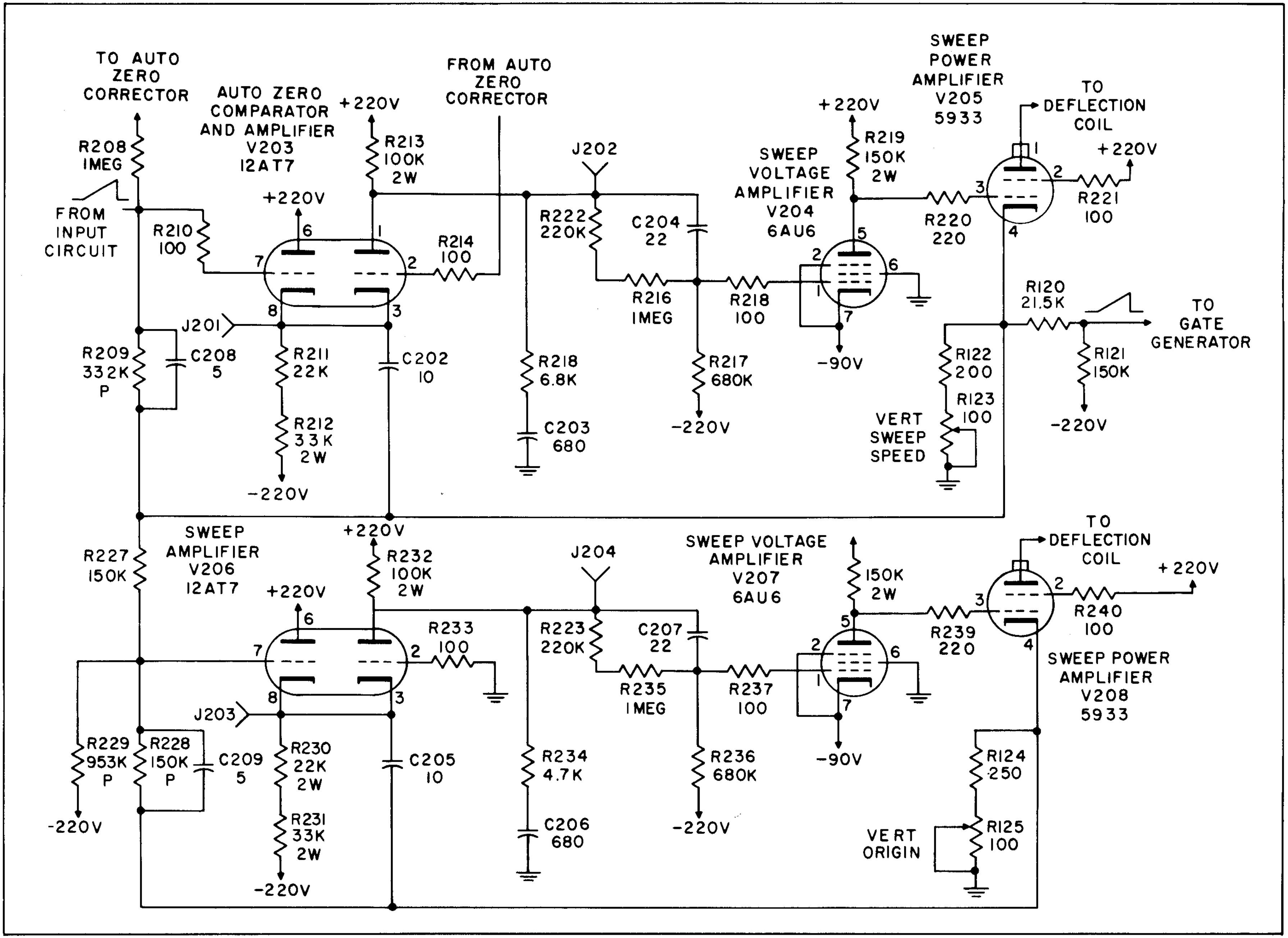


Figure 4–228. Upper and Lower Deflection Circuits, Simplified Schematic Diagram

4–1557. Two additional positive sawtooth voltage outputs are produced from the cathode of sweep driver V205. One sawtooth output is applied as an input to the lower deflection circuit, while the other is sent to the gate generator for positive and negative gate termination.

4–1558. Two feedback circuits are employed within the upper deflection circuit as linearity and amplitude controls. The d-c feedback from the cathode of sweep driver V205 is applied to the control grid of comparator V203A by means of resistor R209. This feedback improves the linearity of the applied sawtooth voltage and corrects for any signal distortion introduced by component variations. The feedback also determines the amplitude of the sawtooth output from amplifier V203B by means of the degenerative effect of the voltage from sweep driver V205. Circuit oscillation is prevented by the a-c feedback provided by capacitors C202 and C205.

4–1559. When the time-share gates are present, the negative height cursor input is applied to the control grid of comparator V203A. The upper deflection circuit then operates in the same manner described in paragraph 4–1556.

4–1560. LOWER DEFLECTION CIRCUIT. A positive sawtooth voltage from the cathode of sweep driver V205 in the upper deflection circuit is applied to the control grid of comparator V206A (figure 4–228). The positive sawtooth output at the plate of amplifier V206B is coupled to the control grid of sweep voltage amplifier V207. A negative sawtooth voltage is thus developed at the plate of amplifier V207 and applied to the control grid of sweep driver V208, thereby reducing the current flow through sweep driver V208. A decreasing height sweep current is produced at the plate of sweep driver V208 through the lower deflection coil to aid the vertical movement of the electron beam in the CRT VERT ORIGIN control R125 adjusts the deflection current to establish the origin position of the vertical sweep.

4–1561. The positive sawtooth voltage developed at the cathode of sweep driver V208 is applied to the control grid of comparator V206A and to the common cathode of amplifier-comparator V206 through feedback resistor R228. This feedback voltage improves the linearity of the input signal to comparator V206A and corrects for any signal distortion introduced by component value variations. Capacitors C202 and C209 provide a-c feedback to prevent circuit oscillation.

4–1562. When the time-share gates are present, a positive voltage from the cathode of sweep driver V205 is applied to the lower deflection circuit. This positive voltage results from the application of the height cursor input to the upper deflection circuit and is applied to the lower deflection circuit in the same manner as the height sweep signal. The lower deflection circuit functions as described in paragraph 4–1560.

4–1563. FUNCTIONING OF HEIGHT SERVO AMPLIFIER.

4–1564. GENERAL. The height servo amplifier consists of an amplifier circuit (figure 4–229) and a motor-driven gear train (figure 4–230). The amplifier circuit is composed of amplifiers V851B, V851A, and V852B, paraphase amplifier V852A, motor drivers V853 and V854, height axis potentiometer R72 of the control stick, height servo feedback control R56, and calibration panel SERVO GAIN control R107. The motor-driven gear train consists of common drive motor B51, absolute height synchro transmitters B52 and B53, relative height synchro transmitter B54, front panel RELATIVE-ABSOLUTE switch S53, and electromagnetic clutch L51.

4–1565. When the control stick is moved, an error voltage is applied to the height servo amplifier. This signal is used to generate the drive voltage for common drive motor B51. The drive motor causes the absolute synchro transmitter to rotate and refraction correction control R63 to produce cursor height input to the height sweep driver. The relative height synchro transmitter, which carries the relative counter drum, rotates simultaneously with the ABSOLUTE height counter when the RELATIVE-ABSOLUTE switch is in the RELATIVE position. Rotation of the common drive motor also mechanically drives height servo feedback control R56 to produce a cancellation of the error signal from the control stick. However, when the control stick is placed in either the maximum upper or lower position, the feedback from control R56 cannot equal the applied signal. As a result, the counters rotate continuously.

4–1566. AMPLIFIER CIRCUIT. When the control stick is moved, a 60-cycle a-c signal is applied to the control grid of amplifier V851B from height axis potentiometer R72, which is geared to the control stick. The 60-cycle output from the plate of amplifier V851B (figure 4–229) is applied to a filter network composed of capacitors C853 and C854 and resistors R857 and R858. The filter network causes a phase shift in the applied signal which subsequently over-comes the inertia, or counterelectromotive force, of common drive motor B51.

4–1567. The output signal developed at the plate of amplifier V851A is applied to SERVO GAIN control R107, which is adjusted to eliminate hunting of the common drive motor. The signal obtained from the arm of control R107 is applied to the control grid of amplifier V852B. This amplifier supplies the input for paraphase amplifier V852A. The signal developed at the plate of amplifier V852A is the input for motor driver V853, while the cathode signal of amplifier V852A is the input for motor driver V854. The polarity relationship of signals applied to the control grids of motor drivers V853 and V854 determines the direction of rotation of common drive motor B51, which in turn controls the readings of the ABSOLUTE height counter and the RELATIVE height dial. A degenerative feedback from the plate of motor driver V854 to the cathode of tube V52B decreases the loop gain and improves system stability.

4–1568. When the signal applied to the drive winding of common drive motor B51 causes rotation, height servo feedback control R56 also rotates because the control is mechanically coupled to drive motor B51. Height servo feedback potentiometer R56 supplies the cancellation voltage for an error signal initiated by movement of the control stick. Thus, when the control stick is moved, drive motor B51 rotates until the voltage developed by potentiometer R56 produces cancellation of the signal from height axis potentiometer R72.

4–1569. The ABSOLUTE height counter is always varied when the control stick is moved. When RELATIVE-ABSOLUTE switch S53 is placed in the RELATIVE position, the RELATIVE height dial also rotates. Rotation occurs because switch S53 completes the circuit for electromagnetic clutch L51, which completes the mechanical drive circuit for the RELATIVE height dial.

4–1570. MOTOR-DRIVEN GEAR TRAIN. Common drive motor B51 is energized and operated by a voltage output from the height servo amplifier (figure 4–229). The armature of drive motor B51 drives an idler shaft (figure 4–230) at a reduced rate of speed, which in turn powers two gear reduction drive assemblies. One drive assembly is used to proportionately reduce the 3000-rpm output of motor B51 to lower speeds in order to drive the ABSOLUTE height counter and the RELATIVE height dial at suitable rates. However, the RELATIVE height dial is engaged only when RELATIVE-ABSOLUTE switch S53 is operated to the RELATIVE position, thus energizing electromagnetic clutch L51. When the RELATIVE height dial is engaged, relative height transmitter synchro B54 is also driven to transmit relative height information to external locations.

4–1571. The second gear reduction drive assembly also reduces the 3000-rpm output of common drive motor B51 to proportionately lower speeds to drive absolute height synchro transmitters B52 and B53. The synchro transmitters transmit height at a rate of 10,000 feet per revolution for transmission of absolute height information to external locations. In addition, refraction correction control R63 and height servo feedback control R56 are driven by this gear reduction drive assembly to provide a cancelling feedback voltage to the height servo amplifier. This feedback results in the removal of the voltage source for motor B51 when the desired height is attained. Control R56 can be driven through a 300-degree (maximum) arc, after which the friction drive clutch is permitted to slip. Thus, the power for rotation is removed from control R56.

4–1572. The stop gear contained in the second gear reduction drive assembly locks and prevents further rotation of the gears when the counters reach an indicated height of 100,000 feet. In this manner, the counters are prevented from displaying false height indications above 100,000 feet.

4–1573. BLOCK DIAGRAM OF RANGE MARK GENERATOR. (See figure 4–231.)

4–1574. The range mark generator produces appropriate range marks during alternate sweeps. These range marks are applied to the video amplifier for presentation on the CRT. The range mark generator is composed of the ring multivibrator, oscillator, and relay circuits.

4–1575. Positive gate pulses from the gate generator are applied to the ring multivibrator circuit at the sweep repetition rate of 360 pps. This circuit consists of a three-stage multivibrator, composed of tubes V251A, V252A, and V252B. The width of a positive gate is equal in duration to that of the selected sweep. In turn, the ring multivibrator produces negative gates equal in width to, and synchronized with, every other received positive gate. These negative gates are applied to the oscillator circuit.

4–1576. During each received negative gate, the oscillator circuit produces either 10-, 20-, or 50-mile range marks. The oscillator circuit is composed of oscillator clamp V251B, oscillator V253A, regenerative amplifier V253B, pulse amplifier V254A, and blocking oscillator V254B. The 10-mile range marks are produced when the range is between 50 and 70 miles. A range between 70 and 150 miles results in 20-mile range marks, and between 150 and 300 miles, in 50-mile range marks. The interval between range marks generated by the oscillator circuits is controlled by the relay circuit, which selects the frequency at which the oscillator operates for the selected range. The range marks are applied to the video amplifier.

4–1577. The relay circuit determines the oscillator circuit frequency which governs the type of range marks developed. This circuit is composed of relays K251 and K252 and range mark control microswitches S51 and S52. The relay circuit is mechanically linked to front panel "RANGE" control R61. As the "RANGE" control is rotated, the proper relay or relays within the relay circuit are energized. This action causes the oscillator to operate at the proper frequency to produce either 10-, 20-, or 50-mile range marks when the selected range is within either the 50- to 70-, 70- to 150-, or 150- to 300-mile range, respectively.

4–1578. CIRCUIT ANALYSIS OF RANGE MARK GENERATOR.

4–1579. RING MULTIVIBRATOR CIRCUIT. Positive gates from the gate generator are simultaneously applied to capacitor C257 and through resistor R251 to capacitor C252 (figure 7–140). Two differentiator networks, one composed of capacitor C252 and resistors R251 and R253, and the other of capacitor C257 and resistor R263, convert the positive-going edge of each positive gate into a positive pulse and the negative-going edge into a negative pulse. Both the positive and negative pulses developed across resistor R253 are ap-

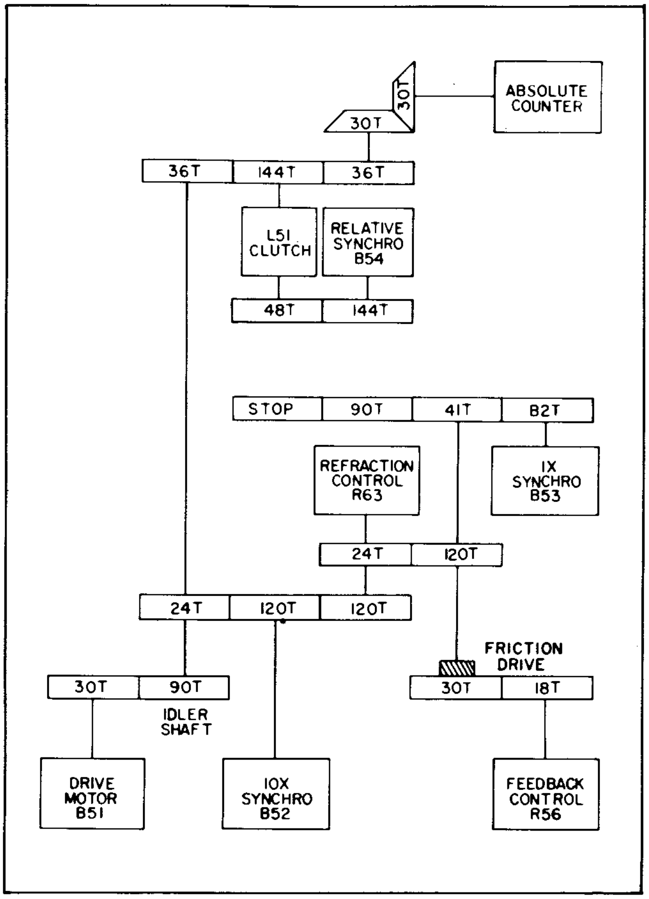


Figure 4–230. Absolute and Relative Drive Gear Train, Schematic Diagram

plied to the grid of tube V251A. The other differentiating network passes only the positive pulses to the grid of tube V252B because of the unidirectional characteristics of diode CR251.

4–1580. Before the receipt of a positive gate, the ring multivibrator can be in one of two states. However, for purposes of this discussion, it is assumed that tube V251A is cut off, tube V252A is conducting, and tube V252B is cut off.

4–1581. The plate voltage change of any stage is coupled to the grid of each of the other two stages of the ring multivibrator. The plate voltage of tube V252B is capacitively coupled and the plate voltage of tube V252A is resistively coupled to the grid of the first stage, tube V251A. Similarly, the plate voltage of tube V251A is capacitively coupled and the plate voltage of tube V252B is resistively coupled to the grid of the second stage, tube V252A. In a similar manner, the plate voltage of tube V252A is capacitively coupled to the grid of the third stage, tube V252B.

4–1582. In order for a stage to conduct, the coupled plate voltages of the other two stages must be at the highest possible positive level. This occurs only when the other two stages are both cut off. For example, during the static state mentioned (tube V251A cut off, tube V252A conducting, and tube V252B cut off), the plate voltages of tubes V251A and V252B are at their maximum positive levels and the plate voltage of tube V252A is negative with respect to the other plate voltages. Thus, the two plate voltages coupled to the grid of tube V252A are both positive, while the plate voltage of tube V252A, coupled to the grids of tubes V251A

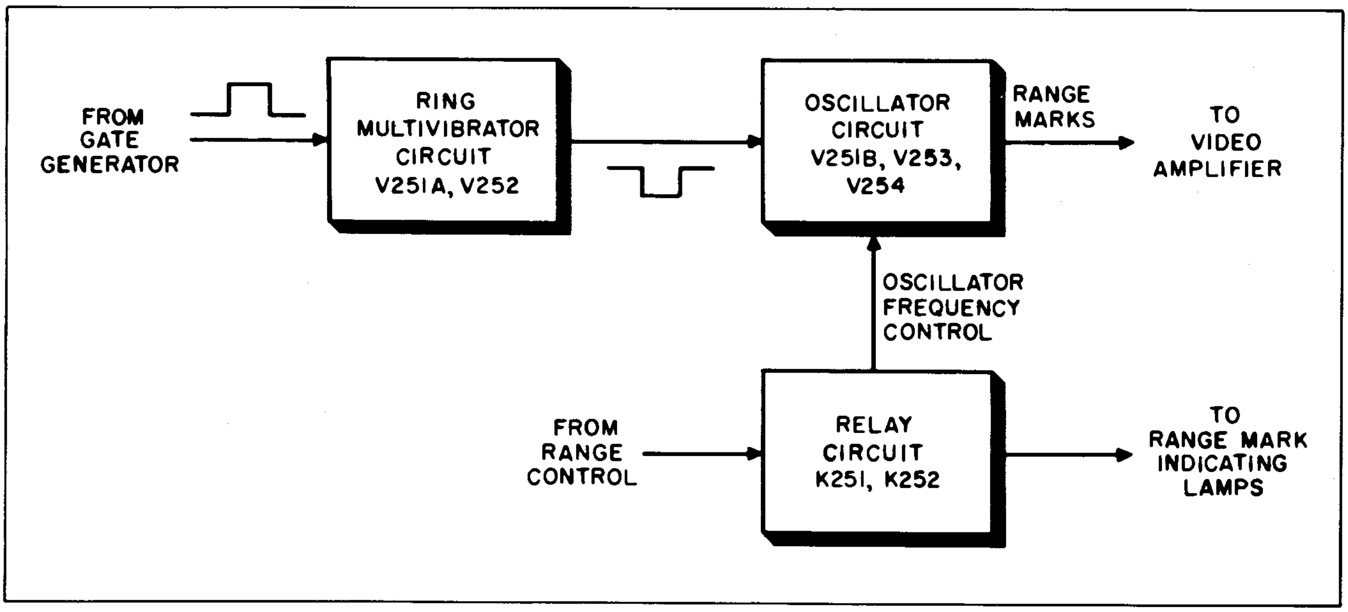


Figure 4–231. Range Mark Generator, Block Diagram

and V252B, is comparatively negative. The resulting positive potential on the grid of tube V252A maintains conduction of the tube, while the resulting lowered potential on the grid of tubes V251A and V252B holds these stages at cutoff.

4–1583. In the following detailed discussion of the ring multivibrator, reference to figure 4–232 may help to clarify the operation of the multivibrator. The time relationships of the changes in the three plate voltages are shown in A of figure 4–232. The polarities (step by step) for each of the three plate voltages, in all possible combinations, as such a positive gate is received, are shown in B of this illustration.

4–1854. Upon receipt of a positive gate, positive trigger pulses produced by the action of the two differentiator networks are simultaneously applied to the grids of tubes V251A and V252B. Since both tubes are cut off, the positive pulses tend to drive them into conduction. However, the d-c cathode level of tube V252B (0 volt) is coupled to the grid of tube V251A through resistor R253. This results in a more negative bias on tube V251A than on tube V252B and therefore allows tube V252B to be triggered first when the trigger arrives. When tube V252B conducts, its plate voltage drop is capacitively coupled through capacitor C251 to the grid of tube V251A, and resistively coupled by resistors R258 and R260 to the grid of tube V252A. This decrease in voltage overrides the action of the positive trigger pulse, and tube V251A is kept at cutoff. The drop in the plate voltage of tube V252B also drives tube V252A to cutoff. At the end of the first change, tube V251A is still cut off, tube V252A is cut off, and tube V252B is conducting.

4–1585. At the end of the first positive gate, a negative pulse is delivered to the grid of tube V251A by the differentiator network containing capacitor C252. This stage is presently cut off, and therefore the negative pulse has no effect. At the same time, the negative pulse produced by the differentiator network containing capacitor C257 is blocked by diode CR251, as are all negative pulses, and does not reach the grid of tube V252B.

4–1586. The next circuit condition change occurs when the leading edge of the next positive gate is received. Again positive trigger pulses are simultaneously applied to the grids of tubes V251A and V252B. Immediately before such application, tube V251A is cut off, tube V252A is cut off, and tube V252B is conducting. Upon receipt of the positive pulses, tube V251A is driven into conduction. The pulse has no effect upon tube V252B because it is conducting. The plate voltage of tube V251A then drops. This voltage drop is capacitively
V251A then drops. This voltage drop is capacitively
coupled through capacitor C254 to the grid of tube
coupled through capacitor C254 to the grid of tube
V252A, and resistively coupled by resistors R265 and R266 to the grid of tube V252B. As a result, tube V252B is driven to cutoff, its plate voltage rise is coupled to the grids of tubes V251A and V252A, and tube V252A is maintained at cutoff. At the end of the second change, tube V251A is conducting and tubes V252A and V252B are cut off.

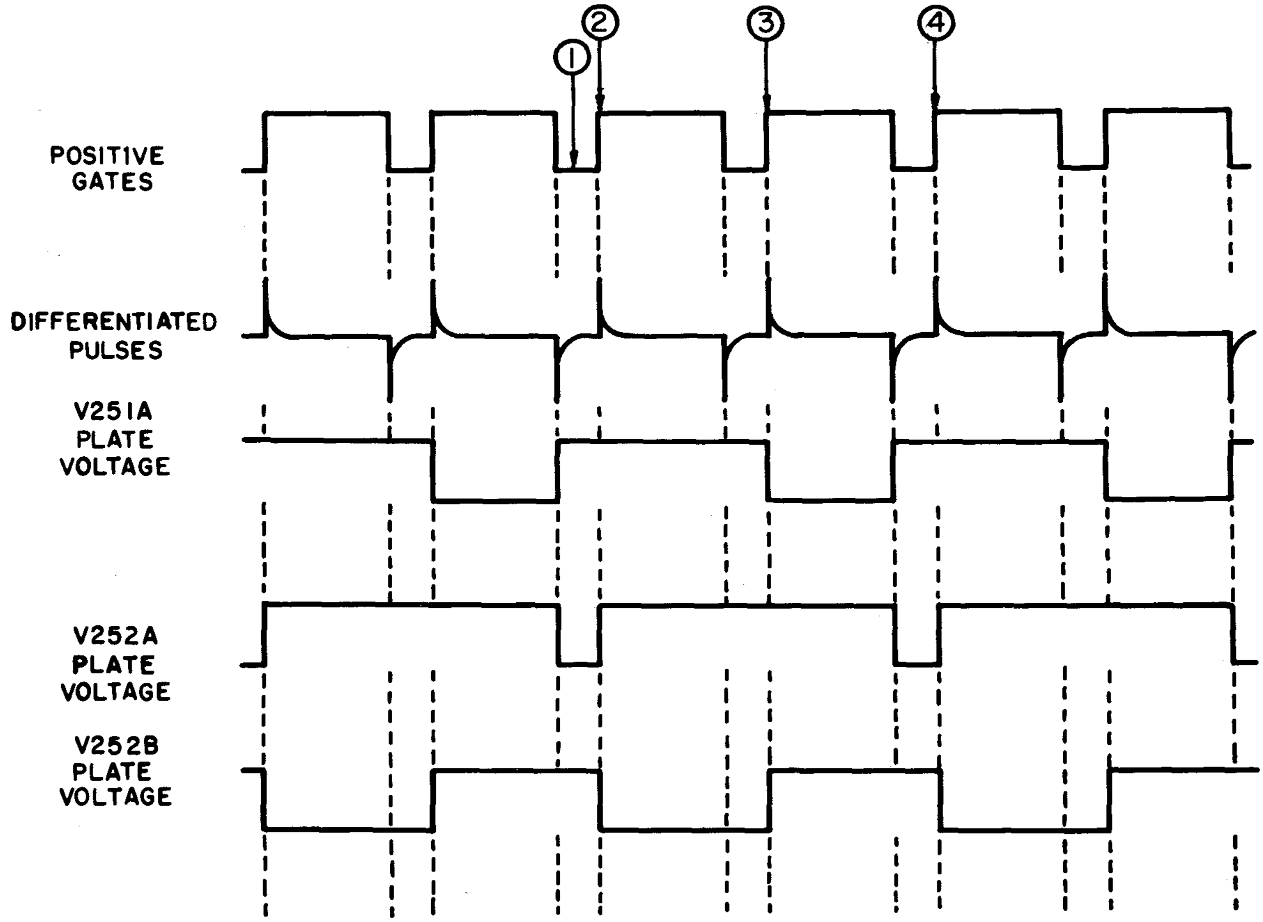
4–1587. A third circuit condition change occurs at the end of the positive gate whose leading edge caused the preceding change. Immediately prior to the end of this positive gate, tube V251A is conducting and tubes V252A and V252B are cut off. At the end of the positive gate, the negative pulse applied to the grid of tube V251A drives this tube to cutoff. The increase in the plate voltage of tube V251A is coupled to tube V252A, driving the latter tube into conduction. The effect of the rise in the plate voltage of tube V251A is overcome by the fall in the voltage of tube V252B (both coupled to tube V252A), and tube V252B is held cut off. The ring multivibrator is then back in the initial static condition. The three circuit condition changes described are repeated for each pair of positive gates applied.

4–1588. The output of the ring multivibrator is taken from the junction of resistors R269 and R270 and applied to the oscillator circuit. Resistor R269 is connected to the plate of tube V251A, whose actions therefore determine the output of the ring multivibrator. By referring to A of figure 4–232, it can be seen that a negative gate is developed at the plate of tube V251A during alternate positive gates. This negative gate is taken from the junction of resistors R269 and R270 and forwarded to the oscillator circuit.

4–1589. OSCILLATOR CIRCUIT. The negative gates from the ring multivibrator are applied to the oscillator circuit at the control grid of oscillator clamp V251B (figure 7–140). Initially, tube V251B is conducting, placing a constant d-c potential across its cathode circuit. Tube V251B thereby prevents oscillations in the range mark tuned circuit located in the cathode circuit of this tube. The incoming negative gate drives tube V251B to cutoff, thus removing the constant d-c potential and permitting the range mark tuned circuit to oscillate.

4–1590. Simultaneously, the oscillations from the range mark tuned circuit are applied to the control grid of range mark oscillator V253A, which provides the required amplification, and to the control grid of regenerative amplifier V253B. A feedback path for the oscillator is provided by decoupling capacitor C260A. The oscillations from the tuned circuit applied to the control grid of regenerative amplifier V253B are amplified and applied to the grid of pulse amplifier V254A. The circuit is a Hartley oscillator. Capacitor C260A provides decoupling from B+.

4–1591. The negative-going portion of each oscillation is amplified and applied to the control grid of pulse amplifier V254A, driving it into conduction. The conduction of amplifier V254A causes the coupling of a positive pulse through transformer T251 to the control grid of blocking oscillator V254B. This positive pulse triggers the blocking oscillator. Because resistor R280 is common to both regenerative amplifier V253B and



A. TIMING CHART

Plate Voltage Changes	Comparative Polarity of Plate Voltage Coupled to:					
	V251A from		V252A from		V252B from	
	V252A	V252B	V251A	V252B	V251A	V252A
1 Static state	−	+	+	+	+	−
2 First (positive pulse applied to V251A and V252B)	+	−	+	−	+	+
3 Second (positive pulse applied to V251A and V252B)	+	+	−	+	−	+
4 Third (negative pulse applied to V251A)	−	+	+	+	+	−

B. RING MULTIVIBRATOR COMPARATIVE PLATE VOLTAGE POLARITIES

Figure 4–232. Ring Multivibrator Operation Cycles pulse amplifier V254A, regenerative feedback is obtained by regenerative amplifier V253B which aids in the amplification of the oscillations.

4–1592. When blocking oscillator V254B is triggered, a positive range mark pulse is developed across cathode resistor R283. This pulse is sent to the video amplifier circuit. During conduction of oscillator V254B, regenerative feedback is transformer-coupled from the plate to the control grid through transformer T251. The feedback ends when saturation is reached. Oscillator V254B is then driven back to cutoff as the field about winding 3-7 of transformer T251 collapses and applies a negative pulse to the control grid.

4–1593. RELAY CIRCUIT. Relays K251 and K252 (figure 4–233) are energized when microswitches S51 and S52, respectively, are operated by RANGE control R61 in accordance with the selected sweep length (range). When a sweep length of not more than 70 miles is selected, microswitches S51 and S52 provide a path to energize relay K251, which selects the tuned circuit containing inductor L253, and to illuminate the 10-mile range mark indicator. The tuned circuit containing inductor L253 is tuned to oscillate at the proper frequency to generate 10-mile range marks. This 10-mile mark tuned circuit is connected to the oscillator circuit when relay K251 is energized and relay K252 is de-energized.

4–1594. When a sweep length of 70 to 150 miles is required, relays K251 and K252 are energized. The tuned circuit containing inductor L252 is thus selected and connected to the oscillator circuit. This tuned circuit causes a range mark to be generated for every 20 miles of sweep. As the sweep length is increased to a range between 150 and 300 miles, only relay K252 is energized, and the tuned circuit containing inductor L251 is selected. This results in the generation of 50-mile range marks and the illumination of the corresponding 50-mile range mark indicator.

4–1595. Diodes CR252 and CR253 act as shunts for relays K251 and K252, respectively, thus providing a means for rapidly discharging the coils of these relays. Capacitors C251 and C252 are connected across the contacts of microswitches S51 and S52 to suppress arcing bounce.

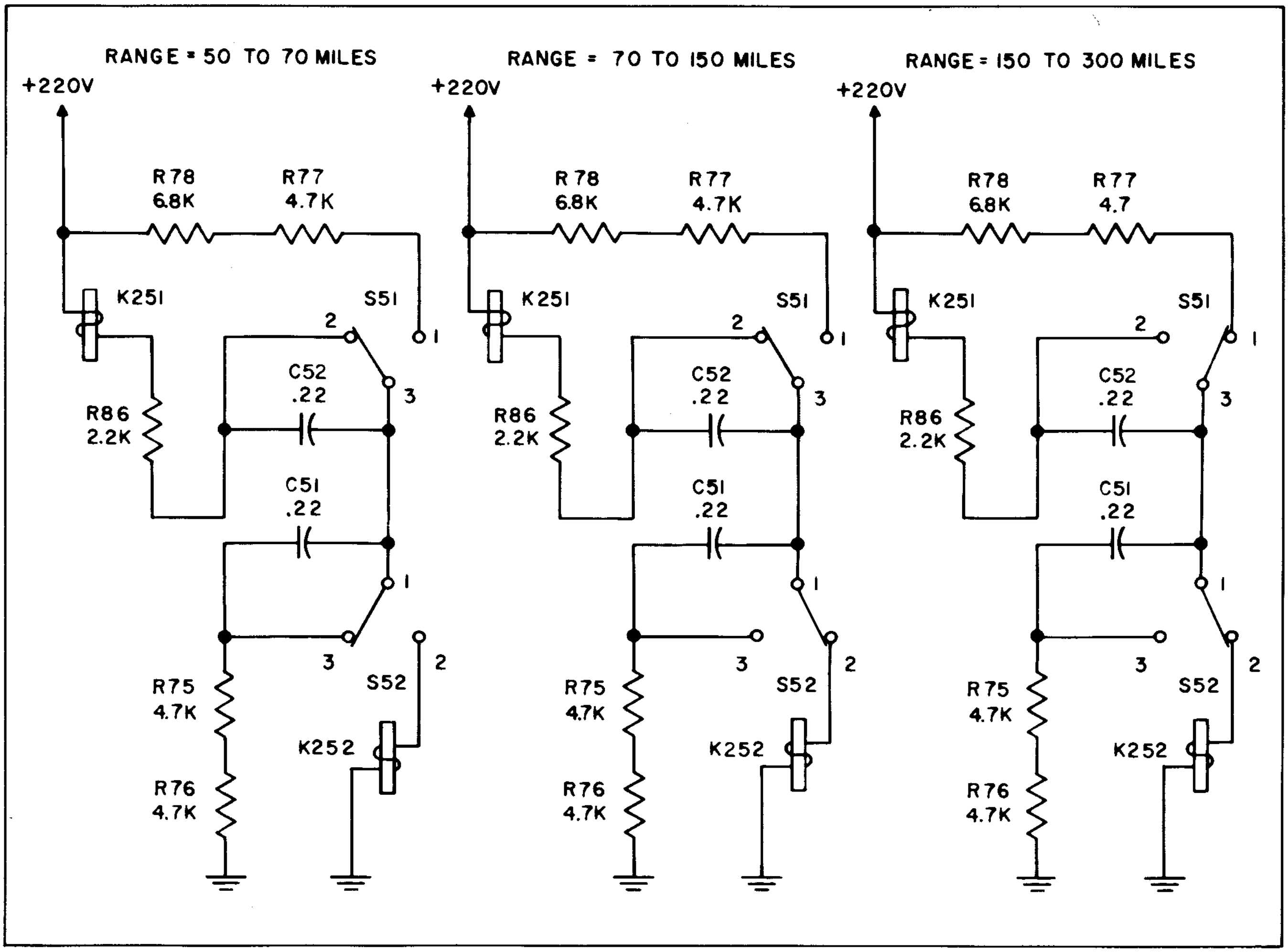


Figure 4–233. Range Mark Generator Relay Circuit, Simplified Schematic Diagram

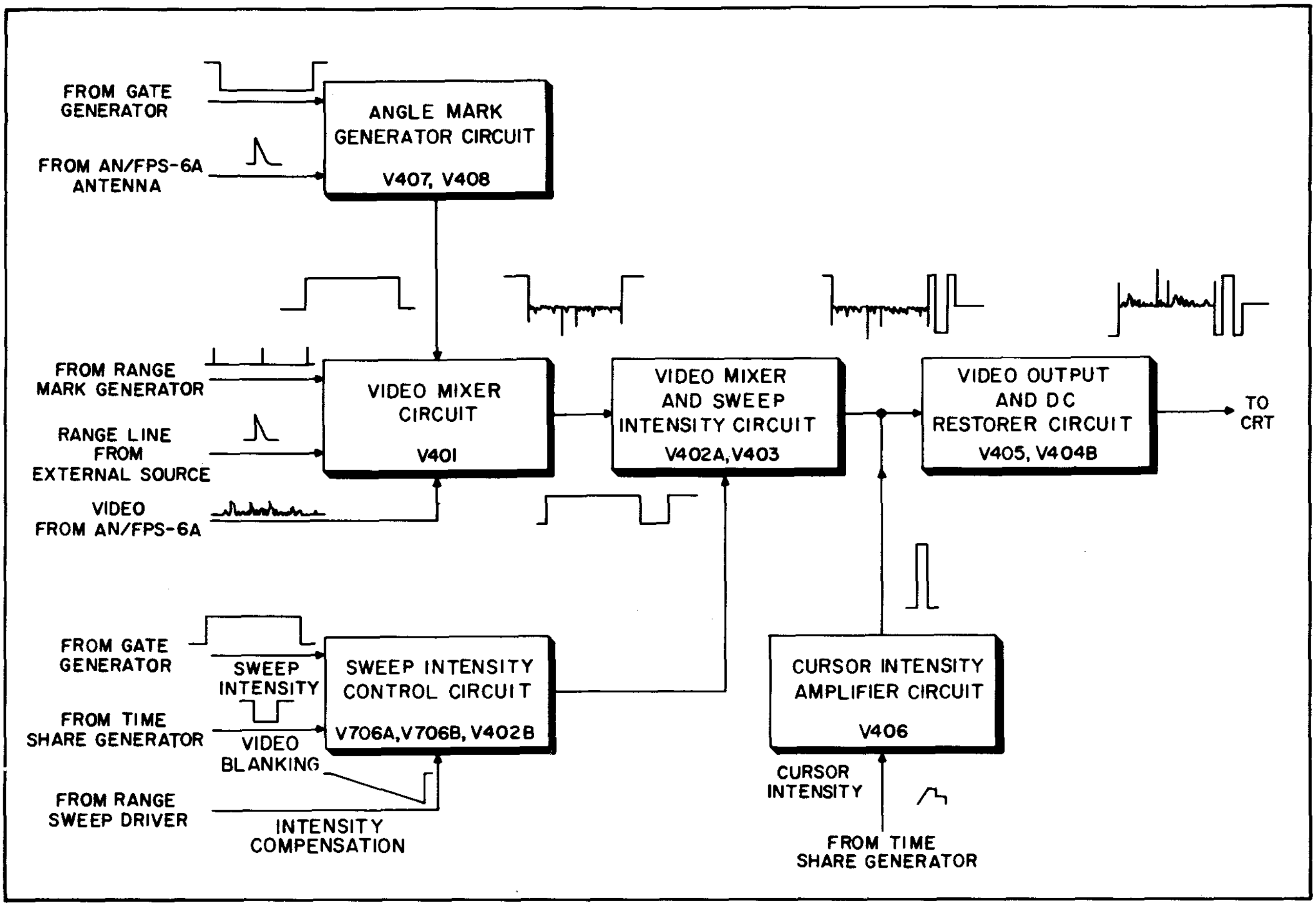


Figure 4–234. Video Amplifier, Block Diagram

4–1596. BLOCK DIAGRAM OF VIDEO AMPLIFIER. (See figure 4–234.)

4–1597. The video amplifier controls the intensity of the CRT beam and thus causes the display of the range height trace (with video and nonvideo signals superimposed) and of the cursor. Video signals are target returns supplied by Radar Set AN/FPS-6A; nonvideo signals are angle and range marks generated within the indicator and range line marks supplied by an external source (remote PPI indicator). Angle marks are produced within the video amplifier. Video and nonvideo signals are intensity-modulated signals impressed upon the range height trace by the video amplifier circuits which form a common path for all signals intended for display upon the trace. The video amplifier also contains circuits which maintain a constant trace brightness for all ranges and cause the cursor presentation. These circuits of the video amplifier are: the angle mark generator, video mixer, sweep intensity control, video mixer cathode follower, sweep intensity amplifier, cursor intensity amplifier, and the video output amplifier and d-c restorer.

4–1598. The angle mark generator produces a positive angle mark gate for every combination of an angle mark trigger pulse and negative gate pulse received. Angle mark trigger pulses are received from the antenna and negative gate pulses from the gate generator. The angle mark generator circuit is composed of trigger amplifiers V407A and V407B, angle mark multivibrator V408, and front panel ANGLE MARK control R51. An angle mark trigger pulse is produced at the antenna for every 5-degree arc through which the antenna passes. Negative gates are produced by the gate generator at the sweep repetition rate of 360 pps in synchronism with the range sweep, and vary in duration according to the sweep length. The function of the angle marks is to increase the intensity of a complete trace once for every 5 degrees of antenna motion. An angle mark is initiated with the receipt of an angle trigger pulse and terminated at the end of the negative gate received after the angle mark trigger. The positive angle mark gates are forwarded to the video mixer circuit.

4–1599. The video mixer circuit receives video information from the normal receiver, range marks from the range mark generator, angle marks from the angle mark generator, and range line marks from an external source. The video mixer is composed of mixer V401, RANGE LINE control R52, RANGE MARK control R53, VIDEO control R57, and ANGLE MARK control R51. This circuit handles the four types of input signals either individually or simultaneously. Simultaneously received signals are mixed to form one composite signal. The signal or composite signal is amplified and passed to the video mixer cathode follower circuit.

4–1600. The sweep intensity control circuits are composed of three cathode followers: a video intensity cathode follower, V706A, receiving positive gates from the gate generator; a video blanking cathode follower, V706B, receiving negative video blanking gates from the time-share gate generator; and an intensity compensation cathode follower, V402B, receiving negative range sweep signals from the range sweep driver. SWEEP control R54 and INT COMP control R105 are also included in the sweep intensity circuit. The three circuits combine their outputs to produce video intensifier gates which are applied to the sweep intensity amplifier to establish its conducting time. The duration of a positive video intensifier gate is usually determined by the length of the positive gates received by the video intensity cathode follower. The duration of a positive gate is equal to sweep duration. Thus, the sweep intensity amplifier is permitted to conduct only during sweep time.

4–1601. As range is increased, the interval required by the CRT beam to move across the CRT screen to form a trace is also increased. If the intensity of the beam at a high range is adequate for proper visibility, but is not adjusted when the range is decreased, the trace is then less visible because the CRT beam passes across the screen faster. To obtain equal trace brightness at all ranges, an intensity compensation circuit produces a d-c level which is increased or decreased by the video intensifier gates. The resulting composite signal is then applied to the sweep intensity amplifier. This compensation level automatically decreases the sweep intensity as range increases. The intensity compensation circuit consists of a pi-type filter which receives negative range sweep signals from the range sweep driver and produces the compensation level. The compensation level is forwarded by the intensity compensation cathode follower to the point where the video intensifier gates are added. This d-c level becomes proportionately more negative for an increase in range, and vice versa. Consequently, sweep intensity is automatically varied and the brightness of the trace is kept constant at all ranges.

4–1602. A cursor is displayed on the CRT at a rate of 20 pps. The cursor signal is generated at the end of a range height sweep, which recurs at 360 pps. Thus, after every eighteenth range height sweep (the ratio of the two frequencies), a cursor is produced. Since the positive gates produced by the gate generator occur in synchronism with the range height sweep, and negative video blanking pulses recur at the cursor display rate of 20 pps, a negative video blanking pulse occurs after every eighteenth positive gate.

4–1603. A negative video blanking pulse is 375 microseconds in width. Within its duration, the video intensifier gate is held negative whether or not a portion of a positive gate is present. This may occur at high ranges when the interval between successive sweeps is less than 375 microseconds. The 375-microsecond interval is required for the presentation of the cursor; consequently, the range height sweep must be suppressed during this time. The sweep is suppressed when the video intensifier gate is held negative by the video blanking gate. This prevents the sweep intensity amplifier from conducting during cursor display time, especially when the cursor display time overlaps a portion of the following sweep time.

4–1604. Video mixer cathode follower V402A couples the video and nonvideo signals to sweep intensity amplifier V403. The sweep intensity amplifier conducts only during sweep time, as controlled by the video intensifier gates received from the sweep intensity control circuits. During sweep time, a negative sweep gate is produced whose width is equivalent to the sweep time. The amplitude of the negative sweep gate is increased as video and nonvideo signals are received. The negative sweep signals are transferred to the video output amplifier circuit.

4–1605. Outputs from the sweep intensity amplifier follow the same path to the video output amplifier circuit as cursor signals from the cursor intensity amplifier. The cursor intensity amplifier circuit receives a cursor intensifying gate immediately following each eighteenth sweep. This circuit is composed of regenerative amplifier V406 and CURSOR control R55. During its reception, the sweep intensity amplifier is cut off, as explained previously. The cursor intensifying signal is modified from a positive 375-microsecond pulse to a 125-microsecond negative rectangular pulse. The rectangular pulse is forwarded to the video output circuit 125 microseconds after the end of the preceding sweep.

4–1606. The video output amplifier circuit inverts and amplifies sweep and cursor signals and transfers them to the CRT for presentation. This circuit is composed of amplifiers V405 and V406 and AUX INTENSITY control R148. The d-c restorer establishes a static negative CRT control grid voltage which, with no signals applied, holds the CRT cut off. The positive sweep and cursor signals intensify the CRT trace by overriding this negative CRT control grid voltage. The amplitude of these signals determines the intensity of the CRT beam during the duration of the signals. The amplitude of the sweep and cursor gates is sufficient to present a trace. Nonvideo signals are of sufficient amplitude to increase the intensity of this trace slightly during their duration, and thus cause their display on the trace. Video signals are larger in amplitude than nonvideo signals and appear brighter.

4–1607. CIRCUIT ANALYSIS OF VIDEO AMPLIFIER.

4–1608. ANGLE MARK GENERATOR CIRCUIT. Positive rectangular angle mark pulses from the antenna are received and differentiated by capacitor C401 and resistor R401 (figure 4–235). The resulting trigger pulses, first positive and then negative, are applied to the control grid of trigger amplifier V407A.

4–1609. Trigger amplifier V407A is biased slightly above cutoff because of the cathode bias effect of resistor R402 and capacitor C402. Consequently, positive input triggers are amplified, but negative input triggers are suppressed. Both types of triggers are inverted. Thus, the output of trigger amplifier V407A is a large negative, and then a small positive, trigger pulse for each positive rectangular angle mark pulse received from the antenna. These pulses are coupled through capacitor C403 to the control grid of the A half of bistable angle mark multivibrator V408.

4–1610. With no signal applied, the A-half of multivibrator V408 is conducting and the B-half is cut off. When a negative trigger is received by the control grid of tube V408A, this normally conducting half of multivibrator V408 is driven to cutoff. The plate voltage of tube V408A rises rapidly. The sharp increase of the plate voltage of tube V408A is coupled to the grid of tube V408B by capacitor C404, and immediately drives tube V408B into conduction. The plate voltage of tube V408B then drops sharply. This sharp reduction in voltage, coupled through capacitor C403, aids in the rapid cutoff of tube V408A. The existing condition of multivibrator V408 is the reverse of its static condition: tube V408A is cut off and tube V408B is conducting. The multivibrator remains in this state until a negative trigger pulse is applied to tube V408B by sweep trigger amplifier V407B, which then returns the multivibrator to its static state.

4–1611. Negative gates are received from the gate generator at a rate of 360 pps by a differentiator network composed of capacitor C406 and resistor R410. Each negative gate is transformed by the differentiator network into a negative and then a positive trigger pulse. A negative gate occurs in synchronism with a sweep signal and varies in duration according to the range used.

4–1612. The negative and positive pulses produced by the differentiator network of capacitor C406 and resistor R410 are applied to the control grid of sweep trigger amplifier V407B. This amplifier operates in the same manner as trigger amplifier V407A, and therefore delivers a small positive and then a large negative trigger pulse for each negative gate received from the gate generator. The output of trigger amplifier V407B is coupled through capacitor C404 to the grid of tube V408B.

4–1613. Angle mark trigger pulses recur at a slower rate than negative gate pulses. Consequently, angle mark multivibrator V408 can be in either its static condition or in the reverse condition, brought about by the receipt of an angle mark trigger pulse, when a negative gate occurs. If multivibrator V408 is in the static state (tube V408A conducting and tube V408B cut off) when a negative gate occurs, the small positive and then large negative trigger pulse output of trigger amplifier V407B have no affect upon the multivibrator. However, if the multivibrator is in the condition precipitated by the receipt of an angle mark trigger pulse (tube V408A cut off and tube V408B conducting) when a negative gate occurs, the negative trigger output of trigger amplifier V407B returns the multivibrator to its static con-

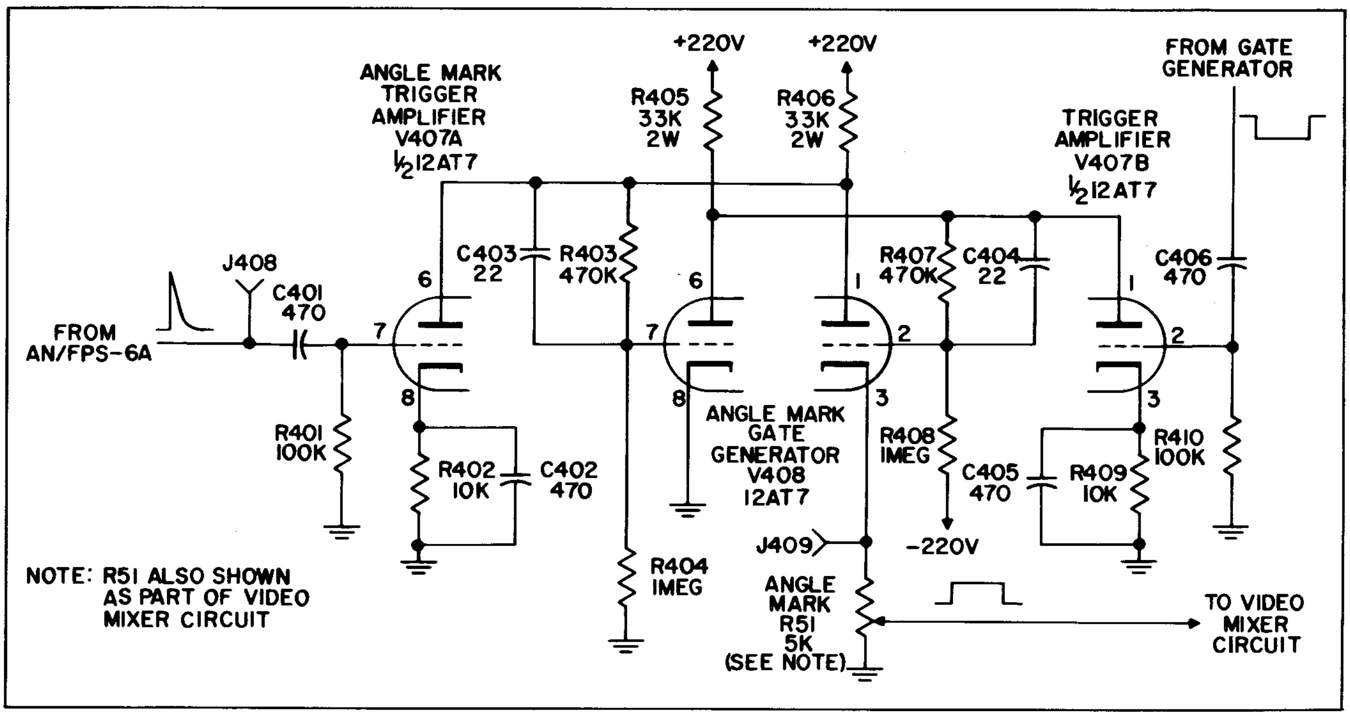


Figure 4–235. Angle Mark Generator, Simplified Schematic Diagram

dition. The positive trigger outputs of both trigger amplifiers V407A and V407B are of insufficient amplitude to have any affect upon the multivibrator.

4–1614. The cathode resistor of tube V408B is ANGLE MARK control R51, which is physically located on the front panel. During the multivibrator operations that occur between the receipt of an angle mark trigger and a negative gate pulse, a positive angle mark gate is developed across control R51. The amplitude of this positive angle mark gate is varied by the movable arm of control R51 and forwarded to the video mixer circuit. The multivibrator is returned to its static condition at the end of a negative gate, which is coincident in time with the sweep. Therefore, the angle mark gates are terminated at the end of the sweep during which they occur.

4–1615. VIDEO MIXER CIRCUIT. Video signals (targets) from Radar Set AN/FPS-6A are developed across VIDEO control R57 (figure 4–236), which is mounted on the front panel. A portion of the amplitude of the video signal is tapped from this control by its movable contact and coupled through capacitor C407 to the control grid of video mixer V401. In this manner, VIDEO control R57 controls the amplitude of the video signals applied to the video mixer. The amplitude of the video signal ultimately determines the video intensity. In a similar manner, the intensity of the range and angle marks and the range line pulses are controlled by RANGE MARK control R53, ANGLE MARK control R51, and RANGE LINE control R52, respectively. These controls are also mounted on the front panel. The range and angle marks and the range line pulses are coupled from the movable contact of their respective intensity controls and applied to the suppressor grid of video mixer V401 through coupling diodes CR401, CR402, and CR403, respectively.

4–1616. Video mixer V401 conducts lightly during its steady state because of the control grid voltage developed by the voltage divider formed by resistors R413 and R414. Resistor R415 is the plate load resistor and L401 is a video peaking coil which increases the gain of the video mixer for video signals only.

4–1617. Upon receipt of any of the four types of input signals, the conduction of video mixer V401 increases, causing a drop in plate voltage. The input signals appear at the plate as negative amplified pulses.

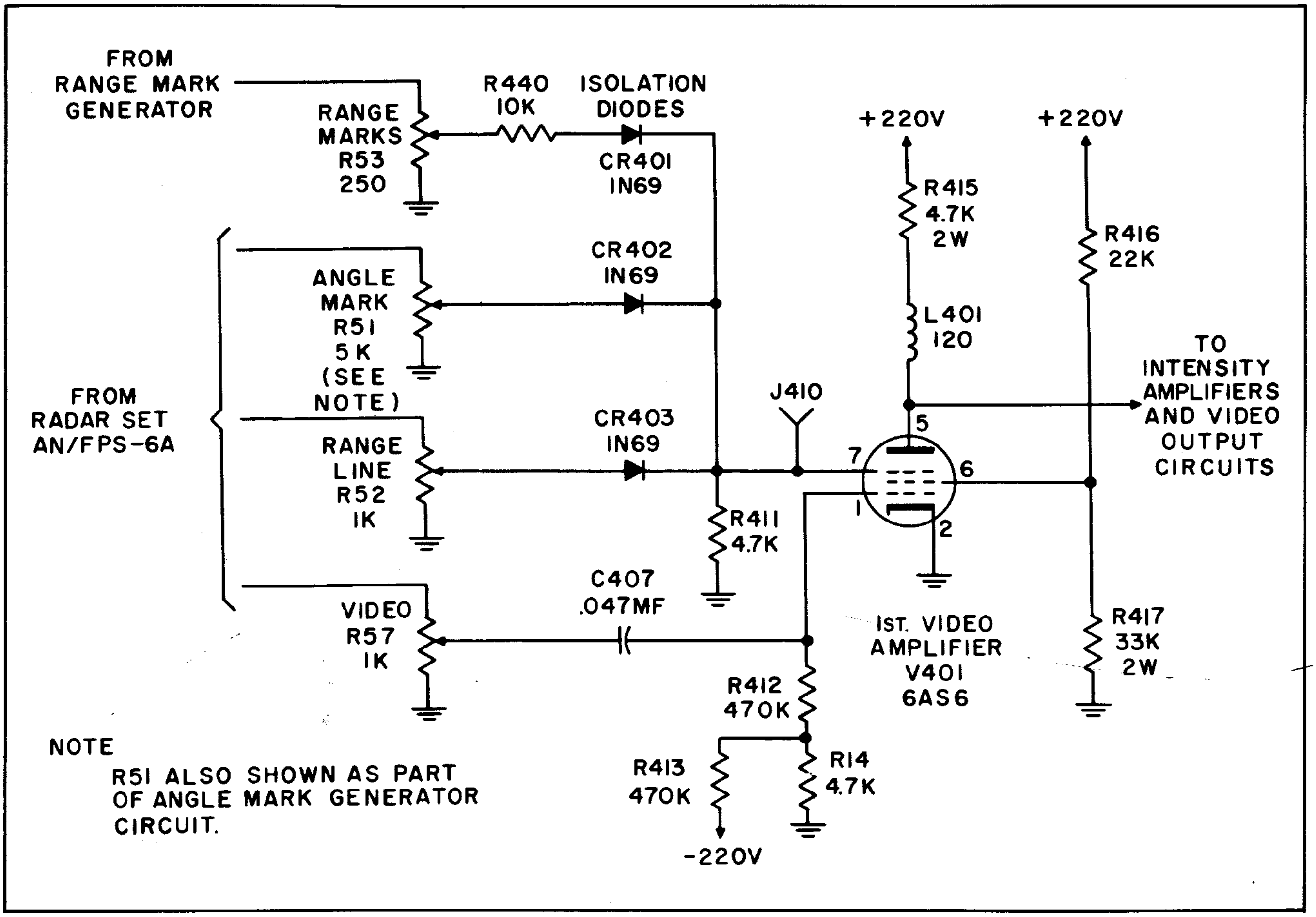


Figure 4–236. Video Mixer, Simplified Schematic Diagram

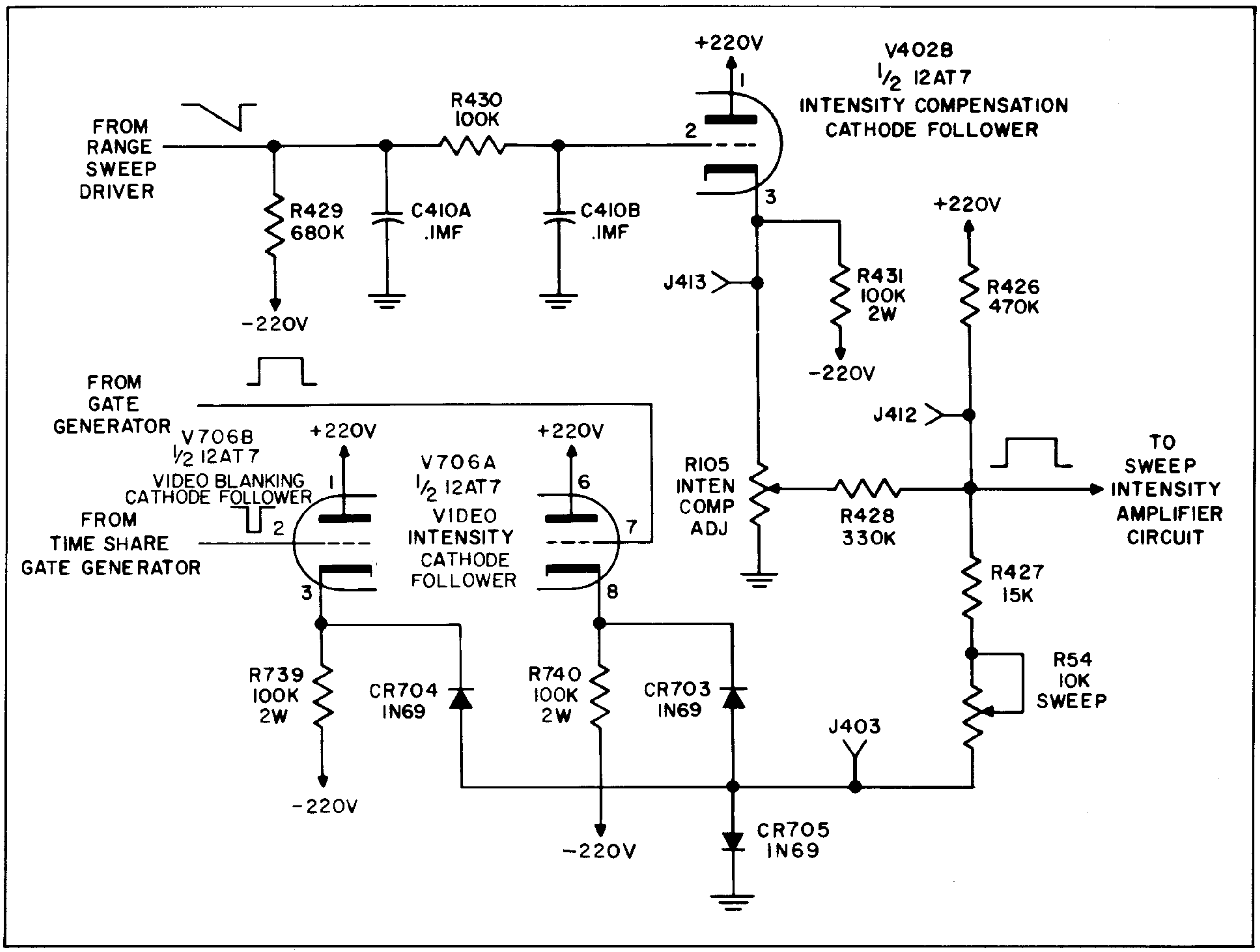


Figure 4–237. Sweep Intensity Control Circuit, Simplified Schematic Diagram

However, because the video signals are applied to the control grid and the other input signals to the suppressor grid, and due to the peaking action of coil L401, the video signals are amplified more than the range and angle marks and the range line pulses. The negative signals developed at the plate of video mixer V401 are forwarded to the video mixer cathode follower circuit.

4–1618. SWEEP INTENSITY CONTROL CIRCUIT. Positive rectangular gate pulses, whose variable duration is equivalent in time to that of the selected range (sweep length), are applied to the control grid of video intensity cathode follower V706A by the gate generator (figure 4–237). Negative rectangular, 375-microsecond video blanking pulses, which recur at the set rate of 20 pps, are applied by the time-share gate generator to video blanking cathode follower V706B. The cathodes of cathode followers V706A and V706B are connected to a common point through clamping diodes CR703 and CR704, respectively. Clamping diode CR705 is also connected to this common point from ground.

4–1619. Positive gate pulses are produced at a repetition rate of 360 pps, which is considerably faster than the 20-pps rate at which the video blanking pulses are produced. When generated, a negative video blanking pulse occurs immediately following a positive gate pulse. Because of the difference in frequencies, a negative video blanking pulse is received by video blanking cathode follower V706B during the interval following every eighteenth positive gate. As the range is increased, the interval between successive positive gates (between the end of one sweep and the triggering of the next) decreases. On the highest range, the video blanking pulse overlaps a portion of the positive gate. Consequently, at maximum range, the negative video blanking pulse causes the CRT to be blanked during approximately the first 20 miles of every eighteenth sweep.

4–1620. Initially, diode CR705 conducts, placing the anodes of diodes CR703 and CR704 at approximately ground potential. However, if one or both of the cathodes of cathode follower V706 become negative, its clamping diode conducts, thereby clamping the voltage at the common point at virtually the voltage on the negative cathode. In the reverse condition, when both cathodes are positive with respect to ground, the ground potential at the common point cuts off clamping diodes CR703 and CR704, and diode CR705 clamps the common point at approximately ground potential.

4–1621. During the application of a positive gate pulse, the cathode voltage of video intensity cathode follower V706A rises and clamping diode CR703 is cut off. At the same time, the cathode of video blanking cathode follower V706B is also positive because a negative video blanking pulse is not generated during a positive gate. Thus, clamping diode CR704 is also cut off. Clamping diode CR705 then conducts and places the ground potential on the common point. This condition occurs during each sweep.

4–1622. When a positive gate pulse falls, the cathode of cathode follower V706A drops to approximately −11 volts. Clamping diode CR703 then conducts and clamps the common point at approximately −11 volts. Similarly, when a negative video blanking pulse is received, the cathode of cathode follower V706B falls to the negative amplitude of the blanking pulse and diode CR704 conducts and clamps the common point at almost the negative cathode potential. This condition occurs at the end of a sweep and persists until the initiation of the next positive gate or termination of the video blanking pulse.

4–1623. SWEEP control R54 and resistors R427 and R426 are connected in series between the common point of the clamping diodes and +220 volts. Resistor R428 and INT COMP control R105 are connected between the junction of resistors R426 and R427 and the cathode of intensity compensation cathode follower V402B. The voltage at the junction of resistors R426 and R427 and control R105 is applied to the control grid of the sweep intensity amplifier.

4–1624. Negative sawtooth sweep signals from the range sweep driver circuit are applied to the junction of resistors R428 and R430. Resistor R430 is part of a pi-type filter which also contains capacitors C410A and C410B. This filter converts the negative sawtooth signals into a d-c level which varies with range. As the range increases, the d-c level becomes more negative, and vice versa. This level is applied to the control grid of intensity compensation cathode follower V402B. In its operation, the cathode voltage of the cathode follower is approximately equal to the d-c level on the grid. This voltage is varied and applied by INT COMP control R105 to the sweep intensity amplifier. The purpose of this level is to maintain a constant sweep brightness on all ranges by controlling the d-c level of the sweep intensity amplifier. Control R105 is used as a final adjustment compensation through which the intensity compensating level is applied to the control grid of the sweep intensity amplifier.

4–1625. The variation of the potential at the common point of diode clamps CR703, CR704, and CR705 also affects the sweep intensity amplifier control grid voltage. As explained previously, the common point to which the clamp diodes are connected is at ground potential during a positive gate. For the duration of these positive gates, the amplitude of the d-c level applied to the control grid of the sweep intensity amplifier is sufficient to intensify the sweep so that it is visible on the CRT. During this sweep time, SWEEP control R54 controls the brightness of the sweep. At the end of the sweep and of the positive gate, the potential at the common point of rectifiers CR703, CR704, and CR705 falls to a negative voltage. This drop in voltage is also felt at the junction of resistors R426 and R427 and at INT COMP control R105 (the control grid of the sweep intensity amplifier), causing the sweep intensity amplifier to be driven toward cutoff. The sweep is blanked at this time and is not visible on the CRT.

4–1626. In summary, the intensity compensation level which can be varied by INT COMP control R105 sets the d-c level at the control grid of the sweep intensity amplifier. The intensity compensation level is developed by the pi-type filter connected to the intensity compensation cathode follower. The potential at the common connection of the clamping diodes is ground during a sweep and negative between sweeps. This change in voltage is reflected at the control grid of the sweep intensity amplifier by a positive or negative swing of the intensity compensation d-c level. This action allows the sweep intensity amplifier to conduct during a sweep and to be cut off between sweeps.

4–1627. VIDEO MIXER CATHODE FOLLOWER AND SWEEP INTENSITY AND CURSOR INTENSITY AMPLIFIER CIRCUIT. Negative video and marker signals from the video mixer are coupled through capacitor C408 to the control grid of video mixer cathode follower V402A (figure 4–238). Resistor R422 is a common cathode resistor for cathode follower V402A and sweep intensity amplifier V403. The negative video and marker signals are cathode coupled from cathode follower V402A to sweep intensity amplifier V403 by means of resistor R422.

4–1628. As explained in paragraph 4–1626, the control grid of sweep intensity amplifier V403 is positive during a sweep and below cutoff potential between sweeps. During a sweep, when no signals are applied, sweep intensity amplifier V403 conducts sufficiently to intensify the CRT beam so that the sweep trace is visible. When a negative video or marker signal is received during a sweep, the conduction of sweep intensity amplifier V403 increases. This raises the CRT beam intensity and trace brilliance for the duration of the video or marker signal.

4–1629. Resistor R423 and video peaking coil L402 comprise the common plate load for both sweep in-

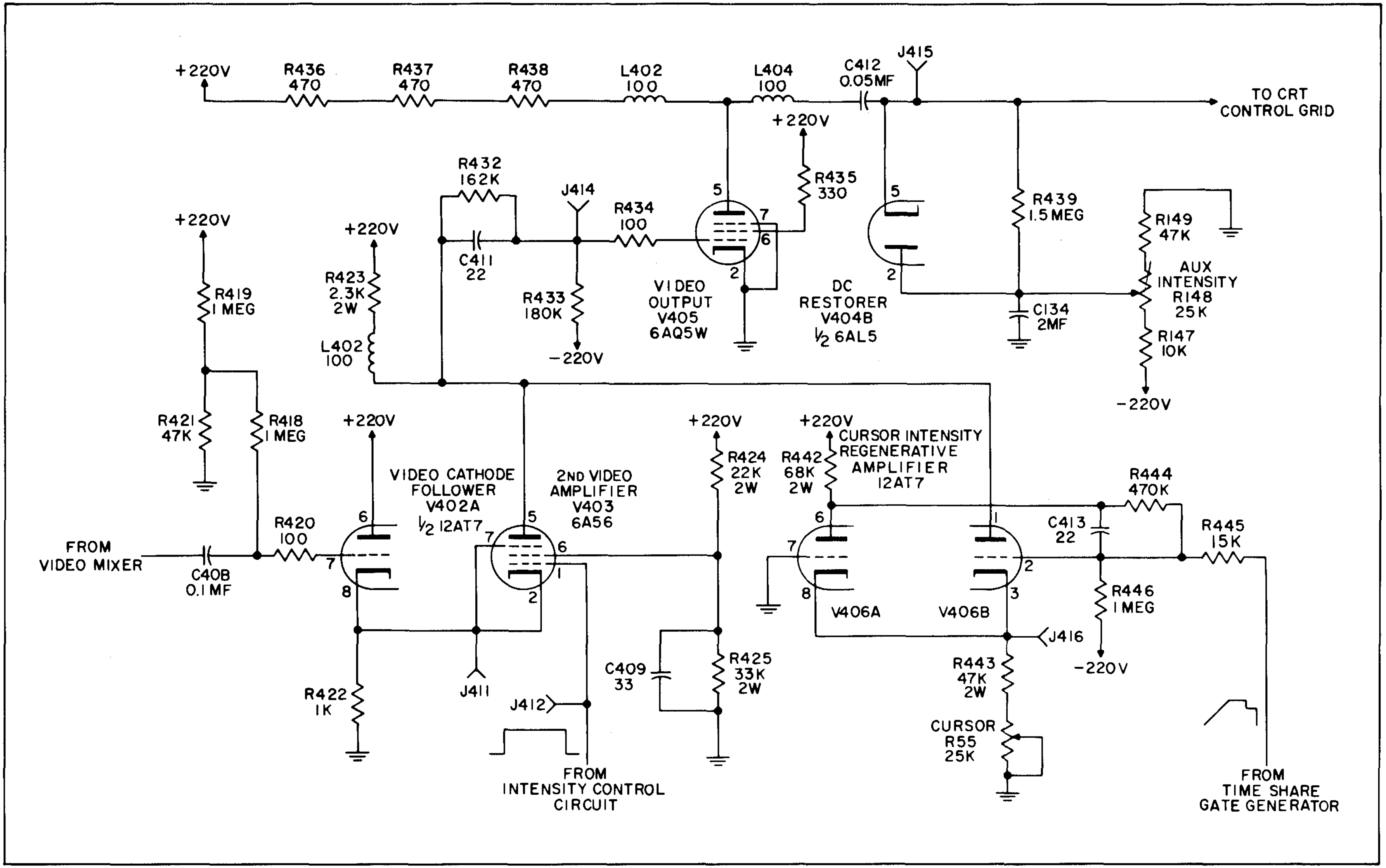


Figure 4–238. Intensity Amplifiers and Video Output Circuits, Simplified Schematic Diagram

tensity amplifier V403 and cursor intensity amplifier V406. In addition, resistors R432 and R433, together with capacitor C411, form the common coupling path from sweep intensity amplifier V403 and cursor intensity amplifier V406 to the video output circuit.

4–1630. A positive cursor intensifying gate, recurring at the rate of 20 pps in synchronism with the cursor sweep, is applied by the time-share gate generator through resistor R445 to the control grid of one-half of cursor intensity amplifier V406. During the static condition, this half of amplifier V406 is maintained at cutoff by the conduction of the opposite half, the degenerative effect of common cathode resistor R443 and CURSOR control R55, and by a negative control grid potential.

4–1631. The duration of a cursor intensifying gate received from the time-share gate generator is 375 microseconds. The first 125 microseconds are occupied by a linear positive rise in voltage from approximately —40 volts to 0 volt. During the next 125 microseconds, the amplitude of the cursor intensifying gate remains constant at 0 volt. At the completion of the second 125-microsecond interval within the cursor intensifying gate, the amplitude rapidly falls to approximately —11 volts and remains at this voltage for the remaining 125-microsecond interval. When the cursor intensifying gate is terminated, the amplitude immediately drops to the static —40-volt d-c level.

4–1632. When a cursor intensifying gate is received, the negative bias is overcome during the 125-microsecond period in which the gate is at 0 volt. Normally cut off amplifier V406B then conducts and the common cathode voltage rises. As the cathode voltage becomes positive with respect to ground, normally conducting tube V406A is cut off because of the degenerative effect of the common cathode resistance. The plate voltage of the normally cut off half then increases. This increase in voltage is coupled through capacitor C413 and resistor R444 as regenerative feedback, thereby aiding conduction of the normally cut off half of cursor intensity amplifier V406. This half of cursor intensity amplifier V406 continues to conduct for the 0-volt, 125-microsecond duration of the positive cursor intensifying gate.

4–1633. At the completion of the 125-microsecond interval during which the cursor intensifying gate is at 0 volt, the amplitude drops to approximately —11 volts. The conducting half of cursor intensity amplifier V406 is driven to cutoff and remains cut off until the receipt of another cursor intensifying gate. As a result of the effect of the cursor intensifying gate, a negative 125-microsecond rectangular pulse is developed at the plate of the normally cut off half of cursor intensity amplifier V406 and coupled to the video output amplifier circuit. This action occurs at the cursor sweep rate of 20 pps at a period of 125 microseconds after every eighteenth range sweep.

4–1634. CURSOR control R55 is used to control the amplitude of the 125-microsecond negative rectangular pulse coupled to the video output circuit. Control R55 accomplishes this by determining the amount of current drawn through tube V406B and plate load resistor R473. If control R55 is set for minimum resistance, maximum current is drawn through the plate load resistor and a maximum amplitude intensifying pulse is developed; conversely, minimum current is drawn when control R55 is set for maximum resistance.

4–1635. VIDEO OUTPUT AMPLIFIER AND D-C RESTORER CIRCUIT. Negative video and marker pulses are applied to the control grid of video output amplifier V405 (figure 4–238) during a sweep. At an interval of 125 microseconds after every eighteenth sweep, a 125-microsecond negative cursor signal is applied to the control grid of amplifier V405. The input signals are amplified, inverted and coupled through video peaking coil L404 and capacitor C412 to the CRT control grid.

4–1636. During the absence of the video and cursor signals, a d-c blanking level of —155 volts charges capacitor C412. This places a potential of more than —155 volts on the control grid of the CRT and on the cathode of d-c restorer V404B. Restorer V404B is thus permitted to conduct, decreasing the negative charge on capacitor C412 to a level slightly less than —155 volts. Capacitor C412 maintains this level because the value of resistor R439 is sufficiently large to permit capacitor C412 to discharge only a small amount. The positive-going video signal is coupled to the control grid of the CRT through capacitor C412. As a result of the stored potential, capacitor C412 restores this video signal to a level slightly less than —155 volts. The amplitude of the positive-going video signal is sufficient to intensify the CRT for video display.

4–1637. POWER SUPPLIES.

4–1638. GENERAL. Radar Set AN/FPS-6A supplies 115-volt, 60-cps, single-phase power for the operation of all power supplies within Indicator Group OA-929/FPS-6A. Regulated supplies of —220, +220, and —90 volts are used to supply all voltages for the circuits in the RHI. An unregulated +250-volt power supply is used for the servo motor and the CRT deflection coils and a 10-kilovolt power supply for the CRT anode. An 8- to 10-volt unregulated, selenium rectifier power supply provides voltage for the RELATIVE height dial clutch.

4–1639. —220-VOLT POWER SUPPLY. A source voltage of 115 volts ac from Radar Set AN/FPS-6A is applied to the primary of power transformer T912 (figure 7–150). This voltage is stepped up across each half of the secondary and applied to full-wave rectifiers V913 and V914. Choke coil L912 and filter capacitors C914 through C916 compose an L-type choke input filter which maintains a constant d-c potential for the voltage regulator and control circuits.

4–1640. The negative 220 volts is obtained from the center tap of transformer T912 to ground across the indicator load and voltage divider resistors R983 and R985 and voltage reference tube V966. Series regulators V961 and V962, control tube V964B, and regulator amplifier V965 compose an automatic voltage regulator and maintain a steady —220-volt d-c output at terminals 4 and 12 of terminal board TB922. Reference voltage cathode follower V963 provides a constant, low-impedance voltage source for regulator amplifier V965.

4–1641. Automatic zero correction tube V964A effects regulator action if the d-c reference voltage of Radar Set AN/FPS-6A is altered or the —220-volt level changes with respect to the d-c reference voltage. When the d-c reference voltage increases (goes more positive), an automatic zero correction signal of negative polarity is applied to the control grid of tube V964A. This negative signal initiates regulator action to increase (make more negative) the —220-volt output in proportion to the change in the d-c reference supply. If the d-c reference voltage decreases (becomes less positive), a positive signal is supplied to the control grid of tube V964A, thus correspondingly decreasing (making less negative) the —220-volt output.

4–1642. +220-VOLT POWER SUPPLY. The +220-volt power supply is similar to the —220-volt power supply. The +220-volt power supply (figure 7–150) consists of rectifiers V911 and V912, series regulators V931 and V932, regulator amplifier V933, and voltage and amplifier-comparator tube V934. Rectifiers V911 and V912 operate in the same manner as full-wave rectifiers V913 and V914 in the —220-volt power supply (paragraph 4–1639).

4–1643. The +220-volt output is developed across the indicator load and applied to voltage divider resistors R951 and R952 from transformer T911. Series regulators V931 and V932, regulator amplifier V933, and voltage and amplifier-comparator tube V934 comprise an automatic voltage regulator which holds the positive output at a voltage level proportional to the value of the —220 voltage (+220 volts nominal).

4–1644. The automatic zero corrector circuit initially sets the junction of voltage divider resistors at 0 volt, thereby placing this potential on the control grid of tube V934A. The automatic zero corrector circuit also maintains a zero potential at the junction of resistors R951 and R952 when component values change and are not compensated by regulator action. This compensation is provided by the automatic zero corrector circuit, which supplies the necessary voltage to the control grid of tube V934. This input maintains the potential at the junction of resistors R951 and R952 at 0 volt. Capacitor C933 provides a feedback path for high-frequency noise on the +220-volt output.

4–1645. Voltage divider resistors R951 and R952 maintain a constant 0-volt level at the control grid of tube V934A with respect to the —220-volt reference input. When the —220-volt reference level increases (becomes more negative), a negative error voltage is present at the control grid of regulator amplifier V933, initiating regulator action and proportionally raising (making more positive) the +220-volt output. The junction of resistors R951 and R952 remains at 0 volt regardless of the change in the —220-volt reference level because each resistor drops an equal amount of voltage. Similarly, when the —220-volt reference level becomes less negative, regulator action occurs causing the +220-volt output to become proportionately less positive. This same voltage regulator action occurs to compensate for load variations which increase or decrease the +220-volt output.

4–1646. —90-VOLT POWER SUPPLY. The —90-volt power supply consists of voltage divider resistors R781 and R782, amplifier-comparator V781, error amplifier V782A, and error cathode follower V782B (figure 7–147). A voltage of —90 volts is developed across voltage divider resistors R796 through R798 and is tapped at the cathode of error cathode follower V782B.

4–1647. The junction of resistors R781 and R782 and the control grid of tube V781A are initially set at 0 volt by the automatic zero corrector circuit. This circuit also compensates for component value variations by supplying the necessary voltage to maintain the junction of resistors R781 and R782 at zero potential. Since the +220-volt input varies proportionally when the —220-volt reference level changes, the junction of resistors R781 and R782 is maintained at a constant zero potential. However, the —90-volt output varies proportionally with the change of the +220- and —220-volt references.

4–1648. When the load of the —90-volt power supply increases, the current through cathode resistors R796 through R798 also increases. The voltage at the cathode of cathode follower V782B therefore decreases and a negative-going voltage is applied to the control grid of tube V781A. This error signal is inverted by amplifier V782A and subsequently applied to the control grid of cathode follower V782B, returning the cathode voltage to —90 volts. Similarly, if the load of the —90-volt power supply decreases, regulator action occurs in reverse to stabilize the —90-volt output.

4–1649. +250-VOLT UNREGULATED POWER SUPPLY. A source voltage of 115 volts ac is applied to the primary of power transformer T913 from Radar Set AN/FPS-6A (figure 7–150). This voltage is stepped up across each half of the secondary to provide the plate potential for rectifiers V915 and V916. A full-wave output is obtained from these rectifiers and applied to two series-connected L-type filters, which maintain a steady d-c output. A +250-volt unregulated d-c output is supplied to the CRT deflection coils and to the servo drive motor of Indicator Group OA-929/FPS-6A.

4–1650. RELATIVE HEIGHT COUNTER CLUTCH POWER SUPPLY. A source voltage of 115 volts ac is

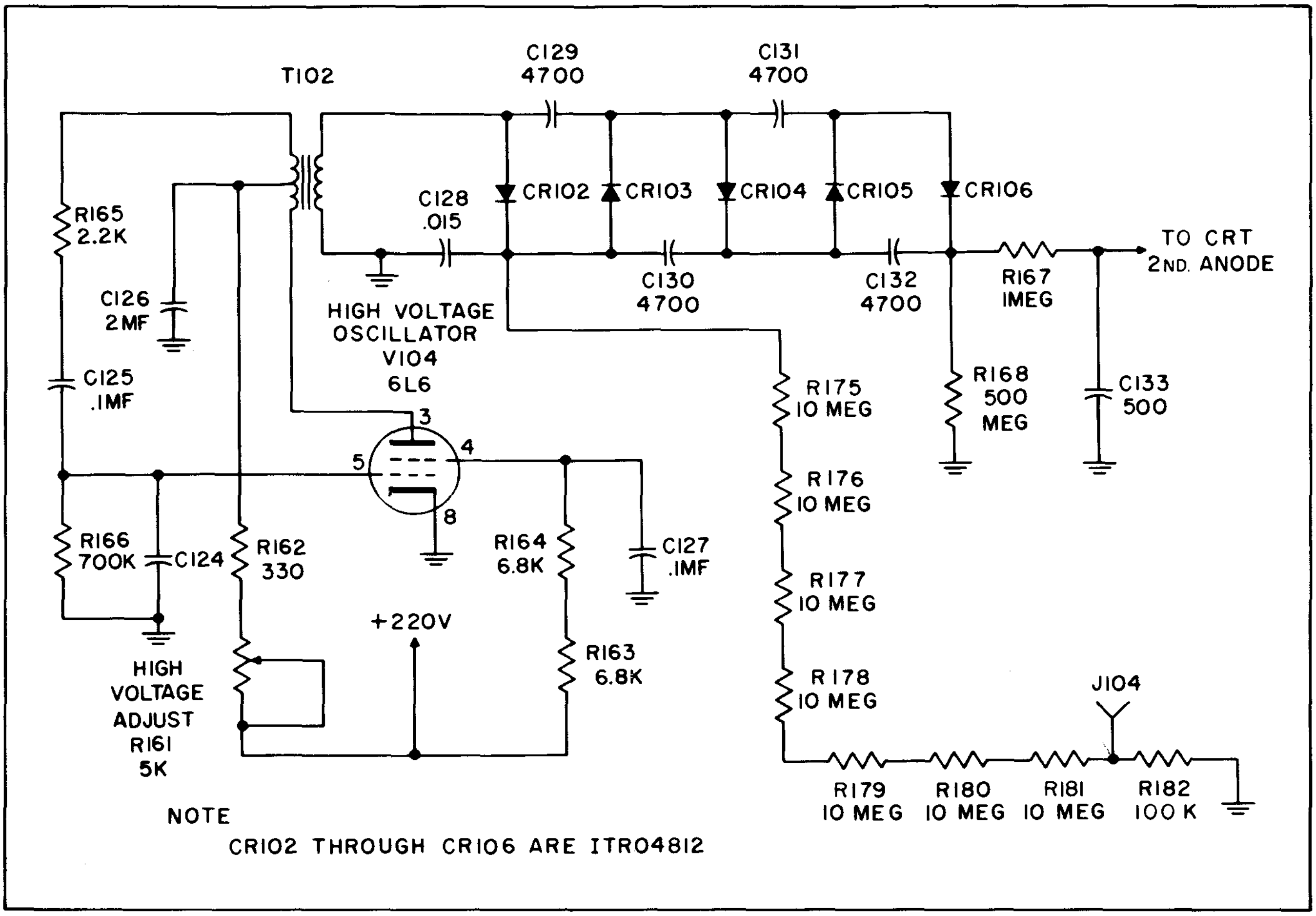


Figure 4–239. High-voltage Supply, Simplified Schematic Diagram

applied to the primaries of power transformers T103 and T104. The secondaries of these transformers step down the applied 115 volts ac to 6.3 volts each. The secondaries of these transformers are connected in series, resulting in 12.6 volts. This voltage is rectified by full-wave selenium rectifier CR101 and filtered by capacitor C123, providing an unregulated 8- to 10-volt d-c supply. This d-c voltage is applied to coil L51 to energize the relative height counter clutch. Coil L51 is energized only when the RELATIVE-ABSOLUTE switch S53 is operated to the RELATIVE position.

4–1651. HIGH-VOLTAGE POWER SUPPLY. Free-running audio-frequency oscillator V104 generates continuous audio-frequency oscillations which are applied as a voltage source to the voltage multiplier. The plate and control grid of oscillator V104 (figure 4–239) are tied to opposite ends of the primary of transformer T102. Because of a tap on transformer T102, only a portion of the plate voltage is fed back regeneratively to the grid circuit, resulting in continuous oscillations whose frequency is determined by the circuit component values. The a-c voltage present at the primary of transformer T102 is stepped up to approximately 2 kilovolts at the secondary. The voltage multiplier connected across the secondary of transformer T102 increases the 2 kilovolts to approximately 10 kilovolts at the output. This is accomplished by sequentially adding the voltages to which capacitors C128 through C132 are charged in relation to the 2 kilovolts at the secondary of transformer T102. A series resistance network composed of resistors R175 through R182 permits current readings at test point J104. High-voltage adjust control R161 varies the magnitude of the screen grid potential of oscillator V104, thereby controlling the amplitude of the oscillations produced at the plate of oscillator V104. Thus, high-voltage adjust control R161 controls the amplitude of the signal across the primary of transformer T102 and the output of the high-voltage power supply. A filter network composed of resistor R167 and capacitor C133 smooths the 10-kilovolt output to the CRT. Resistor R168 is the bleeder resistor for the 10-kilovolt output.

4–1652. BLOCK DIAGRAM OF AUTOMATIC ZERO CORRECTOR. (See figure 4–240.)

4–1653. The automatic zero corrector insures that the reference level of certain critical circuits of the equipment are maintained at a constant zero potential. The voltages sampled by the automatic zero corrector are normally at zero potential from the summing junction

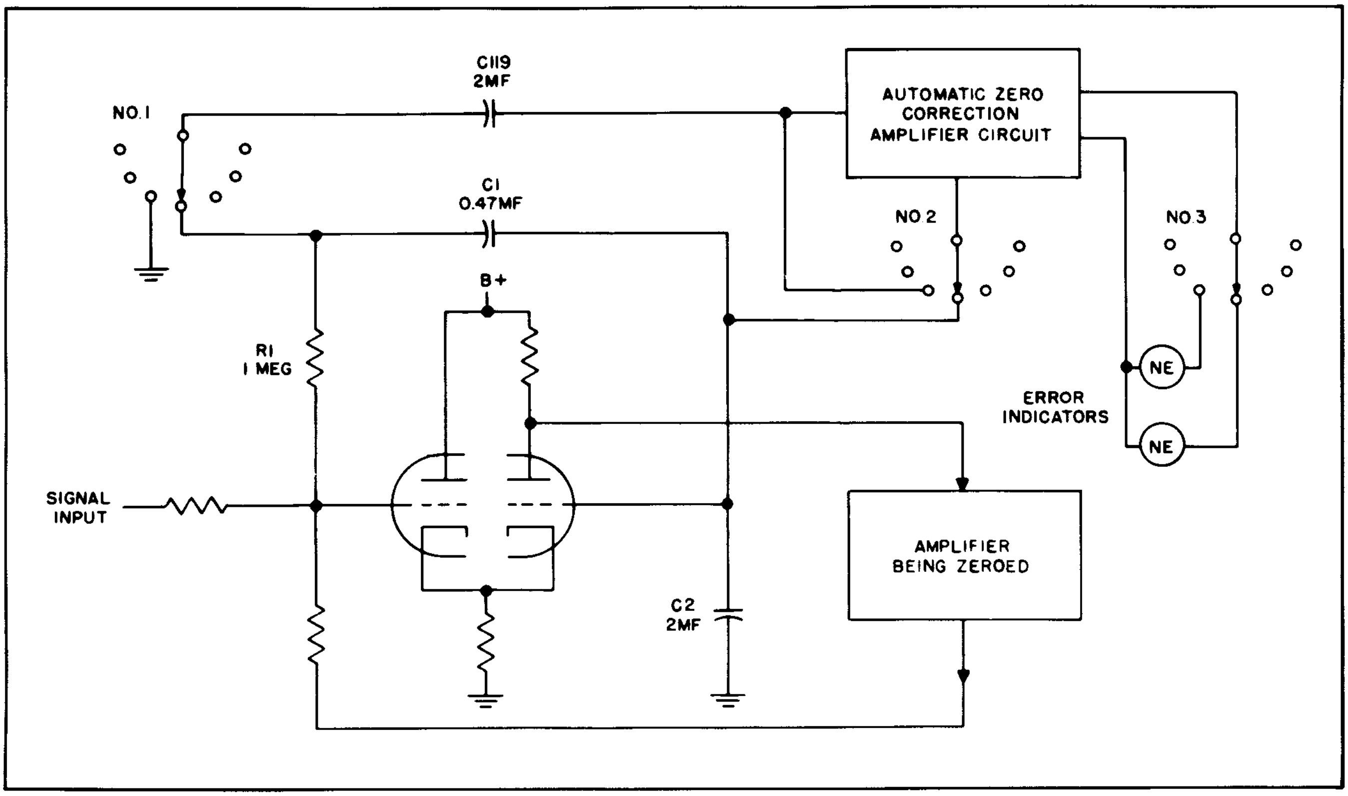


Figure 4-240. Automatic Zero Corrector, Block Diagram

of a feedback amplifier. If the sampled voltage is not zero, the automatic zero corrector supplies the necessary voltage to the sampled circuit to return its voltage to 0 volt.

4-1654. The automatic zero corrector consists of a motor-driven stepping switch, an automatic zero correction amplifier circuit, storage capacitors, error indicators, and a system reference comparator. The automatic zero corrector samples the operation of the automatic zero control amplifier. In addition, the following samples are applied to the automatic zero corrector:

a. Range sweep generator

b. Range sweep clamp

c. Range sweep driver

d. Height sweep generator

e. Height sweep clamp

f. Height sweep driver

g. +220-volt regulator

h. —90-volt regulator

i. —220-volt regulator

4-1655. CIRCUIT ANALYSIS OF AUTOMATIC ZERO CORRECTOR.

4-1656. When a-c power is applied to the RHI, motor-driven switch Z101 starts rotating. When this switch is in the second position (figure 4-241), the movable contact of deck 1 receives a sample voltage from the amplifier-comparator of the range sweep generator. The input is obtained from capacitor C101, which is charged to the difference in potential of the sample and correction control grids of the amplifier-comparator. The voltage from capacitor C101 is applied to the control grid of amplifier V751A. The polarity of the signal from the plate of amplifier V751 is the same as that of the applied signal, since coupling is from the control grid of amplifier V751A to the common cathode and then to the plate of amplifier V751B. The signal at the plate of amplifier V751B is applied to the control grid of amplifier V752. An inverted signal is then developed at the plate of amplifier V752 and coupled to the control grid of amplifier V753A. Two signals are developed by amplifier V753A. The signal at the cathode is used both as a degenerative a-c feedback to the cathode of amplifier V751 and as the input to deck 2, the correction deck, of switch Z101. The plate of amplifier V753A supplies the voltage for illumination of the error indicators.

4-1657. The positive and negative limits (±3.2 volts) of the voltage applied to the correction deck of switch Z101 from the cathode of amplifier V753A are clamped by rectifiers CR701 and CR702, respectively. The voltage at the junction of these rectifiers is applied to the movable contact of deck 2 of switch Z101. This voltage controls the charge of capacitor C102, which is the storage capacitor for the amplifier-comparator of the range sweep generator. The charge of capacitor C102 is applied directly to the correction control grid of the amplifier-comparator. Cathode follower action occurs and the voltage at the sample grid returns to its normal potential of 0 volt.

4–1658. All error indicators are connected between the plates of amplifiers V753A and V753B and in parallel with capacitor C754. When the sample voltage applied to the automatic zero control amplifier exceeds the limit for which a correction voltage can be produced by the circuit, front panel ERROR indicator DS51 and calibration panel RG SWP GEN error indicator DS101 light. The voltage at the plate of amplifier V753A is applied to one side of both indicators through deck 3 and the control grid of amplifier V753B. The plate voltage of amplifier V753B is applied to the other side of the indicators. The difference in potential across the indicators is applied to capacitor C754, and when the capacitor is charged to this voltage, the indicators light.

4–1659. The voltage sampled by the automatic zero corrector from certain circuits, such as the range and height sweep drivers, is normally 0 volt. If, because of component value variations, the sampled voltage is other than 0 volt, the automatic zero corrector supplies the voltage to the sampled circuit, which is necessary to return the sample voltage to 0 volt. In this manner, the automatic zero corrector provides the initial zero potential to the sampled circuits for proper operation.

4–1660. During system operation of the RHI, EXT DC REF-INT DC REF switch S105 is in the EXT position. An input from Radar Set AN/FPS-6A is applied to the system reference comparator circuit through switches S105 and Z101 and the automatic zero control amplifier circuit. The input voltage from Radar Set AN/FPS-6A is normally +275 volts dc. When this voltage increases, the output of the —220-volt power supply of the RHI becomes more negative. Since the —220-volt power supply controls the +220- and —90-volt power supplies, these outputs also vary. The +220-volt output becomes more positive and the —90-volt output more negative.

4–1661. The input and output lines to and from the automatic zero control regulator control the —220-volt regulator. When switch S105 is placed in the INT DC REF position, these lines are placed at ground potential. Therefore, the only regulation of the —220-volt power supply is normal series regulator action, controlled by the voltage regulator tube and resistor R985. The INT DC REF position of switch S105 is used only during calibration and maintenance procedures, or with Radar Set AN/FPS-6 systems which do not have a system reference voltage.

4–1662. The automatic zero corrector circuit checks itself 6 times during the 16 sampling operations which occur in 1 sampling cycle. The control grid of amplifier V751A is normally at zero potential; however, if component value variations occur, the control grid of amplifier V751A may be at some potential other than 0 volt. When this error potential exists, an output from the automatic zero corrector charges storage capacitor C119. This capacitor is charged in such a direction and amplitude as to cancel this error voltage and return the control grid of amplifier V751A to 0 volt. This self-checking operation facilitates accurate sampling of the circuits in the equipment by the automatic zero corrector.

4–1663. RAID SIZE INDICATOR (INDICATOR GROUP OA-1040/GPA).

4–1664. BLOCK DIAGRAM. (See figure 4–242.)

4–1665. GENERAL. The gate generator circuit of the raid size indicator (RSI) supplies a rectangular pulse to the sweep generator and the intensifier circuits. The leading edge of this pulse is initiated by a positive trigger from the system PPI. The trailing edge of the rectangular pulse is the result of a positive sweep voltage feedback from the sweep driver circuit. The duration of the output of this rectangular pulse determines the length of the sweep and the period of time that the CRT is unblanked.

4–1666. The positive-going portion of the rectangular pulse from the gate generator triggers the sweep generator. The output of the sweep generator is a negative sawtooth which is simultaneously applied to one horizontal deflection plate and to the sweep driver. The sweep driver inverts the negative sawtooth and simultaneously applies this voltage to a second horizontal deflection plate and to the gate generator.

4–1667. Video information is continuously being fed to the RSI from the normal receiver. The video information is amplified by the video amplifier and applied to a push-pull video driver circuit. The output of the video driver circuit is applied to the vertical deflection plates of the CRT. The video information applied to the vertical deflection plates is displayed on the CRT only during the unblanking period.

4–1668. LOW-VOLTAGE POWER SUPPLY AND REGULATOR. The low-voltage power supply provides power for all circuits except the CRT. This power supply feeds directly into a series voltage regulator. The voltages available at the regulator outputs are +250 and —208 volts.

4–1669. HIGH-VOLTAGE POWER SUPPLY. The high-voltage power supply provides voltages of +2000 and —2000 volts. These voltages supply all CRT potentials, with the exception of those applied to the deflection plates.

4–1670. CATHODE-RAY TUBE. The RSI uses a type 5ADP2 cathode-ray tube. Both focusing and deflection are accomplished electrostatically. The 5-inch viewing screen displays oscilloscope patterns within a 5-nautical mile sector.

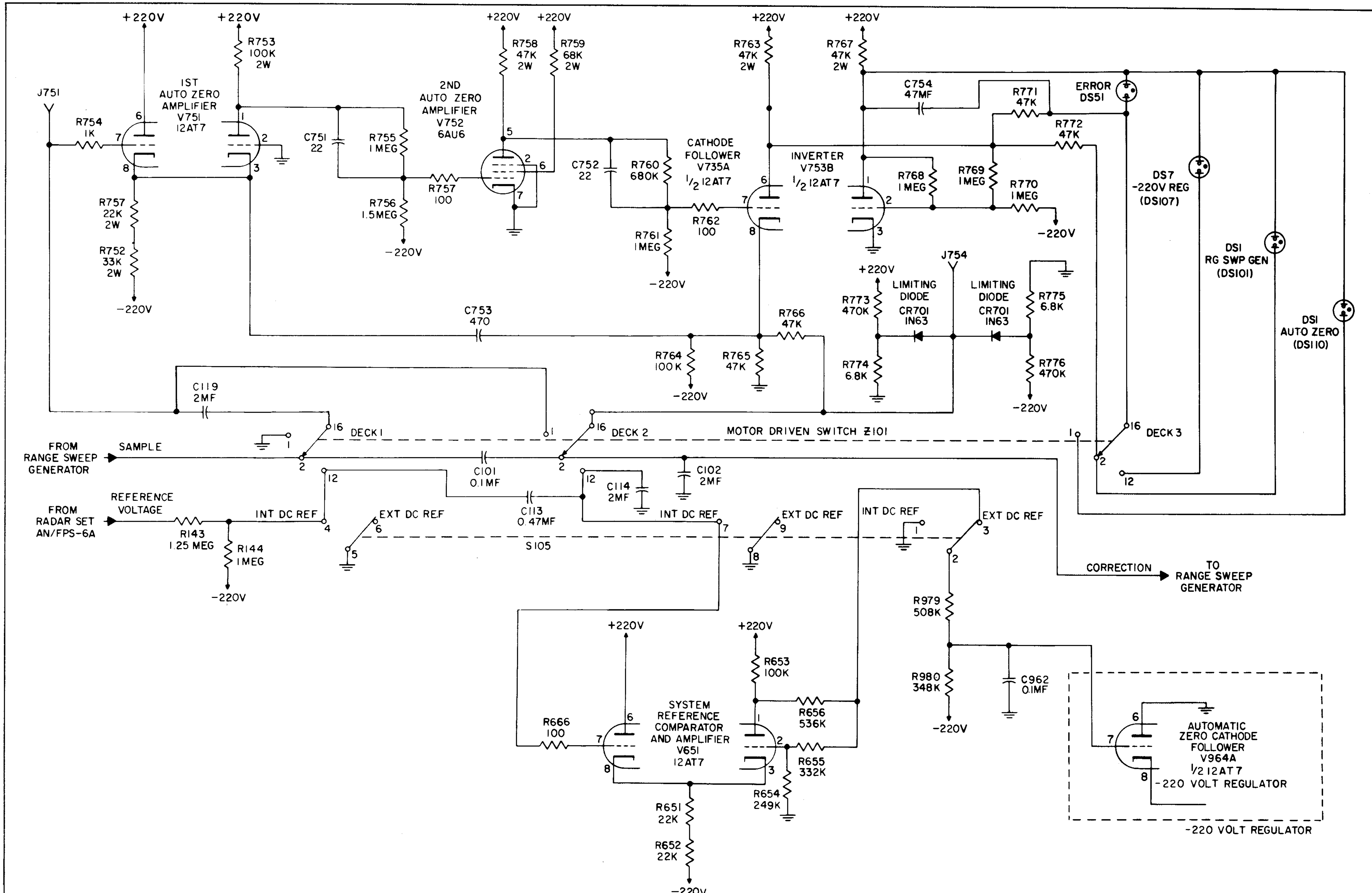


Figure 4–241. Automatic Zero Corrector, Simplified Schematic Diagram

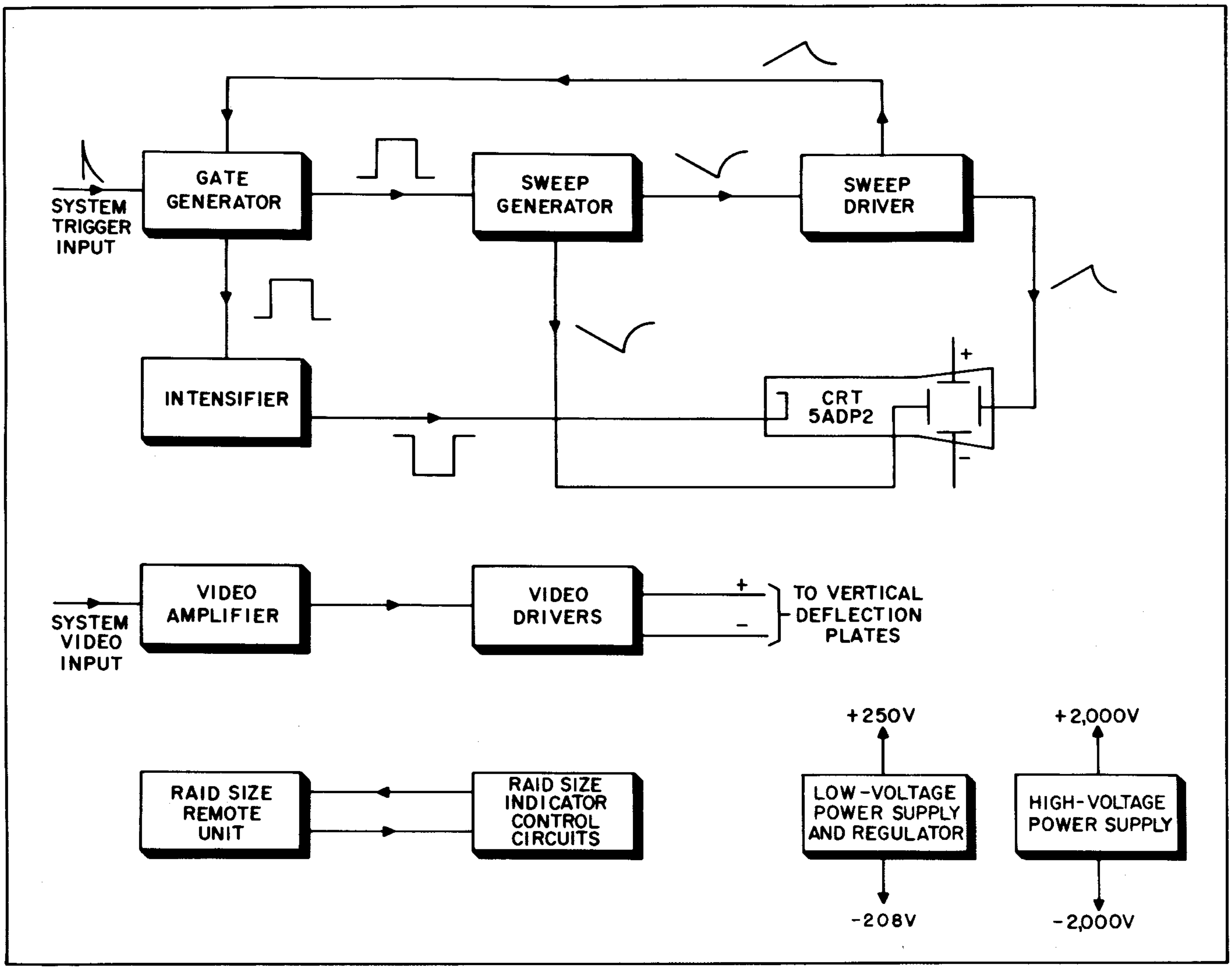


Figure 4–242. Raid Size Indicator, Block Diagram

4–1671. CONTROL CIRCUITS. The control circuits consist of a group of switches, indicators, and relays which enable the manual transmission of information from the RSI to the RSRU (raid size remote unit) when such information is requested. The RSRU is a separate component located adjacent to the PPI. Switches and indicators provide a means for the PPI operator to request information from the RSI operator. Indicators on the RSRU display the information transmitted from the RSI.

4–1672. CIRCUIT ANALYSIS OF RSI GATE GENERATOR.

4–1673. GENERAL. The gate generator circuits (figure 4–243) generate a positive gate which determines the start and duration of the sweep voltages. The gate generator circuits are actuated by a positive trigger from the associated search radar which initiates the start of the sweep generating circuits. When the sweep voltage has reached a predetermined amplitude, a portion of this voltage is fed back to the gate generator circuits, thereby terminating the gate.

Note

A variable delayed trigger must be supplied to the RSI by the associated search radar.

4–1674. TRIGGER AMPLIFIER V1B. A positive pulse of approximately 10 volts is applied to the grid of trigger amplifier V1B from the associated search radar. Amplifier V1B is at cutoff, with approximately −10 volts on its grid. The positive trigger applied to the grid of amplifier V1B drives this tube into conduction, causing a sharp decrease in plate voltage. This negative-going voltage is applied directly to the grid of multivibrator V2B.

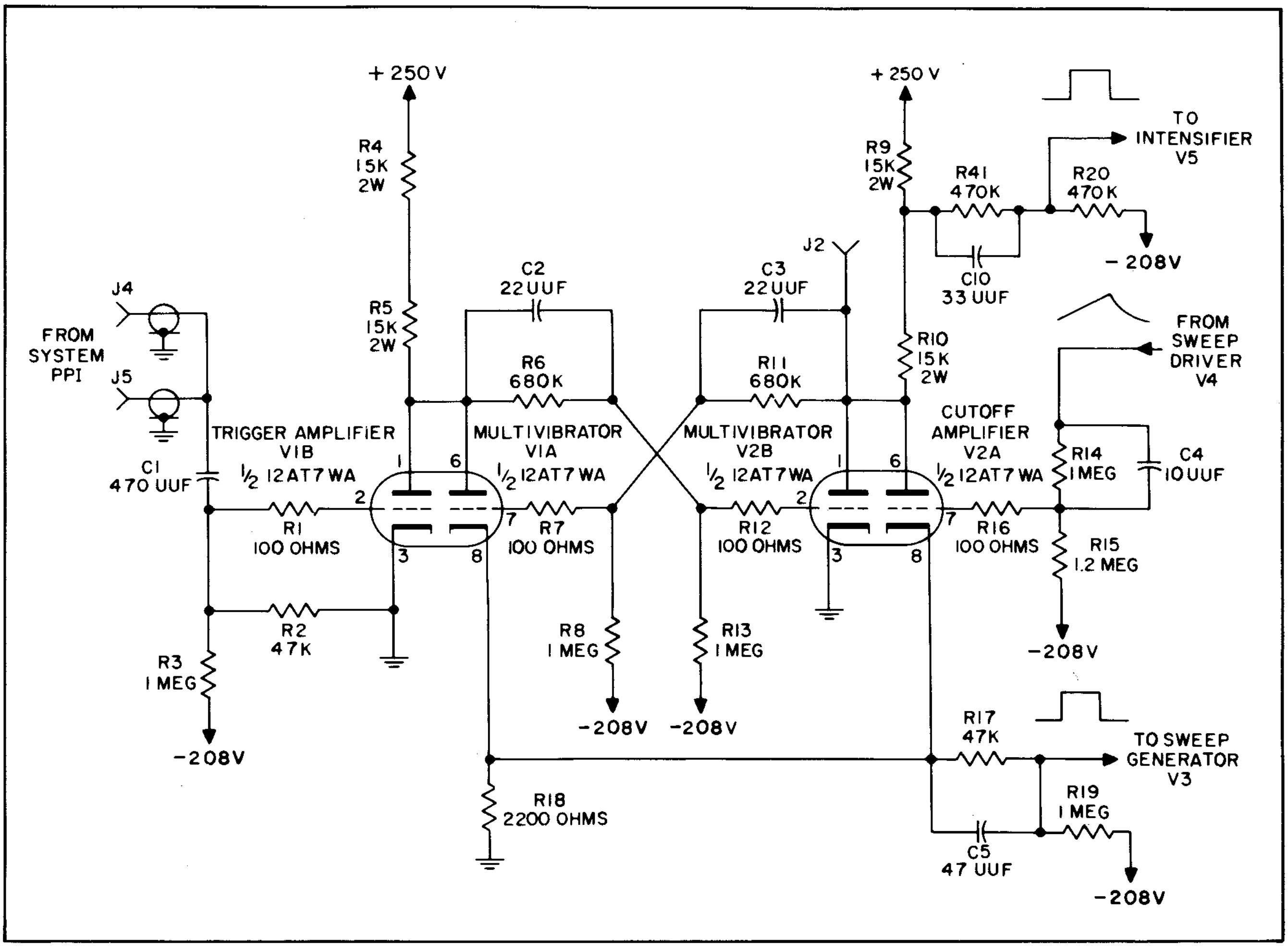


Figure 4–243. Gate Generator, Simplified Schematic Diagram

4–1675. BISTABLE MULTIVIBRATOR V1A AND V2B. Bistable multivibrator V1A and V2B has two states of stable operation: one tube is at saturation while the other is at cut off. Each state is maintained until an external action causes the nonconducting section to conduct and the conducting section to stop conducting.

4–1676. With no signal applied, the bistable multivibrator is in a steady state, with tube V1A cut off and tube V2B conducting. When the negative-going pulse from tube V1B is applied to the grid of conducting tube V2B, the multivibrator flips to its second stable condition, with tube V2B cut off and tube V1A conducting. This results in a positive-going voltage at the cathode of tube V1A, which remains at this potential until the multivibrator is returned to its original state. The multivibrator is returned to its original state by a negative-going trigger voltage applied to tube V1A from the plate of gate cutoff amplifier V2A. The bistable multivibrator then returns to its original state and a negative-going voltage is developed at the cathode of tube V1A, completing the gate. The positive gate at the cathode of tube V1A is applied to the sweep generator (paragraph 4–1678) and intensifier circuits (paragraph 4–1688).

4–1677. GATE CUTOFF AMPLIFIER V2A. Gate cutoff amplifier V2A is normally at cutoff. However, a positive sawtooth voltage from sweep driver V4 is applied directly to the grid of amplifier V2A. When this voltage reaches an amplitude sufficient to overcome the bias on amplifier V2A, this tube conducts and decreases in plate voltage. The negative-going voltage at the plate of amplifier V2A is then applied to the grid of tube V1A, causing the bistable multivibrator to return to its original state.

4–1678. CIRCUIT ANALYSIS OF RSI SWEEP STAGES.

4–1679. SWEEP GENERATOR V3. The sweep generator (figure 4–244) develops a linear negative sawtooth voltage which is applied to one horizontal deflection plate and to the control grid of sweep driver V4. The

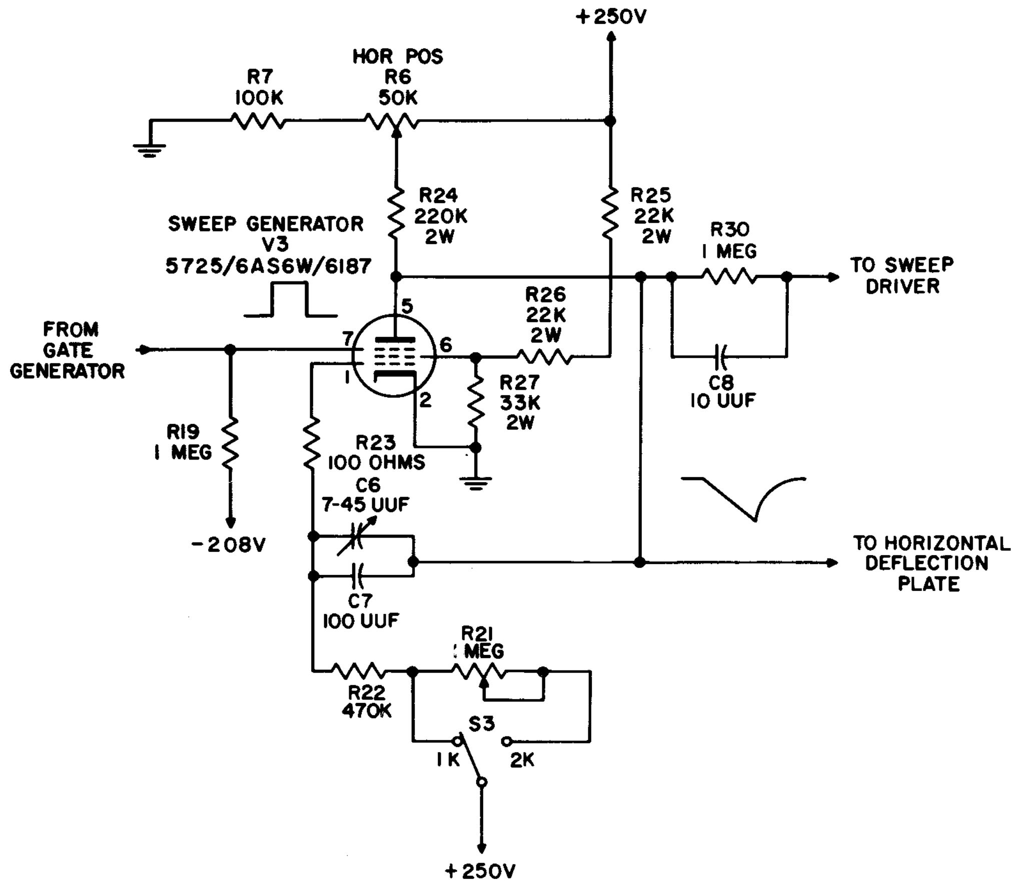


Figure 4–244. Sweep Generator, Simplified Schematic Diagram

input to sweep generator V3 is a positive rectangular pulse from the gate generator circuits.

4–1680. Prior to the application of a positive pulse from the gate generator, sweep generator V3 is cut off by a negative potential at the suppressor grid. In addition, the control grid of sweep generator V3 is connected to a positive potential, resulting in grid current. The current in the grid circuit develops a bias for this tube and charges sweep capacitors C6 and C7, with the grid side negative and the plate side positive.

4–1681. When the positive pulse from the gate generator is applied to the suppressor grid, sweep generator V3 conducts and decreases in plate potential. Sweep capacitors C6 and C7 then discharge to this new potential. Because of feedback from the plate to the grid of sweep generator V3, the current and voltage in the grid circuit remain constant. This results in a linear decrease of voltage across the sweep capacitors and a linear negative sweep at the plate. When the rectangular pulse applied to the suppressor grid goes negative, sweep generator V3 is again cut off and capacitors C6 and C7 charge to the increased plate potential, terminating the sawtooth voltage. The negative sawtooth voltage at the plate of sweep generator V3 is simultaneously applied to the grid of sweep driver V4 and to one horizontal deflection plate. SCALE FT/DIV switch S3 in the grid circuit of the sweep generator determines whether the sawtooth voltage developed is used for a 2-1/2- and a 5-mile range. Variable resistor R6 is used to adjust the starting point of the sweep. The 2-1/2- and 5-mile sweeps are calibrated by variable capacitor C6 and variable resistor R21, respectively.

4–1682. SWEEP DRIVER V4. The sweep driver (figure 4–245) inverts the negative sawtooth from sweep generator V3 and applies this positive sawtooth to a second horizontal deflection plate. A portion of the positive sawtooth waveform at the plate of sweep driver V4 is fed back to the gate generator (paragraph 4–1677). A feedback network composed of capacitor C9 and resistors R32 and R33 is used to obtain a positive sawtooth voltage of equal amplitude to the negative sawtooth applied to the other horizontal deflection plate.

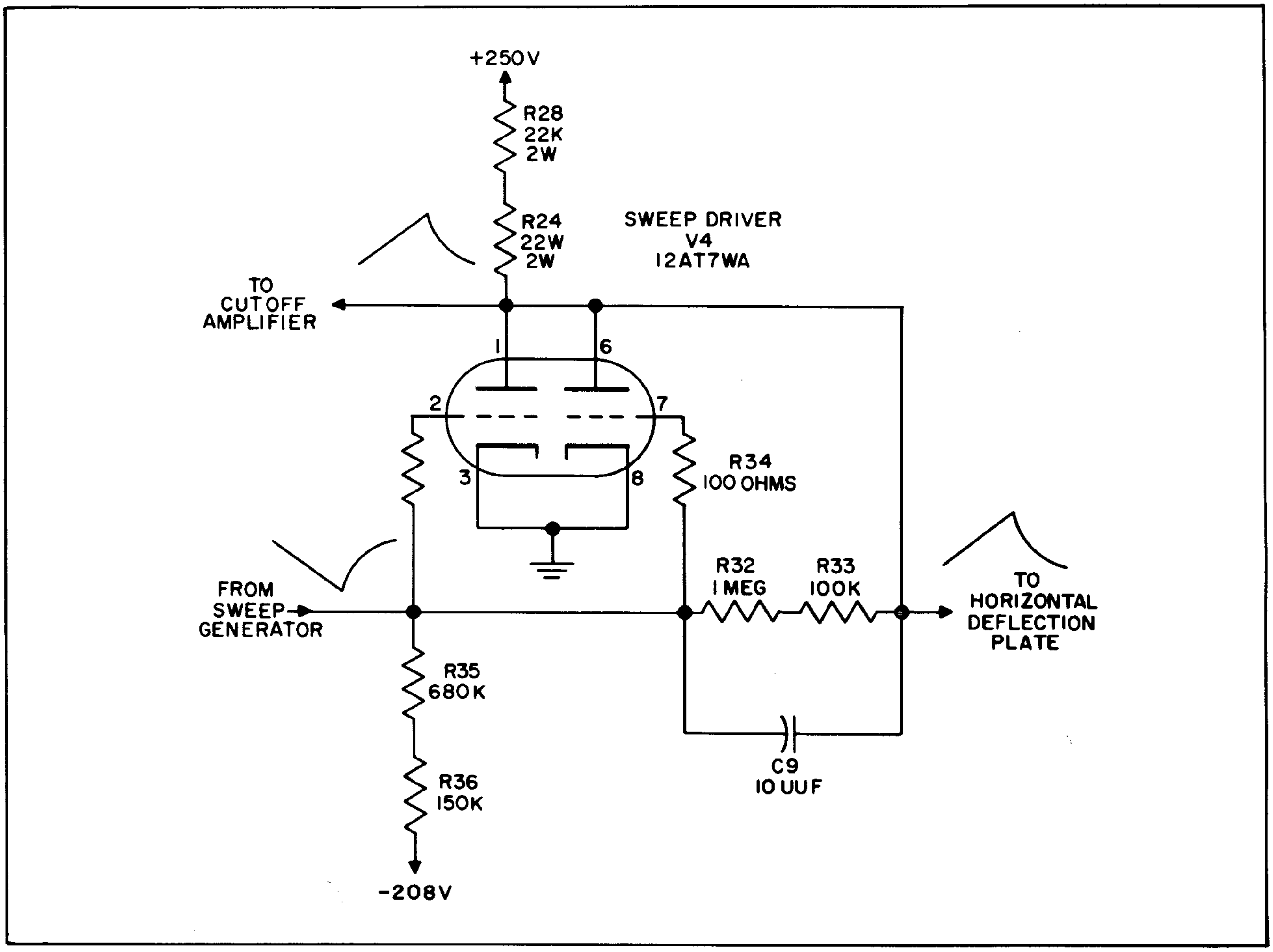


Figure 4–245. Sweep Driver, Simplified Schematic Diagram

4–1683. CIRCUIT ANALYSIS OF RSI VIDEO STAGES.

4–1684. VIDEO AMPLIFIER V1. The video amplifier (figure 7–153) amplifies target information obtained from the system of Radar Set AN/FPS-6A. This amplified signal is then applied to the video driver circuits. Cathode follower V2, connected in series with the plate of video amplifier V1, varies the plate load of amplifier V1.

4–1685. A positive video signal from the system of Radar Set AN/FPS-6A is applied to parallel-connected jacks J6 and J7 and appears across VIDEO GAIN control resistor R12. The position of variable resistor R12 determines the portion of the video signal applied to the grid of video amplifier V1 through coupling capacitor C1. The signal is amplified and applied to video drivers V3 and V4. Inductor L1, connected in the plate circuit of amplifier V1, is used to improve the high-frequency response.

4–1686. CATHODE FOLLOWER V2. Cathode follower V2 is connected in the plate circuit of video amplifier V1. This cathode follower is used to change the plate voltage of amplifier V1 when VERT POS control resistor R10 in the grid circuit of tube V2 is varied. A negative voltage, fed back from the plate of video driver V3 to the grid of cathode follower V2, is used to obtain fine control of the CRT display in the vertical plane when control resistor R10 is varied.

4–1687. VIDEO DRIVERS V3 AND V4. Video drivers V3 and V4 comprise a paraphrase amplifier. The output of video amplifier V1 is applied between the grid of driver V3 and the common cathode. The application of the signal in this manner results in voltages of approximately equal amplitude and 180 degrees out-of-phase being applied to the grids of video drivers V3 and V4. The outputs taken at the plates of the video drivers are applied to the vertical deflection plates through high-frequency series compensation inductors L3 and L5. Inductors L2 and L4, located in the plate circuits of video drivers V3 and V4, respectively, also improve the high-frequency response.

4–1688. INTENSIFIER V5. The intensifier (figure 7–153) supplies an unblanking pulse to the CRT for the duration of the sweep. Intensifier V5 blanks the CRT screen during the time of sweep retrace. A positive rectangular pulse from the gate generator is applied to the control grid of intensifier V5 and amplified and inverted at its plate. The negative pulse is then applied to the cathode of the CRT, permitting the CRT to conduct for the duration of the pulse. The pulse durations of the output of the intensifier are the same as the sawtooth voltage; therefore, the CRT screen is unblanked during the sweep time. The trailing edge of the intensifier output blanks the CRT, thereby preventing the sawtooth retrace line from appearing on the CRT screen.

4–1689. RSI LOW-VOLTAGE POWER SUPPLY AND REGULATOR.

4–1690. The low-voltage power supply and regulator (figure 7–153) supplies regulated +250 and —208 volts to all circuits of Indicator Group OA-1040/GPS, with the exception of the CRT. Additional windings and transformers are used to provide all the necessary filament and indicator voltages. The input to the power supply is 115 volts, 60 cps, which is applied to terminals A and B of receptacle J3 from the RHI assembly of Radar Set AN/FPS-6A.

4–1691. When power switch S1 is placed in the upper (on) position, 115 volts is simultaneously applied to the primaries of transformers T1 through T3 and to fan motor B1. The 115 volts at the primary of transformer T3 is stepped down to 6.3 volts for all scale and panel indicators and for red POWER indicator DS1. The 115 volts at the primary of transformer T2 is stepped down to supply all a-c voltages for the tube filaments, with the exception of the rectifier filaments. The rectifier filament voltage is obtained across one secondary winding of transformer T1. The 115 volts at the primary of transformer T1 is stepped up and applied to two full-wave rectifiers.

4–1692. The two full-wave rectifiers connected across the secondary winding of transformer T1 provide both positive and negative voltages. Selenium rectifiers CR1 and CR2, in conjunction with resistors R1 and R2 and filter capacitors C3 and C4, provide a rectified-filtered voltage for the negative supply. Rectifier tube V2, together with reactor L1 and filter capacitors C1 and C2, provide a rectified-filtered voltage for the positive supply. Both voltages are applied to a regulator circuit. The low-voltage regulator provides regulation for B+ and B— voltages.

4–1693. The rectified-filtered output from full-wave rectifiers CR1 and CR2 is applied across regulator tubes V3 and V4 through series-dropping resistor R1. The voltage across these regulator tubes remains at —208 volts regardless of changes in load. The regulated —208 volts acts as a reference level for the +250-volt regulated supply.

4–1694. A rectified filtered voltage of 415 volts dc is applied to the plate of series regulator tube V2. This tube acts as a variable resistor and drops sufficient voltage to obtain a constant +250 volts across output resistors R9 and R10. Any variations in input or output voltage must appear across regulator tube V2 to keep the output voltage constant.

4–1695. If the load current increases, the output voltage tends to decrease. This decreasing negative voltage appears across resistor R9, increasing the negative voltage at the grid of error amplifier V1 and increasing the plate voltage of this tube. The positive-going voltage at the plate of error amplifier V1 is directly coupled to the grids of series regulator tube V2. Thus, the impedance of regulator tube V2 as well as the voltage drop across this tube decreases. Since the output voltage is decreasing, the decreased voltage drop across tube V2 increases the output voltage.

4–1696. RSI HIGH-VOLTAGE POWER SUPPLY.

4–1697. The high-voltage power supply (figure 7–153) provides a +2000- and a —2000-volt d-c source for the CRT. High voltage is obtained by means of r-f oscillator V1, setup transformer T4, and half-wave rectifiers CR3 and CR4. Oscillator V1 generates a sine wave voltage which is stepped up to 2100 volts by transformer T4. The positive half cycle of the secondary voltage is rectified by rectifier CR4, filtered by capacitor C9, and applied to the second anode of the CRT. The negative half cycle of the secondary is rectified by rectifier CR3 and filtered by resistor R21 and capacitors C8 and C10. The —2000 volts is applied to a voltage divider. Potentials for the CRT control grid, cathode, and first anode accelerator grid are selected from this voltage divider.

4–1698. Limiter neon indicator DS1 and rectifiers CR1 and CR2, in series with the CRT cathode, provide a cathode load. The negative-going intensifier pulse is developed across this cathode load. The resistance offered to inverse conduction by selenium rectifiers CR1 and CR2 is the load across which the intensifier pulse is developed. When the negative pulse reaches a level sufficient to light indicator DS1, rectifiers CR1 and CR2 are shunted, thereby limiting the maximum bias developed between the grid and cathode.

4–1699. RSI CONTROL CIRCUITS.

4–1700. GENERAL. The RSI contains control circuits for manually transmitting target information to the RSRU. The information transmitted consists of the number of targets, the separation between targets, and the type of formation for a particular group of targets. This specific information is obtained by the RSI operator by evaluating the information appearing on the CRT of the RSI, as well as any other available information. The RSRU contains control circuits for requesting information from the RSI for a particular raid. Dials display the information transmitted from the RSI. The RSI operator can only transmit information requested by the RSRU operator. Once a request has been made, the RSRU or the RSI operator can cancel the request. However, the RSI operator can transmit information without an additional request being made by the RSRU operator.

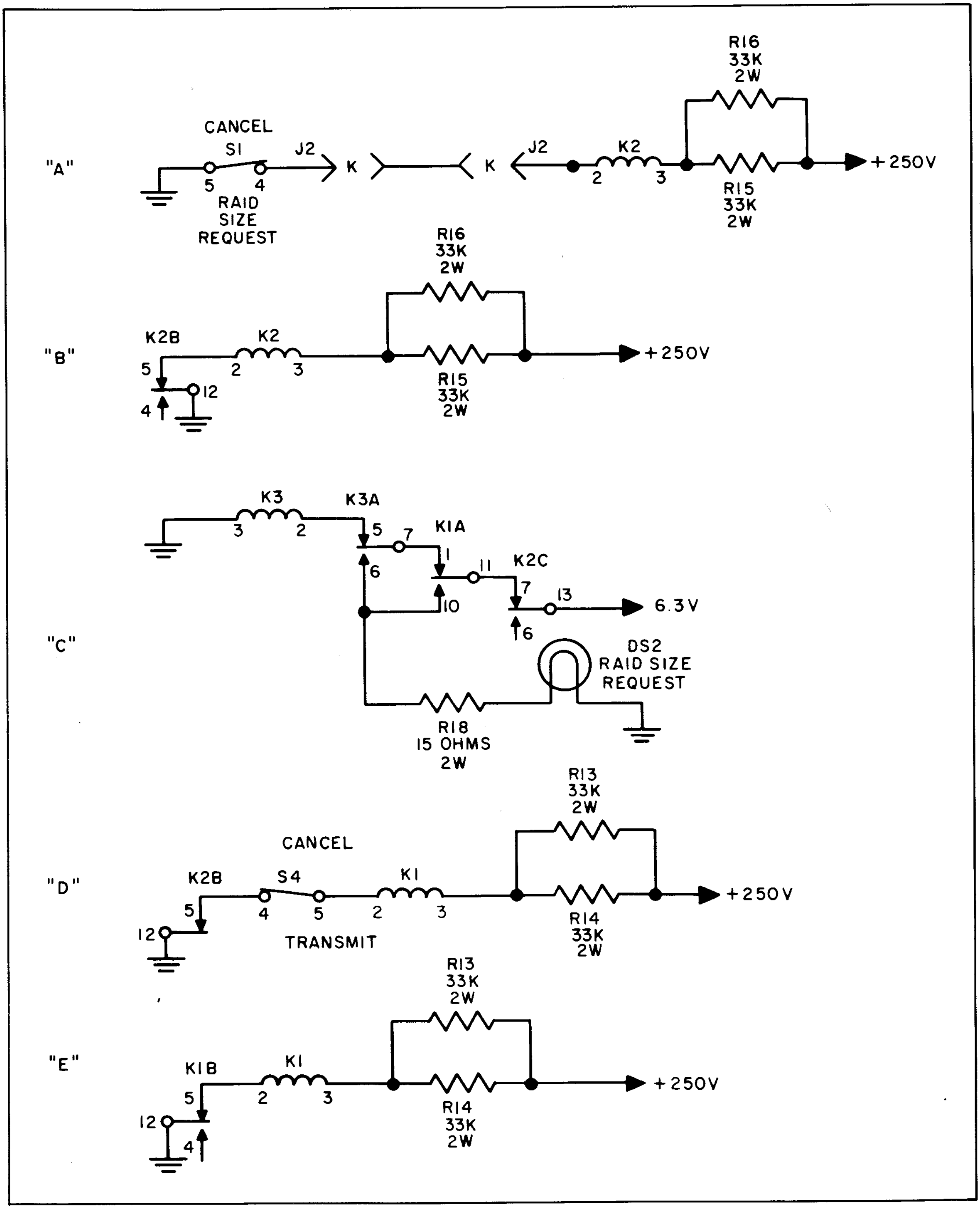


Figure 4–246. Control Circuits, Simplified Schematic Diagram

4–1701. REQUEST CIRCUITS. The RSRU operator initiates a request for information about a group of targets by momentarily placing CANCEL-RAID SIZE REQUEST switch S1 in the RAID SIZE REQUEST position. The operation of this switch completes a circuit for relay K2, as indicated on A of figure 4–246. When relay K2 operates, the movable arm (12) of contact K2B moves from position 4 to 5, providing a permanent ground for relay K2 (B, figure 4–246). The movable arm (13) of contact K2C moves from position 6 to 7, completing a circuit for relay K3 (C, figure 4–246).

4–1702. When relay K3 operates, the movable arm (7) of contact K3A moves from position 5 to 6, providing a path for RAID SIZE REQUEST indicator DS2 (C, figure 4–246) and breaking the circuit for relay K3. Relay K3 then releases, returning contacts K3A to their normal position (7-5) and thereby breaking the indicator circuit. When contacts K3A return to their normal position, a circuit is again completed for relay K3. The operation and release of relay K3 results in the flashing of RAID SIZE REQUEST indicator DS2. This flashing indicator is a signal to the RSI operator that raid size information is requested for the targets appearing on the CRT.

4–1703. TRANSMITTING CIRCUITS. Once a request has been made, the RSI operator evaluates the targets and manually rotates switches S5 through S7 to the appropriate positions. In addition, the RSI operator also momentarily places CANCEL-TRANSMIT switch S4 in the TRANSMIT position, providing a complete circuit for relay K1 (D, figure 4–246).

4–1704. When relay K1 operates, the movable arm (12) of contact K1B moves from position 4 to 5, providing a permanent ground for relay K1 (E, figure 4–246). The movable arm (11) of contact K1A moves from position 1 to 10, releasing relay K3 and providing a permanent circuit for RAID SIZE REQUEST indicator DS2 (C, figure 4–246). The movable arm (13) of contact K1C moves from position 6 to 7, providing 6.3 volts to the arms of switches S5 through S7. The voltage is then applied through these switches to selected terminals of receptacles J1 and J2 (figure 7–153). The 6.3 volts is then coupled through cables to corresponding terminals on receptacles J1 and J2 in the RSRU and applied across indicators connected to these terminals (figure 7–155). The indicators corresponding to the positions selected by switches S5 through S7 light, and remain lighted until a cancellation request is made in either the RSI or RSRU.

4–1705. CANCELLATION. A cancellation request (figures 7–152 and 7–155) from the RSRU releases relays K1 and K2, returning the control circuits to their initial condition. Additional or new information is obtained when the RSRU initiates a request. However, a cancellation request from the RSI only releases relay K2 and the information previously submitted and lights CANCN indicator DS2 in the RSRU. New information can be transmitted without any new request being made by the RSRU.

4–1706. ELEVATION DRIVE AND CONTROL.

4–1707. The nodding motion of the reflector is provided by a double-reduction, concentric-shaft gear motor, elevation drive motor B3002. Motor B3002 is an induction type which is powered by 3-phase, 208-volt, 60-cps ac. The motor has two sets of field windings so that it is capable of delivering 5 horsepower with the armature rotating at 1750 rpm and 3.3 horsepower at 1150 rpm. The output shaft of the motor then turns at either 30 or 20 rpm, respectively. The elevation drive motor is mounted just above and to the side of the yoke hub as shown in figure 4–247. A pivot arm (crank) is mounted on the output shaft of the motor and is attached to the upper section of the reflector by a connecting rod of adjustable length. As the motor turns the crank, the reflector nods up and down about the elevation axis.

4–1708. As shown in figure 4–248, the elevation drive motor can be controlled from the safety box at the antenna assembly, from the antenna control panel at the control group assembly, and from the RHI antenna control at the RHI assembly. When the 30-nod-per-minute rate is desired, any of the FAST buttons is pushed, applying three-phase power to the fast field winding of the elevation drive motor. When the 20-nod-per-minute rate is desired, any of the SLOW buttons is pushed, applying three-phase power to the slow field winding of the elevation drive motor. The field windings of the elevation drive motor are interlocked so that a STOP button must be pushed before changing from one nodding rate to the other. Pushing any of the STOP buttons removes all power from the elevation control circuit to halt the nodding motion of the antenna.

4–1709. Interlocks in the elevation control circuit protect personnel and equipment. Personnel are protected by the manually-operated SAFE-RUN switch on the safety box, by the elevation brake interlock, and by the temperate tower personnel hatch interlock. Equipment is protected by the overload contacts of relay K6901 and by the arctic tower pressure interlock.

4–1710. CONTROL CIRCUIT ANALYSIS (See figure 4–248).

4–1711. Three-phase power (phases D, E, F, and the antenna neutral NAP) are made available to the elevation control circuit when the ANTENNA POWER circuit breaker S6402 is closed. If any of the FAST buttons is pushed, phase D power is applied through the chain of STOP buttons, through the AUX interlock contacts (closed if the SLOW section of K6901 is de-energized)

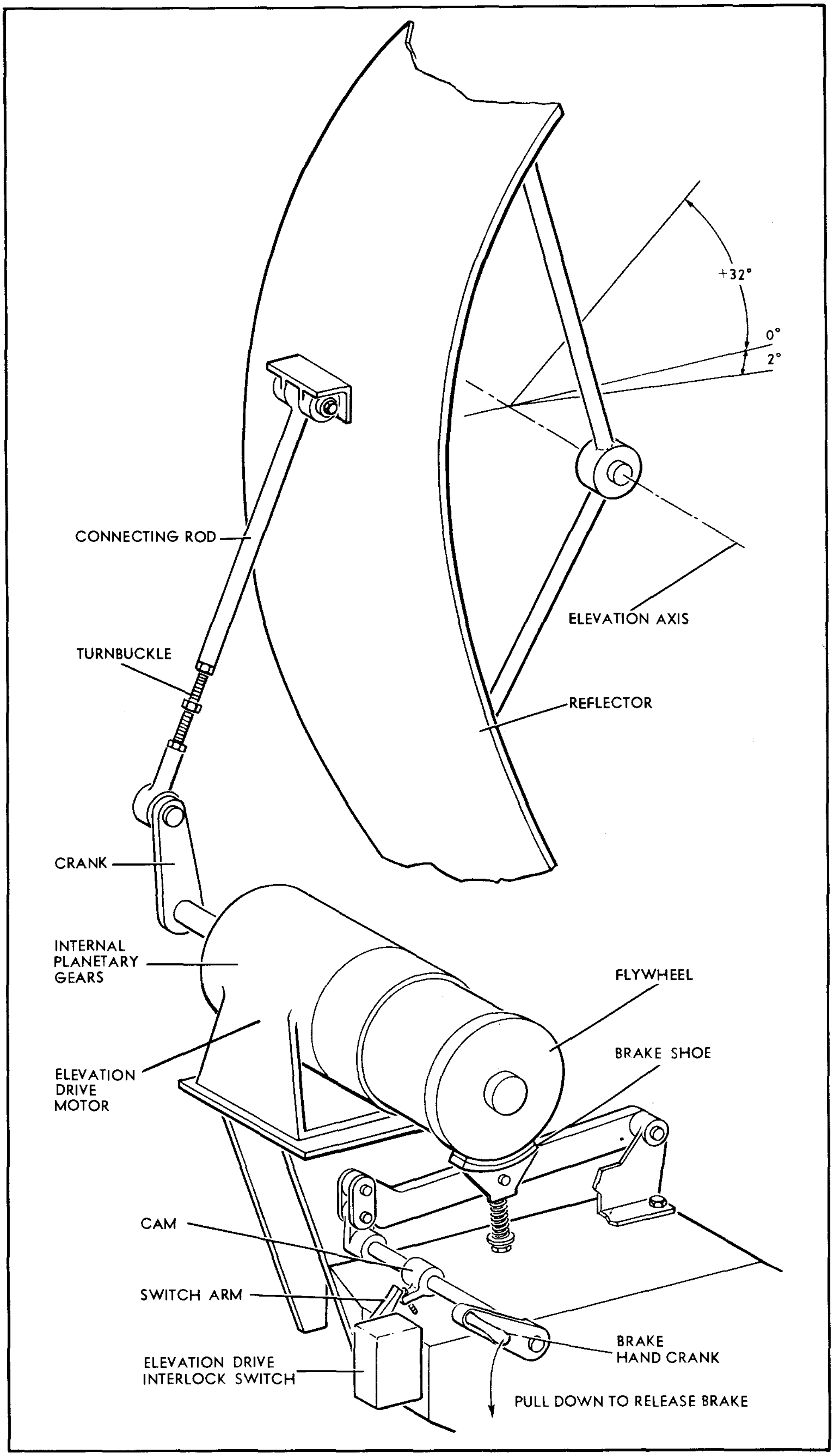


Figure 4–247. Elevation Drive and Brake Assembly, Mechanical Schematic Diagram

to the fast solenoid of K6901. The fast contacts then close, applying three-phase power to the fast field winding of the elevation drive motor and phase D power to the fast solenoid of K6901 to hold it energized. Energizing of the fast solenoid also opens the AUX interlock contacts in the operate path of the slow solenoid.

4–1712. To change to slow nodding, the STOP button is first pressed and then a SLOW button. Pressing a STOP button causes the fast solenoid to release, allowing the AUX interlock contacts in the operate path of the slow solenoid to close. Then, pressing a SLOW button applies phase D power to the slow solenoid of K6901; energizing of the slow solenoid applies three-phase power to the slow field winding of the elevation drive motor and phase D power to the slow solenoid of K6901 to hold it energized.

4–1713. INTERLOCK CIRCUIT ANALYSIS (See figures 4–247 and 4–248.)

4–1714. ELEVATION BRAKE INTERLOCK. Figure 4–247 shows the elevation brake and the relationship of the brake to the elevation drive assembly. The elevation brake is shown in a clamped-on position, with the brake handcrank pushed up. The cam has actuated the switch arm on the elevation drive interlock switch, thus opening the elevation drive interlock circuit. The brakeshoe is pressed against the rim of the flywheel, preventing any motion of the flywheel.

4–1715. When the brake handcrank is pulled down, the brakeshoe moves away from the rim of the flywheel, releasing the switch arm and the elevation drive interlock switch closes. The elevation drive motor can then be operated.

4–1716. SAFETY BOX. When the SAFE-RUN switch on the safety box is placed in the SAFE position, the elevation drive circuit is opened. This procedure is always followed whenever personnel are required to perform any maintenance near the antenna. (See also paragraph 4–1769 for a more complete description of the safety box circuits.)

4–1717. PERSONNEL HATCH INTERLOCK. The hatchway leading to the antenna platform of the temperate tower is provided with an interlock which removes elevation drive power whenever the hatch is lifted. This switch is shorted in Radar Set AN/MPS-14.

4–1718. OVERLOAD CIRCUIT OF CONTACTOR K6901. (See figures 7–29 and 7–30.) An overload coil, part of contactor K6901, is in series with each of the lines leading to the field windings of the elevation drive motor. If the load on any of the lines should become too great, the coil will pull open a pair of contacts, opening the line to the antenna neutral (NAP). This action releases K6901, removing all drive power from the elevation drive motor. The overload condition is signalled by a red flag which appears next to the overload coil. A reset switch adjacent to the overload coil can then be operated to restore power.

4–1719. PRESSURE INTERLOCK. In the arctic tower installation, the antenna drive interlock circuit includes an interlock switch in the pressure switch box. When the pressure in the radome decreases to the point where the sagging radome might be cut by the moving antenna, this pressure switch opens and all antenna motion ceases.

4–1720. ELEVATION SELSYN AND ANGLE MARK UNIT.

4–1721. ANGLE MARK COMMUTATOR E3002.

4–1722. Marker pulses denoting the instant at which the reflector passes each additional 5 degrees of elevation are initiated by the elevation angle mark commutator. Figure 4–249 is a diagram of the commutator and of the carbon brushes which make contact.

4–1723. Commutator E3002 contains two connected rings, each in contact with a carbon brush. One of these rings has a conducting segment 360 degrees wide and the other a conducting segment 5-1/2 degrees wide. This commutator is geared to the nodding motion of the reflector at a ratio of 72:1, and is therefore referred to as the 72-speed commutator.

4–1724. The brush which bears on the 360-degree wide segment of commutator E3002 is connected to the grid of angle mark generator tube V5301B in the control group assembly. When the grid of tube V5301B is grounded, a voltage pulse appears at the plate of this tube, causing the initiation of a marker pulse. The 5-1/2-degree segment of the remaining brush of commutator E3002 is then grounded. When both brushes are properly oriented, the path from the grid of angle mark generator tube V5301B to ground is complete and a pulse is initiated.

4–1725. The commutator is in the position shown in A of figure 4-249 when the reflector is looking into 0 degree of elevation. The circuit from grid to ground is then complete, so that a pulse is initiated as the reflector passes through the 0-degree position. At every 5 degrees of elevation, the commutator is in the same position. The 72-speed commutator has rotated 72 times 5 degrees, or one full revolution. Therefore, the 5-1/2-degree segment broke contact with its brush shortly after the reflector left the 0-degree position and made contact again at 5 degrees of elevation. A second marker pulse is initiated at 5 degrees. At 10 degrees of elevation, the 72-speed commutator has made another full rotation, so that another marker pulse is initiated at 10 degrees.

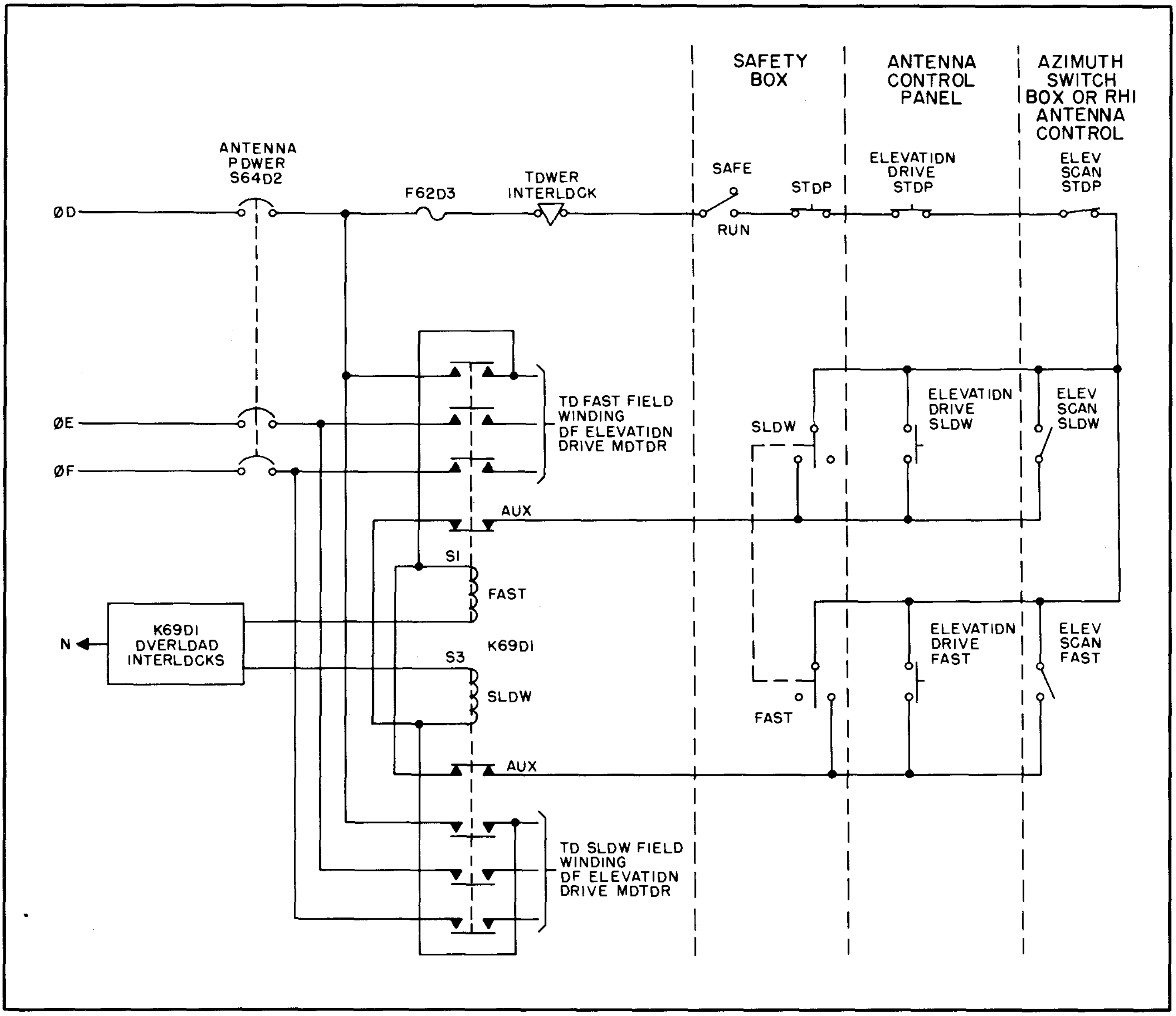


Figure 4–248. Elevation Drive Control Circuits, Simplified Schematic

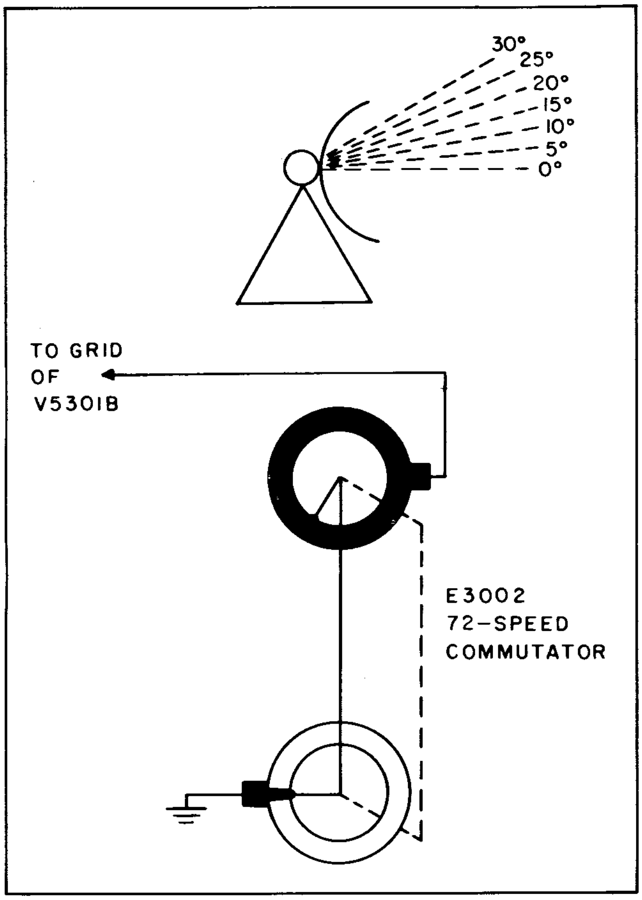


Figure 4–249. Angle Mark Commutator for Radar Set AN/FPS-6, Simplified Schematic Diagram

4–1726. The angle mark commutators used in Radar Set AN/FPS-6A differ from those in Radar Set AN/FPS-6 only in that two brushes are used on the segment of the commutators. If a single brush were used on the commutator segment, there would be a difference in the angle marks generated on the upswing and downswing of the antenna. This difference is illustrated in figure 4–250. As shown in this illustration, the brush first makes contact with the upper edge of the conducting segment on the upswing; on the downswing, the brush first makes contact with the lower edge of the conducting segment. Therefore, two angle marks are generated: one during the upswing and one during the downswing, differing by approximately 1/6 degree on the display.

4–1727. To eliminate this difficulty, the double-brush arrangement shown in B of figure 4–250 is used. The spacing between the brushes is slightly narrower than the width of the conducting segment. Therefore, only an instant exists when the circuit is complete. At this instant, the angle mark pulse is generated. This instant must be the same during both the upswing and downswing of the antenna.

4–1728. Reference to figures 7–18 and 7–19 shows that the wires leading from the commutators toward the grid of angle mark generator V5301B connect to jack J3003 on the elevation selsyn and angle mark unit. In addition, a cable assembly leads to jacks J3012 and J3015 on the girder junction box. Another cable assembly leads from jack J3015 to slip rings 3 and 4 in the cone junction box, and then to terminals 2 of terminal boards TB3401 and TB3403 in the cone junction box. From these terminals, wires connect to jack J3401, from which a coaxial cable goes to the control group assembly through a stuffing tube and cable grip in the cone junction box.

4–1729. ELEVATION SELSYN B3001.

4–1730. The rotor of elevation selsyn B3001 is geared at a 1:1 ratio to the elevation motion of the reflector. The rotor of this selsyn acts as the inductance of a tank circuit tuned to 1500 cps. The elevation selsyn is located electrically in the plate circuit of 1500-cps oscillator tube V5401 in the elevation data generator of the control group assembly. The selsyn rotor is fed with 1500-cps a-c power generated by this oscillator, and induces a 1500-cps voltage in the stator windings. The magnitude and polarity of the voltage induced in each stator winding depend upon the relative angular position of the rotor and stator, and therefore vary with the angle of elevation of the reflector.

4–1731. Two types of synchros may be used as elevation selsyn B3001. The 2JHAI or 5HG synchro is used with Elevation Data Generator C-993/FPS-6 on Radar Set AN/FPS-6. The 5SCT synchro is used with Elevation Data Generator TD-170/FPS-6A on Radar Set AN/FPS-6A. Figure 7–15 shows the circuit of the elevation selsyn using the 2JHAI or 5HG type synchro. The ends of stator windings S1, S2, and S3 are connected to terminals 6, 5, and 4, respectively, of terminal board TB3001. The windings then connect to a loading network composed of resistors R3001 and R3002 and capacitors C3001 and C3002. The circuit from windings S1 and S3 looks into a load consisting of the elevation selsyn stator coaxial cable and its termination.

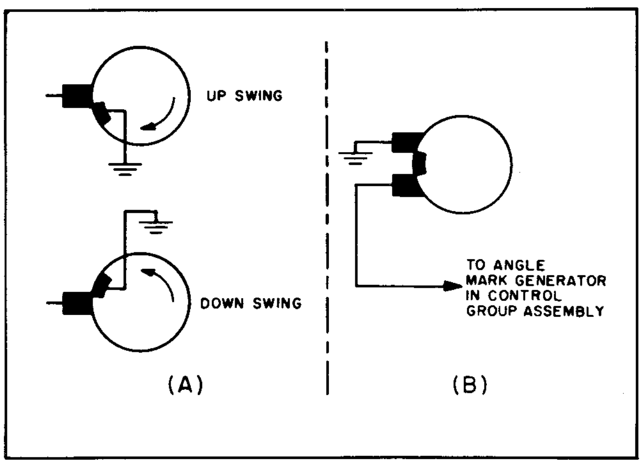


Figure 4–250. Elevation Angle Mark Commutations for Radar Set AN/FPS-6A, Simplified Schematic Diagram

This load looks like a 100-kilohm resistance in parallel with a capacitor whose value is approximately 0.01 microfarad. Capacitor C3001 and resistor R3001 simulate this load for the circuit from winding S2 to winding S3, and capacitor C3002 and resistor R3002 simulate this load for the circuit from winding S2 to resistor S1. The loading network thus provides a balanced load on the selsyn. The winding S1 to winding S3 voltage output of the selsyn appears at jack J3001. The selsyn is adjusted so that this voltage is a minimum when the reflector is looking into 0 degree of elevation. The voltage that appears at jack J3001 at any elevation angle is proportional to the sine of that elevation angle. The voltage at jack J3001 for angles above the horizontal (positive elevation angles) is 180 degrees out of phase with the voltage for angles below the horizontal (negative elevation angles). This volage is fed to circuits in the elevation data generator of the control group assembly, where it is used for the production of the elevation sweep of the RHI's.

4–1732. The path from the rotor to the oscillator in the control group assembly is as follows: rotor to terminals 1 and 2 of terminal board TB3001; wires to jack J3002; cable assembly to jacks J3011 and J3016 in the girder junction box; cable assembly to slip rings 5 and 6 in the cone junction box; wires to terminals 3 on terminal boards TB3401 and TB3403; wires to jack J3403; and coaxial cable to the control group assembly. The path from the summation network to the control group assembly is as follows: from jack J3001, a cable assembly to jacks J3010 and J3017 in the girder junction box; cable assembly to slip rings 7 and 8 in the cone junction box; wires to terminals 4 on terminal boards TB3401 and TB3403; wires to jack J3404; and coaxial cable to the control group assembly.

4–1733. As stated in paragraph 4–1731, Elevation Data Generator TD-170/FPS-6A in Radar Set AN/FPS-6A requires the use of a 5SCT type synchro as elevation selsyn B3001. Essentially, the function of the 5SCT synchro is the same as that of the 2JHAI or 5HG type synchro used with Elevation Data Generator C-993/FPS-6. The electrical connections are different for the 5SCT synchro. Rotor windings R1, R2, and R3 are connected to terminals 6, 5, 4, respectively, of terminal board TB3001. Stator winding S1 is connected to terminal 2 and stator windings S2 and S3 to terminal 1 of terminal board TB3001.

4–1734. ELEVATION SELSYN AND ANGLE MARK UNIT (MECHANICAL).

4–1735. Figure 4–251 is a mechanical schematic diagram of the elevation selsyn and angle mark unit. The shaft, marked ELEVATION ROTATION INPUT, turns with the nodding motion of the reflector. This shaft imparts 1-speed motion to the rotor of elevation selsyn B3001. The stator clamps, which may be loosened to allow zeroing of the selsyn, are also shown in figure 4–251.

4–1736. The large gear on the input shaft engages the small gear on the 9-speed shaft. The large gear on the 9-speed shaft engages the gear on the 72-speed shaft, rotating 72-speed commutator E3002. The brush rigging on the commutator is indicated in figure 4–251.

4–1737. AMPLIDYNE GENERATOR SET (MOTOR-GENERATOR PU-293/G OR PU-293A/G).

4–1738. Figure 7–61 is a schematic diagram of the amplidyne generator set and its interconnection with the azimuth drive motor and the control group assembly. The amplidyne generator set contains a drive motor, marked M, an exciter generator, marked G, and an amplidyne generator with an overload relay.

4–1739. The amplidyne drive motor is a 10-horsepower, 3-phase, 60-cps, 120/208-volt, 3600-rpm, a-c motor. This motor serves to rotate the amplidyne and the exciter generator at constant speed and receives its power from phases D, E, and F in the control group assembly. START and STOP buttons on the antenna control panel control power to the amplidyne drive motor. For a discussion of the power control circuit of this motor, refer to paragraph 4–172.

4–1740. The exciter generator is a 100-watt d-c machine, generating 115 volts at 0.85 ampere when rotated at 3600 rpm. The generator supplies power to the field winding of the azimuth drive motor through fuses F6201 and F6202 in the antenna control panel of the control group assembly. The field current also passes through the coil of relay K6201 in the antenna control panel. This relay serves as a protective device for the azimuth drive motor, in the following way: The contacts of relay K6201 (not shown) are in series with a circuit which must be closed in order for control current to reach the amplidyne control field. If field current in the azimuth drive motor fails, these relay contacts open, removing control current from the control field. The amplidyne then has virtually zero output and therefore cannot feed power to the armature of the azimuth drive motor. Were the armature of the azimuth drive motor to be fed power without current being present in the field winding, the armature current would become extremely large, and the armature might overheat to the point of burning out. The current in the armature of a d-c motor is not limited to a safe value by the resistance of the armature, which is negligible, but rather by the back voltage induced in the armature by the magnetic field set up the current in the field winding. In addition, a d-c shunt motor operated without excitation of its shunt field speeds up tremendously, so that relay K6201 also serves as a protection against the destruction which would result from such excessive speeds.

4–1741. The amplidyne is a d-c generator whose power output is proportional to the power applied to its control field winding. The special characteristic of the amplidyne is that a very small amount of power in the

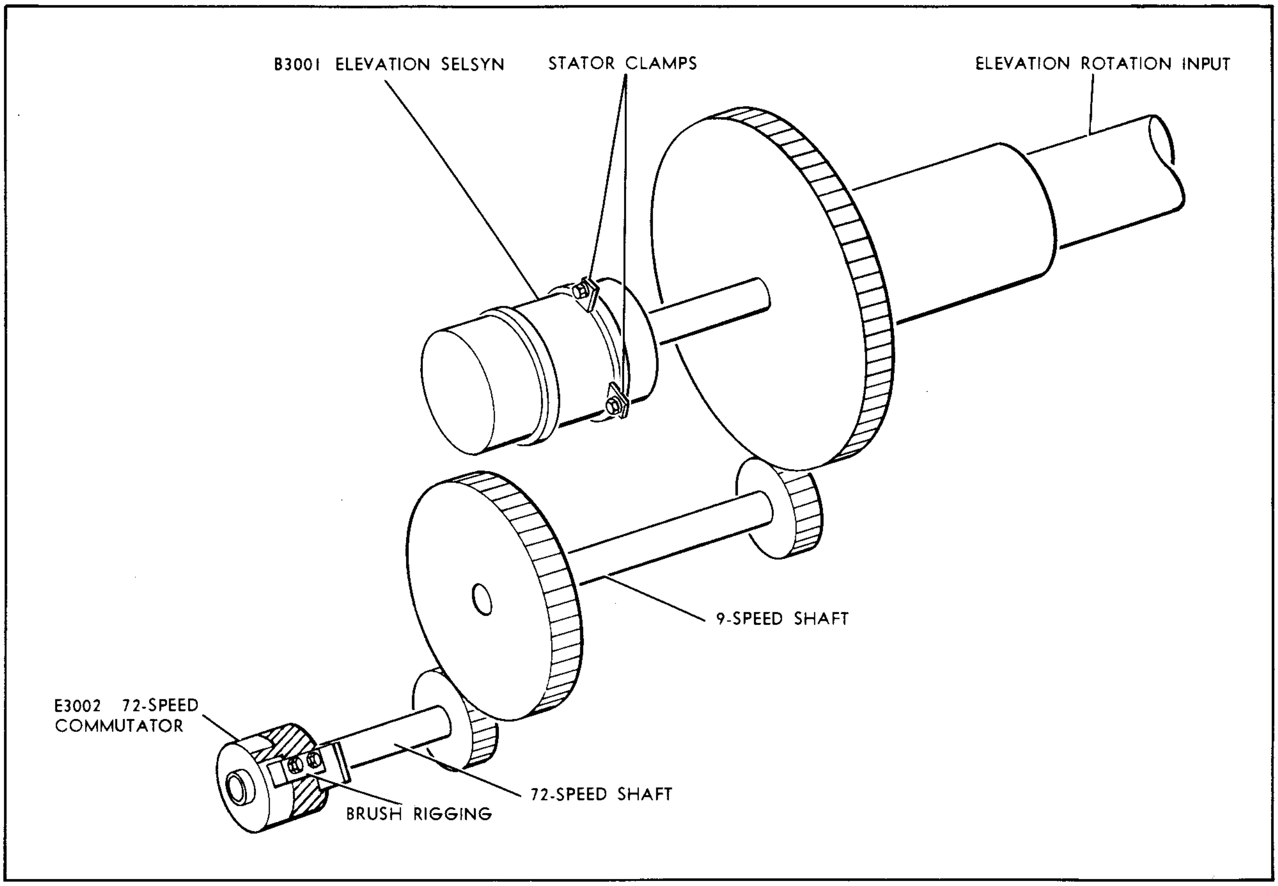


Figure 4–251. Elevation Selsyn and Angle Mark Unit, Mechanical Schematic Diagram

control field is able to control very large amounts of output power, so that the amplidyne acts as a high-gain power amplifier. An amplidyne operates in the following manner: Consider first an ordinary d-c generator, which contains a shunt field winding, excited by means of some external source of power, and an armature rotated in the field produced. Power is generated in the armature by virtue of its rotation in the magnetic field, and this power is delivered to a load. The amount of power which must be provided to excite the field of this generator is large, so that its power gain is small. Moreover, the large amounts of power necessary to excite the field winding cannot be delivered conveniently by an electronic device, so that such a generator cannot conveniently be used as a power amplifier.

4–1742. If only a small amount of power is used to excite the field winding, the amount of magnetic flux that the armature cuts is severly reduced, so that the output of the generator falls greatly. The amplidyne solves the problem of how to keep the power output of the generator high, while the amount of power required for the field winding remains quite small. When this is done, the field winding can be supplied with power from a small electronic power amplifier. Use of an electronic amplifier permits convenient control of large amounts of power output from the armature.

4–1743. The amplidyne takes advantage of the fact that when the armature of an ordinary d-c generator is delivering power to a load, a large current flows in the armature. This current sets up a magnetic field across the armature at right angles to that supplied by the field winding. The magnitude of this armature field depends only upon the magnitude of the current flowing through the armature. To make an amplidyne, take a d-c generator and remove the load from the armature. Lower the power in the field winding to a very small value. Place a short circuit across the brushes leading from the armature. Now, even though the intensity of the field produced by the field winding is small because of the small excitation power, the current flowing in the armature will be very large because of the short circuit across it. Therefore, the armature field produced by the short circuit current in the armature will be very large. This armature field, because it is at right angles to the field produced by the field winding, will induce current in the armature that can be taken from the armature by means of a pair of brushes located at right angles to the brushes which are shorted. These new brushes are the output brushes, which are connected to the load of the amplidyne. The field winding of the amplidyne, now called the control field, can be supplied from a vacuum tube amplifier, and will control very large amounts of output power.

4–1744. The load current drawn from the output brushes is made to flow through an additional field winding, which is in series with the output of the amplidyne. This field, marked C1 and C2, is shown in figure 7–61. The field is called the compensating field and its function is the cancellation of the new magnetic field caused by the load current flowing through the armature by means of the output brushes. For the benefit of clarity, the currents flowing in the armature and the magnetic fields across the armature are summarized in the following paragraphs.

4–1745. (See figure 4–252.) Differential current (control current) from the servo amplifier flows in the control winding of the amplidyne. This current provides the excitation power and causes a magnetic field which lies across the armature in a particular direction. This magnetic field is called the differential field. The armature cuts the differential field and brushes, which are properly oriented with respect to this field, allow current to be drawn from the armature. These brushes are shorted, so that a heavy short-circuit current flows in the armature. This short-circuit current produces a second magnetic field, called the short-circuit field. The latter field lies across the armature at right angles to the differential field. Those windings in the armature which are appropriately oriented cut the short circuit field, and a second current is induced in the armature. Output brushes, which are at right angles to the shorted brushes, allow this current to be drawn from the armature by the load. (This current is the load current flowing to the azimuth drive motor.) However, the load current flowing through the armature also causes a magnetic field, called the load field. This field is at right angles to the short-circuit field, and therefore is at an angle of 180 degrees to the differential field. Therefore, the load field tends to cancel the differential field, which would prevent proper operation of the amplidyne if the condition were not corrected. The load current which causes the load field is also passed through a compensating winding, thus producing a fourth magnetic field, called the compensating field. The compensating winding is so oriented that the compensating field cancels out the load field, leaving the differential field unaffected.

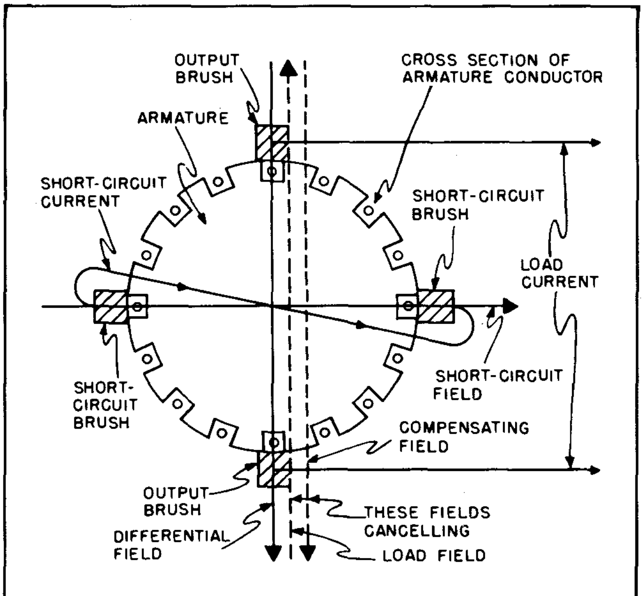


Figure 4–252. Magnetic Fields in Amplidyne Armature

4–1746. The amplidyne is rated at a 1-kilowatt output for continuous duty, delivered at 27 volts and 37 amperes, when rotated at 3600 rpm. Of course, the actual output voltage and current delivered at any instant depends upon the excitation supplied at that instant to the control winding. The amplidyne is capable of a momentary output as high as 14.5 kilowatts, delivered at 112 volts and 130 amperes. The amplidyne feeds the armature of the azimuth drive motor through the overload relay, whose contacts are in the amplidyne drive motor control unit. These contacts will open, causing the drive motor to stop, if the current drawn from the amplidyne becomes excessive. Thus, the overload relay serves to protect the amplidyne and the drive motor armature from excessive currents.

4–1747. Still another winding is built into the amplidyne, the quadrature field winding. The quadrature winding does not aid in the generation of power by the amplidyne, but serves as a source of voltage for feedback into the servo amplifier. Voltage is induced into the quadrature field winding as the amplidyne operates, and the amplitude of this voltage serves as a measure of the manner in which the amplidyne is operating at any given instant. The quadrature voltage is a source of one of the several types of antihunt feedback incorporated into the azimuth positioning and control servo system. Refer to paragraph 4–855 for details of the theory of this feedback and of the torque and current feedback to the servo amplifier from terminal C1 of the amplidyne compensating and commutating fields.

4–1748. AZIMUTH DRIVE MOTOR B3201.

4–1749. Figure 7–61 shows the internal wiring diagram of this d-c motor and its mechanical construction. Azimuth drive motor B3201 is rated at 1 horsepower for continuous duty when 27 volts at 37 amperes dc is delivered to its shunt field. When operated at these ratings, the speed of the azimuth drive motor is 452 rpm.

4–1750. Figure 7–61 also shows how the azimuth drive motor is connected into the azimuth positioning and control system. Excitation power from the exciter generator in the amplidyne generator set is delivered to the shunt field (F1 and F2) of the motor. The path of this power is described in paragraph 4–1742. Armature power is supplied by the amplidyne generator as described in paragraph 4–1746.

4–1751. It should be noted that current flowing in the armature of this motor is also made to flow through compensating and commutating field winding C1 and C2. This winding actually consists of two parallel-connected field windings: the commutating field winding and the compensating field winding. Fields C1 and C2 function to suppress arcing at the brushes of the motor. The fields generate a small magnetic flux which is positioned so that it opposes that component of the normal armature flux which tends to cause arcing at the brushes.

4–1752. The mechanical output of the azimuth drive motor is linked to a gear in the azimuth drive unit and turns the reflector through the train of gears in this box. The motor also links to gears in the azimuth selsyn gear unit, driving the 1- and 36-speed selsyns and the tachometer contained in this unit. The physical location of the azimuth drive motor, which is mounted vertically on the azimuth drive unit, is shown in figure 4–253.

4–1753. AZIMUTH DRIVE UNIT.

4–1754. Figure 4–253 is a mechanical schematic diagram of the azimuth drive. This illustration shows the gear train linkages in the azimuth drive unit, the azimuth drive motor and azimuth selsyn gear unit, the main rotating shaft carrying the slip rings, and the main rotating shaft driving gear. The azimuth drive unit contains the HAND-AUTO shift lever and shifting arrangement, the azimuth interlock switch, the azimuth handcrank arrangement, the motor gear, and eight spur gears.

4–1755. The HAND-AUTO shift lever is shown in the HAND position in figure 4–253. The sliding gear on the spline shaft has been moved up by the shift lever and shifting yoke so that it engages spur gear No. 1. When the azimuth handcrank is manually rotated, bevel gear No. 1, which at all times meshes with bevel gear No. 2, drives the spline shaft. This rotation is transmitted through the sliding gear and spur gears 1 through 8 to the main rotating shaft driving gear. The rotation of the main shaft moves the reflector and its supporting structure in azimuth. In additon, the motion of the yoke arm, which occurred when the HAND-AUTO shift lever was placed in the HAND position, has actuated the interlock linkage. The azimuth interlock switch is now open, so that power cannot reach the azimuth drive motor.

WARNING

Operate SAFE-RUN switch to SAFE position before placing HAND-AUTO shift lever in HAND position. When opened, the azimuth interlock switch allows a slight residual creep in the system, causing the handcrank to rotate and creating danger to personnel.

4–1756. To permit motor drive of the antenna in azimuth, the HAND-AUTO shift lever is operated downward to its AUTO position. The shifting yoke moves the sliding gear down on the spline shaft. The sliding gear disengages from spur gear No. 1. The yoke arm actuates the interlock linkage, operating the azimuth interlock switch so as to close the circuits which allow power to reach the azimuth drive motor. As the motor rotates, the motor gear, which is always meshed with spur gear No. 1, also rotates. Rotational power is applied to the main rotating shaft driving gear through spur gears 1 to 8.

4–1757. The main rotating shaft is hollow and terminates at its lower end in a gear type coupling flange. The upper face of the main rotating shaft driving gear also bears a gear type coupling flange. These two flanges mesh and are bolted together, making the driving gear an extension of the rotating shaft. The portion of the driving gear within its coupling flange is cut out, so that the hollow in the shaft extends through the driving gear.

4–1758. AZIMUTH SELSYN GEAR UNIT.

4–1759. ELECTRICAL ANALYSIS.

4–1760. Figure 7–61 shows how the electrical parts of the azimuth selsyn gear unit, 1-speed selsyn B3202, 36-speed selsyn B3203, and tachometer B3204, are connected into the azimuth positioning section. The two rotor leads of each selsyn are connected to terminals 7 and 8 of terminal board TB3201. Leads go to pins C and D of jack J3202. A cable assembly goes to jack J6905 on the control group assembly, where 60-cps power is picked up for rotor excitation. The two sets of selsyn stator leads connect to pins E, F, G, H, J, and K of jack J6905 through a similar cable assembly. The stator leads are connected through the control group assembly to the junction box, where relays connect these stators to the stators of the similar selsyns located in the azimuth control overlays and the azimuth switch boxes.

4–1761. Tachometer B3204 connects through terminals 10 and 11 of terminal board TB3201, pins A and B of jack J3202, and a cable assembly to pins A and B of jack J6905 in the control group assembly. Leads go to terminals 5 and 6 of terminal board TB6002 on the servo amplifier. The tachometer output voltage, which is a measure of the instantaneous velocity in azimuth of the reflector, is thus applied as a negative feedback and velocity-limiting voltage to the servo amplifier.

4–1762. MECHANICAL ANALYSIS.

4–1763. Figure 4–254 is a mechanical schematic diagram of the contents of the azimuth selsyn gear unit. The shaft of the azimuth drive motor extends into the selsyn gear unit, carrying dual gears 1 and 2. Gear 1 drives gear 16 on the shaft of tachometer B3204. Gear 2

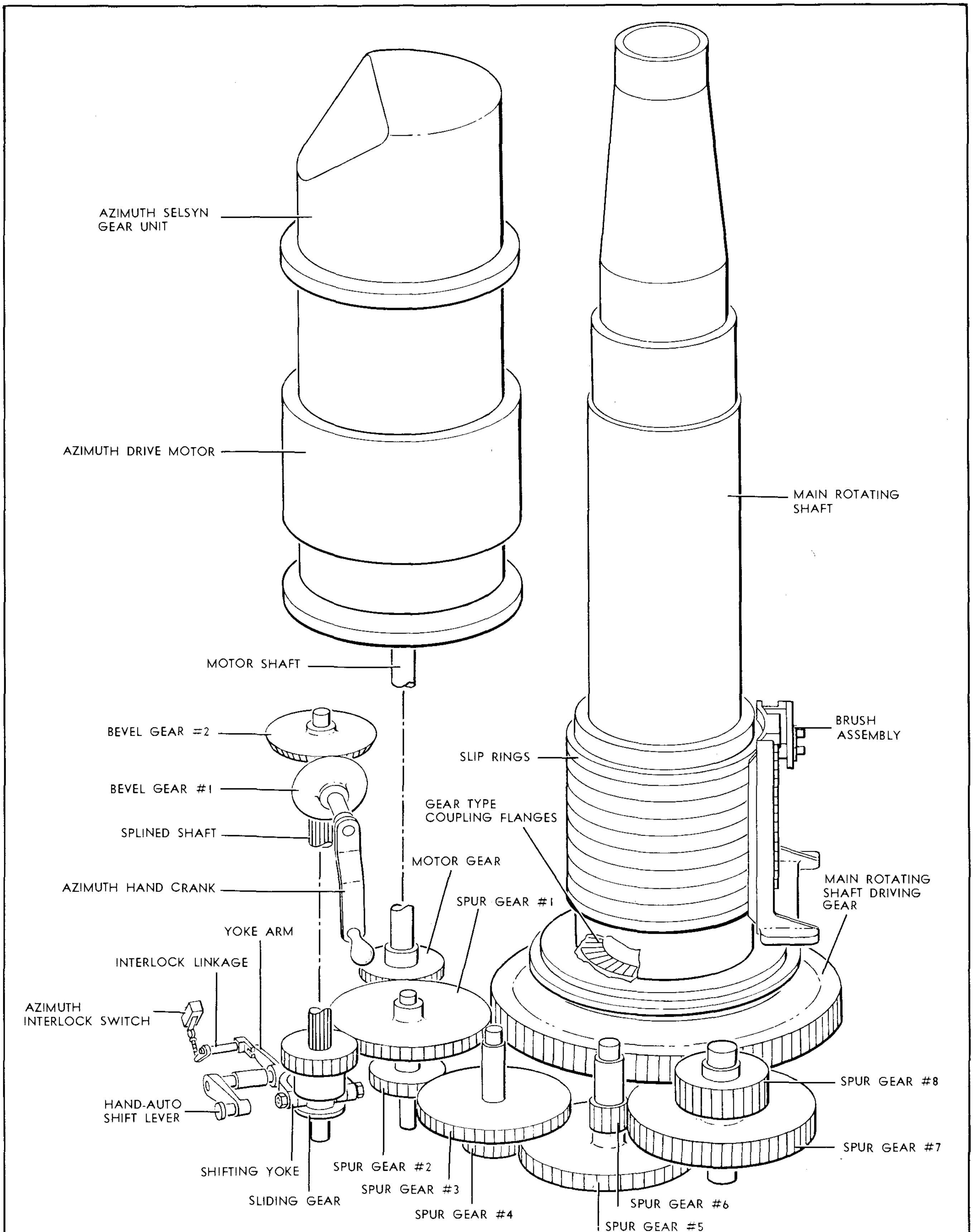


Figure 4–253. Azimuth Drive, Mechanical Schematic Diagram

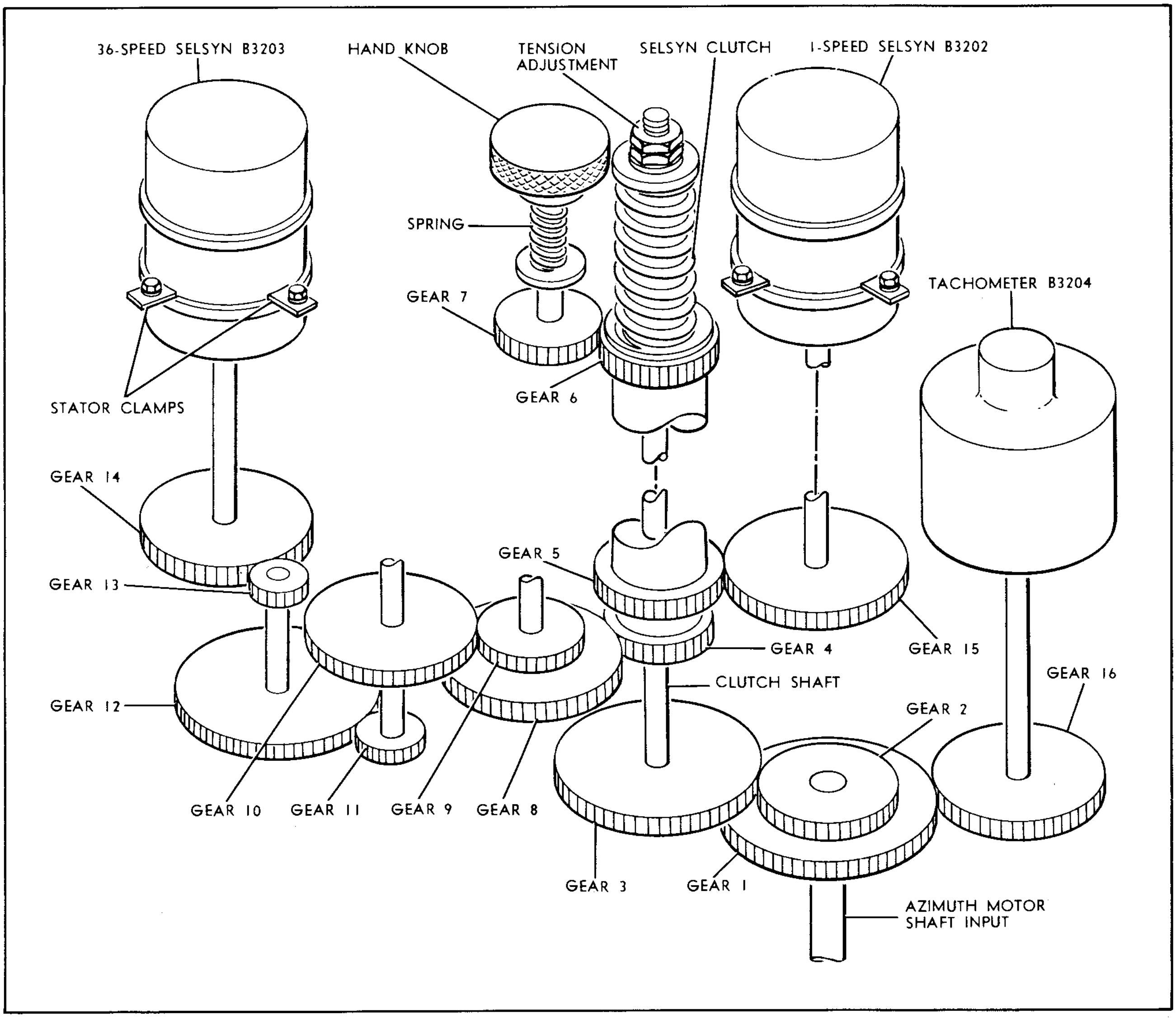


Figure 4–254. Azimuth Selsyn Gear Unit, Mechanical Schematic Diagram

drives gear 3 on the clutch shaft. The rotation of the clutch shaft turns triple gear 4, 5, and 6 through the selsyn clutch arrangement consisting of spring, collar, and tension adjustment nut.

4–1764. The selsyn clutch acts in conjunction with the hand knob to permit a special orientation operation. This action is described in paragraph 4–1767. During normal operation of Radar Set AN/FPS-6, however, the clutch merely acts to transmit the rotational motion of gear 3 to triple gear 4, 5, and 6 exactly as if this triple gear were firmly fixed to the clutch shaft.

4–1765. Gear 5 engages with gear 15, driving 1-speed selsyn B3202. Gear 4 engages gear 8 of dual idler gear 8 and 9. Gear 9 drives gear 10 of dual idler gear 10 and 11. Gear 11 drives dual idler gear 12 and 13, which in turn engages gear 14 on the shaft of 36-speed selsyn B3203.

4–1766. In order to allow for zeroing of the 1- and 36-speed selsyns, each is held in position by a set of stator clamps. These clamps can be loosened to permit the body of a selsyn to be rotated manually about the axis of its shaft for electrical zeroing.

4–1767. The selsyn clutch operates as follows: Triple gear 4, 5, and 6 is made from one piece. The gear body floats on the clutch shaft; that is, the gear body slips freely on the shaft in the absence of the spring and collar. However, the spring presses on the collar, which bears on the gear body, so that the triple gear turns with the shaft whenever gear 3 is rotated by gear 2. The tension of the spring is adjusted so that it is sufficient to force the triple gear to drive its load, which consists of the (maximum) resistance to turning offered by the gear trains driving the two selsyns. If the tension were made smaller, or if the resistance to turning were increased, the triple gear would slip on the clutch shaft, and the selsyns would not be driven. During normal operation, there is no slipping.

4–1768. However, as part of the alinement procedure used in placing Radar Set AN/FPS-6 into operation, it is necessary to aline the reflector of Radar Set AN/FPS-6 with the reflector of the associated search radar installation. During this procedure, the hand knob is depressed against the tension of its retaining spring after the tension adjustment nuts have been backed off. When the hand knob is depressed, gear 7 on the hand knob shaft engages with gear 6 (part of the triple gear). The hand knob is then turned, rotating the selsyns. This causes the servo system to receive orders to move the reflector, so that the azimuth drive motor immediately begins to turn. This rotation causes gear 2 to drive gear 3. Under normal operating conditions, the motion of gear 3 would be transmitted through the triple gear to the selsyns, which would be immediately repositioned so as to stop the motion of the reflector. During the alinement procedure under consideration, however, it is not desired that this should happen. Instead, it is desired that the position of the selsyns should be determined only by operation of the hand knob. The engagement of gear 7 with the triple gear, combined with the loosening of the tension adjustment nuts, acts as a resistance to the motion of the triple gear, so that the selsyn clutch then slips. Thus, the motion of gear 3 is not transmitted to the triple gears, and the selsyns retain the position determined by the hand knob.

4–1769. SAFETY BOX (CONTROL, ANTENNA C-1055/FPS-6).

4–1770. The safety box contains four switches which provide maintenance personnel with a measure of control over the antenna system. These are the SAFE-RUN, HV SAFE-OPER, SLOW-FAST, and STOP switches. A schematic diagram of the safety box is given in figure 7–63.

4–1771. The SLOW-FAST switch selects either the 20 or 30 cpm nodding rate. The STOP switch causes the antenna to cease nodding. The actions of these switch sections are similar to the switches on the azimuth switch box and antenna control panel. Diagrams of these switches in the elevation control circuit are given in figures 7–29 and 7–30.

4–1772. When the SAFE-RUN switch is placed in the SAFE position, phase D power is removed from both the azimuth and elevation interlock circuits. (See figure 4–248.) Driving power cannot be applied to the antenna by any electrical means. When the HV SAFE-OPER switch is place in the SAFE position, the h-v interlock circuit is opened. (See figures 4–36 and 4–38.) The magnetron cannot be fired and hence r-f will not be radiated at this time.

4–1773. CONE JUNCTION BOX HEATERS AND CONVENIENCE OUTLETS.
(See figure 7–62.)

4–1774. The cone junction box contains a pair of 250-watt heater units which protect the slip rings and associated wiring from condensation. These heaters are wired in parallel and are fed by 120-volt, 60-cps, single-phase power from terminals 1 and 4 of terminal board TB3301. Thermostatic switch S3301, in series with the heaters, turns the heaters on when the temperature in the cone junction box falls below 50°F (10°C). At atmospheric pressure, the dew point is considerably below 50°F, so that these heaters prevent condensation.

4–1775. Convenience outlets J3306 and J3307 are available at the cone junction box. These outlets are fed with single–phase, 120-volt, 60-cps power from terminals 2 and 5 of terminal board TB3301 through 8-ampere fuses F3001 and F3002.

4–1776. ANTENNA R-F SECTION.

4–1777. ELECTRICAL ANALYSIS.

4–1778. GENERAL. The electrical theory of the r-f section of the antenna system is described in paragraph 4–434. However, one aspect of the electrical theory of the antenna is discussed in the following paragraphs for the benefit of maintenance personnel.

4–1779. DIFFERENCE BETWEEN ELECTRICAL AND MECHANICAL AXES OF REFLECTOR. (See figure 4–255.) As shown in the referenced illustration, the mechanical axis of the reflector is its geometric axis. The electrical axis of the reflector is the line along which the transmitted beam proceeds. Angle A is the angle between these two axes.

4–1780. It is obvious that in alinement and use of the antenna system, it is the electrical axis which is important. To set the reflector so that it is looking into 0 degree of elevation, the electrical, and not the mechanical axis of the reflector must be horizontal. All references to the angle of elevation of the reflector, therefore, are to the electrical axis of the reflector.

4–1781. The level bracket assembly on the reflector, located near the elevation selsyn and angle mark unit, has its level adjusted so that when this level is centered between the index lines, the electrical axis of the reflector is horizontal. That is, the antenna is looking, electrically, into 0 degree of elevation.

4–1782. The magnitude of the angle A shown in figure 4–255 may vary from reflector to reflector. The magnitude of angle A is within 1 degree when the feedhorn is properly adjusted and located.

4–1783. MECHANICAL ANALYSIS.

4–1784. Figure 4–256 shows the r-f section of the antenna. Radio-frequency energy from the transmitter-receiver cabinet enters the azimuth rotating joint through a length of waveguide not shown in the illustration.

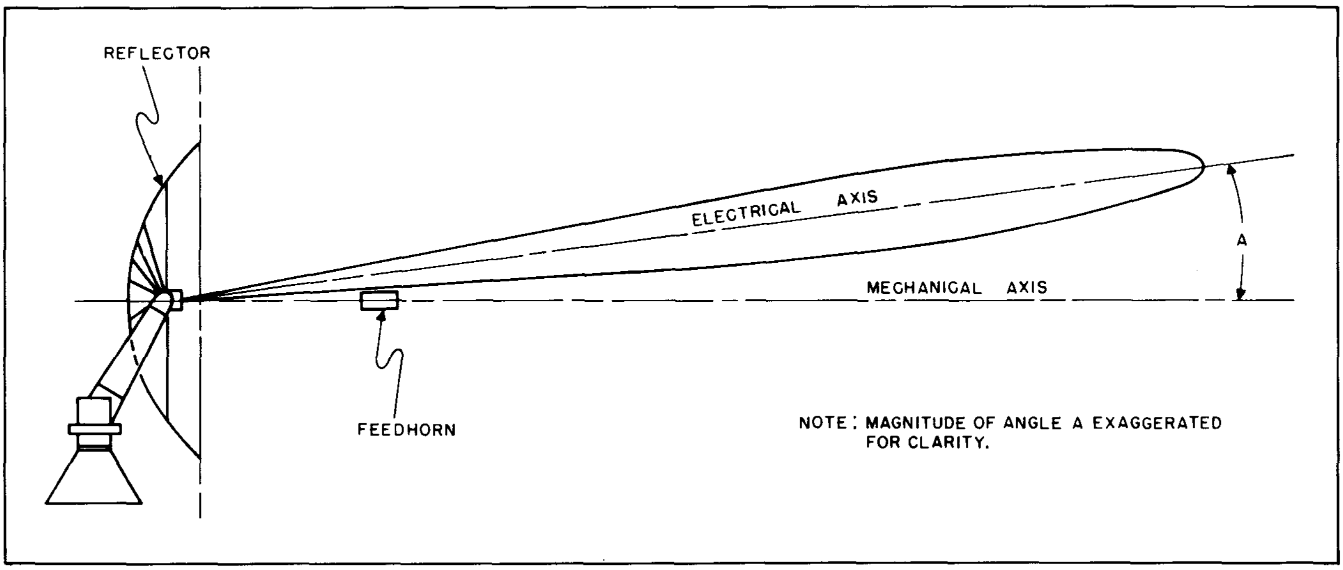


Figure 4–255. Electrical and Mechanical Axes of Antenna

The energy is conveyed through the joint and is fed upward through the cone assembly through a vertical length of rigid waveguide. This waveguide runs up through the hollow center of the main rotating shaft (not shown) and extends up through the yoke hub, at B. At the yoke hub, another length of rigid waveguide connects to the vertical guide and runs out along the main girder and the yoke arm. A short length of flexible waveguide is connected here, leading up to the rigid input waveguide of the elevation rotating joint. The r-f energy is conveyed through the elevation rotating joint and into a twist waveguide. From here, rigid and flexible waveguides carry the energy to the feedhorn at the focus of the paraboloid reflector. The feedhorn supporting structure maintains the feedhorn at the focal position.

4–1785. The internal mechanical operation of the azimuth rotating joint, the yoke hub, and the elevation rotating joint is shown in insets in figure 4–256.

4–1786. In order to maintain the pressurization of the waveguide system, each junction between any two pieces of waveguide, or between a piece of wave guide and a rotating joint, is sealed. The flanged ends of the waveguide components are firmly bolted together and have a gasket tightly squeezed between the metal faces of the flanges. A laminated fiberglass radome is bolted with a gasket seal over the aperture of the feedhorn.

4–1787. Dehydrated air at a pressure of 30 psi is maintained in the waveguide system by the pressurizing and dehydrating equipment. This equipment is discussed in paragraph 4–1804. The inlet from this unit to the waveguide system is located in the magnetron cabinet.

4–1788. ANTENNA SYSTEM OF RADAR SET AN/FPS-6B.

4–1789. COMPARISON WITH RADAR SETS AN/FPS-6 AND AN/FPS-6A.

4–1790. The antenna system of Radar Set AN/FPS-6B differs from that of Radar Sets AN/FPS-6 and AN/FPS-6A in the following manner:

a. Radar Set AN/FPS-6B antenna system includes a variable-nod mechanism which permits the elevation scan angle or arc to be continuously variable from a maximum of 34 degrees (—2 to +32 degrees) to a minimum of 1 degree. The center of this nodding arc is also variable.

b. The antenna system of Radar Set AN/FPS-6B uses a modified girder junction box which is similar in function to that of Radar Sets AN/FPS-6 and AN/FPS-6A. However, the shape of the AN/FPS-6B girder junction box is such that it clears the rotating variable-nod mechanism, and two additional cables within the girder junction box are provided as part of the variable-nod control circuit.

c. The waveguide which passes through the girder junction box is also different in shape from that of Radar Set AN/FPS-6 to clear the rotating variable-nod mechanism.

d. The elevation motor and brake are mounted on a different bracket to allow for the differential physical arrangement of the antenna drive system due to the presence of the variable-nod mechanism.

e. The variable-nod mechanism of Radar Set AN/FPS-6B replaces the connecting rod and elevation crank arm of Radar Set AN/FPS-6.

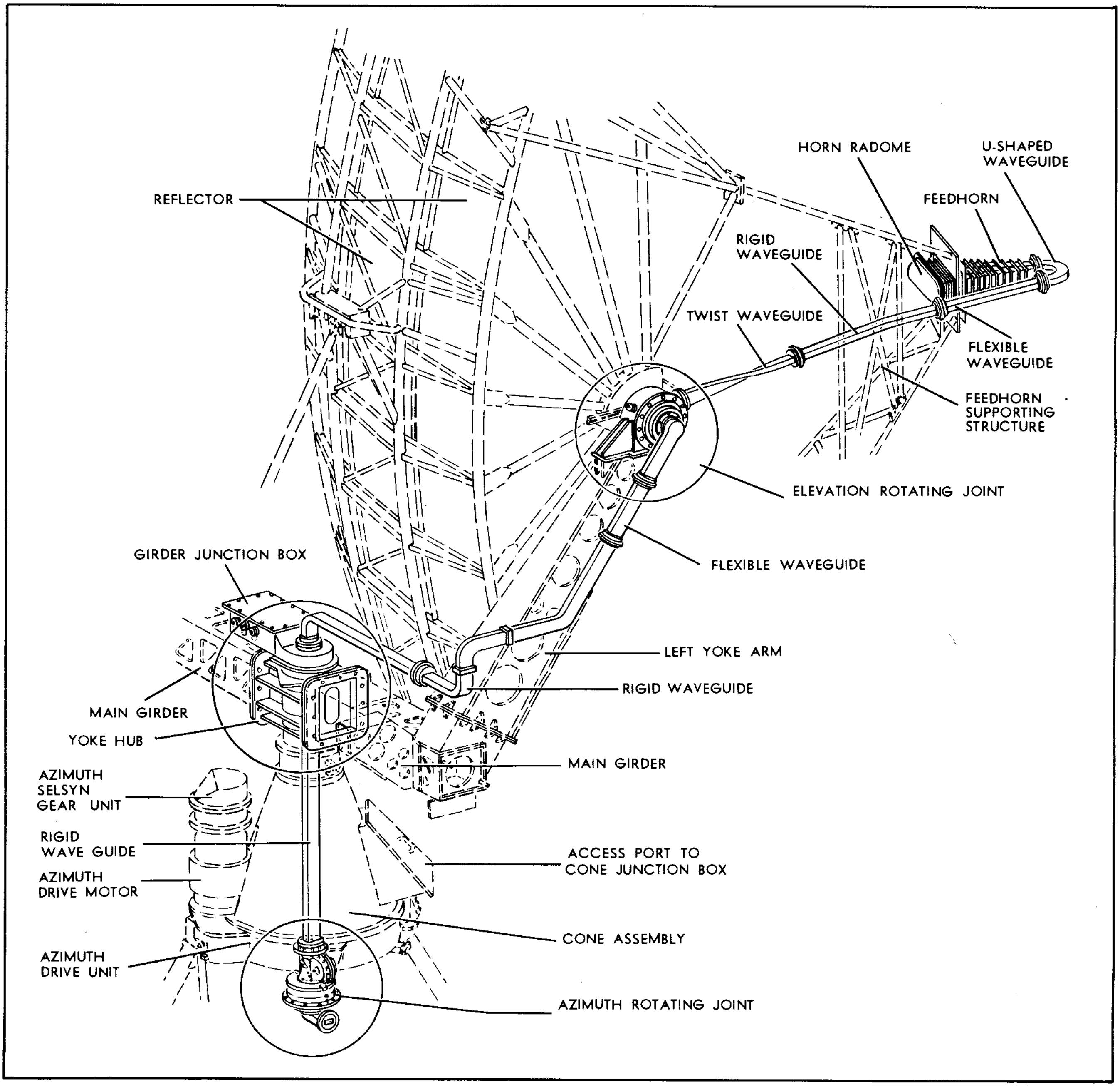


Figure 4–256. R-f Section, Mechanical Schematic Diagram

f. The reflector frame and hubs differ slightly, to accommodate the variable-nod mechanism.

g. Slip rings 1, 2 and 11 through 14, which are spares in the AN/FPS-6 cone junction box, are used in the power and control circuits of the AN/FPS-6B.

h. Connectors and terminals boards in the AN/FPS-6B differ to accommodate the different power and control circuits.

4–1791. Figure 4–257 shows schematically the physical arrangement of the components that adjust the elevation nod angle and position in the antenna system of Radar Set AN/FPS-6B. A simplified schematic diagram of the control circuit of the variable-nod mechanism is included in figure 4–248. The following paragraphs are primarily concerned with a discussion of the variable-nod mechanism of Radar Set AN/FPS-6B. Where differences exist in other portions of the antenna system, these are designated. A complete wiring diagram of the antenna of Radar Set AN/FPS-6B is presented in figure 7–62.

4–1792. VARIABLE-NOD MECHANISM.

4–1793. The essential components of the variable-nod mechanism (figure 4–257) are the two threaded rods

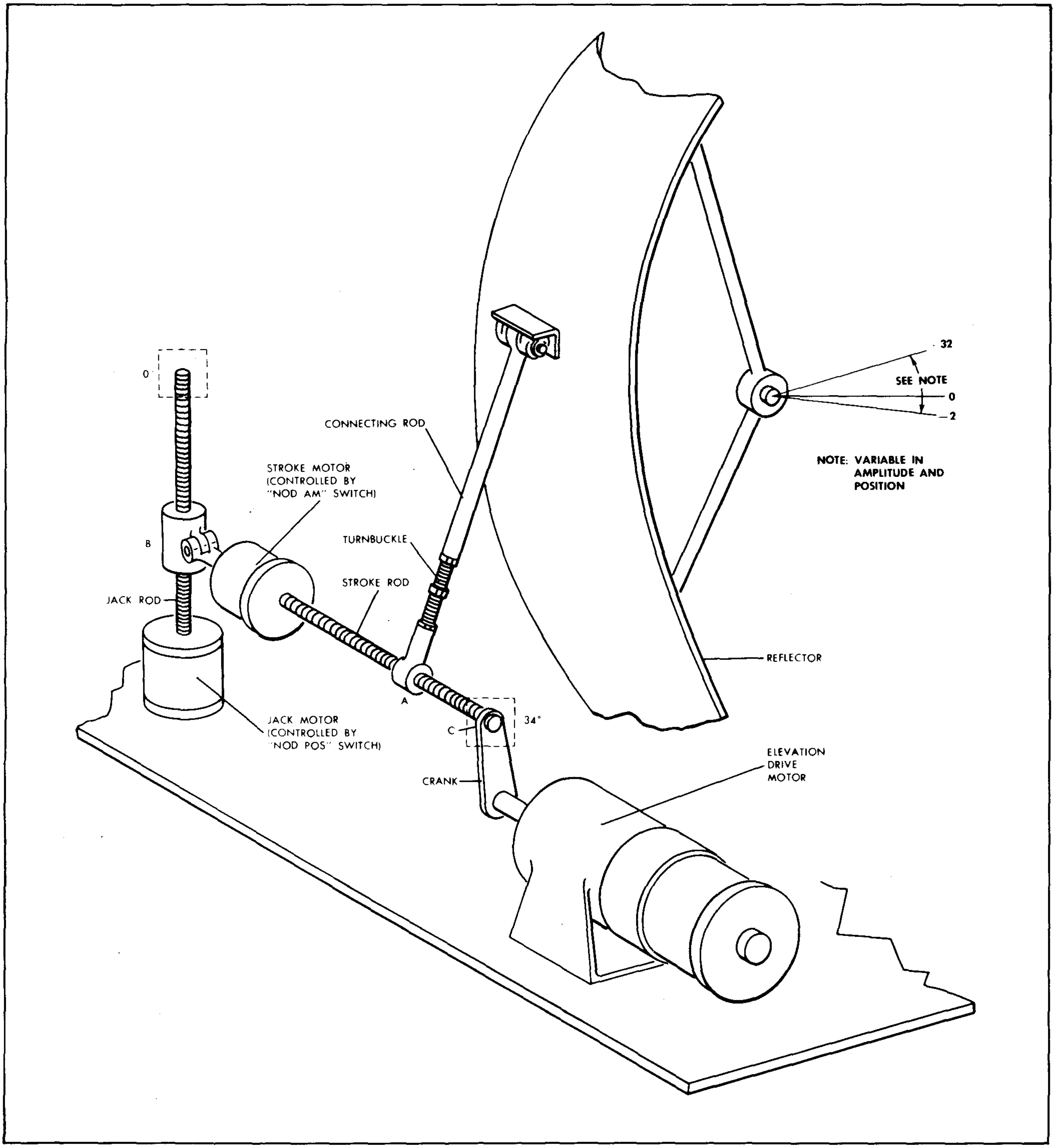


Figure 4-257. Elevation Nod, Angle Controls for Radar Set AN/FPS-6B, Simplified Schematic Diagram

and the stroke and jack motors. For purposes of clarity and conciseness, the terms "stroke" and "jack" motors are used in the following discussion. The stroke motor is the nod-amplitude motor and its associated shaft is the nod-amplitude shaft. The jack motor is the nod-position motor and its associated shaft is the nod-position shaft. A brake is located on the end of each nod motor to maintain any selected position of the variable-nod mechanism. The brake is locked when power is removed from the respective nod motor and is released when the motor is energized for variable-nod operations. Manual operation is also provided for each brake. Figure 4–258 is an illustration of the AN/FPS-6B antenna system showing the variable-nod mechanism.

4–1794. The amplitude of the nodding arc is controlled by the stroke motor. The motor rotates the threaded stroke rod, moving connector A (figure 4–257) horizontally. Assume that connector B, the sleeve on the jack rod, remains in a fixed position. Rotation of the elevation motor makes the stroke rod describe a cone-shaped path: the vertex of the cone at the pivot B and the base at connector C. The circumference of the cross section of this cone is minimum at the point nearest to pivot B and increases continuously toward the base, connector C. The stroke motor, by rotating the threaded stroke rod, controls the position of the connector A, and, therefore, the distance that the connecting rod moves up and down with each revolution of the elevation motor. Connector A can be moved to the left by the stroke motor to a position where the nodding arc of the reflector is a minimum of 1 degree, and to the right to a position where the nodding arc of the reflector is a maximum of 34 degrees.

4–1795. Referring to figure 4–258, the crank is the pivot arm, connector C is the universal joint connection, connector A is the actuating nut and yoke, and connector B is the U-shaped bracket in the elevation tower assembly. The universal joint connection, the actuating nut and yoke, and the connecting rod permit free movement of the mechanism. The up-and-down motion of the connecting rod is cushioned by the rubber shock mounts of the rod, and this motion is transferred to the reflector frame by means of the reflector drive tube and drive arms which are bolted to the frame and hubs, respectively.

4–1796. Operation of the stroke motor is controlled by NOD AM switch S6508 in the RHI antenna control. This is a double-pole, double-throw switch with center neutral. When pushed upward, the switch applies power to the stroke motor so that connector A is moved to the right, increasing the nod amplitude. When pushed downward, the switch applies power to the stroke motor in opposite polarity, causing connector A to move to the left, decreasing the nod amplitude.

4–1797. The center of the nodding arc (nod position) is controlled by the jack motor. This motor moves connector B (figure 4–257) vertically. Since B is the pivot of the stroke rod and the vertex of the cone (the path described by the rod when the elevation motor rotates), moving B upward causes the cone to move upward and the center of the nodding arc of the reflector to move downward. When B is moved downward, the reverse takes place. At the upper limit of the jack rod, the center of the nodding arc is 2 degrees below the horizon (—2 degrees); at the lower limit of the jack rod, the center of the nodding arc is 32 degrees above the horizon (+32 degrees).

4–1798. Referring to figure 4–258, the jack rod and connector B are included in the elevation tower assembly. The U-shaped bracket to which the stroke (nod-amplitude) motor and shaft is connected slides backward and forward along the two shafts (guide rails) of the tower assembly. The upper shaft of the tower assembly is the jack rod, and the threaded screw shaft controls the position of the U-shaped bracket.

4–1799. Operation of the jack motor is controlled by NOD POS switch S6509 in the RHI antenna control. This is a double-pole, double-throw switch with center neutral. When pushed upward, the switch applies power to the jack motor so that connector B is moved downward. When pushed downward, the switch applies power to the jack motor in opposite polarity, moving the connector upward.

4–1800. Limit switches on the stroke motor prevent the antenna from being driven further than the limits of 1 degree minimum amplitude and 34 degrees maximum amplitude. Limit switches on the jack motor prevent the antenna from being driven further than the limits of —2 degrees minimum nod position and +32 degrees maximum position. This also prevents the variable-nod mechanism from jamming. An additional interlock opens the elevation drive circuit whenever the nod angle is made to exceed 15 degrees while the antenna is in fast nod.

4–1801. The stroke and jack motors are induction type motors and are connected to their respective threaded screw shafts through gear assemblies. Power to these motors is 120 volts ac, phase D, supplied by the RHI antenna control and controlled by the NOD AM and NOD POS switches.

4–1802. R-F SECTION.

4–1803. The waveguide which passes through the girder junction box is different in shape from that of Radar Set AN/FPS-6. This waveguide (Waveguide CG-939A/FPS-6) is shaped so that it allows the variable-nod mechanism to operate freely. The shape of the girder junction box is also different for a similar reason. In addition, the girder junction box contains two extra cables to provide for control of the variable-nod mechanism. Otherwise, the r-f section of Radar Set AN/FPS-6B is identical to that of Radar Set AN/FPS-6.

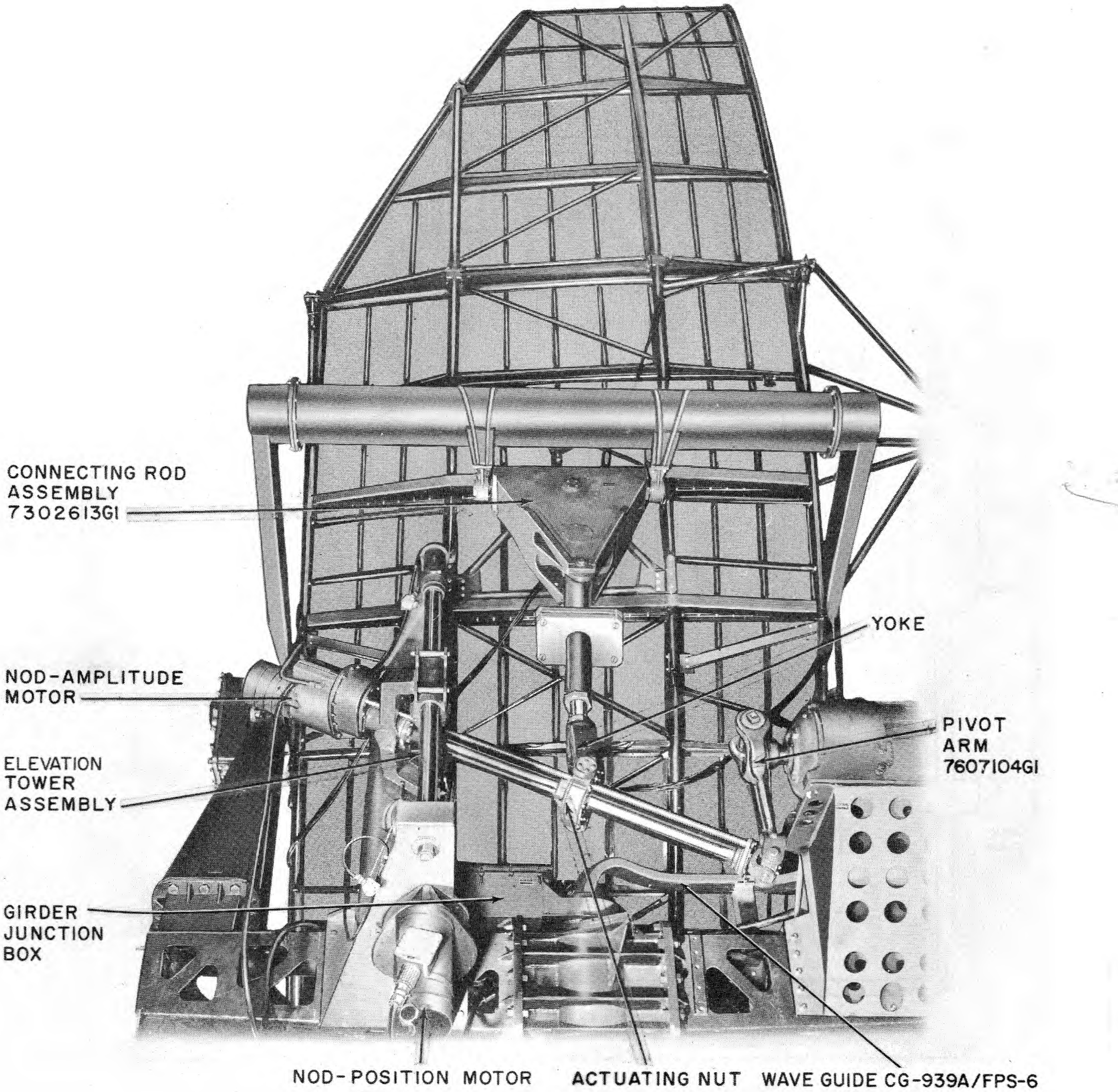


Figure 4–258. Antenna Group OA-2040/FPS-6B

4–1804. PRESSURIZER AND DEHYDRATOR (DEHYDRATOR, DESICCANT, ELECTRIC HD-187/FPS-6).

4–1805. GENERAL FUNCTIONING.

4–1806. The air in the waveguide system is pressurized by means of a compressor. Silica gel units dehydrate (dry) the air. To insure continuous operation, two silica gel units are used. While one unit is absorbing moisture from the compressed air, the other is being dried by heaters. Switching from one unit to the other is accomplished automatically.

4–1807. Figure 4–259 shows the path through which the compressed air flows while the right dehydrating cylinder is active. Fresh air, drawn in through an intake filter on compressor B1, is pumped into air storage tank O2 and allowed to build up to a predetermined pressure. The air, at a constant pressure determined by regulator M1, is then passed through right supply valve K7 to right dehydrating cylinder MS2. Most

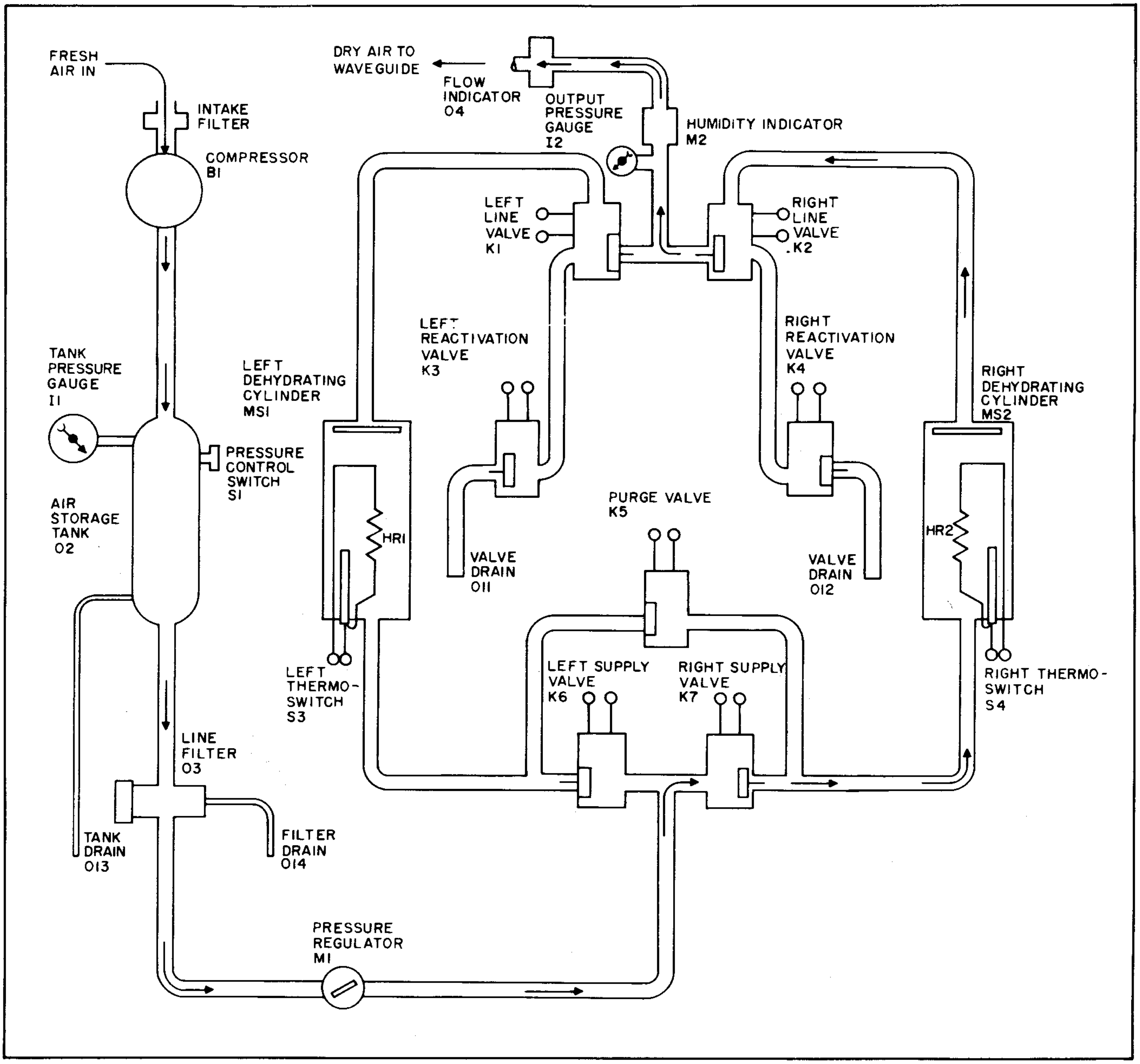


Figure 4–259. Pressurizer and Dehydrator, Simplified Flow Diagram

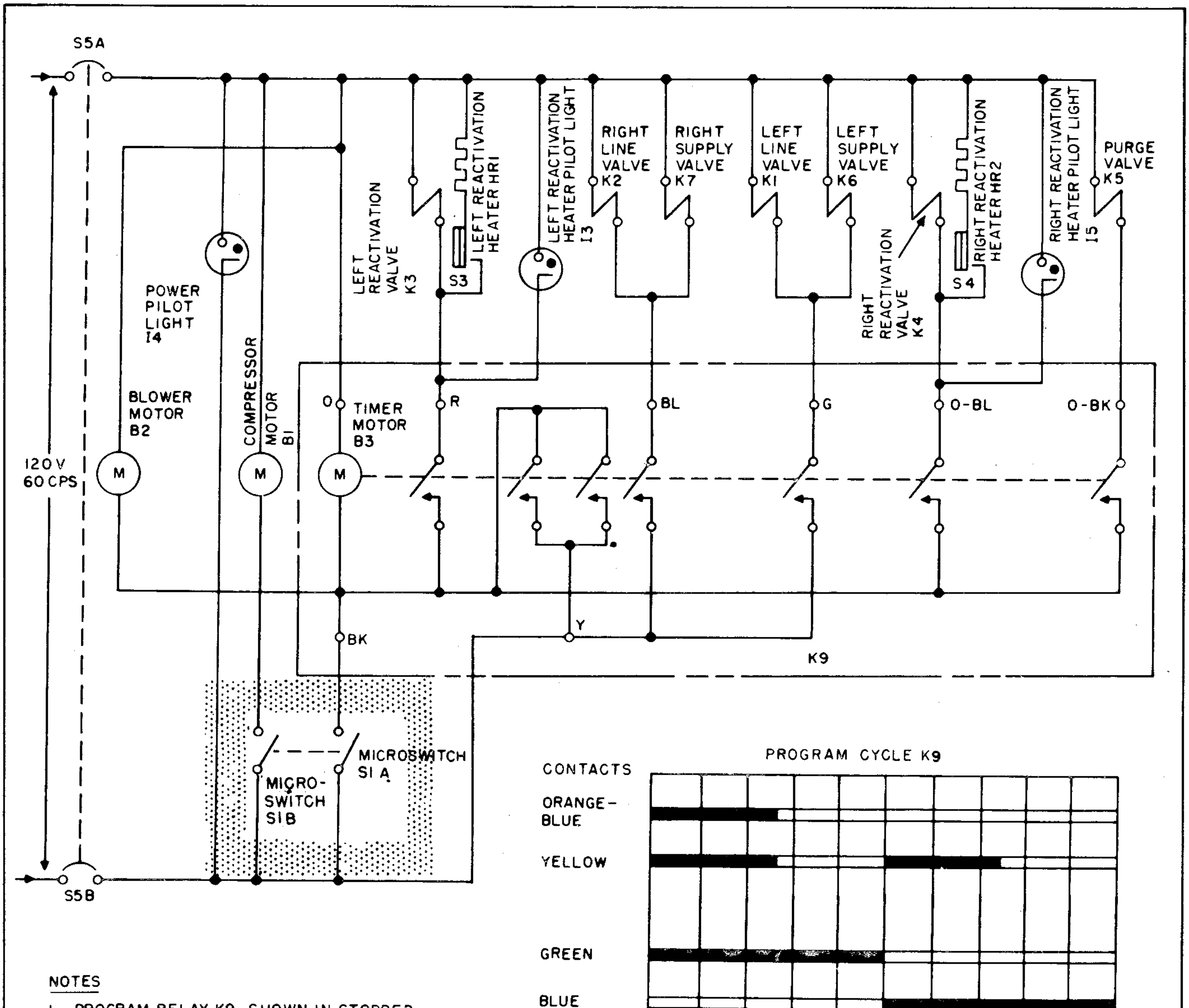
of the moisture in the compressed air is absorbed by the silica gel in the right dehydrating cylinder. The dehumidified air passes through right line valve K2 and enters the waveguide. As air escapes from the waveguide (because of losses in the system), the compressor takes in fresh air and maintains the operating pressure in air storage tank O2.

4–1808. During this time, left dehydrating cylinder MS1 is idle. Compressed air cannot reach the left dehydrating cylinder because left supply valve K6 is closed. The left dehydrating cylinder is sealed off from the waveguide at this time because left line valve K1 is closed. At the end of 5 hours, the left dehydrating cylinder assumes the dehumidifying and pressurizing functions, while the silica gel in the right dehydrating cylinder is dried by a heating unit and then permitted to cool. Thus, one dehydrating cylinder is active in dehumidifying the compressed air while the other cylinder is being dried out. The program timer (paragraph 4–1810) automatically reverses the conditions of the two dehydrating cylinders (that is, the idle cylinder becomes active while the active cylinder is made idle) at intervals depending upon the air loss in the waveguide. However, reversal frequency is limited to once every 5 hours.

4-1809. DETAILED ANALYSIS.
(See figures 4-259 and 4-260.)

4-1810. PROGRAM TIMER. The heart of the automatic switching circuit shown in figure 4-260 is the program timer. The timer consists of a small timer motor, a camshaft, and a switch assembly. The unit is completely enclosed in a metal box with a hinged cover. When the timer motor runs, cams mounted on the motor shaft rotate and alternately press and release the switch contacts. In this manner, the rotation of the motor opens and closes the switch contacts in a desired sequence, called the program.

4-1811. The program timer controls the opening and closing of solenoid-operated valves. Closing of the program timer switch contacts applies a line voltage of 120 volts ac to certain valve solenoids. The magnetic field which builds up within the solenoid pulls the valve open. When the program timer opens the switch contacts, the magnetic field collapses and spring action closes the valve.



NOTES
1 PROGRAM RELAY, K9, SHOWN IN STOPPED POSITION SHORTLY AFTER ZERO TIME
2 ALL MANUALLY-OPERATED SWITCHES SHOWN IN "OFF" POSITION
3 PROGRAM CYCLE CHART INDICATES CLOSED CONTACTS

Figure 4-260. Program Timer Circuit, Simplified Schematic Diagram

4–1812. PROGRAM. Each of the two dehydrating sections goes through a four-part cycle (program) consisting of the active, reactivation, purge, and cooling periods. During the active period, compressed air is passed through the dehydrating cylinder, where it is dehumidified and sent to the waveguide. During the reactivation period, the silica gel is dried for 2-1/2 hours by electric heaters. Moisture is ejected from the equipment during the purge period, which occupies the final 30 minutes of the reactivation period. During the cooling period, the silica gel is allowed a minimum of 2-1/2 hours to cool. During this period, the timer motor operates only when the pressure in the waveguide drops below a predetermined point. If the waveguide has no losses, the air stays free of excessive moisture and the waveguide pressure is maintained. Under these conditions, the timer motor remains off and the cooling period may last much longer. Under leaky conditions, when the timer motor runs continuously, the cooling period lasts only 2-1/2 hours. In the following paragraphs, the operation of the left dehydrating cylinder through a complete four-part program is discussed.

4–1813. ACTIVE PERIOD. The green contact in the program timer is closed during this period. This opens left supply valve K6 and left line valve K1. Compressed air is then admitted to the left dehydrating cylinder through the left supply valve, while dehumidified air from the left dehydrating cylinder is permitted to enter the waveguide through the left line valve. During this time, the right dehydrating cylinder is idle and is sealed off from the compressor by right supply valve K7 and from the waveguide by right line valve K2.

4–1814. REACTIVATION PERIOD. The reactivation period starts when the green contact in the program timer opens. Left supply valve K6 and left line valve K1 then close, sealing off the left dehydrating cylinder. At the same time, the yellow, red, and blue contacts in the program timer close. Timer motor B3 and the program timer contacts are energized constantly through the yellow contact. The timer motor runs continuously during the entire 2-1/2 hours of the reactivation period.

4–1815. The closing of the red contact in the program timer at the start of the reactivation period turns on left reactivation heater HR1 and opens left reactivation valve K3. The left reactivation heater drives the moisture out of the silica gel in left dehydrating cylinder MS1. The moisture escapes in the form of steam through the open left reactivation valve.

4–1816. The closing of the blue contact in the program timer causes right supply valve K7 and right line valve K2 to open. Any air that leaks out of the waveguide is replaced by compressed air drawn through right supply valve K7 and passed to the waveguide through right line valve K2.

4–1817. PURGE PERIOD. Steam released by the silica gel in left dehydrating cylinder MS1 during the reactivation period tends to condense on the inner walls of the pipe leading from the left dehydrating cylinder to the left line valve. During the purge period, this moisture is blown out of the pipes by compressed air from the reservoir. The orange-black contact in the program timer closes at the beginning of the purge period, opening purge valve K5. Air from the compressor passes through right supply valve K7, purge valve K5, left dehydrating cylinder MS1, left line valve K1, and left reactivation valve K3, and then out into the atmosphere through valve drain O11. This purge continues for about 30 minutes, which is long enough to purge the left dehydrating cylinder circuit of any moisture that may have condensed during the reactivation period.

Note

The resistance to airflow through the circuit being purged is high enough to maintain an output line pressure of 30 psi during the purge period.

4–1818. COOLING PERIOD. At the end of the purge period, the orange-black, red, and yellow contacts in the program timer open. This allows purge valve K5 and left reactivation valve K3 to close, and left reactivation heater HR1 to turn off. The silica gel, now thoroughly dry, is permitted to cool.

4–1819. In addition, the opening of the yellow contact in the program timer places timer motor B3 under the control of pressure switch S1. Timer motor B3 is subsequently energized only when the waveguide pressure drops below the operate setting of pressure switch S1. Therefore, the cooling period may actually extend over a period of days, depending upon the amount of air loss in the waveguide.

4–1820. After timer motor B3 has run for 5 hours (including the reactivation period, the purge period, and the cooling period), the program timer switches over to the second half cycle. The second half cycle is identical to the first, except that left dehydrating cylinder MS1 becomes the active cylinder and right dehydrating cylinder MS2 becomes the idle cylinder (the one being reactivated).

4–1821. STORAGE TANK. The pressure within tank O2 is built up to 120 psi by the compressor. Once this pressure is reached, control switch S1 turns off the compressor. The storage tank then maintains a nearly uniform pressure within the system. The tank also performs another useful service: the high pressure within the tank condenses some of the moisture in the air. By reducing the amount of moisture in the remainder of the system, the storage tank reduces the burden on the dehydrating cylinders.

4–1822. TANK DRAIN. If too much moisture is allowed to collect in the storage tank, some of it may leak out into the line and add to the load on the dehydrating cylinders. In addition, water condensed in the storage tank may freeze during cold weather, reducing the efficiency of the system. For these reasons, the maintenance technician should drain the reservoir daily by opening TANK DRAIN valve O13.

4–1823. FILTER DRAIN. Air passing through line filter O3 from the storage tank is still quite moist. Since the air is also under pressure, moisture condenses on the filter. FILTER DRAIN valve O14 is provided to drain off water that has collected on the filter.

4–1824. HEAT EXCHANGER FOR MAGNETRON (COOLER, LIQUID, ELECTRON TUBE HD-188/FPS-6).

4–1825. AIR CIRCUIT.

4–1826. Cool air is drawn into the heat exchanger by the fan through a grill on the rear of the enclosure. This cool air passes over the finned-surface cooling coil that carries the heated coolant from the magnetron assembly. The coil gives off the excess heat to the air, which is then discharged through louvers on the sides and front panel of the enclosure. During the passage of the air over the coil, the air temperature is raised approximately 4.4°C (8°F) when 4 kilowatts of energy is being dissipated.

4–1827. LIQUID CIRCUIT. (See figure 4–261.)

4–1828. Heated liquid returning from the magnetron assembly enters the heat exchanger coolant inlet, passes through the open inlet valve, and enters the expansion tank. From the expansion tank, the warm liquid goes to the pump, which discharges the liquid to the lower end of the finned-surface coil. This coil operates on the counterflow principle; that is, the hot liquid enters at the lower end of the coil assembly while the coiling air enters at the upper end. The fins on the surface coil enable the liquid to give off its heat readily to the moving air. The liquid leaves the coil at the upper end, where the air is coolest. From there it flows, under pressure from the pump, through the outlet valve and colant outlet, and returns to the magnetron assembly.

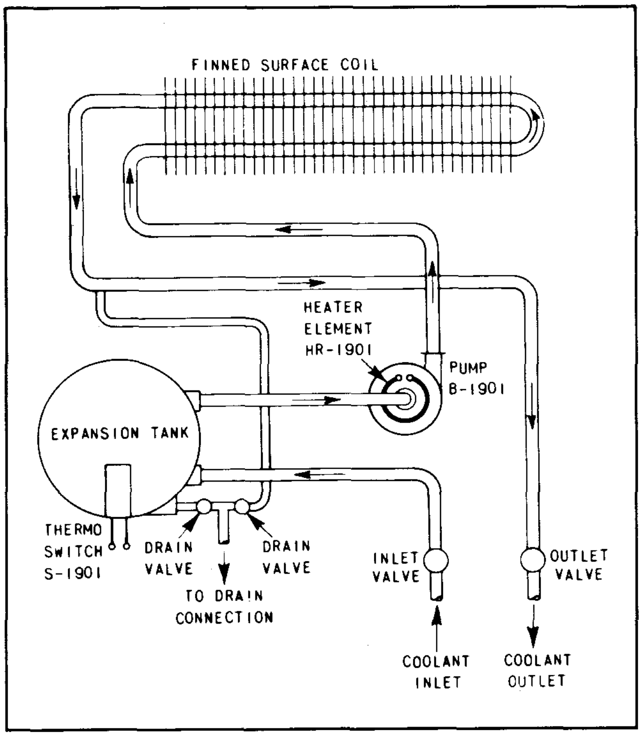


Figure 4–261. Heat Exchaiger for Magnetron Liquid Flow Circuit

4–1829. ELECTRICAL CIRCUIT.

4–1830. GENERAL. Except for a common power supply, the electrical circuit consists of two independent parts: one for the drive motor, and one for the heater element (figure 7–52).

4–1831. POWER MOTOR CIRCUIT. The power source supplies 208-volt, 60-cps, 3-phase ac through the connector to the line side of the circuit breaker or main power switch. In addition to serving as an on-off control, the circuit breaker gives overload protection. The circuit breaker is set to trip whenever the load current exceeds 9.0 amperes. When the circuit breaker is closed, power from the load side is applied to the 1-horsepower motor that drives both the pump and the fan. As seen from the pump end, the motor drives in a clockwise direction, producing both air and coolant flow.

4–1832. HEATER ELEMENT CIRCUIT. During extended shutdown periods in very cold weather, the liquid circuit and its pump may become chilled to a point where they will not operate properly when the equipment is first started up. To help prevent this, the thermostatic switch is set to close whenever the temperature of the coolant in the tank drops below —17.7°C (0°F). The switch and heater element are connected in series with each other and across lines A and C on the supply side of the circuit breaker. The heater circuit is therefore independent of the circuit breaker position.

WARNING

Always de-energize or disconnect the supply line when working on this switch and heater, since they are normally energized even when the circuit breaker is open.

4–1833. When coolant temperature drops below the minimum, the bimetallic element of the thermostatic switch closes the series circuit and energizes the heater. When the coolant is warmed enough, the switch opens and the heater stops. The heater element is mounted on the face of the pump and serves primarily to keep the pump warm. If the pump is not kept above the minimum temperature of —17.7°C (0°F), it may not, immediately on starting, be able to handle the required volume of flow. Consequently, there may be some delay (approximately 2 to 4 minutes) before coolant flow closes the contacts on the flow switch in the magnetron assembly, and the application of power to the magnetron may therefore be delayed. For this reason, the heat exchanger should be kept connected to the power source at all times during cold weather. The capacitor connected across the thermostatic switch suppresses interference that might result from sparking of the switch contacts.

4–1834. HEAT EXCHANGER FOR FERRITE ISOLATOR (COOLER, LIQUID, R-F ISOLATOR HD-289/FPS-6A).

4–1835. AIR CIRCUIT.

4–1836. The fan draws cool air into the heat exchanger through filters on the side panels. This cool air passes over the finned-surface cooling coil that carries the heated coolant from the ferrite isolator. The finned coil gives off the excess heat to the air, which is then discharged through the rear. During the passage of the air over the coil, the air temperature is raised approximately 6°C (10.8°F) when 1 kilowatt of energy is being dissipated.

4–1837. LIQUID CIRCUIT. (See figure 4–262.)

4–1838. Heated liquid returning from the ferrite isolator enters the heat exchanger coolant inlet and passes through the open inlet valve, the Y-strainer, and the manifold into the finned-surface coil. This coil operates on the counter flow principle; that is, the hot liquid enters at one end while the cool air enters at the other. The fins on the coil enable the liquid to give off its heat readily to the moving air. The cooled fluid then enters the expansion reservoir. The expansion reservoir is at barometric pressure, therefore the fluid is fed by gravity to the pump. From there, the fluid is pumped through the outlet valve and coolant outlet to the ferrite isolator.

4–1839. ELECTRICAL CIRCUIT. (See figure 4–263.)

4–1840. GENERAL. The electrical circuit consists of two independent parts: one for the drive motor and one for the safety interlock circuit.

4–1841. POWER MOTOR CIRCUIT. The r-f assembly supplies 208/120-volt, 60-cps, 3-phase, 4-wire ac to connector J2301. From terminal A of connector J2301, single-phase power at 120 volts is applied to the line side of circuit breaker S2301. In addition to serving as an on-off control, the circuit breaker gives overload protection. The circuit breaker is set to trip whenever the load current exceeds 6 amperes. When the circuit breaker is closed, power from the load side is applied to 1/3-horsepower motor B2301, which drives both the pump and the fan. As seen from the pump end, motor B2301 drives in a counterclockwise direction, producing both air and coolant flow. The other side of the motor is returned to neutral at terminal D of connector J2301.

4–1842. Three-phase a-c power is also wired from connector J2301 to connector J2302. From connector J2302, three-phase power is applied to connector J1901 of the magnetron heat exchanger.

4–1843. SAFETY INTERLOCK CIRCUIT. The heat exchanger safety interlock circuit is in series with the high-voltage interlock circuit of the transmitter-receiver

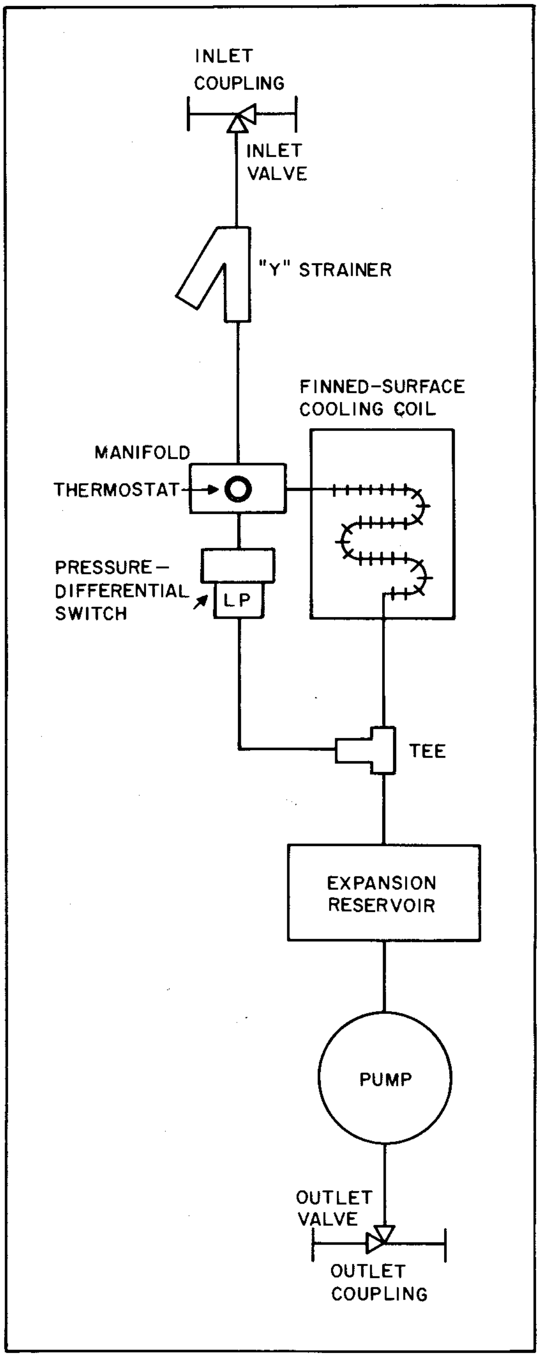


Figure 4–262. Heat Exchanger for Ferrite Isolator Liquid Flow Circuit

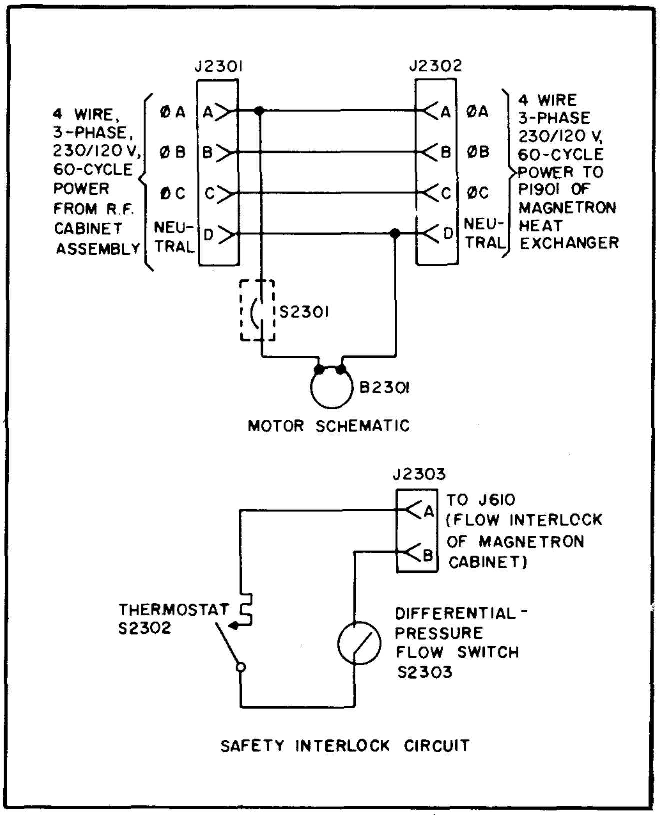


Figure 4–263. Heat Exchanger for Ferrite Isolator, Motor and Safety Interlock Circuits, Schematic Diagram

system (paragraph 4–273). In essence, the high-voltage interlock circuit is a series-connected circuit containing various switches, relays, and contacts. An open circuit at any point releases main contactor relay K10401 in the modulator high-voltage power supply, opening the contacts through which regulated three-phase power is applied to the modulator high-voltage power supply circuit. Thus, power to the modulator is cut off, the magnetron cannot oscillate, and the system cannot radiate until the high-voltage interlock circuit is once again closed and the radar started.

4–1844. The two heat exchanger components in the high-voltage interlock chain are thermostat S2302 and pressure differential switch S2303. During normal operation, both the thermostat and the pressure differential switch are closed. The thermostat opens whenever the incoming fluid temperature exceeds 75°C (167°F). The pressure differential switch opens whenever coolant flow is slowed enough so that the pressure between the cooling coil and the restriction in the manifold falls below 4 psi. This occurs when the coolant flow decreases to below 0.8 gpm.

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SECTION V

ORGANIZATIONAL MAINTENANCE

5–1. INTRODUCTION.

5–2. SCOPE.

5–3. This section contains the following information:

a. Preliminary inspection checklist (figure 5–1)

b. Lubrication instructions (figure 5–2)

c. Initial control settings (figure 5–8)

d. Procedure for energizing equipment for alinement and testing (figure 5–9)

e. System minimum performance standards (figure 5–10)

f. System trouble analysis chart (figure 5–11)

g. System alinement (paragraphs 5–33 through 5–105)

h. System tests (paragraph 5–106 through 5–161)

5–4. The procedures given in this section are concerned with maintenance of Radar Set AN/FPS-6 as a system. Detailed instructions for individual chassis are given in Section VI.

5–5 TEST POINTS.

5–6. Significant test points are identified by distinctive symbols throughout Sections V, VI, and VII. Separate types of symbols are used for major, secondary, and minor test points. The symbol is an aid to more quickly locating the test points on a schematic or servicing diagram. The type of symbol indicates the relative importance of the test point.

5–7. Major test points are indicated by star-enclosed Arabic numerals. For example, 1 and 2 designate test points for isolating the trouble to an overall system function or power distribution system for the equipment.

5–8. Secondary test points are indicated by encircled capital letters. For example, A and B designate test points for isolating the trouble to a subsystem or component.

5–9. Minor test points are indicated by encircled capital letters followed by Arabic numerals. For example, A1 and B1 designate test points for isolating the trouble to one or more circuits of a component or assembly.

5–10. SAFETY PRECAUTIONS.

5–11. ANTENNA PRECAUTIONS.

5–12. When performing any work on the antenna platform, disable both the azimuth and elevation drives by placing the SAFE-RUN switch on the safety box in the SAFE position. Turn off the r-f power by placing the HV SAFE-OPER switch on the safety box in the SAFE position. Be sure that all personnel and all equipment are clear of the antenna path before returning the SAFE-RUN switch to the RUN position. Do not stand in front of the reflector while r-f power is being radiated; i.e., while the HV SAFE-OPER switch is in the OPER position.

5–13. After placing the azimuth gear shift (AUTO-MANUAL) in the MANUAL position, tie the handle to the antenna frame with a rope. This must be done before placing any ladders against the antenna.

5–14. Do not attempt to climb up the antenna framework to reach the elevation brake or the elevation selsyn and angle mark unit. Use a sturdy ladder braced against the main girder.

5–15. Do not climb the antenna framework to set elevation brake by hand. Fabricate and use an antenna safety pole, 12 fet in length, from wood or aluminum. Fasten a metal eyebolt of 1-1/2 inches inside diameter at one end of the pole. Use this safety pole to set the elevation brake from the antenna platform of Radar Set AN/FPS-6 or from the ground in Radar Set AN/MPS-14.

5–16. HIGH-VOLTAGE PRECAUTIONS.

5–17. This equipment contains high voltages that are dangerous to life. Extreme caution must be exercised when working on this equipment, particularly with components of the modulating and transmitting systems.

5–18. When the thyratron compartment (lower right-hand door of the modulator assembly) is opened, 12 kilovolts is exposed. Do not come within 6 inches of any exposed components. When shorting out the modulator pulse, be sure to use the insulated grounding rod (figure 5–21).

5–19. X-rays are emitted by certain modulating and transmitting system components.

Note

Be sure that the lead cap is installed on the magnetron and that the protective door is installed on the thyratron compartment.

5–20. PRELIMINARY INSPECTION CHECKLIST.

5–21. Figure 5–1 is a checklist of items to be checked during physical inspection of the equipment. Such inspection should be made at the intervals specified and just prior to performing the minimum performance standards.

5–22. LUBRICATION.

5–23. Figure 5–2 lists the components to be lubricated, the procedures, lubricants, and lubrication intervals. The intervals given in this figure apply primarily to operation in arctic and temperate climates; more frequent lubrication is required in tropical climates. Do not attempt lubrication while equipment is operating. Before lubrication or oil changes, wash all readily accessible parts with carbon tetrachloride. Check all grease seals and lubrication fittings for serviceability and replace all readily accessible seals and fittings that are worn and have overhaul teams. Also replace worn items that are not accessible. Wipe off all excess grease after lubrication. See figures 5–3 through 5–7 to locate lubrication points on the equipment.

Item to be Inspected	Inspection	Interval			Remarks
		Daily	Weekly	Monthly	
Cases, covers, mountings, exposed surfaces	Dirt, dust, corrosion	X	X	X	Wipe with clean, dry cloth
	Proper mounting of cases and chassis		X	X	Tighten hardware on cases, chassis
Cabling	Cuts, breaks, fraying, strains, kinks, or deterioration	X	X	X	Tape worn spots temporarily; replace as soon as possible
	Tightness of connectors	X	X	X	Maintain tightness
	Cleanliness of connectors			X	Clean all connectors and replace worn parts
Nameplates, indicator window glass, lamp lenses	Dirt, scratches, and physical damage	X	X	X	Replace as necessary
Front panel controls	Binding, scraping, or excessive looseness		X	X	Tighten, clean, or replace as required
Fuses and lamps	Mounting, proper operation	X	X	X	Mount securely and replace defective fuses
	Absence of spares		X	X	Replenish spares
Electrical connections, terminals, and tie points	Loose connection or corrosion		X	X	Resolder or clean, as required
Electron tubes	Improper seating in sockets		X	X	Straighten bent pins and/or reseat, as required
Capacitor and associated leads	Bulging and discoloration			X	Replace defective component
Resistors and associated leads	Blistering or discoloration			X	Replace defective component
Transformers	Signs of heating			X	Determine if heating is excessive; if so, replace faulty component
Switches and unsealed relays	Dirt, corrosion, burned or pitted contacts			X	Clean and replace, as necessary
Potentiometers	Dirt, corrosion, improper connection, excessive play in shaft			X	Clean, resolder, or replace, as necessary
Coils	Dirt, corrosion, or damaged windings			X	Clean and replace, as necessary
Air filters	Dirt			X	Clean with gasoline, as required

Figure 5–1. Preliminary Inspection Checklist

Component	Procedure	Lubricant	Interval
Deleted			
Deleted			
Azimuth drive motor (See figure 5–3.)	a. Remove grease-release plug b. Add grease until expelled c. Run 20 minutes d. Replace plug	Grease MIL-G-3278	Semiannually
Amplidyne generator set (See figure 5–5.)	Same as azimuth drive motor	Grease MIL-G-3278	Semiannually
Elevation motor (See figure 5–3.)	Same as azimuth drive motor	Grease MIL-G-3278	Semiannually
Connecting rod bearings (See figure 5–3.)	Fill from grease gun	Marfak HD ED-1	Semiannually
Mounting ring assembly jack screws (See figure 5–3.)	Coat lightly	Grease MIL-G-3278	Semiannually
Elevation motor gear box (See figure 5–3.)	a. Remove drain plug b. Drain oil c. Replace plug d. Fill until oil runs freely from level plug	Above 0°F, use MIL-L-2105, GR.90; below 0°F, use MIL-L-10324, GR.W	Semiannually
Azimuth drive unit (See figure 5–3.)	a. Remove drain plug b. Drain oil c. Replace plug d. Fill to center of glass on oil level	Above 0°F, use MIL-L-2105, GR.90; below 0°F, use MIL-L-10324 GR.W	Semiannually
Deleted			
Variable-nod mechanism (See figure 5–4.)	See lubrication chart in Section VI	———	———
Pressurizer and dehydrator compressor crankcase (See figure 5–7.)	a. Remove drain plug b. Drain oil c. Replace plug d. Fill to oil filler hole level (approximately 1/3 pint)	MIL-L-26087	Monthly
Pressurizer and dehydrator compressor motor (See figure 5–7.)	Insert few drops oil in oil cup	MIL-L-7870	Monthly

Figure 5–2. Lubrication Chart

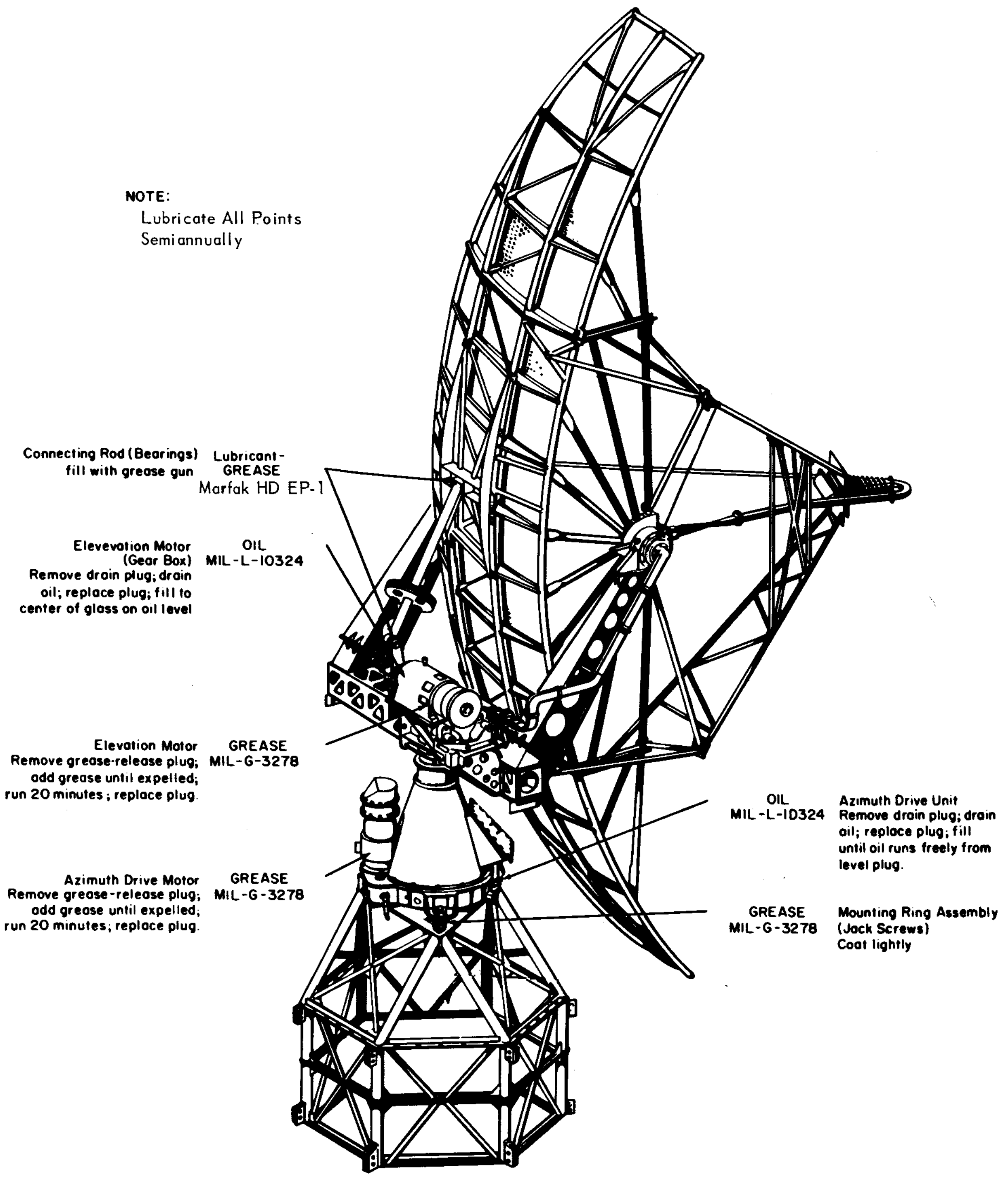
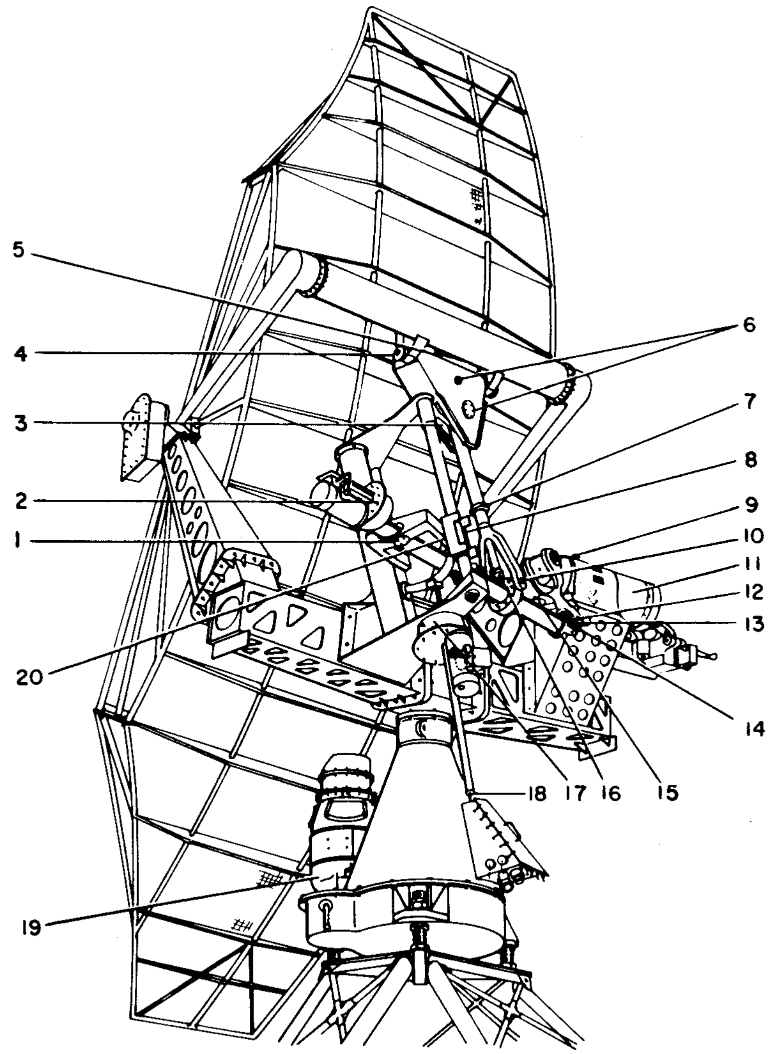


Figure 5–3. Antenna Lubrication for Radar Sets AN/FPS-6 and AN/FPS-6A



1. Cone shaft pivot bearing
2. Amplitude control
3. Ball bushing
4. Drive tube pillow block bearings
5. Reflector drive tube, rod end bearings
6. Compensator box trunnion bearings
7. Connecting rod pivot bearings
8. Position slide
9. Pivot arm—pivot bearings
10. Connecting rod yoke trunnion bearings
11. Elevation drive motor gear-case
12. Cone shaft drive bearing
13. Pivot arm universal ball bearings
14. Pivot arm universal needle bearings
15. Amplitude acme screw
16. Cone shaft slide
17. Position control gear case
18. Drain
19. Azimuth drive motor gear-case
20. Guide rail housings

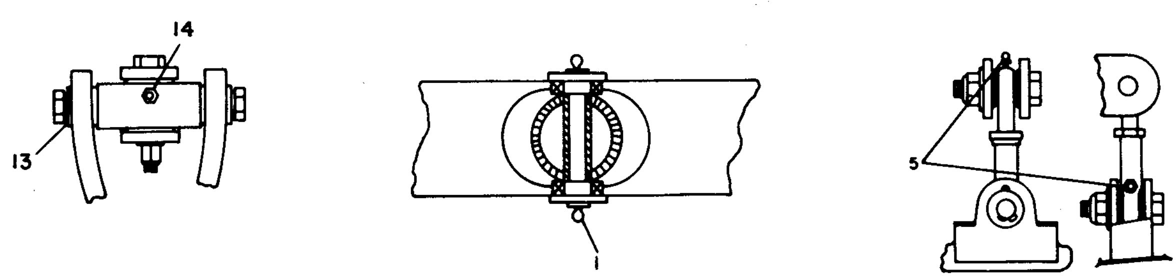


Figure 5–4. Antenna Lubrication for Radar Set AN/FPS-6B

5–24. INITIAL CONTROL SETTINGS.

5–25. Before energizing the equipment, set the controls as outlined in figure 5–8.

5–26. ENERGIZING EQUIPMENT FOR ALINEMENT AND TESTING OPERATIONS.

5–27. Upon completion of the initial control settings (figure 5–8), proceed to energize the equipment as outlined in figure 5–9. All controls are located on units in

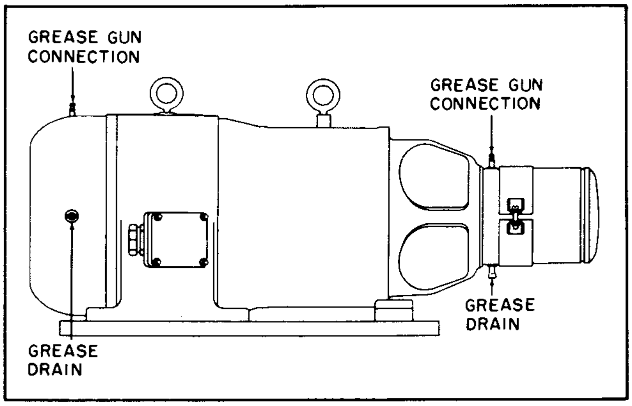


Figure 5–5. Lubrication of Amplidyne Generator Set

Figure 5–6. Deleted

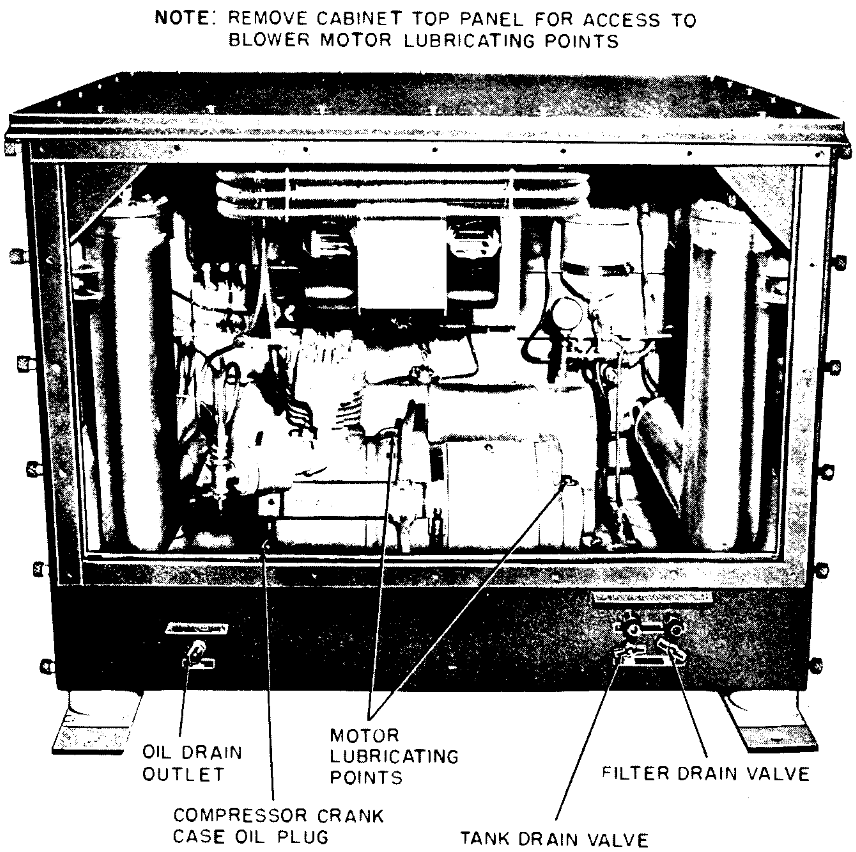


Figure 5–7. Lubrication of Pressurizer and Dehydrator

the control group assembly. Allow the equipment to warm up for one-half hour before proceeding with the initial adjustments.

Note

Follow step 10 of figure 5–9 only if the synchronizing system trigger from the associated search radar is used.

5–28. SYSTEM MINIMUM PERFORMANCE STANDARDS.

5–29. Figure 5–10 is used to determine whether the equipment meets certain minimum standards of performance. This procedure is also used to localize a malfunction to a particular system.

5–30. A detailed record, or maintenance log, of performance data should be kept to obtain best results from the regular inspections. This log should contain readings at test points (as specified in the chart of minimum performance standards) and results of performance tests. The log can then be used to determine a decrease in operating efficiency or any marked variation in equipment performance over a fixed period of time.

5–31. SYSTEM TROUBLE ANALYSIS.

5–32. Figure 5–11 is used to supplement the system minimum performance standards chart, thereby further localizing the cause of a malfunctioning system to a particular stage or part within a component.

Name of Unit	Figure No.	Name of Control	Setting
Power distribution panel	1–44		All switches in off (down) position.
Remote R-f control panel	1–43[2]	AFC MANUAL switch	AFC
	1–42[1]	STC ON-OFF switch	OFF
		FTC ON-OFF switch	OFF
		AVNL ON-OFF switch	OFF
	1–42[1]	NOISE SOURCE switch	OFF
Control group power supply No. 1	1–40		All toggle switches in off (down) position.
Generator-blanker assembly	1–47[2]	BLANKER BYPASS switch	BYPASS
	1–46[1]	1 MICROSEC DELAY switch	OUT
		TERM NO. 1 switch	ON
		TERM NO. 2 switch	ON
		TERM NO. 3 switch	ON
		OPER-CAL switch[2]	OPER
RHI assembly, left and right-hand panels	1–49[2]		All control knobs fully counterclockwise.
			All toggle switches in off (down) position (both units).
RHI power supply panel	1–50[1]		All toggle switches in off (down) position (both units).
RHI power supply	1–52[2]	POWER switch	Off (down) position
RHI oscilloscope	1–51[2]	ABS HGT-REL HGT switch	ABS
		RANGE control	Adjust for 200 miles on range counter MILES dial.
	1–51[2]	Control stick range section	Counterclockwise.
		Control stick height section	Zero height position.
		All other controls.	Fully counterclockwise.

[1]For Radar Set AN/FPS-6 only
[2]For Radar Set AN/FPS-6A

Figure 5–8. Initial Control Settings (Sheet 1 of 3)

Name of Unit	Figure No.	Name of Control	Setting
RHI oscilloscope calibration panel	1–52[2]	PANEL LIGHT switch SWEEP CURVATURE switch HGT CURSOR CURVATURE switch EXT TRIG-INT TRIG switch ANT REF-ZERO ELEV 200 FT/M switch EXT DC REF-INT REF switch INT CURSOR-EXT CURSOR switch	OFF ON ON EXT TRIG ANT REF EXT DC REF INT CURSOR
Raid size indicator	1–53[2]	POWER switch VIDEO switch SCALE FT DIV switch CANCEL-TRANSMIT switch NUMBER switch SEPARATION switch FORMATION switch HOR POS control VERT POS control Other panel controls	OFF 1 1K Center 1 0-500 ABST Center Center Fully counterclockwise.
Raid size remote unit	1–54[2]	CANCEL-RAID SIZE REQUEST switch DIMMER control	Center Fully counterclockwise.
Time-sharing master control	1–56	TIMER switch AUTOMATIC-MANUAL SELECTOR switch	Off (up) position. PPI 1
RHI antenna control	1–55[2]	MODE SWITCH	PPI CONT
Azimuth switch box	1–57[1]	AZIMUTH CONTROL switch	Off (up) position.
Azimuth control overlay	1–59	PASS-ON-OFF switch	ON (four units)
Junction box	1–60	S-1 through S-4 switches S-5 switch	Connect RHI assemblies to respective PPI indicators, as desired, by rotating switches to indicated positions. ASB-1
Azimuth blanker	1–48[2]	ON-BY-PASS switch	BY-PASS
Heat exchanger for magnetron	1–72	Power switch Inlet and outlet valves	On (up) position. Open
Heat exchanger for ferrite isolator	1–73[2,3]	Power switch Inlet and outlet valves	On (up) position. Open
Modulator assembly power panel	1–67[1]	MOD CONT POWER switch	ON
	1–68[2]	BATTLE SHORT switch[1] INTERLOCK SHORT switch[2] INTERLOCK TEST switch[2]	OFF OFF OFF

[1]For Radar Set AN/FPS-6 only
[2]For Radar Set AN/FPS-6A
[3]Not applicable for units fitted with air-cooled ferrite isolator (CU-492A/FPS-6A)

Figure 5–8. Initial Control Settings (Sheet 2 of 3)

Name of Unit	Figure No.	Name of Control	Setting
Modulator assembly, regulator subassembly	5–18	AUTO-MANUAL switch[4] AGE-NORMAL switch	AUTO NORMAL
Pressurizer and dehydrator	1–74	Power switch	On (up) position.
Indicator and test panel	1–61[1] 1–62[2]	PANEL LIGHTS switch INTERLOCK TEST switch	OFF OFF
Local control panel	1–63[1] 1–64[2]	POWER switch INTERLOCK SHORT switch	ON OFF
Preamplifier local oscillator power supply	1–65	POWER switch PLATE switch	On (up) position. ON
AFC-LO assembly	1–66	MANUAL-AFC switch	AFC

WARNING

Place SAFE-RUN and HV SAFE-OPER switches on safety box in SAFE position before performing the following steps. Safety box is located on floor of antenna platform near personnel hatch.

Antenna platform	—	—	Remove any obstructions from rotating and elevating paths of antenna.
Antenna assembly	1–75	Azimuth drive handcrank Elevation drive brake	Place HAND-AUTO lever in AUTO position. Released
Safety box	1–76	SAFE-RUN switch HV SAFE-OPER switch	RUN OPER
Personnel hatch interlock (located on antenna platform adjacent to personnel hatch on temperate tower only)	—	Interlock switch	Closed

[1]For Radar Set AN/FPS-6 only
[2]For Radar Set AN/FPS-6A

Figure 5–8. Initial Control Settings (Sheet 3 of 3)

Step No.	Figure No.	Control Location	Procedure	Result
1	1–44	Power distribution panel	Apply primary sources of electronic and antenna power to control group assembly.	Both groups of three LINE indicators light.
2	1–44	Power distribution panel	Throw ELECTRONIC POWER switch to ON position.	ELECTRONIC POWER indicator lights. ELECTRONIC POWER timer on generator-blanker panel (figure 1–39) begins to register.
3	1–44	Power distribution panel	Throw ANTENNA POWER switch to on (up) position.	ANTENNA POWER indicator lights.
4	1–46	Generator-blanker assembly	Rotate MONITORING SWITCH to all indicated positions.	Line voltage for each position appears on LINE VOLTAGE meter and should be 120 volts ±5%. Power line frequency appears on LINE FREQUENCY meter and should be 60 cps ±5%.
5	1–44	Power distribution panel	Throw CONTROL GROUP power switch to on (up) position.	CONTROL GROUP indicator lights.
6	1–40	Control group power supply No. 1	Throw POWER switch to ON (up) position.	POWER indicator lights.
7	1–40	Control group power supply No. 1	Throw +28V DC power switch to on (up) position.	+28V DC indicator lights.
8	1–40	Control group power supply No. 1	Throw −150V DC switch to on (up) position.	−150V DC indicator lights.
9	1–40	Control group power supply No. 1	Throw PLATE SUPPLY switch to on (up) position.	+500V DC indicator lights after 15-second time delay. Low-voltage indicator lights immediately.
10	—	—	Apply system trigger from associated search radar to jack J6921 on left side of control group assembly.	—

Figure 5–9. Energizing Equipment for Alinement and Testing Operations

Step	Test Point	Procedure	Normal Indication	Possible Cause of Abnormal Indication
Note References in parentheses pertain to Radar Set AN/FPS-6A where different from Radar Set AN/FPS-6.				
1	—	Perform energizing procedure of figure 5–9.	Same as result column of figure 5–9.	Defective power distribution panel.
2	1 POWER MEASURE jack J904	Measure peak r-f power output of transmitting system as directed in paragraph 5–115 (5–118).	Approximately 4.3 megawatts.	Defective or misalined modulating system. Defective magnetron.
3	1 POWER MEASURE jack J904	Measure VSWR as directed in paragraph 5–120 (5–122).	Less than 1.3 (1.5).	Defective waveguide; examine for dents or other damage. Dirty, loose, or distorted waveguide sections.
4	2 NOISE AMPLITUDE meter M1001	Measure and record noise figure as directed in paragraph 5–127 (5–129).	Not appreciably larger than last noise figure measurement.	Defective or misalined receiving system.
5	3 TEST VIDEO jack J932	Measure minimum discernible signal as directed in paragraph 5–131.	104 db below 1 milliwatt.	Defective or misalined receiving system.
6	—	Check antenna system as directed in paragraph 5–133.	Same as noted in paragraph 5–133.	Defective or misalined antenna system.

Figure 5–10. System Minimum Performance Standards (Sheet 1 of 2)

Step	Test Point	Procedure	Normal Indication	Possible Cause of Abnormal Indication
7	—	Check time-sharing system operation as directed in paragraph 5–138 through 5–161.	Same as noted in paragraphs 5–138 through 5–161.	Defective or misalined time-sharing system.
8	—	Check RHI presentation as directed in section VI.	Same as noted in Section VI.	Defective or misalined RHI system.
9	—	Check RSI operation as directed in Section VI.	Same as noted in Section VI.	Defective or misalined RSI system.

Figure 5–10. System Minimum Performance Standards (Sheet 2 of 2)

Trouble	Probable Cause	Test Point	Remedy
TRANSMITTER SYSTEM			
Note References in parentheses pertain to Radar Set AN/FPS-6A where different from Radar Set AN/FPS-6			
1. No r-f power. RADIATE indicator remains lit. Magnetron is not fired.	a. Loss of system trigger	4 J2205, figure 7–57 (7–59)	a. Check for system trigger input at SYSTEM TRIG jack J2205 on modulator assembly panel. If trigger is present at jack J2205, trouble is in transmitter-receiver system.
		W J5203, figure 7–85	b. If trigger is missing at jack J2205, check for system trigger at jack J5203 on range mark generator of control group assembly. If trigger is missing at jack J5203, check range mark generator as directed in Section VI.
		BB J6922, figure 7–109	c. If trigger is present at jack J5203, system trigger cabling is faulty. Check for system trigger at jack J6922 in control group assembly. If trigger is present at jack J6922, check cable W9506 which connects control group assembly and modulator assembly. If trigger is missing at jack J6922, check cabling between jacks J6922 and J5203.

Figure 5–11. System Trouble Analysis Chart (Sheet 1 of 24)

Trouble	Probable Cause	Test Point	Remedy
TRANSMITTER SYSTEM (cont)			
2. No r-f power. RADIATE indicator is off, READY indicator lights, and radar cannot be placed in radiation operation.	a. Open interlock circuit	Visual	a. Check high-voltage interlock circuit, using INTERLOCK TEST switch on test and indicator panel of r-f assembly. Refer to Section VI if INTERLOCK TEST indicator does not light in a position of test switch.
	b. Loss of waveguide pressurization	Visual	b. IF INTERLOCK TEST indicator does not light when test switch is in WG PRESS position, trouble is either a leaky waveguide section or a faulty pressurizer and dehydrator unit. Determine if waveguide is leaking by removing rubber tube from quick disconnect dry-air outlet on pressurizer and dehydrator, and placing finger tightly over outlet. If pressure builds up quickly to normal 30-psi operating pressure, as indicated on output pressure meter, waveguide is leaking.
	c. Defective heat exchanger	Visual	c. If INTERLOCK TEST indicator does not light when test switch is in LIQUID FLOW or LIQUID TEMP position, trouble is in coolant hose plumbing in magnetron assembly or in heat exchanger.
MODULATING SYSTEM			
3. No or low r-f power; high voltage cannot be raised to give normal magnetron current.	a. Defective modulator high-voltage regulator	BW J10301-A figure 7–126 BX J10301-B figure 7–126 BY J10301-C figure 7–126	a. Check a-c voltages between test points. If voltages do not measure 208 volts, trouble is in modulator high-voltage regulator.
	b. Defective modulator high-voltage power supply	5 TB2102-5, figure 7–55	b. If HV meter M2103 does not indicate 12 kilovolts, trouble is in high-voltage power supply.
	c. Defective modulator trigger amplifier	A J2203, figure 7–57 (7–59)	c. If waveform does not compare with test trigger, refer to Section VI; trouble is in modulator trigger amplifier.

Figure 5–11. System Trouble Analysis Chart (Sheet 2 of 24)

Trouble	Probable Cause	Test Point	Remedy
MODULATING SYSTEM (cont)			
	d. Magnetron defective	1 J904, figure 7–44 (7–42)	d. Tune echo box for maximum response. If echo box cannot be tuned for maximum response, check operation of thyratron tube V2201. If satisfactory, replace magnetron. **CAUTION** Handle all magnetrons, including those believed to be defective, with care.
4. High VSWR; no arcing heard in waveguide.	Defective quartz tube in duplexer	Duplexer test points	Fit neon-lamp radiation detector over each test point on duplexer in turn. If quartz tube is good, neon bulb in detector lights. If detector fails to light, replace quartz tube adjacent to that test point.
5. High VSWR; arcing heard in waveguide.	Dirty, loose, or distorted waveguide sections	—	Examine waveguide sections and joints. Clean or replace, as required.
RECEIVING SYSTEM			
6. High noise figure.	a. Defective signal crystals	2 M1002	a. Turn RECEIVER TEST switch at local control panel to REC XTAL CUR 1 and REC XTAL CUR 2 positions. If meter does not read 0.6 milliampere, change crystal.
	b. Defect in ground loops	6 M6103	b. Disconnect preamplifier power plug P21501. Check continuity to ground at each crystal current lead shield (CR1, CR2 and AFC). Remove any grounds discovered.
	c. Deleted	—	c. Deleted.
	d. Defective noise figure measurement component	—	d. Check noise tube, noise test components of Radar Set AN/FPS-6, and performance monitor noise figure circuits of Radar Set AN/FPS-6A.
7. Weak video. AFC XTAL CUR sweeps; REC XTAL CUR sweeps VSWR normal.	a. Defective preamplifier-local oscillator power supply	7 M1102	a. Use METER SWITCH and voltmeter on preamplifier-local oscillator power supply panel, figure 1–65, to test output voltages. Check regulated supply voltage adjustments.

Figure 5–11. System Trouble Analysis Chart (Sheet 3 of 24)

Trouble	Probable Cause	Test Point	Remedy
RECEIVING SYSTEM (cont)			
	b. Defective AFC crystal	6 M6103	b. If preamplifier-local oscillator power supply is normal, place MANUAL-AFC switch in MANUAL position, figure 1–66. Adjust MANUAL TUNE control for maximum crystal current. If AFC XTAL CUR is still abnormal, replace AFC crystal.
	c. Defective AFC-LO unit	—	c. Check AFC-LO unit.
8. Weak video. AFC XTAL CUR sweep; REC XTAL CUR sweeps, VSWR high.	Magnetron spectrum has deteriorated	8 M2102, figure 7–55	Spectrum deterioration follows such symptoms as: high VSWR in waveguide system, low magnetron filament current for an extended period, failure of pulse-forming network, and low MAG CURRENT readings over an extended period. Remedy is to replace magnetron.
9. Weak video on RHI assembly No. 2; RHI assembly No. 1 video is satisfactory.	a. Video stages in defective RHI assembly	CG J4903 figure 7–84 (7–142)	a. Check defective RHI assembly.
	b. Defective cable	V J4901, figure 7–71 CB J22004 for AN/FPS-6A, figure 7–137	b. Check jack J4901 or J22004 of RHI assembly No. 2. If video is low, check cable W9519 which runs from jack J4203 or J22004 of RHI assembly No. 2 to jack J4211 or J22003 of RHI assembly No. 1.
10. Weak video AFC XTAL CUR and REC XTAL CUR satisfactory.	a. Preamplifier defective	BZ J21502, figure 7–131 (7–133) CA J21503, figure 7–131 (7–133)	a. Test preamplifier i-f outputs to normal receiver at jack J21502 and to MTI receiver at jack J21503. Should either output be abnormal, trouble is in preamplifier.
	b. Normal receiver defective	9 J6104, figure 7–102, (7–103)	b. If waveform does not compare with test video waveform in Section VI, trouble is in normal receiver.

Figure 5–11. System Trouble Analysis Chart (Sheet 4 of 24)

Trouble	Probable Cause	Test Point	Remedy
RECEIVING SYSTEM (cont)			
	c. Defective cable or interference blanker	V J4901, figure 7–71 or CB J22004, figure 7–137 Y J5505, figure 7–91	c. Set BLANKER BYPASS switch on interference blanker to BLANKER BYPASS. Check for video jack J4901 or J22004. If video is abnormal, check for at jack J5505 on interference blanker. If video is normal, check for defective cables. If video is abnormal at jack J5505, trouble is in interference blanker.
RANGE HEIGHT INDICATOR			
11. Trace missing from both RHI displays.	a. Loss of system trigger pulse	T J4301, figure 7–71 CD J22008, figure 7–137	a. Check range mark generator in control group assembly.
	b. Defective cable	18 J6923, figure 7–109 (7–110)	b. Check for system trigger at test point on RHI No. 1. If trigger is missing, check for trigger at jack J6923 of control group assembly. If trigger appears at jack J6923, cable W9501 is faulty and should be replaced.
		10 J6921, figure 7–109 (7–110)	If no system trigger appears at jack J6923, disconnect plug P6921 and check for sync trigger at its center pin. If sync trigger is missing, check cable W9522 which feeds sync trigger from associated search radar to jack J6921 of control group assembly.
12. Range markers missing on one display and present on other display of Radar Set AN/FPS-6.	Defective RHI or interconnecting cable	Visual	Check RHI with missing range markers as directed in Section VI. If RHI No. 1 displays range markers and RHI No. 2 does not, check cable W9521 which runs between jack J4214 of RHI No. 1 to jack J4206 of RHI No. 2.

Figure 5–11. System Trouble Analysis Chart (Sheet 5 of 24)

Trouble	Probable Cause	Test Point	Remedy
RANGE HEIGHT INDICATOR (cont)			
13. Range line missing on both RHI displays; azimuth control overlays cannot position height-finding antenna in azimuth.	Loss of 28-volt d-c supply	Visual	Check fuse F5616 and check 28-volt d-c supply as directed in Section VI.
14. Range line from neither PPI displayed at RHI assembly. Range line satisfactorily displayed at other RHI assembly.	a. Defective junction box	BS J9719, figure 7–125	a. Check for range line input at jack J4603 or J22020 of affected RHI assembly. If range line is missing from RHI assembly No. 1, follow cable to jack J9719 at junction box. If range line is missing from RHI assembly No. 2, follow cable to jack J9721 at junction box.
	b. Defective range line circuits in RHI assembly	BU J9721, figure 7–125	b. If range line input to RHI assembly is satisfactory, troubleshoot range line circuits in affected RHI assembly.
15. No video on either RHI display.	a. Defective cable or transmitter-receiver system	11 J6934, figure 7–109 (7–110)	a. Check for video input at jack J4901 or J22004 of RHI No. 1. If video is missing, check for it at jack J6934 of control group assembly. If video appears at jack J6934, cable W9534 is defective and should be replaced. If no video appears at jack J6034, set BLANKER BYPASS switch on interference blanker (part of control group assembly) at BYPASS. If video appears at jack J6934, set BLANKER BYPASS switch at BLANK and check interference blanker as directed in Section VI. If no video output is obtained with BLANKER BYPASS switch at BYPASS, check transmitter-receiver system as directed in Section VI.
	b. Defective azimuth blanker	Visual	b. Check azimuth blanker as directed in Section VI.
16. Vertical sweep missing from both RHI assemblies.	a. Antenna is not nodding	Visual	a. Press ELEV SCAN SLOW switch on azimuth switch box or RHI antenna control.
	b. Defective cable carrying d-c elevation voltage to RHI assembly	10 P4202, figure 7–71 CC P22006, figure 7–137	b. Check for d-c elevation voltage at test point on RHI assembly No. 1, If voltage is missing, check for it at jack J6930 of control group assembly. If elevation voltage appears at jack J6930, cable W9502 is faulty and should be replaced.

Figure 5–11. System Trouble Analysis Chart (Sheet 6 of 25)

Trouble	Probable Cause	Test Point	Remedy
RANGE HEIGHT INDICATOR (cont)			
	c. Defective elevation data generator	BD J6928, figure 7–15 (7–16)	c. If no elevation voltage is measured at jack J6930, check for 1500-cps signal at jack J6928. If this signal is absent, check elevation data generator as directed in Section VI. In Radar Set AN/FPS-6 only, also check cabling to elevation selsyn per step d, below.
	d. Defective antenna cabling in Radar Set AN/FPS-6 only	BD J6928, figure 7–15 BE J6929, figure 7–15	d. If signal is missing from jack J6928, check cabling through rotor of elevation selsyn. Also check cabling to stator of elevation selsyn.
	e. Defective antenna cabling in Radar Set AN/FPS-6A	BD J6928, figure 7–16 BE J6929, figure 7–16	e. If signal appears at jack J6928, check cabling to elevation selsyn.
17. Vertical sweep does not line up with height scales at left edge of display.	a. Elevation selsyn not zeroed	Visual	a. Zero elevation selsyn as directed in paragraph 5–98.
	b. Elevation data generator misalined	—	b. Aline elevation data generator as directed in paragraph 5–98.
18. Angle markers missing from both RHI displays.	a. Loss of angle mark triggers	13 J6927, figure 7–15 CH J4604, figure 7–81 CI J22012, figure 7–137	a. Check for angle mark triggers at test point on RHI assembly No. 1. If triggers are missing, check for them at jack J6927 of control group assembly. If triggers appear at jack J6927, cable W9504 which runs from jack J4604 or jack J22012 of RHI assembly No. 1 to jack J6927 of control group assembly is faulty and should be replaced.

Figure 5–11. System Trouble Analysis Chart (Sheet 7 of 24)

Trouble	Probable Cause	Test Point	Remedy
RANGE HEIGHT INDICATOR (cont)			
	b. Defective cabling, angle mark generator or range mark generator in control group assembly	X P5302, figure 7–87	b. If angle marks triggers do not appear at jack J6927, angle mark generator may not be reciving proper inputs (system trigger and angle mark commutator pulse). Check also that antenna is nodding. Test for system trigger at plug P5302. If missing, check cabling back to jack J5203 of range mark generator. Replace cabling if defective. If cabling is satisfactory, check range mark generator as directed in Section VI.
		BC J6926, figure 7–109 (7–110)	Check angle mark commutator pulse at plug P6926. If pulse is missing, check circuit leading back to angle mark commutators in antenna assembly. Adjust commutator circuits as directed in Section VI. If system trigger and commutator pulse inputs are satisfactory, check angle mark generator as directed in Section VI.
19. Range markers missing on RHI display of Radar Set AN/FPS-6A.	Defective range mark generator in RHI assembly	Visual	Check range mark generator as directed in Section VI.
20. Range markers missing on both RHI displays of Radar Set AN/FPS-6.	Defective range mark generator or cabling	U J4601, figure 7–80 14 J6925, figure 7–109	Check for range markers at jack J4601. If markers are missing, check for them at jack J6925 of control group assembly. If markers appear at jack J6925, cable W9505 is faulty and should be replaced. If no range markers appear at jack J6925, check range mark generator as directed in Section VI.
21. Video missing from RHI assembly No. 2, RHI assembly No. 1 operates satisfactorily.	Defective cable	V J4901, figure 7–84	Check jack J4901 or J22004 of RHI assembly No. 2. If video is absent, check cable W9519 which runs from jack J4203 or J22004 of RHI assembly No. 2 to jack J4211 or J22003 of RHI assembly No. 1.
		CB J22004, figure 7–137	If video is present at jack J4901 or J22004, check RHI as directed in Section VI.

Figure 5–11. System Trouble Analysis Chart (Sheet 8 of 24)

Trouble	Probable Cause	Test Point	Remedy
RANGE HEIGHT INDICATOR (cont)			
22. Range line from one PPI site missing. Range lines from other three PPI sites satisfactory. Relative height dial of remote height display associated with missing range line cannot be released.	Defective relay(s) in junction box	BP K9711, figure 7–125 BN K9709, figure 7–125 BJ K9707, figure 7–125	If missing range line and stuck relative height dial are associated with PPI sequence No. 1, check solenoid and contacts of junction box relay K9711. If sequence No. 2, check relay K9709; if sequence No. 3, check relay K9707; if sequence No. 4, check relay K9705.
		BH K9705, figure 7–125	If azimuth control of antenna is possible, trace range line signal from affected RHI assembly back through junction box to search radar. Look especially for worn or dirty contacts on switches and relays.
23. Range line from one PPI site remains on display in excess of azimuth control period. Each range line can bem ade to appear in turn only by operating AUTOMATIC-MANUAL SELECTOR switch on time-sharing master control from PPI 1 position through PPI 4 position.	Time-sharing system is not sequencing	Visual	Check time-sharing master control as directed in Section VI.
TIME-SHARING SYSTEM			
24. Time-sharing system completely inoperative.	Loss of 28-volt d-c supply	Visual	Determine whether 28-volt supply has been turned on at control group power supply No. 1. Check fuse F5616 in this power supply.
25. None of the azimuth control overlays can position height-finding antenna in azimuth; none of the remote height displays receive height data; neither azimuth switch box or RHI antenna control can obtain positioning control over height-finding antenna; and no range lines appear on RHI assemblies.	Loss of 28 volts d-c	BA J6915-M figure 7–109 (7–110) BM J9709-M, figure 7–125	Check 28-volt line from jack J6915-M at control group assembly to jack J9709-M at junction box.
		Visual	Check fuse F9714 in junction box.

Figure 5–11. System Trouble Analysis Chart (Sheet 9 of 24)

Trouble	Probable Cause	Test Point	Remedy
TIME-SHARING SYSTEM (cont)			
		BF K9701-1, 2 figure 7–125	Test for continuity between contacts 1 and 2 of junction box relay K9701.
26. One PPI site completely inoperative. Azimuth control overlay at affected site cannot position height-finding antenna; remote height display at affected site receives neither absolute height nor relative height data; and no range line obtained from affected site.	Defective sequence switch	Visual	Use AUTOMATIC-MANUAL SELECTOR switch on time-sharing master control to give control manually to affected PPI site. If control can be transferred manually, PPI site again functions. Check contacts 21 through 26 of relevant sequence switch for dirt and for open contacts. Inspect switch visually for broken connections. If control cannot be transferred manually, check cabling between time-sharing master control and affected relay group in junction box.
27. One azimuth control overlay is unable to position height-finding antenna in azimuth; remote height display at affected site functions properly; and control indicator does not light.	a. Defective azimuth control overlay	Visual	a. Disconnect plug P3601 from affected azimuth control overlay and disconnect another plug P3601 from an azimuth control overlay known to be good. Connect plug P3601 of good overlay to jack J3601 of affected unit. If overlay is still inoperative, trouble is in azimuth control overlay.
	b. Defective junction box or cabling	Visual	b. If affected azimuth control overlay functions properly when plug P3601 of a different azimuth control overlay is substituted, trouble in either junction box or cabling. Test continuity of cabling and junction box relay contacts. Also test continuity of all selsyn lines.
28. In Radar Set AN/FPS-6, azimuth switch box is unable to position height-finding antenna in azimuth; control indicator does not light on affected unit; and all overlays function properly.	Affected unit not placed in control	Visual	Check circuit from AZIMUTH CONTROL switch S3904 of azimuth switch box through junction box.
29. Same as step 28, but control indicator lights.	Defective selsyn circuit between azimuth switch box and antenna azimuth selsyns	Visual	Check continuity of selsyn circuits, particularly rotors.
30. In Radar Set AN/FPS-6A, RHI antenna control is unable to position height-finding antenna in azimuth.	a. Defective RHI antenna control	Visual	a. Check RHI antenna control as directed in Section VI.
	b. Defective selsyn circuit between RHI antenna control and antenna azimuth	Visual	b. Check continuity of selsyn circuits.

Figure 5–11. System Trouble Analysis Chart (Sheet 10 of 24)

Trouble	Probable Cause	Test Point	Remedy
REMOTE HEIGHT DISPLAYS			
31. Absolute height counter revolves rapidly and noisily during entire period of azimuth control by affected PPI site. Same symptom at other remote height display(s) connected to same RHI assembly. Remote height display(s) connected to other RHI assembly function properly.	a. Loss of 120-volt ac excitation to RHI	Q R TB4207-10, 11, figure 7–71 CE CF TB22102-1, 4, figure 7–137	a. If RHI assembly No. 1 is suspected, check fuse F9719 in junction box. Blown fuse deprives RHI assembly height selsyns of 120-volt ac excitation. If RHI assembly No. 2 is suspected, check fuse F9720 in junction box. If fuse is satisfactory, check for presence of 120 volts ac between test points of suspected RHI assembly. If this voltage is not present, selsyn excitation is missing from RHI assembly; check back to source.
	b. If sympton appears at only one of the remote height displays connected to an RHI assembly, trouble probably lies in junction box relay which channels height data between remote height display and RHI assembly, or in cabling between junction box and remote height display	BQ K9714, figure 7–125 BR K9717, figure 7–125 BT K9720, figure 7–125 BV K9723, figure 7–125	b. If symptom appears at PPI site No. 1, check solenoid of relay K9714. If at PPI site No. 2, check relay K9717; if at PPI site No. 3, check relay K9720; if at PPI site No. 4, check relay K9723. (See figure 5–9 for locations of relays.)
		Visual	Check cabling between junction box and remote height display selsyn inputs.
		Visual	Check contacts of relevant RHI selector switch (S9701, S9702, S9703, S9704, figure 5–9), for dirt and for open circuits.
32. Absolute height counter in remote height display does not respond to new height data. Indicator and dial lamps function properly.	a. Open fuse in junction box	—	a. If remote height display No. 1 is faulty, check fuse F9715 in junction box; if No. 2, check fuse F9716; if No. 3, check fuse F9717; if No. 4, check fuse F9718.

Figure 5–11. System Trouble Analysis Chart (Sheet 11 of 24)

Trouble	Probable Cause	Test Point	Remedy
REMOTE HEIGHT DISPLAYS (cont)			
	b. Defective cabling	N J3701, figure 7–66 CJ J3701-H, figure 7–66 CK J3701-R, figure 7–66	b. Disconnect suspected remote height display and substitute a unit known to be good. If symptom persists, check cabling, particularly lines G, H, and R from jack J3701 of remote height display under test to relevant jack on junction box (J9701, J9706, J9711, J9714).
	c. Defective remote height display	Visual	c. If symptom clears up after substitution is made, fault lies within remote height display. Check servo amplifier in remote height display.
	d. If dial lamps on remote height display do not go off at beginning of azimuth control period, trouble may be in automatic clearing circuit	BO K9710, figure 7–125 BK K9708, figure 7–125 BI K9706, figure 7–125 BG K9704, figure 7–125	d. Operate CLEAR switch of affected remote height display. If symptoms disappear, trouble lies in automatic clearing circuit in junction box. If affected remote height display is located at PPI site No. 1, check relay K9710 and capacitor C9701; if at site No. 2, check relay K9708 and capacitor C9702; if at site No. 3, check relay K9706 and capacitor C9703; if at site No. 4, check relay K9704 and capacitor C9704. If operating CLEAR switch does not cause dial lamps to go out, test relays in remote height display.
	e. If only one remote height display is inaccurate, cabling may be defective	N J3701-G, figure 7–66	e. Disconnect suspected remote height display and substitute one known to be good. If symptom persists, disconnect jack J4217 or J22051 at associated RHI assembly and check continuity of stator lines between affected remote height display and junction box. Replace defective cabling.

Figure 5–11. System Trouble Analysis Chart (Sheet 12 of 24)

Trouble	Probable Cause	Test Point	Remedy
REMOTE HEIGHT DISPLAYS (cont)			
		CJ J3701-H, figure 7–66 CK J3701-R, figure 7–66	If cabling is satisfactory, use AUTOMATIC-MANUAL SELECTOR switch on time-sharing master control to give azimuth control to affected PPI site. Make voltage checks of those junction box relays and switches which carry height data.
33. Absolute height counter operates inaccurately. Same symptoms at other remote height display(s) connected to same RHI assembly. Remote height display(s) connected to other RHI assembly function properly.	a. Defective selsyn wiring	CO TB4207-1, 2, 5, figure 7–76 CP TB22101-1, 2, 3 figure 7–137	a. Test for open stator line. Measure voltage at test points (for Radar Set AN/FPS-6, see figure 5–13). It may be necessary to rotate height selsyns (for Radar Set AN/FPS-6, see figure 5–14) to obtain some readings. Zero voltage even after rotor has been turned to new position) indicates an open line. Then trace trouble to open stator winding or defective lead.
	b. If symptom appears at only one remote height display, and indicator lamps at affected unit and absolute height counter function properly, relative height circuit may be defective	CL J3701-P, figure 7–66 CM J3701-Q, figure 7–66 CN J3701-J, figure 7–66	b. Disconnect affected remote height display and substitute a unit known to be good. If symptom does not clear up, check relative height circuit (lines P, Q, and J of jack J3701). If symptom clears up, check selsyn B3703. Test relative height brake E3701.
34. Relative height dial does not respond to new data. Same symptom at other remote height display(s) connected to same RHI assembly. Remote height display(s) connected to other RHI assembly function properly. Dial and indicator lamps function properly.	a. Defective selsyn wiring	Q TB4207-10, 11 figure 7–76	a. Check continuity between rotor terminals of relative height selsyn (figure 5–14) at suspected RHI assembly.
	b. If dial lamps do not function properly, absolute-relative height switch may be defective	CQ TB4207-8, 9 figure 7–76	b. Check absolute-relative switch S4205 (figure 5–14) at suspected RHI assembly.

Figure 5–11. System Trouble Analysis Chart (Sheet 13 of 24)

Trouble	Probable Couse	Test Point	Remedy
REMOTE HEIGHT DISPLAYS (cont)			
		CT S22053, figure 7–137	
AZIMUTH DRIVE AND CONTROL SECTION			
35. AZIMUTH DRIVE START indicator I6203 on antenna control panel lights momentarily when START button on panel (figure 1–34) is pressed and then goes off. Amplidyne drive motor does not run.	Overload relay in amplidyne generator has tripped, or one or both amplidyne drive motor overload coils L1 and L2 of K6902 in control group cabinet have tripped **WARNING** High voltages exposed in power distribution compartment	Visual	Swing power distribution panel open and observe coils L1 and L2 (figure 5–15). If one or both trip as START button is pressed, trouble is either a short circuit in amplidyne drive motor circuit, a mechanical overload on amplidyne drive motor (bad bearings, for example), or a defective overload coil (L1 or L2). Trouble shoot amplidyne drive motor circuit and amplidyne generator set. If neither coil L1 or L2 trips, overload relay in amplidyne generator set is tripping. (Recovery time for automatic reset of this overload coil is approximately 1 minute.) Trouble shoot this coil and its associated circuits.
36. Antenna cannot be electrically driven in azimuth, but can be manually driven in azimuth. Amplidyne drive motor does not operate. ON indicator on antenna control panel does not light.	a. Defective drawer interlock in control group assembly	Visual	a. Throw INTERLOCK SHORT switch S5606 to ON. If trouble clears, repair defective drawer interlock.
	b. Open azimuth interlock circuit	AJ TB6203-3, figure 7–104 AP TB6204-7, figure 7–104	b. Pull antenna control assembly forward and short drawer interlock switch by throwing INTERLOCK SHORT switch on control group power supply No. 1. Place a screwdriver against case of relay K6202 and listen to observe whether relay K6202 becomes energized when ANTENNA POWER switch S6402 is thrown. If relay K6202 is not energized, check that 120 volts ac exist between terminal boards TB6203-3 and TB6204-7. If this voltage is present with relay K6202 not energized, there is an open in azimuth interlock circuit in antenna assembly or in cable W9416. Check cable. Trouble shoot azimuth interlock circuit. If 120 volts ac do not exist between terminal boards TB6203-3 and TB6204-7 with relay K6202 not energized, energizing voltage is not reaching interlock circuit through switch S6402 on power distribution panel of control group assembly. Trouble shoot control group assembly.

Figure 5–11. System Trouble Analysis Chart (Sheet 14 of 24)

Trouble	Probable Cause	Test Point	Remedy
AZIMUTH DRIVE AND CONTROL SECTION (cont)			
			If relay K6202 is energized, energizing circuit of relay K6902 in control group cabinet is open. Trouble shoot this circuit.
	c. Amplidyne overload relay trips because short exists in azimuth drive motor armature circuit, or in winding of armature of azimuth drive motor. Mechanical overload, such as caused by bearing failure, can also trip overload relay	CR J3203-A, D figure 7–28	c. Unplug P3203 from azimuth drive motor. Check for short in armature circuit and repair. Check for short, or partial short, in armature. If trouble is not as above, check that shaft of machine (bearings) is free. Repair defective bearings as directed in technical manual of overhaul instructions.
	d. Amplidyne overload relay contacts defective or relay circuit is open	KL J3502-L, M, figure 7–64	d. Set SAFE-RUN and HV SAFE-OPER switches at safety box to SAFE position. Unplug P3502 from amplidyne generator set. Use an ohmmeter to find open or defective contacts in relay circuit from jack J3502-L to jack J3502-M. Repair open, or clean and adjust relay contacts, or replace relay if necessary.
	e. Amplidyne drive motor circuit or field winding open	CS J3501, figure 7–64	e. Unplug jack J3501 from amplidyne drive motor. Use an ohmmeter to locate open in circuit connected to jack J3501. Repair open.
37. Antenna cannot be electrically driven in azimuth, but can be manually driven in azimuth. Amplidyne drive motor operates. ON indicator lights on antenna control panel.	a. Fuse F6201 or F6202 on antenna control panel is blown	—	a. Check fuses. If new fuses blow, look for short in shunt winding of exciter generator or in shunt field of azimuth drive motor.
	b. Relay K6201 in antenna control panel is defective	—	b. Replace with relay known to be good. If difficulty does not clear, see step c.
	c. Undercurrent relay K6201 in antenna control panel has opened servo amplifier power supply primary source because shunt field of azimuth drive motor is receiving no excitation. Circuit from exciter generator to shunt field is open, or exciter generator winding is open	I J3502-B, C, figure 7–61 J J3502-D, S	c. See Figure 7–28. Set SAFE-RUN and HV SAFE-OPER switches at safety box to SAFE position. Unplug P3204 from azimuth drive motor. Unplug P3502 from amplidyne generator set. Use an ohmmeter to locate open in exciter generator circuit from jack J3502-B, C to jack J3502-D, E. Repair open in circuit. Use an ohmmeter to locate open in shunt field circuit from jack J3204-A, B, C to jack J3204D, E, F. Repair open in circuit.

Figure 5–11. System Trouble Analysis Chart (Sheet 15 of 24)

Trouble	Probable Cause	Test Point	Remedy
AZIMUTH DRIVE AND CONTROL SECTION (cont)			
		G J3204-A, B, C H J3204-D, E, F	
	d. Circuit between amplidyne generator and azimuth drive motor is open	—	d. See figure 7–28. Set SAFE-RUN and HV SAFE-OPER switches at safety box to SAFE position. Unplug P3204 from azimuth drive motor. Unplug P3502 from amplidyne generator set. Use an ohmmeter to locate open between A1 and C2 on amplidyne generator and A1 and C2 on azimuth drive motor. Repair open.
	e. Azimuth drive motor armature winding or compensating and commutating windings are open	—	e. Set SAFE-RUN and HV SAFE-OPER switches at safety box in SAFE position. Use an ohmmeter to locate open.
	f. Amplidyne generator armature winding or compensating field winding is open	—	f. Set SAFE-RUN and HV SAFE-OPER switches at safety box in SAFE position. Use an ohmmeter to locate open.
	g. Open in center tap circuit of control field winding of amplidyne generator	—	g. Same as step f.
	h. Relay K6204 not energized	AO TB6204-6, figure 7–104 AN TB6204-5, figure 7–104	h. If 120 volts ac is present between terminals 5 and 6 of terminal board TB6204, troubleshoot azimuth circuits in antenna control panel, particularly relay K6204.
	i. 120-volt servo reference voltage missing	AM TB6204-1, figure 7–104 AL TB6203-5, figure 7–104	i. Measure for 120 volts ac between terminals 1 (TB6204) and 3 (TB6203) of antenna control assembly. If this voltage is missing, troubleshoot antenna control panel.

Figure 5–11. System Trouble Analysis Chart (Sheet 16 of 24)

Trouble	Probable Cause	Test Point	Remedy
AZIMUTH DRIVE AND CONTROL SECTION (cont)			
38. Antenna can be placed in continuous rotation, but cannot be driven by synchro servo system.	a. Selsyn excitation not reaching antenna selsyns	AA TB3201-7 (figure 7–28) CU TB3201-8 (figure 7–28)	a. Troubleshoot as follows: (1) Throw SAFE-RUN and HV SAFE-OPER switches to SAFE position. (2) Remove cover of azimuth selsyn gear unit. (3) Connect a-c voltmeter on 150-volt range between terminals 7 and 8 of terminal board TB3201, using long test leads so that voltmeter and man who is to read it are outside limits of area swept by antenna. (4) Throw SAFE-RUN switch to RUN position. (5) Remove relay K6201 from antenna control panel and press AZIMUTH DRIVE START button. (6) Voltmeter should read 120 volts. (7) Throw SAFE-RUN switch to SAFE position while removing voltmeter. (8) Return relay K6201 to socket.
	b. Error signals not reaching servo amplifier		b. Check operate path for junction box relays K9726 and K9727.
39. Antenna cannot be electrically or manually driven in azimuth.	Rotating mechanism is jammed	—	Look for obstructions within gear trains of antenna assembly.
40. Antenna creeps or runs away in azimuth. (Normal speed under continuous rotation operation is 1/16 rpm or 60° per minute.	a. Control field winding or circuit to winding is open, or some turns on one side of control field winding are shorted	—	a. See figure 7–28. Unplug P3501 and P3502 from amplidyne generator set. Use an ohmmeter to locate open on control field winding or circuit, and to check that each side of control field winding has same resistance. If circuit is open, repair.
	b. Servo amplifier not balanced	—	b. Set BALANCE control per paragraph 5–84.
41. Antenna runs away when operated in continuous rotation mode. (Normal speed of rotation is 1/16 rpm or 60° per minute.)	a. Velocity feedback from tachometer in azimuth selsyn gear unit of antenna assembly is not reaching servo amplifier	AG TB6002-5, figure 7–99 AH TB6002-6, figure 7–99	a. Measure with a d-c voltmeter, set to a suitable range, between terminals 5 and 6 of terminal board TB6002 of servo amplifier, with antenna rotating continuously. The approximate voltage which should be read at these terminals is 16.5 volts per rpm of antenna. **CAUTION** Do not allow antenna to rotate longer than is necessary to reach the abovementioned voltage reading, since the antenna will soon reach an excessive speed of rotation.

Figure 5–11. System Trouble Analysis Chart (Sheet 17 of 24)

Trouble	Probable Cause	Test Point	Remedy
AZIMUTH DRIVE AND CONTROL SECTION (cont)			
		E J3202-A F J3202-B	If tachometer voltage is not present, set SAFE-RUN and HV SAFE-OPER switches at safety box to SAFE position. Unplug P3202 from azimuth selsyn gear unit. Use an ohmmeter to find open in tachometer or tachometer circuit from jack J3202-A to jack J3202-B. Repair open. If tachometer winding is open, replace tachometer.
	b. Defective servo amplifier	—	b. If correct tachometer voltage is present, servo amplifier is defective. Troubleshoot servo amplifier.
42. Antenna synchronizes a multiple of 10 degrees away from correct position.	a. Defective 1-speed selsyn system not supplying servo amplifier with error signals	Z TB6001-1, (figure 7–99) AA TB6001-2 (figure 7–99)	a. Pull antenna control assembly forward. Throw INTERLOCK SHORT switch S5606 on control group power supply No. 1. Connect an a-c voltmeter between terminals 1 and 2 of terminal board TB6001. Press START button on antenna control panel. With equipment operating, turn and crank on azimuth control overlay while observing voltmeter vary from 0 to 65 volts.
		B C TB3201, figure 7–28	If no error signal is present at terminals 1 and 2 of terminal board TB6001, stop antenna at safety box. (See figure 7–28). Remove cover of azimuth selsyn gear unit with a screwdriver. Using an a-c voltmeter, check that 120-volt a-c excitation appears at rotor leads of 1-speed selsyn B3202. Also check that a changing voltage appears at terminal board TB3201, terminals 1, 2, and 3, when antenna is manually rotated.
	b. Defective servo amplifier	Z AA TB6001-1, 2	b. If correct error voltage is present at terminals 1 and 2 of terminal board TB6001, servo amplifier is defective. Troubleshoot servo amplifier.
43. Antenna synchronizes with large positioning error.	a. Defective 36-speed selsyn system not supplying servo amplifer with error signals	Z AB TB6001-1, 3	a. Pull antenna control assembly forward. Throw INTERLOCK SHORT switch S5606 on control group power supply No. 1. Connect an a-c voltmeter between terminals 1 and 3 of terminal board TB6001. Press START button on antenna control panel. With equipment operating, turn handcrank on azimuth control overlay while observing voltmeter vary from 0 to 87 volts.

Figure 5–11. System Trouble Analysis Chart (Sheet 18 of 24)

Trouble	Probable Cause	Test Point	Remedy
AZIMUTH DRIVE AND CONTROL SECTION (cont)			
			If no error signal is present at terminals 1 and 3 of terminal board TB6001, stop antenna at safety box. (See figure 7–28.) Remove cover of azimuth selsyn gear unit with a screwdriver. Using an a-c voltmeter, check that 120-volt excitation appears at rotor leads of 36-speed selsyn B3203. Also check that a changing voltage appears at terminal board TB3201, terminals 4, 5, and 6, when antenna is manually rotated.
	b. Defective servo amplifier	—	b. If correct error voltage is present at terminals 1 and 3 of terminal board TB6001, servo amplifier is defective. Troubleshoot servo amplifier.
44. Antenna hunts and is repeatedly locked out. Hunt and lockout indicators operate normally.	a. Current feedback circuit has failed	AC TB6002-1, (figure 7–99) AD TB6002-2, (figure 7–99)	a. Pull antenna control assembly forward, and throw INTERLOCK SHORT switch S5606 on control group power supply No. 1. Place antenna in continuous rotation at azimuth switch box or RHI antenna control and start antenna. Measure current feedback voltage (with a d-c voltmeter set to a suitable low-voltage range) between terminals 1 and 2 of terminal board TB6002 on servo amplifier (figure 5–16). Voltage between these terminals should be approximately 0.25 volt. If voltage is missing, set SAFE-RUN and HV SAFE-OPER switches to SAFE position and locate open circuit between jacks J3502-A and J3204-G.
	b. Quadrature feedback circuit has failed	AE TB6002-3, (figure 7–99) AF TB6002-4, (figure 7–99)	b. Measure similarly between terminals 3 and 4 of terminal board TB6002 where quadrature-feedback voltage appears. Reading should be 0 volt. If voltage is missing, set SAFE-RUN and HV SAFE-OPER switches to SAFE position and locate open circuit between jacks J3502-F and J3502-G.
	c. Velocity feedback circuit has failed	AG TB6002-5, (figure 7–99)	c. Measure similarly between terminals 5 and 6 of terminal board TB6002 where velocity-feedback voltage appears. Reading should be approximately 16.5 volts per antenna rpm. If voltage is missing, set SAFE-RUN and HV SAFE-OPER switches to SAFE position and locate open circuit between jacks J3202-A and J3202-B.
	d. Defective servo amplifier	—	d. If all these voltages appear, trouble is in servo amplifier. Troubleshoot servo amplifier.
	e. 1-speed and 36-speed selsyns not zeroed with respect to each other	—	e. Zero 1-speed and 36-speed selsyns as directed in Section VI.

Figure 5–11. System Trouble Analysis Chart (Sheet 19 of 24)

Trouble	Probable Cause	Test Point	Remedy
AZIMUTH DRIVE AND CONTROL SECTION (cont)			
45. Antenna hunts for more than 90 seconds; hunt indicators I6207 and I6208 flicker continuously.			**Note** If antenna hunts excessively, stop all motion in azimuth by depressing STOP button on antenna control panel before proceeding with troubleshooting.
	a. Lockout relay K6208 inoperative	AY K6208-2 (figure 7–104) AK TB6203-4, (figure 7–104)	a. Connect a clip lead from terminal board TB6203-4 to relay K6208-2 and determine whether relay K6208 energizes. If so, LOCKOUT indicator I6206 should light. If indicator does not light, replace it. If indicator I6206 still fails to light, replace relay K6208.
	b. Time-delay relay K6207 inoperative	AK TB6203-4, (figure 7–104)	b. Connect a clip lead from terminal board TB6203-4 to relay K6207-2. After 90 seconds, relays K6207 and K6208 should be energized, and LOCKOUT indicator should light. If not, replace relay K6207.
46. Antenna hunts for more than 90 seconds; hunt indicators do not flicker, and LOCKOUT indicator does not light.	Defect in shunt indicator circuit	AQ TB6205-1 AR TB6205-2, figure 7–104)	Check lockout relay K6208 and time-delay relay K6207 and LOCKOUT indicator I6206 as outlined in step 45. Start antenna motion in azimuth. If excessive hunting persists, connect test oscilloscope to terminal board TB6205-1 and 2. Check for presence of low frequency (2 to 10 cps) signal. If signal is present, check for same signal between relay K6206-1 and 9.
		AV AW K6206-1, 9 (figure 7–104)	If low-frequency signal is present, determine whether relay K6206 energizes. Relay should energize twice each cycle. If it does not, replace relay.
47. Antenna hunts continually; hunt indicators flicker and LOCKOUT indicator lights.	Short in lockout circuit	AT TB6205-9, (figure 7–104) AU TB6205-10, (figure 7–104)	With STOP switch S6205 depressed, make continuity check between terminal board TB6205-9 and 10. If short is indicated, troubleshoot lockout circuit.

Figure 5–11. System Trouble Analysis Chart (Sheet 20 of 24)

Trouble	Probable Cause	Test Point	Remedy
AZIMUTH DRIVE AND CONTROL SECTION (cont)			
48. Antenna remains locked out after depressing AZIMUTH DRIVE RESET switch S6206; LOCKOUT indicator lights.	Defective AZIMUTH DRIVE RESET switch S6206	AK TB6203-4 (figure 7–104) AS TB6205-7 (figure 7–104)	a. Remove power. Disconnect lead from RESET SWITCH to terminal board TB6205-7 at terminal board. Make continuity check across AZIMUTH DRIVE RESET DRIVE switch while it is depressed. If meter indicates continuity, replace. If not, troubleshoot lockout circuit.
ELEVATION DRIVE AND CONTROL SECTION			
49. Elevation drive motor does not start when either FAST or SLOW button on safety box, antenna control panel of control group assembly, azimuth switch box, or RHI antenna control is pressed. Motor starter relay K6901 in control group cabinet is not actuated when FAST or SLOW button is pressed. Power is entering control group cabinet at terminal board TB6901 (on floor of cabinet) from antenna power source.	Energizing voltage is not reaching coils of line contactor K6901 because of open in interlock and control circuit	15 K6901-9, (figure 7–109) (7–110)	Swing power distribution panel open to expose relay K6910 (figure 5–17). With power removed from control group assembly, check continuity between neutral terminal of terminal board TB6901 (on floor of control group cabinet) and neutral ends of two energizing coils. If continuity checks, circuit is not open on neutral side of relay K6901.
		AF TB6002-4 (figure 7–99)	Pull antenna control assembly of control group assembly forward, and short drawer interlock switch by throwing INTERLOCK SHORT switch on control power supply No. 1. Close ANTENNA POWER switch on power distribution panel. Using an a-c voltmeter set to a suitable range, measure for 120 volts ac between neutral terminal of terminal board TB6901 (on floor of control group cabinet) and terminal 4 of terminal board TB6202 on antenna control panel (figure 5–14).
		AZ S6402-4, (figure 7–106) AI TB6202-4, (figure 7–104) BL TB9708-6, figure 7–125	If 120 volts ac is present, elevation interlock circuit is open. Locate open, using voltmeter between neutral and points electrically located between terminal board TB6202-4 and contact 4 of switch S6402, or by using an ohmmeter. If interlock circuit is not open, use voltmeter to measure voltage between neutral and terminal board TB9708-6 in junction box (figure 5–12). (Neutral in junction box can be found at jack J9708-J or at J9703-D, figure 5–12). An open is indicated by lack of a 120-volt ac reading at these points. Locate open by measuring between neutral and points electrically located between terminal boards TB6202-4 and TB9708-6.

Figure 5–11. System Trouble Analysis Chart (Sheet 21 of 24)

Trouble	Probable Cause	Test Point	Remedy
ELEVATION DRIVE AND CONTROL SECTION (cont)			
50. Same as step 49, but motor starter relay K6901 is actuated when FAST or SLOW button is pressed.	a. Open circuit to line-closing contacts of relay K6901	16 K6901-L1, L2, and L3, figure 7–109 (7–110)	a. Use ohmmeter or voltmeter to locate open between terminal board TB6901 (on floor of control cabinet) and line-closing contacts of relay K6901 (figure 5–16).
	b. One or more of overload relays A, C, D, F of K6901 (figure 5–14) trip when FAST or SLOW buttons are pressed	—	b. Troubleshoot antenna system.
51. Same as step 50, except elevation drive motor does not start when FAST button on either safety box, antenna control panel of control group assembly, azimuth switch box, or RHI antenna control is pressed. However, elevation drive motor does start when any SLOW button is pressed. Fast section of relay K6901 (figure 5–16) is not energized when FAST button is pressed.	Energizing voltage is not reaching energizing coil of fast section of relay K6901 because of open in fast control circuit	16 K6901-L1, figure 7–109 (7–110)	Check fast control circuit as follows: Swing power distribution panel open to expose relay K6901 (figure 5–16). With power removed from control group assembly, check continuity between bottom of fast energizing coil and neutral terminal of terminal board TB6901 (on floor of control group cabinet). If continuity checks, circuit is not open on neutral side of relay K6901. Pull antenna control assembly of control group assembly forward and short drawer interlock switch by throwing INTERLOCK SHORT switch S5606 on control group power supply No. 1. Close ANTENNA POWER switch S6402 on power distribution panel. Using an a-c voltmeter set to a suitable range, measure for 120 volts ac between neutral and contact 1 of SLOW switch S6202 on antenna control panel. If such voltage does not appear, there is an open in line leading to contact 1 of switch S6202 from SLOW switch in safety box (figure 1–75), or in line to SLOW switch in safety box from ELEV. SCAN SLOW switch S3901 in azimuth switch box or switch S6503 in RHI antenna control. Locate open, using an ohmmeter or voltmeter.
52. Same as step 51, but fast section of relay K6901 is energized when FAST button is pressed. Overload relays A and C of relay K6901 (figure 5–16) do not trip.	Power is not reaching elevation drive motor because of defective motor or an open in motor fastpower cir-circuit	16 K6901,-L1, L2 and L3 figure 7–109 (7–110)	Check continuity through cable W9417 from relay K6901 (in control group cabinet behind power distribution panel). If trouble is not located here, troubleshoot antenna system.

Figure 5–11. System Trouble Analysis Chart (Sheet 22 of 24)

Trouble	Probable Cause	Test Point	Remedy
ELEVATION DRIVE AND CONTROL SECTION (cont)			
53. Same as step 52, but fast section of relay K6901 is momentarily energized when FAST button is pressed. Overload relays A and/or C of K6901 (figure 5–16) then trip.	Partial or dead short in motor fast winding or in motor fastpower circuit	—	Use ohmmeter to check if short is in wiring (in control group cabinet behind power distribution panel) or in cable W9417.
54. Elevation drive motor does not start when SLOW button on either safety box, antenna control panel of control group assembly, azimuth switch box, or RHI antenna control is pressed. Elevation drive motor starts when any FAST button is pressed.	Energizing voltage is not reaching energizing coil of slow section of relay K6901 because of open in slow control circuit.	—	Swing power distribution panel open to expose relay K6901 (figure 5–16). With power removed from control group assembly, check continuity between bottom of slow energizing coil and neutral terminal of terminal board TB6901 (on floor of control group cabinet). If continuity checks, circuit is not open on neutral side of relay K6901.
Slow section of relay K6901 (figure 5–16) is not energized when SLOW button is pressed.		—	Pull antenna control assembly of control group assembly forward and short drawer interlock switch by throwing INTERLOCK SHORT switch S5606 on control group power supply No. 1. Close ANTENNA POWER switch S6402 on power distribution panel. Using an a-c voltmeter set to a suitable range, measure for 120 volts ac between neutral and contact 1 of FAST switch S6201 on antenna control panel. If such voltage does not appear, there is an open in line leading to contact 1 of switch S6201 from FAST switch in safety box (figure 1–76), or in line to FAST switch in safety box from ELEV. SCAN FAST switch S3902 in azimuth switch box or switch S6504 in RHI antenna control. Locate open, using an ohmmeter or voltmeter.
55. Same as step 54, but slow section of relay K6901 is energized when SLOW button is pressed. Overload relays D and F of relay K6901 (figure 5–16) do not trip.	Power is not reaching elevation drive motor because of defective motor or an open in motor slow-power circuit	—	Check continuity through cable W9418 from relay K6901 (in control cabinet behind power distribution panel). If trouble is not located here, troubleshoot antenna system.
56. Same as step 55, but slow section of relay K6901 is momentarily energized when SLOW button is pressed. Overload relays D and/or F of relay K6901 (figure 5–16) then trip.	Partial or dead short in motor slow winding or in motor slowpower circuit		Use ohmmeter to check for short in wiring between relay K6901 (in control group cabinet behind power distribution panel) or in cable W9418. If trouble is not located, troubleshoot antenna system.
57. Elevation drive motor does not respond to SLOW or FAST button located on a particular unit normally capable of controlling motor. Motor responds properly to SLOW and FAST button on all other units.	Particular unit whose buttons do not cause elevation drive motor to respond is defective. Most probable defect is a faulty FAST or SLOW switch		Replace defective switch.

Figure 5–11. System Trouble Analysis Chart (Sheet 23 of 24)

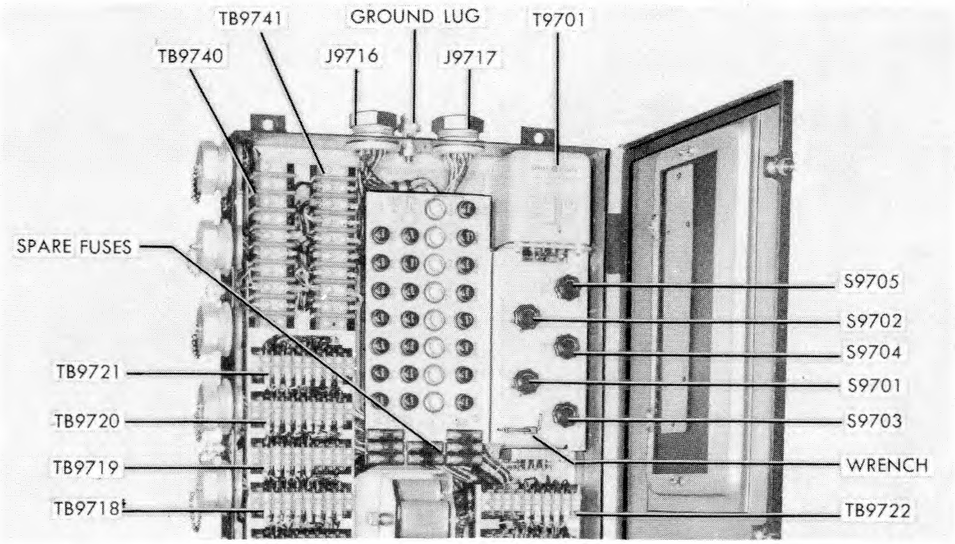


Figure 5–12. Junction Box, Cover Opened

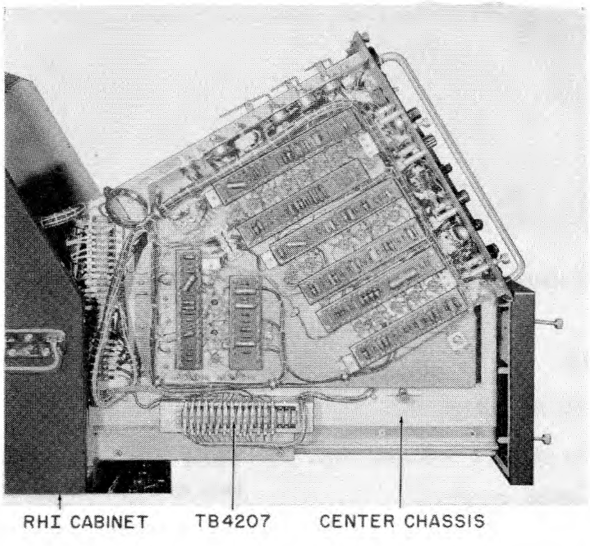


Figure 5–13. RHI Frame Assembly of Range and Height Indicator IP-188/FPS-6, Left Side View

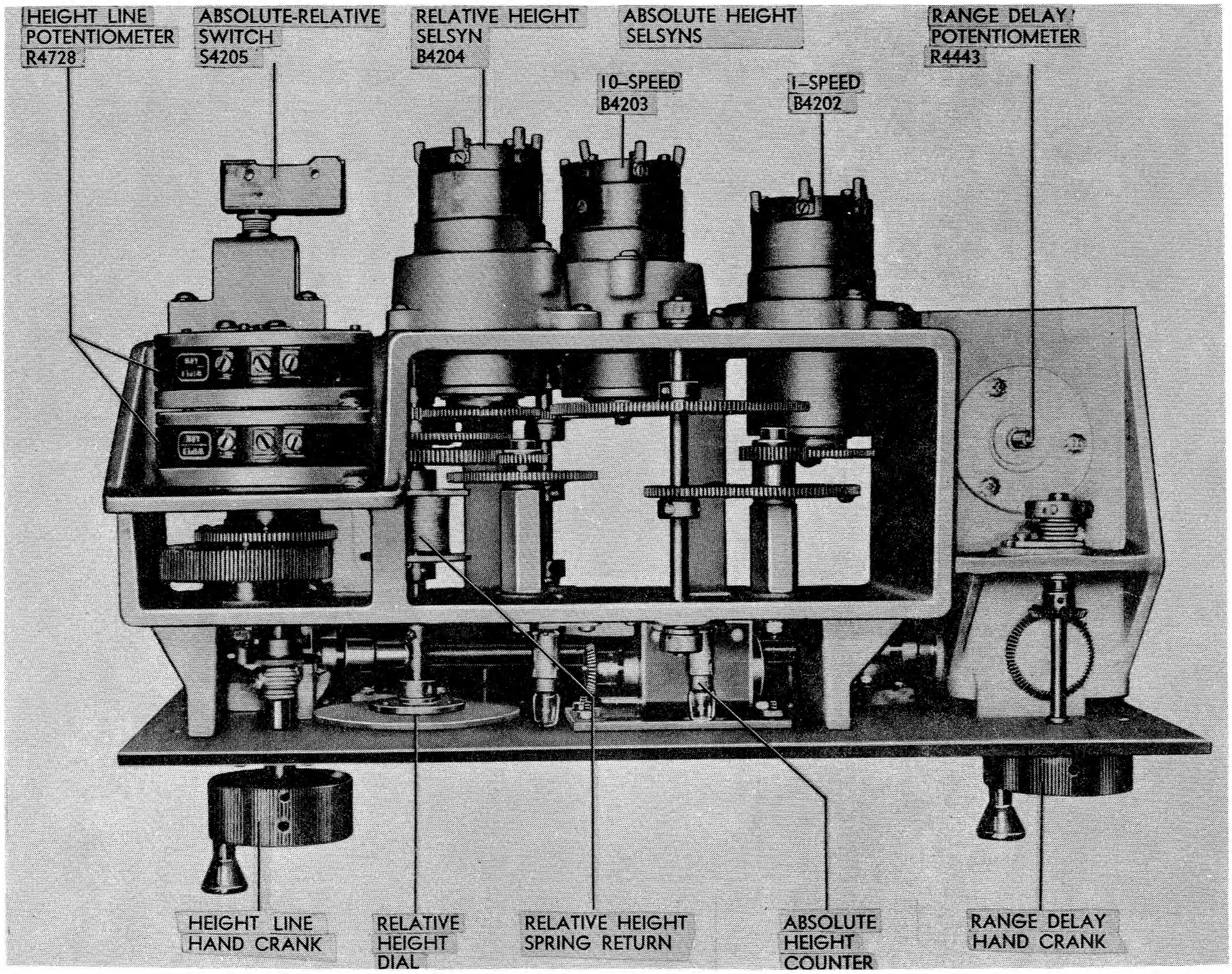


Figure 5–14. Height Selsyns and Drive Mechanism of Range and Height Indicator IP-188/FPS-6

5–33. INITIAL ADJUSTMENTS.

5–34. POWER TURN-ON PROCEDURES.

5–35. To turn on the power, see figures 5–8 and 5–9.

5–36. CONTROL GROUP POWER SUPPLY ADJUSTMENT.

5–37. To perform the control group power supply adjustment, proceed as follows:

a. Rotate meter switch S5605 on control group power supply No. 2 (figure 1–45) and check voltage readings on adjacent voltmeter M5601.

b. If necessary, adjust +275V ADJUST, +140V ADJUST, and −150V ADJUST controls to bring meter readings into agreement with indicated values.

5–38. SYSTEM TRIGGER PRF ADJUSTMENT.

5–39. To perform the system trigger PRF adjustment, proceed as follows:

a. Connect vertical plates of test synchroscope (Synchroscope AN/USM-24) to TEST TRIGGER jack J5202 on range mark generator (figures 1–46 and 1–47). Check for a pulse 20 volts in amplitude.

b. Disconnect vertical plates of synchroscope from TEST TRIGGER jack. Use output of TEST TRIGGER jack as a synchronizing signal for synchroscope.

c. Connect vertical plates of test synchroscope to RANGE MARKS jack J5214.

d. Adjust TRIGGER REP-RATE control R5207 to provide required number of range markers on synchroscope: 20 range markers for a 400-pps rate, and 22 range markers for a 360-pps rate.

5–40. PREAMPLIFIER-LOCAL OSCILLATOR POWER SUPPLY ADJUSTMENT.

5–41. To perform the preamplifier-local oscillator power supply adjustment, proceed as follows:

a. At power distribution panel (figure 1–44), throw XMITTER RECEIVER power switch to ON position.

b. At local control panel (figures 1–63 and 1–64), throw REMOTE LOCAL CONTROL switch to position which causes LOCAL indicator to light.

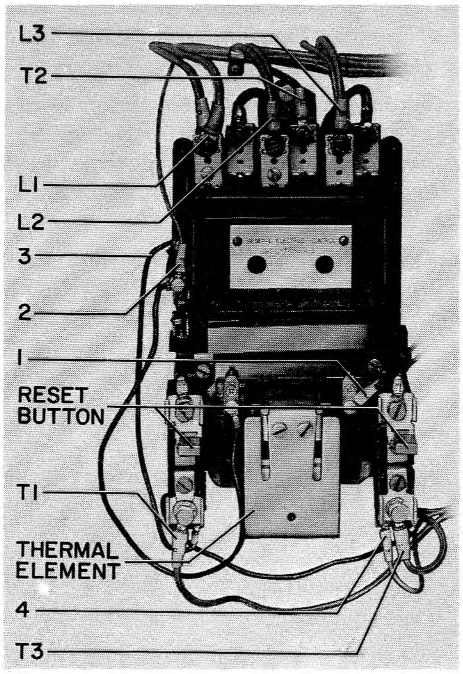


Figure 5–15. Motor Starter Relay K6902

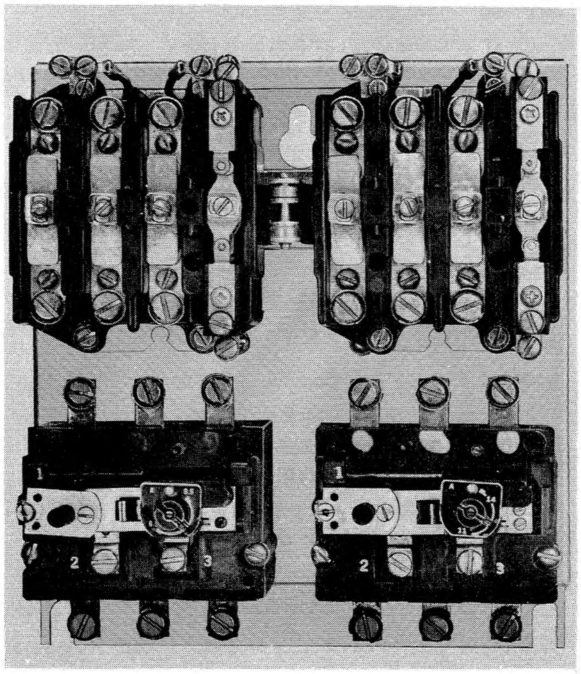


Figure 5–16A. Alternate Contactor K6901

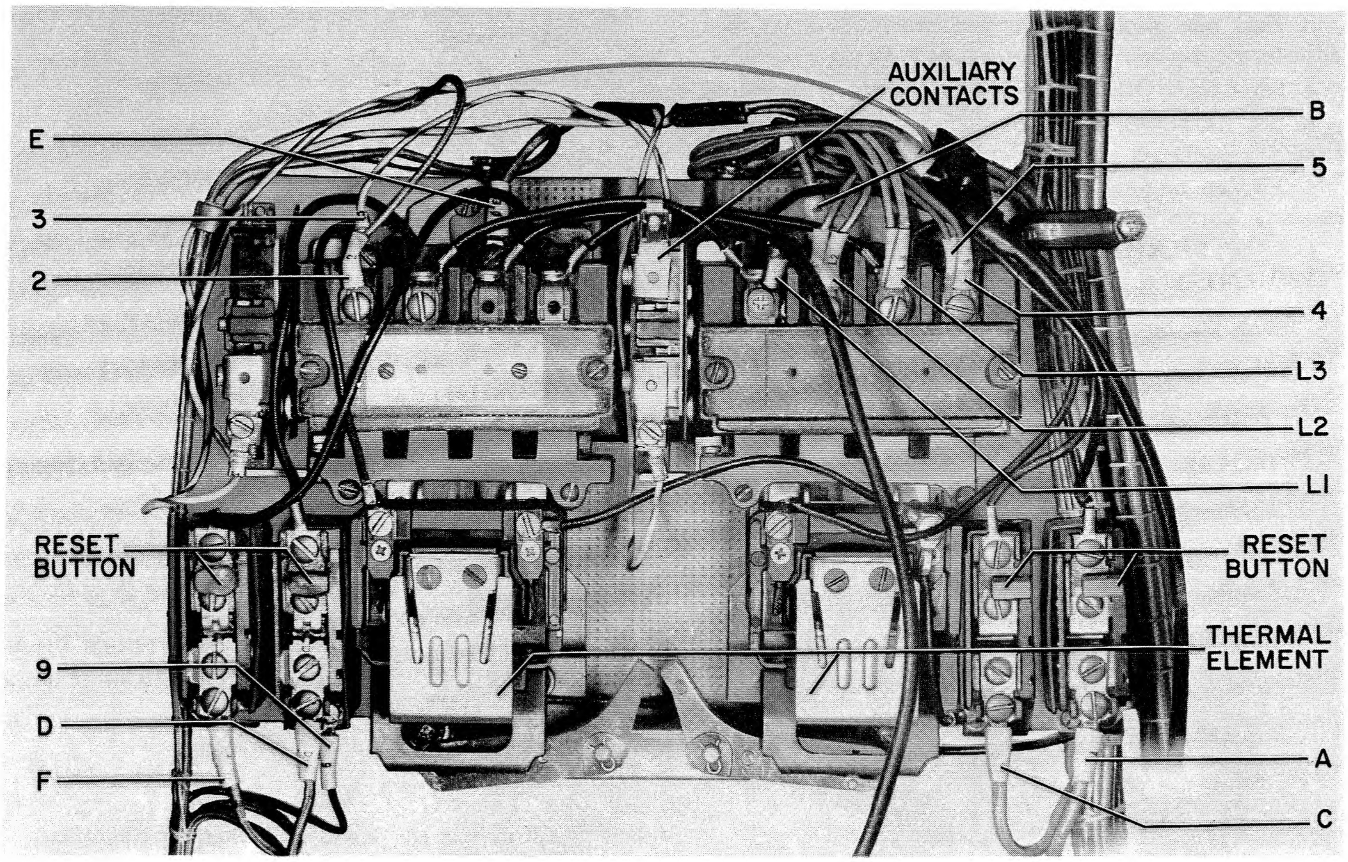


Figure 5–16. Motor Starter Relay K6901

c. Rotate METER SWITCH S1101 on preamplifier-local oscillator power supply (figure 1–65) to its indicated positions and check voltage readings on voltmeter M1102.

d. If necessary, adjust +140V ADJUST, +375V ADJUST, and +300V ADJUST controls to bring meter readings into agreement with indicated values.

Note

No adjustment is provided for the —210-volt supply. This voltage must be within ±5 percent.

5–42. MODULATING SYSTEM ALINEMENT.

5–43. POWER TURN-ON PROCEDURE.

5–44. To turn on power, proceed as follows:

a. Remove plug P10403 from jack J10403 on modulator high-voltage power supply (figure 5–17).

b. Set MODULATOR power switch to ON position on power distribution panel (figure 1–44). MODULATOR indicator should light.

5–45. MODULATOR AND MAGNETRON FILAMENT CURRENT ADJUSTMENT.

5–46. To perform the modulator and magnetron filament adjustment, proceed as follows:

a. Set BATTLE SHORT switch or INTERLOCK SHORT switch on modulator assembly power panel (figures 1–67 and 1–68) to ON position.

b. Pull out modulator control unit chassis so that adjustment controls shown in figure 5–18 are accessible.

c. Set AGE-NORMAL switch to NORMAL position.

d. Set AUTO-MANUAL switch to MANUAL position.

e. Lift up modulator control unit subchassis so that controls shown in figure 5–19 are accessible.

f. Adjust FILAMENT VOLTAGE SENSITIVITY and FILAMENT VOLTAGE controls for a reading of 120 volts on MOD FIL SUPPLY meter located on modulator control panel (figure 1–69). FILAMENT VOLTAGE SENSITIVITY control should be turned as far clockwise as is possible before modulator filament control circuit hunts. (Hunting is indicated by oscillation of meter pointer around an average value.)

Figure 5–17. High-voltage Power Supply

g. Calibrate magnetron heater circuit used in Radar Set AN/FPS-6A, as described in paragraph 5–47, in cases where a modulator or magnetron assembly has been changed, or when parts of magnetron heater circuit have been replaced.

h. Adjust MAGNETRON FILAMENT READY control (figure 5–19) until MAG FIL CURRENT meter reads value recorded on its nameplate or value indicated in "Ready" column of the following table. Keep MAGNETRON FILAMENT SENSITIVITY control as far clockwise as is possible without causing hunting of magnetron filament powerstat.

Pulse Transformer	*M2105 Reading*	
	Ready	*Radiate*
Maloney	7.70	7.42
GE Types A and B	7.90	7.63
GE Types C and D	8.50	8.20

i. Place BATTLE SHORT or INTERLOCK SHORT switch on modulator assembly power panel (figures 1–67 and 1–68) in OFF position.

j. Open power panel and loosen two allen-type setscrews of center cam on top of magnetron filament powerstat T2251.

k. Rotate cam clockwise until it actuates microswitch. Tighten setscrews.

l. Place BATTLE SHORT or INTERLOCK SHORT switch on modulator assembly power panel (figures 1–67 and 1–68) in ON position.

m. Reduce MAG FIL CURRENT reading by adjustment of MAGNETRON FILAMENT READY control and note that powerstat motor operates.

n. Increase MAG FIL CURRENT reading by adjustment of MAGNETRON FILAMENT READY control and note that power is removed from powerstat at setting of step h.

o. Place RADIATE–STOP & RESET switch (figure 1–69) in RADIATE position.

p. Adjust MAGNETRON FILAMENT RADIATE control (figure 5–19) until MAG FIL CURRENT meter reads value recorded on its nameplate or value indicated in "Radiate" column of table in step h. If magnetron filament powerstat hunts, rotate MAGNETRON FILAMENT SENSITIVITY control counterclockwise until hunting stops and repeat step h.

q. Close modulator control unit drawer.

Note

Perform filament power adjustment (paragraph 5–48A) after 72 hours of magnetron operation.

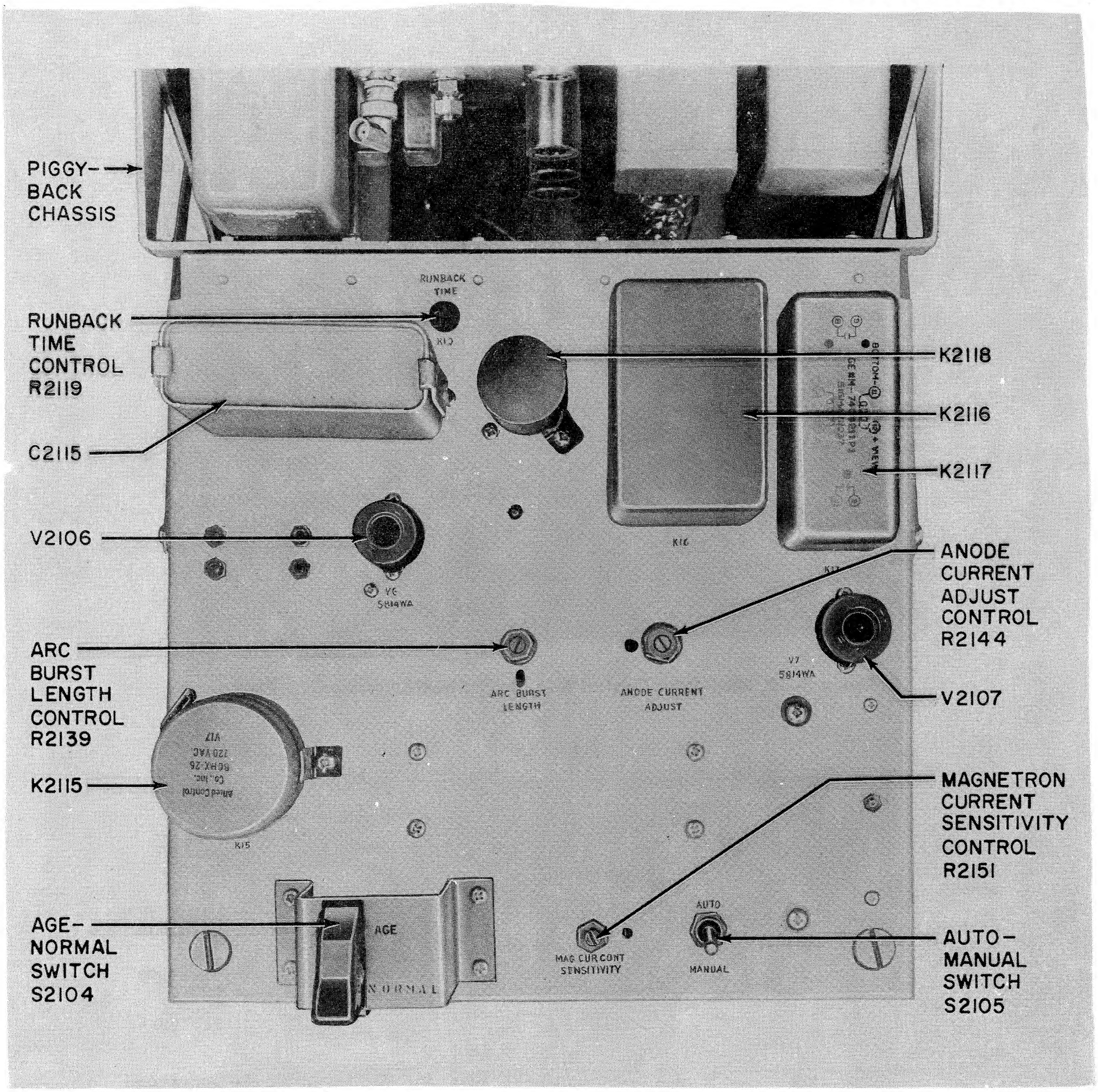


Figure 5–18. Modulator Control Unit Subchassis

5–47. MAGNETRON HEATER CIRCUIT CALIBRATION.

5–48. Calibrate the magnetron heater circuit of Radar Set AN/FPS-6A when either a modulator or magnetron assembly has been changed or when parts of the magnetron heater circuit have been changed. Proceed as follows:

a. Remove power from system. Check that plug P10403 is disconnected from jack J10403 on high-voltage power supply (figure 5–17).

b. Check that power switches on magnetron heat exchanger and pressurizer are OFF.

c. Remove MAGNETRON FILAMENT fuse F2102.

d. Remove magnetron from magnetron cabinet.

e. Place a splice between magnetron input and output water cooling hoses and turn on water. A jumper between terminals 4 and 8 of terminal board TB2101 will serve the same purpose.

f. Turn MODULATOR switch at power distribution panel to ON position.

g. Insert magnetron heater calibrator plug into magnetron socket (figure 5–20).

h. Replace fuse F2102.

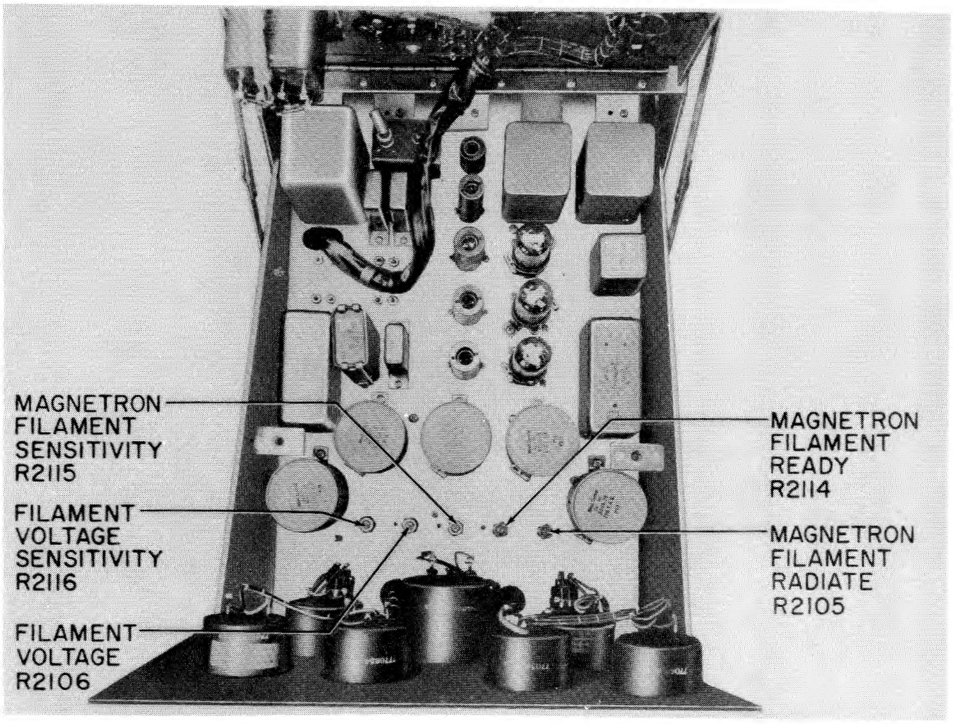


Figure 5–19. Modulator Control Unit, Adjustment Controls, Top View

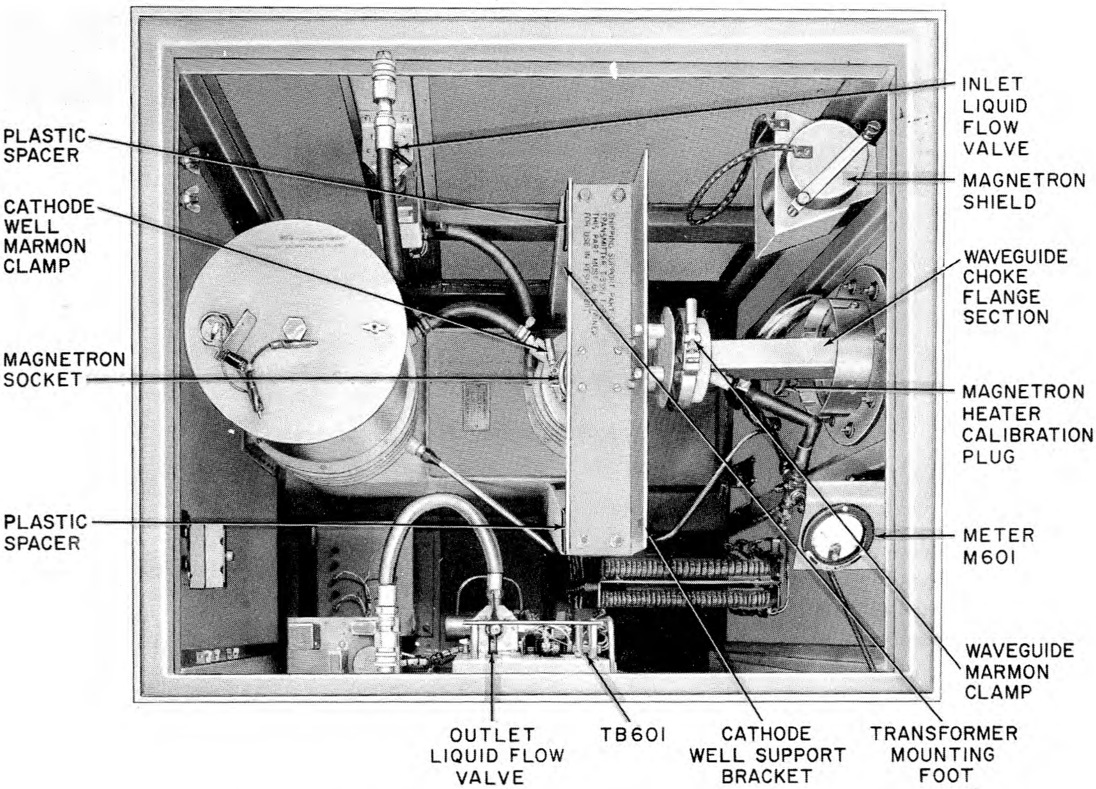


Figure 5–20. Magnetron Assembly, Interior View

i. Set MAGNETRON FILAMENT SENSITIVITY control (figure 5–19) to maximum clockwise setting which does not produce hunting of transformer T2251.

j. Adjust MAGNETRON FILAMENT READY control R2114 (figure 5–19) for the following readings on MAGNETRON FILAMENT meter M601 (figure 5–20):

Magnetron to be Installed	*M601 Reading*
QK-338	85 milliamperes
QK-338A	Stamped value

k. Read MAG FIL CURRENT meter M2105 and record value on nameplate above meter in space provided for standby current.

l. Place RADIATE STOP & RESET switch S2101 in RADIATE position.

m. Adjust MAGNETRON FILAMENT RADIATE control R2105 for the following reading on MAGNETRON FILAMENT meter M601:

Magnetron to be Installed	*M601 Reading*
QK-338	82 milliamperes
QK-338A	Stamped value

n. Read MAG FIL CURRENT meter M2105 and record value on nameplate above meter in space provided for radiate current.

o. Remove MAGNETRON FILAMENT fuse.

p. Install a magnetron and return system to its normal operating condition. Do not reconnect plug P10403.

q. Place RADIATE STOP & RESET switch S2101 in RADIATE position.

r. Adjust MAGNETRON FILAMENT RADIATE control (figure 5–19) to obtain reading on meter M2105 noted in step n. If control circuit hunts, rotate MAGNETRON FILAMENT SENSITIVITY control counterclockwise until hunting ceases.

s. Take system out of radiate condition and reconnect plug P10403 to jack J10403 (figure 5–17).

Note

Radar Set AN/FPS-6 systems are not equipped with a heater calibrator, but it is possible to plot the MAGNETRON FILAMENT (M601) meter readings versus the MAG FIL CURRENT (M2105) meter readings which may be used to set the correct filament currents. These calibrations will be valid for the particular modulator and magnetron cabinet used at the time of calibration.

5–48A. MAGNETRON FILAMENT POWER ADJUSTMENT.

5–48B. For the first 72 hours of magnetron operation, the filament current is held constant at the level established by the procedures described in paragraph 5–45. After 72 hours of operation, the magnetron filament power (filament voltage multiplied by filament current) is held constant at the level established by the following procedure:

a. Perform the following tests while the equipment is radiating at normal filament current and record results:

(1) Magnetron spectrum (paragraph 5–124)
(2) Modulator output pulse (paragraph 5–111)
(3) R-f power output (paragraph 5–116 or 5–118)
(4) VSWR (paragraph 5–120 or 5–122)

b. Adjust MAGNETRON FILAMENT RADIATE control (figure 5–19) until reading on MAG FIL CURRENT meter M2105 (figure 1–69) is reduced 0.2 ampere.

c. After 15 minutes, again perform the tests listed in step a. If results are satisfactory, proceed with step d. If results are not satisfactory, return the filament current level to its former value.

d. Continue reduction of filament current in steps of 0.2 ampere, allowing 15 minutes for magnetron to stabilize between each step, until tests of step a yield unsatisfactory results.

e. Raise filament current at least 0.3 ampere above the level indicated in step d.

f. Place RADIATE-STOP & RESET switch (figure 1–69) in STOP & RESET position. Adjust MAGNETRON FILAMENT READY control (figure 5–19) until MAG FIL CURRENT meter M2105 reads midway between setting of paragraph 5–46h and new value established in step e above.

g. Repeat steps a through f at 24-hour intervals until no further reduction in filament current is possible.

h. Multiply readings of MAG FIL CURRENT meter M2105 and MAG FIL VOLTAGE meter M2106. This is the optimum filament power level. Post this value prominently on the modulator control panel.

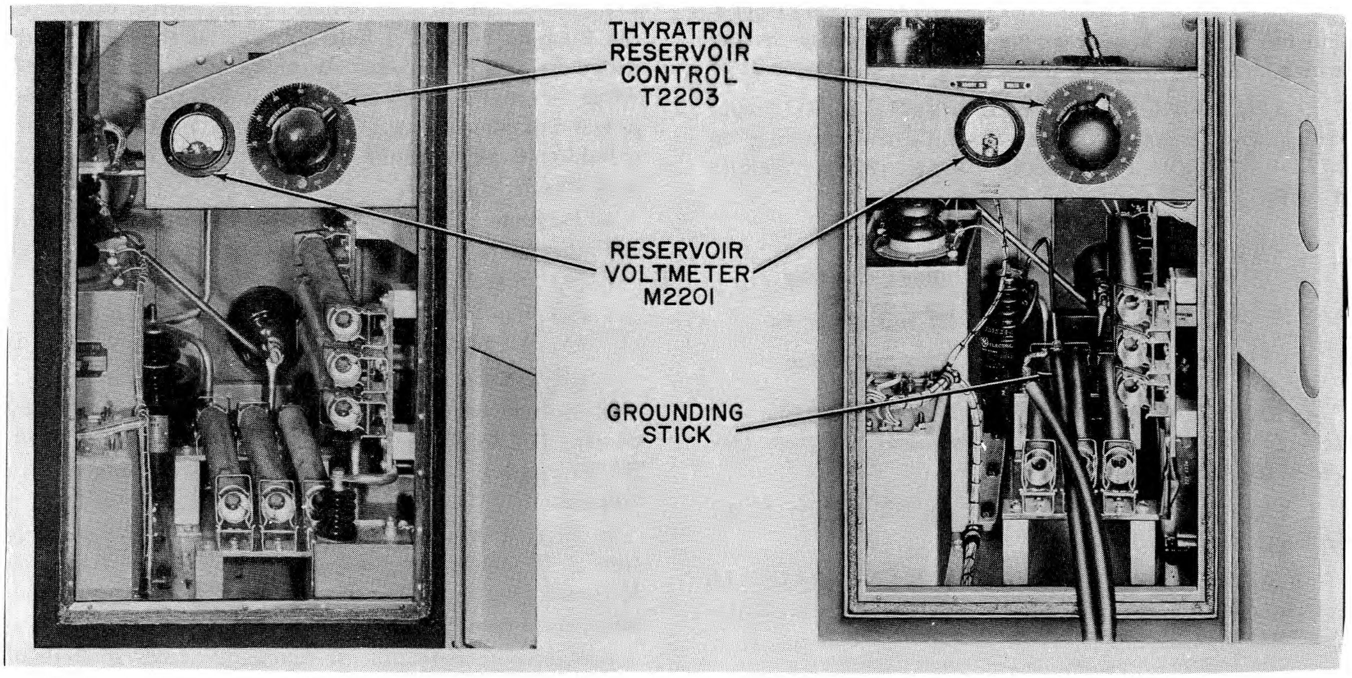
i. When spectrum deterioration, arcing, pulse skipping, appreciable r-f power reduction or increased VSWR are encountered, adjust the FILAMENT VOLTAGE and MAGNETRON FILAMENT RADIATE controls (figure 5–19) until the product of the MAG FIL CURRENT and MAG FIL VOLTAGE meter readings again equals the value obtained in step h.

j. If after prolonged operation at the filament power established in step h, it becomes impossible to eliminate spectrum deterioration or other undesirable results, proceed as follows:

(1) Adjust MAGNETRON FILAMENT RADIATE control until MAG FIL CURRENT meter reading increases 0.2 ampere. Wait 15 minutes before performing step (2).

(2) Repeat step (1) in intervals of 0.2 ampere until a new stable point is reached.

(3) Increase filament current 0.2 ampere above the level reached in step (2).



(A) Radar Set AN/FPS-6

(B) Radar Set AN/FPS-6A

Figure 5–21. Modulator Assembly, Thyratron Compartment

k. If a new stable point cannot be found by the procedure of step j, return filament current to value obtained in step h and follow instructions in paragraph 5–58.

5–49. THYRATRON RESERVOIR CONTROL ADJUSTMENT.

5–50. To perform thyratron reservoir control adjustment, proceed as follows:

a. Check that plug P10403 (figure 5–17) has been disconnected from jack J10403 on modulator high-voltage power supply.

b. Throw INTERLOCK SHORT switch (figure 1–68) or BATTLE SHORT switch (figure 1–67) to ON position and open thyratron compartment door of modulator assembly (figure 5–21).

c. Adjust thyratron RESERVOIR CONTROL for voltage reading on RESERVOIR VOLTAGE meter equal to voltage stamped on small nameplate just below voltmeter.

d. Close compartment door and throw INTERLOCK SHORT switch (figure 1–68) or BATTLE SHORT switch (figure 1–67) on modulator assembly power panel to OFF position.

e. Be sure that HV IND REG power switch (figure 1–44) on power distribution panel is in OFF position.

f. Replace plug P10403 (figure 5–17) on high-voltage power supply.

g. Turn HV IND REG power switch to ON position.

h. Observe that READY indicator on modulator control panel (figure 1–69) is on.

WARNING

During high-voltage operation of the modulator, opening the lower doors exposes 25,000 volts. A transparent protective cover placed over the door opening is suggested as a safety precaution. The protective cover should allow access to the control knob of transformer T2203.

i. Throw RADIATE-STOP & RESET SWITCH (figure 1–69) on modulator control panel to RADIATE position. This switch is spring-loaded and will return to its center position when released.

CAUTION

Final adjustment of the thyratron capsule voltage (explained in the following steps) must be made as soon as possible after the system is placed in the radiate condition for the first time.

j. Throw INTERLOCK SHORT switch (figure 1–68) or BATTLE SHORT switch (figure 1–67) on modulator assembly power panel to ON position.

k. Carefully observe JAN 5948 hydrogen thyratron to determine whether reservoir voltage setting is correct. Too high a voltage is indicated by a brighter than ordinary glow within the hydrogen thyratron, and by the slamming of the HV CURRENT meter pointer against the meter scale stop. If this condition is observed, open thyratron compartment door and lower reservoir voltage by rotating thyratron RESERVOIR CONTROL while observing RESERVOIR VOLTAGE meter. Lower voltage in increments of 0.2 volt until proper setting has been obtained. After each adjustment, give thyratron 10 minutes to stabilize before reapplying high voltage.

l. Too low a reservoir voltage is indicated by both a red-hot thyratron plate and the failure of the high-voltage power supply current source (zero reading on HV CURRENT meter). If this happens, stop modulator immediately by throwing RADIATE-STOP & RESET switch on modulator control panel to STOP & RESET position. Raise reservoir voltage in increments of 0.2 volt until proper setting has been obtained. After each adjustment, give thyratron 10 minutes to stabilize before applying high voltage.

m. Close thyratron compartment door and return INTERLOCK SHORT switch or BATTLE SHORT switch on modulator assembly power panel to OFF position.

n. Hold HV RAISE-HV LOWER switch in HV RAISE position to increase power input until MAG CURRENT meter indicates rated value.

Note

With a PRF of 360, a magnetron current up to 93.5 milliamperes is allowable. Maximum allowable magnetron current as read on MAG CURRENT meter, varies directly with PRF and can be determined from figure 2-1 T.O. 31P3-2FPS6-1 or from figure 4-126 T.O. 31P3-2FPS6-165.

o. If REV CURRENT indicator lights, modulator will cease firing of magnetron and RADIATE indicator will go off. Restore RADIATE-STOP & RESET switch to RADIATE position. REV CURRENT indicator should then go off and RADIATE indicator should light.

Note

If hydrogen thyratron tube in modulator assembly flashes over, d-c overload relay K2250 opens and modulator ceases firing of magnetron. In this instance, RADIATE indicator should go off but REV CURRENT indicator should not light. Restore modulator to firing action by first throwing RADIATE STOP & RESET switch to STOP & RESET position and then to RADIATE position.

5–51. MAGNETRON ANODE CURRENT ADJUSTMENTS.

5–52. With the radar in radiation operation, adjust the magnetron anode current circuit as follows:

a. Turn ANODE CURRENT ADJUST control on modulator control unit subchassis (figure 5–18) to its midposition.

b. Throw AUTO-MANUAL control on modulator control unit subchassis to AUTO position.

c. Observe HV CURRENT meter. Ten seconds after radar is placed in radiation operation, anode current should increase and remain stable.

d. Turn ANODE CURRENT ADJUST control to obtain desired magnetron anode current.

Note

When ANODE CURRENT ADJUST control is turned clockwise, current will increase after a 10-second delay.

e. Adjust magnetron current as read on MAG CURRENT meter to 93.5 milliamperes.

f. Close modulator control unit drawer.

5–53. TRANSMITTING SYSTEM ALINEMENT.

5–54. POWER TURN-ON PROCEDURE.

5–55. Proceed as follows to apply power to the transmitting system:

a. Follow procedures given in figures 5–8 and 5–9.

b. At power distribution panel (figure 1–44), turn the following switches to the ON position: HV IND REG switch S6403, MODULATOR switch S6404, and XMITTER RECEIVER switch S6405.

c. At local control panel (figure 1–63 or 1–64), place REMOTE-LOCAL CONTROL switch S1001 in LOCAL position. LOCAL indicator I1002 should light.

5–56. MAGNETRON BREAK-IN PROCEDURE.

5–57. New magnetrons must be "seasoned" in the following manner:

a. Place RADIATE-STOP & RESET switch on modulator control panel (figure 1–69) in RADIATE position.

b. Allow anode current to come up to operating value in normal manner. Some arcing and instability may be noticed with many tubes; therefore, allow 5 to 10 minutes for tube to stabilize. A stable condition can be determined when radar set can be placed in radiate condition without reverse-current buzzer sounding at frequent intervals. If, after 10 minutes, runback circuit does not reduce anode current at frequent intervals, tube is satisfactory and normal operation can be resumed.

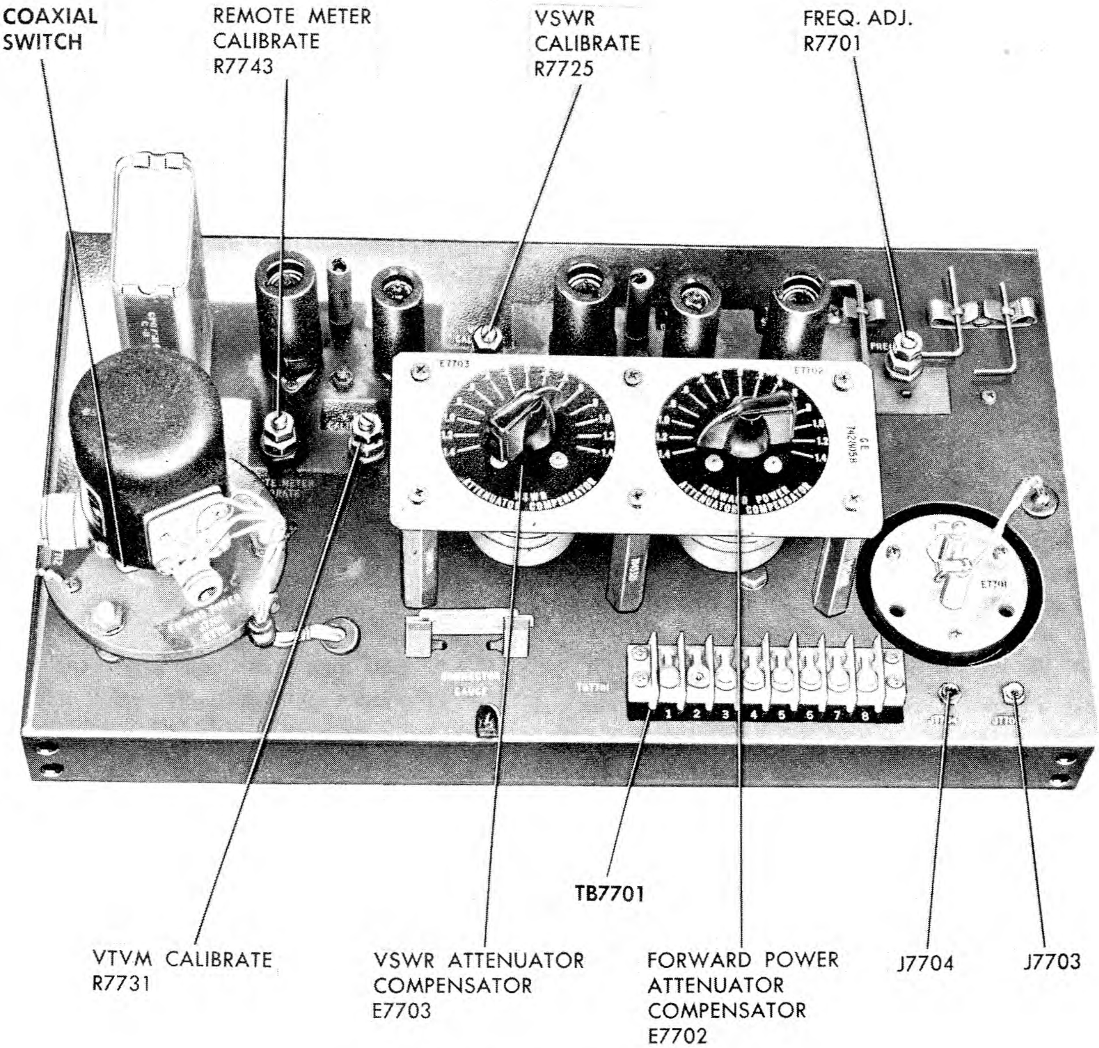


Figure 5–22. Power Monitor, Rear View

c. If, after the completion of step b, reverse-current circuit is still running high voltage back to frequent intervals, place INTERLOCK SHORT switch (figure 1–60) or BATTLE SHORT switch (figure 1–67) on modulator assembly in ON position. Open modulator control unit drawer.

d. Throw AGE-NORMAL switch on modulator control unit subchassis (figure 5–18) to AGE position. Allow magnetron to operate in this fashion for 30 minutes.

e. If operation becomes stable after 30 minutes, return AGE-NORMAL switch to NORMAL position and close modulator control unit drawer. Return INTERLOCK SHORT or BATTLE SHORT switch to OFF position.

f. If procedure in step d does not stabilize magnetron, throw AUTO-MANUAL switch to MANUAL position and operate HV RAISE-HV LOWER switch to HV RAISE position until HV CURRENT meter reads 2 or 3 milliamperes above normal operating point. Hold anode current at this level from 5 to 10 minutes.

g. Return AUTO-MANUAL switch to AUTO position and AGE-NORMAL switch to NORMAL position.

h. If operation is now stable, close modulator control unit drawer and return INTERLOCK SHORT or BATTLE SHORT switch to OFF position. If operation is still unstable, replace magnetron.

5–58. MAGNETRON STABILIZATION PROCEDURE.

5–59. Occasionally, a magnetron may become unstable after operating normally for some time. An unstable condition exists when the runback circuits operate at frequent intervals to reduce the anode current. If stability becomes so bad that the system operation is unsatisfactory, the following steps should be taken:

a. Throw INTERLOCK SHORT switch (figure 1–68) or BATTLE SHORT switch (figure 1–67) on modulator assembly power panel to ON position and open modulator control unit drawer.

b. Place AGE-NORMAL switch (figure 5-18) in AGE position and allow magnetron to operate in this fashion for 30 minutes.

c. If tube stabilizes after a half hour, return AGE-NORMAL switch to NORMAL position. Close modulator control unit drawer and return INTERLOCK SHORT or BATTLE SHORT switch to OFF position.

d. If procedure in step b does not remedy the condition, set magnetron anode current to a lower level (paragraph 5-51), if this is permissible under site operating conditions.

e. If lower power operation is not permissible, a new magnetron must be installed.

5-60. POWER AND VSWR MONITOR ADJUSTMENT.

5-61. To adjust the performance monitor power and VSWR circuits, proceed as follows:

Note

Before starting this adjustment, energize the performance monitor power supply as outlined in steps a through d of paragraph 5-118.

a. Pull power and noise figure drawer forward.

b. Connect a vacuum-tube voltmeter (Voltmeter ME-6D/U) between jack J7703 and ground (figure 5-22).

c. Adjust ZERO SET-COARSE control until voltmeter reads as close to 1.57 volts as possible. Adjust ZERO SET FINE control until voltmeter reads exactly 1.57 volts. Remove voltmeter.

d. Turn FORWARD POWER-VSWR switch to FORWARD POWER-ZERO SET position.

e. Adjust VTVM CALIBRATE control until power meter reads zero.

f. Turn FORWARD POWER VSWR switch to VSWR-ZERO SET position.

g. Note position of VSWR ATTENUATOR COMPENSATOR and FORWARD POWER ATTENUATOR COMPENSATOR. Then, turn both compensators to zero.

h. Adjust VSWR CALIBRATE control until power meter reads zero.

i. Return VSWR ATTENUATOR COMPENSATOR and FORWARD POWER ATTENUATOR COMPENSATOR to their normal positions.

j. Turn FORWARD POWER-VSWR switch to FORWARD POWER-READ position.

k. Turn the NORMALIZING ATTENUATING control until FORWARD POWER indicator lights.

l. Place RADIATE-STOP & RESET switch on modulator control panel (figure 1-69) in RADIATE position. Wait until the RADIATE indicator lights.

m. Adjust REMOTE METER CALIBRATE control until RADIATED POWER meter on remote r-f control panel (figure 1-36) reads the same value as power meter on performance monitor front panel.

n. If meter needle vibrates rapidly, adjust FREQ. ADJ. control until meter needle stops vibrating.

Note

To convert the radiated average power read on the meter to peak power in megawatts, refer to RADIATED POWER CHART below the meter.

o. Return INTERLOCK SHORT switch on performance monitor power supply panel (figure 1-64) to OFF position and close power and noise figure assembly.

5-62. RECEIVING SYSTEM ALINEMENT.

5-63. POWER TURN-ON PROCEDURE.

5-64. Proceed as follows to apply power to the receiving system:

a. Follow procedures given in figures 5-8 and 5-9.

b. At power distribution panel (figure 1-44), turn the following switches to the ON position: HV IND REG switch S6403, MODULATOR switch S6404, and XMITTER RECEIVER switch S6405.

c. At local control panel (figure 1-63 or 1-64), place REMOTE-LOCAL CONTROL switch S1001 in LOCAL position. LOCAL indicator I1002 should light.

d. At modulator control unit (figure 1-69), place RADIATE STOP & RESET switch S2101 in RADIATE position. RADIATE indicator I2105 should light.

5-65. AFC-LO ADJUSTMENT.

5-66. To perform the AFC-LO adjustment, proceed as follows:

a. At AFC-LO panel (figure 1-66), throw MANUAL-AFC switch to MANUAL position.

b. At local control panel (figure 1-63 or 1-64), place RECEIVER TEST switch in AFC XTAL CUR position.

c. Connect an echo box (Echo Box TS-270A/U) to DIRECTIONAL COUPLER jack on indicator and test panel (figure 1-62).

d. Tune echo box for a maximum indication on its meter and note measured magnetron frequency.

e. Disconnect echo box from DIRECTIONAL COUPLER jack and place INTERLOCK SHORT switch on local control panel (figure 1-63 or 1-64) in ON position. Roll out AFC-LO drawer-mounted assembly (figure 1-66) to its fully extended position. Open left-hand compartment door of the r-f assembly.

f. Disconnect plug P21303 from jack J21303 of AFC-LO unit (figure 5-23). This jack is located near top rear of left side of drawer-mounted chassis assembly. Connect 10-db coaxial attenuator CN-42/UP to jack J21303. Connect echo box to output end of coaxial attenuator.

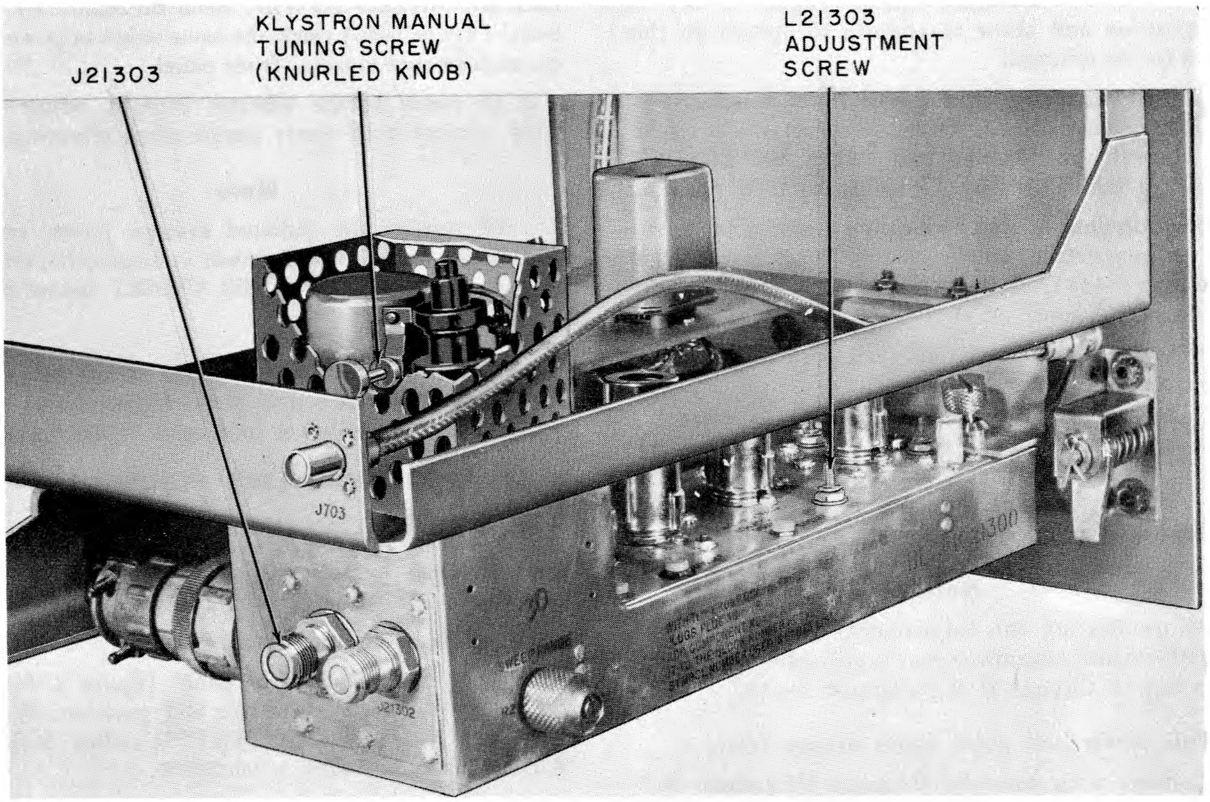


Figure 5–23. AFC-LO Panel, Interior View

g. Using klystron manual tuning screw adjustment knob and MANUAL TUNE control, adjust both simultaneously to tune klystron to a frequency 30 megacycles less than magnetron frequency measured in step d. Klystron manual tuning screw adjustment knob (figure 5–23) is on left side of AFC-LO assembly, at extreme rear of assembly near top of AFC-LO unit. Knob is spring-loaded and must be pushed and held in and rotated until it engages klystron tuning screw. MANUAL TUNE control is located on front panel of AFC-LO assembly (figure 1–66).

Note

Klystron tuning is extremely critical. Use echo box as a frequency indicating device to determine proper direction of rotation of tuning controls. Then, slowly tune controls to a frequency 30 megacycles less than the magnetron frequency, as measured by echo box in step d.

h. Disconnect echo box and remove 10-db coaxial attenuator. Reconnect plug P21303 to jack J21303. Return drawer-mounted AFC-LO assembly to its normal cabinet position.

i. Release knurled locking nut on AFC mixer probe screw (figure 5–24) and adjust screw for reading of 0.6 milliampere on meter M1002 located just above RECEIVER TEST switch on local control panel (figure 1–63 or 1–64). RECEIVER TEST switch should be in AFC XTAL CUR position. Probe screw can be reached by placing right hand into left-hand compartment of r-f assembly and reaching around neck of waveguide switch to grasp screw and locking nut. A second man should be stationed to observe meter as adjustment is made.

j. Throw MANUAL-AFC switch on local control panel to AFC position. Meter M1002, just above RECEIVER TEST switch, should show a sweep or two of

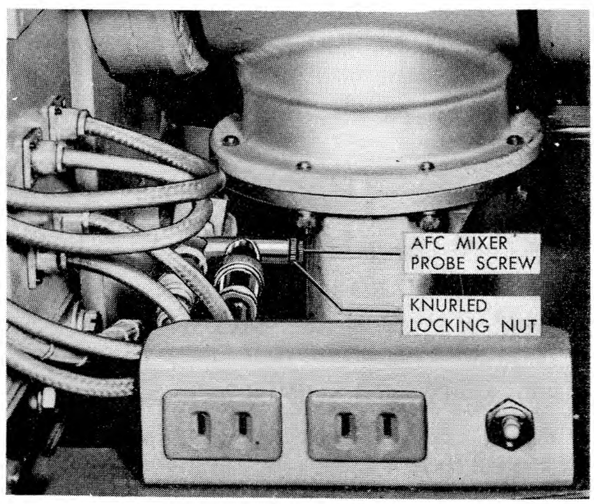


Figure 5–24. AFC Mixer Probe Screw

pointer and then become stable, indicating AFC lockon has been achieved.

k. Connect echo box to DIRECTIONAL COUPLER jack on indicator and test panel (figure 1-55) and tune echo box for maximum indication on its meter.

l. Using test synchroscope (Synchroscope AN/USM-24), connect synchroscope trigger input to TEST TRIGGER jack on indicator and test panel. Connect vertical input of synchroscope to TEST VIDEO jack on indicator and test panel.

m. Adjust RECEIVER GAIN control on local control panel (figure 1-63 or 1-64) for maximum length of echo box return signal, as seen on synchroscope.

n. Throw MANUAL-AFC switch on AFC-LO panel (figure 1-66) to MANUAL position and adjust MANUAL TUNE control on AFC-LO panel for maximum length of echo-box return signal, as seen on the synchoscope.

o. Compare results of steps m and n. Length of echo box return signal should be approximately the same for both steps.

p. If the comparison of echo box return signal lengths is not as outlined in step o, return MANUAL-AFC switch to AFC position. Pull out drawer-mounted AFC-LO assembly and adjust klystron manual tuning screw adjustment knob (figure 5-23) slightly to obtain maximum length of echo box return signal, as seen on the synchroscope.

Note

The 30 megacycle point of lockon may not be identical in frequency with the receiver intermediate frequency. If the procedure outlined in step p does not provide the maximum echo box signal return, tune AFC discriminator coil L21303 for maximum return signal. This requires a very slight screwdriver adjustment of coil tuning screw on left side of AFC-LO assembly and on tube-mounting side of AFC-LO unit (figure 5-23).

q. Leave MANUAL-AFC switch in AFC position after adjustments have been completed. Return AFC-LO assembly to its normal cabinet position.

CAUTION

Use extreme care when adjusting the C21543 mixer adjustment screw (figure 5-25). Excessive torque may break the polystyrene attenuator connecting rod.

r. Place RECEIVER TEST switch on local control panel (figure 1-63 or 1-64) in REC XTAL CUR 1 and REC XTAL CUR 2 positions. Adjust C21543 mixer adjustment screw (figure 5-25) for an average reading of 0.6 milliampere on meter for both switch positions. Throw RADIATE-STOP & RESET switch on modulator control panel (figure 1-69) to STOP & RESET position.

s. Close left-hand compartment door of r-f assembly. Place INTERLOCK SHORT switch on local control panel (figure 1-63 or 1-64) in OFF position.

5-67. I-F ALINEMENT.

5-68. The i-f channel of the preamplifier and normal receiver has been alined properly at the factory. Do not realine the i-f channel except where actual physical damage to the units occurs or upon replacement of an i-f tube or i-f circuit element. In addition, do not peak the receiver on video returns. Use the proper test equipment as outlined in Section VI of this technical manual.

5-69. RELATIVE TUNING INDICATOR ADJUSTMENTS FOR RADAR SET AN/FPS-6A.

5-70. To perform the relative tuning adjustment, proceed as follows:

a. Set INTERLOCK SHORT switch on local control panel (figure 1-64) to ON position.

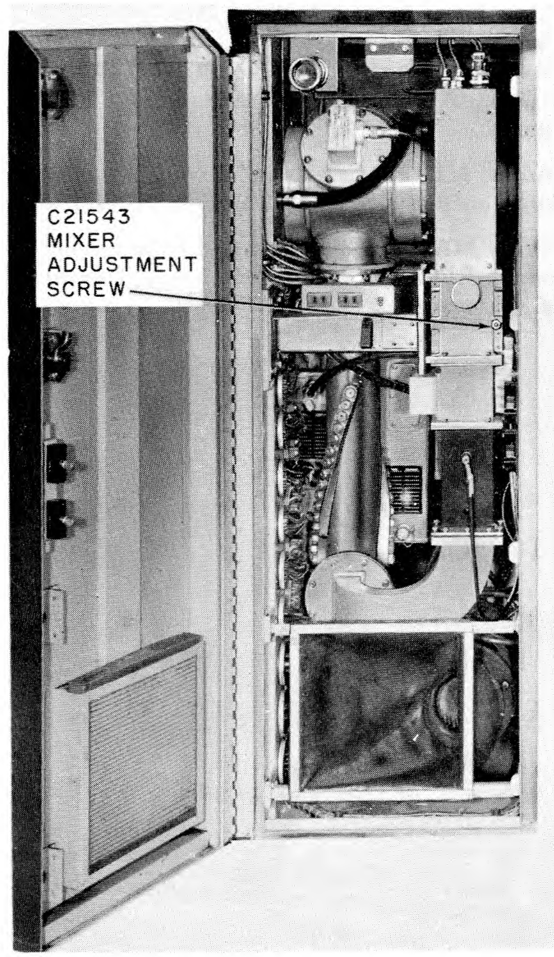


Figure 5-25. R-F Assembly, Left-Hand Compartment Mixer Adjustment Screw, for Radar Set AN/FPS-6 Only

b. Withdraw AFC-LO assembly drawer to permit access to relative tuning indicator chassis (figure 5–26).

c. Throw OPERATE-CALIBRATE switch on relative tuning indicator chassis to CALIBRATE position.

d. Adjust METER ZERO control for reading of 30 megacycles on RELATIVE TUNING meter on local control panel (figure 1–64).

e. Set relay contacts on RELATIVE TUNING meter to their extreme off-scale positions. (There are three adjustment screws on the front of the meter. The upper left screw adjusts the lower-limit contact; the upper right screw adjusts the upper-limit contact.)

f. Throw OPERATE-CALIBRATE switch to OPERATE position.

g. Place radar in radiation condition.

h. Place REMOTE-LOCAL CONTROL switch on local control panel in position which causes LOCAL indicator to light.

i. If RELATIVE TUNING meter does not indicate 30 megacycles, adjust discriminator L506 until proper indication is obtained.

j. At AFC-LO panel (figure 1–66), throw MANUAL-AFC switch to MANUAL position.

k. At AFC-LO panel, vary MANUAL TUNE control for a peak off-center indication on RELATIVE TUNING meter.

l. Adjust METER CALIBRATE control for full-scale deflection on that side of RELATIVE TUNING meter.

m. Vary MANUAL TUNE control for maximum deflection of RELATIVE TUNING meter toward other side of 30 megacycles.

n. If reading in step k is not full scale (± 0.1 megacycle), adjust inductors L505 and L506 to balance amount of deflection on each side of 30 megacycles.

o. Adjust METER CALIBRATE control so that larger of two readings obtained in step n is full scale.

p. Adjust MANUAL TUNE control so that RELATIVE TUNING meter reads 30 megacycles.

q. Position each relay contact of RELATIVE TUNING meter individually to desired limit.

r. Use MANUAL TUNE control to cause RELATIVE TUNING meter pointer to touch lower-limit relay contact. Pointer should lock on to contact and DETUNING INDICATOR should light.

s. Set MANUAL TUNE control toward position which causes meter pointer to move toward 30 megacycles and press ALARM RESET switch on local control panel. Pointer should then be released from relay contact and DETUNING INDICATOR should go out.

t. Repeat steps r and s for upper-limit relay contact.

u. Set MANUAL TUNE control so that RELATIVE TUNING indicator reads 30 megacycles.

v. Place MANUAL-AFC switch at AFC-LO panel (figure 1–66) in AFC position.

w. Return AFC-LO drawer assembly to its normal position in cabinet.

x. Return INTERLOCK SHORT switch on local control panel to OFF position.

y. Check that RELATIVE TUNING meter on local control panel reads within 50 kilocycles of RELATIVE TUNING meter on remote r-f control panel (figure 1–42). If two meters do not agree, one must be faulty. Replace defective meter.

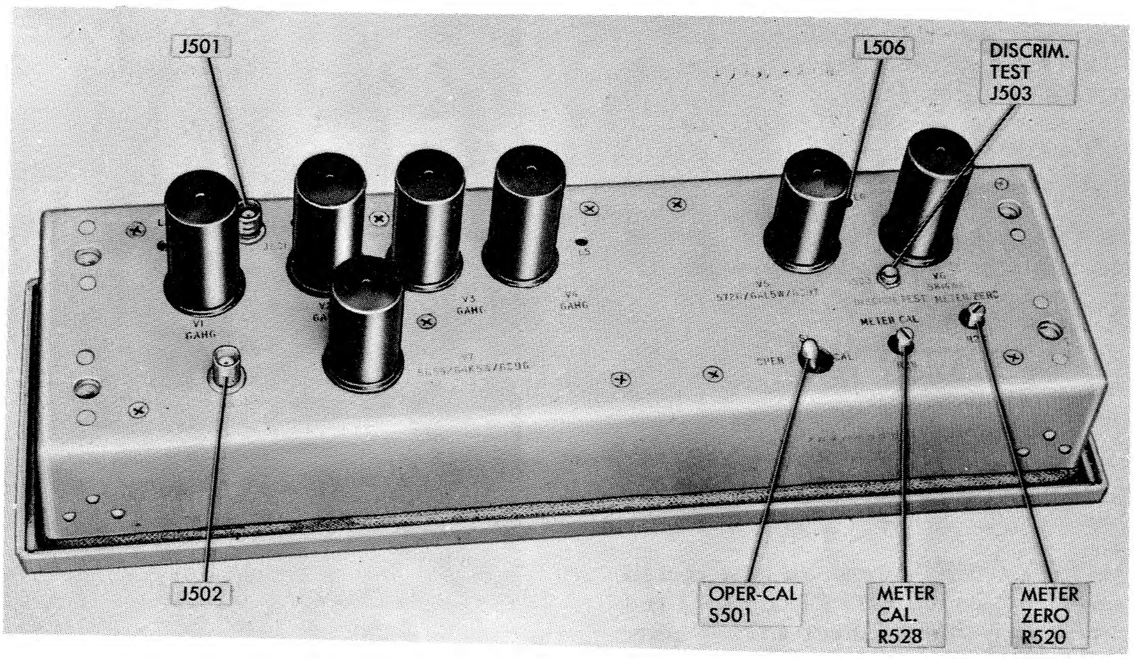


Figure 5–26. Relative Tuning Indicator Chassis

5–71. NOISE-FIGURE MONITOR ADJUSTMENTS FOR RADAR SET AN/FPS-6A.

5–72. To aline the noise-figure monitor, proceed as follows:

a. At AFC-LO panel (figure 1–66), place MANUAL-AFC switch in MANUAL position.

b. Follow procedure given in paragraph 5–118 to energize performance monitor power supply.

c. Withdraw power and noise figure assembly (figure 1–70) from cabinet.

d. Noise figure gate generator (figure 5–27) is mounted on right-hand side of power and noise figure assembly. Connect test synchroscope (Synchroscope AN/USM-24) to jack J8005 and measure width of gate. Adjust GATE WIDTH control until gate is 200 microseconds wide and remove test synchroscope.

e. At AFC-LO panel (figure 1–66), return MANUAL-AFC switch to AFC position.

f. Noise-figure i-f amplifier (figure 5–28) is mounted across top of power and noise figure assembly, directly behind power monitor. Set DETECTOR BIAS control to midposition.

g. Noise figure detector (figure 5–29) is mounted on left-hand side of power and noise figure assembly. Connect VTVM (TS-375A/U) between terminal board TB8201-6 and ground (jack J8206).

h. Adjust AGC LOCK-ON control to obtain −3 ±0.5 volt of AGC signal. Note tendency of AGC circuit to return AGC voltage to almost the same value after each variation of AGC LOCK-ON control. It may be necessary to adjust NOISE MONITOR GAIN control on AFC-LO assembly to obtain desired AGC level. Remove VTVM.

i. Place OPERATE-CAL switch in OPERATE position. Using VTVM, measure voltage at jack J8204.

Note

> With OPERATE-CAL switch in OPERATE position, jack J8204 is a high-impedance point. The reading should be obtained by momentarily connecting the meter to jack J8204.

j. Place OPERATE-CAL switch in CAL position.

k. Connect VTVM to NOISE OFF jack J8204, and adjust NOISE-OFF REFERENCE control until meter reads the same as in step i.

l. Open door leading to left-hand compartment of r-f assembly and locate noise figure directional coupler (Coupler, Directional CU-556/FPS-6) at bottom of compartment, just above blower inlet. (A chart of magnetron frequency versus coupler attenuation is stenciled on coupler.) Using magnetron frequency obtained in paragraph 5–124, determine coupler attenuation from this chart. Close left-hand compartment door.

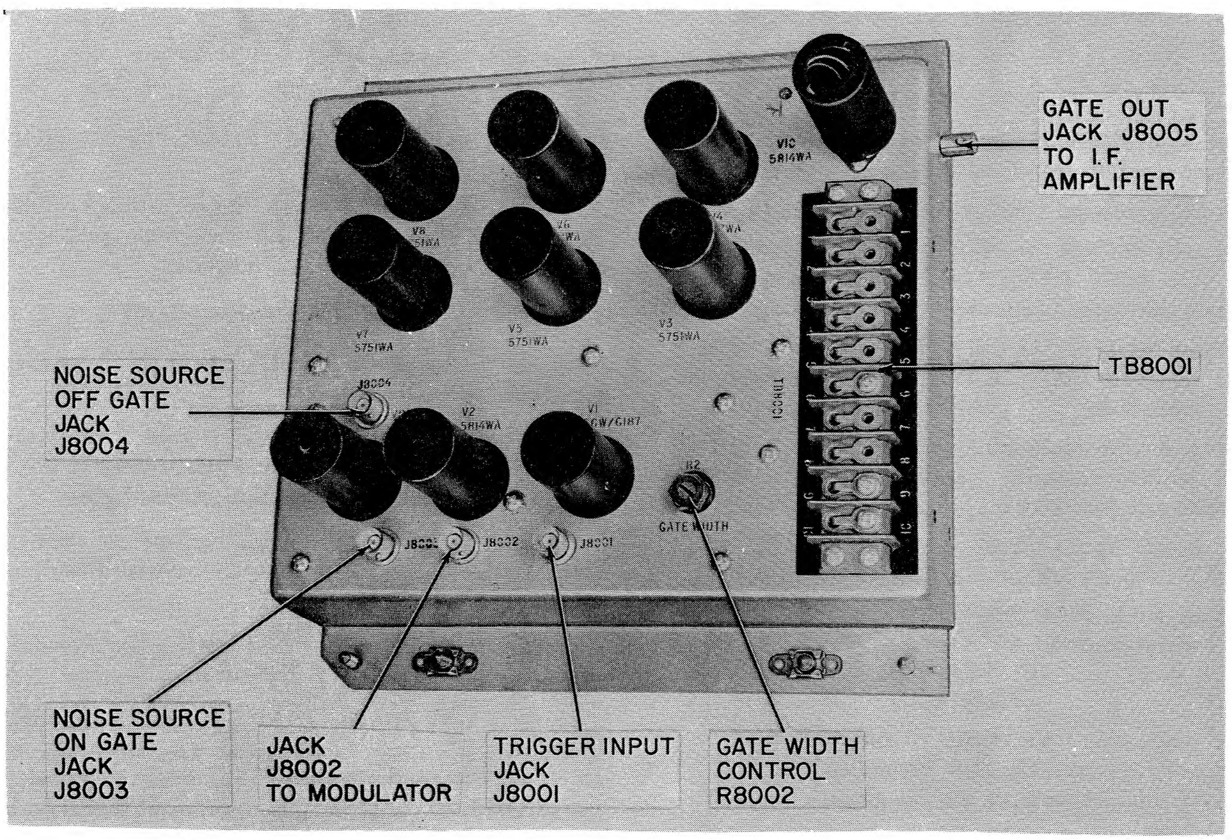


Figure 5–27. Noise Figure Gate Generator, Top View

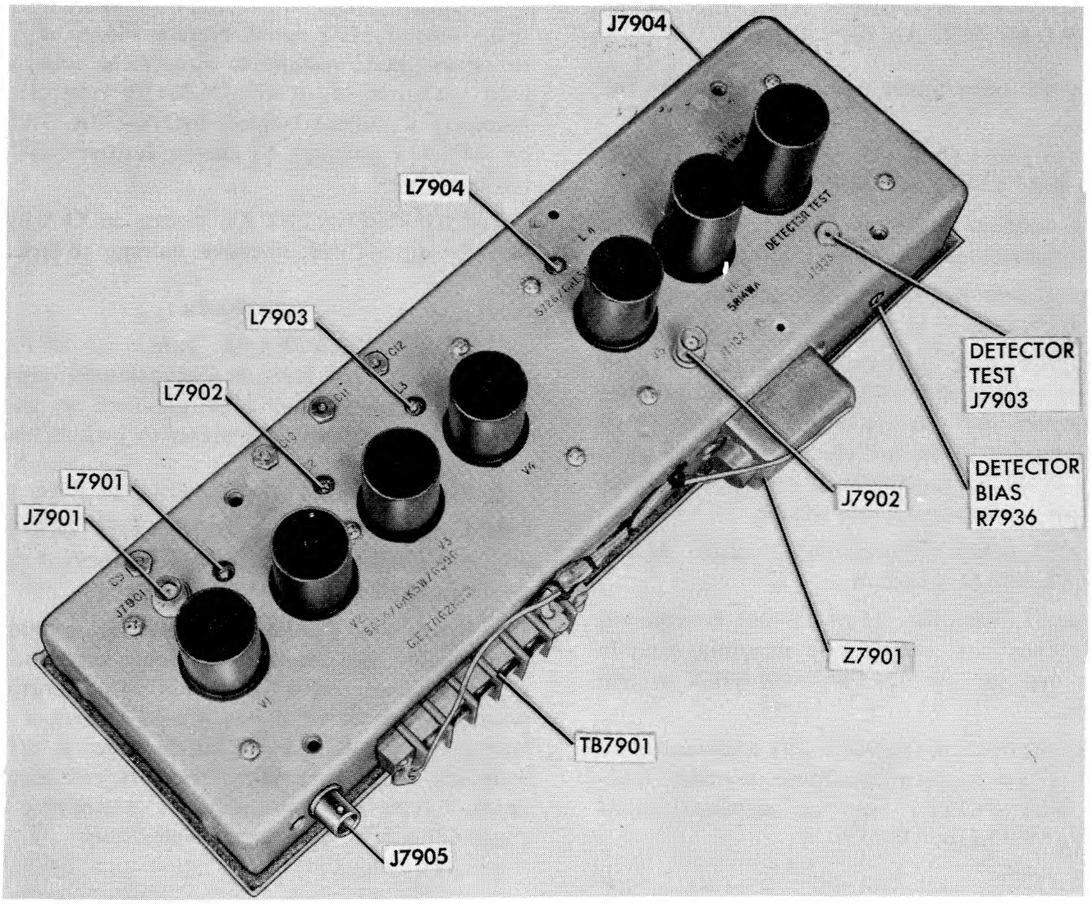


Figure 5–28. Noise Figure I-f Amplifier, Top View

m. See figure 5–30. Using value of coupler attenuation determined in step l, determine voltage ratio S.

n. Multiply voltage ratio by value measured in step i.

o. Connect VTVM to NOISE-ON jack J8205 and adjust NOISE-ON REFERENCE control until meter reads value calculated in step n.

p. Adjust METER CALIBRATE control until NOISE FIGURE meter on front panel of power and noise figure assembly reads 8 db.

q. Noise source modulator (figure 5–31) is located in local control assembly (figure 1–64). Disconnect pulse cable from jack J8103.

r. At noise figure detector (figure 5–29), place OPERATE-CAL switch in OPERATE position.

s. Adjust BALANCE ADJUST control until NOISE FIGURE meter reads ∞.

Note

The response of the meter circuit to this adjustment is extremely slow because of the 40-second time constant of the integrator circuits.

t. Reconnect pulse cable to jack J8103 of noise source modulator (figure 5–31).

u. Read noise figure directly on NOISE FIGURE meter.

v. Close power and noise figure assembly drawer. Return INTERLOCK SHORT switch on performance monitor power supply to OFF position.

5–73. RECEIVER TEST METER ADJUSTMENT.

5–74. To perform the RECEIVER TEST meter adjustment, proceed as follows:

a. At remote r-f control panel (figure 1–42 or 1–43), throw REMOTE-LOCAL CONTROL switch to position which causes green REMOTE indicator to light.

b. Rotate RECEIVER GAIN control on remote r-f control panel to extreme counterclockwise position for minimum receiver gain.

c. Rotate RECEIVER TEST switch on remote r-f control panel to DET VOLT position.

d. Place INTERLOCK SHORT switch on control group power supply No. 1 panel (figure 1–40) in on (up) position. Roll out drawer-mounted remote r-f control assembly to expose normal receiver of this assembly.

e. Adjust METER ZERO ADJUST control of normal receiver to obtain a zero reading on meter located

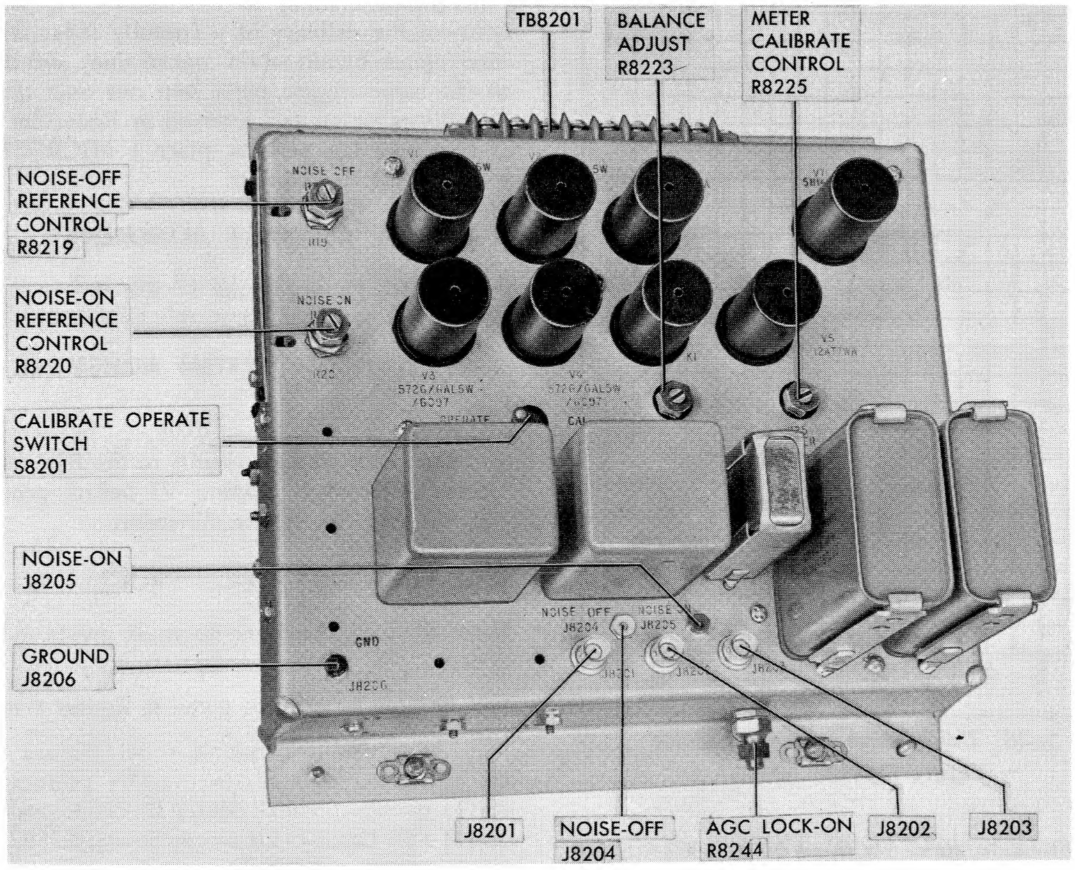


Figure 5–29. Noise Figure Detector, Top View

just above RECEIVER TEST switch on remote r-f control panel.

f. Return remote r-f control assembly to its normal cabinet position and place INTERLOCK SHORT switch on control group power supply No. 1 panel in off (down) position.

5–75. NOISE KLYSTRON CALIBRATION (RADAR SET AN/FPS-6 ONLY).

5–76. Upon completion of system installation and testing, a spare noise klystron must be calibrated in accordance with the following procedure:

a. Measure noise figure of receiver, using procedure outlined in paragraph 5–127.

b. Remove these crystals and set them aside together with a record of the noise figure and the position of the crystals in the mixers.

c. Repeat noise figure measuring procedure several times, each time using a new set of crystals, until a pair of crystals which give a high noise figure (on the order of 11 or 12 db) is obtained.

d. Remove this pair of crystals and set them aside together with a record of the noise figure and the position of the crystals in the mixer.

Note

When the crystals are removed from the mixer, they must be immediately placed in their metal containers to prevent damage from stray radio frequency in the area.

e. Remove klystron noise source and replace klystron with new one to be calibrated (paragraph 5–65).

f. Return klystron noise source to cabinet.

g. Install pair of crystals used in step a.

h. Measure noise figure of receiver as in step a. Using a spare chart, plot this point from the db measured in step a and the current measured in this step.

i. Remove this pair of crystals and install the pair obtained in step c.

j. Measure noise figure and plot this point as in step h.

k. Connect these two points by a straight line, similar to the original chart.

l. Remove original chart from its frame and replace with new chart obtained in step k.

m. Pack original klystron with its calibration chart and hold as a calibrated spare.

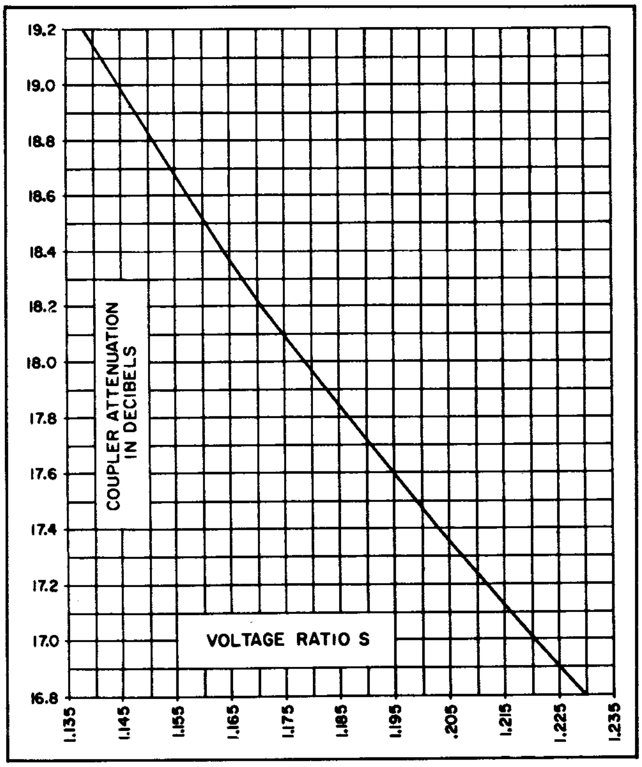


Figure 5–30. Calibration Curve for Noise Figure Monitor

n. Plot calibration curve obtained in step k on chart of remote control panel.

5–77. INTERFERENCE BLANKER ADJUSTMENT.

5–78. If interference from friendly radar sets is not expected, place the BLANKER BYPASS switch (figures 1–46 and 1–47) in the BYPASS position. If interference from friendly radar sets is expected, proceed as follows:

a. Place TERM NO. 1, TERM NO. 2, and TERM NO. 3 switches in ON position. These switches are normally kept in the ON position unless the corresponding trigger pulse is too weak to activate the gating network. When this condition arises, place appropriate switch in OFF position.

b. Adjust TRIGGER GAIN NO. 1, TRIGGER GAIN NO. 2, and TRIGGER GAIN NO. 3 controls to provide a clearly defined rectangular gate, as seen with test synchroscope (Synchroscope AN/USM-24) connected to BLANKING GATE jack.

c. Adjust GATE WIDTH control to blank out all interference from friendly radar sets, as seen with synchroscope connected to VIDEO OUT jack.

d. Adjust RESIDUAL GATE control for a zero residual gate, as seen with synchroscope connected to VIDEO OUT jack.

e. Adjust VIDEO GAIN control for same signal level seen with synchroscope connected to VIDEO IN and VIDEO OUT jacks.

f. A 1-microsecond delay line is incorporated in the interference blanker to compensate for any time lag between the delivery of a friendly radar trigger to the interference blanker (via coaxial line) and the reception of the same trigger pulse sent out over the air by the friendly radar set and received by Radar Set AN/FPS-6. If this time lag persists, place 1 MICROSEC DELAY switch in the IN position.

5–79. RHI ASSEMBLY ALINEMENT.

5–80. Refer to Section VI of this technical manual for the procedure for RHI assembly alinement.

5–81. ANTENNA SYSTEM ALINEMENT.

Note

Complete all adjustments to the RHI assembly as outlined in Section VI before proceeding with antenna system alinement.

5–82. POWER TURN-ON PROCEDURE.

5–83. Proceed as follows to apply power to the antenna system:

a. Follow procedures given in figures 5–8 and 5–9.

b. At power distribution panel (figure 1–44), turn the following switches to the ON position: HV IND REG switch S6403, MODULATOR switch S6404, XMITTER RECEIVER switch S6405, JUNCTION BOX switch S6408, and R.H.I. switch S6411.

c. At modulator control unit (figure 1–69), place RADIATE STOP & RESET switch S2101 in RADIATE position. RADIATE lamp I2105 should light.

d. In Radar Set AN/FPS-6 only, turn the following switches at the RHI power supply (figure 1–50) to the ON position: FILAMENTS switch S4101, BIAS switch S4103, PLATE switch S4104, and H. VOLT switch S4105.

5–84. SERVO AMPLIFIER ADJUSTMENT.

5–85. To perform servo amplifier adjustment, apply power in accordance with paragraph 5–82 and, after a 15-minute warmup, proceed as follows:

a. Place PPI No. 1 in control of azimuth positioning of antenna.

b. Pull out antenna control panel and connect a clip lead from test point TP6003 on servo amplifier chassis to ground.

c. Set a multimeter to its d-c range and connect between terminals 5 and 6 of terminal board TB6002.

d. Press START button on antenna control panel.

e. Adjust INVERTER GAIN control R6024 until meter reads 0 volt.

f. Move clip lead from test point TP6003 to test point TP6002.

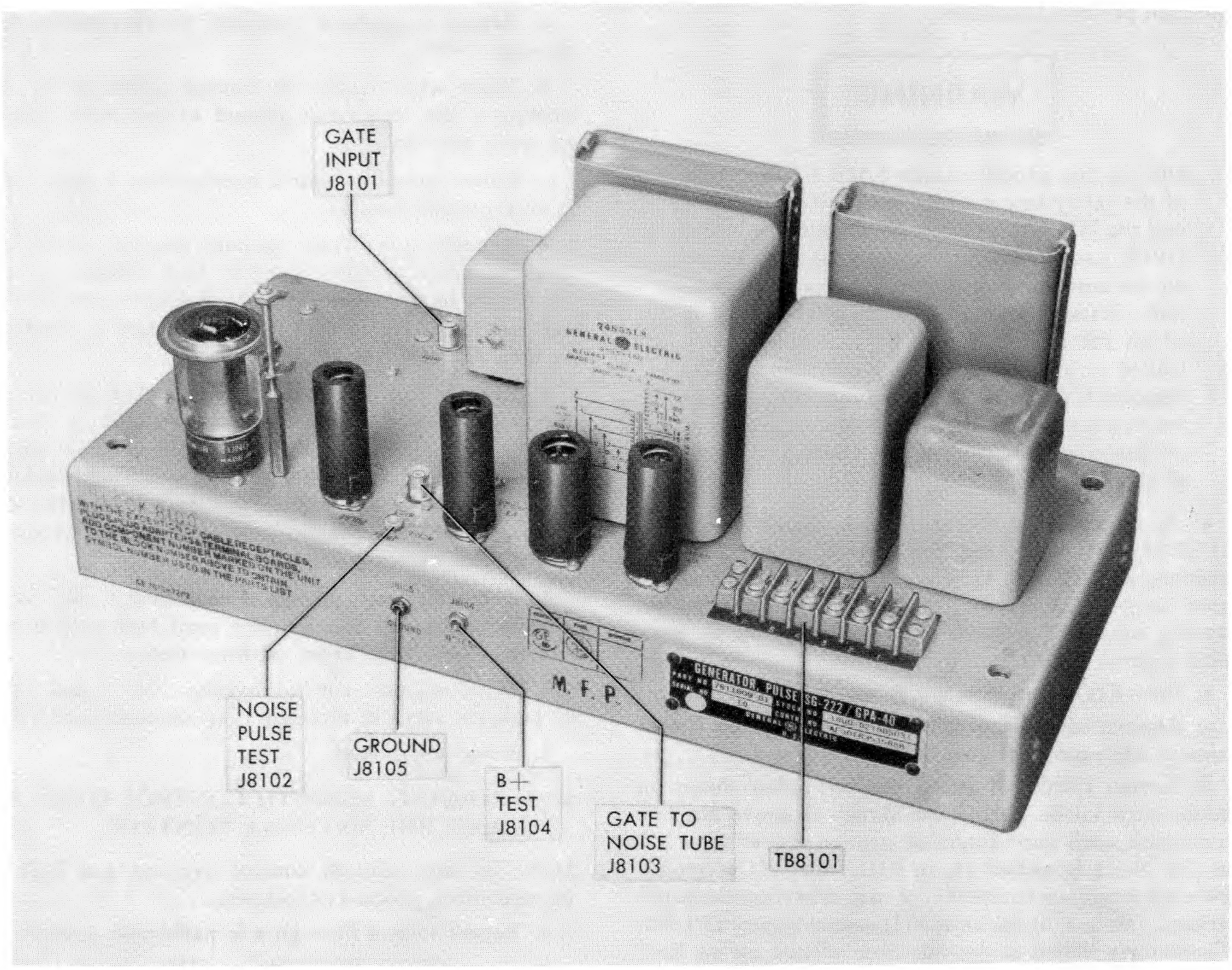


Figure 5–31. Noise Source Modulator, Top View

g. Remove multimeter from terminal board TB6002.

h. Set multimeter to its a-c range and connect between test point TP6001 and ground.

i. Adjust BALANCE control R6050 for a minimum reading on multimeter.

j. Rotate azimuth overlay handcrank 3 or 4 degrees clockwise.

k. Meter reading should be the same as in step i. If not, adjust BALANCE control R6050 until two readings correspond.

l. Disconnect multimeter and remove clip lead.

m. Set the following controls at the time-sharing master control:

(1) SEQUENCE 1 switch to PPI 1

(2) SEQUENCE 2 switch to PPI 2

(3) SEQUENCE 3 and 4 switches to PASS

(4) INTERVAL SECS control to minimum

n. Rotate azimuth control overlay at PPI 2 until it is 150 degrees away from setting of PPI 1 overlay.

o. At time-sharing master control, set AUTOMATIC-MANUAL SELECTOR switch to AUTO.

p. At antenna control panel, press START button.

q. Station a man at antenna to observe antenna as it locks on at both azimuths. If lockon occurs smoothly, system is operating correctly. If not, adjust ANTICIPATION CONTROL R6010 in small increments until smooth operation is obtained.

r. After half an hour of servo operation, recheck step e.

5–86. ZEROING ANTENNA WITH ASSOCIATED SEARCH RADAR.

5–87. To zero the height finding antenna with the antenna of the associated search radar, read paragraph 5–11 and then proceed as follows:

WARNING

During this procedure, the SAFE-RUN switch of the safety box must be in the RUN position and the HV SAFE-OPER switch must be in the OPER position. Assure that no loose tools are on the antenna or in the path of antenna rotation. Station personnel at all stations from which the motion of the antenna can be controlled to prevent manipulation of controls by personnel unaware that antenna adjustments are in progress. Since the antenna is radiating r-f power at this time, avoid standing in front of the reflector.

a. At time-sharing master control (figure 1–56), set AUTOMATIC-MANUAL SELECTOR switch to PPI 1 position. At PPI No. 1, select a strong, fixed, and isolated target (for example, a ground return) and set bearing cursor of azimuth control overlay on it. Wait until antenna stops rotating.

b. Press STOP button at safety box.

c. Remove cover from azimuth selsyn unit on top of azimuth drive motor (figure 6–55).

d. Loosen clutch adjusting nut and press down on hand clutch knob. Turn knob slowly to move antenna in azimuth until same target or ground clutter observed on PPI No. 1 is picked up on RHI screen. (Use sound-powered telephone equipment to maintain communcation between antenna, operator at RHI assembly, and PPI No. 1 operator.) When target has been picked up on RHI screen, release hand clutch knob and tighten clutch adjusting nut.

e. Replace cover on azimuth selsyn unit.

5–88. AZIMUTH SCALE DIAL ADJUSTMENT.

5–89. After completing procedure outlined in paragraph 5–87, adjust azimuth dial scale as follows:

a. Position cursor of azimuth control overlay (figure 1–59) against 0-degree mark. Allow antenna to synchronize to overlay.

b. Place SAFE-RUN and HV SAFE-OPER switches of safety box in SAFE position.

c. Referring to figure 6–55, note that azimuth dial scale is located at the top of the cone assembly. Loosen cap screws (under yoke hub of main girder) that clamp dial ring of azimuth scale dial in position. Rotate scale dial so that 0-degree mark on dial is opposite pointer of azimuth dial scale. Tighten cap screws.

d. Return SAFE-RUN switch to RUN position and HV SAFE-OPER switch to OPER position.

5–90. ZEROING AZIMUTH CONTROL OVERLAYS AND AZIMUTH SWITCH BOX.

5–91. To zero azimuth control overlays and azimuth switch box, proceed as follows:

a. Repeat procedures outlined in paragraphs 5–86 through 5–89.

b. Place servo system in 1-speed operation by connecting a clip lead from ground to test point TP6002 of servo amplifier.

c. Rotate azimuth control overlay No. 1 until cursor is exactly under 0 mark.

d. Remove cover from azimuth control overlay and measure stator voltages S1-S3 of both selsyns. A minimum voltage (less than 0.5 volt) should be read. If voltage reading is satisfactory, proceed to step e; if unsatisfactory, proceed to step f.

e. Remove tube V6002 and measure voltage between terminal board TB6001-1 and lower end of resistor R6099. If reading is less than 0.25 volt, no adjustment is needed. If more than 0.25 volt is read, rotate stator of 1-speed selsyn until a minimum voltage (less than 0.25 volt) is read. This should require only a small adjustment. Then, perform step g.

f. If measurement in step d exceeds 0.5 volt, loosen 1-speed selsyn and rotate stator until both selsyns read less than 0.25 volt. Then, perform step e.

g. With azimuth control overlay No. 1 still set at 0, perform steps d through f at azimuth switch box.

h. Remove clip lead.

5–92. ZEROING AZIMUTH CONTROL OVERLAYS AND RHI ANTENNA CONTROL.

5–93. To zero azimuth control overlays and RHI antenna control, proceed as follows:

a. Repeat steps a through e in paragraph 5–91.

b. Place MODE SWITCH on RHI antenna control in RHI CONT position.

c. Rotate handcrank on lower left of front panel until ANTENNA AZIMUTH INDICATOR dial reads 0 degree.

d. Perform steps d through f in paragraph 5–91 on selsyns B6501 and B6502 in RHI antenna control.

e. Remove clip lead.

5–94. AZIMUTH CONTROL SELSYNS ADJUSTMENT.

5–95. To perform azimuth control selsyns adjustment, proceed as follows:

WARNING

Be sure SAFE-RUN and HV SAFE-OPER switches on safety box are in SAFE position during this procedure.

a. Place ANTENNA POWER switch on power distribution panel (figure 1–44) in ON position. ANTENNA POWER indicator immediately above switch should light.

b. Operate AUTO-MANUAL handle on bevel gear housing on antenna pedestal to MANUAL position.

c. Open selsyn gear box, located on top of azimuth drive motor, by removing cover held down by thumbscrews.

d. Connect jumper between terminal boards TB3201-1 and TB3201-8 in selsyn gear box.

e. Measure voltage between terminal boards TB3201-7 and TB3201-2 with a voltmeter set to 100-volt range.

f. If voltage measured in step e does not measure approximately 37 volts, rotate antenna with handcrank on side of bevel gear housing until 37 volts is obtained.

g. Connect voltmeter between terminal boards TB3201-1 and TB3201-3 and measure voltage. Carefully adjust handcrank until voltage is minimum (usually less than 0.1 volt).

h. Move jumper from terminal board TB3201-1 to terminal board TB3201-6. Leave other end of jumper on terminal board TB3201-8.

i. Set voltmeter to 100-volt range. Connect voltmeter between terminal boards TB3201-5 and TB3201-7 and measure voltage.

j. If voltage reading obtained in step i is not approximately 37 volts, loosen three clamping bolts on B3203 and rotate selsyn case until 37-volt reading is obtained. Do not tighten bolts.

k. Connect voltmeter between terminal boards TB3201-4 and TB3201-6. Rotate selsyn case until a minimum voltage is obtained (usually less than 0.1 volt).

l. Tighten three clamping bolts, being careful not to rotate B3203 or antenna.

m. Remove voltmeter and jumper between terminal boards TB3201-6 and TB3201-8.

n. Recheck 1-speed selsyn. Both 1- and 36-speed selsyns should indicate a minimum reading at the same azimuth. If not, readjust 36-speed selsyn until this occurs.

o. Return AUTO-MANUAL handle on bevel gear housing of antenna pedestal to AUTO position.

p. Clear antenna platform for antenna rotation and check that all interlocks are closed.

q. Return SAFE-RUN switch on safety box to RUN position and HV SAFE-OPER switch to OPER position.

r. Remove jumper between terminal boards TB6203-5 and TB6204-1 on antenna control panel.

s. At antenna control panel (figure 1–44), press AZIMUTH DRIVE-START button. Amplidyne should start. Fifteen seconds later, +500V DC indicator should light at control group power supply No. 1 (figure 1–43).

5–96. ADJUSTMENT OF AZIMUTH DRIVE MOTOR BRUSH RIGGINGS.

5–97. Under most circumstances, no adjustment is required, since the brushes are set at electrical neutral at the factory. To determine whether an adjustment is necessary, the following steps should be taken after the procedures outlined in paragraphs 5–84 through 5–90 have been performed:

a. Place SAFE-RUN and HV SAFE-OPER switches at safety box in SAFE position and manually tilt antenna to maximum elevation. Lock antenna in place. Return SAFE-RUN switch to RUN position and HV SAFE-OPER switch to OPER position.

b. Have antenna scan 120-degree sector from 300 to 60 degrees and observe whether deceleration and switching from 1-speed to 36-speed is uniform in both directions. If in one direction the antenna stops suddenly and then drifts into correspondence while in the other direction it rushes towards correspondence and perhaps overshoots, then an adjustment is necessary.

c. Remove power. Make a chalk mark or scribe a line on azimuth drive motor to designate present position of brush rigging. Loosen brush rig locking nut and move brush rig one or two commutator segments.

d. Restore power and test azimuth motion again. Moving brush rigging one or two commutator segments one way or the other, as required should provide the desired uniformity of motion.

5–98. ADJUSTMENT OF ELEVATION DATA CIRCUITS.

5–99. Elevation data circuits consist of the elevation selsyn, the elevation data generator, and the RHI assemblies. When first installed, or after maintenance has been performed on the antenna, the elevation data circuits should be alined by following the procedures outlined in paragraphs 5–100 through 5–105.

5–100. Prepare to aline the elevation selsyn in the following manner:

a. Energize elevation data generator in control group assembly. Elevation selsyn is then excited by a 1500-cps signal.

b. Place SAFE-RUN and HV SAFE-OPER switches on safety box in SAFE position.

c. Manually rotate flywheel on elevation drive wheel until bubble in elevation level (located on side of reflector) is centered. Antenna reflector is now at zero elevation.

d. Using antenna safety pole, set elevation brake so that antenna reflector is locked in place.

e. Remove cover from cone junction box (figure 6–55) by loosening knurled thumbscrews. Use a screwdriver, if necessary.

f. Set VTVM to 200-volt range and connect between terminal 4 of terminal board TB3401 and terminal 4 of terminal board TB3403 in cone junction box. One man should remain at cone junction box while a second climbs up to elevation selsyn and angle work unit.

g. Elevation selsyn and angle mark unit is mounted at end of right-hand yoke arm on antenna pedestal. Remove cover plate of this unit by loosening knurled thumbscrews. Use a screwdriver, if necessary.

5–101. Aline the elevation selsyn in Radar Set AN/FPS-6A as directed in paragraph 5–102. Aline the elevation selsyn in Radar Set AN/FPS-6 in the following manner:

a. Loosen clamps on inner bolt circles and rotate elevation selsyn manually to obtain a minimum of less than 1.0 volt on VTVM at cone junction box. Tighten clamps on inner bolt circle.

b. Loosen clamps on outer bolt circle. Make a fine adjustment for minimum voltage by using horizontal positioning screws to position selsyn mounting ring. Clamp outer bolt circle and lock positioning screws.

c. Replace covers of elevation selsyn and angle mark unit and of cone junction box. Tighten knurled thumbscrews fingertight.

d. Using antenna safety pole, release elevation brake.

e. Place SAFE-RUN switch at safety box in RUN position and HV SAFE-OPER switch in OPER position.

f. With antenna nodding, observe RHI display. If sweep swings down off bottom of screen as antenna scans upward, elevation selsyn must be rotated 180 degrees and rezeroed.

g. Adjust elevation data generator (Control, Indicator C-993/FPS-6) and RHI assembly (Radar Set Group OA-270/FPS-6) as described in Section VI.

5–102. Aline the elevation selsyn in Radar Set AN/FPS-6A in the following manner:

a. With the SAFE-RUN and HV SAFE-OPER switches at the safety box in the SAFE position, loosen three locking bolts that hold adjusting ring around elevation selsyn. These locking bolts are located on outer bolt circle.

b. Locate two horizontal adjusting bolts that push against a small arm which is part of adjusting ring around elevation selsyn. Move adjusting bolts until meter reads less than 1.5 volts.

c. At elevation data generator in the control group assembly, set OPER-CAL switch S5701 at CAL and 0°-30° switch S5702 at 0 position.

d. Connect VTVM between test jacks J5706 and J5708.

e. Adjust ZERO SET potentiometer R5733 until VTVM reads 0 volt.

f. Set OPER-CAL switch to OPER position.

g. Slightly readjust elevation selsyn until VTVM reads 0 volt.

h. Tighten three bolts on outer circle until adjusting ring is locked in place. Check VTVM reading to be sure zero did not shift as selsyn was tightened. Remove voltmeter.

i. Replace covers of elevation selsyn and angle mark unit and cone junction box. Tighten knurled thumbscrews fingertight.

j. Using antenna safety pole, release elevation brake.

k. Place SAFE-RUN switch at safety box in RUN position and HV SAFE-OPER switch in OPER position.

l. With antenna nodding, observe RHI display. If elevation sweep folds over at bottom of display, elevation selsyn will have to be rotated 180 degrees and rezeroed.

5–103. Adjust Indicator Group OA-929/FPS-6A (RHI assembly for Radar Set AN/FPS-6A) to elevation data generator as follows:

Note

Where Elevation Calibrator TD-170/FPS-6A is used with one Indicator Group OA-929/FPS-6A and one Radar Set Group OA-270/FPS-6 (RHI assembly for Radar Set AN/FPS-6), follow instructions in paragraph 5–103. Where Elevation Calibrator TD-170/FPS-6A is used with two OA-270's, follow instructions in paragraph 5–104.

a. Calibrate both RHI assemblies following instructions in Section VI.

b. Turn HEIGHT CURSOR CURVATURE switch S22104 and EARTH CURVATURE switch S22103 on calibration panel to OFF position.

c. Position cursor of one RHI to intersect 100-mile range mark.

d. Set height counter to 53,000 feet.

e. With antenna nodding, adjust potentiometer R5747 until 5-degree angle mark intersects cursor at 100 miles.

f. Check that same calibration holds on other RHI.

Note

In all cases, elevation data voltage adjustments should be made prior to setting the site elevation in the RHI.

5–104. Perform the following steps when Elevation Data Generator TD-170/FPS-6A is used with one OA-929/FPS-6A and one OA-270/FPS-6 range height indicator:

a. Calibrate Indicator Group OA-929/FPS-6A as outlined in Section VI.

b. Calibrate Radar Set Group OA-270/FPS-6, using output now available from elevation data generator.

5–105. Perform the following steps when Elevation Data Generator TD-170/FPS-6A is used with two OA-270/FPS-6 range height indicators:

a. Remove cover from elevation selsyn and angle mark unit and zero 5SCT synchro as outlined in steps a through h of paragraph 5–102.

b. Position antenna reflector to 30 degrees by positioning angle mark brush on commutator at top of reflector swing.

c. With OPER-CAL switch S5701 in OPER position, adjust R5747 to obtain same voltage at jack J5706 as measured at jack J5707.

d. Place switch S5701 in CAL position and switch S5702 in 30° position. Adjust potentiometer R5733 to obtain same voltage at jack J5706 as measured at jack J5707.

e. Set switch S5701 to OPER position.

f. Calibrate OA-270/FPS-6 range height indicator, using output available from elevation data generator.

g. With switch S5701 in CAL position and switch S5702 in 0° position, adjust potentiometer R5733 for 0 ouput at jack J5706.

h. Set switch S5702 to 30° position. Adjust potentiometer R5747 for same output at jack J5706 as measured at jack J5707.

5–106. MODULATING SYSTEM TESTING.

Note

Refer to paragraph 5–43 for power turn-on procedure.

5–107. HIGH-VOLTAGE INTERLOCK TEST.

5–108. At the indicator and test panel of the r-f assembly proceed as follows to check the high-voltage interlocks:

Note

Check that READY and REV CURRENT indicators on modulator control panel (figure 1–69) are lit. These indicators light 15 minutes after modulator assembly is energized.

a. Place PANEL LIGHTS switch in ON position.

b. Rotate INTERLOCK TEST switch to all of its indicated positions. INTERLOCK TEST indicator should light at each position, indicating that particular interlock is closed.

c. Turn INTERLOCK TEST switch to OFF position.

5–109. SYSTEM TRIGGER INPUT TEST.

5–110. To test the system trigger input, proceed as follows:

a. Connect test synchroscope (Synchroscope AN/USM-24) to SYSTEM TRIG jack J2205 on modulator assembly power panel (figure 1–67 or 1–68).

b. Compare observed waveform with system trigger waveform.

5–111. MODULATOR PULSE OUTPUT TEST.

5–112. To test the modulator pulse output, proceed as follows:

a. Using 21 inches of RG-59A/U cable, connect test synchroscope (Synchroscope AN/USM-24) to MOD OUTPUT jack J2202 on modulator assembly power panel (figure 1–67 or 1–68).

b. Compare observed waveform with modulator output waveform shown in Section VI (symbol block 2100).

5–113. REVERSE-CURRENT CIRCUIT TESTS.

5–114. This test should be performed only if a malfunction is suspected in the reverse-current circuit. It is not a routine check. Proceed as follows:

a. Throw INTERLOCK SHORT switch (figure 1–68) or BATTLE SHORT switch (figure 1–67) on modulator assembly power panel to ON position.

b. Pull out modulator control unit and check that modulator control unit subchassis is secured in place with two thumbscrews.

WARNING

Exercise extreme caution while performing this procedure since exceedingly high voltages are involved. Become familiar with the procedure outlined in steps c through e before performing the procedure specified in these instructions.

c. Using a grounding rod with a well-insulated handle (figure 5–21), ground modulator output pulse on bus connecting E2202, pulse output cable, and pulse network in modulator assembly.

d. Check time from application of short circuit to start of sounding of reverse-current buzzer. It should be 1 $\pm$0.2 second.

e. If time in step d is not within limits, adjust ARC BURST LENGTH control on modulator control unit subchassis (figure 5–18).

Note

Return magnetron anode current to normal operating level each time a rundown occurs. Use HV RAISE-HV LOWER switch on front panel of modulator control panel.

f. With radar in radiation condition, set magnetron anode current at normal operating level.

g. Ground modulator output pulse and check time from start of reverse-current buzzer until REV CURRENT indicator lights on modulator control panel (figure 1–69). This time should be from 7 to 8 seconds.

h. If time in step g is not within limits, adjust RUN-BACK TIME control on modulator control unit subchassis (figure 5–18) accordingly.

i. Throw AGE-NORMAL switch on modulator control subchassis to AGE position.

j. Adjust magnetron anode current to normal operating level with radar in radiation condition.

k. Ground modulator output pulse and check time from application of ground to start of sounding of reverse-current buzzer.

l. This time should be 4-1/2 ±1-1/2 seconds.

m. Return AGE-NORMAL switch to NORMAL position.

5–115. TRANSMITTING SYSTEM TESTING.

Note

Refer to paragraph 5–54 for power turn-on procedure.

5–116. R-F POWER OUTPUT TEST FOR RADAR SET AN/FPS-6 ONLY.

5–117. To test the r-f power output, proceed as follows:

a. Connect bolometer mount (supplied with Summation Bridge AN/URM-23) to UG-88/U plug at end of summation bridge input cable.

b. Connect summation bridge power cord to a 115-volt a-c power source, and turn power ON-OFF switch to ON position. Turn selector switch to SET ZERO.

c. Allow 20 minute warm-up period.

d. Set COMPENSATE ATTENUATOR dial to zero.

e. Using SET ZERO control, adjust galvanometer pointer to balance at zero.

f. Rotate selector switch to CALIBRATION LEVEL position. Note reading on nonlinear red scale of power meter M101.

g. Rotate selector switch to ADJUST CALIBRATION position. Vary ADJUST CALIBRATION knob until same value indicated in step f appears on black scale of power meter. Summation bridge is now calibrated for use.

h. Using Adapter UG-57 B/U, connect bolometer mount to POWER MEASURE jack on r-f assembly indicator and test panel.

i. Check that coaxial switch on indicator and test panel is in POWER RADIATED position.

j. Rotate summation bridge selector switch to ADJUST BALANCE position, and vary ADJUST BALANCE knob until galvanometer pointer is centered at zero after stabilization. (Do not readjust SET ZERO control.)

Note

If the selector switch is left in CALIBRATION LEVEL or ADJUST CALIBRATION position for more than a few seconds, return selector switch to SET ZERO position and repeat steps e through i.

k. Read r-f power on black scale of power meter and record this value.

l. Convert power reading obtained in step k to dbm, using power to dbm conversion chart (figure 5–32).

m. Note attenuation stamped on coaxial switch panel.

n. To determine average power in dbm, add the following values:

Power meter reading in dbm (step l)

Attenuation from coaxial switch panel (step m)

o. Using power to dbm conversion chart (figure 5–32), determine average power radiated. Record this value and label it Po.

p. From average to peak power conversion chart (figure 5–33), determine duty cycle in db.

q. Add the following values to determine peak power:

Average power (step n)

Duty cycle (step p)

r. Using power to dbm conversion chart (figure 5–32), determine peak power. Peak power should be at least 4.3 megawatts.

s. Proceed to measure VSWR as described in paragraph 5–120.

5–118. R-F POWER OUTPUT TESTS FOR RADAR SET AN/FPS-6A.

5–119. The performance monitor power supply is normally energized (FIL, BIAS, and PLATE indicators lit). If not, perform steps a through d before attempting to measure r-f power output.

a. Throw FIL switch to ON (up) position. FIL indicator should light.

b. Throw BIAS switch to ON position. BIAS indicator should light.

c. Throw PLATE switch to ON position. PLATE indicator should light.

d. Rotate METER SWITCH to its indicated positions. Check voltage readings on voltmeter above switch. If readings differ from indicated values, rotate −150V ADJUST, +250V ADJUST, and +140V ADJUST controls, as required, to bring meter readings into agreement with indicated values.

e. If FORWARD POWER indicator is lit, read power directly on performance monitor meter. If FORWARD POWER lamp is not lit, perform steps f through m.

f. Turn FORWARD POWER-VSWR switch to FORWARD POWER-ZERO SET position.

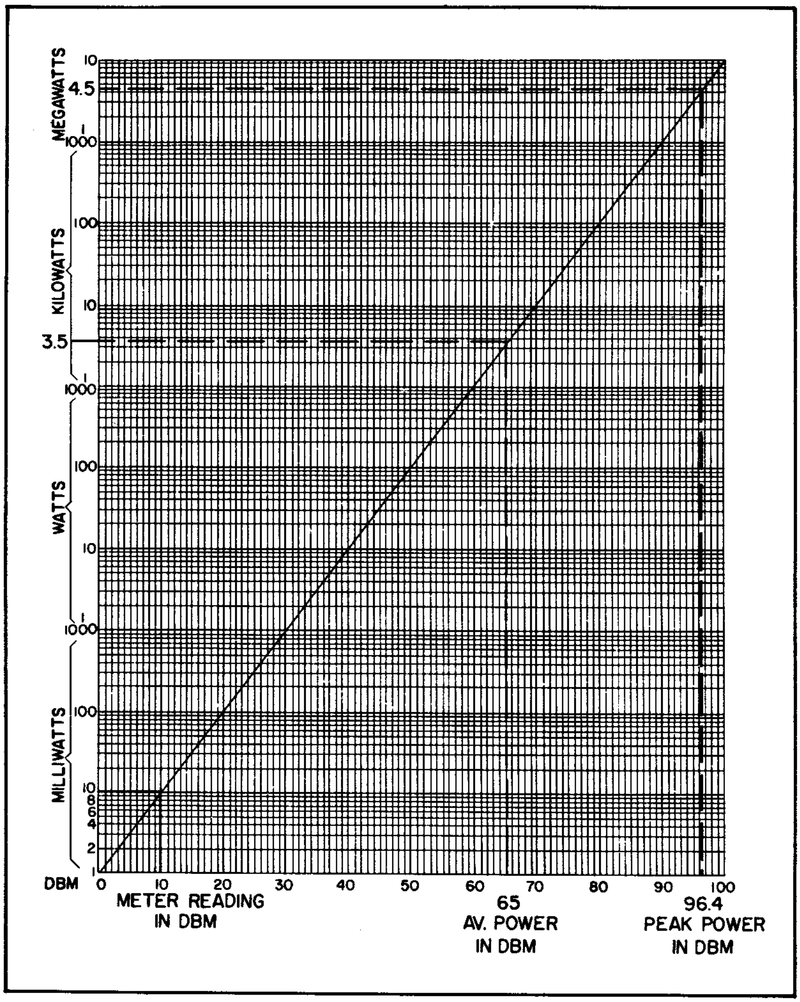


Figure 5–32. Dbm to Power Conversion Chart

g. Adjust VTVM CALIBRATE control until power meter reads zero.

h. Turn FORWARD POWER-VSWR switch to FORWARD POWER-READ position.

i. Turn NORMALIZING ATTENUATING control until FORWARD POWER indicator lights.

j. Place RADIATE-STOP & RESET switch on modulator control panel (figure 1–69) in RADIATE position. Wait until RADIATE indicator lights.

k. Read radiated average power from meter.

l. To convert to peak power in megawatts, refer to RADIATED POWER CHART below meter.

5–120. STANDING WAVE RATIO MEASUREMENT FOR RADAR SET AN/FPS-6 ONLY.

5–121. To measure the standing wave ratio, proceed as follows:

a. Determine Po from step o of paragraph 5–116.

b. Rotate coaxial switch on indicator and test panel to POWER REFLECTED position.

c. Read reflected power on summation bridge power meter as outlined previously and record this value.

d. Determine average power reflected, following the procedure described in paragraph 5–116, steps l through o. Label average reflected power Pr.

e. Determine the numerical value $a = \frac{Pr}{Po}$

f. From VSWR versus $a = \frac{Pr}{Po}$ chart (figure 5–34), determine VSWR, which shall not be greater than 1.3.

g. Return coaxial switch to POWER RADIATED position.

h. Disconnect summation bridge.

5–122. STANDING WAVE RATIO MEASUREMENT FOR RADAR SET AN/FPS-6A.

5–123. To measure the standing wave ratio, proceed as follows:

a. Repeat steps a through d in paragraph 5–118.

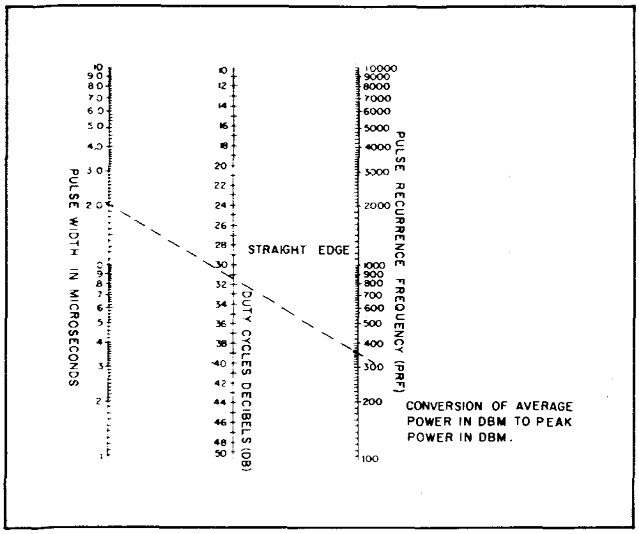


Figure 5–33. Average-to-Peak Power Chart

b. Turn FORWARD POWER-VSWR switch to FORWARD POWER-ZERO SET position.

c. Adjust ZERO SET-FINE control until meter reads zero.

d. Switch back to FORWARD POWER-READ position.

e. Turn NORMALIZING ATTENUATING control until meter reads on red line (full scale). FORWARD POWER indicator should go off and remote meter should be de-energized.

f. Turn meter to VSWR-ZERO SET position.

g. Adjust ZERO SET-FINE control until meter reads zero.

h. Turn FORWARD POWER-VSWR switch to VSWR-READ position and read VSWR directly on meter. This reading should not exceed 1.5.

i. Turn FORWARD POWER-VSWR switch to FORWARD POWER-ZERO SET position and again adjust ZERO SET-FINE control until meter reads zero.

j. Turn FORWARD POWER-VSWR switch to FORWARD POWER-READ position.

k. Turn NORMALIZING ATTENUATING control until FORWARD POWER indicator lights.

5–124. MAGNETRON SPECTRUM MEASUREMENT.

5–125. If it is available, use Spectrum Analyzer AN/UPM-84 to measure magnetron frequency and determine magnetron spectrum. If a spectrum analyzer is not available, use an echo box according to the following instructions:

a. Connect echo box (Echo Box TS-270A/U) to DIRECTIONAL COUPLER jack on indicator and test panel of r-f assembly (figures 1–61 and 1–62).

b. Tune echo box for maximum indication on its meter; this is the magnetron frequency.

c. Carefully rotate the echo box dial knob, first in the clockwise and then in the counterclockwise direction. Record the meter reading and frequency (i.e., dial reading) of each peak indication.

d. Repeat step c, but record all minimum indications.

e. Echo box meter readings obtained in steps c and d should not exceed one third the value of the reading obtained in step b. Readings should not be present beyond 200 mc from each side of magnetron frequency.

f. Disconnect echo box.

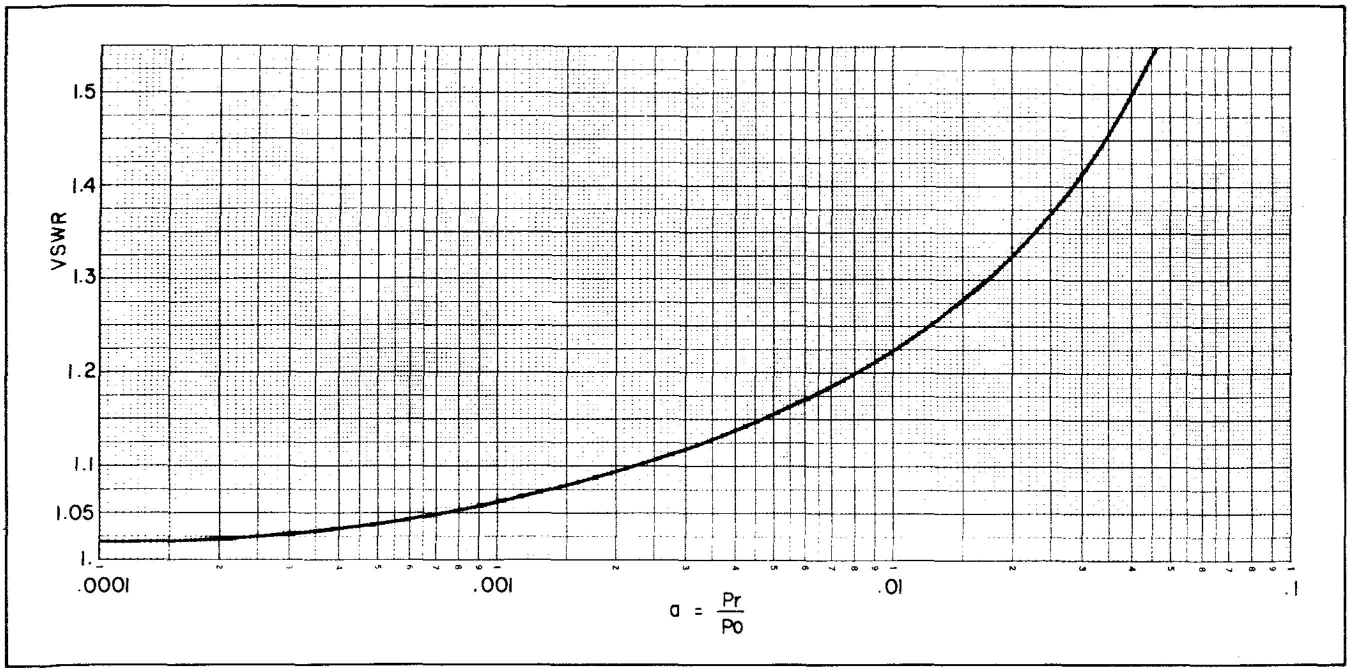


Figure 5–34. VSWR versus P_r/P_o Chart

5–126. RECEIVING SYSTEM TESTING.

Note

Refer to paragraph 5–64 for power turn-on procedure.

5–127. NOISE FIGURE MEASUREMENT FOR RADAR SET AN/FPS-6 ONLY.

5–128. To measure receiver noise figure, proceed as follows:

a. Check that green REMOTE indicator at remote r-f control panel of control group assembly (figure 1–42) is on. If necessary, throw REMOTE-LOCAL CONTROL switch to position which will cause this indicator to come on.

b. Place AFC-MANUAL switch in MANUAL position. Rotate RECEIVER TEST switch to AFC XTAL CUR position.

c. Adjust MANUAL TUNE control for a reading of 0.6 milliamperes on meter located just above RECEIVER TEST switch.

d. Throw NOISE SOURCE switch to ON position and allow noise source to warm up for at least 10 minutes.

e. Rotate RECEIVER TEST switch to DET VOLT position and NOISE AMPLITUDE control to extreme counterclockwise position.

f. Adjust RECEIVER GAIN control to obtain an approximate middle-of-scale reading on meter M1002 located just above RECEIVER TEST switch.

g. Push in ATTENUATOR 3 DB button. ATTENUATOR IN indicator should light.

h. Adjust NOISE AMPLITUDE control to give a middle-of-scale reading on NOISE AMPLITUDE meter with METER MULTIPLIER switch in X1 position.

i. Operate NOISE SOURCE FREQUENCY RAISE-LOWER switch to either RAISE or LOWER position until a maximum reading on meter located just above RECEIVER TEST switch is obtained.

Note

If meter reading goes off scale, adjust NOISE AMPLITUDE control in a counterclockwise direction to bring meter reading on scale. NOISE AMPLITUDE meter reading should be reduced simultaneously. This condition may occur as the adjustment of the noise source frequency approaches the correct value.

j. Adjust NOISE AMPLITUDE control to give same meter reading obtained in step f.

k. Note NOISE AMPLITUDE meter reading and use chart on front panel to determine noise figure. This figure should not exceed 9.3 db.

l. Push in ATENUATOR 3 DB button. ATTENUATOR IN indicator should go off. Return AFC MANUAL switch to AFC position. Place NOISE SOURCE switch in OFF position.

5–129. NOISE FIGURE MEASUREMENT FOR RADAR SET AN/FPS-6A.

5–130. If the noise-figure monitor is known to be accurately alined, the noise figure can be read immediately on the NOISE FIGURE meter atop the performance monitor cabinet. If alinement is necessary, refer to paragraph 5–71.

5–131. MINIMUM DISCERNIBLE SIGNAL MEASUREMENT.

5–132. To measure the minimum discernible signal, proceed as follows:

Note

The adjustments in steps a through q should be performed at the control group assembly, starting with the system in the standby condition.

a. Place a 68-ohm termination on jack J6934 located on left side of control group cabinet.

b. Connect vertical input of test synchroscope (Synchroscope AN/USM-24) to TEST VIDEO jack of remote r-f control panel (figure 1–42 or 1–43).

c. Connect trigger input of test synchroscope to TEST TRIGGER jack of range mark generator (figure 1–45 or 1–46).

d. Place RECEIVER TEST switch on remote r-f control panel in DET VOLT position.

e. Place system in radiate condition.

f. Adjust RECEIVER GAIN control on remote r-f panel for 0.4-volt reading on meter above RECEIVER TEST switch.

g. Place INTERLOCK SHORT switch on control group power supply No. 1 panel (figure 1–40) in ON position.

h. Pull remote r-f control assembly forward so that normal receiver, mounted behind remote r-f control panel, is accessible.

i. Rotate NORMAL LEVEL control on normal receiver to maximum clockwise position.

j. Adjust LIMIT LEVEL control to limit transmitter pulse (as seen on synchroscope) to 2 volts.

k. Adjust NORMAL LEVEL control to give 0.7-volt of noise, as seen on the synchroscope.

l. Recheck steps j and k, adjusting NORMAL LEVEL and LIMIT LEVEL controls until transmitter pulse is 2 volts and noise is 0.7 volt.

m. Use a VTVM to measure voltage at jack J21713 on normal receiver chassis. Disconnect VTVM.

n. Connect VTVM to jack J21714 and adjust AVNL LEVEL control until meter gives same reading as obtained in step m.

o. Check that peak noise measures 0.7 volt, as seen on the synchroscope. If not, readjust AVNL LEVEL control until a 0.7-volt noise level is obtained.

p. Disconnect synchroscope, VTVM, and 68-ohm termination.

q. Return remote r-f assembly to its normal position in control group cabinet. Place INTERLOCK SHORT switch on control group power supply No. 1 panel in OFF position.

r. Determine magnetron frequency as outlined in paragraph 5–124.

s. Connect output from an r-f signal generator (Signal Generator TS-403/U) to DIRECTIONAL COUPLER jack on indicator and test panel of r-f assembly (figure 1–62).

t. Synchronize signal generator with test trigger from TEST TRIGGER jack on indicator and test panel.

u. Connect test synchroscope (Synchroscope AN/USM-24) to TEST VIDEO jack on indicator and test panel.

v. Adjust signal generator frequency to match magnetron frequency measured in step a. Adjust r-f pulse width to 2 microseconds.

w. Delay r-f pulse approximately 200 microseconds. Set attenuator on signal generator to give a pulse on test synchroscope less than limiting signal.

x. Adjust MANUAL TUNE control on AFC-LO panel in r-f assembly (figure 1–66) until synchroscope signal is maximum. If necessary, add signal generator attenuation to prevent receiver limiting of signal.

y. Find minimum discernible signal below 1 milliwatt by increasing signal generator attenuation until signal just disappears into noise. Varying pulse delay of signal generator will help determine this vanishing point. Minimum discernible signal for Radar Sets AN/FPS-6 and AN/FPS-6A is 104 db. Minimum discernible signal for Radar Set AN/FPS-6B is 109 db.

z. Disconnect test equipment.

5–133. ANTENNA SYSTEM TESTING.

Note

Refer to paragraph 5–82 for power turn-on procedure.

5–134. AZIMUTH BLANKER TEST.

5–135. The azimuth blanker is supplied with Radar Set AN/FPS-6A. To test the azimuth blanker, proceed as follows:

a. Place radar in radiation operation.

b. Place MODE SWITCH on RHI antenna control (figure 1–55) in RHI CONT position.

c. Use handcrank on RHI antenna control to position antenna to 180 degrees, as read on ANTENNA AZIMUTH INDICATOR dial.

d. Place BYPASS switch on azimuth blanker (figure 1–24) in ON position.

e. Set SECTOR AZIMUTH POSITION dial on azimuth blanker for 0 degree.

f. Set SECTOR WIDTH dial on azimuth blanker to 60 degrees.

g. At RHI antenna control, turn handcrank quickly so as to rotate antenna clockwise. At 330 degrees, BLANK indicator should light and stay lit until antenna has passed 30 degrees.

h. Turn handcrank on RHI antenna control until antenna is in blanked sector. BLANK indicator on azimuth blanker should light; all targets should disappear from RHI display. Remove antenna from blanked sector before 5 seconds have elapsed. BLANK indicator goes off and targets return to RHI display.

i. Place antenna in blanked sector. Buzzer should sound approximately 5 seconds later and antenna should be automatically slewed out of sector.

j. To stop buzzer, rotate handcrank on RHI antenna control to some azimuth outside of blanked sector, then throw CLEAR switch on azimuth blanker.

k. Rotate antenna into blanked sector, using handcrank on RHI antenna control. Within 5 seconds, press AZIMUTH DRIVE-STOP button on antenna control panel (figure 1–44).

l. Buzzer sounds after 5 seconds. Twenty seconds later, RADIATE indicator on remote r-f control panel goes off and READY indicator lights. ANT DRIVE FAILURE indicator on azimuth blanker lights.

m. Press AZIMUTH DRIVE-START button and place BYPASS switch in BYPASS position.

5–136. ELEVATION CONTROL TESTS.

5–137. To test the elevation control circuit, proceed as follows:

a. At antenna control panel (figure 1–41), press ELEVATION DRIVE-SLOW button. SLOW indicator lights and antenna starts nodding at 20 cpm.

b. Press ELEVATION DRIVE-STOP button. SLOW indicator should go off. Allow reflector to come to a complete halt.

c. Press ELEVATION DRIVE-FAST button. FAST indicator lights and antenna starts nodding at 30 cpm.

Note

Nod power removed at FAST speed from Radar Set AN/FPS-6B if elevation arc (set at RHI antenna control) exceeds 15°.

d. Press STOP button. FAST indicator should go off. Allow reflector to come to a complete halt.

e. At azimuth switch box of Radar Set AN/FPS-6 (figure 1–57) or the RHI antenna control of Radar

Set AN/FPS-6A (figure 1–55), repeat steps a through d of this procedure, using ELEV SCAN STOP, ELEV SCAN SLOW, and ELEV SCAN FAST switches.

f. At safety box (figure 1–76), repeat steps a through d of the procedure, using SLOW-FAST and STOP buttons.

5–138. MANUAL TIME-SHARING TESTS.

Note

See paragraph 5–82 for power turn-on procedure.

5–139. AZIMUTH CONTROL OVERLAY.

5–140. To test the azimuth control overlay, proceed as follows:

a. Place radar in radiation operation with azimuth control overlay of PPI No. 1 in control of antenna azimuth motion.

b. On Radar Set AN/FPS-6A, set MODE SWITCH on RHI antenna control (figure 1–55) at PPI CONT.

c. Place all PASS-ON-OFF switches of azimuth control overlays in ON position (figure 1–53).

d. Place AUTOMATIC-MANUAL SELECTOR switch of time-sharing master control in PPI 1 position (figure 1–60).

e. Blue PPI 1 indicators at remote height displays (figure 1–58) and time-sharing master control (figure 1–56) should light. Red indicator of PPI No. 1 azimuth control overlay should also light.

f. Rotate azimuth handcrank of PPI No. 1 azimuth control overlay and check that antenna azimuth position corresponds to position of azimuth control overlay bearing cursor line.

5–141. REMOTE HEIGHT DISPLAY FOR RADAR SET AN/FPS-6 ONLY.

5–142. To test the remote height display, proceed as follows:

a. Place switches S9701, S9702, S9703, and S9704 of junction box in the RHI 1 position (figure 1–60).

b. Rotate HEIGHT LINE handcrank of RHI assembly No. 1. Reading of ABSOLUTE HEIGHT scale of remote height display at PPI No. 1 should accurately follow reading of ABSOLUTE HGT FEET scale of RHI assembly (figures 1–49 and 1–58).

c. Push in HEIGHT LINE handcrank. ABSOLUTE HEIGHT scale of remote height display should be illuminated and locked against any further action of HEIGHT LINE handcrank.

d. With HEIGHT LINE handcrank pressed, rotate handcrank. RELATIVE HEIGHT scale of remote height display at PPI No. 1 should accurately follow reading of RELATIVE HEIGHT scale at RHI assembly.

e. Pull out HEIGHT LINE handcrank. RELATIVE HEIGHT scale should be illuminated and locked against further information. Both scales of remote height display should now be illuminated and locked against any further action of HEIGHT LINE handcrank.

f. Throw CLEAR switch of remote height display at PPI No. 1. Illumination of both remote height display scales should go off and scale readings should revert to and follow respective scale readings at RHI assembly No. 1.

g. Place PASS-ON-OFF switch of azimuth control overlay at PPI No. 1 in OFF (center) position (figure 1–59). Rotation of HEIGHT LINE handcrank at RHI assembly should not affect scale readings at remote height display.

h. Place switches S9701, S9702, S9703, and S9704 of junction box in RHI-2 position (figure 1–60) and repeat steps b through f.

i. Repeat procedures outlined in paragraphs 5–137 through 5–140 for each PPI position of MANUAL SELECT switch of time-sharing master control.

5–143. REMOTE HEIGHT DISPLAY FOR RADAR SET AN/FPS-6A.

5–144. To test the remote height display, proceed as follows:

a. Place switches S9701, S9702, S9703, and S9704 of junction box (figure 1–60) in RHI 1 position.

b. At RHI assembly No. 1, place RELATIVE-ABSOLUTE switch in ABSOLUTE position. ABSOLUTE indicator should light, illuminating ABSOLUTE height counter.

c. Manipulate control stick to cause electronic cursor to rise. Reading of ABSOLUTE HEIGHT scale of remote height display at PPI No. 1 should accurately follow reading of ABSOLUTE height counter at RHI assembly (figures 1–51 and 1–58).

d. Move control stick until ABSOLUTE height counter reads 60,000 feet. ABSOLUTE HEIGHT scale of remote height display at PPI No. 1 should also read 60,000 feet.

e. Throw RELATIVE-ABSOLUTE switch on RHI assembly to RELATIVE position. Both RELATIVE and ABSOLUTE indicators should light, illuminating both RELATIVE and ABSOLUTE height counters at RHI assembly. ABSOLUTE HEIGHT counter at remote height display should be illuminated and locked against any further action of control stick.

f. Manipulate control stick until ABSOLUTE height counter on RHI assembly reads 70,000 feet. RELATIVE height dial at RHI assembly should read +10,000 feet.

g. ABSOLUTE HEIGHT scale of remote height display at PPI No. 1 should still read 60,000 feet, while RELATIVE HEIGHT scale of remote height display should read +10,000 feet.

h. Manipulate control stick until ABSOLUTE height counter on RHI assembly reads 50,000 feet. RELATIVE height dial at RHI assembly should read —10,000 feet.

i. ABSOLUTE HEIGHT scale of remote height display at PPI No. 1 should still read 60,000 feet, while RELATIVE HEIGHT scale of remote height display should read —10,000 feet.

j. Throw ABSOLUTE-RELATIVE switch at RHI assembly back to ABSOLUTE position. RELATIVE indicator should go off, but ABSOLUTE indicator should remain on. RELATIVE height dial should return to 0 feet.

k. At remote height display, RELATIVE HEIGHT scale should be illuminated and locked against any further information. Both scales of remote height display should now be illuminated and locked against any further action of control stick.

l. Throw CLEAR switch of remote height display at PPI No. 1. Illumination of both remote and absolute height display scales should go off and scale readings should revert to and follow respective scale readings at RHI assembly No. 1.

m. Place PASS-ON-OFF switch of azimuth control overlay (figure 1-59) at PPI No. 1 in OFF position. Manipulation of control stick at RHI assembly should not affect scale readings at remote height display.

n. Place switches S9701 through S9704 of junction box (figure 1-60) in RHI-2 position and repeat steps b through m.

o. Repeat procedures outlined in paragraphs 5-139 through 5-142 for each PPI position of AUTOMATIC-MANUAL SELECTOR switch of time-sharing master control.

5-145. RHI ANTENNA CONTROL.

5-146. To test the RHI antenna control circuit, proceed as follows:

a. Place switch S9705 of junction box (figure 1-60) in ASB-1 position.

b. Turn MODE SWITCH at RHI antenna control to RHI CONT position. LOCAL CONTROL indicator should light.

c. Rotate handcrank and check that antenna azimuth location corresponds to ANTENNA AZIMUTH INDICATOR reading on RHI antenna control within 1 degree. Check every 60 degrees of rotation.

d. Turn MODE SWITCH to PPI CONT position. LOCAL CONTROL indicator should go off and antenna should slew around to some position designated by PPI position now in control.

e. Rotate VERNIER CONTROL knob fully clockwise. Check that antenna moves approximately +4-1/2 degrees clockwise. Rotate VERNIER CONTROL knob fully counterclockwise. Check that antenna moves approximately 4-1/2 degrees counterclockwise from originally designated position.

f. Place MODE SWITCH in SECTOR SCAN position.

g. Set SECTOR WIDTH control at 20 and SECTOR SCAN control at 0.

h. Momentarily depress SECTOR SCAN START switch, which is a spring-return switch. Check that antenna scans 20-degree sector from 350 to 10 degrees.

i. Turn SECTOR SCAN control to 60 and check that antenna scans 20-degree sector from 50 to 70 degrees.

j. Place MODE SWITCH in CW ROT position. Check that antenna rotates clockwise, completing one revolution every 6 minutes.

k. Place MODE SWITCH in CCW ROT position. Check that antenna rotates counterclockwise, completing one revolution every 6 minutes.

l. Place a jumper between terminals 4 and 6 of terminal board TB6001 on servo amplifier (figure 5-16).

5-147. AZIMUTH SWITCH BOX.

5-148. To test the azimuth switch box, proceed as follows:

a. Place switch C9705 of junction box in ASB-1 position (figure 1-60).

b. Throw AZIMUTH CONTROL switch at azimuth switch box (figure 1-57) to ON position. Red AZIMUTH CONTROL indicator should light. Place azimuth rotation switch of this unit in CONT. ROT. OFF position.

c. Rotate azimuth handcrank of azimuth switch box and check that antenna azimuth location corresponds to AZIMUTH scale reading at azimuth switch box.

d. Press ELEV SCAN FAST switch and release. ELEV SCAN FAST indicator should light and antenna should nod at 30 cpm. Press SCAN STOP switch and release. ELEV SCAN FAST indicator should go off and antenna should stop nodding.

e. Press ELEV SCAN SLOW switch and release. ELEV SCAN SLOW indicator should light and antenna should nod at 20 cpm. Press SCAN STOP switch and release. ELEV SCAN SLOW indicator should go off and antenna should stop nodding.

f. Place azimuth rotation switch in CW position and observe that antenna moves continuously in azimuth in a clockwise direction. Place azimuth rotation switch in CCW position and observe that antenna moves continuously in azimuth in a counterclockwise direction.

5-149. AUTOMATIC TIME SHARING TESTS.

Note

Refer to paragraph 5-82 for power turn-on procedure.

5-151. Perform the following preliminary adjustments before starting the automatic time-sharing tests:

a. Set time-sharing master control AUTOMATIC-

MANUAL SELECTOR switch to the AUTO position (figure 1–56).

b. At time-sharing master control, set sequence switches as follows:

Switch	*Position*
SEQUENCE 1	PPI 1
SEQUENCE 2	PPI 2
SEQUENCE 3	PPI 3
SEQUENCE 4	PPI 4

c. Set INTERVAL SECS control of time-sharing master control for about 75 seconds.

d. Set PPI No. 1 azimuth control overlay to about 0 degree, PPI No. 2 azimuth control overlay to about 90 degrees, PPI No. 3 azimuth control overlay to about 180 degrees, and PPI No. 4 azimuth control overlay to about 270 degrees.

e. Place junction box switches S9701, S9702, S9703, and S9704 in RHI 1 position (figure 1–60).

f. Place AZIMUTH CONTROL switch of azimuth switch box in off (up) position (figure 1–57).

g. Throw time-sharing master control TIMER switch to TIMER position. Press down START switch and release.

5–152. PPI NO. 1 FUNCTIONS (RADAR SET AN/FPS-6).

5–153. To test the functions of the PPI No. 1 control circuits, proceed as follows:

a. Place PPI No. 1 in control of antenna.

b. Observe that PPI No. 1 indicators at all remote height displays and at time-sharing master control are lit. Also check that red indicator of PPI No. 1 azimuth control overlay is lit.

c. Observe that antenna positions itself to azimuth location indicated by PPI No. 1 azimuth control overlay.

Note

Perform the remaining steps within 50 seconds. Should more time be required, increase setting of INTERVAL SECS control at time-sharing master control.

d. Rotate HEIGHT LINE handcrank of RHI assembly No. 1. ABSOLUTE HEIGHT scale reading of PPI No. 1 remote height display should follow ABSOLUTE HGT FEET scale reading of range height indicator (figures 1–51 and 1–58).

e. Push in HEIGHT LINE handcrank and continue rotating handcrank. ABSOLUTE HEIGHT scale reading of remote height display should lock and become illuminated. RELATIVE HEIGHT scale reading of remote height display should follow RELATIVE HEIGHT scale reading of RHI assembly.

f. Pull out HEIGHT LINE handcrank. Both remote height display scales should be illuminated and locked against further action of range height indicator HEIGHT LINE handcrank.

5–154. PPI NO. 1 FUNCTIONS (RADAR SET AN/FPS-6A).

5–155. To test the functions of the PPI No. 1 control circuits, proceed as follows:

a. Repeat steps a through c of paragraph 5–153.

b. Throw RELATIVE-ABSOLUTE switch on RHI assembly No. 1 to ABSOLUTE position.

c. Manipulate control stick at RHI assembly. ABSOLUTE HEIGHT scale reading of PPI No. 1 remote height display should follow ABSOLUTE height counter reading on RHI assembly. Manipulate control stick until ABSOLUTE height counter reads 60,000 feet.

d. Throw RELATIVE-ABSOLUTE switch on RHI assembly No. 1 to RELATIVE position. ABSOLUTE HEIGHT scale at PPI No. 1 remote height display should be illuminated and locked.

e. Push control stick at RHI assembly until ABSOLUTE height counter reads 70,000 feet. Both RELATIVE height counter at RHI assembly and RELATIVE HEIGHT dial at remote height display should read +10,000 feet. ABSOLUTE HEIGHT counter at remote height display should continue to read 60,000 feet.

f. Return RELATIVE-ABSOLUTE switch at RHI assembly No. 1 to ABSOLUTE position. Both ABSOLUTE HEIGHT and RELATIVE HEIGHT scales at remote height display should be illuminated and locked.

5–156. PPI NO. 2, 3, AND 4 FUNCTIONS.

5–157. To test the functions of PPI No. 2, 3, and 4 control circuits, proceed as follows:

Note

At the end of the first time interval, control should automatically pass from PPI No. 1 to PPI No. 2.

a. Observe that PPI 1 blue indicators at all remote height displays and at time-sharing master control are off and PPI 2 amber indicators at these units are lit.

b. Observe that red indicator of PPI No. 1 azimuth control overlay is off and indicator of PPI No. 2 at this unit is lit.

c. Observe that both scales of PPI No. 1 remote height display should remain lit.

d. Observe that antenna positions itself to azimuth location indicated by PPI No. 2 azimuth control overlay.

e. Repeat procedures outlined in paragraph 5–139, steps a through g, as PPI No. 2, 3, and 4 successively take control and check lighting and extinguishing of respective indicators and movement of antennas as noted previously.

f. After control interval for PPI No. 4 has elapsed, control should pass back to PPI No. 1. When this occurs, check that scale illuminations at PPI No. 1 remote height display go off. Repeat this observation at respective remote height displays as control is passed from one PPI to the next in sequence.

g. Repeat steps outlined in paragraphs 5–139 and 5–141 with junction box (figure 1–60) switches S9701 through S9704 placed in RHI-2 position.

5–158. BYPASS FUNCTIONS.

5–159. To test the functions of the bypass circuits, proceed as follows:

a. Determine azimuth control overlay in control of antenna, as indicated by its associated red indicator. Throw PASS-ON-OFF switch of this overlay (figure 1–59) to PASS (left) position. Red indicator should go off and antenna control should immediately pass to azimuth control overlay next in sequence, as indicated by its red pilot indicator. Simultaneously, the respective PPI indicators at the remote height displays and at the time-sharing master control should indicate the change in control.

b. Place PASS-ON-OFF switch of azimuth control overlay next in sequence in PASS (left) position and check that when present control interval expires, control bypasses this azimuth control overlay and passes on to overlay next in sequence. Repeat this procedure for remaining azimuth control overlays.

c. After completing steps a and b, return PASS-ON-OFF switch of each overlay to ON position.

d. Set time-sharing master control INTERVAL SECS control for 20 seconds and place SEQUENCE 1 and SEQUENCE 3 switches of this unit in PASS position (figure 1–56). Control should alternate between PPI No. 2 and PPI No. 4, with PPI No. 1 and PPI No. 3 eliminated from control.

e. Return SEQUENCE 1 and SEQUENCE 3 switches to PPI 1 and PPI 3 positions, respectively. Place SEQUENCE 2 and SEQUENCE 4 switches in PASS position. Control should alternate between PPI No. 1 and PPI No. 3, with PPI No. 2 and PPI No. 4 eliminated from control.

f. Return SEQUENCE 2 and SEQUENCE 4 switches to PPI 2 and PPI 4 positions, respectively.

5–160. WARNING FUNCTION.

5–161. To test the functions of the warning circuits, proceed as follows:

a. About 10 seconds before the end of a control interval, place time-sharing master control AUTO-WARN switch in WARN position (figure 1–56). Observe that at the end of the present control interval, control remains with presently controlling PPI. The respective PPI indicators at all remote height displays and at the time-sharing master control should blink continuously on and off, and the red indicator of the controlling PPI azimuth control overlay should remain lit.

b. Place PASS-ON-OFF switch of controlling PPI azimuth control overlay in PASS position (figure 1–59). Control should pass to next PPI in sequence. At the end of the control interval, control should remain with the controlling PPI, its azimuth control overlay red indicator should remain lit, and the respective PPI indicators at all remote height displays and at the time-sharing master control should blink on and off continuously.

c. Repeat procedures outlined in steps a and b for the remaining two PPI's.

d. Place AUTO-WARN switch in AUTO position. Blinking of pilot indicators should cease and, after the timing period, control should pass to the PPI next in sequence.