T.O. No. 16-30APN4-3

HANDBOOK
MAINTENANCE INSTRUCTIONS

RADIO SET
AN/APN-4

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE
AND THE CHIEF OF THE BUREAU OF AERONAUTICS

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Destruction of Abandoned Materiel in the Combat Zone

In case it should become necessary to prevent the capture of this equipment and when ordered to do so, DESTROY IT SO THAT NO PART OF IT CAN BE SALVAGED, RECOGNIZED OR USED BY THE ENEMY. BURN ALL PAPERS AND BOOKS.

Means:-

1. Explosives, when provided.
2. Hammers, axes, sledges, machetes, or whatever heavy object is readily available.
3. Burning by means of incendiaries such as gasoline, oil, paper, or wood.
4. Grenades and shots from available arms.
5. Burying all debris or disposing of it in streams or other bodies of water, where possible and when time permits.

Procedure:-

1. Obliterate all identifying marks. Destroy nameplates and circuit labels.
2. Demolish all panels, castings, switch- and instrument-boards.
3. Destroy all controls, switches, relays, connections, and meters.
4. Rip out all wiring and cut interconnections of electrical equipment. Smash gas, oil, and water-cooling systems in gas-engine generators, etc.
5. Smash every electrical or mechanical part, whether rotating, moving, or fixed.
6. Break up all operating instruments such as keys, phones, microphones, etc.
7. Destroy all classes of carrying cases, straps, containers, etc.
8. Bury or scatter all debris.

DESTROY EVERYTHING!

★

Unsatisfactory Report

For U. S. Army Air Force Personnel:

In the event of malfunctioning, unsatisfactory design, or unsatisfactory installation of any of the component units of this equipment, or if the material contained in this book is considered inadequate or erroneous, an Unsatisfactory Report, AAF Form No. 54, or a report in similar form, shall be submitted in accordance with the provisions of Army Air Force Regulation No. 15-54 listing:

1. Station and organization.
2. Nameplate data (type number or complete nomenclature if nameplate is not attached to the equipment).
3. Date and nature of failure.
4. Radio model and serial number.
5. Remedy used or proposed to prevent recurrence.
6. Handbook errors or inadequacies, if applicable.

For U. S. Navy Personnel:

Report of failure of any part of this equipment during its guaranteed life shall be made on Form N. Aer. 4112, "Report of Unsatisfactory or Defective Material," or a report in similar form, and forwarded in accordance with the latest instructions of the Bureau of Aeronautics. In addition to other distribution required, one copy shall be furnished to the inspector of Naval Materiel (location to be specified) and the Bureau of Ships. Such reports of failure shall include:

1. Reporting activity.
2. Nameplate data.
3. Date placed in service.
4. Part which failed.
5. Nature and cause of failure.
6. Replacement needed (yes—no).
7. Remedy used or proposed to prevent recurrence.

For British Personnel:

Form 1022 procedure shall be used when reporting failure of radio equipment.

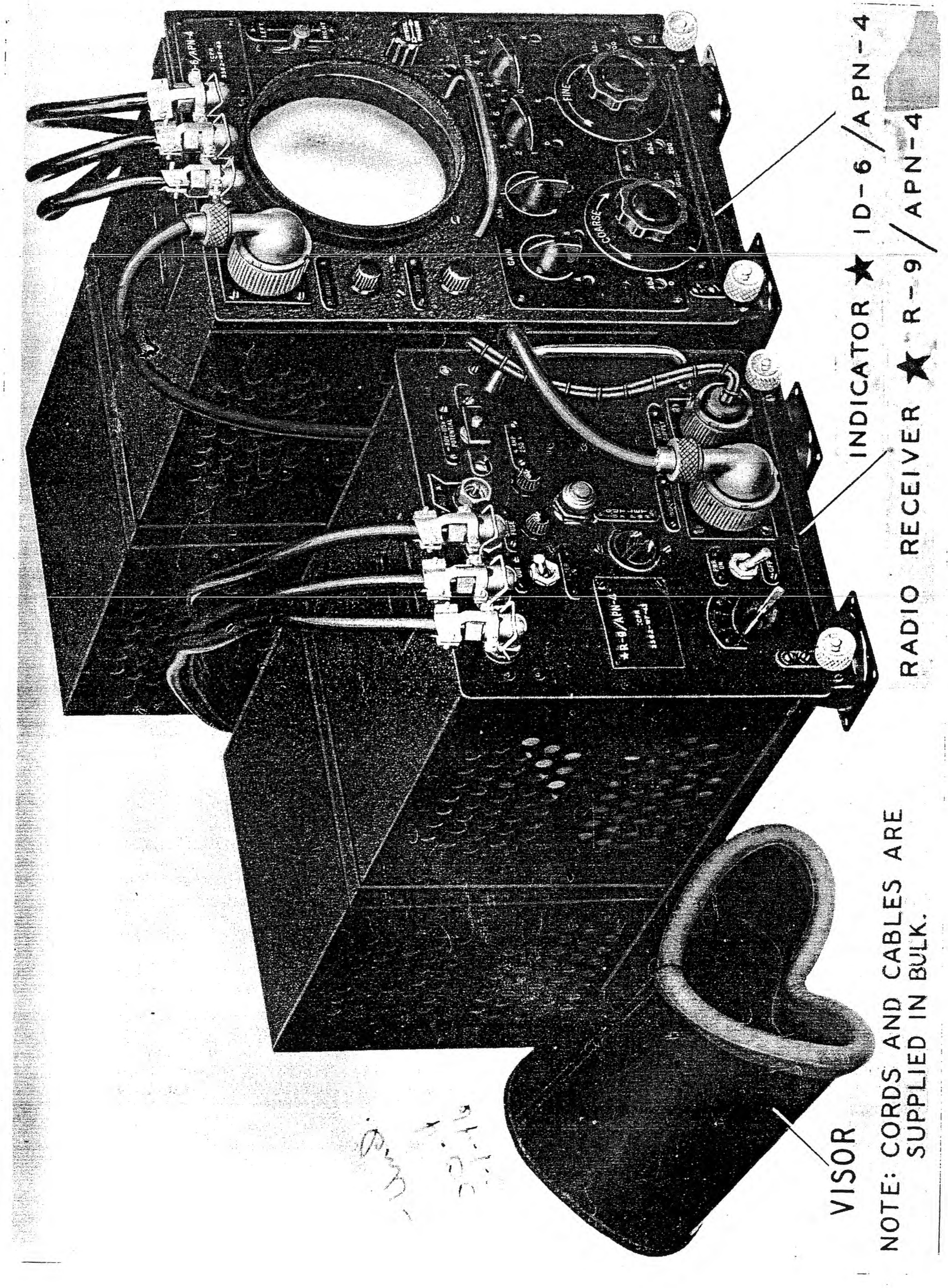


Figure 1-1. Radio Set ★AN/APN-4 (Early)—Components

SAFETY NOTICE

Radio Set ★AN/APN-4 employs high voltages which are dangerous and may be fatal if contacted by operating personnel. Use extreme caution when working with the equipment.

SECTION I
GENERAL DESCRIPTION

1. GENERAL.

a. PURPOSE OF EQUIPMENT.— Radio Set ★AN/APN-4 is airborne navigational equipment used to determine the geographic position of the aircraft in which it is installed.

b. MAJOR ASSEMBLIES.—Major assemblies of the equipment consist of a receiver and an indicator bearing any combination of the following nomenclature: Indicator ★ID-6/APN-4, ★ID-6A/APN-4, or ★ID-6B/APN-4 and Radio Receiver ★R-9/APN-4, ★R-9A/APN-4, or ★R-9B/APN-4. The assemblies are completely interchangeable electrically and mechanically.

c. POWER REQUIREMENT.—The radio set is designed to operate on either 115- or 80-volt alternating current, any frequency between 400 and 2400 cycles. The switch, marked "80V.-115V. POTENTIAL" on the front panel of Radio Receiver ★R-9/APN-4 or "80V.-115V. LINE VOLTAGE" on Radio Receivers ★R-9A/APN-4 and ★R-9B/APN-4, is used to adapt the equipment to either in-put voltage. The power consumption with the "GAIN" control set at maximum of 278.4 volt-amperes at 0.9 power factor, and, with the "GAIN" control at minimum, 264 volt-amperes at 0.91 power factor.

d. OPERATING TEMPERATURES. — Radio Set ★AN/APN-4, consisting of Receiver ★R-9/APN-4 and Indicator ★ID-6/APN-4, provides dependable operation for all temperatures between —31° and +104° Fahrenheit (—35° and +40° centigrade) at altitudes up to 30,000 feet and conditions of humidity ranging from 40 to 95 percent. Radio Set ★AN/APN-4, consisting of either Radio Receiver ★R-9A/APN-4 or ★R-9B/APN-4 and Indicator ★ID-6A/APN-4 or ★ID-6B/APN-4, provides dependable operation for all temperatures between —65.2° and +122° Fahrenheit (—54° and +50° centigrade) at altitudes up to 30,000 feet and conditions of humidity ranging from 50 to 75 percent.

2. EQUIPMENT SUPPLIED.

The following table lists the equipment supplied with Radio Set ★AN/APN-4: (See figs. 1-1 and 1-2.)

Quantity	*Name of Unit*	*Army Type Designation*	*Over-all Dimensions (inches)*	*Weight (lbs.)*	*Numerical Series*
	Radio Receiver	★R-9/APN-4	19.5 x 9 x 7.87	25.45	101-199
	Mounting for Receiver	FT-447-A or MT-203/APN-4	19.5 x 8.6 x 2.5	2.3	
1*	Radio Receiver	★R-9A/APN-4	19.5 x 9 x 7.87	25.45	101-199
	Mounting	FT-447-A or MT-203/APN-4	19.5 x 8.6 x 2.5	2.3	
	Radio Receiver	★R-9B/APN-4	19.5 x 9 x 7.87	25.45	101-199
	Mounting	FT-447-A or MT-203/APN-4	19.5 x 8.6 x 2.5	2.3	
	Indicator	★ID-6/APN-4	19.5 x 9 x 11.75	35.2	301-399
	Mounting	FT-446	19.5 x 8.6 x 2.5	2.3	
1*	Indicator	★ID-6A/APN-4	19.5 x 9 x 11.75	35.2	301-399
	Mounting	FT-446	19.5 x 8.6 x 2.5	2.3	
1	Indicator, complete with visor, tubes and crystal, type VC5K	★ID-6/APN-4 or ★ID-6A/APN-4	19.5 x 9 x 11.75	35.2	301-399
	Indicator, complete with visor, tubes and crystal, type VC5K	★ID-6B/APN-4	19.5 x 9 x 11.75	35.2	301-399
	Mounting for Indicator	FT-466	19.5 x 8.6 x 2.5	2.3	
1	Mounting	FT-446-A	19.5 x 8.6 x 2.5	2.3	

*Only one receiver and one indicator are furnished as components of one Radio Set ★AN/APN-4; however, any receiver may be installed with any indicator.

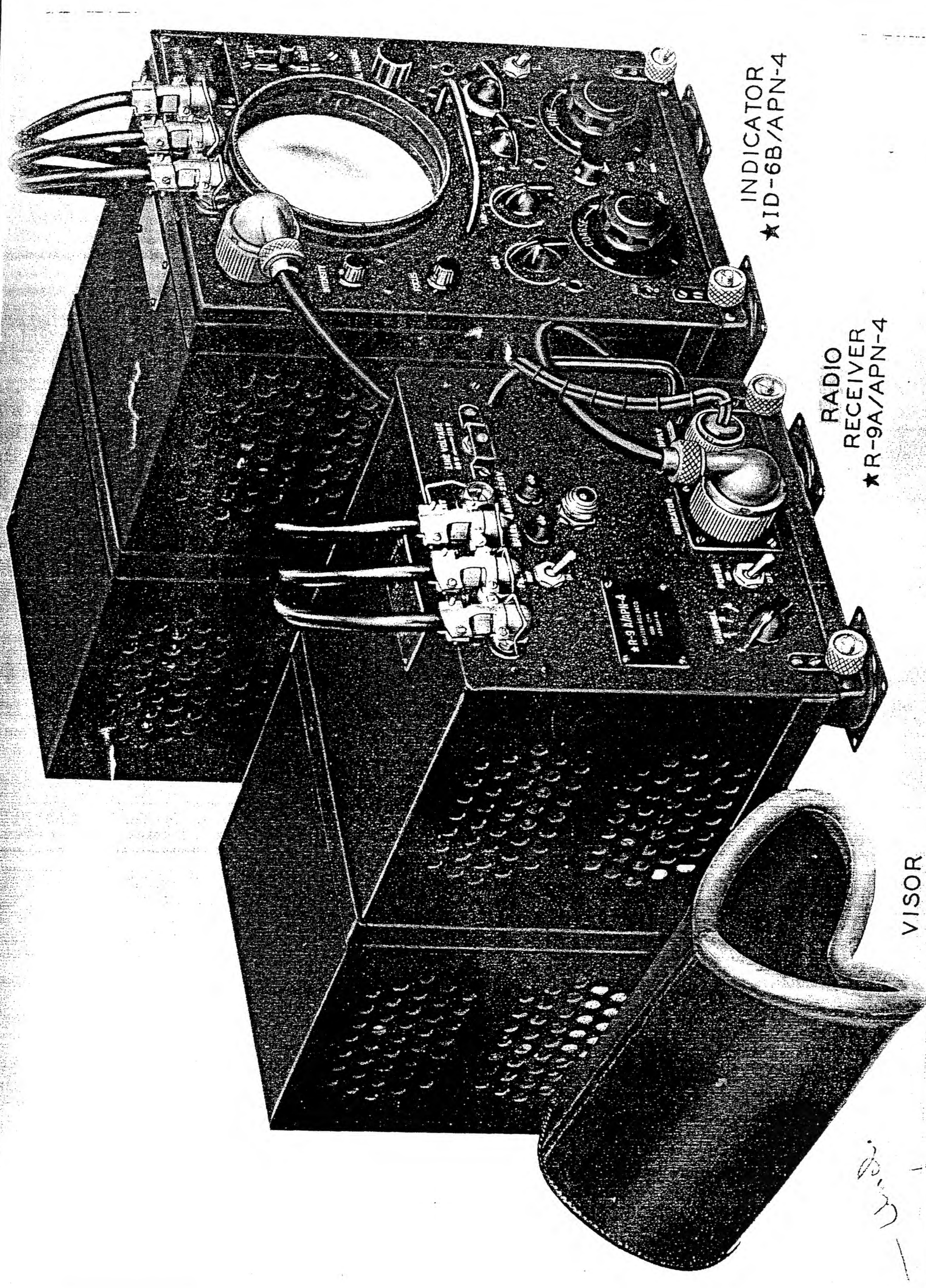


Figure 1-2. Radio Set ★AN/APN-4 (Late)—Components

3. EQUIPMENT REQUIRED BUT NOT SUPPLIED.

The components of Installation Equipment RC-228 or RC-226, which are required for the operation of Radio Set ★AN/APN-4, but are not supplied with it, are listed below:

Quantity	*Name of Unit*	*Army-Type Designation*	*Over-all Dimensions (inches)*	*Weight (pounds)*
1*	Radio Frequency Cable For Receptacle Coded Red (No. 1)	RG-7/U	120 x 0.4 dia.	1.25
1*	Pen Wire No. 16 Airplane Cable For Receptacle Coded Red	AN-J-C-48	120 long	1.25
1*	Radio Frequency Cable For Receptable Coded Yellow (No. 2)	RG-7/U	120 x 0.4 dia.	1.25
1*	Pen Wire No. 16 Airplane Cable For Receptacle Coded Yellow	AN-J-C-48	120 long	1.25
1*	Radio Frequency Cable For Receptacle Coded Blue (No. 3)	RG-7/U	120 x 0.4 dia.	1.25
1*	Pen Wire No. 16 Airplane Cable For Receptacle Coded Blue	AN-J-C-48	120 long	1.25
1*	Radio Frequency Cable Coaxial Antenna For Receptacle Coded Green (Ant.)	RG-8/U	0.45 dia. not exceeding 40 feet	0.13 per foot
1	Antenna Switch (DPDT) or (TPDT)	SA-13/U SW-225		
7	Cable Clamp	M-297 or M-297-A	1.25 x 1.2 x 0.7	0.6
1	Cordage	CO-239-A, C, or D	120 x 0.4 dia.	1.86
1†	Coupling for Radio Frequency Cable RG-8/U	MC-277 (10H/701) or MC-277-A	1.3 x 0.8 x 0.7	0.24
6†	Coupling for Radio Frequency Cable RG-7/U	MC-320 (10H/529) or MC-320-A	1.3 x 0.8 x 0.7	0.36
~~1~~	~~Plug for Power Supply Cable~~	~~PL-167~~	~~1.3 x 1.25 dia.~~	~~0.25~~
2	Plug for Cordage CO-239-A, C, or D	PL-Q171	2.8 x 2.0 x 1.7	0.6
2‡	Ferrule	6Z3824-1	0.4 x 0.7 dia.	0.4

*Color coding not used on U. S. Army equipment, both cables and receptacles color coded on British equipment.
†Couplings show British reference number rather than Signal Corps number.
‡Use this ferrule with Cordage CO-239-D.

4. TOTAL WEIGHT.

Total weight of the major assemblies of Radio Set ★AN/APN-4, less cables, plugs, etc., is 65.5 pounds. Total weight of a typical installation (including installation equipment but not including the power supply cable and antenna reel) is approximately 69 pounds.

5. DESCRIPTION OF MAJOR UNITS.

a. RADIO RECEIVER ★R-9/APN-4. *(See figure 1-3.)*—This receiver is housed in a black wrinkle-finish metal case. Mounted on the front panel are the following: "PWR-ON-OFF" switch, "80V.-115V. POTENTIAL" switch, a "4 AMP" (4AG) fuse, a "SPARE FUSE," a "CHANNEL" switch, an "OUT-FILTER-IN" switch, and an adjustable jewel pilot lamp. The cable receptacles on the front panel are as follows: video receptacle (coded red and numbered 2), gain receptacle (coded blue and numbered 3), "ANT." receptacle (coded green), "INDICATOR" power supply receptacle, "INPUT SUPPLY" receptacle, and an "AUX. PWR. OUTLET." Receiver ★R-9/APN-4 is designed to operate at one of four preset frequencies within two r-f bands. CHANNEL "1" and "2," with a frequency range of 1.6 to 3.3 megacycles, are adjusted at the factory for 1.95 megacycles. CHANNEL "3" and "4," with a frequency range of 7.58 to 11.75 megacycles, are adjusted at the factory for 9.6 megacycles.

b. INDICATORS ★ID-6/APN-4 AND ★ID-6A/APN-4.—Each indicator, mounted in a black wrinkle-finished metal case, is held in place by a single Dzus fastener in the center of the rear panel. Holes in each side of the case provide ventilation. Mounted on the front panel are the "COARSE," "FINE," "GAIN," and "AMP. BALANCE" controls, the eight-position "STATION" selector switch, "CRYSTAL PHASING," "FOCUS," and "INTENSITY" controls, "LEFT-RIGHT" switch, video receptacle (coded red, numbered 1), amplitude balance receptacle (coded yellow, numbered 2), gain receptacle (coded blue, numbered 3), indicator input receptacle marked "RECEIVER," and screw driver adjustments for alignment of stations "A to D" inclusive, and stations "E to K" inclusive, "COARSE ADJ. 0" and "ADJ. 10,000," and "FINE ADJ. 200" and "ADJ. 700." (See fig. 1-4.) In addition to the above panel controls and adjustments, the modified versions of Indicator ★ID-6A/APN-4 have a "PRR-H-L" switch and an additional counter adjustment "D2." (See fig. 1-5.) All models of the indicator are crystal-controlled precision instruments, the various circuits of which primarily affect the func-

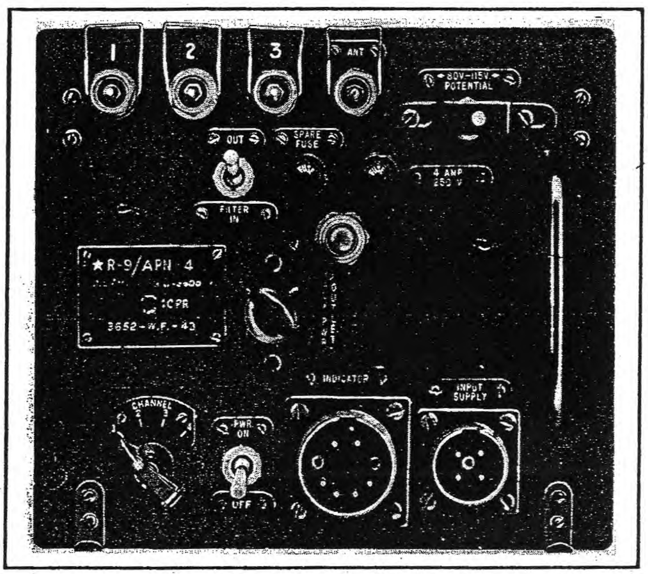


Figure 1-3. Radio Receiver ★R-9/APN-4—Front Panel (Late)

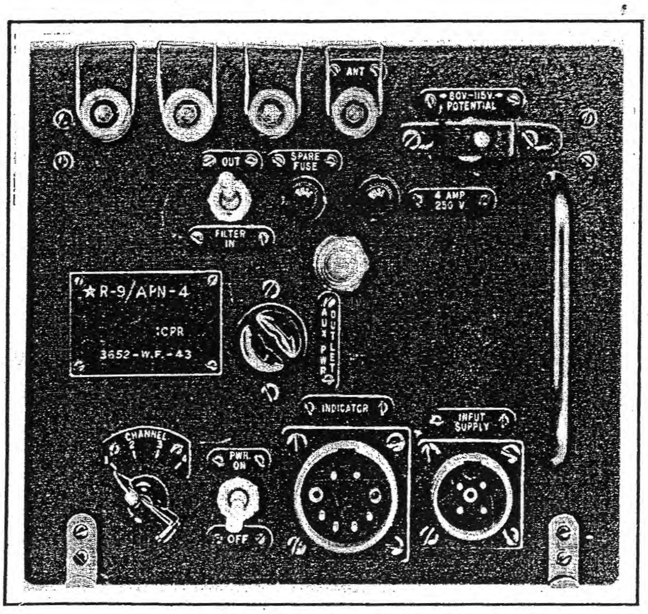


Figure 1-3A. Radio Receiver ★R-9/APN-4—Front Panel (Early)

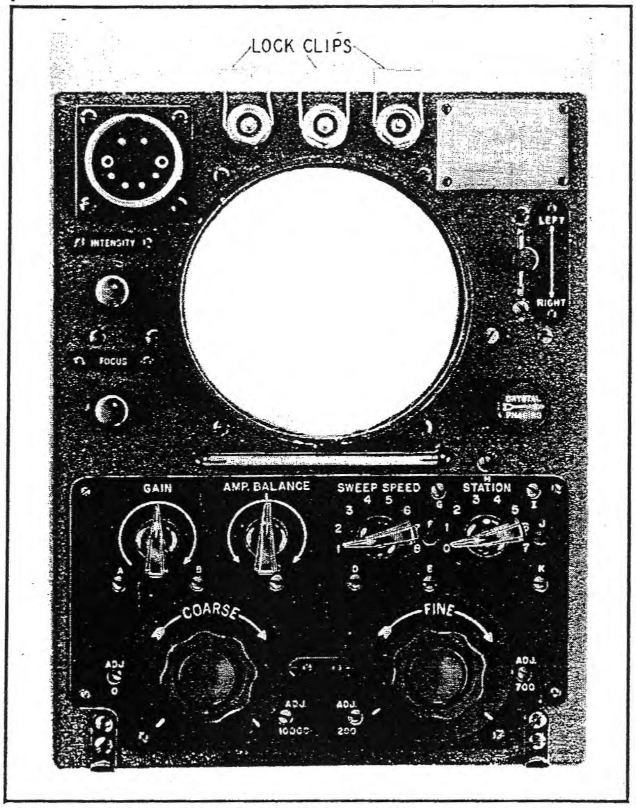


Figure 1-4. Indicator ★ID-6/APN-4—Front Panel (Modifications I, II)

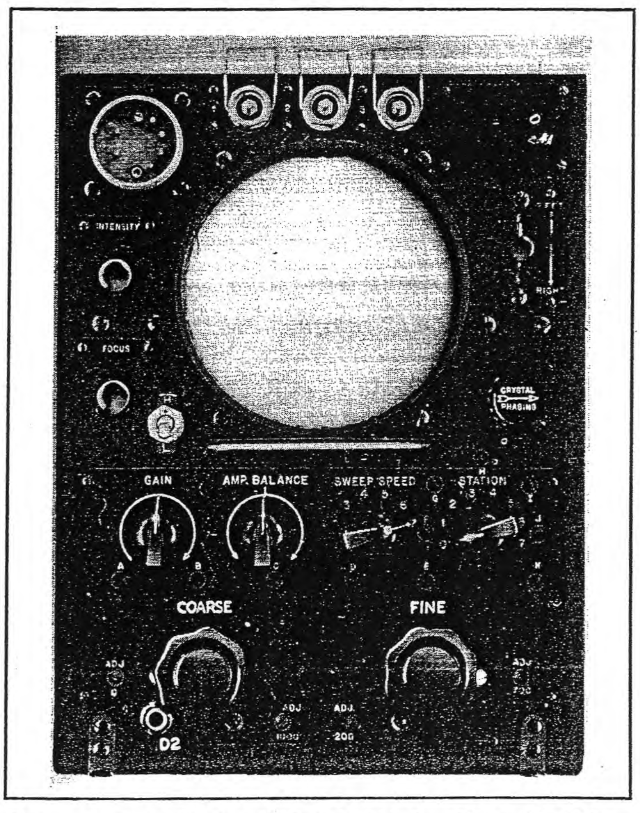


Figure 1-5. Indicator ★ID-6/APN-4—After Modification in Accordance with Technical Order No. 16-35ID6-21

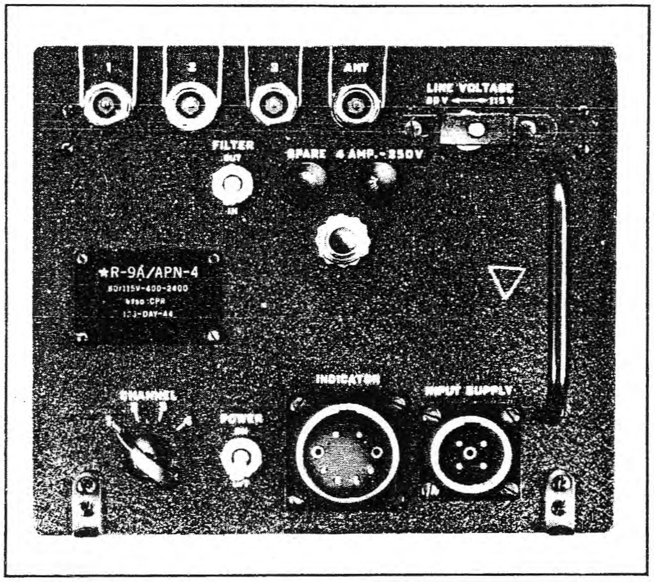


Figure 1-6. Radio Receiver ★R-9A/APN-4 or ★R-9B/APN-4—Front Panel

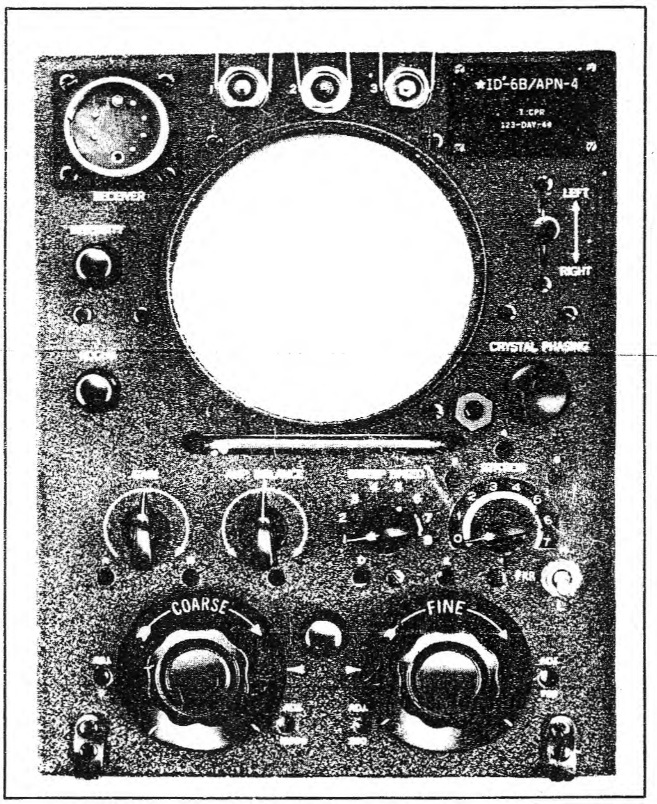


Figure 1-7. Indicator ★ID-6B/APN-4 (Early)—Front Panel

tioning of a cathode-ray tube contained within the units, and synchronize these functions with the recurrence rates of the received pulses. The screen display of the cathode-ray tube consists, in most operations, of two trace patterns calibrated in microseconds. Pulses from ground stations, amplified and rectified by the receiver, also ap-

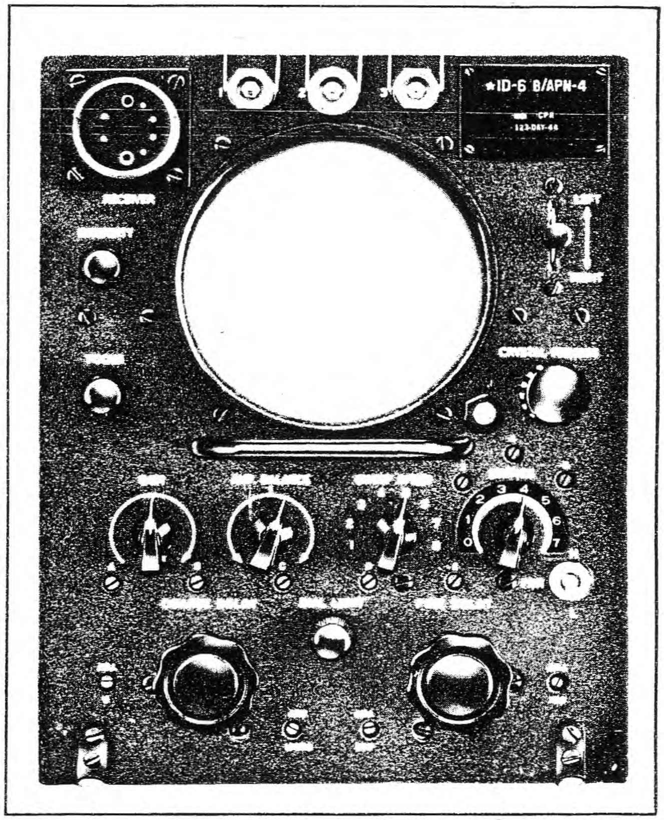


Figure 1-8. Indicator ★ID-6B/APN-4 (Late)—Front Panel

pear on the traces; calibrated scales enable the operator to measure the time interval between the reception of the pulses. For a detailed explanation of electrical characteristics of Radio Receivers ★R-9/APN-4, ★R-9A/APN-4, ★R-9B/APN-4 and Indicator ★ID-6B/APN-4, see section IV. For an explanation of the electrical characteristics of Indicator ★ID-6/APN-4 and ★ID-6A/APN-4, see section VI.

c. RADIO RECEIVERS ★R-9A/APN-4 AND ★R-9B/APN-4. *(See figure 1-5.)*—Each receiver is housed in a black wrinkle-finish metal case and is held in place by a Dzus fastener in the rear panel. Holes in each side of the case provide ventilation and access to the low-voltage power-supply control-potentiometer R-121. Mounted on the front panel are the four-position "CHANNEL" switch: "PWR. ON-OFF" switch; "FILTER-OUT-IN" switch; "80V.-115V. LINE VOLTAGE" switch, "4 AMP.-250V." fuse and a spare fuse, a jeweled pilot lamp, "INDICATOR" power-supply receptacle; "INPUT SUPPLY" receptacle, and four coaxial connectors marked "1" (video, coded red), "2" (amplitude balance, coded yellow), "3" (gain control, coded blue), and "ANT." (coded green).

Receiver ★R-9A/APN-4 is designed to operate at any one of four pre-set frequencies within two r-f bands. Three of the pre-set frequencies lie within the low r-f band between 1.6 and 3.3 megacycles. CHANNEL "1," "2," and "3" are pre-set at the factory for 1.95, 1.85, and

SECTION II
INSTALLATION AND ADJUSTMENTS

1. INSTALLATION.

a. PRELIMINARY PROCEDURE.

(1) UNPACKING AND INSPECTION.—Radio Set ★AN/APN-4 is shipped with a crystal and a complement of tubes installed in their sockets. Included in the tube complement is a cathode-ray tube; therefore, avoid any unpacking procedure which subjects the equipment to severe jolts or shocks. Avoid, also, the use of tools or methods which could cause damage to switches, controls, and connectors located on the front panels of the equipment.

After unpacking, remove the metal covers of both major units, for visual inspection of chassis, tubes, controls, etc. To remove the covers, use a screw driver to loosen the Dzus fasteners. Grasp the handle on the front panel with one hand and pull the unit forward, holding the cover with the other hand. Inspect all tubes for correct types and for firm seating in their sockets. Check the cathode-ray tube for proper and secure position. See that the lead to the snap-terminal (upper side of the tube) is properly connected. (See fig. 8-42.) Check the 100-kilocycle crystal (VC5KS), located near the front panel, right side, for firm socket contact. See that the spring clamp is in proper place.

(2) BENCH TESTS.—To insure dependable operation of the equipment after installation, make a pre-installation bench test for both major units and compare the results of these tests with the standards given in section VI, paragraph 6. For these tests an a-c voltage supply of 80 and 115 volts having a frequency between 400 and 2400 cycles per second is required. It is preferable that the voltage of both a-c supplies be variable: the 80-volt supply from 76 to 84 volts, the 115-volt supply from 109 to 121 volts. Cables, prepared as shown in figures 2-2 to 2-5, are also required.

(a) EQUIPMENT REQUIRED.—For bench test the following equipment is recommended:

1. Signal Generator I-194-A (part of Training Equipment RC-242-A).

2. A-C voltmeter (capable of reading to 150 volts).

3. D-C voltmeter (capable of reading to 3000 volts).

4. Tube checker (any modern standard make).

5. Standard AM signal generator.

6. Non-Metallic screw driver (the type commonly used for r-f and i-f alignment of radio receivers).

(b) TEST PROCEDURE.

1. A-C POWER SUPPLY ADJUSTMENT.

a. Use an a-c voltmeter to check the a-c supply voltage. If adjustable, set voltage at 80 or 115 volts.

b. Loosen the two screws holding the "80V.-115V. LINE VOLTAGE" switch guard and set switch to correspond to the supply voltage used. Retighten guard screws to avoid accidental movement of switch to incorrect position.

c. Use cables prepared as shown in figures 2-2 through 2-5 to connect together the indicator and receiver units.

d. Connect the four-prong a-c Plug PL-167 to four-pin receptacle J106. Carefully observe color code of leads, then connect leads from plug terminals 1 and 2 to the a-c power source.

e. If a battery operated inverter is used to supply the 80 or 115-volt alternating current, pins 3 and 4 of "INPUT SUPPLY" plug may be used to operate the starting relay.

2. D-C VOLTAGE CHECKS.—Check d-c output of the regulated and high-voltage power supplies, using the following procedure:

WARNING

During operation, dangerous high voltage, which could be fatal if contacted by operating or maintenance personnel, exists between many points in this equipment.

a. With "PWR." switch at "OFF" position, remove Plug PL-Q171 from six-prong male receptacle located on the indicator panel. Observe carefully the numbers stamped on the insulating material.

WARNING

During normal operation approximately 2700 volts direct current exists between terminals 1 and 2. Terminal 1 is 1450 volts positive with respect to terminal 5; terminal 2 is 1250 volts negative with respect to terminal 5; terminal 6 is 260 volts positive with respect to terminal 5; terminal 5 is common ground (chassis).

b. Turn "PWR." switch to "ON" position. Use a d-c meter of proper range to check d-c high voltage between terminals 1 and 5, and 2 and 5, at Plug PL-Q171. Voltage readings ± 5 percent may be considered normal.

c. Turn "PWR." switch "OFF"; reconnect Plug PL-Q171 to its receptacle on the indicator panel; turn the receiver on its left side; connect positive test lead of a d-c meter to pin 5 of V-108, and negative lead to chassis.

d. Turn "PWR." switch to "ON." Allow five minutes for warming-up; then adjust regulated voltage control R-121 (see fig. 8-36) until the meter indicates exactly 260 volts.

3. VISUAL TUBE INSPECTION.— Turn "PWR." switch to "ON" position; inspect all tubes for lighted filaments. The filaments of some tubes will normally appear brighter than others, but after five minutes of heating, the brilliance of any tube should be steady. Change in brilliance is a certain indication of bad filament. Replace any apparently defective tube with a similar type known to be good.

4. SENSITIVITY CHECKS.—Make sensitivity checks of the equipment, using the following procedure:

a. Install visor on rim of indicator screen.

b. Turn "STATION" selector on indicator to position "0" and "SWEEP SPEED" switch to position 1.

c. Set "GAIN" control to full counterclockwise position and "AMP. BALANCE" control at center of its range.

d. Adjust "INTENSITY" and "FOCUS" controls to obtain suitable brilliance and definition of the screen display, which should be like that shown in part A of figure 3-1. Should the screen pattern consist of only one trace, adjust "SQ WAVE" control R347 (Indicators ★ID-6/APN-4 and ★ID-6A/APN-4) until another trace appears. Refer to section V, paragraph 6.*b*(5)(*g*) for complete adjustment instructions.

e. Adjust "GAIN" control to maximum (fully clockwise) position. The grass appearing on the indicator screen should be one-half inch or more. Rotation of the "AMP. BALANCE" control alternately to the left and right should cause the grass to disappear from one trace, then the other.

f. Rotate "CHANNEL" selector, located on the receiver front panel, through its four positions. Make sensitivity (grass) test, given in the preceding paragraph, for each position of the "CHANNEL" selector. A further test of receiver sensitivity may be made by touching antenna connector J-101 with a screw driver or short rod and noting the increase of grass on the indicator screen.

5. COUNTER-CIRCUIT ADJUSTMENT CHECKS.

a. Make a careful check of the range and adjustment response of counter-circuit adjustments "A," "B," "C," "D," "D2," and "E," reached through holes on the indicator front panel. Compare the results with standards given in section V, paragraph 6*b*(2).

b. After each check, set adjustment according to instructions and in order given. This is important because the accuracy of succeeding checks depends largely upon proper adjustments of counters.

6. STATION - SELECTOR ADJUSTMENT CHECKS.

a. Adjust the feedback controls R341-2 (Indicators ★ID-6/APN-4, ★ID-6A/APN-4) or R329 (Indicator ★ID-6B/APN-4), following closely the procedure given in section V, paragraph 6.*b*(3)(*a*).

b. Check the range and response of "STATION" selector adjustments "E through K," inclusive (Indicators ★ID-6/APN-4, ★ID-6A/APN-4), or "2," "4," and "6" (Indicator ★ID-6B/APN-4). Refer to section V, paragraph 6.*b*.(3) and figures 2-14 and 2-14A through 2-22 and 2-22A, inclusive.

c. Recheck counter adjustments "A to D" in Indicator ★ID-6/APN-4 and ★ID-6A/APN-4 and "D2" inclusive; or "A to E" (in Indicator ★ID-6B/APN-4) inclusive, for possible change resulting from adjustment or R341 or R329. A recheck of these adjustments will probably be necessary.

7. FINE- AND COARSE-CONTROL ADJUSTMENT CHECKS.

a. Check both range and adjustment response of "FINE" control adjustments "ADJ. 200" and "ADJ. 700;" and "COARSE" control adjustments "ADJ. 0" and "ADJ. 10,000." See instructions in section V, paragraph 6*b*(4), figures 2-23 to 2-28.

8. AUXILIARY-CONTROL ADJUSTMENT CHECKS.—Check the following controls:

a. SQUARE-WAVE GENERATOR CONTROL.—Refer to section V, paragraph 6.*b*.(5)(*g*).

b. "A DELAY" CONTROL.—Refer to section V, paragraph 6.*b*.(4)(*a*).

c. "AUX. FOCUS."—Refer to section V, paragraph 6.*b*.(5)(*f*); section VI, paragraph 4.*b*.(9); and figure 8-60.

d. HORIZONTAL CENTERING.— Refer to section V, paragraph 6.*b*.(5)(*a*); section VI, paragraph 4.*b*.(8); and figures 8-12 and 8-60.

e. SWEEP AMPLITUDES.—Refer to section V, paragraph 6.*b*.(5)(*b*); section VI, paragraph 4.*b*.(5); and figures 8-12 and 8-60.

f. VERTICAL CENTERING.—Refer to section V, paragraph 6.*b*.(5)(*c*); section VI, paragraph 4.*b*.(6); and figure 8-6.

g. TRACE SEPARATION.—Refer to section V, paragraph 6.*b*.(5)(*d*); section VI, paragraph 4.*b*.(7); and figures 8-60 and 8-12.

h. PEDESTAL DURATION.—Refer to section V, paragraph 6.*b*.(5)(*e*); and figure 8-60.

9. OPERATIONAL CHECKS.—Use Test Set RC-242-A to make an operational check of the equipment.

a. Set up Test Set RC-242-A, using same model indicator as one under test.

b. Turn on equipment and set "CHANNEL" selector switch on Signal Generator I-194-A and receiver to position "1."

c. Set "STATION" selectors on both indicators to position "0."

d. Check "AMP. BALANCE," "LEFT-RIGHT," "COARSE" and "FINE DELAY" and "PHASING" control action on "SWEEP SPEED" positions "1," "2," "3," and "4."

e. Repeat step *(d)* on "STATION" selector positions "1 through 7."

Note

To check "CHANNEL" positions "2," "3," and "4," make comparative tests against results obtained for "CHANNEL" position "1." For these tests use a standard audio modulated signal generator connected to the antenna connection of the receiver, the aural test set described in section V, or a vacuum-tube voltmeter connected to the output (video connector) of the receiver.

b. INSTALLATION PROCEDURE.

(1) GENERAL.—Installation of Radio Set ★AN/APN-4 must allow for manual operation of controls located on Radio Receiver ★R-9( )/APN-4 and Indicator ★ID-6( )/APN-4. The indicator must be situated so that the detachable visor may be installed without interference with other equipment located within the airplane. Each interconnecting cable length should not exceed 20 feet.

(2) CORDAGE. *(See figure 2-1.)*—Six cables are necessary; namely, two external cables, three interconnecting coaxial cables having their couplings color coded to correspond with colored rings around the male sockets on the panel of the receiver and indicator, and one six-conductor cord (Cordage CO-239-A, CO-239-B, or CO-239-D) with Plug PL-Q171 on each end and connected as shown in figure 2-1. Make certain that all couplings and plugs are secure and that lock clips (see fig. 1-2) are in place.

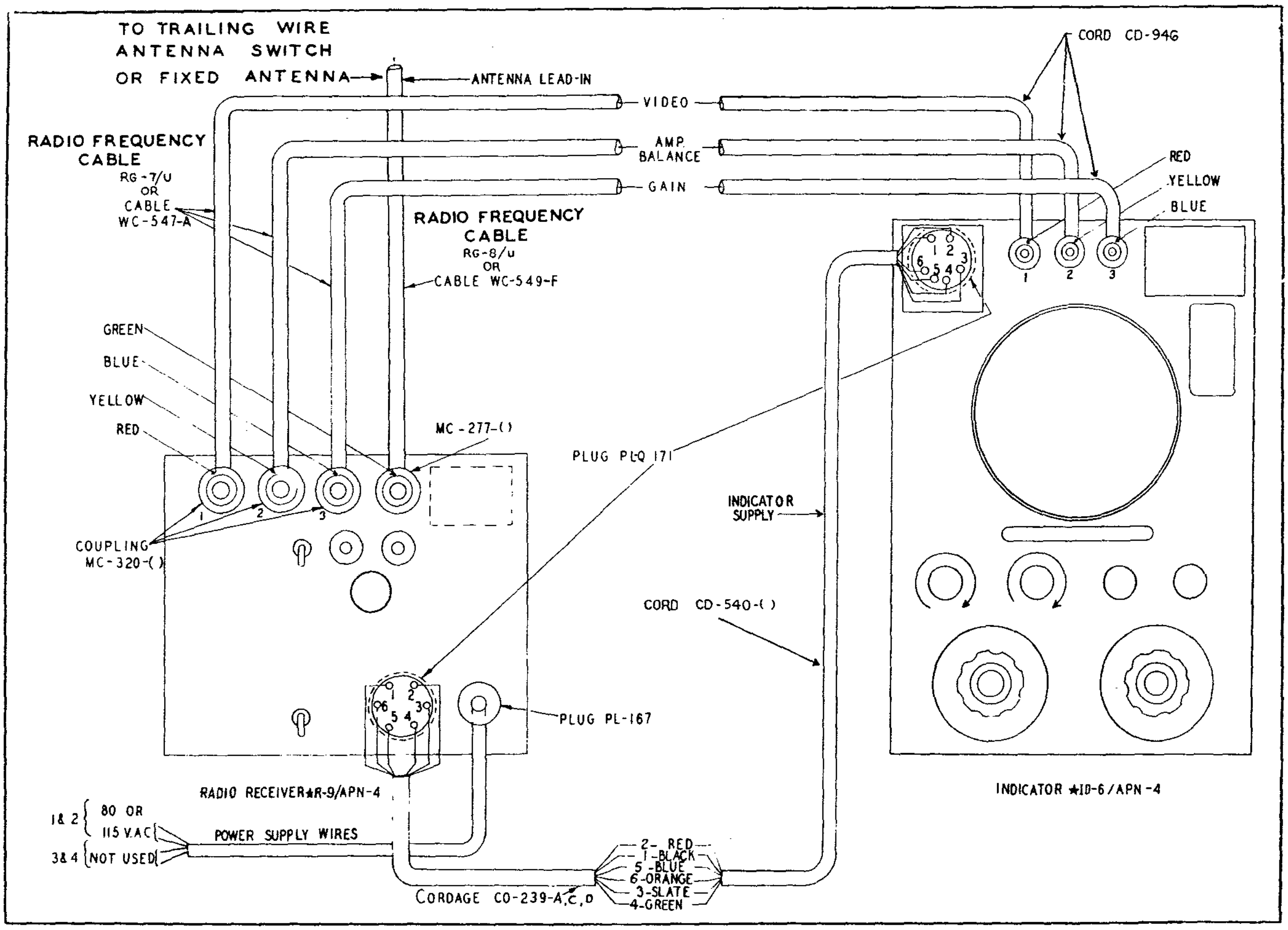


Figure 2-1. Radio Set ★AN/APN-4—Cording Diagram

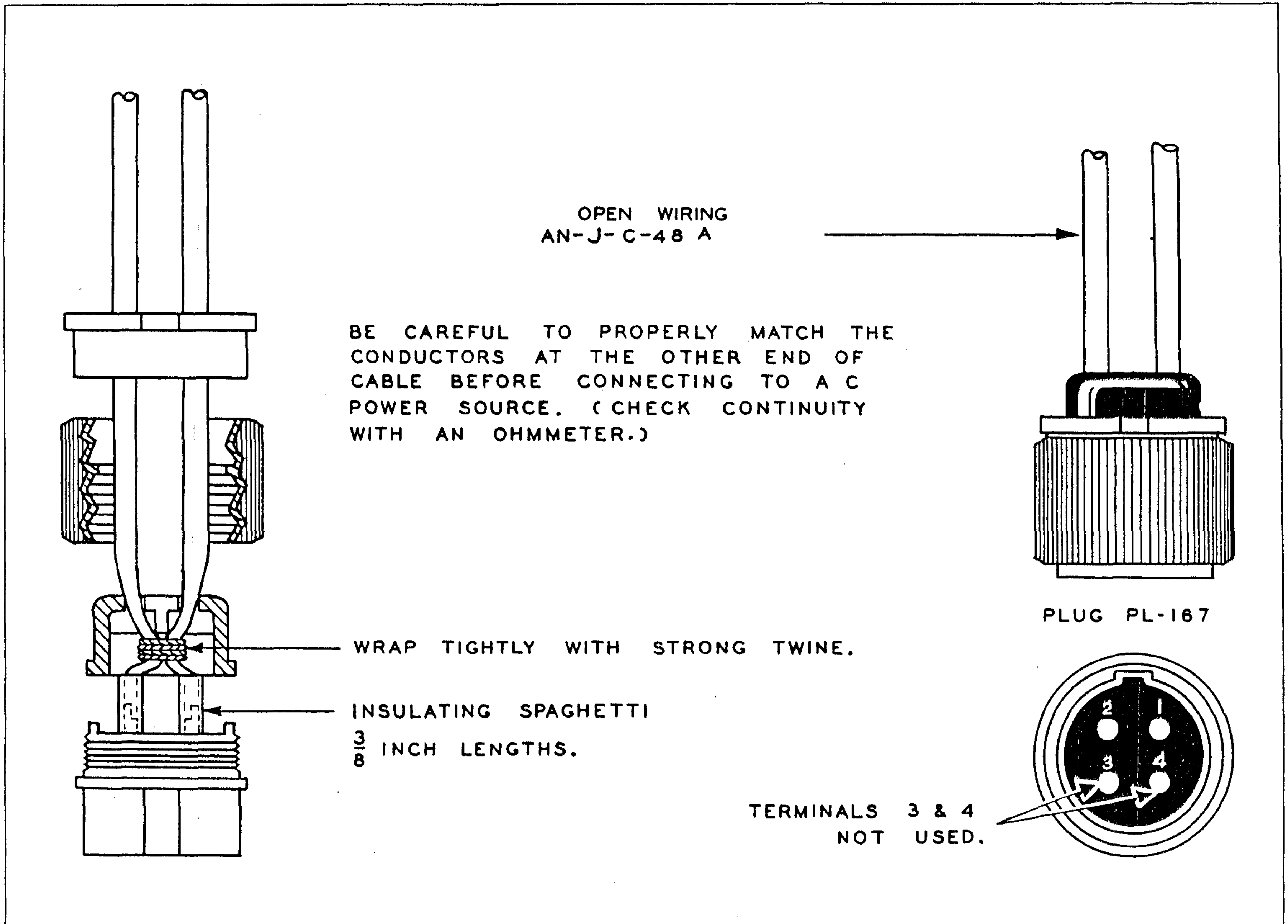
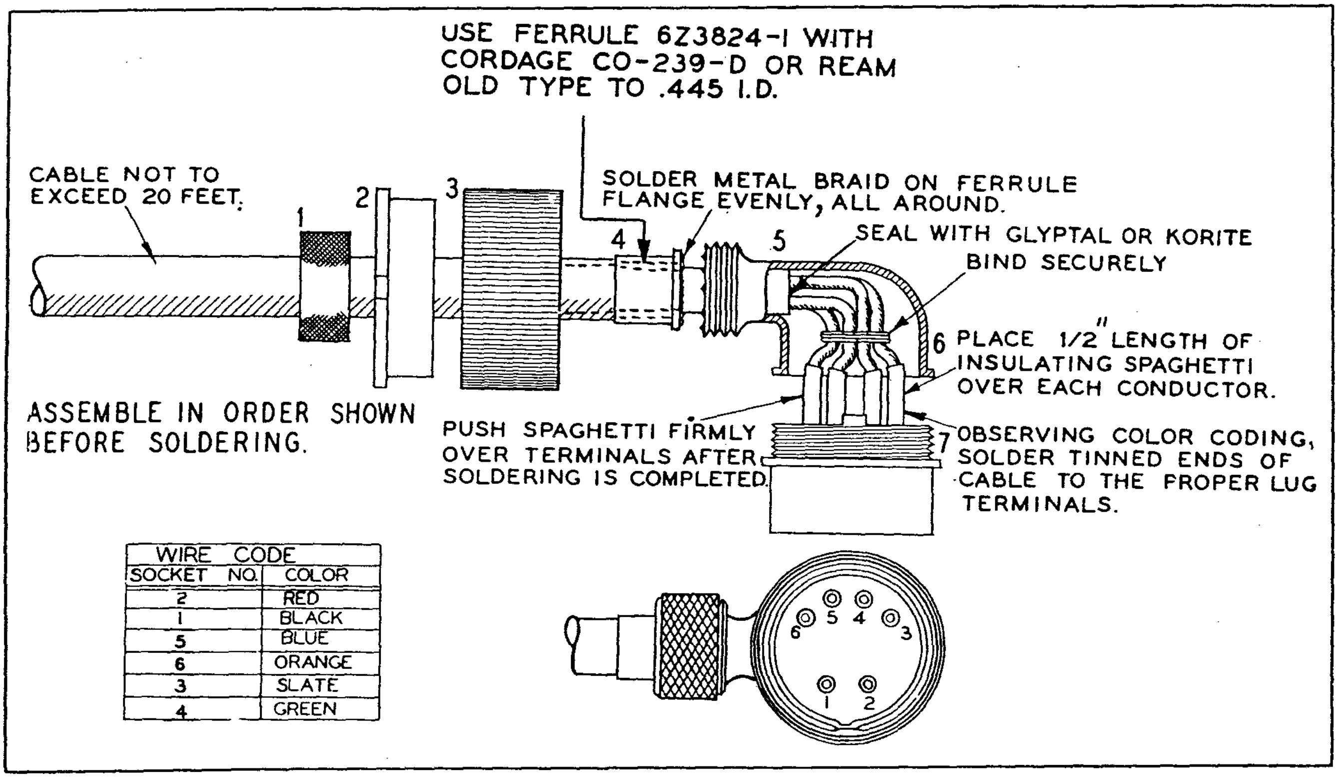


Figure 2-2. A-C Power Cable and Plug Assembly



WIRE CODE	
SOCKET NO.	COLOR
2	RED
1	BLACK
5	BLUE
6	ORANGE
3	SLATE
4	GREEN

Figure 2-3. Cordage CO-239-A, CO-239-C, or CO-239-D—Cable and Plug Assembly

(*a*) CABLE CONSTRUCTION.—Prepare and assemble cables according to figures 2-2 to 2-5. Take care to include insulating spaghetti at connections to plugs and couplings. Use rosin core solder. When preparing the cables for connection to the plugs, use extreme care to avoid damage to the insulation around the individual conductors. The processes of binding and sealing, shown in these figures, are important; if properly done, they insure against breakdown resulting from accumulated moisture. Proper binding also reinforces the cables against the effects of strain caused by manipulation of the equipment during normal use. In the final assembly, allow enough length of individual conductors to permit rotation of the plug inserts for adjustment to any particular installation.

(*b*) CABLE CONNECTIONS. (*See figure 2-1.*)

1. INTER-UNIT CONNECTIONS. — Using the prepared coaxial cables, which may or may not be color coded, connect video receptacle (1), amplitude balance receptacle (2), and gain receptacle (3) on the receiver to correspondingly numbered and color-coded receptacles on the indicator. Connect the six-conductor cable, with Plug PL-Q171 attached to each end, between six pin receptacle on receiver and similar receptacles on indicator. Securely fasten all pin plugs to their receptacles, and lock all coaxial plugs with their lock clips.

2. A-C INPUT CONNECTIONS.—Connect four-conductor cables, with Plug PL-167 attached, between the four-pin receptacle on the receiver and the a-c power source. Carefully observe color coding and connect conductors from terminals 1 and 2 of power plug to a-c power source. The power supply may be either 80 or 115 volts alternating current; the frequency is from 400 to 2400 cycles per second; the power consumption is approximately 270 watts.

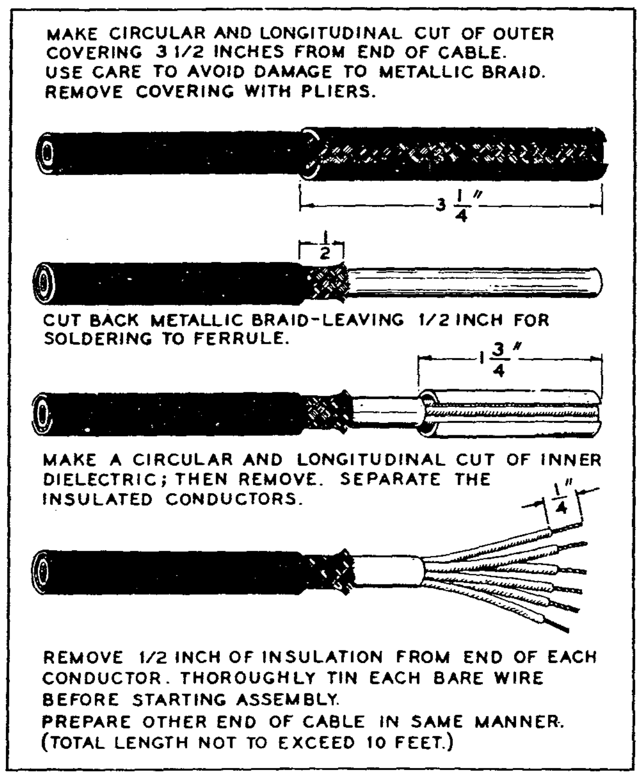


Figure 2-4. Cordage CO-239-A, CO-239-C, or CO-239-D—Cable Preparation

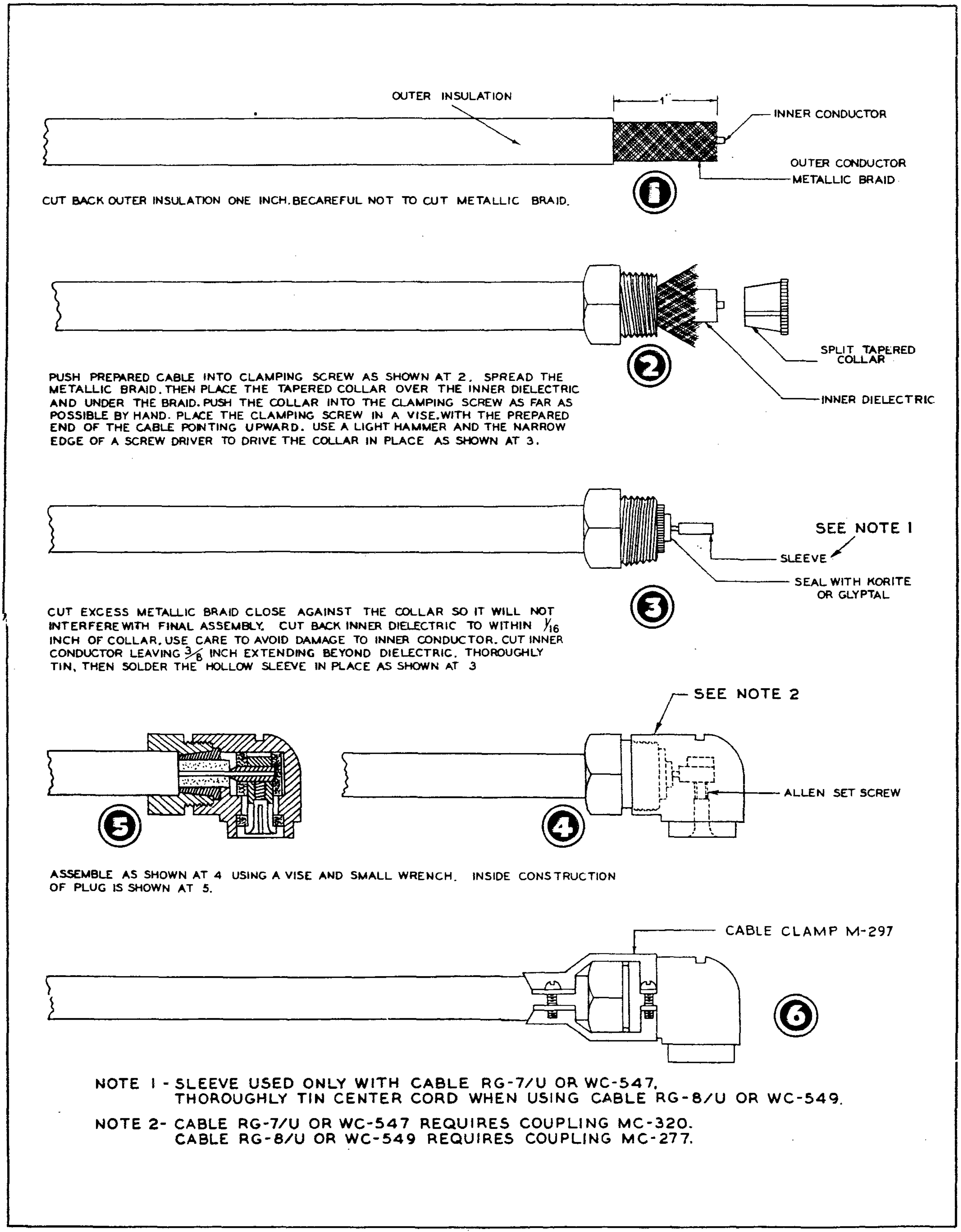


Figure 2-5. Coaxial Radio Frequency Cable and Plug Assembly

CAUTION

The conductors to terminals 3 and 4 of the plug are for switch connections and must not be connected directly across the a-c power source. (See fig. 2-2.) The potential switch must be in the correct position, depending upon the input voltage available. (See fig. 1-3.) This switch is located on the radio receiver. Loosen the two screws holding the switch guard and slide the guard either to the right for 115-volt a-c supply or to the left for 80-volt a-c supply. When in the correct position, tighten the two screws which securely lock the "POTENTIAL" switch.

(3) ANTENNA CONNECTIONS.—Connect Radio Frequency Cable RG-8/U (with coupling MC-277 attached) to the antenna receptacle (color coded green) of the receiver. The other end of the cable is attached to the liaison set antenna knife switch. Switch SA-13/U is used when liaison set has Antenna Tuning Unit BC-306-A, and Switch SW-225 when liaison set has Antenna Tuning Unit BC-306-B. Prepare the end of the cable to be fastened to the knife switch by cutting back the outer covering and metal braid for about 5 inches (see fig. 2-5) and grounding the twisted braid to the metal structure of the aircraft. Connect the center wire of this coaxial cable to the antenna knife switch as shown in figure 2-6. When the liaison set is using the trailing wire antenna, Radio Set ★AN/APN-4 will be switched to the fixed antenna; conversely, when the liaison set is using the fixed antenna, Radio Set ★AN/APN-4 will be switched to the trailing antenna. Both sets cannot use the same antenna simultaneously. (See fig. 2-6.) When only a fixed antenna is installed in the aircraft, Coupler CU-92/APN is used in conjunction with Radio Set ★AN/APN-4 and the liaison receiver. For further information, on Coupler CU-92/APN, refer to Technical Order No. 01-1-268. (See fig. 2-6A.)

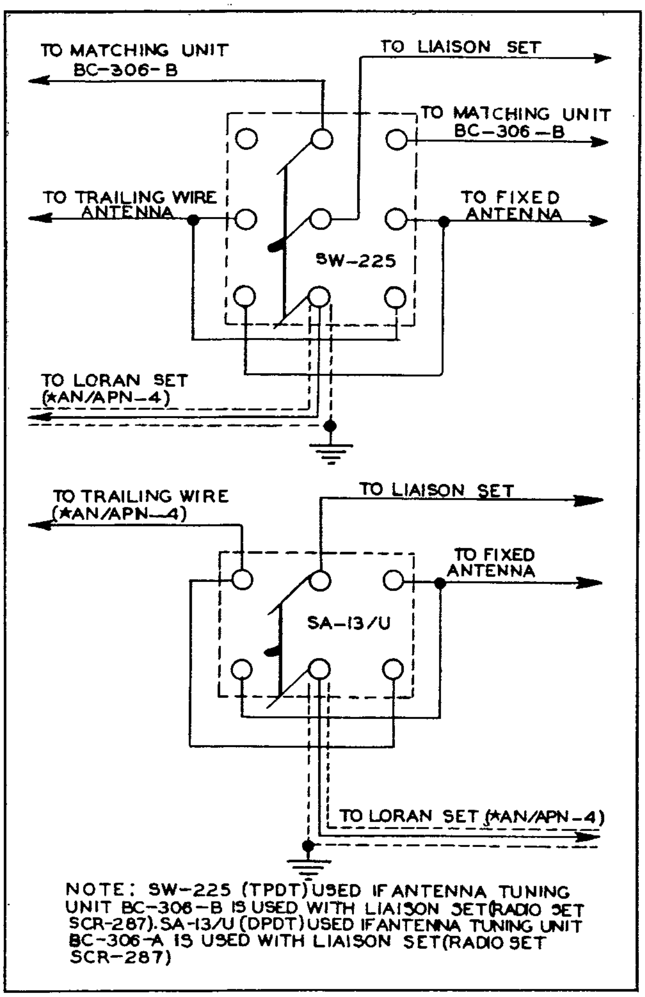


Figure 2-6. Antenna Switch Connections

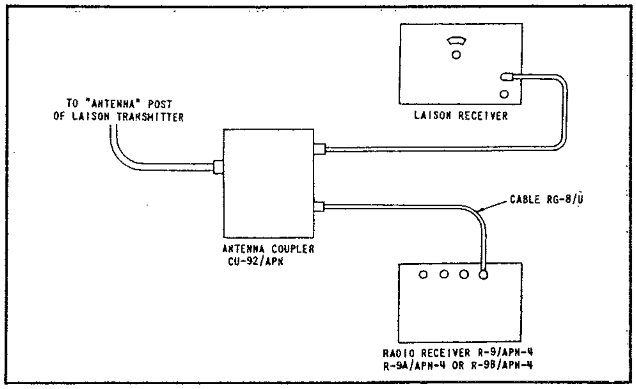


Figure 2-6A. Antenna Coupler CU-92/APN—Wiring Diagram

(4) POWER SUPPLY.—The power supply is either 80 or 115 volts alternating current. Frequency may be from 400 to 2400 cycles per second. Power consumption is about 270 watts.

2. OPERATIONAL ADJUSTMENT.

Note

Adjustments located behind the holes on the panels of the equipment are adjustable with a screw driver. One of non-metallic type is preferable (refer to par. 2*c*(13), this section).

a. RADIO RECEIVERS ★R-9/APN-4, ★R-9A/APN-4 AND ★R-9B/APN-4.

(1) LINE VOLTAGE. — Set "80V-115V LINE VOLTAGE" switch by loosening the two screws holding switch guard and sliding guard to the right for the 115-volt supply or to the left for the 80-volt supply. After placing switch in correct position, lock it in place by tightening the screws which hold the guard.

(2) Turn the "PWR. ON-OFF" switch to the "ON" position. Before attempting further adjustment of the radio receiver or the indicator allow 4 or 5 minutes for the tubes to heat properly and the circuit functions to become stabilized. If the oscilloscope does not indicate a fluorescent pattern, first turn the "INTENSITY" control on the indicator panel to the extreme right position. If no trace appears, the next procedure is to check the 4-ampere fuse located on the panel of the receiver as shown in figure 1-2.

(3) If bench tests are properly carried out, no

further adjustment of the power supply should be necessary. If, however, a particular condition requires further check continue this procedure.

WARNING

High voltage! Carefully observe the pin numbers of Plug PL-Q171 before following the instructions in this section. Between pins 1 and 2, 2600 volts direct current exists. Pin 1 is plus 1300 volts direct current with respect to chassis, and pin 2 is minus 1300 volts with respect to chassis. Pin 5 (negative) is common ground and pin 6 (+260 volts direct current) is connected directly to the d-c output of the voltage regulator located in the receiver.

(4) Connect a 2500-ohm 25-watt resistor in series with flexible leads equipped with alligator clips directly across the two test leads of a d-c voltmeter. With "PWR." switch "ON," connect the d-c voltmeter, thus shunted by the 2500 ohm resistor, between terminals 5 and 6 of plug PL-Q171. Turn screw driver adjustment R121, located on right side of the receiver, until voltmeter indicates exactly 260 volts. (See figure 8-5.)

(5) Turn "PWR." switch "OFF" and reconnect cordage CO-239-A to its receptacle on the indicator panel.

CAUTION

Carefully match the prongs of the receptacle with the holes in Plug PL-Q171. Do not force the plug into the socket unless it has been made certain that prongs are in line with the holes. Turn the "PWR. ON-OFF" switch to the "ON" position.

(6) CHANNEL SELECTOR.—Turn "CHANNEL" switch to the position which permits the receiver to operate at the radio frequency of the available ground stations. "CHANNEL" switch positions "1" and "2" on Radio Receiver ★R-9/APN-4, positions "1," "2," and "3," on Radio Receiver ★R-9A/APN-4, and positions "1," "2," "3," and "4" on Radio Receiver ★R-9B/APN-4 are all pre-set for reception of signals in the low-frequency band. "CHANNEL" positions "3" and "4" on Radio Receiver ★R-9/APN-4, and position "4" on Radio Receiver ★R-9A/APN-4 are pre-set for reception of signals in the high-frequency band. See section VI, paragraph 2.*b.*, and table 6-4 for band coverage and pre-set frequencies.

Note

Radio Receiver ★R-9A/APN-4 has undergone production changes such that the first three positions of the "CHANNEL" selector switch cover the same frequency. The fourth position covers a higher frequency. In Radio Receiver ★R-9B/APN-4 all four positions of the "CHANNEL" selector switch are on the low band between 1.7 and 2.5 megacycles.

(3) Turn the "FILTER-IN-OUT" switch to the "OUT" position. If unusual electrical disturbances are affecting signal reception to the point where trace patterns viewed on the oscilloscope are erratic and distorted, turn the "FILTER-IN-OUT" switch to the "IN" position. The "FILTER-IN-OUT" switch may be turned from "IN" to "OUT" during any stage of operation in an effort to achieve a better signal-to-noise ratio. Normal operating position of this switch should be in the "OUT" position.

b. INDICATORS ★ID-6/APN-4 and ★ID-6A/APN-4. —THE "SWEEP SPEED," "STATION," "COURSE," and "FINE" controls on the indicator require periodic checking and adjustment to insure proper operation of the equipment. Check the adjustments associated with the "SWEEP SPEED" and "STATION" circuits after every four hours of operation, or when sudden changes of altitude or temperature are encountered. Access to the adjustments for these controls on Indicator ★ID-6/APN-4 and ★ID-6A/APN-4 are through holes located on the front panel, letter "A to K;" "ADJ. 0," "ADJ. 10,000," "ADJ. 200," and "ADJ. 700." An additional counter adjustment, "D2," is mounted on the front panel of the early indicator modeis of Indicator ★ID-6A/APN-4 which have been modified for operation with ground stations, with basic pulse recurrence rates of 33-1/3 p.p.s. (See figure 1-5.) Access to the adjustment for the panel

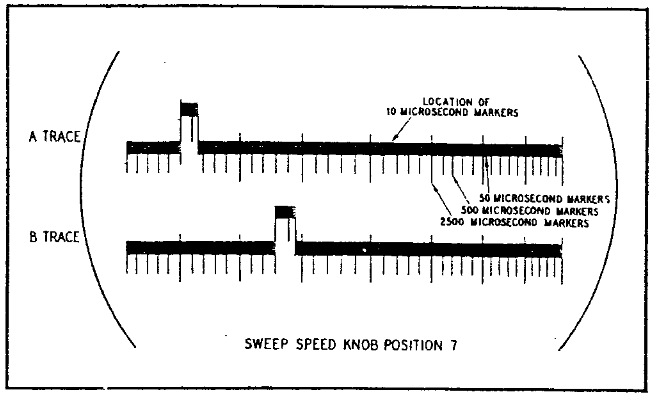


Figure 2-7. Oscilloscope Normal and Desired Trace Pattern

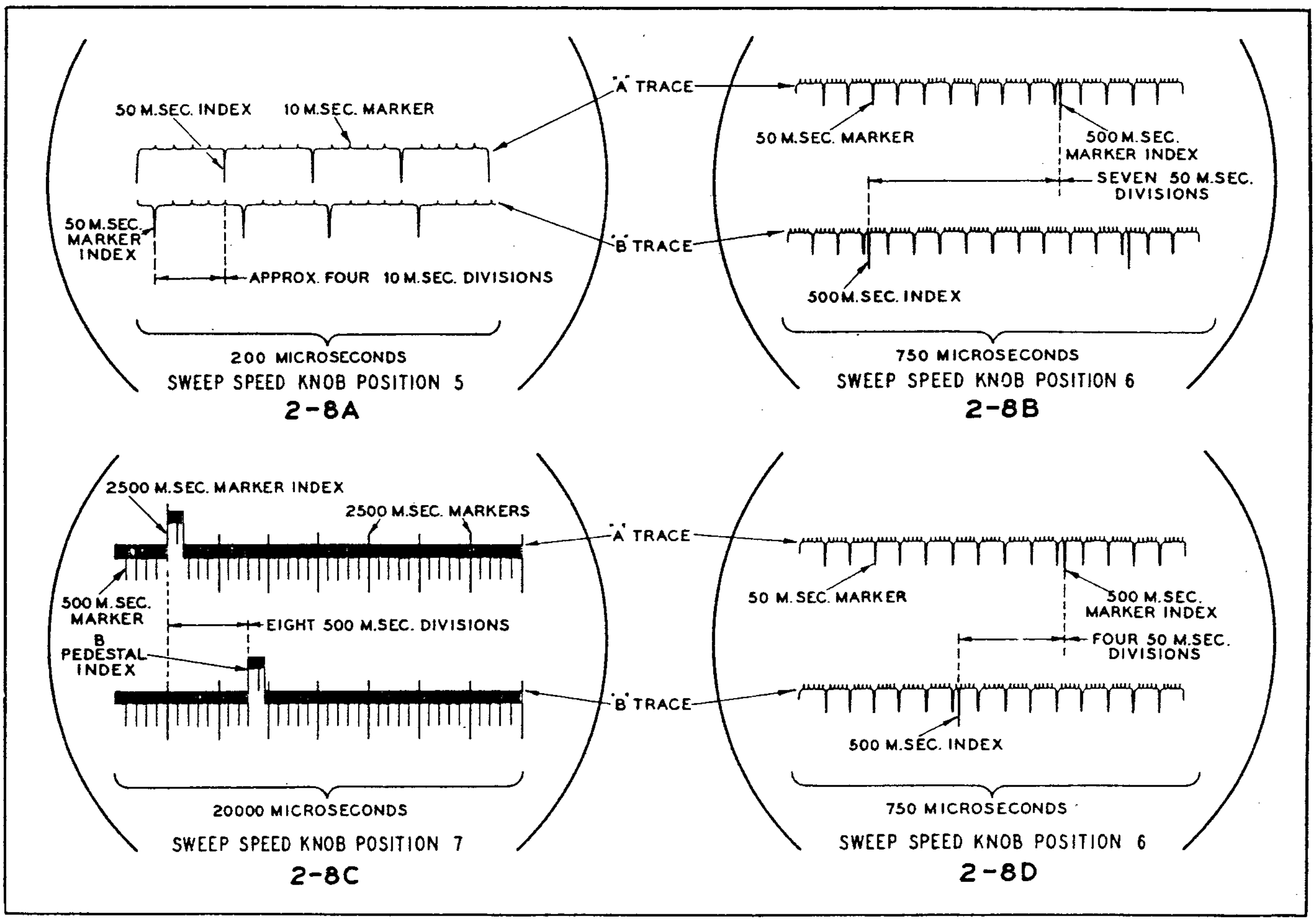


Figure 2-8. Oscilloscope Wave Forms Showing Markers

controls on Indicator ★ID-6B/APN-4 are through holes on the front panel lettered "A to E," "2," "4," and "6," "ADJ. 0," "ADJ. 10,000," "ADJ. 200," and "ADJ. 700." The adjustments associated with the "SWEEP SPEED," "COARSE," and "FINE" controls are variable resistors adjusted by a screw driver of the proper size, which may or may not be non-metallic. The adjustments associated with the "STATION" selector are variable capacitors and screw drivers *must be* non-metallic.

When making any of the indicator adjustments, be sure to center the final setting within the range providing the correct pattern, rather than at any point giving the desired effect. To attain the correct setting, first adjust for the correct pattern on the indicator screen; then, while rotating the adjustment alternately to the left and right, fix the setting mid-way between the two points where the correct pattern starts to change.

(1) PRELIMINARY ADJUSTMENTS.

(a) Turn "PWR." switch on receiver to "ON." Allow four or five minutes for the tubes to heat properly and the circuit functions to become stabilized. Install visor on rim of indicator screen.

(b) Turn the "STATION" selector to "O" position. Adjust the "SWEEP SPEED" to position "7" and observe the two trace patterns appearing on the face of the oscilloscope. These two traces will be referred to hereafter as the A- and B-trace. The A-trace identifies the upper line, and the B-trace identifies the lower line. Figure 2-7 indicates the normal and desired trace pattern.

(c) Adjust "INTENSITY" and "FOCUS" controls to obtain suitable brilliance and definition of pattern. If the bench checks of the square-wave generator are properly made, two traces should appear on the indicator screen. The upper trace will hereafter be referred to as the "A" trace, the lower one as the "B" trace. A small portion of each trace is raised, forming pedestals. The normal position of the "A" pedestal is fixed at a point approximately 3/8 inch from the left end of the "A" trace. The "B" pedestal, with proper settings of the adjustments associated with the "COARSE" and "FINE" controls may be varied from a position approximately 1/2 inch from the left end of the "B" trace to one of two positions (depending on the position of the "PRR-H-L" switch) between the center and right end of the "B" trace.

(2) COUNTER-CIRCUIT ADJUSTMENTS FOR INDICATOR ★ID-6/APN-4 AND ★ID-6A/APN-4.—In the following adjustment procedures it is assumed that the indicator has been bench-checked and that all circuits are normal. It is also assumed that the adjustments for the "square-wave generator," the "A delay," "trace separation," "horizontal centering," and "sweep amplitudes," have been checked and are set correctly. Should an apparently abnormal condition appear during any adjustment, refer to section V, paragraph *6.d.* for explanation of possible causes and instructions for corrective procedure.

(a) 10-MICROSECOND MARKER ADJUSTMENT A.—The trace patterns of the screen display in figure 2-11 are actually the tops of the "A" and "B" pedestals expanded to cover the entire screen. It is therefore important that the "A" and "B" pedestals should be stable in their positions; otherwise "jittery" trace patterns will hinder adjustments of counter circuits. Refer to section V, paragraph *6.b.*(4) for detailed instructions for "A" and "B" pedestal delay adjustments.

1. Turn SWEEP SPEED control to position "5." (See fig. 2-11.) Short positive markers (upward indications) and longer negative markers (downward indications) appear on both the "A" and "B" traces. The short markers are the 10-microsecond markers; the longer ones are the 50-microsecond markers.

2. Starting from full counterclockwise position, adjust screw driver adjustment "A" clockwise until four 10-microsecond markers appear between the 50-microsecond markers on each trace.

3. Continue the clockwise rotation of adjustment "A," and note the position at which instability of pattern or incorrect count occurs.

4. Return adjustment "A" to the approximate center of the range which provides the correct count.

5. Leave adjustment "A" at the position resulting in symmetry and minimum amplitude of the 50-microsecond markers.

(b) 50-MICROSECOND MARKER ADJUSTMENT B.

1. Turn "SWEEP SPEED" control to position "6." (See fig. 2-12.) Negative markers, some of which are longer than others, appear on both traces. The short negative markers are the 50-microsecond markers; the longer ones are the 500-microsecond markers.

2. Turn "FINE" control until two 500-microsecond markers appear on the "B" trace.

3. Adjust screw driver adjustment "B" until there are exactly ten 50-microsecond spaces between the 500-microsecond markers. Center adjustment within the range providing the correct count. The fact that the tenth 50-microsecond marker is not coincident with the 500-microsecond marker is not an evidence of misalignment, but a normal condition which does not affect accuracy of operation.

(c) 500-MICROSECOND MARKER ADJUSTMENT C.

1. Turn "SWEEP SPEED" control to position "7" and "PRR" switch to position "L." The two traces should now appear with their respective pedestals. (See fig. 2-13.) The 50- and 500-microsecond markers appear with long negative 2500-microsecond markers, which extend above the traces.

2. Turn screw driver adjustment "C" until exactly five 500-microsecond spaces appear between the 2500-microsecond markers. Be sure to center the adjustment within the range providing the correct pattern.

(d) 2500-MICROSECOND MARKER ADJUSTMENT D.

1. With "SWEEP SPEED" control still in posi-

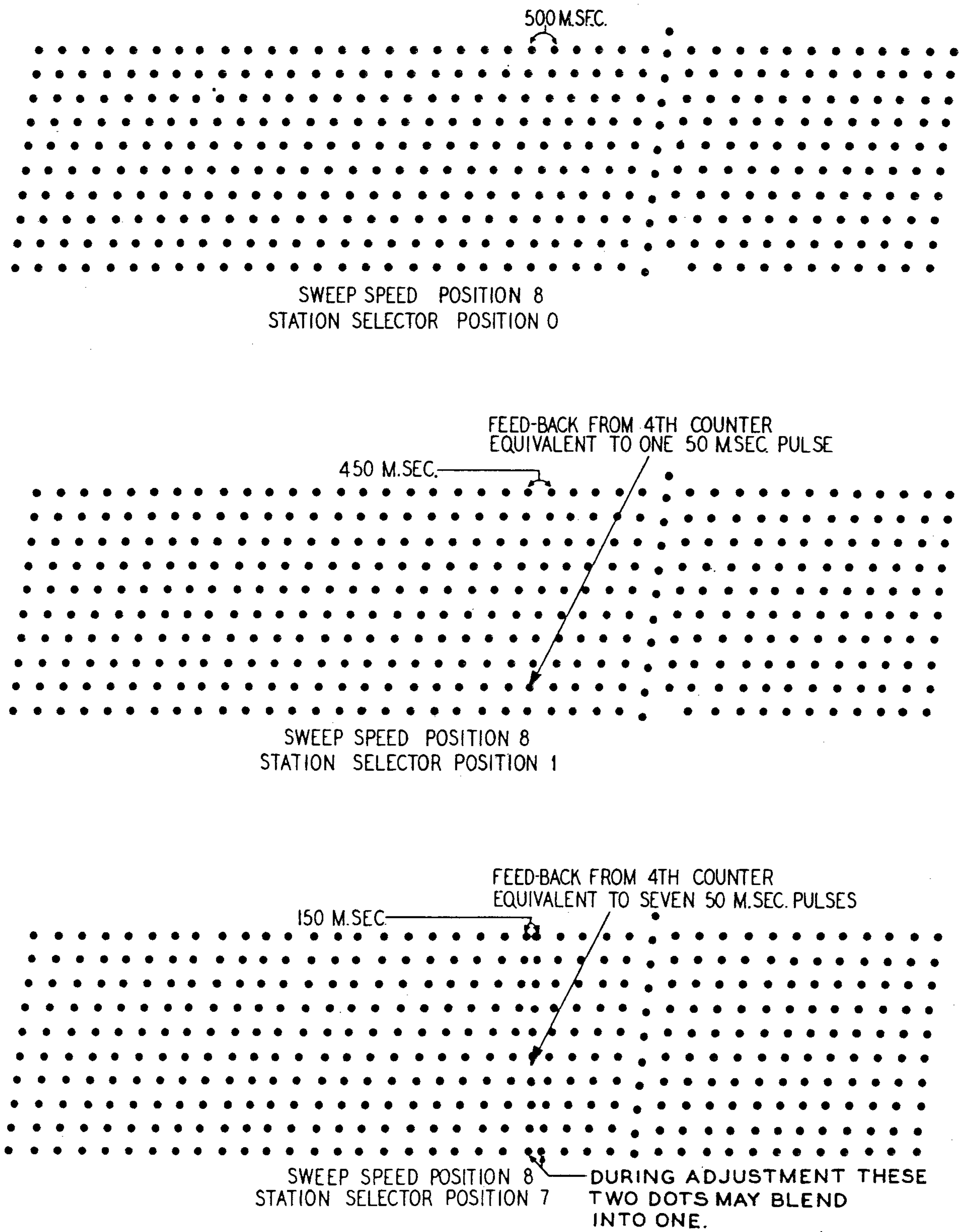


Figure 2-9. Oscilloscope Wave Forms—Station Selector Adjustments

tion "7," adjust screw driver adjustment "D" until there are eight 2500-microsecond markers on each trace. (See fig. 2-13.) The first 2500-microsecond marker should appear approximately 1800 microseconds from the beginning of the trace; the eighth 2500-microsecond marker should appear at the end of the trace.

2. Center adjustment "D" within the range providing the correct pattern.

(e) 2500-MICROSECOND MARKER ADJUSTMENT E.

1. With "SWEEP SPEED" control remaining at position "7," adjust screw driver adjustment "E" until there are six 2500-microsecond markers on each trace. (See figs. 2-14 and 2-14A.) The traces should now end with the sixth 2500-microsecond marker.

2. Center the adjustment within the range providing the correct pattern.

Note

The final settings for preceding marker adjustments as well as those for the following station adjustments can be made only when the last counter feedback controls, R239 or R341-2, have been properly adjusted. To check these adjustments, turn "SWEEP SPEED" control to position "8" and "STATION" selector to position "4." Rotate screw driver adjustment "4" or "H" to the mechanical center (screw driver slot at vertical position for Indicators ★ID-6/APN-4 and ★ID-6A/APN-4; at horizontal position for Indicator ★ID-6B/APN-4). The dots remaining in column "X" in figure 2-19A should show horizontal alignment with the dots in columns on either side. The pattern designated as "X" in figure 2-19 should show horizontal alignment with pattern "Y." Equal rotations of adjustment "4" or "H" to the left or right from center position should result in a nearly equal movement of the dots in column "X," or pattern "X," up or down from horizontal alignment with the rest of the pattern. Should it be necessary to readjust feed-back control R329 or R341-2, follow the procedure given in section V, paragraph 6.*b.*(3); after which a touch-up of the marker adjustments will probably be necessary.

(f) INDICATOR ★ID-6A/APN (MODIFIED 11) ACCORDANCE WITH TECHNICAL ORDER NO. 16-35ID6-21).—With "SWEEP SPEED" remaining at position "7," change "PRR" switch (on Indicators ★ID-6A/APN-4 modified, only) to "H" and adjust screw driver adjustment "D2" until there are six 2500-microsecond markers on each trace. The traces now end with the sixth 2500-microsecond marker. Finally, center the adjustment within the range providing the correct pattern.

(3) STATION SELECTOR ADJUSTMENTS FOR INDICATORS ★ID-6/APN-4 AND ★ID-6A/APN-4.—The "STATION" selector adjustments "E through K" provide the means for adjusting the repetition rate of the traces with any of 8 or 16 different recurrence rates of the received pulses. Proper methods of adjustment are as follows:

(a) STATION POSITION "0."

1. Turn "SWEEP SPEED" control to position "8" and "STATION" selector to position "0."

2. Patterns identical to those shown in figure 2-15 or 2-15A should appear on the indicator screen. Should a widely different pattern appear, check the accuracy of the countercircuit adjustments. Since the pulse-recurrence rate of stations received at this position is the same as the basic trace-repetition rate of the indicator, no special adjustments are required for "STATION" position "0."

(b) STATION POSITION "1."

1. Turn "STATION" selector to position "1." Observe carefully the dot pattern in column "X," figure 2-16A. Notice that the second dot, counting from the lower end of this column, has apparently moved upward to coincide or nearly coincide with the dot in the third row.

2. Adjust panel adjustment "E" until this condition is obtained. Continue the adjustment for exact horizontal alignment of the dots in column "X" with dots in the columns on either side.

(c) STATION POSITION "2."

1. Turn "STATION" selector to position "2." The screen display should appear almost like that shown in figure 2-17A. Observe that the dot in the third row of column "X," has now moved up to coincide, or nearly coincide, with the dot in the fourth row.

2. Adjust panel adjustment "F" to obtain this condition. Continue the adjustment for exact horizontal alignment of dots in column "X" with dots in the columns on either side.

(d) STATION POSITION "3."

1. Turn "STATION" selector to position "2." (See fig. 2-18A.) Observe that the dot in the fourth row of column "X" has moved upward to coincide or nearly coincide with the dot in the fifth row. Notice also that column "X" and the adjacent column of dots (to the left) are moving closer together as the "STATION" selector is rotated to the right. This condition is normal and indicates for each successive position of the "STATION" selector a deletion of 50 microseconds from the normal 500 microseconds between the start of each column.

2. Adjust panel adjustment "G" to obtain the pattern shown in figure 2-18A and exact horizontal alignment of the dots in column "X" with the dots in the columns on either side.

(e) STATION POSITION "4."

1. Turn "STATION" selector to position "4."

2. Adjust panel adjustment "H" to the center of its mechanical range (screw driver slot at vertical setting). If "FEEDBACK" control R341-2 (see fig. 8-12) were properly checked and adjusted during bench tests, the screen pattern should be as shown in figure 2-19A. Only a slight touch-up of adjustment "H" should be necessary to obtain exact horizontal alignment of the dots in column "X" with the dots in the columns on either side.

(f) STATION POSITION "5."

1. Turn "STATION" selector to position "5." Observe that the dot in the sixth row of column "X" has moved upward to coincide, or nearly coincide, with the dot in the seventh row. The faint S-shaped trace pattern in figures 2-15A thru 2-22A, inclusive, is more pronounced in some indicators than others. When definition permits, this pattern provides a good index for "STATION" adjustments, since its upper portion is always attached to the important dot in the screen display.

2. Adjust panel adjustment "I" until the pattern shown in figure 2-20A is obtained. Adjust for exact horizontal alignment of the dots in column "X" with the dots in the columns on either side.

(g) STATION POSITION "6."

1. Turn "STATION" selector to position "6." The screen display should be very similar to that shown in figure 2-21A. Observe that only four dots now appear in column "X," one at the bottom and three near the top. Notice also that column "X" has now moved to the left until the three dots near the top are touching and partially overlapping those in the adjacent column.

2. Adjust panel adjustment "J" until these dots are horizontally aligned.

(h) STATION POSITION "7."

1. Turn "STATION" selector to position "7." (See fig. 2-22A.) The two dots now remaining at the top of column "X" are now nearly coincident with the two upper dots in the adjacent column to the left. The lower dot in column "X" is now merged with the lower dot in the column of dots to its right.

2. Adjust panel adjustment "K" until the two upper dots in column "X" are most nearly merged or horizontally aligned with the two upper dots in the column to the left.

(4) COARSE AND FINE DELAY ADJUSTMENTS.—The settings for panel adjustments "ADJ. 0" and "ADJ. 10,000" determine the effective range of the B-pedestal "COARSE" control. The settings for panel adjustments "ADJ. 200" and "ADJ. 700" determine the range of the "FINE" control which may be considered as a vernier for the "COARSE" control. In the following adjustment procedures it is assumed that, during bench tests and adjustments, the function of pedestal controls and adjustments were found or made normal, and that all adjustments were left at or near their correct positions. Should the position of the "B" pedestal indicate that more than just a touch-up of the adjustments is necessary, refer to section V, paragraphs 6.*b.*(4)*(a)* and 6.*b.*(4)*(b)* for more complete instructions.

(a) COARSE CONTROL ADJUSTMENTS "ADJ. 0" AND "ADJ. 10,000"—USING INDEX-MARKED CONTROLS.

1. Turn "SWEEP SPEED" control to position "7" and "STATION" selector to position "0." (See fig. 2-23.)

2. Rotate both "COARSE" and "FINE" controls counterclockwise until their index marks are in line with the panel index marks.

3. Adjust "ADJ. 0" until the left edge of the "B" pedestal falls between the first 2500-microsecond marker and the first 500-microsecond marker to its right. The edge of the "B" pedestal should be approximately 200 microseconds to the right of the first 2500-microsecond marker on the "B" trace.

4. Rotate "COARSE" control clockwise until the mark on the "COARSE" dial is in line with the panel index mark. (See fig. 2-25.)

5. Adjust "ADJ. 10,000" until left edge of "B" pedestal falls between the fifth 2500-microsecond marker on the "B" trace and the 500-microsecond marker to its right.

6. Recheck "ADJ. 0" for possible interlocking effects between "ADJ. 10,000" and "ADJ. 0." Be sure to center each adjustment within the range providing the correct pattern.

(b) FINE CONTROL ADJUSTMENTS "ADJ. 200" AND "ADJ. 700"—USING INDEX-MARKED CONTROLS.

1. Turn "SWEEP SPEED" to position "6." (See fig. 2-26.)

2. Adjust "COARSE" control to the center of its range.

3. Rotate "FINE" control counterclockwise until the right dial mark is in line with the panel index.

4. Adjust "ADJ. 200" to the center of its mechanical range, then to the left or right until there are four 50-microsecond spaces between the 500-microsecond marker on the "B" trace and the 500-microsecond marker to its right on the "A" trace.

5. Turn "FINE" control clockwise until left dial mark is in line with the panel index mark. (See fig. 2-27.)

6. Adjust "ADJ. 700" until the pattern is the same as that of the preceding "FINE" adjustment. There is considerable interlocking between adjustments "ADJ. 200" and "ADJ. 700" of the "FINE" control. To obtain correct results, touch-up adjustments.

(5) COARSE AND FINE ADJUSTMENTS (USING UNMARKED CONTROL KNOBS).—Proceed as in paragraph 2.*c.*(5), this section.

c. INDICATOR ★ID-6B/APN-4. — The "SWEEP SPEED," "STATION," "COARSE," and "FINE" controls on Indicator ★ID-6B/APN-4 require periodic checking and adjustment to insure proper operation of the equipment. Access to the adjustments for these con-

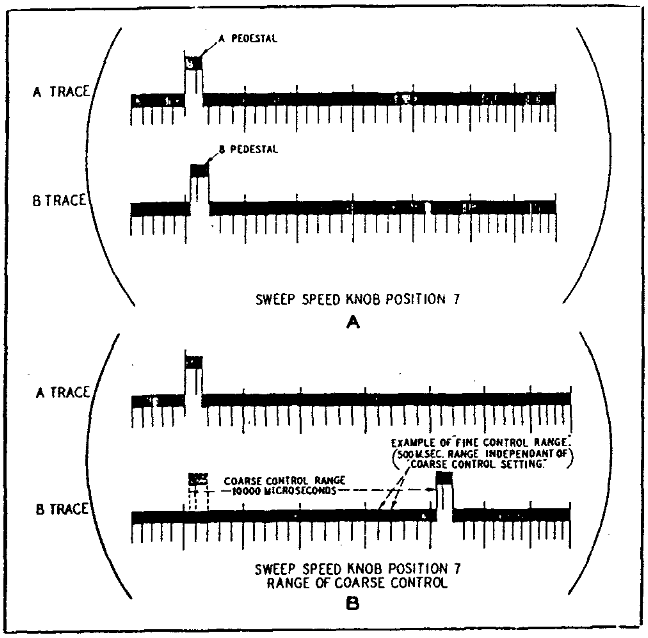


Figure 2-10. Oscilloscope Wave Forms Showing Pedestals

trols are through holes located on the front panel. They are lettered "A" to "E," "2," "4," and "6," "ADJ. 0," "ADJ. 10,000," "ADJ. 200," and "ADJ. 700." The adjustments associated with the "SWEEP SPEED," "COARSE" and "FINE" controls are variable resistors, and are adjusted by a screw driver of the proper size. The adjustments associated with the "STATION" selector are variable capacitors and require the use of a non-metallic screw driver.

Note

When making indicator adjustments, be sure to center the final setting with the range providing the correct pattern, rather than at any point giving the desired effect. To attain the correct setting, first adjust for the correct pattern on the indicator screen; then, while rotating the adjustment alternately to the left and right, fix the setting mid-way between the two points where a change in pattern takes place.

(1) PRELIMINARY ADJUSTMENTS.

(a) Turn the "PWR. ON OFF" switch on the receiver to "ON." Allow 4 or 5 minutes for the tubes to heat properly and the circuit functions to become stabilized.

(b) Install the visor on the rim of the indicator screen.

(c) Turn the "STATION" selector switch to position "0" and the "SWEEP SPEED" control to position "7." Adjust the "INTENSITY" and "FOCUS" controls to obtain suitable brilliance and definition of pattern. Two traces should now appear on the indicator screen. (See fig. 2-13.) The upper trace will hereafter be referred to as the A-trace, the lower one as the B-trace. A small portion of each trace is raised, forming pedestals. The position of the A-pedestal is fixed on the A-trace; the position of the B-pedestal can be varied by adjusting the "COARSE" and "FINE" controls on the indicator panel.

(2) MARKER (COUNTER CIRCUIT) ADJUSTMENTS.

(a) Turn "SWEEP SPEED" to position "5." (See fig. 2-11.) Short, positive markers (upward indications) and longer negative markers (downward indications) appear on both the A- and B-traces. The short markers are the 10-microsecond markers; the longer ones are the 50-microsecond markers. Adjust screw driver adjustment "A" until exactly five 10-microsecond spaces or four 10-micro-

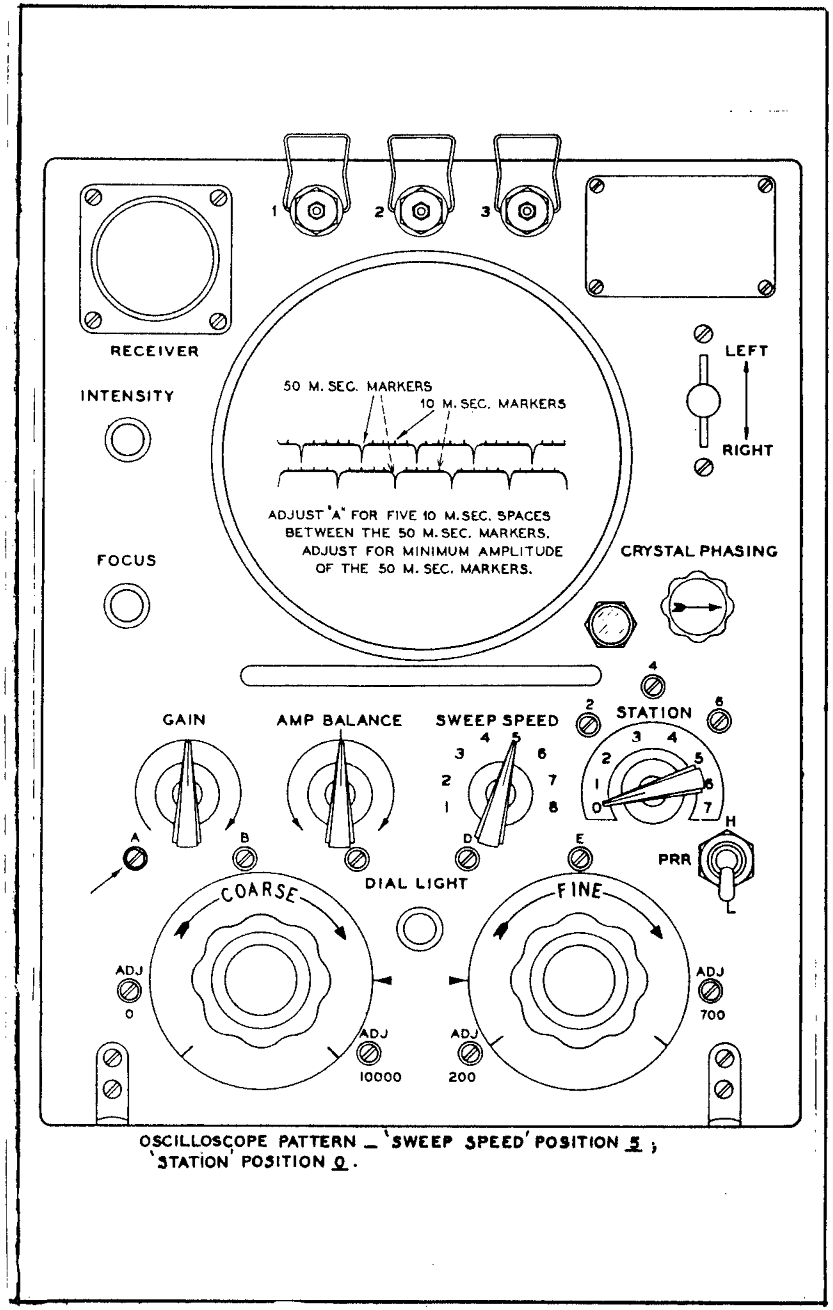


Figure 2-11. Indicator ★ID-6B/APN-4—Counter Circuit Alignment, Adjustment A

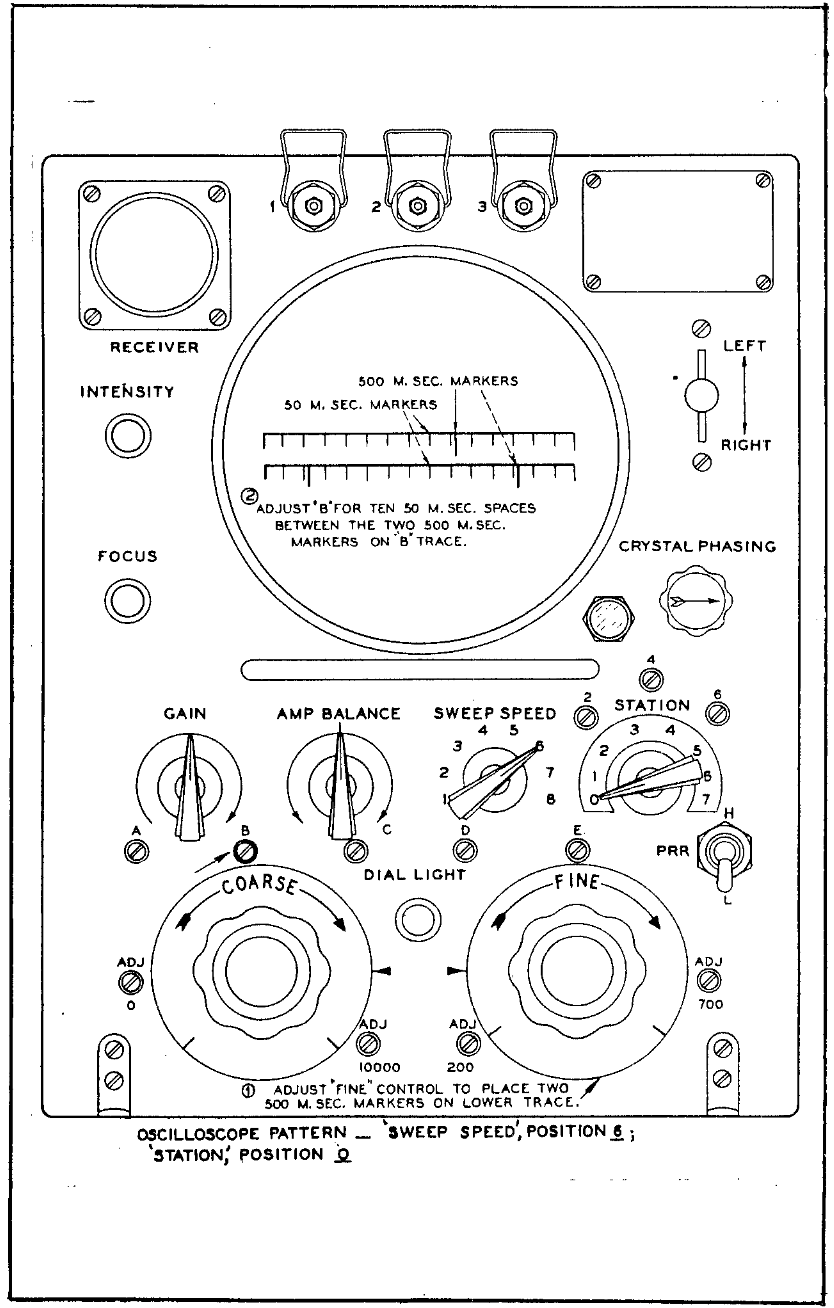
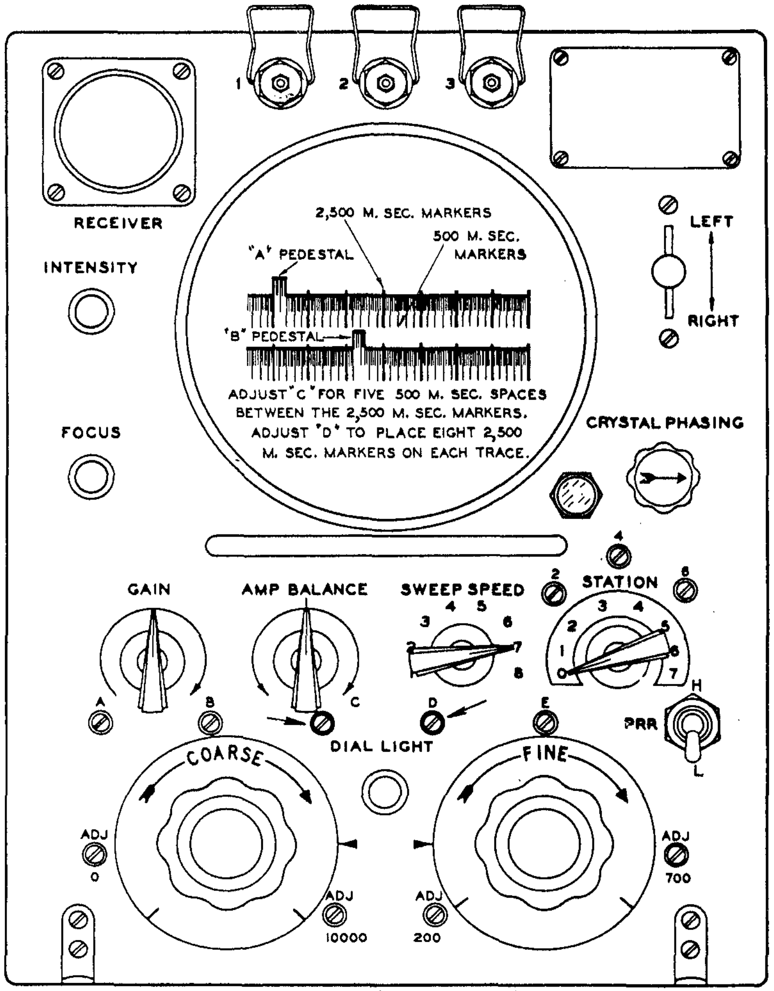
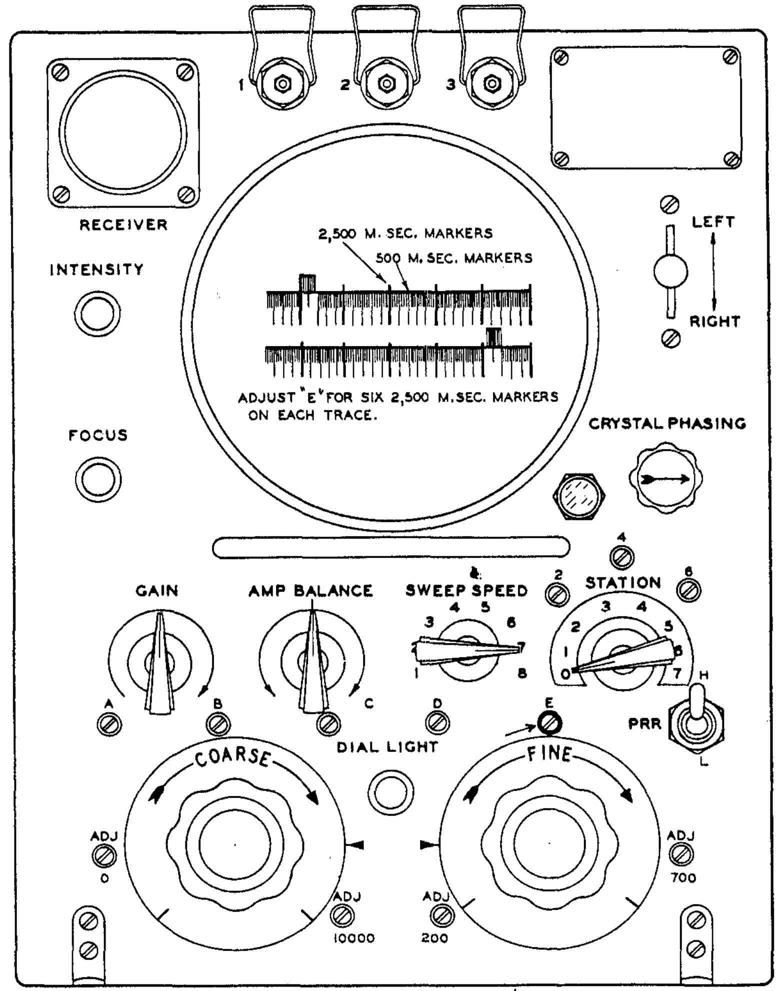


Figure 2-12. Indicator ★ID-6B/APN-4—Counter Circuit Alignment, Adjustment B



OSCILLOSCOPE PATTERN — 'SWEEP SPEED' POSITION, 7; 'STATION' POSITION, 0; 'PRR' POSITION, L.

Figure 2-13. Indicator ★ID-6B/APN-4—Counter Circuit Alignment, Adjustments C and D



OSCILLOSCOPE PATTERN — 'SWEEP SPEED' POSITION, 7; 'STATION' POSITION, 0; 'PRR' POSITION, H.

Figure 2-14. Indicator ★ID-6B/APN-4—Counter Circuit Alignment, Adjustment E

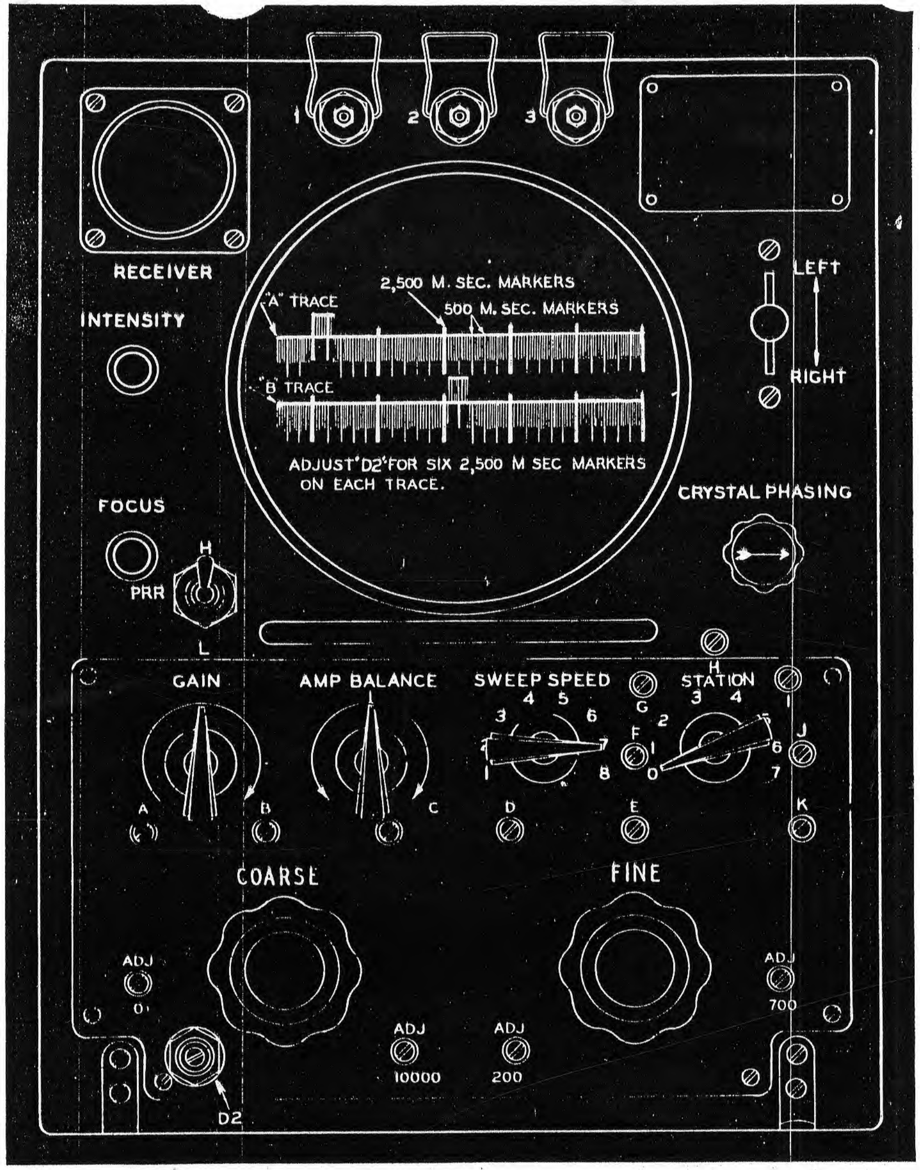


Figure 2-14A. Indicator ★ID-6A/APN-4—Counter Circuit Alignment, Adjustment "D2" After Modification In Accordance With Technical Order No. 16-35ID6-21

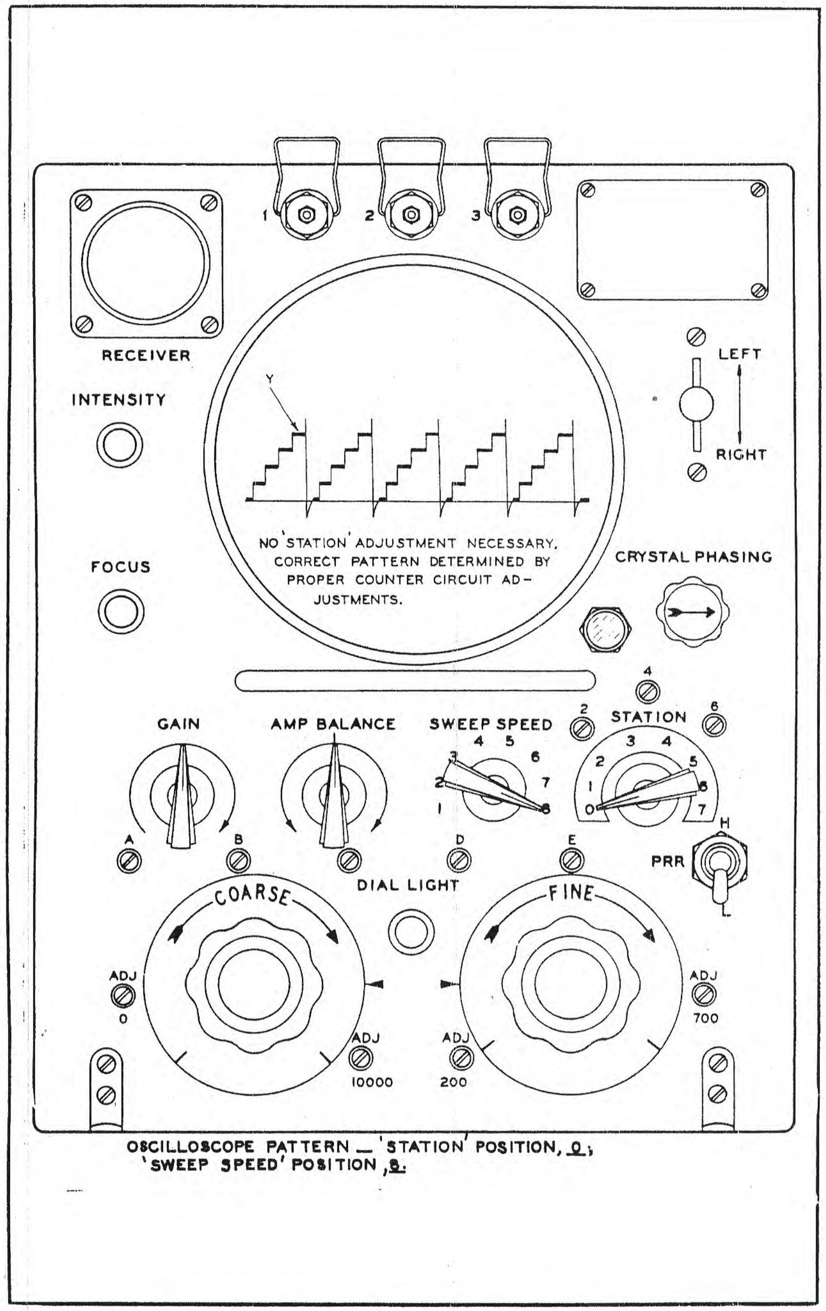


Figure 2-15. Indicator ★ID-6B/APN-4—"STATION" Selector Adjustment—Position "O"

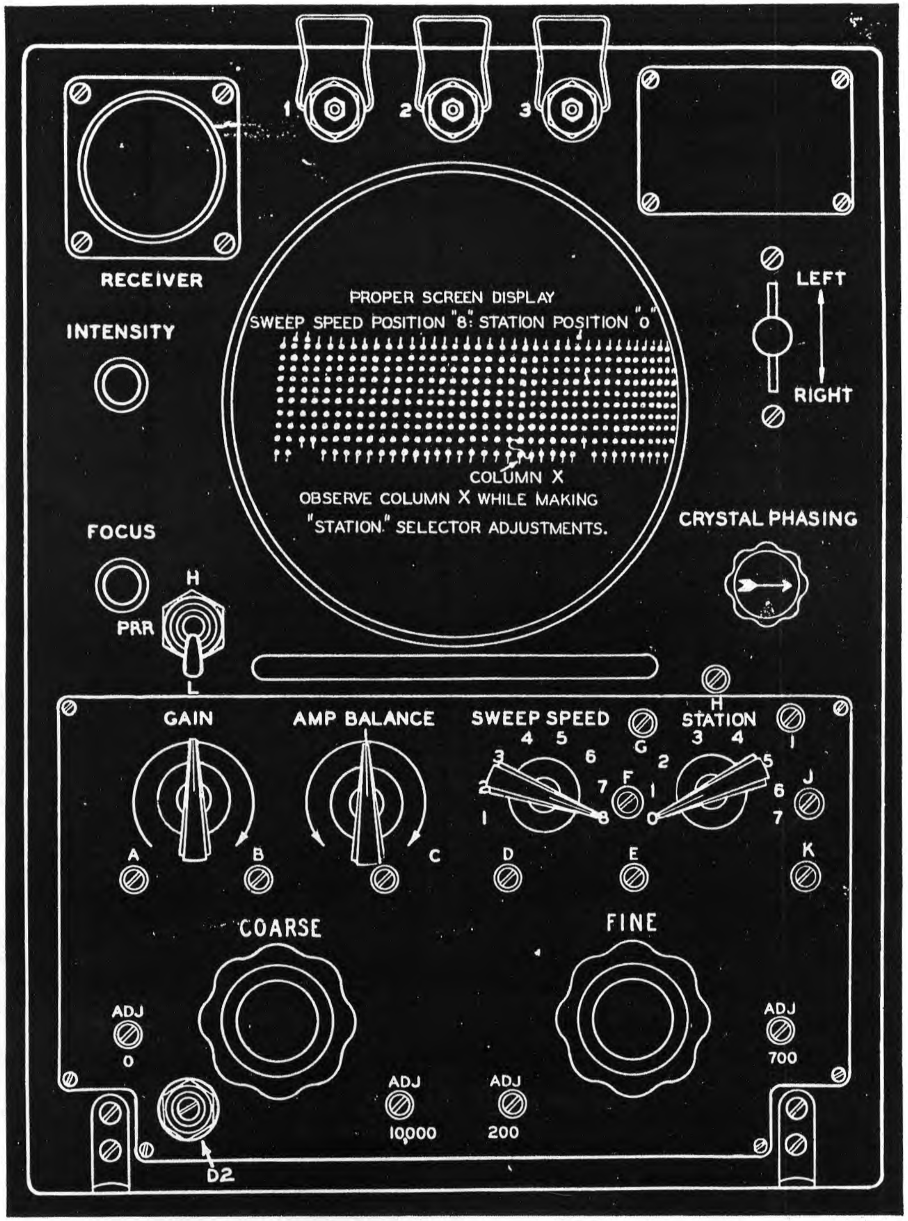


Figure 2-15A. Indicators ★ID-6/APN-4 and ★ID-6A/APN-4—Screen Display "STATION" Selector—Position "0"

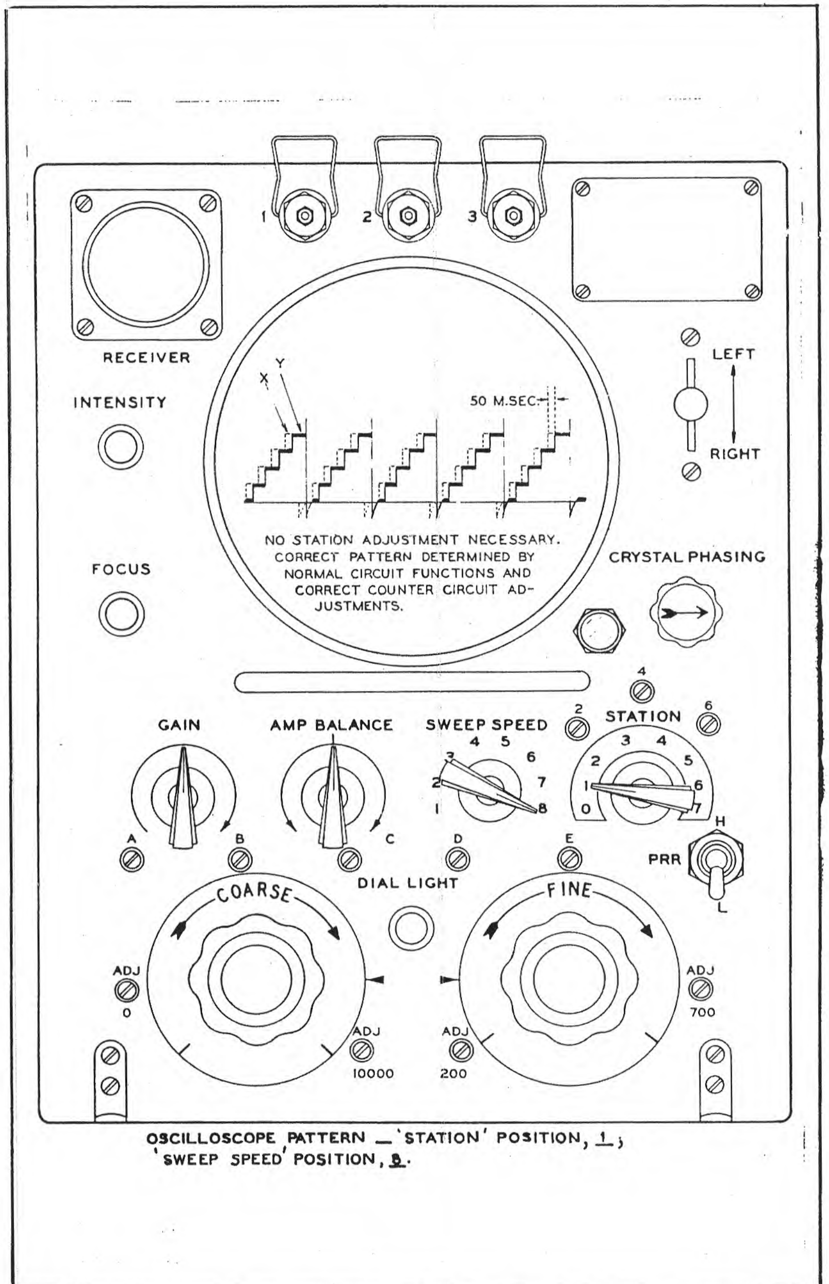


Figure 2-16. Indicator ★ID-6B/APN-4—"STATION" Selector Adjustment—Position "1"

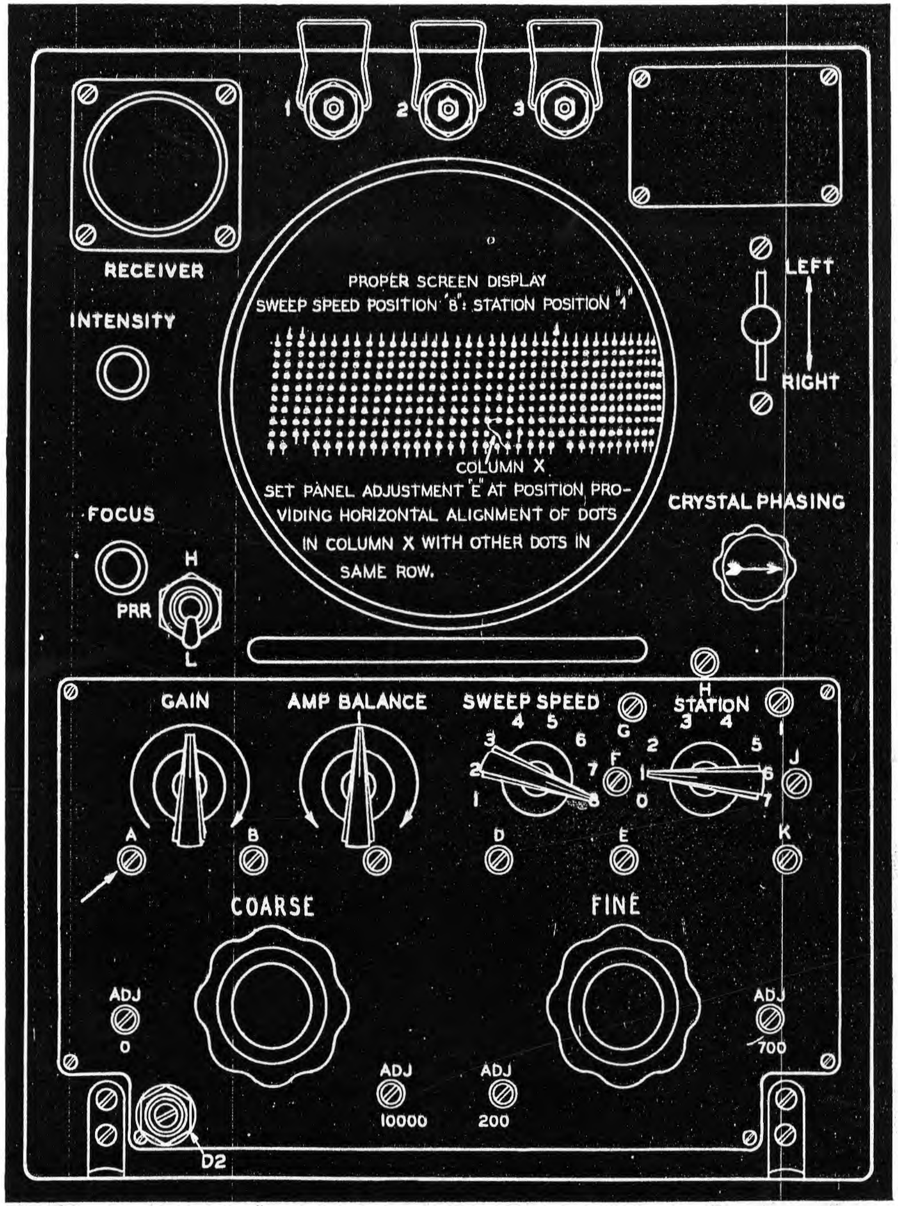


Figure 2-16A. Indicators ★ID-6/APN-4 and ★ID-6A/APN-4—Screen Display "STATION" Selector—Position "1"

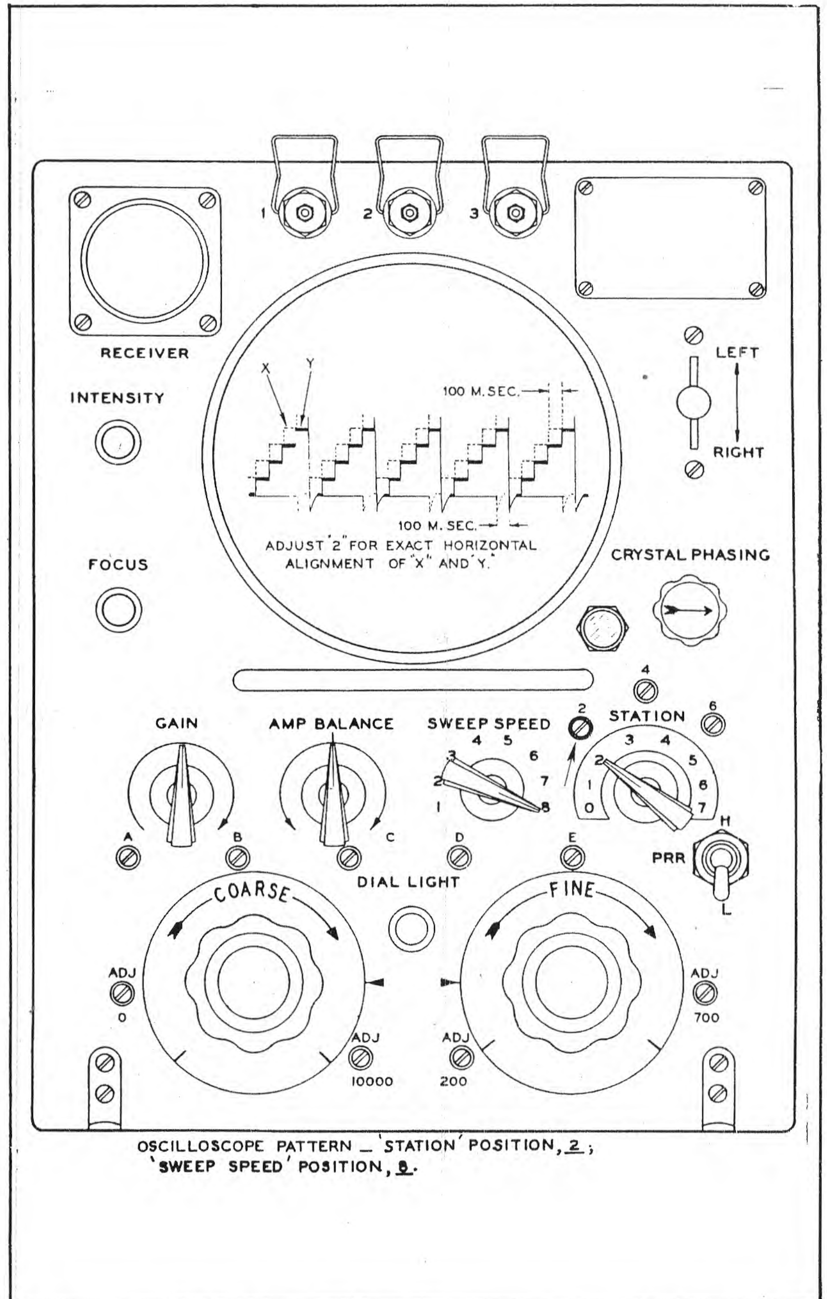


Figure 2-17. Indicator ★ID-6B/APN-4—"STATION" Selector Adjustment—Position "2"

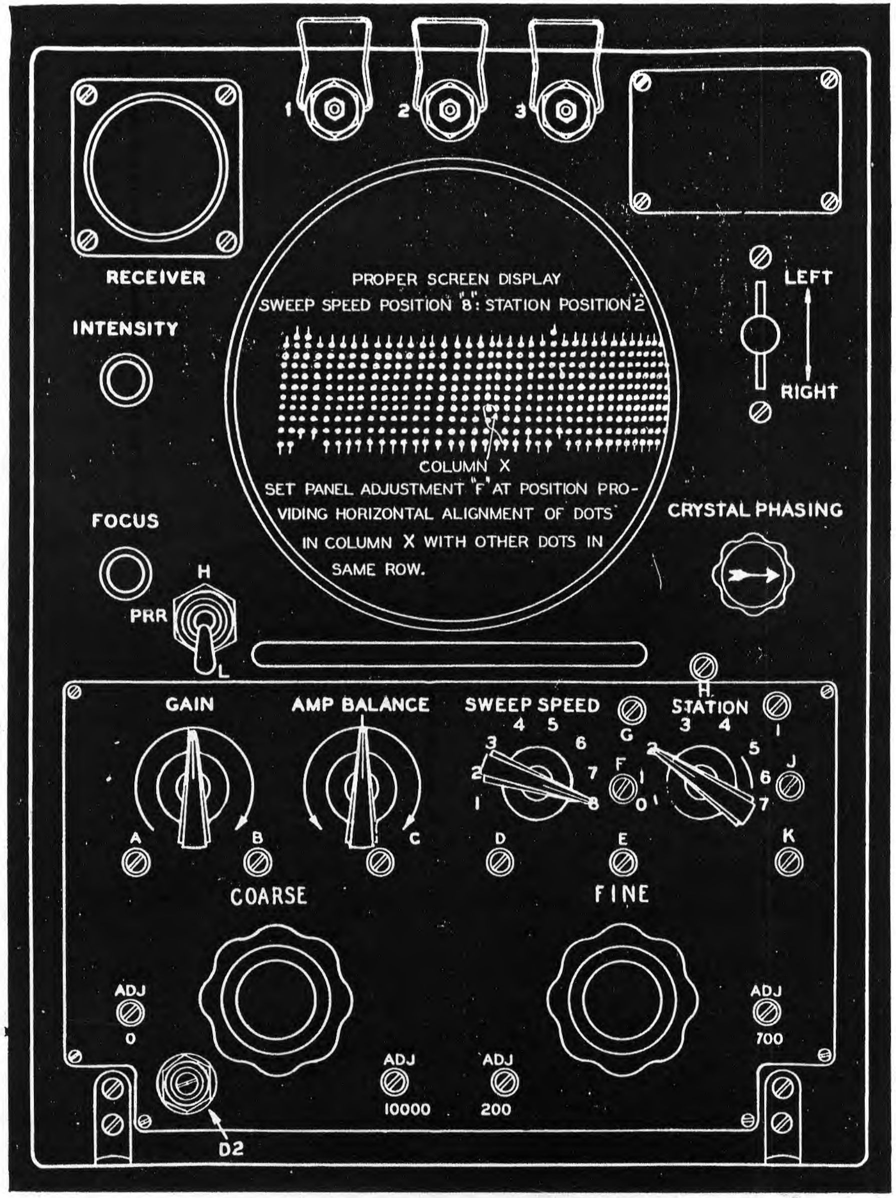
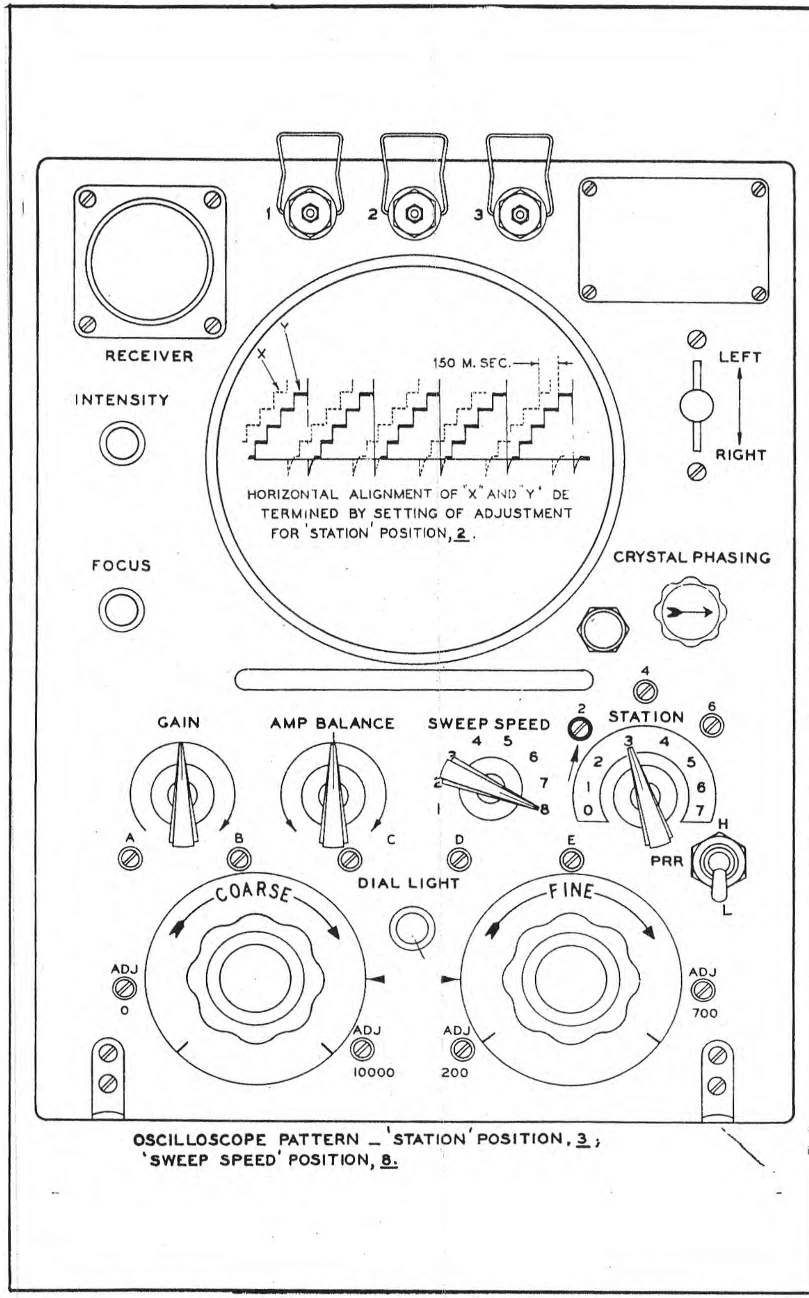


Figure 2-17A. Indicators ★ID-6/APN-4 and ★ID-6A/APN-4—Screen Display "STATION" Selector—Position "2"



OSCILLOSCOPE PATTERN _ 'STATION' POSITION, 3; 'SWEEP SPEED' POSITION, 8.

Figure 2-18. Indicator ★ID-6B/APN-4—"STATION" Selector Adjustment—Position "3"

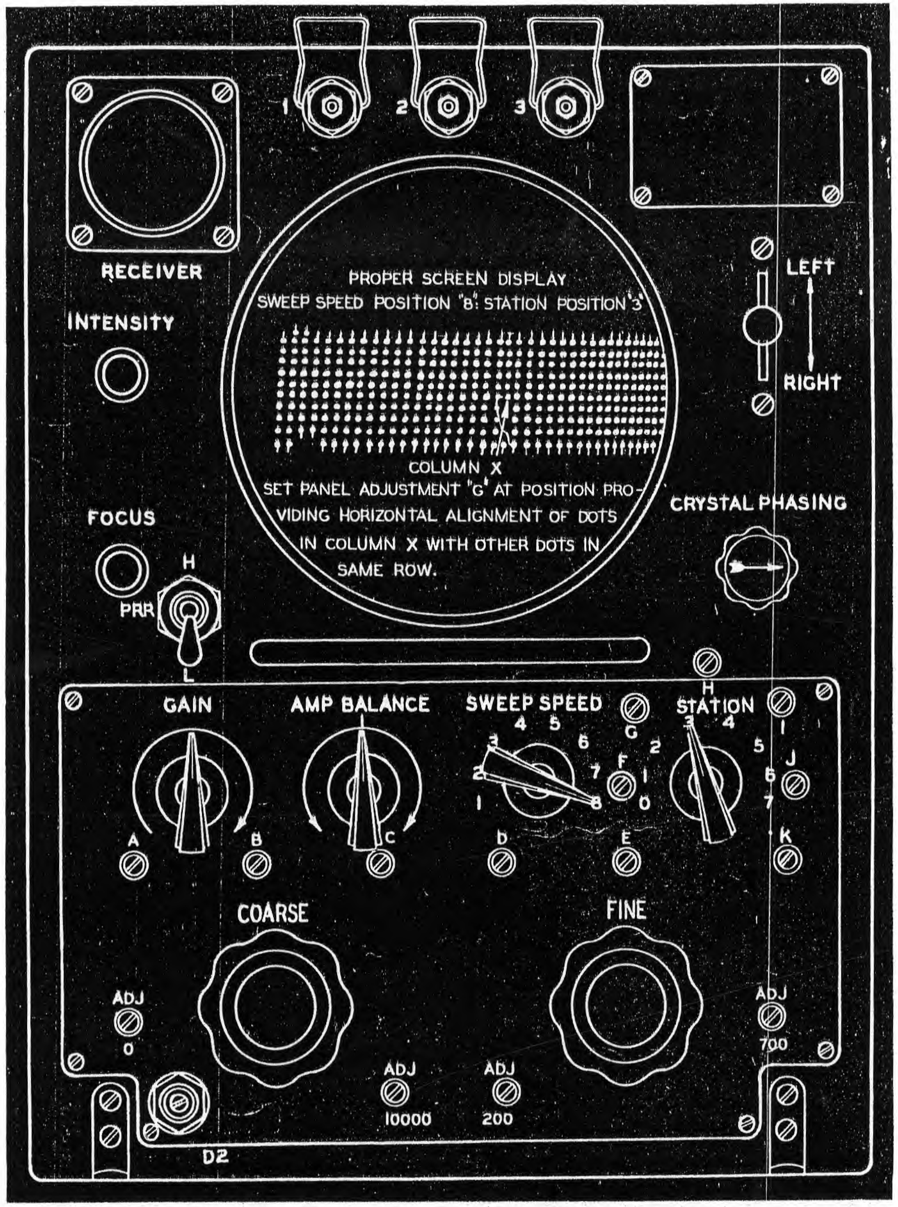


Figure 2-18A. Indicators ★ID-6/APN-4 and ★ID-6A/APN-4—Screen Display "STATION" Selector—Position "3"

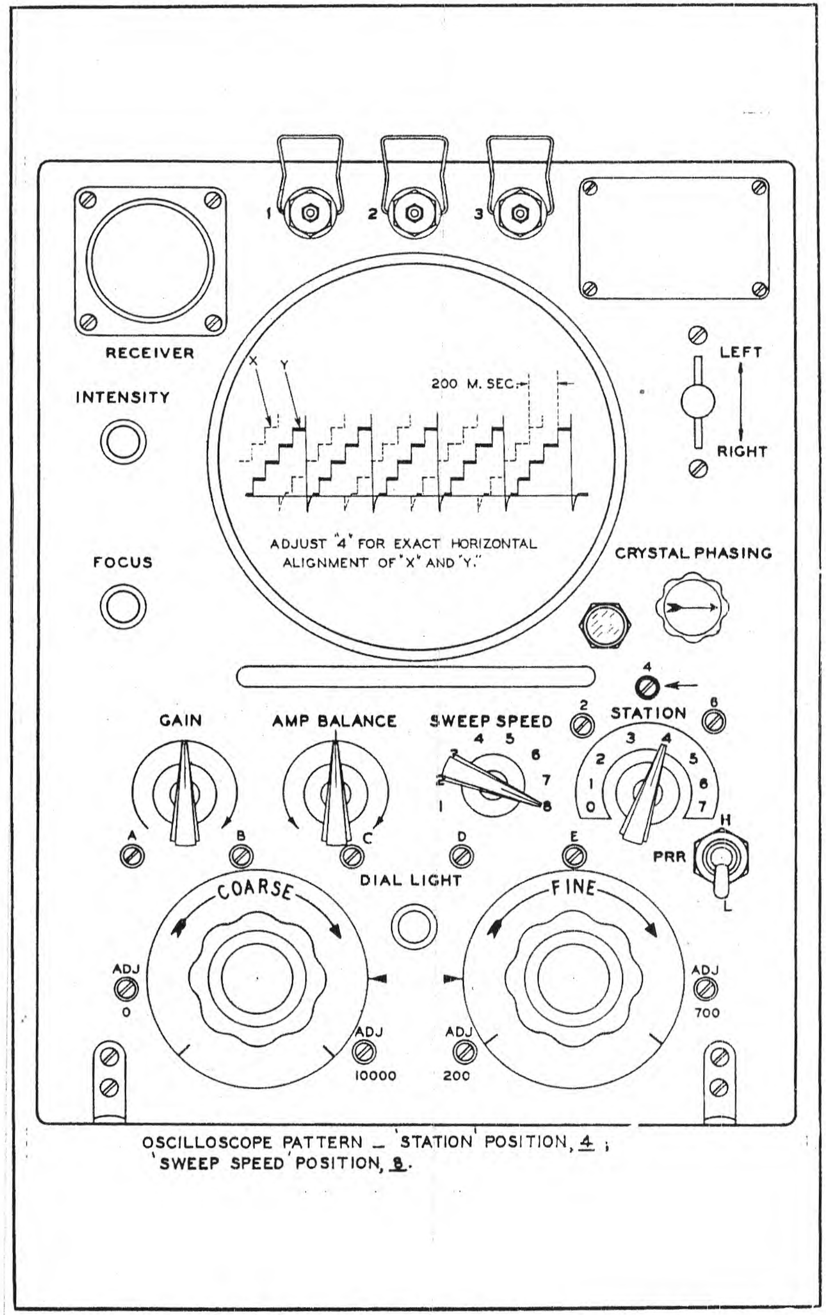


Figure 2-19. Indicator ★ID-6B/APN-4—"STATION" Selector Adjustment—Position "4"

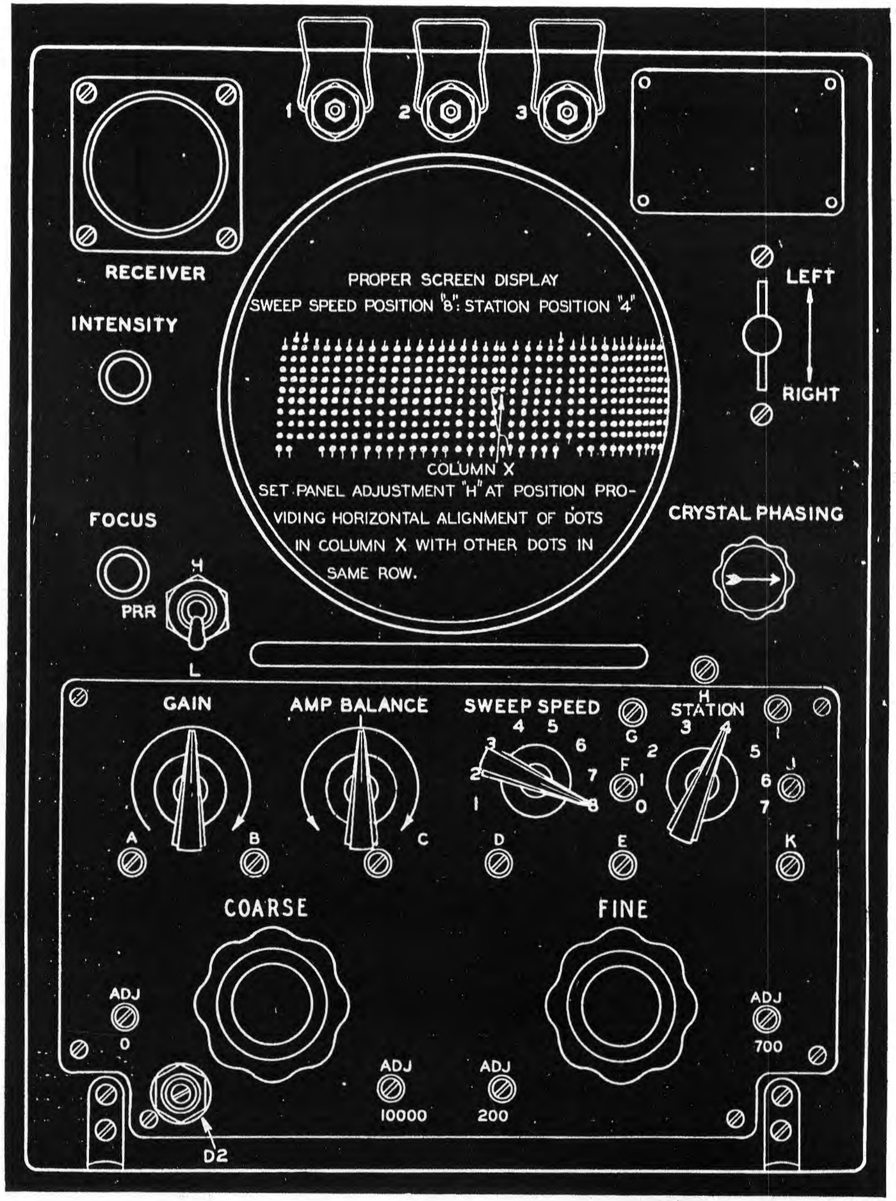


Figure 2-19A. Indicators ★ID-6/APN-4 and ★ID-6A/APN-4—Screen Display "STATION" Selector—Position "4"

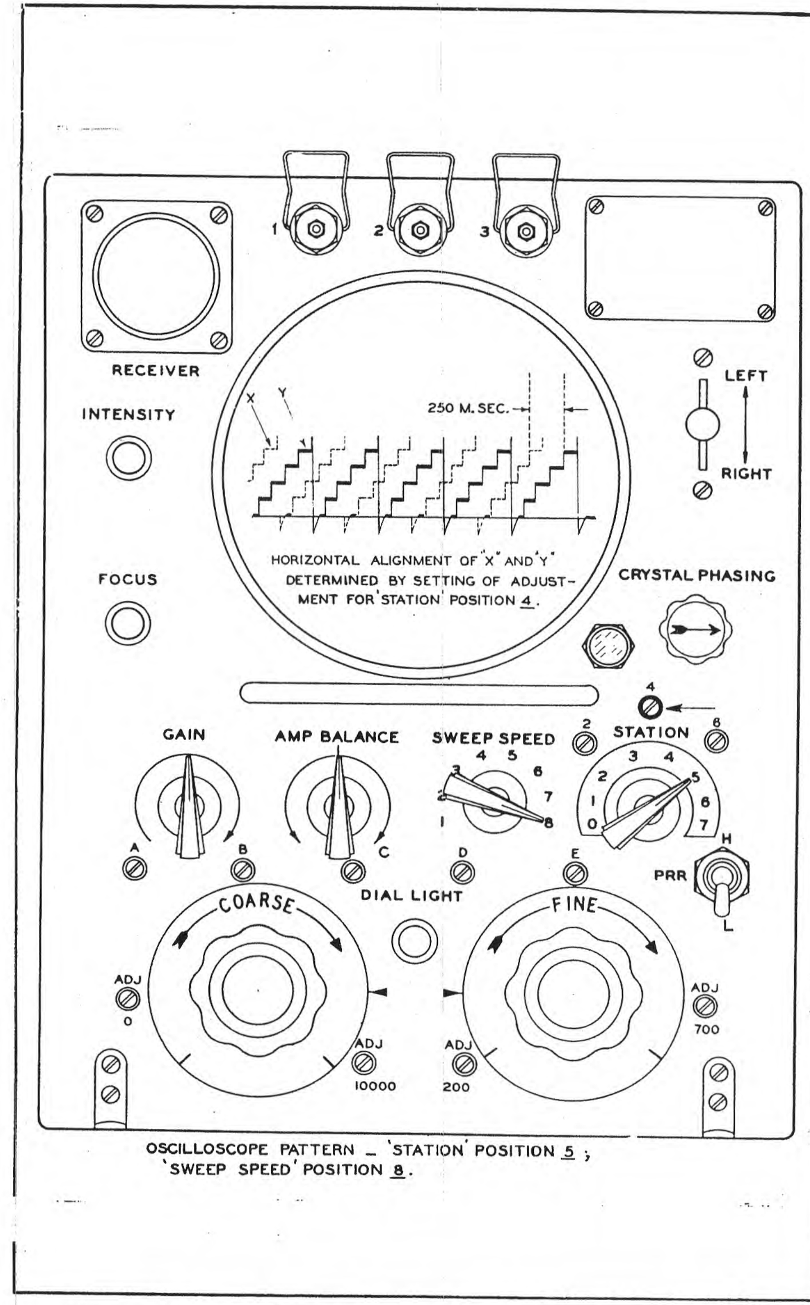


Figure 2-20. Indicator ★ID-6B/APN-4—"STATION" Selector Adjustment—Position "5"

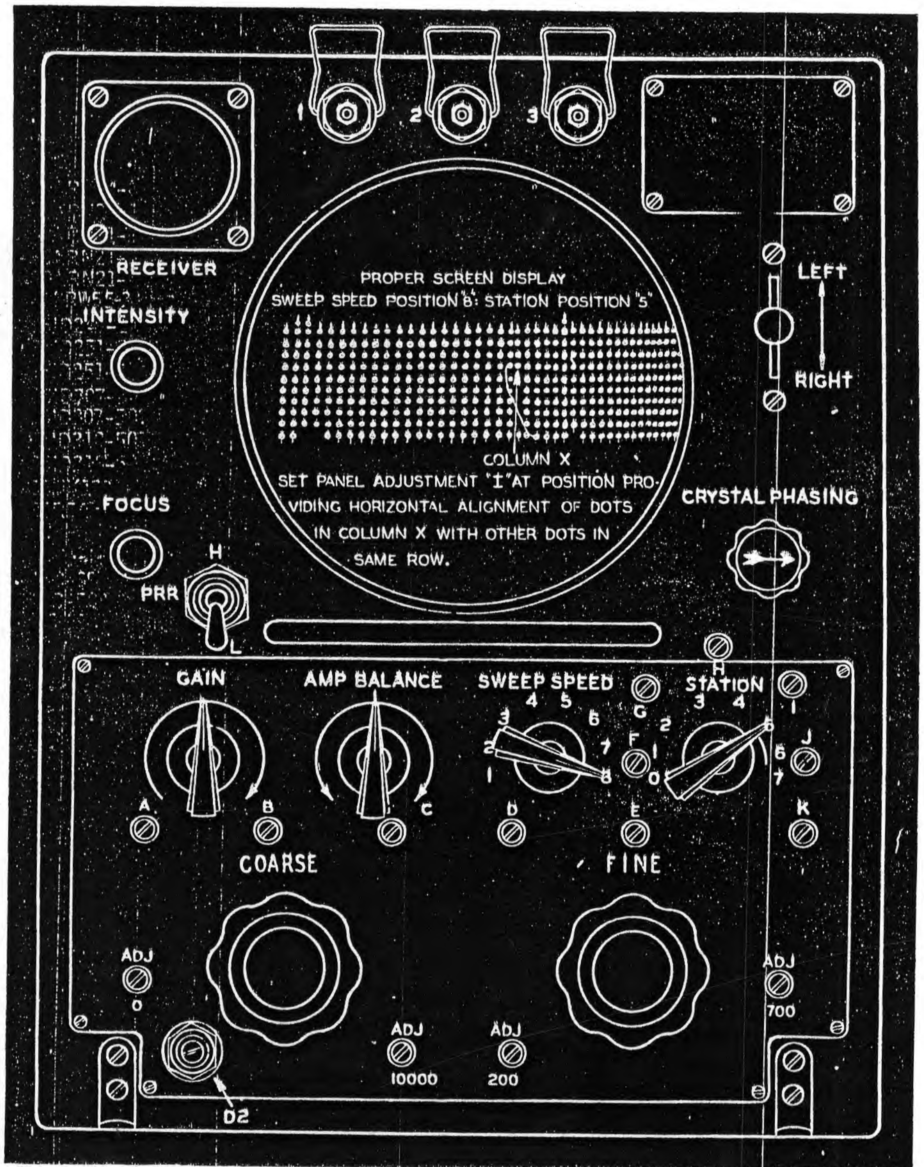


Figure 2-20A. Indicators ★ID-6/APN-4 and ★ID-6A/APN-4—Screen Display "STATION" Selector—Position "5"

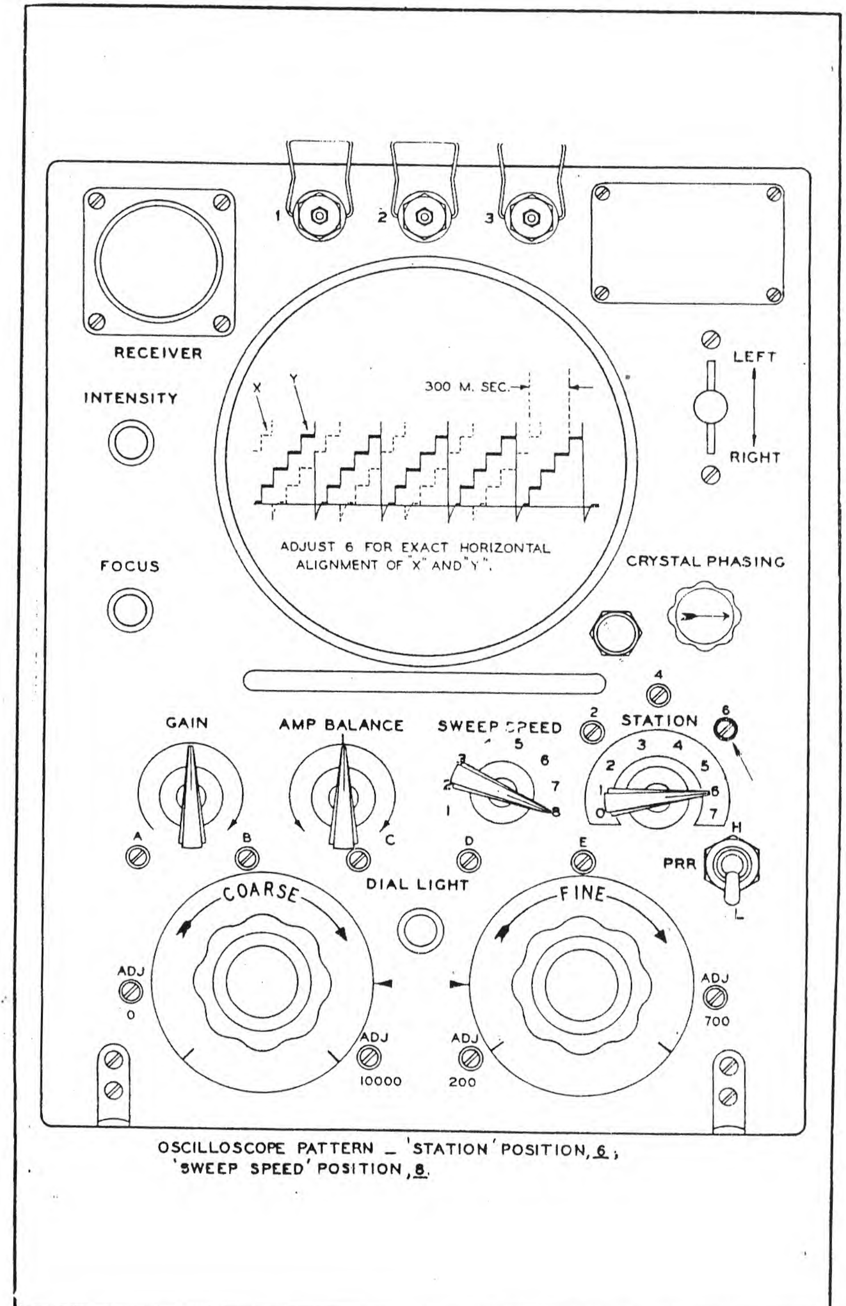


Figure 2-21. Indicator ★ID-6B/APN-4—"STATION" Selector Adjustment—Position "6"

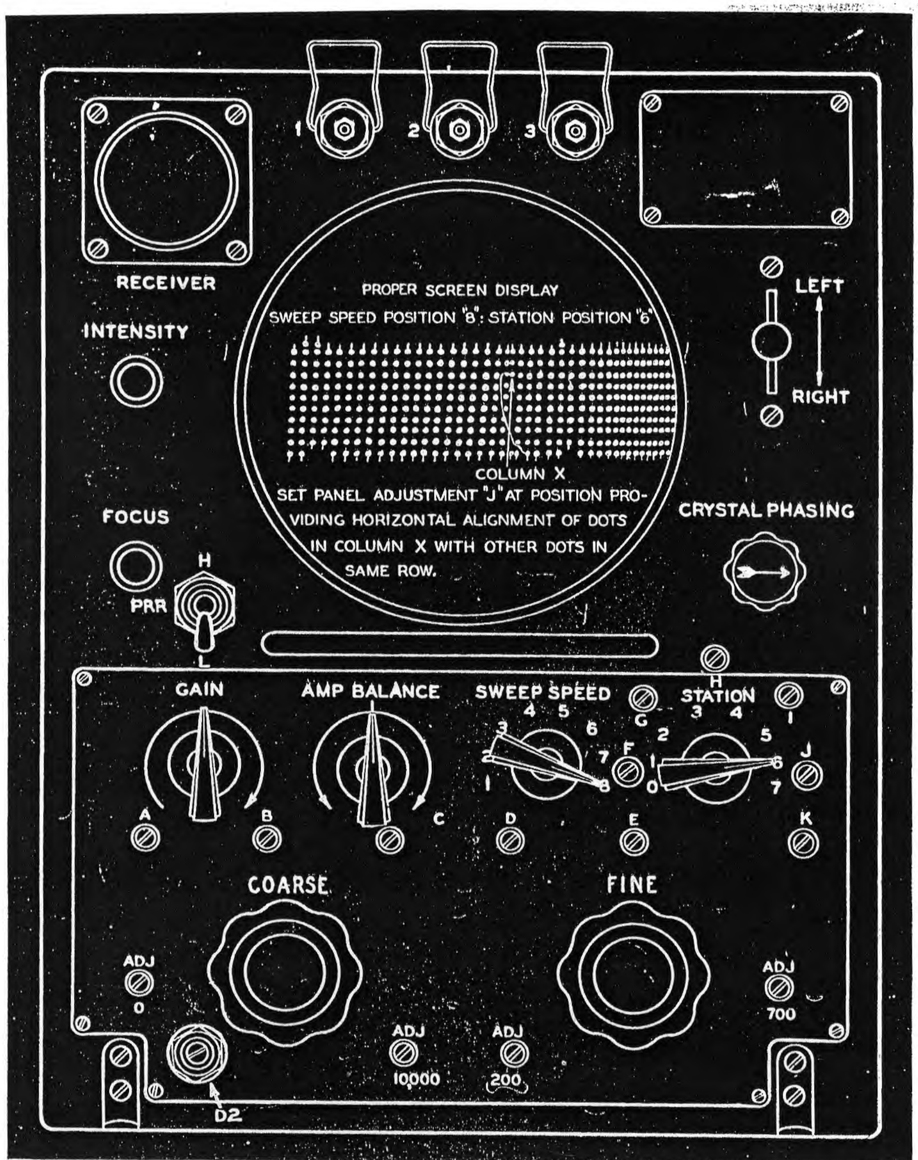


Figure 2-21A. Indicators ★ID-6/APN-4 and ★ID-6A/APN-4—Screen Display "STATION" Selector—Position "6"

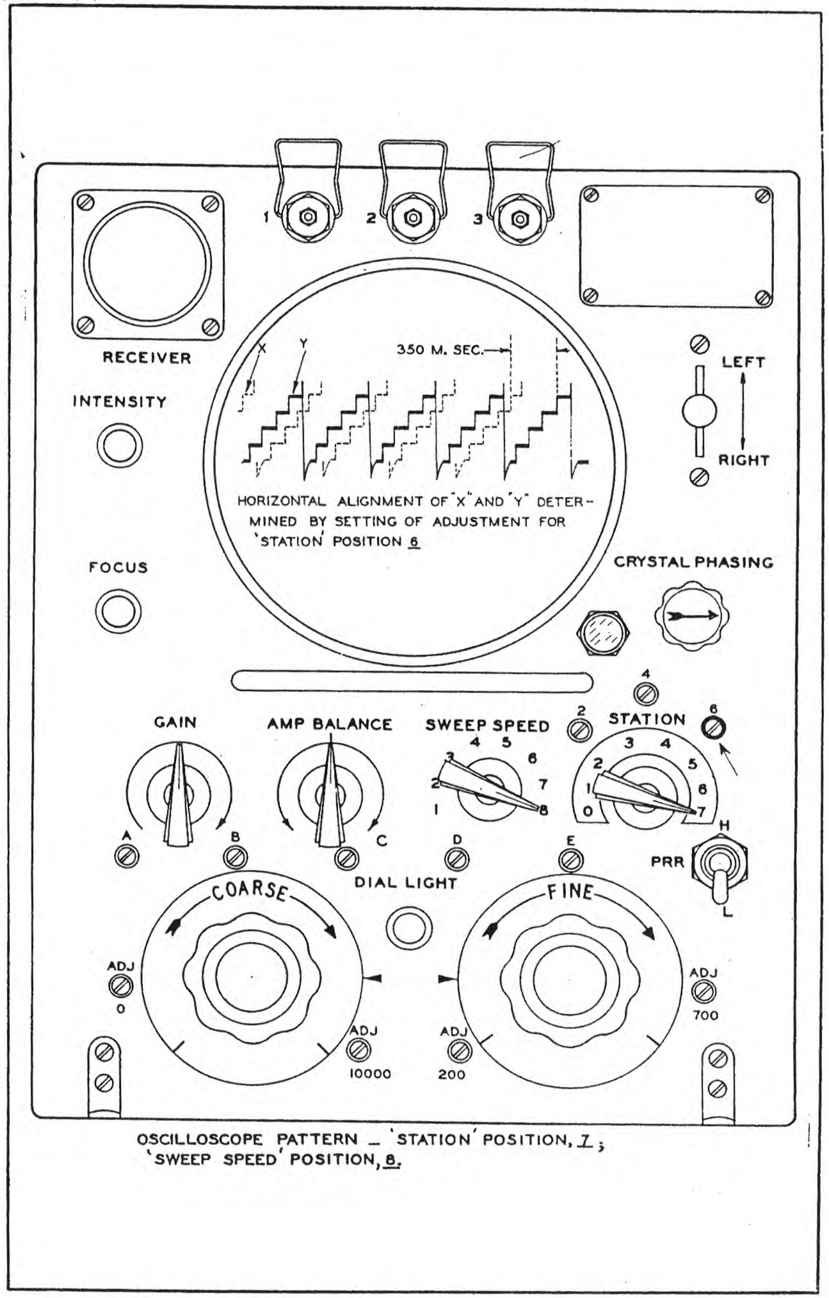


Figure 2-22. Indicator ★ID-6B/APN-4—"STATION" Selector Adjustment—Position "7"

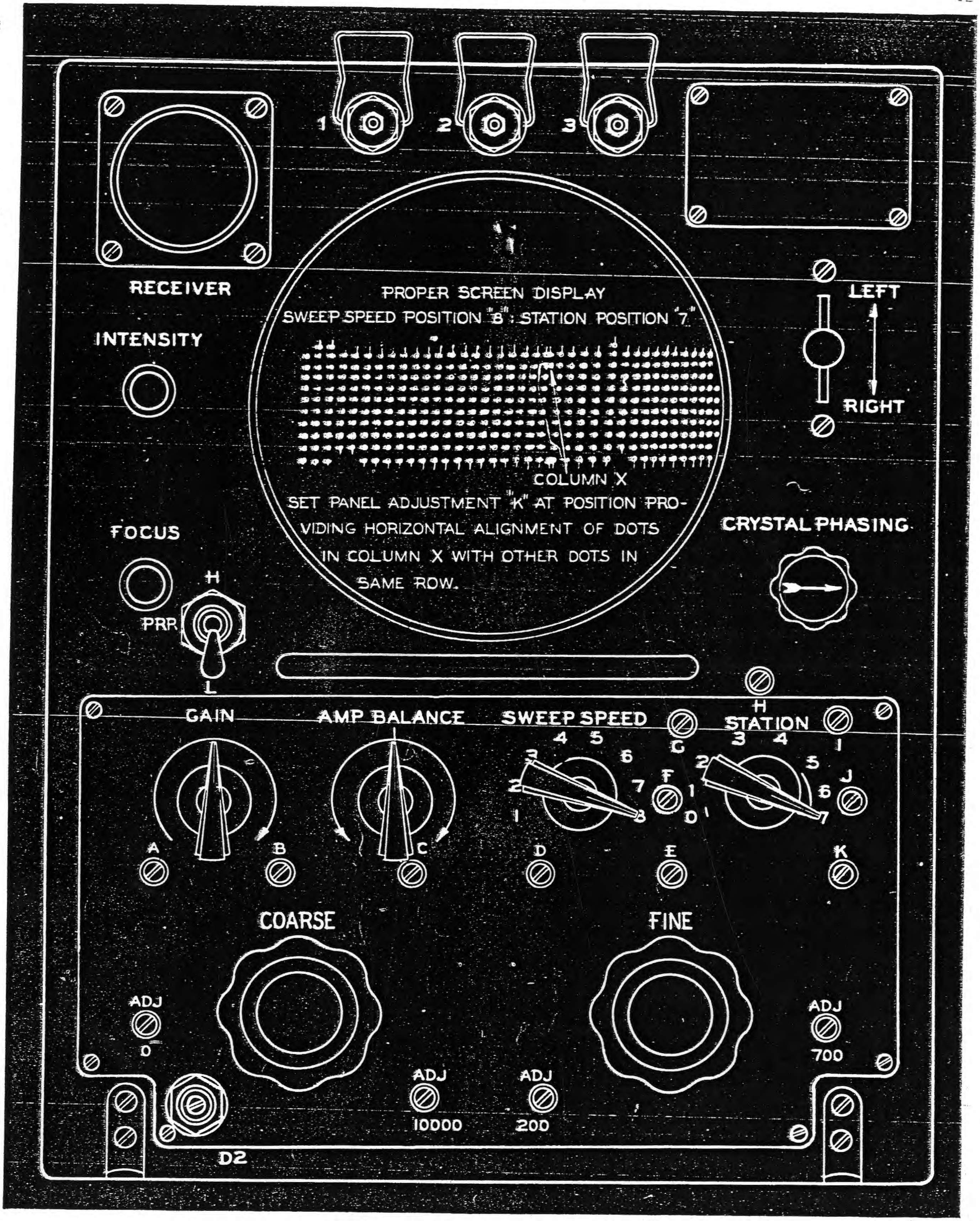


Figure 2-22A. Indicators ★ID-6/APN-4 and ★ID-6A/APN-4—Screen Display "STATION" Selector—Position "7" second markers exist between 50-microsecond markers. Leave the adjustment at the position resulting in minimum amplitude of the 50-microsecond markers.

(b) Turn "SWEEP SPEED" to position "6". (See fig. 2-12.) Downward markers, some of which are longer than others, appear on both traces. The short downward markers are the 50-microsecond markers; the longer ones are the 500-microsecond markers. Turn the "FINE" control until the two 500-microsecond markers appear on the "B" trace. Adjust screwdriver adjustment "B" until there are exactly ten 50-microsecond spaces between the 500-microsecond markers. Center the adjustment as explained in paragraph 2.*c.*, this section. The fact that the tenth 50-microsecond marker is not coincident with the 500-microsecond marker is not an evidence of misalignment, but a normal condition which does not affect accuracy of operation.

(c) Turn "SWEEP SPEED" to position "7" and the "PRR" switch to position "L." The two traces appear with their respective pedestals. (See fig. 2-13.) The 50- and 500-microsecond markers appear together with long, downward 2500-microsecond markers which extend above the traces.

(d) Turn screwdriver adjustment "C" until exactly five 500-microsecond spaces of four 500-microsecond markers appear between the 2500-microsecond markers. Be sure to center the adjustment within the range providing the correct pattern.

(e) With "SWEEP SPEED" still in position "7" and "PRR" remaining at "L," adjust screwdriver adjustment "D" until there are eight 2500-microsecond markers on each trace. (See fig. 2-13.) The first 2500-microsecond marker appears approximately 1800 microseconds from the beginning of the trace; the eighth 2500-microsecond marker appears exactly at the end of the trace.

(f) With "SWEEP SPEED" remaining at position "7," change the "PRR" switch to "H" and adjust screwdriver adjustment "E" until there are six 2500-microsecond markers on each trace. (See fig. 2-14.) The traces now end with the sixth 2500-microsecond marker. Finally, center the adjustment within the range providing the correct pattern.

(3) "STATION" SELECTOR ADJUSTMENTS.—"STATION" selector adjustments "2", "4", and "6" provide for the adjustment of the repetition rate of the traces with any one of 16 different recurrence rates of the received pulses. Proper methods of adjustment are as follows:

(a) Turn "SWEEP SPEED" to position "8" and the "STATION" selector to position "O". A pattern (fig. 2-15) should appear on the indicator screen. Should a different pattern appear, check the accuracy of the counter-circuit adjustments. Since the pulse recurrence rate of stations received at this position is the same as the basic trace repetition rate of the indicator, no special adjustments are required for "STATION" position "O".

(b) Turn the "STATION" selector to position "1." A slightly different screen pattern now appears. (See fig. 2-16.) The original pattern, designated as Y, has moved slightly to its left, a similar but less brilliant pattern, designated as X. The horizontal alignment of the X and Y patterns at the left edge of the screen is an indication that "STATION" selector circuits are functioning correctly. No special adjustments of "STATION" position "1" are necessary; its alignment is taken care of by the normal functions of the circuit components.

(c) Turn the "STATION" selector to position "2." A pattern (fig. 2-17) now appears on the indicator screen.

Adjust "STATION" adjustment "2" for exact horizontal alignment of X and Y. Center the adjustment midway between points providing apparent alignment.

(d) Turn the "STATION" selector to position "3." A screen pattern (fig. 2-18) now appears. If the adjustment for "STATION" position 2 is properly made, X and Y appear properly aligned.

(e) Turn the "STATION" selector to position "4" and adjust "STATION" adjustment "4" for exact horizontal alignment of X and Y. (See fig. 2-19.)

(f) Turn the "STATION" selector to position "5." (See fig. 2-20.) If the alignment for "STATION" position "4" is correct, X and Y remain in alignment.

(g) Turn the "STATION" selector to position "6." Adjust station adjustment "6" for correct alignment of X and Y. (See fig. 2-21.)

(h) Turn the "STATION" selector to position "7." If X and Y are properly aligned for position "6," the horizontal alignment is also correct for position "7." The screen pattern should be as shown in figure 2-22.

(4) "COARSE" AND "FINE" DELAY ADJUSTMENTS.

(a) Turn "SWEEP SPEED" to position "7" and the "STATION" selector to position "O." (See fig. 2-23 or 2-24.) Rotate both "COARSE" and "FINE" controls counterclockwise until their index marks are in line with the panel index marks. Adjust "ADJ. O" until the left edge of the B-pedestal falls between the first 2500-microsecond marker and the first 500-microsecond marker to its left. Be sure to properly center the adjustment within the range providing the correct pedestal position.

(b) Rotate the "COARSE" control clockwise until the left dial mark is in line with the panel index mark. (See fig. 2-25.) Adjust "ADJ. 10000" until the left edge of the B-pedestal falls between the fifth 2500-microsecond marker and the 500-microsecond marker to its right. Center the adjustment within the range providing the correct position of the pedestal.

(c) Turn "SWEEP SPEED" to position "6." (See fig. 2-26.) Adjust the "COARSE" control to the center of its range. With the "FINE" control as previously set (right dial mark in line with the panel index), adjust "ADJ. 200" until there are four 50-microsecond spaces between the 500-microsecond marker on the B-trace and the 500-microsecond marker is to its right on the A-trace.

(d) Turn the "FINE" control clockwise until the left dial mark is in line with the panel index mark. (See figs. 2-27 or 2-28.) Adjust "ADJ. 700" until the pat-

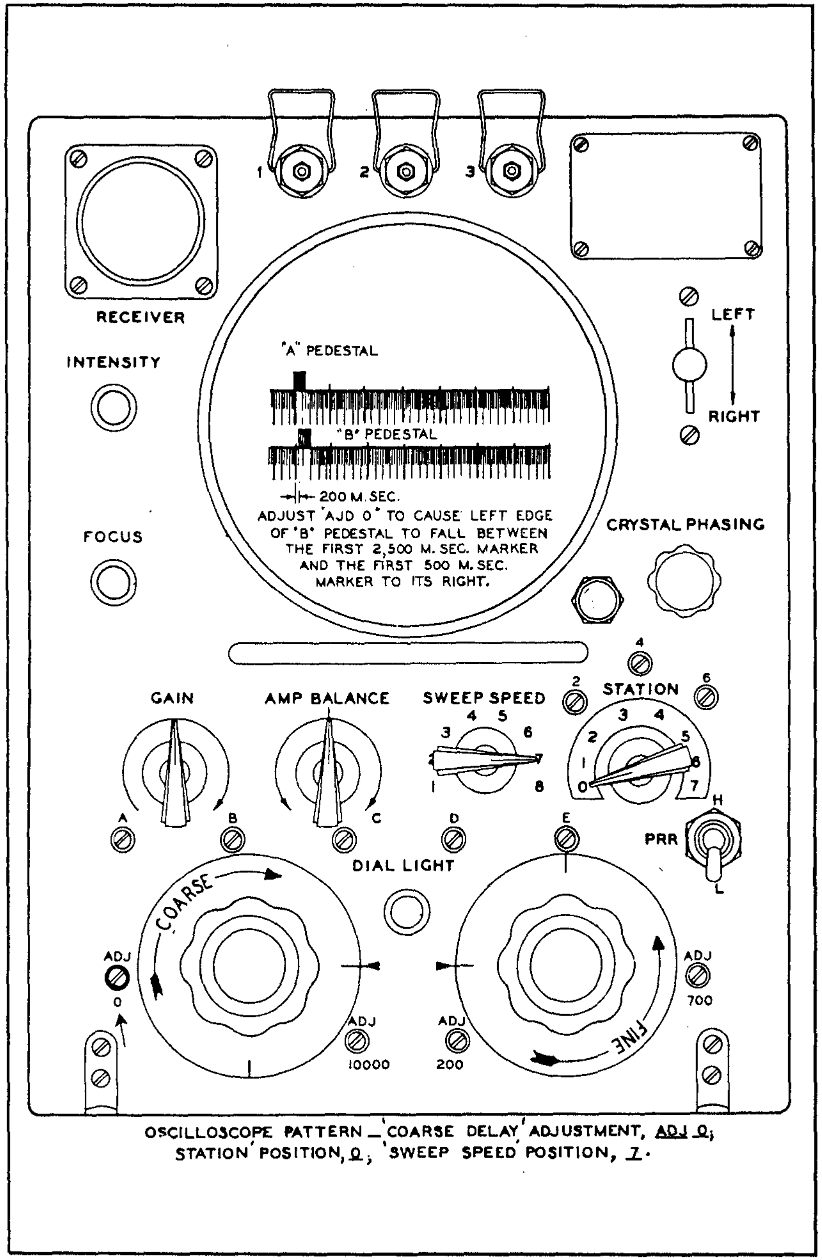


Figure 2-23. "COARSE" Delay Adjustment, "ADJ. 0"—Using Marked Controls

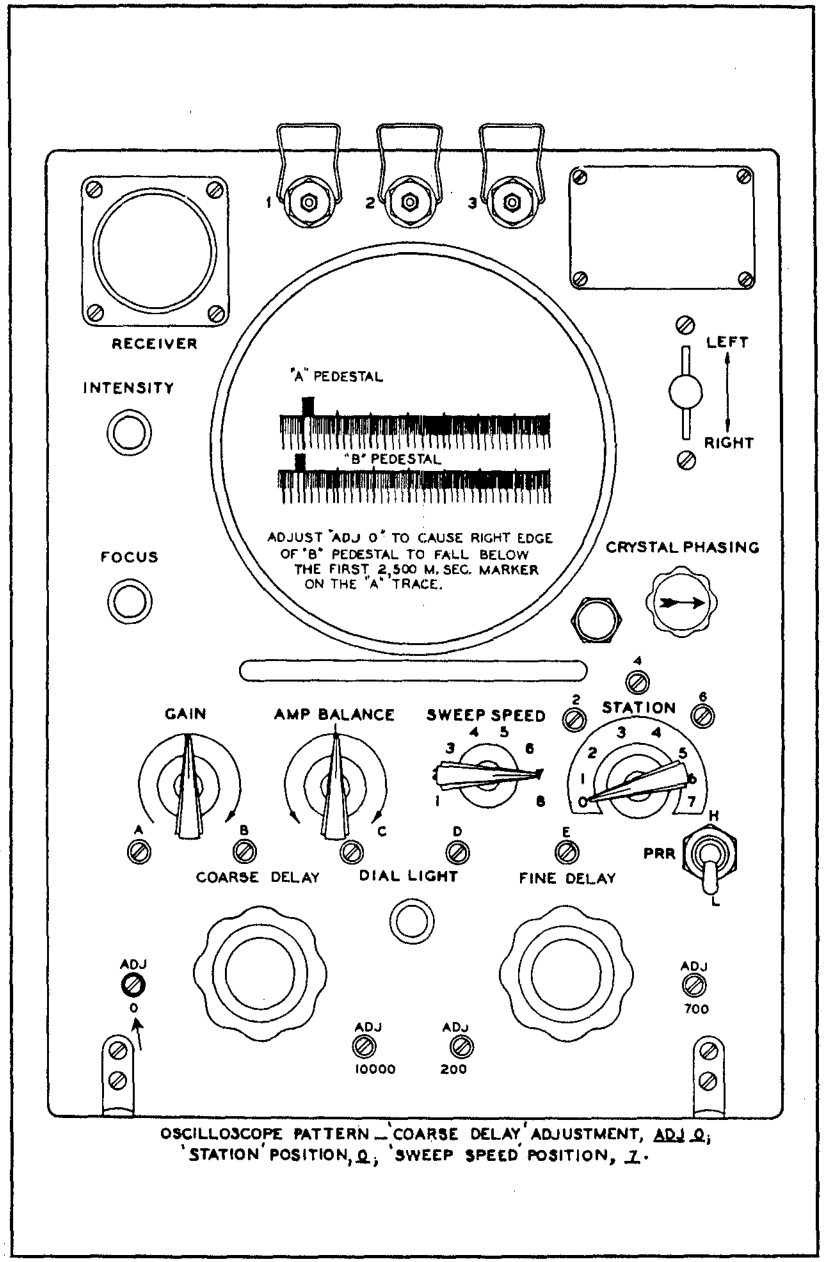


Figure 2-24. "COARSE" Delay Adjustment, "ADJ. 0"— Using Unmarked Controls

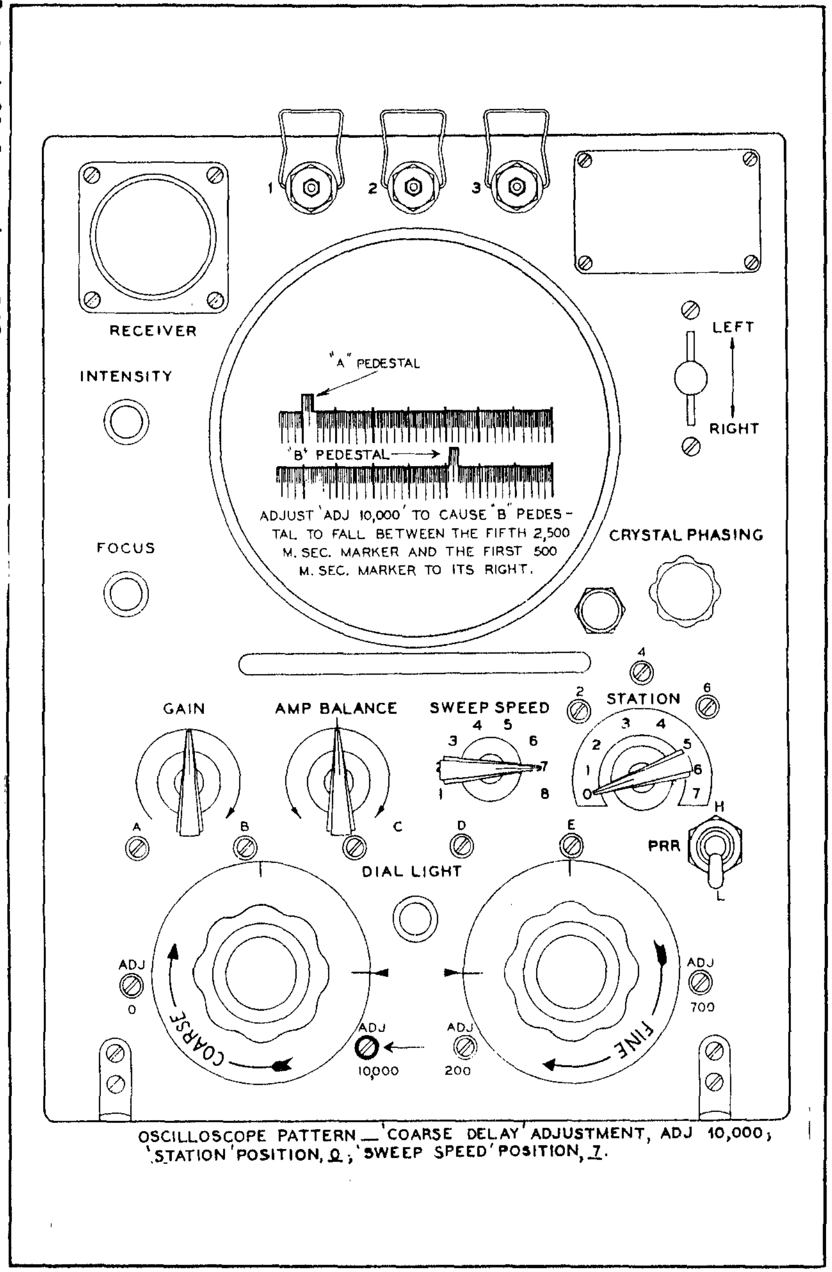


Figure 2-25. "COARSE" Delay Adjustment—"ADJ. 10,000"—Using Marked Controls

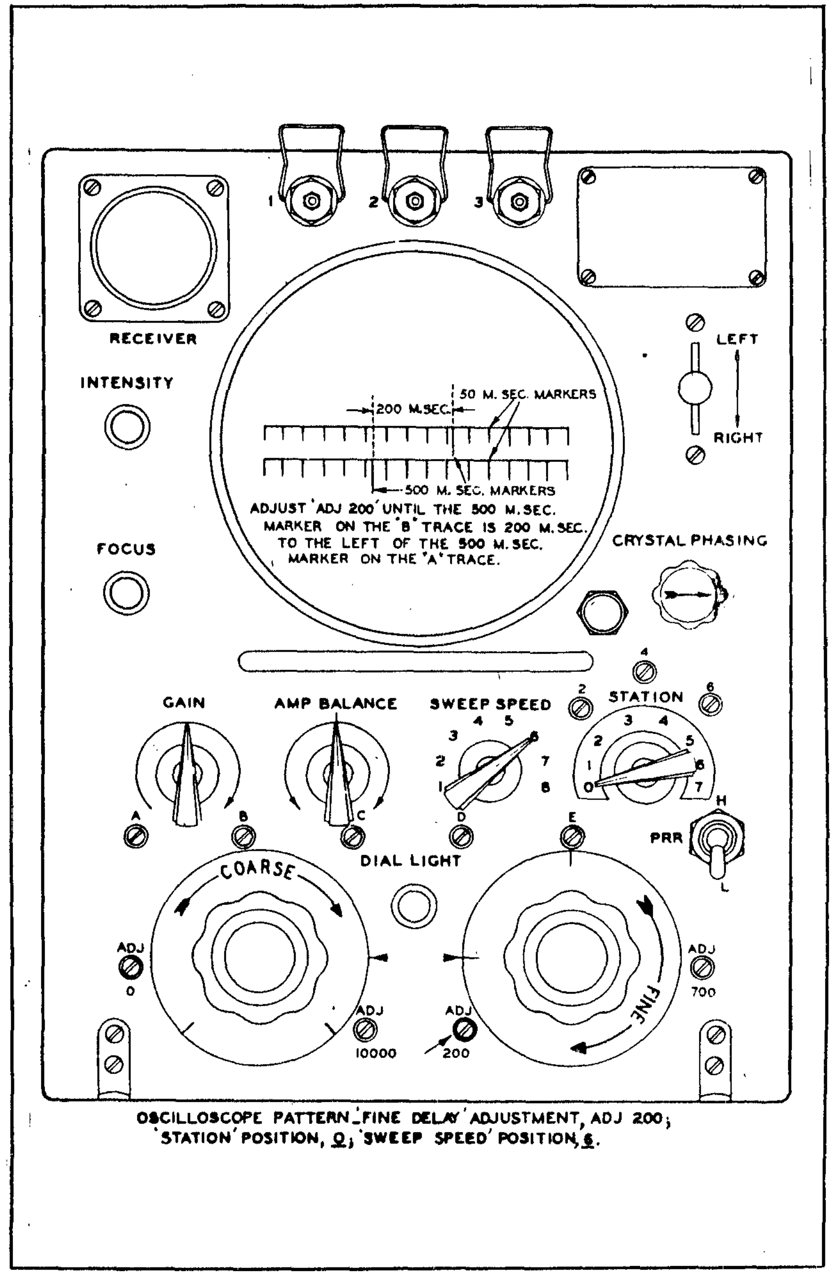


Figure 2-26. "FINE" Delay Adjustment, "ADJ. 200"—Using Marked Controls

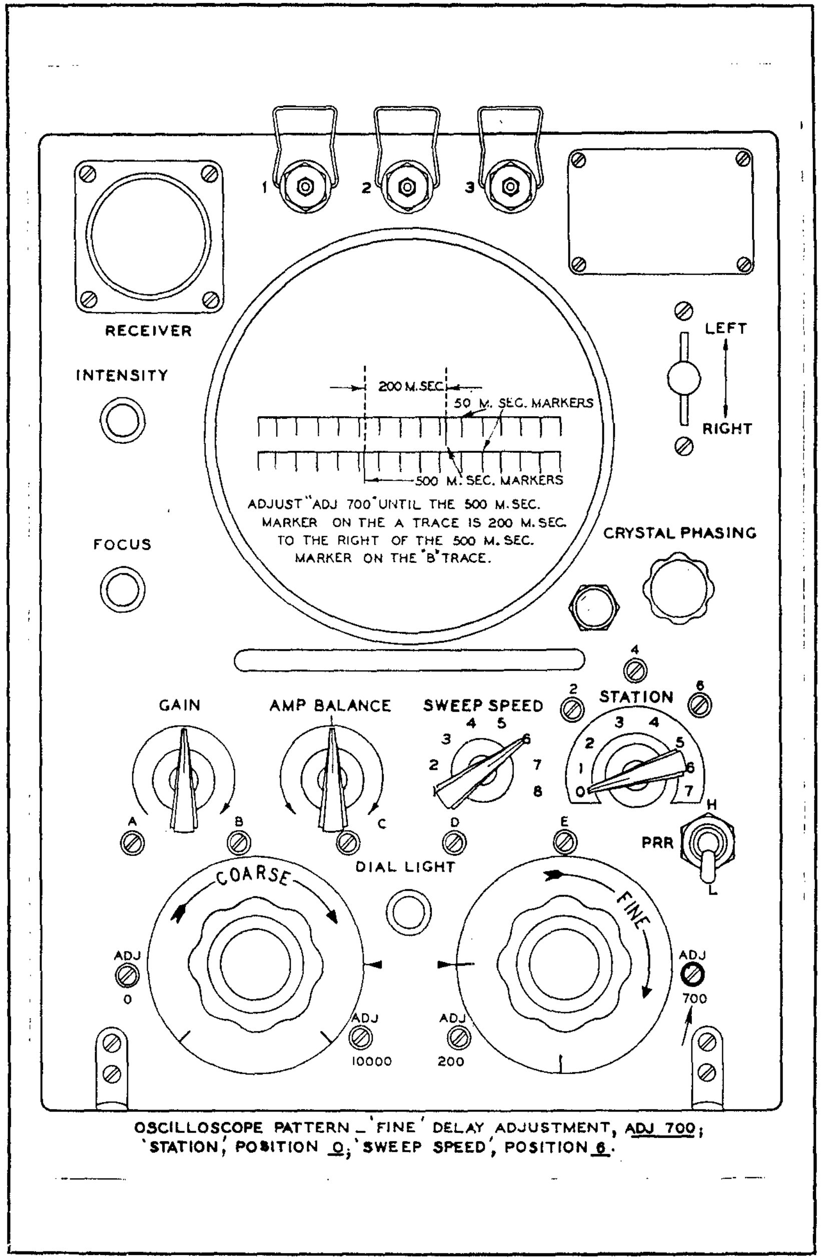
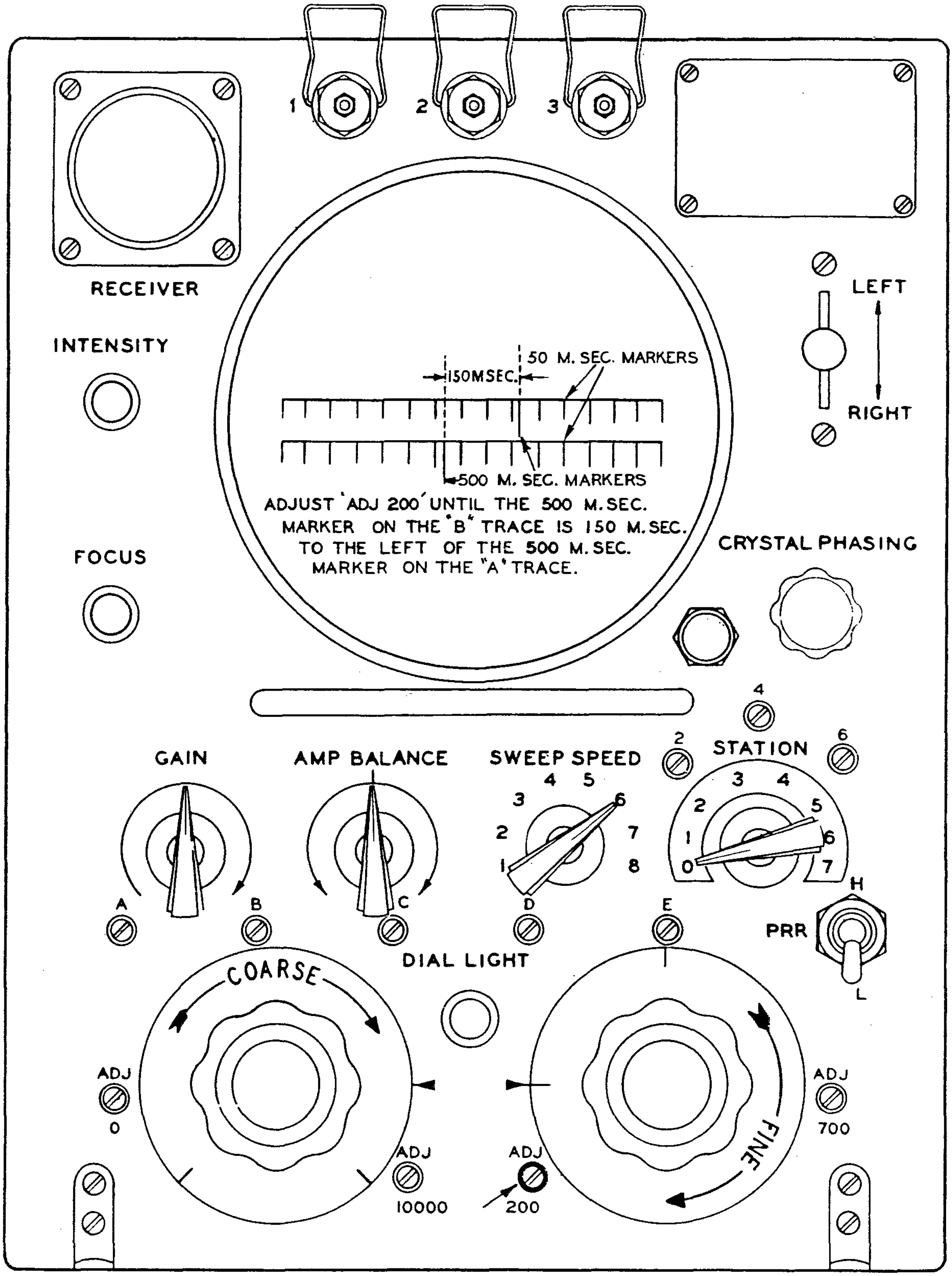


Figure 2-27. "FINE" Delay Adjustment, "ADJ. 700"— Using Marked Controls



OSCILLOSCOPE PATTERN-'FINE DELAY' ADJUSTMENT, ADJ 200; 'STATION' POSITION, 0; 'SWEEP SPEED' POSITION, 6.

Figure 2-28. "FINE" Delay Adjustment, "ADJ. 200"—Using Marked Control tern is the same as for the preceding "FINE" adjustment. Although the patterns for "ADJ. 200" and "ADJ. 700" are exactly alike, they represent a difference of 500 microseconds in the two positions. This is apparent in the movement of the B-pattern, as the "FINE" control is rotated from the counterclockwise to the clockwise index position.

(5) COARSE AND FINE ADJUSTMENTS.
(Using unmarked control knobs).

(a) FINE ADJUSTMENT "ADJ. 200."

1. With "SWEEP SPEED" control at position "6," adjust "COARSE" control to the center of its mechanical range and "FINE" control to full counterclockwise (left) position.

2. Adjust "ADJ. 200" to its mechanical center; then to the right or left to the nearest setting at which a 500-microsecond marker on the B-trace appear exactly 150 microseconds to the left of the 500-microsecond marker or the A-trace. (See fig. 2-26.)

(b) FINE ADJUSTMENT "ADJ. 700."

1. Rotate "FINE" control to full clockwise (right) position.

2. Adjust "ADJ. 700" until the 500-microsecond marker on the B-trace is exactly 250 microseconds to the right of the 500-microsecond marker on the A-trace. (See fig. 2-28.)

3. Touch-up adjustments ("ADJ. 200" and "ADJ. 700") to eliminate probable interaction.

(c) COARSE ADJUSTMENT "ADJ. O."

1. Turn "SWEEP SPEED" control to position "7." Adjust both "COARSE" and "FINE" controls to full counterclockwise (left) position.

2. Adjust "ADJ. O" until the right edge of the B-pedestal is directly below the left edge of the A-pedestal.

3. Rotate "COARSE" control to full clockwise (right) position.

4. Adjust "ADJ. 10,000" until the left edge of the B-pedestal is approximately 200 microseconds to the right of the fifth 2500-microsecond marker on the B-trace.

5. Touch up both adjustments to correct any effects of interaction between adjustments "ADJ. 0" and "ADJ. 10000." Finally center both adjustments within the range providing correct pedestal position.

3. PROCEDURE FOR TESTING RADIO SET ★AN/APN-4 IN THE FIELD.

a. EQUIPMENT NEEDED.—Use Frequency Meter Set SCR-211 for Army testing and Frequency Meter LM-13 for Navy testing.

b. RECEIVER SENSITIVITY. — To test (rough check) the receiver sensitivity, disconnect the antenna cable at the receiver, leaving the antenna terminal open with the gain control fully on and the balance control in central position. The heavy grass on both indicator traces should be ½" or more high. Rotating the balance control clockwise or counterclockwise should cause the grass to disappear alternately on the two traces.

c. ALIGNMENT.—To check the frequency alignment of Radio Receiver ★R-9/APN-4, use either Frequency Meter BC-221 for Army testing or Model LM-13 for Navy testing.

(1) First, connect the antenna post of the frequency meter to the antenna terminal of the receiver or to any part of the antenna lead-in system of this receiver, provided the airplane's antenna is disconnected from the lead-in system.

(2) Calibrate the frequency meter in accordance with the frequency meter instruction book.

(3) Rotate the amplitude balance control on the indicator and adjust the gain control for approximately 1 inch of kickup at the left end of the bottom trace on the indicator.

(4) Tune the frequency meter for maximum trace kickup.

(5) If necessary, readjust the gain control to prevent receiver overload.

(6) If the frequency meter indicates more than 20 kilocycles above or below the correct frequency, realignment of the receiver will be accomplished only by qualified personnel.

(7) In performing the above tests, first tune the frequency meter to a frequency close to that of Radio Set ★AN/APN-4. Exercise caution not to pick out the improper frequency as the receiver will respond to harmonics of the frequency meter.

SECTION III
OPERATION

WARNING

Radio Set ★AN/APN-4 employs high voltages which are dangerous and may be fatal if contacted by personnel. Use extreme caution when working with the equipment.

1. SPECIAL FEATURES.

a. SELECTION OF STATION.—Select the radio frequency by means of the "CHANNEL" switch on the receiver and the pulse frequency by the "STATION" selector switch on the indicator. Use of these switches enables the operator to identify any pair of stations being received. With "STATION" selector switch in any one of its eight positions, pulses of several sizes and shapes may appear on the indicator screen. Some of these will move rapidly along the traces while one on each trace will appear almost stationary. By moving the "STATION" selector switch through its eight positions, one setting will be found where the longest and most regular pulses are stationary. These are the proper ones for use in calculating the position of the aircraft.

b. DRIFTING.—The selected pulses have a tendency to drift. Under some conditions, more than one pulse in each group may remain stationary. These will be found very close together. Consider only that pulse farthest to the left. Move these stationary pulses either to the right or left by operation of the "LEFT-RIGHT" switch. If the pulse appearing on the A-trace is to the right of the pulse appearing on the B-trace, the pulses are reversed. To correct this condition, move these pulses with the "LEFT-RIGHT" switch so that the pulse on the top trace is to the left of the pulse on the bottom trace. Make the A-pulse assume its position on top of the A-pedestal on the upper trace.

c. MATCHING PULSES.—The received pulses will vary in form depending upon the path by which they are received. Figure 3-1 shows the nature of the pulse received by the ground wave. This pulse form does not change its shape and is always the first pulse to the left. Figure 3-2 shows examples of skywave reception.

d. EFFECTS OF GROUND WAVES AND SKY WAVES ON RECEPTION.—The received pulses (see fig. 3-1) are typical forms of ground (direct) waves. However, over long distances, especially at night, the received pulses are sky (reflected) waves. (See fig. 3-2.) A ground-wave pulse does not change in form and is al-

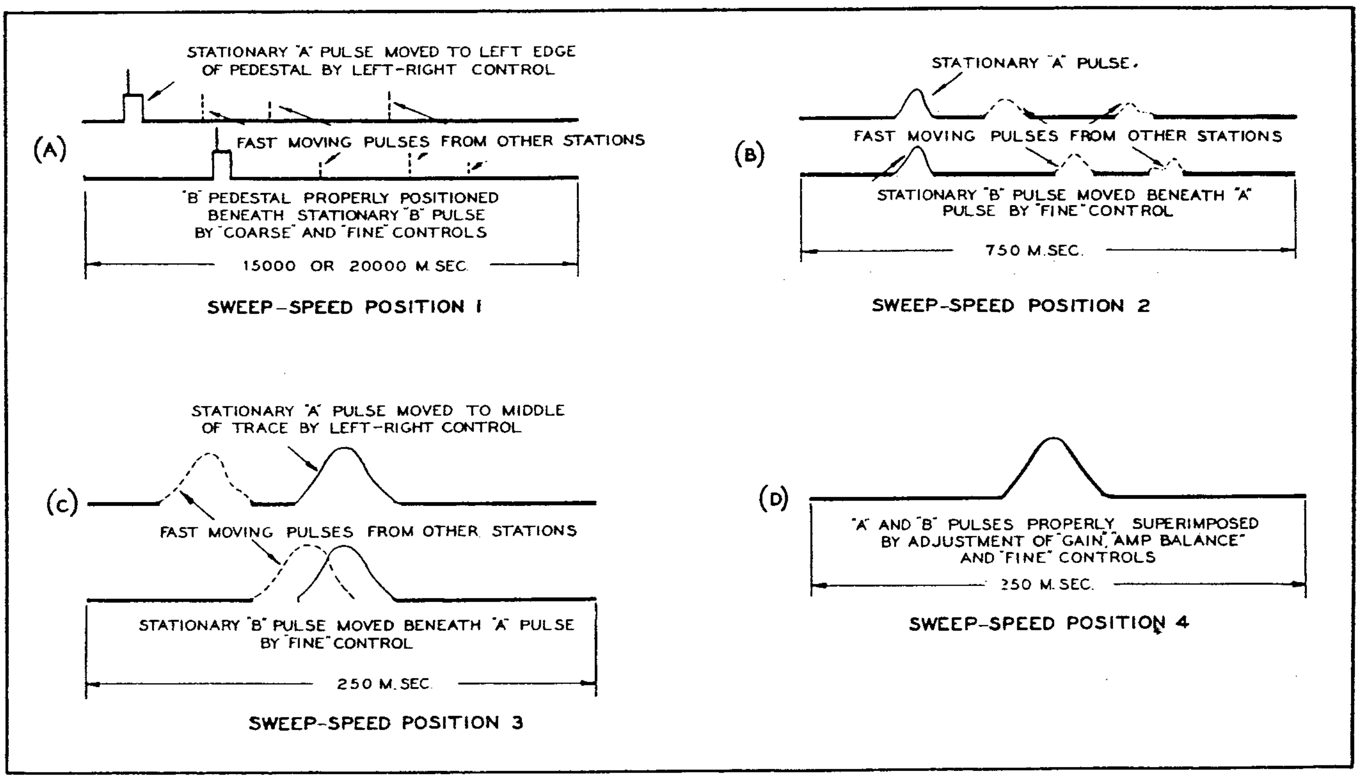


Figure 3-1. Received Pulses—Matching Procedure

ways the first stationary pulse to the left within a daytime range of approximately 600 miles or a night-time range of approximately 400 miles. The ground-wave pulse varies inversely, with the distance in amplitude only. The sky-wave pulse, however, varies in both amplitude and form as the distance from the aircraft to the stations changes.

Figure 3-2 shows various forms of sky-wave pulses. The upper figures show a train of changing pulse forms described as harmless splitting pulses, resulting from deterioration of only the trailing edge of the received pulse. By watching the pulses long enough to be sure that the leading edge of the A-pulse is matched with the leading edge of the B-pulse and by allowing for the additional travel time of the reflected wave, sufficiently accurate readings may be taken from sky-wave pulses.

Part B, figure 3-2, shows a train of forms, described as dangerous splitting pulses, resulting from deterioration of the leading edge of the received pulse. Matching of such pulses is possible only during the early stages of deterioration, or when aligning the trailing edges; in either case, results are seldom accurate.

If the pre-installation bench tests and the installation and operational adjustments given in section II have been carried out properly, the receiver and indicator are now ready for use. However, a pre-flight check of the front panel controls must be made during which a touch-up of the adjustments associated with the "SWEEP SPEED," "STATION," "COARSE" and "FINE" controls will probably be necessary. These adjustments should be made in the order given in section II, paragraph 2.*b.* while observing figures 2-11 to 2-22A, inclusive. A check should also be made of all adjustments at the end of every four hours of operation or when any sudden changes in altitude or temperature are encountered.

2. OPERATING PROCEDURE USING INDICATOR ★ID-6/APN-4 OR ★ID-6A/APN-4.

a. PRELIMINARY ADJUSTMENTS.

(1) Turn the "PWR. ON-OFF" switch (on the receiver) to "ON."

(2) Set "SWEEP SPEED" (on the indicator) to position "1."

(3) Place the "AMP. BALANCE" control at the center position.

(4) Use the "STATION" selector switch (on the indicator) to select the desired station.

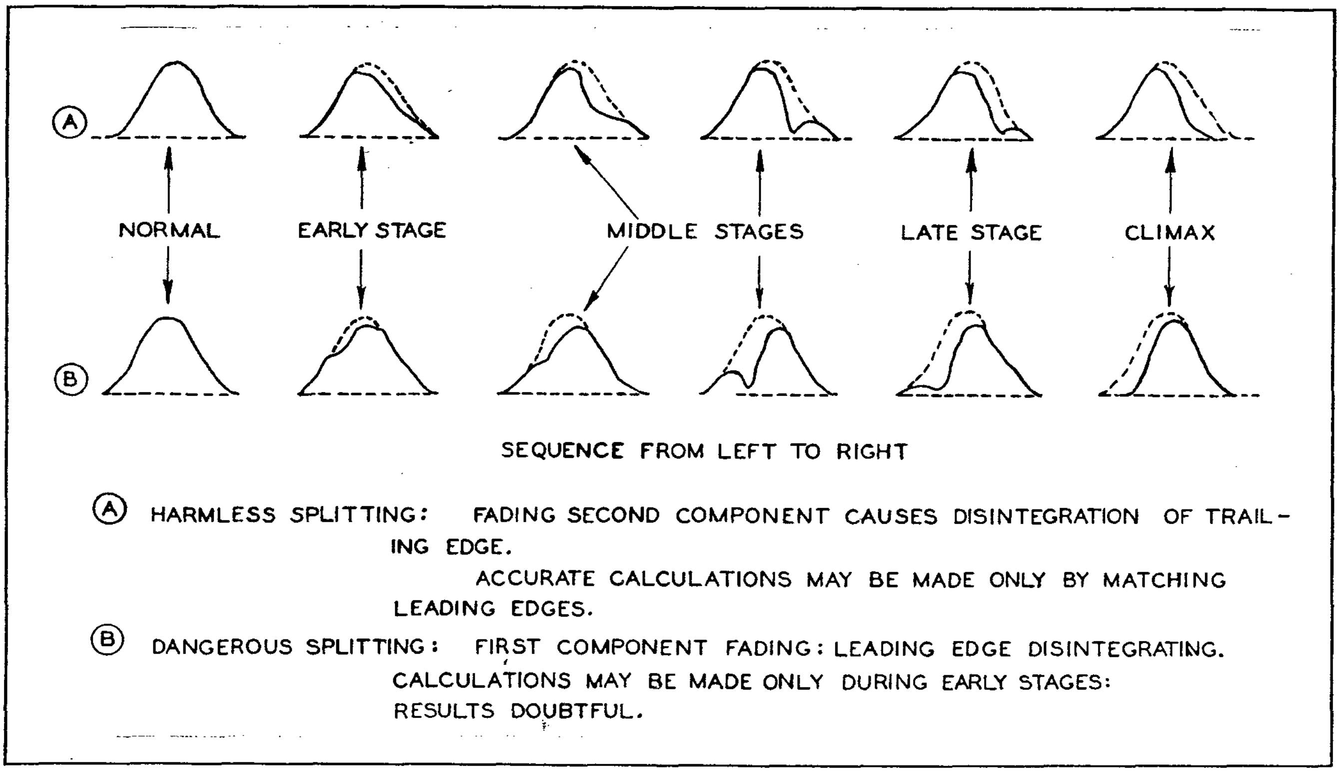
(5) Adjust "PRR H-L" switch to the position which synchronize the indicator with available ground stations.

(6) Adjust "INTENSITY" control until a suitably brilliant trace pattern appears on the indicator screen; then adjust "FOCUS" control to provide a clear definition of pattern.

Note

After the airplane is in the air, let out 100 to 150 turns of the trailing wire antenna and adjust its length to give a maximum signal amplitude on Indicator ★ID-6/APN-4.

b. SELECTION OF SIGNALS TO BE MEASURED.—Two or more pulses will appear on the A- and B-trace line. The pair of pulses (one above the A-trace and one



Figures 3-2. Oscilloscope Waveforms—Showing Sky-Way Effects

above the B-trace (see part A of fig. 3-1)] received from the selected stations, will stand still, or move very slowly, while any other pulses will drift at a faster rate to the left or right across the screen. In daytime operation, probably only one pulse will be seen from each station. If a group of two or more pulses appear close together, consider only the first pulse to the left.

c. PLACEMENT OF PULSES ON THE PEDESTALS.

(1) Slowly advance the "GAIN" control until two or more received pulses are seen on the traces. Some of the received pulses may move across the indicator screen rapidly, others very slowly. Proper setting of the "STATION" selector and "PRR" switch causes one pair of pulses either to remain stationary or to drift very slowly while all other pulses move rapidly to the left or right across the indicator screen. Under some conditions, particularly during night operation, two or more stationary pulses of different amplitudes may appear close together. During daytime operation, usually only one stationary pulse on each trace is received for a particular station position. If strong interference is encountered, throw "FILTER" switch "IN." Some attention of the received signal will usually result, but the greater reduction of interference, indicated by grass on the screen, will more than compensate for the signal reduction. The pulses must be watched carefully and long enough to insure that ground waves are being matched to ground waves or first sky waves to first sky waves.

(2) These stationary pulses may be moved in either direction by use of the "LEFT-RIGHT" switch. If the pulse appearing on the A-trace is to the right of the pulse appearing on the B-trace, then the two pulses are reversed; i.e., the B-pulse is being received on the A-trace and the A-pulse is being received on the B-trace. To correct this situation, hold the "LEFT-RIGHT" switch downward in the "RIGHT" position and allow the pulses to drift to the right. The B-pulse will disappear from the A-trace and will reappear on the B-trace to the extreme left. The A-pulse will drift to the right and will reappear on the extreme left of the A-trace. Allow the "LEFT-RIGHT" switch to assume its neutral or center position when the A-pulse is on top of the left end of the A-pedestal.

d. ALIGNMENT OF PULSES.

CAUTION

Do not change the "COARSE" or "FINE" controls after the desired condition has been reached.

(1) Turn the "COARSE" control, moving the B-pedestal until it is directly under the B-pulse. Adjust the "FINE" control until the extreme left end of the B-pedestal is under the B-pulse. (See part A, fig. 3-1.)

(2) Adjust the "AMP-BALANCE" control to vary the amplitude of the A- and B-pulse so that the two pulse forms will equal each other in height. Adjust the "GAIN" control to obtain suitable amplitude.

Note

If the received pulses drift slightly, adjust the "CRYSTAL PHASING" control until they remain stationary. If heavy interference is encountered or many moving pulses are received with the selected stationary pulses, observation and matching of the selected pulses often becomes very difficult. Observe only the stationary pulse pattern on the screen; ignore both the moving pulses and other interfering patterns.

(3) Turn "SWEEP SPEED" to position "2;" two traces will again be visible. (See part B, fig. 3-1.) The pulses may still have a tendency to drift. Again adjust the "CRYSTAL PHASING" control to cause them to stand still. Turn the "FINE" control until the B-pulse is directly below the A-pulse.

Adjust "GAIN" control toward maximum position. Rotate "AMP. BALANCE" control alternately to the left and right, while watching the screen closely for the appearance of another stationary pulse to the left of either of the "A" and "B" pulse groups. The pulses at the extreme left on both traces are usually the proper ones for matching and reading. It is possible, however, under some conditions, to receive a ground wave on one trace and not on the other. Under this condition, matching of the first pulses would mean that a sky wave is being matched with a ground wave and would result in considerable error. Pulses from ground waves change shape in amplitudes only; sky waves change shapes in both amplitude and general contour. Watch the received pulses long enough to insure matching of only ground waves to ground waves and sky waves to sky waves.

(4) Turn "SWEEP SPEED" to position "3." The pulse forms will now appear as in part C of figure 3-1. Adjust the "CRYSTAL PHASING" control, moving the pulses to the right until they are in the approximate center of the trace line. Adjust the "FINE" control until the B-pulse is directly under the A-pulse.

(5) Turn "SWEEP SPEED" to position "4." Only one trace line will appear, and the two pulses will be superimposed or nearly superimposed upon each other. (See part D, fig. 3-1.) Adjust the "FINE" control until the leading edges of the pulses are superimposed.

Note

Keep both pulses the same height by adjusting the "AMP. BALANCE" control. Adjust "FINE" control to bring the leading edges together. Adjust "GAIN" control to provide the desired pulse amplitude. Received pulses will vary in form, depending upon the path of radiation; i.e., ground or sky wave. Part D, figure 3-1, shows the received pulse using the ground wave. This pulse form does not change its shape and is always the first pulse to the left within a daytime range of approximately 600 miles and within a night time range of approximately 400 miles. The amplitude of the ground wave pulse will vary inversely with distance.

(a) Part A, figure 3-1, shows the effect of receiving many pulses, representing several reflected sky waves appearing at a slightly different time due to different angles of reflection. These pulses are referred to as a "TRAIN."

(b) With "SWEEP SPEED" on position "1," the received pulses will appear as single lines due to the comparatively slow speed of the sweep. With "SWEEP SPEED" in positions "3" and "4," the waveforms will appear much broader, due to the accelerated sweep speed. These forms may appear to change their shape through a cycle of wave-forms as represented in figure 3-2, indicating sky-wave reception. Note that the forms described as "dangerous splitting" (part A, fig. 3-2), show a deterioration of the leading edge of the wave with "SWEEP SPEED" on position "4." If splitting is evident the form must be watched long enough to be sure that the first hump of the leading edge of the A-pulse is being matched against the first hump of the B-pulse. (See part B, fig. 3-2.) If a ground wave is being received from one station and a sky wave from the other, neglect the ground wave that is received and match the first sky wave pair of pulses. Part C, figure 3-2, shows "harmless splitting," in which the leading edge of the pulse remains intact.

e. CALCULATION OF TIME DIFFERENCE.

(1) Turn "SWEEP SPEED" to position "5." As in part A of figure 2-8 there will be two traces, each exhibiting 10- and 50-microsecond markers. The traces are close together so that the 50-microsecond markers on the A-trace point just to the top of the B-trace. Using a 50-microsecond marker on the A-trace as an index, count the number of 10-microsecond spaces between it and the first 50-microsecond index to its left on the B-trace. For example, refer to part A of figure 2-10 and count four full spaces which give a total reading of 40. When the A-trace, 50-microsecond index marker falls between two 10-microsecond markers, the last digit reading is 5.

(2) Turn "SWEEP SPEED" to position "6." Two traces will be visible on which 50- and 500-microsecond markers will extend below the trace line as in part B of figure 2-10. Every tenth 50-microsecond marker is longer and thus identifies a 500-microsecond marker. Using any 500-microsecond marker on the right half of the A-trace as an index, count to the left the number of 50-microsecond spaces appearing between it and the first 500-microsecond marker to its left on the B-trace. For example, count to the left and note four full 50-microsecond spaces, or a reading of 200 microseconds which is to be added to the 40 microseconds obtained in the preceding operation giving a total of 240 microseconds.

(3) Turn "SWEEP SPEED" to position "7" which will give two traces on which pedestals will be visible along with the 2500-, 500- and 50-microsecond markers as in part C, figure 2-8. Using the left edge of the A-pedestal as an index, count the number of full 500-microsecond spaces appearing between this index line and the left edge, or index line, of the B-pedestal. Count only full spaces, ignoring any portions of a 500-microsecond space. Refer again to part C, figure 2-8, as an example and count from the index of the A-pedestal to the index of the B-pedestal, which gives a total of eight full 500-microsecond spaces, or a reading of 4,000 microseconds which is to be added to the figure obtained in sub-paragraphs (1) and (2), above. This gives a total of 4,240 microseconds.

(4) Use this reading to determine a "line of position" on an appropriate chart. If sky waves instead of ground waves were used to obtain this reading, apply a sky-wave correction to the reading to obtain a correct line of position. To obtain a "fix" or intersection of two lines of position, follow the entire procedure just outlined, using either the "CHANNEL" selector on the receiver or the "STATION" selector on the indicator, or both switches, to select another pair of ground stations.

3. OPERATING PROCEDURE USING INDICATOR ★ID-6B/APN-4.

a. STARTING THE EQUIPMENT.—The following table describes and illustrates the preliminary adjustments and placement of the pulses on the pedestal in starting the equipment.

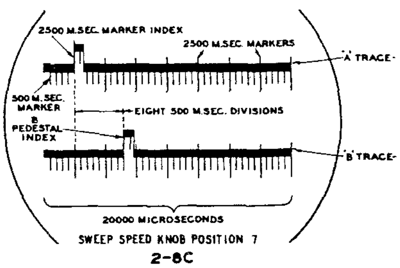
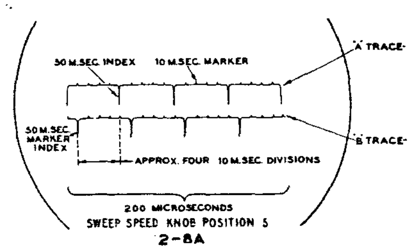
Note

Where variable adjustment is indicated in the operating procedure, adjust to obtain the desired results as indicated in the corresponding picture.

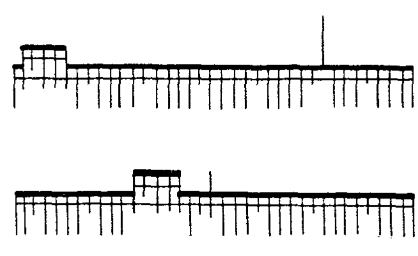
b. PRELIMINARY ADJUSTMENTS.—Figures 3-3 through 3-19 cover pictorial results of adjustments.

CAUTION

After placement and alignment of pulses, do not change settings of "COARSE" or "FINE" controls until all readings and calculations have been made.

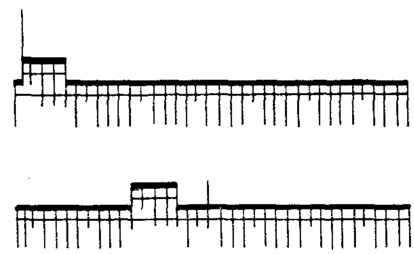
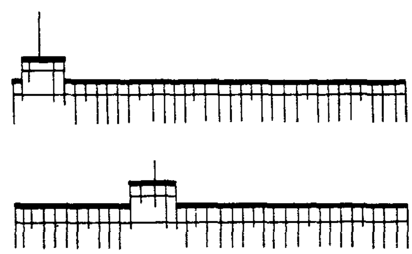
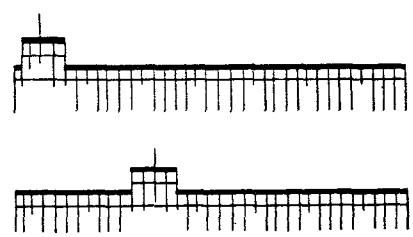
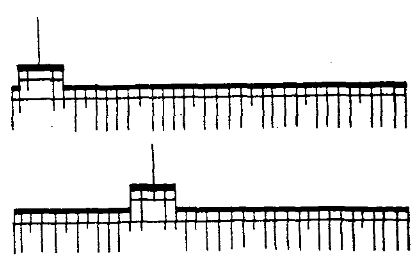
Control	*Position*	*Results*	*Pictorial Results*
POWER "ON-OFF" "INTENSITY" "FOCUS" "SWEEP SPEED" "COARSE" "FINE"	"ON" Adjust 7 Adjust Adjust	A pedestal of 750-microsecond width will appear on each trace. Each trace will have exactly eight 2500-microsecond markers.	 Figure 3-3
"SWEEP SPEED" "FINE"	5 Adjust	Five short 10-microsecond markers will appear between the long 50-microsecond markers.	 Figure 3-4

c. SELECTION OF SIGNALS TO BE MEASURED.

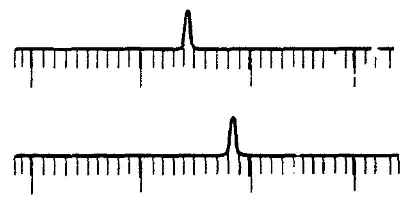
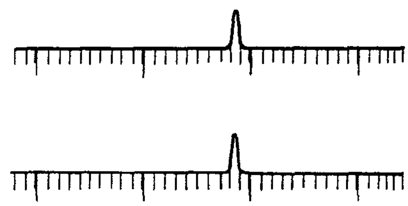
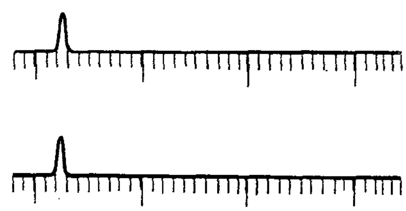
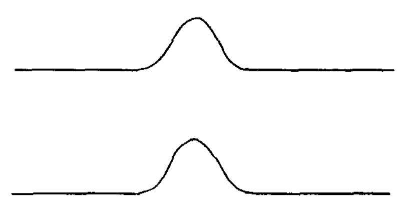
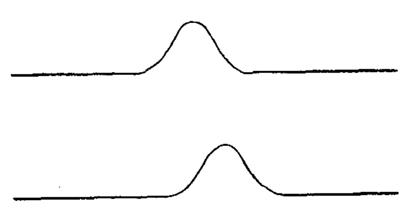
Control	*Position*	*Results*	*Pictorial Results*
"SWEEP SPEED" "AMP. BALANCE" "GAIN" "STATION SELECTOR" CRYSTAL PHASING	1 Slowly to the right 0 to 7 (select one) Adjust	Pulses visible on each trace. One pair of pulses almost stationary Eliminate drifting of pulses	 Figure 3-5

With the "STATION" selector switch in any one of its eight positions, pulses of several sizes and shapes may appear on the indicator screen. Some of these will move rapidly along the trace while one on each trace will appear almost stationary. By moving the "STATION" selector switch through its eight positions, one setting will be found where the longest and most regular pulses are stationary. These stationary pulses are the proper ones to use in calculating the position of the aircraft.

d. PLACEMENT OF PULSES ON THE PEDESTALS.

Control	*Position*	*Results*	*Pictorial Results*
Left and Right	Either	A-Pulse will be centered on the A-Pedestal	 Figure 3-6
"COARSE" "FINE"	Adjust Adjust	A-Pulse centered on A-Pedestal B-Pulse centered on B-Pedestal	 Figure 3-7
"AMP. BALANCE"	Adjust	A-Pulse and B-Pulse same amplitude and still centered	 Figure 3-8
"GAIN" "CRYSTAL PHASING"	Adjust Adjust	Picture readily visible Eliminate tendency to drift, of A- and B-Pulses	 Figure 3-9

e. ALIGNMENT OF PULSES.

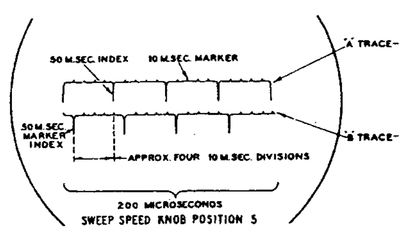
Control	*Position*	*Procedure*	*Pictorial Results*
"SWEEP SPEED" "CRYSTAL PHASING"	2 Adjust	A- and B-Pulses enlarged Eliminate tendency to drift	 **Figure 3-10**
"FINE"	Adjust	B-Pulse directly under A-Pulse	 **Figure 3-11**
"LEFT-RIGHT"	Either	A- and B-Pulses. At left end of A- and B-traces	 **Figure 3-12**
"SWEEP SPEED"		Pulses enlarged	 **Figure 3-13**
"LEFT-RIGHT" "FINE"	Either Adjust	Pulses at center of screen B-Pulses roughly on below A-Pulse	 **Figure 3-14**

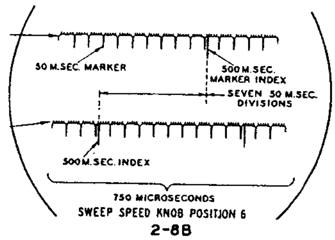
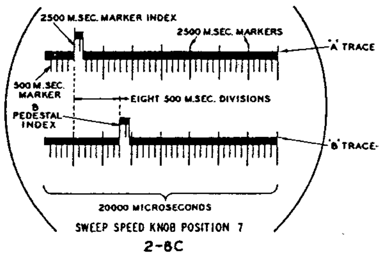
Control	*Position*	*Procedure*	*Pictorial Results*
"SWEEP SPEED"	4	B-Pulse almost super-imposed over A-Pulse	 ***Figure 3-15***
"FINE" "AMP. BALANCE"	Adjust	Leading edge of B-Pulse exactly super-imposed over A-Pulse	 ***Figure 3-16***

Note

After the aircraft is in the air, let out 60 or 70 turns of the trailing wire antenna. Adjust the length of the trailing wire antenna to give maximum signal input.

f. CALCULATION OF TIME DIFFERENCE.—The following table illustrates the method of calculating time differences.

Control	*Position*	*Procedure*	*Pictorial Results*	*Numerical Results In Microseconds*
		10-MICROSECOND MARKERS		
"SWEEP SPEED"	5	Using 50-microsecond marker on the B-trace as an index, count the number of spaces between it and the first 50-microsecond marker to its right on the A-trace.	 ***Figure 3-17***	40

Control	*Position*	*Procedure*	*Pictorial Results*	*Numerical Results In Microseconds*
		50-MICROSECOND MARKERS		
"SWEEP SPEED"	6	Using the 500-microsecond marker on the left side of the B-trace as an index, count the number of full 50-microsecond spaces between it and the first 500-microsecond marker to its right on the A-trace.	 *Figure 3-18*	350
		500-MICROSECOND MARKERS		
"SWEEP SPEED"	7	Using the first 2500-microsecond marker on the B-trace as an index, count the number of 500-microsecond spaces appearing between it and the left edge of the B-pedestal. Count only full spaces.	 *Figure 3-19*	4000
		TOTAL TIME DIFFERENCE READING		
				Add 40+350 +4000 Total=4390

Note

By adding the numerical results of steps (1), (2), and (3) the above time-difference is obtained between station A (master) and station B (slave) of any one pair of ground stations. This number plus any coded delay, is inserted into a hyperbolic chart furnished with the Loran system of navigation to determine the position of the aircraft.

g. STOPPING THE EQUIPMENT.—To stop the equipment turn the power "ON-OFF" switch to off.

4. SUPPLEMENTARY TIME READINGS AND CALCULATION PROBLEMS.

a. Turn "SWEEP SPEED" to position "5." (See part A, fig. 3-20.) The two traces should again appear, exhibiting the 10- and 50-microsecond markers. The trace separation is such that the 50-microsecond markers on the upper trace almost touch the lower trace. Using any 50-microsecond marker on the B-trace as an index, read the space in microseconds between it and the first 50-microsecond marker to its right on the A-trace. The reading for part A of figure 3-20, is 27 microseconds.

b. Turn "SWEEP SPEED" to position "6." The two traces which then appear on the indicator screen should show the 50- and 500-microsecond markers. Using as an index the 500-microsecond marker on the B-trace, which appears to the left of the 500-microsecond markers on the A-trace, count the number of complete 50-microsecond spaces between it and the 500-microsecond marker on the A-trace. Count only full spaces; ignore incomplete spaces. The reading for part B of figure 3-20 is 250 microseconds; add to this the previous reading of 27 microseconds to give a total of 277 microseconds for parts A and B of figure 3-20.

c. Turn "SWEEP SPEED" to position "7;" the two traces should then show the A and B pedestals. The position of the B pedestal is the result of pulse-aligning processes through "SWEEP SPEED" positions "1," "2," "3," and "4." Using the left edge of the A-pedestal as an index, count the number of full 500-microsecond spaces between it and the left edge of the B-pedestal. The incomplete 500-microsecond space represents the two previous readings taken at "SWEEP SPEED" positions "5" and "6." The reading for position "7," part C of figure 3-20, is 3000 microseconds; add to this the previous readings, 27 and 250 microseconds (for "SWEEP SPEED"

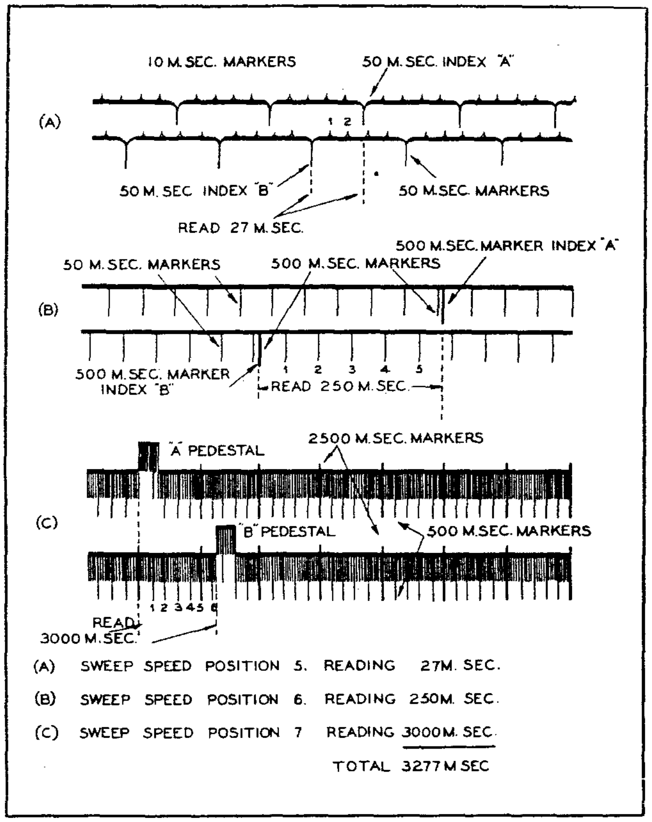


Figure 3-20. Typical Pattern for Time Calculations

positions "5" and "6"), to give a total of 3277 microseconds for parts A, B, and C of figure 3-20. Use this reading to determine a line of position on a chart prepared for the region in which the readings are taken. To obtain a "fix" or intersection of two lines of position, follow the entire procedure just outlined, using either the "CHANNEL" selector on the receiver or the "STATION" selector on the indicator, or both, to select another pair of ground stations.

d. The effects of ground waves and sky waves on reception are as follows: The received pulses are typical forms of ground (direct) waves. However, over long distances, especially at night, the received pulses are sky (reflected) waves. (See fig. 3-21.) A ground-wave pulse does not change in form and is always the first stationary pulse to the left within a daytime range of approximately 600 miles, or a night time range of approximately 400 miles. The ground-wave pulse varies inversely with the distance in amplitude only. The sky-wave pulse, however, varies in both amplitude and form as the distance from the aircraft to the stations changes.

Figure 3-21 shows various forms of sky-wave pulses. Part A, figure 3-21, shows a train of changing pulse forms described as harmless splitting pulses, resulting from deterioration of only the training edge of the received pulse. By watching the pulses long enough to be sure that the leading edge of the A-pulse is matched with the leading edge of the B-pulse and by allowing for the additional travel time of the reflected wave, sufficiently accurate readings may be taken from skywave pulses.

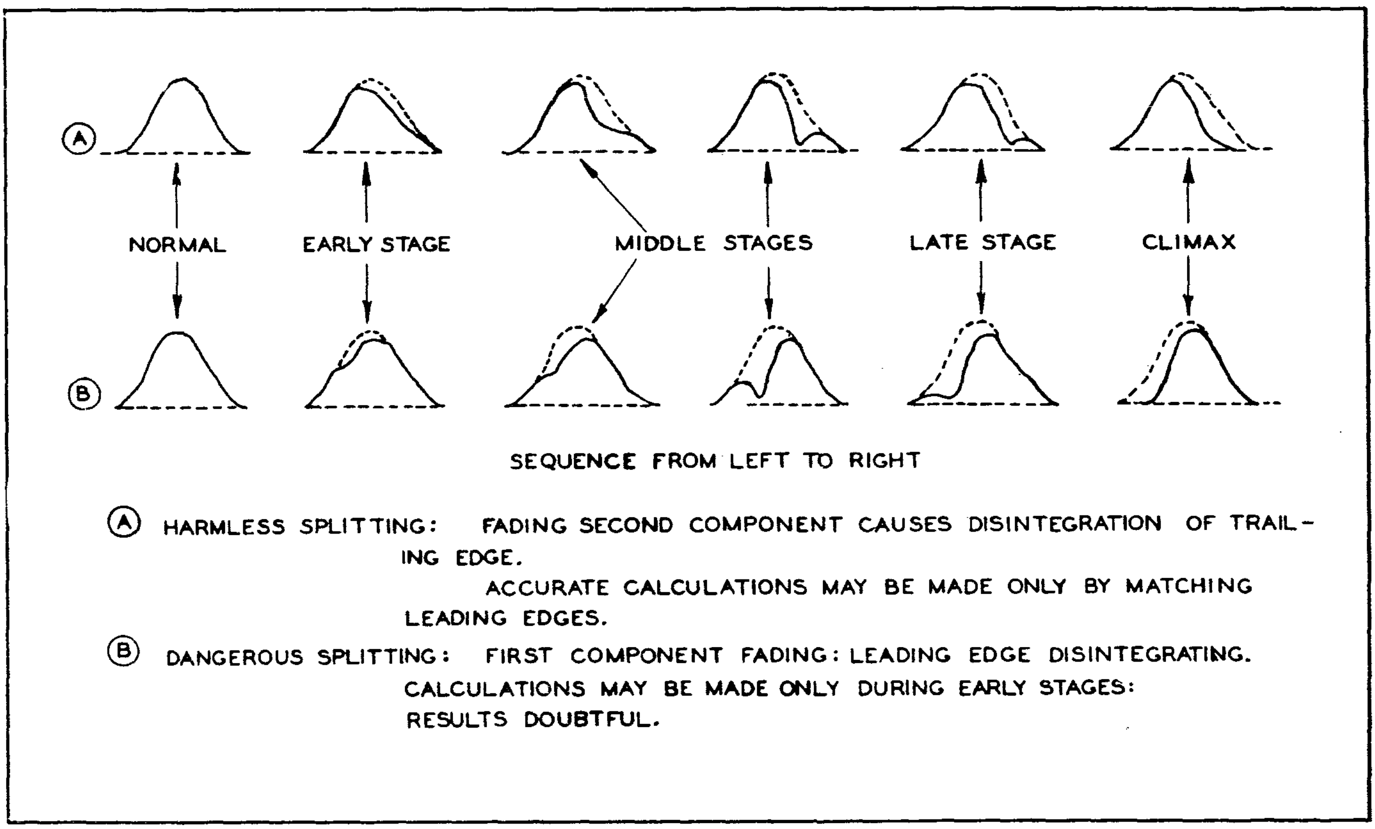


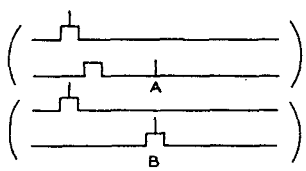
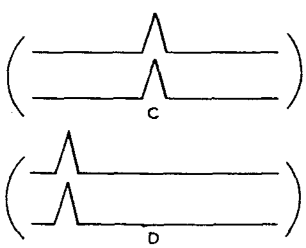
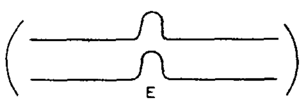
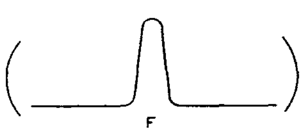
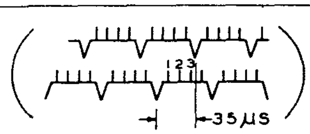
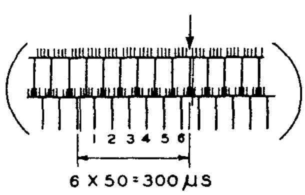
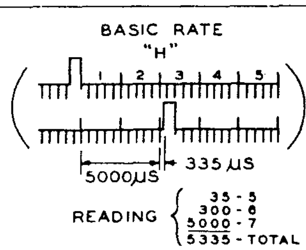
Figure 3-21. Oscilloscope Wave Forms Showing Sky-Wave Effects

Part B, figure 3-21, shows a series of pulse forms, described as dangerous splitting pulses, resulting from deterioration of the leading edge of the received pulse. Matching of such pulses is possible only during the early stages of deterioration or when aligning the trailing edges In either case, results are seldom accurate.

5. OPERATIONAL CHECK SHEET FOR RADIO SET *AN/APN-4. (Modifications I, II and III.)

RECEIVER: Power Switch—"ON"; CHANNEL SWITCH to First No. of L.O.P. Designation; FILTER SWITCH—Normally "OUT"; "IN" Only for Local Interference.

INDICATOR: Intensity & Focus Controls for Sharpest Image on Sweep Speed 5. On Sweep Speed 7 Mid-Adj. "D" Front Panel to have Seven 2500μs Spaces from Left Side of Upper Pedestal to Right End of Trace for Basic Rate "L", and Five 2500μs Spaces for Basic Rate "H". Changing Basic Rates Requires Resetting of Station Selector Controls.

Sweep Speed		
1		1. Station Switch to Specific Recurrance Rate of Desired Station Pair. (Four in 2H4-5335.) 2. Left-Right Switch to place Signals as in Figure "A". 3. Coarse Delay Control to Move Lower Pedestal as in Figure "B". 4 Amp. Balance Control to match Signal Heights. 5. Gain Control to make Signals Easily Distinguishable.
2		6. Fine Delay Control to align Signals as in Figure "C". 7. If unable to align Signals with Fine Delay Control, turn to other Extreme Position, then turn Coarse Delay Control Slightly in Opposite Sense until Signal appears on Lower Trace, then align Signals with Fine Delay Control. 8. Left-Right Switch to move Signals to Left Side of Traces as in Figure "D". 9. Amp. Balance Control to Match Signal Heights. 10. Gain Control to give Signals about One Inch Height.
3		11. Fine Delay Control to align Signals as in Figure "E". 12. Crystal Phasing Control to stop any Creeping of Signals.
4		13. Amp. Balance Control to exactly Match Signal Heights. 14. Gain Control to enlarge the Signals as much as possible without Distorting their Tops (Ground Waves.) 15. Fine Delay Control to Precisely Match the Lower Left Sides of Both Signals as in Figure "F". 16. Note Time to Nearest Half Minute.
5		17. From the 50μs Marker Nearest the Center of the Lower Trace Count the Number of whole 10μs Spaces and estimate any Fraction of such Space to the next 50μs Marker to the Right Extending down from the Upper Trace.
6		18. Count from the 500μs Marker on the Lower Trace to the Right the Number of 50μs Markers Between it and the 50μs Marker just to Left of 500μs Marker on Upper Trace. 19. If there is no 500μs Marker Visible on Lower Trace to Left of Upper Trace 500μs Marker, Count Number of 50μs Markers between Left End of Lower Trace and 50μs Marker just to left of 500μs Marker on Upper Trace.
7		20. Count the Number of Complete 500μs Spaces Between the Left Sides of the Upper and Lower Pedestals. 21. When the Sum of the Readings on Sweep Speeds 5 & 6 is just under 500μs do not Count the Space just to the left of the Lower Pedestal as a Complete 500μs Space. 22. Add Readings on Sweep Speeds 5, 6, & 7 for Total Reading. (2H4-5335)-2 is Channel Switch Setting; & is Basic Recurrence Rate; 4 is Station Switch Setting. 5335 is Time Difference Reading.

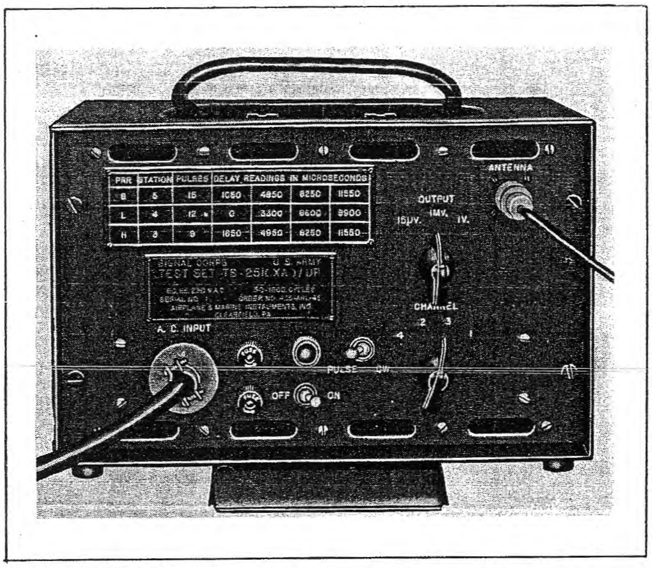


Figure 3-22. Test Set TS-251/UP—Front Panel

6. OPERATIONAL CHECK USING TEST SET TS-251/UP.

a. PRELIMINARY.

(See figures 3-22 and 3-23.)

(1) Remove Test Set TS-251/UP chassis from carrying case.

(a) Loosen 4 knurled screws.

(b) Pull forward.

(2) Check link (bottom of chassis) for position corresponding to available voltage (80-volt, 115-volt, or 230-volt at 50 to 1600 cycles per second).

(3) Replace chassis in carrying case.

(4) Connect Power Cord CX-404/02 and Radio Frequency Cable RG-58/U. (See fig. 3-24.)

b. TO OPERATE.

(1) Turn "POWER" switch to "ON" at Radio Set ★AN/APN-4.

(2) Turn "ON-OFF" switch to "ON" at Test Set TS-251/UP (dial lights up).

(a) Turn "PULSE CW" switch to "PULSE."

(b) Turn "OUTPUT" switch to "1V."

(c) Turn "CHANNEL" switch to correspond to channel switch on the radio set receiver. (Allow 3 minutes to warm up.)

Note

Channel "4" of Radio Receivers ★R-9/APN-4 and ★R-9A/APN-4 are high frequency channels and can not be checked with Test Set TS-251/UP.

(3) Proceed as follows for Radio Set ★AN/APN-4.

(a) Set "SWEEP SPEED" switch at "1" position.

(b) Set "PRR" (Indicator ★ID-6B/APN-4 only) to "L" position.

(c) "STATION SELECTOR" switch to positi n "4."

(d) Adjust "GAIN" control until pulses ap about 1 inch high.

(e) Adjust "CRY. PHAS." control until p ses are almost stationary.

(4) Steps *(d)* to *(e)* above should result 12

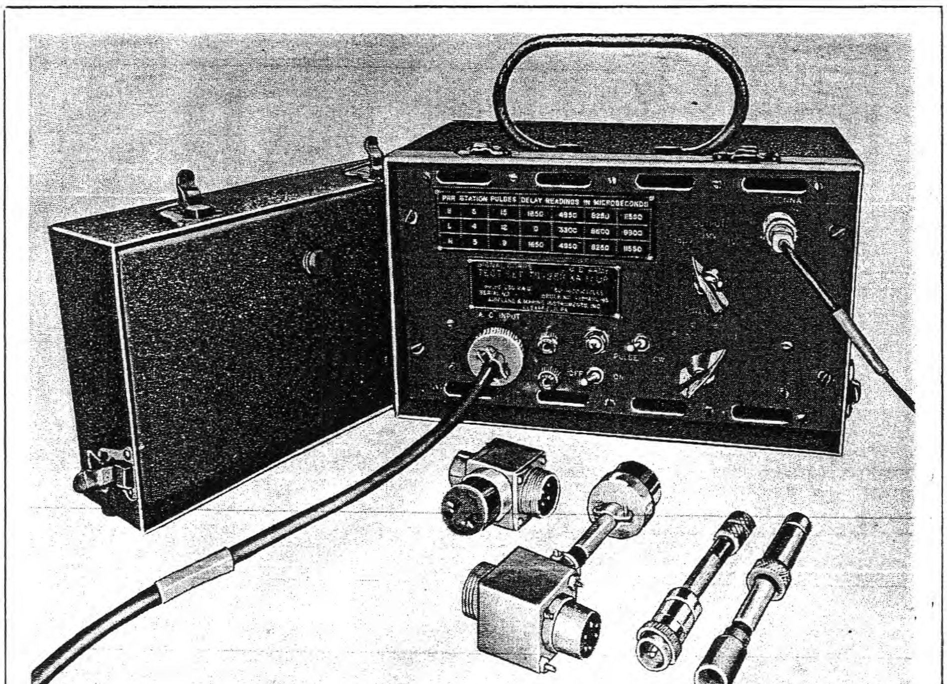


Figure 3-23. Test Set TS-251/UP—Composite View

pulses appearing on the screen of the indicator.

(5) Take delay reading between any pulse on the A-trace and any pulse on the B-trace. These delay readings should correspond to the delay readings in microseconds in line with "PRR. L" appearing on the front panel of Test Set TS-251/UP.

(6) Check action of "LEFT-RIGHT" switch on front panel of indicator. The switch should move pulses left or right in sweep speed positions "1," "2," "3," and "4."

(7) Flip "PRR" switch (Indicator ★ID-6B/APN-4 only) on the indicator to "H" position and "STATION SELECTOR" to position "5." Turn crystal phasing until pulses are almost stationary. Nine pulses should be visible on the scope of the indicator.

(8) Take time delay readings between any pulse on the A-trace and any pulse on the B-trace. These delay readings should correspond to the delay reading in microseconds in line with the "PRR H" column on the front panel of Test Set TS-251/UP.

(9) Turn the "OUTPUT" switch on Test Set TS-251/UP to the 15-microvolt position. Advance the "GAIN" control on the indicator until the pulses are visible. Pulses 1 inch or more high should be seen on the screen of Radio Set ★AN/APN-4 before noise is evident on the cathode-ray tube sweep. Make this check on all channel positions if possible.

7. DEFENSE AGAINST JAMMING.

a. DEFINITION.—Jamming is the intentional generation by the enemy of radio signals designed to reduce the efficiency of Radio Set ★AN/APN-4.

b. EFFECT OF JAMMING.—Several types of jamming are likely to be used by the enemy. They all give various kinds of spurious signals on the indicator which make the normal signals difficult to see and measure.

c. RECOGNIZING JAMMING.—If Radio Set ★AN/APN-4 is defective, it is possible that it can produce effects similar to jamming. Remove the antenna lead to the receiver and if the interference disappears the interfering signal is coming from outside the set. If the interference does not disappear, the set is defective.

d. ACTION.—Report jamming to the Commanding Officer immediately.

e. ANTI-JAMMING PROCEDURE.

(1) Keep calm and think about what you are doing.

(2) Turn on the filter switch located on the receiver chassis.

(3) Try all positions of the gain control from high to low and determine which position gives the best signal indication.

(4) Switch to alternate stations on different frequencies and determine which is the best.

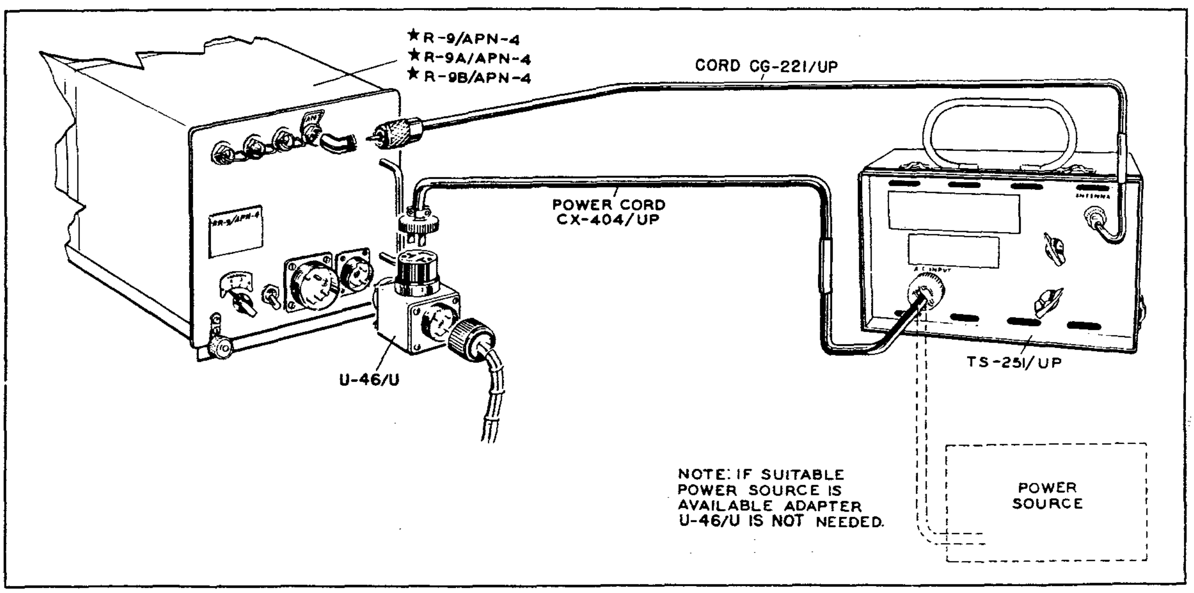


Figure 3-24. Test Set TS-251/UP—Cabling Diagram

SECTION IV
THEORY OF OPERATION

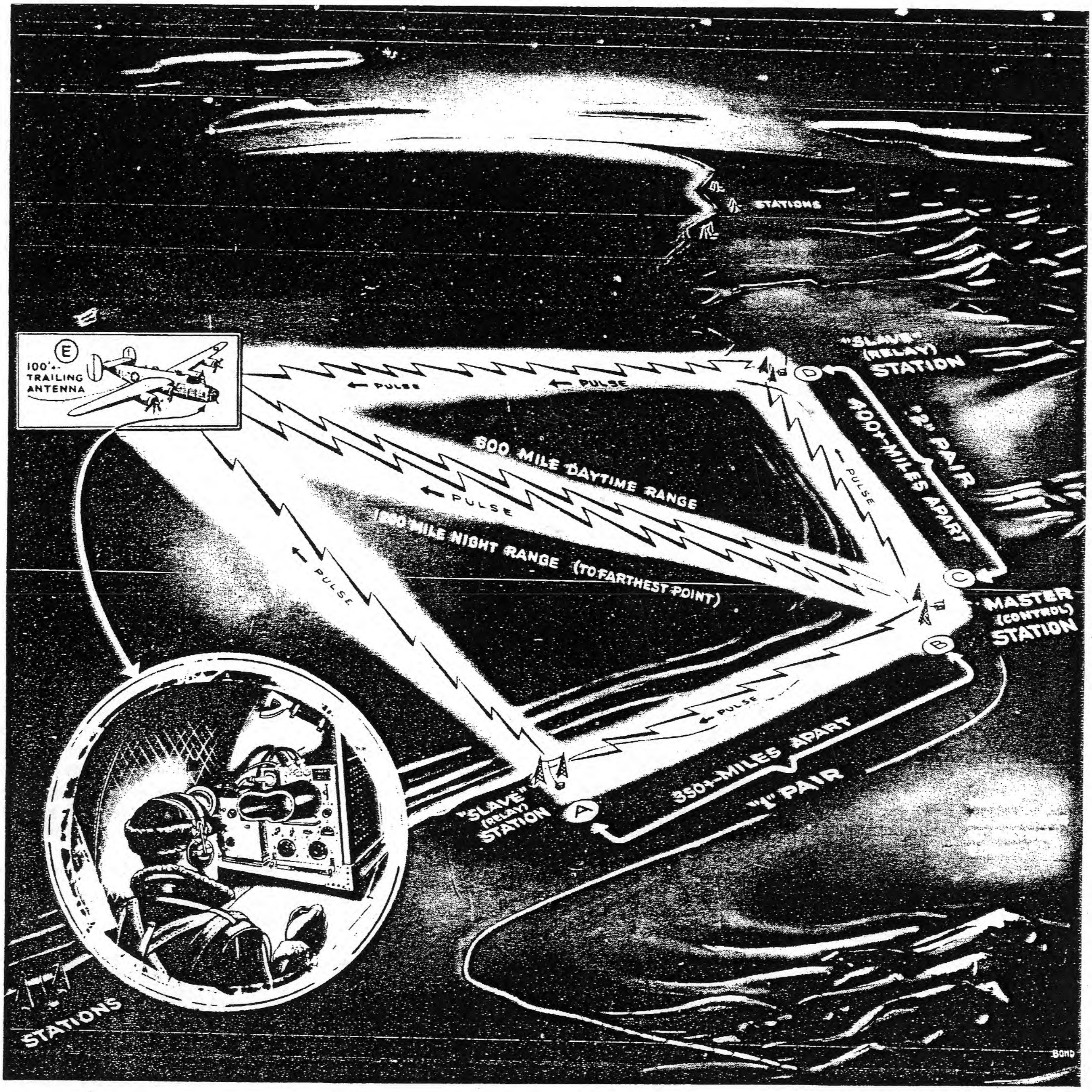


Figure 4-1. LRN (Long Range Navigation) System

1. LORAN SYSTEM.

The Loran system, of which Radio Set ★AN/APN-4 is a part, enables a navigator to determine the position of his craft accurately and quickly. The accuracy of the system and the speed at which readings may be taken and interpreted make the system particularly useful in aircraft. The overall Loran system is made up of the ground system which provides a special radio signal pattern and the receiving system which receives these signals and translates them into information useful to the navigator.

a. GROUND SYSTEM.—The ground system consists of a chain of radio transmitting stations, located at intervals along the shoreline, which transmit pulse-modulated signals at various carrier frequencies and pulse recurrence rates. See figure 4-3 for a general picture of the system. These stations are arranged in groups of eight pairs of stations, numbered "0" through "7." All the stations within a group operate on the same carrier frequency and each group operates on one of the four r-f channels which lie within the two frequency bands of 1.6 to 3.3 and 7.58 to 11.75 megacycles per second. The lower frequencies are used for long distance night-time transmission; the higher frequencies for day-time transmissions. Although all eight pairs of stations of one group operate on the same carrier frequency, each pair within the group transmits at a different pulse recurrence rate. One station of a pair is known as the master station, and the other as the slave station. The master station (station A) of one pair transmits pulses (at a predetermined recurrence rate) which are received by the slave station (station B) of the same pair. Station B is triggered by the received pulses and consequently transmits a train of pulses similar to that transmitted by the A-station. However, each pulse transmitted by the B-station will be delayed from the corresponding pulse transmitted by the A-station by an amount determined partially by the distance separating the two stations and partially by a time delay circuit at the B-station. The approximate delay time is 20,000 microseconds. See figures 4-1, 4-2, and 4-3 for help in understanding the system. Each succeeding pair of stations 0 to 7 of each group has a recurrence rate of 1/16 of a cycle per second higher than the preceding pair. A cycle as used here refers to the time period between succeeding pulses transmitted by a station of pair 0. Stations A and B of station pair 0 each operate at a pulse recurrence rate of 25 cycles per second which represents an interval between pulses of 40,000 microseconds. Stations A and B of station pair 1 operate at 25-1/16 cps; stations A and B of station pair 2 at 25-2/16 cps; etc. These differences in pulse recurrence rate from pair to pair permit the selection of signals from any specific pair within a group for observation. The time difference between the transmission of the A and B stations provides a means for determining which of the two pulses of a pair received by Radio Set ★AN/APN-4 is an A and which is a B pulse.

b. RECEIVING SYSTEM.—Radio Set ★AN/APN-4 is the airborne equipment for accurately measuring the difference in time between the arrival of the two paired pulses from any pair of stations used in the LRN system. This time difference as shown on the indicator screen represents only the difference in the time required for the pulses from stations A and B to reach the aircraft. The fixed time interval between the transmissions from the A and B stations is eliminated in the indicator, and hence, is not included in the calculations. When the time difference in microseconds between the A- and B-pulses from any pair of stations is determined and plotted on a Loran chart of the region, a "line of position" is obtained. Using the same procedure, a reading from another pair of stations provides a second "line of position." The point of intersection of these "lines of position" indicates the exact position of the aircraft.* (See fig. 4-2.) When a plane is to the right of the B station and in line with stations A and B, ***minimum*** time difference between the pulses will exist. This ***minimum*** time difference will always exist rather than zero difference because of time delay introduced by the delay circuit at the slave transmitter. When the aircraft is in a similar position to the left of the A station, the ***maximum*** time difference will exist. This increased time difference results from the longer travel time of the pulse from the B-station to the aircraft, plus the signal transit time between the stations.

2. CIRCUIT FUNCTIONS (EARLY).

Block diagrams, figures 4-4 and 4-10, show the circuit paths of the receiver and indicator systems. Reference to these diagrams, showing the sequence and relation of circuits, will be helpful with the circuit explanations to follow.

a. RADIO RECEIVER ★R-9/APN-4.

(1) ANTENNA STAGE AND R-F BAND SELECTOR.—Tunes the input to the r-f amplifier and provides trap circuits for signals at the intermediate frequency.

*When one of the "lines of position" coincides with a desired course, it is possible to follow the course with high precision by merely setting the indicator for the time difference associated with that "line of position," and so control the heading of the aircraft that the observed time difference remains constant. Such an operation of the system, since it provides continuous averaging of errors, permits the desired course to be followed with much greater accuracy than that obtained by other methods of navigation.

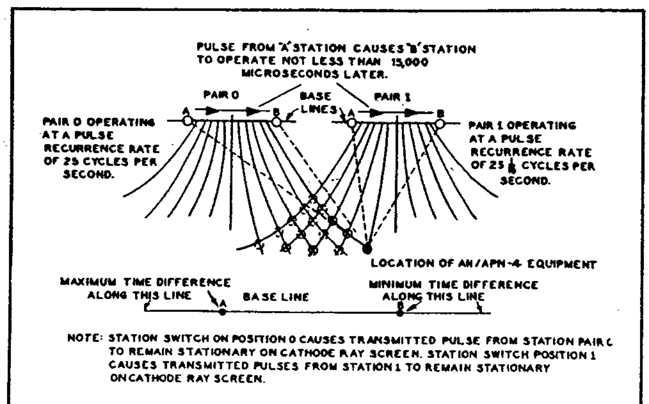


Figure 4-2. Hypothetical Station Arrangement

(2) R-F AMPLIFIER.—Amplifies the incoming signals from the antenna stage.

(3) LOCAL OSCILLATOR AND MIXER.—Provides a frequency which beats with the incoming r-f frequency to give the proper intermediate frequency.

(4) I-F AMPLIFIER STAGES.—Amplifies the signal from the mixer.

(5) AMPLITUDE BALANCE STAGE.—Provides a means of equalizing the amplitudes of signals received from the two transmitting stations of a pair before they are fed to the detector.

(6) DETECTOR.—Rectifies the i-f signal and feeds the resulting series of positive pulses to the video amplifier.

(7) VIDEO AMPLIFIER.—Amplifies the output from the detector and provides a series of positive pulses which are fed to the indicator.

(8) POWER SUPPLIES (Not shown on block diagram).—The regulated supply furnishes plate voltage for the receiver and the indicator. The high voltage supply furnishes voltage to some of the elements of the cathode ray tube.

b. "SWEEP SPEED" SELECTOR FUNCTIONS.—See the following table (page 4-4) for sweep speed switch positions.

c. INDICATORS ★ID-6/APN-4 AND ★ID-6A/APN-4.

(1) OSCILLATOR AND SQUARING AMPLIFIER.—Provides a constant frequency source for the counter and sweep circuits and feeds the 10-microsecond amplifier.

(2) COUNTER CIRCUITS.—Provide a means of stepping down or dividing the 100-kc oscillator frequency in four successive steps so that various pulse frequencies will be available.

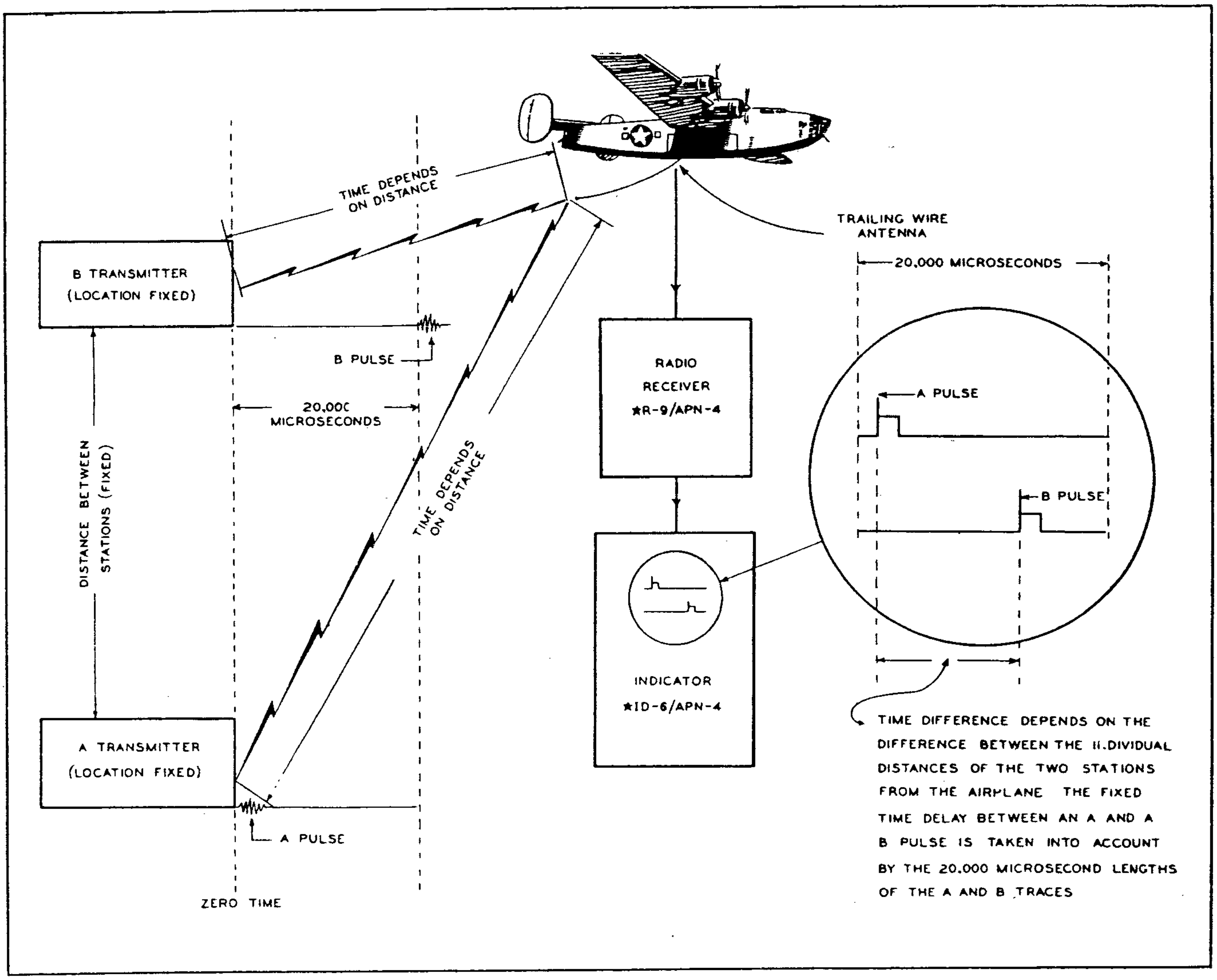


Figure 4-3. Line Sketch Showing Principle of LRN System

	Sweep Speed Switch Position							
Switch Section	1	2	3	4	5	6	7	8
G Controls bias to sweep generator	Slow sweep speed	Medium sweep speed	Fast sweep speed	Same as 3-G	Same as 3-G	Same as 3-G	Same as 1-G	Same as 1-G
F Controls triggering voltage to sweep generator	Negative pulses from pulse broadener	750-microsecond pulses from pedestal generator	220-microsecond pulses from pedestal generator	Same as 3-F	Same as 3-F	Same as 2-F	Same as 1-F	Pulses from B fine delay tube
E Controls cathode circuit of marker amplifier tubes	Cathodes open markers not developed	Same as 1-E	Same as 1-E	Same as 1-E	10- and 50-microsecond markers developed and seen	50- and 500-microsecond markers developed and seen	500- and 2500-microsecond markers developed and seen	Grounds video amplifier cathode for greater vertical deflection on cathode ray tube
D Controls input to trace shift amplifier	Maximum trace separation	Trace separation control R-353-2	Same as 2-D	Input to trace shift amplifier grounded	Trace separation control R-353-1	Trace, separation control R-353-1	Same as 6-D	Same as 4-D
C Controls bias on pedestal generator	Pedestal generator creates 750-microsecond pedestal	Same as 1-C	Pedestal generator creates 220-microsecond pedestal	Same as 3-C	Same as 3-C	Same as 1-C	Same as 1-C	Same as 1-C
B Controls input to video amplifier	Received signal switch in	Same as 1-B	Same as 1-B	Same as 1-B	Received signal switch out	Same as 5-B	Pulse every 2500 microseconds switches in from 3rd counter	Pulses from 2nd counter diode for station selector adjustment
A Switches pedestal generator pulses to 1st counter thru 1-r switch section	Increase 1-r action on position No. 1 only							
Sweep duration	20,000 microseconds	750 microseconds	220 micoseconds	220 microseconds	220 microseconds	750 microseconds	20,000 microseconds	20,000 microseconds (causes trace line to travel off screen)*
Trace separation	Maximum	Variable	Variable	None	Variable	Variable	Variable	None
Observe on scope	Pedestal and received signal (complete trace)	Pedestal top only and received signal	Pedestal top only and received signal	Pedestal top only and received signal	Pedestal top only and markers	Pedestal top only and markers	Pedestal and markers (complete trace)	Feedback action at 2nd counter

*Sweep generator triggered by B pedestal fine delay tube.

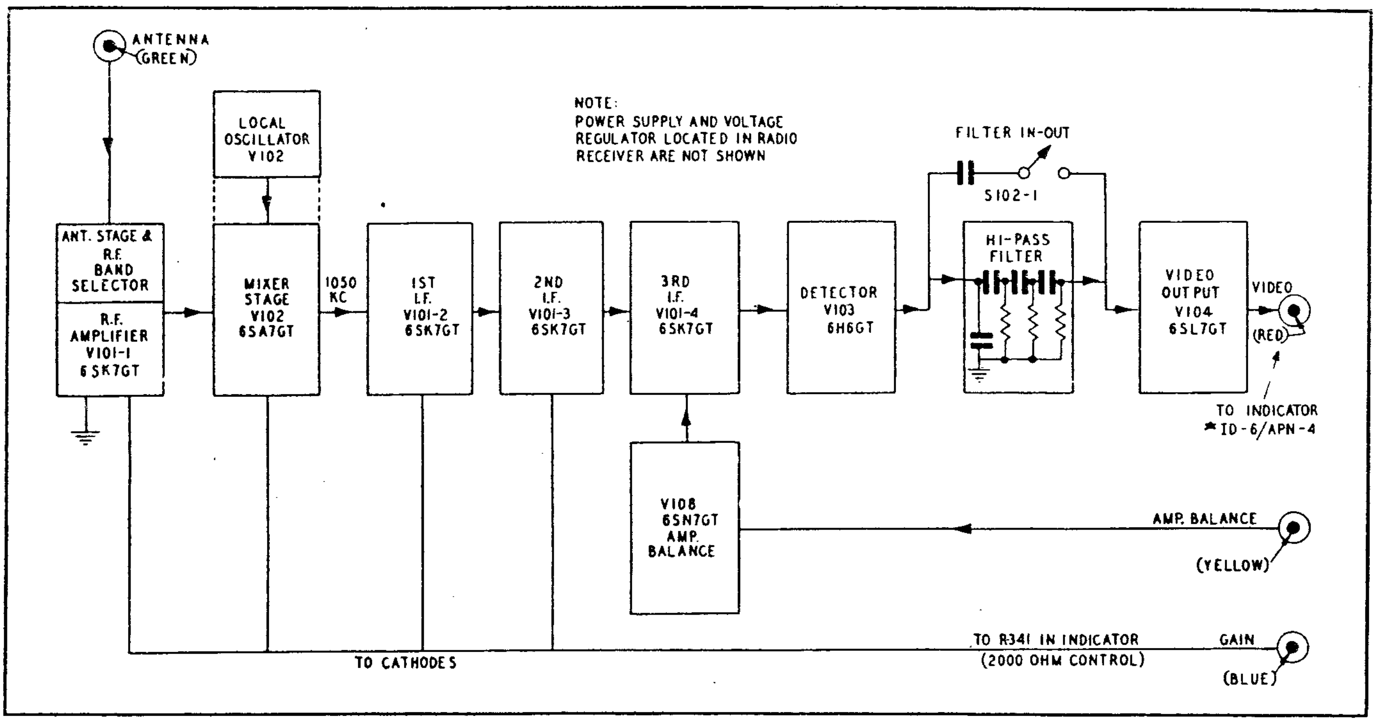


Figure 4-4. Radio Receiver ★R-9/APN-4—Functional Block Diagram

(3) "STATION" SELECTOR.—Provides a means of synchronizing the indicator with the pulse recurrence rate of any desired pair among the different pairs of ground stations.

(4) SQUARE WAVE GENERATOR.—Provides a means of developing two horizontal sweeps at different positions on the indicator screen, and synchronizes the action of the delay circuits with the action of the sweep circuit.

(5) A-PEDESTAL DELAY.—Provides a time delay which places the A-pedestal at a definite position on the A-trace.

(6) B-PEDESTAL DELAY.—Provides a variable time delay which places the B-pedestal at a desired position on the B-trace.

(7) "COARSE" and "FINE" CONTROLS.—Provide a means of moving the B-pedestal along the B-trace so that it may be placed directly under the B-pulse.

(8) PEDESTAL MIXER.—Mixes and inverts the pulses from the A- and B-pedestal delay circuits and feeds them to the pedestal generator.

(9) PEDESTAL GENERATOR.—Develops the A and B pedestals on the slow sweep speeds and controls the action of the sweep generator at high sweep speeds.

(10) SWEEP GENERATOR.—Provides horizontal deflection voltages for the cathode ray tube.

(11) TRACE SEPARATION.—Provides a means of separating the A- and B-traces on the indicator screen.

(12) AMPLITUDE BALANCE.—Feeds the voltage from the square-wave generator to the amplitude balance circuit in the receiver and to the trace separation circuit.

(13) 10-MICROSECOND AMPLIFIER AND PULSE SHAPER.—Amplifies and shapes the output of the 100-kc oscillator [see (1) above] into pulses spaced 10 microseconds apart which are used as markers on the indicator screen.

(14) MARKER MIXER.—Mixes the pulses (which are also used as time markers) from the first and second counter circuits with the output of the 10-microsecond amplifier and feeds them to the signal mixer stage.

(15) SIGNAL MIXER.—Mixes the pulses from the marker mixer with the pulses from the pedestal generator and feeds them to the deflection system of the cathode ray tube.

(16) VIDEO AMPLIFIER.—Amplifies the pulses from the receiver or the time marker-pulses depending on the setting of the "SWEEP SPEED" switch and feeds them to the deflection system of the cathode ray tube.

3. CIRCUIT ANALYSIS (EARLY).

a. RADIO RECEIVER ★R-9/APN-4 AND ★R-9A/APN-4.—These receivers employ a superheterodyne type circuit consisting of one r-f amplifier stage, one converter stage, three stages of i-f amplification, one diode detector, one video amplifier, an amplitude balance stage, and two power supplies. It is designed to operate on four preset frequencies which are selected by the "CHANNEL" control on the front panel of the receiver. Antenna connection J-101 is connected to the selector arm of S-101-A, the first section of S-101, the "CHANNEL" selector switch; the

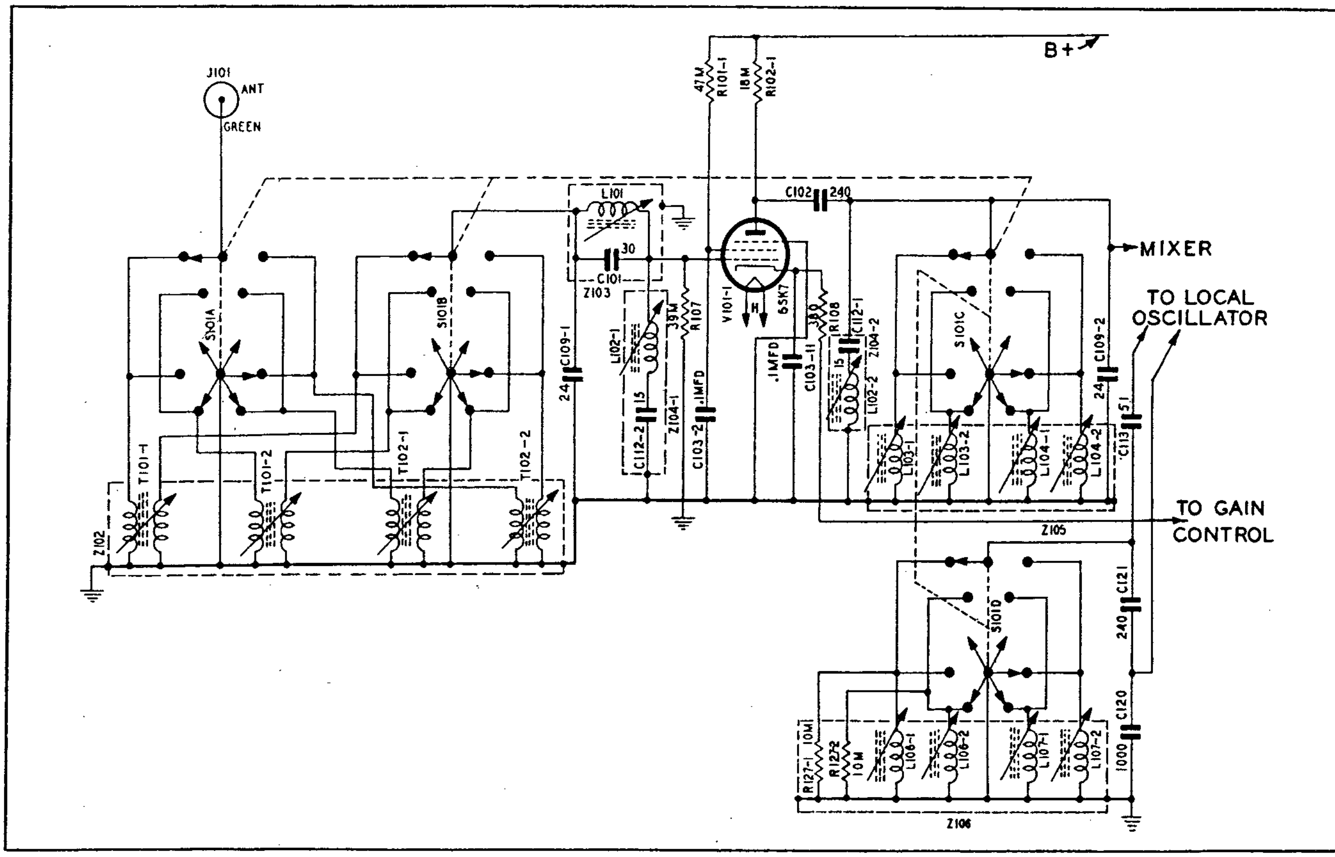


Figure 4-5. Receiver Antenna and R-F Stage

stationary contacts of switch S-101-A are connected to one end of each of the primary windings of antenna transformers T-101-1, T-101-2, T-101-3, and T-101-4. The other ends of these primary windings are grounded. One end of each of the secondary windings is connected to the stationary contacts of S-101-B, the second section of the "CHANNEL" selector switch. The other end of each coil is grounded. The selector arm of S-101-B is connected through wave traps Z-103 and Z-104-1 to ground. The grid of V-101-1, the r-f amplifier tube, is connected to the common point of these two wave traps. Switches S-101-A and S-101-B are ganged. These switches select one primary and one secondary winding at a time and short the unused windings to ground. Antenna transformers T-101-1, T-101-2, T-101-3, and T-101-4 are tuned by movable iron cores. Wave traps Z-103 and Z-104-1 are tuned to the intermediate frequency of 1050 kilocycles to suppress carriers of this frequency which if picked up by the antenna would otherwise interfere with the operation of the receiver. The r-f amplifier stage (V-101-1) amplifies a signal picked up by the antenna and feeds it through capacitor C-102 to the selector arm of section S-101-C of the "CHANNEL" selector switch and to the control grid of V-102, the converter tube. The selector switch selects one of the inductances L-103-1, L-103-2, L-104-1 or L-104-2, and shorts out the unused windings. Wave trap Z-104-2 is connected across the output of the r-f amplifier tube to bypass any remaining undesirable i-f signal components which may have gotten past the antenna circuit traps. A portion of tube V-102 is used as a local oscillator to provide, by heterodyne action, the desired intermediate frequency. The oscillator portion of V-102 is connected to section S-101-D of the "CHANNEL" selector switch and selects one of the following inductances, L-106-1, L-106-2, L-107-1, or L-107-2, and shorts out the unused windings.

The local oscillator section of the tube is electron-coupled to the carrier frequency portion of the converter tube. A signal from the antenna is fed through the r-f amplifier to the converter tube. This tube, operating on a non-linear portion of its characteristic curve, provides an output signal at the intermediate frequency of 1050 kilocycles. This signal is fed through transformer T-103-1 to the grid of the first i-f amplifier tube V-101-2; here it is amplified and fed through transformer T-103-2 to the second i-f amplifier tube V-101-3, where it is further amplified and fed through transformer T-103-3 to the third i-f amplifier tube V-101-4. The output of the third i-f tube is coupled through transformer T-103-4 to the detector tube V-103. Transformers T-103-1, T-103-2, T-103-3, and T-103-4 are tuned by iron cores within the coils. The gain of the receiver is controlled by the cathode bias on the r-f amplifier tube V-101-1, the converter tube V-102, and the intermediate amplifier tubes V-101-2 and V-101-3, and is

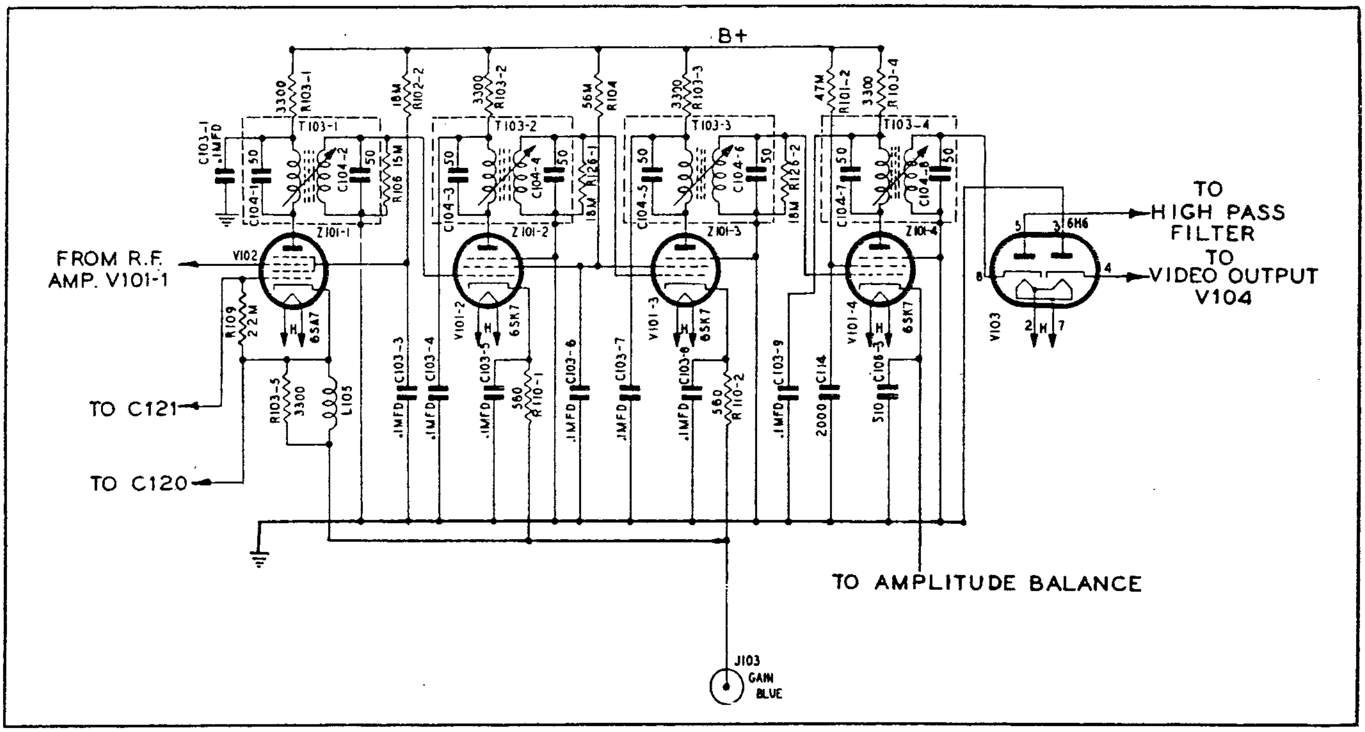


Figure 4-6. Receiver I-F Stages

adjusted by means of the "GAIN" control in the indicator unit.

Pulses arriving from the ground station pair under observation may come into the receiver with considerable difference in amplitude existing between A- and B-pulses. For precise matching of the pulses, it is necessary that the two pulses of each pair appear on the screen at exactly the same amplitude. To accomplish this, the gain of the third i-f amplifier V-101-4 is varied by a square voltage wave from the indicator unit to an extent determined by the setting of the "AMP. BALANCE" control in the indicator unit.

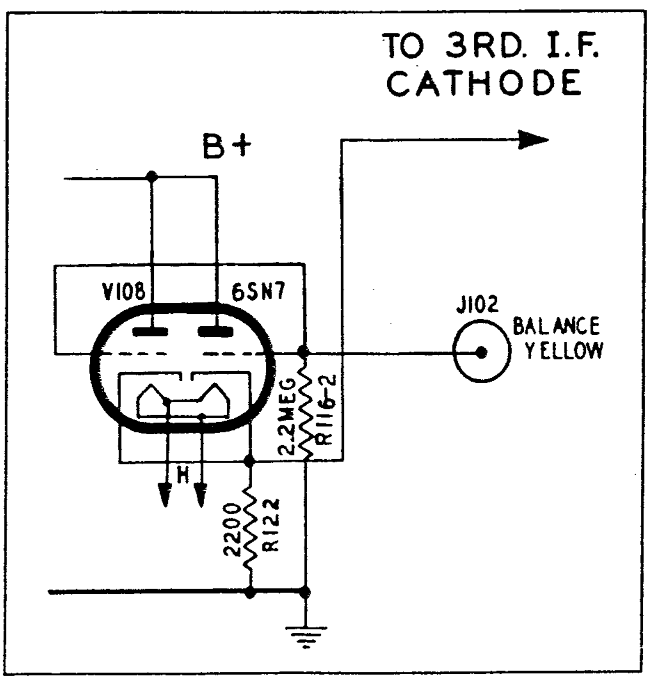


Figure 4-7. Receiver Amplitude Balance

The cathode of the third r-f amplifier shares a common cathode resistor with the amplitude balance tube V-108. (See fig. 4-7.) This circuit is fed with a 25-cycle square voltage wave from the square wave generator through the dual cathode follower V-303-3 located in the indicator unit. The grid of this tube is driven alternately positive and negative causing its plate and cathode current to either rise or fall. While the input voltage is going positive, the current increases and raises the cathode voltage. Since V-108 and V-101-4 have a common cathode resistor, this results in raising the cathode voltage of V-101-4 as well, thereby increasing the grid bias of the third i-f amplifier and reducing its gain. When the input signal from the indicator "AMP. BALANCE" control is swinging negative, it causes reduction of the plate and cathode current of the amplitude balance tube and, consequently, a decrease in its cathode voltage and an increase in the gain of the third i-f amplifier stage. The ratio of the gain available during one pulse to that available during the other pulse of the pair may be made as high as 30 to 1.

The r-f pulses, now of equal amplitude, are rectified by the detector tube V-103 and then fed to a high pass filter circuit, intended to attenuate low frequencies which might otherwise reach the video amplifier grid. This filter is intended to eliminate certain unwanted responses which would interfere with the observation of LRN pulses. For normal operation the signal is bypassed around the filter through capacitor C-105 and the normally closed "FILTER IN-OUT" switch S-101-2. The filter is in the circuit

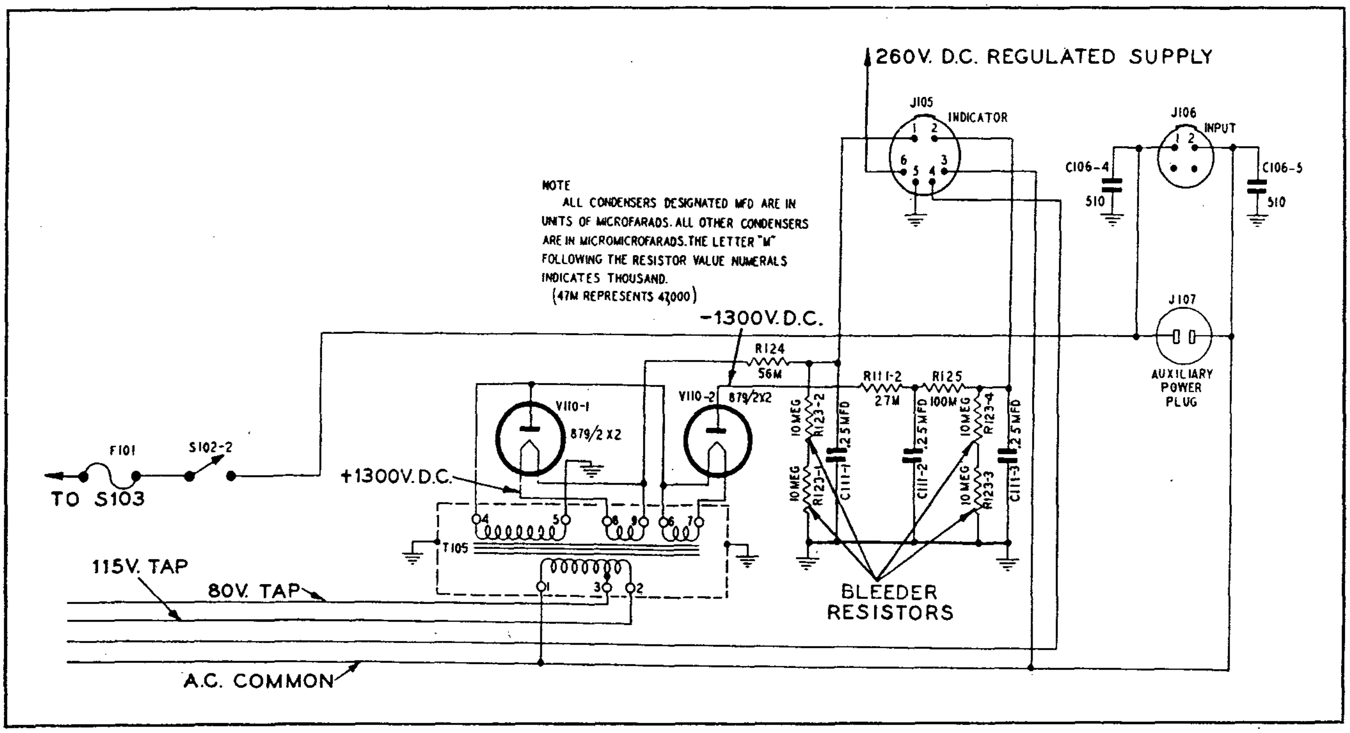


Figure 4-8. High Voltage Power Supply

when the switch is open. The signals are amplified by V-104-A and fed to V-104-B, a cathode follower, which provides lower output and results in a better impedance match with the coaxial cable to the indicator unit.

The amplitude balance voltage from the indicator unit is fed to the receiver through coaxial connector J-102, marked yellow. The "GAIN" control, also in the indicator unit, is connected through coaxial connector J-103, marked blue, and the receiver pulse output is fed through coaxial connector J-104, marked red.

(1) HIGH VOLTAGE POWER SUPPLY.—The power supply for the cathode ray tube is housed in the same case with the receiver. This high-tension supply provides 1300 volts d-c negative with respect to ground, and also 1300 volts direct current positive with respect to ground, or 2600 volts in all. See figure 4-8 for the high voltage rectifier circuit. Resistor R-124 and capacitor C-111-1 form the filter for the positive 1300-volt supply while resistors R-123-1 and R-123-2 act as a bleeder resistor to prevent the capacitor from holding a dangerous charge. This bleeder will discharge capacitor C-111-1 in the event the equipment is operated with the inter-connecting cord disconnected. Resistors R-111-2 and R-125 are the filter resistors of the negative 1300 volts supply, while capacitors C-111-2 and C-111-3 are the filter capacitors for this supply. Resistors R-123-3 and R-123-4 are the bleeders to prevent the retention of charge in the negative high-voltage supply.

WARNING

The high voltage power supply of Radio Receiver ★R-9/APN-4 provides 2600 volts of direct current of which 1300 volts are above ground and 1300 volts are below ground potential. This potential is dangerous and may cause death. Treat it with respect.

(2) REGULATED POWER SUPPLY.—The low voltage power supply for Radio Set ★AN/APN-4 included in Radio Receiver ★R-9/APN-4 (see fig. 4-9) is a voltage-regulated power supply of the electronic type. Three triodes, V-105-1, V-105-2, and V-105-3 are connected in parallel and the set of three is connected in series with the rectifier output. The plates of these tubes are connected directly to the filament of the power rectifier tube V-109. Although the three voltage regulator tubes are connected in parallel, resistors R-115-1, R-115-2, and R-115-3 are connected as isolating resistors between the grids and the grid bias lead to prevent undesirable coupling which might cause the parallel connected triodes to oscillate.

The plate current and, consequently, the output voltage of this voltage regulator are determined by the grid cathode potential of these tubes. They may be considered to act as a variable resistance which varies with the applied grid bias. The more positive this applied grid bias, the lower is the effective resistance.

A sharp cut-off pentode V-106 is the voltage control tube. Its plate current is dependent upon its d-c grid voltage, which is a portion taken from an adjustable voltage divider across the output from the system. Cathode voltage for the control tube is held at a fixed value by the gas-type voltage regulator V-107. Since this cathode voltage is held constant, any tendency of the regulated voltage output to fall, caused either by an increase in load or by a reduction in the input voltage, will cause a more negative grid voltage on the control tube, and consequently a re-

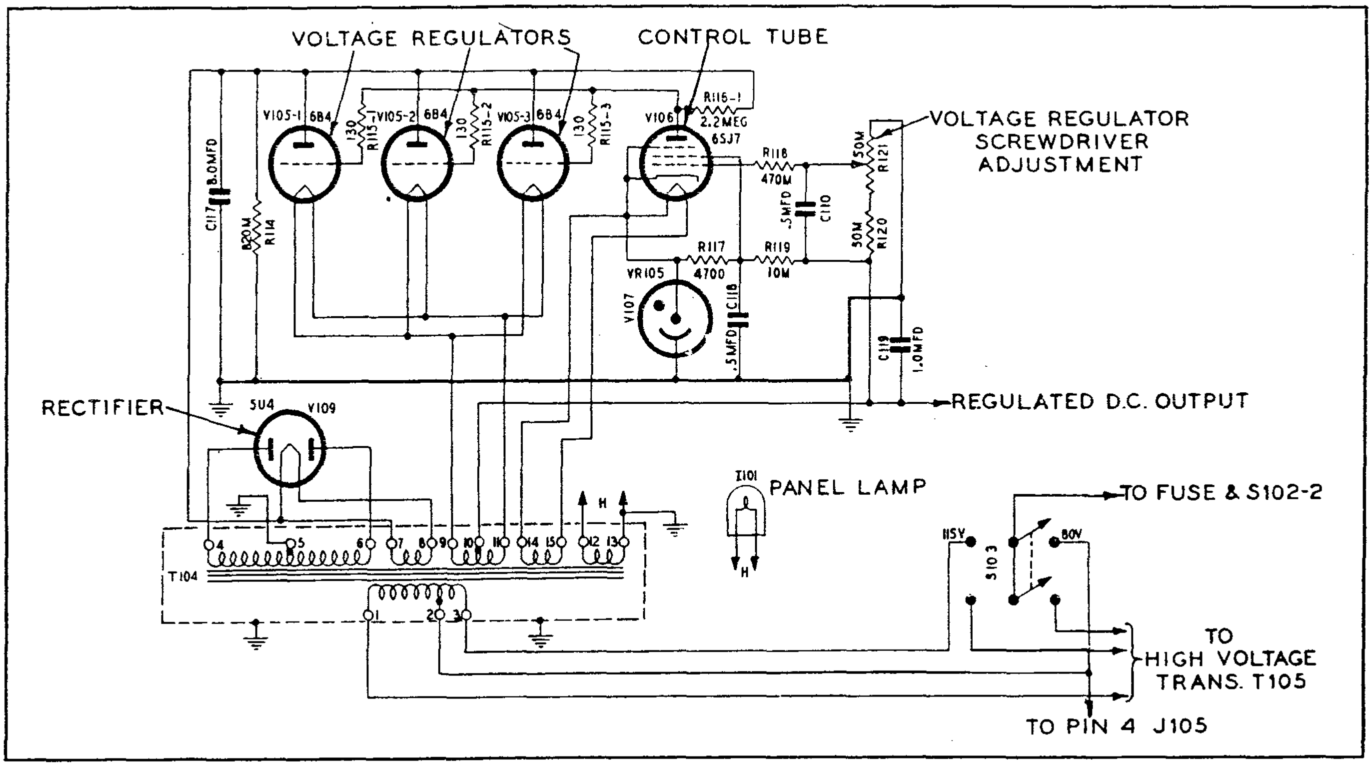


Figure 4-9. Regulated Power Supply

duction in the current through its plate load resistor R-116-1. As the plate voltage rises, the grids of the three triode regulators become less negative and their plate current increases resulting in a corresponding increase in the regulated d-c output voltage.

If the regulated voltage should tend to rise, the control tube grid would become more positive and its plate current would increase. This would drop the control tube plate voltage, causing the grid bias on the voltage regulator tubes to become more negative, thus lowering the plate current and reducing the regulated output voltage.

In this manner, the B potential applied to the receiver and indicator circuits is held at 260 volts positive with respect to ground (this voltage value is determined by the setting of R-121) over a wide range of varying load and input voltage conditions. Capacitor C-117 across the output from the power rectifier, and capacitor C-119 across the output of the regulating system provide the only additional filtering action necessary.

Both the high and the low voltage power transformers have their primary windings tapped for 80 and 115 volts. Switch S-103 permits selection of the proper primary tap so that the equipment may be operated from either of these supply voltages. Transformer T-104 also acts as an auto-transformer, supplying 80 volts to the transformer in the indicator unit when switch S-103 is set for supply from a 115-volt source.

b. INDICATORS ★ID-6/APN-4 AND ★ID-6A/APN-4.

Note

In the following discussions where the two halves of a double vacuum tube are described as the A-section or the B-section, the tube-half appearing to the right is the section called "A" while that appearing to the left in the functional schematic is the "B" section.

(1) CRYSTAL OSCILLATOR AND SQUARING AMPLIFIER. *(See figure 4-11.)*—The timing standard used in the indicator is a crystal oscillator circuit controlled by crystal Y-301, a 100-kilocycle crystal. All the functions of the indicator are directly or indirectly controlled by the crystal. Figure 4-11 shows the crystal oscillator and squaring amplifier circuits in detail.

The first section of V-301-1 functions as a crystal-controlled oscillator. In addition to the crystal and grid leak resistor R-302-1 the oscillator grid circuit is also shunted by reactor L-301 in series with capacitor C-301 and by capacitors C-302, C-304-1, and C-305-1. Feedback is supplemented by capacitor C-304-2 connected between plate and grid of the oscillator. Adjustment of C-302 ("CRYSTAL PHASING") and switch S-302-A ("LEFT-RIGHT") permit approximately 35 cycles of plus or minus deviation from the 100-kilocycle standard. The shunt reactive element comprised of L-301 and C-301 is effective in increasing the control exercised by C-302.

The primary of transformer T-301 together with capacitor C-306-1 forms the tuned plate circuit of the oscillator unit. By adjusting the movable iron core of L-301, the circuit is tuned to give resonance at a fre-

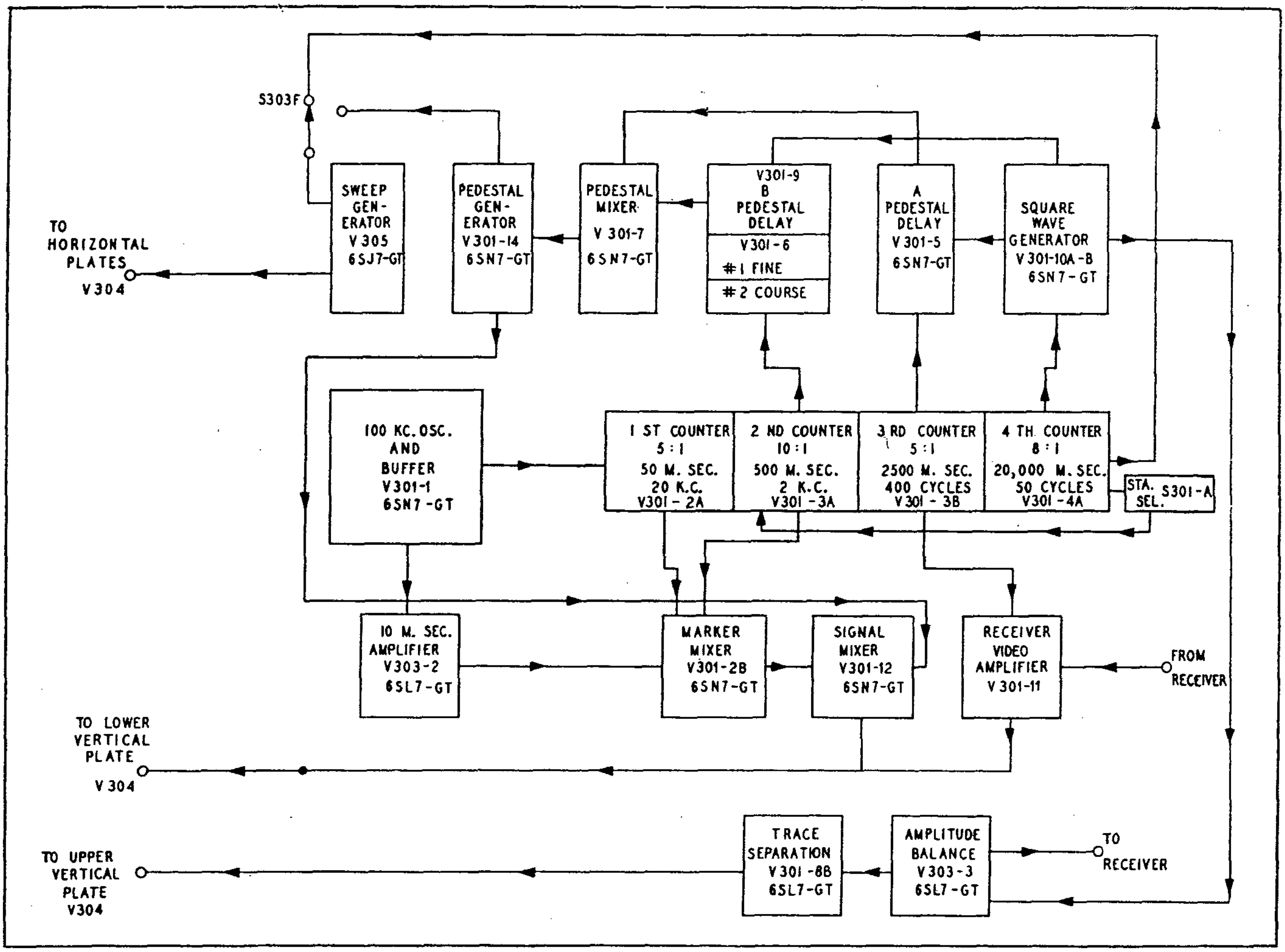


*Figure 4-10. Indicator *ID-6/APN-4—Block Diagram*

quency slightly higher than that at which the CRYSTAL operates. This results in greater frequency stability with some slight sacrifice in output voltage.

R-F energy at a frequency of 100 kilocycles is fed to the second section of V-301-1 through capacitor C-312-6. The voltage is sufficient to drive the grid of V-301-1 alternately past cut-off and to zero bias, resulting in a somewhat rectangular output wave form. See figure 4-11. This wave form is desirable in order to obtain proper counter action in the succeeding stage. The B section of diode V-302-6 is connected across R-305-1 to prevent the development of any positive voltage at the grid. Resistor R-301-1 and capacitor C-303-1 serve to isolate the oscillator plate supply from the main B supply to prevent undesirable coupling. The secondary winding of transformer T-301 feeds into a phase-shifting network made up of capacitors C-303-2, and C-307 together with adjustable resistor R-303. This network permits shifting the phase of the voltage applied to the grid of V-303-2 the marker amplifier so that every fifth 10-microsecond marker may be made to coincide with the 50-microsecond markers provided by the first counter stage. The adjustment for resistor R-303 is located as indicated in figure 8-12, and is set at the factory for correct operation.

(2) COUNTER CIRCUITS (FREQUENCY-DIVIDERS).—Counter circuits are used to reduce the 100-kilocycle oscillator frequency in order to provide the exact time base (approximately 25 cycles per second) necessary for synchronizing the indicator equipment with the various transmitting stations. The counter circuits also provide time marker pulses for use in graduating the oscilloscope trace. (See fig. 4-13.) Each counter circuit requires a double diode and a triode. The double diode functions as the counter unit, while the triode tallies the count. The output of the squaring amplifier tube V-301-1, is fed to the first counter circuit through capacitor C-309 (fig. 4-13). This energy is supplied to the plate of the A section and to the cathode of the B section of double diode V-302-1 (see fig. 4-14). When the plate voltage of V-301-1, the squaring amplifier, is swinging negative, the plate of the A section of V-302-1, will be more positive than the cathode. This section will therefore conduct and cause capacitor C-309 to discharge to a low voltage. During this time the B half of this diode remains idle since its plate is negative with respect to its cathode. On the positive swing of the applied voltage the B-half of diode V-302-1 will conduct while the A half remains idle. Voltage will build up across capacitors C-309 and C-310 (which will be di-

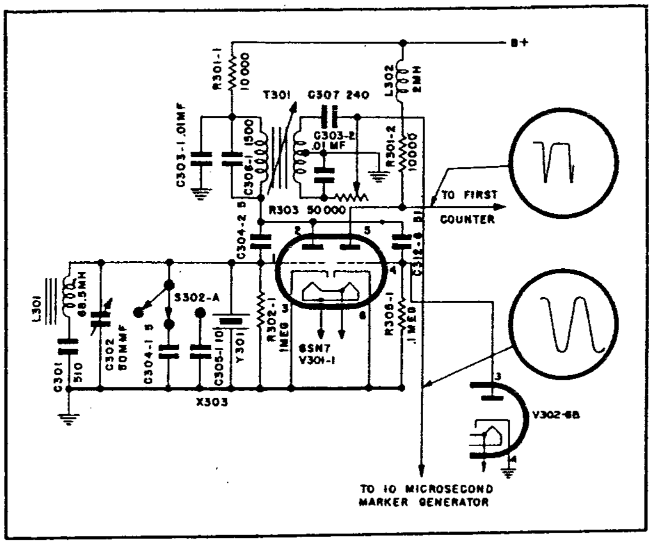


Figure 4-11. Crystal Oscillator and Squaring Amplifier

rectly proportional to the amplitude of the applied voltage and the duration of the applied pulse and inversely proportional to the capacitance and the effective series resistance) and the ungrounded end of capacitor C-310 will become positive. As succeeding positive voltage pulses are applied to the plate of the B-section of diode V-302-1, capacitor C-310 will accumulate a greater charge. The voltage appearing across capacitor C-310 builds up in steps, a step for each positive pulse, until it reaches a value sufficient to just permit plate current flow in the associated triode.

Tube V-301-2A is connected as an oscillator whose grid is returned to ground through the series-connected sections of the double diode V-302-1. The cathode bias of V-301-2A is determined by the setting of variable resistor R-315-1, which is usually adjusted for about 50 volts positive with respect to ground. This adjustment is quite critical as it determines the number of applied positive pulses necessary to initiate the action of the triode circuit. When the voltage appearing across capacitor C-310 reaches a particular value, the grid of V-301-2A becomes sufficiently positive to permit some plate current to flow. This plate current flowing in the primary of T-302-1 induces a voltage across the secondary winding. This secondary winding is so connected that the end which becomes positive is connected to the grid and is therefore in phase with the existing grid voltage and hence drives the grid further positive, causing a greater plate current to flow. This action is cumulative and continues until the increasingly positive grid draws sufficient grid current to prevent a further rise in plate current. When plate current flow reaches its peak, the magnetic field around the windings of T-302-1 collapses, inducing a voltage in the grid winding that is negative at the grid. This immediately drives the grid beyond cut-off. At the moment the plate current reached its peak the grid was drawing heavy grid current. This surge of grid current discharges C-310 restoring the circuit to its initial condition. The surge of plate current during the operating cycle results in a negative voltage pulse appearing at the plate of the triode due to load resistor R-306-1. The values of capacitors C-309 and C-310, together with the critical cathode voltage of V-301-2A, set by R-315-1, are such that five charging pulses on capacitor C-310 are required to trigger V-301-2A. The voltage at the plate of V-301-2A swings first negative, then positive, within a few micro-

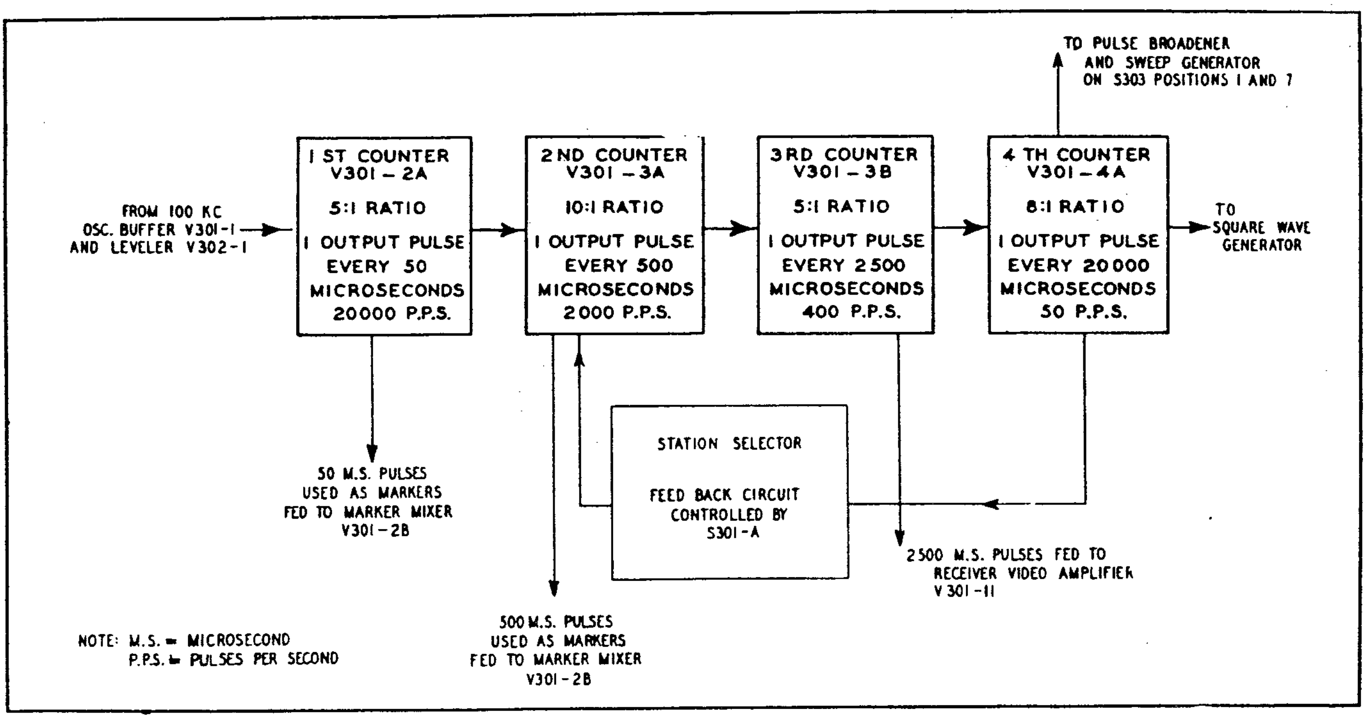


*Figure 4-12. Indicator *ID-6/APN-4—Counter Circuits, Block Diagram*

seconds. Therefore, for five input energy pulses to this counter circuit one output pulse is produced thus, this first counter circuit acts as a frequency divider and divides the input pulse frequency by five. (See fig. 4-12.) The pulses at the plate of V-301-2A will be spaced 50 microseconds apart because the crystal oscillator pulses are 10 microseconds apart. These 50-microsecond pulses are used to provide 50-microsecond markers for the oscilloscope traces, and also to provide input pulses to the second counter, V-302-2 and V-301-3A. The second counter stage requires ten 50-microsecond input pulses to generate one output pulse. Therefore, it may be said to divide the frequency by ten. This counter provides the 500-microsecond markers for the traces and also input pulses to the third counter (V-302-3 and V-301-3B). The third counter requires five input pulses for each output pulse and its output is used to supply 2500-microsecond markers for the traces and input pulses to the fourth counter. The last counter (V-302-4 and V-301-4A) requires eight input pulses for each output pulse. The pulses at its plate are 20,000 microseconds apart. The output pulses from this plate perform many circuit functions. They are used to feed the final (25-cycle) divider and to start the slow sweep which has a duration of 20,000 microseconds. They are also fed back through the counter feed-back circuit to control the output pulse frequency, thus making station selection possible.

(3) STATION SELECTOR CIRCUIT.—The counter feed-back circuit is required to obtain the various frequency rates necessary to identify the various pairs of stations. While one pair operates at exactly 25 cycles per second, other pairs operate at 25-1/16, 25-2/16, 25-3/16, 25-4/16 cps and so on. This requires that the fourth counter operate at rates other than an exact 20,000-microsecond rate. The output pulse frequency of this fourth counter triode can be increased by feeding back into the second counter circuit some of the voltage developed when this counter triode fires. The amount of voltage fed back at different settings of S-301-A can be set by adjusting the variable capacitors in the feed-back circuit which are selected by S-301-A, the "STATION" selector switch. With the exception of position "O" there is a separate variable capacitor for each position of the "STATION" selector switch. (See fig. 4-17.) The output of feedback diode V-302-5 is connected in parallel with the output from counter diode V-302-2. The pulse from the last counter triode is fed through diode V-302-5 and used to supplement the energy received from the 50-microsecond counter V-301-2A through duo-diode V-302-2. (see fig. 4-16.) This increase in the charge on C-314 causes the second counter to fire prematurely by an amount determined by the ratio of the capacitor, selected through the feed-back switching circuit, to capacitor C-314. The last counter, V-301-4A, will be triggered every 40th time that the second counter produces an output pulse.

When the "STATION" selector switch is set to position "1," the voltage fed back from each output pulse of the last counter is such that only nine 50-microsecond pulses are necessary to trigger the second 500-microsecond counter; that is, the second counter fires every 450 microseconds instead of every 500 microseconds. Five output pulses from the second counter triode (ordinarily totaling 2500 microseconds) are needed to trigger the third counter triode, V-301-3B. However, since one 50-microsecond pulse is removed by the action of the feed-back circuit, the actual time required is 2450 microseconds. Eight third-counter pulses are required to fire the fourth counter. One of these pulses will be 2450 microseconds; the other seven will be 2500 microseconds. Hence, the fourth counter will fire at intervals of 19,950 microseconds. The pulse output of the fourth-counter triode, ordinarily 50 cycles, will be 50-1/8 cycles per second.

With the "STATION" selector switch in position "2", two of the 50-microsecond pulses are removed by the feed-back circuit. This will cause the second-counter triode to fire at intervals of 400 microseconds. The fourth counter will then fire every 19,900 microseconds, which is equivalent to 50 and 2/8 pulses per

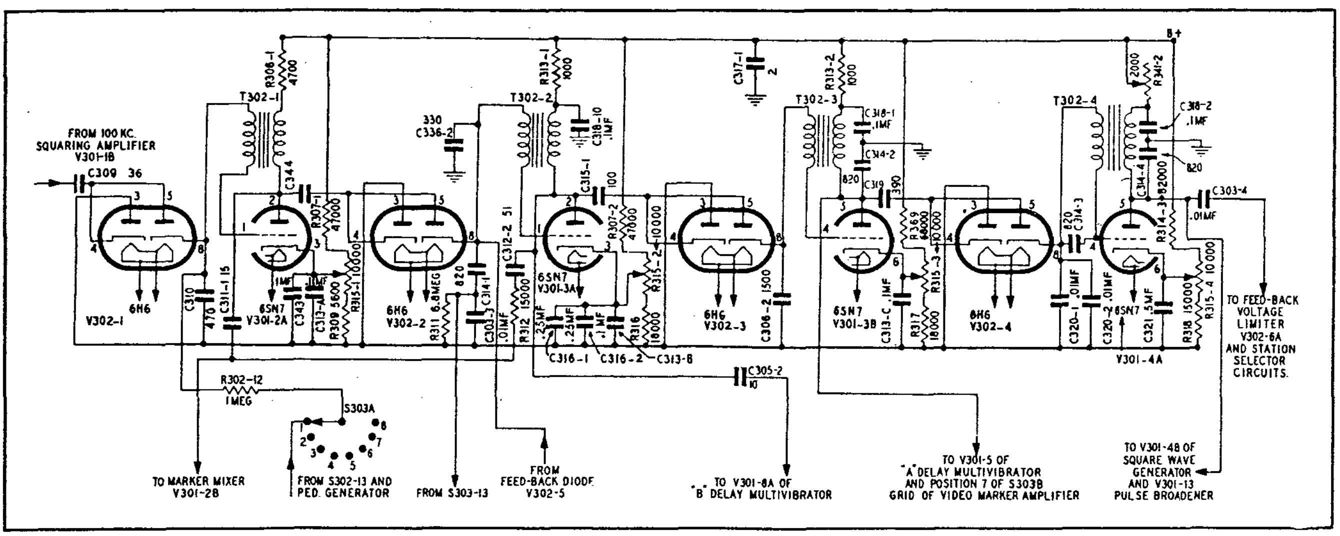


Figure 4-13. Counter Circuits

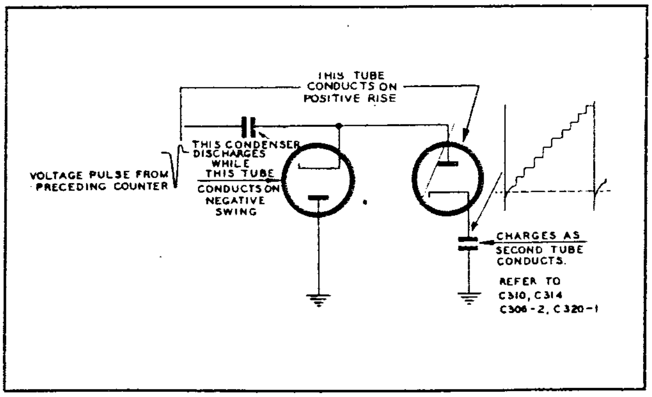


Figure 4-14. Counter Diode Action

second from the final counter or a final frequency of 25 and 1/8 cycles per second. When the variable capacitors associated with switch S-301-A, the "STATION" selector switch, are properly adjusted, successive changing of the switch positions will cause successive 1/8-cycle jumps in the fourth counter output pulse rate. With the station switch in position "7", the pulse rate will be 50 and 7/8 cycles per second. In this manner, non-integral output frequencies are obtained from the normal counter action. The method of calibration of the circuit is described in detail in section II, paragraph 2*b*(3).

To assure a uniform pulse voltage from the last counter triode V-301-4A to the feed-back circuit, a diode pulse limiter V-302-6A is connected across the last counter output. The cathode of this diode is approximately 100 volts positive with respect to the plate, under which condition no current will flow. When a pulse from the last counter is applied to this diode plate, the negative swing of this pulse merely makes the plate more negative, but the positive swing will exceed the cathode bias and make the plate positive. The diode then conducts, passing the portion of the pulse above its cathode potential, and effectively limiting its amplitude to that value.

(4) "LEFT - RIGHT" ACTION. — The "LEFT-RIGHT" control provides the operator with a means for placing the received pulses at their proper positions on the traces by causing them to move to the left or right. This movement is accomplished by momentarily increasing or decreasing the trace sweep recurrence rate.

Section S-302-A of the "LEFT-RIGHT" control is a switching arrangement associated with capacitors C-304-1 and C-305-1 in the grid circuit of the 100-kc oscillator, and connected in such a manner that slight changes in oscillator frequency may be affected. With the "LEFT-RIGHT" control in neutral (center) position, capacitor C-304-1 is connected in parallel with the crystal and the oscillator operates at its correct frequency. When the "LEFT-RIGHT" switch is moved to "LEFT" position, C-305-1 is connected in parallel with C-304-1 causing a slight decrease in the oscillator frequency, and a movement of the pulses to the left. At "RIGHT" position, both of these capacitors are removed from the oscillator grid circuit causing a slight increase in oscillator frequency, and a corresponding movement of the pulses to the right. These slight variations from the normal oscillator frequency cause corresponding changes in the sweep recurrence rates, and provide adequate left-right action for "SWEEP SPEED" positions "2", "3" and "4".

In "SWEEP SPEED" position "1", the sweep duration is sufficient to render the left-right action inadequate, as explained in the preceding paragraph. This is an undesirable condition which interferes with making quick time readings. To accelerate the pulse movement in this sweep position, switch S-302-B is used to provide either positive or negative pulses from pedestal generator V-301-14 to the first counter circuit. One contact of S-302-B is connected through capacitor C-320-3 and resistor R-356-2 to plate 2 of tube V-301-14 from which it is fed a positive voltage pulse each time a pedestal is generated. With the "LEFT-RIGHT" control in "RIGHT" position, this positive voltage is fed through S-303-A and R-302-12 to the storage capacitor, C-310, in the first counter circuit causing the triode V-301-2A to fire after four pulses from the squaring amplifier instead of five. This results in a further increase in the sweep recurrence rate and an adequate rate of pulse shift to

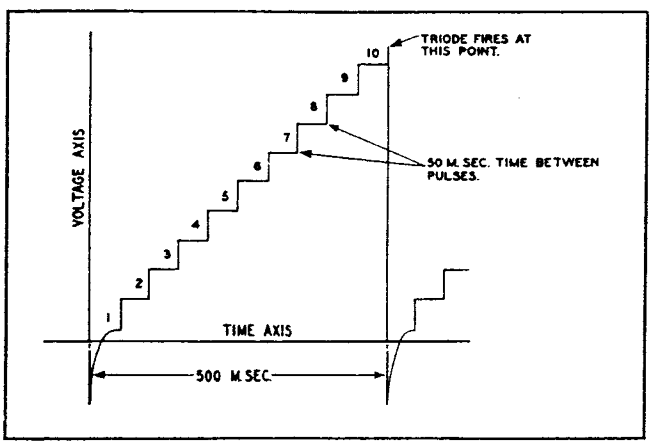


Figure 4-15. Charging Steps—Second Counter

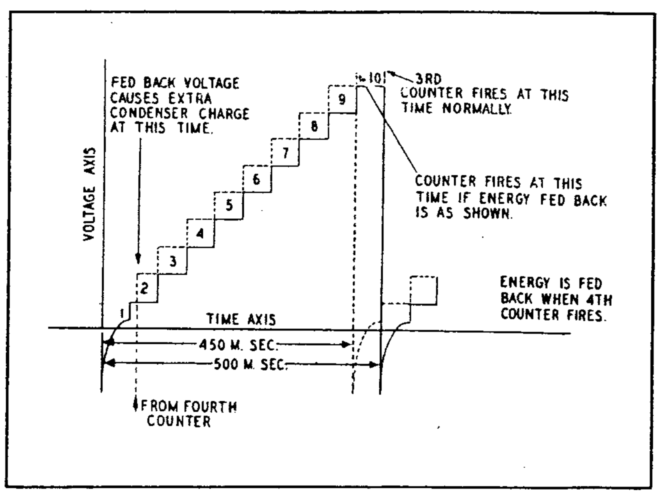


Figure 4-16. Second Counter Showing Effect of Feed-Back

the right. The opposite contact of S-302-A is connected through C-320-4 and R-356-3 to plate 5 of V-301-14 from which it is fed a negative voltage each time a pedestal is generated. With the "LEFT-RIGHT" switch in "LEFT" position, this negative voltage is fed through S-303-A and R-302-12 to C-310 decreasing its charge thus, delaying the firing of the first counter triode until six pulses are received from the squaring-amplifier. This action further decreases the sweep recurrence rate and results in an adequate rate of pulse shift to the left. Because the movement of the pulses resulting from the action just described is too rapid for use on "SWEEP SPEED" positions "2", "3" and "4", S-303-A is so connected that this action takes place in position "1" only and does not occur in any other switch position.

(5) SQUARE - WAVE GENERATOR. — Multivibrator V-301-10 is a duo-triode which with its associated circuit, the two halves of which are symmetrical, constitutes an oscillator whose output is essentially a square wave. This type of multivibrator is derived from the Eccles Jordan trigger circuit. For circuit details see figure 4-18. Associated with tube V-301-10 in this circuit is another tube, V-301-4B which is used to provide negative synchronizing pulses, by inverting positive pulses taken directly from the plate of the fourth counter triode. These negative pulses are used to trigger the square-wave generator, once every 20,000 (approximately), microseconds.

The grid of the A-section of tube V-301-10 is connected to the plate of the B-section through resistor R-345-1; the grid of the B-section is similarly connected to the plate of the A-section through resistor R-345-2. These resistors with grid resistors R-305-7 and R-305-11, provide a voltage divider system that places approximately 20 percent of the voltage appearing at the plate of either triode on the grid of the other.

To simplify the explanation of how the circuit functions, consider the power shut off and tube V-301-10 idle. When filament and plate voltages are applied, one triode section (assume it to be section A) will begin to draw current ahead of the other section. This may be due either to slight differences in the characteristics of the tubes or other parts of the circuit. The current flowing through resistor R-344-1 will cause a voltage change at the plate of the A-section in a negative direction. A portion of this voltage is fed to the grid of the B-section through resistor R-345-2, causing a decrease in the current now flowing through resistor R-344-2. This causes a more positive voltage at the plate of the B-section, a portion of which is fed to the grid of A-section through resistor R-344-1, causing a further increase in its plate current, and corresponding decrease in plate voltage. This action continues until the plate current is maximum for the A-section of the tube, at which time the grid of the B-section will have been driven in a negative direction beyond the value necessary for plate current cutoff. With correct adjustment of cathode resistor R-347, this condition of maximum current, low plate voltage for the A-section, and minimum current, high plate voltage for the B-section, will continue until a negative pulse of high amplitude from tube V-301-4B is fed to both grids. This negative pulse is fed to both grids of the tube at the same time, to the B-section through C-300-7 and R-338-2, and to the A-section through C-330-4 and R-322-4. The B-section now established at plate current cutoff by the previously described action is unaffected by this negative pulse. However, the grid of the A-section, which has through the action just described been established at a positive potential with respect to its cathode, is driven negative. The heavy plate current which has been flowing in this section is reduced and the voltage rises at the plate carrying with it the grid of the B-section in a positive direction. The resulting increase in current flow through R-344-2 results in a drop in voltage at the plate

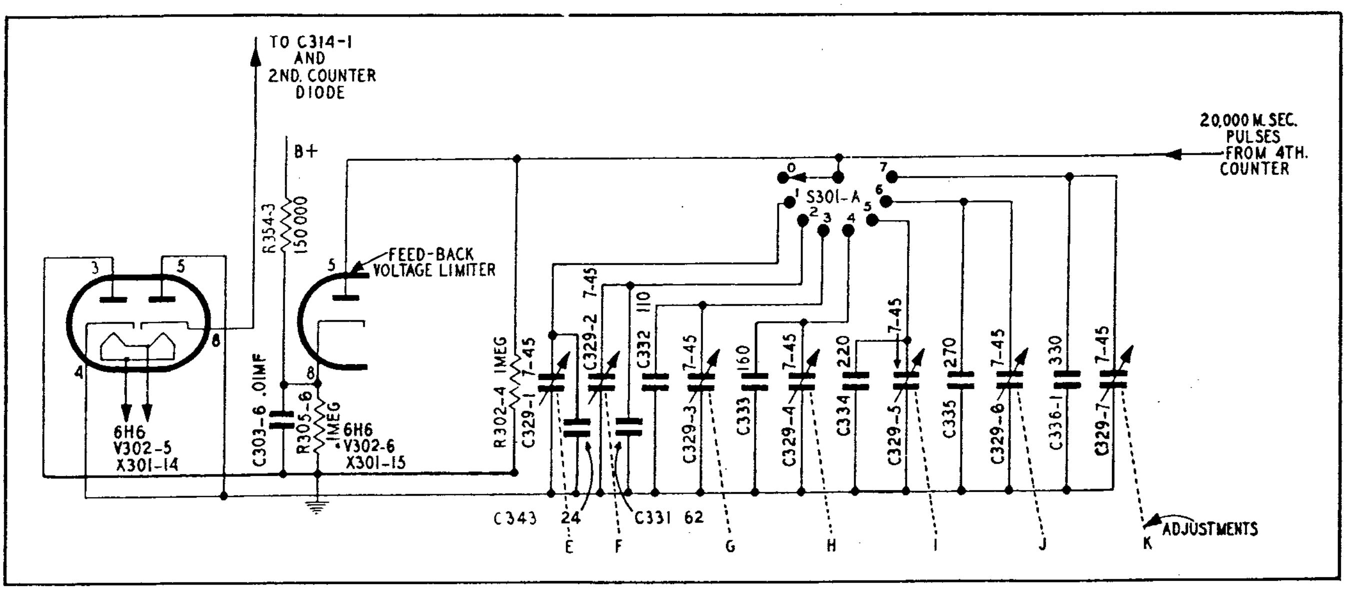


Figure 4-17. Station Selector Circuit

of the B-section. This results in the voltage at the grid of the A-section being driven still further negative with respect to its cathode. This action is cumulative and results in the A-section being driven to plate-current cutoff and being held in this condition until another negative pulse from tube V-301-4B causes another reversal of the whole process. This entire process of shifting the condition of plate current flow from one section of the tube to the other is very rapid.

The condition of high plate current in one section and zero plate current in the other section of V-301-10 exists for the entire interval between the successive output pulses from the fourth counter. Thus, the output from the plates is a square-wave voltage, having an approximate frequency of 25 cycles per second. Capacitors C-330-5 and C-330-6 are used in the circuit to counteract any effects of the grid to cathode capacitances which might tend to make the transfer of operation less abrupt.

Voltage from the square-wave generator is fed to tube V-303-3, a dual cathode follower which supplies the power necessary for operating the amplitude balance circuits in the receiver. This voltage is also fed through variable resistors R-353-1, R-353-2, and R-353-3, and switch S-303-D to tube V-301-8B whose output controls the separation of the traces. The output of the square-wave generator is also used to trigger the pedestal delay multivibrators whose action controls the position of the A- and B-pedestals on the traces.

(6) DIFFERENTIATION.—Pulses of short duration may be obtained from a wave having relatively steep leading or trailing edges by a process called differentiation. A differentiator circuit may be formed by the proper employment of a series RC circuit, the capacitor and resistor used having certain critical values in any given application. If a capacitor of larger than the critical value is placed in series with a resistance across a rectangular wave source, the charge and discharge currents of the capacitor flowing through the resistor will result in a voltage drop across the resistor which will be a counterpart of the applied voltage across the system. If the capacitor is of a value smaller than this critical size, it will take its full charge before the applied rectangular wave falls, and, the current flow having ceased, the voltage developed across the resistor will drop off. This effect may be carried to a point where only a portion of the rising edge of a rectangular wave will appear across the resistor.

The width and shape of pulses obtained in this manner depend upon the value of the capacitors chosen for any particular frequency in relation to the value of the resistor and upon the steepness of the sides of the rectangular wave. Pulses formed by differentiating square and rectangular waves are used in many places through the circuits of Indicator ★ID-6/APN-4.

(7) DELAY MULTIVIBRATORS.—A considerable time must elapse between the beginning of the A- and B-traces and the start of pedestals on the traces. This time lapse, fixed in the case of the A-pedestal, and variable over a wide range in the case of the B-pedestal, is provided by circuits known as delay multivibrators. V-301-5, V-301-6, and V-301-9, are the delay multivi-

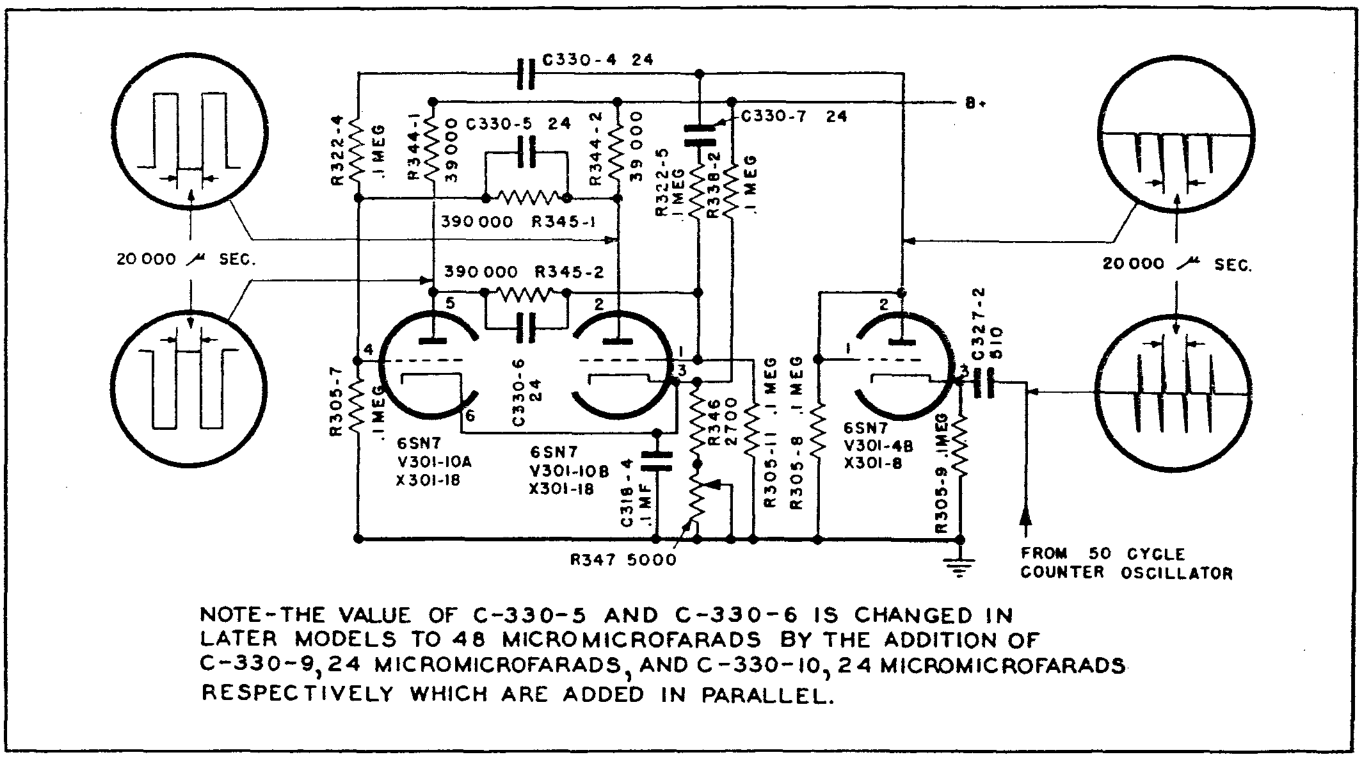


Figure 4-18. Square Wave Generator

brators in Indicator ★ID-6/APN-4. V-301-14 operates in a similar manner but is used as a pedestal generator.

(a) "A" PEDESTAL DELAY MULTIVIBRATOR.—The circuit of the A-delay multivibrator is shown in figure 4-19. On the slow sweep speed, the output wave form of the pedestal generator V-301-14 appears as a vertical displacement of a portion of each trace which is called a pedestal. The A-delay multivibrator provides a delay of 2500 microseconds between the start of the A-trace and the start of the A-pedestal.

The delay multivibrator tube V-301-5 is a double triode, the cathode of which are tied together. The plate of the input section of V-301-5 is coupled to the grid of the output section by capacitor C-323. The grid of the input section of the A-delay multivibrator receives positive and negative pulses (due to differentiation) from one plate of the square wave generator V-301-10, and also negative pulses at 2500-microsecond intervals from the third counter. V-301-3B. The dc grid voltage for this section is obtained through resistor R-321-1 and is controlled by potentiometer R-320-1 which is connected across a portion of the regulated B-supply voltage. The grid of the output section of V-301-5 is connected to the regulated B-voltage supply through grid resistor R-326-1.

In the interval in which pulses are not received at the grid of the input section, the plate current of the output section will be high, due to the fact that its grid will be slightly below zero. Consequently the plate voltage of this section is quite low. The input section of V-301-5 may be operated over a considerable range of plate current by varying its dc grid voltage with potentiometer R-320-1. The grid voltage may be varied from a point far beyond cut-off to a point of normal bias for this type of tube.

The negative pulse derived from the abrupt shift of the square wave from one voltage to a lower voltage will not cause a change of any consequence within this tube. However, when the positive pulse is applied to the grid of the input section, a considerable amount of plate current will flow. As the plate voltage of this section falls, the grid voltage of the output section also falls, due to coupling capacitor C-323, and is driven to cut-off or beyond depending on the setting of the input grid potentiometer R-320-1. As the output plate current decreases, the plate voltage rises steeply and the cathode current and voltage fall. This leaves the input section at reduced grid bias, and still drawing a considerable plate current although the initiating pulse has disappeared.

After the charge on capacitor C-323 reaches its maximum and begins to leak off through resistor R-326-1, the second section of the delay multivibrator begins to take plate current once more. Consequently, the cathode voltage starts to rise, and the input section begins to return to its former grid voltage. The rising plate voltage drives the grid of the output section towards positive, which accelerates the return to normal action. Due to the coupling between the sections of this tube, the changes are quite abrupt from cut-off to saturation and back to cut-off of the input section, and from saturation to cut-off and back to saturation in the output section. The output wave shape from the plate of the output section is rectangular, its width being dependent upon the extent to which the grid of the output section has been driven beyond cut-off. The output grid is controlled by the setting of the grid potentiometer R-320-1 of the input section. By varying the grid potential of the input section, the output wave duration may be adjusted over a wide range.

Due to minor variations in tubes, components, and voltages applied to the various circuits of the delay multivibrator, the exact time of the output wave form pedestal may change. (See wave forms in fig. 4-19.) In the case of the A-delay multivibrator, it is essential that the return to normal of the output section of the tube take place exactly at the first 2500-microsecond marker after the beginning of the trace. To insure the accuracy of this timing, a negative pulse is fed from the 2500-microsecond counter (third counter) to the grid of the input section. This pulse drives the grid towards cut-off, which raises the plate voltage of the input section and causes the output section grid to be driven positive. This causes the output pulse to end abruptly at this 2500-microsecond marker instead of at some nearby point.

The output pulse recurrence rate from the square wave generator is increased in 1/16-cycle steps (for each increasing position of the "STATION" selector switch) which shorten the traces. Although this trace loss occurs at the beginning of the traces the position of the 2500-microsecond markers on the traces remains unchanged. Therefore while the A-pedestal always appears at the first 2500-microsecond marker, the time interval between the beginning of the shortened traces and the 2500-microsecond marker will be less than 2500 microseconds. With the rotation of "STATION" selector switch S-201-B, the grid bias on the input section of the A-delay multivibrator is raised in successive

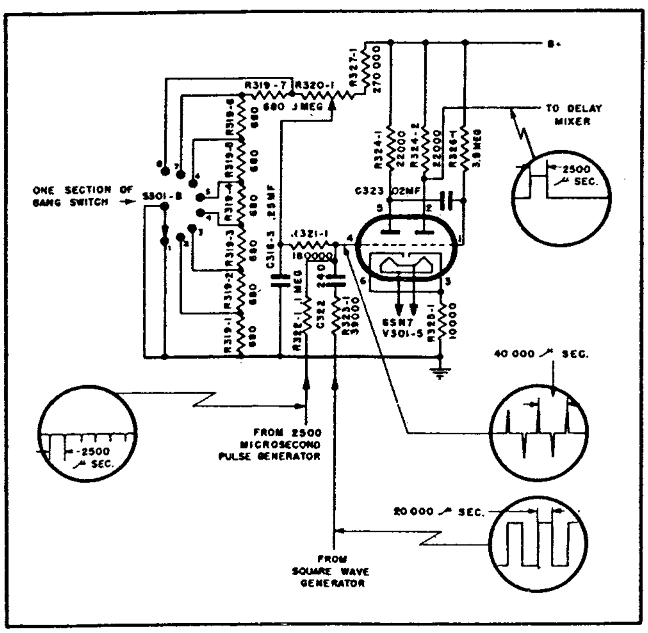


Figure 4-19. A-Delay Multivibrator

steps; hence, proper synchronism is maintained in spite of the shortening of the delay period.

(b) B-PEDESTAL DELAY MULTIVIBRATORS.—The range of time delay available from a multivibrator of the type described in *(a)* par. 3,*b (a)* this section, is dependent upon the value of the coupling capacitor, the output section grid resistor, and the range of grid bias voltage available for the input section.

The B-course delay multivibrator, V-301-9, operates in the same manner as the A-delay multivibrator except that, (1) the initiating pulse for the B-delay must come at the beginning of the B-trace, and therefore is obtained by differentiating the output of the square-wave generator. However, this output is taken from the opposite plate to that which initiates the action of the A-delay multivibrator; and (2) the B-delay output pulse must always end abruptly at a 500-microsecond marker. (See fig. 4-20.) A negative pulse for this purpose is formed by the action of V-301-8A. The grid of this tube is biased near plate current cut-off. A pulse developed in the 500-microsecond counter oscillator is fed to the cathode of this tube so that its negative swing will lower the bias, causing plate current to rise and plate voltage to drop. The positive swing from this oscillator will have little effect on the output from this tube. Therefore, a negative output pulse occurs every 500 microseconds and is fed to the input grid of B-coarse delay multivibrator V-301-9, causing its output pulse to be terminated abruptly at a 500-microsecond marker. V-301-9, the variable grid bias control for V-301-9 (the B-coarse delay multivibrator) is potentiometer R-315-6; it is the front panel control marked "COARSE".

The "FINE" delay control R-315-5 is in the grid circuit of the B-fine delay multivibrator, V-301-6, V-301-7. Potentiometers R-328-2 and R-320-3, marked "ADJ. 0" and "ADJ. 10,000" respectively, set the end points of the voltage range of the "COARSE" control. Potentiometers R-328-1 and R-320-2, marked "ADJ. 200" and "ADJ. 700" respectively, adjust the end points of voltage variation available by means of the "FINE" control. Figure 4-20 shows that the initiating pulse for this multivibrator delay circuit comes from the B-coarse delay multivibrator; it is not necessary to adjust its grid

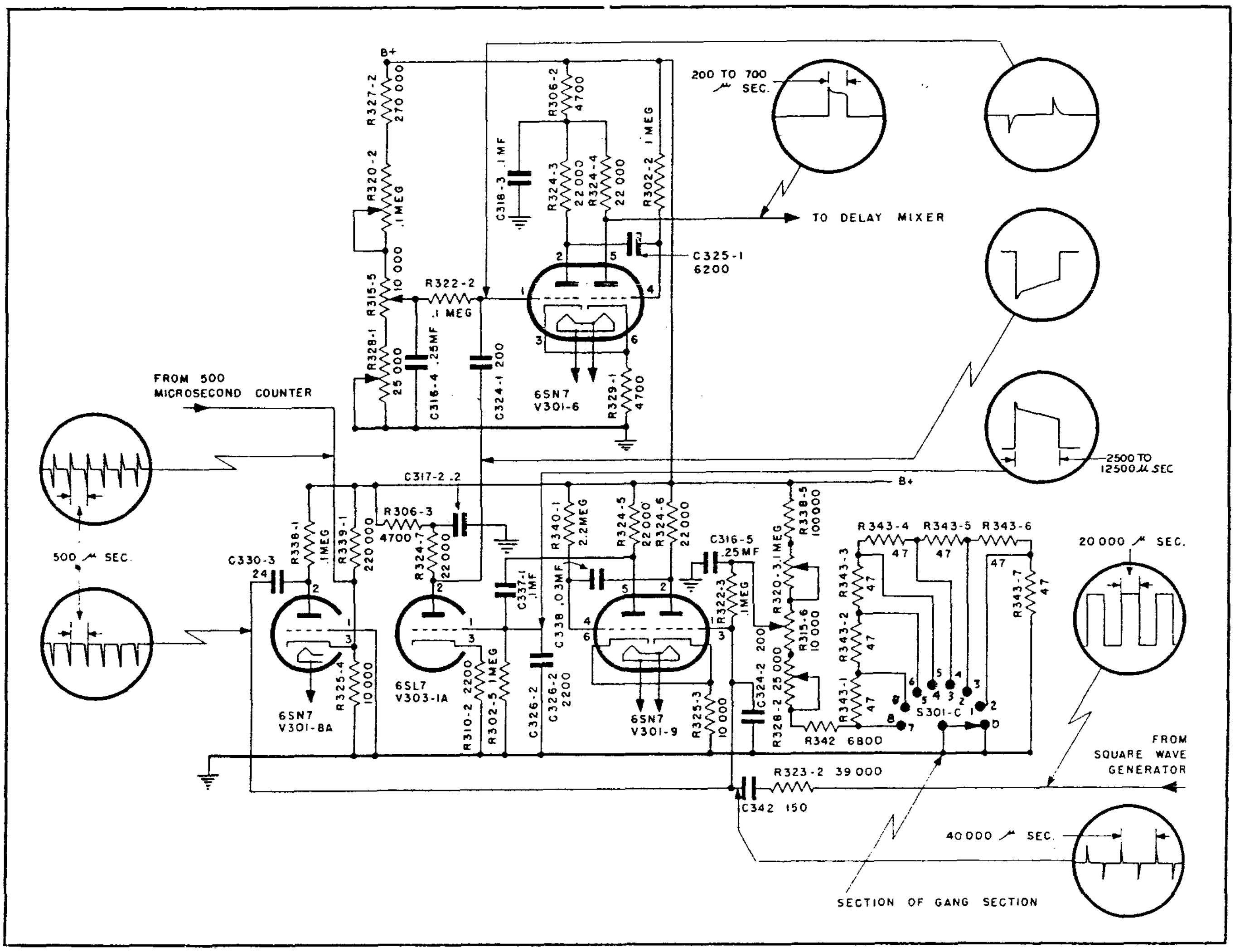


Figure 4-20. B-Delay Multivibrators

bias with changes of the "STATION" selector knob. Its overall delay is short and it is not necessary to synchronize the termination of its output pulse. The initiating signal must be a positive swinging pulse while the trailing edge of the output pulse from the B-coarse delay multivibrator is a negative pulse. V-303-1A is therefore used as a phase inverter to obtain the proper pulse polarity to trigger the B-fine delay multivibrator. This tube normally operates with a high plate current and, consequently, the low plate voltage. The positive leading edge of the output pulse from the B-coarse delay multivibrator causes further reduction in the plate voltage on this tube, which does not affect the B-fine delay multivibrator. At the termination of the output wave from the B-coarse multivibrator, V-301-9, the grid of the inverter tube V-303-1A is driven beyond cut-off and its plate voltage rises abruptly, providing the positive pulse to initiate the action of the B-fine delay multivibrator.

(8) DELAY MULTIVIBRATOR MIXER.—The output pulses from the A- and B-fine delay multivibrators are used to initiate the pedestals on the cathode ray tube traces. The pedestals are formed by pedestal generator V-301-14. Its circuit is shown in figure 4-21. This circuit operates in essentially the same way as a delay multivibrator and requires a positive grid swing to initiate the output pulse. Since the trailing edges of the A- and B-fine delay multivibrator outputs provide negative pulses, tube V-301-7, the delay mixer, is used as a phase inverter for these pulses. It serves an additional function as an electron-coupled mixer. The delay mixer operates with separate grid circuits but with a common plate load resistor. One of the grids is fed through C-315-2 with a pulse obtained by differentiating the output from the A-delay multivibrator, while the other grid is fed through C-315-3 with a pulse similarly obtained from the output of the B-fine delay multivibrator.

Normally, the delay mixer tube draws sufficient

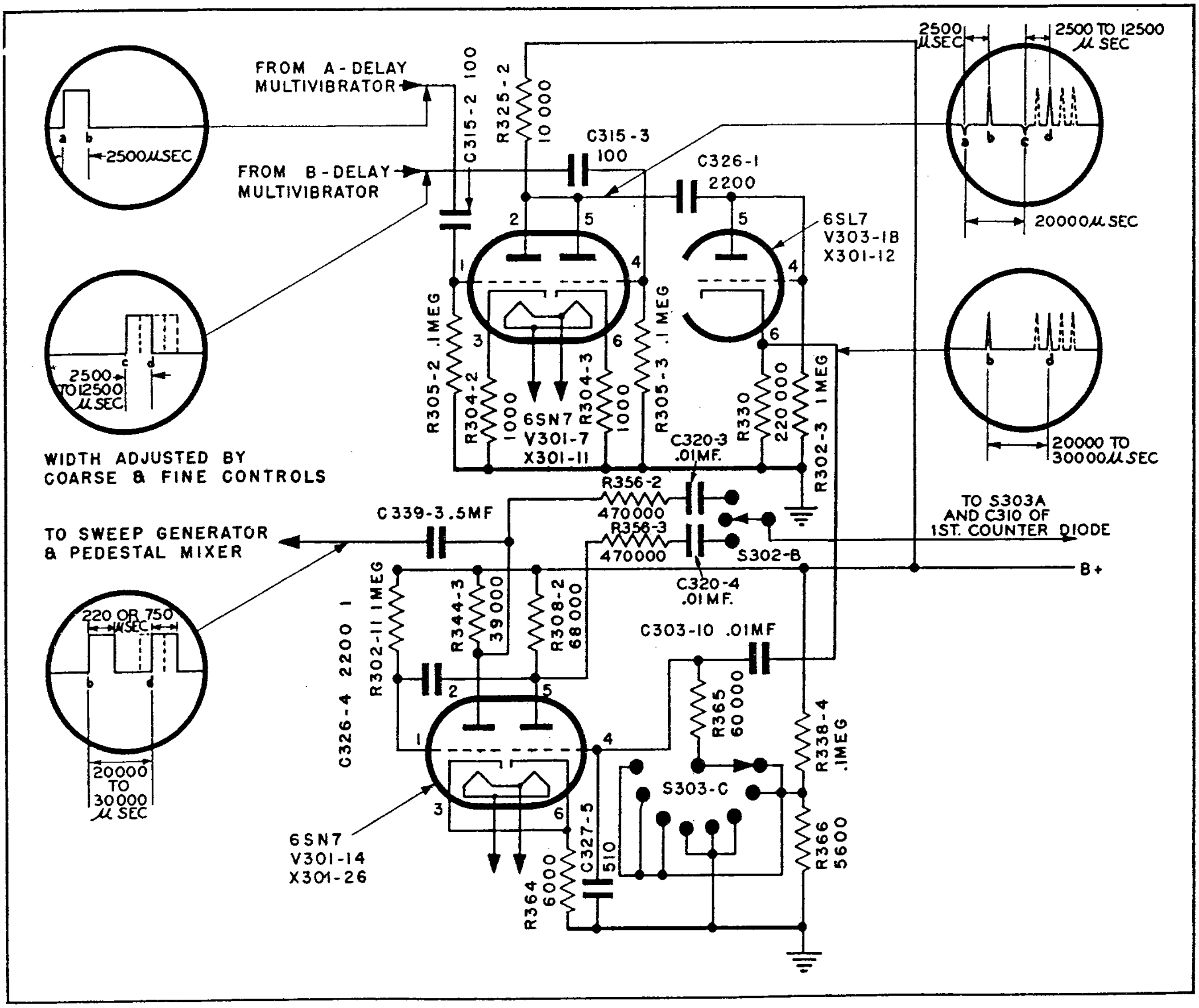


Figure 4-21. Delay Mixer and Pedestal Generator

plate current so that its plates operate at a low voltage. The positive (rising) edges of the output from the delay multivibrators will have little effect upon the plate voltage but the negative (falling) edge at the end of the multivibrator delay period will drive the section of the mixer with which it is connected to plate current cut-off, and the plate voltage will rise. This rising voltage is fed through capacitor C-326-1 into the diode-connected triode V-303-1B. The positive pulse derived from the delay mixer develops pulse voltage across cathode resistor R-330 of the pedestal synchronizing tube, V-303-1B. This voltage is then fed through capacitor C-303-10 to the grid of V-301-14, the pedestal-generator multivibrator.

(9) PEDESTAL - GENERATOR MULTIVIBRATOR.—The pedestal-generator multivibrator is similar to the A- and B-coarse and B-fine delay multivibrators. It differs however in the operating grid potentials, the values of the coupling capacitor between the input and output sections, and the second section grid resistor. The operating grid bias which determines the pedestal-generator output pulse duration and, consequently, the width of the pedestals is selected by the "SWEEP SPEED" selector switch S-303-C. The output from pedestal-generator V-301-14, is a rectangular voltage pulse of (approximately) 220 or 750 microseconds duration. This voltage pulse is fed through capacitor C-339-3 to the sweep generator circuit and to mixer amplifier V-301-12, and in addition, in the fast sweep position of S-303 to the grid of the cathode ray tube to increase the brilliance of the trace during the sweep time and to blank out the trace in the intervals between sweeps. The diode V-302-8 prevents the oscilloscope grid from being driven too far in the positive direction by the pedestal-generator output pulse since the tube will conduct as soon as its plate becomes positive with respect to its cathode. The grid of the cathode ray tube cannot therefore be driven further positive than the setting of the INTENSITY control dictates.

(10) HORIZONTAL DEFLECTION CIRCUITS.

(a) SAWTOOTH GENERATOR.—Figure 4-22 shows the sweep generator circuit. The sweep generator tube is a sharp cut-off pentode V-305. The voltage in the plate circuit is a sawtooth shape. See figure 4-24. Input signal to the sweep generator may come from the pulse-broadener, the B-fine delay circuit or from the pedestal-generator circuit depending on the setting of the "SWEEP" switch. Figures 4-23 and 4-25 illustrate the input wave forms for slow and fast sweep operation respectively. Voltage pulses from one of these three circuits are selected by section S-303-F of the "SWEEP SPEED"

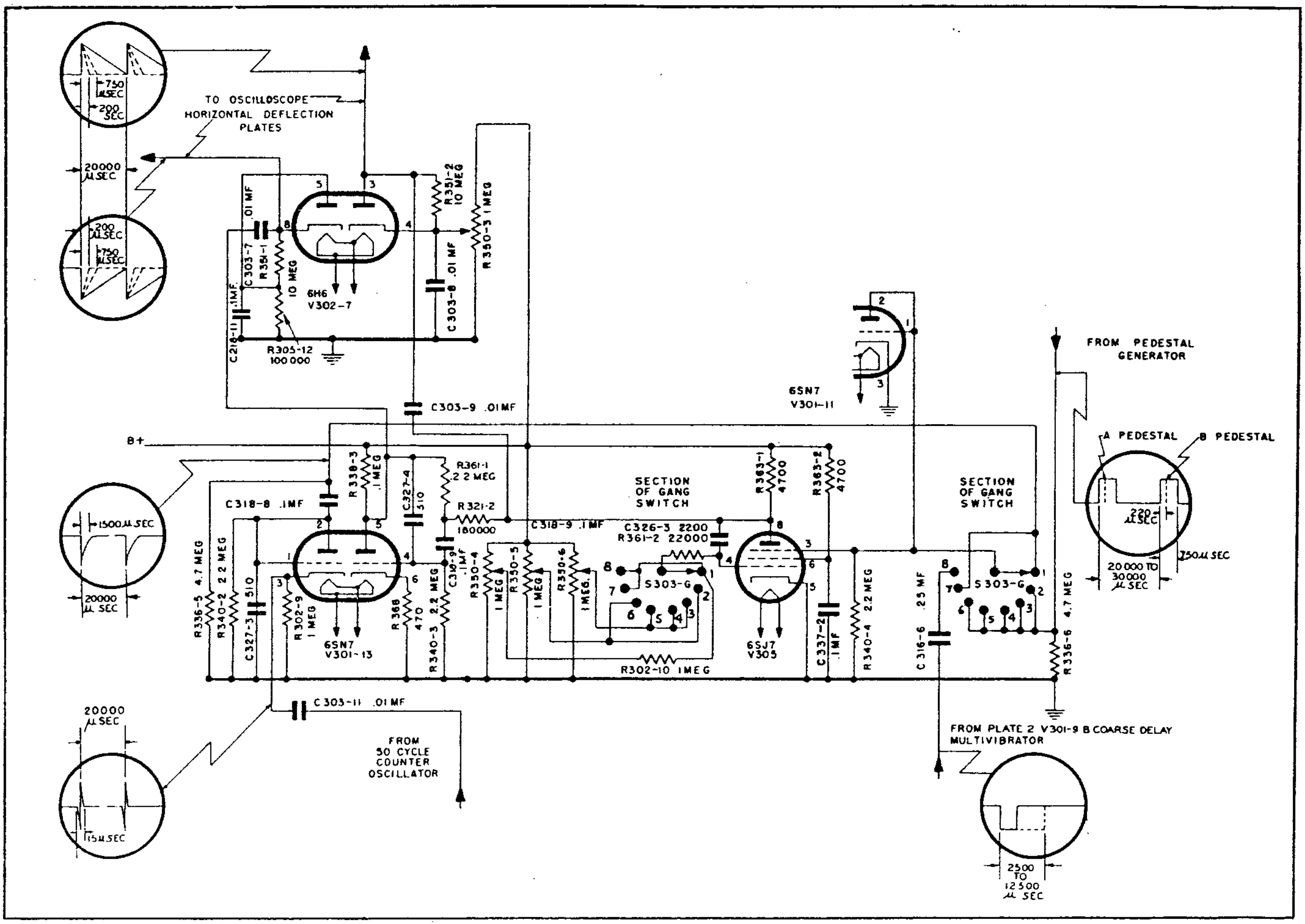


Figure 4-22. Sweep Generator

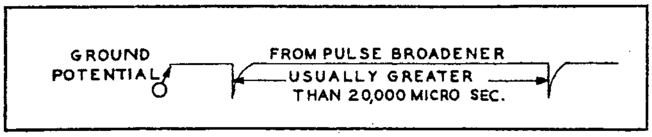


Figure 4-23. Input Wave Form to Sweep Generator for Slow Sweep

switch and fed to the suppressor grid of the sweep generator tube. In positions "1" and "7" of this switch, the sweep generator tube provides a continuous sawtooth wave as shown in figure 4-24. The resultant horizontal trace is substantially linear, and 20,000 microseconds in duration. In positions "2" through "6" of this switch, the output wave form of the sweep generator will be as shown in figure 4-26 and each sawtooth will have a duration corresponding to the width of the pulse from the pedestal generator. In position "8" the circuit receives its triggering pulse from the B-fine delay circuit.

(*b*) SLOW SWEEP OPERATION.—Without a triggering voltage, the tube operates with the grid positive with respect to the cathode resulting in a low value of plate voltage due to the voltage drop across resistor R-363-1. A pulse from the final counter circuit is supplied to the cathode of the pulse broadener diode, V-301-13A. On the positive swing of this pulse, the pulse broadener diode remains idle. On the negative pulse swing from this counter the diode conducts, and current flows through R-340-2 placing a charge on capacitor C-327-3.

Although the pulse duration is only a few microseconds, capacitor C-327-3 assumes a charge which decays slowly due to leakage through resistor R-340-2; this serves to broaden the pulse considerably. This negative pulse is fed through capacitor C-318-8 and "SWEEP SPEED" selector switch S-303-F to the suppressor grid of V-305, the sweep generator tube. This suppressor grid is by-passed to ground through one-half of V-301-11 which is connected as a diode. This connection effectively prevents the grid being driven positive with respect to ground. The negative voltage is sufficient to reduce the plate current of V-305 considerably, causing the plate voltage to rise. The first grid and cathode of this tube act essentially as a limiting diode at this time and the grid potential will be stabilized at the value established by the adjustment of potentiometer R-350-4. The plate is coupled to the first grid through capacitor C-318-3 and consequently, as the plate voltage rises, current flows through this capacitor and the grid cathode circuit of the sweep generator tube charging the capacitor. As the triggering pulse falls off, its influence on the action is removed, and the charge accumulated on C-318-3 results in the first grid of V-305 being driven negative. The charge on C-326-3 gradually leaks off through the path to ground selected by S-303-G, and the first grid of the tube moves in a positive direction returning to the point determined by the setting of potentiometer R-350-4. The sweep generator plate current increases during this time and the voltage on the plate consequently falls.

The falling voltage is applied to the grid through capacitor C-326-3, tending to drive the grid negative, and thus limiting the plate current rise. The plate current proceeds to rise very slowly at a rate determined by the resistance in the grid return circuit and the negative voltage component fed back from the plate to the grid by capacitor C-13-3. The plate voltage change may be adjusted to provide the correct length of trace on the oscilloscope by proper setting of potentiometer R-350-4, the slow sweep adjustment.

For "SWEEP SPEED" position "8", the sweep generator tube is triggered by the trailing (positive) edge of the pulse developed at the plate of the input section of the B-fine delay tube V-301-6. This triggering voltage is a rectangular wave which sets up the sweep action by raising the suppressor grid to ground level at the time the B-fine delay action is terminated, and ends the sweep action by driving the suppressor grid to a high negative value at the beginning of the B-fine delay action. The sweep generator output is a sawtooth wave, continuous except for the short time the B-fine delay action is taking place.

(*c*) FAST SWEEP OPERATION.—The voltages for triggering the sweep generator tube for the fast sweep ("SWEEP SPEED" positions "2", "3", "4", "5", and "6") are obtained from V-301-14, the pedestal generator tube. These voltages are the positive rectangular waves which develop the pedestals for sweep positions "1" and "7". For sweep positions "2" and "6", the triggering voltage rises abruptly to a high positive level where it remains for 750 microseconds, then returns abruptly to its original level. For sweep positions, "3", "4", and "5", the triggering action is similar but lasts for only 220 microseconds. There is a time interval between these triggering pulses of approximately 10,000 to 30,000 microseconds duration, depending upon the relative positions of the A- and B-pedestals.

For the purpose of discussing the circuit action, let us assume a condition with all normal supply voltages applied to the circuit prior to the application of any triggering pulse. Before the first triggering voltage is

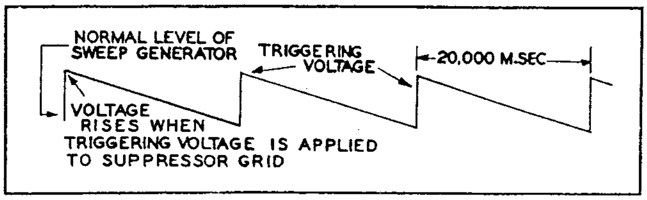


Figure 4-24. Sweep Voltage Wave Form on Slow Sweep

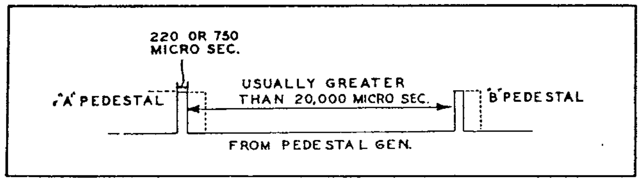


Figure 4-25. Input Wave Form to Sweep Generator for Fast Sweep

applied, the suppressor grid will be at or near ground potential, its negative bias being only that developed by electrons collecting on the grid surface. The potential of the first grid will result from the voltage determined by the setting of R-350-5 or R-350-6 and the voltage coupled from the plate through C-326-3. With the suppressor grid at this level, the plate current of the sweep generator tube will be comparatively high. The positive rise of the first triggering voltage will raise the suppressor grid to ground level but not above, due to the leveling action of diode V-301-11B. As the pulse swings positive, the diode will conduct, charging C-339-3. After 220 or 750 microseconds, depending upon the position of the "SWEEP SPEED" control, the triggering voltage will abruptly drop to its original level. Since the suppressor grid was effectively held at ground potential during the time the triggering voltage was positive, the return of the triggering voltage to its former level will drive the suppressor grid to a high negative value with respect to ground, due to the charge accumulated by C-339-3. Even though the time between the triggering pulses is from 10,000 to 30,000 microseconds, the RC constant of the circuit is such, that each recurring pulse will find an increasingly negative voltage at the suppressor grid. This action finally results in an effective negative voltage level, around which the whole triggering action takes place.

After establishing the circuit condition just described, each triggering voltage pulse from the pedestal generator will find a condition of low current and high voltage at the plate of the sweep generator tube. The positive rise of the triggering pulse will raise the suppressor grid to ground level. At this point the plate current will begin to increase and the plate voltage to drop slowly at a rate determined primarily by the setting of the sweep amplitude control associated with a particular "SWEEP SPEED" position. During this period of dropping plate voltage, a negative voltage component will be coupled to the first grid through capacitor C-326-3 tending to check the rate of plate current rise and resulting in greater linearity in the output wave form. The negative drop at the end of the pedestal generator pulse terminates the sweep action abruptly and immediately reduces the plate current and thus returns the plate voltage to a high level where it remains until the suppressor grid is again raised to ground level by another triggering pulse.

The output for "SWEEP SPEED" positions "2", "3", "4", "5", and "6" is an intermittent sawtooth wave providing linear traces of 750 microseconds duration for "SWEEP SPEED" positions "2" and "6", and 220 microseconds duration for "SWEEP SPEED" positions "3", "4" and "5". Proper adjustment of potentiometer R-350-6 provides the correct sweep amplitude for "SWEEP SPEED" positions "3", "4", and "5". Similar adjustment of potentiometer R-350-5 provides proper sweep amplitude for "SWEEP SPEED" positions "2" and "6". Since the output of the sweep generator for the fast sweeps is intermittent, there is a large time interval during which no sweep is being made. During this interval the intensity control grid of the cathode ray tube is effectively blanked by the negative voltage which always exists in the suppressor grid circuit between sweeps.

(d) SWEEP PHASE INVERTER.—The sawtooth voltage developed in the plate circuit of the sweep generator tube is not of sufficient amplitude to drive the cathode ray beam fully across the face of the tube. To provide sufficient voltage for this purpose, section B of tube V-301-13 is operated as a phase inverter which, with the sweep generator, provides a balanced push-pull type of voltage output for the horizontal deflection plates.

A portion of the sweep voltage developed at the plate of sweep generator tube V-305 is fed through resistor R-321-2 and capacitor C-318-9 to the grid of phase inverter tube V-301-3B. As the sweep generator plate voltage increases, the grid voltage of the phase inverter tube will rise, causing an increase in plate current and a decrease in its plate voltage. As the sweep generator plate voltage falls, the grid voltage on the phase inverter falls also, but the plate voltage rises; consequently, when the sweep generator plate voltage is changing in one direction, the plate voltage of the phase inverter amplifier is changing in the other direction. These voltages are equal in amplitude and opposite in phase, so that the voltage available across the oscilloscope horizontal deflection plates is twice that which could be taken from the sweep generator plate alone.

The output from the phase inverter tube must be an exact counterpart of the output from the sweep generator tube so far as wave shape and voltage are concerned, but exactly opposite in polarity. To obtain this action, resistors R-321-2 and R-361-1 are used as a combination voltage divider and inverse feed-back loop. As a voltage divider these resistors allow only a portion of the voltage from the sweep generator plate circuit to reach the grid of the phase inverter tube. In addition, voltage from the plate of the phase inverter tube is fed back to its own grid. The feed-back voltage is of opposite polarity to the voltage supplied to the grid from the sweep generator. This circuit causes phase inverter V-301-3B to operate without either loss or gain and corrects any tendency of this tube to distort or amplify the sweep generator output wave.

(e) D-C RESTORERS.—To fix a voltage condition around which the sweep action of the cathode ray tube takes place, a part of the regulated d-c voltage is applied to each horizontal deflection plate. The voltage divider system, which supplies this voltage to the right

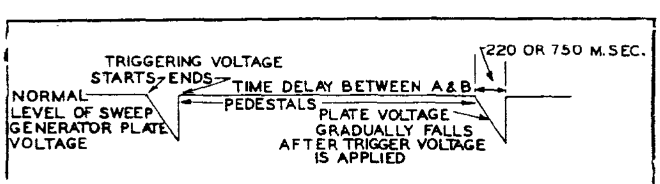


Figure 4-26. Sweep Voltage Wave Form on Fast Sweep

deflection plate, consists of resistor R-332-3 and R-305-12, and provides a positive voltage at the plate (approximately 45 volts) through a 10-megohm isolating resistor, R-351-1. The voltage divider system which supplies the positive voltage to the left deflection plate consists of a 10-megohm isolating resistor R-351-2 and potentiometer R-350-2. The potentiometer permits adjustment of the positive voltage on the left deflection plate to a value (approximately 145 volts) sufficient to attract the beam to the proper starting point at the left edge of the indicator screen.

It is now necessary to provide a means to insure that the sweep action appearing at the horizontal deflection plates will have as its base or starting point the d-c voltage already existing at these plates. This is accomplished by connecting the dual diode, V-302-7, in the sweep circuit as a voltage leveler or d-c restorer. The output from the sweep generator is fed through capacitor C-303-9 to the left deflection plate of the cathode ray tube, and to the plate of the B-section of the diode. The cathode of V-303-7B is connected to the movable arm of potentiometer R-350-3. The abrupt positive rise of the sweep voltage from the sweep generator will cause current flow in the diode which will keep capacitor C-303-9 in a state of discharge. This effectively holds the voltage at the plate of the diode and the deflection plate at their original level. This diode leveler action continues until the rising voltage at the plate of V-305 has reached maximum, at which point the sweep action starts. Since the sweep voltage is in the negative direction, it now counteracts the original positive voltage on the left deflection plate and causes the beam to sweep to the right across the screen. All sweep action of this plate, therefore, is now based at the d-c positive voltage (approximately 145 volts) selected by potentiometer R-350-3.

The output from phase inverter tube V-313-B is also a sawtooth-shaped pulse, which moves abruptly in a negative direction to set up the condition from which sweep action starts, and rises slowly to develop the visible trace. Its output is fed to the right horizontal deflection plate and to the cathode of the A-section of V-302-7 through capacitor C-303-7. The circuit function of this section of the diode is such that conduction takes place throughout the entire abrupt negative drop of the output from the sweep phase inverter. This action keeps capacitor C-303-7 at a state of complete discharge, preventing any change of the positive voltage already existing at the cathode of the tube before the sweep voltage is applied. As soon as the negative voltage applied to C-303-7 is at its maximum, the sweep action starts as a slowly rising voltage. This voltage being positive adds to the already existing positive voltage (45 volts) on the right deflection plate and causes added attraction of the cathode ray beam, effectively aiding the left deflection plate to sweep the beam entirely across the screen. The action of the diode, therefore, places the base for all sweep action from the phase inverter at the (145 volts) positive direct current already existing at the right deflection plate.

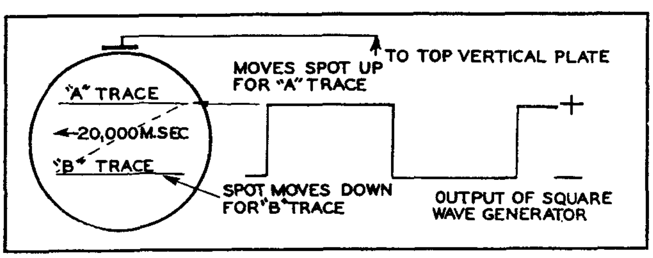


Figure 4-27. Trace Separation

Though the output of the sweep generator for "SWEEP SPEED" positions "1" and "7" is a continuous saw-tooth wave, some blanking of the intensity control grid of the cathode ray tube is necessary to prevent the appearance of a faint trace during the retrace. The blanking of this grid is very necessary for "SWEEP" speed positions "2", "3", "4", "5", "6" and "8" since there is a time interval between the triggering pulses for these sweep speeds during which no movement of the beam is taking place. If the tube were not blanked during this interval, a large brilliant spot would form at the left end of the trace. As already explained in the discussion of the circuit functions for the different "SWEEP SPEED" positions, the triggering voltages for the suppressor grid swing alternately, in both positive and negative directions but never rise above ground potential. To provide blanking action, the triggering voltages at the suppressor grid are fed to the intensity control grid of the cathode ray tube through capacitor C-340-1, C-340-2 and C-340-3. To insure that the positive excursions of these triggering voltages do not change the negative bias (determined by the setting of R-357-2) at the intensity control grid, diode, V-302-8 is connected in the cathode ray tube grid circuit as a d-c restorer. Any positive voltage appearing at the plate of this diode will result in current flow which will effectively limit the intensity grid voltage to the level selected by intensity control R-357-2. With the peak of the positive portion of the triggering pulses held at this selected intensity grid level, the negative portion of these pulses will merely add to the already existing negative voltage and effectively reduce the intensity and blank the cathode ray between sweeps.

(11) VERTICAL DEFLECTION CIRCUITS.— Forty thousand microseconds are required to complete one sweep cycle on the cathode ray screen. This time is divided between the A- and B-traces, each of which is 20,000 microseconds long (less the time lost on the retraces). A deflection voltage is applied to one of the vertical plates of the cathode ray tube which results in a vertical displacement between the two sweeps. The amount of displacement must be adjustable so that the most convenient separation for aligning and comparing the pulses and for reading the time differences between the two pulses may be secured.

Each plate of the square wave generator V-301-10 has two operating plate voltage levels, each of which lasts for 20,000 microseconds. Energy from section-B of this tube is fed to cathode follower V-303-3 whose output voltage appears across the three parallel potentiometers (R-353-1, R-353-2, and R-353-3) in the cathode lead of V-303-3A as an exact replica of the output voltage from the square wave generator. These potentiometers provide various levels of this square wave voltage which may be selected by section S-303-D of the "SWEEP SPEED" selector switch and applied to the trace separation cathode follower tube, V-301-8B. This square wave voltage, of predetermined amplitude, is fed through capacitor C-318-7 to one of the vertical deflection plates of cathode ray tube V-304 and causes the 40,000-microsecond sweep to appear as two separate lines of equal length placed one above the other. (See fig. 4-27.)

(12) AMPLITUDE BALANCE CIRCUIT.—Amplitude balance control R-355, connected between the cathodes of V-303-3, permits control of the size of the received pulses, so they are equal when viewed on the oscilloscope. Positive voltage developed across the cathodes of V-303-3 is taken from R-355 and fed to the receiver. This voltage is applied to both grids of V-108 and may be adjusted to increase the voltage developed across its cathode resistor. This positive voltage is applied to the cathode of the third i-f tube V-101-4, decreasing its gain.

The cathode of section A of V-303-3 is positive while the A-trace is being created on the indicator screen; the cathode of section B is positive while the B-trace is being made. With the slider of R-355 adjusted to the A-side of R-355, the positive voltage fed to the receiver will be greater during the A-trace sweep and will result in a decrease of the amplitude of the A-pulse. By moving the slider to the B-side of R-355, the amplitude of the B-pulse will be decreased. Therefore, by proper adjustment of R-355 the two pulses may be made to appear equal in size on the indicator screen.

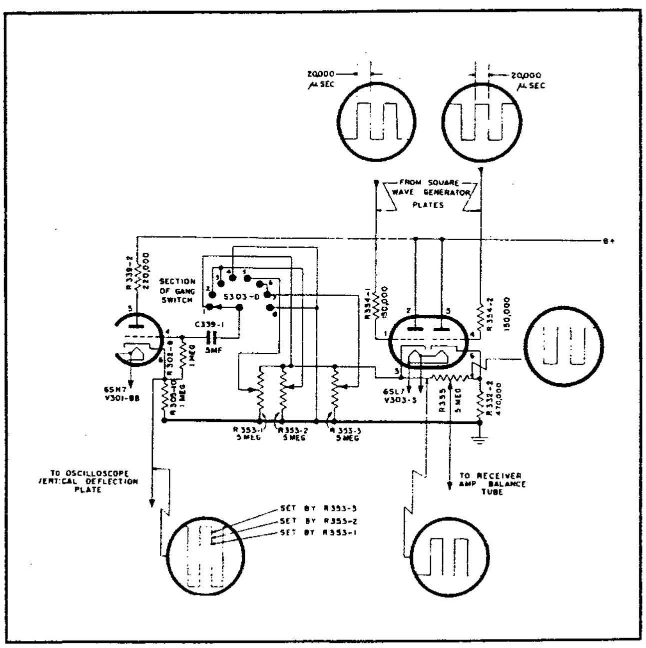


Figure 4-28. Trace Separation and Amplitude Balance Follower

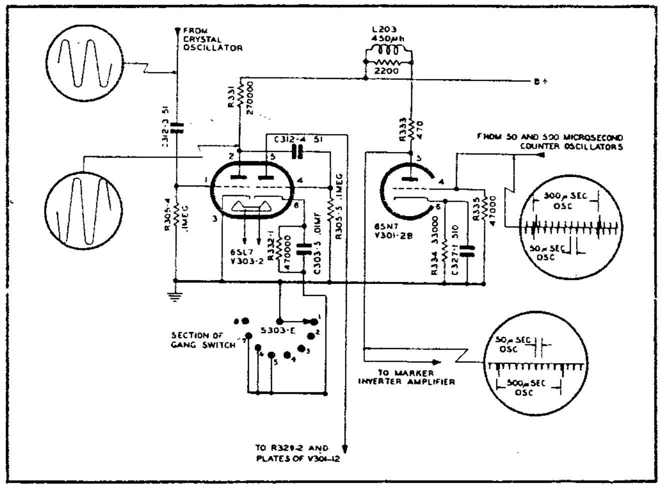


Figure 4-29. Calibration Marker Generator

(14) MARKER CIRCUITS.—After the selected pair of received pulses have been precisely matched at successive positions of the "SWEEP SPEED" selector switch, it is necessary to measure the difference in time of arrival between the two pulses of the pair. To make possible this measurement, time markers are placed on the traces of the cathode ray tube. Every 10 microseconds, 50 microseconds, 500 microseconds, and 2500 microseconds, much like the division markers on a ruler scale. The 10-microsecond markers are produced by the 10-microsecond marker amplifier. V-303-2, and 50- and 500-microsecond markers are formed in the circuit of V-301-2B, the 50-500-microsecond marker mixer. The 2500-microsecond markers are taken directly from the output of the 2500-microsecond counter. These markers are fed to a vertical deflection plate of cathode ray tube V-304 either directly or through the marker inverter V-301-12B.

(*a*) TEN-MICROSECOND MARKER GENERATOR.—The 10-microsecond markers are formed in the 10-microsecond marker amplifier tube, V-303-2. The grid of section A of this tube is fed with sine wave voltage from the 100-kilocycle oscillator. The proper phasing of this voltage is determined by the action of capacitors C-307, C-303-2, and resistor R-303. (See fig. 4-29.) The sine wave signal passes through capacitor C-312-3 to the grid of the A section of the tube which amplifies it. The high amplitude 100-kilocycle sine wave voltage is fed to the second section of the 10-microsecond marker amplifier through capacitor C-312-4. This tube is operated at cut-off bias; therefore, the negative swings of the applied grid voltage cause no change in the plate condition of this tube. On the positive swings, however, plate current rises in the tube and a voltage develops every 10 microseconds across resistor R-329-3 in its plate circuit. Due to the presence of capacitor C-303-5 in the cathode circuit, there occurs a sharp peaking of this voltage which results in a sharp upward deflection of the traces. The 10-microsecond marker generator functions only in the "5," "6," "7," and "8" positions of "SWEEP SPEED" switch S-303, because the marker generator cathode circuit is open in the first four positions of the switch. (See fig. 4-30.)

(*b*) 50-500-MICROSECOND MARKER GENERATOR.—Pulses developed in the plate circuit of the first counter triode, V-301-2A, are fed through capacitor C-311-1, and pulses developed every 500 microseconds in the plate of the second counter triode, V-301-3A, are fed through capacitor C-312-2 and resistor R-312 to the grid of V-301-2B, the 50-500-microsecond marker mixer.

This tube is operated at plate current cut-off and the negative output-swings from the 50- and 500-microsecond counter circuits cause no plate current change in the marker mixer circuit. However, the positive swings from these counters cause the marker mixer tube to draw plate current and, consequently, the plate voltage falls across the plate load resistor, R-333. This falling plate voltage is fed through capacitor C-325-2 to the grid of the marker phase inverter tube, V-301-12B, which inverts these markers so that they will appear as downward deflections on the cathode ray tube traces. These markers appear only in "SWEEP SPEED" switch positions "5," "6," "7," and "8" since the marker inverter tube cathode circuit is open in positions "1," "2," "3," and "4."

(*c*) SIGNAL MIXER-AMPLIFIER. (*See figure 4-30.*)—Twenty-five hundred microsecond markers are picked up by section S-303-B of the "SWEEP SPEED" switch in position "7" only. This marker comes directly from the 2500-microsecond counter output and will therefore swing both above and below the trace line. In "SWEEP SPEED" position "7" the pulses pass through signal amplifier V-301-11A, whose plate current variations appear as plate voltage variations across the common plate resistor R-329-3 and R-329-2 in series. Signal amplifier V-301-11A has several functions which are determined by the setting of section S-303-B of the "SWEEP SPEED" switch. In positions "1," "2," "3," and "4" it is used as a

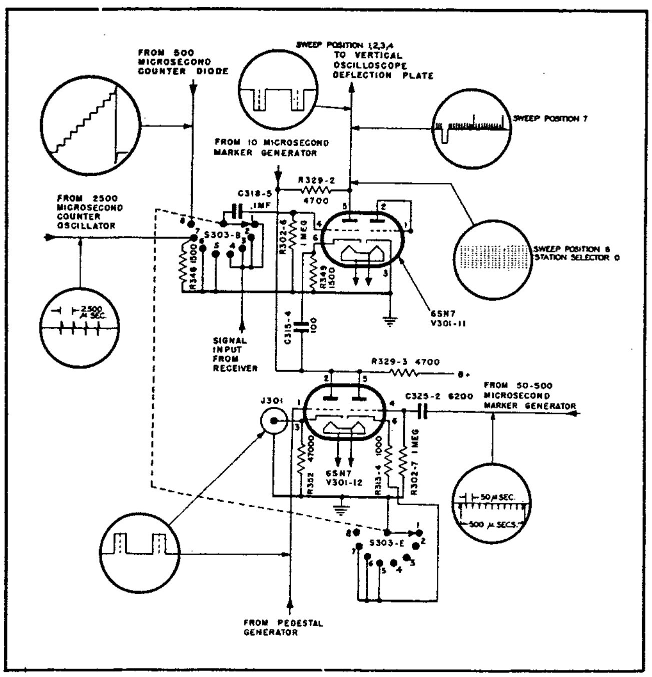


Figure 4-30. Vertical Deflection Mixer and Inverter

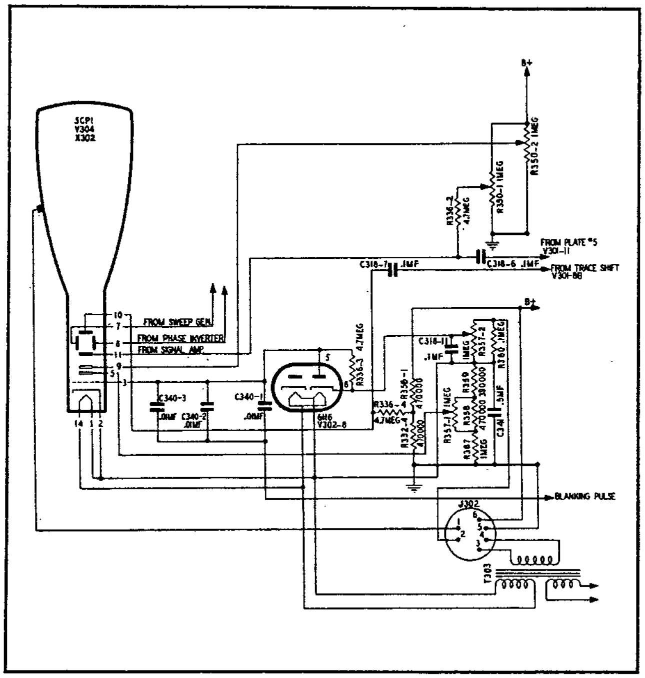


Figure 4-31. Cathode-Ray Tube Circuit

video amplifier for the pulses from the receiver. In positions "5" and "6" the grid of this tube is grounded. In position "7" it amplifies the 2500-microsecond counter oscillator pulses and in position "8" it is used in the station selector calibration system. In addition, the cathode of the signal mixer tube is fed with pulses from the 10, 50, and 500-microsecond marker generator through capacitor C-315-4. The result is amplification of these markers.

(15) CATHODE RAY FUNCTIONS.—The cathode ray tube, functional diagram shown in figure 4-31, provides the visual means for reading the time difference between the reception of the station pulses. The cathode (pin 2) is approximately 1000 volts negative with respect to chassis and is connected directly to its heater. The control or blanking grid (pin 3) is connected through R-336-3 to the moving arm of "INTENSITY" control R-357-2 by which the grid voltage, negative with respect to the cathode, may be adjusted.

Anodes A1 and A2 (pins 5 and 9) respectively focus and accelerate the electron beam toward the screen. Anode A1, whose voltage is adjusted by "FOCUS" control R-357-1, is approximately 600 volts negative with respect to chassis or 400 volts positive with respect to the cathode. Anode A2, whose voltage is adjusted by R-350-2, is approximately 200 volts positive with respect to chassis or 1200 volts positive with respect to the cathode.

The horizontal deflecting plates (pins 7 and 8) cause the beam to move across the screen horizontally. In operation a linear rising positive voltage is impressed on plate 8 while a similar linear falling negative voltage is applied to plate 7. The speed of the rise and fall of these two voltages determines the sweep speed of the deflected beam. The two sections of V-302-7 are connected with the horizontal plates in such a manner that voltages of incorrect polarity can never be impressed upon them. The horizontal centering potentiometer R-350-3 is connected in the cathode of the B-section of V-302-7 to provide means for adjusting the beam horizontally to the center of the screen. The vertical deflecting plates (pins 10 and 11) cause the beam to move up and down in a manner similar to that of the horizontal deflection plates. Resistor R-350-1 changes the residual voltage relationship between the two plates, providing means for centering the beam vertically. Anode A3 is a conductive coating inside the tube and near the screen. It attracts the electrons which rebound from the screen, provides a path for their return to the cathode, and thus prevents the accumulation of negative charges at the screen end of the tube which would otherwise interfere with the formation of a sharply-defined spot.

4. CIRCUIT FUNCTIONS (LATE).

a. RADIO RECEIVERS ★R-9A/APN-4 AND ★R-9B/APN-4. *(See figure 4-32.)*

(1) R-F AMPLIFIER.—The r-f amplifier consists of tube V-101-1 coil assemblies Z-102 and Z-105, wave trap assemblies Z-103, Z-104-1 and Z-104-2, and associated circuit components. The circuit arrangement provides adequate selectivity and amplification of selected station signals, and feeds the signals to the pentode grid of oscillator-mixer tube V-102.

(2) OSCILLATOR MIXER.—The local oscillator consists of the triode section of tube V-102 and its associated circuit components, which include coil assemblies Z-106 and L-105. The oscillator generates r-f signals at a frequency which, when beat with the station signal at the pentode grid of V-102, provides an i-f signal of 1050 kilocycles.

(3) I-F AMPLIFIER.—The i-f amplifier consists of tubes V-101-2, V-101-3 and V-101-4; i-f transformer assemblies Z-101-1, Z-102-2, Z-101-3, and Z-101-4; and associated circuit components which include the gain and amplitude balance controls. The circuit provides three stages of wide-band (45 to 60 kilocycles) amplification of the i-f signals, which are fed to the cathode of one section of duo-diode V-103, used as a diode detector.

(4) DETECTOR, FILTER, AND VIDEO AMPLIFIER.—The detector section of V-103 functions as a half-wave rectifier of the i-f signal and provides, as its output, negative video pulses. These pulses, fed through or around a high-pass filter network to the video amplifier, are amplified, inverted, and fed as positive video pulses to video jack J-104.

(5) REGULATED-VOLTAGE POWER SUPPLY.—The regulated-voltage power supply provides a constant potential of 260 volts direct current to the receiver and indicator circuits. The output of this supply is electronically controlled to deliver a constant voltage over a wide range of current-load and voltage-input variations.

(6) HIGH-VOLTAGE POWER SUPPLY.—The high-voltage power supply provides a total of approximately 2700 (±5%) volts direct current for the cathode-ray tube. This supply functions as two half-wave rectifier circuits, whose outputs are connected in series so that one side provides 1450 volts positive with respect to ground, while the other side provides 1250 volts negative with respect to ground.

b. INDICATOR ★ID-6B/APN-4. *(See figure 4-33.)*

(1) 100-KILOCYCLE OSCILLATOR.—The timing standard for all indicator functions is a crystal-controlled oscillator, whose circuit includes triode V-301-1, crystal Y-301, and tuned plate-transformer T-301. Its output is a 100-kilocycle sine-wave voltage, a part of which is shaped by the limiter tube, V-301-1B, and used to trigger the first counter circuit. A part of its output is also fed to the 10-microsecond marker-generator tube (V-303-2) where it is amplified and shaped into sharp negative pulses which develop the 10-microsecond markers.

(2) COUNTER CIRCUITS—Six blocking-oscillators, designated as counters, are used in the indicator to divide the 100-kilocycle output of the oscillator into various lower frequencies, and provide voltage pulses for the 50, 500, and 2500-microsecond markers which appear on the traces of the cathode ray tube.

(a) The first-counter circuit, which includes tube V-301-2 and associated circuit components, divides the frequency of the 100-kilocycle oscillator by five. The output of the first counter is a series of voltage pulses having a recurrence rate of 20,000 pulses per second thus appearing at intervals of 50 microseconds. A part of the output is used to trigger the second counter; another part is fed to the 50- and 500-microsecond marker-shaper, V-301-6B, where the pulses are clipped, properly shaped, then fed to the marker-mixer tube (V-301-9B) and finally appear on the traces as the 50-microsecond markers.

(b) The second-counter circuit, which includes tubes V-302-1 and V-301-3A and associated circuit components, is triggered by the output of the first counter, and divides the 20,000 pulses per second (50-microsecond) output of this counter by two. The second counter provides voltage pulses having a recurrence rate of 10,000 pulses per second (spaced at 100-microsecond intervals) which are used only to trigger the third counter.

(c) The third counter, consisting of tubes V-301-3B, V-302-2B, and V-301-4A, divides the frequency of the triggering pulses from the second counter by five and provides voltage pulses having a recurrence rate of 2000 pulses per second (500 microsecond intervals). A part of the output from the third counter is fed to the 50- and 500-microsecond marker-shaper (V-301-6B); another part is used to trigger the fourth-counter circuit; while a third part is used to terminate the B-coarse delay action.

(d) The fourth-counter circuit, employing tubes V-302-3 and V-301-5B, divides the 2000-pulses per second (500-microsecond) output of the third counter by five and provides voltage pulses having a recurrence rate of 400 pulses per second (2500-microsecond intervals). Its output, like the third counter, is divided three ways: One part supplies the triggering voltage for the fifth counter; another is used to trigger the sweep generator for "SWEEP SPEED" position "8;" the third is the source of the 2500-

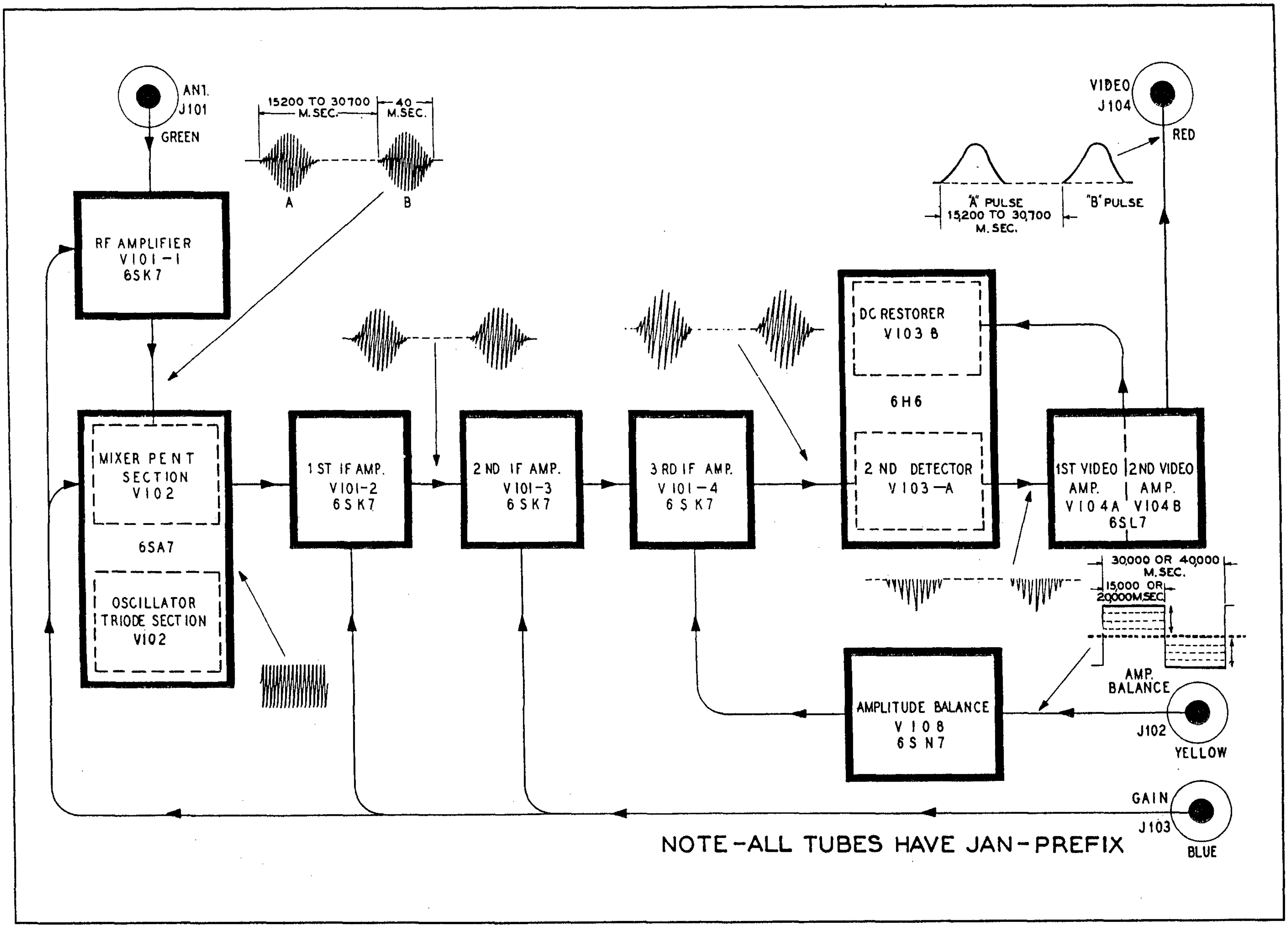


Figure 4-32. Radio Receiver ★R-9A/APN-4—Block Diagram

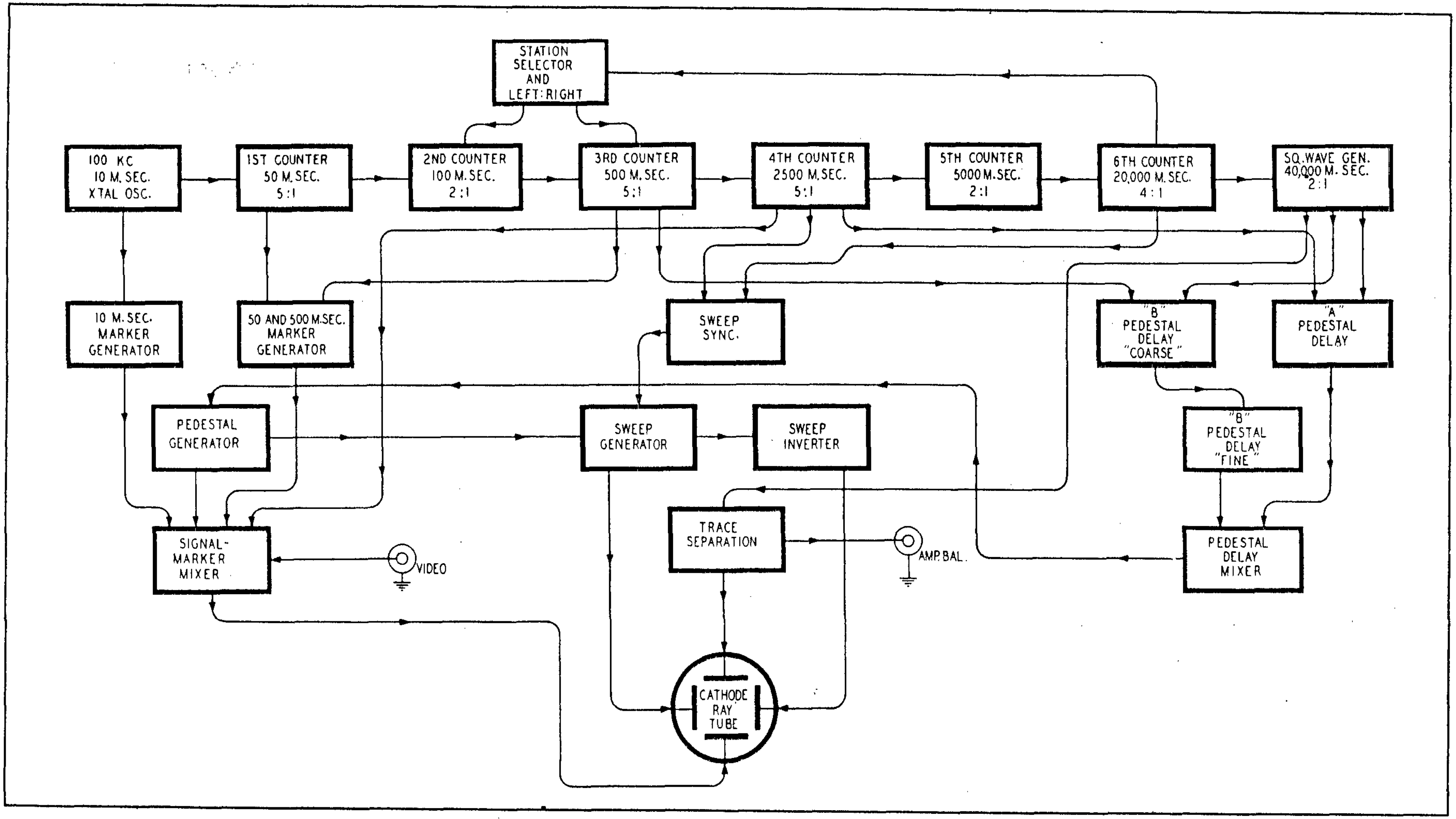


Figure 4-33. Indicator ★ID-6B/APN-4—Block Diagram

microsecond markers which appear on the traces for "SWEEP SPEED" ~~position~~ "7."

(e) The fifth-counter oscillator (V-301-5A), divides the 400-pulses per second (2500-microsecond) output of the fourth counter by two and provides voltage pulses having a recurrence rate of 200 pulses per second (5000-microsecond intervals), which are used only for triggering the sixth counter.

(f) The sixth-counter oscillator (V-301-6A), divides the output of the fifth counter by three with the "PRR" switch at position "H," and by four with the "PRR" switch at position "L." With this switch at position "H," the sixth counter divides the 200-pulses per second (5,000-microsecond) output of the fifth counter by three. The sixth counter pulses, therefore, have a recurrence rate of 66⅔ pulses per second (15,000-microsecond intervals). With the "PRR" switch at position "L," the 200-pulses per second (5,000-microsecond) output of the fifth counter is divided by four. The sixth counter output then has a recurrence rate of 50 pulses per second (20,000-microsecond intervals). The output of the sixth counter is used to trigger the square-wave generator, and the sweep generator for "SWEEP SPEED" positions "1" and "7;" it is also the source of the voltage pulses fed back to the second and third counter circuits for station selector and left-right action.

(3) SQUARE-WAVE GENERATOR.—The square-wave generator, whose circuit includes sync-tube V-301-4B and oscillator V-301-7 develops one complete alternating square-wave for every two output pulses from the sixth counter. It, therefore, divides by two the 50 and 66⅔-pulse output of the sixth counter, and provides a square-wave oscillation having a frequency of 25 or 33⅓ pulses per second. The output of the square-wave generator provides the initiating pulses for the pedestal-delay circuits, the alternating bias levels for the amplitude-balance circuit, as well as the various voltage levels by which the separation of the traces are controlled.

(4) STATION SELECTOR AND LEFT-RIGHT CIRCUIT.—The station selector and left-right circuit includes the two duo-diode tubes V-302-4, and V-302-5, used as positive feedback diodes, and one section of duo-diode V-302-2, used as a lefting-diode. The circuit uses a part of the output from the sixth counter to feed back to the second and third counters either positive or negative pulses, by which the recurrence rate of the sixth counter may be increased or decreased. Since the recurrence rate of the traces are directly controlled by the sixth-counter output, the station selector and left-right circuits provide the operator with a means of synchronizing the cathode-ray sweep circuits with the recurrence rates of the received pulses.

(5) PEDESTAL-DELAY CIRCUITS.—The pedestal-delay circuits consist of the "A" delay, the B-coarse delay, the B-fine delay, and the delay-mixer. These circuits determine the time at which the pedestals appear on their respective traces.

(a) The A-delay circuit consists of the A-delay sync tube, V-301-8A, and the delay multivibrator (V-301 13). The triggering pulse for starting the delay action is supplied by the output of the A-section of the square-wave generator. The terminating pulse is developed in the A-delay sync from a part of the output of the fourth counter, and therefore appears 2500 microseconds after the start of the A-trace. The delay action is, therefore, initiated at the time the A-trace starts, and ends with its first 2500-microsecond marker.

(b) The B-delay circuits, which include the B-coarse delay and B-fine delay, function in series to provide the total B-delay. The B-coarse delay circuit, consisting of multivibrator tube V-301-12, is triggered for its delay action by pulses from the plate of the B-section of the square-wave generator (V-301-4). The delay action is, therefore, initiated at the start of the B-trace. The terminating pulse is obtained from the third (500-microsecond) counter, and controlled by the settings of three variable resistors in the input grid circuit. The "COARSE" control on the indicator front panel and screw driver adjustments "ADJ. 0" and "ADJ. 10,000" determine which of the 500-microsecond pulses, supplied by the third counter, ends the delay action.

(c) The variable output of the coarse delay, the duration of which is adjustable in 500-microsecond steps from 1,500 to 1,250 microseconds (with proper setting of "ADJ. 0" and "ADJ. 10,000"), is used as the triggering pulse for starting the B-fine delay. This delay circuit, consisting of multivibrator tube V-301-11, delay-inverter tube V-303-3A, and the associated circuit components, differs from both the A-delay and B-coarse delay, in that no terminating pulses are used or desired. The delay action, continuously variable from 200 to 700 microseconds, is controlled by the three variable resistors in its grid circuit. One of these resistors is the "FINE" control on the indicator front panel, the other two are the screwdriver adjustments "ADJ. 200" and "ADJ. 700." The total B-delay includes the entire range of the coarse delay, 1500 to 12500 microseconds, plus the variable range of the fine delay of 200 to 700 microseconds. These two delay circuits add together to provide a total variable B-delay of 1700 to 13200 microseconds from the beginning of the B-trace.

(d) The outputs of both the A-delay and B-fine delay circuits are fed to the delay-mixer (V-303-3B), whose function is to invert and properly shape these pulses for triggering the pedestal generator.

(6) PEDESTAL GENERATOR. — The pedestal generator, which includes tube V-301-15 and its associated components, is a form of multivibrator whose output is a positive rectangular pulse of either 250 or 750 microseconds duration. These rectangular positive pulses are used to form the pedestals which appear on both traces. The A-pulse, by which the A-pedestal is developed, appears at the termination of the A-delay action; the B-pulse, by which the B-pedestal is developed, appears at the termination of the B-fine delay. The width or duration of these rectangular voltages is the result of the effects on circuit action by two separate controls. One of these is

the variable plate-voltage control for the input section of the pedestal generator; the other, two values of grid resistance in the output section, selected by the "SWEEP SPEED" control. The output of the pedestal generator is fed to the pedestal-mixer section of the marker-mixer tube (V-301-9), where it is inverted and mixed with the other signals to appear as pedestals on the cathode ray tube. The output of the pedestal generator is also used to trigger the sweep generator for "SWEEP SPEED" (fast sweep) positions "2," "3," "4," "5," and "6." The trace duration for these sweep positions is the same as the pedestal duration. These traces are in effect the tops of the pedestals spread out over the entire width of the screen.

(7) SIGNAL AND MARKER-MIXER CIRCUITS. —The signals, appearing on the traces of the indicator screen, consist of the video pulses from the receiver; the pedestals, developed by the pedestal generator; the 10-microsecond markers, developed from the output of the 100-kilocycle oscillator; the 50-microsecond markers, developed from the output of the first counter; the 500-microsecond markers, developed from the output of the third counter; and the 2500-microsecond markers, developed from the output of the fourth counter.

The 10-microsecond markers are developed and shaped by the 10-microsecond generator (V-303-2). They are amplified in the first section of V-303-2 and clipped and shaped by the second section. The 50- and 500-microsecond markers are developed and shaped in the marker shaper tube (V-301-6B), and fed to the marker mixer (V-301-9). The 2500-microsecond markers are developed in the video amplifier (V-301-10B), which also inverts the video signals from the receiver. These signals are selected by the sweep-speed control and fed to the lower deflection-plate of the cathode-ray tube. The pedestals, video and 10-microsecond marker signals, appear as upward deflections on the traces; the 50- and 500-microsecond markers appear as downward deflections; while the 2500-microsecond markers show both upward and downward deflections.

(8) SWEEP GENERATOR.—The sweep-generator circuit consists of the sweep sync tube V-301-14A, the sweep-input leveler tube V-301-10A, the sweep-generator tube V-304, and the sweep-inverter tube V-301-14B. These tubes function together to develop the linear-sawtooth-voltage wave by which the horizontal deflection of the trace is effected. For slow sweep speeds, "SWEEP SPEED" positions "1" and "7," the triggering voltages are developed from the output of the sixth counter, being properly shaped for triggering action by the sweep-input sync tube, V-301-14A. For fast sweep speeds, "SWEEP SPEED" positions "2," "3," "4," "5," and "6," the sweep generator is triggered by the positive rectangular pulses from the pedestal generator. These pulses not only initiate the sweep actions, but terminate them as well. With the "SWEEP SPEED" control at position "8," sweep-generator tube V-304 is triggered by the output of the fourth counter, the pulses being properly shaped for triggering action by sweep-input sync tube V-301-14A.

A part of the output of the sweep generator (V-304), is fed to the sweep inverter (V-301-14B), whose circuit functions are such that its output is an inverted duplicate of the sawtooth voltage developed by the sweep generator. The output of the sweep generator and sweep inverter provide a push-pull sweep voltage which, when fed to the opposite horizontal-deflection plates, results in a linear horizontal sweep of the traces.

(9) TRACE-SEPARATION AND AMPLITUDE-BALANCE CIRCUITS.—The trace separation and amplitude-balance circuits, consisting of tubes V-303-1 and V-301-8B, provide the various voltage levels by which the traces are separated. They also develop the alternate voltages fed to the receiver amplitude-balance circuit by which the amplitudes of the received pulses are equalized.

(10) CATHODE-RAY TUBE CIRCUIT. — The sawtooth voltages for horizontal deflection of the electron beam are developed by sweep-generator tube V-304 and sweep-inverter tube V-301-14B. The output of the sweep-generator, a negative sawtooth wave, is fed to the left horizontal-deflection plate. The output of the sweep inverter, a positive sawtooth wave, is fed to the right horizontal-deflection plate. These two sawtooth voltages function together in a push-pull manner to give the horizontal sweep. All signals, which include the markers, pedestals and video pulses, are fed to the lower vertical-deflection plate; while the various voltages used for trace separation are fed to the upper vertical-deflection plate.

5. CIRCUIT ANALYSIS (LATE).

a. RADIO RECEIVERS ★R-9A/APN-4 AND ★R-9B/APN-4.

(1) R-F AMPLIFIER. *(See figure 4-34.)*—The r-f amplifier of the receiver consists of V-101-1, coil assembly Z-102 and associated components, and is designed to operate on four pre-set frequencies. The "CHANNEL" selector switch on the front panel of the receiver controls a four-gang wafer-type switch which selects the frequencies. For Radio Receiver ★R-9A/APN-4 (modification III), positions "1," "2," and "3" of the "CHANNEL" selector are for stations in the low-frequency band between 1.6 and 3.3 megacycles, and are adjusted at the factory for 1.95, 1.85, and 1.9 megacycles, respectively. Position "4" of the "CHANNEL" selector is for the high-frequency band of 7.58 to 11.75 megacycles, and is adjusted at the factory for 9.6 megacycles. For Radio Receiver ★R-9B/APN-4 (modification IV) all four r-f channels lie within the low r-f band between 1.7 and 2.5 megacycles, and are pre-set at the factory for 1.95, 1.85, 1.9 and 1.75 megacycles.

The received signal is fed through jack J-101 to one of the rotary arms of switch S-101-A, which selects a primary winding from one of the four tuned-antenna transformers. A second section of this same switch shorts the unused windings to ground, preventing any stray effects on the selected transformer. The secondary of each antenna transformer, permeably tuned to the desired radio frequency, is connected by one section of switch J-101-B to the grid of r-f amplifier tube V-101-1; another section of the same switch shorts the unused secondaries to ground.

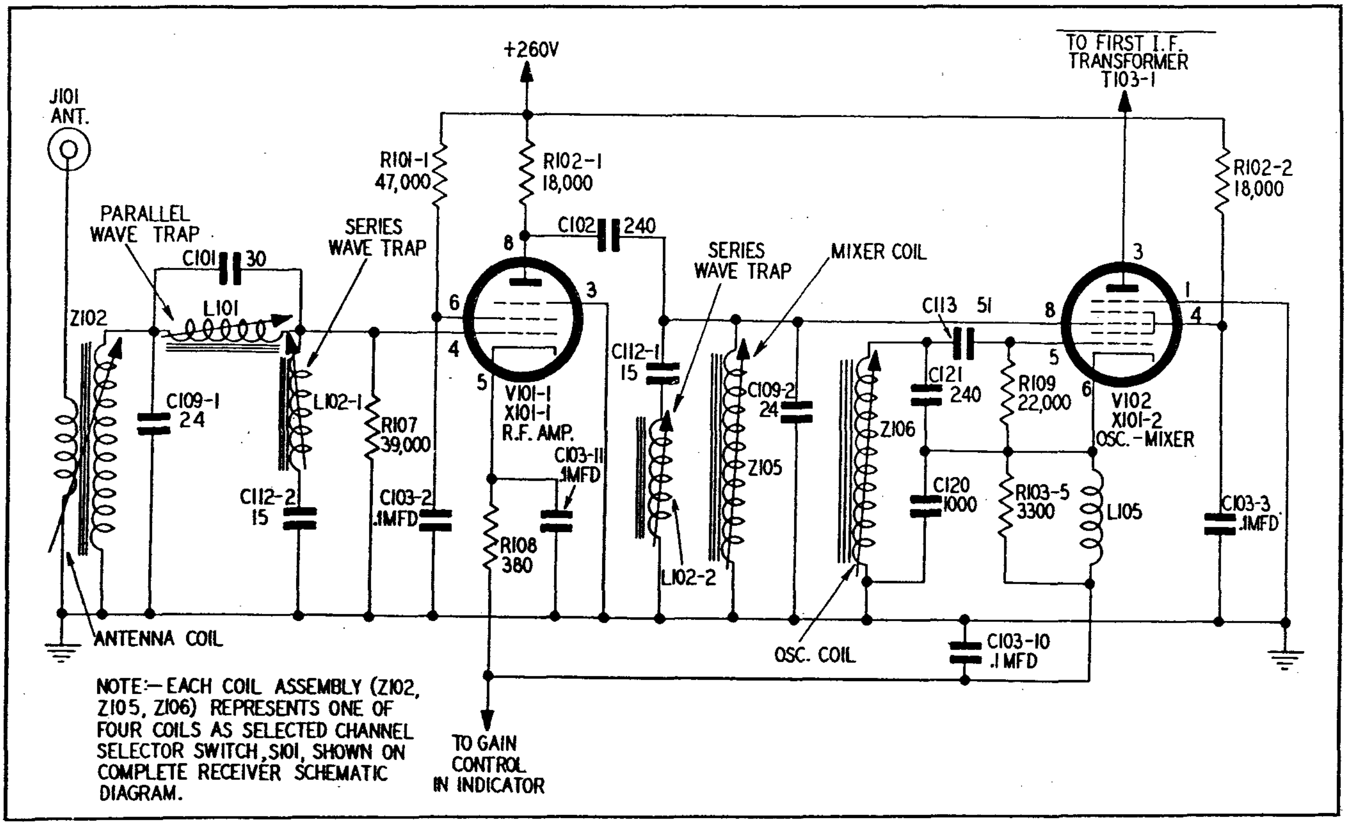


Figure 4-34. Receiver, R-F Mixer, and Oscillator Circuit

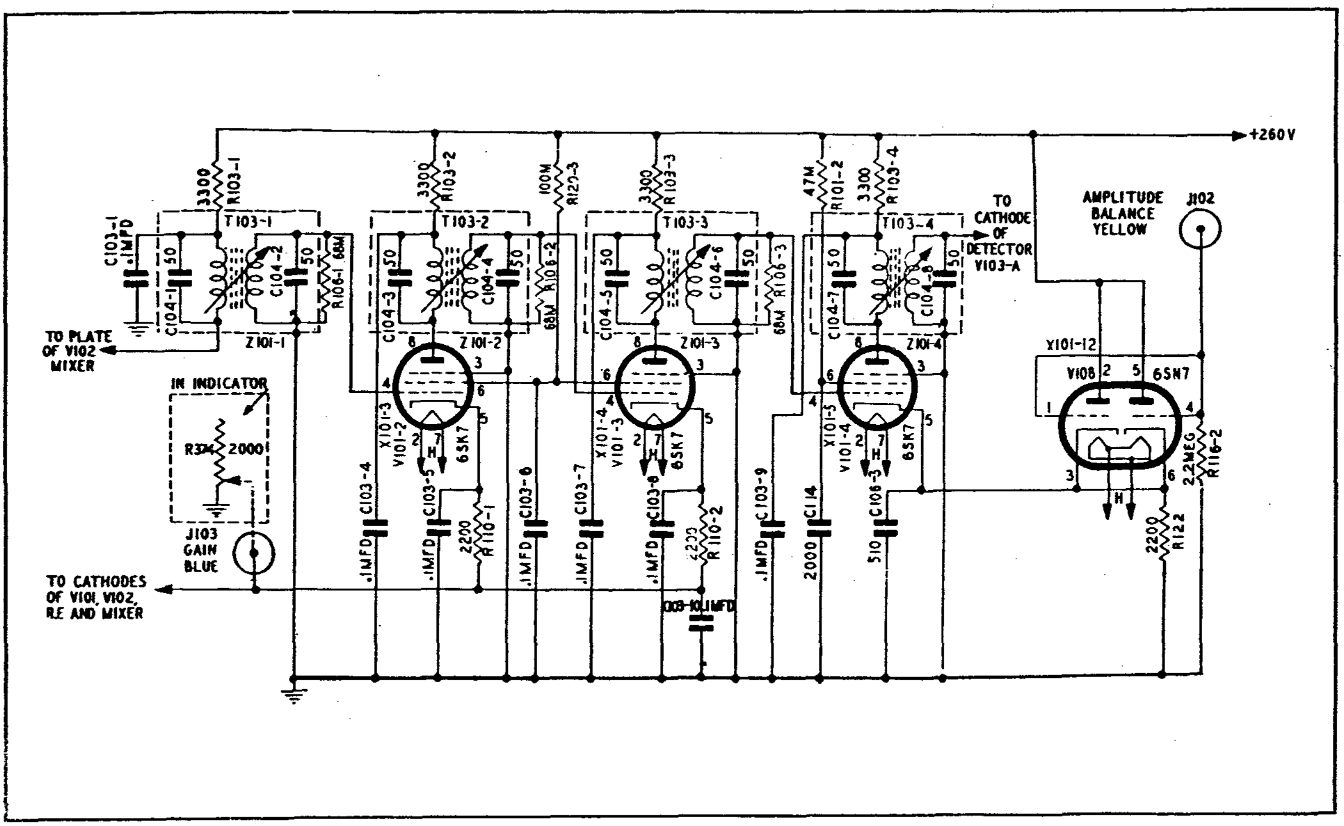


Figure 4-35. Receiver, I-F Amplifier, and Amplitude-Balance Circuits

To reach the grid of tube V-101-1, the signal must pass through parallel-resonant wave trap Z-103, which is tuned to 1050 kilocycles and offers a very high impedance to any signal of this frequency appearing at the antenna; a series-resonant wave trap, Z-104-1, also tuned to 1050 kilocycles, is shunted across the input to the grid, providing a comparatively low-impedance path to ground for the same signal. Capacitor C-109-1, shunted across the grid circuit of tube V-101-1 forms a part of the r-f tuned circuit; its capacitance, therefore, is added to the distributed capacitance of the selected coil to provide the effective tuning capacitance of the circuits.

The output signal voltages are developed across resistor R-102-1 and coupled, through capacitor C-102, to the selector arm of one section of switch S-101-C and the signal grid of oscillator-mixer tube V-102. Switch S-101-C selects one coil at a time from the four tuned-coils of assembly Z-105, which appear with capacitor C-109-2 as a parallel-resonant circuit across the mixer input grid. The selected pre-tuned coil offers maximum impedance to ground and maximum transfer of r-f voltage to the input grid for the frequency to which it is resonant. The series-resonant wave trap (Z-104-2) provides a low-impedance path to ground for any 1050-kilocycle signal that may be present in the output of r-f amplifier tube V-101-1, and further attenuates any signal of this frequency at the signal of oscillator-mixer tube V-102.

(2) OSCILLATOR MIXER.—The local r-f generator for Radio Receiver ★R-9A/APN-4 is a modification of the Colpitts type oscillator and functions around the triode section of tube V-102. The feedback voltage for grid excitation is developed in the cathode circuit across coil L-105, resistor R-103-5 and capacitor C-120, and is coupled to the grid circuit through capacitor C-121. The value of grid excitation voltage is largely determined by the relative values of capacitors C-120 and C-121, which in series, form the tuning capacitance of the grid circuit. Capacitor C-121, which has a negative temperature coefficient of 80 parts per million per degree centigrade of temperature change, tends to counteract the effects of temperature changes on capacitor C-120 and other circuit constants. In Radio Receiver ★R-9B/APN-4, capacitor C-120 is replaced by an 820-micromicrofarad temperature-compensating capacitor (C-123), whose temperature coefficient is —0.00075 micromicrofarad degree centigrade of temperature change. Shunting this capacitor is 200-micromicrofarad capacitor C-124. Capacitor C-121 is replaced by silver-mica capacitor C-122.

Variable tuning of the oscillator is accomplished by adjusting the iron cores of the individual oscillator coils which make up coil assembly Z-106. In Radio Receiver ★R-9A/APN-4 (modification III only) three of these coils, L-106-1, L-106-2 and L-106-3, are electrically identical and are for operation with the low-frequency band of 1.6 to 3.3 megacycles. The fourth coil (L-107) is for operation with the high-frequency band of 7.58 to 11.75 megacycles. In Radio Receiver ★R-9B/APN-4, all four coils are electrically identical and are for operation with the low r-f band between 1.7 and 2.5 megacycles. The type of tuning used, combined with other circuit conditions, normally results in a greater amplitude of oscillator voltage for the low-frequency band than for the high-frequency band. To compensate for this difference, each low-frequency coil is shunted by a 10,000-ohm resistor, effectively reducing the circuit "Q," and holding the oscillator output for these coils to a value adequately near that obtained when the high-frequency coil is used. Switch S-101-D, the fourth wafer section of the channel selector assembly, selects the proper oscillator coil for each channel position, and couples it to the oscillator grid through capacitor C-113; another section of the same switch shorts the unused coils to ground.

The r-f input to the signed grid of tube V-102 and local oscillator produces a 1050-kilocycle beat for the i-f amplifier. (See fig. 4-5.) The "GAIN" control located on the indicator panel controls the gain of the r-f section of the mixer tube as well as the r-f and i-f amplifiers, by increasing or decreasing the resistance in the cathode circuits of these stages. Since the oscillator grid is returned directly to the cathode, the oscillator is but slightly affected by this control.

(3) I-F AMPLIFIER.—The i-f amplifier of Radio Receivers ★R-9A/APN-4 and ★R-9B/APN-4 consists of tubes V-101-2, V-101-3 and V-101-4. The circuit amplifies a band of frequencies 45 to 60 kilocycles wide at 1050 kilocycles. This amplification is accomplished by employing four broad-tuning, low "Q" i-f transformers. The secondary windings of the first, second, and third i-f transformers (T-103-1, T-103-2 and T-103-3), are each shunted by 68,000-ohm resistors R-106-1, R-106-2 and R-106-3, which increase the frequency response by lowering the normal "Q" of the circuits. (See fig. 4-5.)

Two methods of gain control are employed in the i-f amplifier. The first is the conventional cathode-voltage control, employing variable resistor R-374. This resistor is the "GAIN" control and is located on the front panel of the indicator. It is common to r-f amplifier tube V-101-1, mixer tube V-102, and first and second i-f amplifier tubes V-101-2 and V-101-3. It affects the amplitude of both the A- and B-pulses at the same time. Minimum bias for each stage is obtained by use of an individual fixed resistor between the control and each cathode of the amplifier tubes.

The second method of gain control is used for the third i-f amplifier tube (V-101-4). Various levels of positive voltage, generated in the indicator when the A- and B-traces develop, are selected by turning the "AMP. BALANCE" control on the indicator panel. These voltages, fed through jack J-102 to the control grids of amplitude-balance tube V-108, provide a means of decreasing the gain of the receiver during the time the indicator is sweeping either the A- or the B-trace. When the "AMP. BALANCE" control is at its electrical center, the positive voltage fed to the grids of tube V-108 is the same for both traces. When the control is rotated to the right (clockwise), the positive voltage is greater when the A-trace is being developed, and results in an amount of attenuation of the A-pulse depending upon how far the control is adjusted to the right. Rotating the control to the left (counterclockwise) has a similar effect on the B-trace. The final result enables the operator to adjust the amplitude of the two pulses so that they appear equal on the indicator screen, even though they appeared at the antenna at widely different amplitude levels. The output of the third i-f amplifier is fed to the cathode of the A-section of tube V-103, a diode detector which rectifies the i-f signal to provide negative video pulses as its output.

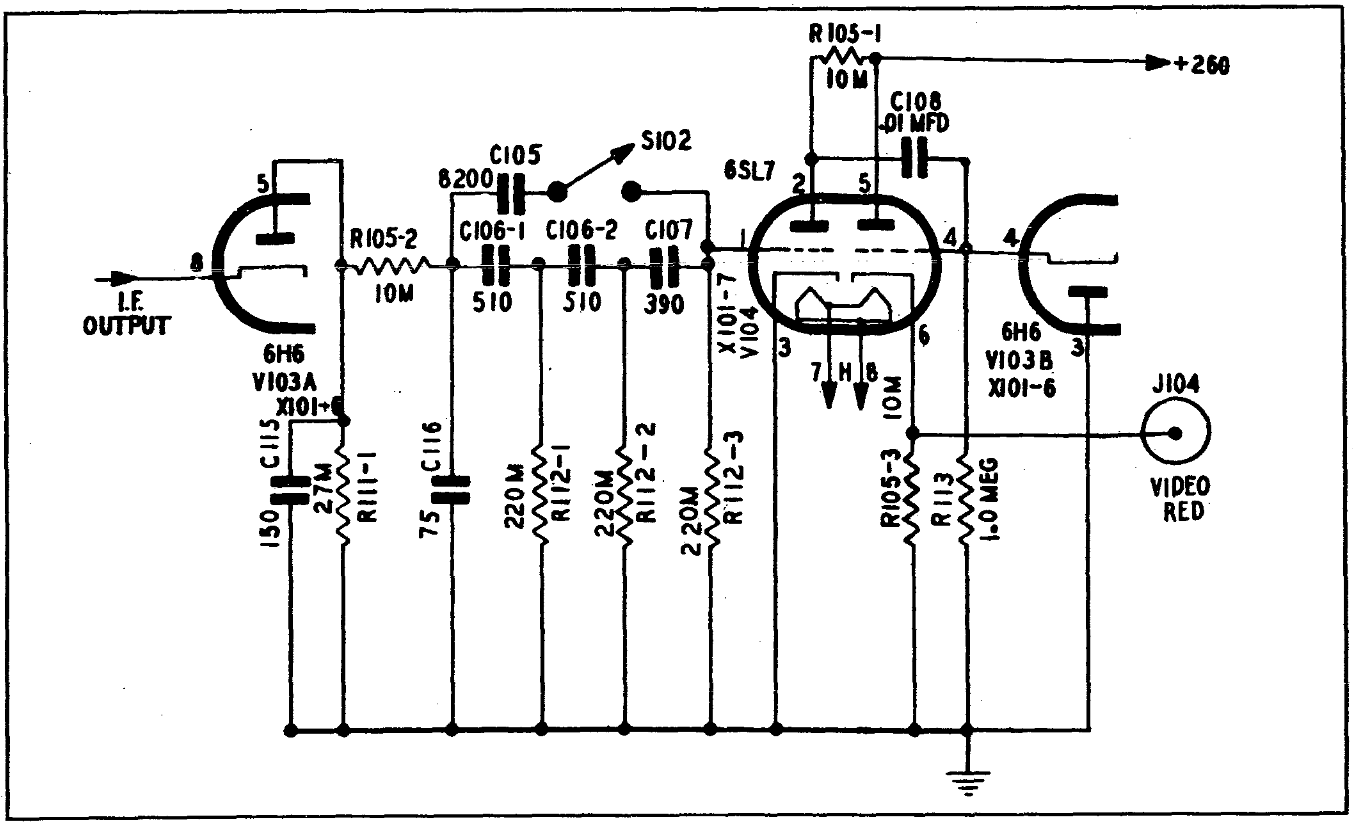


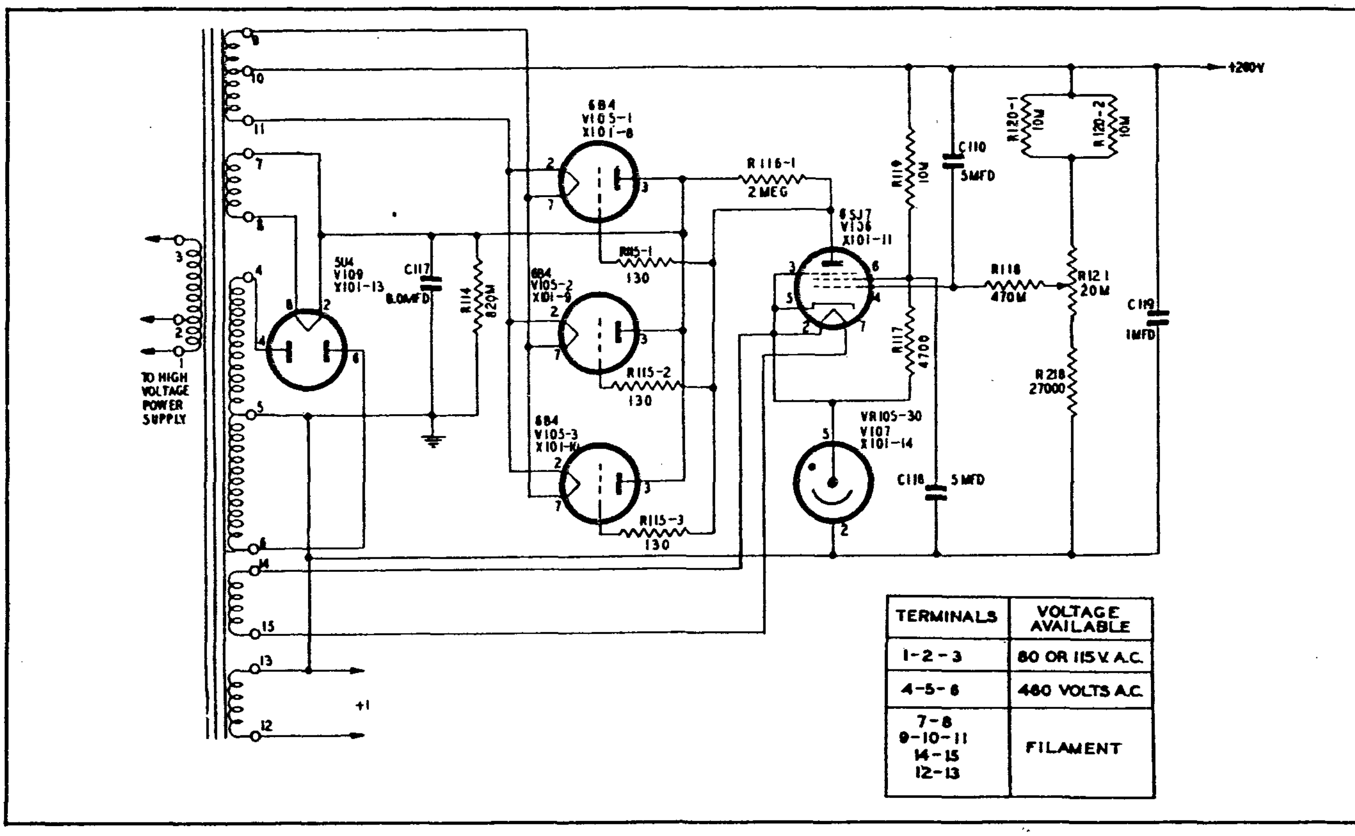
Figure 4-36. Receiver, Detector, and Video Amplifier Circuits

(4) DETECTOR-VIDEO AMPLIFIER. *(See figure 4-36.)*—The A-section of duo-diode tube V-103 functions as the detector for Radio Receivers ★R-9A/APN-4 and ★R-9B/APN-4. The detector is conventional, except that the amplified i-f signal is fed to the cathode instead of the plate. The detector output, therefore, appears across diode load resistor R-111-1 as a negative video pulse. The i-f component is removed from the rectified pulse by the filter action of capacitors C-115 and C-116 and resistor R-105-2. The high-pass filter, which consists of capacitors C-106-1, C-106-2 and C-107, and resistors R-112-1, R-112-2 and R-112-3, is effective against the low-frequency interference caused by generators and motors, and extends its effectiveness well into the high-frequency audio band. Since the filter action also causes some attenuation of the normal video pulses, capacitor C-105 and switch S-102 (controlled from the receiver front panel by the "FILTER IN-OUT" adjustment) feed the video signal around the filter, when filter action is not needed. The filter is out of the circuit when switch S-102 is closed, and in the circuit when the switch is open. (See fig. 4-36.) The rectified and filtered video pulse is fed to the grid of the A-section of tube V-104, where it is amplified and passed on to the grid of the B-section of the same tube as a positive video pulse. The B-section of duo-diode tube V-103 is connected across the grid of tube V-104-B to cause rectification of any negative component of the amplified pulse. The video output is taken off the cathode to provide better impedance matching, which results in lower loss during transition of the signal through the coaxial cable to the indicator.

(5) REGULATED-VOLTAGE POWER SUPPLY. *(See figure 4-37.)*—The regulated voltage power supply includes power transformer T-104, rectifier tube V-109, voltage regulator tubes V-105-1, V-105-2 and V-105-3; regulator control tube V-106; cathode stabilizer tube V-107; and associated switches, resistors, and capacitors. The circuit is designed so that a regulated d-c voltage, held constantly at 260 volts, is delivered to the receiver and indicator circuits.

Power transformer T-104 consists of a single primary winding and five secondary windings. The primary winding, terminals "1," "2," and "3," is tapped to permit operation from either 80- or 115-volt, 400- to 2400-cycles per second alternating current, and functions as an autotransformer to supply 80 volts to the primary of indicator filament transformer T-303 when the equipment is operated from 115-volt alternating current. The secondary windings and their terminals are identified as follows:

High-voltage winding: terminals 4, 5 and 6. Rectifier filament winding: terminals 7 and 8. Regulator-tube



TERMINALS	VOLTAGE AVAILABLE
1-2-3	80 OR 115 V. A.C.
4-5-6	460 VOLTS A.C.
7-8 9-10-11 14-15 12-13	FILAMENT

Figure 4-37. Regulated-Voltage Power Supply

filament winding: terminals 9, 10, and 11. Regulator-control-tube filament winding: terminals 14 and 15. Receiver-tubes filament winding: terminals 12 and 13. The high-voltage winding, with its rectifier tube (V-109), delivers approximately 460 volts direct current to the plates of the regulator tubes. These tubes have their plates connected, in parallel, directly to the positive 460-volt direct current line. The grids of the regulator tubes are isolated from each other by the individual grid resistors R-115-1, R-115-2, and R-115-3, which are connected between each grid and the common grid-control line to suppress any tendency toward parasitic oscillations.

The positive voltage appearing at the grids of the regulator tubes determines the effective resistance of these tubes. The value of this voltage is a result of V-106 plate current flowing through resistor R-116-1. Any increase in current through R-116-1 causes a less positive regulator-grid voltage and a corresponding increase in the resistance of the regulator tubes; a decrease of current through R-116-1 results in a more positive voltage at the grids of the regulator tubes and a corresponding decrease in their effective resistance.

The regulator-control action is the function of control tube V-106, whose cathode voltage is held absolutely constant by the action of voltage-regulator tube V-107. This tube, connected at the lower end of a voltage-divider system which includes resistors R-117 and R-119, provides a constant suppressor grid and cathode voltage of approximately 105 volts. The screen-grid voltage, taken from the same voltage-divider system, is held practically constant at approximately 145 volts. The control grid of the regulator-control tube is connected to the movable arm of potentiometer R-121, which, with resistors R-120-2 and R-128, constitutes a second voltage-divider system. By adjusting R-121, a voltage positive with respect to ground but negative with respect to the cathode, is fed to the grid of tube V-108 through isolating resistor R-118. By setting potentiometer R-121 properly, control tube V-106 functions so that the output at the cathodes of the regulator tubes is 260 volts positive with respect to ground and is constantly held at that potential over a wide range of current demand.

As an example of regulator-control action, assume that normal current is being drawn from the power supply; under this condition, the effective resistance of the regulator tubes is normal. A sudden *increase in current demand causes* the following actions:

A momentary increase in voltage drop through regulator tubes V-105-1, V-105-2 and V-105-3, and a lower positive voltage output at their cathodes (filaments).

A decrease in the positive voltage at the control grid of regulator-control tube V-106, making it more negative with respect to the cathode, whose voltage is held constant by the action of voltage-regulator tube V-107.

A decrease in current through tube V-106, and a corresponding rise in voltage at its plate and at the grids of the regulator tubes.

A decrease in the effective resistance of the regulator tubes, which permits the flow of the required additional current with less voltage drop and returns the output voltage again to the normal level of 260 volts.

A sudden *decrease in current demand* causes the following almost instantaneous actions:

A momentary, higher voltage output at the cathodes (filaments) of the regulator tubes.

An increase in the positive voltage at the control grid of tube V-106, resulting in less grid voltage with respect to the cathode voltage.

An increase in current through tube V-106, and a lower voltage at its plate and the grids of the regulator tubes.

An increase in voltage drop across the regulator tubes, caused by the increased effective resistance and resulting in an output voltage at the normal level of 260 volts.

Adequate filtering of the regulated voltage power supply is provided by the action of capacitor C-117, connected across the 460-volt d-c input to the regulator tubes, and capacitor C-119, across the output of the same tubes. The effective resistance of the regulator tubes, together with the 8-microfarad capacity of C-117, is adequate for the input filtering. The voltage-regulating action of control tube V-106 aids capacitor C-119 in the necessary filtering of the output from the regulator tubes. The bypass action of capacitors C-118 and C-110 across the screen and control grids of V-106 arrests any tendency toward self-oscillation by this tube and at the same time prevents amplification of any ripple appearing at the 260-volt output.

(6) HIGH-VOLTAGE POWER SUPPLY.—The high-voltage power supply, shown in figure 4-38, consists of transformer T-105, half-wave rectifier tubes V-110-1 and V-110-2, and associated capacitors and resistors. Transformer T-105 consists of a single tapped primary winding (terminals "1," "2," and "3") and three secondary windings, which include a single high-voltage winding (terminals "4" and "5") and two separate rectifier-filament windings (terminals "6" and "7," "8" and "9"). The rectifier system may be considered as two half-wave rectifiers with their outputs in series. One end of the high-voltage winding is connected to the plate of rectifier tube V-110-1 and the filament of rectifier tube V-110-2; the opposite end of the same winding is connected to ground, which is actually the center of the rectified output.

The circuit functions in the following manner: When the alternating potential of the high-voltage winding is positive at the plate of V-110-1 and the filament of V-110-2, V-110-1 conducts, developing a positive d-c voltage of approximately 1450 volts between the filament and ground. This voltage is adequately filtered by the actions of the filter resistor R-124 and capacitor C-111-1, and fed to pin 1 of the six-pin connector J-105. A total of 22.4 megohms resistance is provided by the four 5.6-megohm resistors (R-123-1, R-123-2, R-123-3, and R-123-4), connected in series as a bleeder to discharge capacitor C-111-1 when the equipment is turned off.

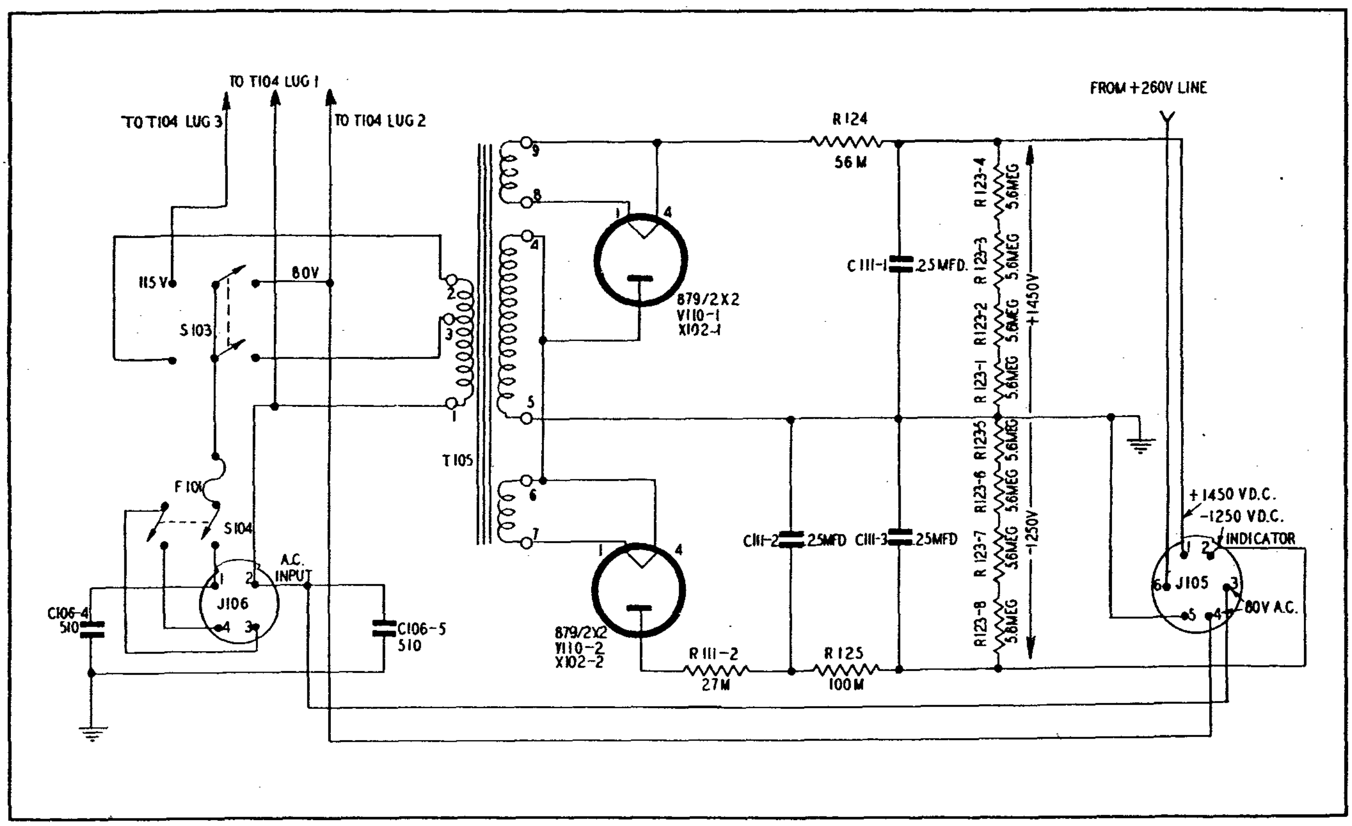


Figure 4-38. High-Voltage Power Supply

When the ungrounded end of the high-voltage winding becomes negative with respect to ground, V-110-2 conducts and develops a negative voltage of approximately 1450 volts between its plate and ground. This voltage, filtered by the combined filter action of resistors R-111-2 and R-125 and capacitors C-111-2 and C-111-3, is fed to pin 2 of the six-pin connector J-105. A bleeder resistance, consisting of resistors R-123-5, R-123-6, R-123-7 and R-123-8, connected in series and totalling 22.4 megohms, permits discharge of capacitors C-111-2 and C-111-3 when the equipment is turned off. The additional filter action of the negative d-c output of the power supply is necessary because various levels of the developed voltage are fed to the intensity-control grid and first accelerating anode of the cathode-ray tube. A ripple in this voltage, when applied to the intensity-control grid or first anode, would prevent the necessary definition of the screen pattern. The positive d-c output, however, does not require the same amount of filtering, since its output is fed only to the final accelerating anode of the cathode-ray tube. The presence of a small amount of ripple in the positive voltage fed to this anode does not greatly affect the screen pattern.

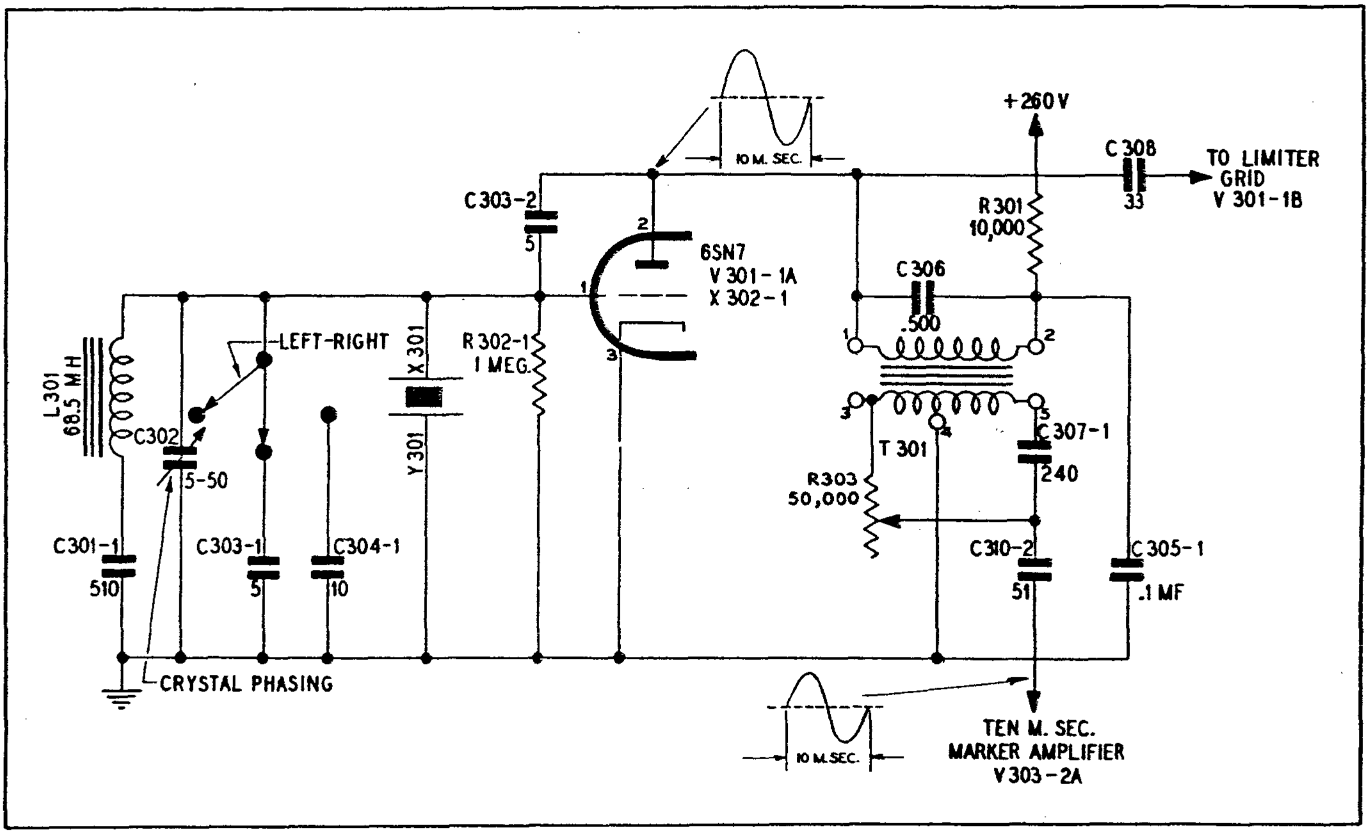


Figure 4-39. 100-Kilocycle Crystal Oscillator

b. INDICATOR ★ID-6B/APN-4.

(1) 100-KILOCYCLE OSCILLATOR AND LIMITER.—The 100-kilocycle oscillator, shown in figure 4-39, is the master timing circuit of the indicator unit. Its purpose is to generate a signal with a frequency of 100 kilocycles, which either directly or indirectly controls the action of all the other circuits. Since the indicator is primarily a time measuring device, the frequency of the oscillator must be very stable to obtain the necessary accuracy of measurement. To meet this requirement, a crystal is used in the grid circuit to hold the oscillator output at a constant frequency of 100 kilocycles.

The oscillator, consisting of one-half of tube V-301-1, uses a crystal-controlled, slightly-variable resonant grid circuit, and a permeability-tuned resonant plate circuit. The resonant grid circuit comprises coil L-301, capacitor C-301-1, "CRYSTAL PHASING" capacitor C-302, and capacitor C-301-1 ("LEFT-RIGHT" switch in neutral position). The resonant plate circuit, consisting of capacitor C-306 and the primary of transformer T-301, is tuned by adjusting the transformer core to a frequency slightly higher than that of the crystal frequency so that it will present an inductive reactance. Sufficient phase shift is provided for the voltage fed back through capacitor C-303-2 to maintain oscillations in the crystal-controlled grid circuit. Correct bias is secured through the action of grid leak resistor R-302-1.

The crystal resonates at 100 kilocycles, and normally will hold the output of the oscillator at this frequency over a wide range of temperatures. It is desirable, however, to shift this frequency slightly when framing the received pulses on fast "SWEEP SPEED" positions 2, 3, and 4, or when synchronizing the trace to keep the received pulses stationary. This frequency shift is accomplished through the action of the "CRYSTAL PHASING" control (variable capacitor C-302) and the "LEFT-RIGHT" switch, which parallels capacitor C-303-1 with capacitor C-304-1 in the "L" position, and removes both capacitors in the "R" position. Varying the capacity tunes the grid circuit to a frequency slightly different from that of the crystal. Since the oscillator is essentially a tuned grid-tuned plate circuit, it will tend to oscillate at the new frequency, dragging the crystal frequency slightly away from its normal value. The maximum frequency variation obtained is approximately 35 cycles above or below the basic 100 kilocycles.

The sinusoidal output of the oscillator, taken from the secondary of transformer T-301 through a phase-shifting network and consisting of the 10-microsecond phasing control R-303, and capacitor C-307-1, is fed to the 10-microsecond marker amplifier. The 10-microsecond phasing control is for securing exact coincidence between each fifth 10-microsecond marker and the corresponding 50-microsecond marker.

Another output is coupled directly from the plate of the oscillator through capacitor C-308 to the grid of the other half of V-301-1, which is the limiter stage. The limiter holds the amplitude of the oscillator output to a constant level to insure stable action of the first counter, which is triggered by the limiter output. Since the limiter stage is operating with zero bias, the sinusoidal wave on the grid will vary the plate current from cutoff to saturation, with the result that both the positive and negative voltage peaks will be limited to a definite amplitude by the non-linearity of the tube at either extreme of plate current. The output from the plate of the limiter, which is no longer a sine wave, is coupled through capacitor C-310-1 to the first-counter trigger tube.

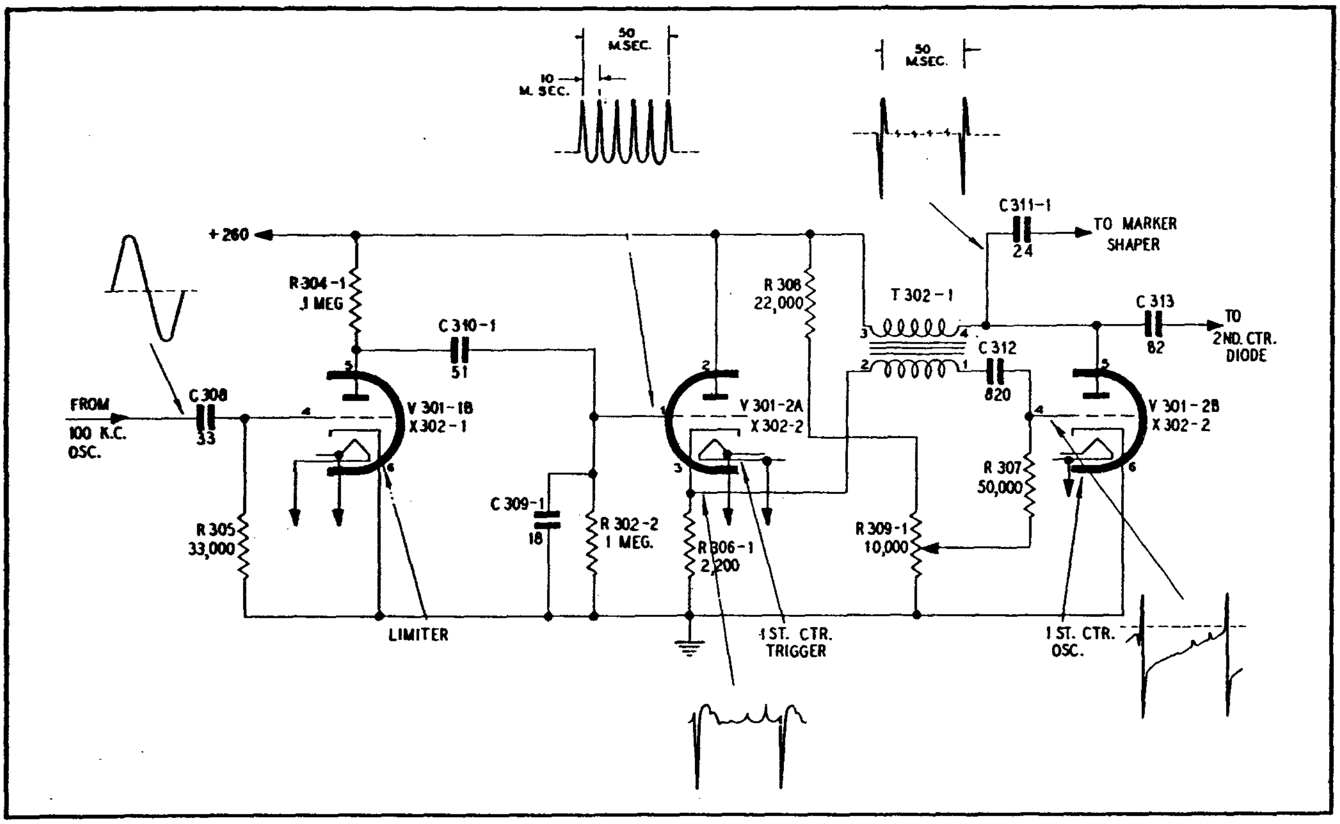


Figure 4-40. First-Counter Circuit

(2) COUNTER CIRCUITS.

(a) FIRST-COUNTER TRIGGER AND OSCILLATOR CIRCUIT.—The first-counter trigger and counter oscillator (see fig. 4-40) utilizes a duo-triode tube (V-301-2), in a circuit giving a pulse ratio of five to one. The function of this circuit is to convert the 100-kilocycle output of the oscillator-limiter stage into pulses spaced at 50-microsecond intervals, or a recurrence rate of 20 kilocycles-per-second. These pulses are used to produce 50-microsecond markers and to trigger the second counter.

The first section of V-301-2, which is connected as a conventional cathode-follower stage with the load resistor R-306-1 in the cathode circuit, constitutes the first-counter trigger. Coupling is made from the cathode through the secondary of transformer T-302-1 and capacitor C-312 to the grid of the second section of V-301-2, which is essentially a blocking-oscillator stage. A d-c potential is applied to this grid through the A-control from a voltage-divider circuit, consisting of resistors R-308 and R-309-1.

The operation of the first-counter trigger and counter oscillator can be understood better by reference to the waveforms shown in figure 4-40. The first-counter oscillator would operate normally as a blocking oscillator at a recurrence rate slightly below the desired rate, without any triggering pulses being applied from the first-counter trigger circuit; however, it is triggered to synchronize its action at the exact rate required. Each time the second section of V-301-2 conducts, current flowing through the primary of transformer T-302-1 induces a voltage in the secondary, which appears as a positive voltage through capacitor C-312 on the grid of the second section (V-301-2), and a negative voltage at the cathode of the first section. This feedback momentarily drives both sections of V-301-2 into heavy conduction, with subsequent grid current flow that places a charge on capacitors C-312, C-309-1 and C-310-1, leaving both grids highly negative. The output section of V-301-2B remains cut off for some time, this being determined by the RC constants of the output grid. In the meantime, positive pulses from the oscillator-limiter stage are being applied to the grid of the first-counter oscillator, but the grid is at such a high negative potential that the first three or four pulses have no effect. Upon the arrival of the fifth pulse the grid of the output section of V-301-2 has approached a voltage level when conduction is about to occur. The fifth pulse, coupled through capacitor C-312, is of sufficient amplitude to drive the grid of the second section of V-301-2 sufficiently positive to raise it above cutoff, which causes the oscillator to conduct prematurely and repeat another cycle of operation in synchronism with the fifth pulse from the oscillator-limiter stage. The A-control varies the d-c potential on the grid and sets the discharge level of capacitor C-312. Proper adjustment of this control will insure five to one counter action.

The output from the plate of the first-counter oscillator (shown in figure 4-40) is coupled through capacitor C-311-1 to the 50-microsecond marker shaper stage V-301-6, and through capacitor C-313 to the second-counter diode V-302-1.

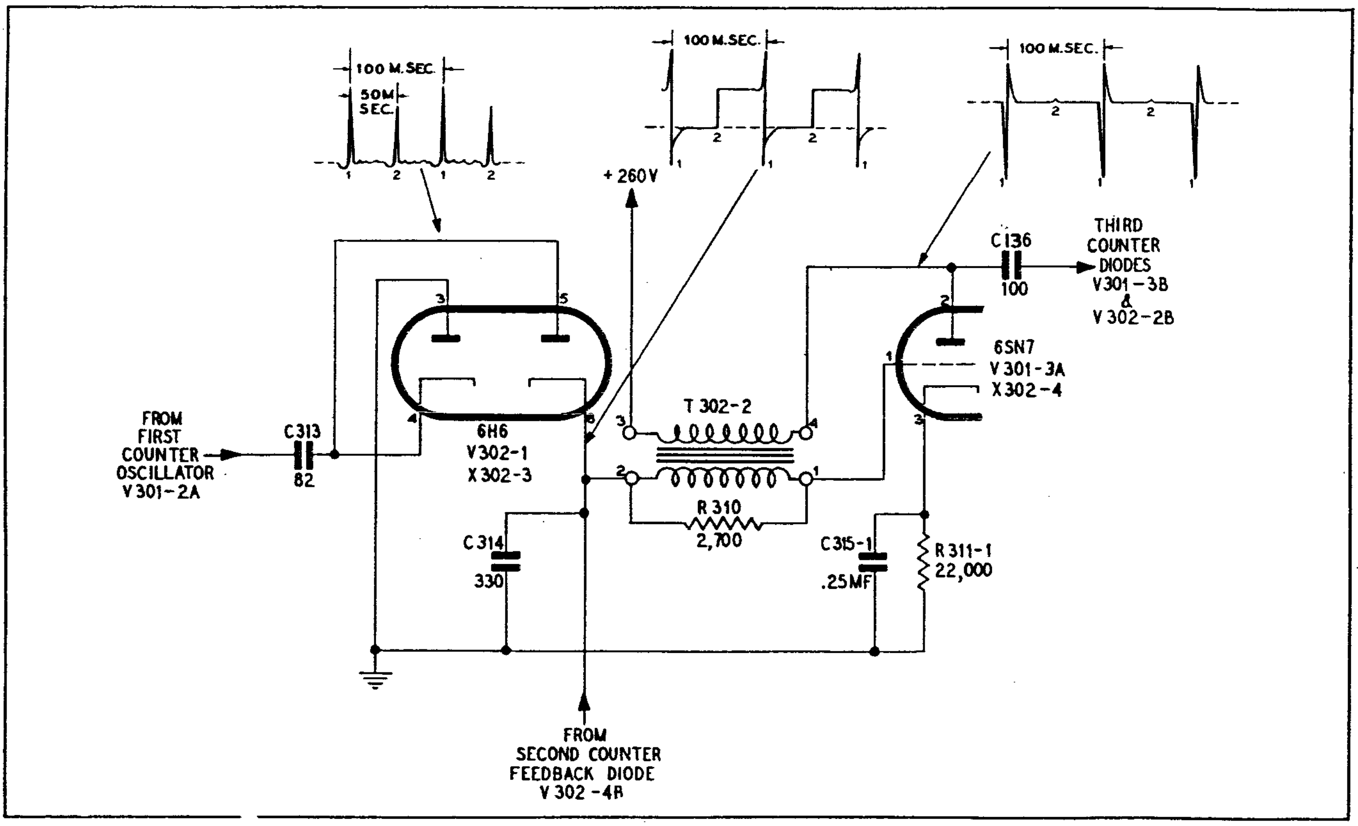


Figure 4-41. Second-Counter Circuit

(b) SECOND COUNTER. *(See figure 4-41.)* —Designed to operate at a ratio of two to one, the second counter consisting of V-302-1 and one section of V-301-3, performs a function similar to that of the first counter. It converts the 50-microsecond pulses from the first counter into pulses spaced at 100-microsecond intervals, or having a recurrence rate of 10,000 pulses per second.

The second counter is a triggered blocking oscillator with feedback from plate to grid through transformer T-302-2. The oscillator output-frequency, together with the time constant of the cathode circuits, is such that after the oscillator fires once, the cathode voltage is held at an almost constant level for all subsequent operations. With the cathode operating at a comparatively constant voltage, the output frequency of the oscillator is determined by the time required for the triggering pulses to raise the grid voltage to a level with respect to the cathode where conduction again takes place. The voltage at the oscillator grid is the result of charges (positive at the ungrounded side) developed across capacitor C-314 by the output of the first counter. These triggering pulses are first fed to the second-counter diode, V-302-1, through capacitor C-313. Throughout the negative excursions of the output from the first counter the input section of the duo-diode V-302-1 (whose plate is grounded) conducts, discharging capacitor C-313 to almost zero level. The positive excursions of the same pulses, however, cause conduction by the second section of the diode, by which a positive voltage is developed across capacitor C-314. The functions and values of the second-counter circuit components are such, that two pulses from the first counter are required to raise the grid voltage to a level with respect to the cathode where conduction takes place and the oscillator fires. The repetition of this cycle of events results in output pulses at 100-microsecond intervals appearing at the plate of the oscillator; these pulses trigger the third counter through capacitor C-316.

Another voltage is fed back from the sixth counter, through the station selector switch and the left-right circuit, to capacitor C-314 to change the trace-recurrence rate on the screen of the cathode-ray tube. The functioning of this feedback circuit is described in another section as station selector action.

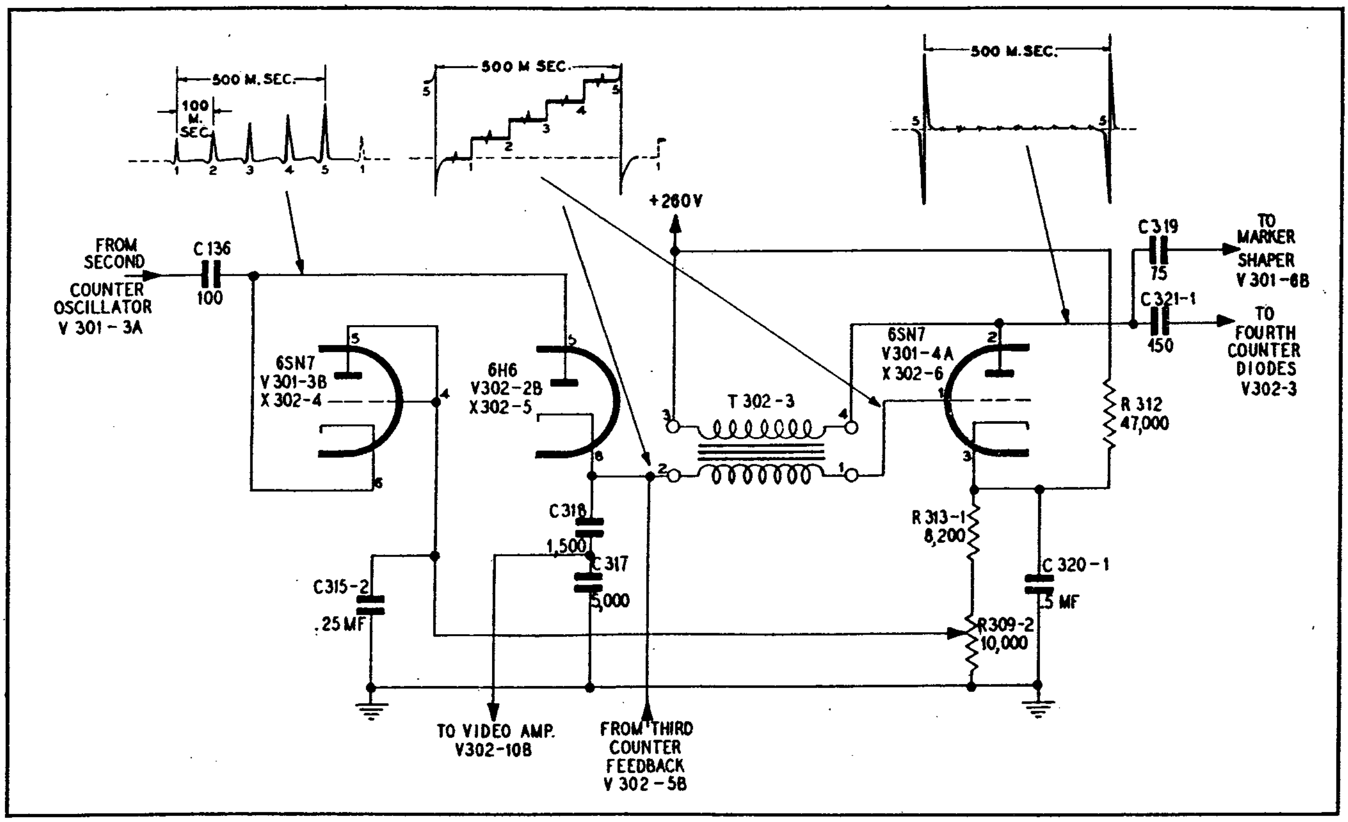


Figure 4-42. Third-Counter Circuit

(c) THIRD COUNTER.—The third-counter circuit, shown in figure 4-42, utilizes one section of each of the three dual-purpose tubes, V-301-3, V-302-2 and V-301-4, to give a counter ratio of five to one. When triggered by 100-microsecond pulses from the second counter, this circuit produces 500-microsecond pulses which are fed to 500-microsecond marker shaper V-301-6, the fourth counter, and the B-coarse delay circuit.

The third-counter circuit is similar to the second-counter circuit with a few important exceptions. The triode section of V-301-3, with the plate and grid connected together, is used as a diode section for the third-counter diode, and the plate is returned to the B-control, R-309-2, in a voltage-divider system consisting of R-309-2, R-312 and R-313-1, connected between the regulated B-supply and ground. The cathode of diode V-302-2 is coupled through capacitors C-317 and C-318 in series to ground, while the cathode of the third-counter oscillator tube (V-301-4) is connected to the same voltage divider as the plate of V-301-3.

The third-counter circuit operates essentially in the same manner as the second counter with the few exceptions that follow. The d-c voltage from the B-control places and holds a d-c charge on capacitors C-317 and C-318 through the conduction of diode sections V-301-3 and V-302-2, in series. This charge is applied to the grid of the third-counter oscillator (V-301-4), as a bias voltage. Proper adjustment of this bias with the B-adjustment allows the build-up voltage on capacitors C-317 and C-318, by the incoming pulses from the second counter, to trigger the oscillator upon the arrival of the fifth pulse.

The 500-microsecond pulses from the plate of the oscillator are coupled through capacitors C-319 and C-321-1 to the 500-microsecond marker shaper and the fourth counter, respectively. A third output from the plate is coupled through resistor R-354 and capacitor C-309-2 to the B-coarse delay circuit. Another output is taken from the cathode circuit of V-302-2, in "SWEEP SPEED" position "8," and fed to video amplifier V-301-10. This output, which appears on the cathode-ray tube screen as a series of voltage steps, enables the operator to make accurate adjustments on the equipment. A voltage is fed back from the sixth counter through the station selector switch and the left-right circuit to the cathode of V-302-2. The purpose and function of this feedback is explained under station selector action.

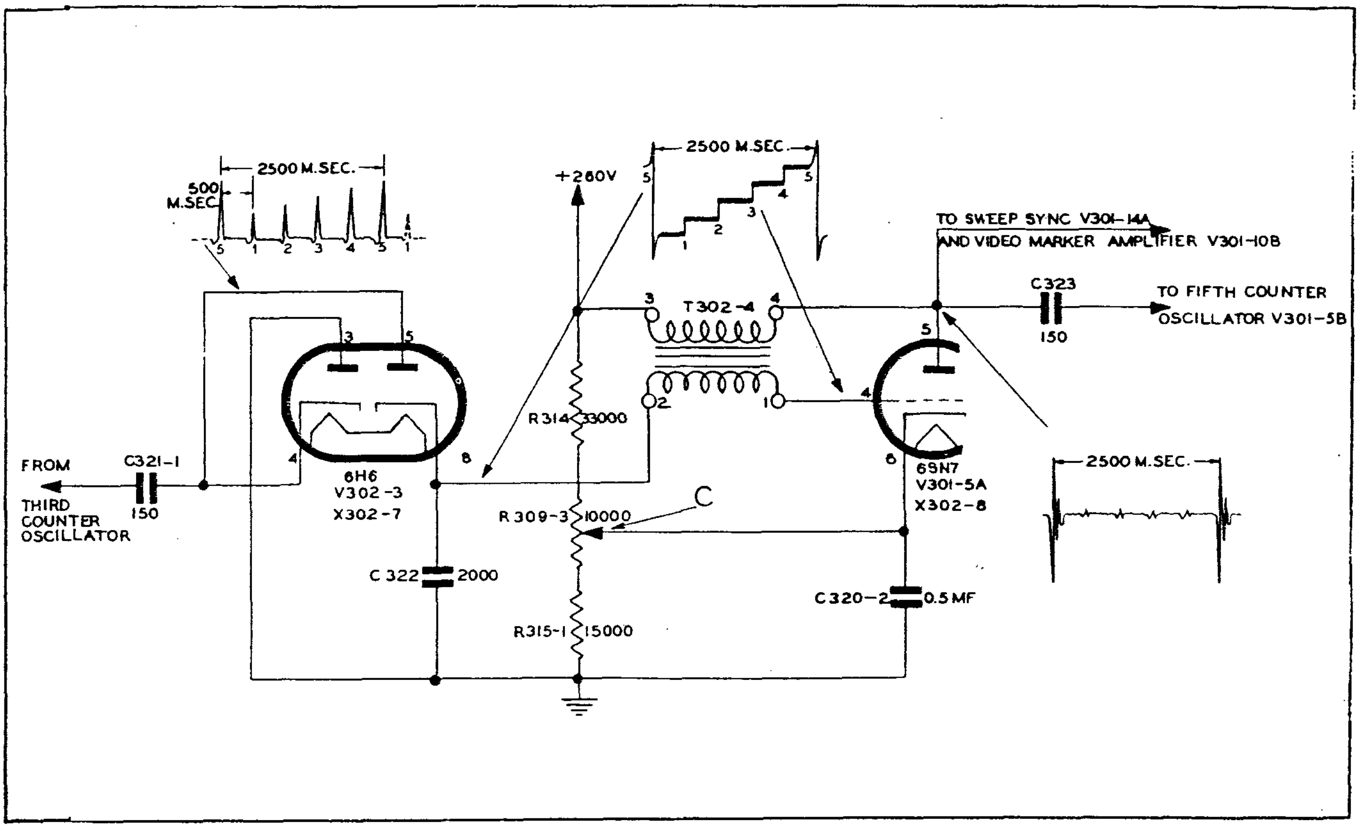


Figure 4-43. Fourth-Counter Circuit

(*d*) FOURTH COUNTER.—The fourth-counter circuit, shown in figure 4-43, has a five to one ratio, thus producing pulses at 2500-microsecond intervals when triggered by 500-microsecond pulses from the third counter. The output of the fourth counter is fed to the fifth counter, the A-delay, the signal marker mixer, and in "SWEEP SPEED" position 8, to the sweep circuit.

The fourth counter utilizes diode V-302-3 and one section of V-301-5 in a circuit that is similar in design and function to the second counter. The chief differences between the two circuits are the value of the components, and the connection of the V-301-5 cathode through the C-adjustment to a voltage divider consisting of resistors R-314, R-309-3, and R-315-1, in series between ground and the regulated B-supply. The C-adjustment sets the bias on the fourth-counter oscillator. This bias, supplemented by the charge built up across capacitor C-320-2 when V-301-5 conducts, determines the number of pulses necessary to charge capacitor C-322 to the point for triggering the oscillator into conduction. When the C-adjustment is properly set, the oscillator fires on the arrival of the fifth pulse from the third counter, or after a lapse of 2500 microseconds.

(*e*) FIFTH COUNTER. (*See figure 4-44.*)—The fifth counter employs the second section of V-301-5 in a blocking-oscillator circuit designed to have a counter action ratio of two to one. This circuit converts the 2500-microsecond pulses from the fourth counter into pulses at 5,000-microsecond intervals for triggering the sixth counter.

The fifth counter functions like any standard blocking-oscillator. Capacitor C-324-1 and resistor R-316-1 have such values that after each conduction period the second section of V-301-5 is held blocked until the arrival of two pulses from the fourth counter. The second pulse drives the tube into conduction again, with the result that an output pulse is produced in the plate circuit of the fifth counter at the end of each 5,000-microsecond interval.

The output from the fifth counter is coupled to the sixth counter through a resonant circuit consisting of coil L-302 and capacitor C-325-1. The fifth-counter out-

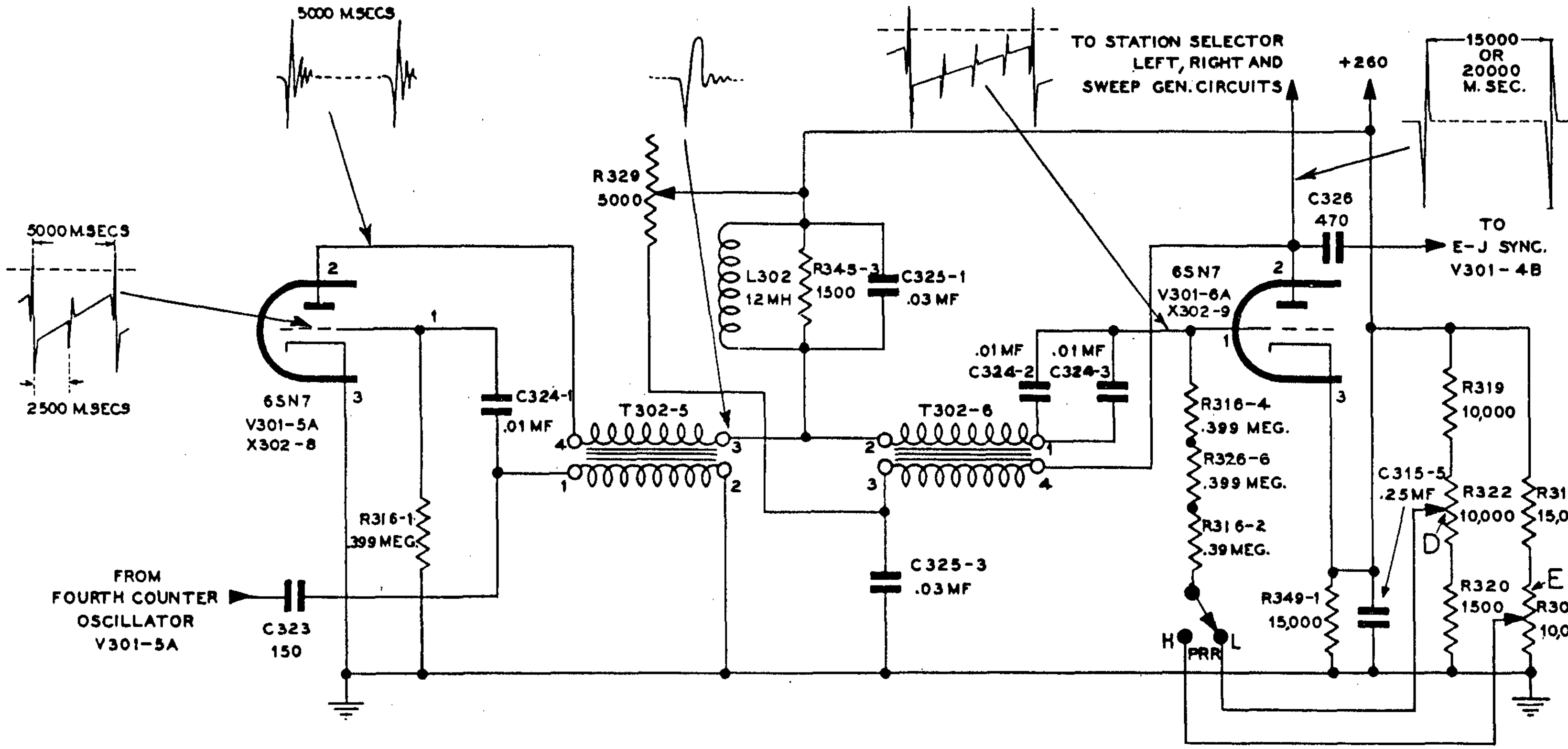


Figure 4-44. Fifth-Counter Circuits

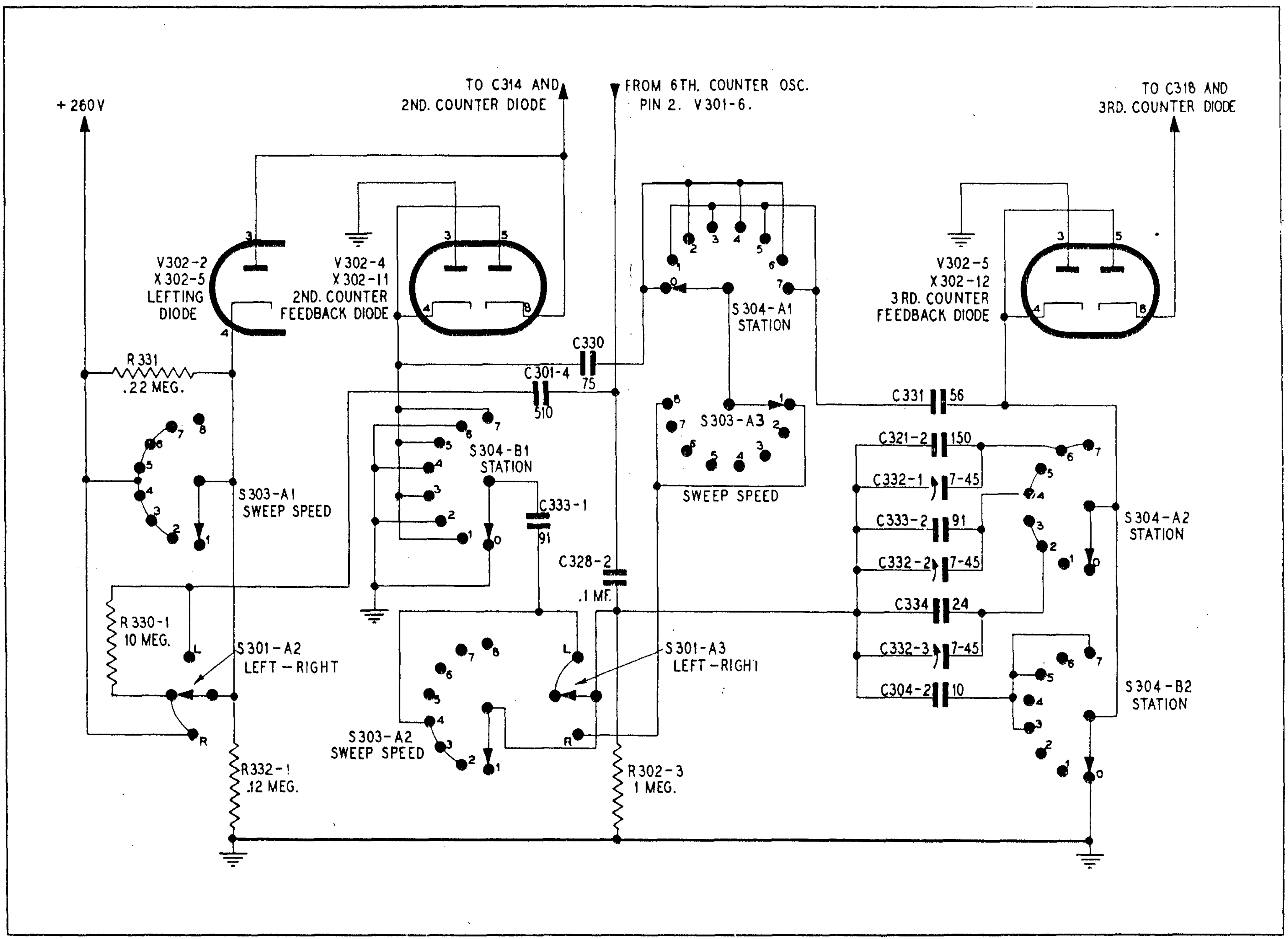


Figure 4-45. "STATION" Selector and Left-Right Circuit

put is a sharp pulse with a steep front, which, if applied directly to the sixth counter, would entail little delay in the triggering of that circuit by the third or fourth pulse. This sharp output pulse excites the resonant circuit into oscillation at its own resonant frequency, and a damped sine wave output is produced. The front of this sine wave rises much more gradually, resulting in a lapse of 25 or 30 microseconds from the time the resonant circuit is excited until the voltage output rises to a sufficient amplitude to trigger the sixth counter. This delay is introduced in the circuit to insure that the feedback from the sixth counter to the second counter occurs approximately 25 microseconds after the second-counter capacitor (C-314) has received a charge from the first counter. Otherwise, the feedback might occur too near the time at which capacitor C-314 is receiving a charge from the first counter; the resulting phase differences between the two voltages would cause the second counter to fire too soon or too late. Introduction of the delay between the fifth and sixth counters prevents any instability that might otherwise occur. Resistor R-345-3 is connected across the resonant circuit to dampen out the oscillations between the arrival of pulses from the fifth counter.

(f) SIXTH COUNTER. *(See figure 4-44.)*—The sixth counter uses the A-section of duo-triode V-301-6 as a free-running blocking oscillator, whose circuit design permits two ratios of counter action. With the "PRR" switch at position "L" the sixth counter functions at a ratio of four to one and converts the 5,000-microsecond output of the fifth counter into pulses spaced at intervals of 20,000 microseconds. With the "PRR" switch at position "H," the counter action is three to one, thus converting the output of the fifth counter into pulses spaced at 15,000-microsecond intervals. The sixth-counter circuit functions are much the same as those of the first and fifth counters. An important difference, however, is the manner by which the triggering voltages are fed to the oscillator grid. The output pulses of the fifth counter are fed to the sixth counter through the two parallel-connected capacitors (C-324-2 and C-324-3), whose combined capacitances together with the effective resistance in the grid circuit determine the long time-constant necessary for proper sixth-counter operation.

The two different intervals between successive outputs by the sixth counter are the results of two different basic grid-to-cathode voltage levels selected by variable resistors R-309-4 (panel adjustment "D") and R-322 (panel adjustment "E"). These adjustments control the interval between outputs by the sixth counter, by limiting the amount of charge placed on capacitors C-324-2 and C-324-3 when the oscillator fires. This in turn determines the time required for the capacitors to discharge to a voltage level where the positive excursions of pulses from the fifth counter can excite the sixth-counter oscillator into conduction again.

(3) STATION SELECTOR AND LEFT-RIGHT CIRCUITS. *(See figure 4-45.)*—The station-selector circuit provides the necessary means for synchronizing the repetition rate of the traces with any one of the 16 different recurrence rates of received pulses. Synchronization is accomplished by feeding back to the second and third counters positive voltage pulses developed from a part of the output of the sixth counter. The feedback action, which occurs only once for each firing of the sixth counter, is fed to the second counter circuit alone for "STATION" position "1;" to the third counter for "STATION" positions "2," "4," and "6;" and to both counters (second and third) for "STATION" positions "3," "5," and "7." The feedback finally causes the sixth counter to fire prematurely by 50 to 350 microseconds, and results in a reduction in the normal interval between successive sweeps of the A- and B-traces and a subsequent increase in their repetition rate. With the "PRR" switch at position "L," rotation of the "STATION" selector from 0 to 7 increases the sweep rate by 1/16-cycle per second for each successive step, and synchronizes the indicator with received pulses whose recurrence rates are based on 25 pps and increase in 1/16-pps steps. With the switch "PRR" at position "H," successive positions of the "STATION" selector, from 0 to 7, synchronize the indicator functions with pulses whose recurrence rates are based on 33⅓ pps, and increased in 1/9-pps steps.

With the "SWEEP SPEED" control at position 1, the left-right circuit also functions with the station circuit, by momentarily accelerating or retarding the normal firing time of the sixth counter. Because of the complexity of circuit functions and the fact that the station selector and left-right actions are so closely associated, the functions of these circuits at each "STATION" position will be discussed together.

(a) "STATION" POSITION "0".—*(See figure 4-46.)*

1. STATION SELECTION.—Since the basic trace-repetition rate (25 or 33⅓ traces per second) is synchronous with the basic recurrence-rate of the received pulses, no fixed station feedback action is provided or necessary for "STATION" position "0." However, to provide left-right action, the left-right control selects either negative or positive pulses, developed from the output of the sixth counter, and feeds them to the storage capacitor (C-314) of the second counter, opposing (for left action) or aiding (for right action) the normal functions of the counter.

2. LEFT ACTION.—To cause a movement of the received pulses to the left (the "LEFT-RIGHT" control being at position "L"), a part of the output from the sixth counter is fed to the cathode of the lefting diode (V-302-2) through capacitor C-314 and section S-301-B. The negative portion of the applied pulse is of sufficient amplitude to drive the cathode negative with respect to the plate, and causes enough conduction within the tube to discharge the second-counter storage capacitor (C-314) to zero level. As shown in figure 4-46, this feedback action occurs approximately 25 microseconds after capacitor C-314 has received a charge from the first counter, and 25 microseconds ahead of the otherwise normal firing time of the second-counter oscillator. With capacitor C-314 discharged to zero level by the feedback voltage, three pulses from the first counter, instead of two, are required to cause the second-counter oscillator to fire again. The result is a 50-microsecond delay in the normal firing time of the second and succeeding counters, a corresponding slowing-down of the trace-repetition rate, and a movement of the pulses to the left.

The lefting diode (V-302-2A) performs an interesting function in the operation of the left-right circuit. When the "LEFT-RIGHT" control is at either neutral or "RIGHT" position, a positive potential of 260 volts exists at the cathode of V-302-2A. (See fig. 4-45.) Under this condition no conduction can take place within the tube; the diode, therefore, cannot act as a discharge path for capacitor C-314 and, as a result, does not affect the normal action of the second counter. With the "LEFT-RIGHT" control at "LEFT" position, a voltage-divider system consisting of resistors R-331 and R-332-1 places a positive potential of approximately 92 volts on the cathode. This cathode voltage is also sufficient to insure against conduction within the tube, except when the tube is triggered by an output pulse from the sixth counter. The negative excursion of the output pulse from the sixth counter is of greater amplitude than the positive voltage existing at the cathode of V-302-2A; therefore, it drives the cathode negative with respect to the plate, causes conduction within the tube, and discharges capacitor C-314 to zero level. With the "LEFT-RIGHT" control at neutral position, a 10-megohm resistor (R-330-1) provides the necessary discharge path for capacitor C-301-4, thus preventing any undesirable effects by this capacitor on the normal operation of associated circuits.

3. RIGHT ACTION.—With the indicator set for slow sweep ("SWEEP SPEED" position "1"), movement of the pulses to the right for "STATION" position "O" is affected by feeding back to the second counter a positive charge each time the sixth counter fires. This positive charge is developed by the action of the second-counter feedback diode (V-302-4) from a voltage pulse developed across resistor R-302-3 and fed to the feedback diode through capacitor C-330. The magnitude of the charge fed back to the second counter, limited by capacitor C-330 to a value necessary to cause the second-counter oscillator to fire, is not critical and requires no special means for adjustment. The feedback, which occurs 25 microseconds after capacitor C-314 has already received a charge from the first counter, causes the second-counter oscillator to fire after 75 microseconds, instead of the normal 100 microseconds. (See fig. 4-46.) The second-counter oscillator fires again after another 75 microseconds, which results in a deletion of 50 microseconds from the normal 200 microseconds from the normal firing time of the sixth counter, an increase of the trace-repetition rate, and a movement of the received pulses to the right. The circuit path for right feedback includes position "R" of section S-301-A3 of the left-right control, position "1", section S-303-A3 of the "SWEEP SPEED" control, and position "O", section S-304-A1 of the "STATION" selector control.

The left-right actions just described are for the slow sweep only ("SWEEP SPEED" position "1"), being effectively blocked or removed by the circuit functions of sections S-303-A1 and S-303-A3 for "SWEEP SPEED" positions "2" to "7" inclusive. Left action is blocked for these sweep positions by using switch section S-303-A1 to place a potential of 260 volts direct current on the cathode of the lefting diode. This cathode voltage prevents the diode from acting as a discharge path for capacitor C-314, even when the "LEFT-RIGHT" control is moved to the "LEFT" position. Switch section S-303-3A is so connected in the circuit that right action through the counters is effective for "SWEEP SPEED" position "1" only, being disconnected for positions "2" to "7", inclusive. However, with the "SWEEP SPEED" control at position "8", the left-right action is again cut into the circuit to provide a means for visually checking its effect on the normal circuit functions.

For "SWEEP SPEED" positions "2", "3", and "4", the left-right control affects only the 100-kilocycle oscillator, causing a slight increase or decrease in normal oscillator frequency.

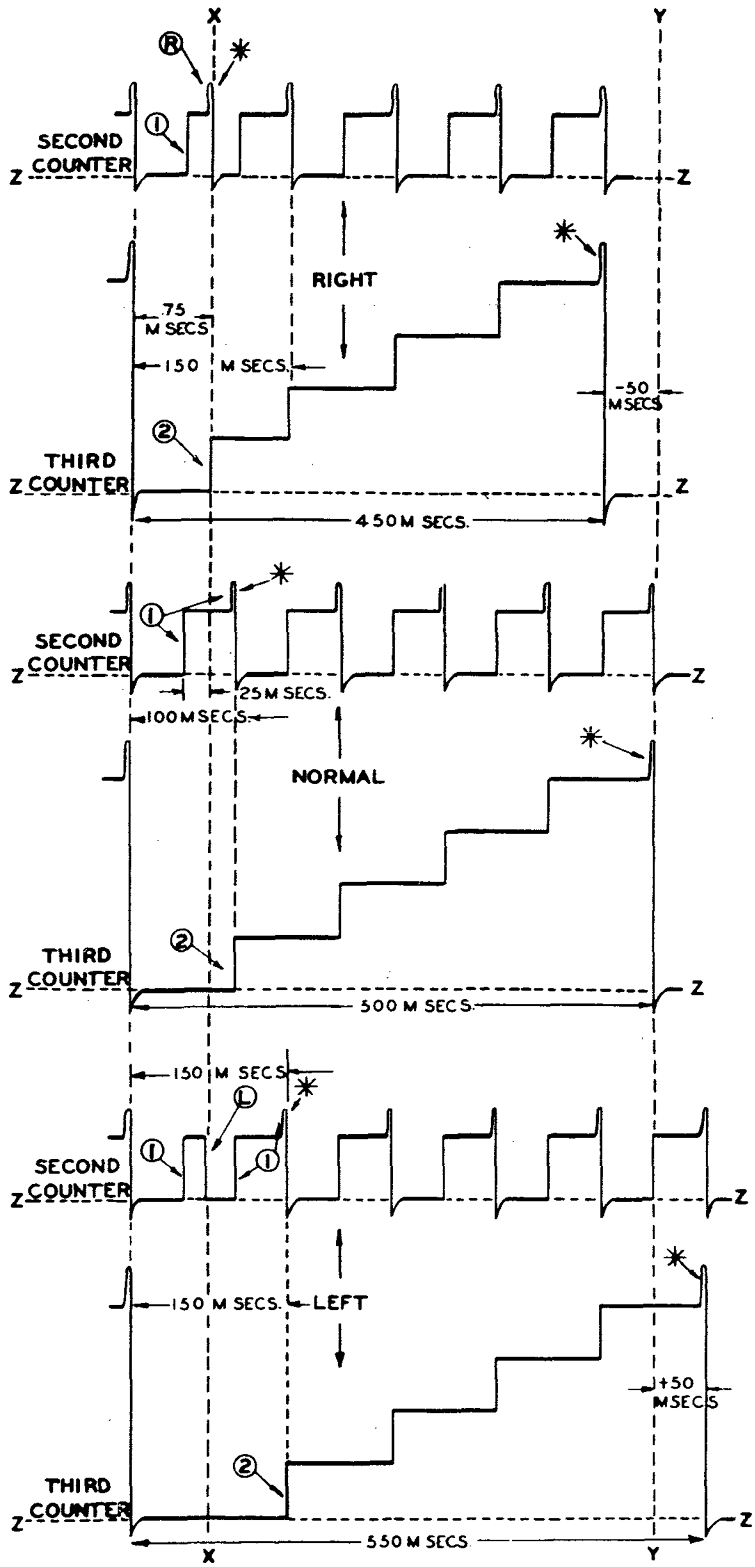
(b) "STATION" POSITIONS "2", "4", AND "6".

1. STATION SELECTION.—With the "STATION" selector at positions "2", "4", or "6", the station feedback voltages are fed to the third counter alone.

a. POSITION "2". *(See figure 4-47.)*—For "STATION" position "2", the feedback voltage supplements the positive charges placed on capacitor C-317 and C-318 by four output pulses from the second counter, and causes the third-counter oscillator to fire after an interval of 400, instead of 500 microseconds. Because of this action the output pulses from the sixth counter are spaced at intervals of 19,900 microseconds for position "L" of the "PRR" switch and 14,900 microseconds for position "H" of the same switch. The magnitude of the feedback charge is limited by the combined capacitance of the two parallel-connected capacitors (C-334 and C-332-3). Capacitor C-332-3 (panel adjustment "2"), which is adjustable, is set to provide a feedback voltage to capacitors C-317 and C-318 approximately equal to that supplied by one output pulse from the second counter.

b. POSITION "4". *(See figure 4-48.)*—For "STATION" position "4", the feedback action is the same as that for position "2", except for the magnitude of the feedback voltage. The feedback charge on capacitors C-317 and C-318 is limited in this position by the parallel-connected capacitors C-333-2 and C-332-2. Capacitor C-332-2 (panel adjustment 4) is adjusted to the value which provides a charge on capacitors C-317 and C-318 equal to that supplied by two output pulses from the second counter. The feedback causes the third counter to fire after an interval of 300, instead of 500, microseconds. As a result, the output pulses from the sixth counter occur at intervals of 19,800 and 14,800 microseconds, and the trace-repetition rate becomes 25-4/16 and 33-7/9 traces per second, respectively.

c. POSITION "6." *(See figure 4-49.)*—For "STATION" position "6", the magnitude of the feed-



X Relative firing time of sixth counter oscillator.

Y Relative normal firing time of third counter oscillator for given station position.

Z Zero charge level.

1 Charge action resulting from an output pulse from first counter.

2 Charge action resulting from an output pulse from second counter.

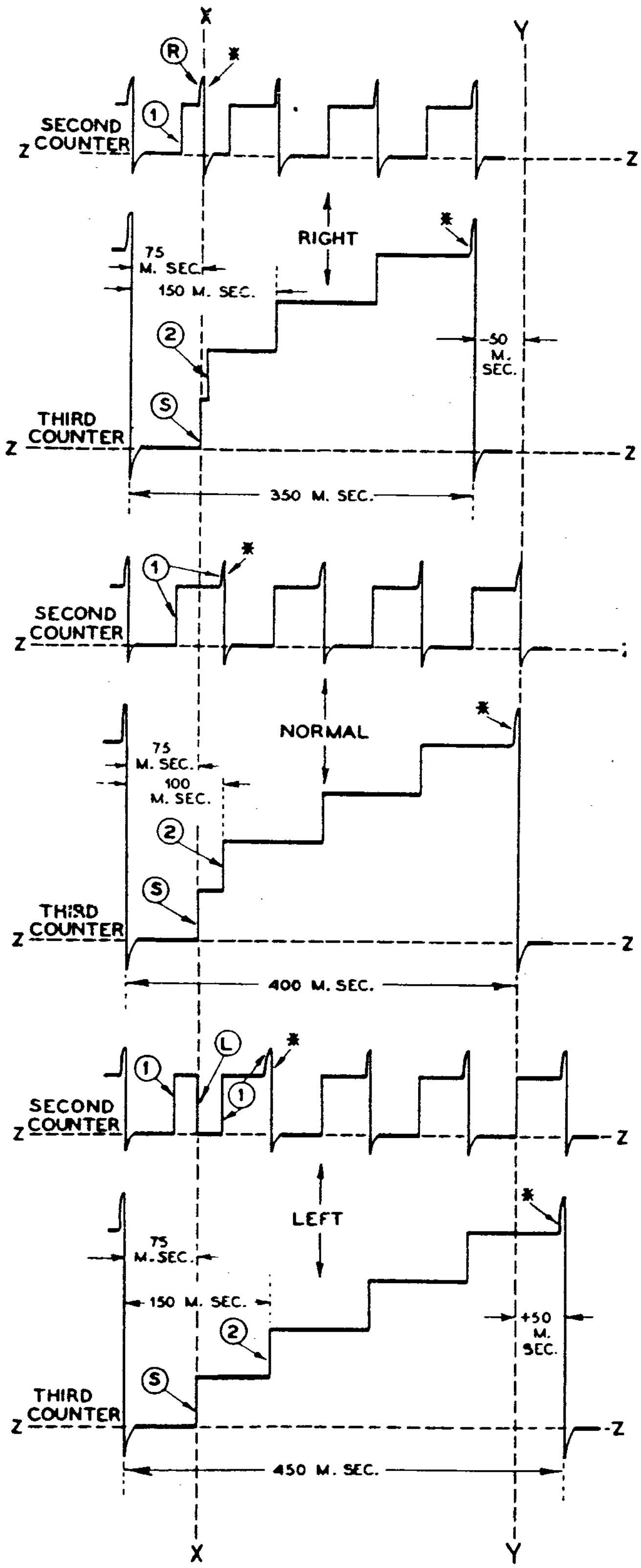
L Discharge action by negative portion of sixth pulse through "LEFT" position of "LEFT-RIGHT" control.

R Charge action by positive portion of sixth counter pulse through "RIGHT" position of "LEFT-RIGHT" control.

★ Relative time at which counter oscillator fires.

NOTE: Patterns indicate actions occurring each time sixth counter fires.

Figure 4-46. Normal and Left-Right Oscilloscope Patterns for "STATION" Selector Position "O"



X Relative firing time of sixth counter oscillator.

Y Relative normal firing time of third counter oscillator for given station position.

Z Zero charge level.

1 Charge action resulting from an output pulse from first counter.

2 Charge action resulting from an output pulse from second counter.

L Discharge action by negative portion of sixth counter pulse through "LEFT" position of "LEFT-RIGHT" control.

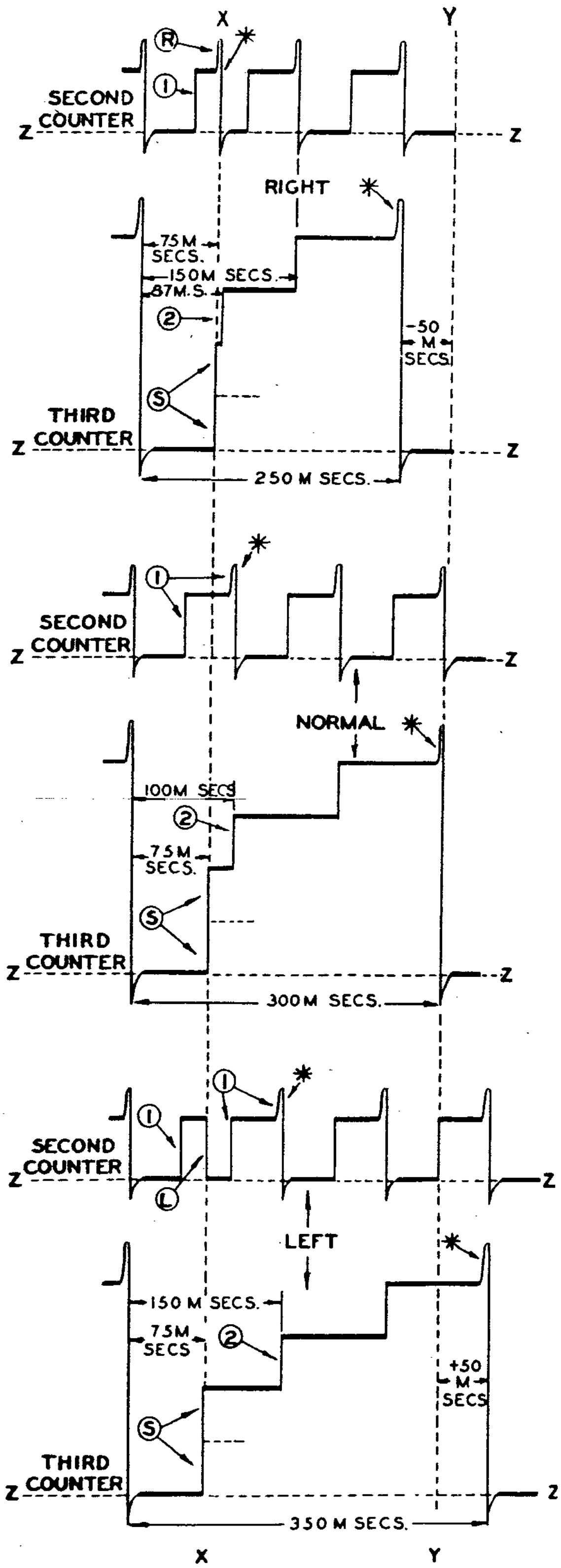
R Charge action by positive portion of sixth counter pulse through "RIGHT" position of "LEFT-RIGHT" control.

S Charge action by positive portion of sixth counter pulse through "STATION" selector feedback capacitors.

★ Relative time at which counter oscillator fires.

NOTE: Patterns indicate actions occurring each time sixth counter fires.

Figure 4-47. Normal and Left-Right Oscilloscope Patterns for "STATION" Selector Position "2"



X Relative firing time of sixth counter oscillator.

Y Relative normal firing time of third counter oscillator for given station position.

Z Zero charge level.

1 Charge action resulting from an output pulse from first counter.

2 Charge action resulting from an output pulse from second counter.

L Discharge action by negative portion of sixth counter pulse through "LEFT" position of "LEFT-RIGHT" control.

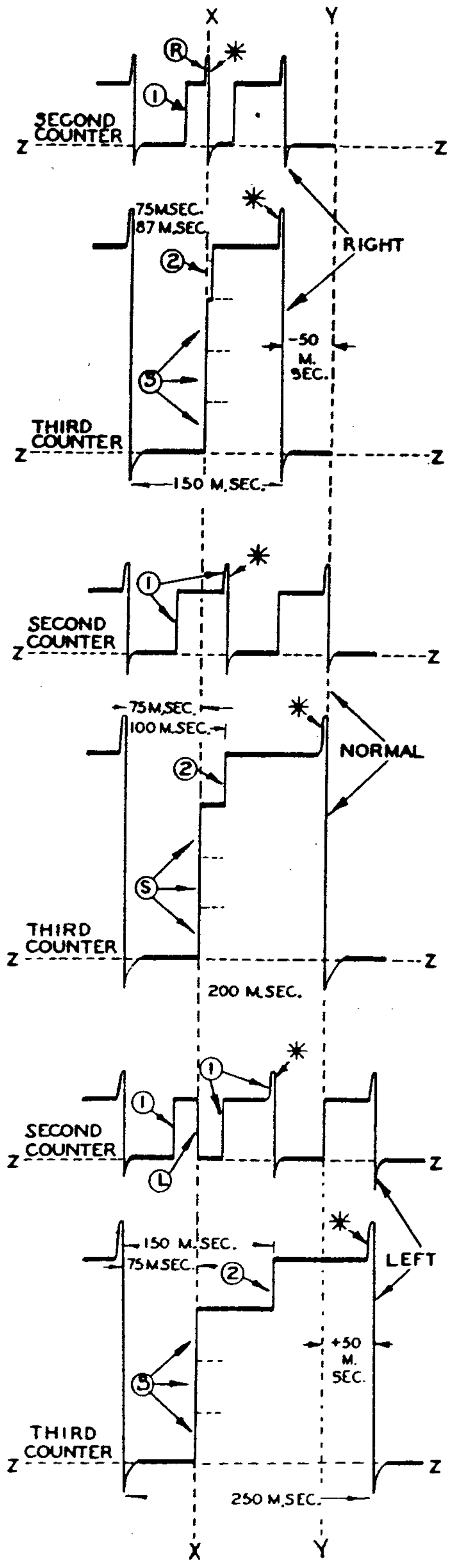
R Charge action by positive portion of sixth counter pulse through "RIGHT" position of "LEFT-RIGHT" control.

S Charge action by positive portion of sixth counter pulse through "STATION" selector feedback capacitors.

★ Relative time at which counter oscillator fires.

NOTE: Patterns indicate actions occurring each time sixth counter fires.

Figure 4-48. Normal and Left-Right Osscilloscope Patterns for "STATION" Selector Position "4"



X Relative firing time of sixth counter oscillator.

Y Relative normal firing time of third counter oscillator for given station position.

Z Zero charge level.

1 Charge action resulting from an output pulse from first counter.

2 Charge action resulting from an output pulse from second counter.

L Discharge action by negative portion of sixth counter pulse through "LEFT" position of "LEFT-RIGHT" control.

R Charge action by positive portion of sixth counter pulse through "RIGHT" position of "LEFT-RIGHT" control.

S Charge action by positive portion of sixth counter pulse through "STATION" selector feedback capacitors.

★ Relative time at which counter oscillator fires.

NOTE: Patterns indicate actions occurring each time sixth counter fires.

Figure 4-49. Normal and Left-Right Oscilloscope Patterns for "STATION" Selector Position "6"

back voltage is limited by the combined capacitance of the parallel-connected capacitors (C-321-2 and C-332-1). C-332-1 (panel adjustment "6") is adjusted to place a charge on capacitors C-317 and C-318 equivalent to that supplied by three output pulses from the second counter. The third counter, as a result, fires after an interval of 200 instead of 500 microseconds, and causes the sixth counter to fire at intervals of 19,700 and 14,700 microseconds. The trace-repetition rate subsequently becomes 25-6/16 and 34 traces per second. The settings of panel adjustments "2", "4", and "6" are critical and require frequent checking when extreme or sudden changes in temperature and altitude are encountered.

2. LEFT ACTION.—To cause a movement of the received pulses to the left for "STATION" positions "2", "4", and "6", the left-right control functions as explained for "STATION" position "O", paragraph (3)*(a)2*. The action, which results in a delay of 50 microseconds in the firing of the second and succeeding counters, occurs only once for each firing of the sixth counter.

3. RIGHT ACTION.—To cause a movement of the received pulses to the right for "STATION" positions "2", "4", and "6", the feedback voltage is developed by the rising or trailing edge of the negative output pulse from the sixth counter and fed to the second counter. The resultant premature firing of the second-counter oscillator places an additional charge across capacitors C-317 and C-318 approximately 12 microseconds after these capacitors have received a charge through the station selector circuit. (See figs. 4-47, 4-48 and 4-49.) The final result is premature firing of the third-counter oscillator by an additional 50 microseconds, a subsequent premature firing of the sixth counter, and a movement of the pulses to the right.

(c) "STATION" POSITIONS "1", "3", "5", AND "7".

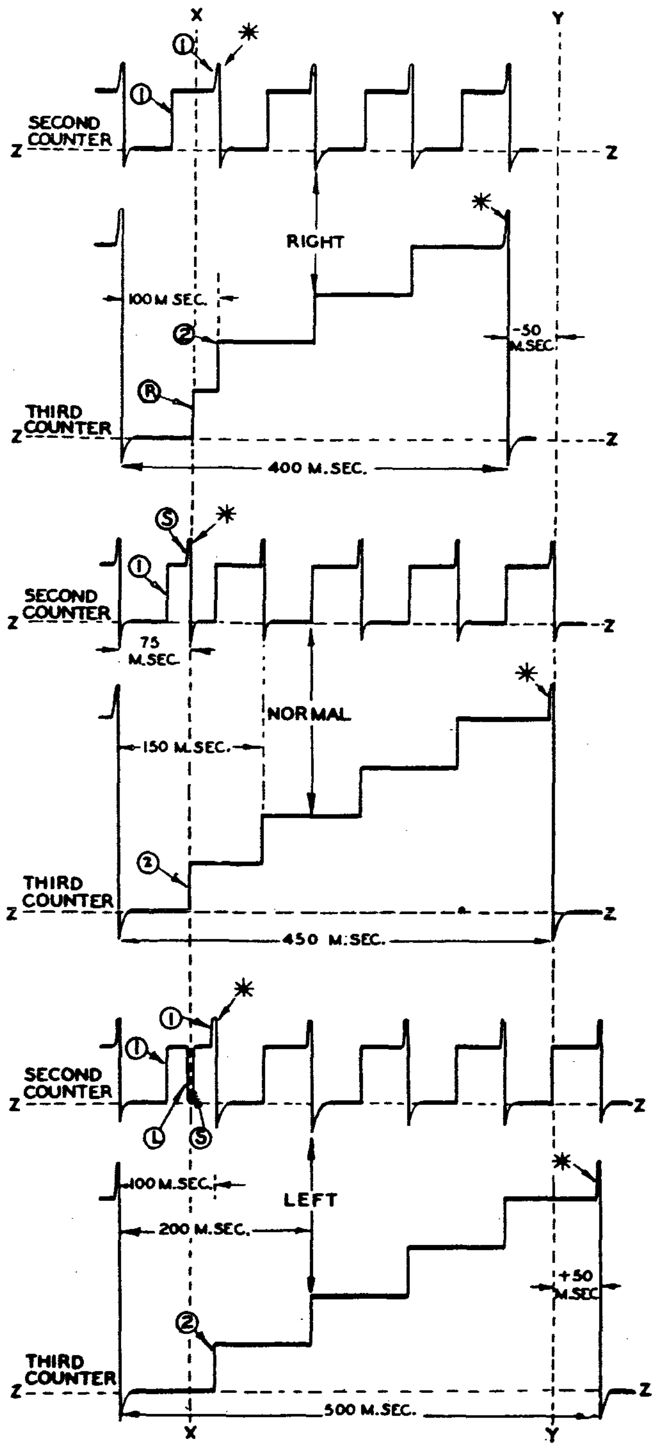
1. STATION SELECTION.

a. POSITION "1". *(See figure 4-50.)*—The trace-repetition rates for "STATION" position "1" are 25-1/16 traces per second for position "L" and 33-4/9 traces per second for position "H" of the "PRR" switch. The increase in the trace-repetition rate is the result of the deletion of 50 microseconds from the normal 20,000 or 15,000-microsecond intervals between successive outputs from the sixth counter, causing this counter to fire at 19,950 and 14,950-microsecond intervals. The positive feedback which causes 50-microsecond deletion is fed to the second-counter storage capacitor (C-314) and has the same effect on the firing time of the second-counter oscillator as the feedback for right action on "STATION" position "O". (See par. 3*b*(3)*(a)3* this section.) The path for the feedback pulse, which is developed across resistor R-302-3 by the output of the sixth counter, includes the center (neutral) position of section S-301-A3 of the left-right control, capacitor C-333-1 position 1 of section S-304-B1 of the "STATION" selector, and the second counter feedback diode (V-302-4). The feedback voltage supplements the charge action of the first counter on capacitor C-314, causing two successive premature firings of the second-counter oscillator at 75-microsecond intervals, instead of the normal 100 microseconds. The result is a deletion of 50 microseconds from the normal firing time of the third counter, which also causes a corresponding 50-microsecond deletion from the normal firing time of the sixth counter.

b. POSITION "3". *(See figure 4-51.)*—The trace-repetition rates for "STATION" position "3" are 25-3/16 and 33-2/3 traces per second, and represent a deletion of 150 microseconds from the normal interval between successive pulses from the sixth counter. Deletion of 50 of the total 150 microseconds is a result of feedback to the second counter, as explained for "STATION" position "1". The deletion of the additional 100 microseconds, however, is the result of a similar feedback to the third counter. The timing of the two feedbacks is such that their effects are added together to cause the third counter to fire prematurely by 150 microseconds, resulting in a subsequent premature firing of the sixth-counter oscillator at intervals of 19,850 or 14,850 microseconds. The feedback path to the third counter is the same as that for "STATION" position "2", except for the addition of capacitor C-304-2 connected to the feedback circuit through position "3", section S-304-B2 of the "STATION" selector switch gang. The additional 10-micro-microfarad coupling capacitance is necessary because, when feedback to both the second and third counters occurs at the same time, the voltage developed across R-302-3 is slightly lower than that obtained when the feedback is to the third counter alone. The additional coupling compensates for the voltage difference and eliminates the necessity for individual adjustments of "STATION" positions "3", "5", and "7".

c. POSITION "5". *(See figure 4-52.)*—The trace-repetition rates for "STATION" position "5" are 25-5/16 and 33-8/9 traces per second, and represent a deletion of 250 microseconds from the normal interval between successive output pulses from the sixth counter. As a result, this counter fires at intervals of 19,750 microseconds with the "PRR" switch at "L" position, and 14,750 microseconds with the "PRR" switch at "H" position. As with "STATION" position "3", the station feedback is to both the second and third counters; the feedback to the second counter providing the 50-microsecond deletion, and feedback to the third counter resulting in the additional 200-microsecond deletion. No specific adjustments are provided or necessary for "STATION" position "5", since the adjustments for "STATION" position "4" adequately supplemented by capacitor C-304-2, provide the correct feedback voltage to the third counter.

d. POSITION "7". *(See figure 4-53.)*—On "STATION" position "7" the voltage fed back to the second and third counters results in a deletion of 350 microseconds from the normal firing time of the third counter, and causes the sixth counter to fire at intervals of 19,650 or 14,650 microseconds, resulting in a trace-repetition rate of 25-7/16 and 34-1/9 traces per second for the respective positions, "L" and "H", of the "PRR" switch.



X Relative firing time of sixth counter oscillator.

Y Relative normal firing time of third counter oscillator for given station position.

Z Zero charge level.

1 Charge action resulting from an output pulse from first counter.

2 Charge action resulting from an output pulse from second counter.

L Discharge action by negative portion of sixth counter pulse through "LEFT" position of "LEFT-RIGHT" control.

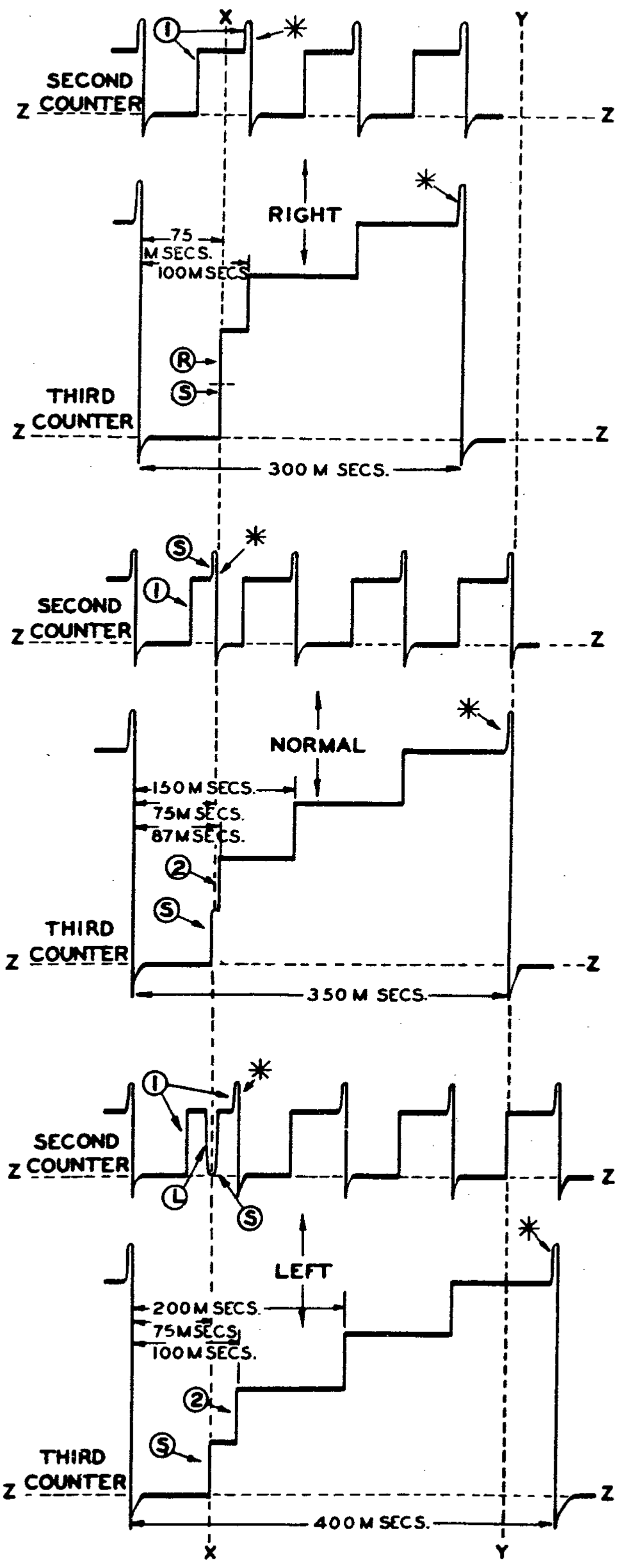
R Charge action by positive portion of sixth counter pulse through "RIGHT" position of "LEFT-RIGHT" control.

S Charge action by positive portion of sixth counter pulse through "STATION" selector feedback capacitors.

★ Relative time at which counter oscillator fires.

NOTE: Patterns indicate actions occurring each time sixth counter fires.

Figure 4-50. Normal and Left-Right Oscilloscope Patterns for "STATION" Selector Position "1"



X Relative firing time of sixth counter oscillator.

Y Relative normal firing time of third counter oscillator for given station position.

Z Zero charge level.

1 Charge action resulting from an output pulse from first counter.

2 Charge action resulting from an output pulse from second counter.

L Discharge action by negative portion of sixth counter pulse through "LEFT" position of "LEFT-RIGHT" control.

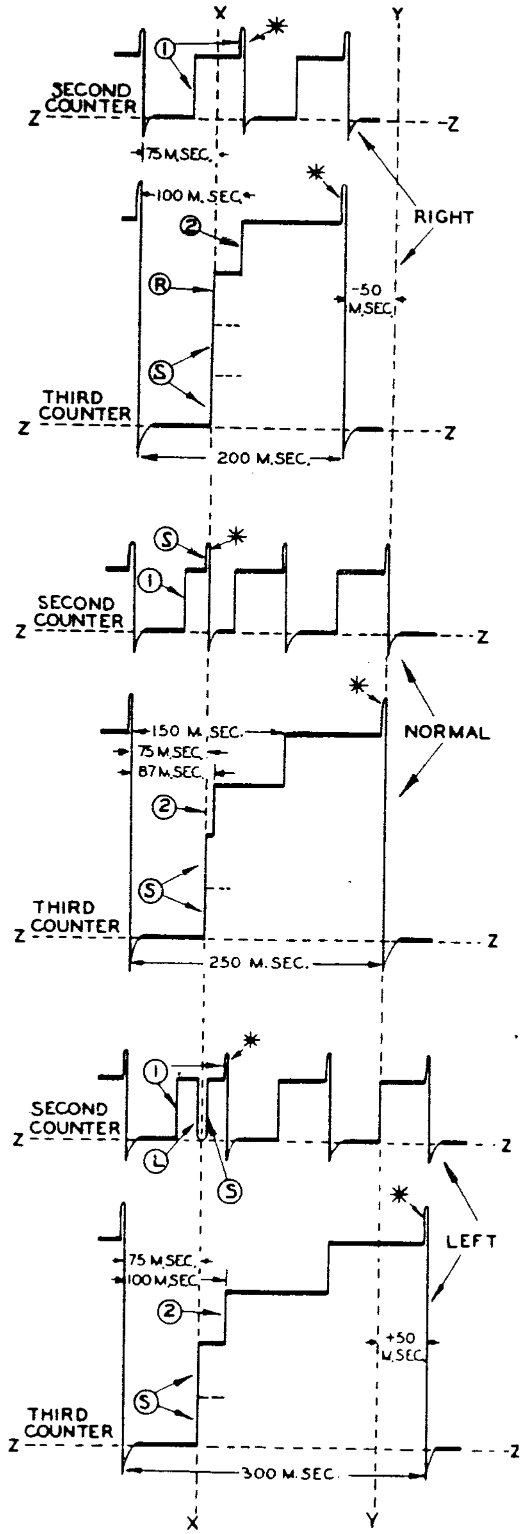
R Charge action by positive portion of sixth counter pulse through "RIGHT" position of "LEFT-RIGHT" control.

S Charge action by positive portion of sixth counter pulse through "STATION" selector feedback capacitors.

★ Relative time at which counter oscillator fires.

NOTE: Patterns indicate actions occurring each time sixth counter fires.

Figure 4-51. Normal and Left-Right Oscilloscope Patterns for "STATION" Selector Position "3"



X Relative firing time of sixth counter oscillator.

Y Relative normal firing time of third counter oscillator for given station position.

Z Zero charge level.

1 Charge action resulting from an output pulse from first counter.

2 Charge action resulting from an output pulse from second counter.

L Discharge action by negative portion of sixth counter pulse through "LEFT" position of "LEFT-RIGHT" control.

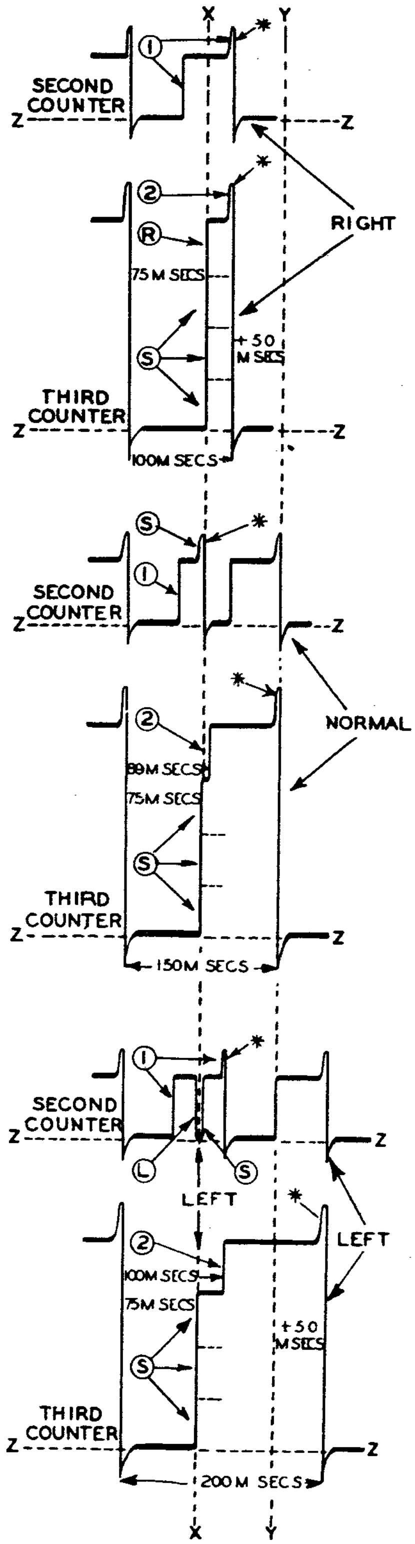
R Charge action by positive portion of sixth counter pulse through "RIGHT" position of "LEFT-RIGHT" control.

S Charge action by positive portion of sixth counter pulse through "STATION" selector feedback capacitors.

★ Relative time at which counter oscillator fires.

NOTE: Patterns indicate actions occurring each time sixth counter fires.

Figure 4-52. Normal and Left-Right Oscilloscope Patterns for "STATION" Selector Position "5"



X Relative firing time of sixth counter oscillator.

Y Relative normal firing time of third counter oscillator for given station position.

Z Zero charge level.

1 Charge action resulting from an output pulse from first counter.

2 Charge action resulting from an output pulse from second counter.

L Discharge action by negative portion of sixth counter pulse through "LEFT" position of "LEFT-RIGHT" control.

R Charge action by positive portion of sixth counter pulse through "RIGHT" position of "LEFT-RIGHT" control.

S Charge action by positive portion of sixth counter pulse through "STATION" selector feedback capacitors.

★ Relative time at which counter oscillator fires.

NOTE: Patterns indicate actions occurring each time sixth counter fires.

Figure 4-53. Normal and Left-Right Oscilloscope Patterns for "STATION" Selector Position "7"

"STATION" POSITION	0	1	2	3	4	5	6	7
STATION FEEDBACK TO	None	2nd. ctr.	3rd. ctr.	2nd. & 3rd. ctr.	3rd. ctr.	2nd. & 3rd. ctr.	3rd. ctr.	2nd. & 3rd. ctr.
Deletion from sixth counter output interval	0	50 M.sec.	100 M.sec.	150 M.sec.	200 M.sec.	250 M.sec.	300 M.sec.	350 M.sec.
Resultant interval (in microseconds) between outputs from sixth counter	15,000; PRR at "H" 20,000; PRR at "L"	14,950; PRR at "H" 19,950; PRR at "L"	14,900; PRR at "H" 19,900; PRR at "L"	14,850; PRR at "H" 19,850; PRR at "L"	14,800; PRR at "H" 19,800; PRR at "L"	14,750; PRR at "H" 19,750; PRR at "L"	14,700; PRR at "H" 19,700; PRR at "L"	14,650; PRR at "H" 19,650; PRR at "L"
* Trace repetition rates ("A" or "B" traces per second; square-wave generator frequencies)	$33\frac{1}{3}$; PRR at "H" 25 ; PRR at "L"	$33\frac{4}{9}$; PRR at "H" $25\frac{1}{16}$; PRR at "L"	$33\frac{5}{9}$; PRR at "H" $25\frac{1}{8}$; PRR at "L"	$33\frac{2}{3}$; PRR at "H" $25\frac{3}{16}$; PRR at "L"	$33\frac{7}{9}$; PRR at "H" $25\frac{1}{4}$; PRR at "L"	$33\frac{8}{9}$; PRR at "H" $25\frac{5}{16}$; PRR at "L"	34 ; PRR at "H" $25\frac{3}{8}$; PRR at "L"	$34\frac{1}{9}$; PRR at "H" $25\frac{7}{16}$; PRR at "L"
# "Right" feedback to Momentary traces per second	2nd. ctr. $33\frac{4}{9}$ and $25\frac{1}{16}$	3rd. ctr. $33\frac{5}{9}$ and $25\frac{1}{8}$	2nd. ctr. $33\frac{2}{3}$ and $25\frac{3}{16}$	3rd. ctr. $33\frac{7}{9}$ and $25\frac{1}{4}$	2nd. ctr. $33\frac{8}{9}$ and $25\frac{5}{16}$	3rd. ctr. 34 and $25\frac{3}{8}$	2nd. ctr. $34\frac{1}{9}$ and $25\frac{7}{16}$	3rd. ctr. $34\frac{2}{9}$ and $25\frac{1}{2}$
† "Left" feedback to Momentary traces per second	2nd. ctr. $33\frac{2}{9}$ and $24\frac{15}{16}$	2nd. ctr. $33\frac{1}{3}$ and 25	2nd. ctr. $33\frac{4}{9}$ and $25\frac{1}{16}$	2nd. ctr. $33\frac{5}{9}$ and $25\frac{1}{8}$	2nd. ctr. $33\frac{2}{3}$ and $25\frac{3}{16}$	2nd. ctr. $33\frac{7}{9}$ and $25\frac{1}{4}$	2nd. ctr. $33\frac{8}{9}$ and $25\frac{5}{16}$	2nd. ctr. 34 and $25\frac{3}{8}$
STATION SWITCH S304								
A1 Selects counter circuits and controls interaction between "right" feedback and normal "station" action	"Right" feedback to 2nd. ctr thru capacitor C330	Breaks "station" feedback to 2nd. ctr.; Connects "right" feedback to 3rd. ctr. thru capacitor C331	Same as 0	Same as 1	Same as 0	Same as 1	Same as 0	Same as 1
A2 Controls "station" feedback to third counter	Grounded; no "station" feed back	Open; "station" feedback is to 2nd. ctr. alone	"Station" feedback to 3rd. ctr. thru capacitors C332-3 & C334	Same as 2 supplemented by feedback thru B2 and capacitor C304-2	"Station" feedback to 3rd. ctr thru capacitors C332-2 & C333-2	Same as 4 supplemented by feedback thru B2 and capacitor C304-2	"Station" feedback to 3rd. ctr. thru capacitors C332-1 & C321-2	Same as 6 supplemented by feedback thru B2 and capacitor C304-2
B1 Controls "station" feedback to second counter	Grounded; no "station" feedback to 2nd. ctr.	"Station" feedback to 2nd. ctr. thru capacitor C333-1	Same as 0	Same as 1; 50-M. sec. feedback to 2nd. ctr. supplements 100-M. sec. feedback to 3rd. ctr.	Same as 0	Same as 1; 50-M. sec. feedback to 2nd. ctr. supplements 200-M. sec. feedback to 3rd. ctr.	Same as 0	Same as 1; 50-M. sec. feedback to 2nd. ctr. supplements 300-M. sec. feedback to 3rd. ctr.
B2 Controls supplementary feedback to third counter for positions 3, 5, and 7	Grounded; no "station" feedback	Open; no supplementary "station" feedback	Same as 2	Supplementary "station" feedback to 3rd. ctr. thru capacitor C304-2	Same as 2	Same as 3	Same as 2	Same as 3
C Controls grid voltage input section "B" coarse delay to synchronize delay action with changes in trace repetition rates	Grounded; grid voltage normal; delay normal	Delay grid voltage raised by adding R357-7 to circuit; delay reduced 50 M. sec.	Delay grid voltage raised by adding R357-6; delay reduced 100 M.sec.	Delay grid voltage raised by adding R357-5; delay reduced 150 M.sec.	Delay grid voltage raised by adding R357-4; delay reduced 200 M.sec.	Delay grid voltage raised by adding R357-3; delay reduced 250 M.sec.	Delay grid voltage raised by adding R357-2; delay reduced 300 M.sec.	Delay grid voltage raised by adding R357-1; delay reduced 350 M.sec.

Figure 4-54. Station Selector Switch S-304—Functional Chart

"SWEEP SPEED" POSITION	1	2	3	4	5	6	7	8
SWEEP DURATION	15,000 or 20,000 M.sec.	750 M.sec.	250 M.sec.	250 M.sec.	250 M.sec.	750 M.sec.	15,000 or 20,000 M.sec.	2,500 M.sec.
TRACE SEPARATION	Maximum	Variable	Variable	None	Variable	Variable	Variable	None
SCREEN DISPLAY	Two traces, ped. & rec. sig.	Two ped. tops & rec. sig.	Two ped. tops & rec. sig.	One ped. top & rec. sig.	Two ped. tops & markers	Two ped. tops & markers	Two traces with markers	3rd. ctr. step pattern
WAFER SECTION								
A1 Permits or prevents negative feedback to second counter for "left" pulse movement	Permits neg. feed-back to 2nd. ctr.	Prevents neg. feed-back to 2nd. ctr.	Same as 2	Same as 2	Same as 2	Same as 2	Same as 2	Permits neg. feed-back for L-R check
A2 Permits or prevents additional positive feedback for "right" pulse movement	Permits breaking of "station" feedback to 2nd. ctr. for "right" feedback to 3rd. ctr.	Prevents any effect on 2nd. ctr. by L-R control	Same as 2	Same as 2	Operative but ineffectual	Same as 5	Same as 5	Permits "right" feedback for check
A3 Continuity path for "right" feedback	"Right" feedback to 2nd. or 3rd. ctr.	Open; no "right" feedback	Same as 2	Same as 2	Same as 2	Same as 2	Same as 2	Permits "right" feedback for check
B Controls signals to grid of video amplifier	Video sig. from rec.	Same as 1	Same as 1	Same as 1	Grounded; no sig.	Same as 5	2,500-M.sec. pulses	Charge steps of 3rd. ctr.
C Controls bias on pedestal generator output grid, and pedestal duration	Ped. duration 750 M.sec.	Same as 1	Ped. duration 250 M.sec.	Same as 3	Same as 3	Same as 3	Same as 1	Ped. gen. inoperative
D1 Controls voltages to grid of trace separation follower	Maximum separation	Variable; 2 & 3, R336-1	Same as 2	No separation	Variable; 5, R336-2	Variable; 6 & 7, R336-3	Same as 6	None; step pattern
D2 Controls cathode circuit of pedestal generator	Cathode circuit closed; peds.	Same as 1	Same as 1	Same as 1	Same as 1	Same as 1	Same as 1	Cathode circuit open; no peds.
E1 Controls cathode circuit of 10-M.sec. marker generator	Circuit open; no 10-M.sec. markers	Same as 1	Same as 1	Same as 1	Circuit closed; markers	Same as 1	Same as 5	Open; no 10-M.sec. markers
E2 Controls cathode circuit of 50 & 500-M.sec. marker-mixer	Circuit open: no markers	Same as 1	Same as 1	Same as 1	Circuit closed; markers	Same as 5	Same as 5	Same as 1
E3 Selects slow sweep sync pulses for sweep generator	Sync pulses from output of 6th. ctr.	Open; no pulses	Same as 2	Same as 2	Same as 2	Same as 2	Same as 1	Sync pulses from output of 4th. ctr.
E1 Selects triggering pulses for sweep generator	Slow sweep; pulses from sweep sync at 15,000 or 20,000-M. sec. intervals	Medium fast sweep; 750-M.sec. pulses from ped. gen.	Fast sweep; 250-M. sec. pulses from ped. gen.	Same as 3	Same as 3	Same as 2	Same as 1	Medium slow sweep; pulses from sweep sync at 2500-M.sec. intervals
F2 Controls signals to blanking grid of cathode-ray tube	Triggering pulses for sweep gen. fed to blanking grid	Same as 1	Same as 1	Same as 1	Same as 1	Same as 1	Same as 1	No blanking voltages to c-r tube
G Selects sweep amplitude controls	Slow sweep; complete trace in 15,000 or 20,000 M.sec.	Medium fast sweep; complete trace in 750 M.sec.	Fast sweep; complete trace in 250 M.sec.	Same as 3	Same as 3	Same as 2	Same as 1	Medium slow sweep; complete trace in 2500 M.sec.

Figure 4-55. Sweep-Speed Control Switch S-303—Functional Chart

Again, as with "STATION" positions "3" and "5", 50 of the total 350 microseconds deleted from the normal firing time of the third counter are the result of feedback to the second counter. The remaining 300-microsecond deletion is the result of feedback directly to the third counter. Capacitors C-321-2 and C-332-1 ·(panel adjustment "6"), supplemented by capacitor C-304-2, provide control of the feedback change to a value equivalent to that of three pulses from the second counter. The third counter, as a result, fires after an interval of 150 microseconds, instead of the normal 500 microseconds.

2. LEFT ACTION.—To cause a movement of the received pulses to the left for "STATION" positions "1", "3", "5" and "7", the left functions of the "LEFT-RIGHT" switch circuit are somewhat the same as those previously explained for "STATION" position "0". However, the left action of the left-right circuit has an interesting effect on the normal station selector action. See oscilloscope patterns, figures 4-51, 4-52, and 4-53. The normal pattern for these "STATION" positions shows the station feedback effect on the firing time of the second-counter oscillator. The positive station feedback to capacitor C-314 is developed from the positive excursion or the trailing edge of the output pulse from the sixth counter, and occurs, as already mentioned, after capacitor C-314 has received a previous charge from the first counter. For left movement of the pulses for these "STATION" positions, the negative pulse developed by the lefting diode V-302-2B from the leading edge of the output pulse from the sixth counter, is used to counteract the normal station selector feedback effect on the second counter. This action causes a discharge of capacitor C-314 a few microseconds ahead of the normal station selector feedback pulse, thus making necessary an additional charge by a first counter pulse before the second-counter oscillator again fires. The final result is an addition of 50 microseconds to the normal interval between successive outputs from the sixth counter for the particular "STATION" position, and a movement of the received pulses to the left.

3. RIGHT ACTION.—To cause a movement of the received pulses to the right for "STATION" positions "1", "3", "5", and "7", section S-304-A1 of the station selector functions with position "R" of section S-301-A3 of the left-right control to disconnect the normal feedback to the second counter and connect it, instead, to the third counter. This action results in an additional deletion of 50 microseconds from the normal interval between successive outputs from the sixth counter, and represents the difference between the 50-microsecond deletion by the normal station-selector action to the second counter, and the 100-microsecond deletion by the right feedback action to the third counter.

(4) SQUARE-WAVE GENERATOR.—The duo-triode tube (V-307-1), with its associated circuit components (see fig. 4-56), constitutes a triggered oscillator whose output is essentially a square wave. This oscillator, commonly known as the Eccles-Jordon, is a modified multivibrator especially designed to require an external triggering pulse to cause a reversal of voltage levels at alter-

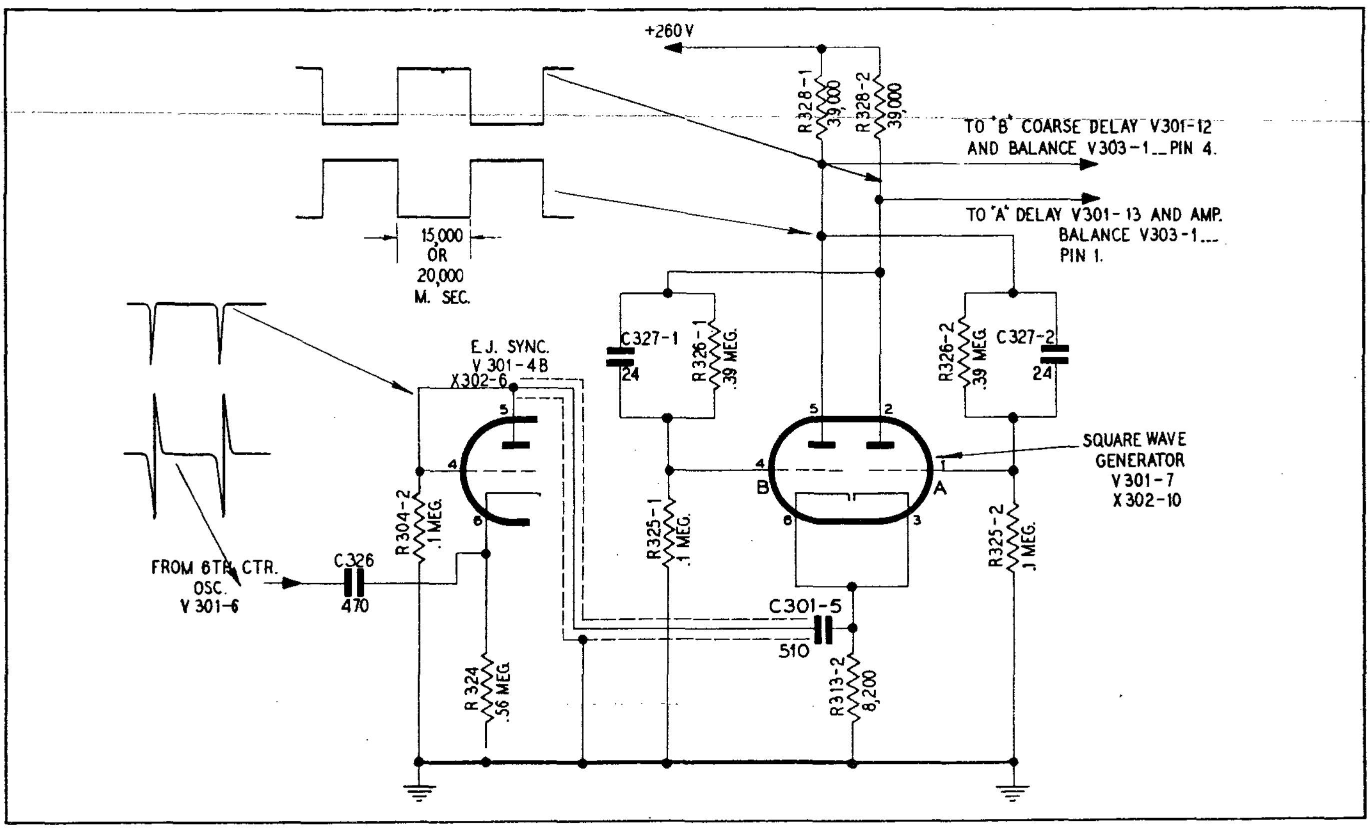


Figure 4-56. Square-Wave Generator Circuit

nate tube sections. The triggering pulse is a negative voltage developed across resistor R-304-2 by the diode action of V-301-4B (a triode connected as a diode), and is the negative portion of the output from the sixth counter. The output voltage pulses of the sixth counter, fed through capacitor C-326, show both negative and positive excursions. The positive portion, when fed to the cathode of tube V-301-4, is ineffective; the negative portion drives the cathode negative with respect to the plate, causes the tube to conduct and develops the triggering voltage for the square-wave generator tube (V-301-7).

To insure that the square-wave generator does not oscillate at some frequency other than that determined by the triggering pulse, direct coupling between the plate of one section of V-301-7 and the grid of the other section is provided by a voltage-divider system. The voltage divider of the A-section of the tube consists of resistors R-328-2, R-326-1 and R-325-1. The circuit connections are such that approximately 20 percent of the voltage developed at the plate of the A-section appears at the grid of the B-section. A voltage-divider system, consisting of resistors R-328-1, R-326-2, and R-325-2, provides a similar voltage relation between the plate of the B-section and the grid of the A-section of tube V-301-7. Capacitors C-327-1 and C-327-2, connected across the coupling resistors R-326-1 and R-326-2 respectively, provide sufficient capacitor coupling between the plate of one section and the grid of the other section to insure an abrupt change in the voltage levels at the alternate elements of the two tube sections, when the generator is triggered by the external pulse. Otherwise, the inter-electrode capacitances of each tube section would cause a slight delay in the voltage changes, resulting in a slanting effect on the vertical portion of the generated square wave.

To simplify the explanation of how the circuit functions, assume the power shut off and V-301-7 idle. When heater and plate voltages are applied, one triode section (let it be section A) will begin to draw current ahead of the other section. This may be the result of slight differences in the characteristics of the tubes or variations in the values of other circuit components. The current flow through R-328-2 causes a voltage change at the plate of the A-section in a negative direction. A portion of this changing voltage instantly appears at the grid of the B-section of the tube, coupled through capacitor C-327-1, this action being slightly ahead of the voltage change resulting from the direct coupling through resistor R-326-1. The resultant negative excursion of the voltage at the grid of the B-section causes a decrease in the current flowing through resistor R-328-1 and a positive excursion of the voltage at the plate. This rising plate voltage, coupled to the grid of the A-section through capacitor C-327-2 and resistor R-326-2, causes a further increase in the current through the A-section until maximum current is reached. The grid of the B-section of tube V-301-7, though still at a slightly positive value with respect to ground, is sufficiently negative with respect to its cathode to cause current cutoff. Because of the direct coupling between the plate of the A-section and the grid of the B-section, this voltage condition remains until a triggering pulse is fed to the commonly connected cathodes.

Since it is already drawing maximum current, the triggering pulse has but slight effect on the A-section of V-301-7. The B-section, however, is excited into condition, starting a train of actions similar to those explained previously for the A-section, which now results in maximum current for the B-section and cutoff for the A-section. The condition of maximum plate current for one section and minimum plate current for the other section of V-301-7 exists for the entire interval between successive pulses from the sixth counter.

The output of the square-wave generator provides the basic voltages by which the separation of the two traces is accomplished. It also provides the alternate voltage levels for the amplitude-balance circuits. The leading or positive portion of the output from the A-section of V-301-7 is also used to trigger the A-delay circuit; the corresponding portion of output of the B-section is used to trigger the B-delay circuit.

(5) PEDESTAL-DELAY MULTIVIBRATORS—Operation of Indicator ★ID-6B/APN-4 requires that considerable time exist between the start of the A- and B-traces and the appearance of their respective pedestals. This delay, fixed in the case of the A-pedestal and variable for the B-pedestal, is provided by circuits designated as the A-delay, B-coarse delay, and B-fine delay. The outputs of these circuits, mixed by a delay-mixer, provide the triggering pulses for the pedestal generator.

(a) A-PEDESTAL-DELAY MULTIVIBRATOR.—The A-delay circuit (see fig. 5-57) includes both sections of duo-triode V-301-13, section A of duo-triode V-301-8 and their associated circuit components. This circuit, whose output is a 2500-microsecond, rectangular voltage pulse, provides the fixed time delay between the start of the A-trace and the appearance of the A-pedestal. The initiating or triggering pulse for the delay action is differentiated from the positive leading edge of the output from section A- of the square-wave generator, and is a part of the voltage which also initiates the trace separation voltage by which the screen pattern is shifted upward at the start of the A-trace. The negative pulse which terminates the delay action is shaped by the A-delay sync tube (V-301-8A) from the output of the fourth-counter oscillator, whose pulses, showing both positive and negative characteristics, are spaced at 2500-microsecond intervals.

The cathodes of delay multivibrator tube V-301-13 are connected together to a common cathode resistor, R-346-3. The grid of the output section, connected to the same positive voltage source as the plates of both sections of the tube, normally causes a high current flow for this section, resulting in a high voltage drop across the common cathode resistor. The grid of the input section, returned through resistor R-360-1 to a voltage-divider system consisting of resistors R-358 and R-359, operates at a grid voltage of approximately 35 volts positive with respect to chassis, but sufficiently negative with respect to cathode to prevent current conduction by the input section. As a result of these circuit connections, the triggering voltage from the square-wave generator finds a condition of no-current high-voltage at the plate of the input section of V-301-13, and high-current low-voltage at the plate of the output section. The triggering voltages from the square-wave generator, differentiated by actions of the capacitor C-307-4 and resistors R-355-2 and R-360-1, show both positive and negative excursions. The negative excursions of the differentiated pulses have no effect on the input section of the tube, since it is already operating at current cutoff; the positive pulses, however, are of sufficient amplitude to excite the input section into conduction. The resultant flow of plate current causes an abrupt voltage drop across the plate load resistor R-311-6. The negative voltage, thus developed at the input plate of V-301-13, is coupled to the grid of the output section through capacitor C-342-1, and is of sufficient amplitude to drive the output section to current cutoff, raising its plate voltage to maximum level.

The interval between the time at which the output section of V-301-13 is driven to plate current cutoff, and the time at which this section is returned to its normal state of conduction, constitutes the delay period. Without a delay terminating pulse the delay period would be considerably more than desired, and would be determined largely by the time required for capacitor C-342-1 to discharge to a level providing a grid-to-cathode voltage relationship which would again permit conduction.

In the A-delay circuit, the delay action is terminated by the first 2500-microsecond pulse appearing after the start of the A-trace. The terminating pulse is developed from the output of the fourth counter, by the diode action of the A-delay sync tube V-301-8A. This tube, a triode connected as a diode, eliminates the positive portion of the 2500-microsecond pulses from the fourth counter, and passes on to the input section grid of V-301-13, a sharp negative pulse of sufficient amplitude to terminate the delay action. At the time the delay terminating pulse appears at the input grid, the input section of V-301-13 is conducting; the output section, though still at cutoff, is gradually returning to grid-to-cathode voltage condition where conduction can again take place. The terminating pulse causes an abrupt rise in the input plate voltage and, at the same time, a drop in the voltage developed across the cathode resistor R-346-3. Both voltages aid each other in exciting the output section into conduction, causing an abrupt return of both sections to their original voltage levels. The functions of the A-delay circuit are very stable and require no special adjustments of circuit values.

(b) B-DELAY MULTIVIBRATORS.—The B-coarse and B-fine delay circuits are shown in figures 4-58 and 4-59. The purpose of these two circuits is to provide a variable time delay between the start of the B-trace and the appearance of the B-pedestal. The B-coarse delay provides a variable time delay in steps of 500 microseconds as the "COARSE" control is rotated. The B-fine delay provides a continuously variable time delay from 700 to 1200 microseconds as the "FINE" control is rotated. These combined delay actions enable the operator

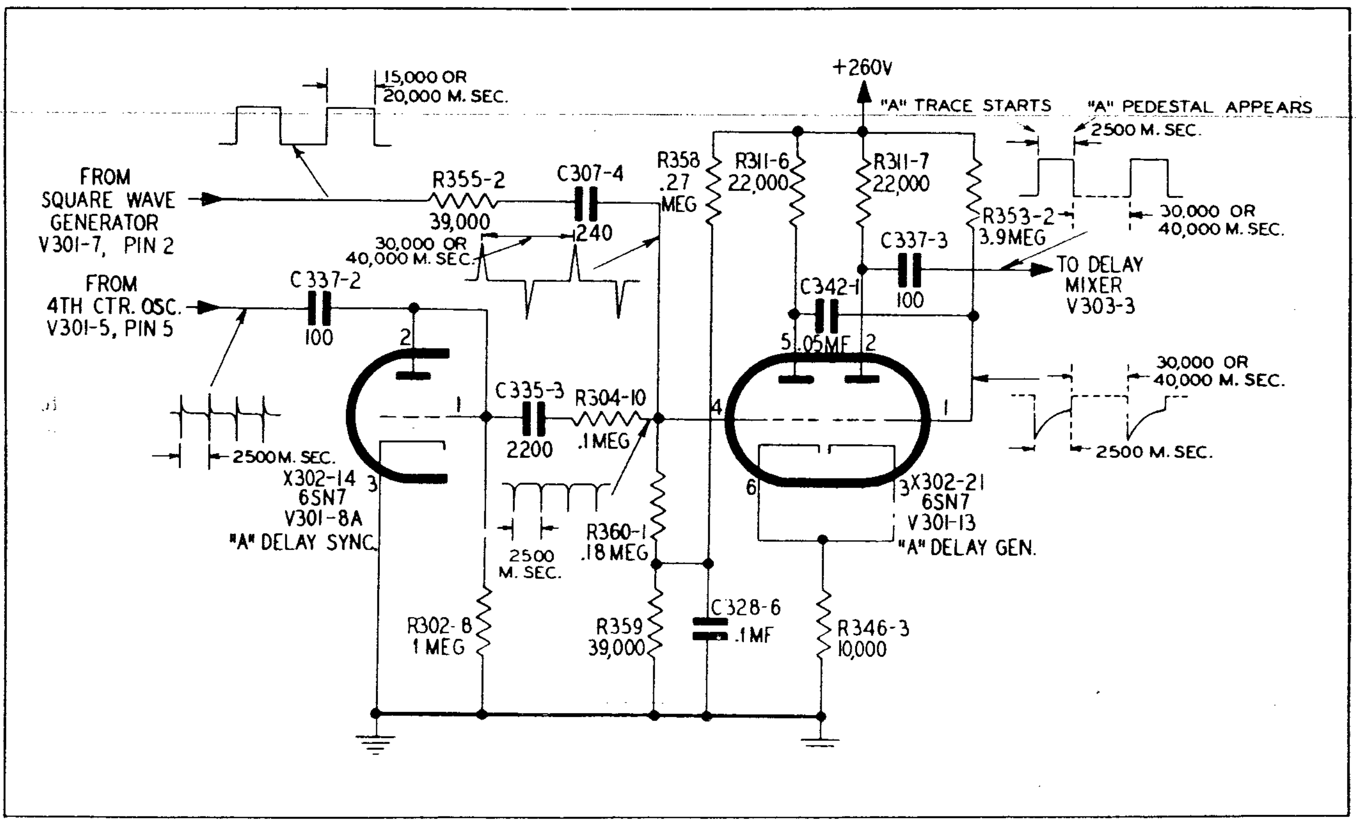


Figure 4-57. A-Delay Circuit

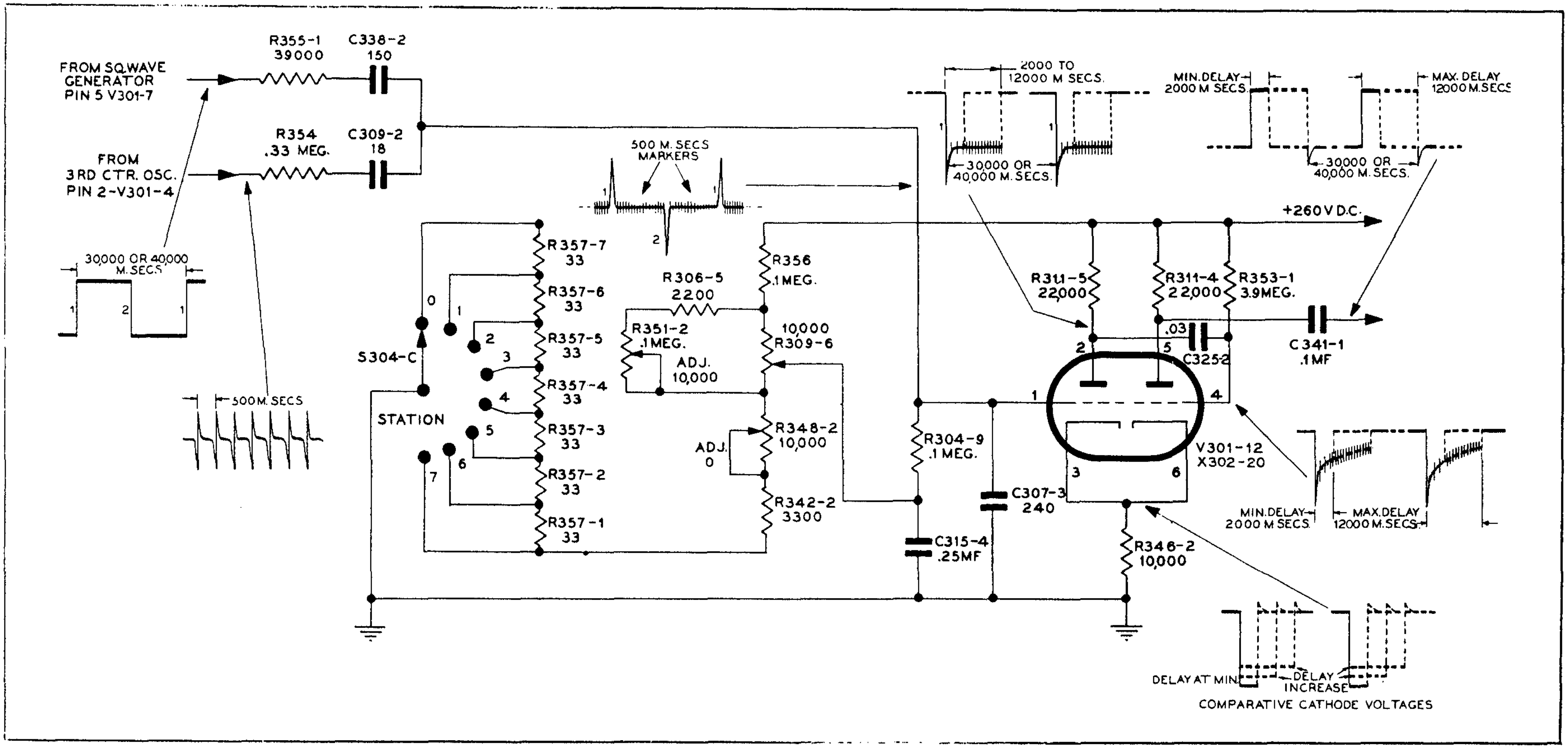


Figure 4-58. B-Coarse Delay Circuit

to set the B-pedestal at the desired point on the B-trace.

1. B-COARSE-DELAY MULTIVIBRATOR.—The B-coarse delay circuit (see fig. 4-58), utilizes a duo-triode tube V-301-12, as a multivibrator, whose circuit functions are somewhat similar to those of the A-delay multivibrator. The two important differences are the source of the triggering pulses which initiate the delay actions, and the delay duration. The triggering pulse for the B-coarse delay is obtained from the opposite plate of the square-wave generator which initiates the A-delay action; the B-delay action, therefore, starts at the same instant the trace pattern is moved down at the start of the B-trace. The duration of the B-delay (unlike that of the A-delay, which is fixed) is variable over a wide range and is determined by the setting of the variable controls in the input grid circuit.

Prior to appearance of the triggering pulse, which is fed to the grid of the input section through resistor R-355-1 and capacitor C-338-2, the output section of V-301-12 is conducting heavily. The resultant flow of current through the common cathode resistor (R-346-2) maintains at the cathode a voltage sufficiently positive to cause current cutoff for the input section. The heavy current for the output section is the result of returning its control grid through the 3.9-megohm resistor (R-353-1) to the positive 260-volt line. The no-signal grid voltage, therefore, is limited only by the grid current flow which develops a voltage drop across the grid resistor. Current cutoff for the input section is the result of returning its grid through resistor R-304-9 to a variable voltage-divider system, connected between the positive 260-volt line and ground. The voltage selected by the various controls in the divider system, though positive with respect to ground, is (prior to excitation by the triggering pulse) sufficiently negative with respect to the cathode to hold the input section V-301-12 at current cutoff.

Differentiation of the output from the square-wave generator results in sharp pulses showing both positive and negative characteristics. The negative pulses, when fed to the input grid V-301-12, have no effect, since this section of the tube is already operating at cutoff. The positive pulses, however, excite the input section into conduction, causing a sharp drop in the plate voltage. The resultant discharge of capacitor C-325-2, connected between the input plate and output grid, drives this grid sufficiently negative to cause current cutoff for the output section of the tube. A long interval of time would normally be required for capacitor C-325-2 to discharge to a level at which conduction could occur again in the output section. This time interval, in the case of the B-coarse delay, is shortened and made variable over a wide range by the circuit actions of the input section of V-301-12.

While the output section is operating at current cutoff, the input section operating at a reduced bias is conducting, the amount of current drawn being determined by settings of the various controls in its grid circuit. The settings of these controls cause an increase or decrease of the positive voltage appearing at the commonly connected cathodes and determine which of the delay terminating pulses can excite the output section into conduction again. The delay terminating pulses, supplied by the third-counter oscillator, are 500 microseconds apart. These pulses, showing both positive and negative characteristics, are fed to the input grid through resistor R-354 and capacitor C-309-2. They appear in amplified form at the plate of the input section and are fed through capacitor C-325-2 to the output section grid. Meanwhile, the charge on capacitor C-325-2 is slowly leaking off, permitting the output grid to return to a voltage level where conduction can take place in the output section. Sometime before this return to conduction can normally occur, a negative excursion of one of the 500-microsecond terminating pulses, by driving the plate of the input section in a positive direction and the commonly connected cathodes in a negative direction, excites the output grid to a voltage relationship with its cathode which causes tube conduction and an abrupt return of the output section to the original state.

The output from the B-delay multivibrator is a rectangular wave, the duration of which is some multiple of 500 microseconds. The exact duration is determined by the setting of the "COARSE" control, which sets the bias on the input section and, therefore, determines which negative pulse will restore the multivibrator to its initial state. Adjustments "ADJ. O" and "ADJ. 10,000" set the lower and upper limits of the voltage range over which the "COARSE" control can be varied and determine the minimum and the maximum time delay that can be introduced by the delay multivibrator.

As the "STATION" selector switch is changed to bring in a different pair of stations, the frequency of the square-wave generator is also changed. The triggering pulse from the square-wave generator to the B-coarse delay multivibrator will not bear the same relationship to the normal 500-microsecond pulses, with the result that the B-pedestal would appear to shift its position with respect to the markers on the trace, as different stations are brought in. To eliminate this shifting effect, the positive d-c potential applied to the grid of the input section of the multivibrator is varied just enough by the "STATION" selector switch to keep the circuit properly synchronized.

2. B-FINE DELAY.

a. DELAY INVERTER.—The output from the B-coarse delay multivibrator is capacitively coupled through C-341-1 to the grid of V-303-3A, which comprises the delay inverter. The function of this circuit is to invert and amplify the output of the B-coarse delay before it is applied to the B-fine delay multivibrator, shown in figure 4-59, whose delay action it initiates. When the positive pulse from the B-coarse delay ends, the voltage on the output plate drops or goes in a negative direction. This change applied to the grid of V-303-3A decreases the conduction of this stage, causing the plate voltage to rise abruptly. This positive-going output is coupled through capacitor C-340 to the input grid of the B-fine delay multivibrator.

b. B-FINE-DELAY MULTIVIBRATOR.—The B-fine delay multivibrator (V-301-11) is similar to the previously described multivibrators, with the exception that the delay action is continuously variable.

Since the initiating pulse for this multivibrator delay circuit comes from the B-coarse delay multivibrator, it is not necessary to adjust its grid bias with changes of the "STATION" selector switch. Its overall delay is comparatively short (700 to 1200 microseconds), the duration of which is controlled by the B-fine control (R-309-5). Synchronized termination of the delay is not used, since a continuously variable delay action is desired. The circuit functions of the fine delay are very similar to those of the B-coarse delay, the main difference being the absence of a delay terminating pulse. The delay duration is the effect of a faster discharge rate for coupling capacitor C-336-2 through R-344-2. Current flow through this section of V-301-11 is largely controlled by the setting of "FINE" control R-309-5, connected as a part of a voltage divider between the positive 260-volt line and ground. The adjustment range of the "FINE" control is affected by the settings of the two potentiometers R-348-1 ("ADJ. 200") and R-351-1 ("ADJ. 700").

(6) PEDESTAL DELAY-MIXER AND GENERATOR.

(a) DELAY MIXER.—The outputs of both the A- and B-fine delay circuits are positive rectangular waves whose trailing edges are abrupt negative excursions. To properly shape these rectangular waves for triggering the pedestal generator, they are first fed through a differentiating system, consisting of capacitors C-337-3 and C-337-4 and resistors R-339-2 and R-350-3, to the grid of the delay mixer-inverter tube V-303-3B. (See fig. 4-60.) The positive pulses resulting from the differentiation have little effect on the tube, which is already conducting heavily. The negative pulses, however, cause the sharp voltage rise at the plate which, when fed to the input grid of the pedestal generator, initiates the action which develops the pedestals. The fact that the outputs from the A-delay and B-fine delay never occur at the same time permits the feeding of both of their outputs to the same tube without danger of undesirable interaction.

(b) PEDESTAL GENERATOR.—The pedestal generator circuit (see fig. 4-60) employs the due-triode V-301-15 in a multivibrator circuit, somewhat similar to those used in the delay circuits. The output of the pedestal generator is a rectangular voltage pulse having two durations determined largely by the selection of two available resistance values in the output grid circuit. To compensate for variations in circuit components, especially tubes, an additional control of the output pulse duration is provided by using a variable resistor (R-351-3) designated as "PED. DURATION", as an input section plate-voltage control.

The triggering voltages for the pedestal generator are the positive pulses developed at the plate of the delay mixer tube (V-303-3B), at the termination of the A-delay and B-fine delay action; these positive triggering pulses are fed to the input section grid through capacitor C-305-4. Prior to the triggering action, the output section of the pedestal generator is drawing heavy current, large-

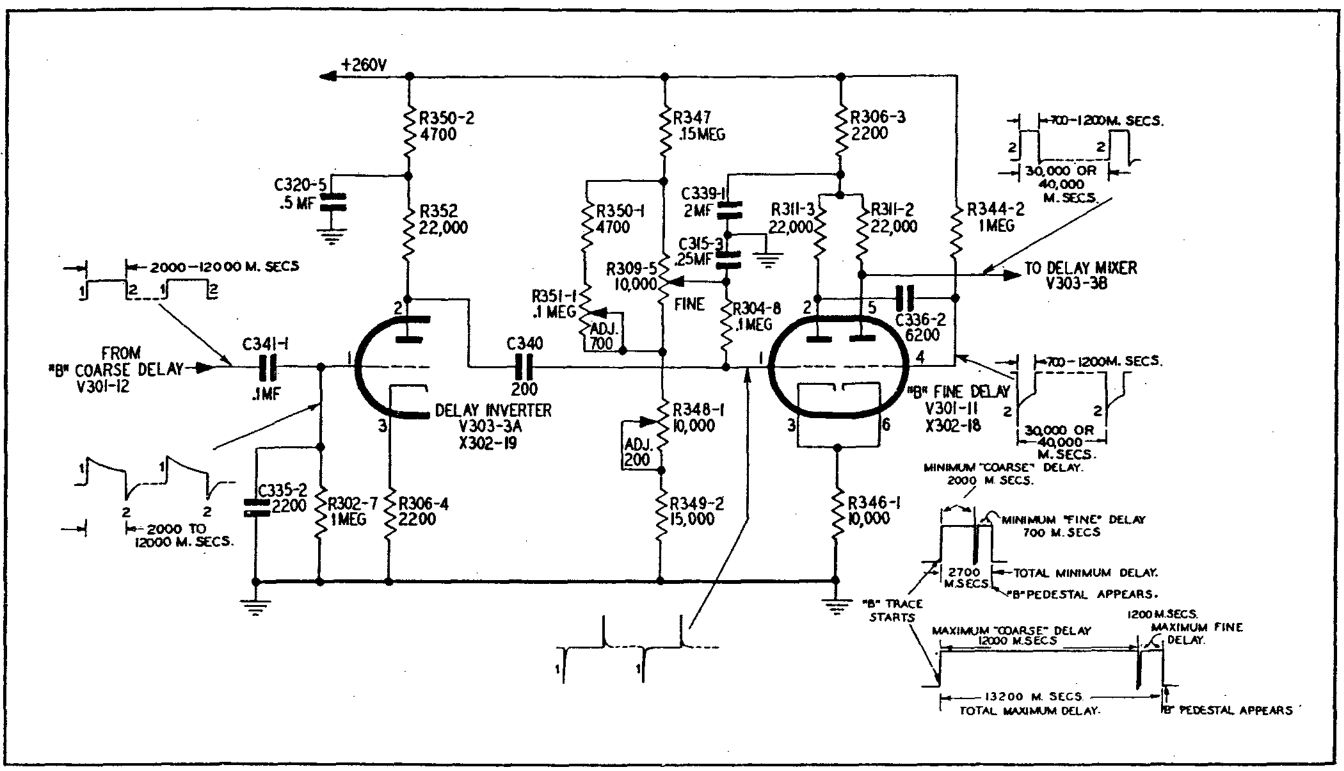


Figure 4-59. B-Fine Delay Circuit

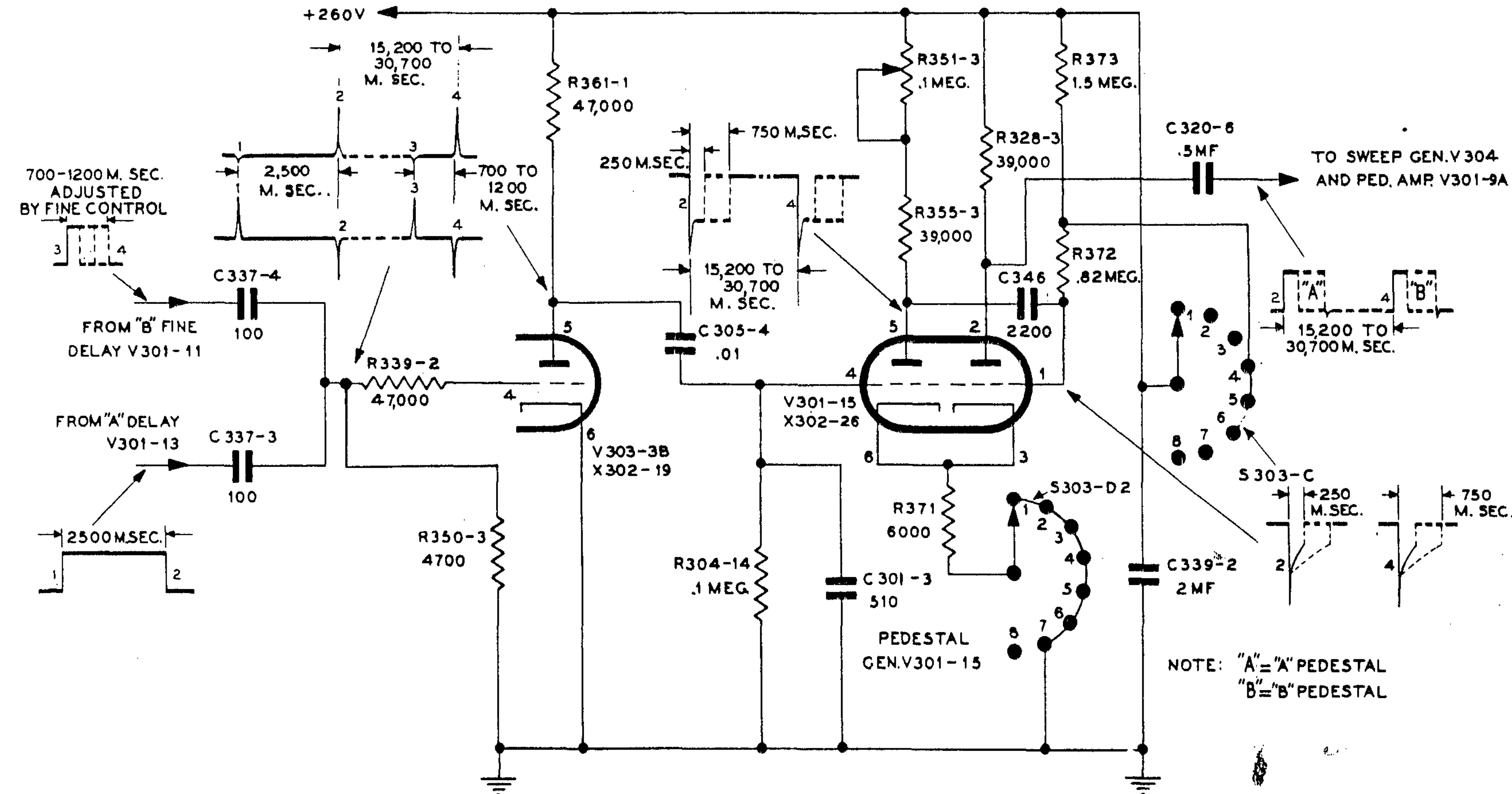


Figure 4-60. Delay Mixer and Pedestal-Generator Circuit

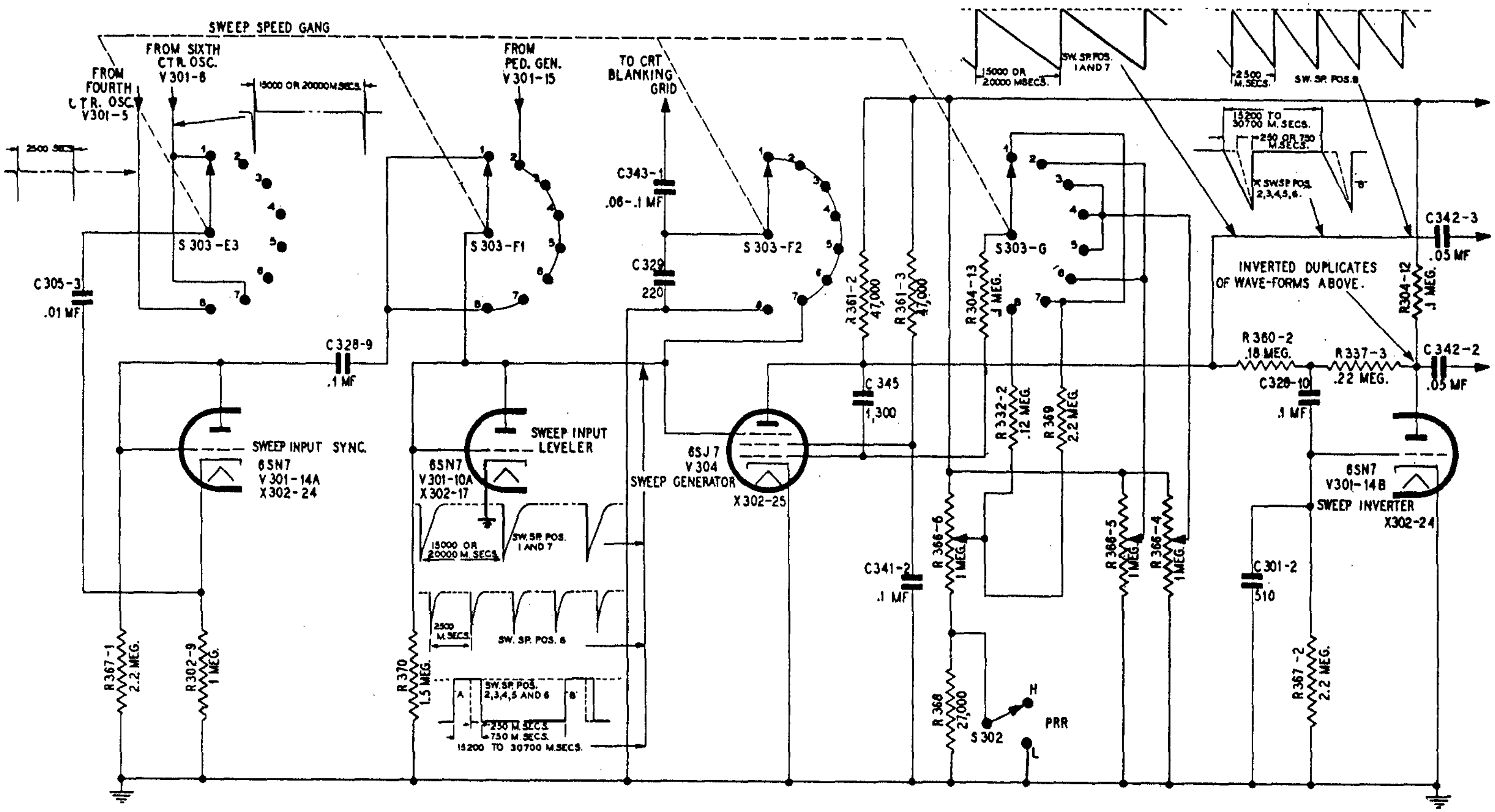


Figure 4-61. Horizontal-Sweep Circuit

ly because its grid is returned through the selected grid resistors to the positive voltage source. The input section, however, is at current cut off, because of the high voltage developed across the common cathode resistor (R-371), by current flowing in the outward section. The positive triggering pulse from the delay mixer is of sufficient amplitude to excite the input section into conduction; the resultant current flow causes an abrupt drop in the voltage at the input plate, which is fed through capacitor C-346 to the grid of the output section. The voltage fed to the output grid drives the output section to current cut-off, where it remains until the discharge of capacitor C-346 through the selected grid resistor or resistors returns the grid to a voltage level where conduction again takes place.

The pedestal duration is largely controlled by two different values of resistance in the output grid circuit. For "SWEEP SPEED" positions "1", "2", "6" and "7", the pedestal duration is approximately 750 microseconds and is largely determined by the discharge rate of capacitor C-346 through the series-connected grid resistors R-372 and R-373. For "SWEEP SPEED" positions "3", "4" and "5", the pedestal duration is 250 microseconds, and is the result of faster discharge of R-346 through grid resistor R-372 alone. Further adjustment of the pedestal duration is obtained through use of the variable plate load resistor (R-351-3), designated as "PED. DURATION." Adjustment of this control provides control of the voltage levels at the plate of the pedestal generator, which effects the amplitude of the negative pulses fed to the output grid, and changes the voltage drop across the cathode resistor during the time the input section is conducting. These actions all add together to increase the pedestal duration as the effective resistance of R-351-3 is increased, and to decrease the pedestal duration as the effective resistance of the control is decreased.

The output of the pedestal generator for "SWEEP SPEED" positions "1" and "7" provides the voltage pulses by which the pedestals are made to appear on the traces. For "SWEEP SPEED" positions "2", "3", "4", "5" and "6", the pedestal generator output provides both the triggering and terminating voltages for the sweep generator. For these sweep positions the traces may be considered as the tops of the pedestals, spread out across the entire screen.

(7) HORIZONTAL-DEFLECTION CIRCUITS.—Sweep generator tube V-304 and sweep inverter tube V-301-14B (see fig. 4-61) function together in push-pull to provide the linear sawtooth voltage for horizontal deflection of the cathode-ray screen. Associated with these two tubes, as important components of the sweep circuit, are two other tubes V-301-14A and V-301-10A. Tube V-301-14A, designated as the sweep input sync, properly shapes the sweep triggering voltages for slow sweep ("SWEEP SPEED" positions "1" and "7") and medium-fast sweep ("SWEEP SPEED" position "8"). Tube V-301-10A, designated as the input voltage leveler, arrests the positive excursions of all triggering voltages at ground level, thus developing the negative voltage around which the triggering takes place and by which the cathode-ray tube is blanked out between successive sweeps.

(a) SLOW-SWEEP OPERATION.—The triggering voltages for developing the slow sweep ("SWEEP SPEED" positions "1" and "7") are supplied from a part of the output of the sixth counter. These pulses, both positive and negative in form, are of improper shape and duration to properly trigger the sweep generator V-304. To shape these pulses, they are first fed to the cathode of tube V-301-14A. The positive part of the pulse fed to this cathode has no effect on tube conduction; the negative part causes conduction between the plate and grid (which are tied together) and ground, producing a negative voltage pulse across resistor R-367-1, which is applied through capacitor C-328-9 to the suppressor grid of V-304. With the "SWEEP SPEED" control at any position except "8", a 220-micromicrofarad capacitor (C-329) is connected across the 1.5-megohm input grid resistor R-370. The resultant RC combination, together with the interelectrode capacitances of the associated tubes, extends the triggering pulse duration enough to insure that voltage at the plate of sweep generator tube V-304 is returned to the same level at the beginning of each sweep. The resultant delay in the start of the traces is approximately 700 microseconds, which is easily observed in oscilloscope patterns for "SWEEP SPEED" positions "1" and "7". Section S-303-F2 of the sweep speed control connects capacitor C-329 in the circuit for sweep positions

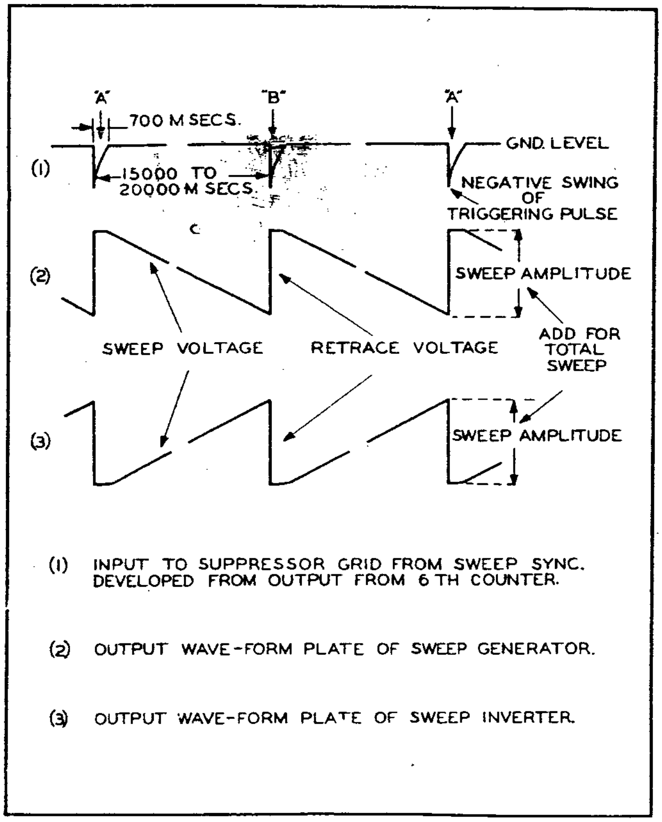


Figure 4-62. Sweep-Generator and Sweep-Inverter Waveforms—"SWEEP SPEED" Positions "1" and "7"

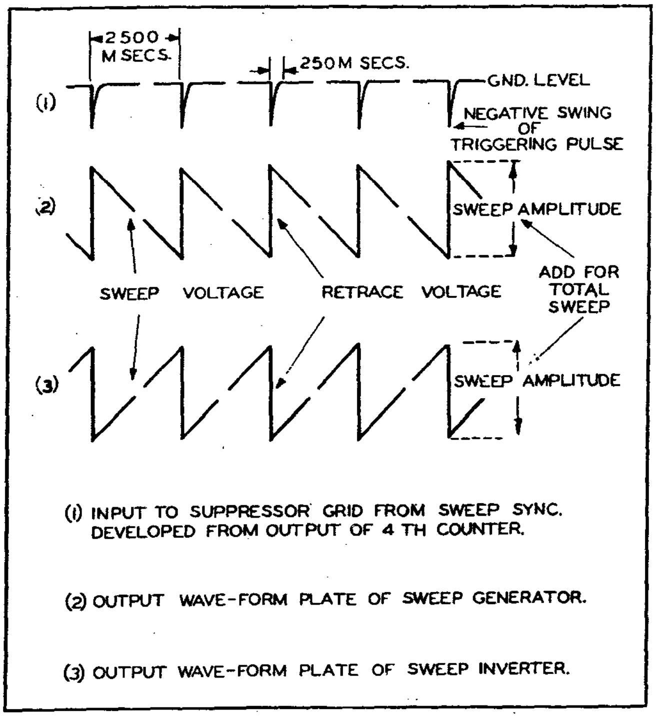


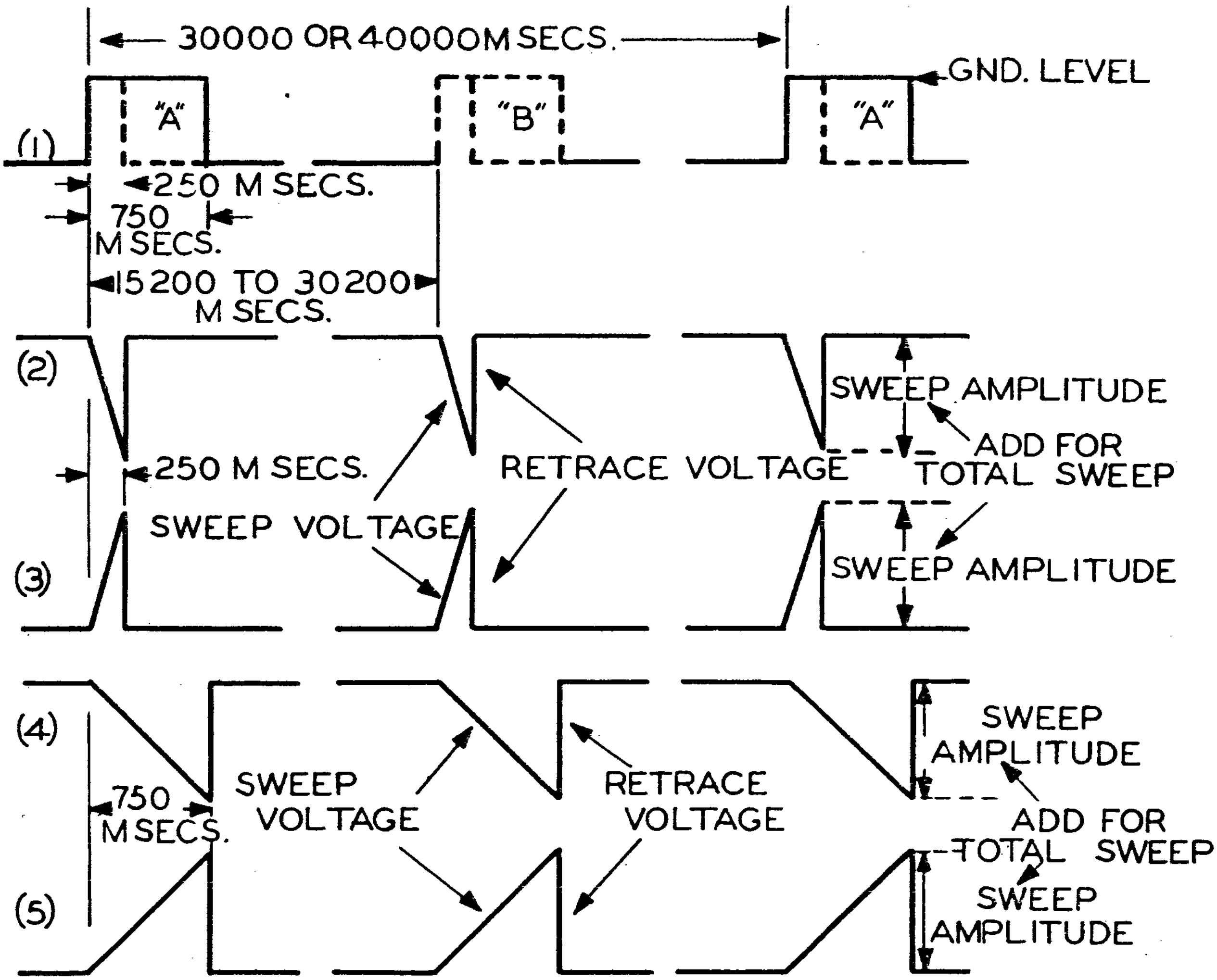
Figure 4-63. Sweep-Generator and Sweep-Inverter Waveforms—"SWEEP SPEED" Position "8"

"1" to "7" and disconnects it for position "8". The removal of the capacitor from the sweep circuit is necessary for "SWEEP SPEED" position "8", because any appreciable delay in the starting of the trace at this position would prevent the appearance of that important part of the oscilloscope pattern at the left side of the screen, used in station-selector alignment.

The negative pulses developed by the sweep input-sync tube V-301-14A ("SWEEP SPEED" positions "1" and "7") appear at intervals of either 15,000 or 20,000 microseconds, and are fed through capacitor C-328-9 and section S-303-F1 of the sweep speed control to the suppressor grid of sweep-generator tube V-304. The negative excursions of these pulses drive the suppressor grid to a high negative value with respect to the cathode, causing a sharp rise in voltage at the plate of the tube. The return of the triggering voltage to ground potential, approximately 700 microseconds later, raises the suppressor grid to ground level, where it remains until another triggering pulse approximately 14,300 or 19,300 microseconds later, causes a repetition of the action. With the suppressor grid held at ground level, the plate current of V-304 starts to increase and drive the plate voltage in the negative direction. This increase in plate current and resultant drop in plate voltage takes place slowly, the rate being governed by the capacitive coupling between the plate and grid 1, the element normally used as the control grid in tube V-304. This grid, connected to the positive voltage source through a system of fixed and variable resistors, controls the rate at which the plate voltage drops. Since it is connected to a positive voltage source, grid current flows, causing a voltage drop across the grid resistor network. Without a signal the voltage at this grid is of a steady value, highly negative with respect to the voltage source, but slightly positive with respect to the cathode.

When the triggering negative voltage is applied to the suppressor grid of V-304, the internal resistance of the tube greatly increases, plate current flow is decreased and the plate voltage quickly rises. The rising plate voltage does not greatly affect the voltage at the control grid (grid 1), even though the plate and grid are coupled by capacitor C-345. The circuit conditions are such that the slightest change of the grid voltage in a positive direction will cause additional grid current. This current flow effectively prevents the appearance of any part of the positive excursion of the plate voltage at the grid, leaving it at its former steady level. Because of this action, the control grid has very little effect on any plate voltage change in a positive direction, except to permit the very abrupt rise of the plate voltage when the suppressor grid is fed the negative triggering pulse. This sets up the condition for the sweep action, as shown at the beginning of the sawtooth waveform, for slow and medium slow sweep-speed operation on "SWEEP SPEED" positions "1", "7" and "8". (See fig. 4-62.)

The positive excursion of the trailing edge of the triggering voltage places the suppressor grid at ground or zero potential. The resultant increase in plate current develops an additional voltage drop across resistor R-361-2 and drives the plate in a negative direction. Except for the coupling between the plate and grid 1 by capacitor C-345, the plate voltage drop would be very abrupt. However any voltage change at the plate in a negative direction causes a discharge action by this capacitor, and a slight change of voltage at the control grid also in a negative direction. The result is a slight decrease in the normal positive voltage of the control grid which, in turn, tends to retard the plate current flow. Since the charge on capacitor C-345 will finally leak off through resistors in the grid circuit, a condition now exists where a continuously changing plate voltage in a negative direction is required to maintain a negative voltage at the control grid. This action results in a plate voltage change controlled by the rate at which the charge on capacitor C-345 can leak off. If the suppressor grid is held at ground level for a long period of time, the plate voltage will continue to drop until it reaches a steady level. However, this drop will not be linear over the entire range of voltage change; therefore, only a portion of it is used for sweep action, to insure linearity. Proper adjustment of resistor R-366-6 controls the rate of change in the plate voltage which, in turn, determines the correct amplitude of the sweep action. The output of "SWEEP SPEED" positions "1" and "7" is a continuous sawtooth wave, providing a substantially linear trace having a duration of approximately 14,300 or 19,300 microseconds. Two different rates by which capacitor C-345 may be discharged are selected by section S-302 of the "PRR" switch. With this switch at "L" position, the discharge rate is such that full sweep amplitude is developed at the



(1) INPUT TO SUPPRESSOR GRID FROM PEDESTAL GENERATOR.

(2) OUTPUT WAVE-FORM PLATE OF SWEEP-GENERATOR SWEEP-SPEED POSITIONS "3", "4", AND "5."

(3) OUTPUT WAVE-FORM PLATE OF SWEEP-INVERTER SWEEP-SPEED POSITIONS "3", "4", AND "5."

(4) OUTPUT WAVE-FORM PLATE OF SWEEP-GENERATOR SWEEP-SPEED POSITIONS "2" AND "6."

(5) OUTPUT WAVE-FORM PLATE OF SWEEP-INVERTER SWEEP-SPEED POSITIONS "2" AND "6."

Figure 4-64. Sweep-Generator and Sweep-Inverter Waveforms—"SWEEP SPEED" Positions "2," "3," "4," "5," and "6" plate of V-304 in approximately 20,000 microseconds. At "H" position of the switch, additional resistance (resistor R-368) is added between the grid and ground. The increased positive voltage accelerates the voltage change at the plate, and provides full sweep amplitude in approximately 15,000 microseconds.

For "SWEEP SPEED" position "8", the sweep-generator tube is triggered by the output of the fourth-counter oscillator V-301-5B. Except for the pulse width, the triggering voltage is similar in form to that which sets up the sweep action for "SWEEP SPEED" positions "1" and "7". The output at the sweep-generator plate is a sawtooth wave, linear and continuous; the input and output waveforms are shown in figure 4-63.

(b) FAST-SWEEP OPERATION.—Voltages for triggering the sweep-generator tube for the fast sweep ("SWEEP SPEED" position "2", "3", "4", "5", and "6") are obtained from pedestal-generator tube V-301-15. These voltages are the positive rectangular waves from which the pedestals for "SWEEP SPEED" positions "1" and "7" are developed. For "SWEEP SPEED" positions "2" and "6" the triggering voltage rises abruptly to a high positive level where it remains for approximately 750 microseconds, then returns abruptly to its original level. For "SWEEP SPEED" positions "3", "4", and "5" the triggering action is similar but lasts for only 250 microseconds. There is a time interval between these triggering pulses, which may be from approximately 5,000 to 30,000 microseconds duration, depending upon the relative positions of the A- and B-pedestals and the setting of "PRR" control.

Before the first triggering voltage is applied, the suppressor grid is at or near ground potential, its only bias being that developed by electrons collecting on the grid surface. With the suppressor grid at this level, the plate current of the sweep-generator tube is comparatively high. The positive rise of the first triggering voltage raises the suppressor grid to ground level but not above, due to the leveling action of diode V-301-10B. After 250 or 750 microseconds, depending upon the position of the "SWEEP SPEED" control, the triggering voltage abruptly drops to its original level. Since the suppressor grid is effectively held at ground potential during the time the triggering voltage is positive, the return of the triggering voltage to its former level drives the suppressor grid to a high negative value with respect to ground. Even though the time between the triggering pulses is 5,000 to 30,000 microseconds, the RC constants of the circuit are such that each recurring pulse will find an increasingly negative voltage at the suppressor grid. This action quickly results in an average negative voltage level, around which the whole triggering action takes place.

The output at the plate of V-304 for fast sweep action, though a linear sawtooth voltage, is not of the same continuous form as that for slow sweep action. (See fig. 4-64.) The plate voltage throughout the interval between triggering pulses is at a high level. The triggering pulse, by raising the suppressor grid voltage to ground level, initiates the sweep action as a slowly increasing plate current and a subsequent slowly decreasing plate voltage. When the negative excursion of triggering pulse returns the suppressor to its negative level, the plate voltage abruptly returns to its original high level where it remains until the suppressor grid is again triggered by another positive pulse from the pedestal generator.

(c) SWEEP PHASE-INVERTER.—The linear portion of the sawtooth voltage developed in the plate circuit of the sweep-generator tube is not of sufficient amplitude to drive the cathode-ray beam fully across the face of the tube. To provide sufficient sweep voltage for this purpose, section B of tube V-301-14 is operated as an inverter which provides, along with the sweep generator, a balanced push-pull type of sawtooth-voltage output for the horizontal-deflection plates.

A portion of the sweep voltage developed at the plate of sweep-generator tube V-304 is fed through resistor R-360-2 and capacitor C-328-10 to the grid of phase-inverter tube V-301-14B. When the voltage of the sweep-generator plate increases, the voltage at the grid of the phase inverter tube increases also, causing an increase in its plate current and a decrease in plate voltage. As the sweep-generator plate voltage falls, the grid voltage on the phase inverter falls also, but the plate voltage rises; consequently, when the sweep-generator plate voltage is changing in one direction, the plate voltage of the phase-inverter amplifier is changing in the other direction. These voltages are equal in amplitude and opposite in polarity, so that the voltage available across the oscilloscope horizontal-deflection plates is twice that which could be taken from the sweep-generator plate alone.

It is essential that the output from the phase-inverter tube, though opposite in polarity, be an exact counterpart of the output from the sweep-generator tube, so far as wave shape and voltage are concerned. To obtain this action, resistors R-337-3 and R-360-2 are used as a combination voltage divider and inverse feedback loop. These resistors, as voltage dividers, permit approximately 10 percent of the voltage from the sweep-generator plate circuit to reach the grid of the phase-inverter tube; as inverse feedback, they also permit a part of the voltage from the plate of the phase-inverter tube to be fed back to its own grid. The feedback voltage, being opposite in polarity to the voltage supplied to the grid from the sweep generator, causes the phase inverter V-301-14B to operate without either loss or gain, and corrects any tendency of this tube to distort or amplify the output of the sweep generator.

(8) MARKER CIRCUITS.—To provide the operator with a means for calculating the difference in the time of arrival between the received pulses, time calibration marks, called markers, are developed in the marker generator circuits, and are made to appear on the traces. (See fig. 4-65.) These markers appear every 10, 50, 500, and 2500 microseconds, much like the fraction marks on a scale. The 10-microsecond marks are developed by the 10-microsecond amplifier V-303-2; the 50- and 500-microsecond marks are shaped by tube V-301-6 and mixed in the 50- to 500-microsecond marker mixer tube V-301-9B.

The 2500-microsecond marks are taken directly from the output of the 2500-microsecond counter (fourth counter). These marks are fed to the lower vertical-deflection plate of the cathode-ray tube V-304 either directly or through the video amplifier tube V-301-10B.

(a) 10-MICROSECOND MARKER GENERATOR.—The 10-microsecond markers are formed in the 10-microsecond marker amplifier tube V-303-2, from the sine-wave voltage output of the 100-kilocycle crystal oscillator. The proper phasing of this voltage is determined by the action of capacitors C-307-1, C-303-2, and resistor R-303. The 100-kilocycle signal is fed through capacitor C-310-2 to the grid of the A-section of tube V-303-2 by which it is amplified, with but slight change in waveform. The high-amplitude 100-kilocycle sine-wave voltage is fed to the second section of the 10-microsecond amplifier through capacitor C-310-3. This tube, by the combined action of C-305-2 and R-334-2 in its cathode circuit, operates at cutoff throughout most of the input cycle. Therefore, the negative swing of the input voltage causes no change in the plate condition of this tube. The peak of the positive swing causes current flow in tube V-303-2B and develops a sharp negative pulse every 10 microseconds across resistor R-340-1, which is also the plate-load resistor of both sections of tube V-301-9. These 10-microsecond pulses, being negative, cause an upward deflection on the traces when fed to the lower vertical-deflection plate of the cathode-ray tube V-305. A part of the negative output from the 10-microsecond marker generator is fed through capacitor C-337-1 to the cathode of video amplifier V-301-10B. Since the final output is taken from the plate of this tube, the coupling effect between cathode and plate results in sharper, more defined 10-microsecond pulses. The 10-microsecond marker generator functions only in "SWEEP SPEED" positions "5" and "7", since its cathode circuit is open in all other positions of the switch. (See fig. 4-65.)

(b) 50 AND 500-MICROSECOND MARKER GENERATOR.—The pulses developed every 50 microseconds in the plate circuit of the first-counter oscillator (V-301-2B) are fed through capacitor C-311-1, while pulses developed every 500 microseconds in the plate of the third-counter oscillator (V-301-4A) are fed through capacitor C-319 to the cathode of the 50 and 500-microsecond mixer tube V-301-6B. The cathode of this tube is held at a high positive potential in relation to ground by a voltage-divider system consisting of R-344-1 and R-343; therefore only the negative component of the incoming pulse affects the plate current of the tube, producing sharp negative pulses at the plate and grid. These negative pulses, fed through capacitor C-336-1 to the grid of marker mixer tube V-301-9A, develop sharp positive pulses at the plate of that tube, which are fed through C-328-4 to the lower vertical-deflection plate of the cathode-ray tube. These markers appear only in "SWEEP SPEED" positions "5", "6", and "7", since the marker-mixer cathode circuit is open in all other positions of the "SWEEP SPEED" switch.

(c) VIDEO AMPLIFIER.—The video amplifier V-301-10B has several functions which are determined by the setting of section S-303-B of the sweep speed control. In positions "1", "2", "3", and "4" it amplifies the signal pulses from the receiver; in position "5" and "6" the grid of this tube is grounded. In position "7" it amplifies pulses from the fourth counter, whose output is spaced at 2500-microsecond intervals. The 2500-microsecond input to the grid of V-301-10A is greatly affected by the RC combination of resistor R-345-2 and capacitor C-309-3 which provides a reduction of the pulse amplitude to the proper value and shapes the pulse-form to a very narrow pulse. The current variations appear at the plate of V-301-10B as voltage variations across the common plate resistors R-340-2 and R-340-1. In position "8" of the "SWEEP SPEED" switch the video amplifier is used in the station-selector calibration system, receiving pulses from a capacitative voltage divider at the output of the third counter diode. The cathode of the video tube is also fed with pulses from the 10-, 50-, and 500-microsecond marker plates (V-303-2B and V-301-9B) through capacitor C-337-1. The effect on the shape of the 50- and 500-microsecond pulses is unimportant; the 10-microsecond pulses, however, are sharpened by the coupling and appear on the traces well defined for easy calibration.

(9) AMPLITUDE BALANCE AND TRACE-SEPARATION FOLLOWER.

(a) AMPLITUDE BALANCE.—Each plate of the square-wave generator V-301-7 is directly coupled through a grid resistor to the grid of one section of the dual triode V-303-1, used as the amplitude balance, and connected as two cathode followers. (See fig. 4-66.) The "AMP. BALANCE" switch control (R-335) connected between the two cathodes of V-303-1, permits control of the received pulses so that they are equal when viewed on the oscilloscope. Each cathode of V-303-1 is returned to ground through its own resistor; the A-section through R-334-1; the B-section through R-336-1, R-336-2, and R-336-3 connected in parallel. Positive voltage developed across these cathode resistors is taken from the sliding arm of variable resistor R-335 and fed to the receiver. This voltage is applied to both grids of V-108 and may be adjusted to increase the voltage developed across its cathode resistor. This positive voltage from the cathode of V-108 is applied to the cathode of the third i-f tube V-101-4, decreasing its gain.

The cathode of section A of V-303-1 is positive while the A-trace is being created on the indicator screen; the cathode of section B is positive while the B-trace is being made. With the slider of R-335 adjusted to its electrical center, the positive voltage fed to the receiver will be equal for both traces. Moving the slider to the A-side of R-335 will result in a greater positive voltage during the A-trace sweep which, in turn results in a decrease in amplitude of the A-pulse. Moving the slider to the B-side of R-335 will, by similar action, cause a decrease in the amplitude of the B-pulse. Thus, by proper adjustment of R-335, the two pulses may be made to appear equal in size on the indicator screen.

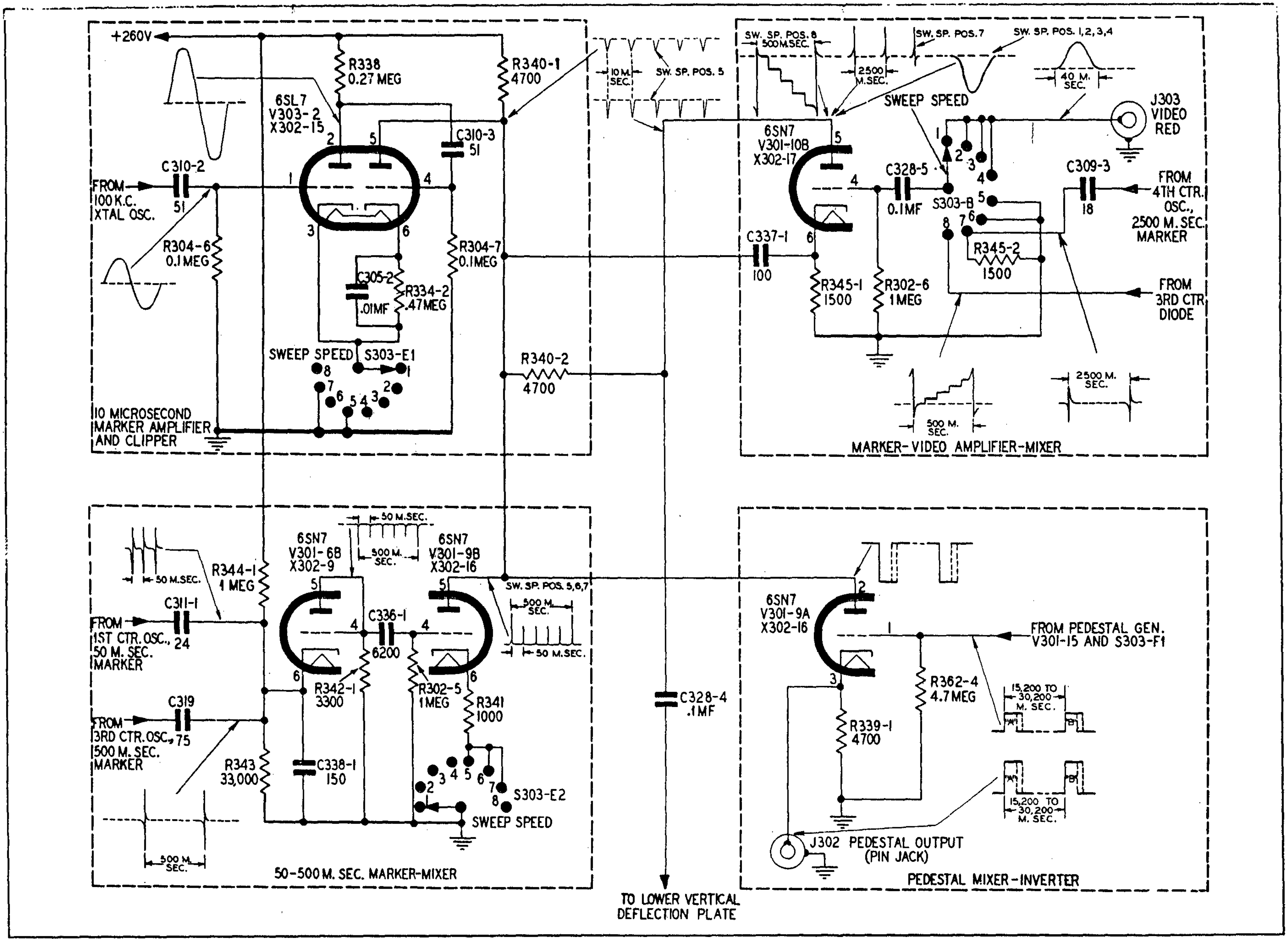


Figure 4-65. Marker-Mixer Circuits

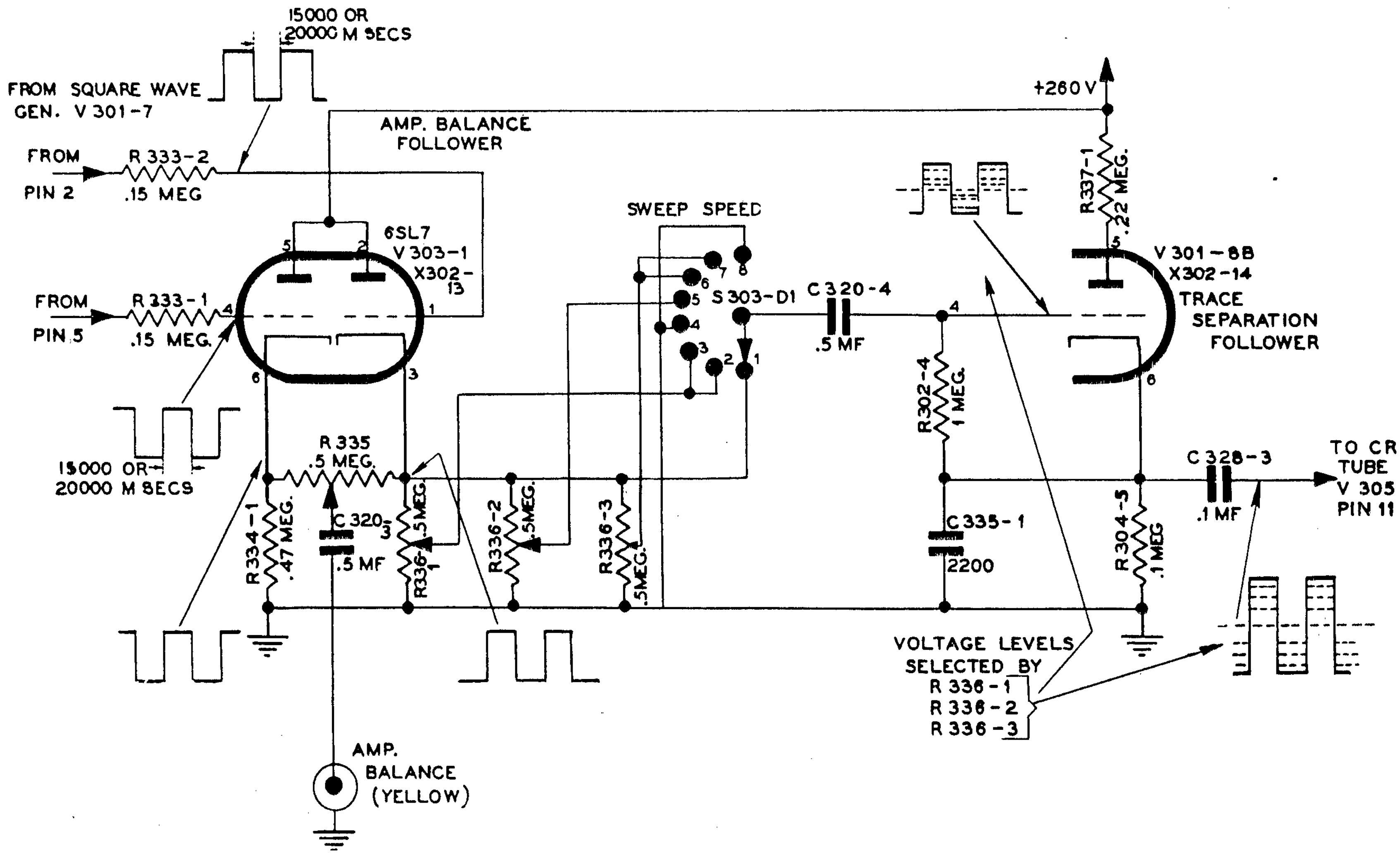


Figure 4-66. Trace Separation and Amplitude-Balance Circuit

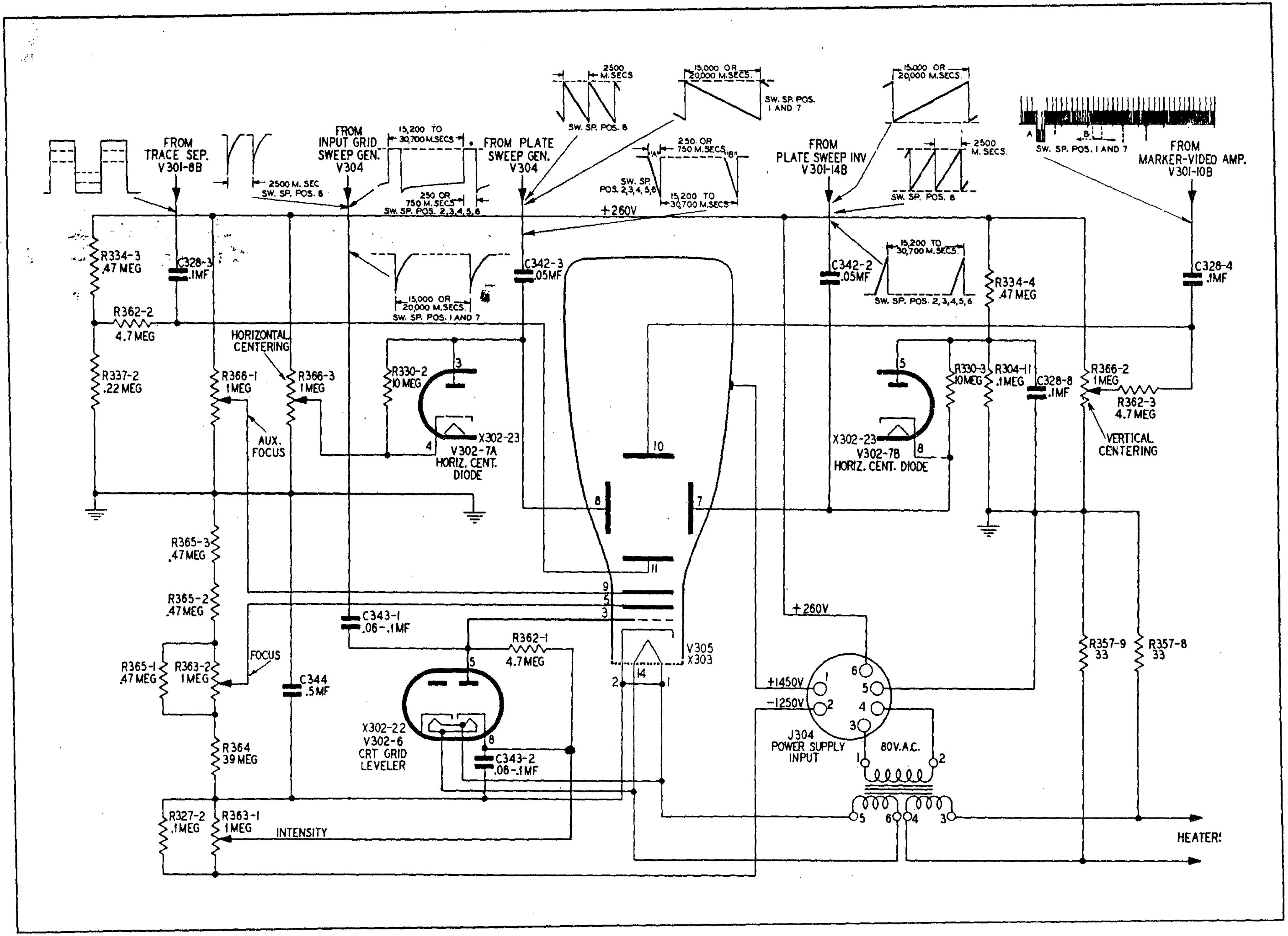


Figure 4-67. Cathode-Ray Tube and Indicator Power Supply Circuit

(b) TRACE-SEPARATION FOLLOWER.—The 30,000 or 40,000 microseconds between successive sweeps of the same area on the cathode-ray tube screen are covered in two sweeps, each lasting 15,000 or 20,000 microseconds and placed one above the other. A deflection voltage is applied to one of the vertical plates of the cathode-ray tube to provide a vertical spacing between the sweeps upon which the pulses appear. The spacings between the traces must be adjustable to provide the most convenient separation for aligning and comparing the pulses and for reading the time calibration on the traces. This function is performed by the trace-separation follower V-301-8B.

The pulses developed across the three variable resistors in the cathode circuit of V-303-1B, R-336-2, and R-336-3, are an exact replica of the output voltage from the square-wave generator V-301-7. Various levels of this square-wave voltage may be selected by section S-303-D1 of the "SWEEP SPEED" selector switch and applied to the trace-separation cathode follower tube V-301-8B. This square-wave voltage of predetermined amplitude is fed through capacitor C-328-3 to one of the vertical-deflection plates of the cathode-ray tube (V-304), and causes the 30,000- or 40,000-microsecond sweeps to appear as two separate lines of equal length, whose spacing can be varied by the settings of R-336-1, R-336-2, and R-336-3.

(10) CATHODE-RAY TUBE FUNCTIONS.—The cathode-ray tube (fig. 4-67) provides the means for reading visually the difference in arrival time of the ground station signals. The operating d-c voltages applied to various tube elements are obtained from both the low-voltage (regulated d-c) and high-voltage power supplies. The cathode, connected directly to its filament, is approximately 1200 volts negative with respect to the indicator chassis. The intensity control grid (number 3 in diagram) is connected through its grid resistor (R-362-1) to the movable arm of the "INTENSITY" control R-363-1 by which the grid voltage may be adjusted from zero to approximately —50 volts, with respect to the cathode. Diode V-302-6, designated as "CRT GRID LEVELER," is connected in the intensity grid control circuit as a d-c restorer. The diode circuit connections are such (the plate connected to the intensity grid, the cathode to the movable arm of the "INTENSITY" control) that the positive peaks of all signals, fed through capacitor C-343-1, are leveled at the d-c voltage selected by the "INTENSITY" control. The negative excursions of the signals, by which blanking of the retrace is effected, are always based at the grid-to-cathode d-c voltage selected by the "INTENSITY" control. The positive excursions of the signals, starting at some negative blanking level, raise the voltage on the intensity control grid to the level selected by the "INTENSITY" control, but no higher.

Anodes A1 and A2 respectively (tube elements numbered 5 and 6 in the diagram) focus and accelerate the electron stream into a very narrow, rapidly moving beam. Focusing-anode A1, whose voltage is adjusted by the "FOCUS" control R-363-2, is operated at a voltage approximately 600 volts positive with respect to cathode and 600 volts negative with respect to chassis. Accelerating-anode A2, whose voltage is adjusted by the "AUX. FOCUS" R-366-1, is operated at a voltage approximately 1450 volts positive with respect to cathode or 200 volts positive with respect to chassis.

A third accelerating anode (A3), a conductive coating inside the cathode-ray tube near the screen, further accelerates the focused beam toward the screen, providing added brilliance to the screen pattern. The conductive coating also provides a return path for the electrons which strike the screen, thus preventing a high static charge at the face of the cathode-ray screen. Horizontal deflection of the screen pattern is the result of linear changes of the electrostatic condition at both of the horizontal-deflection plates (numbers 7 and 8 in the diagram). The voltage fed to the left deflection plate is the sawtooth wave, developed at the plate of sweep generator V-304 and fed to the horizontal-deflection plate (number 8) through capacitor C-342-3. The waveform of this deflection voltage shows a slow and very linear negative drop, by which the sweep action is effected; and an abrupt positive rise to the original level, the latter providing the retrace action. The voltage fed to the right deflection plate is the sawtooth-shaped voltage developed at the plate of sweep inverter tube V-301-14B, and fed to deflection anode 7 through capacitor C-342-2. The output of sweep inverter V-301-14B is an exact but inverted form of the output from the sweep generator V-304. The voltage, by which the visible trace is swept, is the linear and slowly rising part of the sawtooth wave; the abrupt negative part of the wave provides the retrace action.

Since the sweep voltages developed by the sweep generator and sweep inverter circuits are capacitor coupled to the horizontal-deflection plates, it is necessary that these plates have fed to them a d-c voltage around which the sweep action takes place. The d-c voltage base for the right deflection plate (anode 7) is supplied by a voltage-divider system, consisting of resistors R-333-4 and R-304-11. This resistor combination provides a regulated voltage of approximately 45 volts, which is coupled to the horizontal-deflection plate through the 10-megohm isolating resistor R-330-3; a similar, but higher and adjustable d-c voltage base is supplied to the left horizontal deflection plate (anode 8) by the "HORIZ. CENT." control R-336-3. The voltage selected by this control (approximately 145 volts) is coupled to the deflection plate through the 10-mogohm resistor R-330-2.

To insure that the d-c polarizing voltages for the deflection plates remain constant, duo-diode V-302-' designated as "HORIZONTAL CENTERING DIODE," is used as a d-c restorer or voltage leveler. The A-section of duo-diode V-302-7, connected in the left deflection plate circuit across the isolating resistor R-330-2, has its plate connected directly to the deflection plate and capacitor C-342-3. With its cathode connected to the movable arm of the horizontal centering control R-366-3, the diode effectively levels the positive peaks of the sweep voltages at the voltage selected by the control, and maintains this voltage as the d-c base from which the sweep action starts as a linear, slowly dropping voltage.

The B-section of duo-diode V-302-7 functions as a d-c restorer or voltage leveler for the right deflection plate. This diode section, connected across the 10-megohm isolating resistor R-330-3, has its cathode connected directly to the deflection plate and to capacitor C-342-2 and its plate connected to the voltage-divider tap which supplies the polarizing voltage. The diode, thus connected, levels the abrupt negative excursions of the output from the sweep inverter at approximately 45 volts above chassis, and maintains this voltage as the d-c base from which the sweep action starts as a linear, slowly rising voltage.

The plate to which is fed the video, pedestal, and marker signals is the lower vertical-deflection plate (number 10 in diagram). The 10-microsecond markers and the video and pedestal voltages which are fed to the plate in the form of negative pulses cause upward deflections of the beam, with the result that these signals appear as upward indications on the screen. The 50-, 500-, and 2500-microsecond markers, fed to this plate as sharp positive pulses, appear on the screen as downward indications. In addition to the various signals, a d-c voltage, selected by "VERTICAL CENTERING" control R-366-2, is also fed to the anode. Adjustment of R-366-2 provides a voltage relationship between the lower and upper vertical-deflection plates by which vertical centering of the screen pattern is effected. To the upper vertical-deflection plate are fed the various levels of trace separation voltages, developed in the cathode circuit of tube V-301-8B and fed to the cathode-ray tube through capacitor C-328-3. The trace separation voltages operate around a d-c voltage level of approximately 85 volts, determined by a voltage divider consisting of resistors R-334-3 and R-337-2.

SECTION V
MAINTENANCE

WARNING

OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE THE EQUIPMENT WITH HIGH VOLTAGE SUPPLY ON. DO NOT DEPEND UPON DOOR SWITCHES OR INTERLOCKS FOR PROTECTION BUT ALWAYS SHUT DOWN MOTOR GENERATORS OR OTHER POWER EQUIPMENT. UNDER CERTAIN CONDITIONS DANGEROUS POTENTIALS MAY EXIST IN CIRCUITS WITH POWER CONTROLS IN THE OFF POSITION DUE TO CHARGES RETAINED BY CAPACITORS, ETC. TO AVOID CASUALTIES ALWAYS DISCHARGE AND GROUND CIRCUITS PRIOR TO TOUCHING THEM.

1. INSPECTION.

a. PREFLIGHT INSPECTION.

IMPORTANT

Periodic inspections prescribed herein represent minimum requirements. If, because of local conditions, peculiarities of equipment, or abnormal usage they are found insufficient to assure satisfactory operation of equipment, local authorities should not hesitate to increase their scope or frequency. Before starting maintenance of Radio Set ★AN/APN-4, carefully check nomenclature of component units and use the corresponding sections of the handbook of Maintenance Instructions.

(1) Check the first counter, proceeding in the following sequence (see par. 6, this section):

(a) Trace separation.

(b) Number of counts.

(c) Coincidence of markers.

(d) Horizontal amplitude of trace.

(2) Check the second counter in the following sequence (see par. 6, this section):

(a) Trace separation.

(b) Number of counts.

(c) Horizontal amplitude of trace.

(3) Check the third counter as follows (see par. 6, this section):

(a) Number of counts.

(b) Trace centering.

(c) Horizontal amplitude of trace.

(4) Check the fourth counter by determining the number of counts (see par. 6, this section).

(5) Check "STATION" selector alignment in all positions (par. 6, this section).

(6) Check "COARSE" and "FINE" delay circuit adjustments (par. 2, sec. II).

(7) Check the sensitivity of the receiver as follows:

(a) Disconnect the antenna cable from the receiver.

(b) Turn the "GAIN" control to maximum clockwise position and "AMP. BALANCE" control to center index. The heavy grass on both indicator traces should be ½-inch high or more. Rotating the "AMP. BALANCE" control clockwise and counterclockwise should cause the grass to disappear on the bottom and top traces respectively.

b. DAILY INSPECTION.

(1) Check the security of mounting brackets.

(2) Check all cables for proper connections. (See fig. 2-1.)

(3) Check "80V-115V POTENTIAL" switch for proper position. (See sec. II, par. 2.)

(4) Check the antenna lead-in wire and change-over switch (see fig. 2-6).

(5) Check the power supply adjustments (sec. II, par. 2).

(6) Perform all the preflight tests, paragraph 1, this section.

(7) Check "SQ. WAVE" adjustment (ref. No. R-347, fig. 8-12) for trace separation.

(8) Check A-delay (R-320-1, fig. 8-12) for proper position of A-pedestal.

c. 100-HOUR INSPECTION.

(1) Check the tubes (identify each tube and return to proper socket).

(2) Check all interconnecting cables for excessive wear.

(3) Check for decomposed bakelite terminal boards.

(4) Check for mechanical faults, loose terminal boards, nuts and screws.

(5) Check all switch decks for faulty contacts.

(6) Check for frayed or burned wiring.

(7) Check the r-f alignment of the receiver by the following method:

(a) Use Frequency Meter Set SCR-211 for Army testing and Frequency Meter LM-13 for Navy testing.

(b) Disconnect the antenna cable from the receiver and connect the antenna post of the frequency meter to the antenna terminal of the receiver.

(c) Calibrate the frequency meter in accordance with the proper frequency meter instruction book.

(d) Set the frequency meter close to the range of the frequency of Radio Set ★AN/APN-4.

(e) Turn the "AMP. BALANCE" control on the indicator to the extreme counterclockwise position and adjust the "GAIN" control for approximately one inch of kick-up on the left edge of the bottom trace of the indicator. Tune the frequency meter for maximum trace kick-up. If necessary, readjust the "GAIN" control to prevent receiver overload.

(f) The frequency meter should indicate not more than 20 kilocycles above or below the correct receiver frequency.

2. TROUBLE SHOOTING INSTALLED EQUIPMENT.

a. PRELIMINARY CHECKS FOR INDICATOR ★ID-6B/APN-4 AND RADIO RECEIVER ★R-9A/APN-4.—When noisy or intermittent operation, or a dead set, is encountered at the point of installation, make the following checks before replacing major units:

Note

When found necessary, realignment of Radio Receiver ★R-9/APN-4 as well as any major repair work on Radio Set ★AN/APN-4 will be accomplished by third or fourth echelon maintenance personnel at an established communications repair shop.

(1) Remove input connector plug J-106 from the front panel of the receiver; connect terminals 3 and 4 together by inserting a jumper wire into holes in plug. Using an a-c voltmeter, check voltage between terminals 1 and 2. These terminals should have either 80 or 115 volts, depending on the type of inverter used. Discrepancies in voltage at this point indicate defective inverter, batteries, cables, or plugs.

(2) Check "80V-115V LINE VOLTAGE" switch for proper setting.

(3) Check fuse on front panel of receiver for burned or broken element. Replace if doubtful.

(4) Remove connector plug (Plug PL-Q171) from the receiver receptacle and carefully observe pin numbers stamped in insulating material. Then check for voltages as given in the following chart. If the proper voltages appear between pins 3 and 4 and improper voltages appear between other pins, refer to the trouble chart (table 5-1) for possible causes.

Pin	*Voltage*
1 and 5 (Ground)	+1450 volts direct current ±75 volts
2 and 5 (Ground)	—1250 volts direct current ±65 volts
*6 and 5 (Ground)	+260 volts direct current exact
†3 and 4	80 volts alternating current ±4 volts
5 is GROUND	

*To adjust the 260-volt supply, remove receiver from case, connect all power cables, turn receiver on left side, connect voltmeter between pin 5 of tube V-108 and ground, and adjust R-121 on the right side of receiver chassis. To adjust the 260-volt supply without removing the receiver from the case, connect a 2500-ohm 25-watt resistor directly across the voltmeter test leads; then adjust R-121 until the meter indicates exactly 260 volts.

†The voltage between pins 3 and 4 should be 80 volts if "80V.-115V. LINE VOLTAGE" switch is set for proper a-c input.

(5) Remove antenna cable receptacle from receiver, and check with ohmmeter for continuity and shorts in antenna and cable.

(6) Check "GAIN" and "AMP. BALANCE" cables for open or short circuits.

(7) Visually check each tube to see that filament is lighted.

(8) If intermittent or erratic operation is apparent when the receiver or indicator is jarred or shaken, remove the faulty unit from the case, and, with the set turned on, tap each tube lightly with a screw driver or aligning tool. Observe the effects on the indicator screen. Shorted or microphonic tubes will cause jumping or distortion of the screen pattern. Replace doubtful tubes with tubes known to be good.

(9) If above procedure does not eliminate trouble, replace indicator or receiver, or both, if necessary.

Note

Should a thorough check indicate that the trouble is in either or both of the major units, con-

TABLE 5-1. PRELIMINARY TROUBLE CHART.

Item	*Trouble*	*Possible Cause*	*Remedy*
1	No a-c input voltage to set.	(1) Blown fuse in receiver. (2) Defective alternator. (3) Defective cables.	(1) Replace fuse. (2) Replace unit. (3) Check for loose or broken connections in plugs.
2	No indication on indicator screen.	(1) Defective interconnecting cables. (2) Defective cathode-ray tube or other tubes in indicator or power supplies. (3) Defective circuit components in receiver or indicator.	(1) Check cable for loose or broken connections or shorted wiring in connectors. (2) Check tubes and replace if defective. (3) Replace major units, one at a time.
3	Erratic operation when units are jarred.	(1) Shorted or microphonic tubes in receiver or indicator. (2) Defective parts or loose connections in receiver or indicator.	(1) Check by tapping lightly. Replace if defective. (2) Replace major units, one at a time.

sign them to the proper maintenance depot for repair. Include with the order for repairs an accurate record of all previous checks and observations.

b. PRELIMINARY CHECKS FOR INDICATOR ★ID-6/APN-4 AND RADIO RECEIVER ★R9/APN-4.

(1) VISUAL.—Make a visual inspection of all cables, cable connectors and panel controls for mechanical damage.

(2) VOLTAGE CHECKS.—Make both a-c and d-c voltage checks using the following chart. A d-c voltmeter, RCA Voltomyst, Jr. 165 (Army or Navy) and an a-c voltmeter, part of Test Set I-56-(*), (Army); Hickok model 133 (Navy) are required to make these checks.

WARNING

Ground to some bare metal part of chassis or panel. Use an insulated probe for checking voltages at connector pins and keep the hand not in use away from the equipment. Voltages as high as 2600 volts appear across the contacts of the power plug.

Remove connector plug, Plug PL-Q171, from the receiver receptacle. The number is marked in the insulating material within the receptacle opposite each connector pin.

Pin	*Voltage*
Pin 1 to ground	±1300 volts d-c
Pin 2 to ground	—1300 volts d-c
*Pin 6 to ground	± 260 volts d-c
†Pin 3 to pin 4	115 or 80 volts a-c depending on the available supply

*Voltage output of the regulated 260-volt supply may be set by adjustment of resistor R-121.
†If no voltage exists at the above points, check the 4-ampere fuse located on the receiver panel. If 80 volts alternating current appears between pins 3 and 4 but no d-c voltage appears at the above points, refer to the receiver trouble location chart for possible causes.

Note

Do not try to measure voltages on pins 1 and 2 with a meter having only a 1000-volt scale.

(3) OPERATIONAL CHART.—Check operational adjustments using the following chart:

Adjustments	*Reference*
"FOCUS" and "INTENSITY" controls	Section II, paragraph 2
Counter circuit screwdriver adjustments	Section II, paragraph 2
"STATION" selector	Section II, paragraph 2
"COARSE" and "FINE" controls with screwdriver adjustments "ADJ. 0," "ADJ. 10000" "ADJ. 200," "ADJ. 700"	Section II, paragraph 2

(4) INTERMITTENT OPERATION.—Check for intermittent operation and noise which may be caused by loose contacts in cable connectors and plugs, by defective cording between units, by equipment being loose in mounting brackets, and by loose ground connections. With the equipment in operation, locate these defects by slightly jarring the units, shifting the position of the cables, or pulling on them firmly without dislodging them from their fittings. Make checks for intermittent noise with the aircraft engines running to make sure the noise is not due to the vibration of the aircraft or interference from the electrical system. Make checks also with input signal applied; if noise occurs, disconnect the antenna. The conditions causing the noise may be more easily located with the antenna disconnected from the equipment. Intermittent noises are often generated by steady vibration of the metal parts inside the tubes. Tubes having loose parts or intermittent contacts within their assembly cannot readily be tested in tube testing devices. Test all tubes suspected by replacing them one at a time, with tubes known to be in good condition.

(5) INTERFERENCE.—Check for interference caused by microphonic tubes and static set up by the electrical system of the aircraft. These conditions will appear as grass on the indicator screen or may be detected by using a pair of earphones connected to the output of the receiver. Since the effective range of Radio Set ★AN/APN-4 is greatly affected by noise and interference, eliminate all such conditions whenever possible.

3. TROUBLE SHOOTING AT REPAIR STATION.

Depot maintenance will necessarily require repetition of many checks and tests performed as routine inspection or preliminary checks. Maintenance personnel should be thoroughly familiar with the electrical characteristics explained in section IV.

*Applies to all models of the test set, A through J.

Note

In servicing a major component, carefully examine tubes, wiring, etc. for obvious faults, before making extensive tests or disassembling equipment.

a. EQUIPMENT REQUIRED.

(1) Test oscilloscope (RCA 158 or equivalent).

(2) Signal generator.

(3) D-C voltmeters (1,000 and 20,000 ohms-per-volt sensitivity, with ranges up to 2500 volts or more).

(4) A-C voltmeter (with range up to 3,000 volts).

(5) Output meter (preferable a vacuum tube voltmeter).

(6) Aural test set made up at depot from the following parts, as shown in figure 5-1: one pair earphones, one coaxial coupling, Coupling MC-277, one phone jack, Jack JK-26, and one 0.25-microfarad 400-volt capacitor.

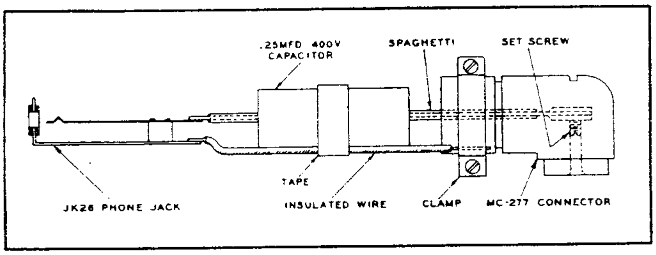


Figure 5-1. Earphone Adapter for Signal Tracing

b. TROUBLE LOCATION BY SIGNAL TRACING.—Many troubles which still exist after the equipment has been given careful inspection for broken or burned out tubes, loose connections, or damaged parts can be readily located by signal tracing.

(1) RADIO RECEIVER ★R-9A/APN-4.

(a) Turn on equipment, set "GAIN" control at maximum (clockwise) position, and set "AMP. BALANCE" at center position.

(b) Check voltages at tube sockets and compare readings taken with those of voltage charts. (See figs. 8-62 to 8-66, inclusive.) If voltages appear normal, but receiver remains weak or inoperative, proceed with signal tracing as follows:

1. Connect earphone adapter to output terminal of receiver, and connect earphones to adapter.

2. Connect ground lead of AM signal generator to receiver chassis, and connect output lead through 0.01-microfarad capacitor to an insulated probe.

3. Set signal generator frequency to 1050 kilocycles and its output control to maximum.

4. With receiver "FILTER" switch at "OUT," connect test probe to pin 8 of the detector tube V-103. If the detector and video amplifier are working, a signal will appear in the earphones. If no sound is heard, recheck voltages and, with equipment turned off, make resistance measurements, and compare results with resistance chart. (See fig. 8-62.) Resistance readings within $\pm 5\%$ of the indicated values may be considered normal.

5. With "AMP. BALANCE" control at center position, connect test probe to pin 4 of third i-f amplifier tube V-104-1. If the stage is operating, a substantial increase in amplitude should be noted in the earphones. If sound is weaker or no sound is heard, make voltage and resistance measurements at the tube socket terminals.

6. With test probe in same position, rotate "AMP. BALANCE" control either side of center position. A chattering sound should be heard in the earphones as the control is rotated. If no change is noticed, check the amplitude-balance circuit for defects.

7. Move test probe successively to pin 4 of the second i-f amplifier V-101-3, and the first i-f amplifier V-101-2. Each movement of the test probe should provide a substantial increase in the output. A decrease in signal strength is an indication of a defective stage at which voltage and resistance measurements should be made.

8. Retune signal generator to the r-f frequency for which the receiver is set, connect the test probe in pin 8 of mixer tube V-102, and listen for the signal. Connect probe to pin 4 of r-f amplifier V-101-1; an increase in output signal should be evident.

9. Connect test probe to coaxial connector J-101 (coded green); the amplitude of the output signal should be approximately the same as that obtained with the test probe connected to the r-f amplifier grid, pin 4.

10. If shorted capacitors are found, always examine closely the associated resistors for signs of burning and changes in resistance values. If burned or charred resistors are found, check for low resistance or shorts in associated circuit components.

(2) INDICATOR ★ID-6B/APN-4.—The signal tracing procedure for the indicator requires the use of a test oscilloscope and the waveform charts shown in figures 8-67 and 8-68. Before attempting signal tracing on the indicator, make a visual inspection of tubes, wiring and parts. In cases where trouble is not found by visual inspection, determine, if possible, the approximate location of the trouble from the indicator trouble chart (table 5-3.) The following method may be used for more detailed testing:

(a) Check voltages at tube sockets, and compare readings taken with those given on voltage charts. (See figs.8-48 to 8-52.) If large voltage variations are found, take resistance readings on affected circuit, and compare readings with resistance chart.

(b) If trouble cannot be located in the above manner, proceed with signal tracing as follows:

1. Connect ground lead of test oscilloscope to indicator chassis.

2. Connect an insulated test probe to vertical input connection through a 10-megohm resistor.

3. If trouble has been isolated to a particular stage or circuit, connect insulated test-probe to points in circuit indicated on waveform chart. (See figs. 8-67 and 8-68.)

4. If no waveform or wide variations of the waveform shown in the chart are observed, recheck voltages and resistances in circuit.

5. If trouble cannot be isolated, check waveforms through entire indicator circuits until defective circuit is located. Make voltage and resistance measurements to isolate the defective part or parts.

Many of the waveforms shown in figures 8-67 and 8-68 are partially theoretical and represent forms which should be obtained when using an oscilloscope whose loading effect on the circuit under test is negligible. This is especially true of rectangular waveforms of long duration. Distortion of these forms increases as the vertical gain of the test oscilloscope is increased and may show a large amount of curved deviation from the normal rectangular shape. Since the loading effects will be different under different test conditions, these effects were disregarded in drawing the waveforms. It is recommended that maintenance personnel make a comparative test of several indicator units known to be good, using available test equipment. Carefully prepared notes of these tests will aid in locating troubles in a defective unit.

(3) RADIO RECEIVER ★R-9/APN-4.—Before servicing the equipment, maintenance personnel should become familiar with the various circuits and their functions as discussed in section IV.

(a) EQUIPMENT REQUIRED FOR RECEIVER MAINTENANCE.

Unit	*Army*	*Navy*
Oscilloscope	RCA-158, part of Test Sets IE-26 and IE-27	Dumont 241
Signal Generator	I-72, part of Test Sets IE-26 and IE-27	Navy Model LM-( )
Output meter	Weston model 571 type 3A or Triplett model 650-SC or Espey model 103 or RCA Voltohmyst, Jr. 165 or part of Test Set I-56-A through I-56-J which is part of Test Sets IE-26 and IE-27 vacuum tube voltmeter	Weston Model 687 RCA Voltohmyst, Jr. 165
Volt-ohm-milliammeter	Any of the set analyzers which are parts of Test Set I-56-A through I-56-J may be used; for example, Weston Set Analyzer Model 665, Type 2	Hickok Model 133

(*b*) SWEEP SPEED SELECTOR FUNCTIONS.

Switch Section	*Sweep Speed Switch Position* 1	2	3	4	5	6	7	8
G Controls bias to sweep generator	Slow sweep speed	Medium sweep speed	Fast sweep speed	Same as 3-G	Same as 3-G	Same as 3-G	Same as 1-G	Same as 1-G
F Controls triggering voltage to sweep generator	Negative pulses from pulse broadener	750-microsecond pulses from pedestal generator	220-microsecond pulses from pedestal generator	Same as 3-F	Same as 3-F	Same as 2-F	Same as 1-F	Pulses from B fine delay tube
E Controls cathode circuit of marker amplifier tubes	Cathodes open markers not developed	Same as 1-E	Same as 1-E	Same as 1-E	10- and 50-microsecond markers developed and seen	50- and 500-microsecond markers developed and seen	500- and 2500-microsecond markers developed and seen	Grounds video amplifier cathode for greater vertical deflection on cathode ray tube
D Controls input to trace shift amplifier	Maximum trace separation	Trace separation control R353-2	Same as 2-D	Input to trace shift amplifier grounded	Trace separation control R353-1	Trace separation control R353-1	Same as 6-D	Same as 4-D
C Controls bias on pedestal generator	Pedestal generator creates 750-microsecond pedestal	Same at 1-C	Pedestal generator creates 220-microsecond pedestal	Same as 3-C	Same as 3-C	Same as 1-C	Same as 1-C	Same as 1-C
B Controls input to video amplifier	Received signal switch in	Same as 1-B	Same as 1-B	Same as 1-B	Received signal switch out	Same as 5-B	Pulse every 2500 microseconds switches in from 3rd counter	Pulses from 2nd counter diode for station selector adjustment
A Switches pedestal generator pulses to 1st counter thru 1-r switch section	Increase 1-r action on position #1 only							
Sweep duration	20,000 microseconds	750 microseconds	220 microseconds	220 microseconds	220 microseconds	750 microseconds	20,000 microseconds	20,000 microseconds (causes trace line to travel off screen)*
Trace separation	Maximum	Variable	Variable	None	Variable	Variable	Variable	None
Observe on scope	Pedestal and received signal (complete trace)	Pedestal top only and received signal	Pedestal top only and received signal	Pedestal top only and received signal	Pedestal top only and markers	Pedestal top only and markers	Pedestal and markers (complete trace)	Feedback action at 2nd counter

*Sweep generator triggered by B-pedestal fine delay tube.

(*c*) FRONT PANEL IDENTIFICATION OF RECEIVER.

Panel Marking (See fig. 1-3)	*Reference Number*	*Schematic Figure Number*	*Physical Location Figure Number*
"Channel"	S-101-A S-101-B S-101-C S-101-D	8-31	8-8
"Pwr. On-Off"	S-102-2	8-31	8-8
"80V-115V Potential"	S-103	8-31	8-7
"Filter In-Out"	S-102-1	8-31	8-8
"Fuse 4 Amp. 250V"	F-101	8-31	1-3
"Spare Fuse"		8-31	1-3
"Input Supply"	J-106	8-31	1-3
"Indicator"	J-105	8-31	1-3
"Aux. Power Outlet"	J-107	8-31	1-3

(*d*) R-F ADJUSTMENTS.

Function (See figs. 4-28 and 8-7)	*Reference Number*	*Schematic Figure Number*	*Physical Location Figure Number*
Antenna coil adjustments	T-101-1, T-101-2 T-102-1, T-102-2	8-31	8-7
R-F coil adjustments	L-103-1, L-103-2 L-104-1, L-104-2	8-31	8-7
Oscillator coil adjustments	L-106-1, L-106-2 L-107-1, L-107-2	8-31	8-7

(*e*) I-F ADJUSTMENTS.

Function (See figs. 4-28 and 8-7)	*Reference Number*	*Schematic Figure Number*	*Physical Location Figure Number*
First i-f coil adjustment	T-103-1	8-31	8-7
Second i-f coil adjustment	T-103-2	8-31	8-7
Third i-f coil adjustment	T-103-3	8-31	8-7
Fourth i-f coil adjustment	T-103-4	8-31	8-7

(*f*) WAVE-TRAP ADJUSTMENTS.

Reference Number (See figs. 4-28 and 8-7)	*Schematic Figure Number*	*Physical Location Figure Number*
L-101, L-102-1, L-102-2	8-31	8-7

(4) BENCH TEST OF RADIO RECEIVER ★R-9/APN-4.

(*a*) EQUIPMENT REQUIRED.—Always perform bench testing Radio Receiver ★R-9/APN-4 with Indicator ★ID-6/APN-4 and all interconnecting cables in place. A d-c voltmeter, an ohmmeter, a 400-cycle modulated signal generator (800-12,000 kilocycles), and an earphone adapter are required. The adapter is made up by attaching one lead of a 0.25-microfarad 400-volt capacitor to the center terminal of a Coupling MC-277 and attaching the other lead of the capacitor to one terminal of Jack JK-26. Then attach the other terminal of the jack to the outer conductor of Coupling MC-277. Check output from the receiver by watching the indicator screen or check using earphones connected to the output of the receiver through the earphone adapter.

(*b*) PROCEDURE.—Make a visual inspection of the receiver for tubes which are broken or not properly inserted in their sockets, for broken wiring and loose connections, and for burned or charred parts. Turn on equipment and make a visual inspection of each tube to see that all filaments light.

With the "GAIN" control on the indicator set near maximum (clockwise) position, and the "AMP. BALANCE" control on the indicator set near the center of its range, a voltage check should be approximately as indicated in figures 8-22 and 8-23.

If discrepancies are found, make a resistance check of the associated circuit using an ohmmeter and by referring to figure 8-23.

If all voltages are normal, but the receiver is inoperative or weak, trace the signal through the receiver equipment. To do this, set up the signal geenrator with a wire connecting its ground to the chassis or radio receiver. Connect the output terminal of the signal generator through a capacitor of approximately 0.1 microfarad to an insulated probe.

Set the test oscillator at 1050 kilocycles and its output control to maximum. Turn the receiver gain control fully clockwise and observe the output of the receiver, then, connect the signal generator probe to pin 8 of the detector tube (V-103) socket. A signal will appear at the output of the receiver if the detector and video amplifier are working properly. If no sound is heard or no oscilloscope pattern appears, the fault lies in this section of the equipment.

If output is obtained, move the probe to pin 4 of the third i-f amplifier V-104-1. This will cause the tone to increase in amplitude considerably. A chattering sound will be heard with the 400-cycle tone if the "AMP. BALANCE" control is not exactly in the center of its rotation. This chattering sound should become louder as the control is moved from the center in either direction. If no difference is noted, the amplitude balance circuit is not operating and must be checked.

Move the input probe successively to pin 4 of the second i-f amplifier V-101-3, and the first i-f amplifier V-101-2. Each movement of this probe towards the input of the receiver should provide a substantial increase in signal amplitude and the signal generator output must be progressively reduced to prevent overloading the receiver.

Next move the probe to pin 1 of mixer tube V-102. This will bring about a considerable decrease in volume and the signal generator output control must be adjusted until the signal is audible. Retune the signal generator to the radio frequency for which the equipment is adjusted. This should cause the output to become very strong. Next, move the probe to pin 4 of the r-f amplifier V-101-1. This should cause an appreciable increase in the output signal. Finally, connect the probe to coaxial connector J-101 (coded green); the output signal should be audible with the input at this point.

Note

In this signal tracing procedure, the point where the signal does not increase in amplitude or disappears entirely identifies the stage which is not functioning normally. Carefully examine the individual components of this stage to determine the circuit defect. Standardize stage gains by checking several normal receivers and establishing the average settings of the signal generator output control required to give a suitable output indication. Variation of as much as two to one may be considered normal. When establishing these standards select receivers giving the performance specified in section VI, paragraph 2*f*.

Replace tube or parts which are suspected of being faulty with identical tubes or parts known to be in good condition. As each individual part is changed, note the results of this change. Never attempt extensive alteration or modification except when authorized by technical orders. Note progress of work while maintenance replacements are under way.

(5) INDICATOR ★ID16/APN-4.

Note

Study carefully the electrical circuit theory of the indicator as discussed in section IV.

(*a*) FRONT PANEL CONTROL IDENTIFICATION OF INDICATOR.

Panel Marking (See fig. 1-4)	*Schematic Reference Number*	*Schematic Figure Number*	*Interior View Figure Number*
"Intensity"	R-357-2	8-33	8-14
"Focus"	R-357-1	8-33	8-14
"Gain"	R-341	8-33	8-14
"Amp. Balance"	R-355	8-33	8-17
"Station"	S-301	8-33	8-12
"Coarse"	R-315-6	8-33	8-18
"Fine"	R-315-5	8-33	8-18
"Crystal-Phasing"	C-302	8-33	8-12
"Left-Right"	S-302-A	8-33	8-17
	S-302-B		
"Sweep Speed"	S-303	8-33	

(*b*) ADJUSTMENTS.

1. COUNTER CIRCUIT ADJUSTMENTS* OF INDICATOR. (*See sec. II, par.* 2*b*(2).)

Panel Marking (See fig. 1-4)	*Schematic Reference Number*	*Schematic Figure Number*	*Interior View Figure Number*
"A"	R-315-1	8-33	8-17
"B"	R-315-2	8-33	8-17
"C"	R-315-3	8-33	8-17
"D"	R-315-4	8-33	8-17

2. STATION SELECTOR ADJUSTMENTS* OF INDICATOR. (*See sec. II, par.* 2*b*(3).)

Panel Marking (See fig. 1-4)	*Schematic Reference Number*	*Schematic Figure Number*	*Interior View Figure Number*
"E"	C-329-1	8-33	
"F"	C-329-2	8-33	
"G"	C-329-3	8-33	
"H"	C-329-4	8-33	
"I"	C-329-5	8-33	8-12
"J"	C-329-6	8-33	8-12
"K"	C-329-7	8-33	8-12

3. DELAY CONTROL ADJUSTMENTS* OF INDICATOR. (*See sec. II, par.* 2*b*(4).)

Panel Marking (See fig. 1-4)	*Schematic Reference Number*	*Schematic Figure Number*	*Interior View Figure Number*
"Adj. 0"	R-328-2	8-33	8-8
"Adj. 10,000"	R-320-3	8-33	
"Adj. 200"	R-328-1	8-33	8-8
"Adj. 700"	R-320-2	8-33	
"A" Delay†	R-320-1	8-33	8-8

*Several of these adjustments are used in circuits which are synchronized with impulses from various counter oscillators. These adjustments marked in the table with an asterisk (*) will not directly control the functioning of circuits, but will move the operating point of these circuits from one synchronizing impulse to the next. It is essential that all these adjustments be set at the EXACT CENTER of the range of rotation providing normal operation, and nowhere else.

†This is not a panel control; adjust from right side of indicator.

4. OSCILLOSCOPE ADJUSTMENTS.

Function	*Schematic Reference Number*	*Schematic Figure Number*	*Interior View Figure Number*
Trace separation "Sweep Speed" positions "2" and "3"	R-353-2	8-33	8-8
Trace separation "Sweep Speed" position "5"	R-353-1	8-33	8-8
Trace separation "Sweep Speed" positions "6" and "7"	R-353-3	8-33	8-8
Vertical centering	R-350-1	8-33	8-13
Secondary focusing ("Fast Sweep")	R-350-2	8-33	8-13
Horizontal centering	R-350-3	8-33	8-12
Sweep amplitude "Sweep Speed" positions "1" and "7"	R-350-4	8-33	8-12
Sweep amplitude "Sweep Speed" positions "2," "6," and "8"	R-350-5	8-33	8-12
Sweep amplitude "Sweep Speed" positions "3," "4," and "5"	R-350-6	8-33	8-13

5. MISCELLANEOUS ADJUSTMENTS.

Function	*Schematic Reference Number*	*Schematic Figure Number*	*Interior View Figure Number*
10-microsecond marker shift	R-303	8-33	8-13
Square-wave generator control	R-347	8-33	8-13
4th counter voltage adjustment	R-341-2	8-33	8-17

c. TROUBLE CHARTS.—In the following charts, only the most common troubles, with their symptoms and probable causes, are listed. In the trouble chart of Indicator ★ID-6B/APN-4, several associated symptoms with their probable causes are grouped under one item. When using voltage and resistance measurements as a means for isolating trouble, readings within ±10 percent of the resistance values given in the charts may be considered normal. However, as a result of differences in the characteristics of the tubes used in the set at the time of the test, voltage readings may vary as much as 15 percent. The use of the test oscilloscope in all cases is recommended as the best means for locating indicator troubles.

TABLE 5-2. RADIO RECEIVER ★R-9A/APN-4—TROUBLE CHART.

Item	*Symptoms*	*Indicated Source of Trouble*	*Notes and Corrective Procedure*
1	Improper illumination of panel light.		
	a. No illumination.	a. (1) Jewel holder assembly improperly adjusted.	a. (1) Check jewel holder by rotating external assembly to the right or left.
		(2) Bulb burned out.	(2) Replace bulb.
		(3) Four-ampere fuse blown.	(3) Remove and interchange with spare. Replace spare at very first opportunity.
		(4) No a-c input to connector J-106.	
	b. Illumination too bright.	b. "80V-115V. LINE VOLTAGE" switch set for 80 volts, with 115-volt input.	b. With terminals 3 and 4 on Plug PL-Q167 shorted with jumper, check a-c voltage between terminals 1 and 2.
	c. Illumination too dim.	c. "80V-115V. LINE VOLTAGE" switch set for 115 volts, with 80-volt input.	c. Same as b.
2	Weak or no output at video connector J-104: (Checked visually on Indicator screen with "Sweep Speed" positions "1," "2," "3," and "4;" or aurally by phones connected between J-104 and ground.)		
	a. With audio or video signal fed to cathode (pin 8) of detector V-103.	a. (1) Power supply failure.	a. (1) Check d-c voltages at pins 5 or 2 of V-108.
		(2) Defective tube -103 or V-104.	(2) Check tubes for open filaments and leakage or shorts between elements.
		(3) Open coupling capacitors C-105 or C-108.	(3) Check by shunting suspected capacitors with a similar capacitor known to be good.
		(4) Open or burned out resistors in filter or video amplifier circuits.	(4) Check for correct voltages and resistances to ground. See charts in figures 8-62 to 8-66 inclusive.
		(5) Grounded center terminal of video connector J-104.	(5) Check for resistance to ground; should be 10,000 ohms.
	b. With modulated i-f signal (1050 kc.) fed to grid (pin 4) of tube V-101-4.	b. (1) Defective tube V-101-4.	b. (1) Perform same check as a.(2).
		(2) Defective i-f transformer T-103-4.	(2) Make resistance checks for open windings; also for shorts in windings or capacitors.
		(3) Defective plate or screen bypass capacitors C-103-9 or C-114.	(3) Check for correct voltage and resistance to ground.
		(4) Short or leakage between elements of amplitude-balance tube V-108.	(4) Check by replacing with tube known to be good.

TABLE 5-2. RADIO RECEIVER *R-9A/APN-4—TROUBLE CHART (Con't)

Item Symptoms	Indicated Source of Trouble	Notes and Corrective Procedure
c. With modulated i-f signal (1050 kc.) fed to grid (pin 4) of tube V-101-3.	c. (1) Defective tube V-101-3.	c. (1) Make same check as a.(2).
	(2) Defective i-f transformer T-103-3.	(2) Make same check as b.(2). Primaries of all i-f transformers: 6.8 ohms. Secondaries of all i-f transformers: 7 ohms.
	(3) Defective screen or plate bypass capacitors C-103-6 or C-103-7.	(3) Make same check as b.(3).
	(4) Open cathode circuit, which includes connectors J-103 (Receiver) and J-305 (Indicator); interconnecting cable; and resistors R-110-2 (at cathode of V-101-3) and R-374 (gain control in Indicator).	(4) Make resistance check between cathode and chassis, while rotating "GAIN" control through its adjustment range. Consult resistance chart, figure 8-62. **Note** Through all c.(4) checks, the "GAIN" interconnecting cable should be thoroughly checked for possible defects.
d. With modulated i-f signal (1050 kc.) fed to grid (pin 4) of tube V-101-2.	d. (1) Defective tube V-101-2.	d. (1) Make same check as a.(2).
	(2) Defective i-f transformer T-103-2.	(2) Make same check as b.(2). A defective i-f transformer whose winding resistances are correct may have a damaged core; remove shield to examine.
	(3) Defective screen or plate bypass capacitors C-103-4 or C-103-6.	(3) Make same check as b.(3).
	(4) Same as c.(4) with exception of R-110-1, cathode resistor for V-101-2.	(4) Make same check as c.(3).
e. With modulated i-f signal (1050 kc.) fed to control grid (pin 8) of amplifier mixer section of V-102.	e. (1) Defective tube V-102.	e. (1) Make same check as a.(2)
	(2) Defective i-f transformer T-103-1.	(2) Make same check as b.(2).
	(3) Defective plate or screen bypass capacitors C-103-1 and C-103-3.	(3) Make same check as b.(3).
Note Use a soldering iron to disconnect green and white lead from wavetrap Z-104-2; replace after test.	(4) Same as c.(4) except for cathode loading coil L-105 and resistor R-103-5.	(4) Make same check as c.(4).
f. With modulated r-f signal fed to control grid (pin 8) of amplifier-mixer section of V-102.	f. (1) Defective oscillator section of V-102.	f. (1) Make same check as a.(2).
	(2) Oscillator coil and switch assembly.	(2) Check at all four CHANNEL switch positions, using correct r-f frequency.
Note The signal generator must be adjusted to the r-f frequency to which the circuits, associated with the r-f channel under test are tuned.	(3) Defective capacitors C-113, C-120, or C-121 (Mod. I, II and III); C-113, C-122, C-123, and C-124 (Mod V).	(3) Replace (one at the time), if tests indicate defective capacitors.
	(4) Shorted windings in coil L-105.	(4) The oscillator circuit is energized by voltage developed across this coil; shorted turns in the winding will prevent oscillation.
g. With modulated r-f signal fed to control grid (pin 4) of r-f amplifier V-101-1. (Signal generator frequencies correct for particular channel under test.)	g. (1) Defective r-f amplifier V-101-1.	g. (1) Make same check as a.(2).
	(2) Defective screen byass capacitor C-103-2 or plate signal-coupling, d-c isolating capacitor C-102.	(2) Check against resistance and voltage charts, figure 8-62 to 8-66 inclusive.
	(3) Defective coil and wavetrap assemblies.	(3) If inoperative at all four "CHANNEL" positions, check wavetraps Z-104-1 and Z-104-2 for short circuits. If operative at some "CHANNEL" positions and inoperative at others, check switch contacts and coils associated with the particular inoperative channel.

TABLE 5-2. RADIO RECEIVER ★R-9A/APN-4—TROUBLE CHART (Con't)

Item	*Symptoms*	*Indicated Source of Trouble*	*Notes and Corrective Procedure*
		(4) Defective cathode and gain control circuit.	(4) Make same check as c.(4). See note under c.(4).
	h. With modulated r-f signal fed to antenna connector J-101. (Signal generator set correctly for particular channel under test.)	h. (1) Grounded center terminal of J-101.	h. (1) Make resistance check.
		(2) Defective antenna coil-assembly. (3) Defective antenna switch assembly, sections S-101A or S-101B.	(2), (3) If inoperative at all "CHANNEL" positions, examine antenna switch terminals and leads for poor contacts or grounds.
		(4) Defective wavetrap Z-103.	(4) Check wavetraps Z-103 and Z-104-1 for defects.
3	Improper signal response to different settings of "AMP. BALANCE" control.	(1) Defective amplitude-balance tube V-108.	(1) Check tubes for open filament, shorts and leakage between elements, and low emission; replace tubes with ones known to be good.
		(2) Defective amplitude-balance cable or connectors J-102 or J-301.	(2) Make resistance check at cathodes of V-101-4 and V-108 with amplitude-balance cable (No. 2) disconnected. Compare with resistance chart, figure 8-62. Make resistance check between center contact of cable while rotating "AMP. BALANCE" control alternately to left and right.
		(3) Defective amplitude-balance control R-355, located on indicator front panel.	(3) Examine leads to control for secure connections. Make resistance check of control for open circuit or poor contacts.
		(4) Defective amplitude-balance follower tube V-303-1, located in indicator.	(4) Same as a.(1).
4	Noise in receiver with center terminal of antenna connector J-101 grounded.	(1) Defective tubes.	(1) Check for leakage and microphonics by watching indicator screen while lightly tapping each tube (except high-voltage rectifiers). Defects which cause noise will be indicated by abrupt deflections in screen display.
		(2) Defective wiring.	(2) Examine wiring for evidence of burns from arc-overs and for poor solder connections (especially important if extensive repairs have been made in field). Do not change the relative position of the wires.
		(3) Defective terminal contacts at tube sockets.	(3) Observe indicator screen while manipulating tubes for evidence of poor socket contact. Poor contact may also exist between tube elements and base pins.
		(4) Defective switch contacts.	(4) Rotate "CHANNEL" selector through its four positions several times to remove small particles of dirt or corrosion. Use a small brush and approved cleaning fluid to remove dirt from switch sections. Do not lubricate switches.
		(5) Defective cables and connectors.	(5) Manipulate all interconnecting cables while watching indicator screen for distortion of screen pattern. Examine connectors and plugs for evidence of decomposition of insulating material.
		(6) Defective power supply, fuses, etc.	(6) Check power-supply input cable and connector. Examine the four-ampere fuse for corrosion or poor contact. Check switches S-103 and S-104 (S-102 in Mod. IV) for clean contact. External shortening of the proper terminals provides a good check for these switches.
		(7) Defective receiver circuit components, including resistors, capacitors, and coils.	(7) Check each stage, starting at the video amplifier, using procedures given under item 2.

TABLE 5-2. RADIO RECEIVER *R-9A/APN-4—TROUBLE CHART (Con't)

Item	*Symptoms*	*Indicated Source of Trouble*	*Notes and Corrective Procedure*
5	Improper regulated d-c voltage (±260).		
		a. (1) Dective 5U4 rectifier tube V-109.	a. (1) Check in tube checker.
		(2) Defective 6B4 voltage-regulator tubes V-105-1, V-105-2, and V-105-3.	(2) Check in tube checker or by substitution with tubes known to be good.
		(3) Defective filter capacitors C-117 and C-119.	(3) Make resistance checks for short circuits.
		(4) Defective power transformer T-104.	(4) Use an a-c voltmeter to measure voltages at transformer terminals.
	b. Low voltage, fluctuating from low to normal.	b. (1) Defective filter capacitor C-118.	b. (1) Check for correct capacity and leakage.
		(2) One or two of the6B4 regulator tubes weak or burned out.	(2) Replace burned out or weak tubes.
	c. Voltage too high; improper response to adjustments of R-121.	c. (1) Defective regulator-control tube V-106 or cathode-stabilizer tube V-107.	c. (1) Same as a.(2).
		(2) Defective voltage-regulator circuit components.	(2) Check individual components for correct values.
6	Improper high-voltage output.		
	a. No high voltage (+1450) between pins 1 and 5 of connector J-105.	a. (1) Defective rectifier tube. V-110-1.	a. (1) Check in tube checker.
		(2) Defective filter capacitor C-111-1.	(2) Check resistance to ground. Be sure capacitor is discharged before making check.
		(3) Burned out resistor R-124.	(3) Check with ohmmeter for proper resistance and continuity.
		(4) Defective power transformer T-105.	(4) Use high scale (2500 volts) a-c voltmeter to check voltage at transformer terminals. **WARNING** Dangerous high voltage between terminals 4, 6, and 7 and chassis.
	b. No high voltage (—1250) between pins 2 and 5 of connector J-105.	b. (1) Defective rectifier tube V-110-2.	b. (1) Make same check as a.(1).
		(2) Defective filter capacitors C-111-2 or C-111-3.	(2) Make same check as a.(2).
		(3) Burned out resistor R-111-2 or R-125.	(3) Make same check as a.(3).
		(4) Defective power transformer T-105.	(4) Make same check as a.(4).

TABLE 5-3. INDICATOR *ID-6B/APN-4—TROUBLE CHART.

Item	*Symptoms*		*Indicated Source of Trouble*		*Notes and Corrective Procedure*
1	No sweep or spot on indicator screen (screen entirely dark).	a.	High-voltage rectifier tube V-110-2 or circuit components.	a.	Check tube in tester or by substitution with tubes known to be good.
		b.	Cathode-Ray tube, transformer T-303.	b.	Use an a-c voltmeter to check voltages at transformer terminals; compare with voltages given in figure 8-35.
		c.	Defective power Cable Cordage CO-239-A, plugs or connectors.	c.	Use ohmmeter to check lead continuity or shorts between leads or terminals.
2	Spot at center of screen.	a.	Defective regulated-voltage power supply.	a.	Check rectifier tube V-109; check voltages at receptacles J-105 and J-302.
		b.	Defective cable assembly. (Cordage CO-239-A.)	b.	Make same check as 1.c.
3	Sine wave on screen.	a.	Voltage-regulator tubes V-106 or V-107 or circuit components.	a.	Check tubes. See corrective procedure in 1.a.
		b.	Weak regulator tubes V-105-1, V-105-2 or V-105-3.	b.	Same check as a. Low emission by either one of the regulator tubes may cause excessive ripple in +260V supply.
4	No control of intensity and improper focus control action.	a.	C-R-T grid-leveler tube V-106 or V-107 or circuit components.	a.	Check tube. See corrective procedure in 1.a.
		b.	Defective intensity control R-363-1.	b.	Check control R-363-1 for mechanical or electrical defects.
*5	No 10-microsecond markers on "SWEEP SPEED" position 5.	a.	100-kc. oscillator or 10-microsecond marker generator tubes V-301-1 or V-302-2.	a.	Check tubes. See corrective procedure 1.a.
		b.	Open capacitors C-307-1, C-310-2 or C-310-3.	b.	Check by shunting with similar capacitor.
		c.	Defective resistors R-301, R-303, R-338, R-340-1, or R-334-2.	c.	Check voltages and resistances to ground at tube sockets; compare with values given in figures 8-49 to 8-51.
		d.	Defective sweep-speed switch section S-303-E1.	d.	Check for mechanical defects or dust and corrosion.
		e.	Defective or incorrectly adjusted oscillator transformer T-301.	e.	Check for adjustment. See paragraph 6.a.
6	No 50 or 500-microsecond markers on "SWEEP SPEED" position 5.	a.	First-counter oscillator tube V-301-2.	a.	Check tube. See corrective procedure in 1.a.
		b.	Defective counter transformer T-302-1.	b. (1)	Make resistance check of transformer windings; secondary terminals 4 and 3 should have 22 ohms ±15%; primary terminals 1 and 2, 33 ohms ±15%.
	Two moving erratic traces on "SWEEP SPEED" position 8.			(2)	Use test oscilloscope to check waveforms; compare with those shown in figure 8-67.
		c.	Defective capacitors or resistors in first-counter circuit.	c.	Make same check at 5.c.
		d.	Defective "A" counter adjustment R-309-1.	d.	Examine for mechanical or electrical defects.
7	No 500-microsecond markers on "SWEEP SPEED" position 5 or 6.	a.	Second-counter diode V-302-1 or feed-back diode V-302-4.	a.	Check tubes. See corrective procedure 1.a.
	Two moving erratic traces on "SWEEP SPEED" position 8.	b.	Defects in capacitors C-313 or C-314.	b.	Make resistance checks at pins 4, 5, and 8. With unit "cold," the reading should show infinity. (See figs. 8-48 to 8-51, inclusive.)

TABLE 5-3. INDICATOR *ID-6B/APN-4—TROUBLE CHART (Con't)

Item	Symptoms	Indicated Source of Trouble	Notes and Corrective Procedure
8	No 500-microsecond markers on "SWEEP SPEED" position 5 and 6.	a. Second-counter oscillator V-301-3 or lefting and third-counter diode V-302-2.	a. Check tubes. See corrective procedure 1.a.
	Single trace (no step pattern) on "SWEEP SPEED" position 8.	b. Defective counter transformer T-302-2.	b. Make same check at 6.b. Also make voltage and resistance checks at tube sockets.
9	No trace on "SWEEP SPEED" positions 5 or 6.	a. Third-Counter oscillator and E. J. sync tube V-301-4.	a. Check tube. See corrective procedure 1.a.
	Single trace on "SWEEP SPEED" positions 1, 7, and 8.	b. Third-Counter transformer T-302-3.	b. Check d-c resistances of primary and secondary windings. See corrective procedure 6.b.
		c. Defective capacitors C-317 or C-318.	c. Check by substitution, or resistance checks at pins 5 and 8 of V-302-2.
		d. Defective counter adjustment "B" (R-309-2).	d. Same as 6.d.
10	A-pedestal near center of screen on "SWEEP SPEED" positions 1 and 7.	a. Fourth-counter diode tube V-302-3.	a. Check tube. See corrective procedure 1.a.
	Five erratic trace lines (no step pattern) on "SWEEP SPEED" position 8.	b. Defective capacitors C-321-1 or C-322.	b. (1) Make resistance checks at pins 4, 5 and 8 or V-302-3; compare with values given in figures 8-48 and 8-49.
			(2) Check by substitutions for open circuits.
11	No A-pedestal on "SWEEP SPEED" positions 1 and 7.	a. Fourth and fifth-counter oscillator tube V-301-5.	a. Check tube. See corrective procedure 1.a.
	Five dots at left edge of screen on "SWEEP SPEED" position 8.	b. Defective counter transformer T-302-4.	b. Same as 6.d.
		c. Defective counter adjustment "C" (R-309-3).	c. Same as 6.d.
12	No sweep on "SWEEP SPEED" positions "1" through "7."	a. Sixth counter and 50- and 500-microsecond marker mixer tube V-301-6.	†a. Check tube. See corrective procedure 1.a.
	Normal step pattern on "SWEEP SPEED" position "8."	b. Defective fifth- or sixth-counter transformers T-302-5 or T-302-6.	b. Same as 6.b.
		c. Defective capacitors or resistors in fifth- and sixth-counter circuits.	c. Check voltages and resistances at tube sockets and compare with values given in figures 8-48 and 8-49.
13	Single trace (no pedestals) on "SWEEP SPEED" position 1.	a. Square-wave generator tube V-301-7.	†a. Check tube. See corrective procedure 1.a.
	No trace on "SWEEP SPEED" positions "2," "3," "4," "5," and "6."	b. Defective capacitors or resistors in circuits associated with tube V-301-7.	b. Check all voltages and resistances at tube socket terminals; compare with values given in figures 8-50 and 8-52.
	Normal step pattern on "SWEEP SPEED" position 8.	c. E. J. sync line from V-301-4 grounded.	c. Make resistance check at pins 4 and 5 of V-301-4. Compare with values given in figures 8-48 and 8-49.

TABLE 5-3. INDICATOR *ID-6B/APN-4—TROUBLE CHART (Con't)

Item	*Symptoms*	*Indicated Source of Trouble*	*Notes and Corrective Procedure*
14	No movement of station selector pattern on "STATION" selector position "1." Improper movement on positions "3," "5," and "7." Normal movement on positions "0," "2," "4," and "6."	a. Second-counter circuit feed-back diode V-302-4. b. Capacitor C-333-1 open. c. Poor contact, section S-301-A3 of "LEFT-RIGHT" control.	a. Check tube. See corrective procedure 1.a. b. Check by substitution. c. Examine for broken lead, dirt, or mechanical or electrical defects.
15	No movement of station selector pattern on "STATION" selector positions "2," "4," and "6." Equal movement (50 microseconds) on positions "1," "3," "5," and "7."	a. Third-counter circuit feed-back diode V-302-5. b. Defective "STATION" selector switch-section S-304-A2.	a. Check tube. See corrective procedure 1.a. b. Examine for mechanical or electrical defects.
16	Single trace showing two pedestals on "SWEEP SPEED" position 1. No amplitude-balance control action.	a. Trace separation and amplitude-balance tube V-303-1. b. Defects in circuit components.	a. Check tube. See corrective procedure 1.a. b. See corrective procedure 13.b.
17	Slight trace separation and multiple pedestals on both traces.	a. "A" delay sync and trace separation tube V-301-8. b. Defective circuit components.	a. Check tube. See corrective procedure 1.a. b. See corrective procedure 13.b.
18	No pedestals and no 50 and 500-microsecond markers.	a. Pedestals and 50/and/500-microsecond marker-mix tube V-301-9.	a. Check tube. See corrective procedure 1.a.
19	Short erratic traces on "SWEEP SPEED" positions "2," "3," "4," "5," and "6." Single trace (no step pattern) on position "8."	a. Sweep-input leveler and video-amplifier tube V-301-10. b. Defective circuit components.	a. Check tube. See corrective procedure 1.a. b. See corrective procedure 13.b.
20	No B pedestal on "SWEEP SPEED" positions "1" and "7." Single trace on "SWEEP SPEED" position "2." Single trace and inverted pedestal on "SWEEP SPEED" position "3." Bright spot at left edge of screen on "SWEEP SPEED" positions "4" and "5."	a. B-fine delay tube V-301-11 or B-coarse delay tube V-301-12. b. Defects in circuit components of fine delay tube V-301-11. (1) Variable controls in input grid circuit. (2) Fixed resistors and capacitors in grid and plate circuits. (3) Open coupling capacitors C-340, C-336-2 or C-337-4. c. Defects in circuit components of coarse delay tube V-301-12. (1) Variable controls, including switch S-304-C in input grid circuit.	a. Check tube. See corrective procedure 1.a. b. (1) Make voltage and resistance checks while rotating controls through their ranges. (2) See corrective procedure 13.b. (3) Check by substitution. c. (1) Same as b.(1) above.

TABLE 5-3. INDICATOR *ID-6B/APN-4—TROUBLE CHART (Con't)

Item	Symptoms	Indicated Source of Trouble	Notes and Corrective Procedure
	Single trace showing 50 and 500-microsecond markers on position "6."	(2) Fixed resistors and capacitors in plate and grid circuits. (3) Open capacitors C-338-2, C-309-2, and C-341-1.	(2) Same as 13.b. (3) Same as b.(3) above.
21	No pedestals on traces at "SWEEP SPEED" positions "1" and "7." No sweep action on positions "2," "3," "4," "5," and "6."	a. Delay inverter and mixer tube V-303-3B; pedestal-generator tube V-301-15. b. Defective circuit components in delay-mixed or pedestal-generator circuit. c. Open coupling capacitors C-305-4, C-346, or C-320-6.	a. Check tubes. See corrective procedure 1.a. b. Check voltages and resistances; compare with values given in figures 8-50 and 8-51. c. Check by shunting with capacitors known to be good.
22	No A-pedestal on "SWEEP SPEED" positions "1" and "7." Single trace on position "2." Large pedestal at left edge of screen on position "3." Bright spot at left edge of screen on positions "4" and "5." Single trace with normal markers on position "8."	a. A-pedestal delay tube V-301-13. b. Defective circuit components. c. Open capacitors C-337-2, C-335-3, C-342-1, or C-337-3.	a. Check tubes. See corrective procedure 1.a. b. Check voltages and resistances at tube sockets. Compare with values given in figures 8-50 and 8-51. c. Check by shunting with capacitors known to be good.
23	Two spots at left edge of screen on "SWEEP SPEED" positions "1," "2," "3," "5," "6," and "7." Five spots at left edge of screen on position "8."	a. Sweep-generator tube V-304. b. Defective circuit components.	a. Check tube. See corrective procedure 1.a. b. Check voltages and resistances; compare with values given in figures 8-50 and 8-51.
24	No traces on "SWEEP SPEED" positions "1," "7," and "8." Half-length traces on positions "2," "3," "4," "5," and "6."	a. Sweep-inverter tube V-301-14. b. Defective circuit components.	a. Check tube. See corrective procedure 1.a. b. Check voltages and resistances; compare with values given in figures 8-50 and 8-51.
25	Pattern on left half of screen on "SWEEP SPEED" positions "1," "7," and "8."	Horizontal-centering diode V-302-7.	Check tube. See corrective procedure 1.a.

*Failure of the 100-kc. oscillator tube or circuit has very little effect on the screen patterns on Indicator *ID-6B/APN-4, except that no 10-microsecond markers appear. A simple method of determining whether the oscillator is operating is to observe the received signals. If the oscillator is inoperative, received signals cannot be synchronized with the indicator circuits on any "STATION" position and will move across the indicator screen continuously.

†For dependable operation of the indicator, the emission test for the 6SN7 tubes used in the 100-kc. oscillator circuit, the sixth-counter circuit and square-wave generator circuit should not show more than 5 per cent deviation from the normal value for this type of tube.

TABLE 5-4. RADIO RECEIVER *R-9/APN-4—TROUBLE LOCATION CHART.

Trouble	*Check*	*References*
No pattern on indicator screen with "INTENSITY" fully clockwise.	Disconnect Plug PL-Q171 from indicator and check voltages at cable connector pins.	See section V, paragraph 2(b) (voltage chart) and figure 1-4.
No. 80 volts alternating current (pins 3 to 4).	Check power source, power cable and connector, and 4-ampere fuse on receiver pulse.	Figures 1-3 and 8-30.
No. 1300 volts (pin 1 to chassis).	Defective rectifier tube V-110-1, short in wiring, or capacitor C-111-1.	Figures 8-7 and 8-30.
No. 1300 volts minus (pin 2 to chassis).	Defective rectifier tube V-110-2 or short in wiring or capacitor C-111-2 or C-111-3.	Figures 8-7 and 8-30.
No. 260 volts plus (pin 6 to chassis).	Defective rectifier tube V-109, voltage control tube, V-106, or improper setting of R-121.	Figures 8-7, 8-8 and 8-30.
Low or no voltage, V-105 plate (pin 3) to chassis.	Transformer T-104 tube, V-109, and capacitor C-117.	Figures 8-7 and 8-30.
Low or no voltage, V-105 grid (pin 5) to chassis.	Resistor R-115 (panel 4).	Figures 8-9 and 8-30.
Low or no voltage, V-106 plate (pin 8) to chassis.	Resistor R-116-1 (panel 4).	Figures 8-9 and 8-30.
Low or no voltage, V-106 cathode (pin 5) to chassis.	Resistors R-117 and R-119 (panel 4), capacitor C-118-1.	Figures 8-8, 8-9 and 8-30.
Low or no voltage, V-106 grid (pin 4) to chassis.	Resistors R-118, R-120, R-121 (panel 4), capacitor C-118-2.	Figures 8-8 and 8-30.
Low or no voltage, V-104 plate (pin 2) to chassis.	Resistor R-105-1 (panel 5), capacitor C-108.	Figures 8-8, 8-9 and 8-30.
Low or no voltage, V-104-4 plate (pin 8) to chassis.	Resistor R-103-4 (panel 6), transformer T-103-4, and capacitor C-103-9 (panel 6).	Figures 8-7, 8-8, 8-9 and 8-30.
Low or no voltage, V-101-4 screen (pin 3) to chassis.	Resistor R-101-2 (panel 6), capacitor C-114 (panel 6).	Figures 8-8, 8-9 and 8-30.
Low or no voltage, V-103-3 plate (pin 8) to chassis.	Resistor R-103-3 (panel 3), transformer T103-3 and capacitor C-103-7 (panel 6).	Figures 8-7, 8-8, 8-9 and 8-30.
Low or no voltage, V-101-3 screen (pin 3) to chassis.	Resistor R-104 (panel 6), capacitor C-103-6 (panel 6).	Figures 8-8, 8-9 and 8-30.
Low or no voltage, V-101-2 plate (pin 8) to chassis.	Resistor R-103-2 (panel 6), transformer T-103-2, capacitor C-103-4 (panel 6).	Figures 8-7, 8-8, 8-9 and 8-30.
Low or no voltage, V-101-2 screen (pin 3) to chassis.	Resistor R-104 (panel 6), capacitor C-103-6 (panel 6).	Figures 8-8, 8-9 and 8-30.
Low or no voltage, V-102 plate (pin 3) to chassis.	Resistor R-103-1 (panel 6), transformer T-103-1, capacitor C-103-1 (panel 6).	Figures 8-7, 8-8, 8-9 and 8-30.
Low or no voltage, V-102 screen (pin 4) to chassis.	Resistor R-102-2 (panel 3), capacitor G-103-3 (panel 3).	Figures 8-7, 8-9 and 8-30.
Low or no voltage, V-101-1 plate (pin 8) to chassis.	Resistor (R-102-1 (panel 1), capacitors C-102 (panel 1), C-109-2, G-112-1.	Figures 8-8, 8-9 and 8-30.
Low or no voltage, V-101-1 screen (pin 4) to chassis.	Resistor R-101-1 (panel 1), capacitor C-103-2 (panel 1).	Figures 8-8, 8-9 and 8-30.
Low or no output.	Defective tubes, r-f or i-f alignment, defective r-f or i-f transformers.	

TABLE 5-5. FOR INDICATOR *ID-6/APN-4—TROUBLE LOCATION CHART.

Trouble	*Check*	*References*
No illumination of cathode ray with "INTENSITY" control full clockwise.	Power source at generator and at power connector.	80 or 115 volts alternating current across auxiliary power plug.
	Voltage at indicator power connector Plug PL-Q171 CAUTION, HIGH VOLTAGE!	Pin 5 to pin 1, +1300 volt pin 1 is positive; pin 5 to pin 2, —1300 volts, pin 2 is negative; pin 3 to pin 4, 80 volts, alternating current.
	Cathode ray tube V-304 for beater operation.	
Stationary spot near center of screen.	Voltage output from PL-Q171 connector.	Pin 5 to pin 6, +260 pin 6 is positive.
Stationary spot near edge of screen at all "SWEEP SPEED" switch position.	Counter-circuits and counterchain tubes V-301-4A, V-302-2, V-302-4, V-301-2A, V-301-3, V-302-1, V 302-3, V-301-1.	See voltage and resistance diagrams figures 8-26 and 8-27 circuits, figure 4-13.
Stationary spot at "SWEEP SPEED" positions "2," "3," "4," "5," and "6;" only one trace, positions "1" and "7."	Square-wave generator circuit and tubes V-301-4B and V-301-10. Resistor R-347.	See voltage and resistance diagram figures 8-27 to 8-29, also figures 4-18 and 4-28.
Two stationary spots near edge of screen.		See voltage and resistance diagrams, and paragraph 5c, section V.
At all positions of "SWEEP SPEED" switch.	Sweep generator circuits and tubes V-305, V-302-7.	See figures 4-22, 4-27 and 8-13.
At "SWEEP SPEED" positions "1" and "7" only.	Pulse broadener circuit and tube V-301-13A.	See voltage and resistance diagrams, also figure 4-22.
At "SWEEP SPEED" positions "2," "3," "4," "5," and "6."	Pedestal generator tube V-301-14.	See voltage and resistance diagrams, figures 8-27 and 8-28 and paragraph 3*b* (3)*(b)*, section V, and figures 4-21, 4-22, 4-27 and 8-13.
	S-303-C and S-303-F Diode-connected section of V-301-11.	
	Phase inverter section of V-301-13B.	
	Delay mixer and inverter tubes V-301-7 and V-303-1B.	
Pedestal on A-trace, none on B-trace, "SWEEP SPEED" positions "1" and "7."	B-delay circuits and tubes V-301-8A, V-303-1A, V-301-9, V-301-6, V-401-7B.	See voltage and resistance diagrams, figures 8-27 and 8-28, also figure 4-20.
Pedestal on B-trace, none on A-trace, "SWEEP SPEED" positions "1" and "7."	A-delay circuits and tubes V-301-5, V-301-7A.	See voltage and resistance diagrams, figures 8-27 and 8-28, also figure 4-19.
No pedestals on traces, "SWEEP SPEED" positions "1" and "7" (traces on all "SWEEP SPEED" positions).	Pedestal mixer circuit and tube V-301-12A.	See voltage and resistance diagrams, figures 8-27 and 8-28, also figures 4-30.
One trace only with pedestals, "SWEEP SPEED" positions "1" and "7."	Amplitude balance follower trace separation circuits and tubes V-303-3 and V-301-8B.	See voltage and resistance diagrams, figures 8-27 and 8-28, also figure 4-28.
No 10-microsecond markers, "SWEEP SPEED" position "5."	10-microsecond marker generator circuit and tube V-303-2.	See voltage and resistance diagrams, figures 8-26 and 8-27, also figure 4-29.
No 50 or 500-microsecond markers, "SWEEP SPEED" switch position "6."	50-500-microsecond marker circuits and tube V-301-2B.	See voltage and resistance diagrams, figures 8-26 and 8-27, also figure 4-29.
Markers too short at "SWEEP SPEED" positions "5" and "6."	Signal marker amplifier circuits and tube V-301-11A.	See voltage and resistance diagrams, figures 8-27 and 8-28, also figure 4-30.
Trace shifts on screen when "SWEEP SPEED" switch is changed from positions "1" and "7" to "2," "3," "4," "5," or "6."	D-C restorer diode circuit and tube V-302-7.	See voltage and resistance diagrams, figures 8-27 and 8-28, also figure 4-22.
Trace shift focus when "SWEEP SPEED" switch is changed from positions "1" and "7" to "2," "3," "4," "5," or "6."	"INTENSITY" leveler diode circuit and tube V-302-8.	See voltage and resistance diagrams, figures 8-26 and 8-27, also figure 4-31.

4. REPLACEMENT OF FUSES AND LAMPS.

Receiver ★R-9A/APN-4 has two fuse extractor posts, "4 AMP.-250V." and "SPARE," mounted on the front panel. To change fuses, unscrew the extractor post caps, and reverse their position in the posts. To change the receiver indicator lamp, unscrew the jewel cap and nut assembly, and replace it with a mazda type 47, 0.150A, 6-8v, or equivalent. To replace the station selector indicator-lamp, unscrew the cap located directly above the "STATION" selector switch, and replace the lamp with a mazda type 322, 190A, 3v.

5. MAINTENANCE PRECAUTIONS FOR REPLACEMENT OF DEFECTIVE PARTS.

a. When soldering connections, be careful not to burn surrounding wiring or parts.

b. Be sure that all mounting bolts or screws are replaced and securely tightened.

c. Be careful not to disturb lead dress in critical circuits.

d. When repairing high-voltage supplies, avoid positioning wiring or leads where arc-over might occur.

6. ALIGNMENT.

a. RADIO RECEIVER ★R-9A/APN-4.—Do not attempt receiver realignment before first making certain that misalignment is the cause of faulty operation. When an i-f or r-f transformer component or complete assembly is replaced, readjust only the disturbed assembly. Should any i-f stage fail to respond properly to the following alignment procedure, check the individual stage where failure is first indicated. A voltage and resistance check will show most causes of failure. These checks should be individual checks of i-f transformer windings. (The primaries of the i-f transformers have a resistance of approximately 6.8 ohms; the secondaries, approximately 7 ohms.) If the resistance and voltage checks appear normal, remove the transformer shield and examine the iron cores.

(1) I-F ALIGNMENT, AM METHOD. *(See par. 6c(1), following for preferred procedure.)*

(a) EQUIPMENT REQUIRED.

1. Signal Generator I-72-H, I-72-J, or Navy Model LM-( ) or LP-( ).

2. D-C voltmeter, either VTVM or 20,000-ohm-per-volt meter.

3. 500-micromicrofarad capacitor.

4. .01-micromicrofarad capacitor.

(b) PROCEDURE FOR RADIO RECEIVERS ★R-9A/APN-4 AND ★R-9B/APN-4.

1. Set voltmeter on 10 or 15-volt range.

2. Connect positive test lead of voltmeter to receiver chassis and negative test lead to diode-detector plate (pin 5 of V-103).

3. Connect 500-micromicrofarad capacitor across secondary of fourth intermediate-frequency transformer (between pin 8 or V-103 and ground).

4. Disconnect amplitude-balance cable, leaving remaining interconnecting cables in place.

5. Detune both primaries and secondaries of all four i-f transformers, by turning their adjustment screws counterclockwise as far as they will go. Do not force.

6. Remove r-f amplifier tube V-101-1 from its socket, and adjust "GAIN" control on indicator to approximately three-fourths of maximum gain position.

7. Connect ground lead of signal generator to receiver chassis and output lead through 0.01-mf. capacitor to control grid (pin 4) of third i-f amplifier V-101-4.

8. Turn power switches of both signal generator and receiver to "ON" position. Allow five minutes for all tubes to warm up.

9. Adjust signal generator frequency control to 1055 kilocycles and its output control to provide a signal to the receiver of one-half to one volt.

10. Adjust primary of fourth i-f transformer T-103-4 for maximum deflection of d-c meter (on low-voltage range, if necessary, to obtain satisfactory reading).

11. Remove 500-micromicrofarad capacitor.

CAUTION

Do not touch primary again after adjustment.

12. Adjust secondary of T-103-4 for maximum meter deflection. Readjust signal generator output to obtain meter reading of approximately five volts.

13. Measure output voltage at 1022 kilocycles and 1087 kilocycles. These voltages should be approximately one-half the voltage at 1055 kilocycles and should not differ by more than 0.1 volt. If the difference exceeds 0.1 volt, readjust T-103-4 secondary to obtain equal readings. Clockwise rotation of the adjustment screw should raise the voltage reading at 1022 kilocycles, while counterclockwise rotation of the adjustment screw should raise the voltage reading at 1087 kilocycles.

14. Check overall response, by slowly changing signal generator frequency from 1022 kilocycles to 1087 kilocycles and watching voltmeter reading. There should be no abrupt increase in voltage reading at any frequency.

15. Remove signal generator lead from pin 4 of V-101-4. Connect 500-micromicrofarad capacitor between pin 4 of V-101-4 and ground (across secondary of third i-f transformer T-103-3).

16. Retune signal generator to 1055 kilocycles, and then connect its output lead through 0.01-microfarad capacitor to control grid (pin 4) of second i-f amplifier tube V-101-3.

17. With "GAIN" control still at three-fourths maximum position, adjust primary of third i-f transformer T-103-3 to obtain maximum reading on voltmeter. Readjust signal-generator output control to keep voltmeter reading at approximately five volts direct current. Carefully touch up primary adjustment for absolute peak reading on voltmeter. Do not touch this adjustment again throughout the remaining adjustment procedure.

18. Remove 500 - micromicrofarad capacitor. Adjust secondary of third i-f transformer T-103-3 for maximum reading on voltmeter. Readjust signal generator output to obtain voltemeter reading of approximately five volts d-c.

19. Adjust signal generator frequency to 1022 kilocycles, and note meter reading; then adjust signal generator to 1080 kilocycles, and again note meter reading. Both readings should be the same and approximately one-half the peak meter reading obtained between these two frequencies. If the meter readings are not the same for both frequencies, touch up the secondary adjustment, and check adjustments as explained in step 14.

20. Remove signal generator lead from pin 4 of V-101-3, and connect 500-micromicrofarad capacitor between pin 4 of V-101-3 and ground (across secondary of second i-f transformer T-103-2).

21. Retune signal generator to 1055 kilocycles, and connect its output lead through 0.01-microfarad capacitor to control grid (pin 4) of first i-f amplifier tube V-101-2.

22. Adjust primary of T-103-2, using procedure given in step 17. *(Do not touch primary of T-103-3.)*

23. Remove 500-micromicrofarad capacitor, and then adjust secondary of second i-f transformer T-103-2 for maximum reading of voltmeter. Readjust signal generator output to keep meter reading approximately five volts d-c.

24. Adjust signal generator frequency first to 1024 kilocycles; then to 1079 kilocycles. The meter readings at these two frequencies should be equal and approximately one-half the peak voltmeter reading obtained between these two frequencies. Touch up secondary tuning adjustment to obtain this condition.

25. Carefully change signal generator frequency from 1024 kilocycles to 1079 kilocycles, and observe voltmeter readings. The voltage rise or fall at the lower frequency side of 1050 kilocycles will be slightly faster than the rise or fall at the higher frequency side of 1050 kilocycles. Should sharp voltage peaks be indicated by the meter as the signal generator frequency is slowly changed from 1024 kilocycles to 1079 kilocycles, check tubes and screen, plate, and cathode bypass capacitors for defects which could cause regeneration. These checks may be carried out by substitution, using components having the required characteristics and known to be good.

26. Remove signal generator output lead from pin 4 of V-101-2. Connect 500-micromicrofarad capacitor between control grid (pin 4) of V-101-2 and ground (across secondary of first i-f transformer T-103-1).

27. Using a soldering iron, disconnect green and white lead of wave trap Z-104-2 from pin 8 of oscillator mixer tube V-102.

28. Connect signal generator output lead through 0.01-microfarad capacitor to control grid (pin 8) of oscillator mixer tube V-102.

29. Retune signal generator to 1055 kilocycles, and adjust primary of first i-f transformer T-103-1 for maximum reading on voltmeter. Readjust signal generator output to keep voltmeter reading at approximately five volts direct current, and touch up primary for peak reading on voltmeter. If erratic meter readings are encountered, retard "GAIN" control to reduce amplified circuit noises.

30. Remove 500-micromicrofarad capacitor, and adjust secondary of T-103-1 for maximum meter deflection. Readjust signal generator output to keep voltmeter reading at approximately five volts direct current. Note first position of secondary adjustment screw where maximum voltmeter reading is obtained, then continue clockwise rotation of screw, while carefully watching meter for any abrupt voltage peaks; note position of screw when meter reading begins to drop. Center adjustment between the two noted positions.

31. Vary signal generator frequency slowly from 1024 kilocycles to 1077 kilocycles, and observe voltmeter readings. The meter reading should not change between 1046 kilocycles and 1054 kilocycles. If the meter reading is not constant between 1046 kilocycles and 1054 kilocycles, touch up secondary adjustment until this condition is obtained. Should it be found impossible to obtain a constant meter reading between 1046 kilocycles and 1054 kilocycles by adjustment of the secondary of T-103-1, adjust secondary of T-103-1 until smallest difference between the meter readings at 1046 kilocycles and 1054 kilocycles is obtained. Then go back to the secondary of fourth i-f transformer T-103-4, and make slight adjustment, until constant meter reading between 1046 kilocycles and 1054 kilocycles is obtained.

32. Check overall response of i-f channel. The voltage chart should be nearly symmetrical, without abrupt peaks at any frequency between 1024 kilocycles and 1077 kilocycles, at which frequencies the meter reading should be approximately one-half the reading obtained at 1050 kilocycles.

33. Resolder green and white lead of wave trap Z-104-2 to control grid (pin 8) on oscillator mixer tube V-102. Dress lead to its former position with relation to the rest of the wiring.

(c) PROCEDURE FOR RADIO RECEIVER ★R-9/APN-4 (MODIFICATIONS I and II).

1. The frequencies of 1050 kilocycles and 1055 kilocycles, where used, remain the same for aligning all modifications of the receiver.

Frequency for Modifications III and IV	*Frequency for Modifications I and II*	*Sub-Paragraph*
1022 kilocycles becomes 1087 kilocycles becomes	989 kilocycles 1119 kilocycles	*13, 14*
1022 kilocycles becomes 1080 kilocycles becomes	993 kilocycles 1109 kilocycles	*19*
1024 kilocycles becomes 1079 kilocycles becomes	996 kilocycles 1106 kilocycles	*24, 25*
1024 kilocycles becomes 1077 kilocycles becomes 1046 kilocycles becomes 1054 kilocycles becomes	997 kilocycles 1103 kilocycles 1042 kilocycles 1058 kilocycles	*31r, 33*

2. The overall response curves for modifications I and II are similar in form to those for modifications III and IV, the difference being in the width of the bandpass, which is approximately 60 kilocycles wide at two times down for modifications III and IV and 95 to 115 kilocycles wide for modifications I and II. The statement "bandwidth at two times down" represents the difference between the lowest frequency setting and the highest frequency setting of the signal generator at which the output (indicated by the meter) is one-half that obtained at the center frequency.

(2) WAVE TRAP ALIGNMENT.—Readjustment of the wave traps is necessary only when the i-f amplifier has been completely realigned or the traps themselves improperly adjusted. Procedure for readjustment follows.

(a) Connect output meter, throughout its series capacitor to plate (pin 5) of detector tube V-103.

(b) Connect ground lead of signal generator to receiver chassis; connect signal generator output lead to control grid (pin 4) of r-f amplifier tube V-101-1.

(c) Adjust "GAIN" control on indicator panel as far as possible, without bringing in too much noise response. Set signal generator for 1050 kilocycles; adjust its output control until output meter reads nearly full scale. Adjust wave trap Z-104-2 for minimum indication on output meter. Advance signal generator output control as the meter reading falls, so that exact minimum output may be found for the adjustment.

(d) Connect signal generator output lead to antenna connector J-101 (coded green). Adjust wave trap Z-103 and Z-104-1 for minimum output, indicated by the output meter. Considerable interlocking exists between adjustments of Z-103 and Z-104-1; touch-up both adjustments until further adjustment of either trap to the left or right causes an increase in the reading on the output meter.

(3) R-F ALIGNMENT.—Alignment of the r-f section in Radio Receiver ★R-9A/APN-4 is necessary only when one of the components in the r-f transformer systems, or a portion of one of these components, has been replaced, or when the receiver is to be tuned to a new frequency. The available r-f frequencies vary with the different receiver modifications. See section VI, paragraph a.*e.* for correct channel frequencies.

IMPORTANT

Do not touch i-f alignment screws when r-f alignment adjustments are being made.

(a) EQUIPMENT REQUIRED.

1. Signal Generator I-72 or equivalent.

2. Output Meter Type 571 (with external capacitor) or vacuum tube voltmeter.

3. One 50-ohm resistor.

(b) PROCEDURE.

1. Connect output meter to receptacle marked red, or pin 5 of detector V-103, through series capacitor provided with output meter.

2. Connect signal generator to control grid (pin 8) of oscillator mixer tube V-102.

3. Turn on receiver and signal generator.

4. Set receiver to channel which is to be aligned.

5. Adjust signal generator output control to maximum position.

6. Rotate receiver "GAIN" control to a point near maximum. This point, limited by the noise level shown on the output meter, should be as high as possible and consistent with low noise output.

7. Adjust signal generator frequency control for maximum response on output meter. The signal generator is now set to the frequency at which the channel is aligned.

8. Move signal generator frequency control in the direction of new frequency (or to the new frequency), adjusting generator output control to keep output meter reading at no more than half scale.

Note

Clockwise rotation of receiver alignment screws causes a decrease in the aligned frequency, while counterclockwise rotation causes the frequency to increase.

9. Turn proper adjustment screw in oscillator coil assembly in direction which causes an increase in output. (See fig. 5-3.) Retard output control of signal generator to keep output meter reading near center of scale.

10. Adjust signal generator in direction of new frequency or exactly to new frequency, if possible. Increase output of signal generator, as required, to keep output meter near center scale.

11. Set oscillator adjustment for maximum output at new frequency by continuing steps 9 and 10.

12. Move signal generator output lead to control grid (pin 4) of r-f amplified V-101-1. Adjust r-f adjustment screw (assembly Z-105) associated with channel being aligned, for maximum reading on output meter.

13. Move signal generator output lead to "ANT." connector J-101. Adjust power antenna adjustment screw (assembly Z-102) for maximum deflection of output meter.

14. Swing signal generator frequency control to either side of the new carrier frequency, and note the frequency settings at which the output, indicated by the meter, is one-half the above maximum reading.

15. Adjust oscillator adjustment screw until the two frequencies are an equal number of kilocycles each side of the desired carrier frequency.

16. Realign r-f coil and antenna transformer for maximum output meter reading.

b. INDICATOR ★ID-6B/APN-4.—No special equipment other than screw drivers of the proper size and material is needed for indicator alignment, since the screen patterns provide the necessary indications of adjustments. Metallic screw drivers may be used for all adjustments except those associated with the station-selector alignment. If major repairs or replacements have been made, several adjustments, especially those associated with the counters, horizontal amplitude, intensity and focus, will show effects of inter-action. An occasional touch-up of previous adjustments will be necessary as the alignment procedure progresses.

(1) 100-KILOCYCLE OSCILLATOR ALIGNMENT.

(a) With the indicator properly connected for operation, turn "PWR-ON-OFF" (or "POWER") switch on receiver front panel to "ON."

(b) Allow five minutes for the tubes to warm up, after which adjust "INTENSITY" and "FOCUS" controls to obtain proper brilliance and definition of screen pattern.

(c) Turn "SWEEP SPEED" control to position "5" and "CRYSTAL PHASING" until capacitor rotor plates are fully enmeshed with stator plates.

(d) Loosen nut which locks adjusting screw on transformer T301; then rotate screw clockwise until the 100-kc. oscillations cease. See figure 8-11. If the adjustments are being made on Indicator ★ID-6/APN-4 or Indicator ★ID-6A/APN-4, the trace pattern either disappears entirely, or the 10-microsecond markers appear spaced as much as twice their normal distance apart. If the adjustments are being made on Indicator ★ID-6B/APN-4, cessation of oscillation is indicated by the disappearance of the 10-microsecond markers on the tracer. (A test oscilloscope may be substituted for the indicator by connecting the vertical input connection to pin "5" on tube V301.)

(e) Turn adjustment screw counterclockwise until 10-microsecond markers reappear; continue counterclockwise rotation an additional one and one-half turns. If the 10-microsecond markers do not disappear with full clockwise rotation of the adjustment screw, leave approximately three-eighths inch of adjusting screw showing.

(f) Set panel adjustment "A" near center of its mechanical range. Rotation of the 10-microsecond phasing control, R-303, alternately to the extreme left or right, should permit the movement of a 10-microsecond marker from one side of the 50-microsecond markers to the other. (See fig. 8-43.) Touch-up the adjustment of the 100-kilocycle oscillator to obtain this condition.

(g) Lock adjustment screw by retightening its locknut.

(h) With "CRYSTAL PHASING" at maximum capacitive setting, turn equipment off and on several times. Watch the trace pattern for the appearance of the 10-microsecond markers. There should be no delay in their appearance with the rest of the screen display.

(2) COUNTER CIRCUIT ALIGNMENT.

(a) ADJUSTMENT "A."

1. Turn "SWEEP SPEED" control to position "5." (See fig. 2-11.) Use a screw driver to turn adjustment "A," located on the indicator front panel, to full counterclockwise position. Three, and sometimes four, short (10-microsecond) markers should appear between the longer (50-microsecond) markers on each trace. Should the screen display consist of only one trace or of two parallel traces interlaced with one or more non-parallel traces, check the adjustments of square-wave generator control R347, "A" pedestal control R320-1, or the front panel adjustments associated with the "B" pedestal positioning. See section V, paragraph 6.*b*.(4) *(b)2.* for definite adjustment instructions.

2. Turn adjustment "A" to full clockwise position. A minimum of six 10-microsecond markers should now appear between the 50-microsecond markers. Return adjustment "A" to mechanical center of its range, at which setting four 10-microsecond markers should appear between the 50-microsecond markers.

3. Carefully rotate adjustment "A" alternately to the left and right, noting mechanical setting at which screen pattern becomes unstable or changes count.

4. Set adjustment "A" between these two positions and at the point providing symmetry and minimum amplitude of the 50-microsecond markers. Should the required setting be too near either of the mechanical settings where instability of pattern occurs, reset the 10-microsecond marker phasing adjustment R-303. (See figs. 8-46 and 8-60 for location of this control.)

(b) ADJUSTMENT "B."

1. Turn "SWEEP SPEED" control to position "6." The trace pattern appearing on the screen should be similar to that shown in figure 2-12.

2. Rotate screw driver adjustment "B" to full counterclockwise position. A minimum of five 50-microsecond markers (the shorter of the downward deflected markers) should appear between two double-markers, consisting of one long 500-microsecond marker and a 50-microsecond marker to its left.

3. Turn adjustment "B" to full clockwise position; rotate "FINE" control until two of the double markers appear on the bottom trace. Eleven or twelve 50-microsecond markers should now appear between the double markers.

4. Return adjustment "B" to a setting near mechanical center of its range, at which position nine 50-microsecond markers or ten 50-microsecond spaces appear between the double markers.

5. Rotate adjustment "B" alternately to the left and right; watch screen pattern carefully, and finally set adjustment at midpoint within range providing current pattern, shown in figure 2-12.

(c) ADJUSTMENT "C."

1. Turn "SWEEP SPEED" control to position "7." With the "PRR" switch at position "L" the normal screen pattern should be as shown in figure 2-13.

2. Turn screw driver adjustment "C" to full counterclockwise position. A maximum of three 500-microsecond markers should appear between the 2500-microsecond markers which extend slightly above the traces as well as below them.

3. Rotate adjustment "C" to full clockwise position. A minimum of five 500-microsecond markers should appear between the 2500-microsecond markers.

4. Return adjustment "C" to approximate center of its range. Four 500-microsecond markers (five 500-microsecond spaces) should now appear between the 2500-microsecond markers. Center adjustment between the two points of adjustment where instability or pattern change begins.

(d) ADJUSTMENT "D."

1. With "SWEEP SPEED" control remaining at position "7" and "PRR" switch at position "L," rotate adjustment "D" to full counterclockwise position. The normal trace pattern shown in figure 2-13 should now appear shortened until only four or five 2500-microsecond markers appear.

2. Rotate adjustment "D" toward its full clockwise position. A setting slightly to the right of the mechanical center of the adjustment range will provide again the correct pattern (eight 2500-microsecond markers). Further rotation of adjustment "D" will cause the traces to move off the right edge of the screen.

3. Return adjustment "D" to the position which provides eight 2500-microsecond markers for each trace (the traces end with the eight 2500-microsecond marker). Center adjustment "D" within range providing correct pattern.

(e) ADJUSTMENT D2 (MODIFIED INDICATOR ★ID-6A/APN-4 ONLY) AND ADJUSTMENT E (INDICATOR ★ID-6B/APN-4 ONLY).

1. With "SWEEP SPEED" control remaining at position "7," throw "PRR" switch to position "H." The screen pattern should be approximately that shown in figure 2-14.

2. Rotate screw driver adjustment "E" (Indicators ★ID-6B/APN-4) or "D2" (Indicator ★ID-6A/APN-4 modified in accordance with Technical Order 16-35ID6-21) to full counterclockwise position. The screen display should consist of two shortened and jittery trace patterns, showing three or four 2500-microsecond markers.

3. Rotate adjustment "E" (Indicators ★ID-6B/APN-4) or "D2" (Indicator ★ID-6A/APN-4 modified in accordance with Technical Order 16-35ID6-21) clockwise. Approximately 30 degrees to the right of its mechanical center position a normal pattern, showing six 2500-microsecond markers on each trace, should appear. Further clockwise rotation of the adjustment will cause the traces to move off the right edge of the screen.

4. Return adjustment "E" (Indicator ★ID-6B/APN-4) or "D2" (Indicator ★ID-6A/APN-4 modified in accordance with Technical Order 16-35ID6-21) to position which provides six 2500-microsecond markers on each trace, and center adjustment within range which gives correct pattern.

(3) STATION SELECTOR ALIGNMENT.

(a) FEEDBACK VOLTAGE ADJUSTMENT.—Correct adjustment of control R-329 provides the right amount of feedback voltage for station selector adjustments. (See fig. 8-61.) For Indicators ★ID-6/APN-4 and ★ID-6A/APN-4 this control is symbolized R341-2 and mounted on the right of the indicator chassis as shown in figure 8-12. For Indicator ★ID-6B/APN-4 this control is symbolized R329 and mounted on the lower left side of the indicator near the front panel. Before attempting alignment of any "STATION" selector adjustments, adjust the feedback, using the following procedure:

1. Turn "SWEEP SPEED" control to position "8" and "STATION" selector to position "4."

2. Adjust screw driver adjustment "4" to center of its adjustment range. This adjustment is lettered "H" on the front panels of Indicators ★ID-6/APN-4 and ★ID-6A/APN-4, and is centered when the screw driver slot is at vertical position. The corresponding adjustment on Indicator ★ID-6B/APN-4 is lettered "4" and is mechanically centered when the screw driver slot is at horizontal position.

3. If either Indicator ★ID-6/APN-4 or ★ID-6A/APN-4 is being aligned, adjust R341-2 until the screen pattern is like that shown in figure 2-19A. Adjust for exact horizontal alignment of the dots in column "X" with the dots in the column on either side. Check the adjustment by rotating panel adjustment "H" alternately to extreme left and right positions. The movements of the dots in column "X" up or down from their correct alignment should be the same for both extreme positions of adjustment "H."

4. If Indicator ★ID-6B/APN-4 is being aligned, adjust feedback control R329 until "X," figure 2-19, is in exact horizontal alignment with "Y." Check feedback adjustment by rotating "STATION" selector adjustment "4," alternately to the left and right. Movement of adjustment "4" to the extreme left or right position should cause nearly equal movement of "X" above and below horizontal alignment with "Y." Return adjustment "4" to position providing horizontal alignment of "X" and "Y." Turn "STATION" selector to position "5." The "X" part of the screen pattern should move a step to the left of the position it held for "STATION" position "4." The horizontal alignment of "X" and "Y," however, should remain unchanged.

(b) STATION ALIGNMENT (INDICATORS ★ID-6/APN-4 AND ★ID-6A/APN-4).

1. STATION POSITION 0.

a. No adjustment is provided or necessary for "STATION" position "0" since the pulse recurrence rate of any station received in this position will be the same as the normal sweep speed of the traces.

b. Check counter circuit adjustments "A," "B," "C," and "D," if a pattern different from that shown in figure 2-15A appears on the indicator screen.

2. STATION POSITION 1.

a. Turn "STATION" selector to position "1." Adjust "FINE" control on indicator until column "X" in figure 2-16A is slightly to the right of the center of the screen.

b. Adjust panel adjustment "E" until the dot in second horizontal row from bottom of column "X" (mentioned in the preceding paragraphs) moves up to coincide with dot above it in same column. When making this adjustment, notice that turning the adjustor too far to the right or left causes the remaining dots in column "X" to move up or down, changing their horizontal alignment with their respective rows. Note the positions to the left and right of the point where this misalignment occurs, and carefully set adjustment "E" midway between them. All the following "STATION" selector adjustments must be centered in a similar manner.

3. STATION POSITION 2.—Adjust panel adjustment "F" until third dot in column "X" moves up to coincide with fourth dot. (See fig. 2-17A.) This column should now be minus dots "2" and "3." The final adjustment for "F" must be centered as explained in the preceding paragraph for adjustment of "E."

4. STATION POSITION 3.—Adjust panel adjustment "G" until the dot in row "4" of column "X" moves up to coincide with the fifth dot. (See fig. 2-18A.) Notice that at each successive position (1 to 7) of the "STATION" selector, the dots move to the left by steps equal to one-tenth of the normal space between the columns. Each step represents an additional 50 microseconds deleted from the normal firing time of the fourth counter.

5. STATION POSITIONS 4, 5, 6, AND 7.

a. Adjust panel adjustment "H" for "STATION" position "4." (See fig. 2-19A.)

b. Adjust panel adjustment "I" for "STATION" position "5." (See fig. 2-20A.)

c. Adjust panel adjustment "J" for "STATION" position "6." (See fig. 2-21A.)

d. Adjust panel adjustment "K" for "STATION" position "7." When adjustments are completed for position "7," only three dots (1, 9, and 10), should remain in column "X." (See fig. 2-22A.) Notice that dot "1" is not affected by the "STATION" selector positions from 1 to 7.

(c) STATION ALIGNMENT (INDICATOR ★ID-6B/APN-4).

1. STATION POSITIONS 2 AND 3.

a. Turn "STATION" selector to position "2."

b. Adjust screw driver adjustment "2" until "X" and "Y" are in horizontal alignment. (See figs. 2-17 and 2-18.)

c. Turn "STATION" selector to position "3." The "X" part of the screen pattern, though moved to the left, should yet show horizontal alignment with "Y."

2. STATION POSITIONS 4 AND 5.

a. Turn "STATION" selector to position "4." (See figs. 2-19 and 2-20.)

b. If the adjustments for feedback control R329 were properly carried out, a slight touch up of panel adjustment "4" should be all that is necessary for "STATION" positions "4 and 5."

3. STATION POSITIONS 6 AND 7.

a. Turn "STATION" selector to position "6."

b. Adjust screw driver adjustment "6" until "X" and "Y" are horizontally aligned. (See fig. 2-21.)

c. Turn "STATION" selector to position "7." The "X" part of the screen pattern should now move to the left, but remain in horizontal alignment with "Y." (See fig. 2-22.)

(4) DELAY-CONTROL ALIGNMENT.

(a) A DELAY.—Only Indicators ★ID-6/APN-4 and ★ID-6A/APN-4 are equipped with means for adjusting the "A" pedestal delay action. The adjustment, lettered "A DELAY," is located on the lower right side of the indicator chassis near the front panel. (See fig. 8-12.) Proper setting of this adjustment, by which the left edge of the "A" pedestal is made to coincide with the first 2500-microsecond marker on the "A" trace, is critical. To obtain the proper setting use the following step by step procedure:

1. Rotate "COARSE" and "FINE" controls on the front panel to full counterclockwise positions.

2. Use a screw driver to rotate "A DELAY" control; "ADJ. 0," "ADJ. 10,000," "ADJ. 200," and "ADJ. 700" to full counterclockwise settings.

3. Turn "SWEEP SPEED" control to position "7." Two trace patterns should appear on the indicator screen. If only one trace appears readjust "SQ. WAVE" control until two stable traces appear. (See fig. 8-12.)

4. Carefully rotate "A DELAY" control clockwise until a pedestal appears at the first 2500-microsecond marker on the "A" trace.

5. Rotate "COARSE" control, and "ADJ. 0" if necessary, until a pedestal also appears on the "B" trace. Continue the adjustments until the pedestal is at left center of the "B" trace.

6. Turn "SWEEP SPEED" control to position "6." Two parallel traces should now appear, probably interlaced with one or more non-parallel trace patterns.

7. Continue the clockwise rotation of "A DELAY" control until the non-parallel traces disappear, leaving only two clean parallel traces.

8. Return "SWEEP SPEED" control to position "7." The pedestal on the "A" trace will now probably appear near the center of the "A" trace.

9. Continue the clockwise rotation of "A DELAY" control until the "A" pedestal again appears at its proper position, with its left edge coincident with the first 2500-microsecond marker on the "A" trace. Center the adjustment within the range providing the correct position.

(b) B DELAY.—All Indicators ★ID-6/APN-4 or ★ID-6A/APN-4 and early units of ★ID-6B/APN-4 were equipped with "B DELAY" "COARSE" and "FINE" controls having indexed-marked knobs. Many Indicators ★ID-6A/APN-4 were later modified in the

field, to permit their use in areas where ground stations operate at basic pulse rates of 33⅓ p.p.s. (Refer to Technical Order No. 16-35ID6-21 for further information on these modifications.) These units have the index-marked discs removed from their control knobs. All later units of ★ID-6B/APN-4 were also equipped with unmarked delay controls at the factory. The removal of the indexed-marked controls makes necessary an alignment procedure in which the controls are set at full clockwise or counterclockwise positions. The following step-by-step procedure outlines the correct method of alignment:

1. B COARSE DELAY.

a. Turn "SWEEP SPEED" control to position "7."

b. Rotate all front panel delay controls and adjustments ("COARSE," "FINE," "ADJ. 0," "ADJ. 10,000," "ADJ. 200," and "ADJ. 700") to full counterclockwise positions.

c. If Indicator ★ID-6/APN-4 is being aligned, rotate panel adjustment "ADJ. 0" clockwise until the "B" pedestal is placed approximately 500 microseconds to the right of the fifth 2500-microsecond marker on the "B" trace. If Indicator ★ID-6A/APN-4 (modified) is being aligned, rotate "ADJ. 0" clockwise until the "B" pedestal is placed approximately 500 microseconds to the left of the third 2500-microsecond marker on the "B" trace. If Indicator ★ID-6B/APN-4 is being aligned, adjust "ADJ. 0" clockwise until the left edge of the "B" pedestal is approximately 500 microseconds to the right of the first 2500-microsecond on the "B" trace.

d. Rotate "COARSE" control to full clockwise position.

e. Adjust "ADJ. 10,000" until "B" pedestal is approximately 500 microseconds to the right of the fifth 2500-microsecond marker on the "B" trace.

f. Return "COARSE" control to full counterclockwise position.

g. Make any adjustments necessary to place the right edge of the "B" pedestal slightly to the left of the first 2500-microsecond marker on the "B" trace. (See fig. 2-24.)

2. B FINE DELAY.

a. Turn "SWEEP SPEED" control to position "6."

b. With "FINE" control, "ADJ. 200" and "ADJ. 700" at full counterclockwise position, rotate "ADJ. 200" clockwise until the 500-microsecond marker on the "B" trace is approximately 200 microseconds to the left of the 500-microsecond marker on the "A" trace. (See fig. 2-26.)

c. Rotate "FINE" control to full clockwise position.

d. Rotate "ADJ. 700" clockwise until the 500-microsecond marker on the "B" trace is exactly 200 microseconds to the right of the 500-microsecond marker on the "A" trace. (See fig. 2-28.)

e. If the "A" trace does not display four distinct 50-microsecond markers to the right of its 500-microsecond marker, adjust "ADJ. 700" for the nearly correct setting; then watch the 500-microsecond marker near the center of the "B" trace, and adjust for 300 microseconds (six 50-microsecond spaces) between it and the 500-microsecond marker on the "A" trace.

f. Touch up adjustments "ADJ. 200" and "ADJ. 700" to obtain the patterns shown in figures 2-26 and 2-28.

(5) AUXILIARY CONTROLS.

(a) HORIZONTAL-CENTERING ADJUSTMENT.

1. Turn "SWEEP SPEED" control to position "1."

2. Adjust "HORIZONTAL CENT." control R350-3 (★ID-6/APN-4 and ★ID-6A/APN-4) or R366-3 (★ID-6B/APN-4) until left end of trace pattern is three-eighths inch from left edge of cathode-ray screen.

Note

The adjustment range of R-366-3 should provide a trace movement of 1½ inches either side of the above setting.

(b) SWEEP-AMPLITUDE ADJUSTMENTS.

1. Turn "SWEEP SPEED" control to position "1." Adjust "SLOW SWEEP AMP." control R350-4 (★ID-6/APN-4 and ★ID-6A/APN-4) or R366-6 (★ID-6B/APN-4) until right end of trace pattern is approximately three-eighths inch from right edge of cathode-ray screen.

Note

This adjustment cannot be properly made unless the counter circuits (especially adjustment "D" and "E") are properly adjusted. After making the above adjustment, check the trace lengths for "SWEEP SPEED" positions "7" and "8" with the "PRR" switch at both positions "H" and "L." Leave the adjustment at the setting providing the most desirable effect for all conditions.

2. Turn "SWEEP SPEED" control to position "2." Adjust "MED. SWEEP AMPL." control R350-5 (★ID-6/APN-4 and ★ID-6A/APN-4) or R366-5 (★ID-6B/APN-4) until right end of trace pattern is ⅜-inch from right edge of cathode-ray screen. Check the effect of this adjustment on trace patterns for "SWEEP SPEED" positions "4 and 5."

3. Turn "SWEEP SPEED" control to position "3." Adjust "FAST SWEEP AMPL." (R-336-4) until right end of trace pattern is three-eighths inch from right edge of cathode-ray screen. Check the effect of this adjustment on trace pattern for "SWEEP SPEED" positions "4" and "5."

(c) VERTICAL-CENTERING ADJUSTMENT.

1. Turn "SWEEP SPEED" switch to position "4."

2. VERTICAL CENTERING ADJUSTMENT.

a. Turn "SWEEP SPEED" switch to position "4."

b. Adjust "VERT. CENT." control R350-1 (★ID-6/APN-4 and ★ID-6A/APN-4) for R366-2 (★ID-6B/APN-4) until the single trace is across center of cathode-ray screen.

Note

Adjustments R350-1 or R366-2 are normally capable of moving the trace line upward 3/4-inch and downward 1 1/2-inch from the center position.

(d) TRACE SEPARATION ADJUSTMENT.

1. Turn "SWEEP SPEED" control to position "2." Adjust "TRACE SEPARATION" control R353-2 (★ID-6/APN-4 and ★ID-6A/APN-4) or R336-1 (★ID-6B/APN-4) for approximate one-inch separation of the traces.

2. Turn "SWEEP SPEED" control to position "5." Adjust "TRACE SEPARATION" control R353-1 (★ID-6/APN-4 and ★ID-6A/APN-4) or R336-2 (★ID-6B/APN-4) until the 50-microsecond marker on the "A" trace touches the tips of the 10-microsecond markers on the "B" trace.

3. Turn "SWEEP SPEED" control to position "6." Adjust "TRACE SEPARATION" control R353-3 (★ID-6/APN-4 and ★ID-6A/APN-4) or R336-3 (★ID-6B/APN-4) until the 500-microsecond markers on the "A" trace barely touch the "B" trace. Check the effect of this adjustment with "SWEEP SPEED" control at position "7." A compromise adjustment between these two positions may be necessary.

(e) PEDESTAL DURATION ADJUSTMENT.

1. Turn "SWEEP SPEED" control to position "5."

2. Adjust "PED-DURATION" (R-351-3) until trace length is approximately 250 microseconds (five complete 50-microsecond spaces).

3. Turn "SWEEP SPEED" control to position "6." The trace pattern should consist of approximately fifteen 50-microsecond spaces.

(f) AUXILIARY FOCUS.

1. Turn "SWEEP SPEED" control to position "7."

2. Adjust "FOCUS" (on indicator front panel) to center of its range.

3. Adjust "INTENSITY" control until a fairly brilliant screen pattern is obtained. Then continue adjustment (clockwise) until pattern blurs.

4. Adjust "AUX. FOCUS" (R-336-1) for maximum definition of pattern.

5. Check operation range of "FOCUS" control (front panel) for all eight "SWEEP SPEED" positions.

(g) SQUARE-WAVE GENERATOR.—Only on Indicators ★ID-6/APN-4 and ★ID-6A/APN-4 is an adjustment of the square-wave generator provided for or necessary. This adjustment, lettered "SQ. WAVE," is located on the lower left side of the indicator chassis near the front panel. Its setting is rather critical and should be made in the following manner:

1. Turn "SWEEP SPEED" control to position "1."

2. Rotate "SQ. WAVE" adjustment (R-347) to full counterclockwise position. (See fig. 8-14.) At this position only one trace should appear on the indicator screen.

3. Rotate "SQ. WAVE" adjustment slowly clockwise and note the setting at which two traces appear.

4. Continue clockwise rotation of "SQ. WAVE" adjustment and note setting at which only one trace again appears on the screen.

5. Center the adjustment between the two settings noted in steps 3 and 4.

6. Rotate "SWEEP SPEED," "STATION," "COARSE," and "FINE" controls through their respective ranges, and watch for any failure of the square-wave generator to maintain proper trace separation.

7. Touch up original setting to the left or right, if necessary, to obtain trace separation stability for all operating positions of panel controls.

c. RADIO RECEIVERS ★R-9/APN, ★R-9A/APN-4, AND ★R-9B/APN-4.

(1) I-F ALIGNMENT METHOD FOR RADIO RECEIVERS ★R-9/APN-4, ★R-9A/APN-4, AND ★R-9B/APN-4.

(a) EQUIPMENT REQUIRED.

1. Signal generator, either Signal Generator I-72-H, I-72-I, I-72-J, Navy Model LP-( ), or equivalent.

2. D-C voltmeter, either VTVM or 20,000 ohms per voltmeter.

3. Fixed capacitor, approximately 200 micro-microfarads.

(b) PROCEDURE FOR RADIO RECEIVERS ★R-9A/APN-4 and ★R-9B/APN-4.

1. Set up receiver and indicator for bench operation, less antenna. Remove dust cover. Power switch should be in "OFF" position.

2. Remove r-f amplifier tube V-101-1.

3. Adjust "GAIN" control to approximately three-fourths maximum gain, and center "AMP. BALANCE" control (controls on indicator).

4. Detune secondaries (LOWER ADJUSTMENTS) of all four i-f transformers (Z-101, -1, -2, -3, -4) by turning the adjustment screws counterclockwise as far as they will go. *Do not force.*

5. Set voltmeter on 3- or 5-volt scale. Connect the positive lead to chassis and the negative lead to pin 5 of V-103.

6. Connect ground lead of signal generator to receiver chassis and output lead to pin 4 of V-101-4.

7. Adjust signal generator frequency to 1050 kilocycles. Set output to approximately one volt (30 percent, 400-cycle modulated).

8. Turn equipment on and allow a five minute warm-up period before making adjustments.

9. Connect fixed capacitor between pin 8 of Tube V-103 and ground.

10. Adjust "TOP" (primary) of Transformer Z-101-4 for maximum output meter reading.

11. Remove fixed capacitor and adjust "LOWER" (secondary) adjustment of Transformer Z-101-4 for maximum meter reading. *Do not change primary adjustment.*

12. Readjust signal generator output as necessary to give an output meter reading of approximately

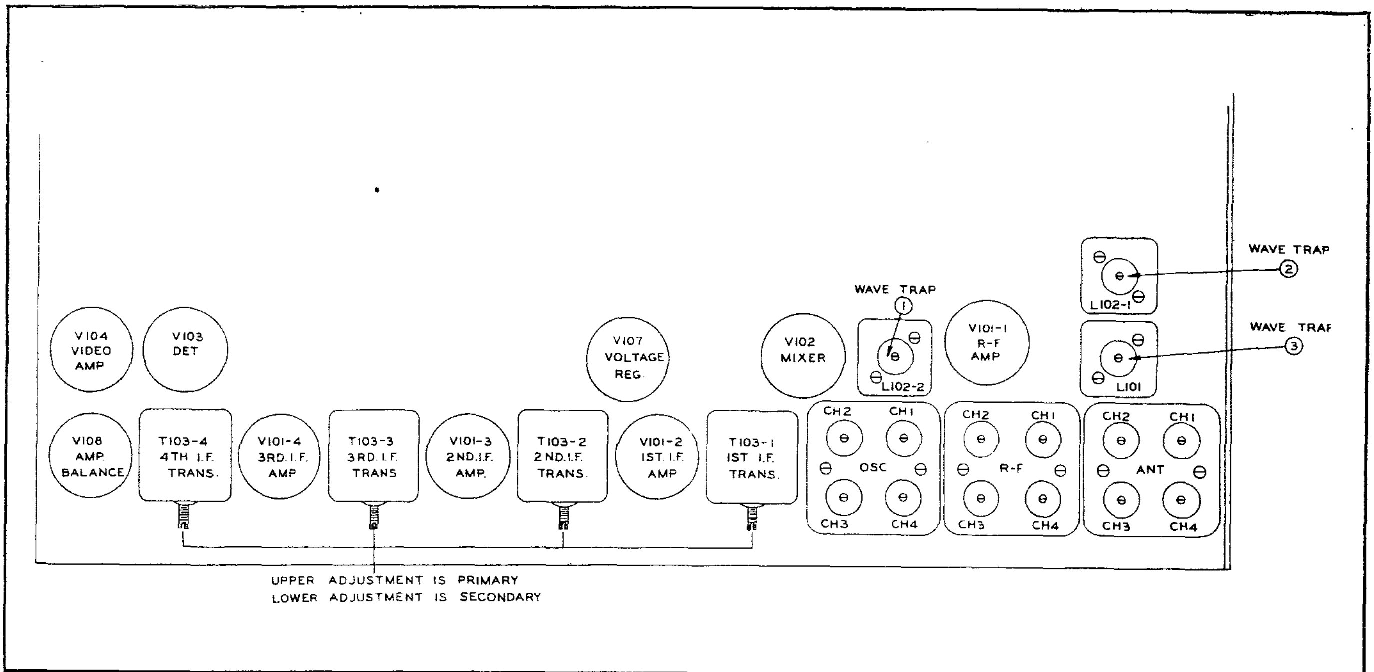


Figure 5-2. Radio Receiver ★R-9A/APN-4 Alignment Diagram

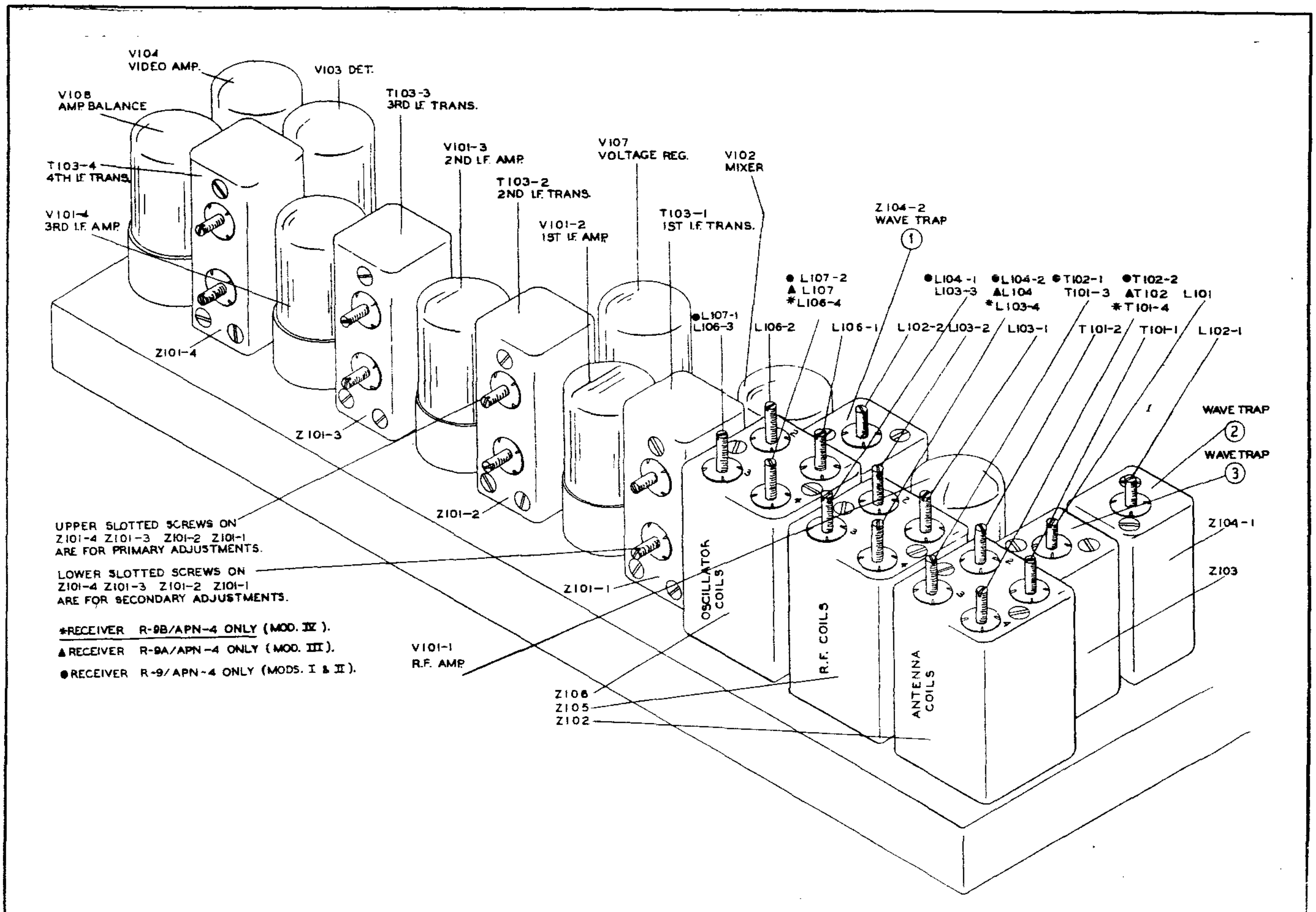


Figure 5-3. Radio Receiver ★R-9B/APN-4 Alignment—Component Location

three-fourths full scale as tuning adjustments are made.

13. Connect signal generator output lead to pin 4 of Tube V-101-3.

14. Connect fixed capacitor between pin 4 of Tube V-101-4 and ground.

15. Adjust "TOP" (primary) of Transformer Z-101-3 for maximum meter reading.

16. Remove fixed capacitor and adjust "LOWER" (secondary) of Z-101-3 for maximum meter reading. *Do not change primary adjustment.*

17. Connect signal generator output lead to pin 4 of Tube V-101-2.

18. Connect fixed capacitor between pin 4 of Tube V-101-3 and ground.

19. Adjust "TOP" (primary) adjustment of Transformer Z-101-2 for maximum meter reading.

20. Remove fixed capacitor and adjust "LOWER" (Secondary) adjustment of Transformer Z-101-2 for maximum meter reading. *Do not change primary adjustment.*

21. Connect signal generator output lead to pin 5 of Tube V-102.

22. Connect fixed capacitor between pin 4 of Tube V-101-2 and ground.

23. Adjust "TOP" (primary) adjustment of Transformer Z-101-1 for maximum reading.

24. Remove fixed capacitor and adjust "LOWER" (secondary) adjustment of Transformer Z-101-1 for maximum meter reading. *Do not change primary adjustment.*

25. Set the signal generator to 1040 and 1060 kilocycles and note the output meter reading at each frequency. The meter readings at these frequencies must be equal. If they are not, readjust the "LOWER" (secondary) adjustment of Transformer Z-101-1 until equal readings are obtained. Counter-clockwise rotation of secondary increases output at 1040 kilocycles.

26. Band width check: At frequencies approximately 25 to 30 kilocycles above and below 1050 kilocycles (or maximum meter reading), the output meter reading should be one-half that at maximum response.

27. Insert Tube V-101-1 and replace set in dust-cover.

(c) PROCEDURE FOR RECEIVER ★R-9/APN-4.

1. The procedure outlined in the preceding sub-paragraph *(b)* is applicable when the following changes are made:

a. Substitute the following in place of step 25: Set signal generator to 1030 and 1070 kilocycles and note the output meter readings at each frequency. In order to secure a more uniform response between these frequencies, readjust the "LOWER" (secondary) adjustments in the following manner. Turn each secondary adjustment counterclockwise approximately one-half turn, then check the response at 1030 and 1070 kilocycles. Repeat this procedure until the meter readings are equal at these frequencies. As equal readings are approached, turn each adjustment less than previously.

b. In step 26, substitute 40 to 60 kilocycles for 25 to 30 kilocycles.

(d) NOTES.

1. In all three types of receivers it will be noted that the center frequency of the i-f response will be a few kilocycles away from 1050 kilocycles when this procedure is used. As long as the center frequency is between 1040 and 1060 kilocycles, the alignment is satisfactory.

2. Radio Receivers ★R-9/APN-4 have an i-f response which is rather flat or very slightly double peaked while Radio Receivers ★R-9A/APN-4 and ★R9B/APN-4 have a slightly rounded, single peaked response.

3. In tuning the i-f transformer secondaries (steps *11, 16, 20, 24*) of Radio Receiver ★R-9/APN-4, a double peak may be found. The proper adjustment is at the first peak encountered as the adjustment screw is screwed "IN."

4. Adjust diode current to zero.

(2) WAVE TRAP ADJUSTMENT.

(a) Adjust the wave traps whenever it is found necessary to completely realign the i-f amplifier and in cases where the traps have been improperly adjusted. Connect the signal generator output lead to pin 4 of the r-f amplifier tube V-101-1. Advance the receiver gain control as far as possible without bringing in too much noise response. Set the signal generator at 1050 kilocycles and advance its output control until the output meter reads nearly full scale. Adjust wave trap inductor L-102-2 for minimum deflection of the output meter. Advance the

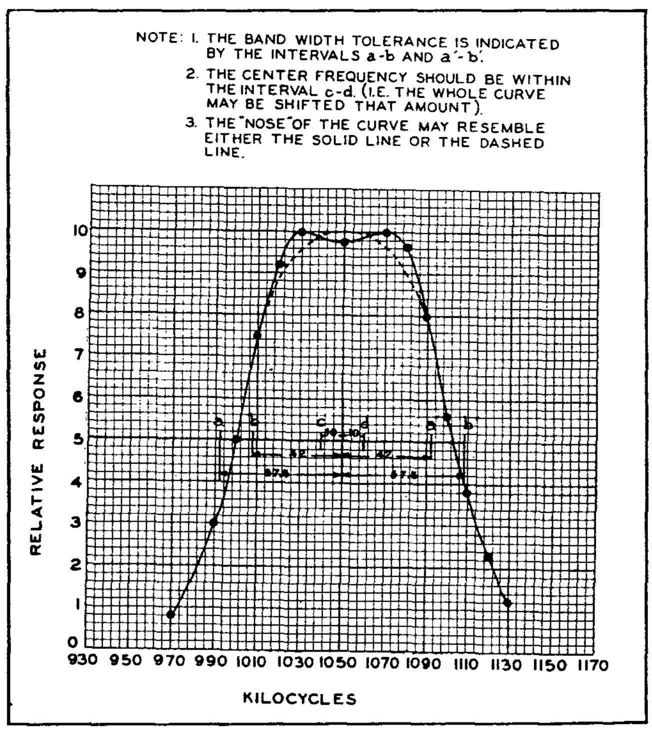


Figure 5-4. Radio Receiver ★R-9/APN-4 Alignment—Wave Form

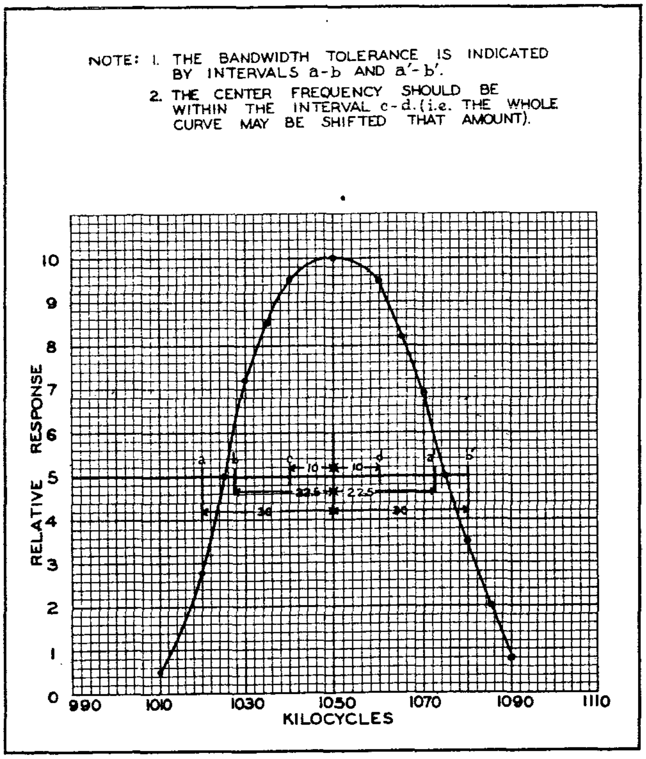


Figure 5-5. Radio Receiver ★R-9A/APN-4 Alignment—Wave Form

signal generator output control as the meter reading falls, so that the exact minimum output may be found by this adjustment. Now connect the signal generator output to the antenna, and adjust wave traps Z-103 and Z-104-1 for minimum output.

(*b*) Considerable interlocking will be noticeable in the adjustment of wave traps Z-103 and Z-104-1. Alternately correct the adjustments of L-101 and L-102-1, first one and then the other until adjustment of either trap to the right or to the left causes an increased reading on the output meter.

(3) R-F ALIGNMENT.

(*a*) Alignment of the r-f transformers in Radio Receiver ★R-9/APN-4 will be found necessary when one of the components in the r-f transformer system or a portion of one of these components has been changed, when the adjustments have been previously misaligned, or when the receiver is to be tuned to a new frequency.

(*b*) There are four preset frequency channels available on the radio receiver. The "CHANNEL" selector switch S-101 selects the transformer and coils associated with each channel: "CHANNEL 1" and "CHANNEL 2" are preset at the factory to 1.95 megacycles, while "CHANNEL 3" and "CHANNEL 4" are preset to 9.6 megacycles per second.

Note

Do not touch the intermediate-frequency alignment screws while radio-frequency alignment adjustments are being made.

(*c*) To align the r-f section of Radio Receiver ★R-9/APN-4, connect the output meter to the coaxial receptacle (marked red) through the series capacitor provided in the output meter case, and connect the signal generator to the coaxial connector (marked green), through a 50-ohm resistor installed between the signal generator output lead and the center conductor of the antenna coaxial connector.

(*d*) Turn on the radio receiver and signal generator and set the signal generator to the maximum output position. Adjust the receiver "GAIN" control as fully as possible without providing unnecessary noise as indicated by erratic voltage readings on the output meter. Set the signal generator output frequency control for maximum response on the output meter. The calibrated dial setting will establish the frequency to which the channel is aligned. Move the signal generator frequency control in the direction of the new frequency (or to the new frequency), adjusting the generator output control to keep the output meter reading at approximately half scale. Clockwise rotation of the antenna, r-f or oscillator alignment screws cause a decrease in the aligned frequency while counterclockwise rotation causes the frequency to increase. Turn the adjustment screw in the oscillator coil shield, associated with the position to which the "CHANNEL" selector switch is set, in the proper direction to increase the indication on the output meter. Reduce the output from the signal generator as required to keep the output meter reading at the center of the scale. Turn the signal generator output frequency control again in the direction of the new frequency, or exactly to the new frequency if possible, as long as the output meter will continue to give a reading near half scale. After the oscillator adjustment has been set for maximum output at the new frequency, set the r-f and antenna adjustment screws, associated with the channel being aligned, for maximum reading on the output meter.

(*e*) Swing the signal geenrator frequency control to either side of the new carrier frequency and note the points at which the two peaks in output appear. Set the oscillator adjustment screw so that these peaks are situated an equal number of kilocycles each side of the desired carrier frequency. After this has been accomplished, realign the r-f coil and antenna transformer for maximum output meter reading.

Note

Serious distortion in the shape of the received pulses occurs when the intermediate- or radio-frequency tuned circuits are seriously misaligned.

Whenever possible, make a final test of the alignment of Radio Receiver ★R-9/APN-4 by observing pulses from ground stations on the indicator screen. They should appear as in figure 3-1. Incorrect alignment will be evident if the pulses lean either to the right or left. Use a receiver known to be in good condition to establish normal shape of pulse for comparison of the receiver which has been aligned. Check the final adjustment of the antenna, radio-frequency, and oscillator adjustments of the channel by observation of the pulse. Set the antenna and radio-frequency adjustment of all channels for maximum pulse amplitude, and the oscillator so that the pulse appears as in figure 3-1.

d. INDICATORS ★ID-6/APN-4 AND ★ID-6A/APN-4.

(1) ADJUSTMENT OF 100-KILOCYCLE OSCILLATOR.

(a) With unit properly connected for operation, proceed as follows:

1. Turn on equipment and allow 5 to 10 minutes for tubes to heat and circuits to become stabilized.

2. Turn adjusting screw on transformer T-301 (see fig. 8-12) in a clockwise direction until oscillation ceases. (This may be seen on the indicator screen.)

3. Turn adjusting screw in a counterclockwise direction until signal appears on indicator screen; then turn screw an additional one and one-half turn.

(b) If oscillation does not cease when adjusting screw is turned to its limit in a clockwise direction, leave about three-eighths inch of the adjusting screw showing.

(c) A test oscilloscope may be substituted for the indicator by connecting the vertical input connection to pin 5 on tube V-301 and the above procedure repeated.

Note

Set the "CRYSTAL PHASING" control on the indicator panel to maximum capacity when making adjustment. For correct wave form of oscillator output see figure 4-11.

(2) MARKER (COUNTER) ALIGNMENTS.

(a) 10-MICROSECOND MARKER (FIRST COUNTER).—For the following adjustments turn "SWEEP SPEED" switch to position "5."

1. Adjust R-353-1 (see figs. 4-27 and 8-12) until the long downward-pointing 50-microsecond markers on the A-trace almost touch the short upward-pointing 10-microsecond markers on the B-trace.

2. Adjust R-315-1 (screw driver adjustment "A") until there are five equal space-divisions between the 50-microsecond markers.

3. Adjust R-303 (see figs. 4-11 and 8-12) until every fifth 10-microsecond marker is exactly coincident with a 50-microsecond marker. At the completion of this adjustment no part of the fifth 10-microsecond marker should be visible.

4. Adjust R-350-6 (see figs. 4-22 and 8-13) until the marker divisions are equally spaced at both ends of the traces. The trace width should be approximately 220 microseconds as shown in figure 2-8.

(b) 50-MICROSECOND MARKER (SECOND COUNTER). For the following adjustments turn "SWEEP SPEED" switch to position "6."

1. Adjust R-353-3 (see figs. 4-31 and 8-13) until the long 500-microsecond marker on the upper trace almost touches the lower trace. This adjustment is common to "SWEEP SPEED" positions "6" and "7" and the setting must be at a point suitable for both positions.

2. Adjust R-315-2 (screw driver adjustment "B") until there are exactly ten 50-microsecond spaces between two 500-microsecond markers. (See fig. 2-8.) The 500-microsecond markers appear slightly to the right of the tenth 50-microsecond marker. This is a result of a slight delay set up by the circuit constants and does not interfere with normal operation of the indicator.

3. Adjust R-350-5 (see figs. 4-22 and 8-12) for proper trace width and linearity. This adjustment is correct when approximately fifteen 50-microsecond spaces appear on each trace, equally spaced over the entire length.

(c) 500-MICROSECOND MARKER (THIRD COUNTER).—For the following adjustments turn "SWEEP SPEED" switch to position "7." (See fig. 2-8.)

1. Adjust R-153-3 (screw driver adjustment "C") until there are five equal 500-microsecond spaces between the 2500-microsecond markers which extend slightly above the trace lines. Make this adjustment for spaces rather than markers since the 2500-microsecond markers will normally appear slightly to the right of the fifth 500-microsecond marker.

2. If necessary, readjust R-353-3 (figs 4-31 and 8-13) so that the time delay between A- and B-pedestals may be easily read.

3. Adjust R-350-4 (see figs. 4-22 and 8-12) for proper trace width and linearity. This adjustment is correct when the marker divisions have approximately equal spacing along the entire length of the traces.

(d) 2500-MICROSECOND MARKER (FOURTH COUNTER).—For the following adjustments turn "SWEEP SPEED" switch to position "7."

Adjust R-315-4 (screw driver adjustment "D") until the traces are divided into exactly eight 2500-microsecond spaces. The first 2500-microsecond marker will appear 2500 microseconds after the start of the traces; the eighth 2500-microsecond marker will appear at the end of each trace.

(3) STATION SELECTOR ALIGNMENT.—For the following adjustments, turn "SWEEP SPEED" switch to position "8." (See fig. 2-9.)

(a) "STATION" SELECTOR POSITION "0."

1. No adjustment is provided for this "STATION" selector setting since the pulse recurrence rate of any station received in this position will be the same as the normal sweep speed of the traces.

2. Check counter circuit adjustments "A," "B," "C," and "D" if a pattern different from that shown in figure 2-8 appears on the indicator screen.

(b) "STATION" SELECTOR POSITION "1."

1. Adjust the "FINE" control on the indicator until the dot appearing alone and above the rest of the pattern is slightly to the right of the center of the screen.

2. Adjust C-329-1 (screw driver adjustment "E") until one dot disappears from the second horizontal row from the bottom and the fifth column to the left of the "lone dot" mentioned in the preceding paragraph. When making this adjustment, notice that turning the adjustor too far to the right or left will cause the remaining dots in the column to move up or down changing their horizontal alignment with their respective rows. Note the positions to the left and right where this misalignment occurs and carefully set adjustment "E" midway between them. Center all the following "STATION" selector adjustments in a similar manner.

(c) "STATION" SELECTOR POSITION "2."

1. Adjust C-329-2 (screw driver adjustment "F") until another dot disappears from the column of dots mentioned in the preceding paragraph. This column will now be minus dot 2 and 3. Center the final adjustment for "F" as explained in the adjustment of "E."

(d) "STATION" SELECTOR POSITION "3."

1. Adjust C-329-3 (screw driver adjustment "G") until the dot in row 4 disappears. Notice that at each successive position ("1" to "7") of the "STATION" selector, the dots move to the left by steps equal to one-tenth of the normal space between the columns. Each step represents an additional 50 microseconds deleted from the normal firing time of each fortieth 500-microsecond pulse.

(e) "STATION" SELECTOR POSITIONS "4," "5," "6," and "7."

1. Adjust C-329-4 (screw driver adjustment "H") for "STATION" selector position "4."

2. Adjust C-329-5 (screw driver adjustment "I") for "STATION" selector position "5."

3. Adjust C-329-6 (screw driver adjustment "J") for "STATION" selector position "6."

4. Adjust C-329-7 (screw driver adjustment "K") for "STATION" selector position "7."

5. Adjust R-341-2 (see figs. 4-13 and 8-12) to provide an output potential from the fourth counter of the proper amplitude for adjustments of "I," "J," and "K" within their normal range. These adjustments are easily affected by temperature and atmospheric changes if their settings are either too tight or too loose. Proper adjustment of the above mentioned control will permit a setting dependable over a wide range of varying conditions.

6. When adjustments are completed for position "7" three dots (1, 9, and 10) will still remain in the significant column. Dot 1 is affected by the "STATION" selector adjustments only in that it moves to the left with each successive switch position "1" to "7." This may be understood by study of the feedback action shown in figure 4-16, and explained in section IV, paragraph 3*b*(3).

7. USE OF TEST OSCILLOSCOPE IN MAINTENANCE OF RADIO SET ★AN/APN-4.

In the maintenance of Radio Receiver ★R-9/APN-4 and Indicator ★ID-6/APN-4, a test oscilloscope is frequently the only means of determining characteristics, such as the voltage amplitude and shape of a signal in a circuit. Maintenance personnel, not familiar with the use and operation of a test oscilloscope, may experience some difficulties in determining these characteristics; therefore, the following information is offered as a guide to the understanding and use of this test equipment.

The controls on the front panel of the oscilloscope provide a means of controlling the various circuits to make a wave form appear at a certain position on the screen, thereby giving a visual indication of the waveform characteristics. If the oscilloscope contains a vertical amplifier, wave forms may be inverted on the screen, that is, a positive voltage fed into the vertical input connection may cause the wave form to appear below the base line, and a negative input to appear above the base line. This is also true if the input is made directly to the vertical plate of the cathode-ray tube. Determine whether inversion is taking place by feeding a signal of known polarity into the vertical input connections. Turning the oscilloscope or the cathode ray tube upside down does not compensate for inversion because the leading and trailing edges of the wave forms are then reversed.

A sweep circuit is usually incorporated in the oscilloscope and controls are provided for adjusting the sweep to the frequency of the input signal; however, in some cases an external sweep generator is used and is fed to a sync input connection on the oscilloscope. The controls are located on the panel of the generator. A switch is provided on the oscilloscope panel for changing from the internal to the external sweep.

In using a test oscilloscope to check Indicator ★ID-6/APN-4, improper wave forms may appear due to loading of the circuits by the oscilloscope. To prevent this, connect a 10-megohm resistor in series with the lead to the vertical input connection when taking all waveforms. Connect or ground the case or housing of the oscilloscope to the indicator chassis.

SECTION VI
SUPPLEMENTARY DATA

1. TUBE COMPLEMENT.

See the following tables for tube complement data on the major assemblies:

TABLE 6-1. RADIO RECEIVERS *R-9/APN-4, *R-9A/APN-4, AND *R-9B/APN-4—TUBE COMPLEMENT.

Symbol Reference	Jan Type	Function	VT Equivalent
V-101-1	JAN-6SK7-GT	R-F amplifier	VT-117-A
V-101-2	JAN-6SK7-GT	First i-f amplifier	VT-117-A
V-101-3	JAN-6SK7-GT	Second i-f amplifier	VT-117-A
V-101-4	JAN-6SK7-GT	Third i-f amplifier	VT-117-A
V-102	JAN-6SA7-GT	Oscillator and mixer	VT-150-A
V-103	JAN-6H6	Detector	VT-90-A
V-104	JAN-6SL7-GT	Video amplifier	VT-229
V-105-1, V-105-2 and V-105-3	JAN-6B4-G	Voltage regulators	
V-106	JAN-6SJ7-GT	Voltage control	VT-116-A
V-107	JAN-0C3/VR-105	Voltage regulator	VT-200
V-108	JAN-6SN7-GT	Amplitude balance	VT-231
V-109	JAN-5U4-G	Low-Voltage rectifier	VT-244
V-110-1 and V-110-2	JAN-2X2	High-Voltage rectifiers	VT-119

TABLE 6-2. INDICATOR *ID-6B/APN-4—TUBE COMPLEMENT.

Symbol Reference	Jan Type	Function	VT Equivalent
V-301-1	JAN-6SN7-GT	100-kilocycle oscillator and limiter	VT-231
V-301-2	JAN-6SN7-GT	First-counter trigger and oscillator	VT-231
V-301-3	JAN-6SN7-GT	Second-counter oscillator; third-counter diode	VT-231
V-301-4	JAN-6SN7-GT	Third-counter oscillator and E.J. sync	VT-231
V-301-5	JAN-6SN7-GT	Fourth and fifth-counter oscillator	VT-231
V-301-6	JAN-6SN7-GT	Sixth-counter oscillator and 50 to 500-microsecond marker shaper	VT-231
V-301-7	JAN-6SN7-GT	Square-wave generator	VT-231
V-301-8	JAN-6SN7-GT	Trace separation follower and "A" delay sync	VT-231
V-301-9	JAN-6SN7-GT	Pedestal mixer	VT-231
V-301-10	JAN-6SN7-GT	Video amplifier and sweep-input leveler	VT-231
V-301-11	JAN-6SN7-GT	B-fine delay	VT-231
V-301-12	JAN-6SN7-GT	B-coarse delay	VT-231
V-301-13	JAN-6SN7-GT	A-delay	VT-231
V-301-14	JAN-6SN7-GT	Sweep-input sync and sweep inverter	VT-231
V-301-15	JAN-6SN7-GT	Pedestal generator	VT-231
V-302-1	JAN-6H6-G	Second-counter diode	VT-90-A
V-302-2	JAN-6H6-G	Third-counter diode and lefting diode	VT-90-A
V-302-3	JAN-6H6-G	Fourth-counter diode	VT-90-A
V-302-4	JAN-6H6-G	Second-counter feedback	VT-90-A
V-302-5	JAN-6H6-G	Third-counter feedback	VT-90-A
V-302-6	JAN-6H6	Cathode-ray tube grid-leveler	VT-90-A
V-302-7	JAN-6H6	Horizontal-centering diode	VT-90-A
V-303-1	JAN-6SL7-GT	Trace separation and amplitude balance	VT-229
V-303-2	JAN-6SL7-GT	10-microsecond marker amplifier	VT-229
V-303-3	JAN-6SL7-GT	Delay inverted and delay mixer	VT-229
V-304	JAN-6SJ7-GT	Sweep generator	VT-116-A
V-305	JAN-5CP1	Cathode-ray tube	

TABLE 6-3. INDICATORS *ID-6/APN-4 AND *ID-6A/APN-4—TUBE COMPLEMENT.

Symbol Reference	Jan Type	Function	VT Equivalent
V-301-1	JAN-6SN7-GT	100-kilocycle oscillator amplifier	VT-231
V-301-2	JAN-6SN7-GT	Second-counter oscillator; 50 and 500 microsecond marker mixer	VT-231
V-301-3	JAN-6SN7-GT	Second and third-counter oscillators	VT-231
V-301-4	JAN-6SN7-GT	Fourth-counter oscillator; square-wave generator sync.	VT-231
V-301-5	JAN-6SN7-GT	A-delay multivibrator	VT-231
V-301-6	JAN-6SN7-GT	B-fine delay multivibrator	VT-231
V-301-7	JAN-6SN7-GT	Delay mixer	VT-231
V-301-8	JAN-6SN7-GT	500-microsecond, pulse shaper; trace-separation amplifier	VT-231
V-301-9	JAN-6SN7-GT	B-coarse delay multivibrator	VT-231
V-301-10	JAN-6SN7-GT	Square-wave generator	VT-231
V-301-11	JAN-6SN7-GT	Video amplifier; suppressor leveler	VT-231
V-301-12	JAN-6SN7-GT	Pedestal amplifier-inverter; marker signal mixer	VT-231
V-301-13	JAN-6SN7-GT	Sweep sync-pulse broadener; sweep phase-inverter	VT-231

TABLE 6-3. INDICATORS ★ID-6/APN-4 and ★ID-6A/APN-4—TUBE COMPLEMENT (Cont'd)

Symbol Reference	*Jan Type*	*Function*	*VT Equivalent*
V-301-14	JAN-6SN7-GT	Pedestal generator	VT-231
V-302-1	JAN-6H6-GT	First-counter diode	VT-90-A
V-302-2	JAN-6H6-GT	Second-counter diode	VT-90-A
V-302-3	JAN-6H6-GT	Third-counter diode	VT-90-A
V-302-4	JAN-6H6-GT	Fourth-counter diode	VT-90-A
V-302-5	JAN-6H6-GT	Station-selector feedback diode	VT-90-A
V-302-6	JAN-6H6-GT	10-microsecond pulse-shaper; diode leveler	VT-90-A
V-302-7	JAN-6H6-GT	Horizontal-deflection centering diode	VT-90-A
V-302-8	JAN-6H6-GT	Cathode-ray tube grid-leveler	VT-90-A
V-303-1	JAN-6SL7-GT	Delay phase-inverter; delay sync.	VT-229
V-303-2	JAN-6SL7-GT	10-microsecond amplifier and clipper	VT-229
V-303-3	JAN-6SL7-GT	Amplitude-balance follower	VT-229
V-304	JAN-5CP1	Cathode-ray tube	
V-305	JAN-6SJ7-GT	Sweep generator	VT-176-A

2. ELECTRICAL CHARACTERISTICS.

a. FREQUENCY RANGE. *(See table 6-4.)*

b. BAND RANGE.

(1) "CHANNEL" selector positions "1" and "2"—1.6 to 3.3 megacycles.

(2) "CHANNEL" selector positions "3" and "4"—7.58 to 11.75 megacycles.

c. PRESET FREQUENCIES.—Four, two adjustable within each of the above frequency bands.

d. POWER SUPPLY.

(1) The power requirements are 80 or 115 volts alternating current, 400 to 2400 cycles per second.

(2) Total current is 2.4 amperes at 115 volts.

(3) Specific data at 120 volts input. "GAIN" control maximum 278.4 volt amperes at 0.9 power factor; "GAIN" control minimum 264 volt amperes at 0.91 power factor.

e. RECEIVER CHARACTERISTICS.—All modifications of the receiver require a power supply of 80 or 115 volts alternating current with a frequency of 400 to 2400 cycles per second. Other characteristics of the various modifications are listed in the following charts:

f. RECEIVER SENSITIVITY.—[Output measured across diode load resistor R-111-1 (270,000 ohms), standard output 5 volts.]

(1) "CHANNEL" positions "1" and "2": 4 to 5 microvolts.

TABLE 6-4. RADIO RECEIVER—GENERAL CHARACTERISTICS.

"Channel" Position	*Receiver Modification*	*Range (Megacycles)*	*Pre-Set at (Megacycles)*	*Sensitivity (Microvolts)*
1 and 2	I and II (Radio Receiver R-9/APN-4)	1.6 to 3.3	1.95	7
3 and 4	I and II (Radio Receiver R-9/APN-4)	7.58 to 11.75	9.6	18
1*, 2*, and 3*	III (Radio Receiver R-9A/APN-4)	1.6 to 3.3	1.95, 1.85, and 1.9	7
4	III (Radio Receiver R-9A/APN-4)	7.58 to 11.75	9.6	18
1, 2, 3, and 4	IV (Radio Receiver R-9B/APN-4)	1.7 to 2.5	1.95, 1.85, 1.9 and 1.75	7

*In first production sets these channels were all aligned to 1.95 megacycles.

TABLE 6-5. RADIO RECEIVER—ELECTRICAL CHARACTERISTICS.

Receiver Modification	*Current Consumption (Amperes)*	*Frequency Range (Megacycles)*	*Selectivity (Kilocycles)*
I	2.4	1.6 to 11.75	†85 to 115
II	2.4	1.6 to 11.75	†85 to 115
III	2.4	1.6 to 11.75	†45 to 60
IV	2.4	1.7 to 2.5	†45 to 60

†Band width at "two times down."

(2) "CHANNEL" positions "3" and "4"; 10 to 15 microvolts.

g. RECEIVER SELECTIVITY.—I-F bandwidth approximately 85 to 95 kilocycles measured 6 db down from maximum response.

3. PARTS CHANGES IN COMPONENTS OF RADIO SET ★AN/APN-4.

Four modifications of the receiver have been shipped. Additional Radio Receivers ★R-9A/APN-4 will be shipped on Order No. 123DAY-44.

Three modifications of the indicator have been shipped. Additional Indicators ★ID-6B/APN-4 will be shipped on Order No. 123DAY-44.

a. CHANGES IN RADIO RECEIVER ★R-9/APN-4.—No major changes were made in modification II of the receiver. The changes listed in the following tables were made for modification III as compared with modifications I and II. Changes in Radio Receiver ★R-9B/APN-4 (modification IV) are discussed in the main text of this manuscript.

TABLE 6-6. RADIO RECEIVER ★R-9A/APN-4—CHANGES, MODIFICATION III

Item and Value	*Function or Location*	*Changed to*	*Purpose or Result*
(1) Transformer T-102-1	(1) Antenna transformer for band III.	(1) Resymbolized T-101-3.	(1) T-101-3 is identical to T-101-1 and T-101-2 and is used on the low frequency band.
(2) Transformer T-102-2	(2) Antenna transformer for band IV.	(2) Resymbolized T-102.	
(3) Coil L-104-1	(3) R-F coil for band III.	(3) Resymbolized L-103-3.	(3) L-103-3 is now identical to coils L-103-1 and L-103-2 and is used on the low-frequency band.
(4) Coil L-104-2	(4) R-F coil for band IV.	(4) Resymbolized L-104.	
(5) Coil L-107-1	(5) Oscillator coil for band III.	(5) Resymbolized L-106-3.	(5) L-106-3 is the same as coils L-106-1 and L-106-2 and is used on the low-frequency band.
(6) Coil L-107-2	(6) Oscillator coil for band IV.	(6) Resymbolized L-107.	
(7) Resistor R-106, 15,000 ohms; Resistor R-126-1, 18,000 ohms; Resistor R-126-2, 18,000 ohms	(7) Shunts the secondaries of the first, second, and third i-f transformers, respectively.	(7) R-106-1, 68,000 ohms. R-106-2, 68,000 ohms. R-106-3, 68,000 ohms.	(7) Reduces the i-f band width to 50-60 kc. and results in an increase in gain per stage.
(8) Resistors R-110-1 and R-110-2, 560 ohms each	(8) Cathode resistors for first and second i-f tubes.	(8) 2200 ohms.	(8) To lower i-f gain resulting from changes listed in (6).
(9) Potentiometer R-121, 50,000 ohms	(9) In regulated power supply.	(9) 20,000 ohms; a fixed 27,000-ohm resistor, R-128, added between the potentiometer and ground.	(9) 50,000-ohm potentiometer not available.
(10) Switch S-102-2, single-pole single-throw	(10) "PWR," "ON-OFF" control.	(10) Double-pole single-throw and resymbolized S-104; extra section is connected in series with terminals 3 and 4 of a-c input jack J-106.	(10) To control an external circuit.
(11) Plug J-107	(11) Auxiliary power outlet.	(11) Removed.	(11) Not needed.
(12) Resistors R-123-1 and R-123-2, 10 megohms each	(12) Bleeder network for positive half of high-voltage power supply.	(12) Four 5.6-megohm resistors, symbolized R-123-1, R-123-2, R-123-3 and R-123-4.	(12) To permit safe voltage drop across each resistor.
(13) Resistors R-123-3 and R-123-4, 10 megohms each	(13) Bleeder network for negative half of high-voltage power supply.	(13) Four 5.6-megohm resistors, symbolized R-123-5, R-123-6, R-123-7, and R-123-8.	(13) Same as (12).
(14) Resistor R-104, 56,000 ohms	(14) Screen-dropping resistor for first and second i-f stages.	(14) Resymbolized R-120-3, 100,000 ohms.	(14) To provide correct screen voltage for new band width and gain per stage.
(15) Resistor R-102-1, 18,000 ohms, 1/2 watt	(15) Plate-dropping resistor for V-101-1.	(15) 2-watt type.	(15) To provide increased voltage rating.
(16) Resistor R-102-2, 18,000 ohms, 1/2 watt	(16) Screen-grid dropping resistor for V-102.	(16) 2-watt type.	(16) Same as (15).
(17) Resistor R-128, 27,000 ohms, 1 watt	(17) Part of voltage divider in regulated power supply.	(17) Added.	
(18) Capacitor C-120, 1,000 mmf., mica	(18) Part of oscillator output voltage divider.	(18) Capacitor C-123 820 mmf., silver mica.	
(19) Capacitor C-124, 200 mmf., mica	(19) Part of oscillator output voltage divider.	(19) Added.	
(20) Capacitor C-121, 240 mmf., mica	(20) Part of oscillator output voltage divider.	(20) Resymbolized C-122.	
(21) Capacitor C-106-4, 510 mmf., mica	(21) Filter capacitor for power input.	(21) Removed.	
(22) Capacitor C-125 0.01 mf., mica	(22) Line filter capacitor.	(22) Added.	

b. CHANGES IN INDICATORS ★ID-6/APN-4.

(1) MODIFICATION I.—The changes listed in the following chart were incorporated in all sets except Serial Nos. 1 to 54 and Serial Nos. 67, 89, 106, 126, and 143 on U. S. Army Signal Corps Order No. 10558WF-43.

TABLE 6-7. INDICATOR ★ID-6/APN-4—CHANGES, MODIFICATION I

Item and Value	*Function or Location*	*Changed to*	*Purpose or Result*
(1) Capacitor C-318-2, 0.1 mf.		(1) Resymbolized C-338-1, 0.03 mf.	(1) To increase the range of the fourth-counter (V-301-4A) output control potentiometer, R-341-2.
(2) Capacitor C-338.	(2) B-coarse delay circuit, V-301-9.	(2) Resymbolized C-338-2.	
(3) Resistor R-363-3, 47,000 ohms, 1 watt, ±5%.		(3) Connected in paralled with R-318-2.	(3) To increase range of the fourth-counter (V-301-4A) control, R-315-4.
(4) Resistor R-361-2, 220,000 ohms.		(4) Resymbolized R-321-3, 180,000 ohms.	(4) To increase the amplitude of the sweep voltage on fast sweep (V-305).

(2) MODIFICATION II.—This modification consists of Serial Nos. 331 and 1650, inclusive, on U. S. Army Signal Corps Order No. 10558WF-43. No electrical changes were made, but an improved type heater transformer was used.

(3) MODIFICATION III.—The changes listed in the following chart cover the difference in modification III compared to modifications I and II.

TABLE 6-8. INDICATOR ★ID-6A/APN-4—CHANGES, MODIFICATION III

Item and Value	*Function or Location*	*Changed to*	*Purpose or Result*
(1) Capacitor C-307.	(1) Secondary of oscillator (V-301-1) plate-transformer.	(1) Resymbolized C-322-2.	
(2) Capacitor C-303-2.	(2) Secondary of oscillator plate-transformer.	(2) Removed.	(2) Not needed.
(3) Capacitor C-309, 36 mmf.	(3) Coupling capacitor for first-counter diode (V-302-1).	(3) Resymbolized C-331-1, 82	(3) To provide proper coupling with new counter circuit arrangement.
(4) Resistor R-309.		(4) Removed.	(4) Provides (with potentiometer R-315-1) a return to ground for first-counter triode, improving stability.
(5) Potentiometer R-315-1, 10,000 ohms.	(5) In circuit of first-counter triode V-301-2A.	(5) New Position; arm of R-315-1 connected to plate of A-section of pin 3, in same circuit.	(5) To improve stability as explained in (4) above.
(6) Capacitor C-313-A, 0.1 mf.	(6) In cathode circuit of first-counter V-301-2A.	(6) Removed, then reconnected from plate to ground of the A-section of the first-counter diode.	(6) To improve stability as explained in (4) above.
(7) Resistor R-307-1.	(7) Connected from potentiometer R-315-1 to B+.	(7) Removed.	(7) To improve stability of first counter diode.
(8) Capacitor C-310, storage type.	(8) Cathode of section B, pin 8, of first-counter diode V-302-1.	(8) 560 mmf., ceramic temperature-compensating type	(8) To improve stability of indicator with respect to temperature changes.
(9) Resistor R-306-1, 4700 ohms.	(9) In series with secondary of transformer T-302-1.	(9) Removed and connected across the primary of the transformer.	(9) To stabilize counter action by limiting voltage developed across the grid winding.

TABLE 6-8. INDICATOR *ID-6A/APN-4—CHANGES, MODIFICATION III (Con't)

Item and Value	*Function or Location*	*Changed to*	*Purpose or Result*
(10) Capacitor C-344, 51 mmf.	(10) Coupling capacitor from first-counter triode V-301-2A to second-counter diode V-302-2.	(10) 75 mmf.	(10) To improve counter action.
(11) Resistor R-302-12, 1 megohm.	(11) Cathode circuit of first-counter diode, pin 8, V-302-1, isolating resistor for left-right circuit.	(11) Resymbolized R-330-2, 220,000 ohms.	
(12) Capacitor C-314-1, storage type.	(12) Cathode circuit of second-counter diode V-302-2.	(12) Resymbolized C-350, ceramic temperature-compensating type.	(12) To improve stability of indicator with respect to temperature variations.
(13) Capacitor C-336-2.	(13) Cathode-to-ground of second-counter diode V-302-2.	(13 Resymbolized C-348.	
(14) Resistor R-313-1.	(14) Plate isolating resistor for second-counter triode V-301-3A.	(14) Resymbolized R-304-4.	
(15) Capacitor C-312-2, 51 mf.	(15) Coupling capacitor from second-counter triode V-301-3A to marker mixer V-301-2B.	(15) Resymbolized C-332-2, 110 mmf.	
(16) Capacitor C-315-1.	(16) Coupling capacitor from second-counter triode V-301-3A to third-counter diode V-302-3.	(16) Resymbolized C-345, silver mica.	
(17) Resistor R-318-1, 15,000 ohms.	(17) Connected from cathode voltage-control of second-counter triode V-301-3A.	(17) Resymbolized R-316, 18,000 ohms.	
(18) Capacitor C-306-2, 1500 mmf., storage type.	(18) Cathode-to-ground circuit of third-counter diode V-302-3.	(18) Resymbolized C-347-2, 750 mmf., ceramic temperature-compensating type.	(18) To improve stability of indicator (with C-347-1) with respect to temperature variations.
(19) Capacitor C-347-1, 750 mmf., ceramic temperature-compensating type.		(19) Added in parallel with C-347-2, mentioned in (18).	(19) To improve stability of indicator as explained in (18).
(20) Resistor R-317, 18,000 ohms, 2 watts.	(20) In series with cathode voltage-control R-315-3 of third-counter triode V-301-3B.	(20) 15,000 ohms.	
(21) Capacitors C-320-1 and C-320-2.	(21) Cathode capacitors for fourth-counter diode V-302-4.	(21) Resymbolized C-351-1 and C-351-2, silver mica.	
(22) Resistor R-341-2, 2000-ohm potentiometer.	(22) Plate voltage-control for fourth-counter triode V-301-4A.	(22) 3,000 ohms.	(22) To provide wider control of feedback for station-selector action.
(23) Capacitor C-318-1, 0.01 mfd.	(23) Plate voltage bypass capacitor for fourth-counter tube V-301-4A.	(23) Resymbolized C-338-2.	
(24) Resistor R-318-2, 15,000 ohms.	(24) From fourth-counter cathode control R-315-4 to ground.	(24) Resymbolized R-318, 10,000 ohms.	
(25) Resistor R-363-3, 47,000 ohms.	(25) Cathode circuit of fourth counter.	(25) Removed.	(25) Not needed.

TABLE 6-8. INDICATOR *ID-6A/APN-4—CHANGES, MODIFICATION III (Con't)

Item and Value	*Function or Location*	*Changed to*	*Purpose or Result*
(26) Resistors R-319-1, R-319-2, R-319-3, R-319-4, R-319-5, R-319-6, and R-319-7, 680 ohms each.	(26) A-delay circuit (V-301-5).	(26) Removed.	(26) Not needed.
(27) Capacitor C-315-2, 100 mmf.	(27) Coupling capacitor from A-delay sync. tube V-301-5 to delay mixer tube V-301-7.	(27) Resymbolized C-332-3, 110 mmf.	
(28) Capacitor C-315-3, 100 mmf.	(28) Coupling capacitor for B-fine delay to delay mixer tube V-301-7.	(28) Resymbolized C-332-4, 110 mmf.	
(29) Resistor R-348, 1500 ohms.	(29) Position 7 to ground of S-303-B.	(29) Resymbolized R-349-1.	
(30) Resistor R-349.	(30) Cathode circuit of marker mixer V-301-11.	(30) Resymbolized R-349-2.	
(31) Capacitor C-315-4, 100 mmf.	(31) Plate of marker-video-pedestal mixer V-301-12 and cathode of marker mixer V-301-11.	(31) Resymbolized C-332-1, 110 mmf.	
(32) Resistor R-352.	(32) Cathode of A-section of V-301-12.	(32) Resymbolized R-352-1.	
(33) Resistor R-313-4.	(33) Cathode circuit of B-section of V-301-12.	(33) Resymbolized R-304-1.	
(34) Resistor R-356-1.	(34) Part of vertical-deflection plate voltage-divider.	(34) Resymbolized R-332-5.	
(35) Capacitor C-327-3.	(35) Grid circuit of pulse broadener V-301-13A to ground.	(35) Resymbolized C-301-4.	
(36) Capacitor C-327-4.	(36) Connected from plate to grid of sweep phase-inverter V-301-13B.	(36) Resymbolized C-301-3 and connected from grid to ground.	(36) Other indicator circuit changes make original connection unnecessary.
(37) Resistors R-377-1 and R-377-2, 33 ohms each.	(37) Connected in series from terminal 3 to terminal 4 of filament transformer T-303; the junction of the two resistors was grounded.	(37) Former ground on one side of heater circuit was removed.	(37) To reduce a-c modulation of screen pattern.
(38) Resistor R-361-1.	(38) Plate circuit of sweep phase-inverter V-301-13B.	(38) Resymbolized as R-330-3.	
(39) Resistor R-366, 3300 ohms.	(39) Pedestal generator circuit (V-301-14).	(39) Removed.	(39) No longer needed.
(40) Resistor R-338-4, 0.1 megohm.	(40) Pedestal generator circuit (V-301-14).	(40) Removed.	(40) No longer needed.
(41) Resistor R-365, 60,000 ohms.	(41) Pedestal generator circuit (V-301-14).	(41) Resymbolized R-305-14, 100,000 ohms; connected from grid to ground.	(41) To improve the functions of the pedestal generator circuit.
(42) Resistor R-302-11, 1 megohm.	(42) Pedestal generator circuit (V-301-14).	(42) Removed and replaced by R-375, 680,000 ohms, and R-348, 1.5 megohm.	(42) Same as (41).
(43) Switch S-303-C.	(43) Pedestal generator circuit (V-301-14).	(43) Connected to short out R-348 in positions 3, 4, and 5.	(43) Same as (41).
(44) Resistor R-308-2.	(44) Plate (pin 5) of pedestal generator V-301-14.	(44) Resymbolized R-308.	

TABLE 6-8. INDICATOR *ID-6A/APN-4—CHANGES, MODIFICATION III (Con't)

Item and Value	*Function or Location*	*Changed to*	*Purpose or Result*
(45) Resistor R-356-2 and R-356-3.	(45) In left-right circuit associated with plate circuits of V-301-14.	(45) Resymbolized R-332-7 and R-332-6.	
(46) Capacitors C-320-3 and C-320-4.	(46) In left-right circuit associated with plate circuits of V-301-14.	(46) Resymbolized C-320-1 and C-320-2.	
(47) Capacitor C-327-5.	(47) Grid (pin 4) of pedestal generator tube V-301-14.	(47) Removed.	
(48) Capacitor C-312-4, 51 mmf.	(48) In 10-microsecond marker circuit (V-303-2).	(48) Resymbolized C-342-2, 150 mmf.	
(49) Resistor R-305-5, 0.1 megohm.	(49) In 10-microsecond marker circuit (V-303-2).	(49) Resymbolized R-352-2, 47,-000 ohms.	
(50) Inductance L-302, 450 microhenries, and the 2200-ohm resistor (not symbolized) in parallel with it.	(50) In 50 and 500-microsecond marker-mixer circuit (V-301-2B).	(50) Removed.	(50) Not needed in new 50-and 500-microsecond marker-mixer circuit.
(51) Resistor R-333, 470 ohms, and capacitor C-327-1, 150 mmf.	(51) In 50 and 500-microsecond marker-mixer circuit (V-301-2B).	(51) Removed.	(51) To provide a more simple and stable 50- and 500-microsecond marker-mixer circuit.
(52) Resistor R-335, 47,000 ohms.	(52) In grid circuit of 50 and 500-microsecond marker-mixer circuit (V-301-2B).	(52) Resymbolized R-372, 3300 ohms.	(52) Same as (51).
(53) Tube V-301-2B.	(53) 50 and 500-marker mixer.	(53) Grid and plate connected together to operate as a diode.	(53) Same as (51).
(54) Resistor R-334.	(54) Cathode of V-301-2 to ground.	(54) Resymbolized R-373.	(54) Same as (51).
(55) Capacitor C-343, 24 mmf.	(55) In station feed-back circuit associated with V-302-6.	(55) Resymbolized C-352, 24 mmf.	(55) To improve stability in the station-selector feedback adjustments.
(56) Capacitor C-331, 62 mmf.	(56) In station feed-back circuit associated with V-302-6.	(56) Resymbolized C-331-2, 82 mmf.	(56) Same as (55).
(57) Capacitor C-332, 110 mmf.	(57) In station feed-back circuit associated with V-302-6.	(57) Resymbolized C-348, 130 mmf.	(57) Same as (55).
(58) Capacitor C-333, 160 mmf.	(58) In station feed-back circuit associated with V-302-6.	(58) 190 mmf.	(58) Same as (55).
(59) Capacitor C-334, 220 mmf.	(59) In station feed-back circuit associated with V-302-6.	(59) 250 mmf.	(59) Same as (55).
(60) Capacitor C-335, 270 mmf.	(60) In station feed-back circuit associated with V-302-6.	(60) 300 mmf.	(60) Same as (55).
(61) Capacitor C-336-1, 330 mmf.	(61) In station feed-back circuit associated with V-302-6.	(61) Resymbolized C-336, 360 mmf.	(61) Same as (55).
(62) Capacitor C-317-2, 2 mmf.	(62) In station feed-back circuit associated with V-302-6.	(62) Read (on drawing) 2 mf.	(62) Same as (55).
(63) Resistor R-310-2	(63) In delay phase-inverter circuit (V-303-1A).	(63) Resymbolized R-310.	
(64) Capacitor C-338-2.	(64) In B-coarse pedestal delay (V-301-9).	(64) Resymbolized C-338-1.	
(65) Resistor R-330-4, 220,-000 ohms, 1/2 watt.	(65) Part of cathode voltage divider, 2nd counter triode (V301-3A).	(65) Added.	
(66) Resistor R-307-2, 47,000 ohms, 2 watts.	(66) Part of cathode voltage divider, 2nd counter triode (V301-3A).	(66) Resymbolized R-307.	
(67) Resistor R-378, 680,000 ohms, 1 watt.	(67) Part of cathode voltage divider, 4th counter triode (V301-4A).	(67) Added.	
(68) Resistor R-314-3, 82,000 ohms, 2 watts.	(68) Part of cathode voltage divider, 4th counter triode (V301-4A).	(68) Resistor R-371 75,000 ohms, 2 watts.	
(69) Capacitor C-330-9, 24 mmf., mica.	(69) Feedback capacitor for square wave generator (V301-10).	(69) Added.	
(70) Capacitor C-330-8, 24 mmf., mica.	(70) Feedback capacitor for square wave generator (V-301-10).	(70) Added.	
(71) Transformer T-303.	(71) Filament transformer.	(71) Resymbolized T-304.	
(72) Resistor R-361-2, 220,-000 ohms.	(72) Grid limiting resistor for sweep generator (V-305).	(72) Resistor R-305-13, 100,000 ohms, 1/2 watt.	
(73) Coil L-301, 68.5 millihenries.	(73) Crystal phasing.	(73) Coil L-301, Adjustable.	

4. RADIO SET ★AN/APN-4—TEST STANDARDS.

a. RADIO RECEIVERS ★R-9/APN-4, ★R-9A/APN-4, AND ★R-9B/APN-4 (MODIFICATIONS I TO IV, INCLUSIVE).

(1) REGULATED-VOLTAGE POWER SUPPLY.

(a) With the "80V.-115V. LINE VOLTAGE" switch properly set for a-c supply voltage and as voltage control R-121 is rotated through its entire range, the minimum range of the regulated voltage should be between 250 and 285 volts direct current (modifications I and II) or 250 to 270 volts direct current (modifications III and IV).

(b) With the "80V.-115V. LINE VOLTAGE" switch at "115V." position, variations of the a-c input from 109 to 121 volts should not cause change in the d-c output.

(c) With the "80V.-115V. LINE VOLTAGE" switch at "80V." position, variations of the a-c input from 76 to 84 volts should not cause change in the d-c output.

(2) HIGH-VOLTAGE SUPPLY.—With the "80V.-115V. LINE VOLTAGE" switch properly set for a-c supply voltage, the high-voltage d-c output should be —1250 volts direct current and +1450 volts direct current ±5 percent.

(3) VIDEO FIDELITY.—With a one-volt signal fed to the plate (pin 5) of detector V-103 and a vacuum tube voltmeter connected to the output cathode (pin 6) of video amplifier V-104, the following responses should be obtained:

(a) With the "FILTER" switch at "OUT," the overall response should be flat within 10 percent for frequencies between 500 and 25,000 cycles.

(b) With the "FILTER" switch at "IN," the overall response should be flat within 20 percent for frequencies between 20,000 and 70,000 cycles.

(c) With the "FILTER" switch at "IN," the attenuation at 3,000 cycles should be 15 db. ±5 db. Test in the following manner: With the "FILTER" switch at "OUT," adjust the 3,000-cycle input to V-103 until an output of 10 volts is indicated by the vacuum tube voltmeter; with the "FILTER" switch at "IN," the output should drop to some reading between 1 and 3.1 volts.

(4) SECOND-DETECTOR SENSITIVITY.—With the "FILTER" switch at "OUT" and a 1-volt, 1000-cycle-per-second signal fed to the detector cathode (pin 8 of V-103), the output at the cathode (pin 6) of video amplifier V-104 should be 12 volts, ±4 volts.

(5) OVERALL SENSITIVITY AND R-F COVERAGE.—With the "GAIN" control at maximum position, "AMP. BALANCE" at center position and a standard output of five volts direct current [determined by a vacuum tube voltmeter connected to plate (pin 5) of V-103] the sensitivity and coverage should be as tabulated in table 6-4.

(6) OVERALL SELECTIVITY.—Using a standard signal generator whose output is fed to antenna connector J-101, and a vacuum tube voltmeter connected to the plate (pin 5) of detector tube V-103, a test of the overall selectivity should indicate band widths which agree with the following chart:

TABLE 6-9. OVERALL SENSITIVITY.

Ratio	*Band Widths for Radio Receiver ★R-9/APN-9 Modifications I and II (Kilocycles)*		*Band Widths for Radio Receivers ★R-9A/APN-4 and ★R-9B/APN-4 Modifications III and IV (Kilocycles)*	
	Minimum	*Maximum*	*Minimum*	*Maximum*
2	85	115	45	60
10	130	165	70	90
100	185	215	100	125
1,000	245	335	150	185

(a) MEASURING BAND WIDTH.—The test for "ratio 2" may be made, using the following procedure:

1. Set signal generator frequency to 1950 kilocycles and its output control to provide an input of 10 microvolts to the receiver.

2. Adjust "GAIN" control on Indicator until vacuum tube voltmeter indicates 5 volts.

3. Adjust output of signal generator to 20 microvolts; then adjust its frequency to the two frequencies, above and below the center frequency, where the vacuum tube voltmeter again reads five volts. The difference between the lowest and highest frequency represents the band width. Similar procedure, using several ratios, may be used to obtain a complete chart of the overall response.

(7) WAVE-TRAP CHARACTERISTICS.—With a signal generator connected to antenna connector J-101 and a vacuum tube voltmeter connected to the plate (pin 5) of detector tube V-103, the indicated rejection ratio of wave traps tuned to any frequency between 1020 and 1080 kilocycles should be 100,000:1; for other than tuned frequencies, 500:1.

(8) SIGNAL-TO-NOISE RATIO.—The signal to noise ratio should be at least 5:1; this may be checked by the following procedure:

(a) Connect output of signal generator to antenna connector J-101.

(b) Adjust signal frequency to 1950 kilocycles and its output (input to receiver) to 7 microvolts.

(c) With the "AMP. BALANCE" control at center position, adjust "GAIN" control until output at plate (pin 5) of detector tube V-103 is five volts (measured with a vacuum tube voltmeter).

(d) Disconnect signal generator; the voltage now indicated by the meter should be less than one volt.

(9) IMAGE-TO-FUNDAMENTAL-SIGNAL RATIO (SENSITIVITY).—The image-fundamental signal ratio for the low-frequency channels should be at least 175:1; for the high-frequency channel (not used in modification IV) the ratio should be at least 35:1. These ratios may be checked by the following procedure:

(a) With the signal generator output connected to antenna connector J-101, and a vacuum tube voltmeter connected to the plate (pin 5) of detector tube V-103, set

"CHANNEL" switch on receiver at position 1 and signal generator frequency control at 4050 kilocycles (4.05 megocycles).

(*b*) Adjust "GAIN" control to maximum position and signal generator output control until meter indicates five volts.

(*c*) Divide 4050 kilocycles sensitivity (required microvolts input to receiver) by the sensitivity at 1950 kilocycles to obtain image ratio. (See table 6-1.) Similar checks may be made at all four channels by checking the sensitivity at the image frequency (fundamental pre-set frequency plus 2100 kilocycles) against the sensitivity of the particular pre-set frequency of each channel.

(10) SPURIOUS RESPONSE.—The sensitivity ratio of all frequencies (except image frequencies), within the tuning range of each channel, to the fundamental sensitivity (see table 6-4) should be not less than 700:1.

(11) OSCILLATOR STABILITY.—Over a period of five hours operation, the oscillator drift should not exceed 15 kilocycles on any channel. It should maintain this stability for all temperatures between —65.2 Fahrenheit (—54 Centigrade) and +122 Fahrenheit (+50 Centigrade) and altitudes up to 30,000 feet.

(12) HUM.—The residual hum should be less than 0.3 volt, peak to peak, when measured at video output connector J-104, with the "GAIN" control at minimum.

(13) WHISTLE MODULATION.—The modulation caused by whistling should not be more than 1 percent with 1,000 microvolts input and 8 percent with 100,000 microvolts input.

(14) AMPLITUDE BALANCE.—The amplitude-balance circuit should handle properly signal ratios up to 40:1.

b. INDICATORS ★ID-6/APN-4 AND ★ID-6A/APN-4 (MODIFICATIONS I, II, AND III) AND ★ID-6B/APN-4 (MODIFICATION V).—The following standards apply only when the regulated d-c voltage is exactly 260 volts, the negative high-voltage —1250 volts ±5 percent; and the positive high-voltage, +1450 volts ±5 percent. (These voltages are supplied by the power supply located in the receiver unit.)

(1) 100-KILOCYCLE OSCILLATOR.—With the "CRYSTAL-PHASING" control at its maximum capacity setting and all other indicator front-panel controls at any one of their several positions, the 100-kilocycle oscillator should start immediately after the tubes have reached normal operating temperature.

It is preferable that this test be made with a properly isolated test oscilloscope connected to pin 5 of V-301-1. During the test the oscillator grid (pin 1) should be grounded several times while watching the test oscilloscope for any slight delay in the reappearance of the generated signal pattern. At room temperature, the "CRYSTAL PHASING" control should be capable of changing the test oscillator frequency ±25 cycles.

(2) COUNTER CIRCUITS.—In modifications I, II and III only four counter circuits are used; in modification V six counters are employed. (See figs. 4-10, 8-32, and 8-33.) With an external test oscilloscope connected to the plates of the counter oscillators under test, the counter range and proper operational count should be as shown in the following table.

TABLE 6-10. INDICATOR COUNTER CIRCUITS.

Counter	*Modification*	*Count Range Min.*	*Max.*	*Proper Count*
I	*I, II and III	4	6	5
	†V	4	6	5
II	*I, II and III	9	11	10
	†V	Fixed	Fixed	2
III	*I, II and III	4	6	5
	†V	4	6	5
IV	*I, II and III	5	9	8
	†V	4	6	5
V	*I, II and III	No fifth counter		0
	†V	Fixed	Fixed	2
VI	*I, II and III	No sixth counter		0
	†V PRR at "L"	3	5	4
	†V PRR at "H"	2	4	3

*Modification of Indicator *ID-6/APN-4 and *ID-6A/APN-4.
†Modification of Indicator *ID-6B/APN-4.

(3) FEEDBACK CONTROL.

(*a*) MODIFICATIONS I, II, AND III.—With the "SWEEP SPEED" control at position "8," "STATION" selector at position "7," and panel adjustment "K" ("7" on some equipment) at the center of its range, the minimum adjustment range of the fourth-counter feedback control (R-341-2), should permit a vertical movement of dots 9 and 10 (in the open column) one-half dot width above and below normal alignment. (See fig. 2-9.)

(*b*) MODIFICATION V.—With the "SWEEP SPEED" control at position "8," "STATION" selector at position "4," and panel adjustment 4 at the center of its range (screw driver slot at horizontal position), the adjustment range of the sixth-counter feedback control (R-329) should permit horizontal alignment of "X" and "Y," as shown in figure 2-19.

(4) PEDESTALS.—The pedestals should be rectangular in shape and approximately 750 microseconds wide.

(*a*) ADJUSTMENT RANGES.

1. With the "SWEEP SPEED" control at position "7," and the "COARSE" and "FINE" controls at full counterclockwise position, the minimum range of "ADJ. 200" should be 150 to 250 microseconds.

2. With the "COARSE" and "FINE" controls at full counterclockwise positions, the minimum adjustment range of "ADJ. 10,000" should be 10,000 to 15,000

microseconds; the minimum range of "ADJ. 700" should be 650 to 750 microseconds.

3. The A-delay in modification V is fixed at 2500 microseconds; in modifications I, II, and III this adjustment should have a minimum range of 0 to 5000 microseconds.

(5) SWEEPS.—All amplitude adjustments should be capable of varying the trace lengths ±25 percent from the normal setting. The normal trace length should be four inches, which, in modification V, should not vary more than one-half inch as the "PRR" switch is thrown from "H" to "L" or vice versa.

TABLE 6-11. SWEEP TRACE DURATION.

"Sweep Speed" Position	*Sweep Duration (Mods. I, II, III)*	*Adjustment or Duration (Mod. V)*
3, 4 and 5 (fast sweep)	200 to 300 Microseconds	Adjusted to desired duration by proper setting of "PED. DURATION" control, R-351-3.
2 and 6 (medium fast sweep)	750 to 1000 Microseconds	Adjusted to desired duration by proper setting of "PED. DURATION" control, R-351-3.
8 (medium slow sweep)	38,800 to 39,200 Microseconds (Mods. I and II) 29,500 to 38,000 Microseconds (Mod. III)	2500 Microseconds
1 and 7 (slow sweep)	18,500 and 19,000 Microseconds	With "PRR" at "L": 19,300 Microseconds With "PRR" at "H": 14,300 Microseconds

In all modifications the slow-sweep duration is affected slightly by the position of the "STATION" selector.

(6) VERTICAL CENTERING.—With the "SWEEP SPEED" control at position 4, the "VERTICAL CENTERING" control R-350-1 (modifications I, II and III) (or "VERT. CENT.," R-366-2, modification V), should permit a trace shift, three-fourths inch upward and one and one-half inch downward from the screen center. The adjustment should be set for exact center positioning of the trace.

(7) TRACE SEPARATION.—With vertical centering properly made, the trace separation range and setting should be as shown in the following chart:

TABLE 6-12. SWEEP TRACE SEPARATION.

"Sweep Speed" Positions	*Minimum Separation Range (inches)*	*Correct Separation (inches)*	*Control System*
1	1-1/8	1-1/8	None
2 and 3	0 to 1-1/8	1	R-353-2 (Mod. I, II, III) R-336-1 (Mod. V)
5	0 to 1-1/8	1/4	R-353-1 (Mod. I, II, III) R-336-2 (Mod. V)
6 and 7	0 to 1-1/8	3/8	R-353-3 (Mod. I, II, III) R-336-3 (Mod. V)

(8) HORIZONTAL CENTERING.—With "HORIZONTAL CENTERING" control R-350-3 (modifications I, II and III) or "HORIZ. CENT." control R-336-3 (modification V) properly set, (left edge of trace 3/8" from edge of screen), further adjustments of these controls to full left or right positions should cause the left end of the traces to move to the left, off the screen; or to the right, 1½" from the normal setting.

(9) FOCUS CONTROLS.—There is considerable interaction between the panel controls: "INTENSITY," R-357-2 (modifications I, II and III) or R-363-1 (modifications V); "FOCUS" R-357-1 (modifications I, II and III) or R-363-2 (modification V); and "AUX. FOCUS," R-350-2 (modifications I, II and III) or R-366-1 (modification V). When the "INTENSITY" control is set for adequate brilliance and the "FOCUS" control is near the center of its range, the "AUX. FOCUS" control should provide adequate definition of pattern or control range for both panel controls.

(10) LEFT-RIGHT CONTROL.—The left-right control should permit the same rate of pulse movement to the left or right. In modification I, II, and III the left-right action is largely affected by the settings of the first and second-counter adjustments, "A" and "B." After centering these panel adjustments for proper count, it will probably be necessary to readjust them to slightly off-center positions to obtain correct left-right action as well as stability of station-selector action. The amount of deviation from the center setting for these adjustments will vary with the individual units; in some units the final setting will be slightly to the left of the center setting; in others, slightly to the right.

In modification V, the effects of the left-right control are easily observed with the "SWEEP SPEED" control at position "8." That position of the screen display designated as "X" should move exactly 50 microseconds to the left or right when the control is operated.

(11) MARKER DIMENSIONS.—The approximate size of the markers should be as listed below:

Markers (Microseconds)	*Height (inches)*	*Width at Base (Microseconds)*
10	1/32	1.5
50	5/32	3
500	5/16	5
2500	5/16	5

5. REPLACING POWER TRANSFORMER IN RADIO RECEIVERS ★R-9/APN-4 AND ★R-9A/APN-4.

a. In present and future production, a new corona-free transformer T-105, (Philco Part Nos. 352-7245-2, 352-7245-5, and 352-7245-6), replaces the old type transformer Philco Part No. 352-7196-2. All units having the new type transformer are identified by the small orange triangle of the Signal Corps, stamped on the front panel of the receiver and on the packing cases. To prevent corona, those units marked with the triangle also use a special wire for the high-voltage rectifier leads. All of the old type transformers used in the field have been, or will be, replaced with one of the new type transformers. A 34-inch length of Vinylite tubing (spaghetti), (Philco Part No. 25-5603000), to insulate the transformer leads and a 15½-inch length of high-voltage wire (Philco Part No. 25-6900000), for use as plate leads for rectifier tubes V-110-1 and V-110-2 are included with each replacement transformer. (See fig. 6-2.)

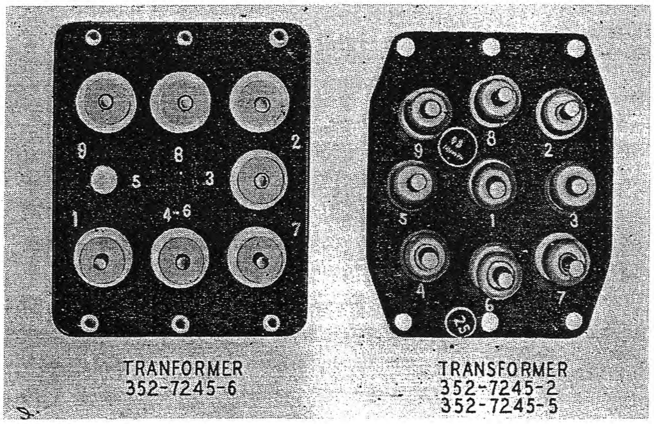


Figure 6-1. Transformer T-105—Terminal Location

Note

Figure 6-2 shows the location of all wiring leads from the transformer (Part Nos. 352-7245-2 and 352-7245-5), tube socket X-102-2, and the high-voltage terminal panel. If the wiring on units in the field is made to conform with that shown in figure 6-2, corona effects will be eliminated.

b. When the old transformer is removed, all leads should be properly identified to aid in installing the new transformer. Figure 6-1 shows the terminal marking for the replacement transformers that will be supplied to the field. Note that on transformer T-105 (Philco Part No. 352-7245-6), terminals 4 and 6 are connected together internally and terminal 1 is in the position normally occupied by terminal 4. After the new transformer is installed, the following lead dress must be used to eliminate corona.

(1) Dress the two high-voltage leads from capacitor C-111-1 and lead from top center terminal of high-voltage panel around stand-off insulator. This places the leads further away from the high-voltage terminals of the transformer.

(2) Remove ground lead from terminal 5 of transformer, and connect new ground lead from this terminal to ground lug on socket X-101-1.

(3) Dress the four wires from transformer T-104 around stand-off insulator.

(4) Dress lead, from capacitor C-111-3 to high-voltage wiring panel, from back to front of panel, as shown in figure 6-2.

(5) Dress all leads from input receptacle J-106 so that they lie between terminal 2 of transformer and front panel of receiver chassis.

(6) Remove leads from stand-off insulator connected to terminal 1 of transformer (Philco Part No. 352-7196-2), and dress lead between terminals 2 and 3 and chassis. If Philco Part No. 352-8245-6 transformer is used, wire

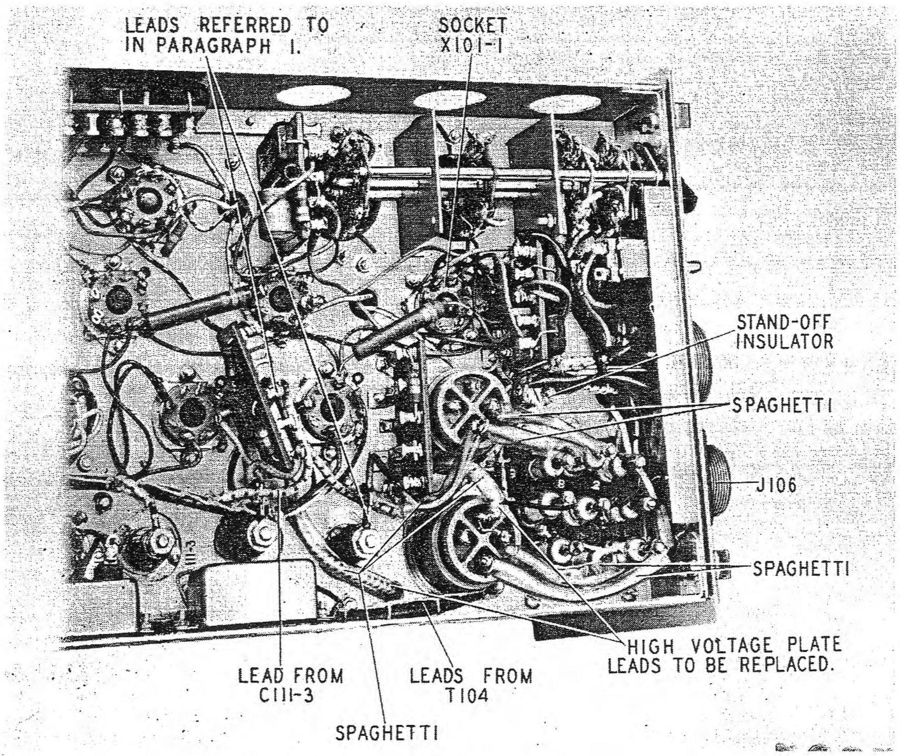


Figure 6-2. Transformer T-105—Transformer Lead Dress for Reducing Corona Effects

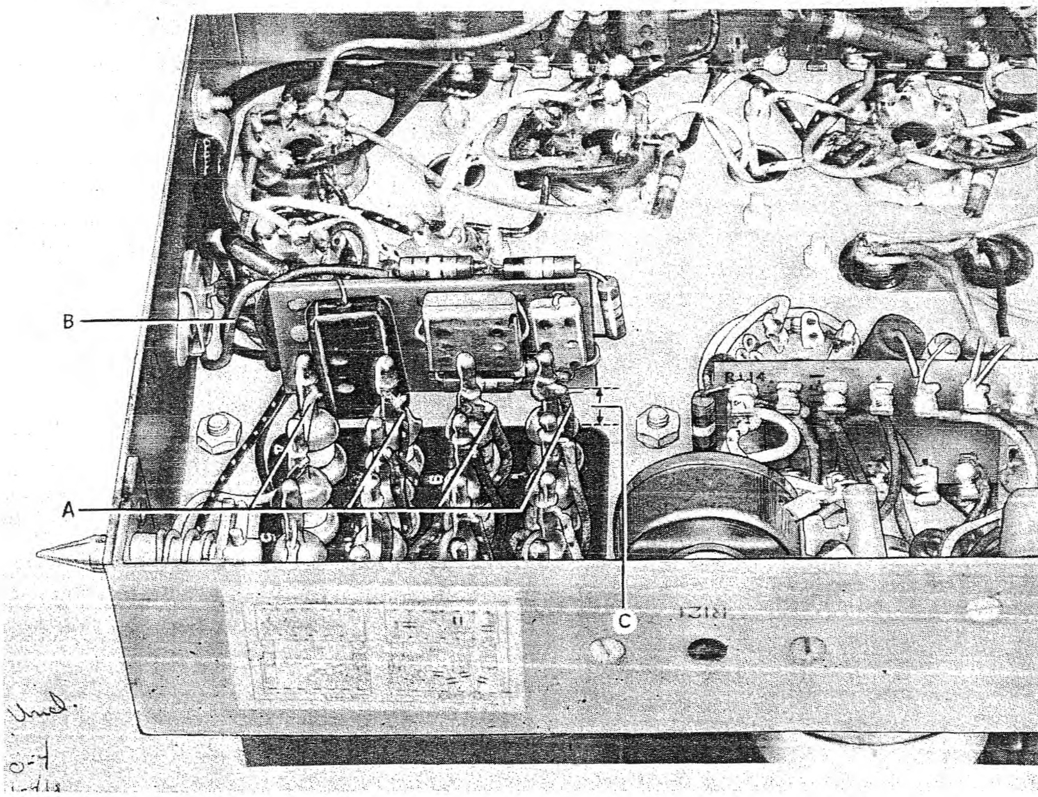


Figure 6-3. Transformer T-104—Transformer Lead Dress for Reducing Ripple

from the stand-off insulator to terminal 1 must be dressed close to sockets X-102-1 and X-102-2, because of the relocation of terminal 1 of the transformer (Philco Part No. 352-7245-6).

(7) Remove the lead from terminal 4 of the transformer (Philco Part No. 352-7245-5), and socket X-102-2, and connect a jumper from terminal 4 to terminal 6 of transformer.

(8) Disconnect lead on pin 3 of socket X-102-2 from terminal 6 of the transformer, and connect it to terminal 4 on tube socket.

(9) Disconnect lead on terminal 2 of socket X-102-2, and connect it to terminal 3.

(10) Remove jumper between terminals 2 and 3 on socket X-102-2.

6. ELIMINATION OF POWER SUPPLY RIPPLE.

Power supply ripple may occur in Radio Receiver ★R-9/APN-4 and early models of Radio Receiver ★R-9A/APN-4.

a. CAUSE.—The ripple may be caused by improper grounding of power source and receiver chassis or leakage due to poor wiring.

b. REMEDY.

(1) Shield the four terminals, marked A, (see fig. 6-3) with spaghetti.

(2) Dress the brown lead from pin 6 of socket X-101-7 to terminal board.

(3) Rewire so that space between transformer T-104 and adjacent terminal board is clear of leads.

(4) Check bonding of power source and receiver chassis.

7. INDICATOR ★ID-6B/APN-4—(MODIFICATION V) SUMMARY.

A new Loran indicator (modification V), designated Indicator ★ID-6B/APN-4, has been designed to improve the stability and operation of the equipment under all conditions. Some of the most outstanding features of the new indicator are:

a. COUNTERS.—To improve stability, the high ratio counters have been eliminated; the 10:1 counter has been replaced by a 2:1 and a 5:1 counter, and the 8:1 counter by a 2:1 and a 4:1 counter. No adjustment is necessary for the 2:1 counter, resulting in 4 controls as in previous indicators. The operation of the 2nd, 3rd, and 4th counters is similar to that of modification III. The first, fifth, and sixth counters are free-running blocking oscillators triggered by positive pulses from a preceding stage; their count rate is controlled by the time constant in the grind circuit.

b. STATION SELECTOR AND LEFT-RIGHT CIRCUITS.—Because of the revised counter chain, feedback for station selector operation must now be applied to both the second (2:1) and third (5:1) counters. This revision necessitated a simplified padding procedure and only three padders are now required for all station adjustments. Stations 2, 4, and 6 are aligned by means of the display pattern ("SWEEP SPEED SW." position "8"). Station 0 requires no feedback, and all odd stations are automatically in adjustment when the even station below is correctly aligned.

Left-right action on slow sweep, no longer associated with the pedestal generator, is accomplished by changing the feedback to the second and third counters, as when changing stations. The speed of L-R action has been made exactly equal to that which would be obtained by changing the "STATION SELECTOR SW." by one station.

c. DISPLAY PATTERN.—A new display has been substituted for the dot pattern ("SPEED SWEEP SW." position "8") used in modification III indicators. (See fig. 6-5.) The sweep is now triggered by the output pulse from the fourth counter, and the charge steps of the third counter storage capacitor appear on the screen of the cathode-ray tube. This pattern is used to pad station selector padders and check L-R and station selector circuit operation. It is also useful for checking third and fourth counter operation.

d. E-J SQUARE WAVE GENERATOR.—Revision of this circuit has resulted in greatly increased stability, allowing the use of fixed bias. The control formerly used in the cathode circuit has therefore been eliminated.

e. RECURRENCE RATE SWITCH. — A switch marked "PRR" has been added to the front panel, permitting selection of either 25- or 33⅓-cycle pulse recurrence rates. This switch changes time constants in the sixth counter grid, causing the counter to operate at either a 4:1 or 3:1 rate. This revision required an additional adjustment for the last counter, for the 33⅓-cycle rate, which is labeled "E" on the front panel.

f. PEDESTAL AND SWEEP DURATION.—In modification III, the length of the pedestal was fixed and the sweep duration on various indicator units differed because of variations in components. In modification V the pedestal duration is adjustable. The control, located on the right side of the chassis, is now adjusted for the fast sweep position and should be set for 250 microseconds. This adjustment also affects the medium sweep duration but must be set only for the fast sweep.

g. FRICTION BRAKE.—In modification III, trouble was sometimes encountered because of the free moving delay control dials. In modification V, friction brakes have been applied to these controls to prevent their being accidentally knocked out of position when other controls are being adjusted.

h. ELIMINATION OF A-DELAY ADJUSTMENT.—The A-delay circuits have been stabilized to such an extent in modification V that the A-delay adjustment could be eliminated.

i. ILLUMINATION OF STATION SELECTOR DIAL.—In modification V, a dial light has been added to illuminate the station selector dial.

j. INSTRUCTION MANUAL.—A new instruction manual is being prepared and will soon be available for modification V. Test procedures, specifications, and schematic circuit diagrams will appear in LORAN ARMB No. 23.

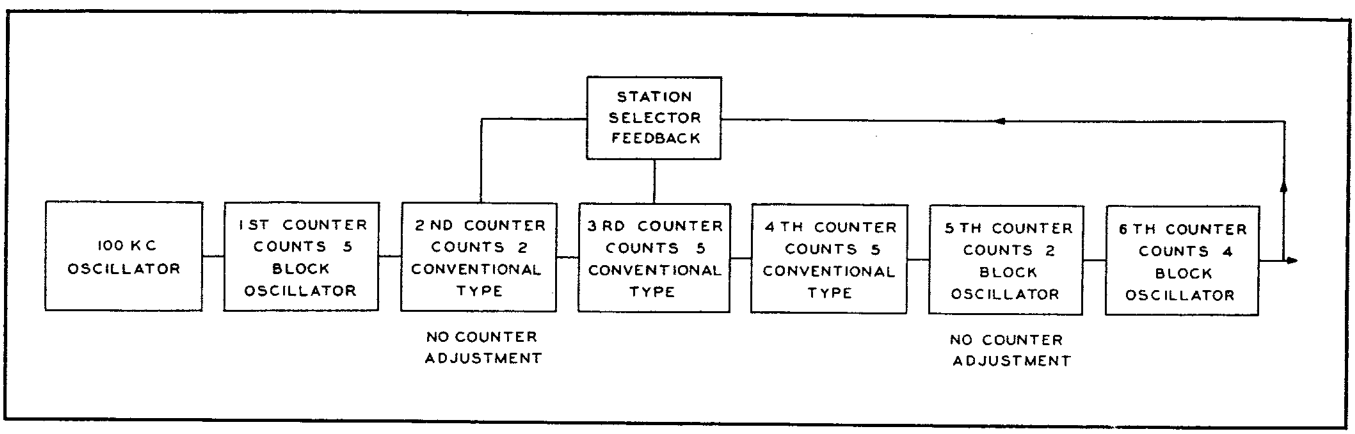


Figure 6-4. Indicator ★ID-6B/APN-4—Counter Circuits, Block Diagram

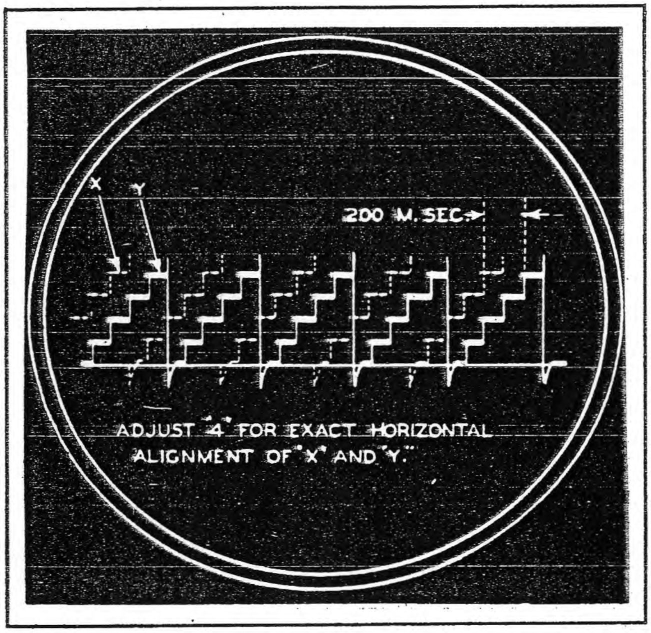


Figure 6-5. Indicator ★ID-6B/APN-4—Display Pattern Sweep Speed Switch Position "8"

8. ADJUSTMENT OF LORAN INDICATORS.

This adjustment is to accommodate a basic pulse rate of 33⅓ per second. Until recently, all Loran stations operated at a basic pulse recurrence rate of 25 per second. Stations operating on the same radio frequency are assigned rates which differ from the basic pulse rate by small amounts. These rates are numbered 0 to 7 and are selected by the station selector switch. Rate 0 is 25 per second, rate 7 is 25-7/16 per second, and the other rates are in between.

In order to increase the number of Loran stations which may operate on the same radio frequency channel, an additional basic recurrence rate of 33⅓ per second will be used for certain new Loran stations. The new stations will be assigned rates which differ from the new basic rate of 33⅓ per second by small amounts. These various rates are also numbered 0 to 7 and are selected by the same station-selector switch that is used for stations operating at a basic pulse rate of 25. Rate 0 will then be 33⅓ per second, rate 7 will be 33-11/12 per second and the other rates will be in between.

The family of eight rates (numbered 0 to 7) based on 25 per second will be known as L (low) rates and the family of eight rates (numbered 0 to 7) based on 33⅓ per second will then be known as H (high) rates.

When the ordinary alignment instructions for Radio Set ★AN/APN-4 and Radio Set SCR-722-A are followed, a basic rate of 25 per second (L) results. To obtain a basic rate of 33⅓ per second (H) it is necessary to adjust the fourth counter in the indicator to count 6 rather than 8. This adjustment is made as follows:

a. For Radio Set ★AN/APN-4, with the sweep speed switch on position 7, turn the indicator front panel adjustment "D" until there are 6 groups of 2500 microsecond spaces on each trace rather than 8 groups of 2500 microsecond spaces.

b. For Radio Set SCR-722-A, with the test lead in the "3-4" test position and the sweep speed "slow," the indicator front panel adjustment "D" is turned until a pattern of six groups of five stairs on each trace is obtained, rather than a pattern of eight groups of five stairs.

c. The most recent production of Radio Set ★AN/APN-4 (modification V) provides a switch for changing the basic pulse rate. This switch is marked "Hi" for 33⅓ and "Lo" for 25 pulses per second.

Note

For modifying Indicator ★ID-6A/APN-4, used in earlier models of Radio Set ★AN/APN-4, to conform with the basic pulse rate of 33⅓, refer to Technical Order No. 16-35ID6-21.

When changing the basic pulse rate of Loran indicators from 25 to 33⅓ in accordance with the above instructions, it will be found that the station selector circuits will be out of adjustment. It is imperative that these circuits be readjusted, but it is neither necessary nor desirable to use the trimmer capacitors for this operation, since it may be very easily accomplished by means of the fourth counter output control R-341-2. Readjustment of this control on position 7 of the station selector switch will bring all of the dots back into line simultaneously. This readjustment is, of course, also required when changing from 33⅓ to 25 cycles basic pulse rate.

SECTION VII
PARTS CATALOG

Introduction

Table of Parts

The parts listed in this table do not constitute a complete electrical and mechanical breakdown of the equipment. The table lists all electrical parts together with such operative mechanical parts as are subject to loss or failure, with the exception of structural and minor parts such as standard bolts, screws, nuts, and the like. In some instances individual detail parts of a sub-assembly may not be listed as separate items, since replacement of such items is impractical.

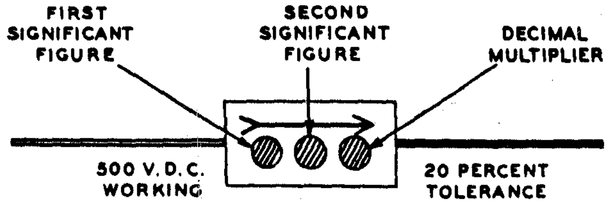
Ordering of Spare Parts

Each Service using this list has established certain depots and service groups for the storage and issue of spare parts to its organizations requiring them. The regulations of each Service should be studied to determine the method and source for requisitioning spare parts. The information in this list, as to manufacturer's or contractor's name, type, model, or drawing number, is not to be interpreted as authorization to field agencies to attempt to purchase identical or comparable spare parts directly from the manufacturer or a wholesale or retail store except under emergency conditions as covered by existing regulations of the Service concerned.

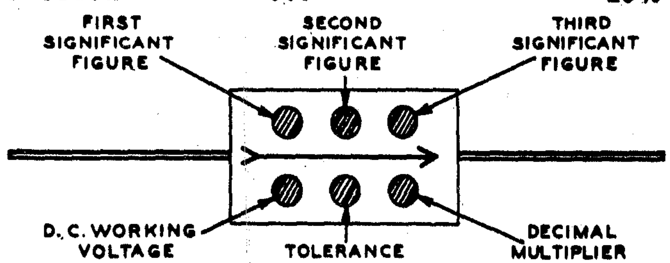
U. S. ARMY PERSONNEL: This table is for information *only* and is not to be used as a basis for requisitioning parts. Authorities for obtaining maintenance items are as follows: 1. For using organizations: applicable Service publications of the 00-30 series of AAF Technical Orders. 2. For higher maintenance and supply echelons: applicable Service publications of the 08-55 series of AAF Technical Orders.

RMA COLOR CODES

CAPACITORS (MMFD)



COLOR	NUMERAL	VOLTS	MULTIPLIER	TOLERANCE
BLACK	0		1	
BROWN	1	100	10	1%
RED	2	200	100	2%
ORANGE	3	300	1,000	3%
YELLOW	4	400	10,000	4%
GREEN	5	500	100,000	5%
BLUE	6	600	1,000,000	6%
VIOLET	7	700	10,000,000	7%
GRAY	8	800	100,000,000	8%
WHITE	9	900	1,000,000,000	9%
GOLD		1000	0.1	5%
SILVER		2000	0.01	10%
NO COLOR		500		20%

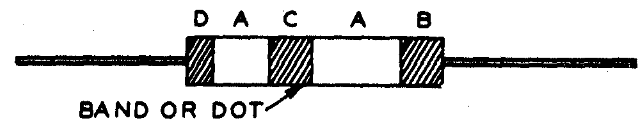


RESISTORS (OHMS)

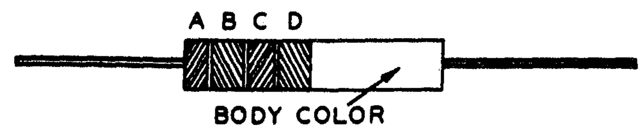
COLOR	A 1st DIGIT	B 2nd DIGIT	C MULTIPLIER
SILVER			0.01
GOLD			0.1
BLACK		0	1.0
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
PURPLE	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	

D — TOLERANCE CODE:

GOLD = 5% SILVER = 10% NO COLOR = 20%



OLD COLOR ARRANGEMENT



NEW COLOR ARRANGEMENT

BODY COLOR (NEW COLOR ARRANGEMENT ONLY) INDICATES TYPE OF RESISTOR, AS FOLLOWS:—

BLACK — COMPOSITION, NON-INSULATED
TAN, OLIVE OR WHITE — COMPOSITION, INSULATED
DARK BROWN — WIRE-WOUND, INSULATED

TABLE OF PARTS

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: RADIO RECEIVER ★R-9/APN-4**

Reference Symbol	*Army Stock Number Navy Stock Number British Ref. Number*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or Standard Type*	*Cont. or Govt. Dwg. or Spec. No.*
C-101	3DK9030-19 —— ——	CAPACITOR: fixed; mica; 30 micromicrofarads, ±5%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" wide, 6/32" thick; axial terminal leads	Part of wave trap	Cornell-Dubilier type 5W Micamold type O	Philco 60-00305337
C-102	3D9240-4 —— ——	CAPACITOR: fixed; mica; 240 micromicrofarads, ±10%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" wide, 6/32" thick; axial leads	Blocking	Cornell-Dubilier type 5W Micamold type O	Philco 60-10245417
C-103-1	3DA100-112 —— ——	CAPACITOR: fixed; paper; 100,000 micromicrofarads, +20% —10%; 400 volts d-c working; wax-impregnated case; case dimensions 1-7/16" long, 3/4" wide, 3/8" thick; axial leads	Primary filter	Micamold type 345-21	Philco 305-1086
C-103-2		CAPACITOR: same as C-103-1	R-F screen bypass		
C-103-3		CAPACITOR: same as C-103-1	Oscillator screen bypass		
C-103-4		CAPACITOR: same as C-103-1	I-F filter		
C-103-5		CAPACITOR: same as C-103-1	I-F cathode bypass		
C-103-6		CAPACITOR: same as C-103-1	I-F screen bypass		
C-103-7		CAPACITOR: same as C-103-1	2nd I-F plate filter		
C-103-8		CAPACITOR: same as C-103-1	2nd I-F cathode bypass		
C-103-9		CAPACITOR: same as C-103-1	3rd I-F filter		
C-103-10		CAPACITOR: same as C-103-1	Bypass in gain circuit		
C-103-11		CAPACITOR: same as C-103-1	1st R-F cathode bypass		
C-104-1	3D9050-7 —— ——	CAPACITOR: fixed; silver mica; 50 micromicrofarads, ±5%; 500 volts d-c working; moulded case; case dimensions 11/16" long, 7/16" wide, 3/16" thick; axial terminal leads	I-F tank, each side of transformer	Cornell-Dubilier type 5RS Micamold type PO	Philco 305-1227
C-104-2		CAPACITOR: same as C-104-1			
C-104-3		CAPACITOR: same as C-104-1			
C-104-4		CAPACITOR: same as C-104-1			
C-104-5		CAPACITOR: same as C-104-1			
C-104-6		CAPACITOR: same as C-104-1			
C-104-7		CAPACITOR: same as C-104-1			
C-104-8		CAPACITOR: same as C-104-1			
C-105	3DKA8.2 —— ——	CAPACITOR: fixed; mica; 8200 micromicrofarads, ±10%; 300 volts d-c working; moulded case; case dimensions 50/64" long, 50/64" wide, 9/32" thick; axial terminal leads	Filter shunt	Aerovox type 1467 Micamold type W	Philco 60-20823414

IMPORTANT

Circuit reference symbols in this table of parts duplicate themselves.
Be sure to check nomenclature of the particular major assembly.

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: RADIO RECEIVER ★R-9/APN-4**

Reference Symbol	Army Stock Number Navy Stock Number British Ref. Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
C-106-1	3DK9510-4 —— ——	CAPACITOR: fixed; mica; 510 micromicrofarads, ±10%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" wide, 6/32" thick; axial terminal leads	Video filter	Cornell-Dubilier type 5W Micamold type O	Philco 60-10515417
C-106-2		CAPACITOR: same as C-106-1			
C-106-3		CAPACITOR: same as C-106-1	4th I-F cathode bypass		
C-106-4		CAPACITOR: same as C-106-1	Input filter		
C-106-5		CAPACITOR: same as C-106-1	Input filter		
C-107	3DK9390-4 —— ——	CAPACITOR: fixed; mica; 390 micromicrofarads, ±10%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" wide, 6/32" thick; axial terminal leads	Video filter	Cornell-Dubilier type 5W Micamold type O	Philco 60-10395417
C-108	3DKA10-178 —— ——	CAPACITOR: fixed; paper; 10,000 micromicrofarads, +20% —10% 600 volts d-c working; moulded case; case dimensions 1-7/16" long, 3/4" wide, 5/16" thick; axial terminal leads	Video stage blocking	Micamold type 342-17 Sprague type P9021	Philco 305-1255
C-109-1	3D9024 —— ——	CAPACITOR: fixed; mica; 24 micromicrofarads, ±5%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" wide, 6/32" thick; axial terminal leads	Antenna tank tuning	Cornell-Dubilier type 5W Aerovox type 1468	Philco 60-00245327
C-109-2		CAPACITOR: same as C-109-1	R-F tank tuning		
C-110	3DA500-68 —— ——	CAPACITOR: fixed; paper; oil-impregnated; 500,000 micromicrofarads, +20% —10%; 600 volts d-c working; metal case; oil-filled; hermetically-sealed; case dimensions 1-13/16" long, 1" wide, 14/16" thick; lug terminal leads out top; 2 mounting brackets 2-1/8" between centers	Filter	Cornell-Dubilier	Philco 305-1154
C-111-1	3DKA250-54 —— ——	CAPACITOR: fixed; paper; dykanol; 250,000 micromicrofarads; standard tolerance; 2500 volts d-c working; metal case; hermetically-sealed; case dimensions 4-5/16" long, 1-3/8" diameter; single lug terminal; clamp-type mounting	Filter	Cornell-Dubilier type PC-2100	Philco 305-1304
C-111-2		CAPACITOR: same as C-111-1			
C-111-3		CAPACITOR: same as C-111-1			
C-112-1	3D9015-17 —— ——	CAPACITOR: fixed; mica; 15 micromicrofarads, ±10%; 500 volts d-c working; moulded case; case dimensions 11/16" long, 7/16" wide, 3/16" thick	Series wave trap	Electromotive type 503M Micamold type OYM	Philco 305-1282
C-112-2		CAPACITOR: same as C-112-1			
C-113	3D9051-3 —— ——	CAPACITOR: fixed; mica; 51 micromicrofarads, ±5%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" wide, 6/32" thick; axial terminal leads	Blocking	Aerovox type 1468 Micamold type O	Philco 60-00515317
C-114	3DA2-66 —— ——	CAPACITOR: fixed; mica; 2000 micromicrofarads, ±10%; 500 volts d-c working; moulded case; case dimensions 50/64" long, 50/64" wide, 9/32" thick; axial terminal leads	4th I-F screen bypass	Cornell-Dubilier type 1W Micamold type W	Philco 60-20205414
C-115	3DK9150-22	CAPACITOR: fixed; mica; 150 micromicrofarads, ±10%;	Output of second	Cornell-Dubilier type	Philco

	—— ——	500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" wide, 6/32" thick; axial terminal leads	detector	5W Micamold type O	60-10155417
C-116	3DK9075-13 —— ——	CAPACITOR: fixed; mica; 75 micromicrofarads, ±10%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" wide, 6/32" thick; axial terminal leads	Video filter	Cornell-Dubilier type 5W Micamold type O	Philco 60-00755417
C-117	3DKB8-52 —— ——	CAPACITOR: fixed; paper; dykanol; 8 microfarads, ±10%; 600 volts d-c working; aluminum case, hermetically-sealed; case dimensions 4-1/2" long, 2" diameter; 2 solder terminals on top; mounted with clamp	Filter	Cornell-Dubilier type CRA-3080	Philco 305-1339
C-118	3DKA500-103 —— ——	CAPACITOR: fixed; paper; oil-impregnated; 500,000 micromicrofarads, +20% —10%; 600 volts d-c working; metal case; hermetically-sealed; case dimensions 1-13/16" long, 7/8" wide, 1" thick; 2 lug solder terminals on side; 2 mounting brackets; 2-1/8" between centers.	Filter	Cornell-Dubilier type DYR-6050 Sprague type P-9047	Philco 305-1335
C-119	3DKB1-0 —— ——	CAPACITOR: fixed; paper; 1 microfarad; 600 volts d-c working; metal case; case dimensions 1-1/2" long, 1-13/16" wide, 1" thick; 2 lug terminals; 2 mounting brackets 2-1/4" between centers	B + filter	Cornell-Dubilier type PC-2147	Philco 305-1366
C-120	3DKA1-106 —— ——	CAPACITOR: fixed; silver mica; 1000 micromicrofarads, ±2%; 500 volts d-c working; case dimensions 1-1/16" long, 15/32" wide, 7/32" thick; axial terminal leads	Voltage divider, oscillator circuit	Cornell-Dubilier type 2R-501	Philco 60-20105241
C-121	3DK9240-6 —— ——	CAPACITOR: fixed; mica; 240 micromicrofarads, ±20%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" wide, 3/16" thick; axial terminal leads	Voltage divider, oscillator circuit	Cornell-Dubilier type 5W Micamold type O	Philco 60-10245247
F-101	3Z2604.6 —— ——	FUSE: cartridge; 4 amperes; 250 volts; 1-1/4" long x 1/4"; new sleeve type 3AG	Power supply	Littelfuse 1357-3AG	Philco 455-2048
J-101	2ZK3010.10 —— ——	CONNECTOR ASSEMBLY: consists of 2 large hex nuts, 3 washers, and green collar with solder lug on rear and retaining clip coming out from green collar; coaxial; single contact; contact mounted by 2 lockwashers and 2 small hex nuts; body 1-5/16" long, 3/4" diameter	Antenna input	Amphenol 10H528 (green)	Philco 358-1267
J-102	2ZK3010.11 —— ——	CONNECTOR ASSEMBLY: consists of 2 large hex nuts, 3 washers, and yellow collar with solder lug on rear and retaining clip coming out from yellow collar; coaxial; single contact; contact mounted by 2 lockwashers and 2 small hex nuts; body 1-5/16" long, 3/4" diameter	Balance connector	Amphenol 10H528 (yellow)	Philco 358-2832
J-103	2Z3010.4 —— ——	CONNECTOR ASSEMBLY: consists of 2 large hex nuts, 3 washers, and blue collar with solder lug on rear and retaining clip coming out from blue collar; coaxial; single contact; contact mounted by 2 lockwashers and 2 small hex nuts; body 1-5/16" long, 3/4" diameter	Gain connector	Amphenol 10H528 (blue)	Philco 358-1305
J-104	2ZK3010.12 —— ——	CONNECTOR ASSEMBLY: consists of 2 large hex nuts, 3 washers, and red collar with solder lug on rear and retaining clip coming out from red collar; coaxial; single contacts; contact mounted by 2 lockwashers and 2 small hex nuts; body 1-5/16" long, 3/4" diameter	Video output	Amphenol 10H528 (red)	Philco 358-1266

IMPORTANT

Circuit reference symbols in this table of parts duplicate themselves.
Be sure to check nomenclature of the particular major assembly.

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: RADIO RECEIVER ★R-9/APN-4**

Reference Symbol	Army Stock Number Navy Stock Number British Ref. Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
J-105	2Z8799-152 —— ——	RECEPTACLE: connector; 2 connections on top; 4 connections on bottom; 6 pin type contacts; 1-9/16" diameter x 1/2" wide aluminum shell protector for pins; outside thread; six solder posts protrude 1/4" backward from bakelite base; body 3/4" deep, 1-3/8" diameter; flange 1-15/16" square, smooth front surface; dull black finish; four mounting holes with 0.152" diameter spaced 1-1/2" apart	Power output to indicator	Amphenol 10H394	Philco 358-4887
J-106	2Z8799.146 —— ——	RECEPTACLE: connector; 4-way; 4 contacts; pin type; 1-1/4" diameter x 1/2"-long aluminum shell outside threaded protector over prongs; 4 solder posts protrude back 1/4" from bakelite base; mounting flange 1.560" square x 1/16" thick; bakelite body; 4 mounting holes with 0.152" diameter spaced 1.200" apart	Power input	Amphenol 10H391	Philco 358-3450
R-101-1	3Z6647-1 —— ——	RESISTOR: fixed; metallized; 47,000 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Screen resistor	I.R.C. BT-1/2	Philco 66-3473344
R-101-2		RESISTOR: same as R-101-1	Screen load		
R-102-1*	3ZK6618-22 —— ——	RESISTOR: fixed; metallized; 18,000 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Plate R-F	I.R.C. BT-1/2	Philco 66-3183344
R-102-2*		RESISTOR: same as R-102-1	Screen resistor, oscillator		
R-102-1		RESISTOR: carbon, insulated, 18,000 ohms, 2 watt; ±5%; length 1-3/8", diameter 3/8" leads	Plate R-F	I-1 BT-2 I.R.C.	Philco 66-3185244
R-102-2		RESISTOR: same as R-106-1	Screen resistor, oscillator		
R-103-1	3Z6330-7 —— ——	RESISTOR: fixed; metallized; 3300 ohms, ±10%; 1/2 watt; insulated; lengths 5/8", diameter 3/16"; axial wire leads 1-1/2" long	1st I-F choke	I.R.C. BT-1/2	Philco 66-2333344
R-103-2		RESISTOR: same as R-103-1	2nd I-F choke		
R-103-3		RESISTOR: same as R-103-1	3rd I-F choke		
R-103-4		RESISTOR: same as R-103-1	4th I-F choke		
R-103-5		RESISTOR: same as R-103-1	Cathode oscillator		
R-104	3ZF4007 —— ——	RESISTOR: fixed; metallized; 56,000 ohms, ±10%; 1 watt; insulated; length 1-1/4", diameter 1/4"; axial wire leads 1-1/2" long	2nd and 3rd I-F screen load	I.R.C. BT-1	Philco 66-3564344
R-105-1	3Z6610-47 —— ——	RESISTOR: fixed; metallized; 10,000 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Video amplifier plate load	I.R.C. BT-1/2	Philco 66-3103344
R-105-2		RESISTOR: same as R-105-1	Video filter attenuator		
R-105-3		RESISTOR: same as R-105-1	Video output		

*Early models.

R-106	3Z6615-1 —— ——	RESISTOR: fixed; metallized; 15,000 ohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	1st I-F loading	I.R.C. BT-1/2	Philco 66-3153244
R-106-1	3Z6615-1 —— ——	RESISTOR: fixed; metallized 68,000 ohms, ±5%, 1/2 watt; insulated 3/16"; axial wire leads, 1-1/2" long	1st I-F loading	I.R.C. BT-1/2	Philco 66-3683244
R-106-2		RESISTOR: Same as R-106-1			
R-106-3		RESISTOR: Same as R-106-1			
R-107	3Z6639-7 —— ——	RESISTOR: fixed; metallized; 39,000 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Antenna load	I.R.C. BT-1/2	Philco 66-3393344
R-108	3ZK6038-2 —— ——	RESISTOR: fixed; metallized; 380 ohms; ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long.	6SK7 cathode load	I.R.C. BT-1/2	Philco 66-1383344
R-109	3Z6622-2 —— ——	RESISTOR: fixed; metallized; 22,000 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wide leads 1-1/2" long	6SA7 grid resistor	I.R.C. BT-1/2	Philco 66-3223344
R-110-1	3Z6056-5 —— ——	RESISTOR: fixed; metallized; 560 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wide leads 1-1/2" long	Cathode resistor 2nd I-F	I.R.C. BT-1/2	Philco 66-156344
R-110-2		RESISTOR: same as R-110-1	Cathode resistor 3rd I-F		
R-110-1		RESISTOR: fixed; metallized filament; 2200 ohms, 1/2 watt; ±10%; insulated; axial leads, wax impregnated; length 3/8", diameter 3/16"	Cathode resistor 2nd I-F	I-1 BT-1/2 I.R.C.	6617563344
R-110-2		RESISTOR: same as R-110-1	3rd I-F		
R-111-1	3Z6627-1 —— ——	RESISTOR: fixed; metallized; 27,000 ohms, ±10%, 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	6H6 plate load	I.R.C. BT-1/2	Philco 66-3273344
R-111-2		RESISTOR: same as R-111-1	Series filter		
R-112-1	3Z6722-1 —— ——	RESISTOR: fixed; metallized; 220,000 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Video filter	I.R.C. BT-1/2	Philco 66-4223344
R-112-2		RESISTOR: same as R-112-1	Video filter		
R-112-3		RESISTOR: same as R-112-1	Grid return		
R-113	3Z6801-19 —— ——	RESISTOR: fixed; metallized; 1 megohm, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Video output grid leak	I.R.C. BT-1/2	Philco 66-5103344
R-114	3ZK6782-3 —— ——	RESISTOR: fixed; metallized; 820,000 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Bleeder	I.R.C. BT-1/2	Philco 66-4823344
R-115-1	3ZK6013-2 —— ——	RESISTOR: fixed; metallized; 130 ohms; ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	6B4 grid suppressors	I.R.C. BT-1/2	Philco 66-1133344

IMPORTANT

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Symbol Reference	British Ref. Number Army Stock Number Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
R-115-2		RESISTOR: same as R-115-1			
R-115-3		RESISTOR: same as R-115-1			
R-116-1	3Z6802A2-6 —— ——	RESISTOR: fixed; metallized; 2.2 megohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	6SJ7 plate load	I.R.C. BT-1/2	Philco 66-5223344
R-116-2		RESISTOR: same as R-116-1	Grid leak		
R-117	3Z6470-3 —— ——	RESISTOR: fixed; metallized; 4700 ohms, ±10%; 1 watt; insulated; length 1-1/4", diameter 1/4"; axial wire leads 1-1/2" long	VR105 anode filter	I.R.C. BT-1	Philco 66-2474344
R-118	3Z6747-1 —— ——	RESISTOR: fixed; metallized; 470,000 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Grid isolating	I.R.C. BT-1/2	Philco 66-4473344
R-119	3ZK6610-91 —— ——	RESISTOR: fixed; wire-wound; 10,000 ohms, ±10%; 5 watts; ceramic-insulated; length 1-7/32", diameter 7/16"; radial wire leads 2-1/2" long	Voltage divider suppressor	Sprague Koolohm type 5K	Philco 353-1351
R-120-1	3Z6700-30 —— ——	RESISTOR: fixed; carbon; 100,000 ohms, ±10%; 1 watt; insulated; length 1-1/4", diameter 1/4"; axial wire leads 1-1/2" long	Voltage divider	I.R.C. BT-1	Philco 66-4104344
R-120-2		RESISTOR: same as R-120-1			
R-120-3		RESISTOR: same as R-120-1	2nd and 3rd screen load		
R-121	2ZK7270.5 —— ——	POTENTIOMETER: wire-wound; 50,000 ohms, ±10%; 3 watts; linear taper; moulded bakelite case; case dimensions 1-5/8", 13/16" deep, 1/4" screwdriver slot shaft 1/8" long from end of bushing; bushing threaded 3/8"-32 for 3/8" with hex nut for mounting; includes hex nut and two washers; solder lug terminals on top back of case	Voltage regulator control screen	Clarostat type P58	Philco 353-5003
R-121		POTENTIOMETER: wire wound, 20,000 ohms, ±10%; 3 watts; linear taper; mounted bakelite case; case dimensions 1-5/8", 13/16" deep; 1/4" screwdriver slot shaft 1/8" long from end of bushing; bushing threaded 3/8"-32 for 3/8" with hex nut for mounting; includes hex nut and two washers; solder lug terminals on top back of case	Voltage regulator control screen	Clarostat type P58	Philco 353-5215
R-122	3ZK6220-16 —— ——	RESISTOR: fixed; metallized; 2200 ohms, ±10%; 1 watt; insulated; length 1-1/4", diameter 1/4"; axial wire leads 1-1/2" long	Bias 4th I-F and balance tube	I.R.C. BT-1	Philco 66-2224344
R-123-1		RESISTOR: fixed; metallized filament; 5.6 megohm, 10%, 1/2 watt, insulated; axial leads, wax impregnated; 5/8" long x 3/16" diameter	Bleeder	I-1 BT-1/2 I.R.C.	66-5563344
R-123-1	3ZK6810-21 —— ——	RESISTOR: fixed; metallized; 10 megohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Bleeder	I.R.C. BT-1/2	Philco 66-6103344

R-123-2		RESISTOR: same as R-123-1			
R-123-3		RESISTOR: same as R-123-1			
R-123-4		RESISTOR: same as R-123-1			
R-123-2		RESISTOR: same as R-123-1	Bleeder		
R-123-3		RESISTOR: same as R-123-1	Bleeder		
R-123-4		RESISTOR: same as R-123-1	Bleeder		
R-123-5		RESISTOR: same as R-123-1	Bleeder		
R-123-6		RESISTOR: same as R-123-1	Bleeder		
R-123-7		RESISTOR: same as R-123-1	Bleeder		
R-123-8		RESISTOR: same as R-123-1	Bleeder		
R-124	3Z6656-1 —— ——	RESISTOR: fixed; metallized; 56,000 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial leads 1-1/2" long	Filter	I.R.C. BT-1/2	Philco 66-3563344
R-125	3Z4550 —— ——	RESISTOR: fixed; metallized; 100,000 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Filter	I.R.C. BT-1/2	Philco 66-4103344
R-126-1	3Z6618-15 —— ——	RESISTOR: fixed; metallized; 18,000 ohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial leads 1-1/2" long	2nd I-F loading	I.R.C. BT-1/2	Philco 66-3183244
R-126-2		RESISTOR: same as R-126-1	3rd I-F loading		
R-127-1	3Z6610-7 —— ——	RESISTOR: fixed; metallized; 10,000 ohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Oscillator loading on band 1	I.R.C. BT-1/2	Philco 66-3103244
R-127-2		RESISTOR: same as R-127-1	Oscillator loading on band 2		
R-128		RESISTOR: fixed, metallized filament; 27,000 ohms, 1 watt, ±5%, insulated; axial leads, wax impregnated, 1-1/4" long x 1/4" diameter	Voltage divider resistor V106	I-1 BT-1 I.R.C.	66-3274244
S-101	3ZK9828-8 —— ——	SWITCH: rotary; 4-section wafer; 20 contacts; 4 positions; shorting type teeth on rotor blades; shaft 1/4" diameter x 3/8" long from bushing; contact clips and rotor blades of solid coin silver; all metal parts stainless steel; XXX bakelite insulation of rotor and stator; case dimensions overall, 6-3/16" long, 2" diameter; solder terminals located around wafers; mounting dimensions, bushing 3/8"-32 thread 3/8" long, without position-indicating plate, without attaching hardware	Channel selector	Oak 25235-H4	Philco 452-1109
S-102-1	3ZK9560-2 —— ——	SWITCH: spst; toggle; silver contacts; contact rated 24 volts, 20 amperes; case dimensions 1-1/8" long, 5/8" wide; 1-3/32" high; screw terminals located at end of back at angle; bat type lever, nickel-plated; mounting dimensions, bushing 15/32"-32 thread, 15/32" long; without position-indicating plate, with attaching hardware; extended luminous tip bakelite housing	A-C power off-on	Cutler-Hammer 8801-K3	Philco 452-1008
S-102-2		SWITCH: same as S-102-1	Shunting video filter in-out		

IMPORTANT

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MODEL: RADIO SET ★AN/APN-4 MAJOR ASSEMBLY: RADIO RECEIVER ★R-9/APN-4

Symbol Reference	British Ref. Number Army Stock Number Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
S-103	3ZK9560-3 —— ——	SWITCH: dpdt; toggle; silver contacts; contact rated 24 volts, 20 amperes; case dimensions 1-25/32" long, 15/16" wide, 3/4" deep; screw terminals located at ends; nickel plated lever; mounting dimensions, bushing 15/32"-32 thread, 15/32" long; luminous tip bakelite housing	80-115 a-c input	Cutler-Hammer 8824-K3	Philco 452-1113
S-104		SWITCH: toggle, dspt, 2 position, on-off bakelite insulation, 20 amps, 24 volts, overall dimensions; 15/16" long x 25/32" high x 3/4" thick; 1/2" mounting hole, mounting shaft 15/32"-32 thread, switch handle 23/32" long	Power on-off switch	C-6 8823 Cutler Hammer	352-7245
T-104	2ZK9613.32 —— ——	TRANSFORMER: input, single phase, 400-2400 cycles per second, 115 volts; core material laminated; primary 115 volts, tapped 80 volts, terminals 1, 2, and 3; secondary No. 1, 440 volts each side of center tap, terminals 7 and 8; secondary No. 3, 6.3 volts, 3 amps, terminals 9 and 11, terminal 10 center tap; secondary No. 4, 6.3 volts, 3 amps, terminals 14 and 15; secondary No. 5, 6.3 volts, 0.3 amps, terminals 12 and 13; electrostatic shield. Cased; case 4-5/16" long, 3-9/16" wide, 3-1/4" high; 15 solder terminals 13/32" long, located on bottom of case, 9/16" centers; 6 mounting holes 7/32" in diameter located 3 on each side	Power	Magnetic Winding C1-306M	Philco 352-7101
T-105	2ZK9613.33 —— ——	TRANSFORMER: high voltage, single phase, 400-2400 cycles per second; core material laminated; primary 115 volts, tapped 80 volts, terminals 1, 2 and 3; secondary No. 1, 1300 volts, 1.25 milliamperes, terminals 4 and 5; secondary No. 2, 2.5 volts, 1.75 amps, terminals 6 and 7; secondary No. 3, 2.5 volts, 1.75 amps, terminals 8 and 9; terminals 4, 5, 6, and 7 have high voltage insulation; terminals 8 and 9 are solder lugs; electrostatic shield. Cased; case 3" long, 2-5/16" wide, 3" high; 9 solder terminals located on bakelite panel on bottom; 6 mounting holes 3/16" in diameter located 3 on each side	High voltage	Magnetic Winding B1-305M	Philco 352-7100
T-105		TRANSFORMER: high-voltage type, 400-2400 cps, single phase, laminated; primary 115 volts, a-c tapped 80 volts; secondary: 1140 volts RMS, 1.25 milliampere, 2.5 volts; 1.75 amperes, 2.5 volts. Cased; 3" long, 2-5/16" wide, 3" high, 9 solder terminals located on bakelite panel on bottom, six 3/16" diameter mounting holes, located 3 on each side, mounting dimensions center 7/8" x 2-11/16"	High voltage	M-3 B1-305M Magnetic Windings	352-7245
X-101-1	2Z8650.1 —— ——	SOCKET: tube; octal; bakelite; 8 contacts; phosphor bronze silver-plated; wafer; 1-1/2" long, 1" diameter, 1/16" deep; two 0.140" holes for mounting.	Socket for V-101-1	Cinch type 6742	Philco 257-6041
X-101-2		SOCKET: same as X-101-1	Socket for V-102		
X-101-3		SOCKET: same as X-101-1	Socket for V-101-2		
X-101-4		SOCKET: same as X-101-1	Socket for V-101-3		

X-101-5		SOCKET: same as X-101-1	Socket for V-101-4		
X-101-6		SOCKET: same as X-101-1	Socket for V-103		
X-101-7		SOCKET: same as X-101-1	Socket for V-104		
X-101-8		SOCKET: same as X-101-1	Socket for V-105-1		
X-101-9		SOCKET: same as X-101-1	Socket for V-105-2		
X-101-10		SOCKET: same as X-101-1	Socket for V-105-3		
X-101-11		SOCKET: same as X-101-1	Socket for V-106		
X-101-12		SOCKET: same as X-101-1	Socket for V-108		
X-101-13		SOCKET: same as X-101-1	Socket for V-109		
X-101-14		SOCKET: same as X-101-1	Socket for V-107		
X-102-1	2ZK8659-8 —— ——	SOCKET: tube; bakelite; 4 contacts; phosphor bronze silver-plated; elliptical steel mounting flange; 2-3/16" long, 1-3/4" wide; 1-5/8" thick overall; two 1/8" diameter holes for mounting; 1-7/8" between centers	For high voltage tubes	Amphenol 77A4T	Philco 257-6042
X-102-2		SOCKET: same as X-102-1			
Z-101-1	2ZK9642.11 —— ——	TRANSFORMER ASSEMBLY: i-f; consists of C-104-1, C-104-2, T-103-1, C-104-1 and C-104-2 capacitors, fixed; silver mica; 50 micromicrofarads, ±5%; 500 volts; frequency 1050 kc; iron core; primary, 134 turns No. 36 SSE wire; inductance 185 millihenries at 1000 cycles; secondary inductance 185 millihenries at 1000 cycles, 134 turns No. 36 SSE wire; tuned by 2 trimmers on side of can; coupler winding 16 turns No. 34 enameled wire with inductance of 3.6 millihenries at 1000 cycles; coils mounted on panel; aluminum case; dimensions 3-1/2" high, 1-3/8" square; 4 leads located through base; 2 spade lugs for mounting located each side of can 1-7/16" between centers	1st I-F	Philco 352-1259	Philco 352-1259
Z-101-2		TRANSFORMER ASSEMBLY: same as Z-101-1	2nd I-F		
Z-101-3		TRANSFORMER ASSEMBLY: same as Z-101-1	3rd I-F		
Z-101-4		TRANSFORMER ASSEMBLY: same as Z-101-1	4th I-F		
Z-102		COIL ASSEMBLY AND PANEL: antenna; consists of T-101-1, T-101-2, and T-102-2; T-101-1, primary 2-1/2 turns No. 36 enameled wire; secondary 105 turns No. 36 enameled wire; Q is 80 at 2.5 mc; color-coded brown; T-101-2 same except color-coded green; T-102-1 primary 1-1/2 turns No. 26 enameled wire; secondary 26 turns No. 26 enameled wire; Q is 120 at 9 mc; color-coded blue; T-102-2 same except color-coded yellow; iron core; tuned by 2 trimmers in tap; aluminum case; dimensions 2-5/8" long, 2" square; wire leads located at base; 2 spade lugs for mounting located each side of can 2" between centers	Antenna	Philco 352-1273	Philco 352-1273
Z-103	3CK4002-3 —— ——	COIL ASSEMBLY: wave trap; consists of 2 windings of 132 turns of 7-44 SSE wirewound in series on form 9/16" outside diameter; 583 millihenries; color-coded blue; ±5%; frequency coverage, 1000 to 1090 kc; mounted in aluminum, dimensions, 2" long x 1-1/8" square; mounting 2 spade lugs, each side of can 1-1/4" centers	Parallel wave trap	Philco 352-1269	Philco 352-1269

IMPORTANT

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TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: RADIO RECEIVER ★R-9/APN-4**

Reference Symbol	British Ref. Number Army Stock Number Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
Z-104-1	3CK4002-3.1 —— ——	COIL ASSEMBLY: wave trap; consists of L-102-1, 2 windings in series of 7-44 SSE wirewound on coil form 19/32" diameter; total inductance of coils 950 millihenries, ±5 millihenries; C-112-2 capacitor; iron core; trimmers in top; 2 wire leads out of base; all mounted in aluminum can 2" long x 1-1/8" square; 2 spade lug mounting 1-3/16" centers; frequency coverage 1010 to 1090 kc	Series	Philco 352-1266	Philco 352-1266
Z-104-2		COIL ASSEMBLY: same as Z-104-1			
Z-105		R-F COIL AND PANEL ASSEMBLY: consists of L-103-1, L-103-2, L-104-1, L-104-2; mounted in aluminum can; each coil has variable iron core; L-103-1, 92-1/2 turns No. 35 enameled wire; Q is 80 at 25 mc; color-coded brown; L-103-2 same except color-coded green; L-104-1, 19-1/2 turns No. 26 enameled wire; Q-max varnished; Q is 120 at 9 mc; color-coded blue; L-104-2 same except color-coded yellow; aluminum case; dimensions 2-5/8" long, 2" square; external adjustments, 2 spade lugs for mounting located each side of can, 2-1/8" between centers	R-F	Philco 352-1261	Philco 352-1261
Z-106	3CK4053-3 —— ——	COIL ASSEMBLY: oscillator; consists of L-106-1, L-106-2, L-107-1, L-107-2, R-127-1, R-127-2 and R-127-33; L-106-1, 30 turns No. 36 wire; 4.8 millihenries; inductance at 1000 cycles; Q is 65 at 5 mc; Q-max varnished; color-coded brown; L-106-2 same except color-coded green; L-107-1, 8 turns No. 20 E wire; 0.6 millihenry inductance at 1000 cycles; Q is 125 at 15 mc, color-coded blue; L-107-2 same except color-coded yellow; R-127-2, resistor; fixed; metallized; 10,000 ohms, ±5%; 1/2 watt; aluminum case; dimensions, 2-5/8" high, 2" square; external adjustments; 2 spade lugs for mounting located each side of can, 2-1/8" between centers	Oscillator	Philco 352-1278	Philco 352-1278
	3ZK3275.2 —— ——	HOLDER ASSEMBLY: fuse; consists of slotted hex nut, rubber washer, holder cap assembly, holder body assembly; moulded black bakelite body; red extractor knob; takes panel up to 5/16" thick; 1/2" mounting hole; knurled finger grip knob which holds fuse; 1-3/4" deep; 2-1/8" overall	Power supply	Littelfuse 1075A	Philco 358-1546
	2ZK5988-23 —— ——	PILOT LAMP ASSEMBLY: consists of pilot lamp assembly with red jewel; white nickel plate finish; solder lug riveted to bayonet base; rotating dim-out feature, 120° uncovers 0.047" diameter opening permitting light to pass through; bracket holding lamp base mounted inside of chassis by covering 11/16" bushing and being held in place by large mounting nut; bracket extends back 1-1/32"	Pilot light	Gothard Mfg. Co. 430P	Philco 358-4735
	2ZK5822-22 —— ——	KNOB: bar; to fit 0.252" shaft; moulded phenolic; brass bushing 5/8" diameter, 1/2" thick; pointer 1-1/4" long, 5/8" thick; 3/4" diameter; white line on pointer; 1 hex socket headless setscrew 8-32 thread; 7/16" long cup point	Channel selector	Kurz-Kasch S-292-3L	Philco 358-4274

2Z2712-1 —— ——	CLIP: grid; ceramic; glazed; 9/16" high tapering 3/8" high with 1/4" diameter hole in end for wire; 7/16" diameter x 1/2" long cap opening with metal spring cap connector inside 1/4" x 5/16" opening to solder wire to metal cap	For high voltage tubes	National Co. SPP-3	Philco 257-4079
2Z8401-5PH8 —— ——	SHOCK MOUNT: F; base plate; length 2-3/8" square; cushion with 0.257" diameter hole; four mounting holes 1-15/16" centers	Vibration absorber	Lord 150-PH-8	Philco 257-8148
2ZK9407-19 —— ——	PANEL ASSEMBLY: XX bakelite; 7 coil mounting plugs 0.185" diameter; one lug terminal 7/16" long; wax-impregnated; one solder lug terminal located near center; strip 1-13/16" long, 1-13/16" wide, 1/16" thick	Wiring panel	Philco 358-3255	Philco 358-3255
2ZK9407-20 —— ——	PANEL ASSEMBLY: cloth base bakelite; two 0.185" diameter coil mounting plugs; 5 lug terminals 3/8" long, material waxed finish; 3 solder lug terminals located on each side; strip 3-3/16" long, 1-5/16" wide, 1/16" thick; mounting 3 stud spacers 0.193" diameter, two at one end 0.875" centers, and one at other end 2.687" center	I-F transformer	Philco 358-3257	Philco 358-3257
6ZK5019 —— ——	HANDLE: steel; black nickel finish; V-shaped; length 4-1/2", height 1-1/4", diameter 5/16"; two 0.136" diameter x 3/8" deep mounting holes drilled and tapped to fit No. 8-32 screw, 4" centers	Carrying handle	Philco 258-1231	Philco 258-1231
2ZK9407-21 —— ——	PANEL ASSEMBLY: cloth base bakelite; 2 lug terminals 5/16" long; center hole 0.185" diameter for bushing; material waxed finish; two solder lug terminals located near center; strip 15/16" long, 15/16" wide, 1/16" thick; stud spacer mounting in opposite corners; 0.193" diameter hole, 13/16" centers	Wave trap	Philco 358-3258	Philco 358-3258
2ZK9407-22 —— ——	TERMINAL PANEL: cloth base bakelite; 14 lug terminals 3/8" long; 2 rows of 7 terminals 3/8" apart located each side; strip 2-3/4" long, 1-3/8" wide, 3/32" thick; two 1/16" thick x 5/16" wide x 1-1/4"; L-shaped cadmium-plated steel brackets on one end; No. 6-32 tapped hole in each foot	Wiring panel	Cinch 8932WI	Philco 358-3261
2ZK9407-26 —— ——	TERMINAL PANEL: cloth base bakelite; 10 terminals 3/32" long; material waxed finish; 5 rows of 2 each terminals located each side; strip 2" long, 1-3/8" wide, 3/32" thick; 2 lug mounting; 2 L brackets 1-1/4" long x 5/16" wide x 1/16" cadmium-plated steel; No. 6-32 tapped hole in each foot 1-1/2" centers	Wiring panel	Cinch 8941	Cinch 358-3361
2ZK9407-24 —— ——	TERMINAL PANEL: cloth base bakelite; 10 terminals 5/16" long; 5 rows of 2 each terminals located each side; strip 2-3/8" long, 1-5/8" wide, 3/32" thick; mounting, 2 L brackets 1-1/4" long x 5/16" wide x 1/16" thick with No. 6-32 tapped hole in each foot; 1" centers	Wiring panel	Cinch 5933W	Cinch 358-3425
2ZK9407-25 —— ——	TERMINAL PANEL: cloth base bakelite; 42 lug terminals 5/16" long; 2 rows of 21 terminals located each side; strip 8" long, 1-3/8" wide, 3/32" thick; 3 holes 0.234" diameter mounting; mounting spacers 5/16" long, one each end and center 3-9/16" centers	Wiring panel	Philco 358-3584	Philco 358-3584
2ZK7409-24 —— ——	RECEPTACLE: 2 pole; female; steel plate moulded in bakelite socket; 2 contacts; bakelite shell; body, 1-1/8" diameter, 9/16" deep; flange, 1-9/32" wide, 1-7/8" long, 1/32" thick; 2 mounting holes 0.156" diameter, 1-1/2" centers; 110-250 volts, 10-15 amperes; accepts all standard 110-volt	Auxiliary output	Amphenol MIP-61F	Philco 257-6097

TABLE OF PARTS

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: RECEIVERS ★R-9A/APN-4 AND ★R-9B/APN-4**

Reference Symbol	British Ref. Number Army Stock Number Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
C101	* —— ——	CAPACITOR: fixed, silver mica, 30 mmf., 500 V d.c. working; wax impregnated; moulded case, dimensions 11/16" x 7/16" x 3/16", axial leads	Wave trap	Dubilier 5RS	305-1114
C102	3D9240-12 —— ——	CAPACITOR: fixed, mica dielectric; 240 mmf. ±10%, 500 working volts, moulded case, wax impregnated, 51/64" long x 15/32" wide x 7/32" thick, axial leads	Plate coupling V101-1	Dubilier 5W Micamold 0	60-10245417
C103-1	3DA100-112 —— ——	CAPACITOR: fixed, paper dielectric; .1 mfd., ±20%; 400 V d.c. working; cardboard case, wax impregnated; 1-7/16" long x 3/4" wide x 3/8" thick; axial leads	Plate bypass V102	Micamold	305-1086
C103-2		Same as C103-1	Screen bypass V101-1		
C103-3		Same as C103-1	Screen bypass V102		
C103-4		Same as C103-1	Plate bypass V101-2		
C103-5		Same as C103-1	Cathode bypass V101-2		
C103-6		Same as C103-1	Screen bypass V101		
C103-7		Same as C103-1	Plate bypass V101-3		
C103-8		Same as C103-1	Cathode bypass V101-3		
C103-9		Same as C103-1	Plate bypass V101-4		
C103-10		Same as C103-1	Cathode bypass V102		
C103-11		Same as C103-1	Cathode bypass V101-1		
C104-1	* —— ——	CAPACITOR: fixed, silver mica, 50 mmf. ±5%, 500 V d.c. working, molded low loss red bakelite, axial, leads 11/16" long, 7/16" wide, 3/16" thickness	I.F. Pri. T103-1	Dubilier 5RS Micamold P.O.	305-1227
C104-2	*	Same as C104-1	I.F. Sec. T103-1		
C104-3	*	Same as C104-1	I.F. Pri. T103-2		
C104-4	*	Same as C104-1	I.F. Sec. T103-2		
C104-5	*	Same as C104-1	I.F. Pri. T103-3		
C104-6	*	Same as C104-1	I.F. Sec. T103-3		
C104-7	*	Same as C104-1	I.F. Pri. T103-4		
C104-8	*	Same as C104-1	I.F. Sec. T103-4		
C105	3DKA8.2 —— ——	CAPACITOR: fixed, mica dielectric; 8200 mmf., ±10%; 300 V d.c. working; moulded case; wax impregnated; 53/64" long x 53/64" wide x 11/32" thick, axial leads	Grid coupling V104	Aerovox 1467 Micamold W	60-20823414
C106-1	3DK9510-4 —— ——	CAPACITOR: fixed, mica dielectric; 510 mmf., ±10%, 500 V d.c. working; moulded case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick, axial leads	Video filter V104	Dubilier	60-10515417
C106-2		Same as 106-1	Video filter V104		
C106-3		Same as 106-1	Cathode bypass V101-4		
C106-4		Same as 106-1	A.C. input filter		

C106-5		Same as C106-1 (Used on R-9A/APN-4 only)			
C107	3DK9390-4 —— ——	CAPACITOR: fixed; mica dielectric; 390 mmf., ±10%, 500 V d.c. working; moulded case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Video filter V104	Dubilier 5W Micamold 0	60-10395417
C108	3DA10-124 —— ——	CAPACITOR: fixed; paper dielectric; .01 mfd. ±20% 600 V d.c. working; moulded case, wax impregnated; 1-7/16" long x 3/4" wide x 5/16" thick; axial leads	Grid coupling V104	Micamold 342-17 Sprague P9021	305-1255
C109-1	3K2024022 —— ——	CAPACITOR: fixed, mica dielectric; 24 mmf. ±5%, 500 V d.c. working; moulded case, wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Antenna tuning	Dubilier 5W Aerovox 1468	60-00245317
C109-2		Same as C109-1	R.F. tuning		
C110	3DKA500-27 —— ——	CAPACITOR: fixed, paper dielectric; 5 mfd., +20% —10%; 600 V d.c. working; hermetically sealed; metal case; oil filled; 1-13/16" long x 1" wide x 11/16" thick; 2 lug terminals on top: 2 mounting brackets 2-1/8" between centers	Filter V106	Dubilier DYRT6050-4	305-1216
C111-1	3DKA250-54 —— ——	CAPACITOR: fixed, paper dielectric; .25 mfd. +20%, —10%, 2500 V d.c. working; metal case, wax impregnated; hermetically sealed; 4-5/16" long x 1-3/8" diameter; single lug terminal.	Filter V110-1	Dubilier PC-2100	305-1304
C111-2		Same as C111-1	Filter V110-2		
C111-3		Same as C111-1	Filter V110-2		
C112-1	* —— ——	CAPACITOR: fixed, mica; 15 mmf. ±5%, 500 V d.c. working; moulded case; dimensions 51/64" long x 15/32" wide x 7/32" thick; axial leads	Wave Trap V101-1	Electromotive 603-M	60-00155337
C112-2	*	Same as C112-1	Wave Trap V101-1		
C113	3D9051-2 —— ——	CAPACITOR: fixed, mica dielectric, 51 mmf. ±5%; 500 V d.c. working; moulded case, wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Grid coupling V102	Aerovox 1468 Micamold 0	60-00515317
C114	3DA2-51 —— ——	CAPACITOR: fixed, mica dielectric; 2000 mmf., ±10%, 500 V d.c. working; moulded case, wax impregnated; 53/64" long x 53/64" wide x 9/32" thick; axial leads	Screen bypass V101-4	Dubilier 1W Micamold W	60-20205414
C115	3K2015121 —— ——	CAPACITOR: fixed, mica dielectric; 150 mmf. ±10%, 500 V d.c. working; moulded case, wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Plate bypass V103	Dubilier 5W Micamold	60-10155417
C116	3DK9075-13 —— ——	CAPACITOR: fixed, mica dielectric; 75 mmf., ±10%, 500 V d.c. working; moulded case, wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Filter V104	Dubilier 5W Micamold	60-00755417
C117	3DKB8-52 —— ——	CAPACITOR: fixed, paper dykanal; 8 mf. +20% —10%, 600 V d.c. working; metal case, hermetically sealed, dimensions 4-1/2" x 2" D.; 2 solder terminals on top	Filter V109	Dubilier CRA-3080	305-1339
C118	3DKA500-103 —— ——	CAPACITOR: fixed, paper; oil impregnated, .5 mf. +20% —10%, 600 V d.c. working; metal case, hermetically sealed; dimensions 1-13/16" x 7/8" x 1"; 2 solder lug terminals on top, 2 mounting brackets; 2-1/8" center to center	Filter V107	Dubilier DYR6050 Sprague P9047	305-1335
C-119	3DKB1-9 —— ——	CAPACITOR: fixed, paper dielectric, 1 mf ±10%, 600 V d.c. working; metal case, wax impregnated; 1-1/2" long x 1-13/16" wide x 1" thick; 2 terminal lugs; 2 mounting brackets 2-1/4" between centers	B+ filter	Dubilier PC-2147	305-1366

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: RECEIVERS ★R-9A/APN-4 AND ★R-9B/APN-4**

Reference Symbol	British Ref. Number / Army Stock Number / Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
C120	3DKA1-106 —— ——	CAPACITOR: fixed; mica dielectric, 1000 mmf. ±2%, 500 V d.c. working; moulded bakelite case, wax impregnated; 1-1/16″ long x 16/32″ wide x 7/32″ thick; axial leads (Used on R-9A/APN-4 only)	Cathode bypass V102		60-20105241
C121	3D9240-13 —— ——	CAPACITOR: fixed; ceramic dielectric; 240 mmf. ±2%; 300 V d.c. working; wax impregnated; 1.500″ long x 0.265″ diameter; axial leads	Tuning capacitor L106-1	Muter 52N080	305-1505
C122	3K2024143 —— ——	CAPACITOR: fixed mica; 240 mmf., ±2%, 500 V d.c. working; wax impregnated, moulded bakelite case; dimensions 51/64″ x 15/32″ x 7/32″; axial leads	Voltage divider V102	Electromotive 603M	60-10245237
C123	3D9820-5 —— ——	CAPACITOR: fixed, 820 mmf., +2%; 500 V d.c. operating volts; ceramic body, wax impregnated; dimensions 1-1/2″ long x 17/64″ diameter; radial leads (Used on R-9B/APN-4 only)	Voltage divider V102 and temperature compensator	Erie N-750E	305-1554
C124		CAPACITOR, fixed; mica, 200 mmfd., ±5%, 500 V d.c. working, wax impregnated, moulded bakelite case, dimensions 51/64″ x 15/32″ x 7/32″, axial leads	Voltage divider	Electromotive 603M	60-10205337
C125	3K4010332 —— ——	CAPACITOR: fixed, mica, 0.01 mfd. ±5%, 300 V d.c. working; wax impregnated, moulded bakelite case; dimensions 1-1/32″ x 41/64″ x 11/32″; axial leads (Used on R-9B/APN-4 only)	Noise filter	Dubilier 3WLST	60-30103323
E101	# —— ——	INSULATOR: standoff, bakelite, 15/16″ long x 5/16″ diameter; hole tapped No. 6-32 in one end; wax impregnated; black; brass lug; 0.156″ hole, 9/32″ x 3/8″ x 1/64″ approximately	Panel spacer	Philco 358-8119	358-8119
E102	2Z5822-13 —— ——	KNOB: pointer type; black bakelite; 1-1/4″ pointer length, 5/8″ thick, with 0.252″ diameter shaft hole; tapped for a No. 8-32 set screw; hexagon headless, cup point 7/16″ long, brass insert 3/8″ long, 3/8″ diameter	Front panel	Erie S-293-3L	358-4274
F101	3Z2604.6 —— ——	FUSE: cartridge; 4 amperes; 250 volts; dimensions 1-1/4″ long x 1/4″ diameter	115 V a.c. T104, T105	Littlefuse 1357-3AG	455-2048
I101	2Z5952 —— ——	LAMP: pilot, bayonet base, 6.3 volts, 0.15 amps, T3-1/4″ bulb	On-Off indicator	Muter type 47	34-2068
J101	2ZK3010.10 —— ——	CONNECTOR ASSEMBLY: consists of 2 large hex nuts, 3 washers and green collar with solder lug on rear and retaining clip coming out from green collar; coaxial, single contact, mounted by 2 lockwashers and 2 small hex nuts; 1-5/16″ long x 3/4″ diameter	Antenna input	Amphenol IDH528	358-1267
J102	2ZK3010.11 —— ——	CONNECTOR ASSEMBLY: consists of 2 large hex nuts, 3 washers and yellow collar with solder lug on rear and retaining clip coming out from yellow collar; coaxial; signal contact; mounted by 2 lockwashers and 2 small hex nuts; 1-5/16″ long x 3/4″ diameter	Balance connector	Amphenol 0H528	358-2832

J103	2Z3010.4	CONNECTOR ASSEMBLY: consists of 2 large hex nuts, 3 washers and blue collar with solder lug on rear and retaining clip coming out from blue collar; coaxial; single contact; mounted by 2 lockwashers and 2 small hex nuts; 1-5/16" long x 3/4" diameter	Gain connector	Amphenol 10H528	358-1305
J104	2ZK3010.4	CONNECTOR ASSEMBLY: consists of 2 large hex nuts, 3 washers and red collar with solder lug on rear and retaining clip coming out from red collar; coaxial; single contact; mounted by 2 lockwashers and 2 small hex nuts; 1-5/16" long x 3/4" diameter	Video output	Amphenol 10H528	358-1266
J105	2Z7116.32	CONNECTOR: male, 6 contacts, brass, silver plated, one high dielectric melmac No. 592 plug insulation, one high dielectric melmac plug washer, plug body Z-5 alloy; overall dimensions 1.940" x 1.940" x 0.800" mounting hole diameter 1.560", for holes 0.152" diameter, 1.500" center to center, 20 thread per inch	Indicator connector	Amphenol 10H394	358-7219
J106	2Z8799-146	RECEPTACLE: straight; female, 4 contacts; bakelite insert; type 10H391	Power input	Amphenol 10H391	358-3450
L101	*‡	COIL ASSEMBLY: 2 windings of 132 turns of 7-44SSE wire wound on coil form, 9/16" O.D. Total inductance of coils in series 583 millihenries ±5%; wax impregnated; color code blue	Parallel wave trap V101-1	Philco 352-1258	352-1258
L102-1	‡	COIL ASSEMBLY: 2 windings of 168 turns of 7-44SSE wire wound on coil form 19/32" O.D. Total inductance of coils in series 950 millihenries ±5%; wax impregnated	Series wave trap V101-1	Philco 352-1254	352-1254
L102-2	‡	Same as L102-1	Series wave trap V102		
L103-1	*‡	COIL: 96-1/2 turns No. 34E B & S wire, Q at 2 mc is 60; wax impregnated; color code brown (Part of assy 352-1563)	R.F. coil V102	Philco 352-1527	352-1528
L103-2	*‡	Same as L103-1 except color code is green (Part of assy 352-1563)	R.F. coil V102	Philco 352-1528	352-1528
L103-3	*‡	Same as L103-1 except color code is blue (Part of assy 352-1563)	R.F. coil V102	Philco 352-1497	352-1497
L103-4	*‡	Same as L103-1 except color code is yellow. (Part of Assy. 352-1563) (Used on R-9B/APN-4 only)	R.F. coil 352-1560	Philco	352-1560
L104	‡	COIL: R.F.: 19-1/2 turns No. 26 enameled wire; inductance at 1000 cycles 2.2 microhenries ±0.1; minimum Q in air 105 at 9 M.C.; wax impregnated; color code yellow (Used on R-9A/APN-4 only)	R.F. coil V102	Philco 352-1268	352-1268
L105	‡	COIL, R.F.: filter choke; 400 mh ±5%; 2 pi winding; 139 turns each; No. 36 SSE wire, crowlite No. 29 coil form 11/16" long x 5/8" O.D.	Cathode choke V102	Philco 352-1252	352-1252
L106-1	‡	OSCILLATOR COIL: 30 turns 36 wire; enameled, B & S, inductance at 1000 cycles is 4.8 mh, Q at 5 mc is 65; wax impregnated; color code brown	Oscillator V102	Philco 352-1280	352-1280
L106-2	‡	Same as L106-1, except color code is green	Oscillator V102	Philco 352-1275	352-1275
L106-3	‡	Same as L106-1, except color code is blue	Oscillator V102	Philco 352-1494	352-1494
L106-4	‡	Same as L106-1, except color code is yellow (Used on R-9B/APN-4 only)	Oscillator V102	Philco 352-1561	352-1561

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: RECEIVERS ★R-9A/APN-4 AND ★R-9B/APN-4**

Reference Symbol	British Ref. Number Army Stock Number Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
L107	‡ —— ——	OSCILLATOR COIL: 8-1/2 turns 20 wire enameled; inductance at 1000 cycles 0.6 microhenries, Q at 15 MC is 125; wax impregnated; color code yellow (Used on R-9A/APN-4 only)	Oscillator V102	Philco 352-1277	352-1277
R101-1	3RC21BE473K —— ——	RESISTOR: fixed, metallized filament, 47,000 ohms, ±10%, 1/2 watt, insulated; axial leads; wax impregnated; 5/8" long x 3/16" dia	Screen resistor V101-1	Littlefuse BT-1/2	66-3473344
R101-2	3RC21BE473K —— ——	Same as R101-1	Screen resistor V101-4		
R102-1	3ZK6618-26 —— ——	RESISTOR: fixed, metallized filament, 18,000 ohms, ±5%, 2 watt, insulated, axial leads; wax impregnated; 5/8" long x 3/16" dia	Plate resistor V101-1	I.R.C. BT-1/2	66-3185244
R102-2		Same as R102-1	Screen resistor V102		
R103-1	3RC21BE332K —— ——	RESISTOR: fixed, metallized filament; 3300 ohms, ±10%, 1/2 watt, insulated, axial leads; wax impregnated; 5/8" long x 3/16" dia	Plate filter V102	I.R.C. BT-1/2	66-2333344
R103-2		Same as R103-1	Plate filter V101-2		
R103-3		Same as R103-1	Plate filter V101-3		
R103-4		Same as R103-1	Plate filter V101-4		
R103-5		Same as R103-1	Cathode filter V102		
R105-1	3Z6610-49 —— ——	RESISTOR: fixed, metallized filament, 10,000 ohms, ±10%, 1/2 watt, insulated, axial leads; wax impregnated; 5/8" long x 3/16" dia	Plate resistor V104	I.R.C. BT-1/2	66-3103344
R105-2		Same as R105-1	Plate resistor V103		
R105-3		Same as R105-1	Cathode resistor V104		
R106-1	3RC21BE683J —— ——	RESISTOR: fixed, metallized filament, 68,000 ohms, ±5%, 1/2 watt; insulated; axial leads; wax impregnated 5/8" long x 3/16" dia	Bandpass V101-2	I.R.C. BT-1/2	66-3683244
R106-2		Same as R106-1	Bandpass V101-3		
R106-3		Same as R106-1	Bandpass V101-4		
R107	3RC21BE393K —— ——	RESISTOR: fixed, metallized filament, 39,000 ohms, ±10%, 1/2 watt, insulated; axial leads; wax impregnated; 5/8" long x 3/16" dia	Grid resistor V101-1	I.R.C. BT-1/2	66-3393344
R108	3ZK6038-2 —— ——	RESISTOR: fixed, metallized filament, 380 ohms, ±10%, 1/2 watt, insulated; axial leads; wax impregnated; 5/8" long x 3/16" dia	Cathode resistor V101-1	I.R.C. BT-1/2	66-1383344
R109	3Z6622-2 —— ——	RESISTOR: fixed, metallized filament, 22,000 ohms, ±10%, 1/2 watt, insulated; axial leads; wax impregnated; 5/8" long x 3/16" dia	Grid resistor V102	I.R.C. BT-1/2	66-3223344
R110-1	3RC21BE222K —— ——	RESISTOR: fixed, metallized filament, 2200 ohms ±10%, 1/2 watt, insulated; axial leads; wax impregnated; 5/8" long x 3/16" dia	Cathode bias V101-2	I.R.C. BT-1/2	66-2223344

R110-2		Same as R110-1	Cathode bias V101-3		
R111-1	3Z6627-1 —— ——	RESISTOR: fixed, metallized filament; 27,000 ohms, ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Plate resistor V103	I.R.C. BT-1/2	66-3273344
R111-2		Same as R111-1	Plate resistor V110-2		
R112-1	3RC21BE224K —— ——	RESISTOR: fixed, metallized filament; 220,000 ohms, ±10%, 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Video filter V104	I.R.C. BT-1/2	66-4223344
R112-2		SCame as R112-1	Video filter V104		
R112-3		SCame as R112-1	Grid resistor V104		
R113	3RC21BE105K —— ——	RESISTOR: fixed, metallized filament, 1 megohm, ±10%, 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Grid leak V104	I.R.C. BT-1/2	66-5103344
R114	3ZK6782-3 —— ——	RESISTOR: fixed, metallized, filament, 320,000 ohms, ±10%, 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Plate resistor V105-1	I.R.C. BT-1/2	66-4823344
R115-1	3ZK6013-2 —— ——	RESISTOR: fixed, metallized filament, 130 ohms, ±10%, 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Grid resistor V105-1	I.R.C. BT-1/2	66-1133344
R115-2		Same as R115-1	Grid resistor V105-2		
R115-3		Same as R115-1	Grid resistor V105-3		
R116-1	3RC21BE225K —— ——	RESISTOR; fixed, metallized filament; 2.2 megohms; ±10%, 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Plate resistor V106	I.R.C. BT-1/2	66-5223344
R116-2		Same as R116-1	Grid leak V108		
R117	3Z6470-3 —— ——	RESISTOR: fixed, metallized filament; 4700 ohms; ±10%, 1 watt; insulated; axial leads; wax impregnated; 1-1/4" long x 1/4" diameter	Cathode resistor V106	I.R.C. BT-1	66-2474344
R118	3RC31BE474K —— ——	RESISTOR: fixed, metallized filament; 0.47 megohm, ±10%, 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Grid resistor V106	I.R.C. BT-1/2	66-4473344
R119	3ZK6610-91 —— ——	RESISTOR: fixed, wire wound; 10,000 ohms, ±10%; 5 watt; radial leads; insulated; 1-7/32" long x 7/16" diameter	Screen resistor V106	Sprague 5K	353-1351
R120-1	3RC31BE104K —— ——	RESISTOR: fixed, metallized filament; 0.1 megohm, ±10%, 1 watt, insulated; axial leads; wax impregnated; 7/8" long x 9/32" diameter	Voltage divider	I.R.C. BT-1	66-4104344
R120-2		Same as R120-1	Voltage divider		
R120-3		Same as R120-1	Screen resistor V101-2		
R121	3Z7281.33 —— ——	POTENTIOMETER: 20,000 ohms ±10%, wire wound, linear taper; 3 watts; bakelite case, 1-5/8" diameter x 13/16" deep x mounting bushing 3/8" long x 3/8"-32 thread; shaft 1/8" x 1/4" slotted	Voltage divider V106	C.T.S. 25	353-5125
R122	3ZK6220-16 —— ——	RESISTOR: fixed, metallized filament, 2200 ohms ±10%, 1 watt; insulated; axial leads; wax impregnated; 1-1/4" long x 1/4" diameter	Cathode resistor V108	I.R.C. BT-1/2	66-2224344
R123-1	3RC21BE565K —— ——	RESISTOR: fixed, metallized filament; 5.6 meg. ±10%, 1/2 watt, insulated; axial leads; wax impregnated 5/8" long x 3/16" diameter	Bleeder	I.R.C. BT-1/2	66-5563344
R123-2		Same as R123-1	Bleeder		

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: RECEIVERS ★R-9A/APN-4 AND ★R-9B/APN-4**

Reference Symbol	*British Ref. Number Army Stock Number Navy Stock Number*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or Standard Type*	*Cont. or Govt. Dwg. or Spec. No.*
R123-3		Same as R123-1	Bleeder		
R123-4		Same as R123-1	Bleeder		
R123-5		Same as R123-1	Bleeder		
R123-6		Same as R123-1	Bleeder		
R123-7		Same as R123-1	Bleeder		
R123-8		Same as R123-1	Bleeder		
R124	3Z6656-1 —— ——	RESISTOR: fixed, metallized filament, 56,000 ohms, ±10%; 1/2 watt, insulated; axial leads; wax impregnated; 5/8″ long x 3/16″ diameter.	Filter V110-1	I.R.C. BT-1/2	66-3563344
R125	3RC21BE104K —— ——	RESISTOR: fixed, metallized filament, .1 megohm ±10%, 1/2 watt; insulated; axial leads; wax impregnated; 5/8″ long x 3/16″ diameter	Filter V110-2	I.R.C. BT-1/2	66-4103344
R127-1	‡ —— ——	RESISTOR: fixed, metallized filament, 10,000 ohms ±5%; 1/2 watt; wax impregnated; dimensions 5/8″ x 3/16″, axial leads	Grid resistor V102	I.R.C. BT-1/2	66-3103274
R127-2	‡	Same as R127-1	Grid resistor V102		
R127-3	‡	Same as R127-1	Grid resistor V102		
R127-4	‡	Same as R127-1	Grid resistor V102		
R128	3RC31BE273J —— ——	RESISTOR: fixed, metallized filament; 27,000 ohms, ±5%, 1 watt, insulated; axial leads; wax impregnated; 1-1/4″ long x 1/4″ diameter	Voltage divider resistor V106	I.R.C. BT-1	66-3274244
S101	3ZK9828-8 —— ——	SWITCH: rotary, constant contact, 4 positions; 4 sections; wafer, 20 contacts; shorting type teeth on rotor blades, contact clips and rotor blades of solid coin silver, bakelite insulation of rotor and stator, over-all 6-3/16″ solder terminals located around wafers, mounting bushing 3/8″-32 thread, 3/8″ long	Channel selector	Oak 25235-K4	452-1109
S102	3Z9845-5 —— ——	SWITCH: toggle, constant contact, S.P.S.T. 2 positions; insulated; 20 amperes; 24 V d.c. over-all dimensions 1-1/8″ long x 5/8″ wide x 1-3/32″ high; mounting dimensions; bushing 5/32″-32, thread 15/32″ long	Video filter switch V104	C-H 8801-K3	452-1008
S103	3ZK9560-3 —— ——	SWITCH: toggle, constant contact; D.P.D.T. 2 positions; insulated; 20 amperes; 24 V d.c.; over-all dimensions 1-25/32″ long x 15/16″ wide x 3/4″ deep; mounting dimensions; bushing 15/32″ -32 thread 15/32″ long	Hi-lo a.c. supply	C-H 8824-K3	452-1113
S104	3Z9845-11 —— ——	SWITCH: toggle, double pole single throw, two positions, on-off, bakelite insulation, 20 amps, 24 volts, over-all dimensions 1-15/16″ long x 3/4″ wide x 2-1/4″ high, 1/2″ mounting hole, mounting shaft 15/32″-32 thread	Power ON-OFF switch	C-H 8823	452-1196

T101-1	‡* —— ——	ANTENNA COIL: Primary 3–2/3 turns of No. 26 wire, enameled secondary 110 turns of No. 34 wire; enameled; Q at 2 mc is 60 coil; wax impregnated; color code brown	Antenna	Philco 352-1459	352-1459
T101-2	‡*	Same as T101-1, except color antenna code is green	Antenna	Philco 352-1460	352-1460
T101-3	‡*	Same as T101-1, except color code is blue	Antenna	Philco 352-1498	352-1498
T101-4	‡	Same as T101-1, except color code is yellow (Used on R-9B/APN-4 only)	Antenna	Philco 352-1559	352-1559
T102	‡ —— ——	ANTENNA COIL: primary 1–1/2 turns of No. 26 enameled wire; secondary 26 turns No. 26 enameled wire; Q at 9 M.C., 120; inductance 3.4 microhenries at 1000 cycles, wax impregnated; solenoid right hand wound (Used on R-9A/APN-4 only)	Antenna	Philco 352-1272	352-1272
T103-1	2Z9642-42 —— ——	TRANSFORMER: I.F., consists of primary 134 turns No. 36 SSE wire, 185 millihenries at 1000 cycles, secondary 185 millihenries at 1000 cycles, aluminum case 3–1/2" high, 1–3/8" square coil mounted on panel, two spade lugs for mounting located on each side	1st I.F. input	Philco 352-1526	352-1526
T103-2	‡*	Same as T103-1	1st I.F. output		
T103-3	‡*	Same as T103-1	2nd I.F. output		
T103-4	‡*	Same as T103-1	3rd I.F. output		
T104	2Z9619-24 —— ——	TRANSFORMER: power, 400-2400 C.P.S., 115 volt, single phase, laminated; primary 115 volts, tapped 80 volts, secondary 440 volts, 200 milliamps, 5 volts, 3 amps, 6.3 volts, 3 amps., center tapped 6.3 volts 3 amps, 6.3 volts, 3 amps, electrostatic shield, cased 4–5/16" long, 3–9/16" wide, 3–1/4" high, 15 solder terminals located on top of case, six 7/32" diameter mounting holes.	Power	Miagnetic C1-306M	352-7194
T105	2Z9619-33 —— ——	TRANSFORMER: Hi-voltage type, 400-2400 C.P.S. single phase, laminated; primary 115 volts, a.c. tapped 80 volts; secondary; 1140 volts R.M.S., 1.25 milliamperes 2.5 volts 1.75 amps 2.5 volts 1.75 amps, cased, 3" long, 2–5/16" wide, 3" high, 9 solder terminals located on bakelite panel on bottom, six 3/16" diameter mounting holes, located 3 on each side, mounting dimensions center 7/8" x 2–11/16"	High voltage	Miagnetic B1-305M	352-7245
V101-1	‡ —— ——	VACUUM TUBE: type 6SK7GT; triple-grid super-control, amplifier	R-F amp.	Kenrad 6SK7GT S-1 6SK7GT	354-1359
V101-2	‡	Same as V101-1	1st I.F. amp.		
V101-3	‡	Same as V101-1	2nd I.F. amp.		
V101-4	‡	Same as V101-1	3rd I.F. amp.		
V102	‡ —— ——	VACUUM TUBE: type 6SA7GT; pentagrid converter, octal base	Det. Osc.	Kenrad 6SA7GT Sylvania Prod. 6SA7GT	354-1360
V103	‡ —— ——	VACUUM TUBE: type 6H6GT; twin diode	2nd det.	Kenrad 6H6GT Sylvania Prod. 6H6GT	354-1331
V104	‡ —— ——	VACUUM TUBE: type 6SL7GT; twin triode amplifier	Video amplifier	RCA 6SL7GT	354-1307

‡ Not in base spares.
* Not separately replaceable

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET *AN/APN-4 **MAJOR ASSEMBLY: RECEIVERS *R-9A/APN-4 AND *R-9B/APN-4**

Reference Symbol	*British Ref. Number / Army Stock Number / Navy Stock Number*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or Standard Type*	*Cont. or Govt. Dwg. or Spec. No.*
V105-1	# / —— / ——	VACUUM TUBE: type 6B4G; power amplifier triode	Voltage regulator	Sylvania Prod., 6B4G	354-1341
V105-2	#	Same as V105-1	Voltage regulator		
V105-3	#	Same as V105-1	Voltage regulator		
V106	# / —— / ——	VACUUM TUBE: type 6SJ7GT; triple grid detector amplifier	Voltage regulator	Sylvania Prod. 6SJ7GT	354-1330
V107	# / —— / ——	VACUUM TUBE: type VR-105-30	Voltage regulator	Sylvania Prod. VR-105-30	354-1314
V108	# / —— / ——	VACUUM TUBE: type 6SN7GT; twin triode amplifier	Balance	RCA 6SN7GT	354-1321
V109	# / —— / ——	VACUUM TUBE: type 5U4G full-wave rectifier	Rectifier	Sylvania Prod.	354-1312
V110-1	# / —— / ——	VACUUM TUBE: type 879/2X2; half-wave rectifier	Voltage doubler rectifier	RCA	354-1316
V110-2	#	Same as V110-1			
X101-1	2Z8650.1 / —— / ——	SOCKET: tube; mica filled bakelite; 8 prongs; flange mounting type; mounting dimensions two 0.140″ D. holes, 1-5/16″ center to center	R.F. Tube	Cinch 6742	257-6041
X101-2		Same as X101-1	Det. Osc. Tube		
X101-3		Same as X101-1	1st I.F. tube		
X101-4		Same as X101-1	2nd I.F. tube		
X101-5		Same as X101-1	3rd I.F. tube		
X101-6		Same as X101-1	2nd Det. tube		
X101-7		Same as X101-1	Video Amp.		
X101-8		Same as X101-1	Voltage regulator		
X101-9		Same as X101-1	Voltage regulator		
X101-10		Same as X101-1	Voltage regulator		
X101-11		Same as X101-1	Voltage regulator		
X101-12		Same as X101-1	Balance tube		
X101-13		Same as X101-1	Rectifier tube		
X101-14		Same as X101-1	Voltage regulator		
X102-1	2Z8674.15 / —— / ——	SOCKET: tube, mica filled bakelite; 4 prongs; flange mounting type; mounting dimensions; two holes 1-7/8″ center to center	High voltage tubes	Amphenol 77A-4T	257-6042
X102-2		Same as X102-1	High voltage tubes		

Z101-1	2Z9642.42 —— ——	TRANSFORMER: consists of C104-1, C104-2, T103-1, capacitor, fixed, silver mica, 60 mmf. ±5%, 500 volts; primary: 134 turns No. 36 SSE wire, inductance 185 millihenries at 1000 cycles; secondary 185 millihenries at 1000 V, 134 turns of 36 SSE wire, coupler winding 16 turns No. 34 E wire; 3.6 M.H. at 1000 V aluminum case, 3-1/2″ high, 1-3/8″ square coils mounted on panel, two spade lugs for mounting location each side	1st I.F. input input	Philco 352-1526	352-1526
Z101-2		Same as Z101-1	1st I.F. output		
Z101-3		Same as Z101-1	2nd I.F. output		
Z101-4		Same as Z101-1	3rd I.F. output		
Z102	2C4180-9B/C3 —— ——	COIL ASSEMBLY: consists of T101-1, T101-2, T101-3 and T101-4 (Used on R-9B/APN-4 only)	Antenna	Philco 352-1550	352-1550
Z102	2C4180-9A/C1 —— ——	COIL ASSEMBLY: consists of T101-1, T101-2, T101-3 and T102. (Used on R-9A/APN-4 only)	Antenna	Philco 352-1499	352-1499
Z103	3CK4002-3 —— ——	COIL ASSEMBLY: wave trap; consists of 2 windings of 132 turns of 7-44 SSE wire wound in series on form 9/16″ O.D. inductance 583 millihenries ±5%; aluminum can 2″ x 1-1/8″, color coded blue	Parallel wave trap	Philco 352-1269	352-1269
Z104-1	2XK3010-12 —— ——	COIL ASSEMBLY: wave trap, consists of L102-1, 2 PI windings in series number 7-4 SSE wire wound on coil form 19/32″ D. total inductance of coils 950 millihenries ±5% millihenries; C112-2 capacitor all mounted in aluminum can 2″ long x 1-1/8″ square	Series wave trap	Philco 352-1266	352-1266
Z104-2		Same as Z104-1	Series wave trap		
Z105	2C4180-9B/C2 —— ——	COIL ASSEMBLY: consists of L103-1, L103-2, L103-3 and L103-4 (Used on R-9B/APN-4 only)	R.F.	Philco 352-1549	352-1549
Z105	2C4180-9A/C3 —— ——	COIL ASSEMBLY: consists of L103-1, L103-2, L103-3 and L104 (Used on R-9A/APN-4 only)	R.F.	Philco 352-1495	352-1495
Z106	2C4180-9B/C1 —— ——	COIL ASSEMBLY: consists of L106-1, L106-2, L106-3 and L106-4. Also R127-1, R127-2, R127-3 and R127-4 (Used on R-9B/APN-4 only)	Oscillator	Philco 352-1548	352-1548
Z106	2C4180-9A/C3 —— ——	COIL ASSEMBLY: consists of L106-1, L106-2, L106-3 and L107, also R127-1, R127-2, R127-3 (Used on R-9A/APN-4 only)	Oscillator	Philco 352-1492	352-1492

Miscellaneous

	2Z9410.28 —— ——	BOARD, TERMINAL: wax impregnated 2″ x 1-6/16″ x 1/32″; double row 5 solder lug terminals each; 2 steel angle mounting brackets, 1-3/16″ x 5/16″ x 1/16″; 2 mounting holes, 1-1/2″ center to center	Wiring	Philco 358-5561	358-5561
	2Z9410.36 —— ——	BOARD, TERMINAL; bakelite, wax impregnated, 2-3/8″ x 1-3/8″ x 1/32″, double row of 5 solder lug terminals each; 2 steel mounting brackets 1-3/16″ x 5/16″ x 1/16″; 2 mounting holes, 1-1/32″ center to center	Wiring	Philco 358-7267	358-7267

‡ Not in base spares.

Reference Symbol	British Ref. Number Army Stock Number Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
		Miscellaneous			
	2Z9410.40 —— ——	BOARD, TERMINAL: bakelite, wax impregnated, 2–13/32" x 1–3/8" x 1/32", double row of solder lug terminals, 7 in one, 5 in other; 2 steel angle mounting brackets 1–3/16" x 5/16" x 1/16", 2 mounting holes 2–9/32" center to center	Wiring	Philco 358-5558	358-5558
	2Z9410.29 —— ——	BOARD, TERMINAL: bakelite, wax impregnated, 2–3/4" x 1–3/8" x 1/32", double row of solder lug terminals, 7 in one, 5 in other, 2 steel angle mounting brackets, 1–9/32" x 5/16" x 1/16", 2 mounting holes 9/32" center to center	Wiring	Philco 358-5560	358-5560
	2Z9440-40 —— ——	BOARD, TERMINAL: bakelite, wax impregnated; 8" x 1–3/8" x 3/32", double row of solder lug terminals, 21 in each, three 0.234" diameter mounting holes, 3–3/8" x 2–11/16" between centers	Wiring	Philco 358-5639	358-5639
	2Z9408.37 —— ——	BOARD, TERMINAL: bakelite, wax impregnated, 2–3/8" x 1–3/8" x 1/32"; double row of 5 solder lug terminals each; 2 steel angle mounting brackets; 5/16" x 1–3/16" x 1/16"; 2 mounting holes 1" center to center	Wiring	Philco	358-5556
	2Z9412.28 —— ——	BOARD, TERMINAL: bakelite, wax impregnated, 1-3/8" x 2-3/4"; 12 solder lug terminals; 2 steel angle mounting brackets; 2 mounting holes 2–1/4" mtg/C.	Wiring	Philco 358-5559	358-5559
	# —— ——	CLAMP: Irvington fibre sheet natural color; 0.01 thick; Harvel coated; 1–3/8" x 11/16"; .156" dia hole; 1/4" from one end	Wiring	Philco 257-7948	257-7948
	# —— ——	CLAMP: steel No. 20, zinc or cadmium plated, 1/4" radius bend; 1/2" wide x 7/8" long approximately, 0.147" dia hole	Wiring clamp	Philco 258-1426	258-1426
	# —— ——	CLAMP: steel No. 21, zinc or cadmium plated, 5/32" radius bend; 3/8" wide x 3/4" long; 0.144" dia hole	Wiring clamp	Cinch	258-1465
	# —— ——	CLAMPING FOOT: yellow brass; black nickle finish; 1-1/64" long x 7/16" wide x 3/32" thick; offset extends 9/32"; 2 holes 0.144" dia	Receiver	Philco 258-1203	258-1203
	# —— ——	CLIP: tube contact; insulated housing; 1–1/8" x 5/8" x 9/16"	Tube connection		257-4079
	# —— ——	HANDLE: steel, black nickle finish; 4" long; 1-1/4" hand clearance; 5/16" diameter; mounting holes 0.136" dia No. 8-32 tap, 2 holes	Lifting	Philco 258-1231	258-1231
	3ZK3275.2 —— ——	HOLDER ASSEMBLY FUSE: consists of slotted hex nut, rubber washer, holder cap assembly; moulded black bakelite body; red extractor knob; takes panel up to 5/16" thick; 1/2" mounting hole, knurled finger grip knob which holds fuse, 1-3/4" deep 2-1/8" over-all	Power supply protection	Littlefuse 1075A	358-1546

	2Z8401-5PH10 —— ——	MOUNT, vibration: 10 pounds, normal load rating; 2–3/8" x 2–3/8" x 1–11/16"; four 0.196" mtg. holes, 1–15/16" mtg./C	Anti-vibration mtg.	Littlefuse 150PH-10	257-7121
	2Z8401-PH8 —— ——	MOUNT, vibration: 8 pounds normal load rating; 2–3/8" x 2–3/8" x 1–11/16"; four 0.196" mtg. holes, 1–15/16" mtg./C	Anti-vibration mtg.	Lord 150PH8	257-8148
	2ZK5988-23 —— ——	PILOT LAMP ASSEMBLY: consists of pilot lamp assembly with red jewel	Pilot lamp	Gothard	358-4735
		SPRING ASSEMBLY: consists of 0.031" diameter piano wire; close wound, 1–1/16" long, and steel tension spring 1–7/8" long with 1/4" dip in center; includes hardware	Tube hold-down (2X2)		358-8979

MODEL: RADIO SET *AN/APN-4 **MAJOR ASSEMBLY: INDICATOR *ID-6/APN-4 AND *ID-6A/APN-4**

IMPORTANT

Circuit reference symbols in this table of parts duplicate themselves.

Be sure to check nomenclature of the particular major assembly.

C-301	3DK9510-4 —— ——	CAPACITOR: fixed; mica; 510 micromicrofarads, ±10%; 500 volts d-c working; moulded case; dimensions 45/64" long, 29/64" wide, 6/32" thick; axial terminal leads	Untuned series circuit	Cornell-Dubilier type 5W Micamold type O	Philco 60-10515417
C-301-2	3DK9510-4 —— ——	CAPACITOR: same as C-301-1			
C-301-3		CAPACITOR: same as C-301-1			
C-301-4	3DK9510-4 —— ——	CAPACITOR: same as C-301-1			
C-302	3DK9050V-61 —— ——	CAPACITOR: variable; trimmer; air; 50 micromicrofarads maximum to approximate 3 micromicrofarads minimum; 7 rotor and 7 stator plates; brass plated and silver plated; two stator solder posts silver plated 1/2" centers; rotor terminal brought out side approximately 30° below center horizontal line; ceramic base round on top and bottom sections; two No. 4-40 tapped mounting holes in 3/16" square nickle-plated spacer posts 1/8" long, with counter-sunk thread start, 21/32" centers with 1/4" diameter shaft 3/4" long from 3/16" long x 5/16" diameter bushing sleeve; 3/8" shaft mounting hole necessary between mounting spacers; dimensions 1–1/8" deep x 15/16" wide x 1–1/4" high; Philco dwg. and part No. 351-1050 stamped on top of base	Varies capacitance of circuit causing crystal to drag	F. W. Sickels 33063-A7	Philco 351-1050 351-1059
C-303-1	3DA10-124 —— ——	CAPACITOR: fixed; paper; 10,000 micromicrofarads, +20% —10%; 600 volts d-c working; molded case; case dimensions 1–7/16" long, 3/4" wide, 5/16" thick; axial terminal leads	Decoupling oscillator plate	Micamold 342-17	Philco 305-1255
C-303-2		CAPACITOR: same as C-303-1	Bypass or phase shift		

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: INDICATOR ★ID-6/APN-4 AND ★ID-6A/APN-4**

Reference Symbol	*British Ref. Number Army Stock Number Navy Stock Number*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or Standard Type*	*Cont. or Govt. Dwg. or Spec. No.*
C-303-3		CAPACITOR: same as C-303-1	Part of second counter storage condenser to give station selector calibrating voltage		
C-303-4		CAPACITOR: same as C-303-1	Fourth counter output coupling		
C-303-5		CAPACITOR: same as C-303-1	Bypass condenser		
C-303-6		CAPACITOR: same as C-303-1	Cathode bypass condenser		

C-303-7		CAPACITOR: same as C-303-1	Coupling condenser		
C-303-8		CAPACITOR: same as C-303-1	Bypass condenser		
C-303-9		CAPACITOR: same as C-303-1	Coupling condenser		
C-303-10		CAPACITOR: same as C-303-1			
C-303-11		CAPACITOR: same as C-303-1	Coupling condenser		
C-304-1	3DK9005-26 —— ——	CAPACITOR: fixed; mica; 5 micromicrofarads; 500 volts d-c working, ±10%; moulded bakelite case, 51/64" x 15/32" x 7/32"; axial leads	Oscillator switch capacitor	Electromotive 503M	60-00055417
C-305-2	3K2010021 —— ——	CAPACITOR: fixed; mica; 10 micromicrofarads; 500 volts d-c working, ±10%; ASA type CM 20B100K; moulded bakelite case, 51/64" x 15/32" x 7/32"; axial leads	Coupling capacitor	Electromotive 503M	60-00105417
C-306-1	3DKA1.500-15 —— ——	CAPACITOR: fixed; 1500 micromicrofarads, ±5%; 500 volts d-c working; moulded case; case dimensions 50/64" long, 50/64" wide, 9/32" thick; axial terminal leads	Tuning oscillator plate circuit	Micamold type W	Philco 60-20155314
C-306-2		CAPACITOR: same as C-306-1	Storage condenser third counter		
C-307	3DK9240-7 —— ——	CAPACITOR: fixed; mica; 240 micromicrofarads, ±2%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" wide, 6/32" thick; axial terminal leads	Coupling condenser	Cornell-Dubilier Micamold type O	Philco 60-10245227
C-308	3DK9010-42 —— ——	CAPACITOR: fixed; mica; 10 micromicrofarads, ±5%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" wide, 6/32" thick; axial terminal leads	Changes frequency of crystal drag circuit	Cornell-Dubilier type Micamold type O	Philco 60-00105317
C-309	3DK9036-1 —— ——	CAPACITOR: fixed; silver mica; 36 micromicrofarads, ±5%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" thick; axial terminal leads; temperature coefficient —100 +100 parts million deg. C. max. capacitance drift 0.2%	Feed condenser first counter	Electromotive 603M	Philco 60-00365337
C-310	3D2047143 3D9560-4 ——	CAPACITOR: fixed, silver mica; 470 micromicrofarads; 500 volts d-c working ±2%; moulded low loss bakelite case, 51/64" x 15/32" axial leads; ASA number CM20D471G	Cathode bypass	Electromotive 603M	60-10475237
C-311-1	3DK9015-26 (3K3015021) 10%	CAPACITOR: fixed; mica; 15 micromicrofarads, ±5%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" wide, 6/32" thick; axial terminal leads	Coupling condenser	Cornell-Dubilier type 5W Micamold type O	Philco 60-00155317
C-311-2		CAPACITOR: same as C-311-1			
C-312-1	3D9051-2 —— ——	CAPACITOR: fixed; mica; 51 micromicrofarads, ±5%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 19/64" wide, 6/32" thick; axial terminal leads	Feed condenser second Micamold type O	Cornell-Dubilier type 5W Micamold type O	Philco 60-00515327
C-312-2		CAPACITOR: same as C-312-1	Coupling marker		
C-312-3		CAPACITOR: same as C-312-1	Coupling marker		
C-312-4		CAPACITOR: same as C-312-1 (replaced by C-342-2)	Coupling marker		
C-312-5		CAPACITOR: same as C-312-1	Feed condenser in low range switch (right)		
C-312-6	3K2051032 —— ——	CAPACITOR: fixed; mica; 51 micromicrofarads; 500 volts d-c working; ±5%; moulded bakelite case, 51/64" x 15/32" x 7/32" axial leads; ASA number CM20C510J	Feed back (not identical with C-312-1 to 5)	Electromotive 603M	60-00515327

IMPORTANT

Circuit reference symbols in this table of parts duplicate themselves.
Be sure to check nomenclature of the particular major assembly.

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: INDICATOR ★ID-6/APN-4 AND ★ID-6A/APN-4**

Reference Symbol	British Ref. Number Army Stock Number Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
C-313-A	3DA100-105 —— ——	CAPACITOR: fixed; paper; 3 x 100,000 micromicrofarads, +20% —10%; 400 volts d-c working; metal case hermetically sealed; case dimensions, 1-13/16" long, 1" wide, 3/4" thick; 3 lug terminals outside; 2 mounting feet 2-1/8" diameter between centers	Bypass first counter cathode	Sprague P-9051	Philco 304-1108
C-312-B		CAPACITOR: same as C-313-A	Bypass second counter cathode		
C-313-C		CAPACITOR: same as C-313-A	Bypass third counter cathode		
C-314	3D9820-3 —— ——	CAPACITOR: fixed; silver mica; 820 micromicrofarads; 500 volts d-c working ±5%; ASA type CM25D821J; moulded low loss bakelite case 1-1/16" x 15/32"; axial leads	Storage condenser second counter	Cornell-Dubilier 2RS	60-10825331
C-314-1		CAPACITOR: same as C-314			
C-314-4	3DK9820-6 —— ——	CAPACITOR: fixed; silver mica; 820 micromicrofarads; 500 volts d-c working, ±2%; moulded low loss bakelite case; 51/64" x 15/32"; axial leads; temperature coefficient —100 to +100 parts million deg. C; capacitance drift 0.2% (replaced by C-314-1)	Plate bypass not identical with ref. C-314	Electromotive 603-M	60-1082537
C-315-1	3K2010122 —— ——	CAPACITOR: fixed; mica; 100 micromicrofarads, ±5%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" wide, 6/32" thick; axial terminal leads	Feed condenser third counter	Cornell-Dubilier type 5W Micamold type O	Philco 60-10105317
C-315-2		CAPACITOR: same as C-315-1	Coupling condenser A delay mixer		
C-315-3		CAPACITOR: same as C-315-1	Coupling condenser B delay mixer		
C-315-4		CAPACITOR: same as C-315-1	Coupling condenser mixer to input frequency response of markers		
C-316-1	3DKA250-53 —— ——	CAPACITOR: fixed; paper; 250,000 micromicrofarads, ±20%, 200 volts d-c working; moulded case; wax impregnated; case dimensions 1-7/16" long, 3/4" wide, 3/8" thick; axial terminal leads	Bypass second counter cathode	Micamold 345-20	Philco 305-1241
C-316-2		CAPACITOR: same as C-316-1	Bypass second counter cathode		
C-316-3		CAPACITOR: same as C-316-1	Bypass grid of A delay		
C-316-4		CAPACITOR: same as C-316-1	Bypass of fine delay		
C-316-5		CAPACITOR: same as C-316-1	Bypass of grid of coarse delay		
C-316-6		CAPACITOR: same as C-316-1	Coupling for station selector calibration sweep		

C-317-1	3DKB2-13	CAPACITOR: fixed; paper; 2 microfarads, +20% —10%; 600 volts d-c working; oil filled metal case hermetically sealed; dimensions overall, 1-13/16" long, 1" wide, 7/8" thick; 2 terminals at top; 2 mounting feet	B+ bypass	Sprague P9068	Philco 305-1364
C-317-2		CAPACITOR: same as C-317-1	Decoupling plate of B delay inverter		
C-318-1	3DA100-112 —— ——	CAPACITOR: fixed; paper; 100,000 micromicrofarads, +20% —10%; 400 volts d-c working; moulded case; case dimensions 1-7/16" long, 3/4" wide, 3/8" thick; axial terminal leads	Decoupling plate of third counter	Micamold 345-21	Philco 305-1086
C-318-2		CAPACITOR: same as C-318-1	Decoupling plate of fourth counter		
C-318-3		CAPACITOR: same as C-318-1	Decoupling plate of fine delay		
C-318-4		CAPACITOR: same as C-318-1	Bypass square wave cathode		
C-318-5		CAPACITOR: same as C-318-1	Coupling video		
C-318-6		CAPACITOR: same as C-318-1	Coupling vertical deflecting plates		
C-318-7		CAPACITOR: same as C-318-1	Coupling vertical deflecting plates		
C-318-8		CAPACITOR: same as C-318-1	Coupling paraphase amplifier		
C-318-9		CAPACITOR: same as C-318-1	Coupling paraphase amplifier		
C-318-10		CAPACITOR: same as C-318-1	Bypass and intensity control		
C-318-12		CAPACITOR: same as C-318-1			
C-319	3DK9390-5 —— ——	CAPACITOR: fixed; mica; 390 micromicrofarads, ±5%; 500 volts d-c working; moulded case; case dimensions 45/64" wide, 6/32" thick; axial terminal leads	Feed condenser fourth counter	Cornell-Dubilier type 5W Micamold type O	Philco 60-10395317
C-320-1	3DKA10-83 —— ——	CAPACITOR: fixed; mica; 10,000 micromicrofarads, ±5%; 300 volts d-c working; moulded case; case dimensions 1" long, 41/64" wide, 11/32" thick; axial terminal leads	Storage fourth counter	Cornell-Dubilier type 3W	Philco 60-30103323
C-320-2		CAPACITOR: same as C-320-1			
C-320-3		CAPACITOR: same as C-320-1			
C-320-4		CAPACITOR: same as C-320-1			
C-321	3DKA500-103 —— ——	CAPACITOR: fixed; paper; 500,000 micromicrofarads, +20% —10%; 600 volts d-c working; oil filled; metal case hermetically sealed; case dimensions; 1-13/16" long, 7/8" wide, 1" thick; 2 lug terminals on sides; 2 mounting feet 2-1/8" between centers	Bypass fourth counter cathode	Cornell-Dubilier type DYR-6050	Philco 350-1335
C-322	3K20224122 —— ——	CAPACITOR: fixed; mica; 240 micromicrofarads, ±5%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" thick; axial terminal leads	Coupling condenser delay	Cornell-Dubilier type 5WL Micamold type O	Philco 60-10245317
C-322-1		CAPACITOR: same as C-322			

IMPORTANT

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TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 — MAJOR ASSEMBLY: INDICATOR ★ID-6/APN-4 AND ★ID-6A/APN-4

Reference Symbol	*British Ref. Number Army Stock Number Navy Stock Number*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or Standard Type*	*Cont. or Govt. Dwg. or Spec. No.*
C-322-2		CAPACITOR: same as C-322-1			
C-323	3DKA20-65 —— ——	CAPACITOR: fixed; paper; 20,000 micromicrofarads, ±5%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" wide, 3/8" thick, axial terminal leads	Set up time constant	Micamold 345-9	Philco 305-1330
C-324-1	3K2020122 —— ——	CAPACITOR: fixed; mica; 200 micromicrofarads, ±5%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" wide, 6/32" thick; axial terminal leads	Coupling fine delay	Cornell-Dubilier type 5W Micamold type O	Philco 60-10205317
C-324-2		CAPACITOR: sames as C-324-1	Bypass condenser		
C-325-1	3K3562232 —— ——	CAPACITOR: fixed; mica; 6200 micromicrofarads; 500 volts d-c working ±5%; ASA type CM35C622J; moulded bakelite case, 53/64" x 53/64" x 11/32"; axial leads	Time constant determinant	Cornell-Dubilier 1W Micamold W	Philco 60-206255324
C-325-2		CAPACITOR: same as C-325-1	Coupling		
C-326-1	3K3022212 —— ——	CAPACITOR: fixed; mica; 2200 micromicrofarads, ±5%; 500 volts d-c working; moulded case; case dimensions 50/64" long, 50/64" wide, 9/32" thick; axial terminal leads	Coupling condenser	Cornell-Dubilier type 1W Micamold type W	60-20225314
C-326-2		CAPACITOR: same as C-326-1	Bypass condenser		
C-326-3		CAPACITOR: same as C-326-1	Time constant sweep circuit		
C-326-4		CAPACITOR: same as C-326-1	Time constant delay		
C-327-1	3K2051122 —— ——	CAPACITOR: fixed; mica; 510 micromicrofarads, ±5%; 500 volts d-c working; moulded case; dimensions 45/64" long 29"64" thick; axial terminal leads	Bypass condenser	Cornell-Dubilier type 5W Micamold type O	Philco 60-10515317
C-327-2		CAPACITOR: same as C-327-1	Coupling condenser 4th counter to square wave generator diode		
C-327-3		CAPACITOR: same as C-327-1	Bypass on paraphase amplifier		
C-327-4		CAPACITOR: same as C-327-1			
C-327-5		CAPACITOR: same as C-327-1	Bypass on grid of pedestal generator		
C-329-1	3DK9045V-2 —— ——	CAPACITOR: variable; trimmer mica; 45 micromicrofarad maximum to 7 micromicrofarad minimum; ceramic base; negative temperature coefficient of .00500 mmf/mmf/ degree C; two solder lug terminals, one each side with 1/8" diameter wire hole; self-supporting or mounts with two small pin clamps 33/64" centers; dimensions 57/64" long x 5/8" wide x 7/32" thick	Station selector switch adjustable feed	Erie TS2AN500	Philco 351-1048
C-329-2		CAPACITOR: same as C-329-1			
C-330-1	3D9024 —— ——	CAPACITOR: fixed; mica; 24 micromicrofarads, ±5%; 500 volts d-c working; moulded case; case dimensions 45/64" long, 29/64" wide, 6/32" thick; axial terminal leads	Feed condenser station selector switch	Cornell-Dubilier type 5W Micamold type O	Philco 60-0024317

C-330-2		CAPACITOR: same as C-330-1	Marker coupling		
C-330-3		CAPACITOR: same as C-330-1	Marker coupling		
C-330-4		CAPACITOR: same as C-330-1	Square wave generator coupling		
C-330-5		CAPACITOR: same as C-330-1	Bypass		
C-330-6		CAPACITOR: same as C-330-1	Bypass		
C-330-7		CAPACITOR: same as C-330-1	Square wave generator coupling		
C-330-8	3DK9024-3 —— ——	CAPACITOR: fixed; silver mica; 24 micromicrofarads; 500 volts d-c working, ±10%; moulded low loss bakelite case, 51/64" x 15/32" x 7/32"; axial leads; temp. coeff. —100 +100/parts million/ deg. C; cap drift 0.2% to 7 (added in parallel with C-330-6)	Coupling capacitor (not identical with C-330-1)	Electromotive 603M	Philco 60-00245437
C-330-9		CAPACITOR: same as C-330-8 (added in parallel with C-330-5)			
C-330-10		CAPACITOR: same as C-330-8			
C-331		CAPACITOR: 82 micromicrofarads			
C-331-1	3DK90062-7 3K2082032 ——	CAPACITOR: fixed; silver mica; 82 micromicrofarads; 500 volts d-c working, ±10%; moulded low loss bakelite case, 51/64" x 15/32" x 7/32" axial leads; temp. coeff. —100 +100 parts million/deg. C; capacitance drift 0.2%	Feed condenser station selector switch	Electromotive 603M	60-00625437
C-331-2		CAPACITOR: same as C-331-1			
C-332		CAPACITOR: 110 micromicrofarads			
C-332-1	3DK9110-5 —— ——	CAPACITOR: fixed; silver mica; 110 micromicrofarads; 500 volts d-c working, ±5%; molded low loss bakelite case, 51/64" x 15/32" x 7/32"; axial leads; temp. coeff. —100 to +100 parts million deg. C; capacity drift 0.2%	Feed condenser station selector switch	Electromotive 603M	60-10115337
C-332-2		CAPACITOR: same as C-332-1 (replaced C-312-2)			
C-332-3		CAPACITOR: same as C-332-1			
C-332-4		CAPACITOR: same as C-332-1			
C-333	3DK9160-2 3DK9190 ——	CAPACITOR: fixed; silver mica; 160 micromicrofarads; 500 volts d-c working, ±5%; moulded low loss bakelite case, 51/64" x 15/32" x 7/32"; axial leads; temp. coeff. —100 +100 parts million deg. C; capacity drift 0.2% (190 mmfd. in late model)	Feed capacitor station selector switch	Electromotive 603M	60-10165337
C-334	3K2022143 3DK9220-5 ——	CAPACITOR: fixed; silver mica; 220 micromicrofarads; 500 volts d-c working, ±2%; ASA type CM20D221G; moulded low loss bakelite case, 51/64" x 15/32"; axial leads (250 mmfd. in late models)	Feed capacitor station selector switch	Electromotive 603M	60-1022537
C-335	3K2027143 —— ——	CAPACITOR: fixed; silver mica; 270 micromicrofarads; 500 volts d-c working, ±2%; ASA type CM20D271G; moulded low loss bakelite case, 51/64" x 15/32" x 7/32" axial leads 300 mmfd. in late model	Feed capacitor station selector switch	Electromotive 603M	60-10275237
C-336	3K2036143 —— ——	CAPACITOR: 360 mmf (changed from C-336-1)			

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TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: INDICATOR ★ID-6/APN-4 AND ★ID-6A/APN-4**

Reference Symbol	*Army Stock Number Navy Type Number British Ref. Number*	*Name of Part and Description*	*Function*	*Mfr. and Designation or Standard Type*	*Drawing or Spec. No.*
C-336-1	3K2033143 —— ——	CAPACITOR: fixed; silved mica; 330 micromicrofarads; 500 volts d-c working, ±2%; ASA type CM20D331G; moulded low loss bakelite case 51/64" x 15/32" x 7/32"; axial leads (changed to C-336; 360 mmfd)	Feed capacitor station selector switch	Electromotive 603M	60-1033537
C-337-1	3DKA100-159 —— ——	CAPACITOR: fixed; paper; 100,000 micromicrofarads, +20% —10%; 600 volts d-c working; oil filled metal case, hermetically sealed; case dimension 1-13/16" long, 1" wide; 3/4" thick; 2 lug terminals out top; 2 mounting feet 2-1/8" between centers	Coupling	Cornell-Dubilier DYRT-6010	Philco 305-1215
C-337-2		CAPACITOR: same as C-337-1	Screen bypass		
C-337-3		CAPACITOR: same as C-337-2	Coupling		
C-338	3DKA30-16 —— ——	CAPACITOR: fixed; paper; 30,000 micromicrofarads, ±20%; 600 volts d-c working; moulded bakelite case; wax-impregnated; case dimensions 1-9/16" long, 3/4" wide; 3/8" thick; axial terminal leads (replaced by C-338-2)	Time delay course	Micamold 345-10	Philco 305-1417
C-338-1		CAPACITOR: same as C-338	Time delay course		
C-338-2		CAPACITOR: same as C-338-1	Decoupling		
C-339-1	3DA500-27 —— ——	CAPACITOR: fixed; paper; 500,000 micromicrofarads, +20% —10%; 600 volts d-c working; oil-filled; metal case; hermetically sealed case dimensions 1-13/16" long, 1" wide, 7/8" thick 2 lug terminals on top; 2 mounting feet 2-1/8" between centers	Coupling	Cornell-Dubilier DYRT-6050	Philco 305-1216
C-339-2	—— —— ——	CAPACITOR: same as C-339-1			
C-340	3DKA10-182 —— ——	CAPACITOR: fixed; paper; 10,000 micromicrofarads, ±10%; 1250 volts d-c working; moulded bakelite case; case dimensions 1-1/4" long, 1-1/8" wide, 7/16" thick; lug terminal on end	Coupling	Cornell-Dubilier type 4ST Sprague M721	Philco 305-1099
C-341	3DKA500-108 —— ——	CAPACITOR: fixed; paper; 500,000 micromicrofarads, ±10%; 2000 volts d-c working; oil-filled; metal case hermetically sealed; case dimensions 2-7/8" long, 1-13/16" wide, 1-1/16" thick; 2 terminals on top 7/8" high (replaced by C-341-1)	High "E" bypass	Cornell-Dubilier type T-2005	Philco 305-1350
C-341-2		CAPACITOR: same as C-341-1			
C-342	3K2015122 —— ——	CAPACITOR: fixed; mica; 150 micromicrofarads, ±5%; 500 volts. d-c working; moulded case; case dimensions 45/64" long, 29/64" wide, 3/16" thick; axial terminal leads (replaced by C-342-1)	Coupling	Cornell-Dubilier type 5W Micamold type O	Philco 60-10155317
C-342-2		CAPACITOR: same as 342-1			
C-343	3DKB1-28 ——	CAPACITOR: fixed; paper; oil-filled; 24 micromicrofarads, 600 volts d-c working, +20% —15%; metal case 1-3/4" x	Cathode bypass	Aerovox 630A per 305-1342	305-1342

	——	1-1/2" x 7/8"; two 3/16" dia. holes spaced 2-1/8" for mounting; solder lug terminal on each end; 305-1342 stamped on can			
C-344	3DK9051-6 3K2075032 ——	CAPACITOR: fixed; silver mica; 51 micromicrofarads; 500 volts d-c working, ±5%; moulded low loss bakelite case, 51/64" x 15/32" x 7/32"; axial leads. "D" characteristics, temp. coeff. —100 +100; capacitance drift 0.2%	Coupling condenser	Electromotive 603M	60-00515337
C345	3DK9100-107 —— ——	CAPACITOR: 100 mmfd; silver mica (replaced C-315-1)			60-10105237
C-346	3K2033143 —— ——	CAPACITOR: 330 mmfd (replaced C-336-2)			
C-347-1	3D9750-12 —— ——	CAPACITOR: 750 mmfd, ±2%; ceramic; temperature compensating; 1-1/2" long x 17/64" dia.			
C-347-2		CAPACITOR: same as C-347-1			
C-348	3K2013133 —— ——	CAPACITOR: 130 mmfd			
C-349	3K300132222 —— ——	CAPACITOR: 1300 mmfd			
C-350	3D9820-5 —— ——	CAPACITOR: 820 mmfd			
C-351-1		CAPACITOR: 10,000 mmfd			
C-351-2		CAPACITOR: same as C-351-1			
C-352		CAPACITOR: 24 mmfd			
L-203		CHOKE: 450 m h			
R-302-4		RESISTOR: same as R-302-1	Diode load		
R-302-5		RESISTOR: same as R-302-1	Grid leak		
R-302-6		RESISTOR: same as R-302-1	Grid leak		
R-302-7		RESISTOR: same as R-302-1	Grid leak		
R-302-9		RESISTOR: same as R-302-1	Cathode load		
R-302-10		RESISTOR: same as R-302-1	Part of grid leak		
R-302-11		RESISTOR: same as R-302-1	Time delay circuit		
R-302-12		RESISTOR: same as R-302-1			
R-303	2ZK7270.6 —— ——	POTENTIOMETER: carbon; 50,000 ohms, ±20%; clock wise rotation 315°; case dimensions 1-1/8" diameter, 1/2" deep; 1/4" screwdriver slot shaft 1/8" long from end of bushing; bushing threaded 3/8"-32 for 3/8" with hex nut for mounting; solder lug terminals on top back of case; Special D taper	Phase shift	Centralab type 35	Philco 353-5104
R-303-8		RESISTOR: same as R-302-1	Grid leak		

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TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: INDICATOR ★ID-6/APN-4 AND ★ID-6A/APN-4**

Reference Symbol	*Army Stock Number Navy Type Number British Ref. Number*	*Name of Part and Description*	*Function*	*Mfr. and Designation or Standard Type*	*Drawing or Spec. No.*
R-304-1	3Z4525 —— ——	RESISTOR: fixed; carbon; 1000 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Distortion amplifier cathode load	I.R.C. BT-1/2	Philco 66-2103344
R-304-2		RESISTOR: same as R-304-1	Delay mixer cathode load		
R-304-3		RESISTOR: same as R-304-1	Delay mixer cathode load		
R-304-4		RESISTOR: same as R-304-1			
R-304-5		RESISTOR: same as R-304-1			
R-305-1	3Z4550 —— ——	RESISTOR: fixed; carbon; 100,000 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Grid leak	I.R.C. BT-1/2	Philco 66-4103344
R-305-2		RESISTOR: same as R-305-1	Grid leak		
R-305-3		RESISTOR: same as R-305-1	Grid leak		
R-305-4		RESISTOR: same as R-305-1	Grid leak		
R-305-5		RESISTOR: same as R-305-1	Grid leak		
R-305-6		RESISTOR: same as R-305-1 (removed)	Cathode load		
R-305-7		RESISTOR: same as R-305-1	Grid leak		
R-305-8		RESISTOR: same as R-305-1	Grid leak		
R-305-9		RESISTOR: same as R-305-1	Cathode load		
R-305-10		RESISTOR: same as R-305-1	Grid leak		
R-305-13		RESISTOR: same as R-305-1	Grid leak		
R-305-14		RESISTOR: same as R-305-1			
R-306-1	3Z6505-11 —— ——	RESISTOR: fixed; carbon; 4700 ohms, ±5%; 1/2 watt insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	First counter damping and plate load	I.R.C. BT-1/2	Philco 66-2473244
R-306-2		RESISTOR: same as R-306-1	Plate filter		
R-306-3		RESISTOR: same as R-306-1	Plate filter		
R-307	3Z6647-22 —— ——	RESISTOR: fixed; carbon; 47,000 ohms, ±5%; 2 watt; insulated; length 1-3/4", diameter 5/16"; axial leads 1-1/2" long	Bleeder resistor	I.R.C. BT-2	Philco 66-3475244
R-308-1	3Z6668-14 —— ——	RESISTOR: fixed; carbon; 68,000 ohms, ±5%; 1 watt; insulated; length 1-1/4", diameter 1/4"; axial wire leads 1-1/2" long	Bleeder resistor	I.R.C. BT-1	Philco 66-3684244
R-308-2		RESISTOR: same as R-308-1 (changed to R-308)	Plate load		
R-309	3Z6505-11 —— ——	RESISTOR: fixed; carbon; 5600 ohms, ±5%; 2 watts; insulated; length 1-3/4", diameter 5/16"; axial wire leads 1-1/2" long (changed to R-376)	Bleeder resistor	I.R.C. BT-2	Philco 66-2565244
R-310-1	3Z6220 —— ——	RESISTOR: fixed; carbon; 2200 ohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long			

R-310-2		RESISTOR: same as R-310-1			
R-311	3ZK6806A8-2 —— ——	RESISTOR: fixed; carbon; 6.8 megohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Second counter storage delay	I.R.C. BT-1/2	Philco 66-5683244
R-312	3Z6615-1 —— ——	RESISTOR: fixed; carbon; 15,000 ohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Isolating resistor	I.R.C. BT-1/2	Philco 66-3153244
R-313-1	3Z6100-9 —— ——	RESISTOR: fixed; carbon; 1000 ohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Filter	I.R.C. BT-1/2	Philco 66-2103244
R-313-2		RESISTOR: same as R-313-1	Filter		
R-313-3		RESISTOR: same as R-313-1	Filter		
R-313-4		RESISTOR: same as R-313-1	Cathode load		
R-314-1	3ZK6682-8 —— ——	RESISTOR: fixed; carbon; 82,000 ohms, ±5%; 2 watts; insulated; length 1-3/4", diameter 5/16"; axial wire leads 1-1/2" long	Voltage divider	I.R.C. BT-2	Philco 66-3825244
R-314-2		RESISTOR: Same as R-314-1			
R-314-3		RESISTOR: Same as R-314-1			
R-315-1	2ZK7262-10M.2 —— ——	POTENTIOMETER: wire wound; 10,000 ohms, ±20%; linear taper; clockwise rotation 300°; case dimensions 1/8" diameter, 1/2" deep; 1/4" screwdriver slot shaft 7/16" long from end of bushing; bushing threaded 3/8"-32 for 3/8" with hex nut for mounting; solder lug terminals on top back of case	Voltage divider	Centralab type 35	Philco 353-5096
R-315-2		RESISTOR: same as R-315-1	Voltage divider		
R-315-3		RESISTOR: same as R-315-1	Voltage divider		
R-315-4		RESISTOR: same as R-315-1	Voltage divider		
R-315-5		RESISTOR: same as R-315-1	Time delay		
R-315-6		RESISTOR: same as R-315-1	Course delay		
R-316		RESISTOR: 18,000			
R-317	3ZK6618-16 —— ——	RESISTOR: fixed; carbon; 18,000 ohms, ±5%; 2 watts; insulated; length 1-3/4", diameter 5/16"; axial wire leads 1-1/2" long	Voltage divider	I.R.C. BT-2	Philco 66-3185244
R-318	3Z6615.47 —— ——	RESISTOR: fixed; carbon; 15,000 ohms, ±5%; 2 watts; insulated; length 1-3/4", diameter 5/16"; axial wire leads 1-1/2" long	Voltage divider	I.R.C. BT-2	Philco 66-3155244 66-2105244
R-319-1	3Z6068 —— ——	RESISTOR: fixed; carbon; 680 ohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Voltage divider	I.R.C. BT-2	Philco 66-1683244
R-319-2		RESISTOR: same as R-319-1			
R-319-3		RESISTOR: same as R-319-1			
R-319-4		RESISTOR: same as R-319-1			
R-319-5		RESISTOR: same as R-319-1			
R-319-6		RESISTOR: same as R-319-1			
R-319-7		RESISTOR: same as R-319-1			

IMPORTANT

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TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: INDICATOR ★ID-6/APN-4 AND ★ID-6A/APN-4**

Reference Symbol	*Army Stock Number Navy Type Number British Ref. Number*	*Name of Part and Description*	*Function*	*Mfr. and Designation or Standard Type*	*Drawing or Spec. No.*
R-320-1	2ZK7262-100M.2 —— ——	POTENTIOMETER: 100,000 ohms, ±20%; 315° rotation; carbon; cover is 1-1/8" diameter x 1/2" deep; shaft for mounting is 3/8"-32; shaft on contact arm slotted for screw-driver adjustment. Special D taper	Voltage divider	Chicago Telephone Supply Co. type 35	Philco 353-5078
R-320-2		RESISTOR: same as R-320-1			
R-320-3		RESISTOR: same as R-320-1			
R-321-1	3Z6718-5 —— ——	RESISTOR: fixed; carbon; 180,000 ohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Isolating resistor	I.R.C. BT-1/2	Philco 66-4183244
R-321-2		RESISTOR: same as R-321-1	Voltage divider		
R-321-3		RESISTOR: same as R-321-1			
R-322-1	3Z6700-6 —— ——	RESISTOR: fixed; carbon; 100,000 ohms; ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Isolating resistor	I.R.C. BT-1/2	Philco 66-4103244
R-322-2		RESISTOR: same as R-322-1	Isolating resistor		
R-322-3		RESISTOR: same as R-322-1	Grid leak		
R-322-4		RESISTOR: same as R-322-1	Isolating resistor		
R-322-5		RESISTOR: same as R-322-1	Isolating resistor		
R-322-6		RESISTOR: same as R-322-1	Voltage divider		
R-323-1	3Z6639 —— ——	RESISTOR; fixed; carbon; 39,000 ohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Isolating resistor	I.R.C. BT-1/2	Philco 66-3393244
R-323-2		RESISTOR: same as R-323-1			
R-324-1	3ZK6622-21 —— ——	RESISTOR: fixed; carbon; 22,000 ohms, ±5%; 1 watt; insulated; length 1-1/4", diameter 1/4"; axial wire leads 1-1/2" long	Plate load	I.R.C.	Philco 66-3224244
R-324-2		RESISTOR: same as R-324-1			
R-324-3		RESISTOR: same as R-324-1			
R-324-4		RESISTOR: same as R-324-1			
R-324-5		RESISTOR: same as R-324-1			
R-324-6		RESISTOR: same as R-324-1			
R-324-7		RESISTOR: same as R-324-1			
R-325-1	3S6610-95 —— ——	RESISTOR: fixed; carbon; 10,000 ohms, ±5%; 1 watt; insulated; length 1-1/4", diameter 1/4"; axial wire leads 1-1/2" long	Cathode load	I.R.C. BT-1	Philco 66-3104244
R-325-2		RESISTOR: same as R-325-1	Plate load		
R-325-3		RESISTOR: same as R-325-1	Cathode load		
R-325-4		RESISTOR: same as R-325-1	Cathode load		
R-326	3ZK6803A0-7 —— ——	RESISTOR: fixed; carbon; 3.9 megohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Dropping resistor	I.R.C. BT-1/2	Philco 66-5393344

R-327-1	3Z6727-12 —— ——	RESISTOR: fixed; carbon; 270,000 ohms, ±5%! 1 watt; insulated; length 1-1/4", diameter 1/2"; axial wire leads 1-1/2" long	Voltage dropping	I.R.C. BT-1	Philco 66-4274244
R-327-2		RESISTOR: same as R-327-1			
R-328-1	2ZK7262-25M.4 —— ——	POTENTIOMETER: carbon; 25,000 ohms, ±20%; clockwise rotation 315°; case dimensions 1-1/8" diameter, 1/2" deep; 1/4" screwdriver slot; shaft 1/8" long from end of bushing; bushing threaded 3/8-32 for 3/8" with hex nut for mounting; solder lug terminals on top back of case; special D taper	Voltage divider	Centralab	Philco 353-5118
R-328-2		POTENTIOMETER: same as R-328-1			
R-329-1	3Z6470-1 —— ——	RESISTOR: fixed; carbon; 4,700 ohms, ±5%; 1 watt; insulated; length 1-1/4", diameter 1/4"; axial wire leads 1-1/2" long	Cathode load	I.R.C. BT-1	Philco 66-2474244
R-329-2		RESISTOR: same as R-329-1	Coupling resistor		
R-329-3		RESISTOR: same as R-329-1	Plate load		
R-330	3Z6722-1 —— ——	RESISTOR: fixed; carbon; 220,000 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 6/32"; axial wire leads 1-1/2" long	Cathode resistor	I.R.C. BT-1/2	Philco 66-4223344
R-330-2		RESISTOR: same as R-330-1			
R-330-3		RESISTOR: same as R-330-1			
R-330-4		RESISTOR: same as R-330-1			
R-331	3Z6727-2 —— ——	RESISTOR: fixed; carbon; 270,000 ohms, ±10%; 1 watt; insulated; length 1-1/4", diameter 1/4"; axial wire leads 1-1/2" long	Plate load	I.R.C. BT-1	Philco 66-4274344
R-332-1	3Z6747-1 —— ——	RESISTOR: fixed; carbon; 470,000 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Cathode bias	I.R.C. BT-1/2	Philco 66-4473344
R-332-2		RESISTOR: same as R-332-1			
R-332-5		RESISTOR: same as R-332-1			
R-332-6		RESISTOR: same as R-332-1			
R-332-7		RESISTOR: same as R-332-1			
R-333	3Z6047-12 —— ——	RESISTOR: fixed; carbon; 470 ohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Plate load	I.R.C. BT-1/2	Philco 66-1473244
R-334	3Z6633 —— ——	RESISTOR: fixed; carbon; 33,000 ohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Cathode bias	I.R.C. BT-1/2	Philco 66-3333244
R-335	3Z6647 —— ——	RESISTOR: fixed; carbon; 47,000 ohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Grid leak	I.R.C. BT-1/2	Philco 66-3473244
R-336-1	3Z6804A7-4 —— ——	RESISTOR: fixed; carbon; 4.7 megohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Cathode bias	I.R.C. BT-1/2	Philco 66-5473344
R-336-2		RESISTOR: same as R-336-1	Dropping resistor		
R-336-3		RESISTOR: same as R-336-1	Coupling resistor		

IMPORTANT

Circuit reference symbols in this table of parts duplicate themselves.
Be sure to check nomenclature of the particular major assembly.

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET *AN/APN-4 **MAJOR ASSEMBLY: INDICATOR *ID-6/APN-4 and *ID-6A/APN-4**

Reference Symbol	Army Stock Number Navy Type Number British Ref. Number	Name of Part and Description	Function	Mfr. and Designation or Standard Type	Drawing or Spec. No.
R-336-4		RESISTOR: same as R-336-1	Dropping resistor		
R-336-5		RESISTOR: same as R-336-1	Bleeder resistor		
R-336-6		RESISTOR: same as R-336-1	Bleeder resistor		
R-338-1	3Z6700-8 —— ——	RESISTOR: fixed; carbon; 100,000 ohms, ±5%; 1 watt; insulated; length 1-1/4", diameter 1/2"; axial wire leads 1-1/2" long	Plate load	I.R.C. BT-1	Philco 66-4104244
R-338-2		RESISTOR: same as R-338-1	Voltage dropping		
R-338-3		RESISTOR: same as R-338-1	Plate load		
R-338-4		RESISTOR: same as R-338-1	Voltage dropping		
R-339-1	3Z6722-20 —— ——	RESISTOR: fixed; carbon; 220,000 ohms, ±5%; 1 watt, insulated; length 1-1/4", diameter 1/2"; axial wire leads 1-1/2" long	Voltage dropping	I.R.C. BT-1	Philco 66-4224244
R-339-2		RESISTOR: same as R-339-1			
R-340-1	3Z6802A2-6 —— ——	RESISTOR: fixed; carbon; 2.2 megohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Voltage dropping	I.R.C. BT-1/2	Philco 66-5223344
R-340-2		RESISTOR: same as R-340-1	Bleeder		
R-340-3		RESISTOR: same as R-340-1	Grid leak		
R-340-4		RESISTOR: same as R-340-1	Suppressor load		
R-340-5		RESISTOR: same as R-340-1			
R-341-2	2ZK7262-2M —— ——	POTENTIOMETER: wire wound; 2000 ohms, ±20%; 1 watt; linear taper; clockwise 300° rotation; case dimensions 1-1/8" diameter, 1/2" deep; 1/4" shaft, 3/8" long from end of bushing; bushing threaded 3/8-32 for 3/8" with hex nut for mounting; solder lug terminal on top back of case	Cathode resistor	Centralab type 35	Philco 353-5097
R-343-1	3ZK6004A7-18 —— ——	RESISTOR: fixed; wire wound; 47 ohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Voltage divider	I.R.C. BT-1/2	Philco 66-0473264
R-343-2		RESISTOR: same as R-343-1			
R-343-3		RESISTOR: same as R-343-1			
R-343-4		RESISTOR: same as R-343-1			
R-343-5		RESISTOR: same as R-343-1			
R-343-6		RESISTOR: same as R-343-1			
R-343-7		RESISTOR: same as R-343-1			
R-344-1	3Z6639-1 —— ——	RESISTOR: fixed; carbon; 39,000 ohms, ±5%; 1 watt; insulated; length 1-1/4", diameter 1/4"; axial wire leads 1-1/2" long	Plate load	I.R.C. BT-1	Philco 66-3394244
R-344-2		RESISTOR: same as R-344-1			
R-344-3		RESISTOR: same as R-344-1			

R-345-1	3Z6739-2 — —	RESISTOR: fixed; carbon; 390,000 ohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Coupling	I.R.C. BT-1/2	Philco 66-4393244
R-345-2		RESISTOR: same as R-345-1			
R-346	3Z6270 — —	RESISTOR: fixed; carbon; 2700 ohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Voltage divider	I.R.C. BT-1/2	Philco 66-2273244
R-347	2ZK7262-5M.3 — —	POTENTIOMETER: wire wound; 5,000 ohms; ±20%; 1 watt; linear taper; clockwise 300° rotation; case dimensions 1-9/32" diameter, 19/32" deep; 1/4" screwdriver slot; shaft 1/8" long from end of bushing; bushing threaded 3/8-32 for 3/8" with hex nut for mounting; solder lug terminals on back of case	Control for square wave generator circuit cathode control	Centralab type 35	Philco 353-5098
R-348		RESISTOR: 1.5 meg.			
R-349	3Z6150-20 — —	RESISTOR: fixed; carbon; 1500 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Cathode bias	I.R.C. BT-1/2	Philco 66-2153344
R-349-2		RESISTOR: same as R-349			
R-350-1	2ZK7269-1000M.1 — —	POTENTIOMETER: variable; carbon; 1 megohm, ±20%; clockwise rotation 315°; case dimensions 1-1/8" diameter, 1/2" deep, 1/4" screwdriver slot shaft 1/8" long from end of bushing; bushing threaded 3/8-32 for 3/8" with hex nut for mounting; solder terminals on top back of case	Centering control (vertical)	Centralab type 35	Philco 353-5077
R-350-2		POTENTIOMETER: same as R-350-1	Intensity control		
R-350-3		POTENTIOMETER: same as R-350-1	Centering control (horizontal)		
R-350-4		POTENTIOMETER: same as R-350-1	Sweep amplifier control		
R-350-5		POTENTIOMETER: same as R-350-1	Sweep amplifier control		
R-350-6		POTENTIOMETER: same as R-350-1	Sweep amplifier control		
R-351-1	3Z6810-5 — —	RESISTOR: fixed; carbon; 10 megohms, ±10%; 1-2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Cathode resistor	I.R.C. BT-1/2	Philco 66-6103344
R-351-2		RESISTOR: same as R-351-1	Coupling		
R-352	3Z6647-1 — —	RESISTOR: fixed; carbon; 47,000 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Cathode bias	I.R.C. BT-1/2	Philco 66-3473344
R-352-2		RESISTOR: same as R-352-1 (replaces R-305-5)			
R-353-1	2ZK7262-500M-4 — —	POTENTIOMETER: carbon; 500,000 ohms, ±20%; clockwise 315° rotation; case dimensions 1-1/8" diameter, 1/2" deep; 1/4" screwdriver slot; shaft 1/8" long from end of bushing; bushing threaded 3/8-32 for 3/8" with hex nut for mounting; solder lug terminals on top back of case; special D taper	Trace separation controls	Centralab type 35	Philco 353-5079

IMPORTANT

Circuit reference symbols in this table of parts duplicate themselves. Be sure to check nomenclature of the particular major assembly.

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 | **MAJOR ASSEMBLY: INDICATOR ★ID-6/APN-4 and ★ID-6A/APN-4**

Reference Symbol	Army Stock Number Navy Type Number British Ref. Number	Name of Part and Description	Function	Mfr. and Designation or Standard Type	Drawing or Spec. No.
R-353-2		POTENTIOMETER same as R-353-1			
R-353-3		POTENTIOMETER same as R-353-1			
R-354-1	3Z6715-3 —— ——	RESISTOR: fixed; carbon; 150,000 ohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Coupling resistors	I.R.C. BT-1/2	Philco 66-4153244
R-354-2		RESISTOR: same as R-354-1			
R-355	2ZK7262-500M.5 —— ——	POTENTIOMETER: carbon; 500,000 ohms, ±20%; 1/3 watt; clockwise 315° rotation; case dimensions 1-1/8" diameter, 1/2" deep, 1/4" shaft 3/8" long from end of bushing; bushing threaded 3/8-32 for 5/16" with hex nut for mounting; solder lug terminals on top back of case; special D taper	Signal amplitude balance	Centralab type 35	Philco 353-5100
R-356	3Z6747 —— ——	RESISTOR: fixed; carbon; 470,000 ohms, ±5%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Voltage divider	I.R.C. BT-1	Philco 66-4473244
R-356-2		RESISTOR: same as R-356-1			
R-356-3		RESISTOR: same as R-356-1			
R-357-1	2ZK7269-1000M.2 —— ——	POTENTIOMETER: carbon; 1 megohm, ±20%; 1/3 watt; clockwise 315° rotation; case dimensions 1-1/8" dia., 1/2" deep; 1/4" "XX" bakelite rod 11/16" long from end of bushing; bushing threaded 3/8-32 threads for 3/8" with hex nut for mounting; 3 solder lug terminals on top back of case; special D taper	Focus	Centralab type 35	Philco 353-5099
R-357-2		POTENTIOMETER: same as R-357-1	Intensity control		
R-358	2Z6747-12 —— ——	RESISTOR: fixed; carbon; 470,000 ohms, ±10%; 1 watt; insulated; axial leads; dimensions 1-1/4" long, 1/2" diameter	Voltage divider	I.R.C. BT-1	Philco 66-4474344
R-359	3ZK673903 —— ——	RESISTOR: fixed; carbon; 390,000 ohms, ±10%; 1 watt; insulated; axial leads; dimensions 1-1/4" long, 1/4" diameter	Voltage divider	I.R.C. BT-1	Philco 66-4394344
R-360	3Z6700-30 —— ——	RESISTOR: fixed; carbon; 100,000 ohms, ±10%; 1 watt; insulated; axial leads; dimensions 1-1/4" long, 1/4" diameter	Voltage divider	I.R.C. BT-1	Philco 66-4104344
R-361-1	3Z6722 —— ——	RESISTOR: fixed; carbon; ±5%; 1/2 watt; 220,000 ohms; insulated; axial leads; dimensions 5/8" long, 3/16" diameter	Coupling condenser	I.R.C. BT-1/2	Philco 66-4223244
R-361-2		RESISTOR: same as R-361-1	Grid coupling		
R-362	3Z6720-1 —— ——	RESISTOR: fixed; carbon; 200,000 ohms, ±5%; 1/2 watt; insulated; axial leads; dimensions 5/8" long, 3/16" diameter	Coupling resistor	I.R.C. BT-1/2	Philco 66-4203244

R-363-1	3ZK6647-8.1 —— ——	RESISTOR: fixed; carbon, 47,000 ohms, ±5%; 1 watt; insulated; length 1-1/4", diameter 1/4"; axial wire leads 1-1/2" long	Plate load	I.R.C. BT-1	Philco 66-347244
R-363-2		RESISTOR: same as R-363-1	Screen load		
R-364	3ZK6560-14 —— ——	RESISTOR: fixed; carbon; 60,000 ohms, ±5%; 1 watt; insulated; length 1-1/4", diameter 1/4"; axial wire leads 1-1/2" long	Cathode bias	I.R.C. BT-1	Philco 66-2604244
R-365	3Z4569 —— ——	RESISTOR: fixed; carbon; 60,000 ohms, ±10%; 1/2 watt; insulated; length 5/8", diameter 3/16"; axial wire leads 1-1/2" long	Grid load	I.R.C. BT-1/2	Philco 66-3603344
R-366	3Z6330-10 —— ——	RESISTOR: fixed; metallized; 3300 ohms; 1/2 watt, ±5%; insulated; 5/8" long, 3/16" diameter with axial leads	Grid resistor	I.R.C. BT-1/2	Philco 66-2333244
R-367	3Z6801-31 —— ——	RESISTOR: fixed; carbon; 1 megohm, ±10%; 1 watt; insulated; length 1-1/4", diameter 1/4"; axial wire leads 1-1/2" long	Voltage divider	I.R.C. BT-1	Philco 66-5104344
R-368	3Z6047 —— ——	RESISTOR: fixed; metallized; 470 ohms; 1/2 watt, ±10%; insulated; 5/8" long x 3/16" diameter with axial leads	Cathode resistor	BT-1/2	66-1473344
R-369	3BC41BE683V 3ZK6668-16 ——	RESISTOR: 68,000 ohms; 2 watts			66-3685244
R-371	3RC41BE753J —— ——	RESISTOR: 75,000 ohms; 2 watts ±5%			
R-372	3RC21BE332K —— ——	RESISTOR: 3300			
R-373	3RC21BE333K —— ——	RESISTOR: 33,000			
R-375		RESISTOR: 680,000			
R-376	3R641BE682J —— ——	RESISTOR: 6,800			
R-377-1		RESISTOR: 33 ohms			66-0333264
R-377-2		RESISTOR: 33 ohms	Filament top		66-0333264
R-378	3Z600303-10 —— ——	RESISTOR: 68,000 ohms; 1 watt, ±20%; 7/8" long x 9/32" diameter; 1-1/2" leads	4th counter	I.R.C.	66-4684544
S-301-A	3ZK9828-10 —— ——	SWITCH: rotary; 3 sections; wafer; 8 positions; locking; phenolic; case dimensions 1-17/32" deep x 1-11/16" diameter; solder terminals, located around wafer; mounting dimensions, bushing 3/8-32 thread 3/8" long; shaft 1-7/16" x 1/4" diameter with 3/8" flat; bracket type two No. 5-40 studs 1-9/16" centers	Station selector	Oak Mfg. Co. 25390-H3	

IMPORTANT

Circuit reference symbols in this table of parts duplicate themselves.
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TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 — **MAJOR ASSEMBLY: INDICATOR ★ID-6/APN-4 and ★ID-6A/APN-4**

Reference Symbol	Army Stock Number / Navy Type Number / British Ref. Number	Name of Part and Description	Function	Mfr. and Designation or Standard Type	Drawing or Spec. No.
S-301-B		SWITCH: same as S-301-A			
S-301-C		SWITCH: same as S-301-A			
S-302-A	3ZK9848.13 —— ——	SWITCH: special toggle type; single section; wafer; 2 circuits; 3 positions; non-locking; phenolic insulation; case dimensions 1-7/8" long, 1-1/2" deep, 7/16" wide; solder terminals located around wafer; lever 5/8" long; two 0.144" diameter mounting holes, mounting centers 1.625"; switch must return to center position after lever is moved to either end position; with position indicating plate; without attaching hardware.	Left-right pulse switch	Centralab N-6717X	Philco 452-1115
S-302-B		SWITCH: same as S-302-A			
S-303-A	3ZK9828-11 —— ——	SWITCH: rotary; 4 sections; wafer; 36 circuits; 8 positions; locking; phenolic insulation; case dimensions 3-1/2" deep x 1-11/16" diameter; shaft 3-7/16" long x 1/4" diameter with 3/8" flat; solder terminals located around wafer; mounting dimensions, bushing 3/8-32 thread 3/8" long; mounting centers 1-9/16" bracket type—two No. 5-40 studs; without position indicating plate; without attaching hardware	Sweep speed selector and trace separations	Oak Mfg. Co. 25560-H4	Philco 452-1116
S-303-B		SWITCH: same as S-303-A			
S-303-C		SWITCH: same as S-303-A			
S-303-D		SWITCH: same as S-303-A			
X-301-2		SOCKET: same as X-301-1			
X-301-3		SOCKET: same as X-301-1			
X-301-4		SOCKET: same as X-301-1			
X-301-5		SOCKET: same as X-301-1			
X-301-6		SOCKET: same as X-301-1			
X-301-7		SOCKET: same as X-301-1			
X-301-8		SOCKET: same as X-301-1			
X-301-9		SOCKET: same as X-301-1			
X-301-10		SOCKET: same as X-301-1			
X-301-11		SOCKET: same as X-301-1			
X-301-12		SOCKET: same as X-301-1			
X-301-13		SOCKET: same as X-301-1			
X-301-14		SOCKET: same as X-301-1			
X-301-15		SOCKET: same as X-301-1			
X-301-16		SOCKET: same as X-301-1			
X-301-17		SOCKET: same as X-301-1			
X-301-18		SOCKET: same as X-301-1			
X-301-19		SOCKET: same as X-301-1			

X-301-20		SOCKET: same as X-301-1			
X-301-21		SOCKET: same as X-301-1			
X-301-22		SOCKET: same as X-301-1			
X-301-23		SOCKET: same as X-301-1			
X-301-24		SOCKET: same as X-301-1			
X-301-25		SOCKET: same as X-301-1			
X-301-26		SOCKET: same as X-301-1			
X-302	2ZK8684-5 —— ——	SOCKET: cathode ray tube; bakelite; 14 contacts; keyway guide; 2-7/32" diameter, 1-3/8" high; 2 holes for mounting, 31/32" between centers inside of circle of contacts; single 0.780" diameter hole for mounting	Cathode ray tube	Cinch 9450	257-6068
X-303	2ZK8761-16 —— ——	SOCKET: crystal; bakelite; 3 contacts; clamp pieces of low loss linen base bakelite 1/16" thick; waxed; 2-3/16" diameter x 1-1/16" wide; two 0.158" diameter holes for mounting, 0.156" between centers	Crystal folder	Cinch type 4033W	Philco 257-6072
Y-301	2ZK3502-100 —— ——	CRYSTAL UNIT: quartz; frequency 100 kc ±15 cycles; must operate between —40° to +50° C.; phenolic holder; case 2-1/8" long, 1-19/32" wide, 1-3/16" thick; fixed pressure unit; 3 prongs 9/16" long for connections located in base	Fundamental frequency of 100 kc.	RCA VC-5-KS	Philco 455-1040
	2ZK5822-23 —— ——	KNOB: round; grooved to fit 1/4" shaft; black tenite; knob 3/4" diameter, 9/16" thick; knob tapers from 1/2" diameter at top to 5/8" above flange; flange 3/4" diameter, 1/16" thick; no markings	Focus control	Kurz-Kasch type S-230-3	Philco 257-4238
	2Z5822-1 —— ——	KNOB: round, black tenite; finger grip, 11/32" thick x 1-5/8" diameter, then 1-3/16" diameter for 15/32" knob 1-5/8" diameter, 1" thick; brass bushing 1/2" O.D. x 1/4" I.D. x 9/16" long; fastened by split bushing and squeeze nut; 2 setscrews, 8-32 thread spaced 90° apart	Course delay—fine delay	Kurz-Kasch type S-309-3	Philco 257-4239

MODEL: RADIO SET ★AN/APN-4 **MAJOR UNIT: INDICATOR ★ID-6/APN-4**

	2ZK5748.14 —— ——	KNOB: round; fluted to fit 1/4" shaft; moulded phenolic; knob 1" diameter, 23/32" thick; one setscrew 6-32 thread; finish "CRYSTAL" stamped in white letters across top; white arrow indicator across knob under lettering; "PHASING" stamped in white letters under arrow	Crystal phasing	American Insulator Company 257-4266	Philco 257-4266
	2ZK8401-5PH6 —— ——	SHOCK MOUNT: steel plate 2-3/8" square x 1-1/16" high; cushions center hole 0.257" diameter; four mounting holes	Vibration absorber	Lord type 150-PH-6	Philco 257-7578
	3FK26100-2 —— ——	WINDOW: plexiglass; clear; overall dimensions 4-25/32" diameter x 1/8" thick	Cathode ray tube protector	Crossdale 257-7971	Philco 257-7971
	2Z8401-5PH8 —— ——	SHOCK MOUNT: 2-3/8" square; steel 0.257" diameter hole through rubber; four mounting holes 1-15/16" centers	Vibration absorber	Lord Mfg. Co. 150-PH-8	Philco 257-8148

IMPORTANT

Circuit reference symbols in this table of parts duplicate themselves.
Be sure to check nomenclature of the particular major assembly.

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 MAJOR ASSEMBLY: INDICATOR ★ID-6/APN-4 AND ★ID-6A/APN-4

Reference Symbol	*Army Stock Number Navy Type Number British Ref. Number*	*Name of Part and Description*	*Function*	*Mfr. and Designation or Standard Type*	*Drawing or Spec. No.*
	2ZK3768-2 —— ——	DIAL: round to fit 9/16" shaft; bakelite; dial 2-5/8" diameter, 1/16" thick; white letters and figures; white arrow through lettering; markings, one side marked "COURSE," opposite side calibrated 0-10,000, 21 equal markings in 280°; three No. 2 size countersunk mounting holes triangular shape 3/4" centers	Course delay	Philco 257-7977	Philco 257-7977
	2ZK3768-1 —— ——	DIAL: round, to fit 1/4" shaft; black bakelite, dial 2-5/8" diameter, 1/16" thick, 9/16" diameter center hole; finish white figures, white arrow through lettering; one side marked "FINE," opposite side calibrated 200-700 with 10 equal spaces in 260°; three No. 2 size mounting holes countersunk, triangular shape 3/4" centers	Fine delay	Philco 257-7978	Philco 257-7978
	6ZK5019 —— ——	HANDLE: steel; black nickel finish; 5/16" diameter, 1-1/4" high; two mounting holes 0.136" diameter x 3/8" deep tapped to fit No. 8-32 screw; 4" mounting centers	Carrying handle	Philco 258-1231	Philco 258-1231
	6R57400 —— ——	WRENCH: No. 8 standard Allen head setscrew wrench	Knobs	Allen No. 8	Philco 1W30964
	3FK3780-1 —— ——	SHIELD ASSEMBLY: cathode ray tube; 0.032" iron zinc plated; clamp assembly on one end for mounting; four rubber grommets on large end for protection; cable clip riveted to shield; shield made up of three separate pieces spot-welded together; tapered from 2-5/16" at base to 5-7/16" at end; length 13-9/32"	Cathode ray tube shield	Philco 358-3434	Philco 358-3434
	2ZK9407-31 —— ——	TERMINAL PANEL: cloth base bakelite; 3 terminals, 2 terminals at one end, one at other end; center between 2 L shaped brackets 1-1/4" long with foot tapped for No. 6-32 mounting hole; strip 1-7/8" long, 1-3/4" wide, 3/32" thick	High voltage	Cinch type EXP-7675	Philco 358-3618
	2ZK9407-32 —— ——	TERMINAL PANEL: cloth base bakelite; 86 terminals; 43 equal rows of lugs 3/8" apart; 5 L-shaped brackets of zinc-plated steel, one at each end and 3 in equal distances in between; each foot tapped; No. 6-32 mounting hole; strip 16-1/2" long, 1-3/8" wide, 3/32" thick	Wiring panel	Cinch type 8931W1	Philco 358-3819
	2ZK9407-33 —— ——	TERMINAL PANEL: cloth base bakelite; 20 lug terminals; 13/16" long; material wax-impregnated finish; 10 rows of 2 each terminals located each side 3/8" apart; strip 3-7/8" long, 1-3/8" wide, 3/32" thick; two 0.156" diameter mounting holes one near each end, 2-1/4" centers.	Wiring panel	Cinch type 8947-W1	Philco 358-3620
	2ZK9407-34 —— ——	TERMINAL PANEL: cloth base bakelite; 26 solder lug terminals; 13 rows 3/8" apart terminals located each side; strip 4-7/8" long, 1-3/8" wide, 3/32" thick; two 0.156" two mounting holes 2.625" centers	Wiring panel	Cinch type 8948-W1	Philco 358-3621

2ZK9407-35	TERMINAL PANEL: cloth base bakelite; 12 solder lug terminals; wax-impregnated; 6 rows 3/8" apart, terminals located each side; strip 2-3/8" long, 1-3/8" wide, 3/32" thick; two 0.156" diameter mounting, mounting centers 1-1/2"	Wiring panel	Cinch type 8949-W1	Philco 358-3628
2ZK9407-36	TERMINAL PANEL: cloth base bakelite; 18 lug terminals; 2 rows of 9 terminals located each side 3/8" apart, strip 3-1/2" long, 1-3/8" wide, 3/32" thick; two 0.156" diameter mounting holes 1.875" centers	Wiring panel	Cinch type 8950-W1	Philco 358-3629
2ZK9407-38	TERMINAL PANEL: cloth base bakelite; 18 lug terminals; 3/8" apart; 2 rows of 9 terminals located each side; 2 zinc-plated L-shaped steel brackets with No. 6-32 tapped mounting hole; also used for ground; strip 3-3/8" long, 1-7/8" wide, 3/32" thick	Wiring panel	Cinch 358-4162	Philco 358-4162
2ZK11117-1	VISOR ASSEMBLY: top grain black cowhide, 5-13/16" from base to center of rivets; 10" long x 6" wide with sponge rubber guard; screw clamp holds visor tight to metal rim of cathode ray tube	For cathode ray vision in daylight	Bellevue Leather Co. 358-4316	Philco 358-4316
2ZK5822-24	KNOB: round; to fit 1/4" shaft; bakelite, black; knob 0.437" diameter, 9/16" long; one setscrew 8-32 thread, 1/8" long, cup pointed	Left-right	Consolidated Moulded Prod. 358-4600	Philco 358-4600
2ZK3010.12	CONNECTOR: red; single-ended coaxial assembly; consists of 2 hex nuts, 3 washers and red collar with solder lug on rear end, retaining clip coming out from red collar; lug mounted by 2 lockwashers and 2 small hex nuts; length 1-5/16", diameter 3/4"	Video connector	Amphenol 10-H-528 (red)	Philco 358-1266
2Z3010.4	CONNECTOR: blue, single-ended coaxial assembly; consists of 2 large hex nuts, 3 washers and blue collar with solder lug on rear and retaining clip coming out of blue collar; lug mounted by 2 lockwashers and 2 small hex nuts; length 1-5/16", diameter 3/4"	Gain connector	Amphenol 10-H-528 (blue)	Philco 358-1305
2ZK3010.11	CONNECTOR: yellow; single-ended coaxial assembly; consists of 2 large hex nuts, 3 washers and yellow collar with solder lug on rear and retaining clip coming out of yellow collar; lug mounted by 2 lockwashers and 2 small nuts; length 1-5/16", diameter 3/4"		Amphenol 10-H-528 (yellow)	Philco 358-2832
2ZK5822-22	KNOB: bar; to fit 0.252" shaft; black bakelite; brass bushing 5/8" diameter, 1/2" thick; pointer 1-1/4" long, 5/8" thick, 3/4" diameter; white line on pointer; 1 hex socket headless setscrew, 8-32 thread, 7/16" long, cup point	Turns shaft	Kurz-Kasch type S-292-3L	Philco 358-4274
2Z5531.3	JACK: phone tip; open circuit; 7/16" diameter insulated head 3/16" thick; threaded bushing 7/16" long; threaded 1/4" coded red; solder terminal at bottom end with hole for wire; one insulating washer, 3/64" thick lockwasher and hex nut	For connections	American Hardware type 138	Philco 358-4314
3DKA3.300-1	CAPACITOR: fixed; mica; 3300 micromicrofarads; 500 volts d-c working; ±5%; ASA type No. CM30B332J; bakelite case 53/64" x 53/64" x 9/32" thick; axial wire leads		Electromotive 502 L	60-20335314

IMPORTANT

Circuit reference symbols in this table of parts duplicate themselves. Be sure to check nomenclature of the particular major assembly.

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 — MAJOR ASSEMBLY: INDICATOR ★ID-6/APN-4 AND ★ID-6A/APN-4

Reference Symbol	*British Ref. Number* *Army Stock Number* *Navy Stock Number*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or Standard Type*	*Cont. or Govt. Dwg. or Spec. No.*
	2Z6622-22 —— ——	RESISTOR: fixed; metallized; 22,000 ohms; 2 watt, ±5%; insulated 1-3/4" long, 5/16" dia. with axial leads		I.R.C. BT-2	66-3225244
	3Z6220-4 —— ——	RESISTOR: fixed; metallized; 2200 ohms; 1/2 watt, ±10%; insulated; 5/8" long, 3/16" dia. with axial leads		BT-1/2	66-2223344
	3Z3915-10A —— ——	TERMINAL STRIP: cloth base bakelite, wax-impregnated; with two solder lug terminals spaced 3/8"; one lug grounding type with 0.14" dia. hole for mounting; 3/4" long, 5/16" wide, 1/16" thick; lugs tinned brass		Cinch 6520	358-3846
	3ZK9828-12 —— ——	SWITCH: rotary; 3 sections; wafer; 8 positions; non-locking; phenolic insulation; case dimensions 2-1/4" long, 1-11/16" diameter; solder terminals located around wafers; mounting dimensions, bushing 3/8-32 thread 3/8" long; mounting centers 1-9/16"; bracket type two No. 5-40 studs 3/8" long, without position-indicating plate, without attaching hardware	Sweep speed switch rear	Oak Mfg. Co. 25392-H3	Philco 452-1117

MODEL: MODIFICATION KIT MX-440/APN-4 — (FOR USE WITH INDICATOR ★ID-6A/APN-4 ONLY)

R-380	*2ZK7262-10M-2 —— ——	Potentiometer: 10,000 ohms; wirewound	Controls grid-to-cathode voltage of fourth counter oscillator		
S-304	*3Z9859-19.1 —— ——	SWITCH: H-L, double-pole, double-throw; hex nut and washer	Selects preset recurrence rates		
R-381	*3RC21BE273-d —— ——	RESISTOR: 27,000 ohms, ±5%, 1/2 watt	When in circuit raises voltage at sweep control grid of V-305		
C-323-2	*3DKA20-65 —— ——	Capacitor: .02 mfd, 600 volts; moulded paper	Counter diode bypass capacitor		

MODEL: RADIO SET ★AN/APN-4 — MAJOR ASSEMBLY: INDICATOR ★ID-6B/APN-4

C301-1	3DK9510-4 —— ——	CAPACITOR: fixed, mica dielectric; 510 mmf. ±10%, 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" thick; axial leads	Series capacitor oscillator grid circuit V301-1	Electromotive 503M	60-10515417
C301-2		Same as C301-1	Sweep inverter grid bypass V301-14		
C301-3		Same as C301-1	Fed. gen. grid bypass V301-15		
C301-4		Same as C301-1	L.R. circuit lefting		

C301-5		Same as C301-1	E. J. sync input		
C302	3D9050V-76 —— ——	CAPACITOR: variable; air dielectric; 5 to 50 mmf. ±3 mmf. at 5 mmf; ±5 mmf. at 50 mmf; 500 V d.c. working; overall dimensions—15/16" x 1-17/32" x 1-7/8"; shaft 7/8" x 0.250" diameter; mounting dimensions—2 holes tapped 4.40; 21/32" center to center	Crystal phasing in 100 KC oscillator grid circuit V301-1		351-1059
C303-1	3DK9005-26 —— ——	CAPACITOR: fixed, mica dielectric; 5 mmf. ±10%; 500 V d.c. working; bakelite case wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Left-Right circuit S301-A	Electromotive 503M	60-00055417
C303-2		Same as C303-1	Plate feedback V301-1		
C304-1	3K2010021 —— ——	CAPACITOR; fixed, mica dielectric; 10 mmf. ±10%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Left-Right circuit S301-A	Electromotive 503M	60-00105417
C304-2		Same as C304-1	Station selections compensation S304-B2		
C305-1	3DA10-124 —— ——	CAPACITOR: fixed, moulded paper dielectric; 0.01 mf. ±20%; 600 V d.c. working; bakelite case; wax impregnated; 1-7/16" long x 3/4" wide x 5/16" thick; axial leads	Oscillator plate filter V301-1	Micamold 342-17	305-1255
C305-2		Same as C305-1	Cathode bypass V303-2		
C305-3		Same as C305-1	Input to sweeps synchronization V301-14		
C305-4		Same as C305-1	Input pedestal general V301-15		
C306	3DKA1.500-15 —— ——	CAPACITOR: fixed, mica dielectric; 1500 mmf; ±5%; 500 V d.c. working; bakelite case; wax impregnated; 53/64" long x 53/64" wide x 9/32" thick; axial leads	Plate tuning of oscillator V301-1	Electromotive 502L	60-20155314
C307-1	3D9240-12 —— ——	CAPACITOR: fixed, mica dielectric; 240 mmf; ±10%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	10 Microseconds phase shift capacitor T301	Electromotive 503M	60-10245417
C307-2		Not used			
C307-3		Same as C307-1	B course grid bypass V301-3		
C307-4		Same as C307-1	A delay V301-13 coupling to E. J. sync		
C308	3K2033021 —— ——	CAPACITOR: fixed, mica dielectric: 33 mmf. ±10%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Grid coupling V301-1	Electromotive 503M	60-00335417
C309-1	3K2018021 —— ——	CAPACITOR: fixed, mica dielectric; 18 mmf. ±10%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Grid bypass V301-2	Electromotive 503M	60-00185417
C309-2		Same as C309-1	Coupling V-301-12		
C309-3		Same as C309-1	Coupling S303		

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET *AN/APN-4 **MAJOR ASSEMBLY: INDICATOR *ID-6B/APN-4**

Reference Symbol	British Ref. Number / Army Stock Number / Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
C310-1	3D9051-7 / —— / ——	CAPACITOR: fixed, mica dielectric; 51 mmf. ±10%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Grid coupling 1st counter trigger V301-2	Electromotive 503M	60-00515417
C310-2		Same as C310-1	Grid coupling feed 10 microseconds marker V303-2		
C310-3		Same as C310-1	Grid coupling 10 microseconds marker V303-2		
C311-1	3K2024022 / —— / ——	CAPACITOR: fixed, mica dielectric; 24 mmf. ±5%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Coupling V301-2	Electromotive 503M	60-00245317
C312	3K2582143 / —— / ——	CAPACITOR: fixed, silver mica dielectric; 820 mmf. ±2%; 500 V d.c. working; bakelite case; wax impregnated; 1-1/16" long x 15/32" wide x 7/32" thick; axial leads	Coupling cond. 1st counter grid V301-2		60-10825231
C313	3D9082 / —— / ——	CAPACITOR: fixed, silver mica dielectric; 82 mmf. ±2%; 500 V d.c. working; bakelite case; wax impregnation; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Coupling 2nd counter and 1st counter osc. V301-2	Electromotive 603M	60-00825237
C314	3K2033143 / —— / ——	CAPACITOR: fixed, silver mica dielectric; 330 mmf. ±2%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	2nd counter V302-1 cathode condenser	Electromotive 603M	60-10335237
C315-1	3DKA250-53 / —— / ——	CAPACITOR: fixed, moulded paper dielectric; 0.25 mf. ±20%; 200 V d.c. working; bakelite case; wax impregnated; 1-7/16" long x 3/4" wide x 3/8" thick; axial leads	Cathode bypass 2nd counter osc. V301-3	Micamold 345-20	305-1241
C315-2		Same as C315-1	3rd counter diode circuit V301-3		
C315-3		Same as C315-1	Filter in grid of B fine delay V301-11		
C315-4		Same as C315-1	Filter in grid of B coarse delay V301-12		
C315-5		Same as C315-1	Cathode bypass of 6th counter osc. V301-6		
C316	3DK9100-17 / —— / ——	CAPACITOR: fixed, silver mica dielectric; 100 mmf. ±2%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	3rd counter coupling V301-3	Electromotive 603M	60-10105237
C317	3DA5-27 / —— / ——	CAPACITOR: fixed, mica dielectric; 5000 mmf. ±5%; 500 V d.c. working; bakelite case; wax impregnated; 53/64" long x 53/64" wide x 11/32" thick; axial leads	Bypass on cathode of V302-2	Electromotive 502L	60-20505314
C318	3K3015243 / —— / ——	CAPACITOR: fixed, silver mica dielectric; 1500 mmf. ±2%; 500 V d.c. working; bakelite case; wax impregnated; 53/64" long x 53/64" wide x 9/32" thick; axial leads	3rd counter storage cathode V302-2	Electromotive 602L	60-20155234

C319	3DK9075-13 —— ——	CAPACITOR; fixed, mica dielectric; 75 mmf. ±10%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Coupling V301-4 plate to 500 microseconds marker	Electromotive 503M	60-00755417
C320-1	3DKA500-27 —— ——	CAPACITOR: fixed, paper dielectric; .5 mf. +20% —10%; 600 V d.c. working; metal case; oil impregnated; 2–1/2" long x 1" wide x 7/8" thick; two lugs on top of case	3rd counter cathode bypass V301-4	Micamold 306	305-1216
C320-2		Same as C320-1	4th counter cathode bypass V301-5		
C320-3		Same as C320-1	Coupling amplitude balance circuit V303-1		
C320-4		Same as C320-1	Coupling trace separation cathode follower V301-8		
C320-5		Same as C320-1	Plate filter B delay Inverter V303-3		
C320-6		Same as C320-1	Output coupling pedestal gen. V301-15		
C321-1	3D9150-30 —— ——	CAPACITOR: fixed, silver mica dielectric; 150 mmf. ±2%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Coupling 4th counter V302-3 plate	Electromotive 603M	60-10155237
C321-2		Same as C321-1	Station selector shunt S304-A2		
C322	3K302043 —— ——	CAPACITOR: fixed, silver mica dielectric; 2000 mmf. ±2%; 500 V d.c. working; bakelite case; wax impregnated; 53/64" long x 53/64" wide x 9/32" thick, axial leads	Cathode cond. storage 4th counter V302-3 plate	Electromotive 602L	60-20205234
C323	3K2015122 —— ——	CAPACITOR: fixed mica dielectric; 150 mmf. ±5%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Coupling 5th counter trigger circuit V301-5	Electromotive 503M	60-10155317
C324-1	3K4010332 —— ——	CAPACITOR: fixed, mica dielectric; 0.01 mf. ±5%; 300 V d.c. working; bakelite case; wax impregnated; 1–1/32" long x 41/64" wide x 11/32" thick; axial leads	Grid coupling 5th counter osc. V301-5	Dubilier 3WLST	60-30103323
C324-2		Same as C324-1	Grid coupling 6th counter osc. V301-6		
C324-3		Same as C324-1	Grid coupling 6th counter osc. V301-6		
C325-1	3DKA30-16 —— ——	CAPACITOR: fixed, moulded paper dielectric; 0.03 mf. ±20%; 600 V d.c. working; bakelite case; wax impregnated; 1–7/16" long x 3/4" wide x 3/8" thick; axial leads	6th counter delay V301-6		305-1417
C325-2		Same as C325-1	B coarse delay circuit V301-12		
C325-3		Same as C325-1	6th counter plate filter		
C326	3K2047121 —— ——	CAPACITOR: fixed, mica dielectric; 470 mmf. ±10%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	E.J. sync. grid coupling V301-4	Electromotive 503M	60-10475417
C327-1		Same as C311-1	Coupling V301-7		
C327-2		Same as C327-1	Coupling V301-7		

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: INDICATOR ★ID-6B/APN-4**

Reference Symbol	British Ref. Number Army Stock Number Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
C328-2	3DA100-112 —— ——	CAPACITOR: fixed, moulded paper dielectric; 0.1 mf. ±20%; 400 V d.c. working; bakelite case; wax impregnated; 1-7/16" long x 3/4" wide x 3/8" thick; axial leads	Output coupling 6th counter osc. V301-6	Micamold 345-21	305-1086
C328-3		Same as C328-2	Coupling cathode follower V301-8 to C.R.T. V305		
C328-4		Same as C328-2	Coupling 10 micro-seconds marker amp. V303-2 to C.R.T. V305		
C328-5		Same as C328-2	Coupling video grid V301-10		
C328-6		Same as C328-2	Grid bias filter A delay V301-13		
C328-7		Same as C328-2	Hor. centering adj. by-pass V302-7		
C328-8		Same as C328-2	Hor. centering fixed by-pass V302-7		
C328-9		Same as C328-1	Input coupling sweep sync. V301-14		
C328-10		Same as C328-1	Input coupling sweep inverter V301-14		
C329	3K2022121 —— ——	CAPACITOR: fixed, mica dielectric; 220 mmf. ±10%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	C.R.T. grid by-pass V305	Electromotive 503M	60-10225417
C330	3D9075-1 —— ——	CAPACITOR: fixed, mica dielectric; 75 mmf. ±5%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Coupling, station selector circuit S304-B1 rotor	Electromotive 503M	60-00755317
C331	3DK9056-9 —— ——	CAPACITOR: fixed, silver mica dielectric; 56 mmf. ±5%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	3rd counter L.R. cathode coupling V302-5	Electromotive 603M	60-00565337
C332-1	3DK9045V-2 —— ——	CAPACITOR: variable; air dielectric; 7 to 45 mmf. ±1 mmf. 500 V a.c. working; over-all dimensions—15/16" x 41/64"; mounting dimensions—2 holes 0.120" D. 7/16" center to center	Station selector or shunt 304-A2	Erie TS2A	351-1048
C332-2		Same as C332-1	Station selector shunt S304-A2		
C332-3		Same as C332-1	Station selector shunt S304-A2		
C333-1	3D9091-4 —— ——	CAPACITOR: fixed, silver mica dielectric; 91 mmf. ±2%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Shunt on station selector S304-A2	Electromotive 603M	60-00915237

C333-2		Same as C333-1	Second counter sta. selector circuit		
C334	3D[illegible]024-1 —— ——	CAPACITOR: fixed, silver mica dielectric; 24 mmf. ±5%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Shunt S304-A2	Electromotive 603M	60-00245337
C335-1	3DA2.200-1 —— ——	CAPACITOR: fixed, mica dielectric; 2200 mmf. ±10%; 500 V d.c. working; bakelite case; wax impregnated; 53/64" long x 53/64" wide x 9/32" thick; axial leads	Cathode by-pass trace separation cathode follower V301-8	Electromotive 502L	60-20225414
C335-2		Same as C335-1	Grid by-pass V303-3 delay inverter		
C335-3		Same as C335-1	A delay to A delay sync. grid coupling V301-8		
C336-1	3K3562232 —— ——	CAPACITOR: fixed, mica dielectric; 6200 mmf. ±5%; 500 V d.c working; bakelite case; wax impregnated; 53/64" long x 53/64" wide x 11/32" thick; axial leads	Coupling of 50 and 500 microseconds marker input V301-6	Electromotive 502L	60-20625324
C336-2		Same as C336-1	Feedback cond. B fine delay V301-11		
C337-1	3K2010121 —— ——	CAPACITOR: fixed, mica dielectric; 100 mmf. ±10%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 8/32" thick, axial leads	Coupling pedestal mixer V301-9 to cathode V301-10	Electromotive 503M	60-10105417
C337-2		Same as C337-1	Coupling A delay sync plate V301-8		
C337-3		Same as C337-1	A delay mixer tube V303-3 grid coupling		
C337-4		Same as C337-1	A delay mixer tube V303-3 grid coupling		
C338-1	3K2015121 —— ——	CAPACITOR: fixed, mica dielectric; 150 mmf. ±10%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Cathode cond. V301-6	Electromotive 503M	60-10155417
C338-2		Same as C338-1	Coupling cond. E. J. sync to B coarse delay V301-12		
C339-1	3DKB2-13 —— ——	CAPACITOR: fixed; paper dielectric; 2 mf +20 —10%; 600 V d.c. working; metal case; oil impregnated; 2-3/4" long x 2" wide x 1-1/8" thick; two lugs on top of case	B fine delay plate filter V301-11	Sprague P-9068	305-1364
C339-2		Same as C339-1	B+ filter		
C340	3K2020121 —— ——	CAPACITOR: fixed, mica dielectric; 200 mmf. ±10%; 500 V d.c. working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Coupling input to B fine V301-11	Electromotive	60-10205417
C341-1	3DKA100-159 —— ——	CAPACITOR: fixed, paper dielectric; 0.1 mf. +20 —10%; 600 V d.c. working; metal case; oil impregnated; 2-1/2" long x 1" wide x 3/4" thick; two lugs top of case	Output circuit B coarse delay V301-12	Dubilier DYRT-6010-3	305-1215
C341-2		Same as C341-1	Sweep gen. screen		

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET *AN/APN-4 **MAJOR ASSEMBLY: INDICATOR *ID-6B/APN-4**

Reference Symbol	British Ref. Number / Army Stock Number / Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
C342-1	3DA50-42 —— ——	CAPACITOR: fixed, moulded paper dielectric; 0.05 mf. ±20%; 600 V d.c. working; bakelite case; wax impregnated; 1-7/16" long x 3/4" wide x 3/8" thick; axial leads	A delay circuit V301-13	Micamold 345-22	305-1033
C342-2		Same as C342-1	Sweep inverter output circuit V301-14		
C342-3		Same as C342-1	Sweep output circuit V304		
C343-1	3DA80-1 —— ——	CAPACITOR: multiple section; paper dielectric; oil filled; 0.06 x 0.1 mfd. +20% —10%; 1500 V d.c. working; metal case; 2-1/2" x 1-5/8" two lugs; top of case	C.R.T. grid coupling V305	Dubilier PC24040	305-1526
C343-2		Same as C343-1	CRT grid by-pass V302-6		
C344	3DKA500-108 —— ——	CAPACITOR: fixed, paper dielectric; .5 mf. ±10%; 2000 V d.c. working; metal case; oil impregnated; 3-3/4" long x 1-13/16" wide x 1-1/16" thick; 2 solder lugs	C.R.T. cathode by-pass V305	Dubilier T20005-2	305-1350
C345	3K3013222 —— ——	CAPACITORS: fixed, mica dielectric; 1300 mmf. ±5%; 500 V d.c. working; bakelite case; wax impregnated; 53/64" long x 53/64" wide x 9/32" thick; axial leads	Charging cond. sweep gen. V304 circuit	Electromotive 502L	60-20135314
C346	3K3022222 —— ——	CAPACITOR: fixed, mica dielectric; 2200 mmf. ±5%; 500 V d.c. working; bakelite case; wax impregnated; 53/64" long x 53/64" wide x 9/32" thick; axial leads	Pedestal gen. feed back cond	Electromotive 502L	60-20225314
I301	2Z5881-4 —— ——	LAMP: pilot; torpedo base; 3 volts; 0.19 amps T322 bulb	Illumination	Muter	354-1411
J301	2ZKK3010.11 —— ——	CONNECTOR: male, consisting of hex nut, brass; coaxial connector collar, steel (Yellow); three laminated bakelite washers; two lockwashers, steel; two hex nuts, brass; coaxial connector stud brass; soldering lug, phosphor bronze; threaded bushing, brass; 3 washers, steel; retaining clip, steel wire No. 18; over-all width of connector approx. 3/4" x 1-5/16" long	Amplifier balance	Amphenol 10H/528	358-2832
J302	2Z5531.3 —— ——	JACK: phone, tip, single circuit, open; contact washer insulated; mounting hole 0.312 diameter 15/16" x 7/16"	Pedestal output cathode V301-9	Amer. Rad. Hdwe. 358-4314	358-4314
J303	2ZK3010.4 —— ——	CONNECTOR: male, consisting of hex nut, brass; coaxial connector collar, steel (red) three laminated bakelite washers; two lockwashers, steel; two hex nuts, brass, coaxial connector, stud, brass; holding lug, phosphor bronze; threaded bushing, brass; 3 washers, steel; retaining clip, steel wire No. 18; over-all width of connector approx. 3/4" x 1-5/16" long	Video input (red) S303-B	Amphenol 10H/528	358-1266
J304	2Z7116.32 —— ——	CONNECTOR; plug, female, bakelite; 6 contacts; flange mounting type; mounting dimensions—four 3/16" D holes; 1-1/2" center to center	Voltage supply input	Amphenol 10H/394	358-7219

J305	2Z3010.4 —— ——	CONNECTOR: male, consisting of hex nut, brass, coaxial connector collar, steel (blue); three laminated bakelite washers; two lockwashers, steel; two hex nuts, brass, coaxial connector stud brass; holding lug, phosphor bronze; threaded bushing, brass; 3 washers, steel, retaining clip, steel wire No. 18; over-all width of connector approx. 3/4" x 1-5/16" long	Receiver gain (blue) R374	Amphenol 10H/528	358-1305
L301	3CK318-12 —— ——	COIL: crystal phasing choke; 68.5 mh; single pi winding; 1850 turns No. 38SSE wire; bakelite coil form 1-1/8" long x 1" O.D.; wax impregnated; d.c. resistance 215 ohms; lug mounting; 2 holes 5/32" diameter	100 KC osc. grid V301-1		352-1251
L301+	—— ——	COIL: osc. crystal phasing choke; 68.3 to 86 millihenries variable; universal wound; single winding 2520 turns No. 38SSE wire; bakelite coil form; wax impregnated; powdered iron adjustable core; cased; dimensions of con 3" h x 1-3/16" sq. over-all; 2 mtg. studs thrded 8-32; 7/8" mtg./C	100 KC osc. grid V301-1	Philco 352-1585	352-1585
L302	3C318-36 —— ——	COIL: R.F. filter choke; 12 mh; spool winding; 1675 turns No. 36 formex wire; coil form 27/32" long x 19/32" O.D.; varnish impregnated; d.c. resistance 75 ohms; lead mounting	5th counter delay		352-1477
R301	3RC318E103K —— ——	RESISTOR: fixed, metallized filament 19000 ohms; ±10%; 1 watt, insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Plate filter V301-1	I.R.C. BT-1	66-3104344
R302-1	3RC21BE105K —— ——	RESISTOR: fixed, metallized filament; 1 megohm; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3-1/6" diameter	Grid bias V301-1	I.R.C. BT-1/2	66-5103344
R302-2		Same as 302-1	Grid load V301-2		
R302-3		Same as 302-1	Plate isolation V301-6		
R302-4		Same as 302-1	Grid load V301-8		
R302-5		Same as 302-1	Grid load V301-9		
R302-6		Same as 302-1	Grid load V301-10		
R302-7		Same as 302-1	Grid load V303-3		
R302-8		Same as 302-1	Diode load V301-8		
R302-9		Same as 302-1	Cathode bias V301-14		
R303	2ZK7270.6 —— ——	POTENTIOMETER: 50,000 ohms ±20% carbon; special "D" taper; 1/2 watt; metal case 1-1/8" diameter x 1/2" deep; mounting bushing 3/8" long; threaded 3/8-32; shaft 1/8" long x 0.250" diameter	Phase shift V303-2	C.T.S. 35	353-5104
R304-1	3RC21BE104K —— ——	RESISTOR: fixed; metallized filament; 0.1 megohm; +10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Plate load V301-1	I.R.C. BT-1/2	66-4103344
R304-2		Same as R304-1	Plate grid load V301-4		
R304-3		Not used			
R304-4		Not used			
R304-5		Same as R304-1	Cathode load V301-8		
R304-6		Same as R304-1	Grid load V303-2		
R304-7		Same as R304-1	Grid load V303-2		

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: INDICATOR ★ID-6B/APN-4**

Reference Symbol	*British Ref. Number Army Stock Number Navy Stock Number*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or Standard Type*	*Cont. or Govt. Dwg. or Spec. No.*
R304-9		Same as R304-1	Grid load V301-12		
R304-10		Same as R304-1	Grid coupling V301-13		
R304-11		Same as R304-1	Plate divider V302-7		
R304-12		Same as R304-1	Plate load V301-14		
R304-13		Same as R304-1	Grid coupling V304		
R304-14		Same as R304-1	Grid load V301-15		
R305	3RC21BE333K —— ——	RESISTOR: fixed metallized filament; 33,000 ohms; ±10%; 1/2 watt; insulated axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid load V301-1	I.R.C. BT-1/2	66-3333344
R306-1	3RC21BE222K —— ——	RESISTOR: fixed metallized filament; 2200 ohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Cathode bias first counter V301-2	I.R.C. BT-1/2	66-2223344
R306-2		Not used			
R306-3		Same as R306-1	Plate filter V301-11		
R306-4		Same as R306-1	Cathode bias V303-3		
R306-5		Same as R306-1	B coarse divider network		
R307	3Z6650-141 —— ——	RESISTOR: fixed; wire wound; 50,000 ohms; ±3%; 1 watt; solder lug terminals; glyptol coating; dimensions 1" x 9/16"	Grid load V301-2	I.R.C. BT-1	353-1681
R308	3RC41BE223J —— ——	RESISTOR: fixed, metallized filament; 22,000 ohms; ±5%; 2 watts; insulated; axial leads; wax impregnated; 1-3/4" x 5/16" diameter	Grid bias divider V301-2	I.R.C. BT-2	66-3225244
R309-1	2ZK7262-10M-2 —— ——	POTENTIOMETER: 10,000 ohms; +30 —10%; wire wound; linear taper; 4 watts; metal case 1-9/32" diameter x 19/32" deep; mounting bushing 5/16" long, threaded 3/8-32; shaft 3/4" long x 0.250 diameter	First counter adjustment V301-2	C.T.S. 252	353-5096
R309-2		Same as R309-1	Third counter adjustment V301-3		
R309-3		Same as R309-1	Fourth counter adjustment V301-5		
R309-4		Same as R309-1	Sixth counter adjustment V301-6		
R309-5		Same as R309-1	B fine delay V301-11		
R309-6		Same as R309-1	Coarse adjustment V301-12		
R310	3RC21BE272K —— ——	RESISTOR: fixed, metallized filament; 2700 ohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Damping second counter V301-3	I.R.C. BT-½	66-2273344

R311-1	3RC31BE223J —— ——	RESISTOR: fixed, metallized filament; 22,000 ohms; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Cathode bias V301-3	I.R.C. BT-1	66-3224244
R311-2		Same as R311-1	Plate load V301-11		
R311-3		Same as R311-1	Plate load V301-11		
R311-4		Same as R311-1	Plate load V301-12		
R311-5		Same as R311-1	Plate load V301-12		
R311-6		Same as R311-1	Plate load V301-13		
R311-7		Same as R311-1	Plate load V301-13		
R312	3RC41BE473J —— ——	RESISTOR: fixed, metallized filament; 47,000 ohms; ±5%; 2 watt; insulated; axial leads; wax impregnated; 1-3/4" x 5/16" diameter	Cathode bias divider V301-4	I.R.C. BT-2	66-3475244
R313-1	3RC31BE822J —— ——	RESISTOR; fixed metallized filament; 8200 ohms; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1-¼" x ¼"	Divider cathode D	I.R.C. BT-1	66-2824244
R313-2		Same as R313-1	E.J. cathode		
R314	3RC41BE333J —— ——	RESISTOR; fixed metallized filament; 33,000 ohms; ±5%; 2 watt; insulated; axial leads; wax impregnated; 1-3/4" x 5/16" dia.	Cathode bias V301-5	I.R.C. BT-2	66-3335244
R315-1	3RC41BE153K —— ——	RESISTOR; fixed metallized filament; 15,000 ohms; ±5%; 2 watt; insulated; axial leads; wax impregnated; 1-¾" x 5/16" diameter	Cathode bias divider V301-5	I.R.C. BT-2	66-3155244
R315-2		Same as R315-1	Grid bias divider V301-6		
R316-1	3Z679J9 —— ——	RESISTOR; fixed, wire wound; 0.399 megohms; ±3%; 1 watt; solder lug terminals; glyptol coating; dimensions 1" x 9/16"	Grid load V301-5	I.R.C. BT-1	353-1887
R316-2		Same as R316-1	Grid load V301-6		
R316-3		Not used			
R316-4		Same as R316-1	Grid load V301-6		
R-319	3RC41BE103J —— ——	RESISTOR: fixed, metallized filament; 10,000 ohms; ±5%; 2 watts; insulated; axial leads; wax impregnated; 1-¾" x 5/16" diameter	Bias dropping V310-6	I.R.C. BT-2	66-3105244
R320	3RC31BE152J —— ——	RESISTOR; fixed metallized filament; 1500 ohms; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1-¼" x ¼" diameter	Grid bias	I.R.C. BT-1	66-2154244
R321		Not used			
R322	2Z7280-91 —— ——	POTENTIOMETER; 10,000 ohms; ±20%; wire wound; linear taper; 4 watts; metal case 1-9/32" diameter x 19/32" deep; mounting bushing 5/16" long, threaded ⅜-32; shaft 7/16" long x 0.250 diameter	Sixth counter adjustment V301-6	C.T.S. 252	353-5226
R323		Not used			
R324	3RC31BE564K —— ——	RESISTOR; fixed metallized filament; 0.56 megohms; ±10%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	Cathode bias V301-4	I.R.C. BT-1/2	66-4563344
R325-1	3RC21BE104J —— ——	RESISTOR; fixed, metallized filament; 0.1 megohm; ±5%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" dia	Grid load V301-7	I.R.C. BT-1/2	66-4103244

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET *AN/APN-4 **MAJOR ASSEMBLY: INDICATOR *ID-6B/APN-4**

Reference Symbol	*British Ref. Number / Army Stock Number / Navy Stock Number*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or Standard Type*	*Cont. or Govt. Dwg. or Spec. No.*
R326-1	3RC21BE394J —— ——	RESISTOR; fixed, metallized filament; 0.39 megohms; ±5%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" dia	Grid bias network V301-7	I.R.C. BT-1/2	66-4393244
R326-2		Same as R326-1	Grid bias network V301-7		
R326-3		Not used			
R326-4		Not used			
R326-5		Not used			
R326-6		Same as R366-1	Grid load V301-6		
R327-1		Not used			
R327-2	3RC31BE104K —— ——	RESISTOR; fixed metallized filament; 1 megohm; ±10%; 1 watt; insulated; axial leads; wax impregnated; 1–¼" x ¼" diameter	Plate divider network V302-6	I.R.C. BT-1	66-4104344
R328-1	3RC31BE393J —— ——	RESISTOR; fixed metallized filament; 39,000 ohms; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1–¼" x ¼" diameter	Plate load V301-7	I.R.C. BT-1	66-3394244
R328-2		Same as R328-1	Plate load V301-7		
R328-3		Same as R328-1	Plate load V301-15		
R329	2ZK7262-10M-2 —— ——	POTENTIOMETER; 5000 ohms; ±20%; wire wound; linear taper; 4 watts; metal case 1-9/32" diameter x 19/32" deep; mounting bushing ⅜" long, threaded ⅜–32; shaft ½" long x 0.250" diameter	Cathode bias V301-7	C.T.S. 252	353-5098
R330-1	3RC21BE106K —— ——	RESISTOR; fixed metallized filament; 10 megohms; ±10%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" dia	Left right switch V302-2	I.R.C. BT-½	66-6103344
R330-2		Same as R330-1	Diode load V302-7		
R330-3		Same as R330-1	Diode load V302-7		
R331	3RC21BE184K —— ——	RESISTOR; fixed metallized filament; 0.22 megohm; ±5%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" dia	Grid bias V302-2	I.R.C. BT-1/2	66-4223244
R332-1	3RC21BE124J —— ——	RESISTOR; fixed metallized filament; 0.12 megohms; ±5%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" dia	Cathode bias V302-2	I.R.C. BT-1/2	66-4123244
R332-2		Same as R332-1	Grid coupling sweep speed switch, contact #4		
R333-1	3RC21BE154K —— ——	RESISTOR: fixed; metallized filament; 0.15 megohm; ±10%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" dia	Grid coupling V303-1	I.R.C. BT-1/2	66-4153344
R333-2		Same as R333-1	Grid coupling V303-1		
R334-1	3RC21BE474K —— ——	RESISTOR; fixed metallized filament; 0.47 megohms; ±10%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" dia	Cathode bias V303-1	I.R.C. BT-1/2	66-4473344

R334-2		Same as R334-1	Cathode bias V303-2		
R334-3		Same as R334-1	Vertical center divider network V303		
R334-4		Same as R334-1	Plate load V302-7		
R334-5		Same as R334-1	Cathode bias network V301-6		
R335	2ZK7262-500M.5 —— ——	POTENTIOMETER; 0.5 megohms; ±20%; carbon; special "D" taper; ½ watt; metal case 1-⅛" diameter x ½" deep; mounting bushing 5/16" long, threaded ⅜-32; shaft ⅜" long x 0.250" diameter	Amplitude balance V303-1	C.T.S. 35	353-5100
R336-1	2ZK7262-500M.4 —— ——	POTENTIOMETER: ±0.5 megohms; ±20%; carbon; special "D" taper; ½ watt; metal case 1-⅛" diameter x ½" deep; mounting bushing ⅜" long, threaded ⅜-32; shaft length ⅛" long x 0.250" diameter	Trace separation V303-1	C.T.S. 35	353-5079
R336-2		Same as R336-1	Trace separation V303-1		
R336-3		Same as R336-1	Trace separation V303-1		
R337-1	3RC21BE224K —— ——	RESISTOR; fixed metallic filament; 0.22 megohms; ±10%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	Plate decoupling V301-8	I.R.C. BT-½	66-4223344
R337-2		Same as R337-1	Vertical center divider network V303		
R337-3		Same as R337-1	Plate feedback V301-14		
R338	3RC21BE274K —— ——	RESISTOR; fixed metallized filament; 0.27 megohms; ±10%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	Plate load V303-2	I.R.C. BT-½	66-4273344
R339-1	3RC21BE473K —— ——	RESISTOR; fixed metallized filament; 47,000 ohms; ±10%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	Cathode bias V301-9	I.R.C. BT-1/2	66-3473344
R339-2		Same as R339-1	Grid coupling V303-3		
R340-1	3RC318BE472J —— ——	RESISTOR; fixed metallized filament; 4700 ohms; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1-¼" x ¼" diameter	Plate load V301-9	I.R.C. BT-1/2	66-2474244
R340-2		Same as R340-1	Plate load V301-9		
R341	3RC21BE102J —— ——	RESISTOR; fixed metallized filament; 1000 ohms; ±5%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	Cathode bias V301-9	I.R.C. BT-1/2	66-2103244
R342-1	3RC21BE332K —— ——	RESISTOR; fixed metallized filament; 3300 ohms; ±10%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	Marker load V301-6	I.R.C. BT-1/2	66-2333344
R342-2		Same as R342-1	B Coarse delay divider network		
R343	3RC21BE333J —— ——	RESISTOR; fixed metallized filament; 33,000 ohms; ±5%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	Cathode bias V301-6	I.R.C. BT-1/2	66-3333244
R344-1	3RC21BE105J —— ——	RESISTOR; fixed metallized filament; 1 megohm; ±5%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 5/16" diameter	Cathode bias divider V301-6	I.R.C. BT-1/2	66-5103244
R344-2		Same as R344-1			

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: INDICATOR ★ID-6B/APN-4**

Reference Symbol	*British Ref. Number Army Stock Number Navy Stock Number*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or Standard Type*	*Cont. or Govt. Dwg. or Spec. No.*
R345-1	3RC21BE152J —— ——	RESISTOR; fixed metallized filament; 1500 ohms; ±5%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" dia	Cathode bias V301-10	I.R.C. BT-1/2	66-2153244
R345-2		Same as R345-1	Sweep speed; marker switch tap #6		
R345-3		Same as R345-1	Damping plate circuit V301-5		
R346-1	3RC31BE103J —— ——	RESISTOR; fixed metallized filament; 10,000 ohms; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1-¼" x ¼" dia	Cathode bias V301-11	I.R.C. BT-1	66-3104244
R346-2		Same as R346-1	Cathode bias V301-12		
R346-3		Same as R346-1	Cathode bias V301-13		
R347	3RC31BE154J —— ——	RESISTOR; fixed metallized filament; 0.15 megohm; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1-¼" x ¼" dia	Grid dropping network V301-11	I.R.C. BT-1	66-4154244
R348-1	2Z7269.112 —— ——	POTENTIOMETER; 10,000 ohms; ±20%; carbon; special "D" taper; 2 watt; metal case 1-⅛" diameter x ½" deep; mounting bushing ⅜" long, threaded ⅜-32; shaft ⅛" long x 0.250" diameter	B fine adjustment V301-11	C.T.S. 35	353-5216
R348-2		Same as R348-1	B coarse adjustment V301-12		
R349-1	3RC21BE153K —— ——	RESISTOR; fixed metallized filament; 15,000 ohms; ±10%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	Cathode bias V301-6	I.R.C. BT-1/2	66-3153344
R349-2		Same as R349-1	Bias network V301-11		
R350-1	3RC21BE472K —— ——	RESISTOR; fixed metallized filament; 4700 ohms; ±10%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	B fine delay divider network	I.R.C. BT-1/2	66-2473344
R350-2		Same as R350-1	Filter delay inverter V303-3		
R350-3		Same as R350-1	Grid load V303-3		
R351-1	2ZK7262-100M.2 —— ——	POTENTIOMETER; 0.15 megohms; ±20%; carbon; special "D" taper; ½ watt; metal case 1⅛" diameter x ½" deep; mounting bushing ⅜" long, threaded ⅜-32; shaft ⅛" long x 0.250" diameter	B fine adjustment V301-11	C.T.S. 35	353-5078
R351-2		Same as R351-1	B coarse adjustment V301-12		
R351-3		Same as R351-1	Plate decoupling V301-15		
R352	3RC31BE223K —— ——	RESISTOR; fixed metallized filament; 22,000 ohms; ±10%; 1 watt; insulated; axial leads; wax impregnated; 1-¼" x ¼" diameter	Plate load V303-13	I.R.C. BT-1	66-3224344

R353-1	3RC21BE395J	RESISTOR; fixed metallized filament; 3.9 megohms; ±5%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid bias V301-12	I.R.C. BT-1/2	66-5393244
R353-2		Same as R353-1	Grid bias V301-13		
R354	3RC21BE334K	RESISTOR: fixed metallized filament; 0.33 megohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid coupling V301-12	I.R.C. BT-1/2	66-4333344
R355-1	3RC21BE393K	RESISTOR; fixed metallized filament; 39,000 ohms; ±10%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	Coupling V301-7 to V301-12	I.R.C. BT-1/2	66-3393344
R355-2		Same as R355-1	Coupling V301-7 to V303-1		
R355-3		Same as R355-1	Plate load V301-15		
R356	3RC31BE104J	RESISTOR; fixed metallized filament; 0.1 megohm; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1–¼" x ¼" diameter	Grid bias divider network V301-12	I.R.C. BT-1	66-4104244
R357-1	3Z6003C3-12	RESISTOR; fixed; wire wound; 33 ohms; ±10%; ½ watt; axial leads; wax impregnated; ⅝" x 3/16" diameter	B coarse delay station selector switch contact #6	I.R.C. BT-1/2	66-0333364
R357-2		Same as R357-1	B coarse delay station selector switch contact #7		
R357-3		Same as R357-1	B coarse delay station selector switch contact #6		
R357-4		Same as R357-1	B coarse delay station selector switch contact #5		
R357-5		Same as R357-1	B coarse delay station selector switch contact #4		
R357-6		Same as R357-1	B coarse delay station selector switch contact #3		
R357-7		Same as R357-1	B coarse delay station selector switch contact #2		
R357-8		Same as R357-1	Tap #3 on T303		
R357-9		Same as R357-1	Tap #4 on T303		
R358	3RC31BE274J	RESISTOR; fixed metallized filament; 0.27 megohms; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1–¼" x ¼" diameter	Grid bias network V301-13	I.R.C. BT-1	66-4274244
R359	3RC21BE393J	RESISTOR; fixed metallized filament; 39,000 ohms; ±5%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid divider bias network V301-13	I.R.C. BT-½	66-3393244
R360-1	3RC21BE184K	RESISTOR; fixed metallized filament; 0.18 megohms; ±5%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	Grid load V301-13	I.R.C. BT-½	66-4183344
R360-2		Same as R360-1	Plate coupling V304 to V301-14		

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET *AN/APN-4 **MAJOR ASSEMBLY: INDICATOR *ID-6B/APN-4**

Reference Symbol	British Ref. Number / Army Stock Number / Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
R361-1	3RC31BE473K / —— / ——	RESISTOR; fixed metallized filament; 47,000 ohms; ±10%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Plate load V303-3	I.R.C. BT-1	66-3474344
R361-2		Same as R361-1	Plate load V304		
R361-3		Same as R361-1	Screen dropping V304		
R362-1	3RC21BE475K / —— / ——	RESISTOR; fixed metallized filament; 4.7 megohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid bias V302-6	I.R.C. BT-1/2	66-5473344
R362-2		Same as R362-1	Vertical deflection plate V305		
R362-3		Same as R362-1	Vertical deflection plate V305		
R362-4		Same as R362-1	Grid bias V301-9		
R363-1	2ZK7296-1000M.2 / —— / ——	POTENTIOMETER: 1 megohm; ±20%; carbon; special "D" taper; 1/2 watt; metal case 1-1/8" diameter x 1/2" deep; mounting bushing 3/8" long, threaded 3/8-32; shaft 2-1/4" long x 0.250" diameter	Brilliance control V305	I.R.C. 35	353-5099
R363-2		Same as R363-1	Focus V305		
R364	3RC31BE399K / —— / ——	RESISTOR; fixed metallized filament; 0.39 megohms; ±10%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Intensity divider V302-6	I.R.C. BT-1	66-4394344
R365-1	3RC31BE474K / —— / ——	RESISTOR; fixed metallized filament; 0.47 megohms; ±10%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Focus control shunt V302-6	I.R.C. BT-1	66-4474344
R365-2		Same as R365-1	Focus control dropping V302-6		
R365-3		Same as R365-1	Focus control dropping V302-6		
R366-1	2ZK7269-1000M.1 / —— / ——	POTENTIOMETER; 1 megohm; ±20%; carbon; special "D" taper; 1/2 watt; metal case 1-1/8" diameter x 1/2" deep; mounting bushing 3/8" long, threaded 3/8-32; shaft 1/8" long x 0.250" diameter	Auxiliary focus V305	C.T.S. 35	353-5077
R366-2		Same as R366-1	Vertical center V305		
R366-3		Same as R366-1	Horizontal center V302-7		
R366-4		Same as R366-1	Fast sweep amplitude S303-G		
R366-5		Same as R366-1	Medium sweep amplitude S303-G		
R366-6		Same as R366-1	Slow sweep amplitude S303-G		

R367-1	3RC21BE225K —— ——	RESISTOR; fixed metallized filament; 2.2 megohms; ±10%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	Diode load V301-14	I.R.C. BT-½	66-5223344
R367-2		Same as R367-1	Grid load V301-14		
R368	3RC21BE273J —— ——	RESISTOR; fixed metallized filament; 27,000 ohms; ±5%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	Grid bias divider V304	I.R.C. BT-½	66-3273244
R369	3RC21BE225J —— ——	RESISTOR; fixed metallized filament; 2.2 megohms; ±5%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	Grid dropping network V304	I.R.C. BT-½	66-5223244
R370	3RC21BE155K —— ——	RESISTOR; fixed metallized filament; 1.5 megohms; ±10%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	Diode load V301-10	I.R.C. BT-½	66-5153344
R371	3ZK6560-14 —— ——	RESISTOR; fixed metallized filament; 6000 ohms; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1–¼" x ¼" diameter	Cathode bias V301-15	I.R.C. BT-1	66-2604244
R372	3RC21BE824J —— ——	RESISTOR: fixed metallized filament; 0.82 megohms; ±5%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	Grid coupling V301-15	I.R.C. BT-½	66-4823244
R373	3RC21BE155J —— ——	RESISTOR; fixed metallized filament; 1.5 megohm; ±5%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	Grid bias divider network V301-15	I.R.C. BT-½	66-5153244
R374	2Z7280-71 —— ——	POTENTIOMETER; 3000 ohms; ±20%; wire wound; linear taper; 4 watts; metal case 1-9/32" diameter x 19/32" deep; mounting bushing 5/16" long, threaded 3/8–32; shaft 11/16" long x 0.250" diameter	Receiver gain J305	C.T.S. 252	353-5214
R375	3RC21BE471K —— ——	RESISTOR; fixed metallized filament; 470 ohms; ±10%; ½ watt; insulated; axial leads; wax impregnated; ⅝" x 3/16" diameter	Cathode bias V301-14 (Section B)	I.R.C. BT-½	66-1473344
R376	3Z6002-45 —— ——	RESISTOR; fixed; wire wound; 20 ohms; ±10%; 1 watt; axial leads; wax impregnated; 1–¼" x ¼" diameter	Dial light series dropping resistor	I.R.C. BT-1	66-0204340
R377	3Z7277.66 —— ——	POTENTIOMETER; 75 ohms; ±20%; wire wound; linear taper; 2 watts; metal case 1–⅛" diameter x 9/16" deep; mounting bushing 5/16" long, threaded ⅜–32, shaft 11/16" long x 0.250" diameter	Dial light I301 brilliance	C.T.S. 2252	353-5229
S301	3Z9580-10.1 —— ——	SWITCH; left-right; 9 contacts, 3 position bakelite insulation; overall dimensions 1–½" x 1⅞" x 7/16"; mounting dimensions two 0.144 D holes; 1.625" center to center	Left-right	Centralab N7344X	452-1226
S302	3Z9859-19.1 —— ——	SWITCH: toggle; double pole; double throw; bakelite insulation; overall dimensions 1–5/16" x ¾" x 25/32"; mounting dimensions 15/32" hole	Hi-Lo	C-H 8825-K2	452-1228
S303 ABCD	3Z9825-75.3 —— ——	SWITCH; selector; 5 sections; 12 contacts; bakelite insulation; overall dimensions 3½" x 1–⅞" diameter; shaft 3–13/16" long x 0.250" diameter; mounting dimensions ⅜" hole	Sweep speed	OAK 27009-H3	452-1224
S303 EFG	3Z9825-75.4 ——	SWITCH; selector; 5 sections; 12 contacts; bakelite insulation; overall dimensions 2–3/16" x 1–9/16"; shaft 8–13/32" long x 0.250" diameter; mounting dimensions ⅜" hole	Sweep speed	OAK 27008-H3	452-1222

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET *AN/APN-4 **MAJOR ASSEMBLY: INDICATOR *ID-6B/APN-4**

Reference Symbol	British Ref. Number / Army Stock Number / Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
S304	3Z9825-75.2 —— ——	SWITCH; selector; 5 sections; 12 contacts; bakelite insulation; overall dimensions 1-3/8" x 1-7/8"; mounting dimensions 3/8" hole; shaft 2¼" long x 0.250" diameter	Station selector	OAK 27106-H3	
T301	2C1565-6B/C1 —— ——	TRANSFORMERS; osc.; 100KC; primary—320 turns of #32 wire; S.N.E. 1150 mh; secondary—140 turns #32 wire; S.N.E. 330 mh; bakelite coil form 2" long x ½" diameter; wax impregnated; metal case; mounted on shelf	100K osc. plate V301-1		358-8598
T302-1	2Z9638-19 —— ——	TRANSFORMER; counter; primary; 214 turns of #37 wire; enameled; 22 ohms d.c. resistance ±15%; secondary 292 turns of #37 wire; enameled; 33 ohms d.c. resistance ±15%; leakage between either winding or winding and case greater than 10,000 megohms; laminated core; mounting dimensions 2-3/8" long x 1-3/8" wide x 1-21/32" thick; steel case; two mounting holes 0.187" D., 2" center to center	1st counter	Miagnetic 1-418R	352-7224
T302-2		Same as T302-1	2nd counter		
T302-3		Same as T302-1	3rd counter		
T302-4		Same as T302-1	4th counter		
T302-5		Same as T302-1	5th counter		
T302-6		Same as T302-1	6th counter		
T303	2Z9617-30 —— ——	TRANSFORMER: filament; primary 2 terminals; 80 V. A. C. ; 400 to 2400 cycles; secondary 2 terminals; 6.8 V.A.C.; 15 amperes; secondary 2 terminals; 6.3 V.A.C.; 0.9 ampere; six solder termina; steel case; overall dimensions 2-7/16" x 2-½" x 2¼"; mounting flange 3" x 2½"; 6 holes 3/16" diameter; 7/8" x 2-11/16" center to center	Heater supply tubes	Miagnetic 1-417R	352-7198
V301-1	#	VACUUM TUBE; Type 6SN7GT; twin triode; octal base	100 KC osc. & limiter	Kenrad 6SN7GT	354-1321
V301-2	——	Same as V301-1	Trigger; first counter		
V301-3	——	Same as V301-1	2nd, 3rd counters		
V301-4		Same as V301-1	3rd counter E-J sync		
V301-5		Same as V301-1	4th, 5th counters		
V301-6		Same as V301-1	6th counter		
V301-7		Same as V301-1	E-J osc		
V301-8		Same as V301-1	Trace separation A delay sync		
V301-9		Same as V301-1	Pedestal, marker, mixer		
V301-10		Same as V301-1	Video, input leveler		
V301-11		Same as V301-1	B fine delay		
V301-12		Same as V301-1	B coarse delay		
V301-13		Same as V301-1	A delay		
V301-14		Same as V301-1	Switch sync		
V301-15		Same as V301-1	Ped. generator		

V302-1	#	VACUUM TUBE; Type 6H6GT; twin diode, octal base	Second counter diode		354-1331
V302-2	——	Same as V302-1	Left-right diode		
V302-3	——	Same as V302-1	4th counter diode		
V302-4		Same as V302-1	2nd counter feedback		
V302-5		Same as V302-1	3rd counter feedback		
V302-6		Same as V302-1	CR tube blanking		
V302-7		Same as V302-1	Sweep leveler		
V303-1	#	VACUUM TUBE; Type 6SL7GT; twin triode; octal base	Amplifier balance	Kenrad 6SL7GT	354-1307
V303-2	—— ——	Same as V303-1	10 MS marker amplifier		
V303-3		Same as V303-1	B delay inverter V303-3		
V304	# —— ——	VACUUM TUBE; Type 6SJ7GT; pentode; octal base	Sweep generator		354-1330
V305	# —— ——	VACUUM TUBE; Type 5CP1; cathode ray; 14 contact; flush mounting	CR tube		354-1361
X301	2ZK8761-16 —— ——	SOCKET; crystal holder; low loss bakelite; wax impregnated; 3 receptacle; flange mounting; mounting dimensions—two 0.156" D holes 1.875 center to center	Crystal holder V301-1	Cinch 4033WI	257-6072
X302-1	2Z8650.1 —— ——	SOCKET; tube; phenolic; wax impregnated; 8 receptacles; flange mounting; mounting dimensions—two 0.140" D holes 1.312 center to center	Octal socket		257-6041
X302-2		Same as X302-1			
X302-3		Same as X302-1			
X302-4		Same as X302-1			
X302-5		Same as X302-1			
X302-6		Same as X302-1			
X302-7		Same as X302-1			
X302-8		Same as X302-1			
X302-9		Same as X302-1			
X302-10		Same as X302-1			
X302-11		Same as X302-1			
X302-12		Same as X302-1			
X302-13		Same as X302-1			
X302-14		Same as X302-1			
X302-15		Same as X302-1			
X302-16		Same as X302-1			
X302-17		Same as X302-1			
X302-18		Same as X302-1			
X302-19		Same as X302-1			
X302-20		Same as X302-1			
X302-21		Same as X302-1			
X302-22		Same as X302-1			
X302-23		Same as X302-1			
X302-24		Same as X302-1			
X302-25		Same as X302-1			

Not in base spares

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET *AN/APN-4 — MAJOR ASSEMBLY: INDICATOR *ID-6B/APN-4

Reference Symbol	British Ref. Number Army Stock Number Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
X302-26		Same as X302-1			
X303	2Z8684-14 —— ——	SOCKET; tube; mica filled bakelite; 14 contacts; flush mounting type; mounting dimensions—1-1/8" x 2.219"	CR tube		257-6120
X304	# —— ——	SOCKET; pilot; brass; 0.015 phosphor bronze contact spring, silver plated; screw mounting 0.187 D; 3/8-32 thread; mounting dimensions 13/16" x 1-1/8"	Dial light		756-1039
Y301	2ZK3502-100 —— ——	CRYSTAL; 100 KC; 3 prongs; overall dimensions 2-11/16" x 1-19/32" x 1-3/16"	Frequency determining standard	Philco 455-1040	455-1040

MODEL: RADIO SET *AN/APN-4 — MAJOR ASSEMBLY: INDICATOR *ID-6B/APN-4 MISCELLANEOUS

Reference Symbol	British Ref. Number Army Stock Number Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
	2Z9422.9 —— ——	BOARD, TERMINAL; bakelite; wax impregnated; 5" x 1-3/8" x 3/32"; double row of solder lug terminals; 13 in one, 11 in other; 2 terminals are molded; 2 steel angle mounting brackets, cadmium plate; 1-1/4" x 5/16" x 1/16"; 2 mounting holes tapped #6-32; 3" center to center	Wiring purposes left rear chassis	Cinch 9163W1	358-8553
	2Z9424-11 —— ——	BOARD, TERMINAL; bakelite; wax impregnation; 5-3/4" x 1-3/8" x 3/32"; double row of solder lug terminals; 15 in one; 13 in other; 4 are molded terminals; 2 steel angle mounting brackets; cadmium plated; 1-1/4" x 5/16" x 3/32"; mounting holes tapped #6-32; 3" center to center	Wiring purposes right center chassis	Cinch 9133W1	358-8555
	2Z9427 —— ——	BOARD, TERMINAL; bakelite; wax impregnated; 5-3/4" x 1-3/8" x 3/32"; double row of solder lug terminals, 15 in one, 13 in other, one terminal is molded; 2 steel angle mounting brackets, cadmium plated; 1-1/4" x 5/16" x 1/16"; 2 mounting holes tapped #6-32; 3" center to center	Wiring purposes left center chassis	Cinch 9128W1	358-8552
	2Z9420.15 —— ——	BOARD, TERMINAL; bakelite; wax impregnated; 5" x 1-3/8" x 3/32"; double row of solder lug terminals; 13 in one, 11 in other; 4 are molded terminals; 2 steel angle mounting brackets, cadmium plate 1-1/4" x 5/16" x 3/32", 2 mounting holes, tapped #6-32; 3" center to center	Wiring purposes left front chassis	Cinch 9131W1	358-8551
	2Z9418.25 —— ——	BOARD, TERMINAL; bakelite; wax impregnated; 3-7/8" x 1-3/8" x 3/32"; double row of solder lug terminals, 8 in one, 10 in other; 3 0.156 D mounting holes in horizontal plane 1-1/8" center to center (Used in ID-6B/APN-4 only)	Wiring purposes left shelf rear	Cinch 9162W1	358-8537
	2Z9403-81 —— ——	BOARD, TERMINAL; bakelite; wax impregnated; 1-3/4" x 1-7/8" x 3/32"; 3 solder lug terminals; 2 steel, angle mounting brackets; zinc plate; 1-1/4" x 5/16" x 1/16"; 2 mounting holes tapped #6-32; 1.25" center to center	Wiring purposes left shelf bottom	Cinch 9096W1	358-8539
	2Z9424-12 —— ——	BOARD, TERMINAL; bakelite; wax impregnated; 4-1/2" x 1-3/8" x 3/32"; double row of 12 solder lug terminals each; 2 0.156 D mounting holes in horizontal plane 3" center to center	Wiring purposes left shelf front	Cinch 9161WJ	358-8536

2Z9418.24	BOARD, TERMINAL; bakelite; wax impregnated; 3-½" x 1-⅜" x 3/32"; double row of 9 solder lug terminals each; 2 0.156 D mounting holes in horizontal plane; 1.875" center to center	Wiring purposes right shelf front	Cinch 9103W1	358-8540
	BOARD, TERMINAL; 2 copper solder lug terminals, one terminal grounded; ⅝" lg x ⅞" h; paper base bakelite; 0.144" diam. mtg. hole through ground lug, right angle mtg (Used on ID-6B/APN-4 only)	Mtg. and wiring	Philco 358-7935	358-7935
	BOARD, TERMINAL; 3 copper solder lug terminals, center terminal grounded; 1-⅜" lg x ⅞" h; cloth base bakelite; 0.144" diam. mtg. hole through ground lug; right angle mtg	Mtg. and wiring	Philco 358-4024	358-4024
	BOARD, TERMINAL: 12 copper solder lug terminals, 2-3/8" x 1-3/8" x 3/32"; bakelite; two 0.156" diam. mtg. holes, 1.500" mtg./C	Mtg. and wiring	Philco 358-5663	358-5663
2Z9416.32	BOARD, TERMINAL: bakelite; wax impregnated; 3-3/8" x 1-7/8" x 7/32"; double row of solder lug terminals, 7 in one, 9 in other; 2 steel angle mounting brackets, zinc plate; 5/16" x 1-¼" x 1/16"; 2 mounting holes tapped #6-32; 3 inches center to center	Wiring purposes top front chassis	Cinch 9099W1	358-8544
2Z9409.27	BOARD, TERMINAL; bakelite; wax impregnated; 1-¾" x 1-⅞" x 3/32"; 8 solder lug terminals; 8 0.101 D holes adjacent to solder lug terminals; Cinch lug bent 90° mounted in center of panel on top edge of mounting bracket; 2 steel angle mounting brackets; cadmium plated; 1-⅝" x 5/16" x 1/16"; 2 mounting holes tapped #6-32; 17/32" center to center	Wiring purposes	Cinch 9125W1	358-8318
2Z9423.2	BOARD, TERMINAL; bakelite; wax impregnated; 5" x 1-⅜" x 3/32"; double row of solder lug terminals; 13 in one, 11 in other; 1 terminal is molded; 2 steel angle mounting brackets; cadmium plate; 1-¼" x 5/16" x 1/16"; 2 mounting holes tapped #6-32; 3" center to center	Wiring purposes right front chassis	Cinch 9130W1	358-8554
2Z9419-6	BOARD, TERMINAL; bakelite; wax impregnated; 5" x 1-⅜" x 3/32"; double row of solder lug terminals; 13 in one, 11 in other; 5 are molded terminals; 2 steel angle mounting brackets; cadmium plated; 1-¼" x 5/16" x 3/32"; mounting holes tapped #6-32; 3" center to center	Wiring purposes right rear chassis	Cinch 9165W1	358-8556
2Z9426-5	BOARD, TERMINAL; 26 copper solder lug terminals; 4-⅞" x 1-⅜" x 3/32"; bakelite; two 0.156" diam. mtg. holes, 2-⅝" mtg./C. Symbolized for capacitors and resistor positions	Mtg. and wiring	Philco 358-5635	358-5635
	CLAMP; steel; consists of base bracket and clinch nuts. Bracket 1-5/64" radius bend with clinch nuts on each end, 2-11/16" center to center; base spot welded to bracket with 0.156" mtg. holes, one slotted, on 2-11/16" mtg./C; 51/64" above clinch nuts	Lower C.R. tube clamp	Philco	358-8487
	CLAMP; steel; 3" bracket with 1-1/16" radius bend, ½" wide; two 0.156" mtg. holes, 2-11/16" center to center	Upper C.R. tube clamp	Philco 258-4111	258-4111
	CLAMP; steel; 1-27/32" lg x 5/16" wd; rounded ends; two 0.171" holes, 1.343" center to center and two 0.047" holes 1-23/32" center to center	Crystal holddown	Philco 258-8075	258-8075

* Not in base spares

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: INDICATOR ★ID-6B/APN-4 MISCELLANEOUS**

Reference Symbol	British Ref. Number / Army Stock Number / Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
	# —— ——	CLAMP; upper bracket has 1.078 R. curve; 3–1/32″ long x ½″ wide x 0.0598; steel; 2 holes in outer ends 0.156″ diameter; zinc plate; eronak treatment	C.R. tube support	Philco 258-7973	258-7973
	# —— ——	CLAMPING FOOT; yellow brass; black nickle finish; 1–1/32″ x 7/16″ x 3/32″; 2 holes 0.144″ diameter spaced 0.375″ center to center; foot extends 6/32″	C.R. tube	Philco	258-1203
		CLIP, tube contact; as supplied by Cinch Mfg. Co.	High voltage anode connection	Cinch E.X.P. 7001F	257-4216
	# —— ——	CUSHION; black felt ring; 4–¾″ O.D. x 3/16″ wide x ¾″ thick	C.R. tube support	Philco 257-7970	257-7970
	2Z3766-3 —— ——	DRIVE, dial; planetary; drive ratio 5:1; knob shaft, brass ¼″ diam. x 13/32″ lg, flatted; main shaft ⅜″ lg, mounts by three #6 screws on 1–9/32″ diam., holes 120° apart	Dial drive	Philco 358-3443	358-3443
	# —— ——	FELT PAD; wood flat; 3–⅛″ x ½″ x 1/16″, weight #100	Power unit	Philco 257-7969	257-7969
	# —— ——	FLEXIBLE COUPLING; for ¼″ shaft; 1–3/32″ diameter ⅝″ wide; 4 net screws #8–32 x ¼″ long; hex, socket headless; steel, zinc plated	Shaft coupling	Oak	358-3624
	2Z4885-3 —— ——	GUIDE ASSEMBLY; wire; bakelite; 1–⅜″ lg x ⅜″ wd x 1/16″ thk; two ⅛″ sq. holes on ½″ centers; mounts with mtg. lug bent at right angle	Wiring guide	Philco 358-7215	358-7215
	2Z4885-2 —— ——	GUIDE ASSEMBLY: wire; bakelite; 1–3/8″ lg. x 3/8″ wide x 1/16″ thk; two ⅛″ holes on ½″ centers; mounts with mtg. lug bent at 30° angle	Wiring guide	Philco 358-7214	358-7214
	2ZK5748.14 —— ——	KNOB; round; fluted; moulded phenolic; fits ¼″ shaft; 1″ diam. x 23/32″ thk; one 6–32 set screw	Crystal phasing	Philco 257-4266	257-4266
	# —— ——	KNOB; knurled, black phenolic or moulded wood flour compound; 23/32″ long; 1″ dia. with 0.253″ diameter shaft hole tapped for 2 #8–32 set screws; Allen head; cup point 3/16″ long; brass insert ⅜″ diameter, 11/32″ long	Crystal		257-7813
	2Z5788-43 —— ——	KNOB AND DIAL ASSEMBLY: knob round, fluted, black bakelite; for 1/4″ diam. shaft; set screw type; 1–5/8″ diam. x 3/4″ h.; dial 1/2″ diam.; paper base bakelite; black; 2–5/8″ diam. x 1/16″ thk	"Coarse" adj	Philco 358-8048	358-8048
	2Z5788-44 —— ——	KNOB AND DIAL ASSEMBLY: same as 358-8048 except for marking	"Fine" adj	Philco 358-8047	358-8047
	2Z5822-13 —— ——	KNOB: pointer type; black bakelite; 1–1/4″ pointer length 5/8″ thick with .252″ diam. shaft hole tapped for a No. 8-32 set screw, hexagon headless, cup point 7/16″ long brass insert 3/8″ long 3/8″ diameter	Front panel	Kurz-Kasch S293-3L	358-4274

2Z5788-42	KNOB: black resinvox, 9/16" long, 0.437" diameter; rectangular shaft hole 0.375" length 0.198" wide 0.054" thick; tapped for a No. 8-32 hexagon socket headless cupped point 3/16" long, zinc plated set screw	Left-Right	Oak 257-4296	257-4296
#	KNOB ASSEMBLY: fluted; black bakelite; 1-5/8" diameter x 3/4" thick; shaft diameter 1/4" brass insert approx. 9/16" x 9/16" hex socket headless setscrew No. 8-32, 3/16" long, cupped point; three holes No. 2-56, tap 3/8" full thread for mounting dial plate	Tuning adjustment	Philco 257-4299	257-4299
2ZK5822-23	KNOB: knurled black tenite 9/16" long, 3/4" diameter, with 1/4" diameter shaft hole; tapped for two No. 8-32 set screws; hex socket headless, 1/8" long, cup point, zinc plated brass insert	Focus intensity	Kurz-Kasch S-230-3	257-4238
#	LOCKWASHER: standard steel, special zinc finish; inside diameter 0.151"; outside diameter 0.237"; thickness 1/32"; width 1/16"	For mounting counter transformer 352-7224	Philco 1W35045FA33	1W35045FA33
2Z8401-5PH6	MOUNT, vibration; 6 pounds normal rating; 2-3/8" sq. mtg. flange; four 0.196" mtg. holes, 1-15/16" mtg./C	Anti-vibration mtg	Lord 150-PH-6	257-7578
2Z8401-PH8	MOUNT, vibration: 8 pounds normal rating; 2-3/8" x 2-3/8" x 1-1/16"; four 0.196" mtg. holes, 1-15/16" mtg./C	Anti-vibration mtg	Lord 150-PH-8	257-8148
#	SCREW: steel, special zinc finish; slotted straight side binding machine screw 3/8" length; 32 threads per inch	For mounting counter transformer 352-7224	Philco 1W10798FA33	1W10798FA33
	SHIELD ASSY: C.R. tube; Aimac Iron 0.032" thick; consisting of C.R.T. shield clamp, tube shields end, center and base; four grommet cushions; neoprene, earless fuse clip No. 125-2; approx. over-all length 13-5/8" x 2nd width 5-1/2" x base width 2-9/16"	C.R. tube		756-1406+
	SPACER: bakelite; 1-1/8" lg x 5/8" diam., one end threaded 3/8"-32; other end has metal insert moulded into it. Insert concentric with bakelite spacer, threaded 3/8-32	Bushing	Philco 358-4088	358-4088
	SPRING: music wire; 1-1/2" free length x .125" diam. 7/64" radius hook on one end, 5/16" radius hook on other end; approximately 63 turns, tight wound. Replaces 358-8744 in ID-6A/APN-4	Tuning condenser	Philco 258-8037	258-8037
	TUBING, extruded: 0.234" I.D. flameproof transparent flexible tubing. Irvington type XTE-130	Insulation		25-5603000
2ZK1117-1	VISOR: leather; round shape; approx. 10" long x 5-3/8" diameter; metal clamp around mounting end; sponge rubber guard around other end	To prevent paralax light	Philco 358-4316	358-4316
	WASHER: curved type, spring steel; 0.012" thk; 3/4" O.D. x 3/8" I.D. x 9/64" high			1W56402FE7
3FK26100-2	WINDOW, clear plexiglas 1/8" thick; 4-25/32" diameter	Mounting hardware		257-7971

TABLE OF PARTS (Cont'd)

Reference Symbol	*British Ref. Number Army Stock Number Navy Stock Number*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or Standard Type*	*Cont. or Govt. Dwg. or Spec. No.*
C101	(Not separately replaceable)	CAPACITOR: fixed; silver mica, 30 mmf., ±5%, 500 V d-c working; wax impregnated; moulded case; dimensions 11/16" x 7/16" x 3/16", axial leads	Wave trap	C-3 5RS	305-1114
C102	3D9240-13 —— ——	CAPACITOR: fixed, ceramic dielectric; 240 mmf., ±2%, 300 working volts, wax impregnated, 1.500" long x .265" diameter, axial leads	Plate coupling V-101-1	M-8 52NO80	305-1505
C103-1	3DA100-112 —— ——	CAPACITOR: fixed, paper dielectric; 2 mfd., +20 —10%; 400 V d-c working; cardboard case; wax impregnated; 1-7/16" long x 3/4" wide x 3/8" thick; axial leads	Plate bypass V102	M-1	305-1086
C103-2		Same as C103-1	Screen bypass V101-1		
C103-3		Same as C103-1	Screen bypass V102		
C103-4		Same as C103-1	Plate bypass V101-2		
C-103-5		Same as C103-1	Cathode bypass V102-2		
C103-6		Same as C103-1	Screen bypass V101		
C103-7		Same as C103-1	Plate bypass V101-3		
C103-8		Same as C103-1	Cathode bypass V101-3		
C103-9		Same as C103-1	Plate bypass V101-4		
C103-10		Same as C103-1	Cathode bypass V102		
C103-11		Same as C103-1	Cathode bypass V101-1		

C-104-1	(Not separately replaceable)	CAPACITOR: fixed; silver mica; 50 mmf. ±5%; 500 V d-c working, molded low loss red bakelite, axial, leads 11/16" long, 7/16" wide, 3/16" thickness	I.F. Pri. T-103-1	C-3 5RS M-1 P.O.	305-1227
C-104-2		Same as C-104-1	I.F. Sec. T-103-1		
C-104-3		Same as C-104-1	I.F. Pri. T-103-2		
C-104-4		Same as C-104-1	I.F. Sec. T-103-2		
C-104-5	(Not separately replaceable)	Same as C-104-1	I.F. Pri. T-103-3		
C-104-6		Same as C-104-1	I.F. Sec. T-103-3		
C-104-7		Same as C-104-1	I.F. Pri. T-103-4		
C-104-8		Same as C-104-1	I.F. Sec. T-103-4		
C-105	3DKA8.2 —— ——	CAPACITOR: fixed, mica dielectric; 8200 mmf., ±10%; 300 V d-c working; moulded case; wax impregnated; 53/64" long x 53/64" wide x 11/32" thick, axial leads	Grid coupling V-104	A-2 1467 M-1 W	60-20823414
C-106-1	3DK9510-4 —— ——	CAPACITOR: fixed; mica dielectric; 510 mmf., ±10%; 500 V d-c working; moulded case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick, axial leads	Video filter V-104	C-3 5W M-1 0	60-10515417
C-106-2		Same as C-106-1	Video filter V-104		
C-106-3		Same as C-106-1	Cathode bypass V-101-4		
C-106-4		Same as C-106-1	A.C. input filter		
C-106-5		Not used			
C-107	3DK9390-4 —— ——	CAPACITOR: fixed; mica dielectric; 390 mmf., ±10%, 500 V d-c working; moulded case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Video filter V-104	C-3 5W M-1 O	60-10395417
C-108	3DA10-124 —— ——	CAPACITOR: fixed; paper dielectric; .01 mfd., +20 —10%; 600 V d-c working; moulded case; wax impregnated; 1-7/16" long x 3/4" wide x 5/16" thick; axial leads	Grid coupling V-104	M-1 342-17 S-4 P9021	305-1255
C-109-1	3K2024032 —— ——	CAPACITOR: fixed, silver mica dielectric; 24 mmf., ±5%, 500 V d-c working; moulded case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Antenna tuning	3-3 5W A-2 1468	60-00245327
C-109-2		Same as C-109-1	R.F. tuning		
C-110	3DA500-27 —— ——	CAPACITOR: fixed; paper dielectric; 5 mfd. +20% —10%; 500 volts d-c working; hermetically sealed; metal case; oil filled; 1-13/16" long x 1" wide x 11/16" thick; 2 lug terminals on top; 2 mounting brackets 2-1/8" between centers	Filter V-106	C-3 DYRT6050-4	305-1216

IMPORTANT

Circuit reference symbols in this table of parts duplicate themselves.
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TABLE OF PARTS (Cont'd)

MODEL: RADIO SET *AN/APN-4 (MODIFICATION IV) MAJOR ASSEMBLY: RADIO RECEIVER *R-9B/APN-4

Reference Symbol	*Army Stock Number Navy Type Number British Ref. Number*	*Name of Part and Description*	*Function*	*Mfr. and Designation or Standard Type*	*Drawing or Spec. No.*
C-111-1	3DKA250-54 —— ——	CAPACITOR: fixed; paper dielectric; .25 mfd. +20% —10%; 2500 volts d-c working; metal case; wax impregnated; hermetically sealed; 4-5/16" long x 1-3/8" diameter; single lug terminal	Filter V-110-1	C-3 PC-2100	305-1304
C-111-2		Same as C-111-1	Filter V-110-2		
C-111-3		Same as C-111-1	Filter V-110-2		
C-112-1	(Not separately replaceable)	CAPACITOR: fixed; mica; 15 mmf. ±5%; 500 volts d-c working; moulded case; dimensions 51/64" long x 15/32" wide x 7/32" thick; axial leads	Wave trap V-101-1	E-2 603-M	60-00155337
C-112-2		Same as C-112-1	Wave trap V-101-1		
C-113	3K2051022 —— ——	CAPACITOR: fixed; mica dielectric; 51 mmf. ±5%; 500 volts d-c working; moulded case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Grid coupling V-102	A-2 1468 M-1 O	60-00515317
C-114	3K3020221 —— ——	CAPACITOR: fixed; mica dielectric; 2000 mmf. ±10%; 500 volts d-c working; moulded case; wax impregnated; 53/64" long x 53/64" wide x 9/32" thick; axial leads	Screen bypass V-101-4	C-3 1W M-1 W	60-20205414
C-115	3K2015121 —— ——	CAPACITOR: fixed; mica dielectric; 150 mmf. ±10%; 500 volts d-c working; moulded case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Plate bypass V-103	C-3 5W M-1 O	60-10155417
C-116	3DK9075-13 —— ——	CAPACITOR: fixed; mica dielectric; 75 mmf. ±10%; 500 volts d-c working; moulded case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Filter V-104	C-3 5W M-1 O	60-00755417
C-117	3DKB8-52 —— ——	CAPACITOR: fixed; paper dykanol; 8 mf. +20% —10%; 600 volts d-c working; metal case hermetically sealed; dimensions 4-1/2" x 2" diameter; 2 solder terminals on top	Filter V-109	C-3 CRA-3080	305-1339
C-118	3DA500-97.21 —— ——	CAPACITOR: fixed; paper; oil impregnated; .5 mf. +20% —10%; 600 volts d-c working; metal case; hermetically sealed; dimensions 1-13/16" x 7/8" x 1", 2 solder lug terminals on top; 2 mounting brackets 2-1/8" center to center	Filter V-107	C-3 DYR6050 S-4 P9047	305-1335
C-119	3DKB1-9 —— ——	CAPACITOR: fixed; paper dielectric; 1 mf. ±10%; 600 volts d-c working; metal case; wax impregnated; 1-1/2" long x 1-13/16" wide x 1" thick; 2 terminal lugs; 2 mounting brackets 2-1/4" between centers	B+ filter	C-3 PC-2147	305-1366
C-120		Not used			
C-121		Not used			

C-122	3K2024143 —— ——	CAPACITOR: fixed; mica; 240 mmf. ±2%; 500 volts d-c working; wax impregnated; moulded bakelite case; dimensions 51/64" x 15/32" x 7/32"; axial leads	Voltage divider V-102	E-2 603M	60-10245237
C-123	3D9820-5 —— ——	CAPACITOR: fixed; silver mica; 820 mmf. ±2%; 500 volts d-c operating volts; ceramic body; wax impregnated; dimensions 1-1/2" long x 17/64" diameter; radial leads	Voltage divider V-102 and temperature compensator	E-1 N-750E	305-1554
C-124	3D9500-65 —— ——	CAPACITOR: fixed; mica; 200 mmfd. ±5%; 500 volts d-c working; wax impregnated; moulded bakelite case; dimensions 51/64" x 15/32" x 7/32"; axial leads	Voltage divider	E-2 603M	60-10205337
C-125	3DKA10-183 —— ——	CAPACITOR: fixed; mica; .01 mfd. ±5%; 300 volts d-c working; wax impregnated; moulded bakelite case; dimensions 1-1/32" x 41/64" x 11/32"; axial leads	Noise filter	C-3 3WLST	60-30103323
E-101	(Not in base spares.)	INSULATOR: standoff; bakelite; 15/16" long x 5/16" diameter; hole tapped No. 6-32 in one end; wax impregnated; black; brass lug; .156" hole; 9/32" x 3/8" x 1/64" approximately	Panel spacer	P-1 358-8119	358-8119
E-102	2Z5822-13 —— ——	KNOB: pointer type; black bakelite; 1-1/4" pointer length; 5/8" thick, with .252" diameter shaft hole; tapped for a No. 8-32 setscrew; hexagon headless; cup point 7/16" long; brass insert 3/8" long 3/8" diameter	Front panel	E-1 S-293-3L	358-4274
F-101	(Not in base spares.)	FUSE: cartridge; 4 amperes; 250 volts; dimensions 1-1/4" long x 1/4" diameter	115 volts a-c T-104, T-105	L-1 1357-3AG	455-2048
I-101	2Z5952 —— ——	LAMP: pilot; bayonet base; 6.3 volts; .15 amps. T3-1/4" bulb	On-off indicator	M-8 Type 47	34-2068
J-101	2ZK3010.10 —— ——	CONNECTOR ASSEMBLY: consists of 2 large hex. nuts, 3 washers and green collar with solder lug on rear and retaining clip coming out from green collar; coaxial; single contact; mounted by 2 lockwashers and 2 small hex. nuts; 1-5/16" long x 3/4" diameter	Antenna input	A-1 IDH528	358-1267
J-102	2ZK3010.11 —— ——	CONNECTOR ASSEMBLY: consists of 2 large hex. nuts; 3 washers and yellow collar with solder lug on rear and retaining clip coming out from yellow collar; coaxial single contact; mounted by 2 lockwashers and 2 small hex. nuts; 1-5/16" long x 3/4" diameter	Balance connector	A-1 OH528	358-2832
J-103	2Z3010.4 —— ——	CONNECTOR ASSEMBLY: consists of 2 large hex. nuts; 3 washers and blue collar with solder lug on rear and retaining clip coming out from blue collar; coaxial single contact; mounted by 2 lockwashers and 2 small hex. nuts; 1-5/16" long x 3/4" diameter	Gain connector	A-1 1OH528	358-1305
J-104	2ZK3010.12 —— ——	CONNECTOR ASSEMBLY: consists of 2 large hex. nuts; 3 washers and red collar with solder lug on rear and retaining clip coming out from red collar; coaxial; single contact; mounted by 2 lockwashers and 2 small hex. nuts; 1-5/16" long 3/4" diameter	Video output	A-1 1OH528	358-1266

IMPORTANT

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TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 (MODIFICATION IV) MAJOR ASSEMBLY: RADIO RECEIVER ★R-9B/APN-4

Reference Symbol	*Army Stock Number Navy Type Number British Ref. Number*	*Name of Part and Description*	*Function*	*Mfr. and Designation or Standard Type*	*Drawing or Spec. No.*
J-105	2Z7116.32 —— ——	CONNECTOR: male; 6 contacts, brass, silver plated; one high dielectric melmac No. 592 plug insulation; one high dielectric melmac plug washer; plug body Z-5 alloy; overall dimensions 1.940" x 1.940" x .800" mounting hole diameter 1.560", for holes .152" diameter 1.500" center to center 20 thread per inch	Indicator connector	A-1 1OH394	358-7219
J-106	2Z8799-146 —— ——	RECEPTACLE: straight; female; 4 contacts; bakelite insert; type 1OH391	Power input	A-1 1OH391	358-3450
L-101	(Not separately replaced; not in base spares.)	COIL ASSEMBLY: 2 windings of 132 turns of 7-44SSE wire wound on coil form, 9/16" O.D. Total inductance of coils in series 583 millihenries ±5%, wax impregnated, color code blue	Parallel wave trap V-101-1	P-1 352-1258	352-1258
L-102-1	(Not in base spares.)	COIL ASSEMBLY: 2 windings of 168 turns of 7-44 SSE wire wound on coil form 19/32" O.D.; total inductance of coils in series 950 millihenries ±5%; wax impregnated	Series wave trap V-101-1	P-1 352-1254	352-1254
L-102-2		Same as L-102-1	Series wave trap V-102		
L-103-1	(Not separately replaceable; not in base spares.)	COIL: 96-1/2 turns No. 34E B & S wire; Q at 2 mc is 60; wax impregnated; color code brown (Part of Assy 352-1563)	R.F. coil V-102	P-1 352-1527	352-1527
L-103-2		Same as L-103-1 except color code is green (Part of Assy 352-1563)	R.F. coil V-102	P-1 352-1528	352-1528
L-103-3		Same as L-103-1 except color code is blue (Part of Assy 352-1563)	R.F. coil V-102	P-1 352-1497	352-1497
L-103-4		Same as L-103-1 except color code is yellow (Part of Assy 352-1563)	R.F. coil V-102	P-1 352-1560	352-1560
L-104		Not used			
L-105	(Not in base spares.)	COIL: R.F. filter choke; 400 mh ±5%; 2 pi winding; 139 turns each, No. 36 SSE wire; crowlite No. 29 coil form 11/16" long x 5/8" O.D.	Cathode choke V-102	P-1 352-1252	352-1252
L-106-1	(Not in base spares.)	OSCILLATOR COIL: 30 turns 36 wire; enameled, B & S; inductance at 1000 cycles is 4.8 mh; Q at 5 mc is 65; wax impregnated; color code brown	Oscillator V-102	P-1 352-1280	352-1280
L-106-2		Same as L-106-1, except color code is green	Oscillator V-102	P-1 352-1275	352-1275
L-106-3		Same as L-106-1, except color code is blue	Oscillator V-102	P-1 352-1494	352-1494
L-106-4		Same as L-106-1, except color code is yellow	Oscillator V-102	P-1 352-1561	352-1561
L-107		Not used			

R-101-1	3RC21BE473K —— ——	RESISTOR: fixed; metallized filament; 47,000 ohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Screen resistor V-101-1	L-1 BT-1/2	66-3473344
R-101-2		Same as R-101-1	Screen resistor V-101-4		
R-102-1	3RC41BE183J —— ——	RESISTOR: fixed; metallized filament; 3300 ohms, ±5%; 2 watts; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Plate resistor V-101-1	I-1 BT-1/2	66-3135244
R-102-2		Same as R-102-1	Screen resistor V-102		
R-103-1	3RC21BE332K —— ——	RESISTOR: fixed; metallized filament; 3300 ohms ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Plate filter V-102	I-1 BT-1/2	66-2333344
R-103-2		Same as R-103-1	Plate filter V-101-2		
R-103-3		Same as R-103-1	Plate filter V-101-3		
R-103-4		Same as R-103-1	Plate filter V-101-4		
R-103-5		Same as R-103-1	Cathode filter V-102		
R-105-1	3RC21BE103K —— ——	RESISTOR: fixed; metallized filament; 10,000 ohms ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Plate resistor V-104	I-1 BT-1/2	66-3103344
R-105-2		Same as R-105-1	Plate resistor V-103		
R-105-3		Same as R-105-1	Cathode resistor V-104		
R-106-1	3RC21BE683J —— ——	RESISTOR: fixed; metallized filament; 68,000 ohms ±5%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Bandpass V-101-2	I-1 BT-1/2	66-3683244
R-106-2		Same as R-106-1	Bandpass V-101-3		
R-106-3		Same as R-106-1	Bandpass V-101-4		
R-107	3RC21BE393K —— ——	RESISTOR: fixed; metallized filament; 39,000 ohms ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Grid resistor V-101-1	I-1 BT-1/2	66-3393344
R-108	3ZK6038-2 —— ——	RESISTOR: fixed; metallized filament; 380 ohms ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Cathode resistor V-101-1	I-1 BT-1/2	66-1383344
R-109	3RC21BE223K —— ——	RESISTOR: fixed; metallized filament; 22,000 ohms ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Grid resistor V-102	I-1 BT-1/2	66-3223344
R-110-1	3RC21BE222K —— ——	RESISTOR: fixed; metallized filament; 2200 ohms ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Cathode bias V-101-2	I-1 BT-1/2	66-2223344
R-110-2		Same as R-110-1	Cathode bias V-101-3		
R-111-1	3RC21BE273K —— ——	RESISTOR: fixed; metallized filament; 27,000 ohms ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Plate resistor V-103	I-1 BT-1/2	66-3273344
R-111-2		Same as R-111-1	Plate resistor V-110-2		
R-112-1	3RC21BE224K —— ——	RESISTOR: fixed; metallized filament; 220,000 ohms ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Video filter V-104	I-1 BT-1/2	66-4223344

IMPORTANT

Circuit reference symbols in this table of parts duplicate themselves.
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TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 (MODIFICATION IV) MAJOR ASSEMBLY: RADIO RECEIVER ★R-9B/APN-4

Reference Symbol	Army Stock Number Navy Type Number British Ref. Number	Name of Part and Description	Function	Mfr. and Designation or Standard Type	Drawing or Spec. No.
R-112-2		Same as R-112-1	Video filter V-104		
R-112-3		Same as R-112-1	Grid resistor V-104		
R-113	3RC21BE105K —— ——	RESISTOR: fixed; metallized filament; 1 megohm ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Grid leak V-104	I-1 BT-1/2	66-5103344
R-114	3RC21BE824K —— ——	RESISTOR: fixed; metallized filament; 320,000 ohms ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Plate resistor V-105-1	I-1 BT-1/2	66-4823344
R-115-1	3ZK6013-2 —— ——	RESISTOR: fixed; metallized filament; 130 ohms ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Grid resistor V-105-1	I-1 BT-1/2	66-1133344
R-115-2		Same as R-115-1	Grid resistor V-105-2		
R-115-3		Same as R-115-1	Grid resistor V-105-3		
R-116-1	3RC21BE225K —— ——	RESISTOR: fixed; metallized filament; 2.2 megohms ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Plate resistor V-106	I-1 BT-1/2	66-5223344
R-116-2		Same as R-116-1	Grid leak V-108		
R-117	3RC31BE472K —— ——	RESISTOR: fixed; metallized filament; 4700 ohms; ±10%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" long x 1/4" diameter	Cathode resistor V-106	I-1 BT-1	66-2474344
R-118	3RC21BE474K —— ——	RESISTOR: fixed; metallized filament; .47 megohm ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Grid resistor V-106	I-1 BT-1/2	66-4473344
R-119	3ZK6610-91 —— ——	RESISTOR: fixed; wire wound; 10,000 ohms ±10%; 5 watts; radial leads; insulated; 1-7/32" long x 7/16" diameter	Screen resistor V-106	S-4 5K	353-1351
R-120-1	3RC31BE104K —— ——	RESISTOR: fixed; metallized filament; .1 megohm ±10%; 1 watt; insulated; axial leads; wax impregnated; 7/8" long x 9/32" diameter	Voltage divider	I-1 BT-1	66-4104344
R-120-2		Same as R-120-1	Voltage divider		
R-120-3		Same as R-120-1	Screen resistor V-101-2		
R-121	2Z7281.33 —— ——	POTENTIOMETER: 20,000 ohms ±10%; wire wound; linear taper; 3 watts; bakelite case; 1-5/8" diameter x 13/16" deep x mounting bushing 3/8" long x 3/8"-32 thread; shaft 1/8" x 1/4" slotted	Voltage divider V-106	C-1 25	353-5215
R-122	3RC31BE222K —— ——	RESISTOR: fixed; metallized filament; 2200 ohms ±10%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" long x 1/4" diameter	Cathode resistor V-108	I-1 BT-1/2	66-2224344
R-123-1	3RC21BE565K —— ——	RESISTOR: fixed; metallized filament; 5.6 meg. ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Bleeder	I-1 BT-1/2	66-5563344

R-123-2		Same as R-123-1	Bleeder		
R-123-3		Same as R-123-1	Bleeder		
R-123-4		Same as R-123-1	Bleeder		
R-123-5		Same as R-123-1	Bleeder		
R-123-6		Same as R-123-1	Bleeder		
R-123-7		Same as R-123-1	Bleeder		
R-123-8		Same as R-123-1	Bleeder		
R-124	3RC21BE563K —— ——	RESISTOR: fixed; metallized filament; 56,000 ohms ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Filter V-110-1	I-1 BT-1/2	66-3563344
R-125	3RC21BE104K —— ——	RESISTOR: fixed; metallized filament; .1 megohm ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" long x 3/16" diameter	Filter V-110-2	I-1 BT-1/2	66-4103344
R-127-1	3RC21BE103J ——	RESISTOR: fixed; metallized filament; 10,000 ohms ±5%; 1/2 watt; wax impregnated; 5/8" x 3/16"; axial leads	Grid resistor V-102	I-1 BT-1/2	66-3103274
R-127-2		Same as R-127-1	Grid resistor V-102		
R-127-3		Same as R-127-1	Grid resistor V-102		
R-127-4		Same as R-127-1	Grid resistor V-102		
R-128	3RC31BE273J —— ——	RESISTOR: fixed; metallized filament; 27,000 ohms ±5%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" long x 1/4" diameter	Voltage divider resistor V-106	I-1 BT-1	66-3274244
S-101	3ZK9828-8 —— ——	SWITCH: rotary; constant contact; 4 positions; 4 sections; wafer; 20 contacts; shorting type teeth on rotor blades; contact clips and rotor blades of solid coin silver; bakelite insulation of rotor and stator; overall 6-3/16" solder terminals located around wafers; mounting bushing 3/8"-32 thread, 3/8" long	Channel selector	O-1 25235-H4	452-1109
S-102-1	3Z9845-5 —— ——	SWITCH: toggle; constant contact; S.P.S.T.; 2 positions; insulated; 20 amperes; 25 volts d-c; overall dimensions 1-1/8" long x 5/8" wide x 1-3/32" high; mounting dimensions; bushing 5/32"-32 thread, 15/32" long	Video filter switch V-104	C-6 8801-K3	452-1008
S-102-2	3Z9845-11 —— ——	SWITCH: toggle; double pole; single throw; two positions; on-off; bakelite insulation; 20 amps; 24 volts; overall dimensions 1-15/16" long x 3/4" wide x 2-1/4" high; 1/2" mounting hole; mounting shaft 15/32"-32 thread	Power ON-OFF switch	C-6 8823	452-1196
S-103	3ZK9560-3 —— ——	SWITCH: toggle; constant contact; D.P.D.T.; 2 positions; insulated; 20 amperes; 24 volts d-c; overall dimensions 1-25/32" long x 15/16" wide x 3/4" deep; mounting dimensions; bushing 15/32"-32 thread; 15/32" long	Hi-lo a-c supply	C-6 8824-K3	452-1113
S-104		Not used			
T-101-1	(Not separately replaceable; not in base spares.)	ANTENNA COIL: Primary 3-2/3 turns of No. 26 wire; enameled secondary 110 turns of No. 34 wire; enameled; Q at 2 mc is 60 coil; wax impregnated; color code brown	Antenna	P-1 352-1459	352-1459
T-101-2		Same as T-101-1, except color antenna code is green	Antenna	P-1 352-1460	352-1460

IMPORTANT

Circuit reference symbols in this table of parts duplicate themselves. Be sure to check nomenclature of the particular major assembly.

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 (MODIFICATION IV) — MAJOR UNIT: RADIO RECEIVER ★R-9B/APN-4

Reference Symbol	*Army Stock Number Navy Type Number British Ref. Number*	*Name of Part and Description*	*Function*	*Mfr. and Designation*	*Drawing or Specification No.*
T-101-3		Same as T-101-1, except color code is blue	Antenna	P-1 352-1498	352-1498
T-101-4		Same as T-101-1, except color code is yellow		P-1 352-1559	352-1559
T-102		Not used			
T-103-1	(Not separately replaceable. Not in base spares.)	TRANSFORMER: I.F.; consists of primary 134 turns No. 36 SSE wire, 185 millihenries at 1000 cycles, secondary 185 millihenries at 1000 cycles; aluminum case 3-1/2" high, 1-3/8" square coil mounted on panel; two spade lugs for mounting located on each side	1st I.F. input	P-1 352-1526	352-1526
T-103-2		Same as T-103-1	1st I.F. output		
T-103-3		Same as T-103-1	2nd I.F. output		
T-103-4		Same as T-103-1	3rd I.F. output		
T-104	(Not in base spares.)	TRANSFORMER: power; 400-2400 C.P.S.; 115 volts, single phase; laminated; primary 115 volts; tapped 80 volts; secondary 440 volts; 200 milliamps; 5 volts; 3 amps.; 6.3 volts; 3 amps; center tapped 6.3 volts; 3 amps; 6.3 volts; 3 amps.; electrostatic shield; cased 4-5/16" long, 3-9/16" wide, 3-1/4" high; 15 solder terminals located on top of case; six 7/32" diameter mounting holes	Power	M-3 C1-306M	352-7194
T-105	2Z9619-33 —— ——	TRANSFORMER: Hi-voltage type; 400-2400 C.P.S. single phase; laminated; primary 115 volts; a-c; tapped 80 volts; secondary; 1140 volts R.M.S.; 1.25 milliamperes 2.5 volts 1.75 amps.; 2.5 volts 1.75 amps.; cased; 3" long, 2-5/16" wide, 3" high; 9 solder terminals located on bakelite panel on bottom; six 3/16" diameter mounting holes; located 3 on each side; mounting dimensions center 7/8" x 2-11/16"	High voltage	M-3 B-1-305M	352-7245
V-101-1	(Not in base spares.)	VACUUM TUBE: JAN-6SK7GT; triple-grid super-control; amplifier	R-F amp.	K-2 6SK7GT S-1 6SK7GT	354-1359
V-101-2		Same as V-101-1	1st I.F. amp.		
V-101-3		Same as V-101-1	2nd I.F. amp.		
V-101-4		Same as V-101-1	3rd I.F. amp.		
V-102	(Not in base spares.)	VACUUM TUBE: type JAN-6SA7GT; pentagrid converter; octal base	Det. osc.	K-2 6SA7GT S-1 6SA7GT	354-1360
V-103	(Not in base spares.)	VACUUM TUBE: type JAN-6H6GT; twin diode	2nd det.	K-2 6H6GT S-1 6H6GT	345-1331

V-104	(Not in base spares.)	VACUUM TUBE: type JAN-6SL7GT; twin triode amplifier	Video amplifier	R-1 6SL7GT	354-1307
V-105-1	(Not in base spares.)	VACUUM TUBE: type JAN-6B4G; power amplifier triode	Voltage regulator	S-1 6B4G	354-1341
V-105-2		Same as V-105-1	Voltage regulator		
V-105-3		Same as V-105-1	Voltage regulator		
V-106	(Not in base spares.)	VACUUM TUBE: type JAN-6SJ7GT; triple grid detector amplifier	Voltage regulator	S-1 6SJ7GT	345-1330
V-107	(Not in base spares.)	VACUUM TUBE: type JAN-VR-105-30	Voltage regulator	S-1 VR-105-30	354-1314
V-108	(Not in base spares.)	VACUUM TUBE: type JAN-6SN7GT; twin triode amplifier	Balance	R-1 6SN7GT	354-1321
V-109	(Not in base spares.)	VACUUM TUBE: type JAN-5U4G full-wave rectifier	Rectifier 5U4G	S-1	354-1312
V-110-1	(Not in base spares.)	VACUUM TUBE: type JAN-879/2x2; half-wave rectifier	Voltage doubler	R-1 879-2X2	354-1316
V-110-2		Same as V-110-1	Rectifier		
X-101-1	2Z8650.1 —— ——	SOCKET: tube; mica filled bakelite; 8 prongs; flange mounting type; mounting dimensions two .140" diameter holes, 1-5/16" center to center	R.F. tube	C-2 6742	257-6041
X-101-2		Same as X-101-1	Det. osc. tube		
X-101-3		Same as X-101-1	1st I.F. tube		
X-101-4		Same as X-101-1	2nd I.F. tube		
X-101-5		Same as X-101-1	3rd I.F. tube		
X-101-6		Same as X-101-1	2nd det. tube		
X-101-7		Same as X-101-1	Video amp.		
X-101-8		Same as X-101-1	Voltage regulator		
X-101-9		Same as X-101-1	Voltage regulator		
X-101-10		Same as X-101-1	Voltage regulator		
X-101-11		Same as X-101-1	Voltage regulator		
X-101-12		Same as X-101-1	Balance tube		
X-101-13		Same as X-101-1	Rectifier tube		
X-101-14		Same as X-101-1	Voltage regulator		
X-102-1	2Z8674.15 —— ——	SOCKET: tube; mica filled bakelite; 4 prongs; flange mounting type; mounting dimensions; two holes 1-7/8" center to center	High voltage tubes	A-1 77A-4T	257-6042
X-102-2		Same as X-102-1	High voltage tubes		
Z-101-1	2Z9642.42 —— ——	TRANSFORMER: consists of C-104-1, C-104-2, T-103-1; capacitor; fixed; silver mica; 50 mmf ±5%; 500 volts; primary; 134 turns No. 36 SSE wire; inductance 185 millihenries at 1000 cycles; secondary 185 millihenries at 1000 volts; 134 turns of 36 SSE wire; coupler winding 16 turns No. 34 E wire; 3.6 mh at 1000 volts; aluminum case 3-1/2" high, 1-3/8" square coils mounted on panel; two spade lugs for mounting location each side	1st I.F. input	P-1 352-1526	352-1526

IMPORTANT

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TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 (MODIFICATION IV) MAJOR UNIT: RADIO RECEIVER ★R-9B/APN-4

Reference Symbol	Army Stock Number Navy Type Number British Ref. Number	Name of Part and Description	Function	Mfr. and Designation	Drawing or Specification No.
Z-101-2		Same as Z-101-1	1st I.F. output		
Z-101-3		Same as Z-101-1	2nd I.F. output		
Z-101-4		Same as Z-101-1	3rd I.F. output		
Z-102		COIL ASSEMBLY AND PANEL: consists of T-101-1, T-101-2, T-101-3, T-101-4; T-101-1 primary 3-2/3 turns No. 26 enameled wire. Secondary 110 turns, No. 34 enameled wire. Q is 60 at 2 mc.; wax impregnated; color coded brown; T-101-2 same as T-101-1 except color coded green; T-101-3 same as T-101-1 except color coded blue; T-101-4 same as T-101-1 except color coded yellow	Antenna	P-1 352-1562	352-1562
Z-103	3CK4002-3 —— ——	COIL ASSEMBLY: wave trap; consists of 2 windings of 132 turns of 7-44 SSE wire wound in series on form 9/16" O.D. inductance 583 millihenries ±5%; aluminum can 2" x 1-1/8", color coded blue	Parallel wave trap	P-1 352-1269	352-1269
Z-104-1	3CK4002-3.1 —— ——	COIL ASSEMBLY: wave trap; consists of L-102-1, 2 PI windings in series number 7-4 SSE wire wound on coil form 19/32" diameter; total inductance of coils 950 millihenries ±5% millihenries; C-112-2 capacitor all mounted in aluminum can 2" long x 1-1/8" square	Series wave trap	P-1 352-1266	352-1266
Z-104-2		Same as Z-104-1	Series wave trap		
Z-105		COIL, R.F. AND PANEL ASSEMBLY: consists of L-103-1, L-103-2, L-103-3, L-103-4 mounted in aluminum can; each coil has variable iron core; L-103-1, 96-1/2 turns No. 34 enameled wire; wax impregnated; Q of 60 at 2 mc.; color coded brown; L-103-2, L-103-3 same as L-103-1 except coded green and blue; L-103-4 same as L-103-1 except color code yellow	R.F.	P-1 352-1563	352-1563
Z-106		COIL ASSEMBLY, OSCILLATOR: consists of L-106-1, L-106-2, L-106-3, L-106-4, R-127-1, R-127-2, R-127-3, R-127-4; L-106-1, 30-1/2 turns No. 36E; 4.8 millihenries at 1000 cycles; Q is 65 at 5 mc.; Q max. varnished; color coded brown; L-106-2 same as L-106-1 except color code green; L-106-3 same as L-106-1 except color code blue; L-106-4 same as L-106-1 except color coded yellow	Oscillator coil	P-1 352-1564	352-1564

MODEL: RADIO SET ★AN/APN-4 (MODIFICATION IV) MAJOR UNIT: RADIO RECEIVER ★R-9B/APN-4—MISCELLANEOUS

	(Not in base spares.)	CLAMP: Irvington fibre sheet natural color; .010" thick; Harvel coated; 1-3/8" x 11/16"; .156" diameter hole; 1/4" from one end	Wiring	P-1 257-7948	257-7948
	(Not in base spares.)	CLAMP: steel; No. 20; zinc or cadmium plated; 1/4" radius bend; 1/2" wide x 7/8" long approximately; .147" diameter hole	Wiring clamp	P-1 258-1426	258-1426
	(Not in base spares.)	CLAMP: steel; No. 21; zinc or cadmium plated; 5/32" radius bend; 3/8" wide x 3/4" long; .144" diameter hole	Wiring clamp	C-2	258-1465

(Not in base spares.)	CLAMPING FOOT: yellow brass; black nickle finish; 1-1/64" long x 7/16" wide x 3/32" thick; offset extends 9/32"; 2 holes .144" diameter	Receiver	P-1 258-1203	258-1203
6ZK5019 —— ——	HANDLE: steel; black nickle finish; 4" long; 1-1/4" hand clearance; 5/16" diameter; mounting holes .136" diameter No. 8-32 tap; 2 holes	Lifting	P-1 258-1231	258-1231
3ZK3275.2 —— ——	HOLDER ASSEMBLY FUSE: consists of slotted hex. nut; rubber washer; holder cap assembly; moulded black bakelite body; red extractor knob; takes panel up to 5/16" thick; 1/2" mounting hole; knurled finger grip knob which holds fuse; 1-3/4" deep; 2-1/8" overall	Power supply protection	L-1 1075A	358-1546
(Not in base spares)	PILOT LAMP ASSEMBLY: consists of pilot lamp assembly with red jewel	Pilot lamp	G-7 430P	358-4735
2Z9440-40 —— ——	TERMINAL PANEL: bakelite; wax impregnated; 8" x 1-3/8" x 3/32"; double row of solder lug terminals, 21 in each; three .234" diameter mounting holes, 3-3/8" x 2-11/16" between centers	Wiring	P-1 358-5639	358-5639
2Z9408.37 —— ——	TERMINAL PANEL: bakelite; wax impregnated; 2-3/8" x 1-3/8" x 1/32"; double row of 5 solder lug terminals each; 2 steel angle mounting brackets; 5/16" x 1-3/16" x 1/16"; 2 mounting holes 1" center to center	Wiring	P-1 358-5556	358-5556
2Z9410.28 —— ——	TERMINAL PANEL: bakelite; wax impregnated; 2" x 1-6/16" x 1/32"; double row of 5 solder lug terminals each; 2 steel angle mounting brackets; 1-3/16" x 5/16" x 1/16"; 2 mounting holes, 1-1/2" center to center	Wiring	P-1 358-5561	358-5561
2Z9410.36 —— ——	TERMINAL PANEL: bakelite; wax impregnated; 2-3/8" x 1-3/8" x 1/32"; double row of 5 solder lug terminals each; 2 steel angle mounting brackets; 1-3/16" x 5/16" x 1/16"; 2 mounting holes, 1-1/32" center to center	Wiring	P-1 358-7267	358-7267
2Z9412.40 —— ——	TERMINAL PANEL: bakelite; wax impregnated; 2-13/32" x 1-3/8" x 1/32"; double row of solder lug terminals, 7 in one, 5 in other; 2 steel angle mounting brackets 1-3/16" x 5/16" x 1/16"; 2 mounting holes 2-9/32" center to center	Wiring	P-1 358-5558	358-5558
2Z9410.29 —— ——	TERMINAL PANEL: bakelite; wax impregnated; 2-3/4" x 1-3/8" x 1/32"; double row of solder lug terminals, 7 in one, 5 in other; 2 steel angle mounting brackets, 1-9/32" x 5/16" x 1/16"; 2 mounting holes 9/32" center to center	Wiring	P-1 358-5560	358-5560
6R57400 —— ——	WRENCH: hexagon; width across flats .0771"; length short arm 33/64"; short length 1-25/32"; L shaped 5/64" radius bend	Tool	P-1 1W30964	1W30964

IMPORTANT

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TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 (MODIFICATION V) — MAJOR ASSEMBLY: INDICATOR ★ID-6B/APN-4

Reference Symbol	Army Stock Number Navy Type Number British Ref. Number	Name of Part and Description	Function	Mfr. and Designation	Drawing or Specification No.
C-301-1	3DK9510-4 —— ——	CAPACITOR: fixed; mica dielectric; 510 mmf. ±10%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" thick; axial leads	Series capacitor osc. grid circuit V-301-1	E-2 503M	60-10515417
C-301-2		Same as C-301-1	Sweep inverter grid bypass V-301-14		
C-301-3		Same as C-301-1	Ped. gen. grid bypass V-301-15		
C-301-4		Same as C-301-1	L.R. circuit lefting		
C-301-5		Same as C-301-1	E.J. Sync input		
C-302	3D9050V-76 —— ——	CAPACITOR: variable; air dielectric; 5 to 50 mmf; ±3 mmf. at 5 mmf; ±5 mmf at 50 mmf; 500 volts d-c working; overall dimensions 15/16" x 1-17/32" x 1-7/8"; shaft 7/8" x .250" diameter; mounting dimensions, 2 holes tapped 4-40; 21/32" center to center	Crystal phasing in 100 KC osc. grid circuit V-301-1	T-1 AP-9-44	351-1059
C-303-1	3DK9005-26 —— ——	CAPACITOR: fixed; mica dielectric; 5 mmf. ±10%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Left-right circuit S-301-A	E-2 503M	60-00055417
C-303-2		Same as C-303-1	Plate feedback V-301-1		
C-304-1	3Z2010021 —— ——	CAPACITOR: fixed; mica dielectric; 10 mmf. ±10%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Left-right circuit S-301-A	E-2 503M	60-00105417
C-304-2		Same as C-304-1	Station selections compensation S-304-B2		
C-305-1	3DA10-124 —— ——	CAPACITOR: fixed; moulded paper dielectric; .01 mf. ±20%; 600 volts d-c working; bakelite case; wax impregnated; 1-7/16" long x 3/4" wide x 5/16" thick; axial leads	Osc. plate filter V-301- 1	M-1 342-17	305-1255
C-305-2		Same as C-305-1	Cathode bypass V-303-2		
C-305-3		Same as C-305-1	Input to sweeps syncronization V-301-14		
C-305-4		Same as C-305-1	Input pedestal gen. V-301-15		
C-306	3DKA1.500-15 —— ——	CAPACITOR: fixed; mica dielectric; 1500 mmf. ±5%; 500 volts d-c working; bakelite case; wax impregnated; 53/64" long x 53/64" wide x 9/32" thick; axial leads	Plate tuning of osc. V-301-1	E-2 502L	60-20155314
C-307-1	3D9240-12 —— ——	CAPACITOR: fixed; mica dielectric; 240 mmf. ±10%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	10 microseconds phase shift capacitor T-301	E-2 503M	60-10245417
C-307-3		Same as C-307-1	B-coarse grid bypass V-301-3		

C-307-4		Same as C-307-1	A-delay V-301-13 coupling to E.J. sync.		
C-308	3K2033021 —— ——	CAPACITOR: fixed; mica dielectric; 33 mmf. ±10%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Grid coupling V-301-1	E-2 503M	60-00335417
C-309-1	3K2018021 —— ——	CAPACITOR: fixed; mica dielectric; 18 mmf. ±10%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Grid bypass V-301-2	E-2 503M	60-00185417
C-309-2		Same as C-309-1	Coupling V-301-12		
C-309-3		Same as C-309-1	Coupling S-303		
C-310-1	3D9051-7 —— ——	CAPACITOR: fixed; mica dielectric; 51 mmf. ±10%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Grid coupling 1st counter trigger V-301-2	E-2 503M	60-00515417
C-310-2		Same as C-310-1	Grid coupling feed 10 microseconds marker V-303-2		
C-310-3		Same as C-310-1	Grid coupling 10 microseconds marker V-303-2		
C-311-1	3D9024-3 —— ——	CAPACITOR: fixed; mica dielectric; 24 mmf. ±10%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Coupling V-301-2	E-2 503M	60-00245417
C-312	3K2582143 —— ——	CAPACITOR: fixed; silver mica dielectric; 820 mmf. ±2%; 500 volts d-c working; bakelite case; wax impregnated; 1-1/16" long x 15/32" wide x 7/32" thick; axial leads	Coupling cond. 1st counter grid V-301-2	S-6 2R	60-10825231
C-313	3D9082 —— ——	CAPACITOR: fixed; silver mica dielectric 82 mmf. ±2%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Coupling 2nd counter and 1st counter osc. V-301-2	E-2 603M	60-00825237
C-314	3K2033143 —— ——	CAPACITOR: fixed; silver mica dielectric; 330 mmf. ±2%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	2nd counter V-302-1 cathode capacitor	E-2 603M	60-10335237
C-315-1	3DKA250-53 —— ——	CAPACITOR: fixed; moulded paper dielectric; .25 mf. ±20%; 200 volts d-c working; bakelite case; wax impregnated; 1-7/16" long x 3/4" wide x 3/8" thick; axial leads	Cathode bypass 2nd counter osc. V-301-3	M-1 345-20	305-1241
C-315-2		Same as C-315-1	3rd counter diode circuit V-301-3		
C-315-3		Same as C-315-1	Filter in grid of B-fine delay V-301-11		
C-315-4		Same as C-315-1	Filter in grid of B-coarse delay V-301-12		
C-315-5		Same as C-315-1	Cathode bypass of 6th counter osc. V-301-6		
C-316	3DK9100-107 —— ——	CAPACITOR: fixed; silver mica dielectric; 100 mmf. ±2%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	3rd counter coupling V-301-3	E-2 603M	60-10105237

IMPORTANT

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Reference Symbol	Army Stock Number / Navy Type Number / British Ref. Number	Name of Part and Description	Function	Mfr. and Designation	Drawing or Specification No.
C-317	3DA5-50 —— ——	CAPACITOR: fixed; mica dielectric; 5000 mmf. ±5%; 500 volts d-c working; bakelite case; wax impregnated; 53/64" long x 53/64" wide x 11/32" thick; axial leads	Bypass on cathode of V-302-2	E-2 502L	60-20505314
C-318	3K3015243 —— ——	CAPACITOR: fixed; silver mica dielectric; 1500 mmf. ±2%; 500 volts d-c working; bakelite case; wax impregnated; 53/64" long x 53/64" wide x 9/32" thick; axial leads	3rd counter storage cathode V-302-2	E-2 602L	60-20155234
C-319	3DK9075-13 —— ——	CAPACITOR: fixed; mica dielectric; 75 mmf. ±10%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Coupling V-301-4 plate to 500 microseconds marker	E-2 503M	60-00755417
C-320-1	3DA500-27 —— ——	CAPACITOR: fixed; paper dielectric; 5 mf. +20 —10%; 600 volts d-c working; metal case; oil impregnated; 2-1/2" long x 1" wide x 7/8" thick; two lugs on top of case	3rd counter cathode bypass V-301-4	M-1 306	305-1216
C-320-2		Same as C-320-1	4th counter cathode bypass V-301-5		
C-320-3		Same as C-320-1	Coupling amplitude balance circuit V-303-1		
C-320-4		Same as C-320-1	Coupling trace separation cathode follower V-301-8		
C-320-5		Same as C-320-1	Plate filter B-delay inverter V-303-3		
C-320-6		Same as C-320-1	Output coupling pedestal gen. V-301-15		
C-321-1	309150-30 —— ——	CAPACITOR: fixed; silver mica dielectric; 150 mmf. ±2%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Coupling 4th counter V-302-3 plate	E-2 603M	60-10155237
C-321-2		Same as C-321-1	Station selector shunt S-304-A2		
C-322	3K3020243 —— ——	CAPACITOR: fixed; silver mica dielectric; 2000 mmf. ±2%; 500 volts d-c working; bakelite case; wax impregnated; 53/64" long x 53/64" wide x 9/32" thick; axial leads	Cathode cond. storage 4th counter V-302-3	E-2 602L	60-20205234
C-323	3K2015122 —— ——	CAPACITOR: fixed; mica dielectric; 150 mmf. ±5%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Coupling 5th counter trigger circuit V-301-5	E-2 503M	60-10155317
C-324-1	3K4010332 —— ——	CAPACITOR: fixed; mica dielectric; .01 mf. ±5%; 300 volts d-c working; bakelite case; wax impregnated; 1-1/32" long x 41/64" wide x 11/32" thick; axial leads	Grid coupling 5th counter osc. V-301-5	C-3 3WLST	60-30103323
C-324-2		Same as C-324-1	Grid coupling 6th counter osc. V-301-6		

C-324-3		Same as C-324-1	Grid coupling 6th counter osc. V-301-6		
C-325-1	3DKA30-16 —— ——	CAPACITOR: fixed; moulded paper dielectric; .03 mf. ±20%; 600 volts d-c working; bakelite case; wax impregnated; 1-7/16" long x 3/4" wide x 3/8" thick; axial leads	6th counter delay V-301-6 T-302-6	S-14 MRMW6-.03-20	305-1417
C-325-2		Same as C-325-1	B-coarse delay circuit V-301-12		
C-325-3		Same as C-325-1	6th counter plate filter		
C-326	3K2047121 —— ——	CAPACITOR: fixed; mica dielectric; 470 mmf. ±10%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	E.J. sync. grid coupling V-301-4	E-2 503M	60-10475417
C-327-1	3K2024022 —— ——	CAPACITOR: fixed; mica dielectric; 24 mmf. ±5%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Coupling V-301-7	E-2 503M	60-00245317
C-327-2		Same as C-327-1	Coupling V-301-7		
C-328-2	3DA100-112 —— ——	CAPACITOR: fixed; moulded paper dielectric; .1 mf. +20% —10%; 400 volts d-c working; bakelite case; wax impregnated; 1-7/16" long x 3/4" wide x 3/8" thick; axial leads	Output coupling 6th counter osc. V-301-6	M-1 345-21	305-1086
C-328-3		Same as C-328-2	Coupling cathode follower V-301-8 to C.R.T. V-305		
C-328-4		Same as C-328-2	Coupling 10 microseconds marker amp. V-303-2 to C.R.T. V-305		
C-328-5		Same as C-328-2	Coupling video grid V-301-10		
C-328-6		Same as C-328-2	Grid bias filter A-delay V-301-13		
C-328-7		Same as C-328-2	Hor. centering adj. bypass V-302-7		
C-328-8		Same as C-328-2	Hor. centering fixed bypass V-302-7		
C-328-9		Same as C-328-2	Input coupling sweep sync. V-301-14		
C-328-10		Same as C-328-2	Input coupling sweep inverter V-301-14		
C-329	3K2022121 —— ——	CAPACITOR: fixed, mica dielectric; 220 mmf. ±10%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	C.R.T. grid bypass V-305	E-2 503M	60-10225417
C-330-1	3K2075022 —— ——	CAPACITOR: fixed; mica dielectric; 75 mmf. ±5%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Coupling, station selector circuit S-304-B1 rotor	E-2 503M	60-00755317

IMPORTANT

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TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 (MODIFICATION V) — MAJOR ASSEMBLY: INDICATOR ★ID-6B/APN-4

Reference Symbol	Army Stock Number Navy Type Number British Ref. Number	Name of Part and Description	Function	Mfr. and Designation	Drawing or Specification No.
C-331	3DK9056-9 —— ——	CAPACITOR: fixed; silver mica dielectric; 56 mmf. ±5%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	3rd counter L.R. cathode coupling V-302-5	E-2 603M	60-00565337
C-332-1	3DK9045V-2 —— ——	CAPACITOR: variable; air dielectric; 7 to 45 mmf. ±1 mmf. 500 volts a-c working; overall dimensions 15/16" x 41/64"; mounting dimensions 2 holes .120" D. 7/16" center to center	Station selector or shunt S-304-A2	E-1 TS2A	351-1048
C-332-2		Same as C-332-1	Station selector or shunt S-304-A2		
C-332-3		Same as C-332-1	Station selector or shunt S-304-A2		
C-333-1	3D9091-4 —— ——	CAPACITOR: fixed; silver mica dielectric; 91 mmf. ±2%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Shunt on station selector S-304-A2	E-2 603M	60-00915237
C-333-2		Same as C-333-1	Second counter sta. selector circuit		
C-334	3D9024-1 —— ——	CAPACITOR: fixed; silver mica dielectric; 24 mmf. ±5%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Shunt S-304-A2	E-2 603M	60-00245337
C-335-1	3DA2.200-1 —— ——	CAPACITOR: fixed; mica dielectric; 2200 mmf. ±10%; 500 volts d-c working; bakelite case; wax impregnated; 53/64" long x 53/64" wide x 9/32" thick; axial leads	Cathode bypass trace separation cathode follower V-301-8	E-2 502L	60-20225414
C-335-2		Same as C-335-1	Grid bypass V-303-3 delay inverter		
C-335-3		Same as C-335-1	A-delay to A-delay sync. grid coupling V-301-8		
C-336-1	3K3562232 —— ——	CAPACITOR: fixed; mica dielectric; 6200 mmf. ±5%; 500 volts d-c working; bakelite case; wax impregnated; 53/64" long x 53/64" wide x 11/32" thick; axial leads	Coupling of 50 and 500 microseconds marker input V-301-6	E-2 502L	60-20625324
C-336-2		Same as C-336-1	Feedback cond. B-fine delay V-301-11		
C-337-1	3K2010121 —— ——	CAPACITOR: fixed; mica dielectric; 100 mmf. ±10%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 8/32" thick; axial leads	Coupling Pedestal mixer V-301-9 to cathode V-301-10	E-2 503M	60-10105417
C-337-2		Same as C-337-1	Coupling A-delay sync. plate V-301-8		
C-337-3		Same as C-337-1	A-delay mixer tube V-303-3 grid coupling		

C-337-4		Same as C-337-1	A-delay mixer tube V-303-3 grid coupling		
C-338-1	3K2015121 —— ——	CAPACITOR: fixed; mica dielectric; 150 mmf. ±10%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Cathode cond. V-301-6	E-2 503M	60-10155417
C-338-2		Same as C-338-1	Coupling cond. E.J. sync. to B-coarse delay V-301-12		
C-339-1	3DKB2-13 —— ——	CAPACITOR: fixed; paper dielectric; 2mf. +20% —10%; 600 volts d-c working; metal case; oil impregnated; 2-3/4" long x 2" wide x 1-1/8" thick; two lugs on top of case	B-fine delay plate filter V-301-11	S-4 P-9068	305-1364
C-339-2		Same as C-339-1	B+ filter		
C-340	3K2020121 —— ——	CAPACITOR: fixed; mica dielectric; 200 mmf. ±10%; 500 volts d-c working; bakelite case; wax impregnated; 51/64" long x 15/32" wide x 7/32" thick; axial leads	Coupling input to B-fine V-301-11	E-2	60-10205417
C-341-1	3DKA100-159 —— ——	CAPACITOR: fixed; paper dielectric; .1 mf. +20% —10%; 600 volts d-c working; metal case; oil impregnated; 2-1/2" long x 1" wide x 3/4" thick; two lugs top of case	Output circuit B-coarse delay V-301-12	C-3 DYRT-6010-3	305-1215
C-341-2		Same as C-341-1	Sweep gen. screen bypass V-304		
C-342-1	3DA50-42 —— ——	CAPACITOR: fixed; moulded paper dielectric; .050000 mf. ±20%; 600 volts d-c working; bakelite case; wax impregnated; 1-7/16" long x 3/4" wide x 3/8" thick; axial leads	A-delay circuit V-301-13	M-1 345-22	305-1033
C-342-2		Same as C-342-1	Sweep inverter output circuit V-301-14		
C-342-3		Same as C-342-1	Sweep output circuit V-304		
C-343-1	3DA8D-1 —— ——	CAPACITOR: Multiple section; paper dielectric; oil filled; .06 x .1 mfd. +20% —10%; 1500 volts d-c working; metal case; 2-1/2" x 1" x 1-5/8"; two lugs; top of case	C.R.T. grid coupling V-305	C-3 PC-24040	305-1526
C-343-2		Same as C-343-1	C.R.T. grid bypass V-302-6		
C-344	3DKA500-108 —— ——	CAPACITOR: fixed; paper dielectric; .5 mf. ±10%; 2000 volts d-c working; metal case; oil impregnated; 3-3/4" long x 1-13/16" wide x 1-1/16" thick; 2 solder lug.	C.R.T. cathode bypass V-305	C-3 T20005- 2	305-1350
C-345	3K313222 —— ——	CAPACITORS: fixed; mica dielectric; 1300 mmf. ±5%; 500 volts d-c working; bakelite case; wax impregnated; 53/64" long x 53/64" wide x 9/32" thick; axial leads	Charging cond. sweep gen. V-304 circuit	E-2 502L	60-20135314
C-346	3K3022222 —— ——	CAPACITOR: fixed; mica dielectric; 2200 mmf. ±5%; 500 volts d-c working; bakelite case; wax impregnated; 53/64" long x 53/64" wide x 9/32" thick; axial leads	Pedestal gen. feedback cond.	E-2 502L	60-20225314
I-301	2Z5932 —— ——	LAMP: pilot; torpedo base; 3 volts; .19 amps T-332 bulb	Illumination	M-8	354-1411

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TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 (MODIFICATION V) **MAJOR ASSEMBLY: INDICATOR ★ID-6B/APN-4**

Symbol Reference	*Army Stock Number Navy Type Number British Ref. Number*	*Name of Part and Description*	*Function*	*Mfr. and Designation*	*Drawing or Specification No.*
J-301	2ZK3010.11 —— ——	CONNECTOR: male; consisting of hex. nut, brass; coaxial connector collar, steel (yellow); three laminated bakelite washers; two lock washers, steel; two hex. nuts, brass; coaxial connector stud, brass; soldering lug, phosphor bronze; threaded bushing, brass; 3 washers, steel; retaining clip, steel wire No. 18; overall width of connector approx. 3/4" x 1-5/16" long	Amplifier balance (yellow)	A-1 1CH/528	358-2832
J-302	2Z5531.3 —— ——	JACK: phone; single circuit; open; 1 contact washer insulated; mounting hole .312 diameter 15/16" x 7/16"	Pedestal output cathode V-301-9	A-5 358-4314	358-4314
J-303	2ZK3010.12 —— ——	CONNECTOR: male; consisting of hex. nut, brass; coaxial connector collar, steel (red); three laminated bakelite washers; two lock washers, steel; two hex. nuts, brass; coaxial connector; stud, brass; holding lug, phosphor bronze; threaded bushing, brass; 3 washers, steel; retaining clip, steel wire No. 18 overall width of connector approx. 3/4" x 1-5/16" long	Video input (red) S-303-B	A-1 10H/528	358-1266
J-304	2Z7116.32 —— ——	CONNECTOR: plug; female; bakelite; 6 contacts; flange mounting type; mounting dimensions four 3/16" D holes; 1-1/2" center to center	Voltage supply input	A-1 10H/394	358-7219
J-305	2Z3010.4 —— ——	CONNECTOR: male; consisting of hex. nut, brass; coaxial connector collar, steel (blue); three laminated bakelite washers; two lock washers, steel; two hex. nuts, brass; coaxial connector stud, brass; holding lug, phosphor bronze; threaded bushing, brass; 3 washers, steel; retaining clip, steel wire No. 18; overall width of connector approx. 3/4" x 1-5/16" long	Receiver gain (blue) R-374	A-1 10H/528	358-1305
L-301	3CK318-12 —— ——	COIL: crystal phasing choke; 68.5 mh; single pi winding; 1850 turns No. 38SSE wire; bakelite coil form 1-1/8" long x 1" O.D.; wax impregnated; d-c resistance 215 ohms; lug mounting; 2 holes 5/32" diameter	100 KC osc. grid V-301-1	S-6 352-1251	352-1251
L-302	3C318-36 —— ——	COIL: R.F. filter choke; 12 mh; spool winding; 1675 turns No. 36 Formex wire; coil form 27/32" long x 19/32" O.D.; varnish impregnated; d-c resistance 75 ohms; lead mounting	5th counter delay	S-6 352-1477	352-1477
R-301	3RC31BE103K —— ——	RESISTOR: fixed; metallized filament 10000 ohms; ±10%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Plate filter V-301-1	I-1 BT-1	66-3104344
R-302-1	3RC21BE105K —— ——	RESISTOR: fixed; metallized filament; 1 megohm; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3-1/6" diameter	Grid bias V-301-1	I-1 BT-1/2	66-5103344
R-302-2		Same as R-302-1	Grid load V-301-2		
R-302-3		Same as R-302-1	Plate isolation V-301-6		
R-302-4		Same as R-302-1	Grid load V-301-8		

R-302-5		Same as R-302-1	Grid load V-301-9		
R-302-6		Same as R-302-1	Grid load V-301-10		
R-302-7		Same as R-302-1	Grid load V-303-3		
R-302-8		Same as R-302-1	Diode load V-301-8		
R-302-9		Same as R-302-1	Cathode bias V-301-14		
R-303	2ZK7270.6 —— ——	POTENTIOMETER: 50,000 ohms ±20%; carbon; special "D" taper; 1/2 watt; metal case 1-1/8" diameter x 1/2" deep; mounting bushing 3/8" long; threaded 3/8"-32; shaft 1/8" long x .250" diameter	Phase shift V-303-2	C-1 35	353-5104
R-304-1	3RC21BE104K —— ——	RESISTOR: fixed; metallized filament; .1 megohm; +10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Plate load V-301-1	I-1 BT-1/2	66-4103344
R-304-2		Same as R-304-1	Plate grid load V-301-4		
R-304-5		Same as R-304-1	Cathode load V-301-8		
R-304-6		Same as R-304-1	Grid load V-303-2		
R-304-7		Same as R-304-1	Grid load V-303-2		
R-304-8		Same as R-304-1	Grid load V-301-11		
R-304-9		Same as R-304-1	Grid load V-301-12		
R-304-10		Same as R-304-1	Grid coupling V-301-13		
R-304-11		Same as R-304-1	Plate divider V-302-7		
R-304-12		Same as R-304-1	Plate load V-301-14		
R-304-13		Same as R-304-1	Grid coupling V-304		
R-304-14		Same as R-304-1	Grid load V-301-15		
R-305	3RC21BE333K —— ——	RESISTOR: fixed; metallized filament; 33000 ohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid load V-301-1	I-1 BT-1/2	66-3333344
R-306-1	3RC21BE222K —— ——	RESISTOR: fixed; metallized filament; 2200 ohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Cathode bias first counter V-301-2	I-1 BT-1/2	66-2223344
R-306-3		Same as R-306-1	Plate filter V-301-11		
R-306-4		Same as R-306-1	Cathode bias V-303-3		
R-306-5		Same as R-306-1	B-coarse divider network		
R-307	3Z6650-141 —— ——	RESISTOR: fixed; wire wound; 50,000 ohms; ±3%; 1 watt; solder lug termials; Glyptol coating; dimensions 1" x 9/16"	Grid load V-301-2	I-1 BT-1	353-1681
R-308	3RC41BE223J —— ——	RESISTOR: fixed; metallized filament; 22,000 ohms; ±5%; 2 watts; insulated; axial leads; wax impregnated; 1-3/4" x 5/16" diameter	Grid bias divider V-301-2	I-1 BT-2	66-3225244
R-309-1	2ZK7262-10M-2 —— ——	POTENTIOMETER: 10,000 ohms; +30 —10%; wire wound; linear taper; 4 watts; metal case 1-9/32" diameter x 19/32" deep; mounting bushing 5/16" long, threaded 3/8"-32; shaft 3/4" long x .250 diameter	First counter adjustment V-301-2	C-1 252	353-5096

IMPORTANT

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TABLE OF PARTS (Cont'd)

MODEL: RADIO SET *AN/APN-4 (MODIFICATION V) **MAJOR ASSEMBLY: INDICATOR *ID-6B/APN-4**

Reference Symbol	Army Stock Number Navy Type Number British Ref. Number	Name of Part and Description	Function	Mfr. and Designation	Drawing or Specification No.
R-309-2		Same as R-309-1	Third counter adjustment V-301-3		
R-309-3		Same as R-309-1	Fourth counter adjustment V-301-5		
R-309-4		Same as R-309-1	Sixth counter adjustment V-301-6		
R-309-5		Same as R-309-1	B-fine delay V-301-11		
R-309-6		Same as R-309-1	Coarse adjustment V-301-12		
R-310	3RC21BE272K —— ——	RESISTOR: fixed; metallized filament; 2700 ohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Damping second counter V-301-3	I-1 BT-1/2	66-2273344
R-311-1	3RC31BE223J —— ——	RESISTOR: fixed; metallized filament; 22000 ohms; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Cathode bias V-301-3	I-1 BT-1	66-3224244
R-311-4		Same as R-311-1	Plate load V-301-12		
R-311-5		Same as R-311-1	Plate load V-301-12		
R-311-6		Same as R-311-1	Plate load V-301-13		
R-311-7		Same as R-311-1	Plate load V-301-13		
R-312	3RC41BE473J —— ——	RESISTOR: fixed; metallized filament; 47000 ohms; ±5%; 2 watts; insulated; axial leads; wax impregnated; 1-3/4 x 5/16" diameter	Cathode bias divider V-301-4	BT-2	66-3475244
R-313-1	3RC31BE822J —— ——	RESISTOR: fixed; metallized filament; 8200 ohms; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Divider cathode	I-1 BT-1	66-282424
R-313-2		Same as R-313-1	E.J. cathode		
R-314	3RC41BE333J —— ——	RESISTOR: fixed; metallized filament; 33,000 ohms; ±5%; 2 watts; insulated; axial leads; wax impregnated; 1-3/4" x 5/16" diameter	Cathode bias V-301-5	I-1 BT-2	66-3335244
R-315-1	3RC41BE153J —— ——	RESISTOR: fixed; metallized filament; 15,000 ohms; ±5%; 2 watts; insulated; axial leads; wax impregnated; 1-3/4 x 5/16" diameter	Cathode bias divider V-301-5	I-1 BT-2	66-3155244
R-315-2		Same as R-315-1	Grid bias divider V-301-6		
R-316-1	3Z6739J9 —— ——	RESISTOR: fixed; wire wound; .399 megohms; ±3%; 1 watt; solder lug terminals; Glyptol coating; dimensions 1" x 9/16"	Grid load V-301-5	I-1 BT-1	353-1887 353-1687
R-316-2		Not used			
R-316-3		Same as R-316-1	Grid load V-301-6		
R-316-4		Same as R-316-1	Grid load V-301-6		

R-319	3RC41BE103J —— ——	RESISTOR: fixed; metallized filament; 10000 ohms; ±5% 2 watts; insulated; axial leads; wax impregnated 1-3/4" x 5/16" diameter	Bias dropping V-310-6	I-1 BT-2	66-3105244
R-320	3RC31BE152J —— ——	RESISTOR: fixed; metallized filament; 1500 ohms; ±5%; 1 watt; insulated; axial leads; wax impregnated 1-1/4" x 1/4" diameter	Grid bias	I-1 BT-1	66-2154244
R-322	2Z7280-91 —— ——	POTENTIOMETER: 10000 ohms; ±20%; wire wound; linear taper; 4 watts; metal case 1-9/32" diameter x 19/32" deep; mounting bushing 5/16" long, threaded 3/8"-32; shaft 7/16" long x .250 diameter	Sixth counter adjustment V-301-6	C-1 252	353-5226
R-324	3RC21BE564J —— ——	RESISTOR: fixed; metallized filament; .56 megohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Cathode bias V-301-4	I-1 BT-1/2	66-4563344
R-325-1	3RC21BE104J —— ——	RESISTOR: fixed; metallized filament; .1 megohm; ±5%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid load V-301-7	I-1 BT-1/2	66-4103244
R-325-2		Same as R-325-1	Grid load V-301-7		
R-326-1	3RC21BE394J —— ——	RESISTOR: fixed; metallized filament; .39 megohms; ±5%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid bias network V-301-7	I-1 BT-1/2	66-4393244
R-326-2		Same as R-326-1	Grid bias network V-301-7		
R-326-6		Same as R-326-1	Grid load V-301-6		
R-327-2	3RC31BE104K —— ——	RESISTOR: fixed; metallized filament; 1 megohm; ±10%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Plate divider network V-302-6	I-1 BT-1	66-4104344
R-328-1	3RC31BE393J —— ——	RESISTOR: fixed; metallized filament; 39,000 ohms; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Plate load V-301-7	I-1 BT-1	66-3394244
R-328-2		Same as R-328-1	Plate load V-301-7		
R-328-3		Same as R-328-1	Plate load V-301-15		
R-329	2ZK7262-5M.3 —— ——	POTENTIOMETER: 5000 ohms; ±20%; wire wound; linear taper; 4 watts; metal case 1-9/32" diameter x 19/32" deep; mounting bushing 3/8" long; threaded 3/8"-32; shaft 1/2" long x .250" diameter	Cathode bias V-301-7	C-1 252	353-5098
R-330-1	3RC21BE106K —— ——	RESISTOR: fixed; metallized filament; 10 megohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Left-right switch V-302-2	I-1 BT-1/2	66-6103344
R-330-2		Same as R-330-1	Diode load V-302-7		
R-330-3		Same as R-330-1	Diode load V-302-7		
R-331	3RC21BE224J —— ——	RESISTOR: fixed; metallized filament; .22 megohm; ±5%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid bias V-302-2	I-1 BT-1/2	66-4223244
R-332-1	3RC21BE124J —— ——	RESISTOR: fixed; metallized filament; .12 megohm; ±5%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Cathode bias V-302-2	I-1 BT-1/2	66-4123244

IMPORTANT

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Reference Symbol	*Army Stock Number Navy Type Number British Ref. Number*	*Name of Part and Description*	*Function*	*Mfr. and Designation*	*Drawing or Specification No.*
R-332-2		Same as R-332-1	Grid coupling sweep speed switch, contact No. 4		
R-333-1	3RC21BE154K —— ——	RESISTOR: fixed; metallized filament; .15 megohm; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid coupling V-303-1	I-1 BT-1/2	66-4153344
R-333-2		Same as R-333-1	Grid coupling V-303-1		
R-334-1	3RC21BE474K —— ——	RESISTOR: fixed; metallized filament; .47 megohm; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Cathode bias V-303-1	I-1 BT-1/2	66-4473344
R-334-2		Same as R-334-1	Cathode bias V-303-2		
R-334-3		Same as R-334-1	Vertical center divider network V-303		
R-334-4		Same as R-334-1	Plate load V-302-7		
R-334-5		Same as R-334-1	Cathode bias network V-301-6		
R-335	2ZK7262-500M.5 —— ——	POTENTIOMETER: .5 megohms; ±20%; carbon; special "D" taper; 1/2 watt; metal case 1-1/8" diameter x 1/2" deep; mounting bushing 5/16" long; threaded 3/8"-32; shaft 3/8" long x .250" diameter	Amplitude balance V-303-1	C-1 35	353-5100
R-336-1	2ZK7262-500M.4 —— ——	POTENTIOMETER: .5 megohms; ±20%; carbon; special "D" taper; 1/2 watt; metal case 1-1/8" diameter x 1/2" deep; mounting bushing 3/8" long; threaded 3/8"-32; shaft length 1/8" long x .250" diameter	Trace separation V-303-1	C-1 35	353-5079
R-336-2		Same as R-336-1	Trace separation V-303-1		
R-336-3		Same as R-336-1	Trace separation V-303-1		
R-337-1	3RC21BE224K —— ——	RESISTOR: fixed; metallized filament; .22 megohm; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Plate decoupling V-301-8	I-1 BT-1/2	66-4223344
R-337-2		Same as R-337-1	Vertical center divider network V-303		
R-337-3		Same as R-337-1	Plate feedback V-301-14		
R-338	3RC21BE274K —— ——	RESISTOR: fixed; metallized filament; .27 megohm; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Plate load V-303-2	I-1 BT-1/2	66-4273344
R-339-1	3RC21BE473K —— ——	RESISTOR: fixed; metallized filament; 47,000 ohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Cathode bias V-301-9	I-1 BT-1/2	66-3473344

R-339-2		Same as R-339-1	Grid coupling V-303-3		
R-340-1	3RC31BE472J —— ——	RESISTOR: fixed; metallized filament; 4700 ohms; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Plate load V-301-9	I-1 BT-1	66-2474244
R-340-2		Same as R-340-1	Plate load V-301-9		
R-341	3RC21BE102J —— ——	RESISTOR: fixed; metallized filament; 1000 ohms; ±5%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Cathode bias V-301-9	I-1 BT-1/2	66-2103244
R-342-1	3RC21BE332K —— ——	RESISTOR: fixed; metallized filament; 3300 ohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Marker load V-301-6	I-1 BT-1/2	66-2333344
R-342-2		Same as R-342-1	B-coarse delay divider network		
R-343	3RC21BE333J —— ——	RESISTOR: fixed; metallized filament; 33,000 ohms; ±5%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Cathode bias V-301-6	I-1 BT-1/2	66-3333244
R-344-1	3RC21BE105J —— ——	RESISTOR: fixed; metallized filament; 1 megohm; ±5%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 5/16" diameter	Cathode bias divider V-301-6	I-1 BT-1/2	66-5103244
R-344-2		Same as R-344-1	Grid bias V-301-11		
R-345-1	3RC21BE152J —— ——	RESISTOR: fixed; metallized filament; 1500 ohms; ±5%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Cathode bias V-301-10	I-1 BT-1/2	66-2153244
R-345-2		Same as R-345-1	Sweep speed; marker switch tap No. 6		
R-345-3		Same as R-345-1	Damping plate circuit V-301-5		
R-346-1	3RC31BE103J —— ——	RESISTOR: fixed; metallized filament; 10,000 ohms; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Cathode bias V-301-11	I-1 BT-1	66-3104244
R-346-2		Same as R-346-1	Cathode bias V-301-12		
R-346-3		Same as R-346-1	Cathode bias V-301-13		
R-347	3RC31BE154J —— ——	RESISTOR: fixed; metallized filament; 150 megohms; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Grid dropping network V-301-11	I-1 BT-1	66-4154244
R-348-1	2Z7269.112 —— ——	POTENTIOMETER: 10,000 ohms; ±20%; carbon; special "D" taper; 2 watts; metal case 1-1/8" diameter x 1/2" deep; mounting bushing 3/8" long, threaded 3/8"-32; shaft 1/8" long x .250" diameter	B-fine adjustment V-301-11	C-1 35	353-5216
R-348-2		Same as R-348-1	B-coarse adjustment V-301-12		
R-349-1	3RC21BE153K —— ——	RESISTOR: fixed; metallized filament; 15,000 ohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Cathode bias V-301-6	I-1 BT-1/2	66-3153344
R-349-2		Same as R-349-1	Bias network V-301-11		

IMPORTANT

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TABLE OF PARTS (Cont'd)

Reference Symbol	Army Stock Number / Navy Type Number / British Ref. Number	Name of Part and Description	Function	Mfr. and Designation	Drawing or Specification No.
R-350-1	3RC21BE472K —— ——	RESISTOR: fixed; metallized filament; 4700 ohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	B-fine delay divider network	I-1 BT-1/2	66-2473344
R-350-2		Same as R-350-1	Filter delay inverter V-303-3		
R-350-3		Same as R-350-1	Grid load V-303-3		
R-351-1	2ZK7262-100M.2 for 100K —— ——	POTENTIOMETER: .15 megohms; ±10%; carbon; special "D" taper; 1/2 watt; metal case 1-1/8" diameter x 1/2" deep; mounting bushing 3/8" long; threaded 3/8"-32; shaft 1/8" long x .250" diameter	B-fine adjustment V-301-11	C-1 35	353-5078
R-351-2		Same as R-351-1	B-coarse adjustment V-301-12		
R-351-3		Same as R-351-1	Plate decoupling V-301-15		
R-352	3RC31BE223K —— ——	RESISTOR: fixed; metallized filament; 22,000 ohms; ±10%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Plate load V-303-13	I-1 BT-1	66-3224344
R-353-1	3RC21BE395J —— ——	RESISTOR: fixed; metallized filament; 3.9 megohms; ±5%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid bias V-301-12	I-1 BT-1/2	66-5393244
R-353-2		Same as R-353-1	Grid bias V-301-13		
R-354	3RC21BE334K —— ——	RESISTOR: fixed; metallized filament; .33 megohm; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid coupling V-301-12	I-1 BT-1/2	66-4333344
R-355-1	3RC21BE393K —— ——	RESISTOR: fixed; metallized filament; 39,000 ohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Coupling V-301-7 to V-301-12	I-1 BT-1/2	66-3393344
R-355-2		Same as R-355-1	Coupling V-301-7 to V-303-1		
R-355-3		Same as R-355-1	Plate load V-301-15		
R-356	3RC31BE104J —— ——	RESISTOR: fixed; metallized filament; 1 megohm; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Grid bias divider network V-301-12	I-1 BT-1	66-4104244
R-357-1	3Z6003C3-12 —— ——	RESISTOR: fixed; wire wound; 33 ohms; ±10%; 1/2 watt; axial leads; wax impregnated; 5/8" x 3/16" diameter	B-coarse delay station selector switch contact No. 6	I-1 BT-1/2	66-0333364
R-357-2		Same as R-357-1	B-coarse delay station selector switch contact No. 7		
R-357-3		Same as R-357-1	B-coarse delay station selector switch contact No. 6		

R-357-4		Same as R-357-1	B-coarse delay station selector switch contact No. 5		
R-357-5		Same as R-357-1	B-coarse delay station selector switch contact No. 4		
R-357-6		Same as R-357-1	B-coarse delay station selector switch contact No. 3		
R-357-7		Same as R-357-1	B-coarse delay station selector switch contact No. 2		
R-357-8		Same as R-357-1	Tap No. 3 on T-303		
R-357-9		Same as R-357-1	Tap No. 4 on T-303		
R-358	3RC31BE274J —— ——	RESISTOR: fixed; metallized filament; .27 megohm; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Grid bias network V-301-13	I-1 BT-1	66-4274244
R-359	3RC21BE393J —— ——	RESISTOR: fixed; metallized filament; 39000 ohms; ±5%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid divider bias network V-301-13	I-1 BT-1/2	66-3393244
R-360-1	3RC21BE184K —— ——	RESISTOR: fixed; metallized filament; .18 megohm; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid load V-301-13	I-1 BT-1/2	66-4183344
R-360-2		Same as R-360-1	Plate coupling V-304 to V-301-14		
R-361-1	3RC31BE473K —— ——	RESISTOR: fixed; metallized filament; 47,000 ohms; ±10%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Plate load V-303-3	I-1 BT-1	66-3474344
R-361-2		Same as R-361-1	Plate load V-304		
R-361-3		Same as R-361-1	Screen dropping V-304		
R-362-1	3RC21BE475K —— ——	RESISTOR: fixed; metallized filament; 4.7 megohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid bias V-302-6	I-1 BT-1/2	66-5473344
R-362-2		Same as R-362-1	Vertical deflection plate V-305		
R-362-3		Same as R-362-1	Vertical deflection plate V-305		
R-362-4		Same as R-362-1	Grid bias V-301-9		
R-363-1	2ZK7269-1000M.2 —— ——	POTENTIOMETER: 1 megohm; ±20%; carbon; special "D" taper; 1/2 watt; metal case 1-1/8" diameter x 1/2" deep; mounting bushing 3/8" long; threaded 3/8"-32; shaft 2-1/4" long x .250" diameter	Brilliance control V-305	C-1 35	353-5099
R-363-2		Same as R-363-1	Focus V-305		
R-364	3RC31BE394K —— ——	RESISTOR: fixed; metallized filament; .39 megohm; ±10%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Intensity divider V-302-6	I-1 BT-1	66-4394344

IMPORTANT

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TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 (MODIFICATION V) **MAJOR ASSEMBLY: INDICATOR ★ID-6B/APN-4**

Reference Symbol	*Army Stock Number Navy Type Number British Ref. Number*	*Name of Part and Description*	*Function*	*Mfr. and Designation*	*Drawing or Specification No.*
R-365-1	3RC31BE474K —— ——	RESISTOR: fixed; metallized filament; .47 megohm; ±10%; 1 watt; insulated; axial leads; wax impregnated: 1-1/4" x 1/4" diameter	Focus control shunt V-302-6	I-1 BT-1	66-4474344
R-365-2		Same as R-365-1	Focus control dropping V-302-6		
R-365-3		Same as R-365-1	Focus control dropping V-302-6		
R-366-1	2ZK7269-1000M.1 —— ——	POTENTIOMETER: 1 megohm; ±20%; carbon; special "D" taper; 1/2 watt; metal case 1-1/8" diameter x 1/2" deep; mounting bushing 3/8" long; threaded 3/8"-32; shaft 1/8" long x .250" diameter	Auxiliary focus V-305	C-1 35	353-5077
R-366-2		Same is R-366-1	Vertical center V-305		
R-366-3		Same is R-366-1	Horizontal center V-302-7		
R-366-4		Same as R-366-1	Fast sweep amplitude S-303-G		
R-366-5		Same as R-366-1	Medium sweep amplitude S-303-G		
R-366-6		Same as R-366-1	Slow sweep amplitude S-303-G		
R-367-1	3RC21BE225K —— ——	RESISTOR: fixed; metallized filament; 2.2 megohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Diode load V-301-14	I-1 BT-1/2	66-5223344
R-367-2		Same as R-367-1	Grid load V-301-14		
R-368	3RC21BE273J —— ——	RESISTOR: fixed; metallized filament; 27000 ohms; ±5%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Gric bias divider V-304	I-1 BT-1/2	66-3273244
R-369	3RC21BE225J —— ——	RESISTOR: fixed; metallized filament; 2.2 megohms; ±5%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid dropping network V-304	I-1 BT-1/2	66-5223244
R-370	3RC21BE155K —— ——	RESISTOR: Fixed; metallized filament; 1.5 megohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Diode load V-301-10	I-1 BT-1/2	66-5153344
R-371	3ZK6560-14 —— ——	RESISTOR: fixed; metallized filament; 6000 ohms; ±5%; 1 watt; insulated; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Cathode bias V-301-15	I-1 BT-1	66-2604244
R-372	3RC21BE824J —— ——	RESISTOR: fixed; metallized filament; .82 megohm; ±5%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid coupling V-301-15	I-1 BT-1/2	66-4823244

R-373	3RC21BE155J —— ——	RESISTOR: fixed; metallized filament; 1.5 megohm; ±5%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Grid bias divider network V-301-15	I-1 BT-1/2	66-5153244
R-374	2Z7280-71 —— ——	POTENTIOMETER: 3000 ohms; ±20%; wire wound; linear taper; 4 watts; metal case 1-9/32" diameter x 19/32" deep; mounting bushing 5/16" long; threaded 3/8"-32; shaft 11/16" long x .250 diameter.	Receiver gain J-305	C-1 252	353-5214
R-375	3RC21BE471K —— ——	RESISTOR: fixed; metallized filament; 470 ohms; ±10%; 1/2 watt; insulated; axial leads; wax impregnated; 5/8" x 3/16" diameter	Cathode bias V-301-14 (section B)	I-1 BT-1/2	66-1473344
R-376	(Not in base spares)	RESISTOR: fixed; wire wound; 20 ohms; ±10%; 1 watt; axial leads; wax impregnated; 1-1/4" x 1/4" diameter	Dial light series dropping resistor	I-1 BT-1	66-0204340
R-377	2Z7277.66 —— ——	POTENTIOMETER: 75 ohms; ±20%; wire wound; linear taper; 2 watts; metal case 1-1/8" diameter x 9/16" deep; mounting bushing 5/16" long; threaded 3/8"-32; shaft 11/16" long x .250 diameter.	Dial light I-301 brilliance	C-1 2252	353-5229
S-301	3Z9580-10.1 —— ——	SWITCH: left-right; 9 contacts, 3 position; bakelite insulation; overall dimensions 1-1/2" x 1-7/8" x 7/16"; mounting dimensions two .144 D holes; 1.625" center to center.	Left-right	C-5 N7344X	452-1226
S-302	3Z9859-19.1 —— ——	SWITCH: toggle; double pole; double throw; bakelite insulation; overall dimensions 1-5/16" x 3/4" x 25/32"; mounting dimensions 15/32" hole	Hi-lo	C-6 8825-K2	452-1228
S-303 ABCD	3Z9825-75.3 —— ——	SWITCH: selector; 5 sections; 12 contacts; bakelite insulation; overall dimensions; 3-1/2" x 1-7/8" diameter; shaft 3-13/16" long x .250" diameter; mounting dimensions 3/8" hole	Sweep speed	O-1 27009-H3	452-1224
S-303 EFG	3Z9825-75.4 —— ——	SWITCH: selector; 5 sections; 12 contacts; bakelite insulation; overall dimensions; 2-3/16" x 1-9/16"; shaft 8-13/32" long x .250 diameter; mounting dimensions 3/8" hole	Sweep speed	O-1 27008-H3	452-1222
S-304	3Z9825-75.2 —— ——	SWITCH: selector; 5 sections; 12 contacts; bakelite insulation; overall dimensions 1-3/8" x 1-7/8"; mounting dimensions 3/8" hole; shaft 2-1/4" long x .250" diameter	Station selector	O-1 27106-H3	452-1221
T-301	2C1565-6B/C1 —— ——	TRANSFORMERS: osc.; 100KC; primary—320 turns of No. 32 wire; S.N.E. 1150 mh; secondary—140 turns No .32 wire; S.N.E.; 330 mh; bakelite coil form 2" long x 1/2" diameter; wax impregnated; metal case; mounted on shelf	100K osc. plate V-301-1	S-6 358-8598	358-8598
T-302-1	2Z9638-19 —— ——	TRANSFORMER: counter; primary; 214 turns of No. 37 wire; enameled; 22 ohms d.c. resistance ±15%; secondary 292 turns of No. 37 wire; enameled; 33 ohms d.c. resistance ±15%; leakage between either winding or winding and case greater than 10,000 megohms; laminated core; mounting dimensions; 2-3/8" long x 1-3/8" wide x 1-21/32" thick; steel case; two mounting holes .187" D., 2" center to center	1st counter	M-3 1-418R	352-7224
T-302-2		Same as T-302-1	2nd counter		
T-302-3		Same as T-302-1	3rd counter		

IMPORTANT

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TABLE OF PARTS (Cont'd)

MODEL: RADIO SET *AN/APN-4 (MODIFICATION V) MAJOR ASSEMBLY: INDICATOR *ID-6B/APN-4

Reference Symbol	Army Stock Number Navy Type Number British Ref. Number	Name of Part and Description	Function	Mfr. and Designation	Drawing or Specification No.
T-302-4		Same as T-302-1	4th counter		
T-302-5		Same as T-302-1	5th counter		
T-302-6		Same as T-302-1	6th counter		
T-303	2Z9617-30 —— ——	TRANSFORMER: Filament; primary 2 terminals; 80 V.A.C.; 400 to 2400 cycles; secondary; 2 terminals; 6.8 V.A.C.; 15 amperes; secondary; 2 terminals; 6.3 V.A.C.; .9 ampere; six solder terminal; steel case; overall dimensions 2-7/16" x 2-1/2" x 2-1/4"; mounting flange 3" x 2-1/2"; 6 holes 3/16" diameter; 7/8" x 2-11/16" center to center	Heater supply tubes	M-3 1-417R	352-7198
V-301-1	(Not in base spares.)	VACUUM TUBE: type 68N7GT; twin triode; octal base	100 KC Osc. and Limiter	K-2 6SN7GT	354-1321
V-301-2		Same as V-301-1	Trigger; First Counter		
V-301-3		Same as V-301-1	2nd, 3rd counters		
V-301-4		Same as V-301-1	3rd counter, E-J sync.		
V-301-5		Same as V-301-1	4th, 5th counters		
V-301-6		Same as V-301-1	6th counter		
V-301-7		Same as V-301-1	E-J osc.		
V-301-8		Same as V-301-1	Trace separation A delay sync.		
V-301-9		Same as V-301-1	Pedestal, marker, mixer		
V-301-10		Same as V-301-1	Video, input leveler		
V-301-11		Same as V-301-1	B fine delay		
V-301-12		Same as V-301-1	B coarse delay		
V-301-13		Same as V-301-1	A delay		
V-301-14		Same as V-301-1	Switch sync.		
V-301-15		Same as V-301-1	Ped. generator		
V-302-1	(Not in base spares)	Vacuum tube; type 6H6GT; twin diode, octal base	Second counter diode	N-1 6H6GT	354-1331
V-302-2		Same as V-302-1	Left-right diode		
V-302-3		Same as V-302-1	4th counter diode		
V-302-4		Same as V-302-1	2nd counter feedback		
V-302-5		Same as V-302-1	3rd counter feedback		
V-302-6		Same as V-302-1	CR tube blanking		
V-302-7		Same as V-302-1	Sweep leveler		
V-303-1	(Not in base spares)	VACUUM TUBE: Type 6SL7GT; twin triode; octal base	Amplifier balance	K-2 6SL7GT	354-1307

V-303-2		Same as V-303-1	10 MS marker amplifier		
V-303-3		Same as V-303-1	B delay inverter V-303-3		
V-304	(Not in base spares)	VACUUM TUBE: Type 6SJ7GT; pentode; octal base	Sweep generator	R-6 6SJ7GT	354-1330
V-305	(Not in base spares)	VACUUM TUBE: Type 5CP1; cathode ray; 14 contact; flush mounting	CR tube	N-1 5CP1	354-1361
X-301	2ZK8761-16 —— ——	SOCKET: Crystal holder; low loss bakelite; wax impregnated; 3 receptacle; flange mounting; mounting dimensions; two .156D holes 1.875 center to center	Crystal holder V-301-1	C-2 4033WI	257-6072
X-304		SOCKET: pilot; brass; .015 phosphor bronze contact spring, silver plated; screw mounting; .187 D; 3/8"-32 thread; mounting dimensions 13/18" x 1-1/8"	Dial light	C-2 2403	756-1039
X-301	2ZK3502-100 —— ——	CRYSTAL: 100 KC; 3 prongs; overall dimensions 2-11/16" x 1-19/32" x 1-3/16	Frequency determining standard	P-1 455-1040	455-1040
X-302-1	2Z8650.1 —— ——	SOCKET: Tube; phenolic; wax impregnated; 8 receptacles; flange mounting; mounting dimensions two .140" D holes 1.312 center to center	Octal socket	O-2 9919	257-6041
X-302-2		Same as X-302-1			
X-302-3		Same as X-302-1			
X-302-4		Same as X-302-1			
X-302-5		Same as X-302-1			
X-302-6		Same as X-302-1			
X-302-7		Same as X-302-1			
X-302-8		Same as X-302-1			
X-302-9		Same as X-302-1			
X-302-10		Same as X-302-1			
X-302-11		Same as X-302-1			
X-302-12		Same as X-302-1			
X-302-13		Same as X-302-1			
X-302-14		Same as X-302-1			
X-302-15		Same as X-302-1			
X-302-16		Same as X-302-1			
X-302-17		Same as X-302-1			
X-302-18		Same as X-302-1			
X-302-19		Same as X-302-1			
X-302-20		Same as X-302-1			
X-302-21		Same as X-302-1			
X-302-22		Same as X-302-1			
X-302-23		Same as X-302-1			

IMPORTANT

Circuit reference symbols in this table of parts duplicate themselves.
Be sure to check nomenclature of the particular major assembly.

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 (MODIFICATION V) MAJOR ASSEMBLY: INDICATOR ★ID-6B/APN-4

Reference Symbol	Army Stock Number Navy Type Number British Ref. Number	Name of Part and Description	Function	Mfr. and Designation	Drawing or Specification No.
X-302-24		Same as X-302-1			
X-302-25		Same as X-302-1			
X-302-26		Same as X-302-1			
X-303	2Z8684-14 —— ——	SOCKET: tube; mica filled bakelite; 14 contacts; flush mounting type; mounting dimensions 1-1/8" x 2.219"	CR tube	O-2 9453	257-6120

MODEL: RADIO SET ★AN/APN-4 (MODIFICATION V) MAJOR ASSEMBLY: MISCELLANEOUS

Reference Symbol	Army Stock Number Navy Type Number British Ref. Number	Name of Part and Description	Function	Mfr. and Designation	Drawing or Specification No.
	(Not in base spares)	CLAMP: upper bracket has 1.078 R. curve; 3-1/32" long x 1/2" wide x .0598; steel; 2 holes in outer ends .156" diameter; zinc plate; eronak treatment	C.R. tube support	P-1 258-7973	258-7973
	(Not in base spares)	CLAMPING FOOT: yellow brass; black nickle finish; 1-1/32" x 7/16" x 3/32"; 2 holes .144" diameter spaced .375" center to center; foot extends 6/32"	C.R. tube	P-1 258-1203	258-1203
	(Not in base spares)	CUSHION: black felt ring; 4-3/4" O.D. x 3/16" wide x 3/4" thick	C.R. tube support	P-1 257-7970	257-7970
	(Not in base spares)	FELT PAD: wool felt; 3-1/8" x 1/2" x 1/16"; weight No. 100	Power unit	P-1 257-7969	257-7969
	(Not in base spares)	FLEXIBLE COUPLING: for 1/4" shaft; 1-3/32" diameter x 5/8" wide; 4 set screws No. 8-32 x 1/4" long; hex., socket headless; steel; zinc plated	Shaft coupling	O-1	358-3624
	6ZK5019 —— ——	HANDLE: steel, black nickel finish; 4" long; 1-1/4" hand clearance, 5/16" diameter; mounting holes .136" diameter No. 8-32 tap, 2 holes	Front panel	R-12 258-1231	258-1231
	2Z5844-14 —— ——	KNOB: knurled, black phenolic or moulded wood flour compound; 23/32" long; 1" diameter with .253" diameter shaft hole tapped for 2 No. 8-32 set screws; Allen head; cup point 3/16" long; brass insert 3/8" diameter, 11/32" long	Crystal	W-11 257-7813	257-7813
	225822-13 —— ——	KNOB: pointer type; black bakelite; 1-1/4" pointer length 5/8" thick with .252" diameter shaft hole tapped for a No. 8-32 set screw, hexagon headless, cup point 7/16" long brass insert 3/8" long, 3/8" diameter	Front panel	K-1 S-293-3L	358-4274
	2Z5788-42 —— ——	KNOB: black resinvox, 9/16" long, .437" diameter; rectangular shaft pole .375" length, .198" wide, .054" thick; tapped for a No. 8-32 hexagon socket headless cupped point 3/16" long, zinc plated set screw	Left-Right	O-10 Moulded 257-4296	257-4296
	2Z5788-53 —— ——	KNOB ASSY: fluted; black bakelite; 1-5/8" diameter x 3/4" thick; shaft diameter 1/4" brass insert approx. 9/16" x 9/16" hex socket headless set screw No. 8-32, 3/16" long, cupped point; three holes No. 2-56 tap 3/8" full thread for mounting dial plate	Tuning adjustment	P-1 257-4299	257-4299

2ZK5822-23 —— ——	KNOB: knurled black tenite 9/16" long, 3/4" diameter; with 1/4" diameter shaft hole; tapped for 2 No. 8-32 set screws; hex socket headless, 1/8" long, cup point, zinc plated brass insert	Focus intensity	K-1 S-230-3	257-4238
6Z70006C-1 —— ——	LOCKWASHER: standard steel, special zinc finish; inside diameter .151"; outside diameter .237"; thickness 1/32"; width 1/16"	For mounting counter transformer 352-7224	P-1 1W35045FA33	1W3504FA33
6L6632-6.8Z —— ——	SCREW: steel; special zinc finish; slotted straight side binding machine screw 3/8" length; 32 threads per inch	For mounting counter transformer 352-7224	P-1 1W10798FA33	1W10798FA33
2Z8304.45 —— ——	SHIELD ASSY: C.R. tube; Aimac iron .032" thick; consisting of C.R.T. shield clamp; tube shields end, center and base; 4 grommet cushions; neoprene, earless fuse clip No. 125-2; approximate overall length 13-5/8" x 2nd width 5-1/2" x base width 2-9/16"	C.R. tube	S-16 358-8744	756-1406
	SUPPORT ASSY: bracket has 1-5/64" R curve; 2 cinch nuts at its outer ends; base is spotwelded to center of bracket; No. 16 Ga. steel, zinc plate, cronak treatment; 3-1/32" x 1" x .0598"	Rear C.R. tube support	P-1 358-8487	358-8487
2Z9403.81 —— ——	TERMINAL PANEL: bakelite; wax impregnated; 1-3/4" x 1-7/8" x 3/32"; 3 solder lug terminals; 2 steel, angle mounting brackets; zinc plated; 1-1/4" x 5/16" x 1/16"; 2 mounting holes tapped No. 6-32; 1.25" center to center	Wiring purposes left shelf bottom	C-2 9096W1	358-8539
2Z9424-12 —— ——	TERMINAL PANELS: bakelite; wax impregnated; 4-1/2" x 1-3/8" x 3/32"; double row of 12 solder lug terminals each; 2 .156 D mounting holes in horizontal plane 3" center to center	Wiring purposes left shelf front	C-2 9161WJ	358-8536
2Z9418.24 —— ——	TERMINAL PANEL: bakelite; wax impregnated; 3-1/2" x 1-3/8" x 3/32"; double row of 9 solder lug terminals each; 2.156 D mounting holes in horizontal plane; 1.875" center to center	Wiring purposes right shelf front	C-2 9103WI U-1 152924	358-8540
2Z9418.25 —— ——	TERMINAL PANEL: bakelite; wax impregnated; 3-7/8" x 1-3/8" x 3/32"; double row of solder lug terminals, 8 in one, 10 in other; 3 .156 D mounting holes in horizontal plane 1-1/8" center to center	Wiring purposes left shelf rear	C-2 9162WI U-1 152920	358-8537
2Z9416.32 —— ——	TERMINAL PANEL: Bakelite; wax impregnated; 3-3/8" x 1-7/8" x 7/32"; double row of solder lug terminals; 7 in one; 9 in other; 2 steel angle mounting brackets, zinc plated; 5/16" x 1-1/4" x 1/16"; 2 mounting holes tapped No. 6-32; 3 inches center to center	Wiring purposes top front chassis	S-2 9099WI U-1 152937	358-8544
2Z9409.27 —— ——	TERMINAL PANEL: bakelite; wax impregnated; 1-3/4" x 1-7/8" x 3/32"; 8 solder lug terminals; 8 .101 D Holes adjacent to solder lug terminals; cinch lug bent 90° mounted in center of panel on top edge of mounting bracket; 2 steel angle mounting brackets; cadmium plated; 1-5/8" x 5/16" x 1/16"; 2 mounting holes tapped No. 6-32; 17/32" center to center	Wiring purposes	C-2 9125WI U-1 152939	358-8318

IMPORTANT

Circuit reference symbols in this table of parts duplicate themselves. Be sure to check nomenclature of the particular major assembly.

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 (MODIFICATION V) **MAJOR ASSEMBLY: MISCELLANEOUS**

Reference Symbol	Army Stock Number Navy Type Number British Ref. Number	Name of Part and Description	Function	Mfr. and Designation	Drawing or Specification No.
	2Z9423.2 —— ——	TERMINAL PANEL: bakelite; wax impregnated; 5" x 1-3/8" x 3/32"; double row of solder lug terminals; 13 in one, 11 in other; 1 terminal is molded; 2 steel angle mounting brackets, cadmium plated; 1-1/4" x 5/16" x 1/16"; 2 mounting holes tapped No. 6-32; 3" center to center	Wiring purpose right front chassis	C-2 9130WI U-1 152936	358-8554
	2Z9422.9 —— ——	TERMINAL PANEL: bakelite; wax impregnated; 5" x 1-3/8" x 3/32"; double row of solder lug terminals; 13 in one, 11 in other; 2 terminals are molded; 2 steel angle mounting brackets; cadmium plated; 1-1/4" x 5/16" x 1/16"; 2 mounting holes tapped No. 6-32; 3" center to center	Wiring purposes left rear chassis	C-2 9163WI U-1 152925	358-8553
	2Z9424-11 —— ——	TERMINAL PANEL: bakelite; wax impregnated; 5-3/4" x 1-3/8" x 3/32"; double row of solder lug terminals; 15 in one, 13 in other; 4 are molded terminals; 2 steel angle mounting brackets; cadmium plated; 1-1/4" x 5/16" x 3/32"; mounting holes tapped No. 6-32; 3" center to center	Wiring purposes right center chassis	C-2 9133WI U-1 152938	358-8555
	2Z9427 —— ——	TERMINAL PANEL: bakelite; wax impregnated; 5-3/4" x 1-3/8" x 3/32"; double row of solder lug terminals, 15 in one, 13 in other; one terminal is molded; 2 steel, angle mounting brackets, cadmium plated; 1-1/4" x 5/16" x 1/16"; 2 mounting holes tapped No. 6-32; 3" center to center	Wiring purposes left center chassis	C-2 9128WI U-1 152926	358-8552
	2Z9420.15 —— ——	TERMINAL PANEL: bakelite; wax impregnated; 5" x 1-3/8" x 3/32"; double row of solder lug terminals, 13 in one, 11 in other; 4 are molded terminals; 2 steel angle mounting brackets, cadmium plated 1-1/4" x 5/16" x 3/32"; 2 mounting holes, tapped No. 6-32; 3" center to center	Wiring purposes left front chassis	C-2 9131WI U-1 152922	358-8551
	2Z9419-6 —— ——	TERMINAL PANEL: bakelite; wax impregnated; 5" x 1-3/8" x 3/32"; double row of solder lug terminals; 13 in one, 11 in other; 5 are molded terminals; 2 steel angle mounting brackets; cadmium plated; 1-1/4" x 5/16" x 3/32"; mounting holes tapped No. 6-32; 3" center to center	Wiring purposes right rear chassis	C-2 916SWI U-1 152919	358-8556
	2ZK11117-1 —— ——	VISOR: leather; round shape; approximately 10" long x 5-3/8" diameter; metal clamp around mounting end; sponge rubber guard around other end.	To prevent paralax light shield	P-1 358-4316	358-4316
	3FK26100-2 —— ——	WINDOW: Clear plexiglass 1/8" thick; 4-25/32" diameter	Mounting hardware	S-41 257-7971	257-7971
	6R57400 —— ——	WRENCH: steel, hexagon socket screw wrench; 0.78" width; 1-31/32" length of long arm; 45/64" length of short arm; radius of band 5/64"	Tool	P-1	1W30964

Note

The following list of parts constitutes the differences between the Indicators ★ID-6A/APN-4 and ★ID-6B/APN-4. Cross reference is made to part numbers and descriptions by symbol reference to the Indicator ★ID-6B/APN-4 parts list (*indicates Indicator ★ID-6B/APN-4 symbol number).

C301		Same as C301*	Untuned series circuit crystal drag. circuit		
C302		Same as C302*	Varies capacitance of circuit causing crystal to drag		
C303-1		Same as C305-1*	Decoupling osc. plate		
C303-2		Same as C303-1	Bypass on 10 microseconds phase shift		
C303-3		Same as C303-1	Part of second 1st counter storage condenser to give station selector calibration voltage		
C303-4		Same as C303-1	4th counter output coupling		
C303-5		Same as C303-1	Bypass		
C303-6		Same as C303-1	Cathode bypass		
C303-7		Same as C303-1	Coupling		
C303-8		Same as C303-1	Bypass		
C303-9		Same as C303-1	Coupling		
C303-10		Same as C303-1	Coupling		
C303-11		Same as C303-1	Coupling		
C304-1		Same as C303-1*	Changes frequency in crystal drag. circuit		
C304-2		Same as C304-1	Osc. feed-back		
C305-1		Same as C304-1*	Changes frequency of crystal drag circuit		
C306		Same as C306*	Tuning osc. plate circuit		
C307		Not used			
C308		Not used			
C309		Not used			
C310	3D9560-4 —— ——	CAPACITOR, fixed: ceramic dielectric; 560 mmf., ±2%; 500 V d-c w; ceramic body, wax impregnated; 1-1/2" lg x 17/64" diam.; radial leads	Cathode bypass (V302-1)	Erie N-750-E	305-1552
C311-1	3DK9015-26 —— ——	CAPACITOR, fixed: mica dielectric; 15 mmf., ±5%; 500 V d-c w, moulded bakelite; 51/64" lg x 15/32" wd x 7/32" thk; axial leads	Coupling condenser 50 microseconds	Dubilier 5W Micamold 0	60-00155317

‡ Not in base spares.

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: INDICATOR ★ID-6A/APN-4**

Reference Symbol	*British Ref. Number Army Stock Number Navy Stock Number*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or Standard Type*	*Cont. or Govt. Dwg. or Spec. No.*
C311-2		Same as C311-1	Coupling condenser 2500 microseconds Locking E for "A" delay		
C312-1		Not used			
C312-2		Not used			
C312-3	3D9051-2 —— ——	CAPACITOR, fixed; mica dielectric; 51 mmf., ±5%; 500 V d-c w; moulded bakelite case; 51/64" x 15/32" x 7/32"; axial leads	Coupling 10 microseconds marker	Dubilier	60-00515317
C312-4		Not used			
C312-5		Not used			
C312-6		Same as C312-3	V301-1 osc. feedback		
C313A	3DA100-105 —— ——	CAPACITOR, fixed: paper dielectric; 3 x 100,000 mmf., ±20% —10%; 400 V d-c w; metal case, hermetically sealed; 1-13/16" lg x 1" wd x 3/4" thk; 3 solder lug terminals; 2 mtg. brackets 2-1/8" between centers	Bypass, 1st counter cathode	Sprague P9051	305-1108
C313B		Part of C313	Bypass, 2nd counter cathode		
C313C		Part of C313	Bypass, 3rd counter cathode		
C314-1		Same as C312*	V301-4A plate		
C314-2		Same as C314-1	V301-3B plate		
C314-3		Same as C314-1	T302-4 primary		
C315		Not used			
C316-1		Same as C315-1*	Bypass, 2nd counter cathode		
C316-2		Same as C316-1	Bypass, 2nd counter cathode		
C316-3		Same as C316-1	Bypass, grid of "A" delay		
C316-4		Same as C316-1	Bypass, grid of fine delay		
C316-5		Same as C316-1	Bypass, grid of coarse delay		
C317-1		Same as C339-1*	B+ bypass		
C317-2		Same as C317-1	Decoupling plate of "B" delay inverter		
C318-1		Same as C328-2*	Decoupling plate of 3rd counter		
C318-2		Same as C318-1	Decoupling plate of 4th counter		

C318-3		Same as C318-1	Decoupling plate of fine delay		
C318-4		Same as C318-1	Bypass sq. wave cathode		
C318-5		Same as C318-1	Coupling video		
C318-6		Same as C318-1	Coupling vertical deflection plates		
C318-7		Same as C318-1	Coupling vertical deflection plates		
C318-8		Same as C318-1	Coupling paraphase amplifier		
C318-9		Same as C318-1	Coupling paraphase amplifier		
C318-10		Same as C318-1	Bypass and intensity control		
C318-11		Same as C318-1	V302-7 plate		
C318-12		Same as C318-1	V302-9 plate to S303-F		
C319	3K2039142 —— ——	CAPACITOR, fixed: mica dielectric; 390 mmf., ±5%; 500 V d-c w; moulded bakelite case; 51/64" lg x 15/32" wd x 7/32" thk; axial leads	Feed cond. 4th counter	Electromotive 603M	60-10395337
C320-1		Not used			
C320-2		Not used			
C321	3DKA500-103 —— ——	CAPACITOR, fixed: paper dielectric; 500,000 mmf., +20% —10%; 600 V d-c w; oil filled; hermetically sealed metal case; 1-13/16" lg x 7/8" wd x 1" thk; two solder lug terminals on side; 2 mtg. brackets, 2-1/8" mtg./C	Bypass, 4th counter cathode	Dubilier DYR-6050	305-1335
C322-1	3D9240-3 —— ——	CAPACITOR, fixed: mica dielectric; 240 mmf., ±10%; 500 V d-c w; moulded bakelite case; 51/64" lg x 15/32" wd x 7/32" thk; axial leads	Coupling "A" delay	Dubilier 5W Micamold 0	60-10245317
C322-2		Same as C322-1	Coupling "A" delay		
C323	3DKA20-65 —— ——	CAPACITOR, fixed: paper dielectric; 20,000 mmf. ±20%; 600 V d-c w; moulded bakelite case; 1-7/16" x 3/4" wd x 3/8" thk; axial leads	Sets up time constant	Micamold 345-9	305-1330
C324-1	3D9200-5 —— ——	CAPACITOR, fixed: mica dielectric; 200 mmf., ±5%; 500 V d-c w; bakelite case; 51/64" x 15/32" x 7/32"; axial leads	Coupling fine delay	Dubilier 5W Micamold 0	60-10205317
C324-2		Same as C324-1	Bypass		
C325-1		Same as C336-1*	Time constant determinate		
C325-2		Same as C325-1	Coupling		
C326-1		Same as C346*	Coupling		
C326-2		Same as C326-1	Bypass		
C326-3		Same as C326-1	Time constant sweep circuit		
C326-4		Same as C326-1	Time constant delay		
C327-1 to 5		Not used			
C328		Not used			

Reference Symbol	British Ref. Number Army Stock Number Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
C329-1		Same as C322-1*	Station selector sw. adjustable feed		
C329-2		Same as C329-1	Station selector sw. adjustable feed		
C329-3		Same as C329-1	Station selector sw. adjustable feed		
C329-4		Same as C329-1	Station selector sw. adjustable feed		
C329-5		Same as C329-1	Station selector sw. adjustable feed		
C329-6		Same as C329-1	Station selector sw. adjustable feed		
C329-7		Same as C329-1	Station selector sw. adjustable feed		
C330-1		Not used			
C330-2		Same as C327-1*	2500 microseconds markers coupling		
C330-3		Same as C330-2	500 microseconds markers coupling		
C330-4		Same as C330-2	Sq. wave gen. coupling		
C330-5		Same as C330-2	Bypass		
C330-6		Same as C330-2	Bypass		
C330-7		Same as C330-2	Sq. wave gen. coupling		
C330-8		Same as C330-2	Bypass		
C331-1	3K2082032 —— ——	CAPACITOR, fixed: mica dielectric; 82 mmf., ±5%; 500 V d-c w; moulded bakelite; 51/64" x 15/32" x 7/32"; axial axial leads	V301-1 to V302-1 coupling	Electromotive 603M	60-00825337
C331-2		Same as C331-1	Feed cond. station selector sw		
C332-1	3DK9110-2 —— ——	CAPACITOR, fixed: mica dielectric; 110 mmf., ±5%; 500 V d-c w; moulded bakelite; 51/64" x 15/32" x 7/32"; axial leads	Feed cond. station selector sw	Dubilier 5W Micamold	60-10115317
C332-2		Not used			
C332-3		Same as C332-1	Grid coupling V301-5 to V301-6		
C332-4		Same as C332-1	Grid coupling V301-6 to V301-7		
C333	3D9190 —— ——	CAPACITOR, fixed: mica dielectric; 190 mmf., ±2%; 500 V d-c w; bakelite case; 51/64" lg x 15/32 wd x 7/32" thk; axial leads	Feed cond. station selector sw	Electromotive 603M	60-10195237

C334	3D9250-18.1 —— ——	CAPACITOR, fixed: mica dielectric; 250 mmf., ±2%; 500 V d-c w; bakelite case; 51/64″ lg x 15/32″ wd x 7/32″ thk; axial leads	Feed cond. station selector sw	Electromotive 603M	60-10255237
C335	3K2030143 —— ——	CAPACITOR, fixed: mica dielectric; 300 mmf., ±2%; 500 V d-c w; bakelite case; 51/64″ lg x 15/32″ wd x 7/32″ thk; axial leads	Feed cond. station selector sw	Electromotive 603M	60-10305237
C336	3K2036143 —— ——	CAPACITOR, fixed: mica dielectric; 360 mmf., ±2%; 500 V d-c w; bakelite case; 51/64″ lg x 15/32″ wd x 7/32″ thk; axial leads	Feed cond. station selector sw	Electromotive 603M	60-10365237
C337-1		Same as C341-1*	Grid coupling V303-1A		
C337-2		Same as C337-1	Screen bypass V305		
C338-1		Same as C325-1*	Grid to plate coupling V301-9		
C338-2		Same as C338-1	T302-4 secondary time delay		
C339-1		Same as C320-1*	Grid coupling V301-8B		
C339-2		Same as C339-1	Coupling to J304		
C339-3		Same as C339-1	Grid coupling V301-12		
C340-1	3DKA10-182 —— ——	CAPACITOR, fixed: paper dielectric; 10,000 mmf., ±10%; 1250 V d-c w; bakelite case; 1–1/4″ lg x 1–1/8″ wd x 7/16″ thk; solder lug terminal on end	V304 grid coupling	Dubilier 4ST	305-1099
C340-2		Same as C340-1	V304 grid coupling		
C340-3		Same as C340-1	V304 grid coupling		
C341		Same as C344*	V302-8 and V304 filament bypass		
C342-1		Same as C323*	Grid coupling V301-9		
C342-2		Same as C342-1	V303-2 grid to plate coupling		
C343	3DA100-226 —— ——	CAPACITOR, fixed: paper dielectric; oil filled; 1 mf., +20% —15%; 600 V d-c, w; metal case 2–1/2″ lg x 7/8″ wd x 2–1/8″ h; two solder lugs, top of case	V301-2A cathode bypass	Dubilier	305-1507
C344	3K2075032 —— ——	CAPACITOR, fixed: mica dielectric; 75 mmf., ±5%; 500 V d-c. w; bakelite case; 51/64″ lg x 15/32″ wd x 7/32″ thk; axial leads	Cathode coupling V302-2	Electromotive 603M	60-00755337
C345		Same as C316*	Cathode coupling V302-3		
C346		Same as C314*	Cathode bypass V302-2		
C347-1	3D9750-12 —— ——	CAPACITOR, fixed: ceramic dielectric; 750 mmf., ±2%; 500 V d-c. w; ceramic body; 1–1/2″ lg x 17/64″ diam.; radial leads	Cathode bypass V302-3	Erie CN-149	305-1553
C347-2		Same as C347-1	Cathode bypass V302-3		
C348	3K2013133 —— ——	CAPACITOR, fixed: mica dielectric; 130 mmf., ±2%; 500 V d-c. w; bakelite case; 51/64″ lg x 15/32″ wd x 7/32″ thk; axial leads	Feed cond. station selector sw.	Electromotive 603M	60-10135237
C3[illegible]		Same as C345*	Grid to plate V305		

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: INDICATOR ★ID-6A/APN-4**

Reference Symbol	*British Ref. Number Army Stock Number Navy Stock Number*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or Standard Type*	*Cont. or Govt. Dwg. or Spec. No.*
C350	3D9820-5 —— ——	CAPACITOR, fixed: ceramic dielectric; 820 mmf., ±2%; 500 V d-c. w; 1-1/2" lg x 17/64" dia.; radial leads	V302-2 cathode	Philco N-750 (E820)	305-1554
C351-1		Same as C324-1*	Cathode bypass V302-4		
C351-2		Same as C351-1	Cathode bypass V302-4		
C352		Same as C334*	Feed Cond. station selector sw		
J301		Same as J302*	V301-12 cathode connection		
J302		Same as J304*	Power input		
J303		Same as J303*	Video connection		
J304		Same as J301*	Amplitude balance connector		
J305		Same as J305*	Gain connector		
L301		Same as L301*	5th counter delay		
L302	3CK318-13 —— ——	COIL: R.F., choke; 2 coils, 305 turns #38SSE wire, each wound on ceramic form; 11/16" lg x 1/4" O.D.; 2000 microhenries ±5%; wax impregnated; encased in bakelite	Peaking coil	Philco 352-1409	352-1409
R301-1		Same as R301*	Plate decoupling V301-1		
R301-2		Same as R301-1	Distortion amplifier plate load V301-1		
R301-3		Same as R301-1	Cathode V301-8A		
R302-1		Same as R302-1*	Grid load V301-1		
R302-2		Same as R302-1	Grid V301-6		
R302-3		Same as R302-1	Diode load V303-1B		
R302-4		Same as R302-1	Time constant C303-4 4th counter output		
R302-5		Same as R302-1	Grid load V303-1A		
R302-6		Same as R302-1	Grid load V301-11		
R302-7		Same as R302-1	Grid load V301-12		
R302-8		Same as R302-1	Grid load V301-8B		
R302-9		Same as R302-1	Cathode load V301-13		
R303		Same as R303*	Phase shift V303-2		
R304-1	2Z4525 —— ——	RESISTOR, fixed: composition; 1000 ohms, ±10%; 1/2 watt; insulated; 7/16" lg x 7/32" diam., axial leads	Cathode load V301-12	I.R.C. BT 1/2	66-2103344
R304-2		Same as R304-1	Cathode load V301-7		
R304-3		Same as R304-1	Cathode load V301-7		
R304-4		Same as R304-1	Decoupling plate V301-3A		

R304-5		Same as R304-1	Decoupling plate V301-3B		
R305-1		Same as R304-1*	Grid load V301-1		
R305-2		Same as R305-1	Grid load V301-7		
R305-3		Same as R305-1	Grid load V301-7		
R305-4		Same as R305-1	Grid load V303-2		
R305-5		Not used			
R305-6		Not used			
R305-7		Same as R305-1	Grid load V301-10A		
R305-8		Same as R305-1	Grid load V301-4B		
R305-9		Same as R305-1	Cathode load V301-4B		
R305-10		Same as R305-1	Cathode load V301-8B		
R305-11		Same as R305-1	Grid load V301-10B		
R305-12		Same as R305-1	Part of cathode load V302-7		
R305-13		Same as R305-1	Grid load V305		
R305-14		Same as R305-1	Grid load V301-14		
R306-1	3Z6470	RESISTOR, fixed: composition; 4700 ohms, ±5%; 1/2 watt; insulated; 7/16" lg x 7/32" diam.; axial leads	Plate load damping V301-2A	I.R.C. BT 1/2	66-2473244
R306-2		Same as R306-1	Plate filter V301-6		
R306-3		Same as R306-1	Plate filter V303-1A		
R307		Same as R312*	Bleeder R315-2		
R308	3Z6668-14	RESISTOR, fixed: composition; 68,000 ohms, ±5%; 1 watt; insulated; 7/8" lg x 9/32" diam.; axial leads	Plate load V301-14	I.R.C. BT-1	66-3684244
R309		Not used			
R310		Same as R306-1*	Cathode load V303-1A		
R311	3ZK6806A8-2	RESISTOR, fixed: composition; 6.8 megohms, ±5%; 1/2 watt; insulated; 7/16" long x 7/32" diam.; axial leads	V302-2 storage decay (2nd counter)	I.R.C. BT 1/2	66-5683244
R312	3Z6615-1	RESISTOR, fixed: composition; 15,000 ohms, ±5%; 1/2 watt; insulated; 7/16" long x 7/32" diam.; axial leads	Isolating resistor V301-3A	I.R.C. BT 1/2	66-3153244
R313		Not used			
R314		Not used			
R315-1		Same as R309-1*	Cathode bias divider V301-2A		
R315-2		Same as R315-1	Cathode bias divider V301-3A		
R315-3		Same as R315-1	Cathode bias divider V301-3B		
R315-4		Same as R315-1	Cathode bias divider V301-4A		
R315-5		Same as R315-1	Fine delay		
			Coarse delay		

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: INDICATOR ★ID-6A/APN-4**

Reference Symbol	*British Ref. Number Army Stock Number Navy Stock Number*	*Name of Part and Description*	*Function*	*Mfr. and Desig. or Standard Type*	*Cont. or Govt. Dwg. or Spec. No.*
R316	3ZK6618-26 —— ——	RESISTOR, fixed: composition; 18,000 ohms, ±5%; 2 watts; insulated; 1-3/8" lg x 3/8" diam.; axial leads	Cathode bias divider V301-3A	I.R.C. BT 2	66-3185244
R317		Same as R315-1*	Cathode bias divider V301-3B		
R318		Same as R319*	Cathode bias divider V301-4A		
R319		Not used			
R320-1		Same as R351-1*	Grid voltage divider V301-5		
R320-2		Same as R320-1	Grid voltage divider V301-6		
R320-3		Same as R320-1	Grid voltage divider V301-9		
R321-1	3Z6718-5 —— ——	RESISTOR, fixed; composition; 0.18 megohm, ±5%; 1/2 watt; insulated; 7/16" lg x 7/32" dia.; axial leads	Isolation grid V301-5	I.R.C. BT 1/2	66-4183244
R321-2		Same as R321-1	Voltage divider		
R322-1		Same as R325-1*	Isolating resistor V301-5		
R322-2		Same as R322-1	Grid isolating V301-6		
R322-3		Same as R322-1	Grid leak V301-9		
R322-4		Same as R322-1	Grid isolating V301-10A		
R322-5		Same as R322-1	Isolating resistor, grid V301-10B		
R323-1		Same as R355-1*	Isolation resistor		
R323-2		Same as R323-1	Isolation resistor		
R324-1		Same as R311-1*	Plate load V301-5		
R324-2		Same as R324-1	Plate load V301-5		
R324-3		Same as R324-1	Plate load V301-6		
R324-4		Same as R324-1	Plate load V301-6		
R324-5		Same as R324-1	Plate load V301-9		
R324-6		Same as R324-1	Plate load V301-9		
R324-7		Same as R324-1	Plate load V303-1A		
R325-1		Same as R346-1*	Cathode load V301-5		
R325-2		Same as R325-1	Plate load V301-7		
R325-3		Same as R325-1	Cathode load V301-9		
R326	3ZK6803A9-7 —— ——	RESISTOR, fixed: composition; 3.9 megohms, ±10%; 1/2 watt; insulated; 7/16" lg x 7/32" diam.; axial leads	Grid filter V301-5	I.R.C. BT-1/2	66-5393344

R327-1		Same as R358*	Voltage dropping R320-2		
R327-2		Same as R327-1	Voltage dropping R320-1		
R328-1	2ZK7262-25M-4	RESISTOR, variable; composition; 25,000 ohms, ±20%; 1-1/2" diam. x 1/2" deep; screw driver slotted shaft 1/4" diam. x 1/8" lg; 3/8-32 mtg. bushing	Voltage divider V301-6 grid	Centralab 35	353-5118
R328-2		Same as R328-1	Voltage divider V301-9 grid		
R329-1		Same as R340-1*	Cathode load V301-6		
R329-2		Same as R329-1	Plate coupling V301-11 to V301-12		
R329-3		Same as R329-1	Plate load V301-12		
R330-1		Same as R337-1*	Cathode load V303-1B		
R330-2		Same as R330-1	Cathode coupling V302-1		
R330-3		Same as R330-1	Voltage divider V305		
R331	3Z6727-2	RESISTOR, fixed; composition; 0.27 megohm, ±10%; 1 watt; insulated; 7/16" lg x 7/32" diam.; axial leads	Plate load V303-2	I.R.C. BT-1	66-4274344
R332-1		Same as R334-1*	Cathode load V303-2		
R332-2		Same as R332-1	Cathode load V303-3		
R332-3		Same as R332-1	Plate load V302-7		
R332-4		Same as R332-1	Voltage divider (V304)		
R332-5		Same as R332-1	Voltage divider (V304)		
R332-6		Same as R332-1	Left-right circuit		
R332-7		Same as R332-1	Left-right circuit		
R333-1	3RC21BE154K	RESISTOR, fixed; composition, 0.15 megohm, ±10%; 1/2 watt; insulated; 7/16" long x 7/32" diam.; axial leads	Grid filter V303-1	I.R.C. BT 1/2	66-4153344
R333-2		Same as R333-1	Grid filter V303-1		
R334		Not used			
R335		Not used			
R336-1		Not used			
R336-2		Same as R362-1*	Dropping resistor V304 deflection plate		
R336-3		Same as R336-2	Coupling resistor V302-8		
R336-4		Same as R336-2	Dropping resistor V304 deflection plate		
R336-5		Same as R336-2	Bleeder resistor V305		
R336-6		Same as R336-2	Grid load V301-12		
R337		Not used			
[illegible]		Same as R356*	Plate load V301-8A		

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: INDICATOR ★ID-6A/APN-4**

Reference Symbol	British Ref. Number / Army Stock Number / Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
R338-2		Same as R338-1	Coupling grid V301-10B		
R338-3		Same as R338-1	Plate load V301-13		
R338-4		Not used			
R338-5		Same as R338-1	Voltage dropping R315-6		
R339-1	3Z6722-20 —— ——	RESISTOR, fixed; composition; 0.22 megohms, ±5%; 1 watt; insulated; 7/8" lg x 9/32" diam.; axial leads	Voltage dropping	Erie BT-1	66-4224244
R339-2		Same as R339-1	Plate load V301-8B		
R340-1		Same as R367-1*	Voltage dropping V301-9		
R340-2		Same as R340-1	Bleeder V301-13		
R340-3		Same as R340-1	Grid load V301-13		
R340-4		Same as R340-1	Bleeder V305		
R340-5		Same as R340-1	Voltage dropping R350-4		
R341-1		Same as R374*	Gain control		
R342	3ZK6568-17 —— ——	RESISTOR, fixed; composition; 6800 ohms, ±5%; 1 watt; insulated; 7/8" lg x 9/32" diam.; axial leads	Voltage dropping	I.R.C. BT-1	66-2684244
R343-1	3ZK6004A7-18 —— ——	RESISTOR, fixed; wire wound; 47 ohms, ±5%; 1/2 watt; 5/8" lg x 3/16" diam.; axial leads		I.R.C. BT-1/2	66-0473264
R343-2		Same as R343-1	Voltage divider		
R343-3		Same as R343-1	Voltage divider		
R343-4		Same as R343-1	Voltage divider		
R343-5		Same as R343-1	Voltage divider		
R343-6		Same as R343-1	Voltage divider		
R343-7		Same as R343-1	Voltage divider		
R344-1		Same as R328-1*	Plate load V301-10A		
R344-2		Same as R344-1	Plate load V301-10B		
R344-3		Same as R344-1	Plate load V301-14		
R345-1		Same as R326-1*	Coupling V301-10B to V301-10A		
R345-2		Same as R345-1	Coupling V301-10A to V301-10B		
R346		Same as R310*	Cathode resistor V301-10B		
R347		Same as R329*	E-J circuit cathode control		
R348		Same as R373*	Bleeder		

R349-1	3Z6150-20	RESISTOR, fixed; composition; 1500 ohms, ±10%; 1/2 watt; insulated; 7/16" lg x 7/32" wd; axial leads	Bleeder	I.R.C. BT-1/2	66-2153344
R349-2		Same as R349-1	Cathode V301-11		
R350-1		Same as R366-1*	Vertical centering control		
R350-2		Same as R350-1	Intensity control		
R350-3		Same as R350-1	Centering control		
R350-4		Same as R350-1	Sweep amplitude control		
R350-5		Same as R350-1	Sweep amplitude control		
R350-6		Same as R350-1	Sweep amplitude control		
R351-1		Same as R330-1*	Cathode V302-7		
R351-2		Same as R351-1	Diode load V302-7		
R352-1		Same as R339-1*	Cathode bias V301-12		
R352-2		Same as R352-1	Grid load V303-2		
R353-1		Same as R336-1*	Trace separation control		
R353-2		Same as R353-1	Trace separation control		
R353-3		Same as R353-1	Trace separation control		
R354-1	3Z6715-3	RESISTOR, fixed; composition; 0.15 megohm, ±5%; 1/2 watt; insulated; 7/16" lg x 7/32" diam.; axial leads	Grid coupling V303-3	I.R.C. BT 1/2	66-4153244
R354-2		Same as R354-1	Grid coupling V303-3		
R355		Same as R335*	Signal amplitude balance		
R356		Not used			
R357-1		Same as R363-1*	Focus control		
R357-2		Same as R357-1	Intensity control		
R358		Same as R365-1*	Voltage divider R357-1		
R359		Same as R364*	Voltage divider		
R360		Same as R327-2*	Voltage divider		
R361		Not used			
R362		Not used			
R363-1	3ZK6647-8.1	RESISTOR, fixed composition: 47,000 ohms, ±5%; 1 watt; insulated; 7/8" lg x 9/32" diam.; axial leads	Plate load V305	I.R.C. BT-1	66-3474244
R363-2		Same as R363-1	Screen dropping V305		
R364		Same as R371*	Cathode bias V301-14		
R365		Not used			
R366		Not used			
R367	3Z6810-31	RESISTOR, fixed; composition; 1 megohm, ±10%; 1 watt; insulated; 7/8" lg x 9/32" dia.; axial leads	Voltage divider	I.R.C. BT-1	66-5104344

TABLE OF PARTS (Cont'd)

MODEL: RADIO SET ★AN/APN-4 **MAJOR ASSEMBLY: INDICATOR ★ID-6A/APN-4**

Reference Symbol	British Ref. Number / Army Stock Number / Navy Stock Number	Name of Part and Description	Function	Mfr. and Desig. or Standard Type	Cont. or Govt. Dwg. or Spec. No.
R368		Same as R375*	Cathode bias V301-13		
R369	3RC41BE683J —— ——	RESISTOR, fixed; composition; 68,000 ohms, ±5%; 2 watts; insulated; 1-3/4" x 5/16" diam.; axial leads	Voltage divider R315-3	I.R.C. BT-2	66-3685244
R370		Not used			
R371	3RC41BE753J —— ——	RESISTOR, fixed; composition; 75,000 ohms, ±5%; 2 watts; insulated; 1-3/4" lg x 5/16" diam.; axial leads	Voltage divider R315-4	I.R.C. BT-2	66-3755244
R372		Same as R342-1*	Diode load V301-2B		
R373		Same as R305*	Cathode load V301-2B		
R374		Not used			
R375	3RC21BE684J —— ——	RESISTOR, fixed; composition; 0.68 megohm, ±5%; 1/2 watt; insulated; 5/8" lg x 3/16" diam.; axial leads	Grid V301-14	I.R.C. BT 1/2	66-4683244
R376	3RC41B682J —— ——	RESISTOR, fixed; composition; 6800 ohms, ±5%; 2 watts; insulated; 1-3/4" lg x 5/16" diam.; axial leads	Cathode bias V301-2A	I.R.C. BT 2	66-2685244
R377-1		RESISTOR, fixed: composition; 33 ohms, ±5%; 1/2 watt; insulated; 5/8" lg x 3/16" diam.; axial leads	Filament filter	I.R.C. BT 1/2	66-0333264
R377-2		Same as R377-1	Filament filter		
S301A, B and C	2ZK9828-10 —— ——	SWITCH; 3 sections, wafer type; 8 positions, locking; case dimensions 1-17/32" deep x 1-11/16" diameter; mounting bushing 3/8" lg, threaded 3/8-32; shaft 1-7/16" lg x 1/4" diam.; with 3/8" flat	Station selector	Oak 25390-H3	452-1111
S302A and B	3ZK9848-13 —— ——	SWITCH, special toggle type; single section wafer, 2 circuits, 3 positions, nonlocking; case dimensions 1-7/8" lg x 1-1/2" deep x 7/16" wd; two 0.144" diam. mtg. holes; 7.625" mtg./C	Left-right pulse sw	Centralab N-6717X	452-1115
S303A, B, C and D	3ZK9828-11 —— ——	SWITCH, rotary, 4 sections; wafer type; 36 circuits, 8 positions, locking; case dimensions 3-1/2" deep x 1-11/16" diam.; shaft 3-7/16" lg x 1/4" diam. with 3/8" flat; 3/8" lg mtg. bushing, threaded 3/8-32	Sweep speed selector and trace separations	Oak 25560-H4	452-1116
S303E, F and G	3Z9826-8 —— ——	SWITCH, rotary, 3 sections; wafer type; 8 positions; 2-1/4" lg x 1-1/16" diam.; 3/8" lg mtg. bushing threaded 3/8-32	Sweep speed selector and trace seoarations	Oak	452-1206
T301	3CK1081-3 —— ——	COIL ASSEMBLY: R.F., oscillator. Two primary windings, 160 turns #32 SNE wire; secondary winding 140 turns #32 SNE wire; primary inductance 1150 millihenries ±227 millihenries; secondary inductance 330 millihenries ±6.6 millihenries; cased, wax impregnated; 2-1/4 x 1-1/4 square over-all; spade type mtg. bolts 1-5/16" mtg/C	Oscillator coil	Philco 358-3440	358-3440
T302-1		Same as T302-1*	Oscillator blocking		
T302-2		Same as T302-1	Oscillator blocking		

T302-3	Same as T302-1	Oscillator blocking
T302-4	Same as T302-1	Oscillator blocking
T303	Not used	
T304	Same as T303*	Transformer filament
V301-1 to V301-14	Same as V301-1*	Same as in ID-6B
V302-1 to V302-8	Same as V302-1*	Same as in ID-6B
V303-1 to V303-3	Same as V303-1*	Same as in ID-6B
V304	Same as V305*	Same as in ID-6B (V305)
V305	Same as V304*	Same as in ID-6B (V304)
X301-1 to X301-26	Same as X302-1*	Tube mtg
X302	Same as X303*	Tube mtg
X303	Same as X301*	Tube mtg
Y301	Same as Y301*	100KC fundamental

CODE LETTERS, NAMES AND ADDRESSES OF MANUFACTURERS

Code Letter	*Name*
A-1	American Phenolic Corp.
A-2	Aerowax Corp.
A-5	American Radio Hardware Co.
A-10	American Insulator Corp.
E-5	Bellevue Leather Prod.
C-1	Chicago Telephone Supply Co.
C-2	Cinch Mfg. Co.
C-3	Cornell-Dubilier Elec. Corp.
C-4	Clarostat Mfg. Co.
C-5	Centralab
C-6	Cutler-Hammer
C-10	Consolidated Moulded Prod. Corp.
C-13	Crossdale and DiAngelis
E-1	Erie Resistor Co.
E-2	Electromotive Corp.
G-7	Gothard Mfg. Co.
I-1	International Resistor Corp.
K-1	Kurz-Kasch Inc.

Code letter	*Name*
K-2	Ken Rad Tube & Lamp Corp.
L-1	Littlefuse Co.
L-2	Lord Mfg. Co.
M-1	Micamold Radio Corp.
M-3	Magnetic Windings Co.
M-7	Mueller Brass Co.
M-8	Muter Condenser Co.
N-2	National Co.
O-1	Oak Mfg. Co.
P-1	Philco Corp.
R-1	R.C.A. Mfg. Co.
S-1	Sylvania Elec. Prod. Co.
S-4	Sprague Specialties Co.
T-3	Tungsol Corp.
U-2	T. C. Ulmer Co.
U-5	United Transformer Co.
R-6	Raytheon Prod. Co.

SECTION VIII
DRAWINGS

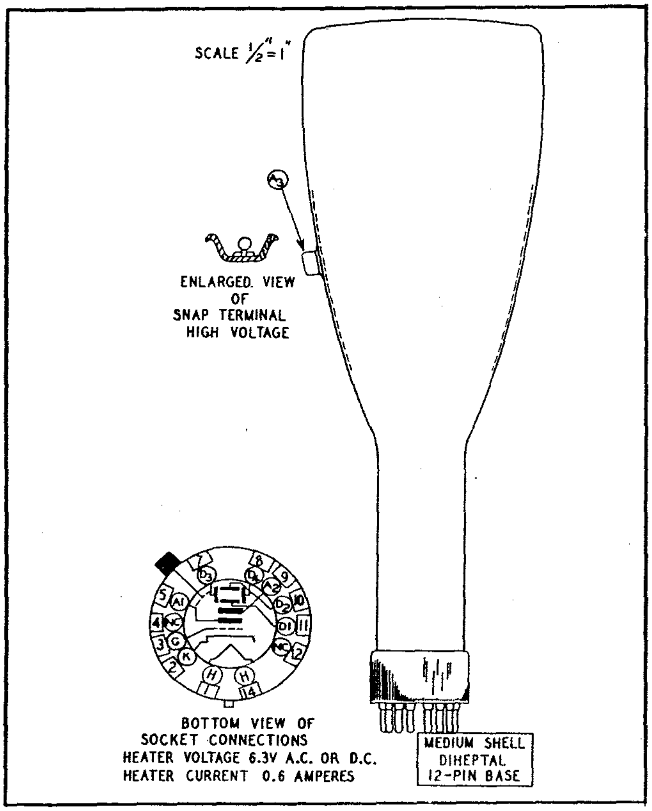


Figure 8-1. Cathode Ray Tube Base Connections (Early)

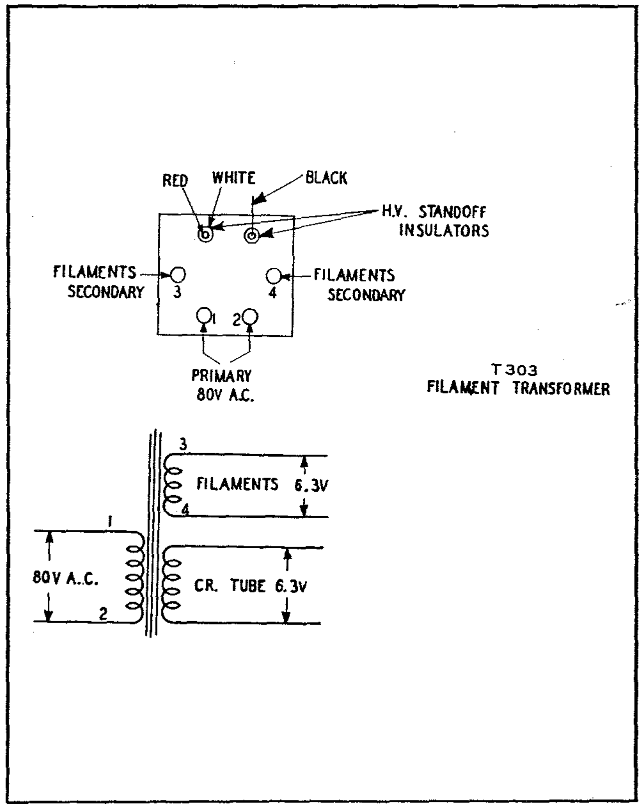


Figure 8-2. Filament Transformer T-303 (Early)

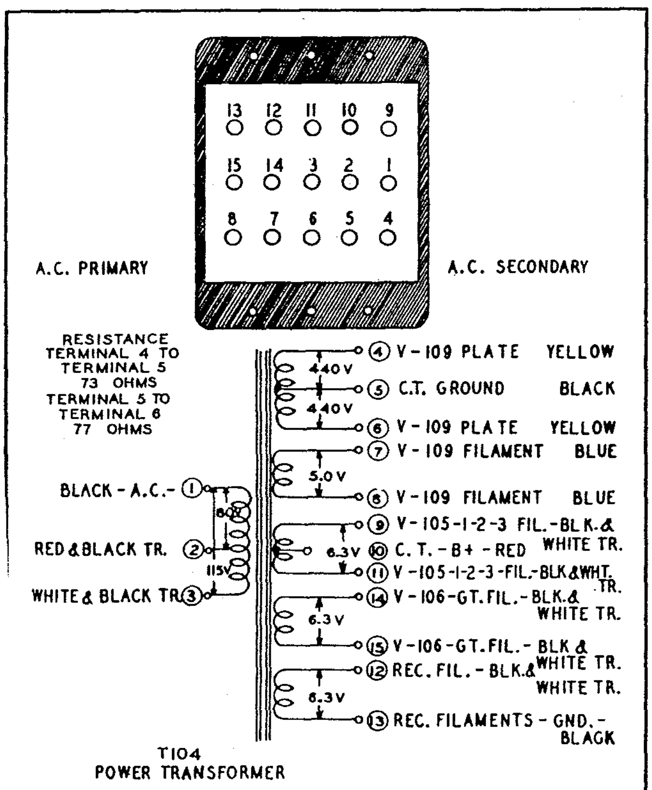


Figure 8-3. Power Transformer T-104 (Early)

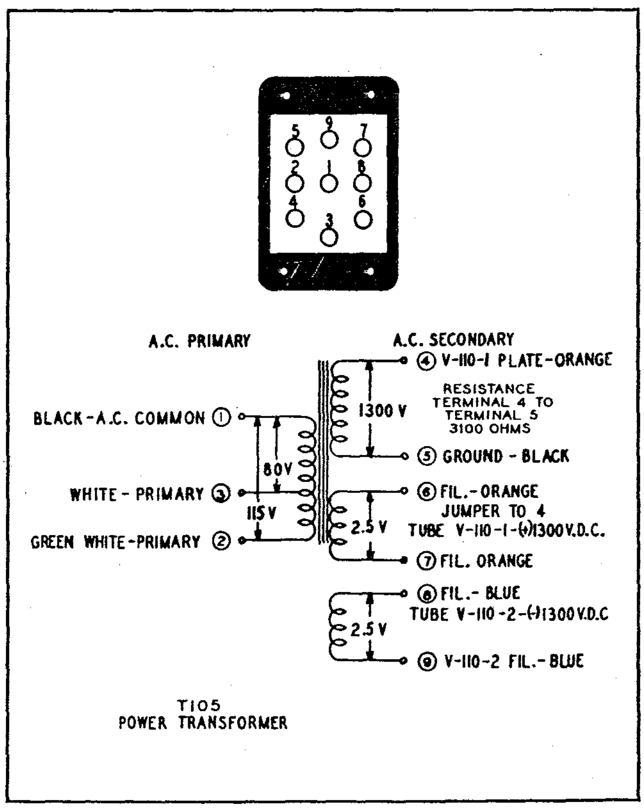


Figure 8-4. Power Transfomer T-105 (Early)

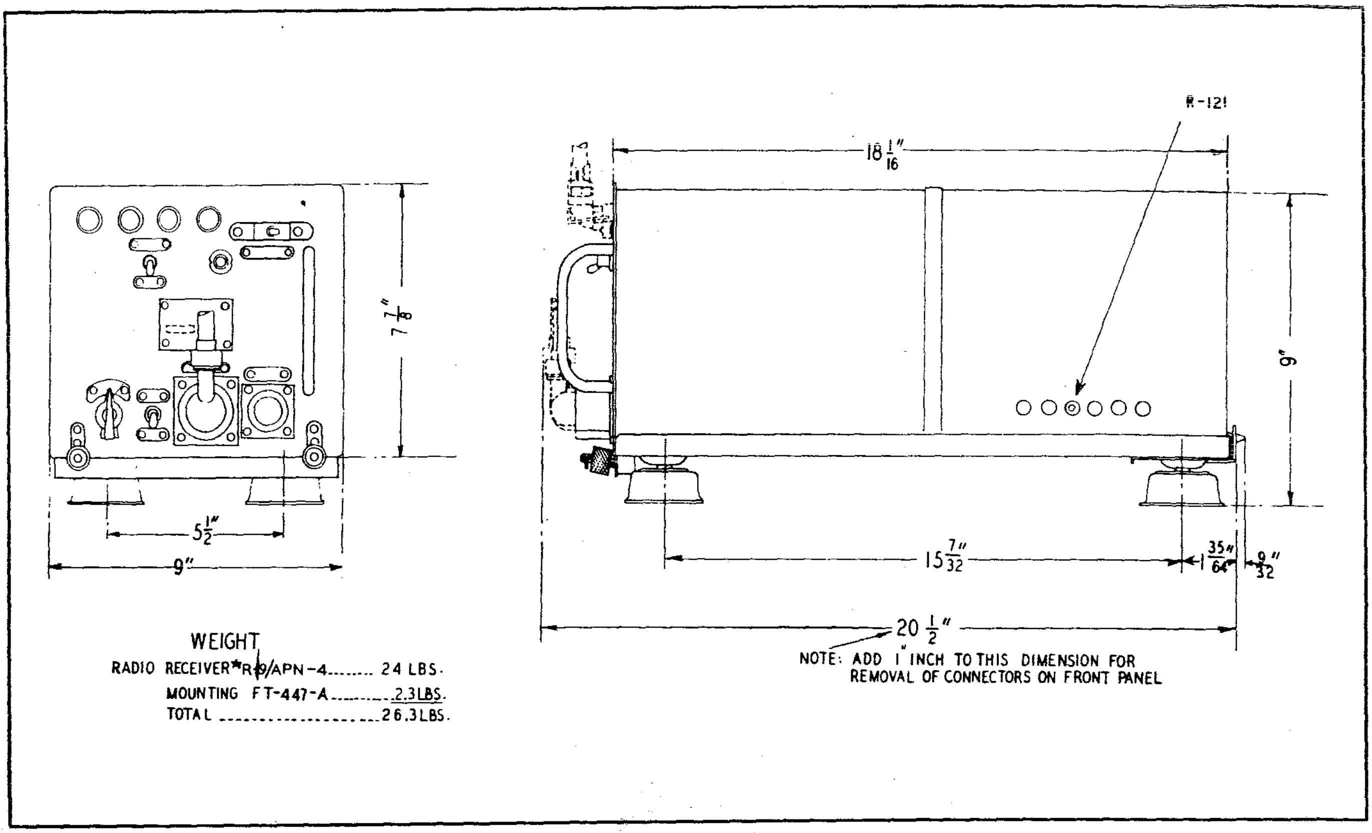


Figure 8-5. Radio Receiver ★R-9/APN-4—Outline Dimensional Drawing (Early)

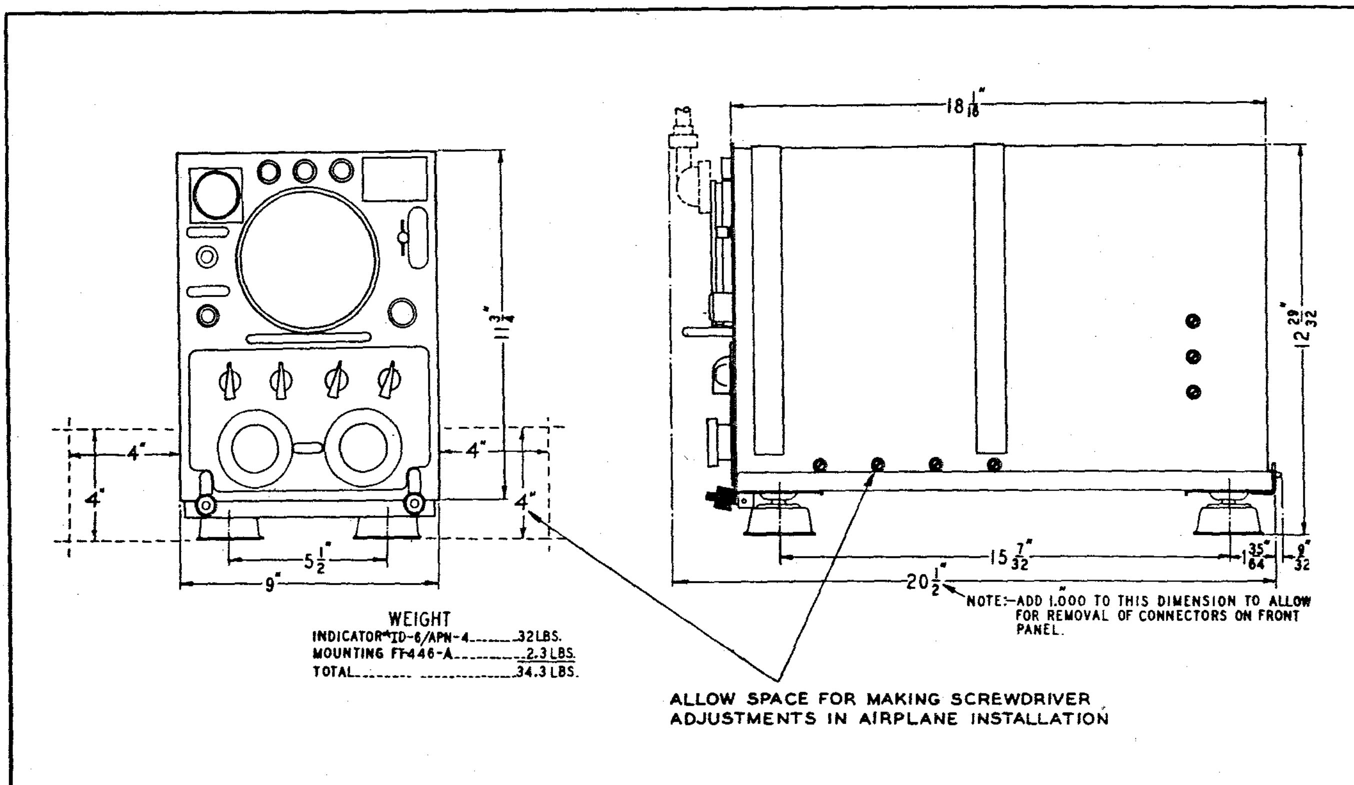


Figure 8-6. Indicator ★ID-6/APN-4—Outline Dimensional Drawing (Early)

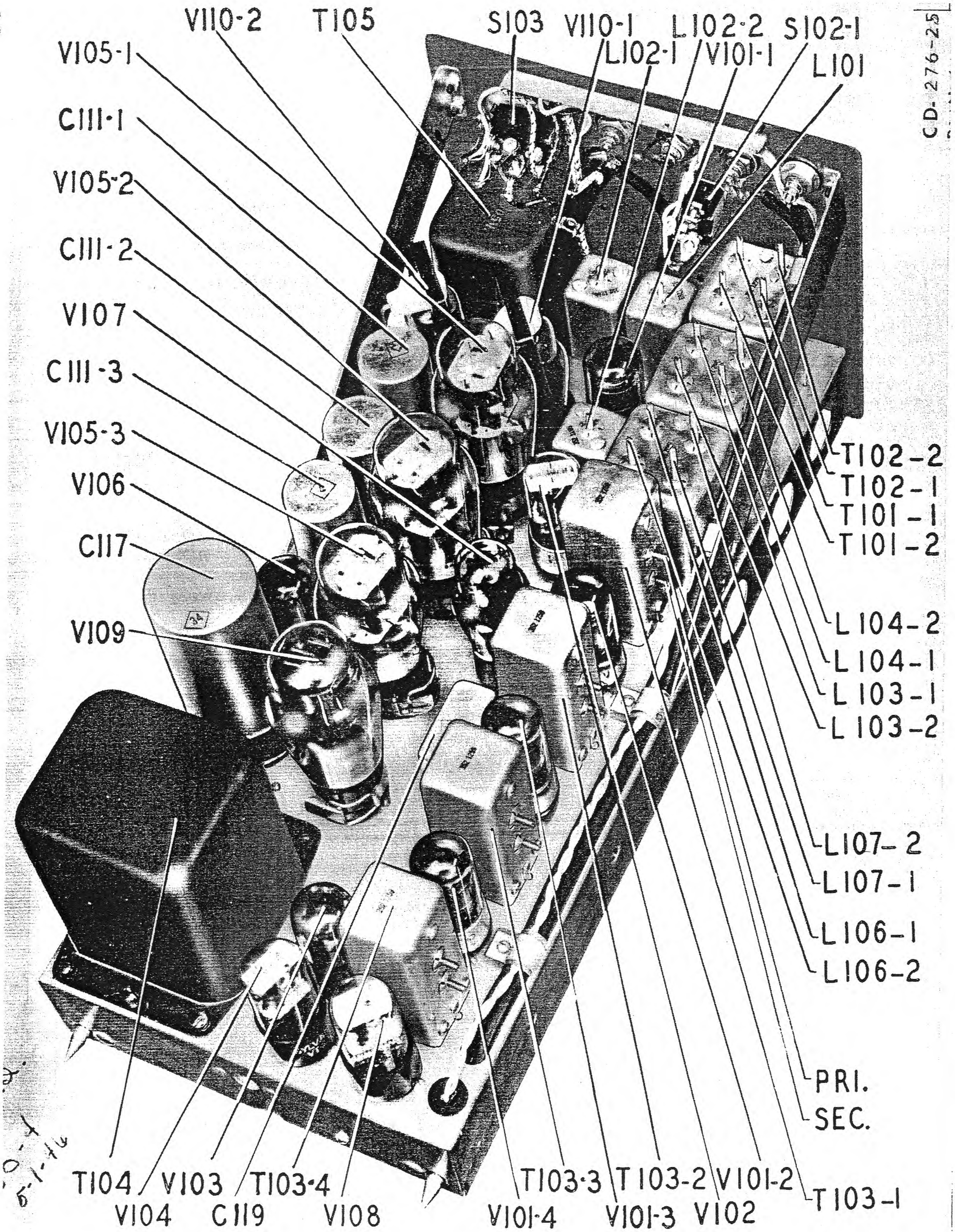


Figure 8-7. Radio Receiver ★R-9/APN-4—Top View of Chassis (Early)

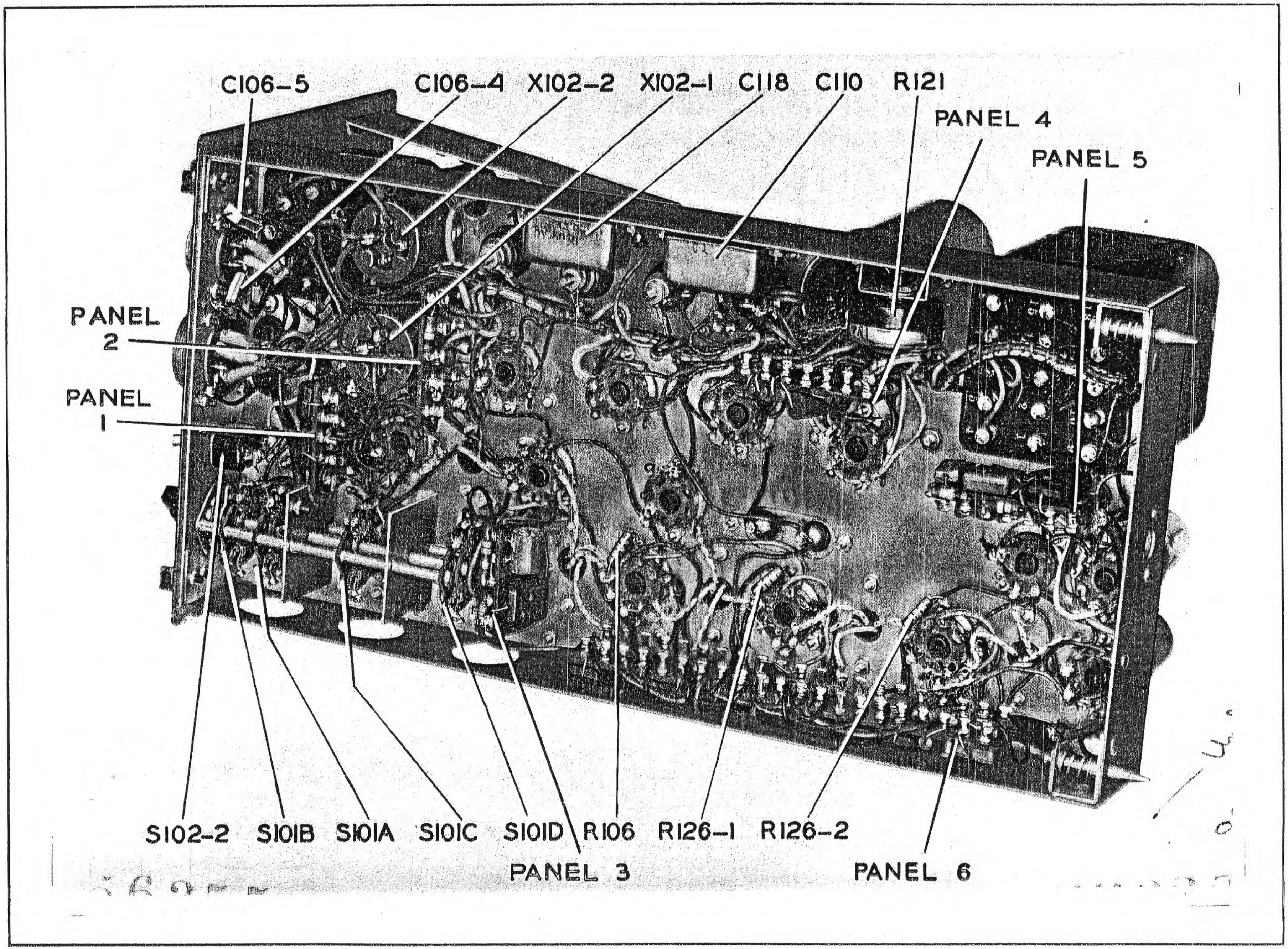


Figure 8-8. Radio Receiver ★R-9/APN-4—Bottom View of Chassis (Early)

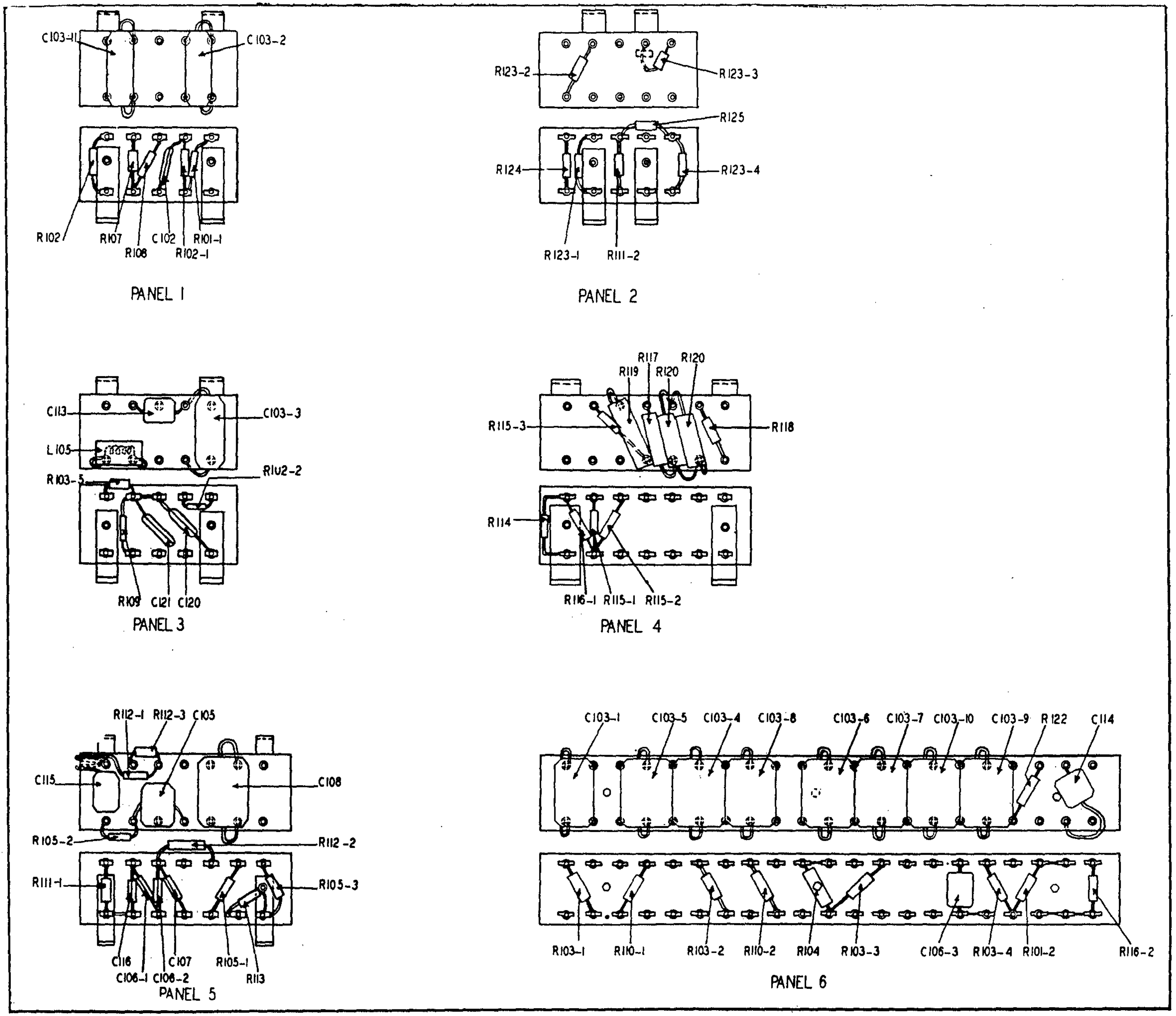


Figure 8-9. Radio Receiver ★R-9/APN-4—Terminal Panel Detail (Early)

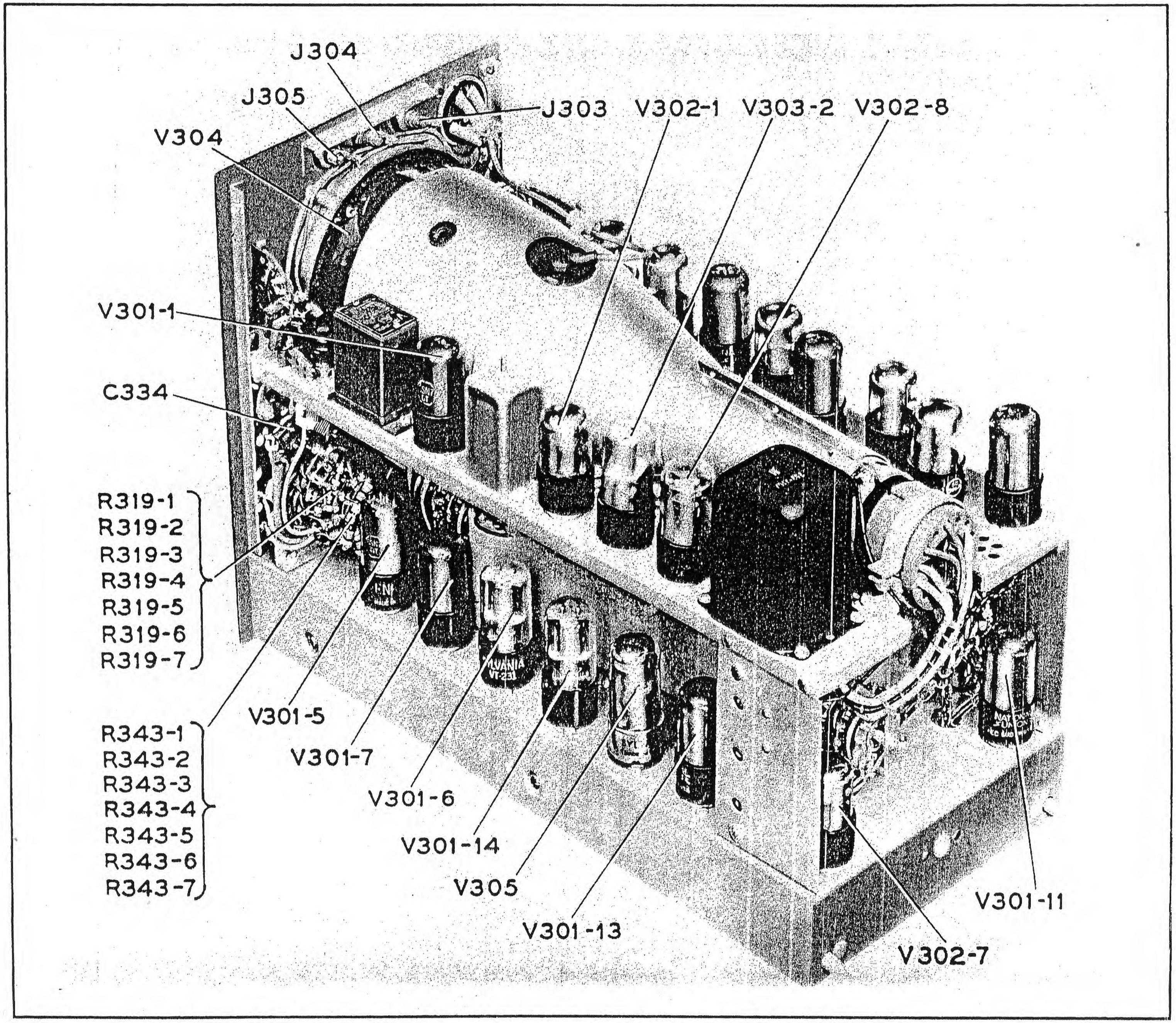
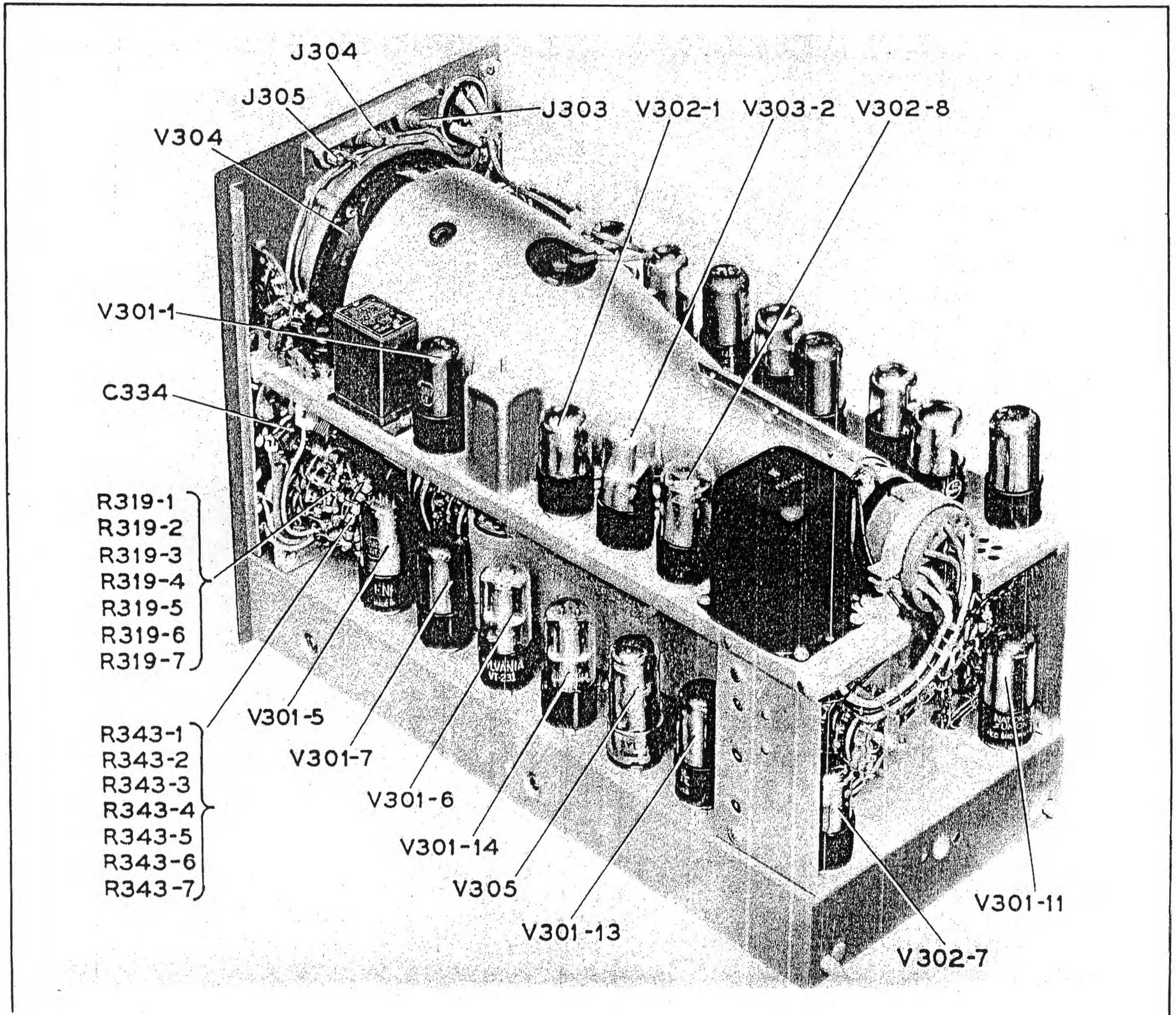


Figure 8-10. Indicator ★ID-6/APN-4—Right Top View of Chassis (Early)


J304
J305
V304
J303
V302-1
V303-2
V302-8
V301-1
C334
R319-1
R319-2
R319-3
R319-4
R319-5
R319-6
R319-7
R343-1
R343-2
R343-3
R343-4
R343-5
R343-6
R343-7
V301-5
V301-7
V301-6
V301-14
V305
V301-13
V302-7
V301-11

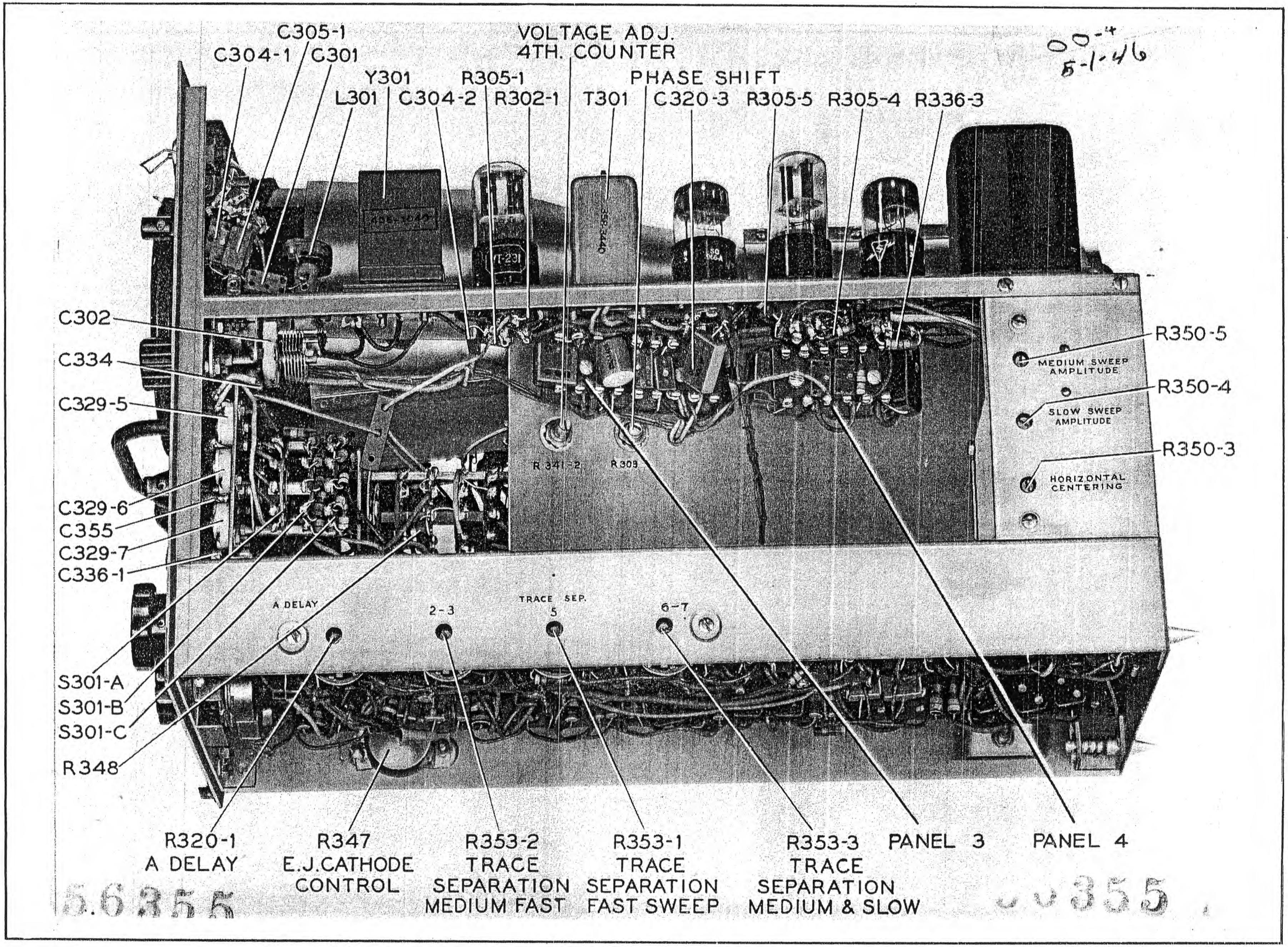


Figure 8-12. Indicator ★ID-6/APN-4—Right Side View of Chassis (Early)

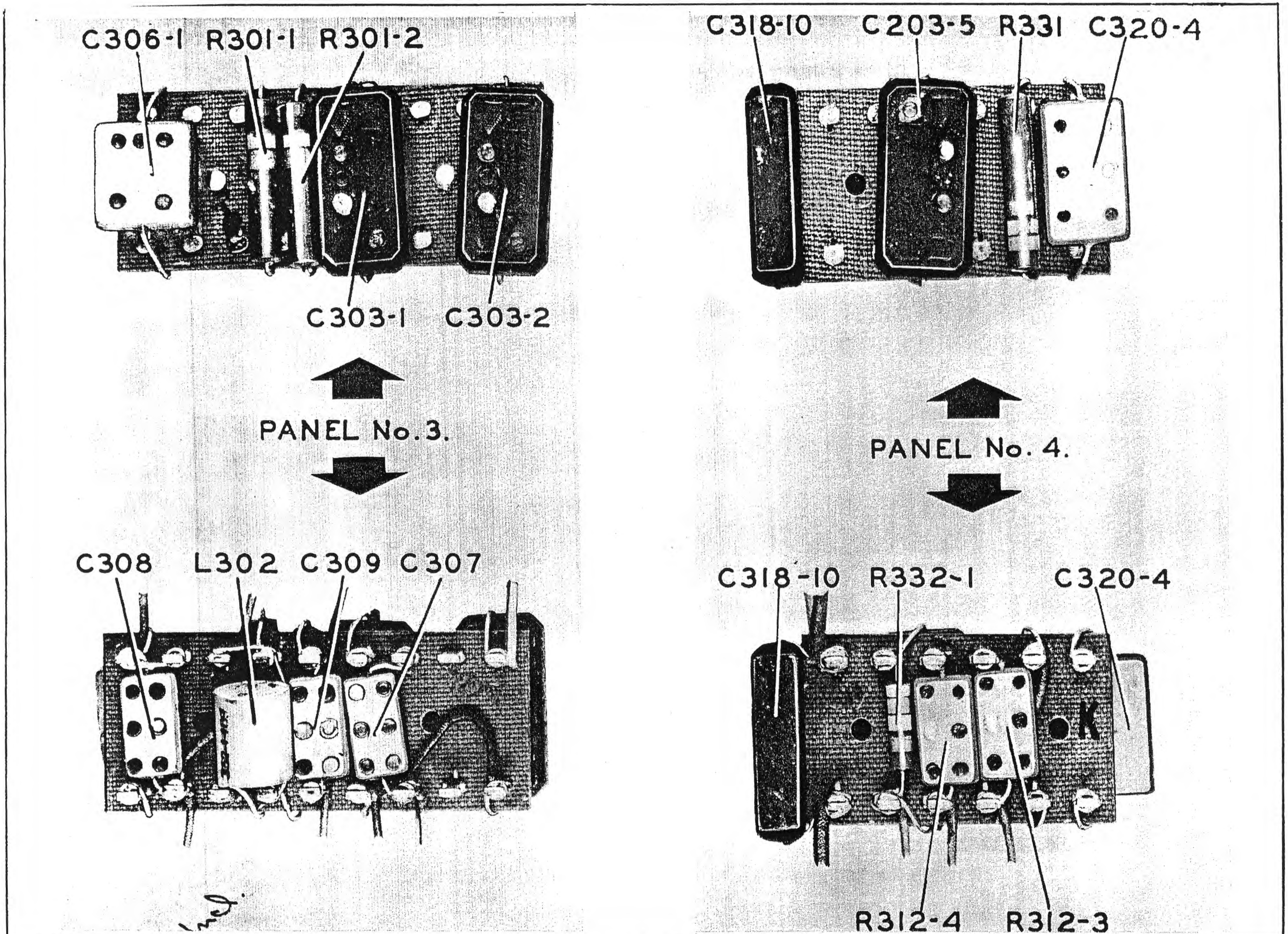


Figure 8-13. Indicator ★ID-6/APN-4—Terminal Panel Detail, Panels No. 3 and 4 (Early)

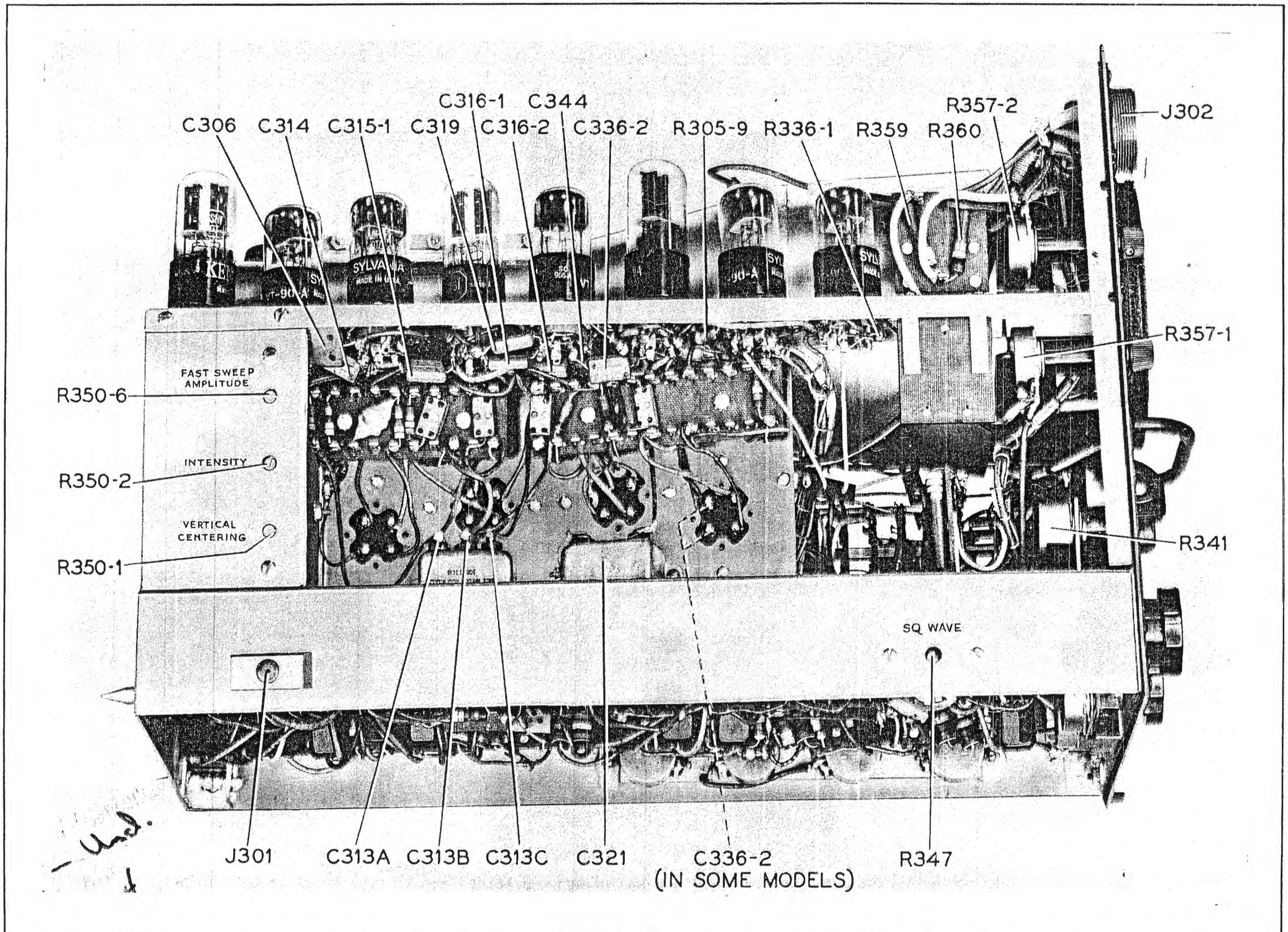


Figure 8-14. Indicator ★ID-6/APN-4—Left Side View of Chassis (Early)

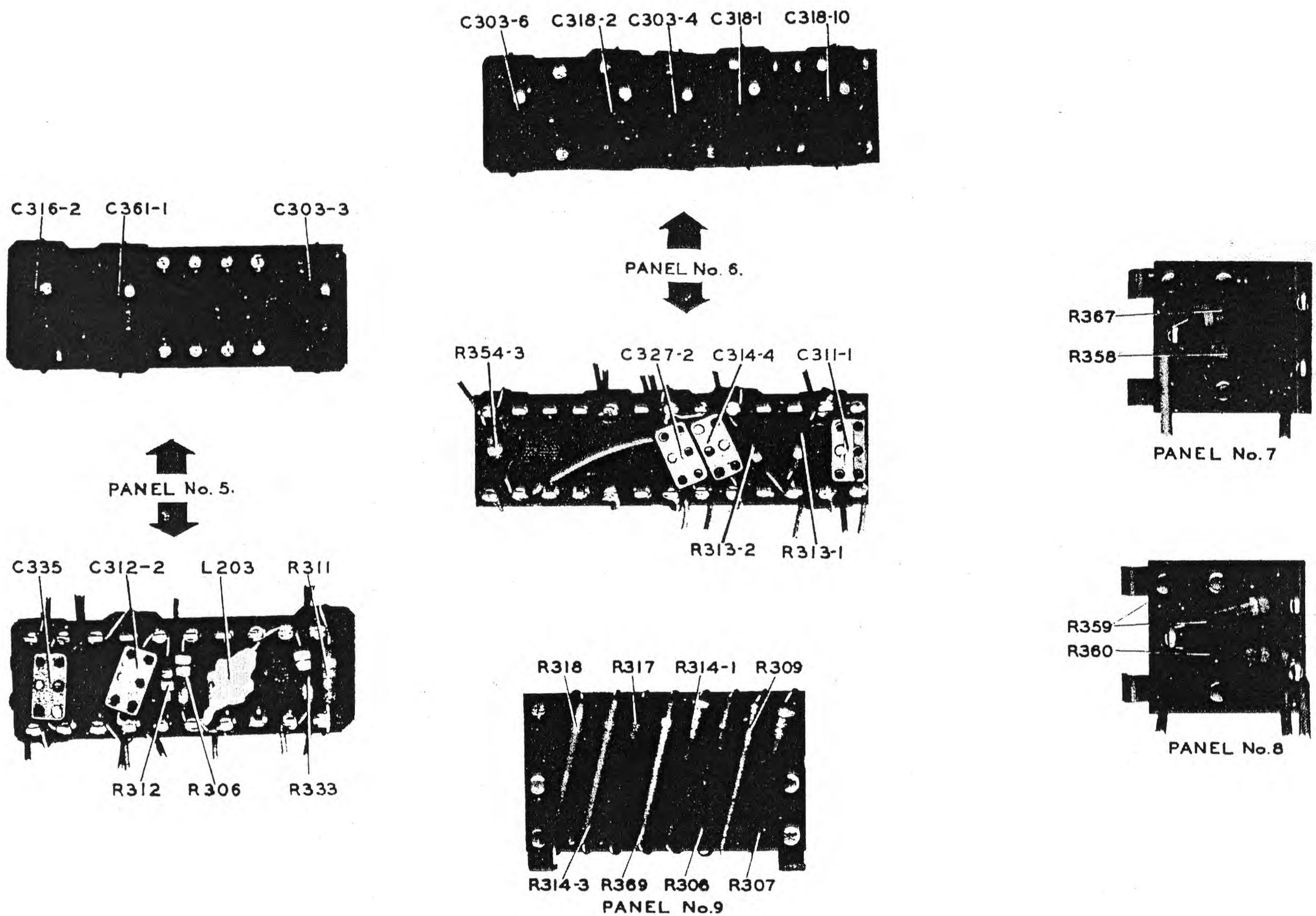


*Figure 8-15. Indicator *ID-6/APN-4—Terminal Panel Detail of Panels No. 5, 6, 7, 8, and 9 (Early)*

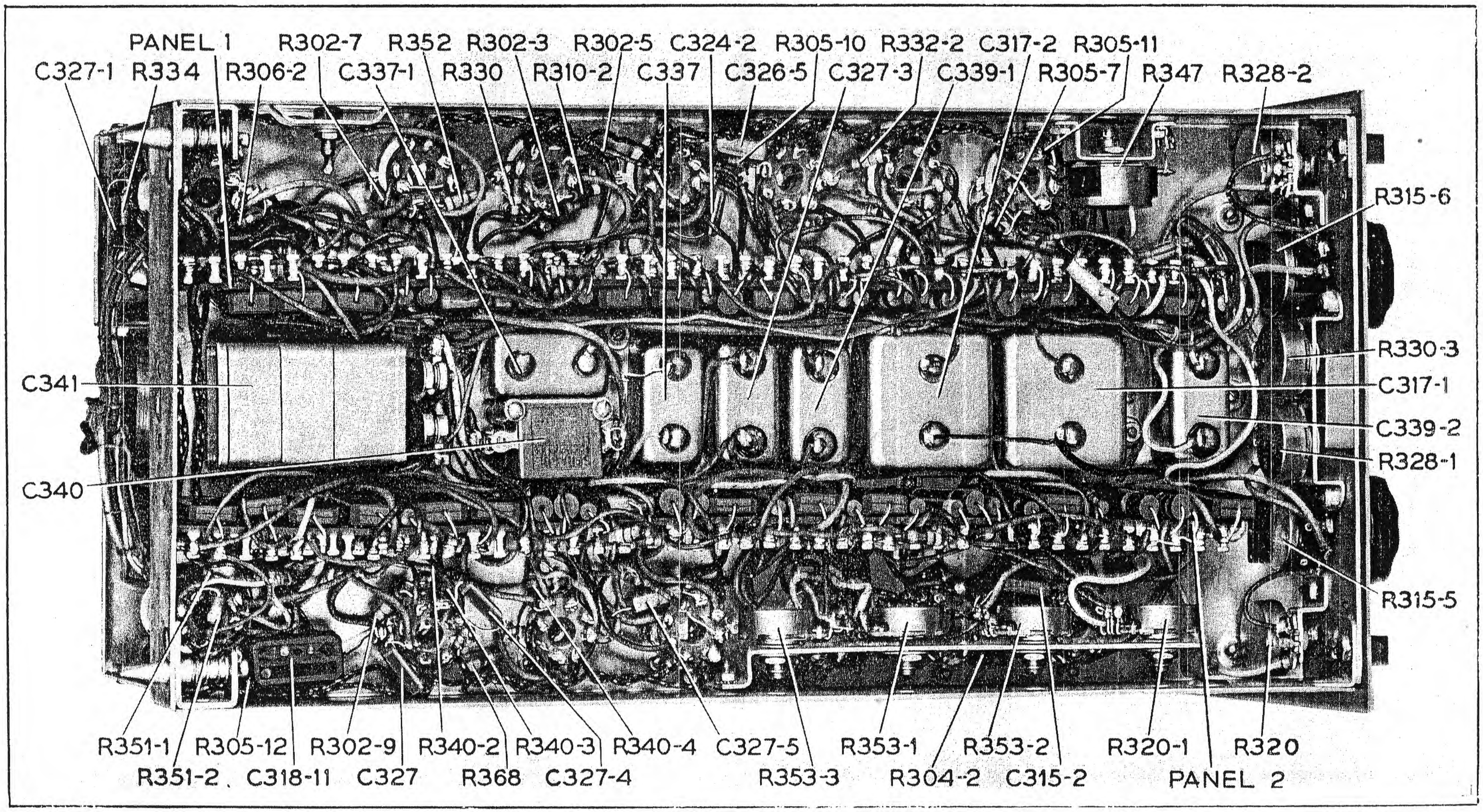


Figure 8-16. Indicator ★ID-6/APN-4—Bottom View of Chassis (Early)

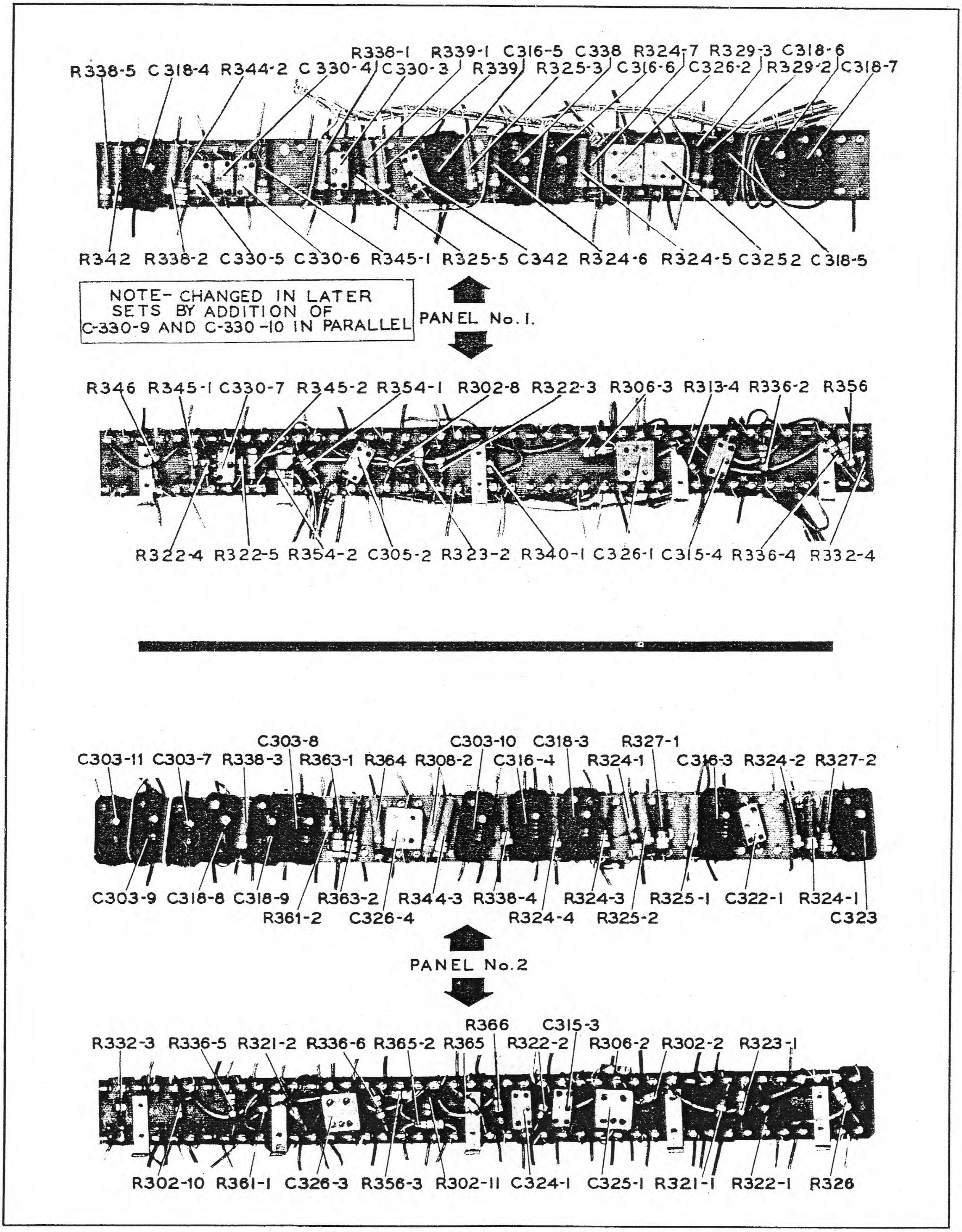


Figure 8-17. Indicator ★ID-6/APN-4—Terminal Panel Detail of Panels No. 1 and 2 (Early)

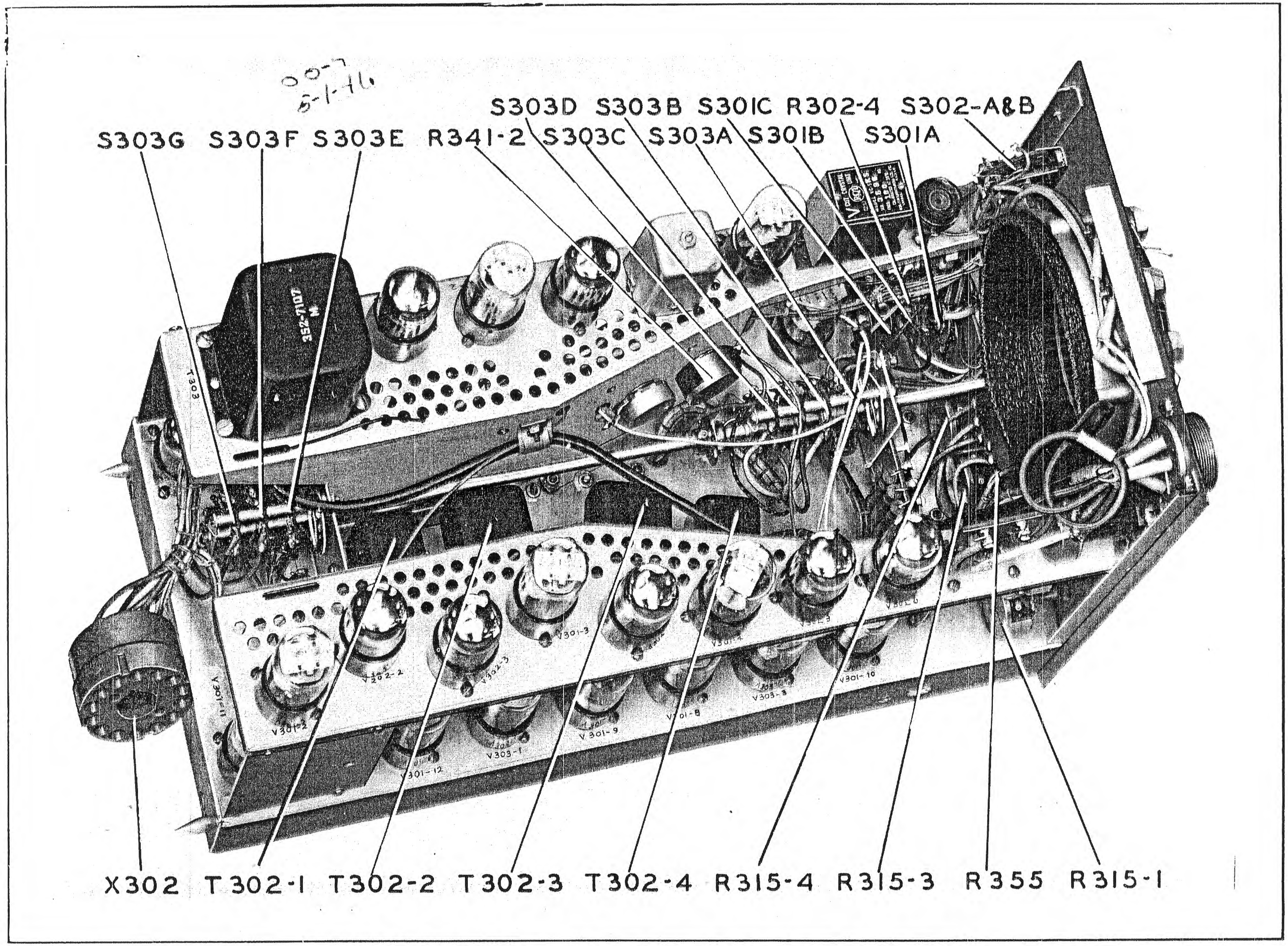
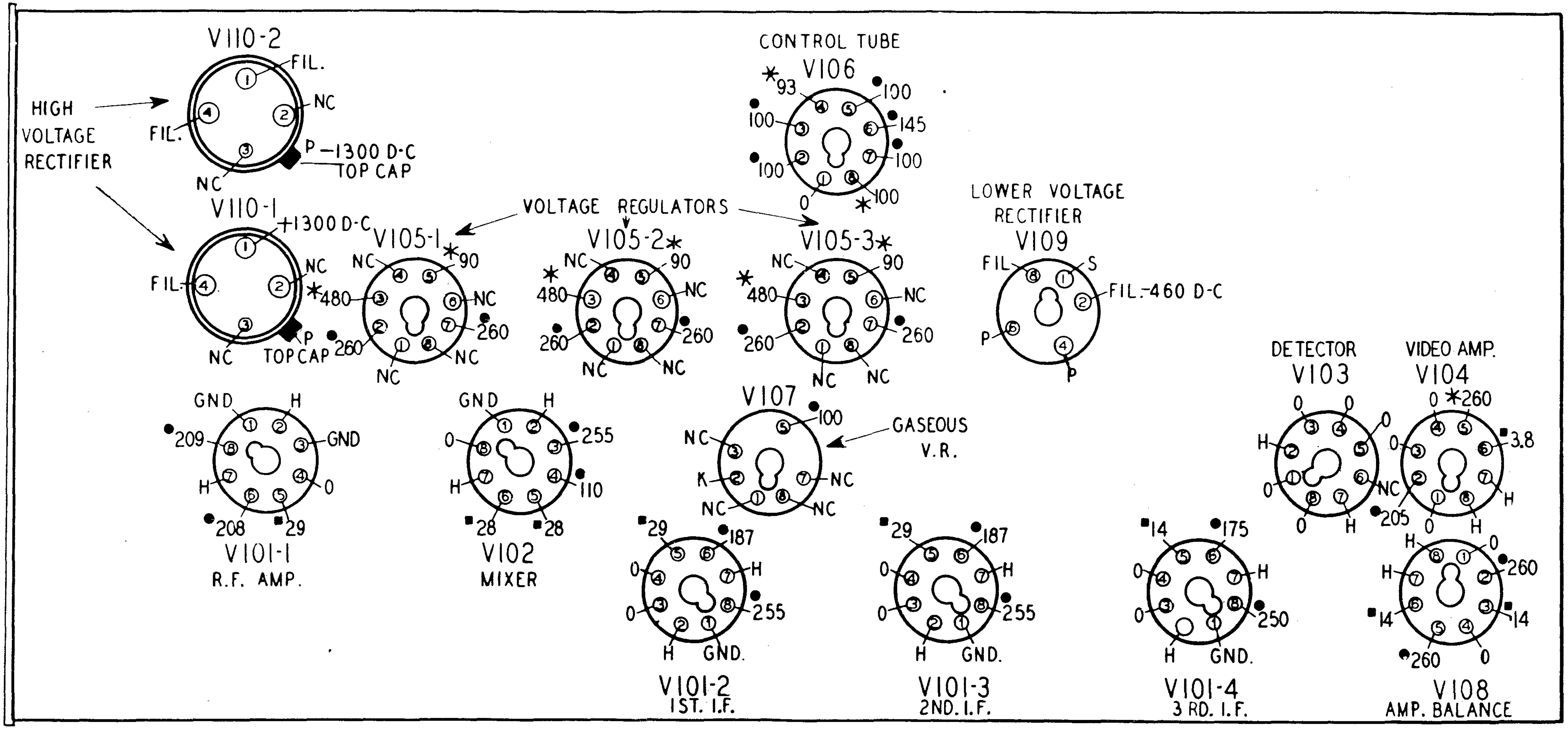


*Figure 8-18. Indicator *ID-6/APN-4—Top View of Chassis with Cathode Ray Tube and Shield Removed (Early)*



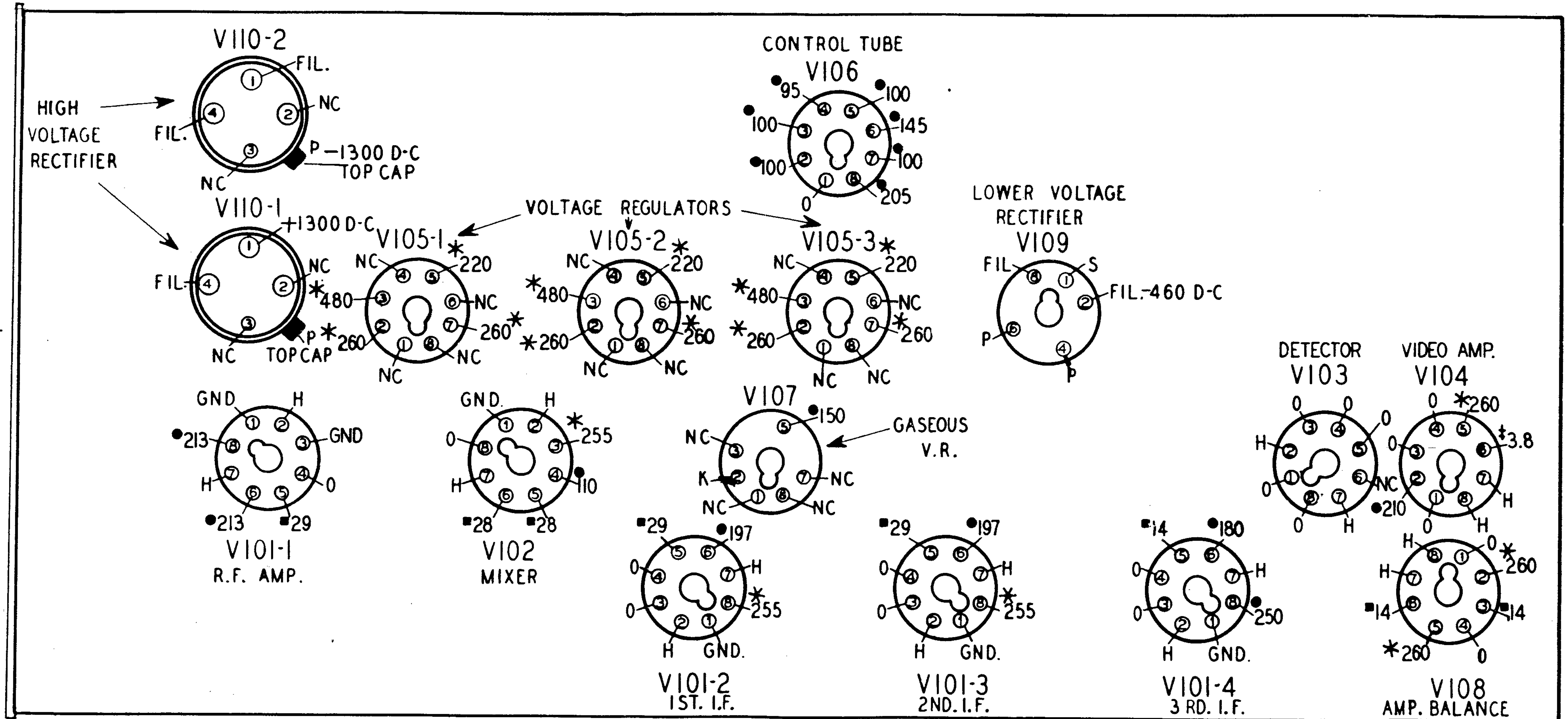
NOTE: GAIN CONTROL R341 LOCATED IN INDICATOR IN MINIMUM GAIN POSITION.
VOLTAGES SHOWN ARE WITH RESPECT TO CHASSIS (GROUND) USING A 1,000 OHM PER VOLT METER.
FOR SOCKET BASE VOLTAGES — MAXIMUM GAIN POSITION SEE FIGURE 70

LEGEND:

FIL.= FILAMENT
GND= GROUND
H = HEATER
K = CATHODE
NC = NO CONNECTION
P = PLATE
S = SHIELD
V = VOLTS D-C TO CHASSIS
VR = VOLTAGE REGULATOR

* 600 VOLT SCALE
● 300 VOLT SCALE
■ 30 VOLT SCALE

***Figure 8-19.** Radio Receiver *R-9/APN-4—Socket Base Voltages Using 1000-Ohm-Per-Volt Voltmeter, Gain Control in Minimum Position (Early)*



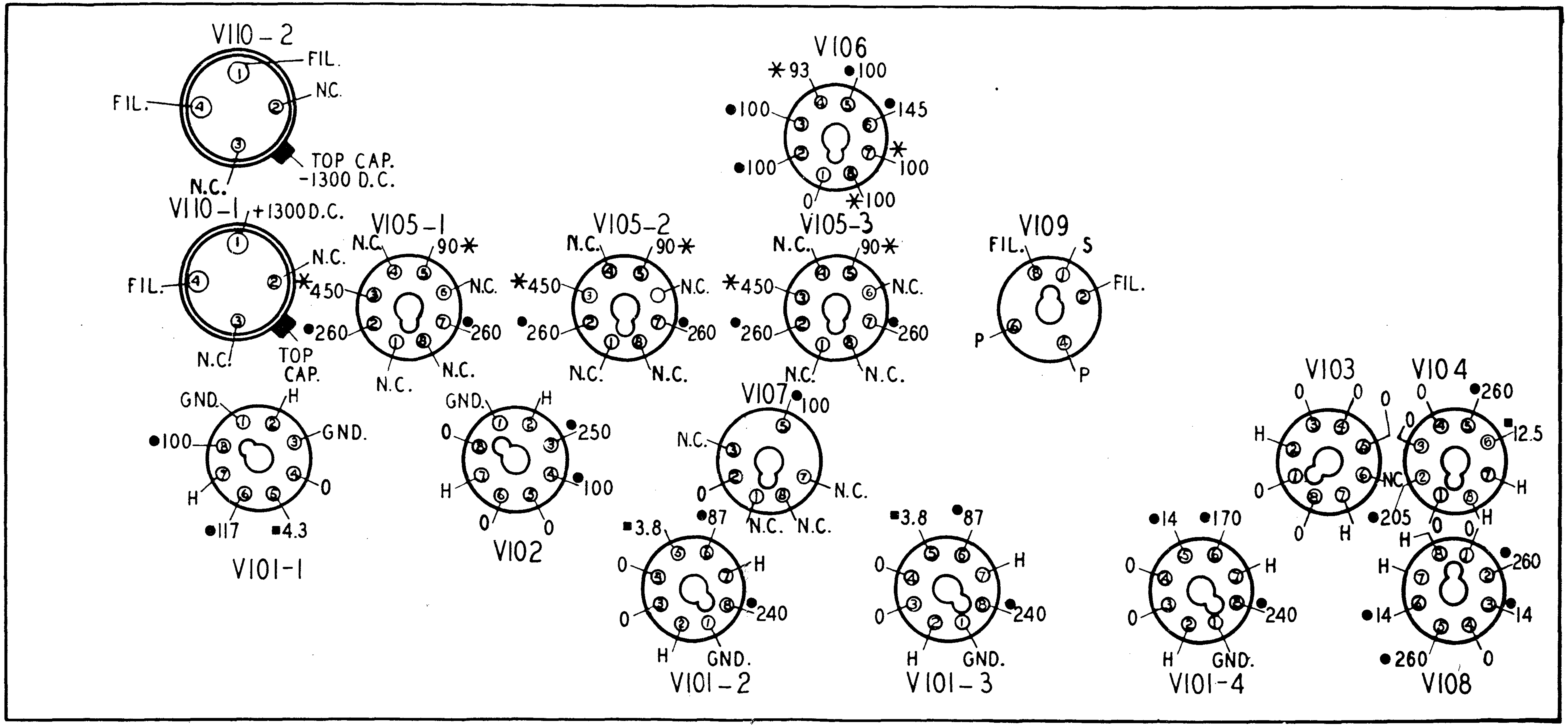
NOTE: GAIN CONTROL R341 LOCATED IN INDICATOR IN MINIMUM GAIN POSITION.
VOLTAGES SHOWN ARE WITH RESPECT TO CHASSIS (GROUND) USING A 20,000 OHM PER VOLT METER.
FOR SOCKET BASE VOLTAGES — MAXIMUM GAIN POSITION SEE FIGURE 71

LEGEND:

FIL.= FILAMENT
GND= GROUND
H = HEATER
K = CATHODE
NC = NO CONNECTION
P = PLATE
S = SHIELD
V = VOLTS D-C TO CHASSIS
V.R. = VOLTAGE REGULATOR

✳ 1000 VOLT SCALE
● 250 VOLT SCALE
■ 50 VOLT SCALE
‡ 10 VOLT SCALE

Figure 8-20. Radio Receiver ★R-9/APN-4—Socket Base Voltages Using 20,000-Ohm-Per-Volt Voltmeter, Gain control in Minimum Position (Early)

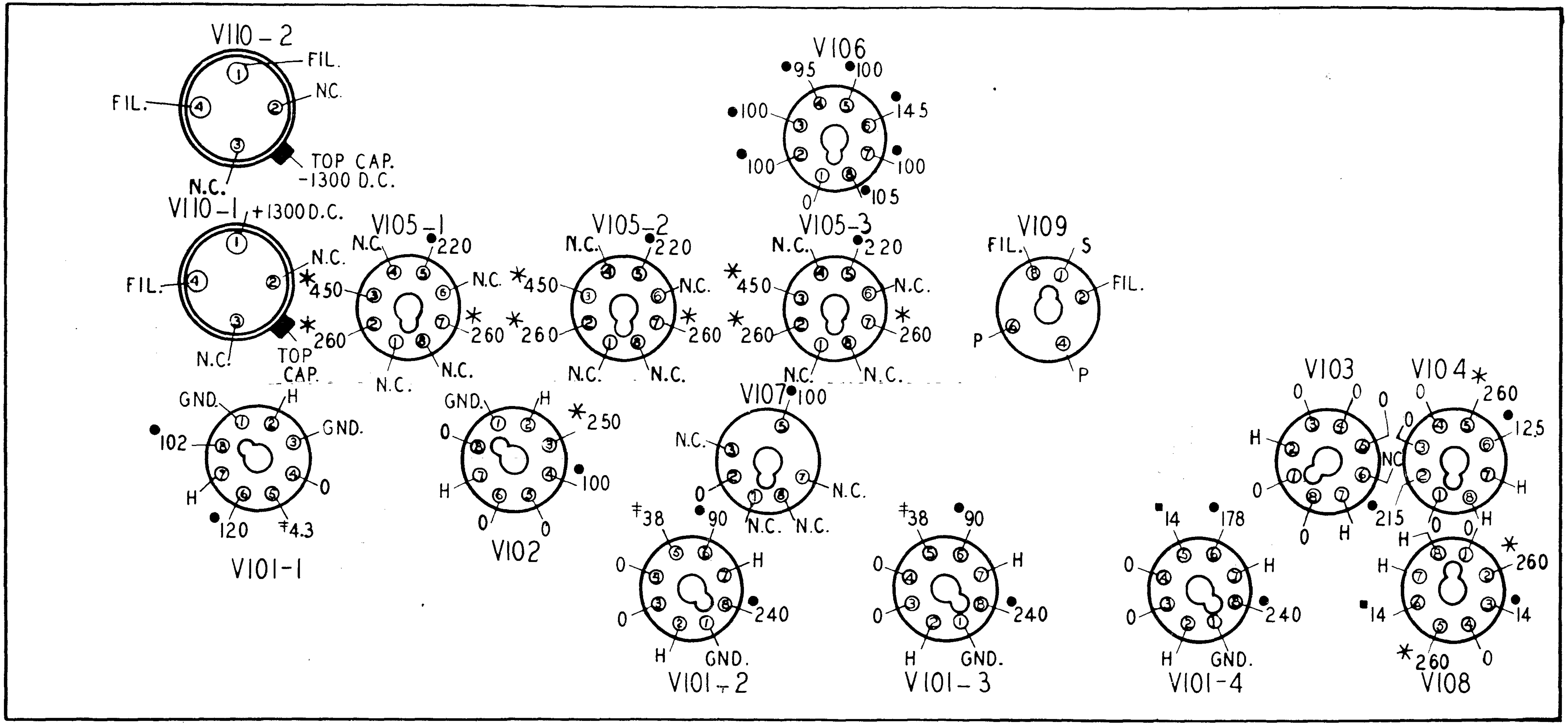


NOTE: GAIN CONTROL R341 LOCATED IN INDICATOR IN MAXIMUM GAIN POSITION.
VOLTAGES SHOWN ARE WITH RESPECT TO CHASSIS (GROUND) USING A 1000 OHM PER VOLT METER.

LEGEND:
■ = 30 VOLT SCALE
● = 300 VOLT SCALE
* = 600 VOLT SCALE
FIL. = FILAMENT
GND. = GROUND
H = HEATER
N.C. = NO CONNECTION
P = PLATE
S = SHIELD
V = VOLTS D.C. TO CHASSIS

*Figure 8-21. Radio Receiver *R-9/APN-4—Socket Base Voltages Using 1000-Ohm-Per-Volt Voltmeter, Gain Control in Maximum Position (Early)*

AN 16-30APN4-3



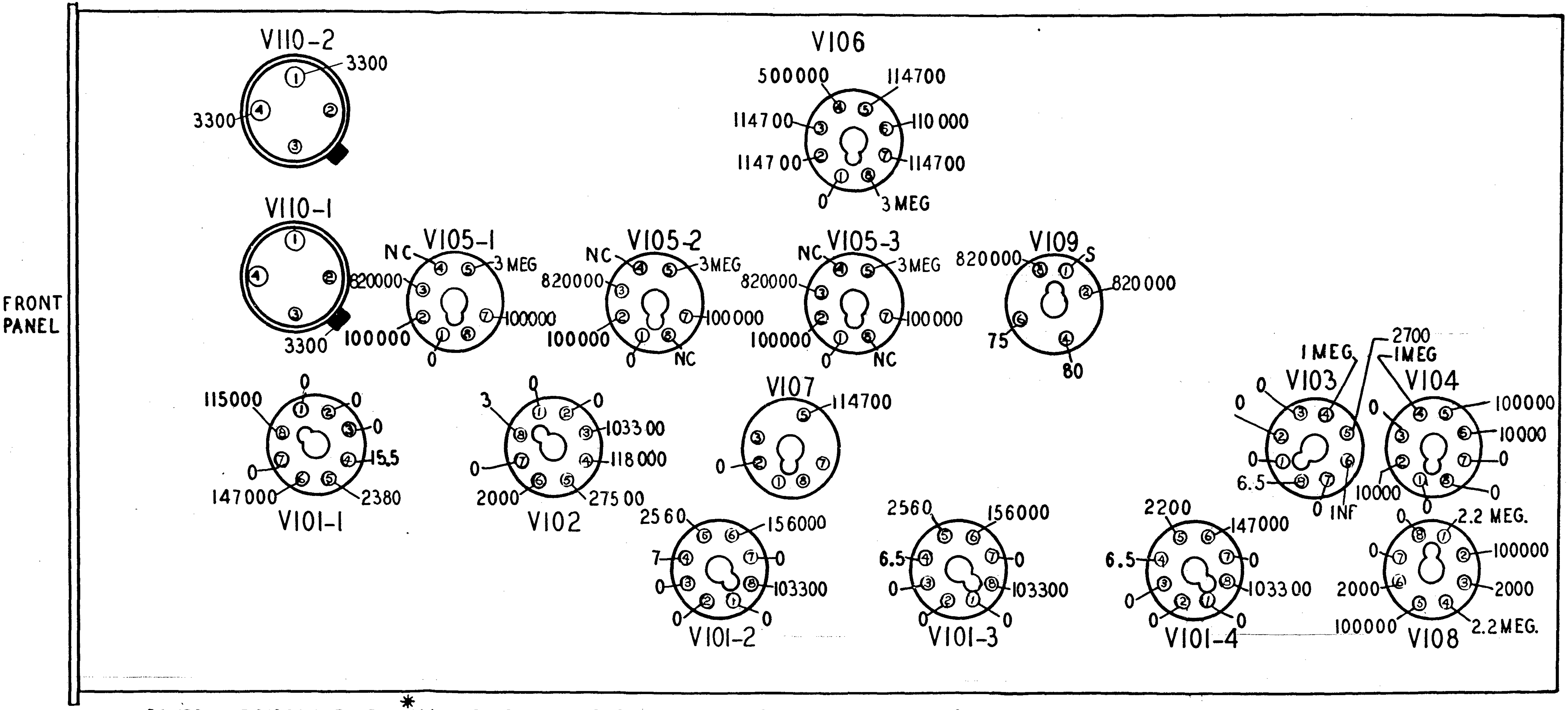
NOTE: GAIN CONTROL R341 LOCATED IN INDICATOR IN MAXIMUM GAIN POSITION.

VOLTAGES SHOWN ARE WITH RESPECT TO CHASSIS (GROUND) USING A 20,000 OHM PER VOLT METER.

LEGEND:
FIL. = FILAMENT
GND. = GROUND
H = HEATER
N.C. = NO CONNECTION
P = PLATE
S = SHIELD
V = VOLTS D.C. TO CHASSIS

✱ 1000 VOLT SCALE
● 250 VOLT SCALE
■ 50 VOLT SCALE
‡ 10 VOLT SCALE

*Figure 8-22. Radio Receiver *R-9/APN-4—Socket Base Voltages Using 20,000-Ohm-Per-Volt Voltmeter, Gain Control in Maximum Position (Early)*



NOTE: POWER LINE DISCONNECTED—*ALL CABLES AND CORDS DISCONNECTED—TUBES IN SOCKETS.
* EXCEPT GAIN CONTROL CORD
GAIN CONTROL IN MAXIMUM POSITION

Figure 8-23. Radio Receiver ★R-9/APN-4—Resistance Measurements, Socket Terminals to Ground (Early)

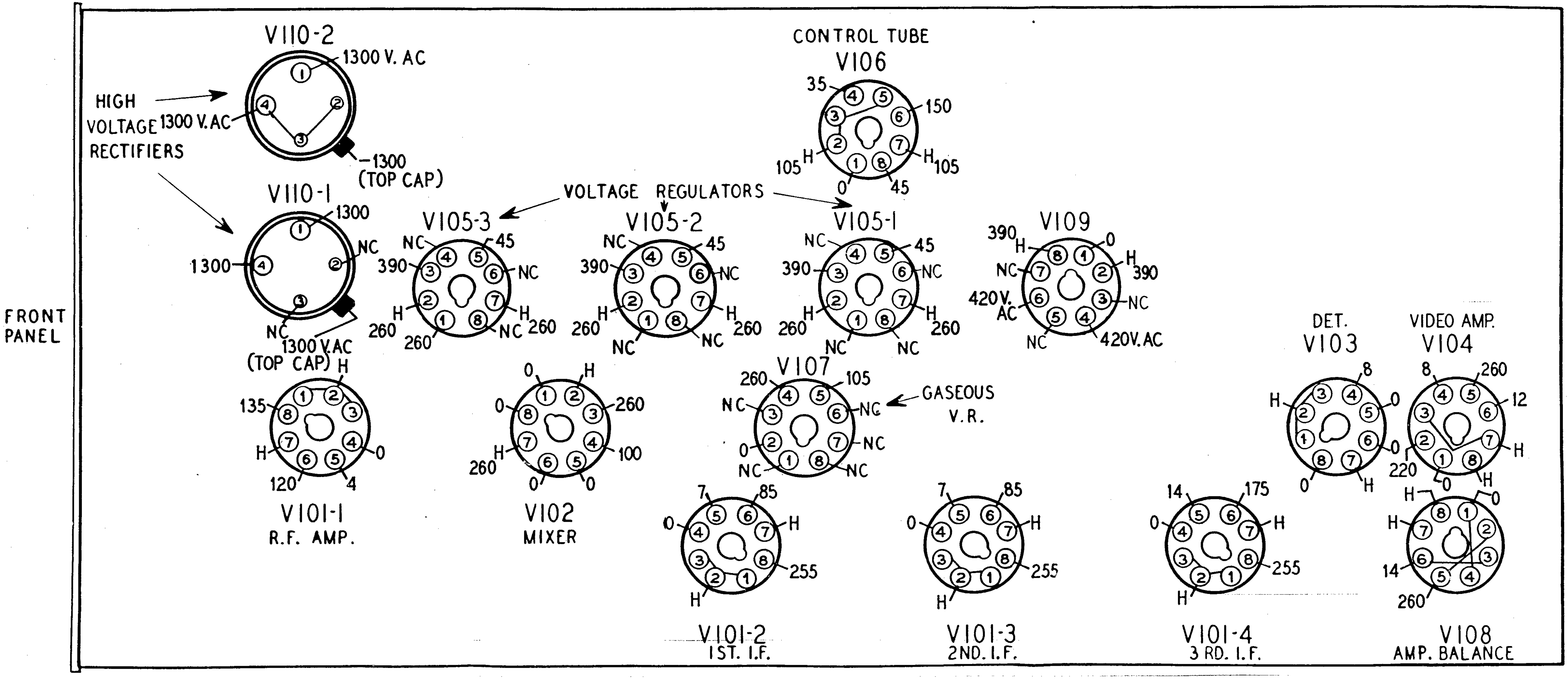


Figure 8-23A. Radio Receiver ★R-9A/APN-4—Socket Base Voltages Using 1000-Ohm-Per-Volt Voltmeter—Gain Control in Maximum Position

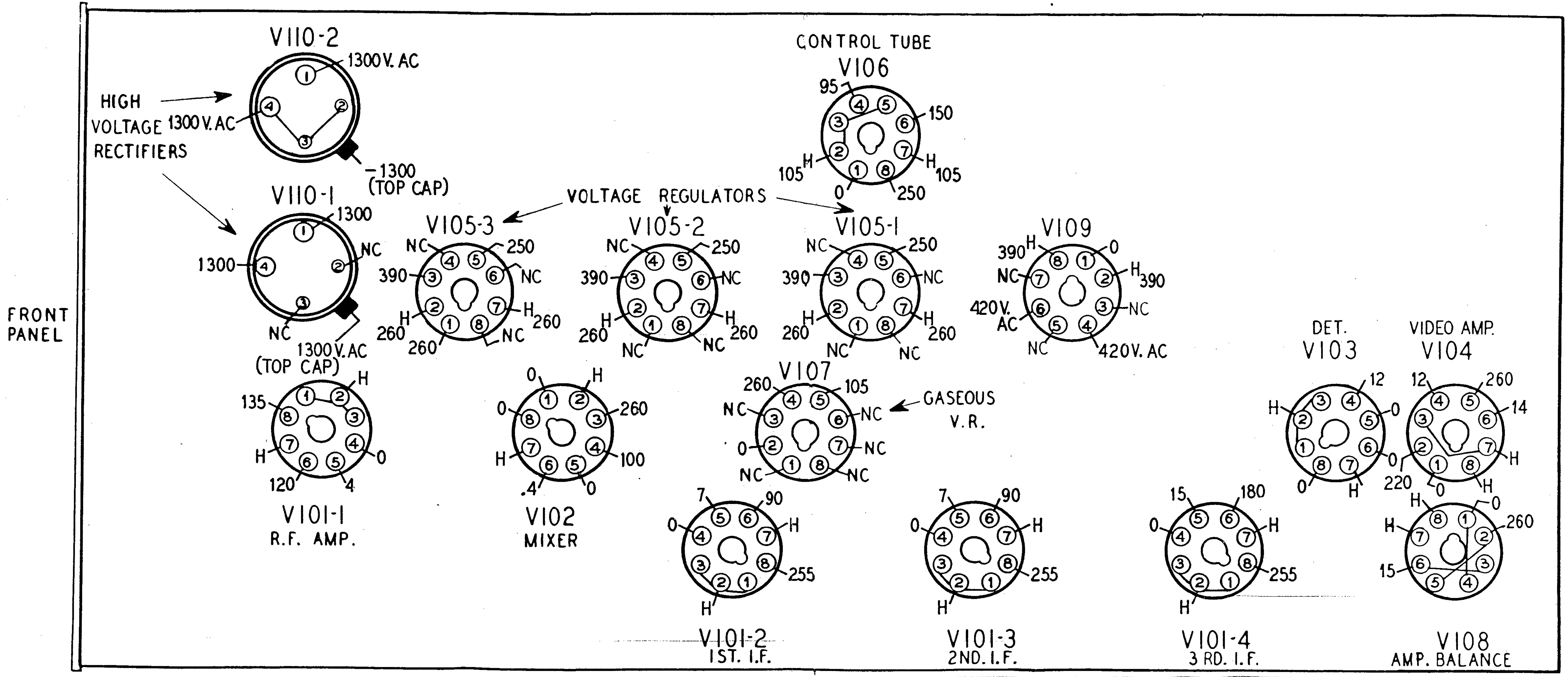


Figure 8-23B. Radio Receiver ★R-9A/APN-4—Socket Base Voltages Using A 20,000-Ohm-Per-Volt Voltmeter—Gain Control in Maximum Position

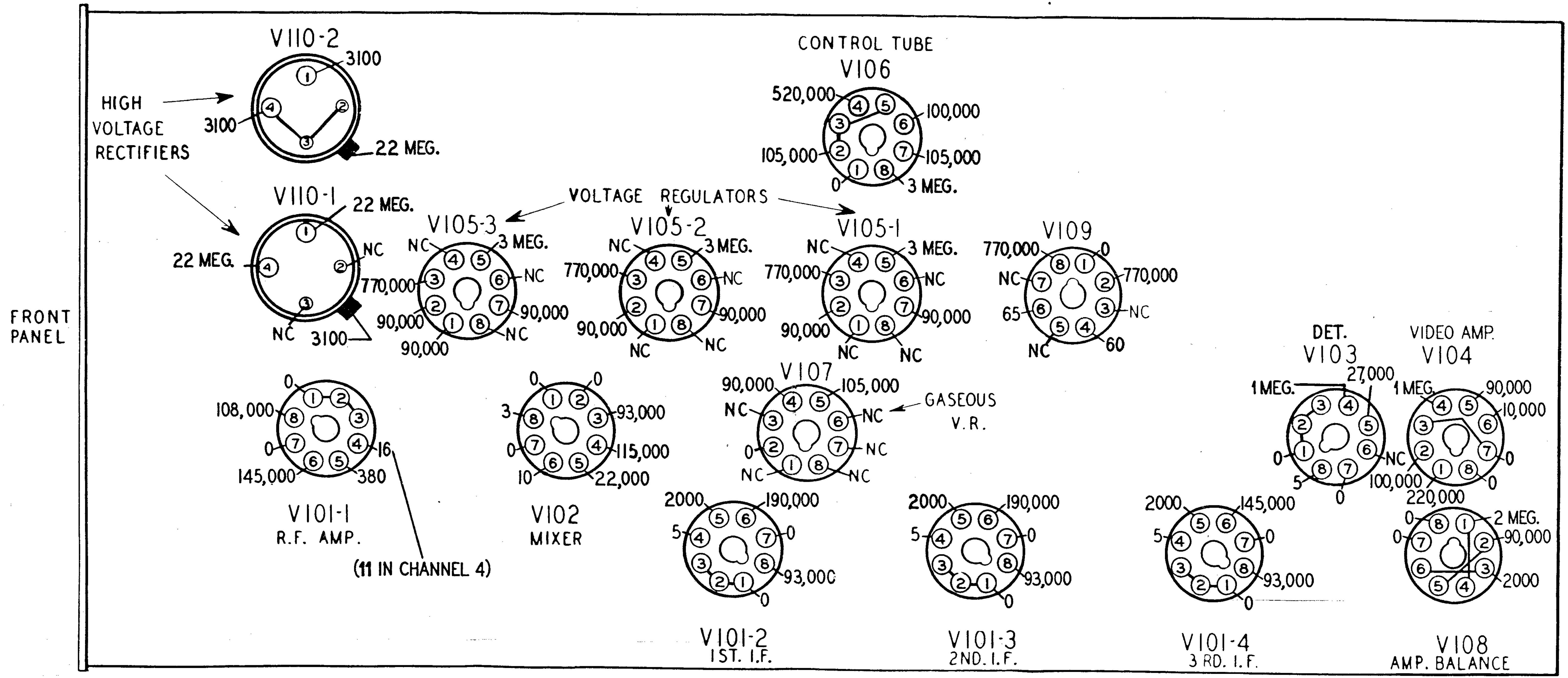


Figure 8-23C. Radio Receiver ★R-9A/APN-4—Resistance Measurements—Socket Terminals to Ground Using a 1000-Ohm-Per-Volt Voltmeter—Gain Control in Maximum Position

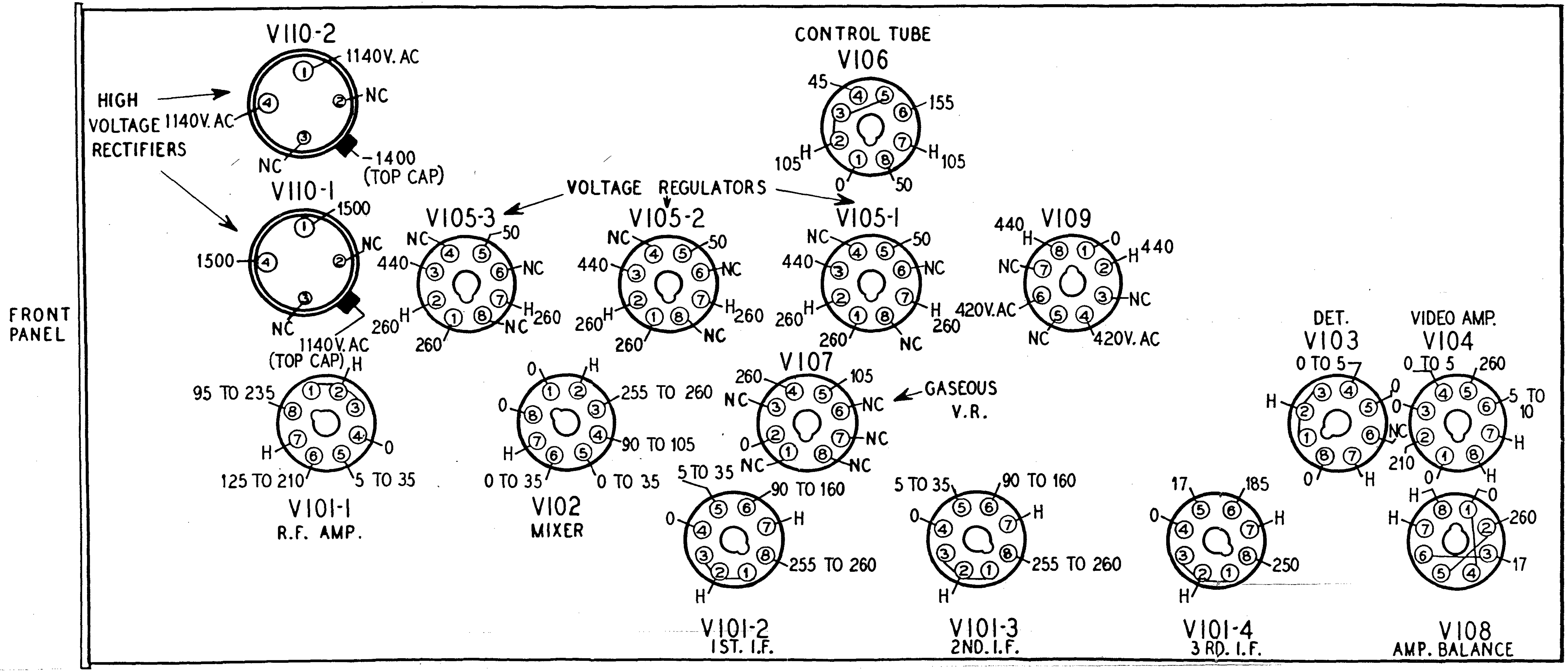


Figure 8-23D. Radio Receiver *R-9B/APN-4—Socket Base Voltages Using A 1000-Ohm-Per-Volt Voltmeter—Gain Control Turned from Minimum to Maximum Positions

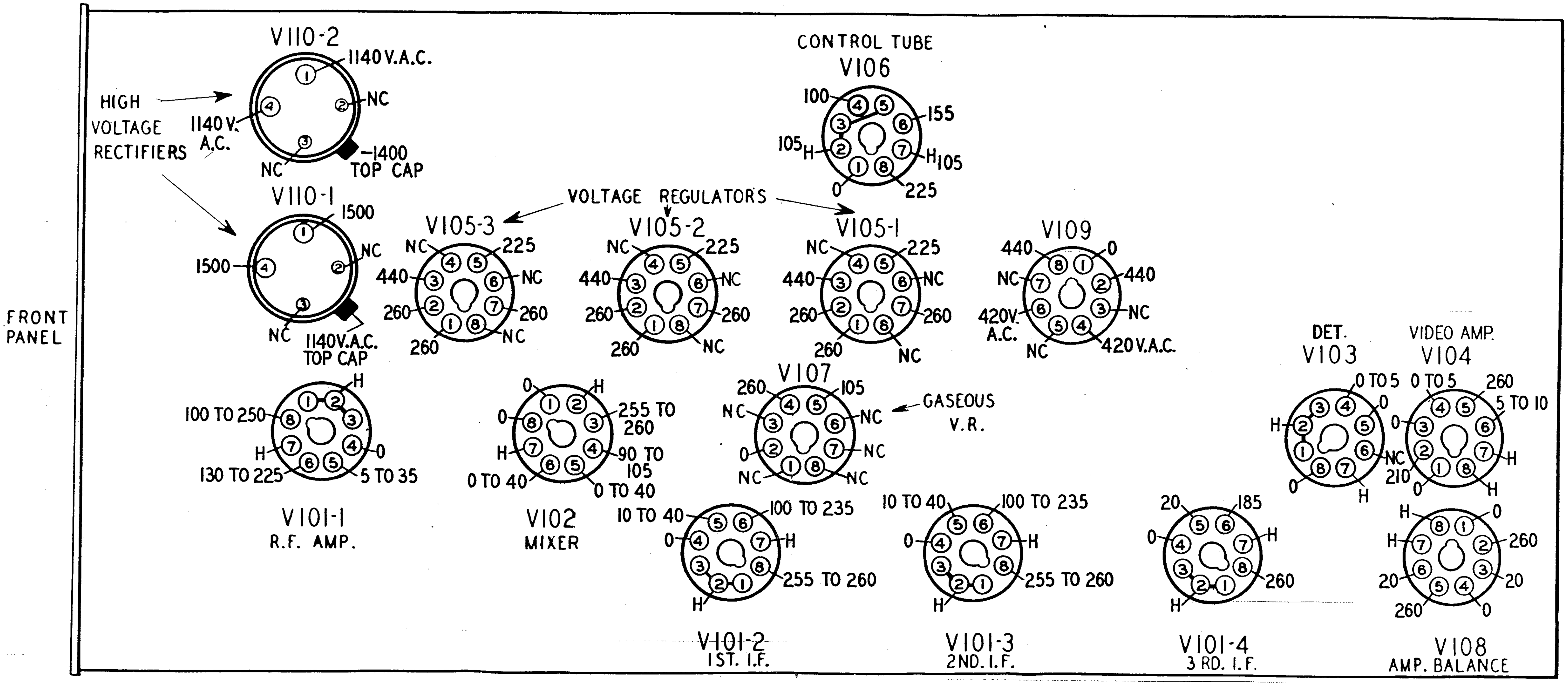


Figure 8-23E. Radio Receiver ★R-9B/APN-4—Socket Base Voltages Using a 20,000-Ohm-Per-Volt Voltmeter—Gain Control in Minimum and Maximum Positions

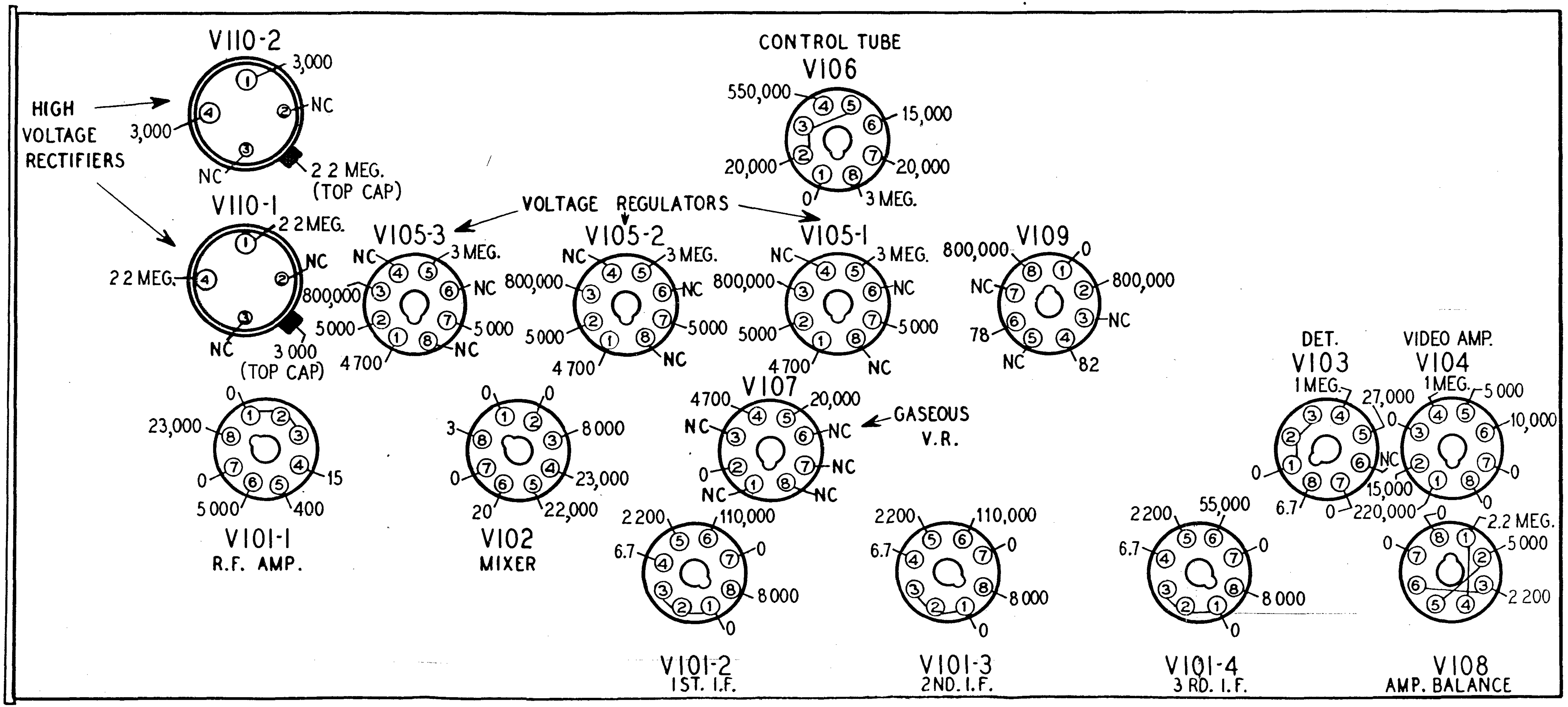
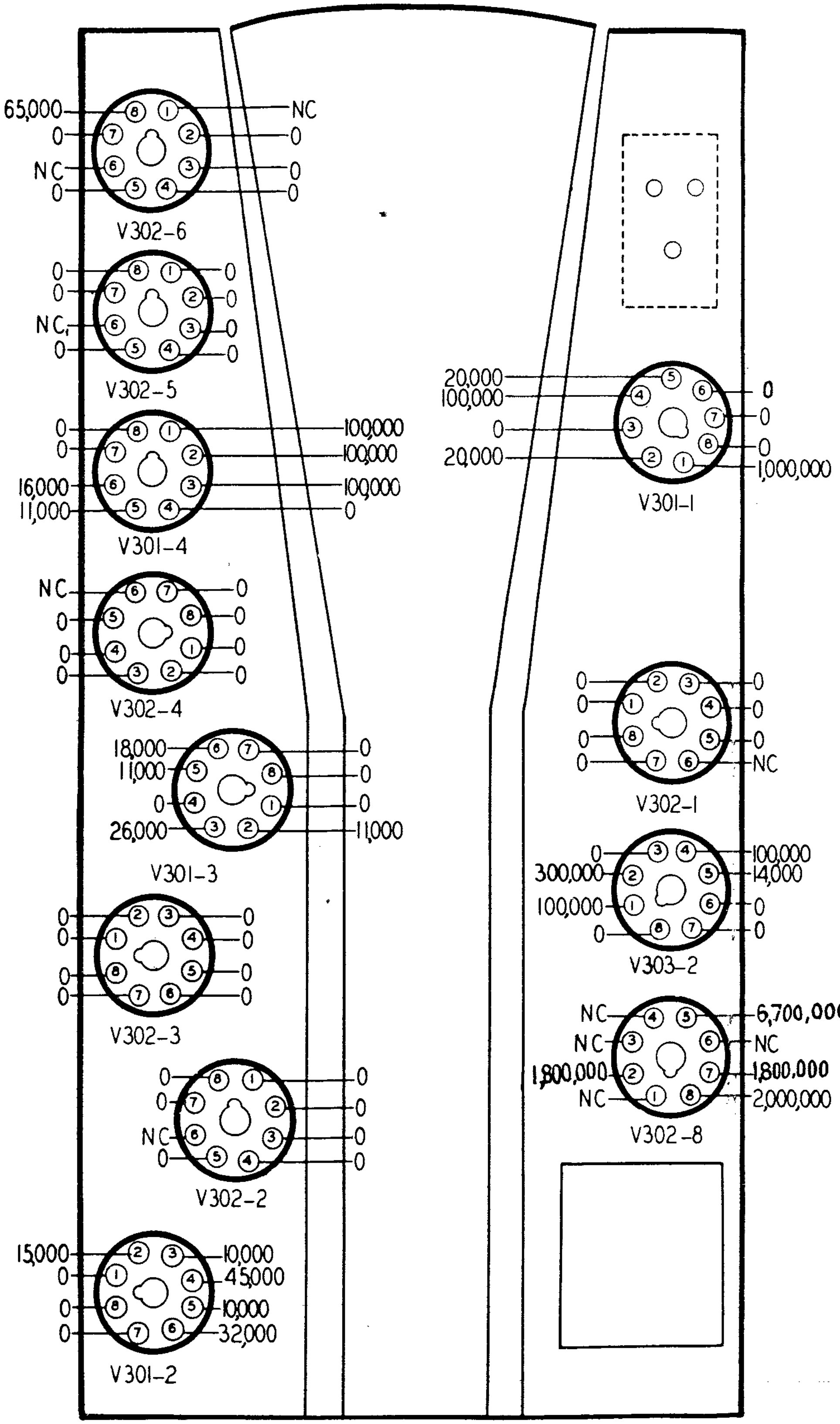


*Figure 8-23F. Radio Receiver *R-9B/APN-4—Resistance Measurements—Socket Terminals to Ground Using a 1000-Ohm-Per-Volt Voltmeter—Gain Control in Maximum Position*

AN 16-30APN4-3



BASE PIN LAYOUT
D.C. RESISTANCE TO GROUND (CHASSIS)

LEGEND

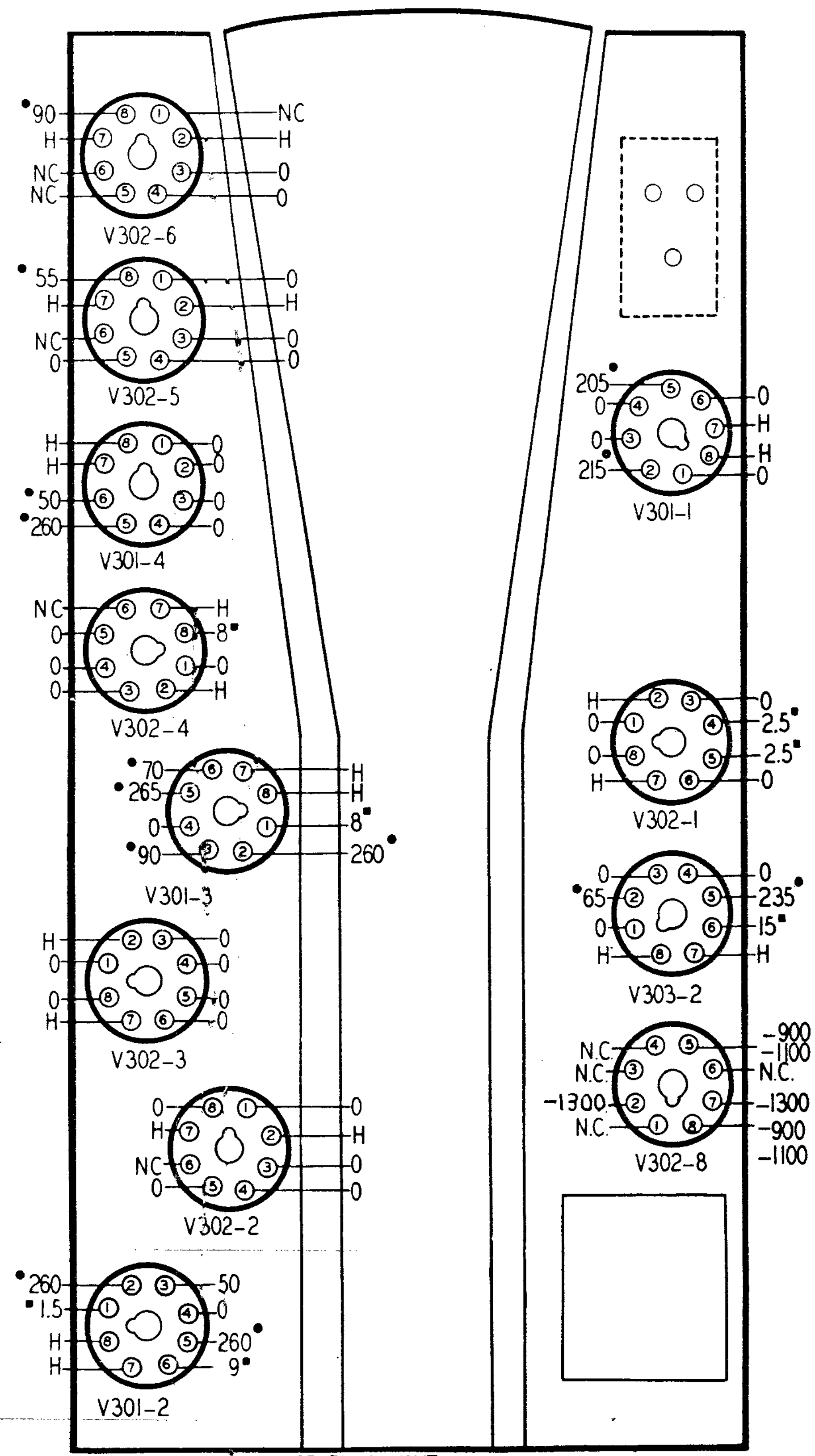
H-HEATER PINS 6.3 V.A.C.
N.C.-NO CONNECTION

RECEIVER POWER SUPPLY SET AT 260 V.D.C. OUTPUT

SWEEP SPEED ON POSITION 1

STATION SELECTOR ON POSITION 0

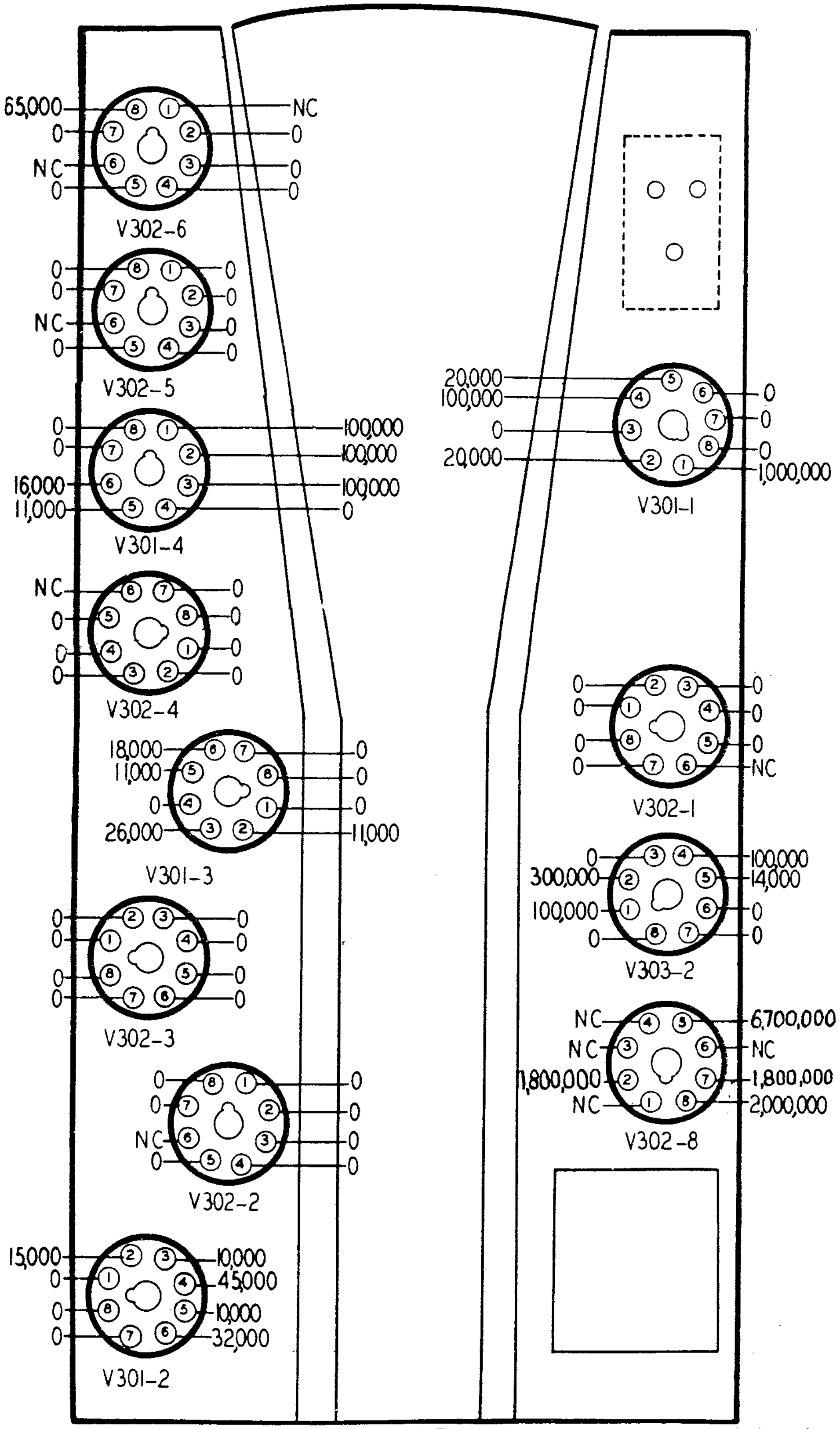
• 300 VOLT SCALE
▪ 30 VOLT SCALE



BASE PIN LAYOUT
D.C. VOLTAGE TO GROUND (CHASSIS)

D.C. VOLTAGES MEASURED WITH 1,000 OHM/V METER

Figure 8-24. Indicator *ID-6/APN-4—Bottom View of Upper Deck, Measured with a 1000-Ohm-Per-Volt Voltmeter (Early)



BASE PIN LAYOUT
D.C RESISTANCE TO GROUND (CHASSIS)

LEGEND:
H-HEATER PINS 6.3V.A.C.
N.C.-NO CONNECTION

RECEIVER POWER SUPPLY SET AT 260V.D.C. OUTPUT

SWEEP SPEED ON POSITION I

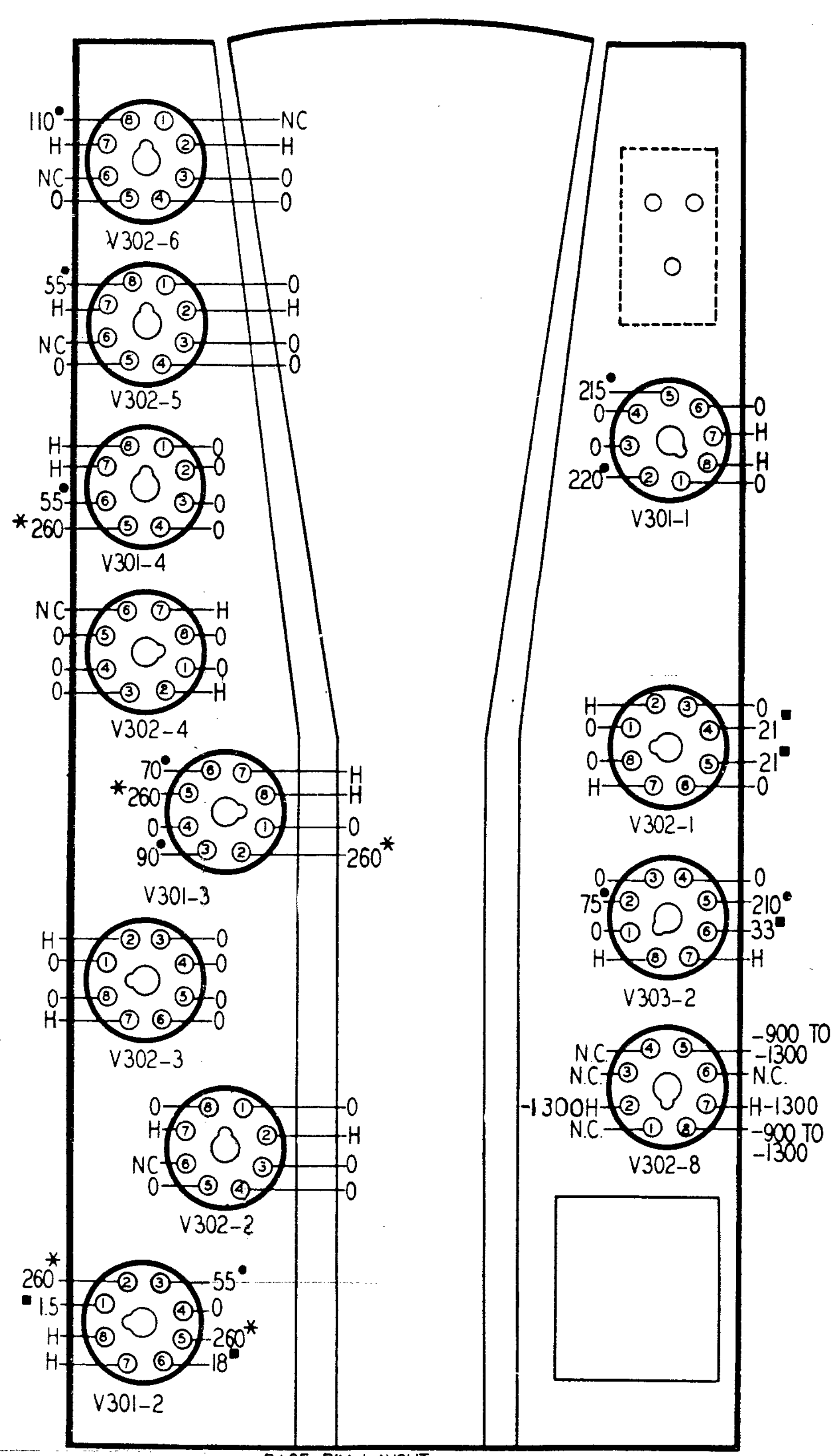
STATION SELECTOR ON POSITION 0

*1000 VOLT SCALE

•250 VOLT SCALE

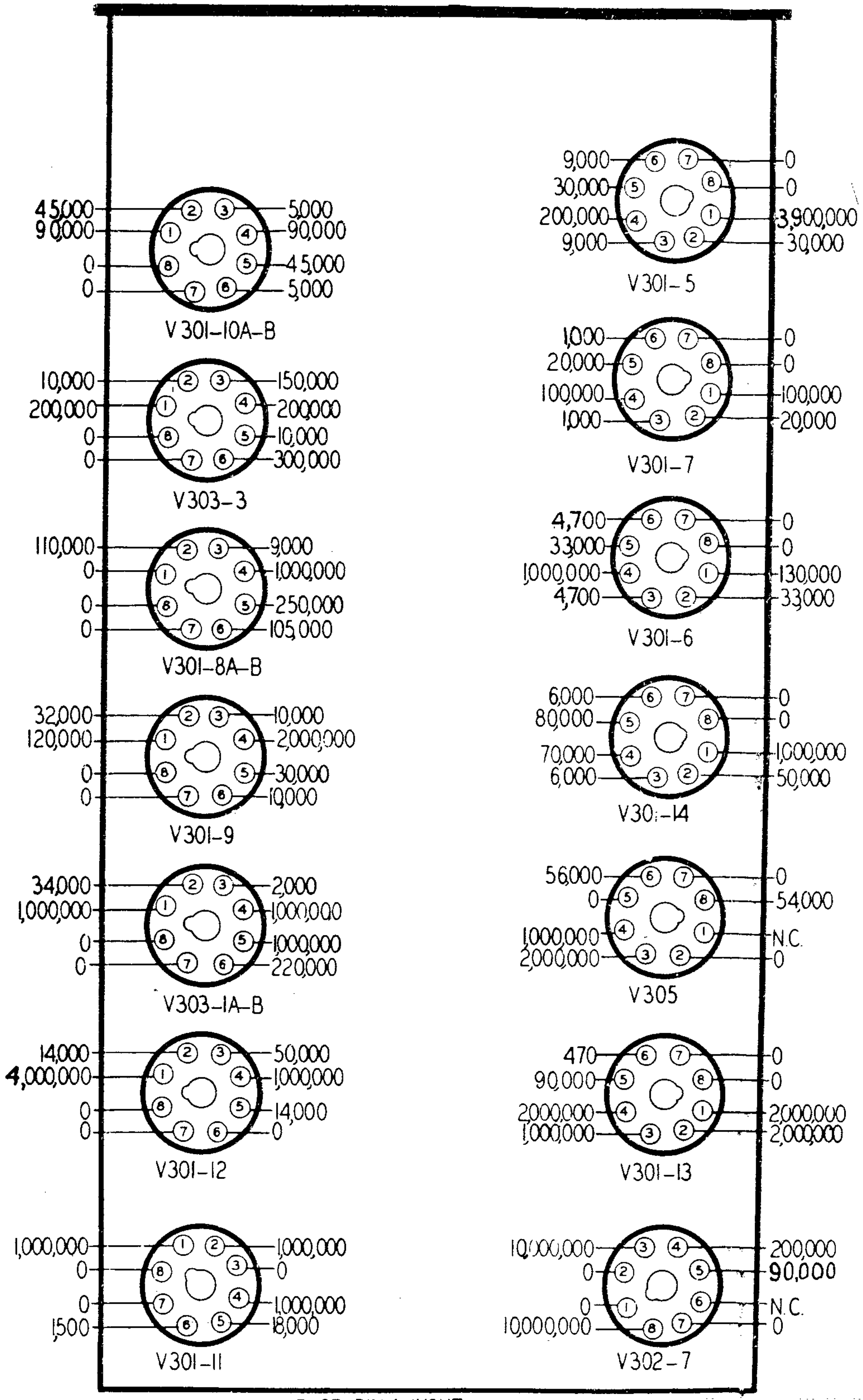
▪50 VOLT SCALE

D.C. VOLTAGES MEASURED WITH 20,000 OHM/V METER



BASE PIN LAYOUT
D.C. VOLTAGE TO GROUND (CHASSIS)

*Figure 8-25. Indicator *ID-6/APN-4—Bottom View of Upper Deck, Measured with a 20,000-Ohm-Per-Volt Voltmeter (Early)*



BASE PIN LAYOUT
D.C. RESISTANCE TO GROUND (CHASSIS)

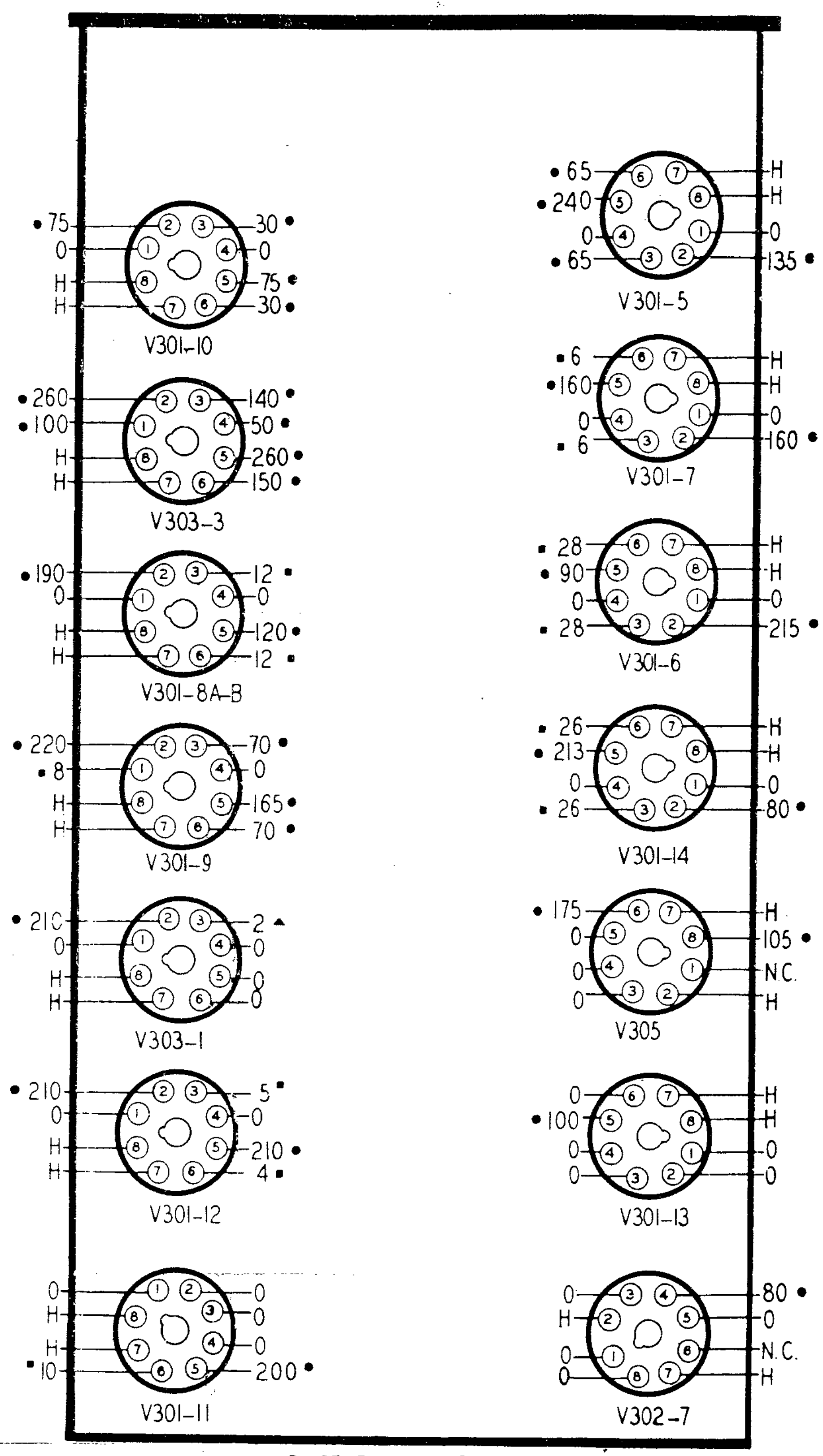
LEGEND
H-HEATER PINS 6.3 V.A.C.
N.C.-NO CONNECTION

RECEIVER POWER SUPPLY SET AT 260 V.D.C. OUTPUT

SWEEP SPEED ON POSITION I

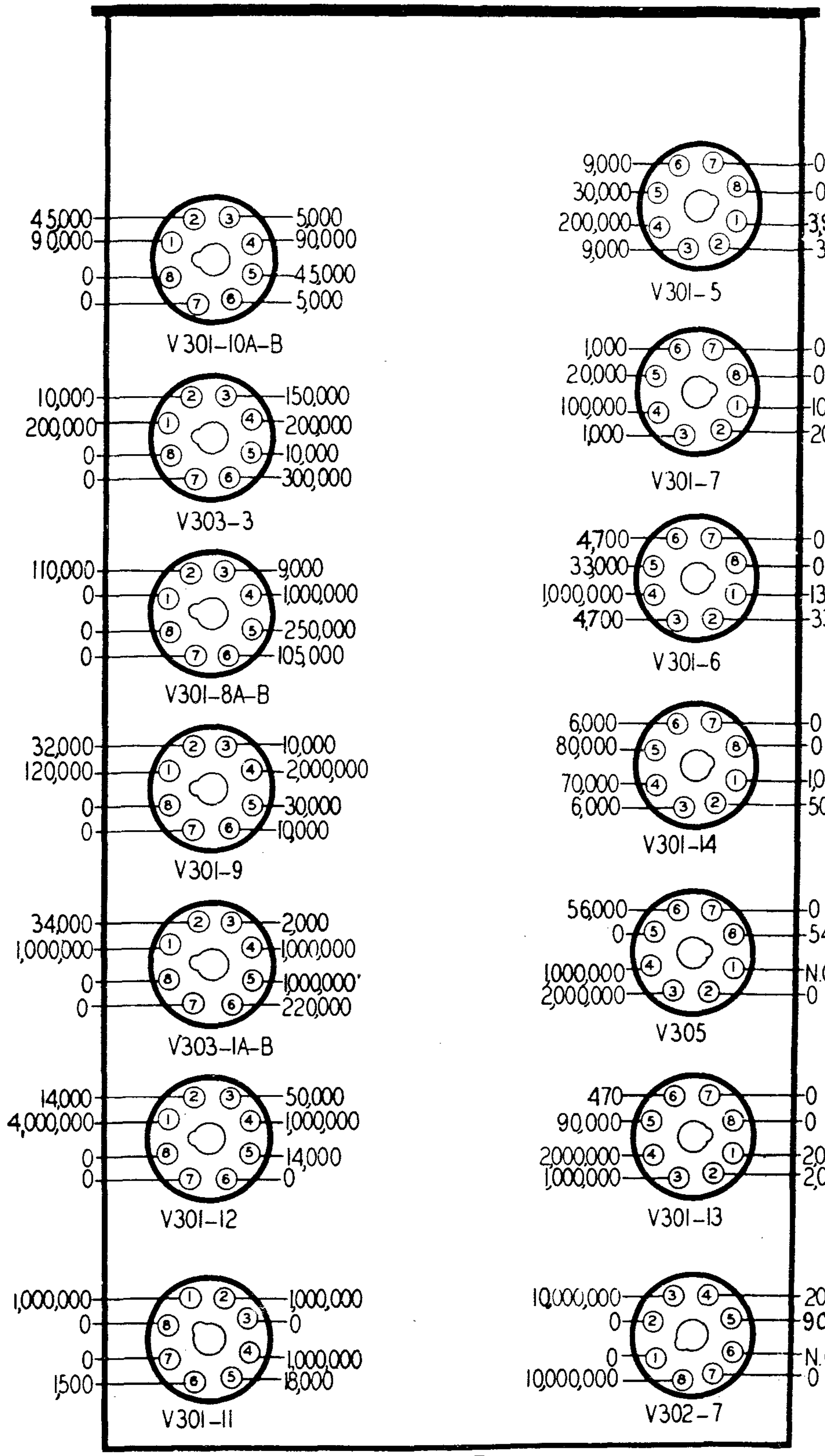
STATION SELECTOR ON POSITION 0

▲ 3 VOLT SCALE
▪ 30 VOLT SCALE
• 300 VOLT SCALE



BASE PIN LAYOUT
D.C. VOLTAGE TO GROUND (CHASSIS)

Figure 8-26. Indicator ★ID-6/APN-4—Bottom View of Lower Deck, Measured with a 1000-Ohm-Per-Volt Voltmeter (Early)



BASE PIN LAYOUT
D.C. RESISTANCE TO GROUND (CHASSIS)

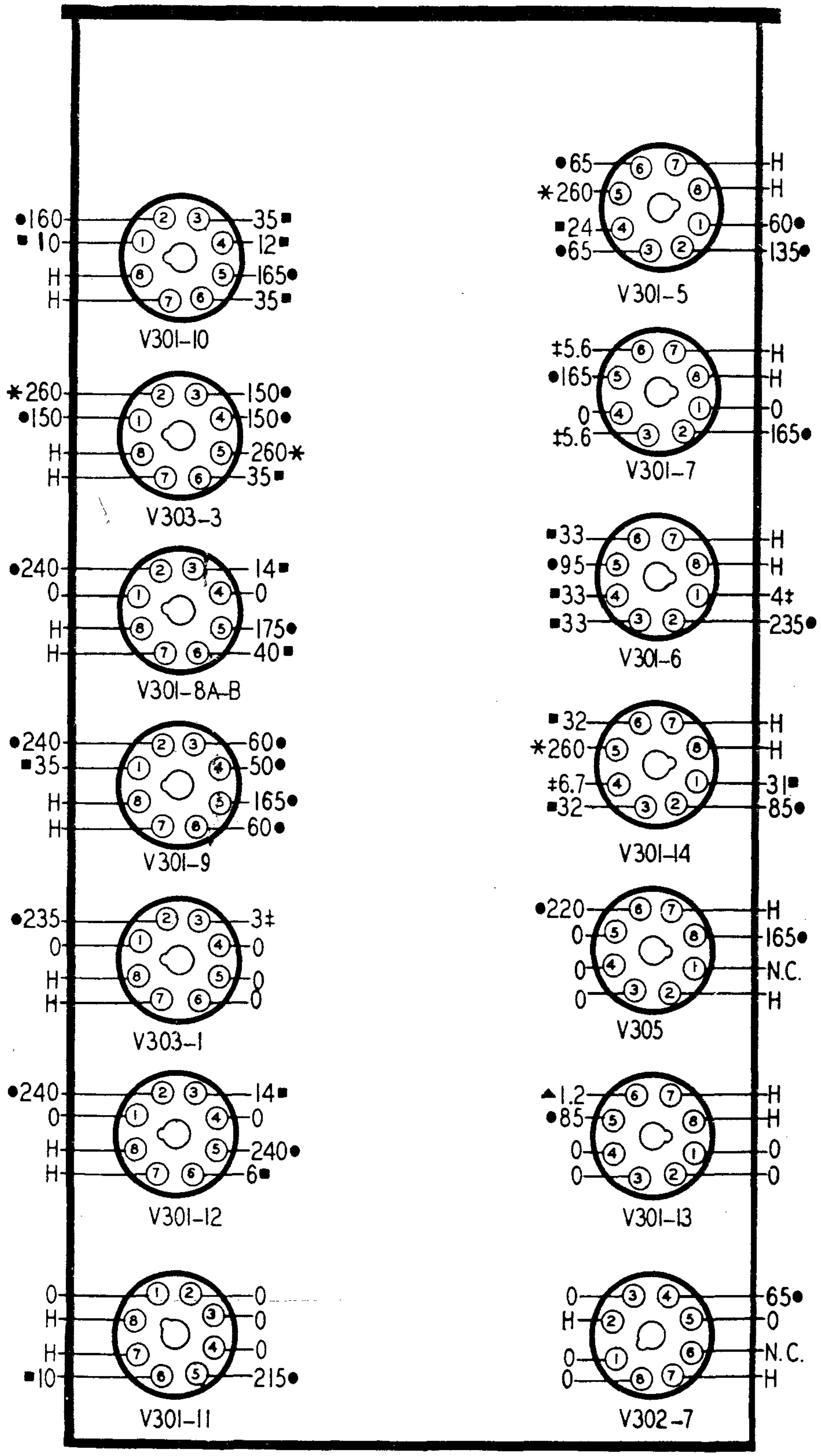
LEGEND:
H-HEATER PINS 6.3V.A.C.
N.C.-NO CONNECTION

RECEIVER POWER SUPPLY SET AT 260V.D.C. OUTPUT

SWEEP SPEED ON POSITION I

STATION SELECTOR ON POSITION 0

▲ 2.5 VOLT SCALE
‡ 10 VOLT SCALE
■ 50 VOLT SCALE
● 250 VOLT SCALE
✱ 1000 VOLT SCALE



BASE PIN LAYOUT
D.C. VOLTAGE TO GROUND (CHASSIS)

D.C. VOLTAGES MEASURED WITH 20,000 OHM/VOLT METER.

Figure 8-27. Indicator *ID-6/APN-4—Bottom View of Lower Deck, Measured with a 20,000-Ohm-Per-Volt Voltmeter (Early)

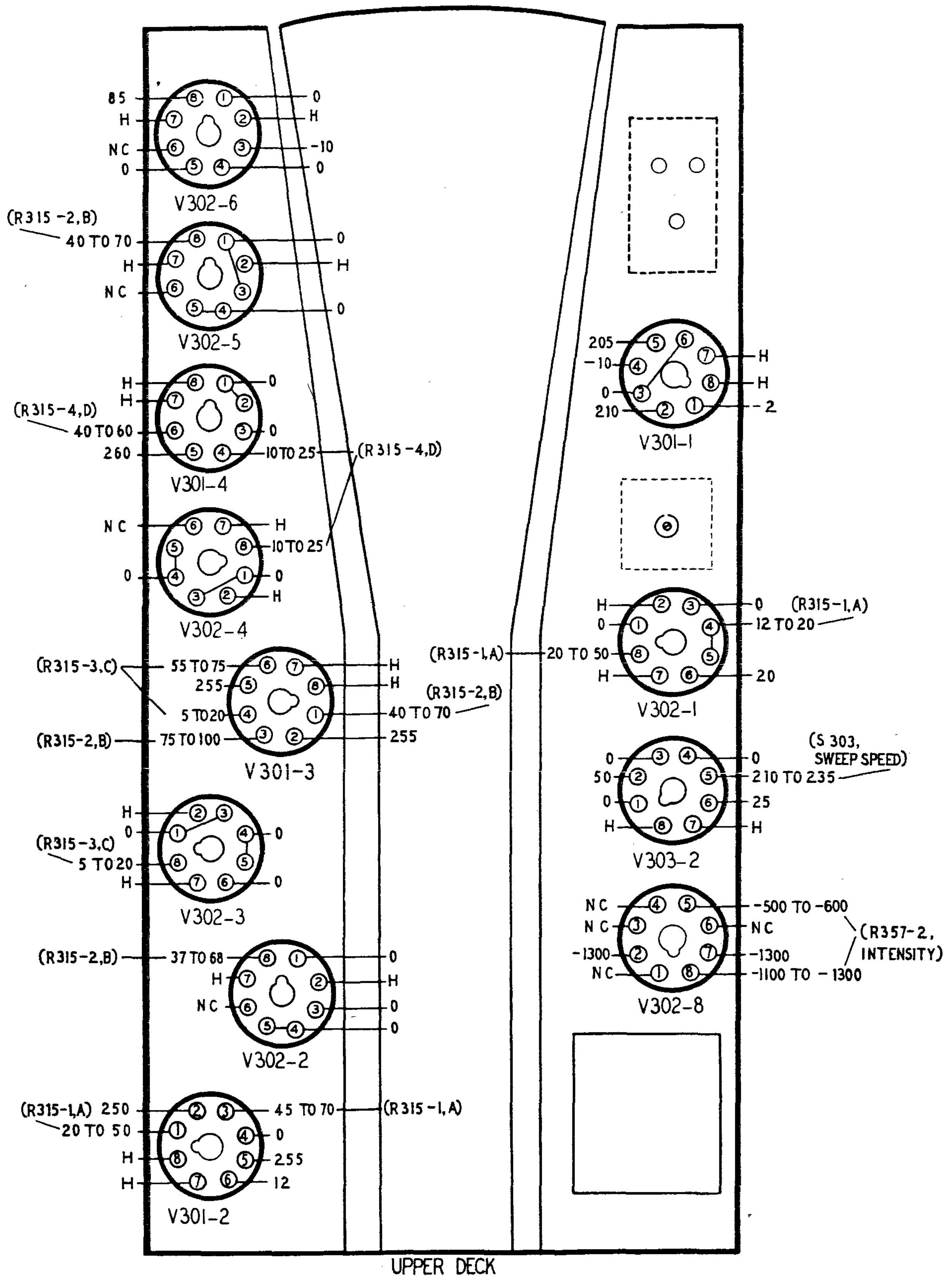


*Figure 8-27A. Indicator *ID-6/APN-4—Bottom View of Upper Deck—Socket Base Voltages Using a 1000-Ohm-Per-Volt Voltmeter—Gain Control in Minimum Position (Late Models)*

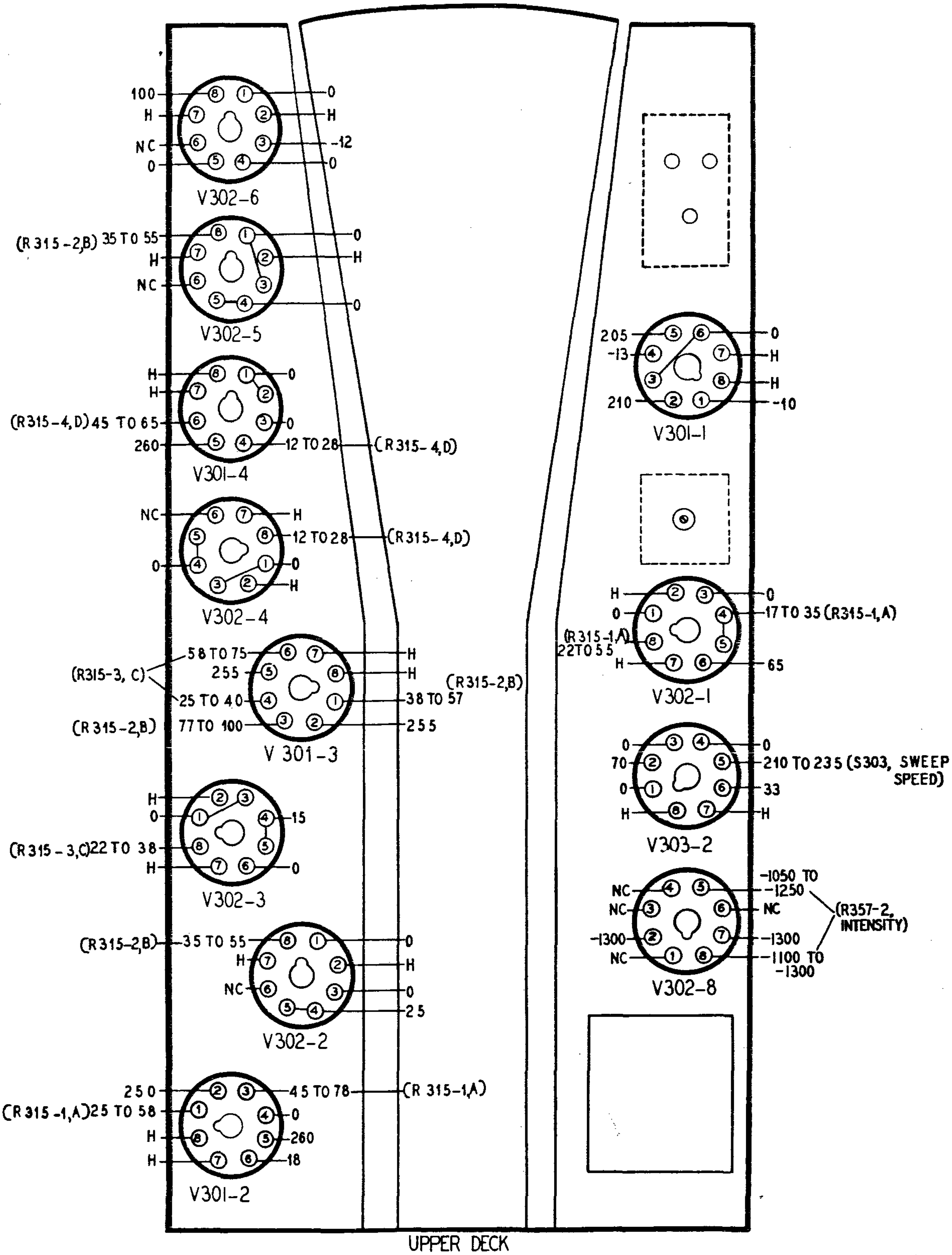


*Figure 8-27B. Indicator *ID-6/APN-4—Bottom View of Upper Deck—Socket Base Voltages Using a 20,000-Ohm-Per-Volt Voltmeter—Gain Control in Minimum Position*

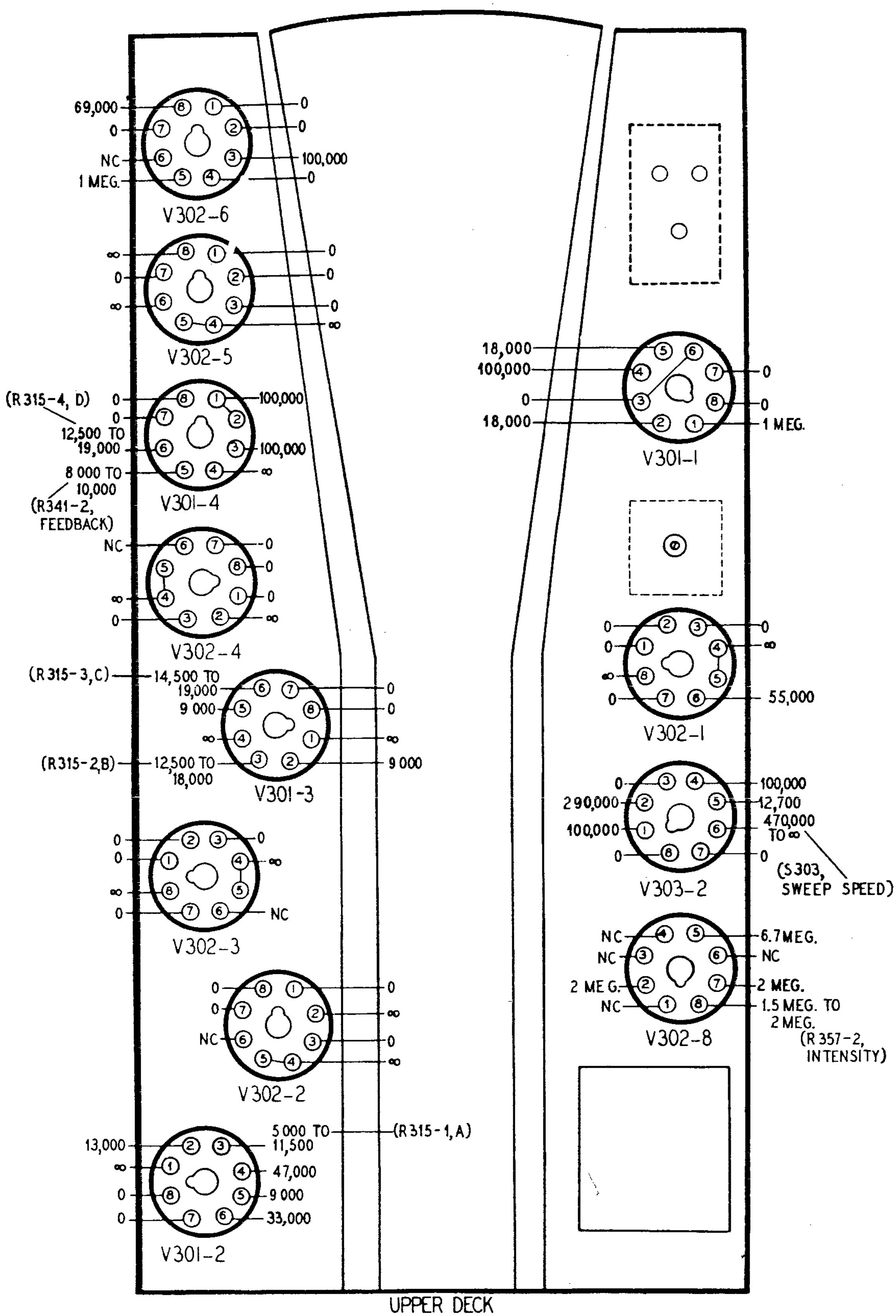


Figure 8-27C. Indicator ★ID-6/APN-4—Bottom View of Upper Deck—Resistance Measurements —Gain Control Turned from Minimum to Maximum Position

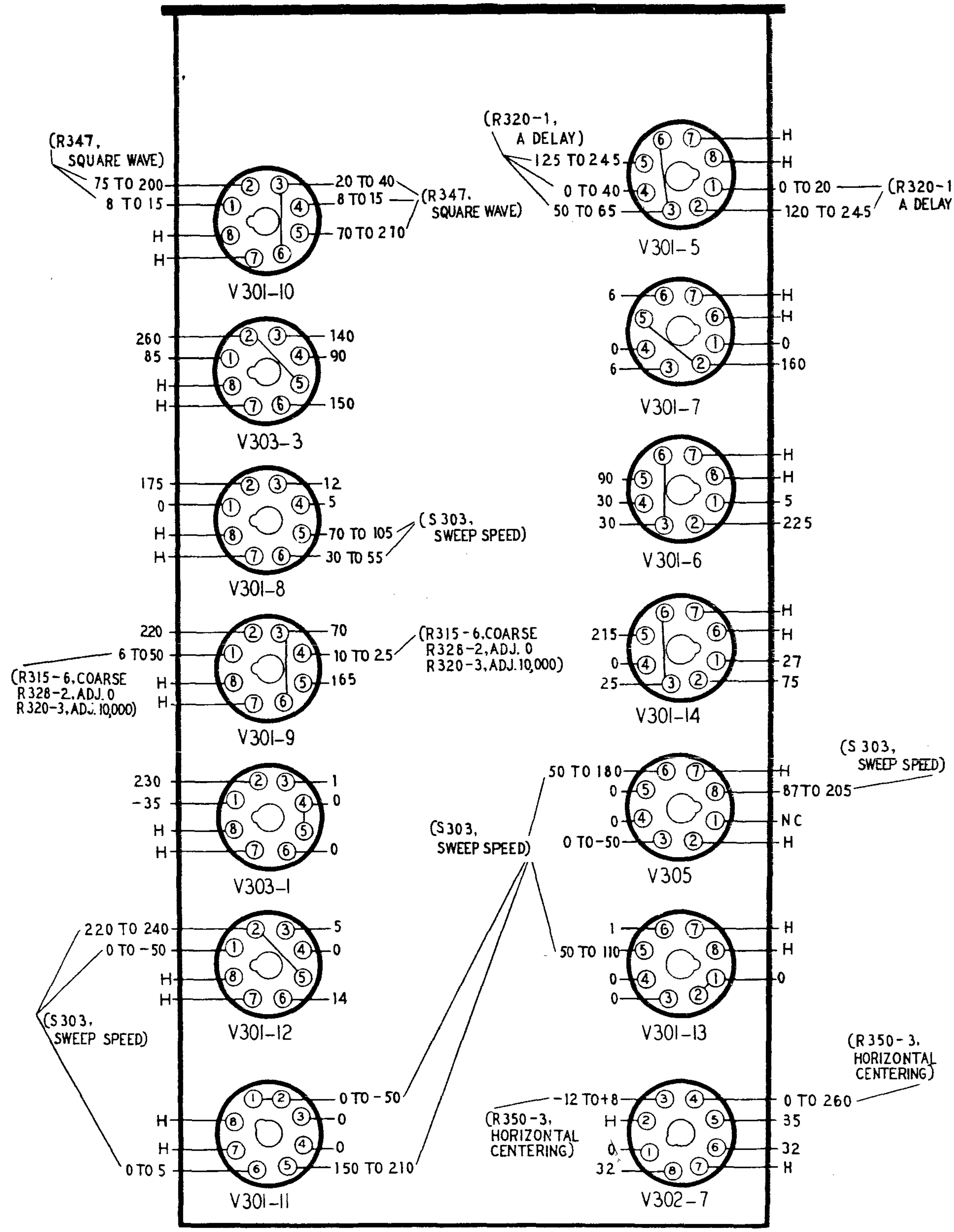


*Figure 8-27D. Indicator *ID-6/APN-4—Bottom View of Lower Deck—Socket Base Voltages Using a 1000-Ohm-Per-Volt Voltmeter—Gain Control in Minimum Position*

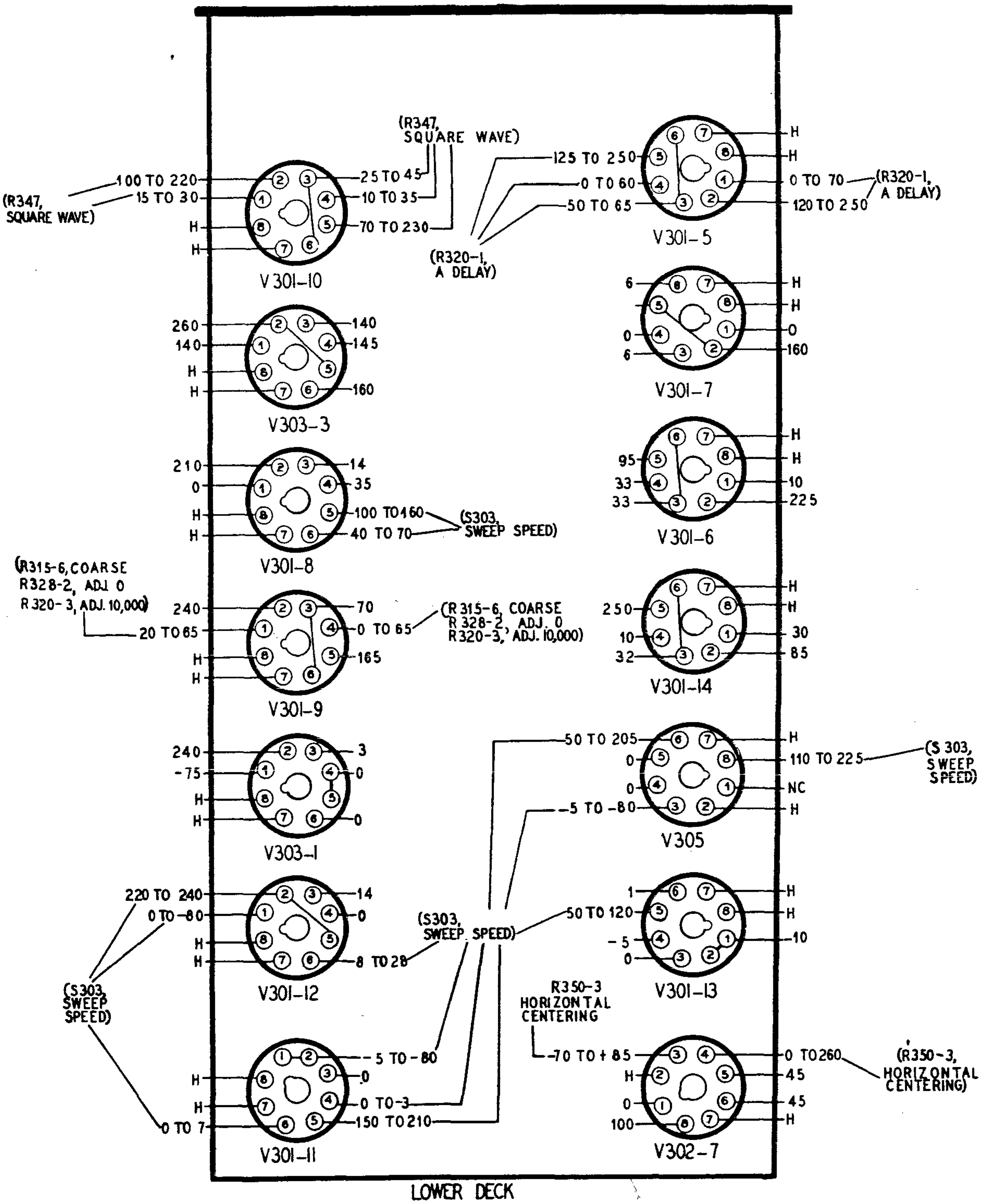


*Figure 8-27E. Indicator *ID-6/APN-4—Bottom View of Lower Deck—Socket Base Voltages Using a 20,000-Ohm-Per-Volt Voltmeter—Gain Control in Minimum Position (Late Models)*

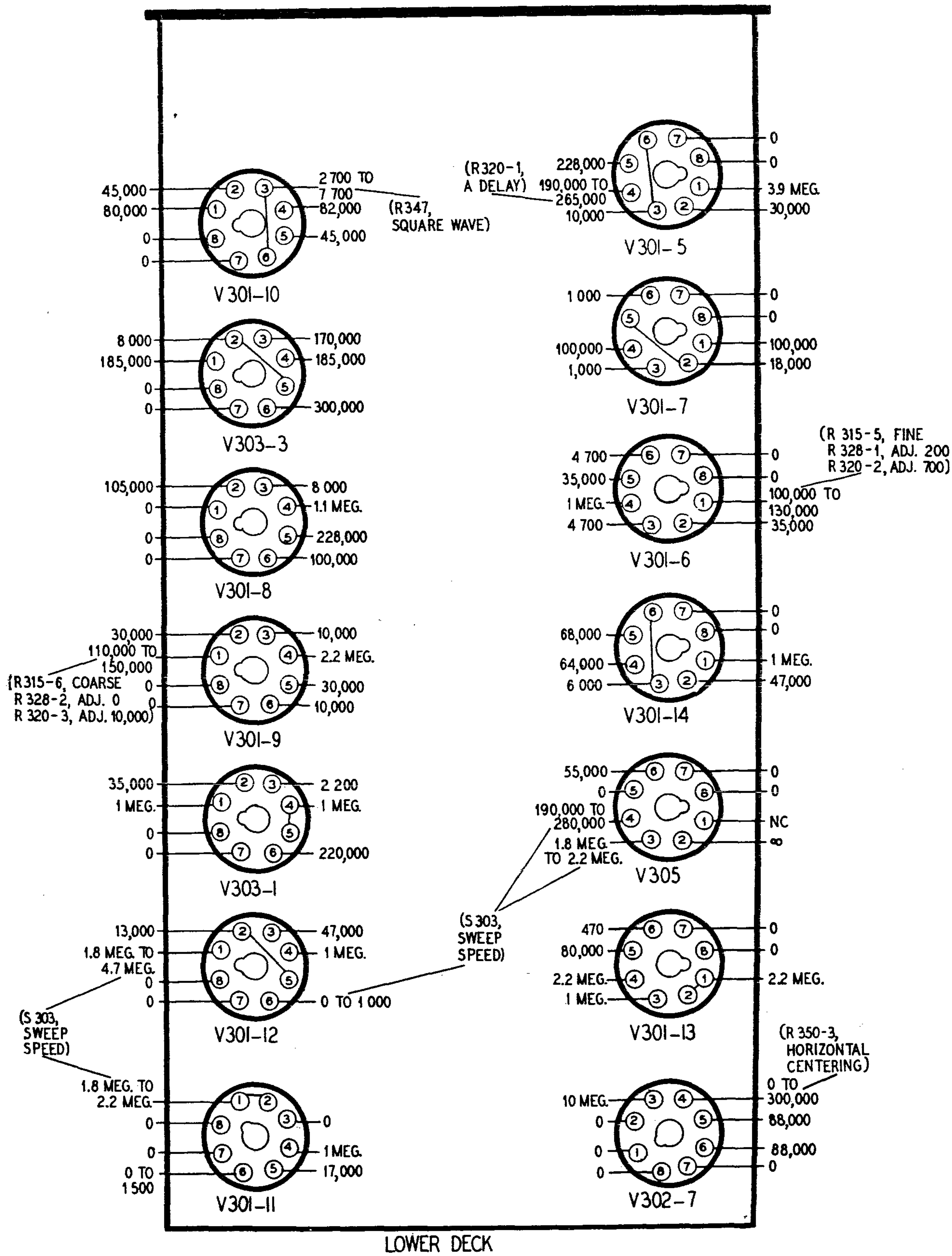


Figure 8-27F. Indicator ★ID-6/APN-4—Bottom View of Lower Deck—Resistance Measurements —Gain Control Turned from Minimum to Maximum

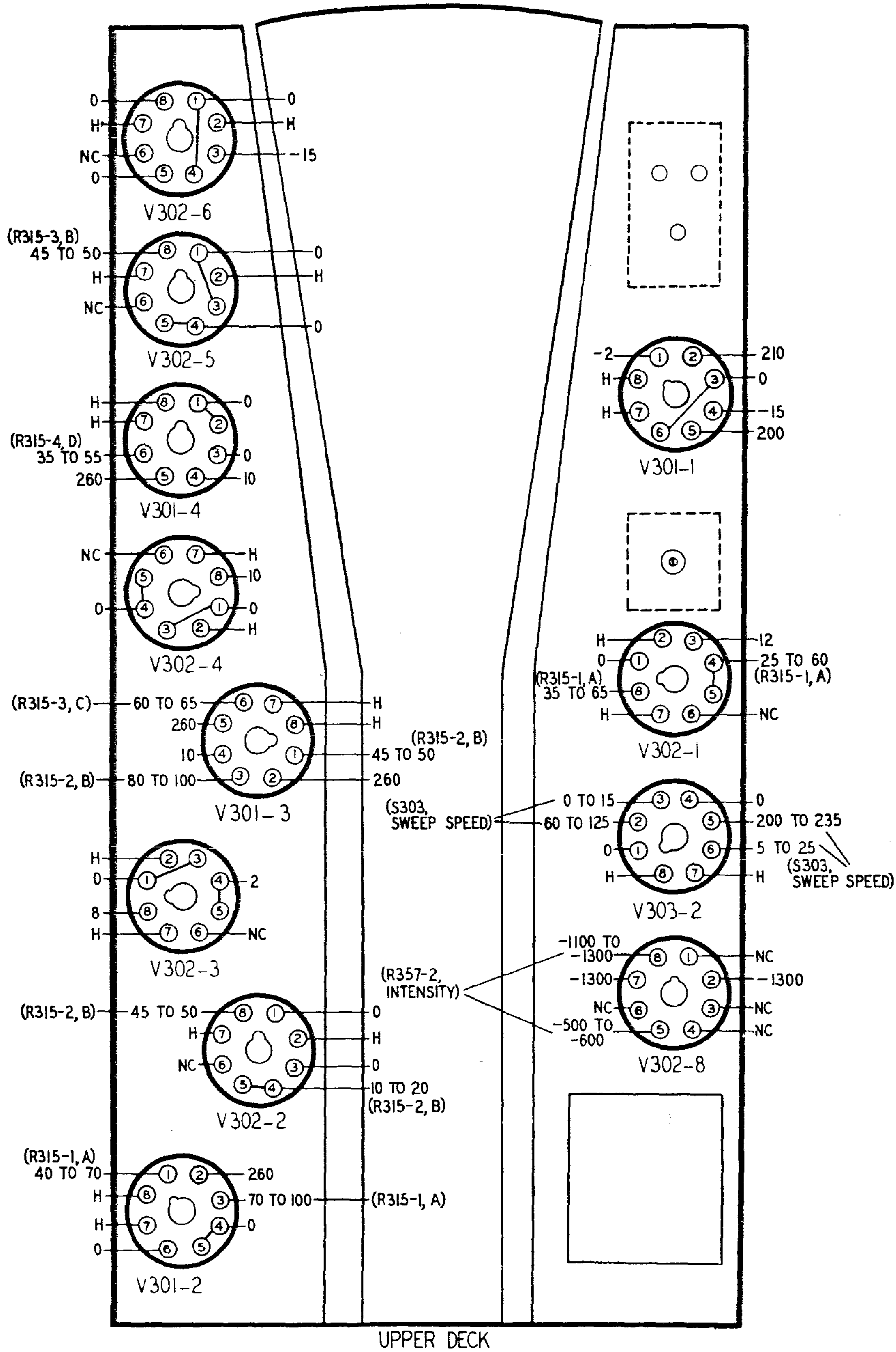


Figure 8-27G. Indicator ★ID-6A/APN-4—Bottom View of Upper Deck—Socket Base Voltages Using a 1000-Ohm-Per-Volt Voltmeter—Gain Control in Minimum Position

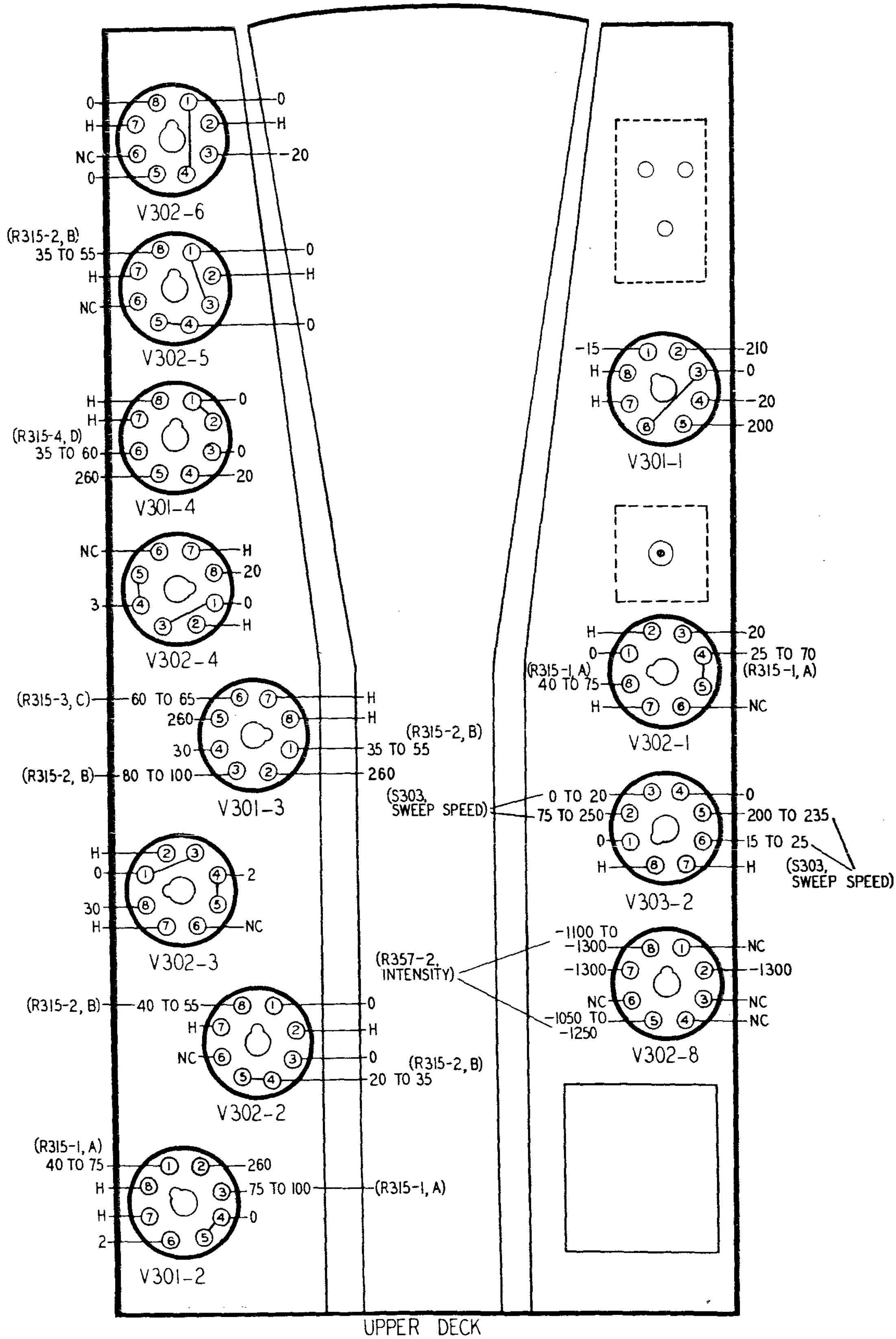


Figure 8-27H. Indicator ★ID-6A/APN-4—Bottom View of Upper Deck—Socket Voltage Measurements Using a 20,000-Ohm-Per-Volt Voltmeter—Gain Control in Minimum Position

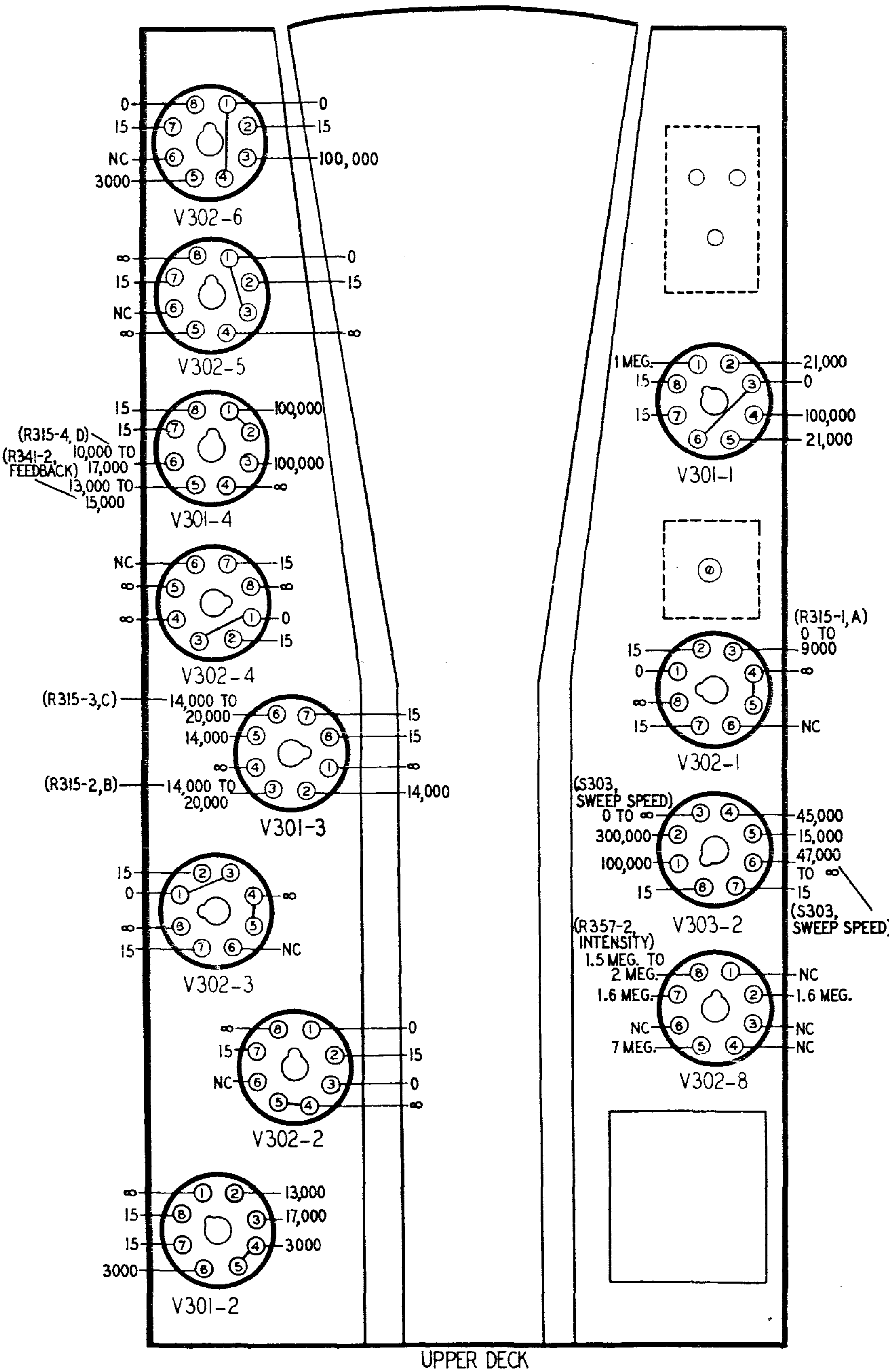


Figure 8-27J. Indicator ★ID-6A/APN-4—Bottom View of Upper Deck—Resistance Measurements—Gain Control Turned from Minimum to Maximum

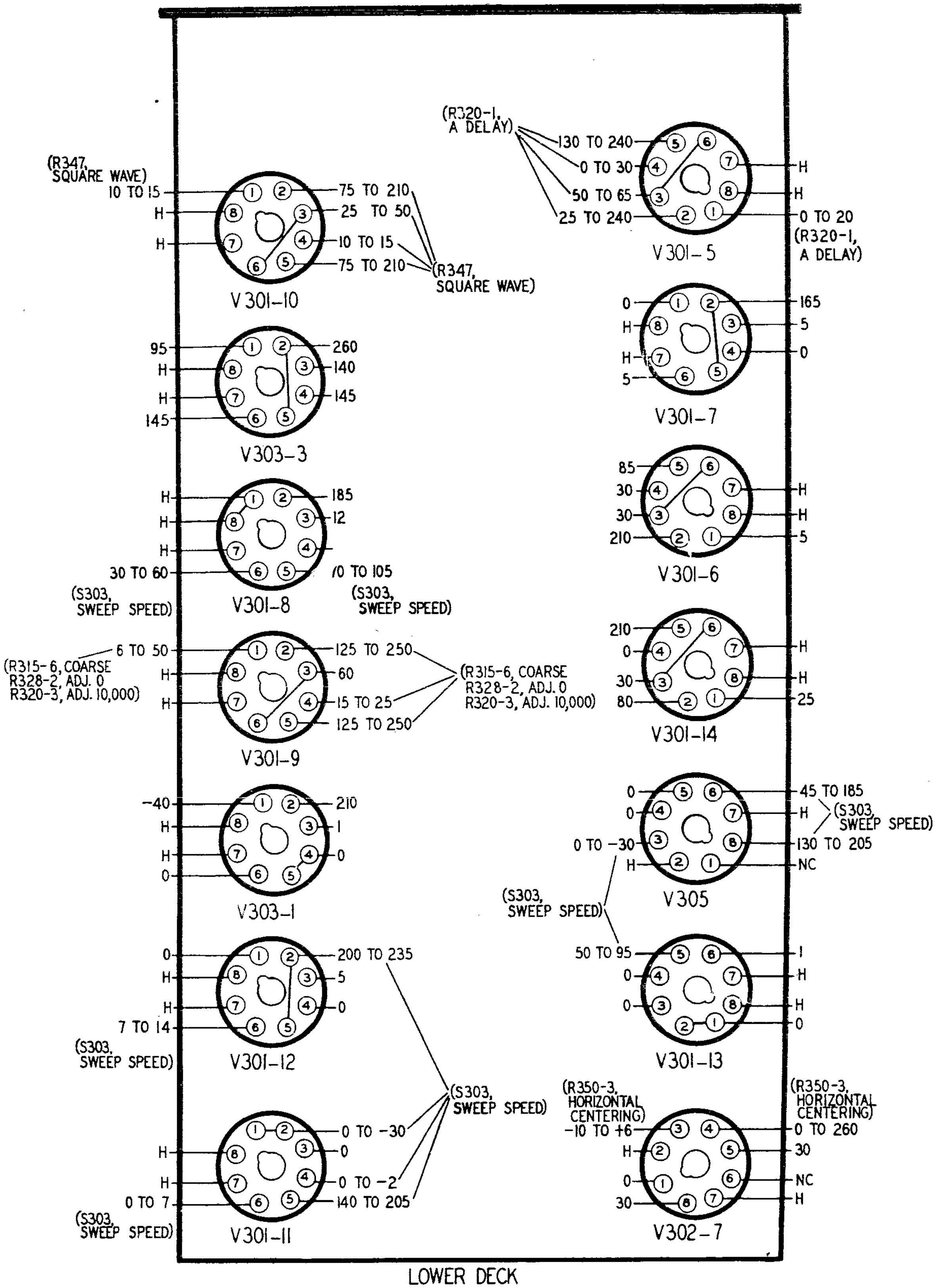


Figure 8-27K. Indicator ★ID-6A/APN-4—Bottom View of Lower Deck—Socket Base Voltages Using a 1000-Ohm-Per-Volt Voltmeter—Gain Control in Minimum Position

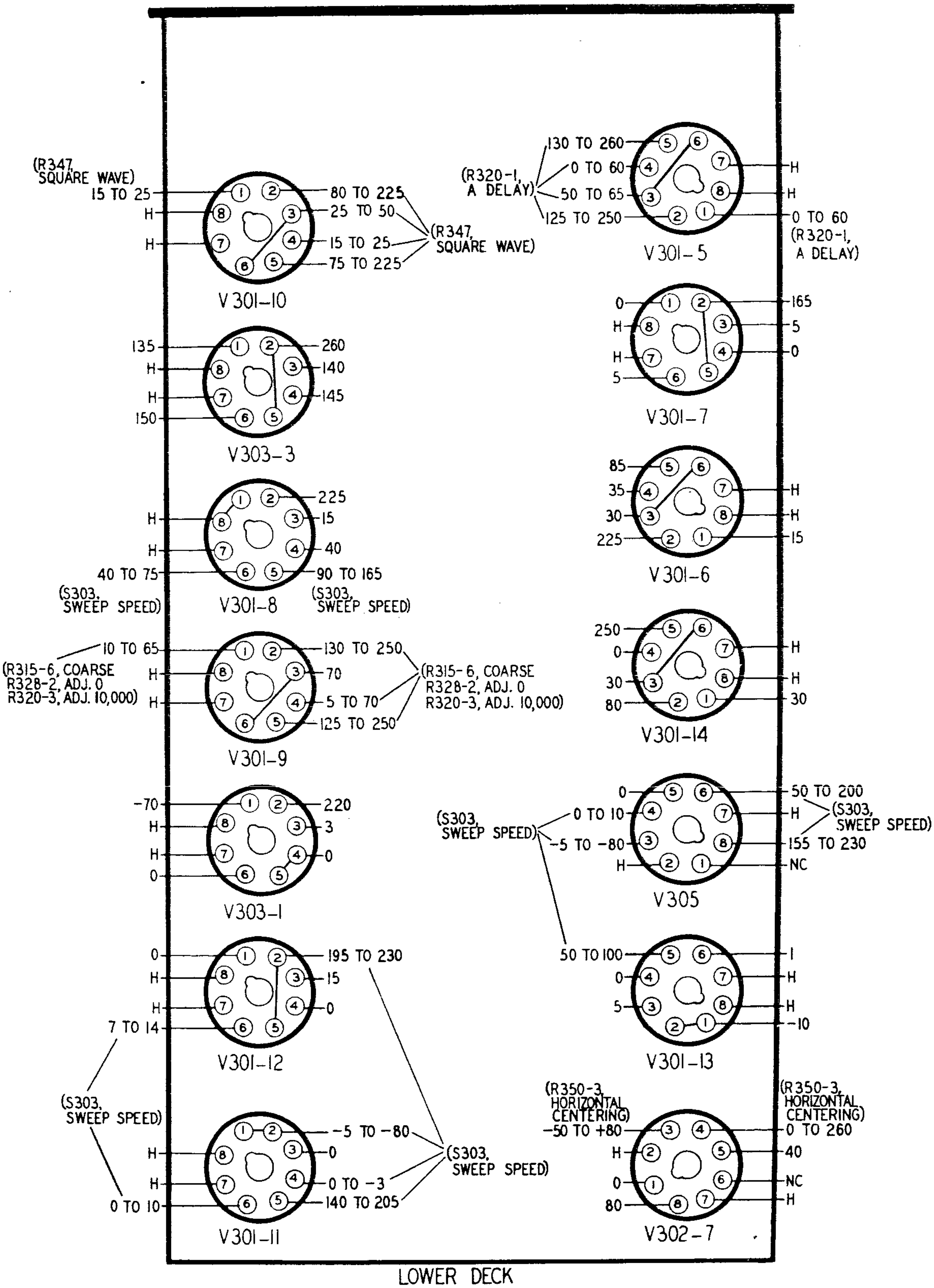


*Figure 8-27L. Indicator *ID-6A/APN-4—Bottom View of Lower Deck—Socket Base Voltages Using a 20,000-Ohm-Per-Volt Voltmeter—Gain Control in Minimum Position*

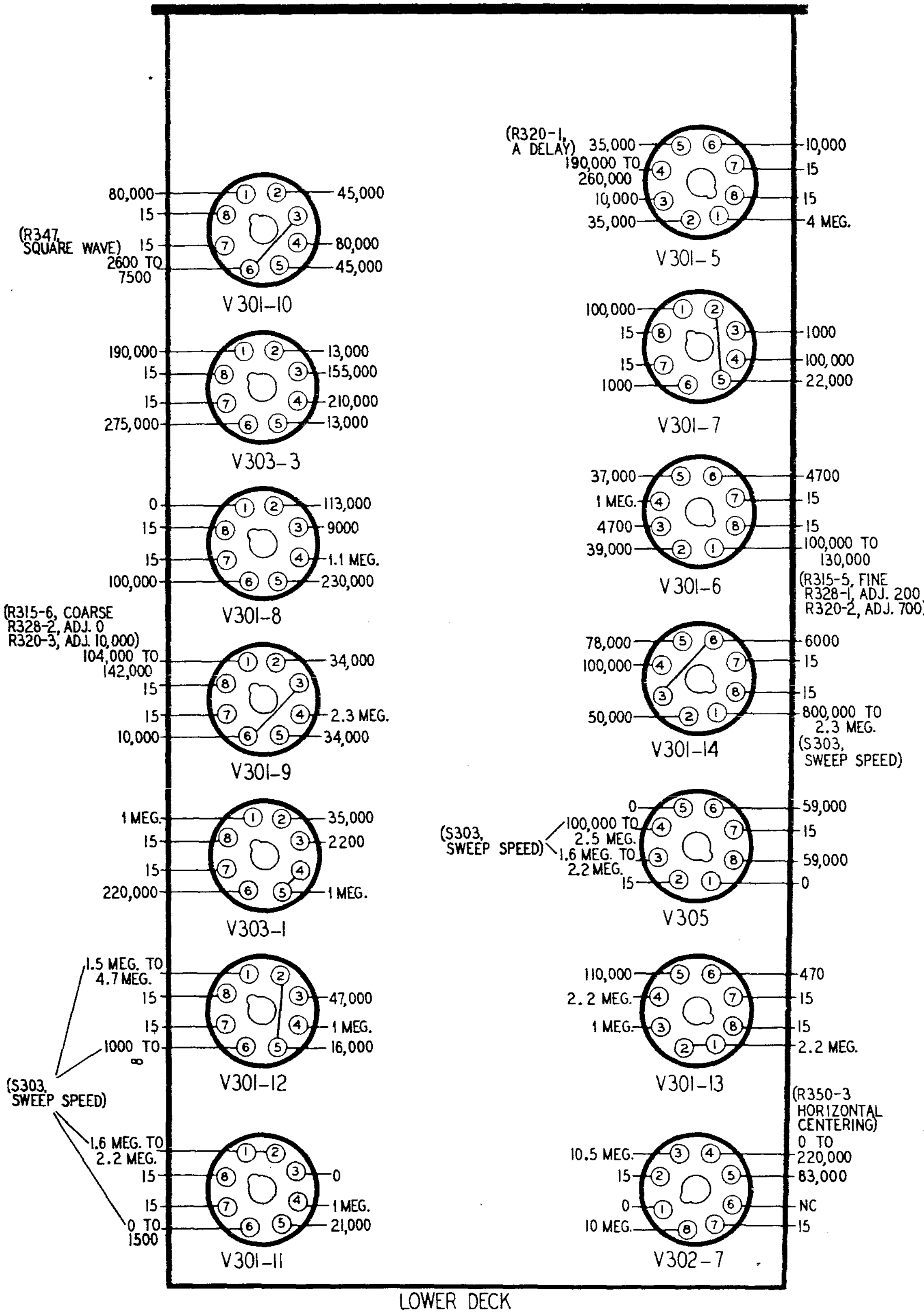


Figure 8-27M. Indicator ★ID-6A/APN-4—Bottom View of Lower Deck—Resistance Measurements—Gain Control Turned from Minimum to Maximum

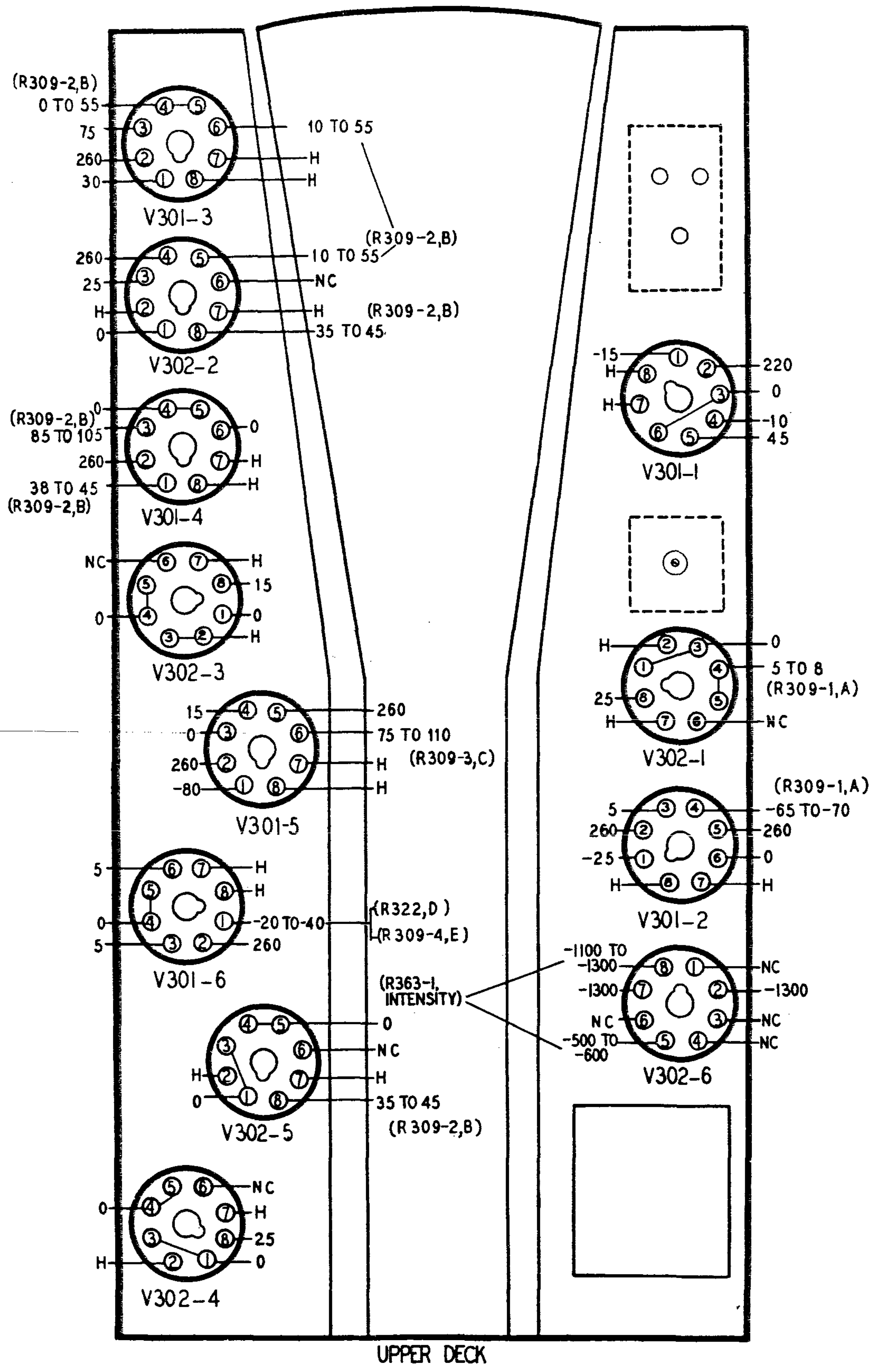
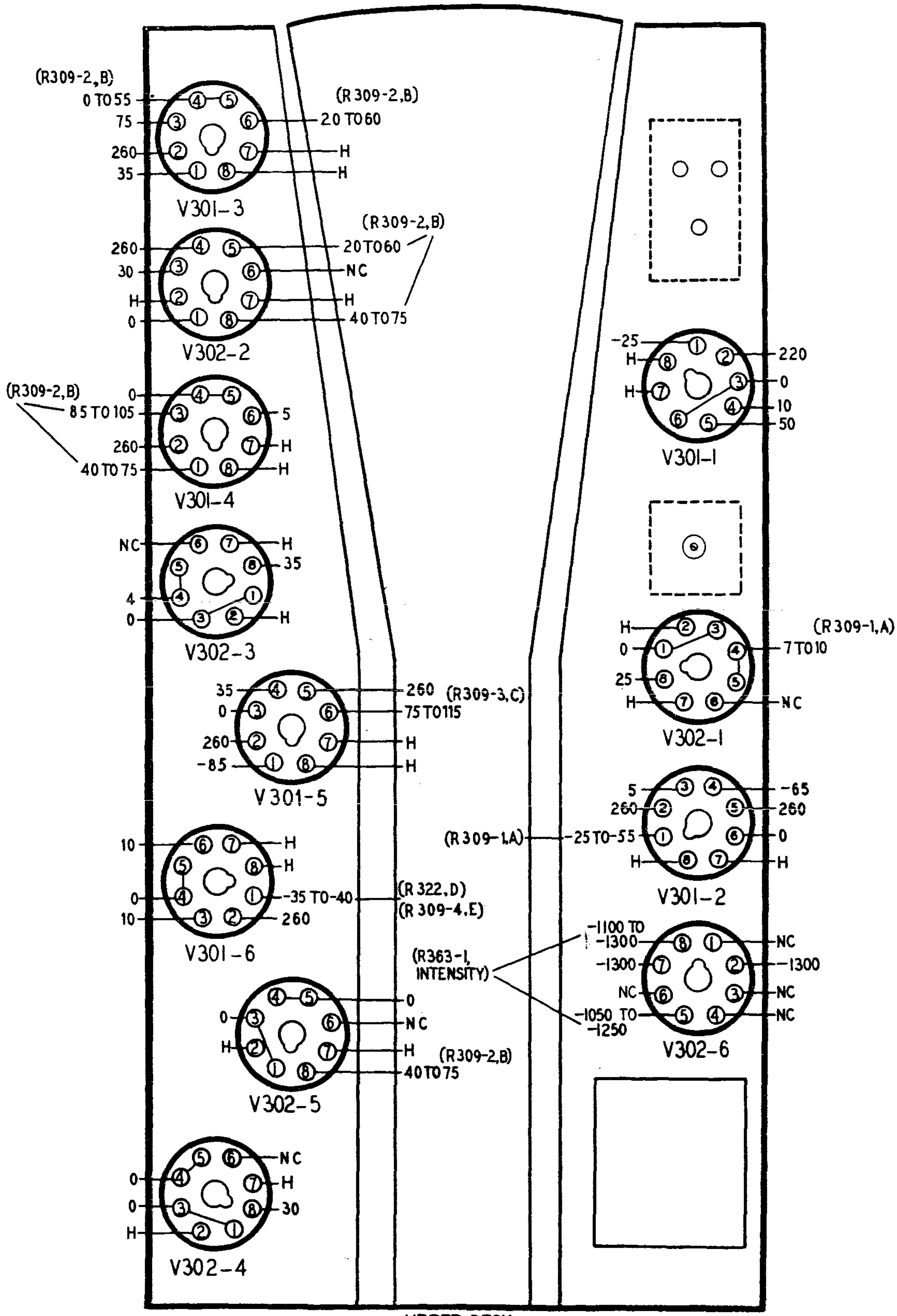


Figure 8-27N. Indicator ★ID-6B/APN-4—Bottom View of Upper Deck—Socket Base Voltages Using a 1000-Ohm-Per-Volt Voltmeter—Gain Control in Minimum Position



UPPER DECK

*Figure 8-27P. Indicator *ID-6B/APN-4—Bottom View of Upper Deck—Socket Base Voltages Using a 20,000-Ohm-Per-Volt Voltmeter—Gain Control in Minimum Position*

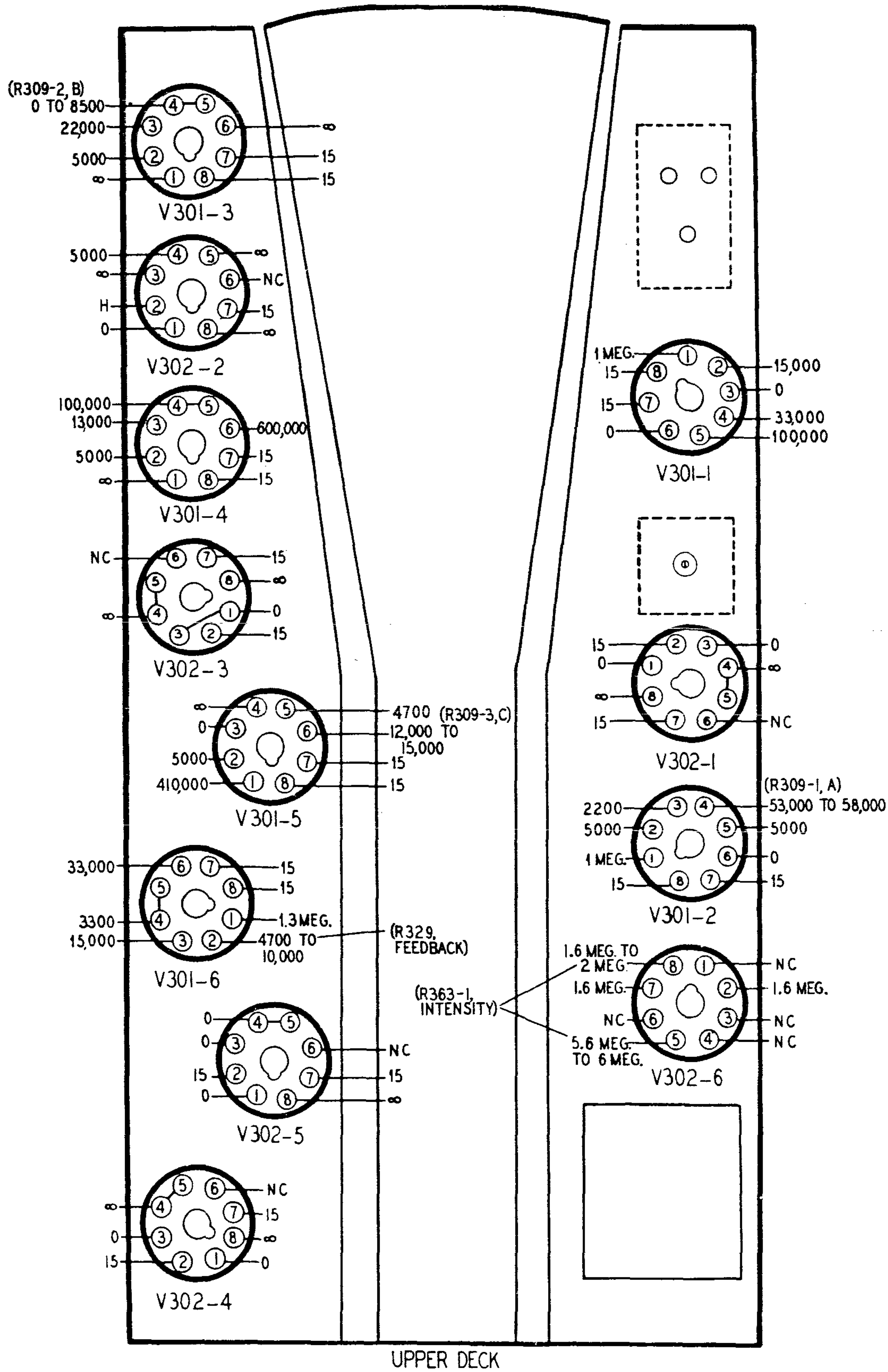


Figure 8-27Q. Indicator ★ID-6B/APN-4—Bottom View of Upper Deck—Resistance Measurements—Gain Control Turned from Minimum to Maximum

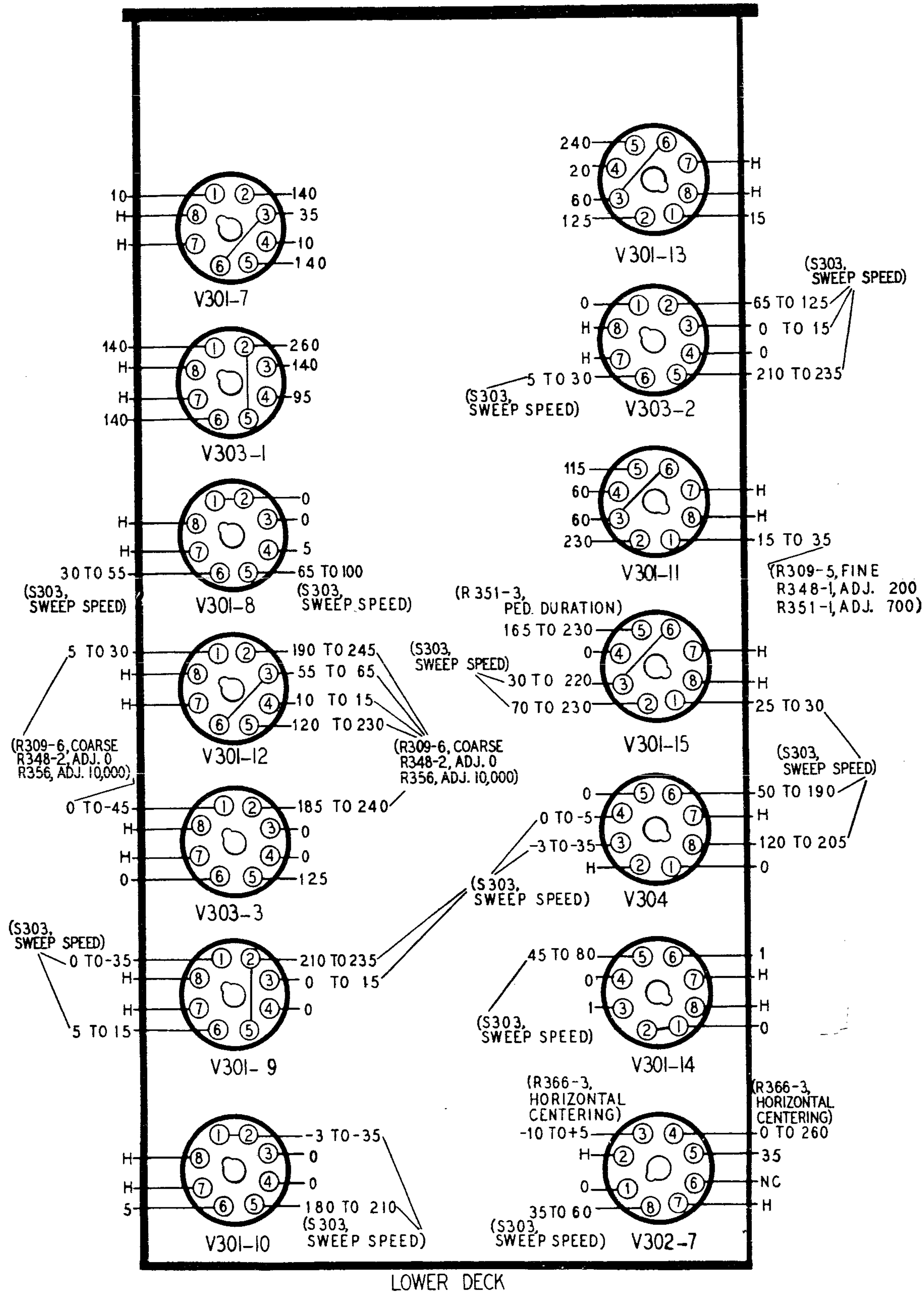


*Figure 8-27R. Indicator *ID-6B/APN-4—Bottom View of Lower Deck—Socket Base Voltages Using a 1000-Ohm-Per-Volt Voltmeter—Gain Control in Minimum Position*

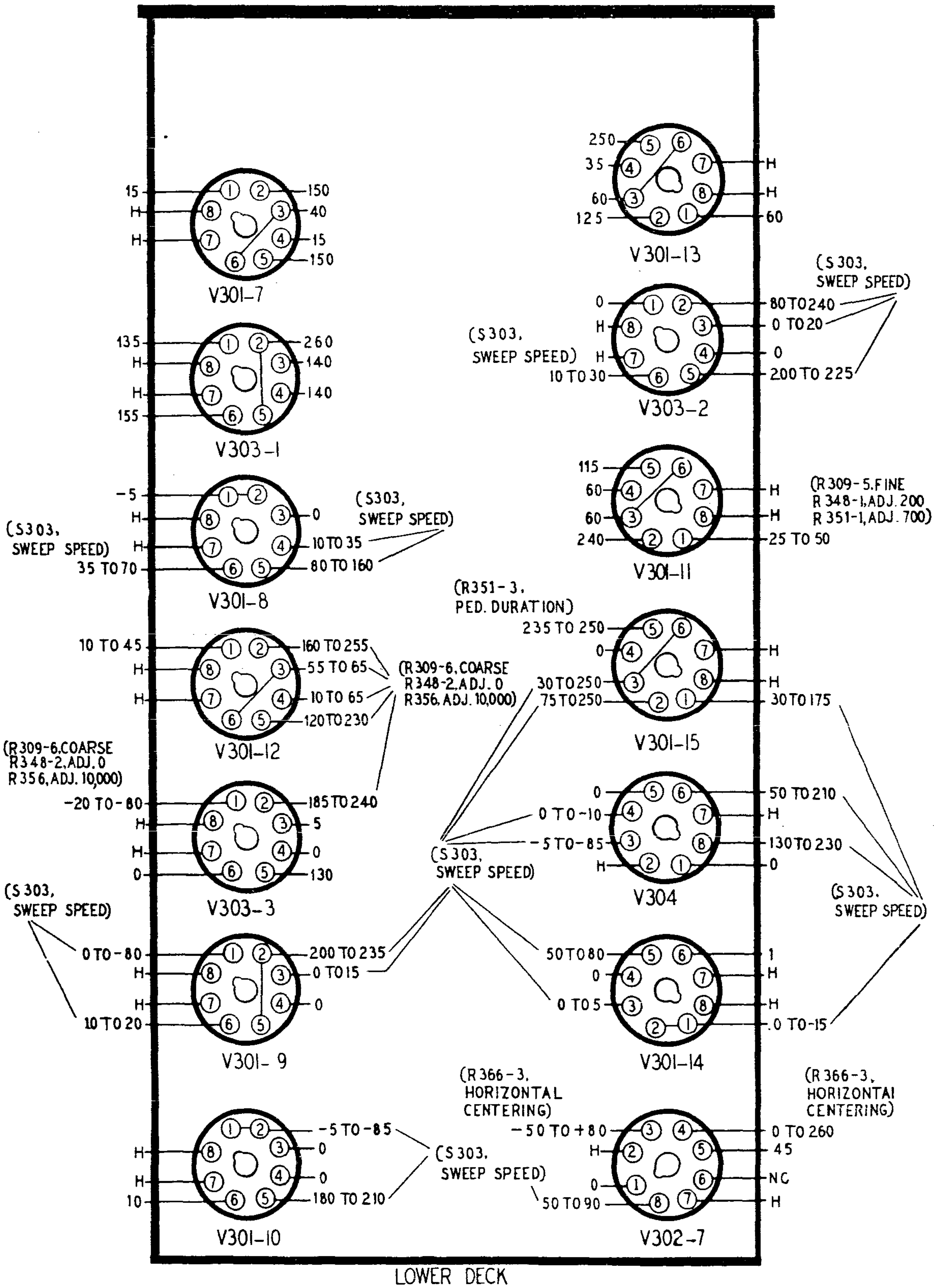


*Figure 8-27S. Indicator *ID-6B/APN-4—Bottom View of Lower Deck—Socket Base Voltages Using a 20,000-Ohm-Per-Volt Voltmeter—Gain Control Turned from Minimum to Maximum Position*

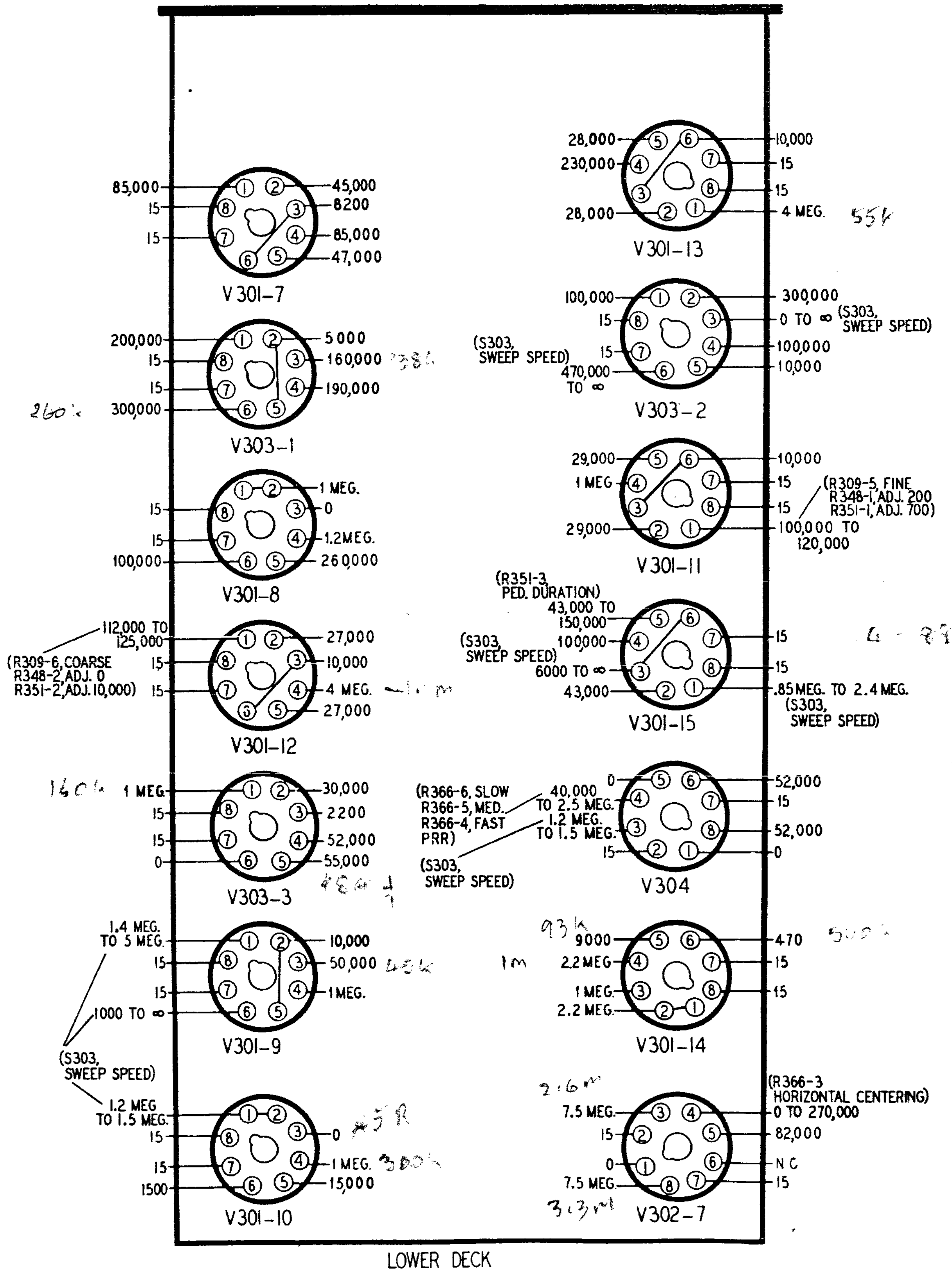


Figure 8-27T. Indicator ★ID-6B/APN-4—Bottom View of Lower Deck—Resistance Measurements—Gain Control in Minimum Position

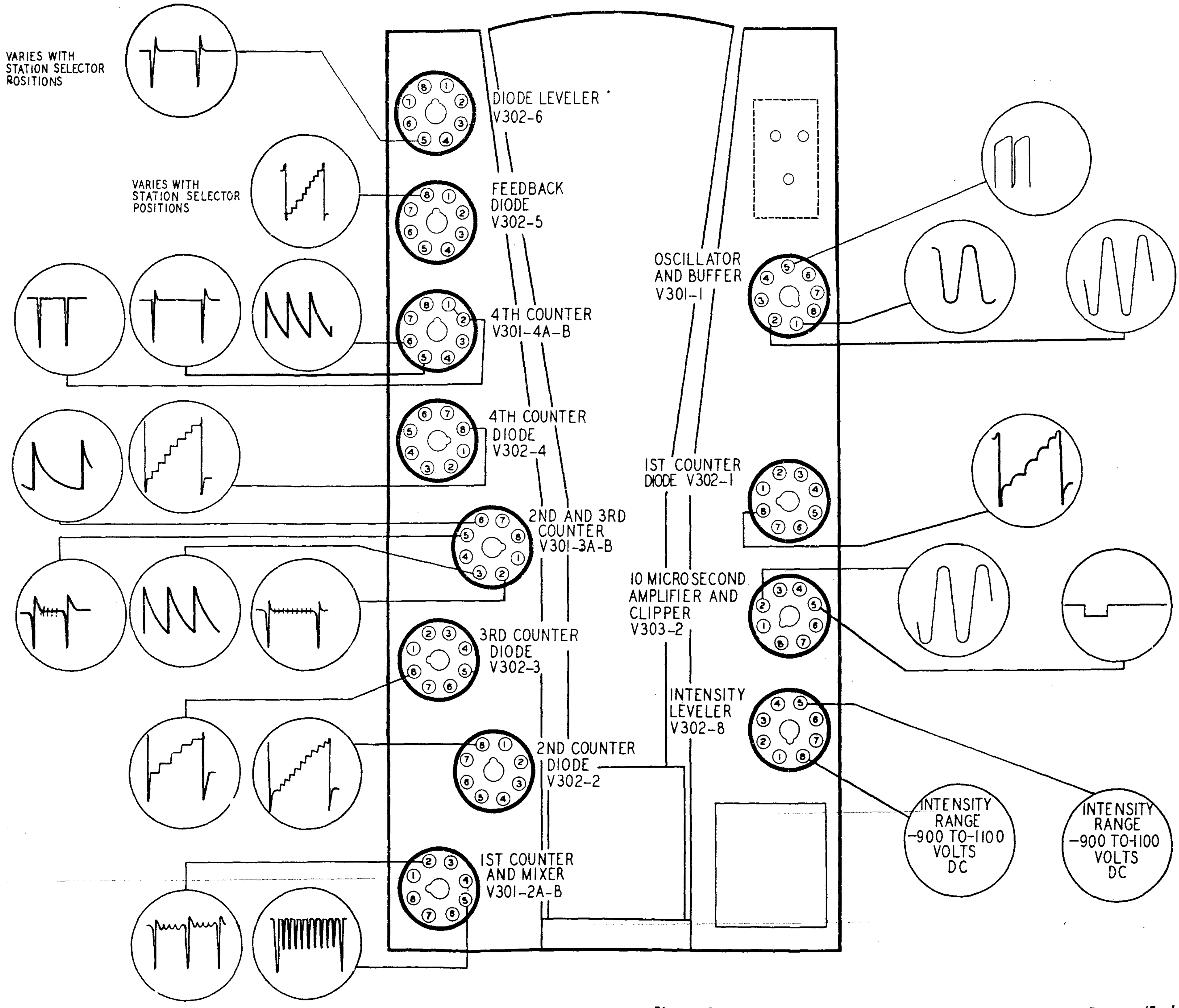


Figure 8-28. Indicator ★ID-6/APN-4—Upper Deck—Wave Forms—(Early)

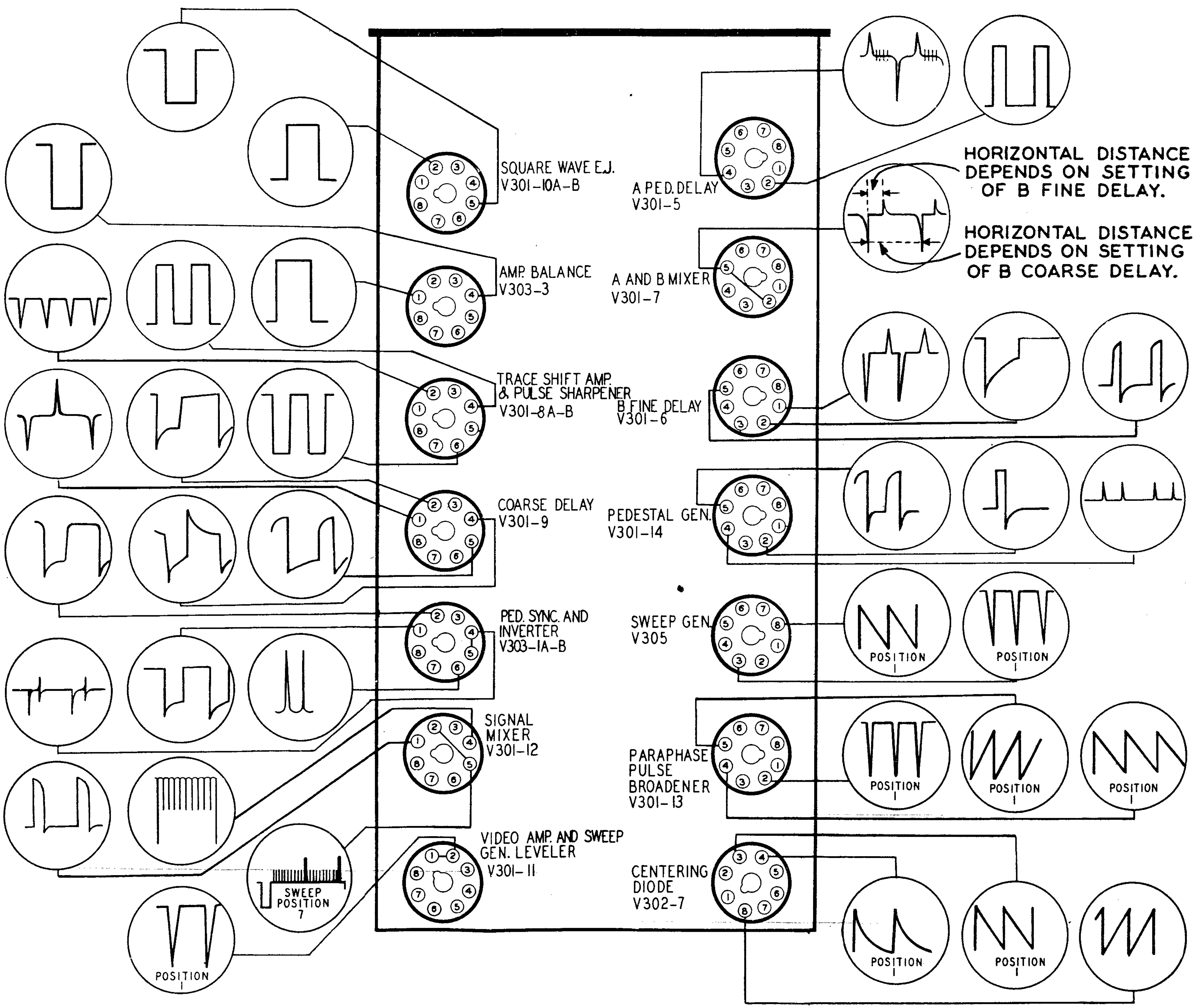


Figure 8-29. Indicator ★ID-6/APN-4—Lower Deck Wave Forms (Early)

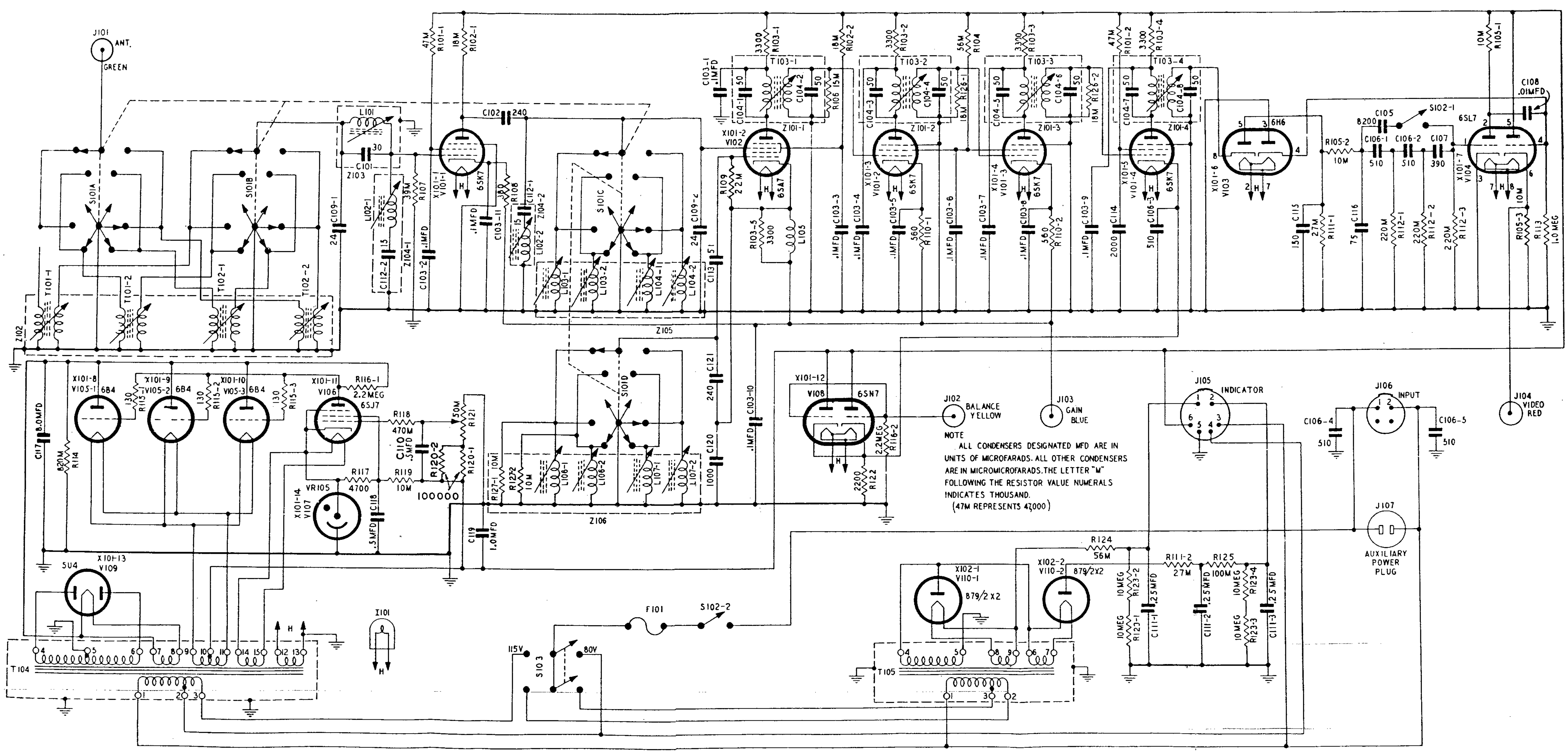


Figure 8-30. Radio Receiver ★R-9/APN-4 (Modifications I and II)— Complete Schematic (Early)

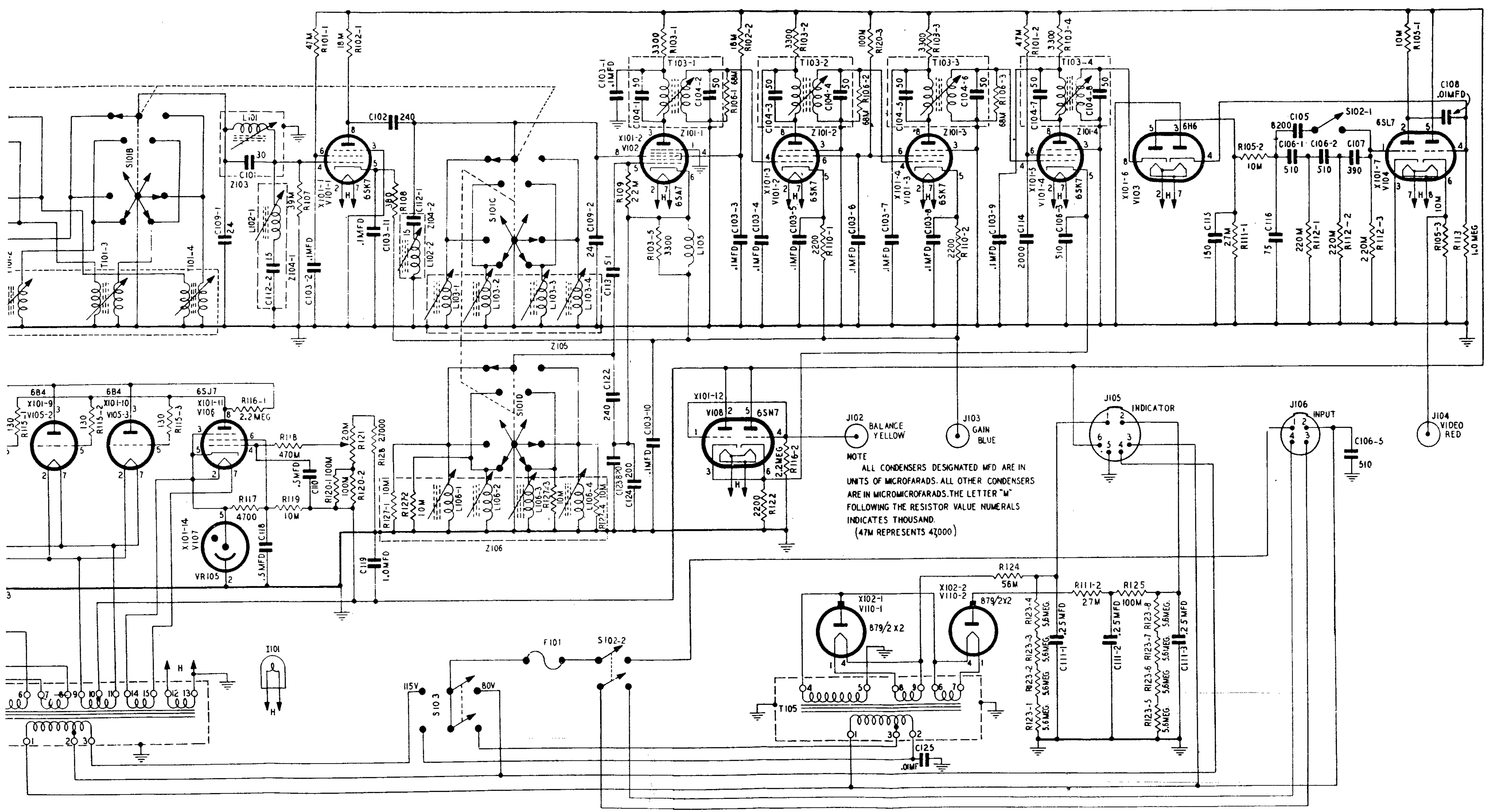
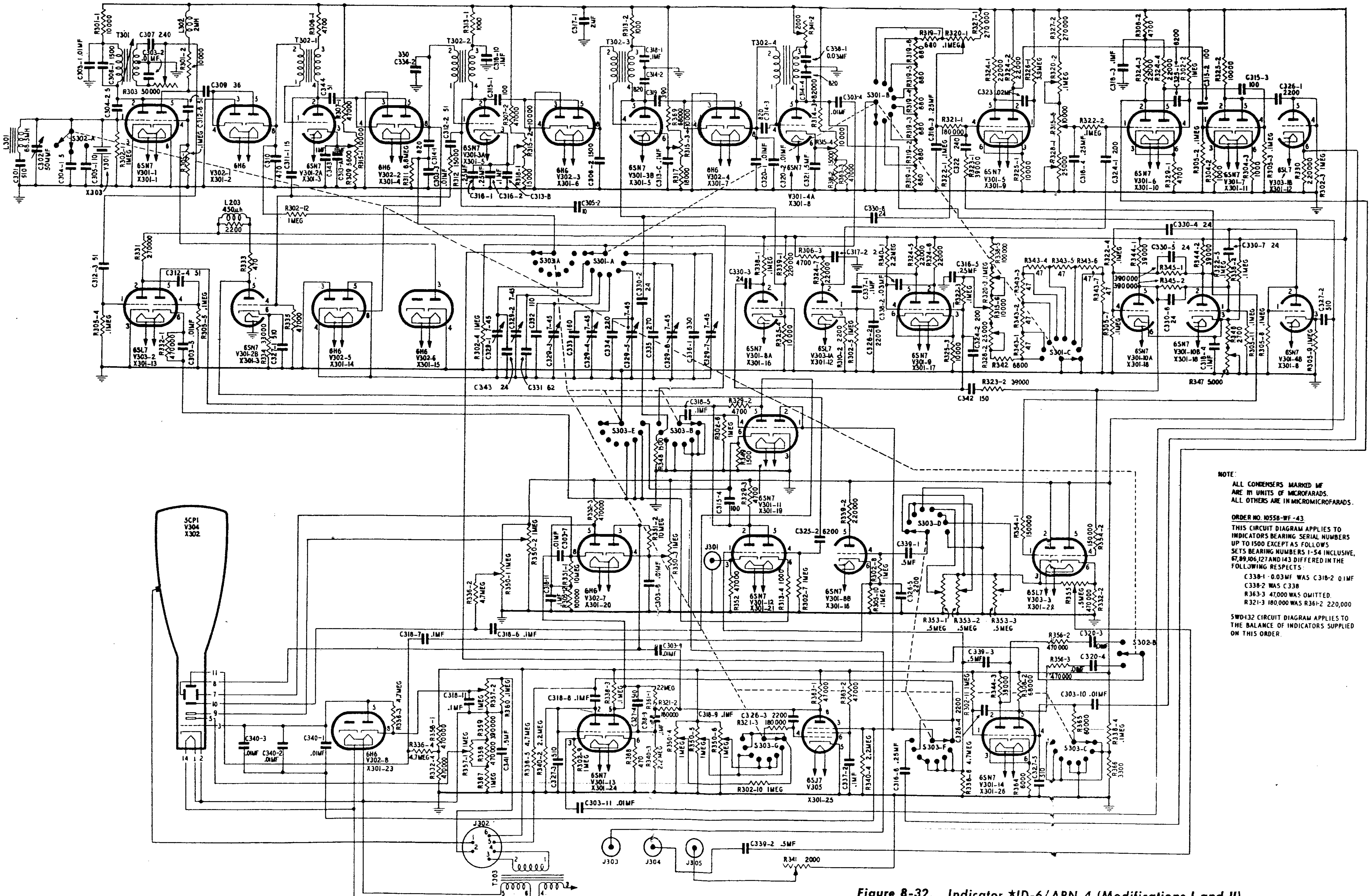


Figure 8-31. Radio Receiver ★R-9A/APN-4 (Modification III)— Complete Schematic (Early)



NOTE:

ALL CONDENSERS MARKED MF ARE IN UNITS OF MICROFARADS.
ALL OTHERS ARE IN MICROMICROFARADS.

ORDER NO. 10558-WF-43.

THIS CIRCUIT DIAGRAM APPLIES TO INDICATORS BEARING SERIAL NUMBERS UP TO 1500 EXCEPT AS FOLLOWS
SETS BEARING NUMBERS 1-54 INCLUSIVE, 67, 89, 106, 127 AND 143 DIFFERED IN THE FOLLOWING RESPECTS:

C338-1 - 0.03MF WAS C318-2 0.1MF
C338-2 WAS C338
R363-3 47,000 WAS OMITTED.
R321-3 180,000 WAS R361-2 220,000

5WD-132 CIRCUIT DIAGRAM APPLIES TO THE BALANCE OF INDICATORS SUPPLIED ON THIS ORDER.

*Figure 8-32. Indicator *ID-6/APN-4 (Modifications I and II)— Complete Schematic (Early)*

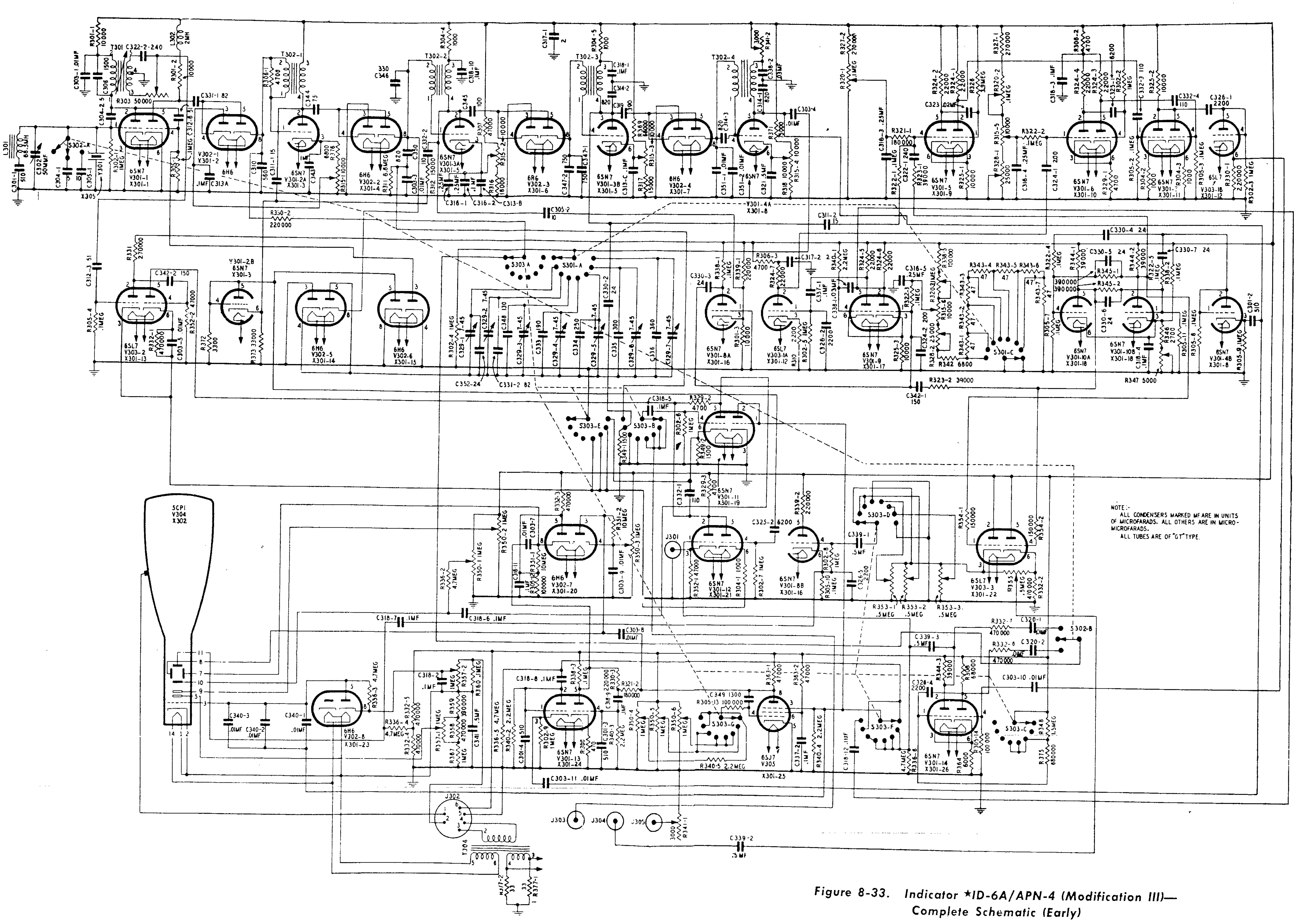


Figure 8-33. *Indicator *ID-6A/APN-4 (Modification III)— Complete Schematic (Early)*

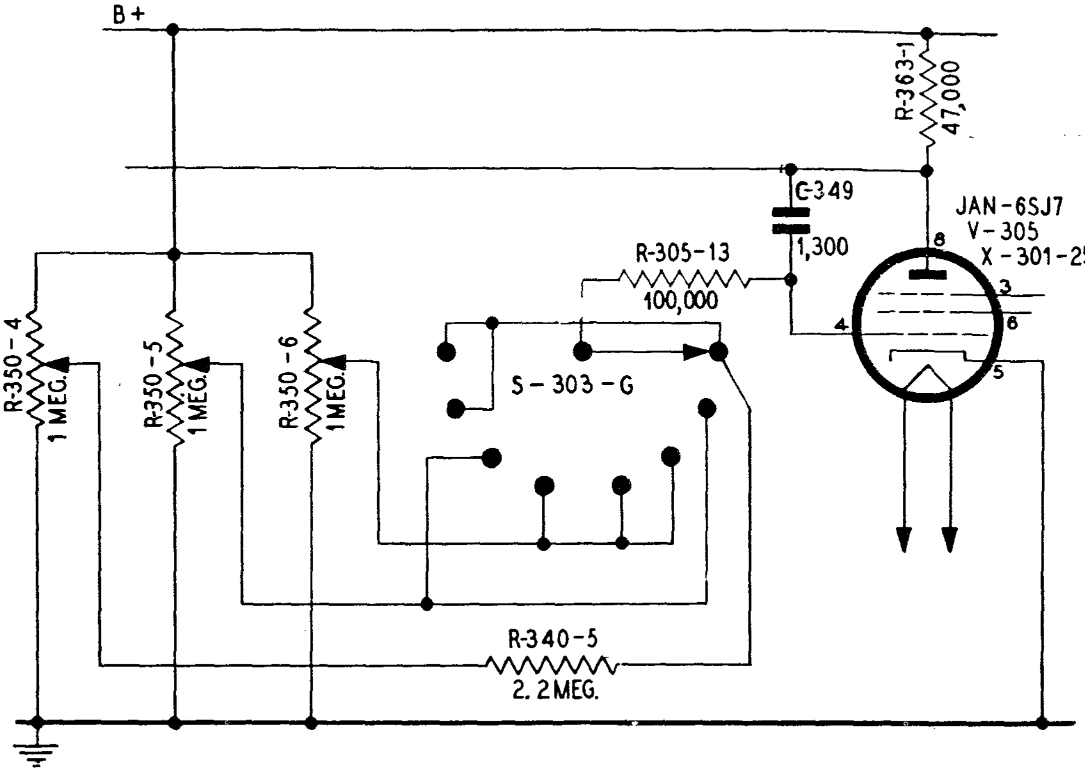


Figure 8-33C. Indicator ★ID-6A/APN-4—Sweep Generator Circuit Before Modification in Accordance with Technical Order No. 16-35ID6-21

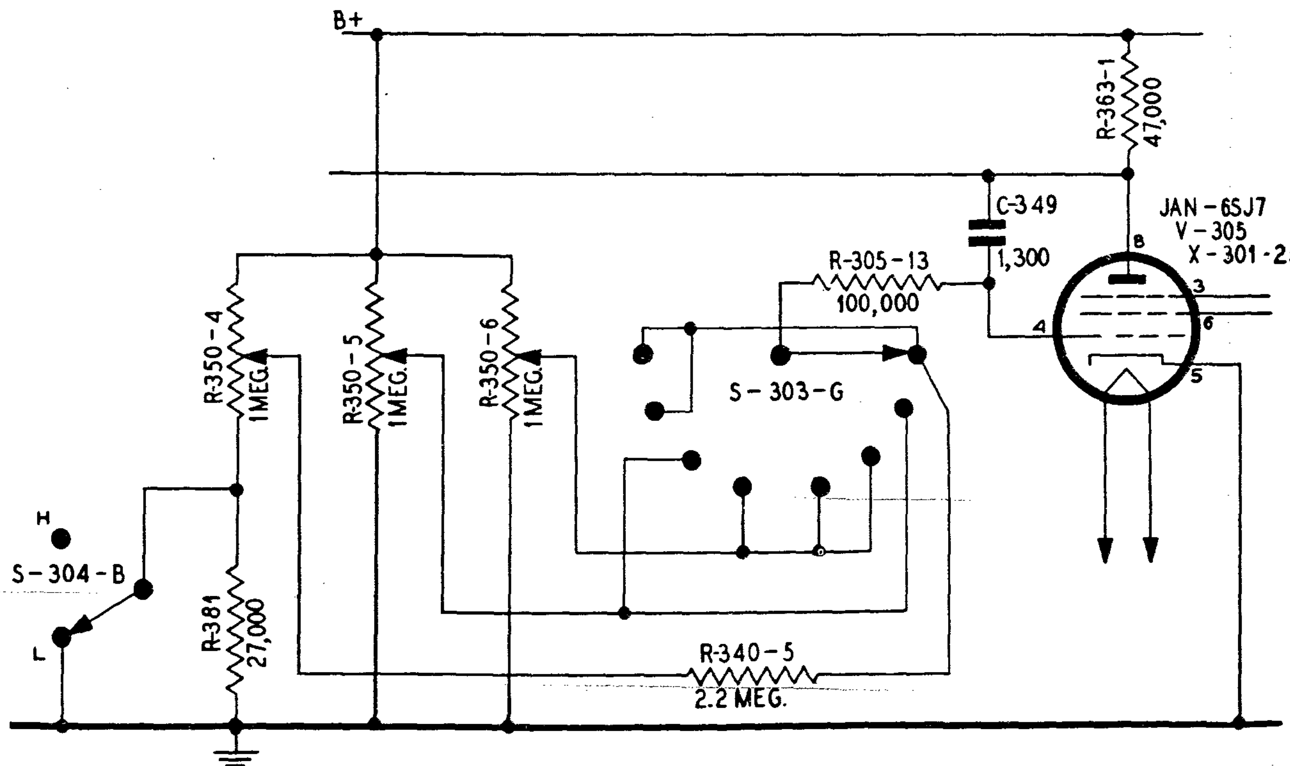


Figure 8-33D. Indicator ★ID-6A/APN-4—Sweep Generator Circuit After Modification in Accordance with Technical Order No. 16-35ID6-21

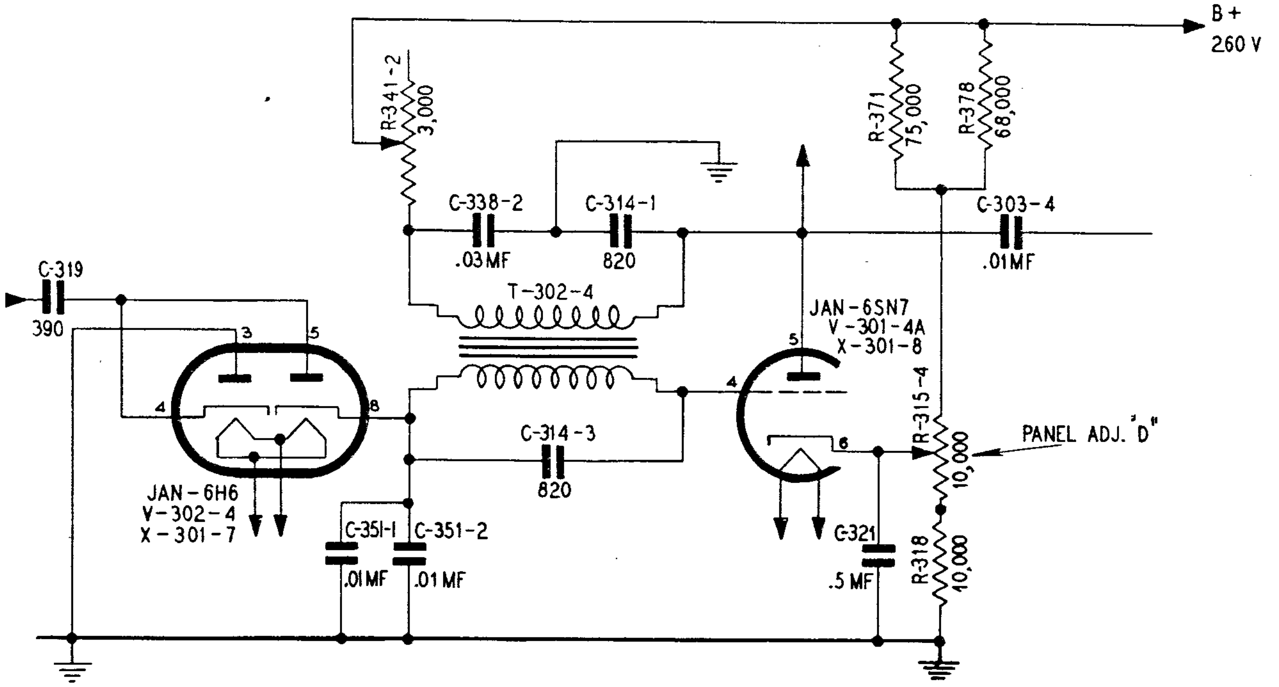


Figure 8-33A. Indicator ★ID-6A/APN-4—Fourth Counter Circuit Before Modification in Accordance with Technical Order No. 16-35ID6-21

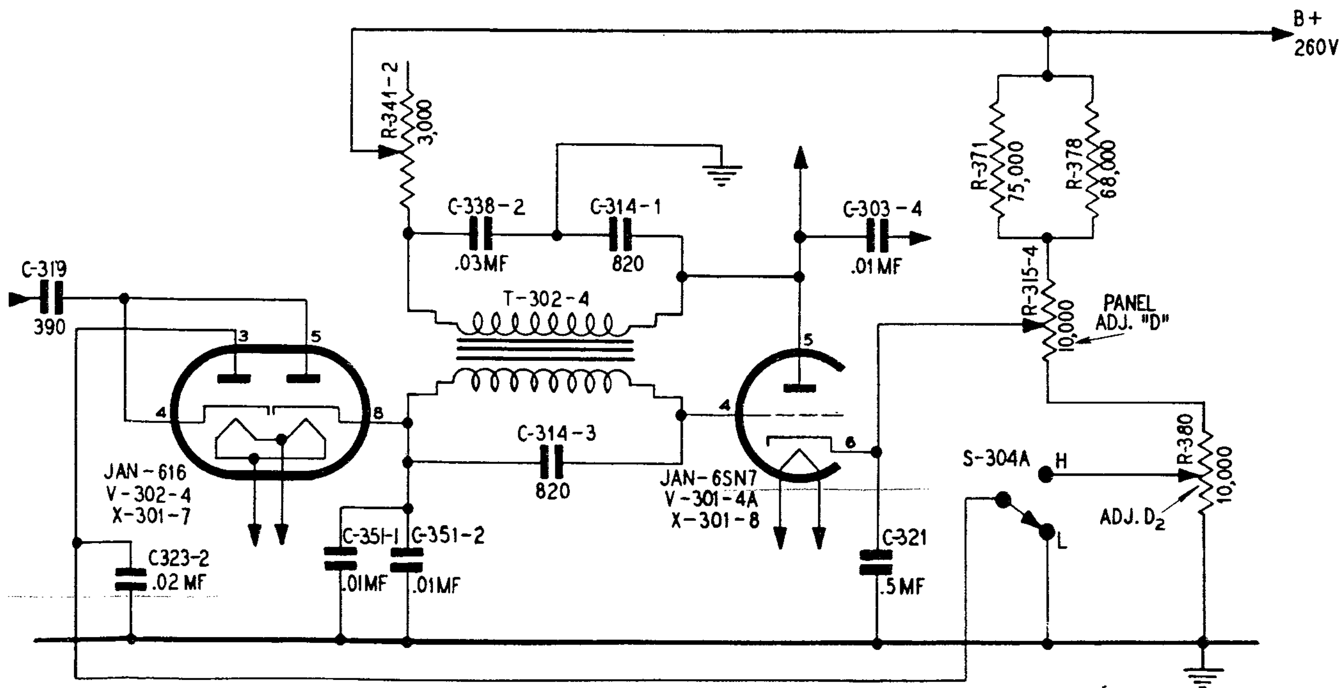


Figure 8-33B. Indicator ★ID-6A/APN-4—Fourth Counter Circuit After Modification in Accordance with Technical Order No. 16-35ID6-21

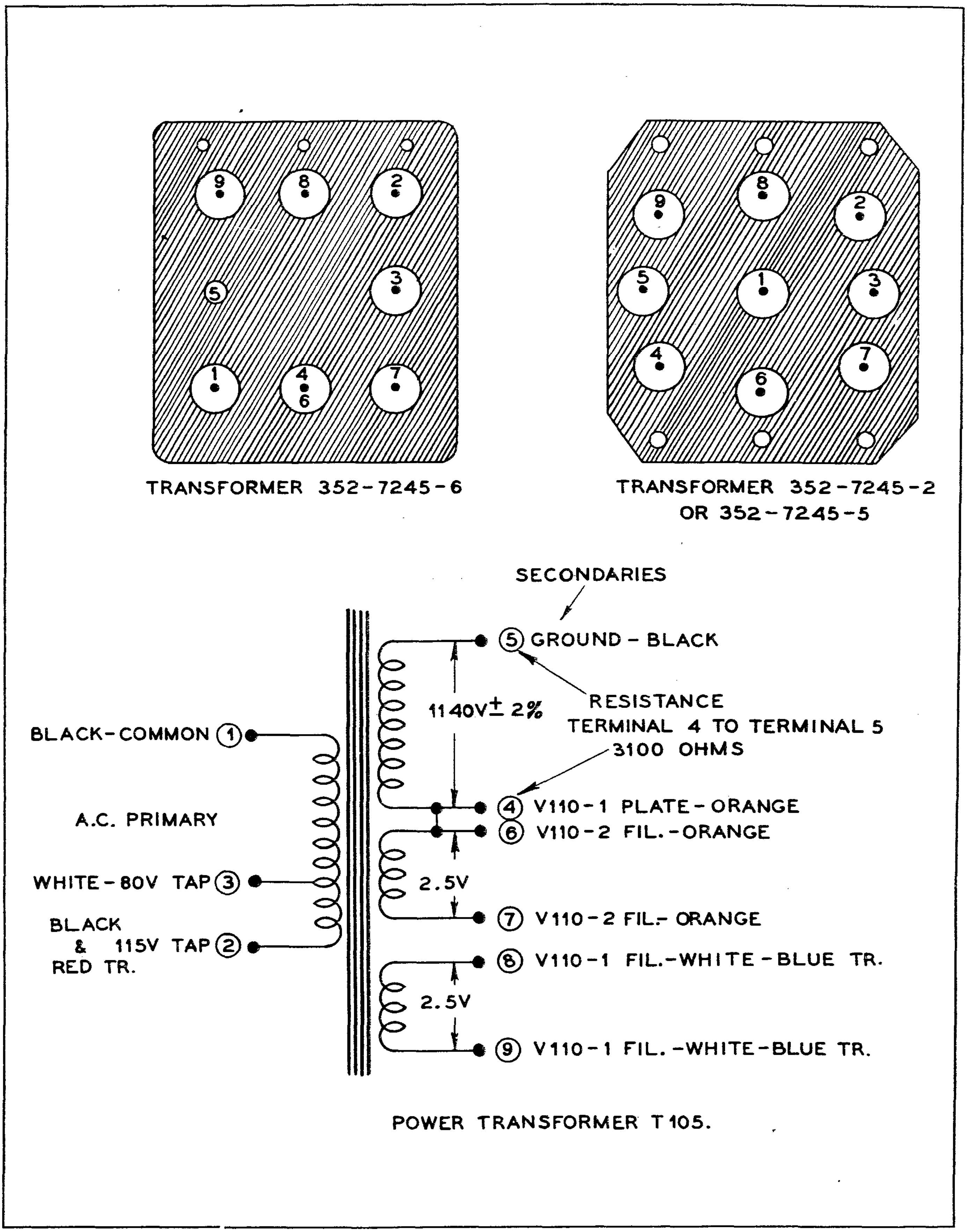


Figure 8-34. Power Transformer T-105—Terminal Location and Winding Schematic (Late)

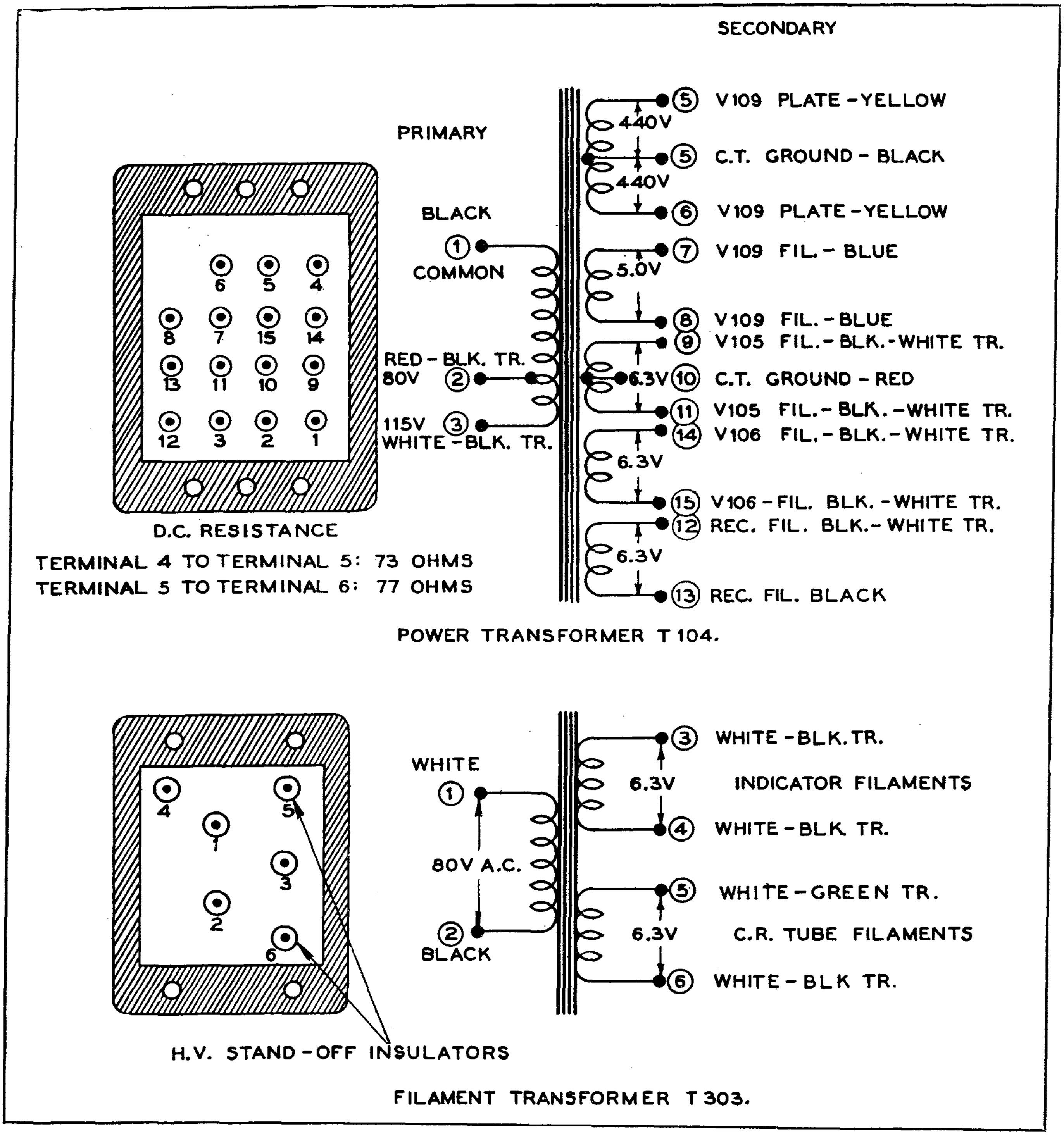


Figure 8-35. Power Transformer T-104 and Filament Transformer T-303—Teminal Location and Winding Schematic (Late)

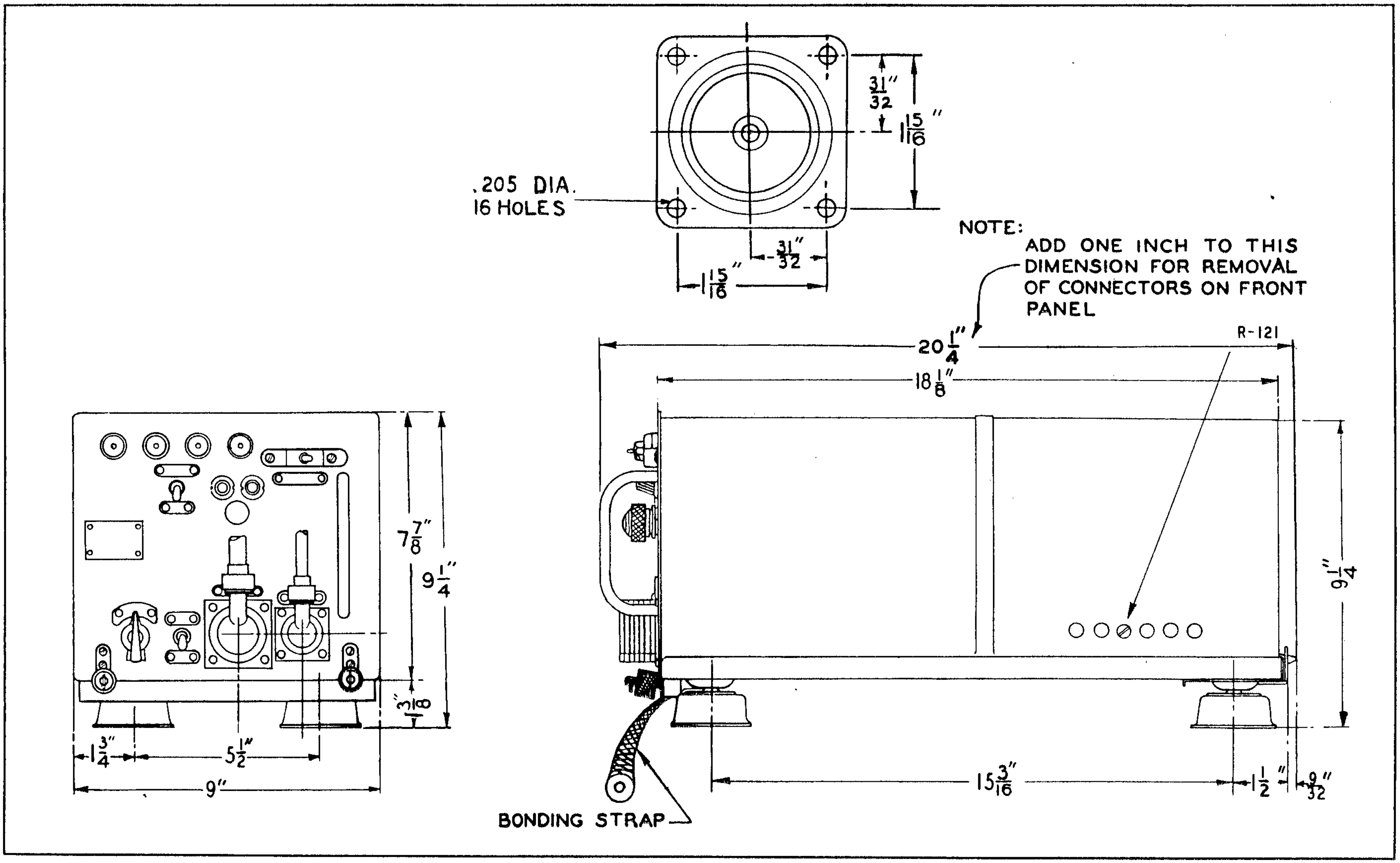


Figure 8-36. Radio Receiver ★R-9A/APN-4—Outline Dimensional Drawing (Late)

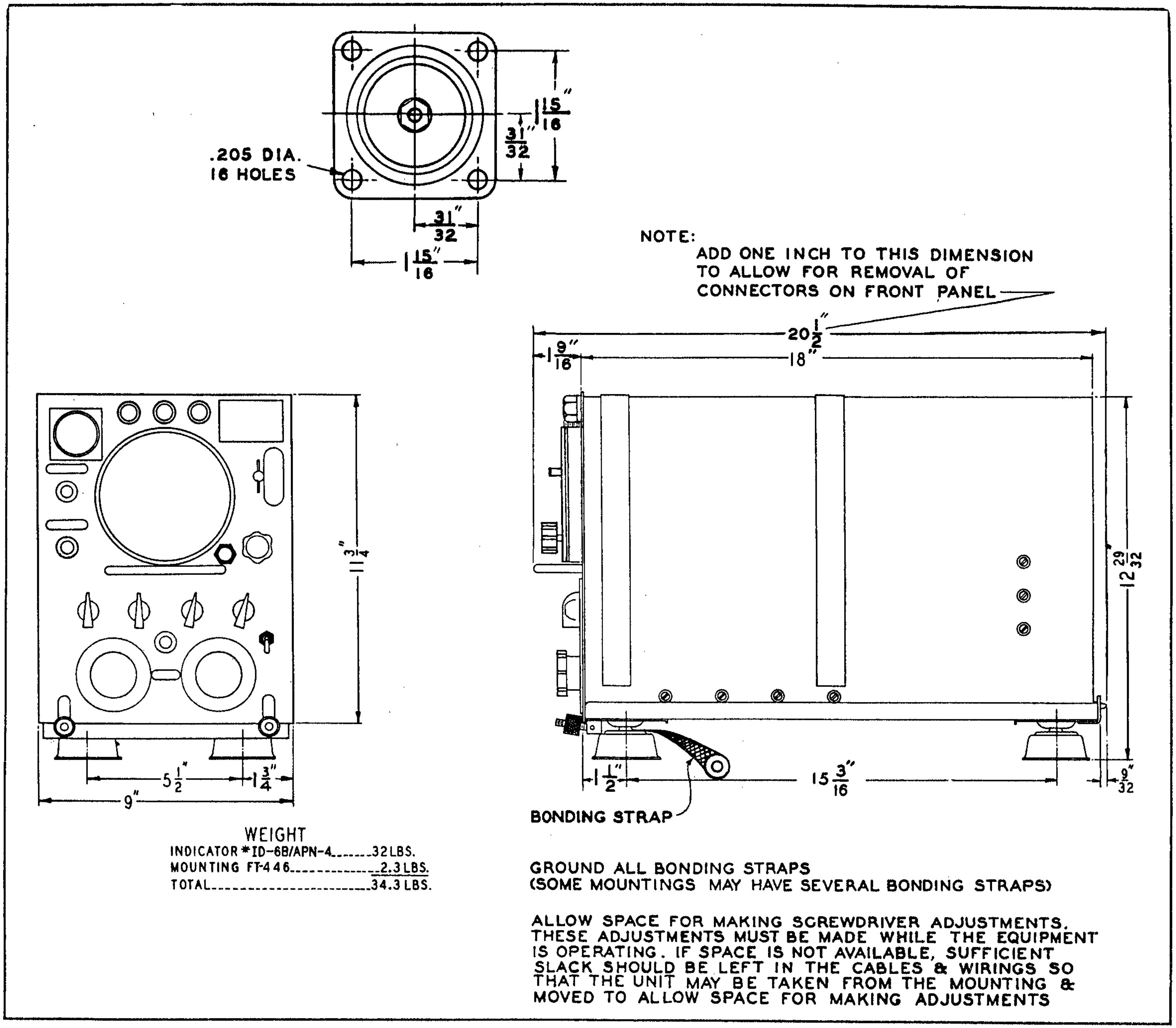


Figure 8-37. Indicator ★ID-6B/APN-4—Outline Dimensional Drawing (Late)

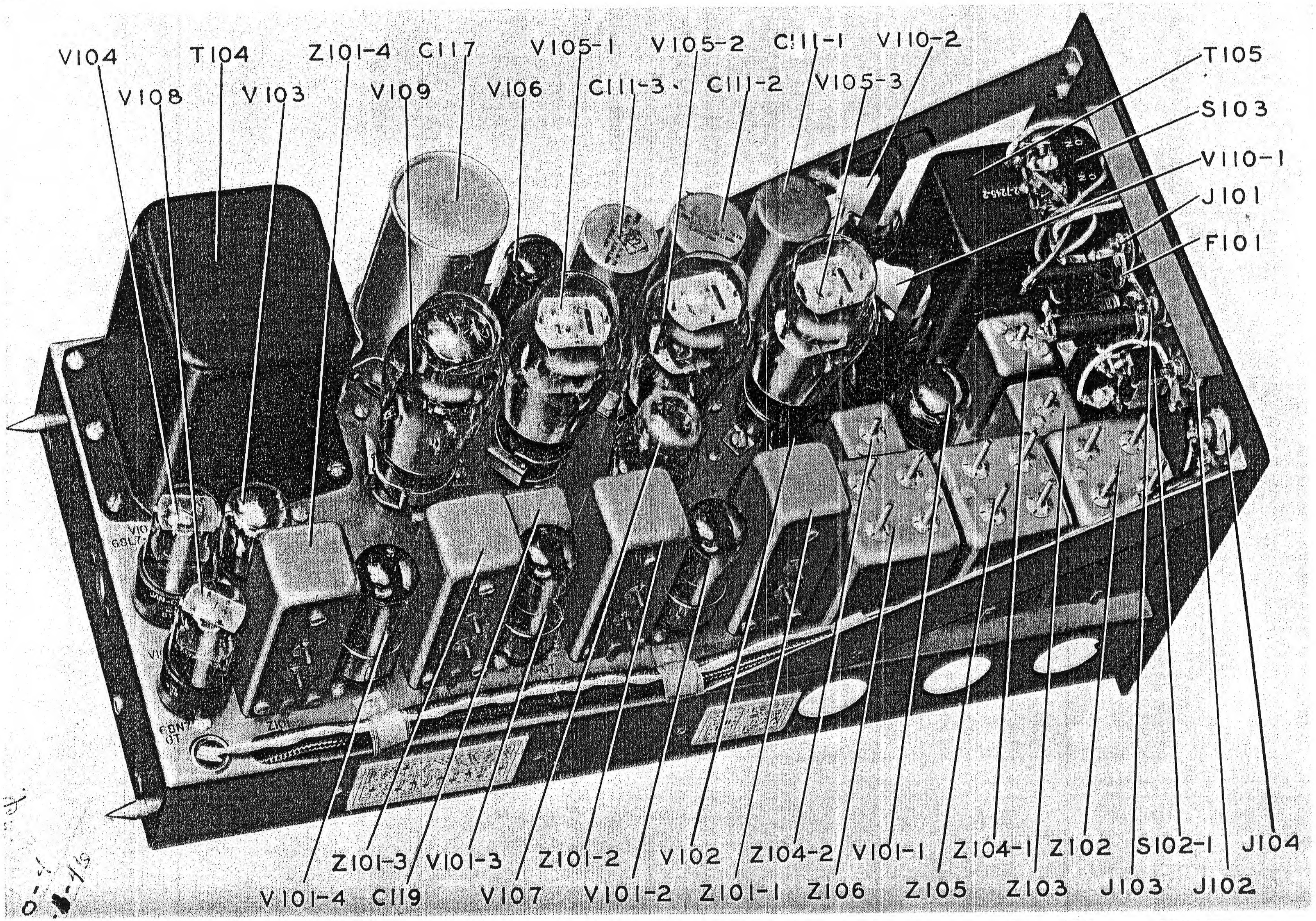


Figure 8-38. Radio Receiver ★R-9A/APN-4—Top View (Late)

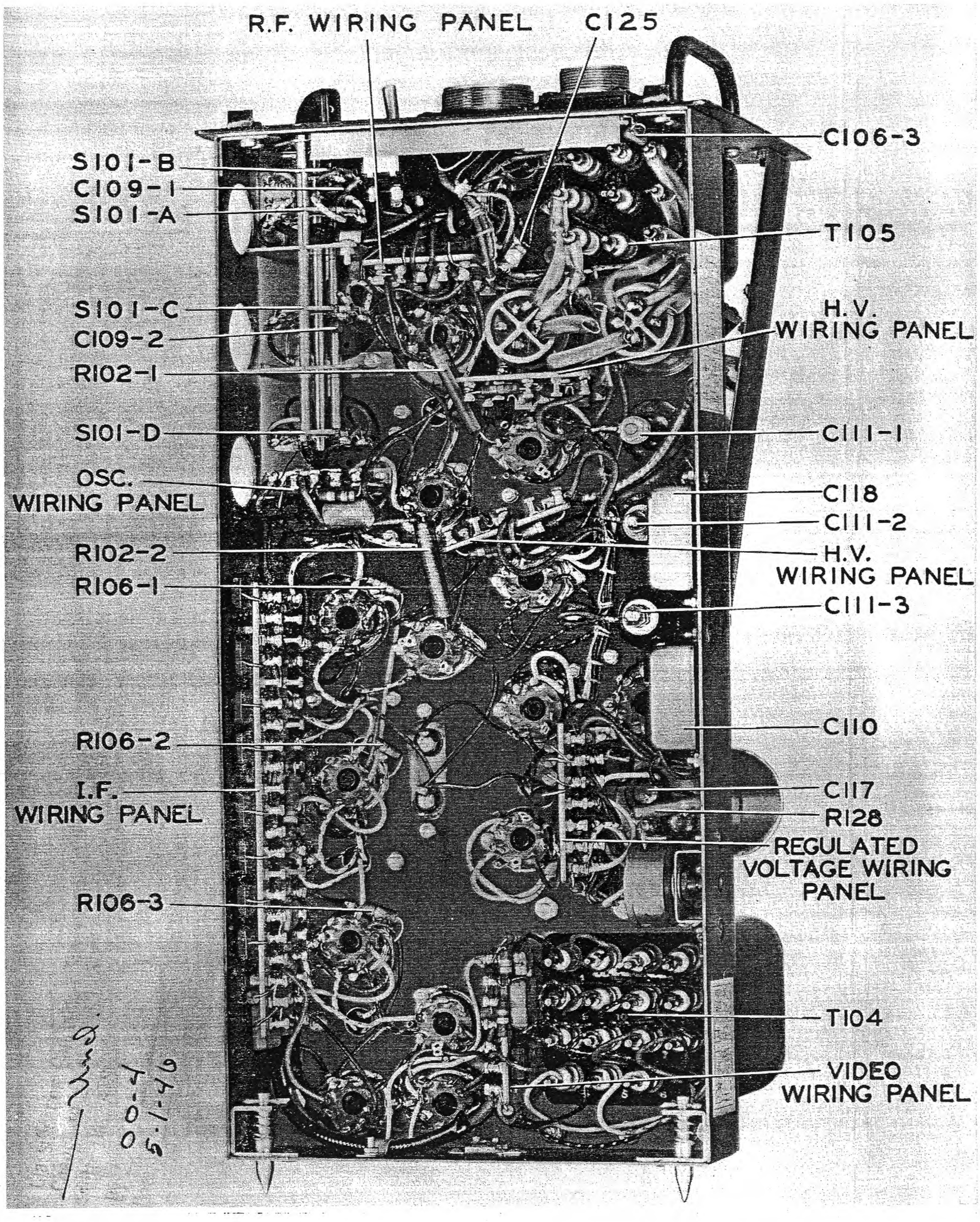


Figure 8-39. Radio Receiver ★R-9A/APN-4—Bottom View (Late)

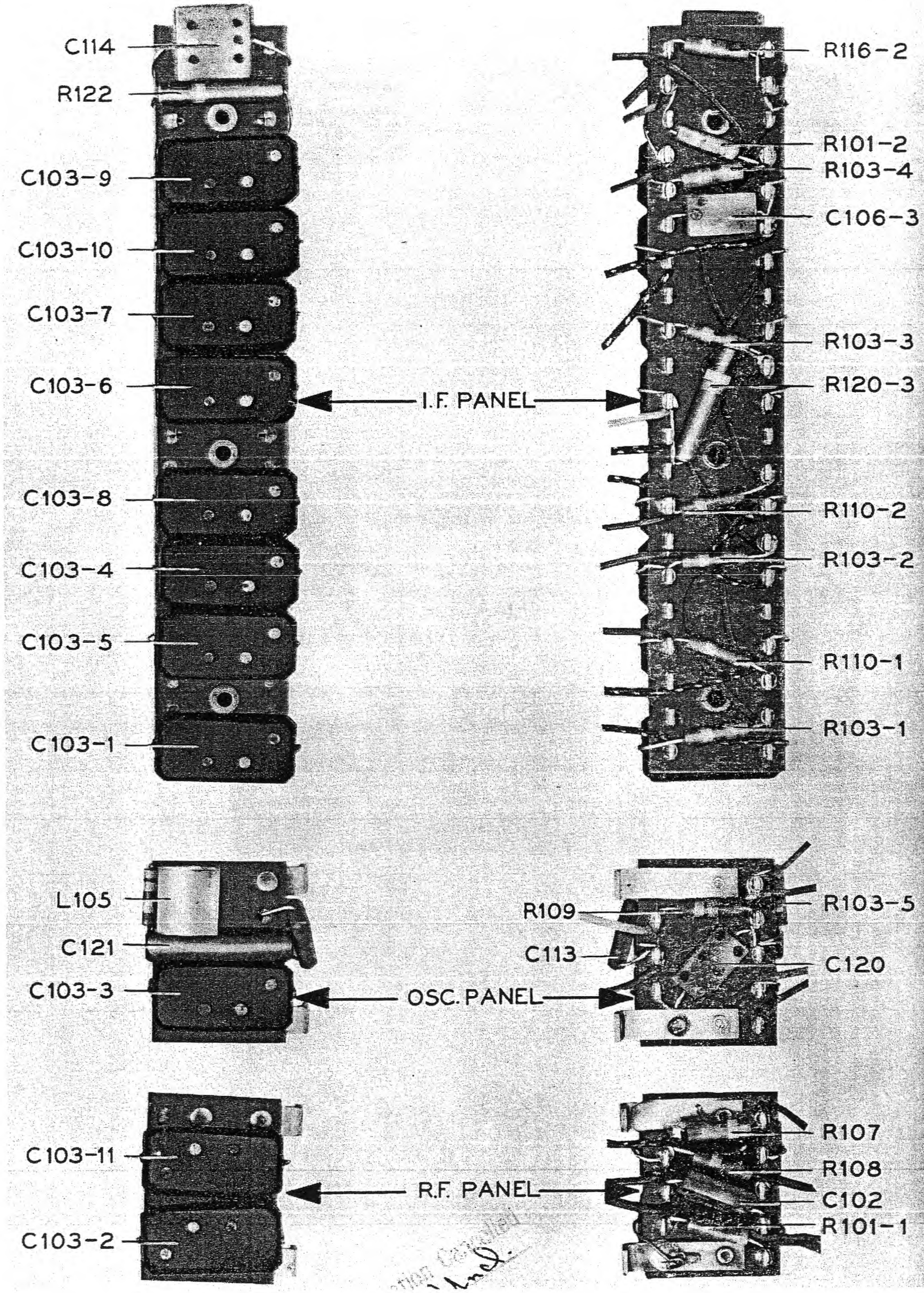


Figure 8-40. Radio Receivers ★R-9A/APN-4 and ★R-9B/APN-4 Wiring Panel Detail—I-F, Oscillator and R-F Panels (Late)

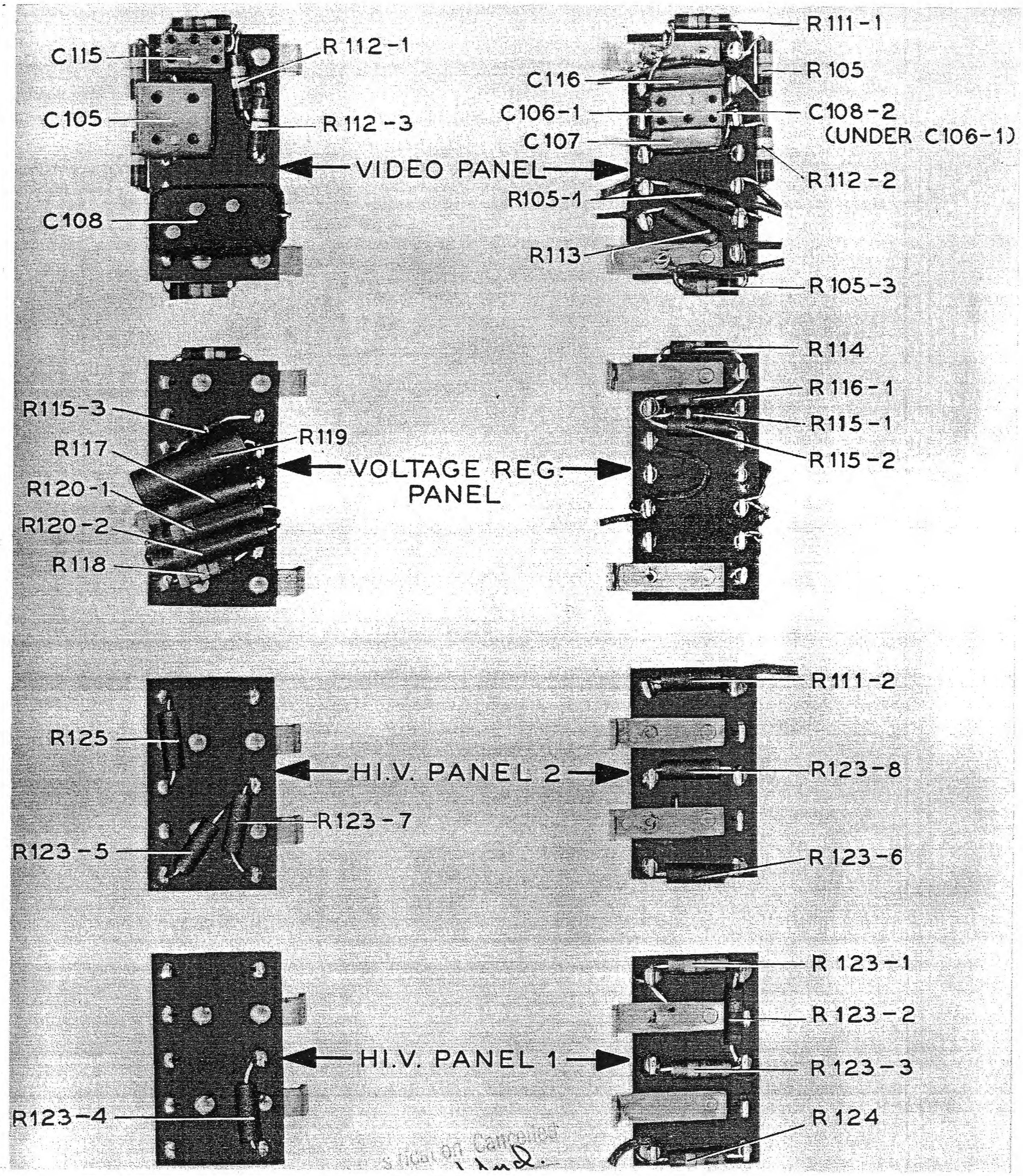


Figure 8-41. Radio Receivers ★R-9A/APN-4 and ★R-9B/APN-4 Wiring Panel Detail—Video, Voltage Regulator and H-V Panels (Late)

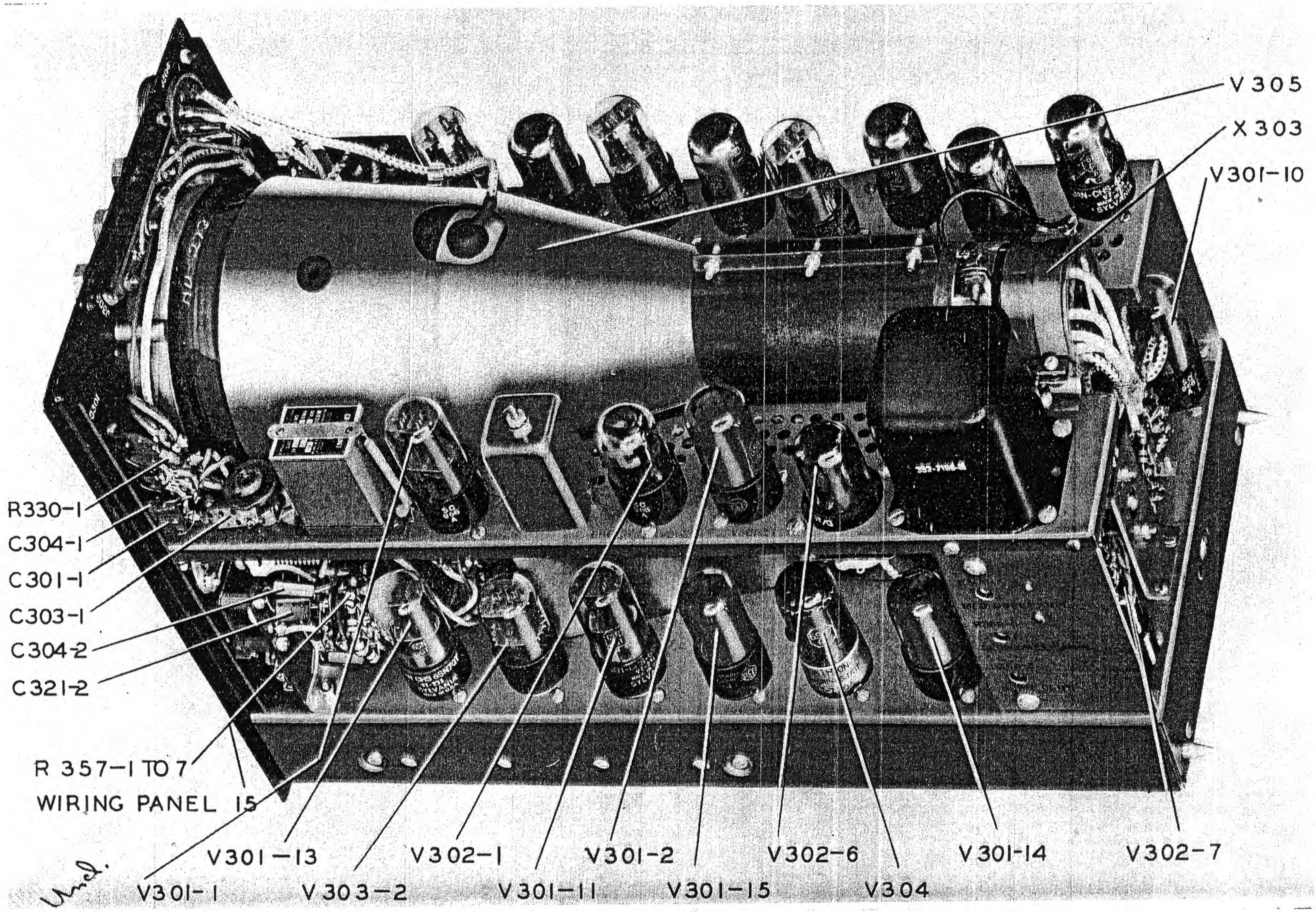


Figure 8-42. Indicator ★ID-6B/APN-4—Right Top View (Late)

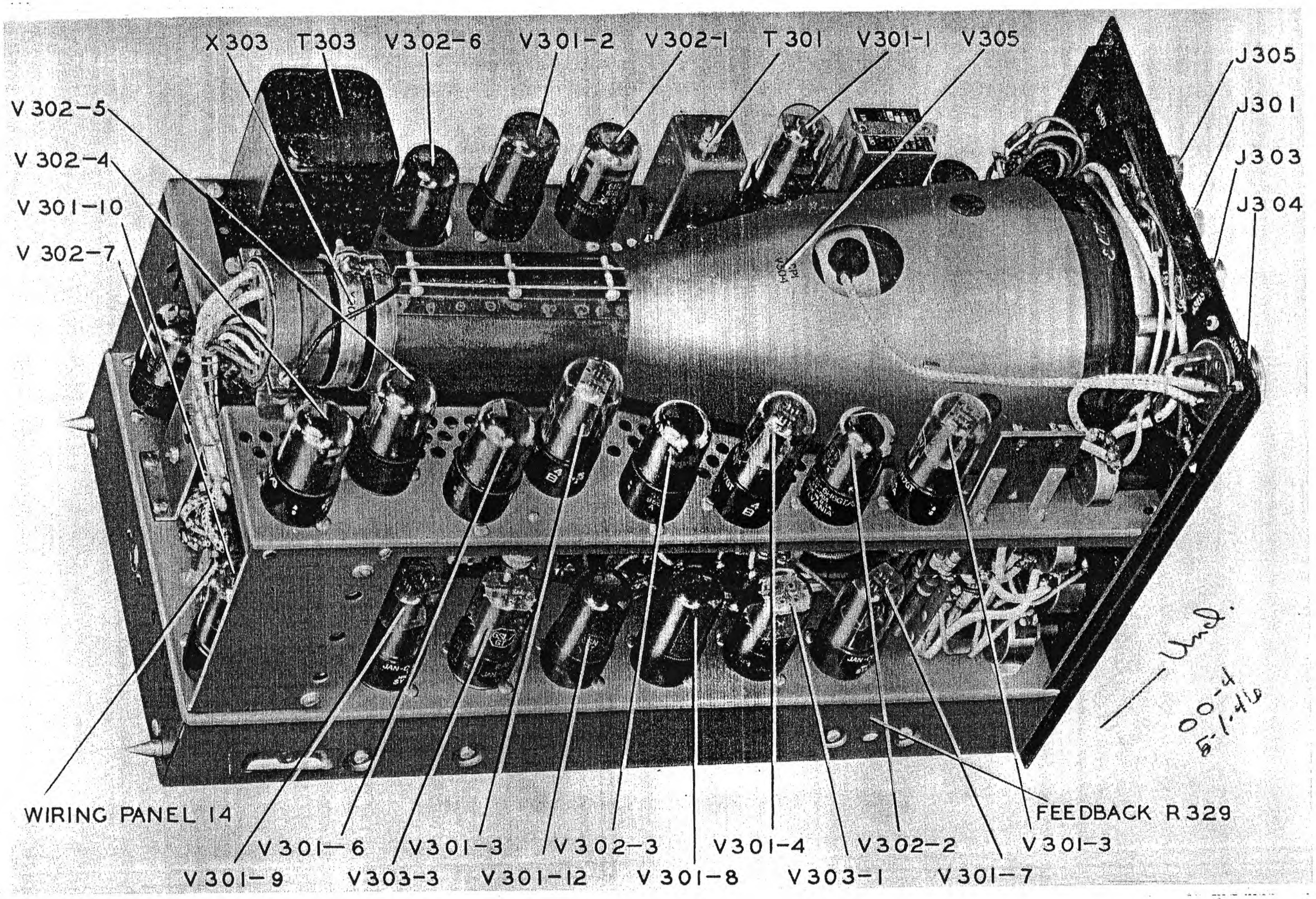


Figure 8-43. Indicator ★ID-6B/APN-4—Left Top View (Late)

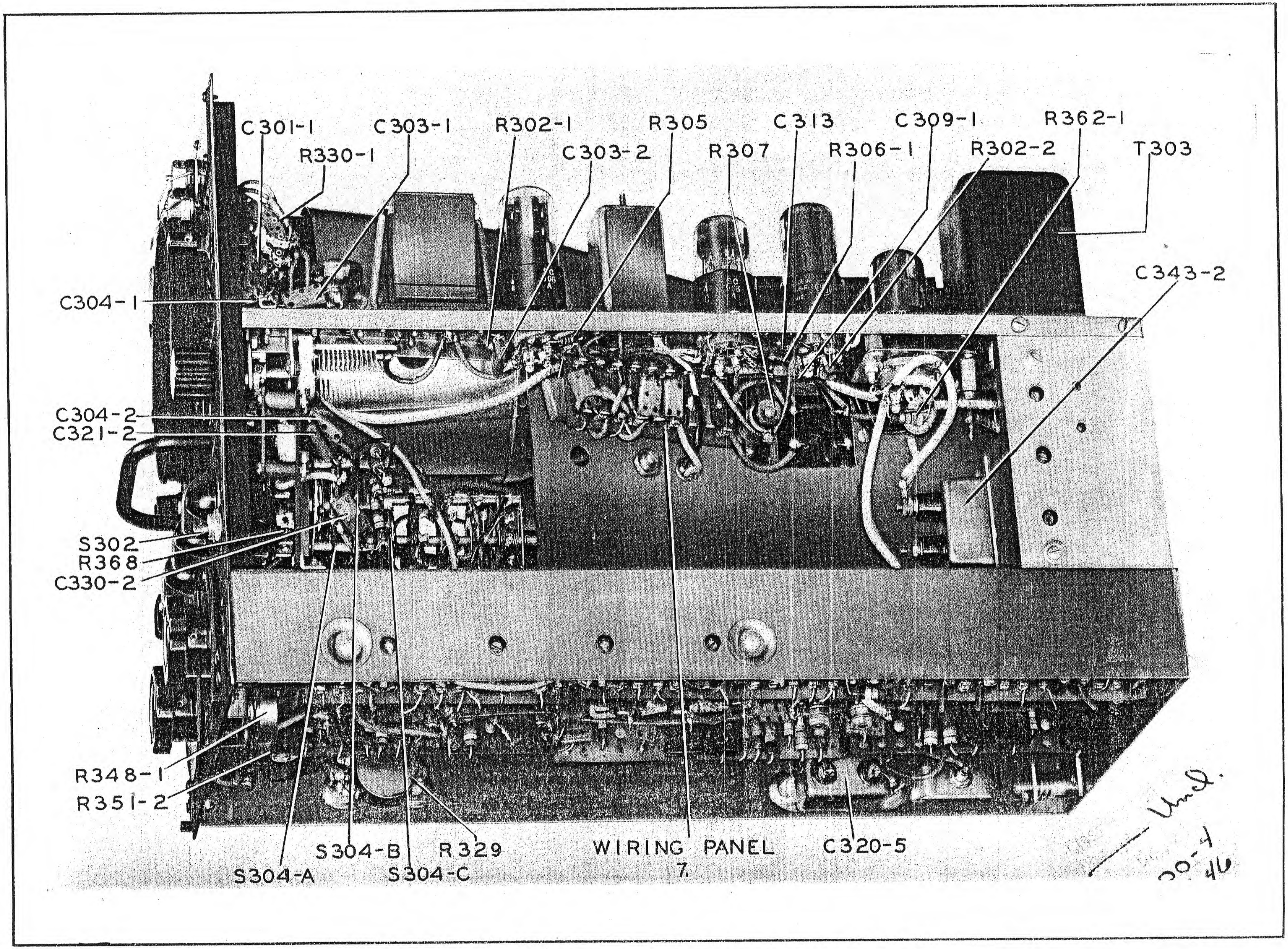


Figure 8-44. Indicator ★ID-6B/APN-4—Right Side View (Late)

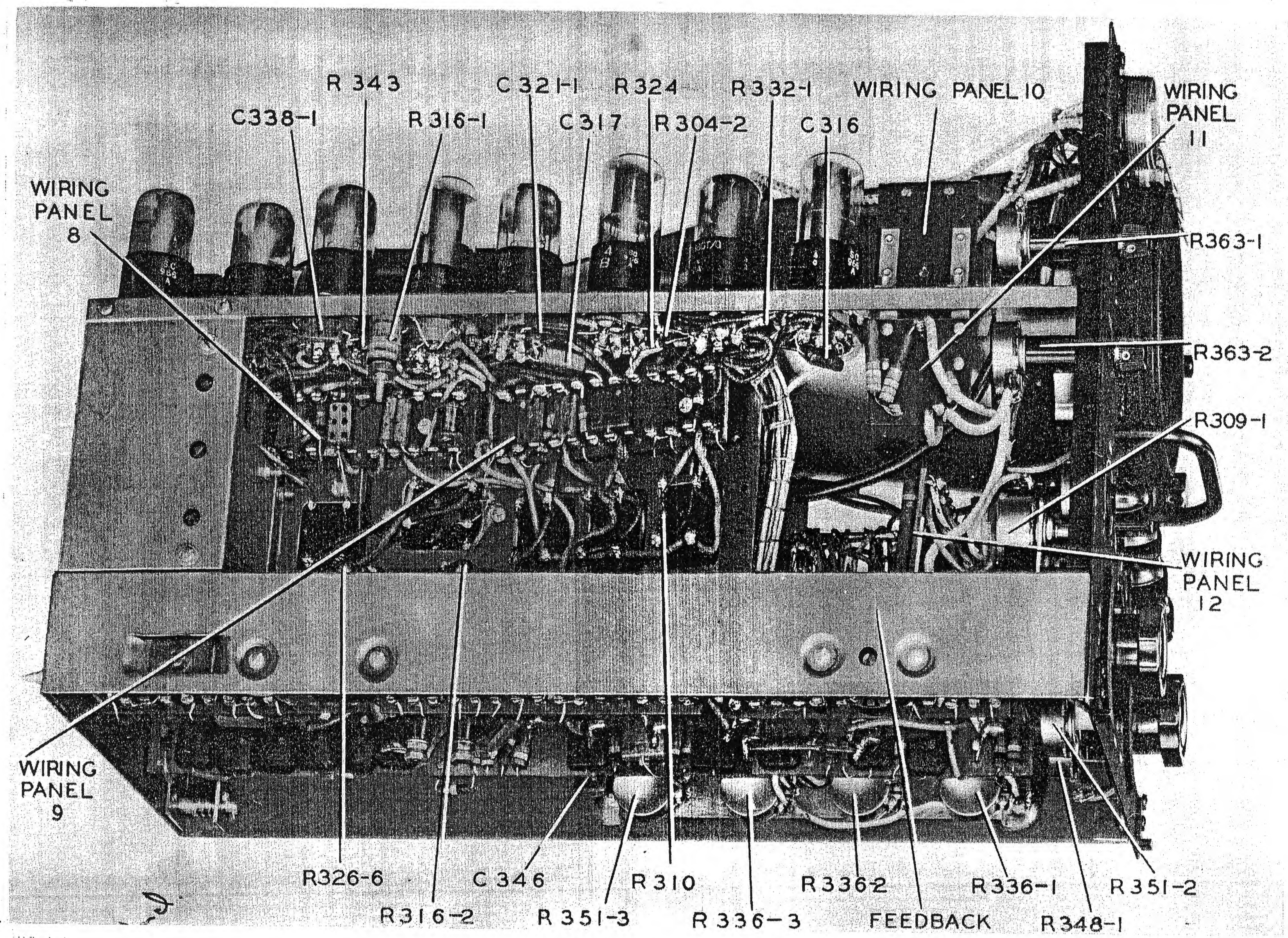


Figure 8-45. Indicator *ID-6B/APN-4—Left Side View (Late)

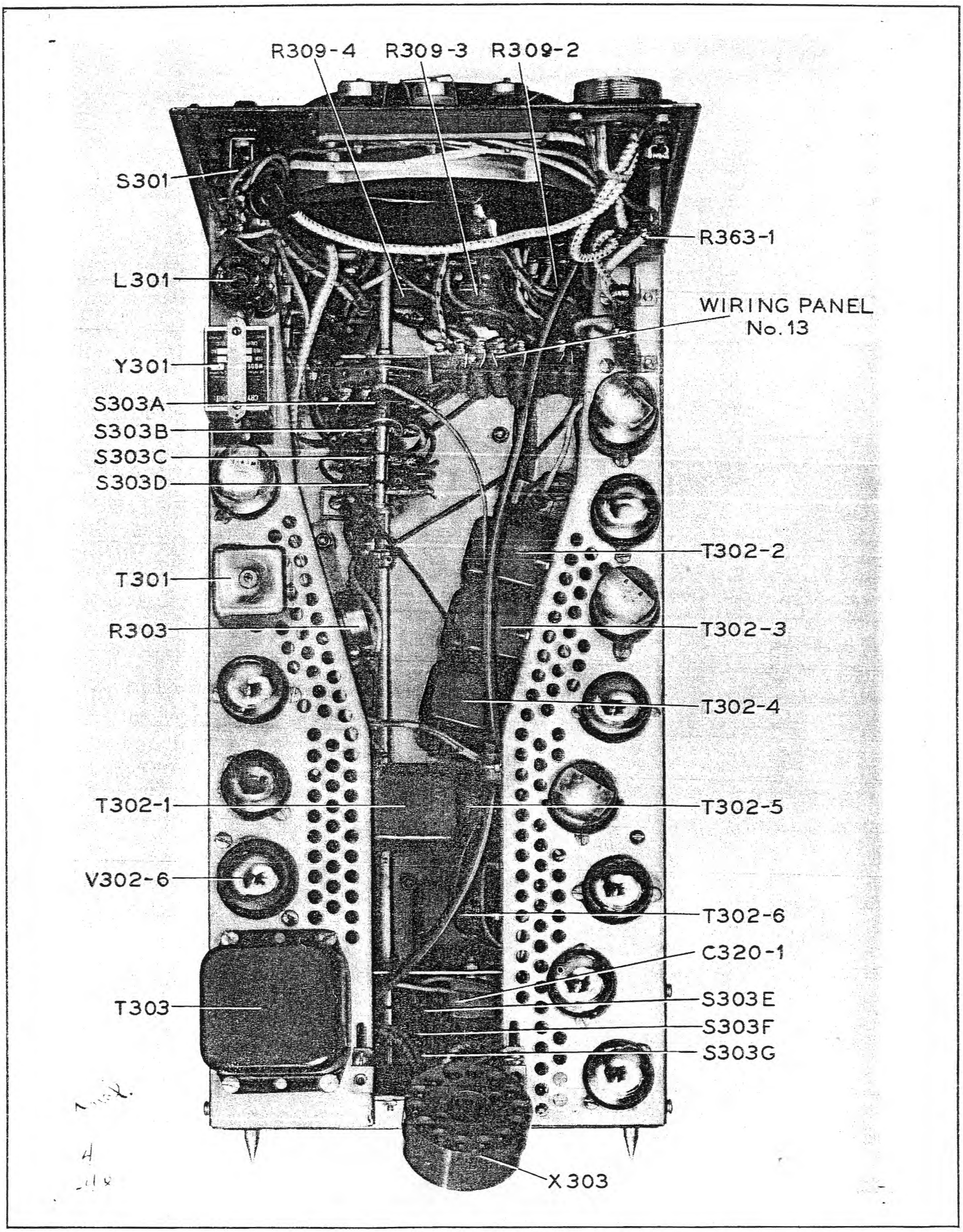


Figure 8-46. Indicator ★ID-6B/APN-4—Top View, Cathode—Ray Tube Removed (Late)

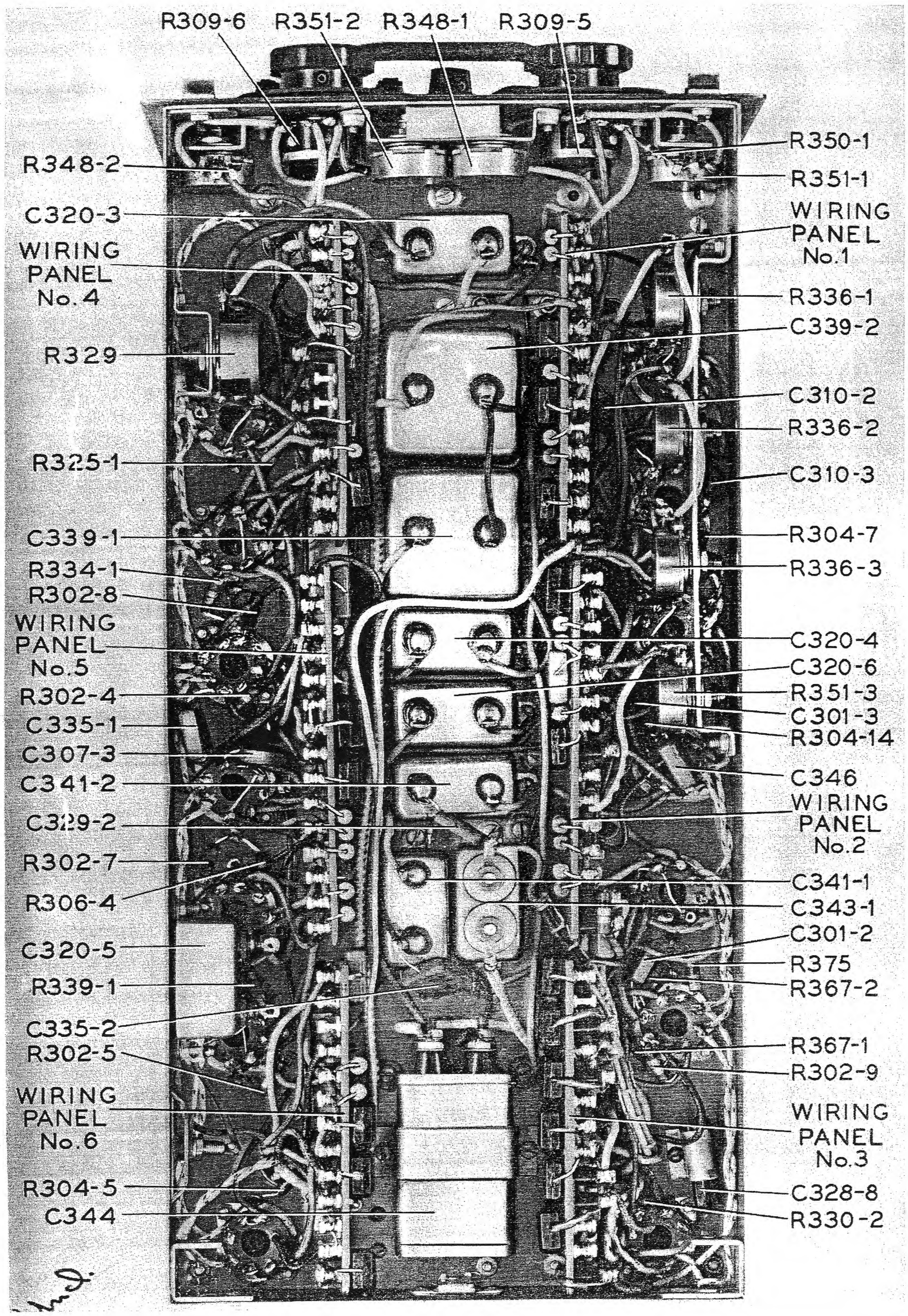


Figure 8-47. Indicator ★ID-6B/APN-4—Bottom View (Late)

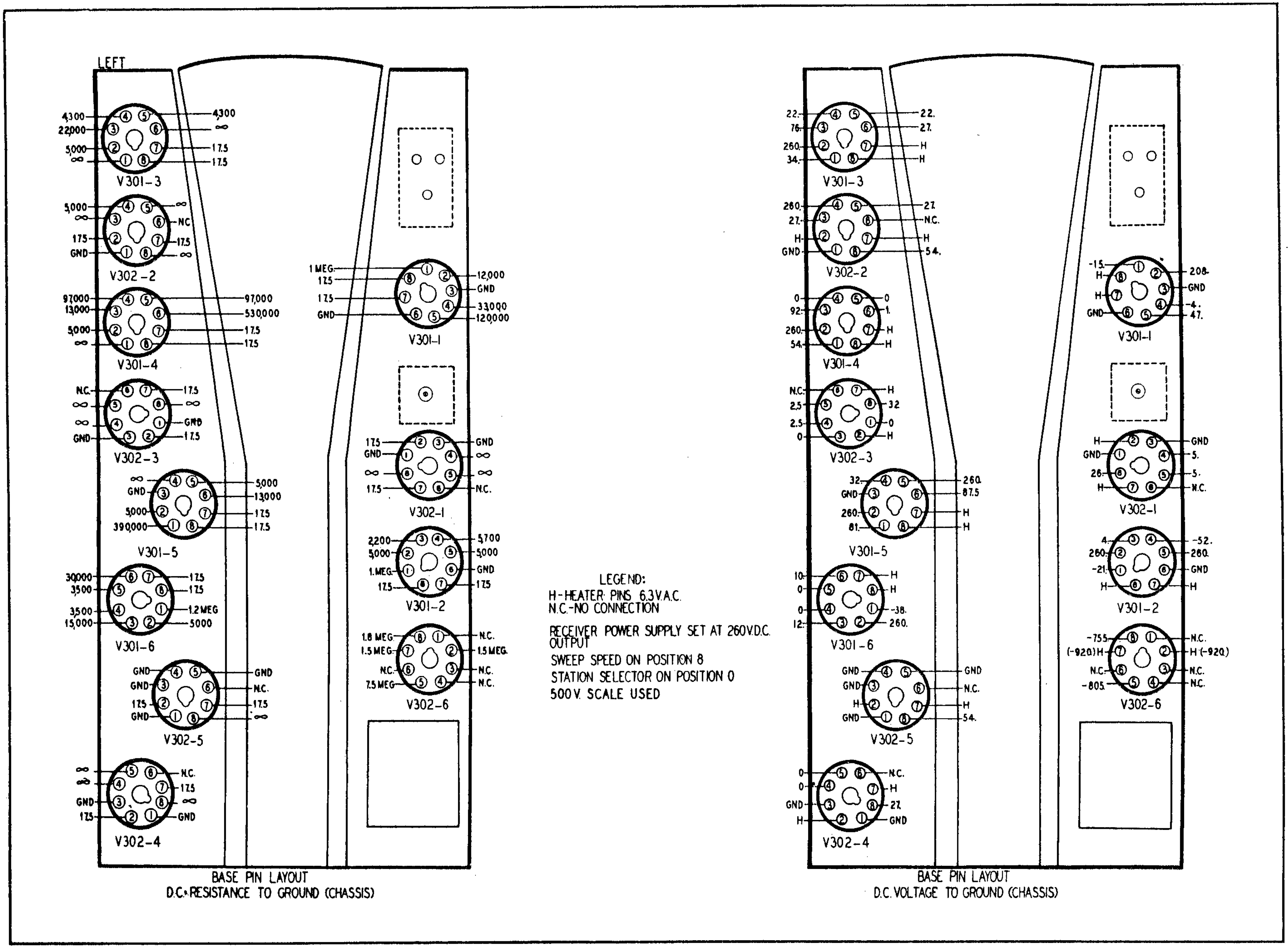


Figure 8-48. Indicator ★ID-6B/APN-4—Bottom View of Upper Deck—D-C Voltages Measured with 1000-Ohm-Per-Volt Meter (Late)

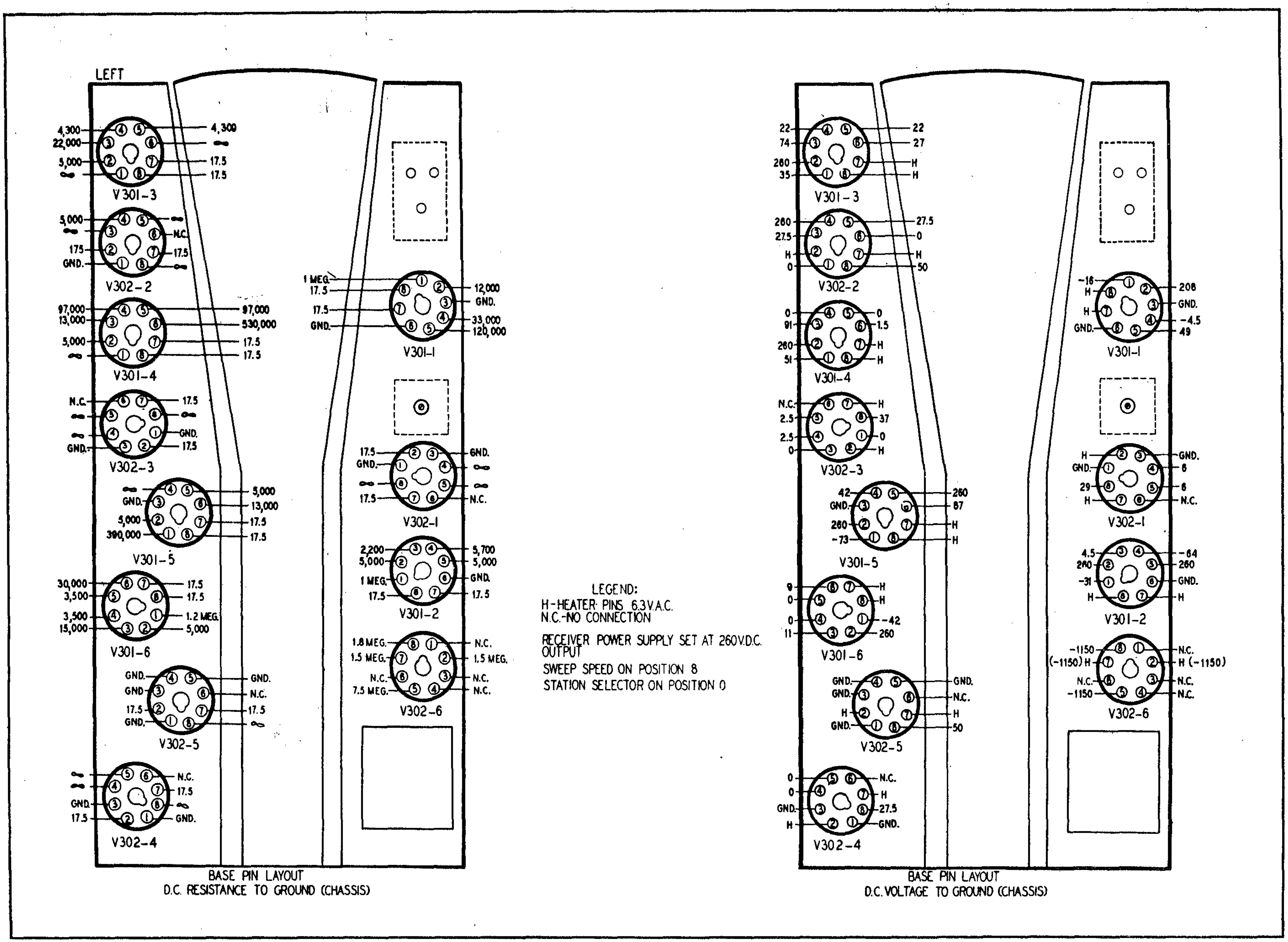
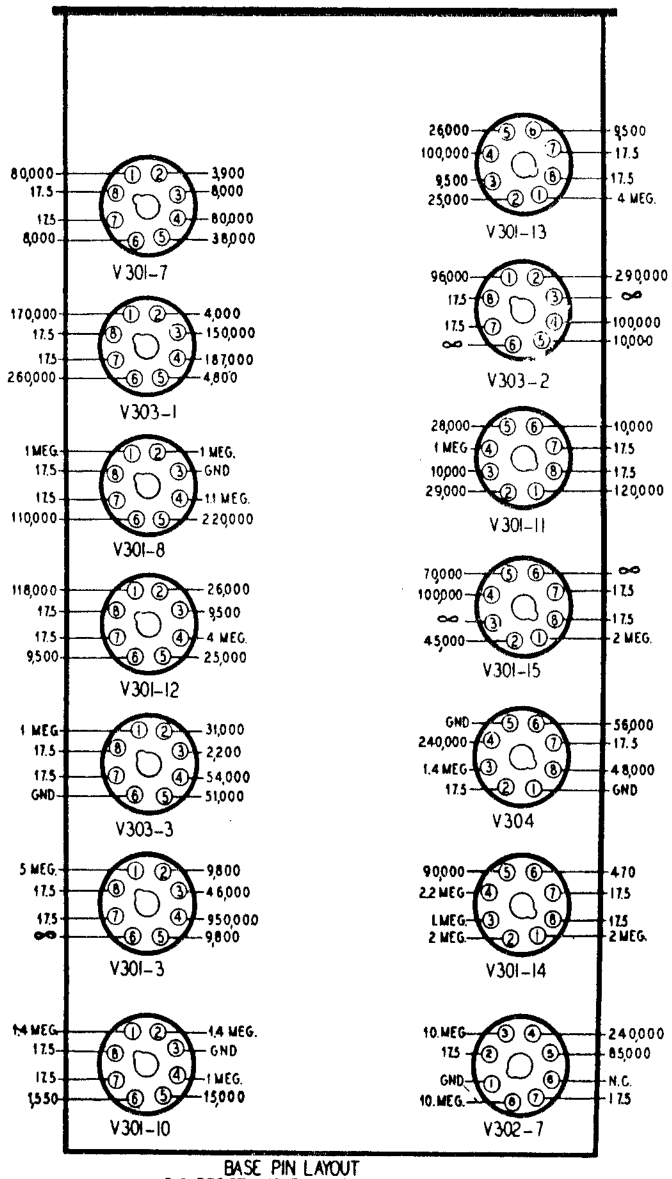


Figure 8-49. Indicator ★ID-6B/APN-4—Bottom View of Upper Deck—D-C Voltages Measured with 20,000-Ohm-Per-Volt Meter (Late)



LEGEND
H-HEATER PINS 6.3V A.C.
N.C-NO CONNECTION

RECEIVER POWER SUPPLY SET AT 260VDC. OUTPUT

SWEEP SPEED ON POSITION 8

STATION SELECTOR ON POSITION 0

ALL READINGS ON 500V SCALE

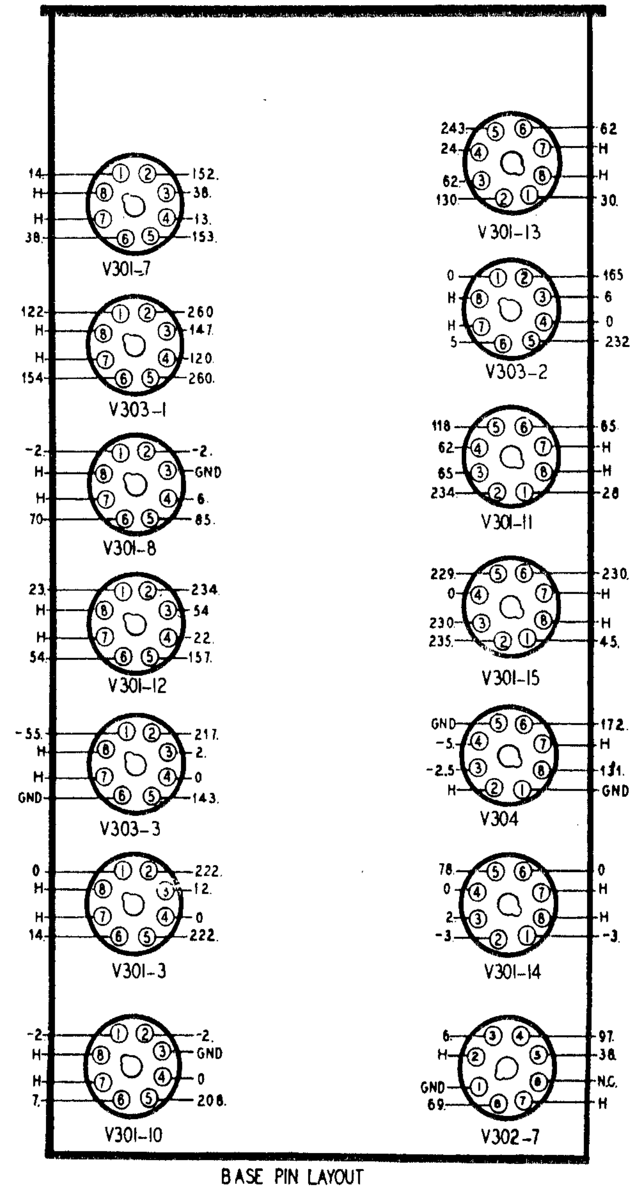


Figure 8-50. Indicator ★ID-6B/APN-4—Bottom View of Lower Deck—D-C Voltages Measured with 1000-Ohm-Per-Volt Meter (Late)

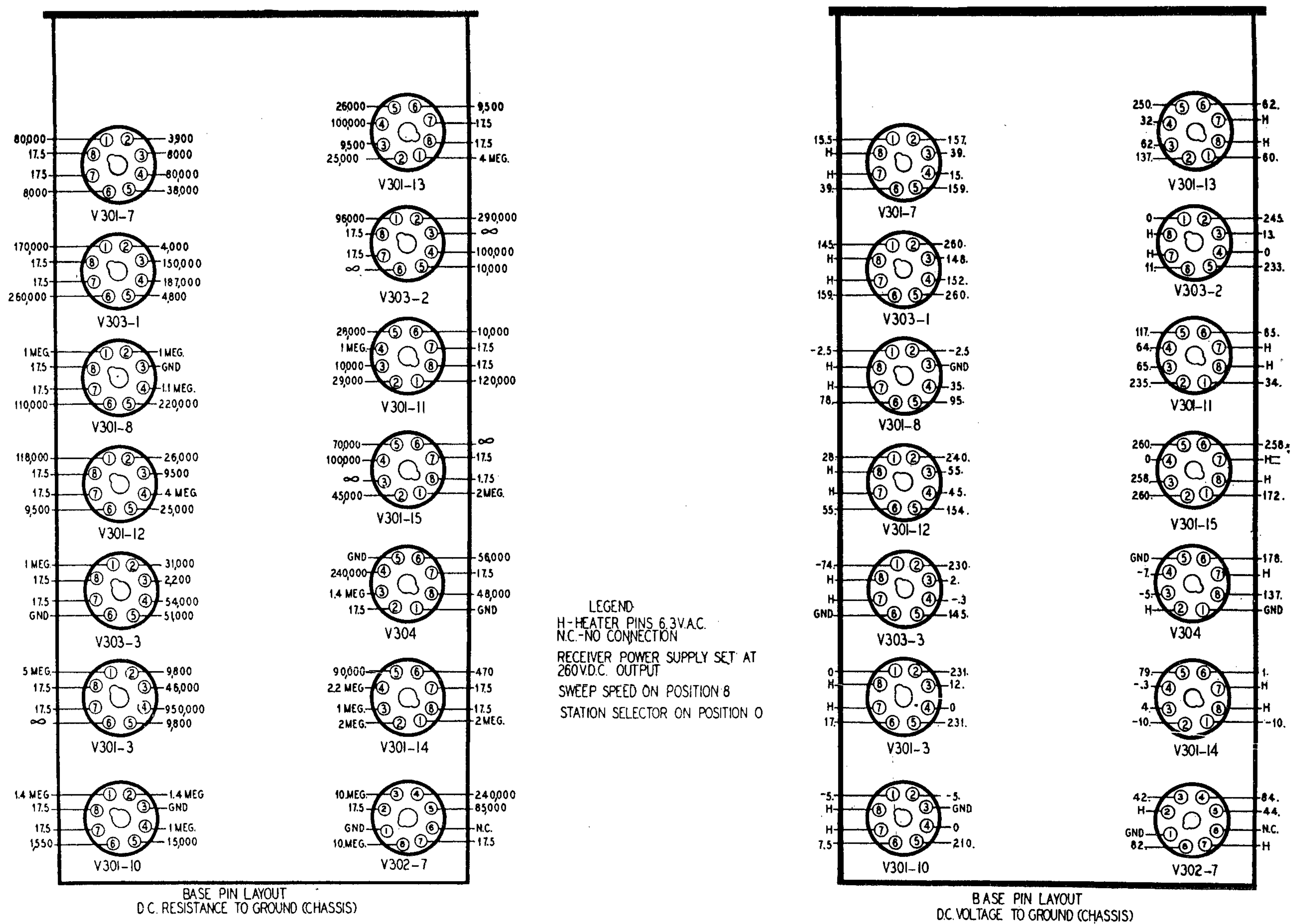


Figure 8-51. Indicator ★ID-6B/APN-4—Bottom View of Lower Deck—D-C Voltages Measured with 20,000-Ohm-Per-Volt Meter (Late)

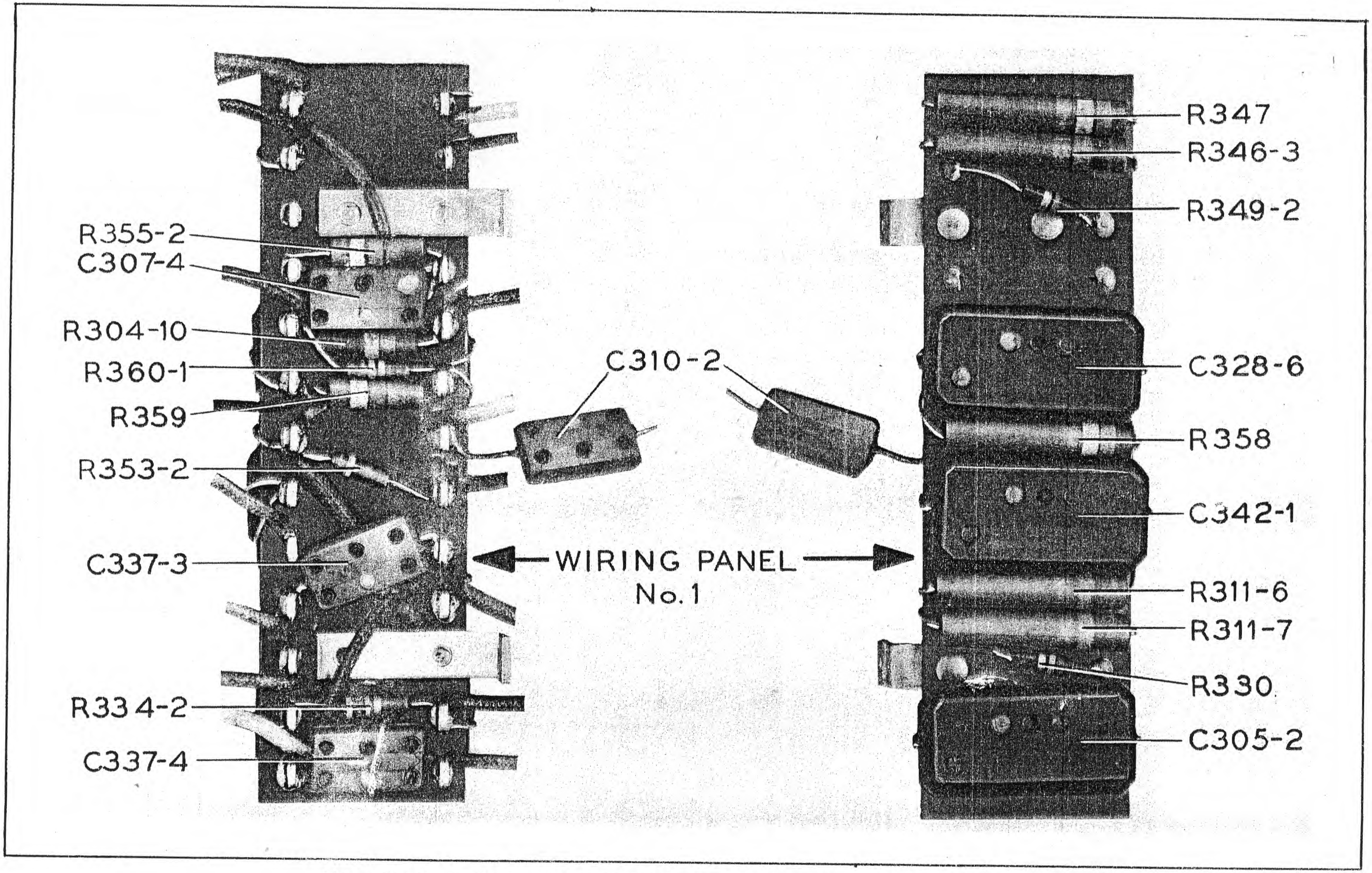


Figure 8-52. Indicator ★ID-6B/APN-4—Panel No. 1, Wiring Panel Detail (Late)

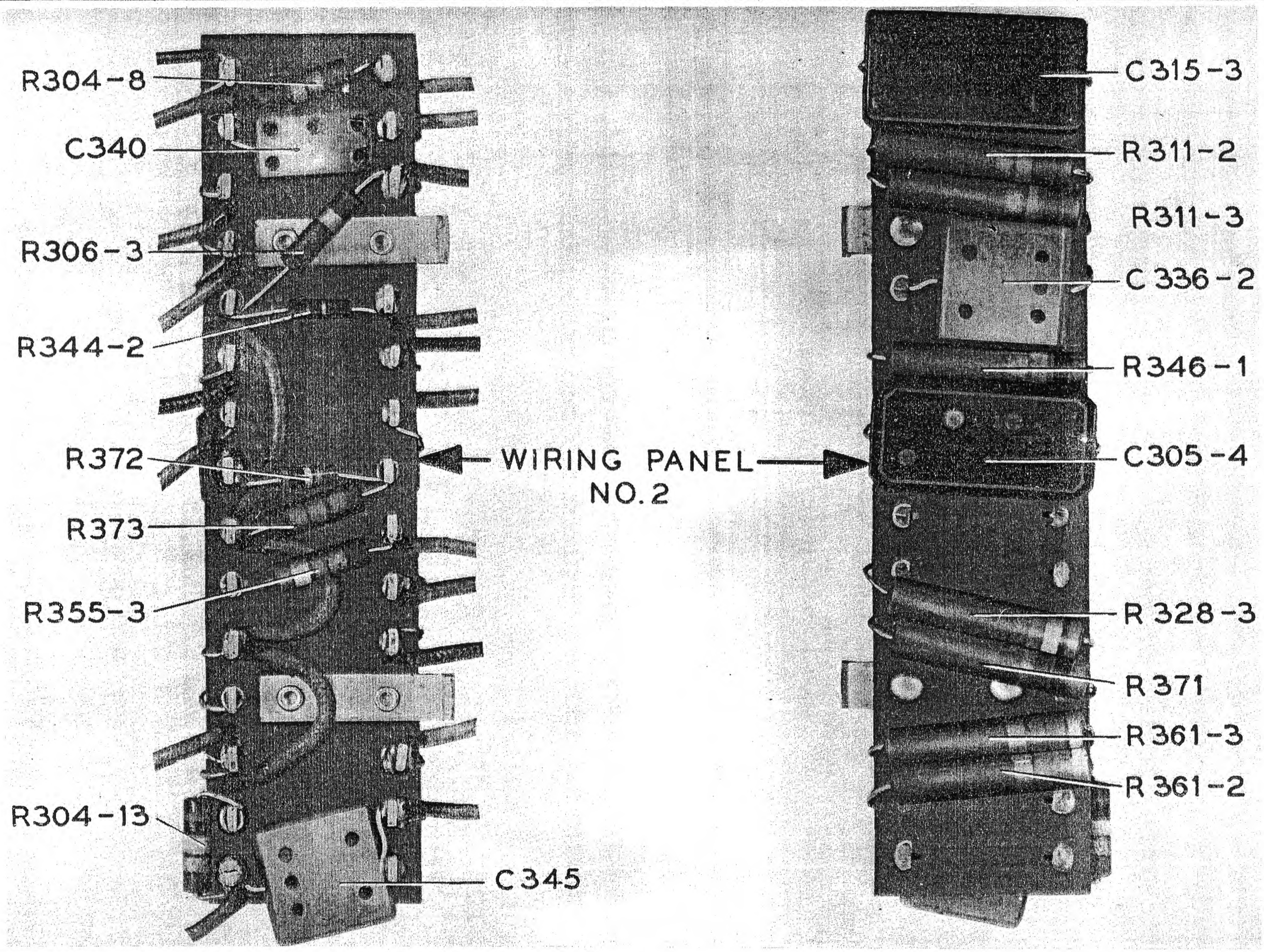


*Figure 8-53. Indicator *ID-6B/APN-4—Panel No. 2, Wiring Panel Detail (Late)*

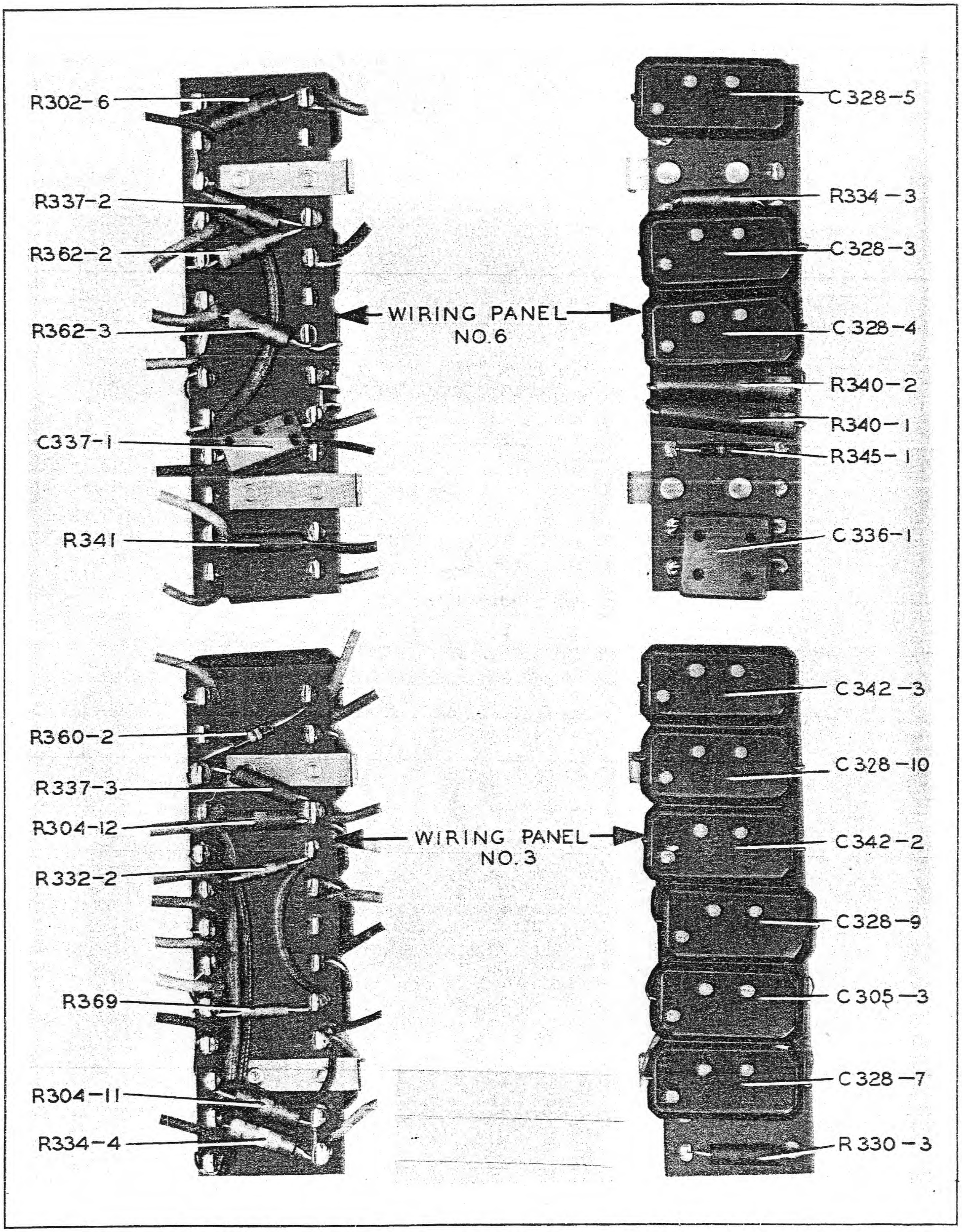


*Figure 8-54. Indicator *ID-6B/APN-4—Panels No. 3 and 6, Wiring Panel Detail (Late)*

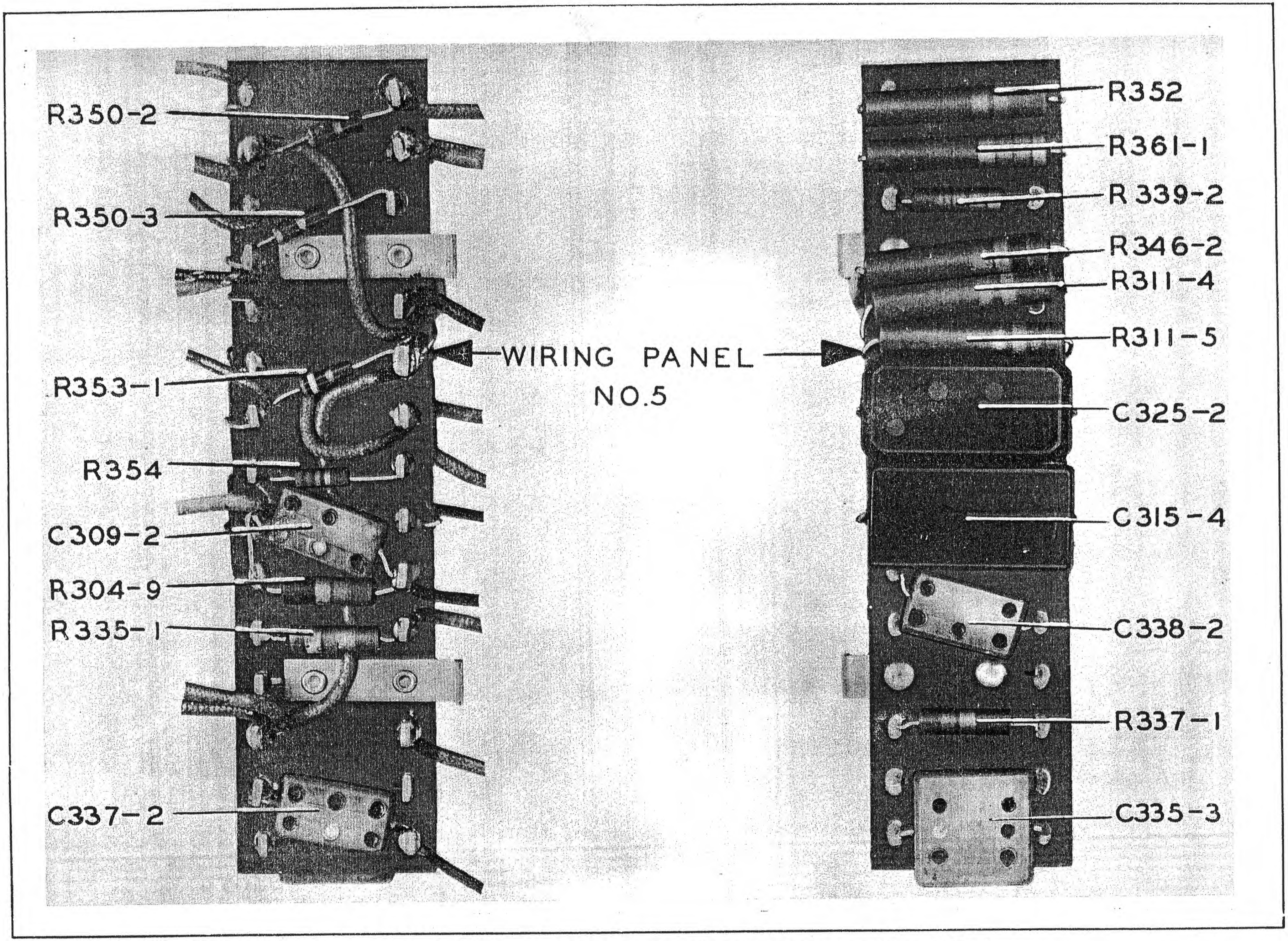


Figure 8-55. Indicator *ID-6B/APN-4—Panel No. 5, Wiring Panel Detail (Late)

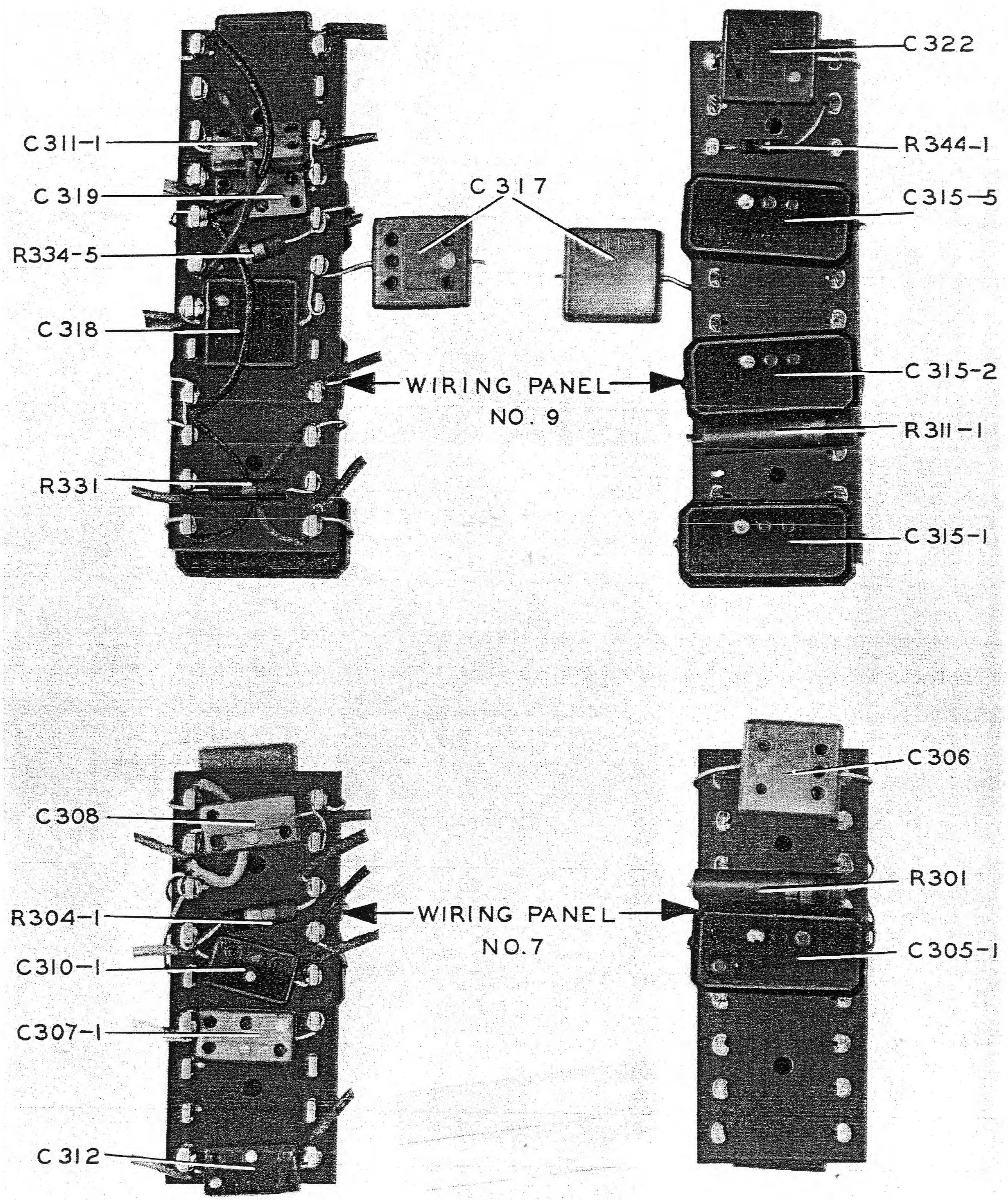


Figure 8-56. Indicator ★ID-6B/APN-4—Panels No. 7 and 9, Wiring Panel Detail (Late)

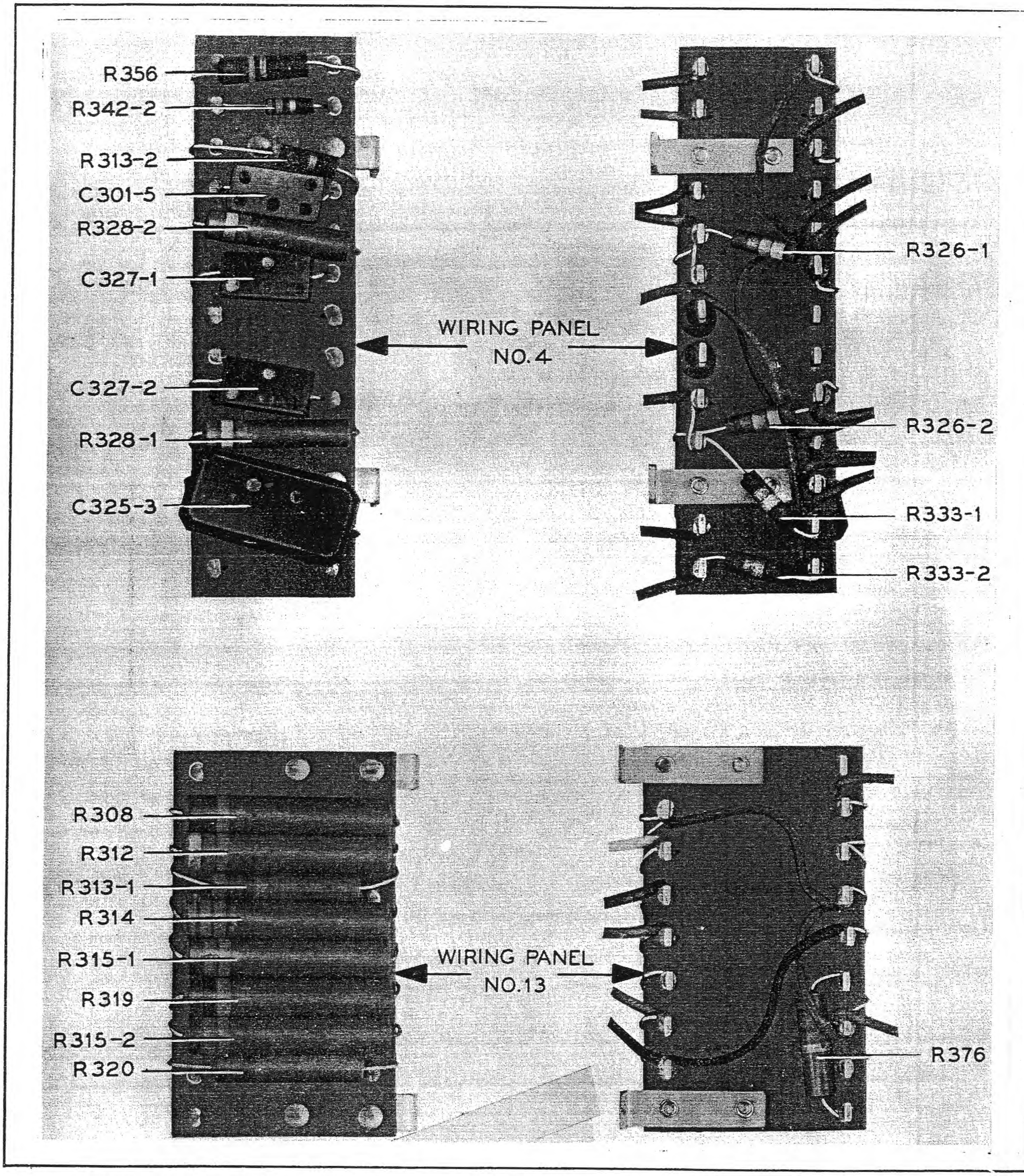


Figure 8-57. Indicator ★ID-6B/APN-4—Panels No. 4 and 13, Wiring Panel Detail (Late)

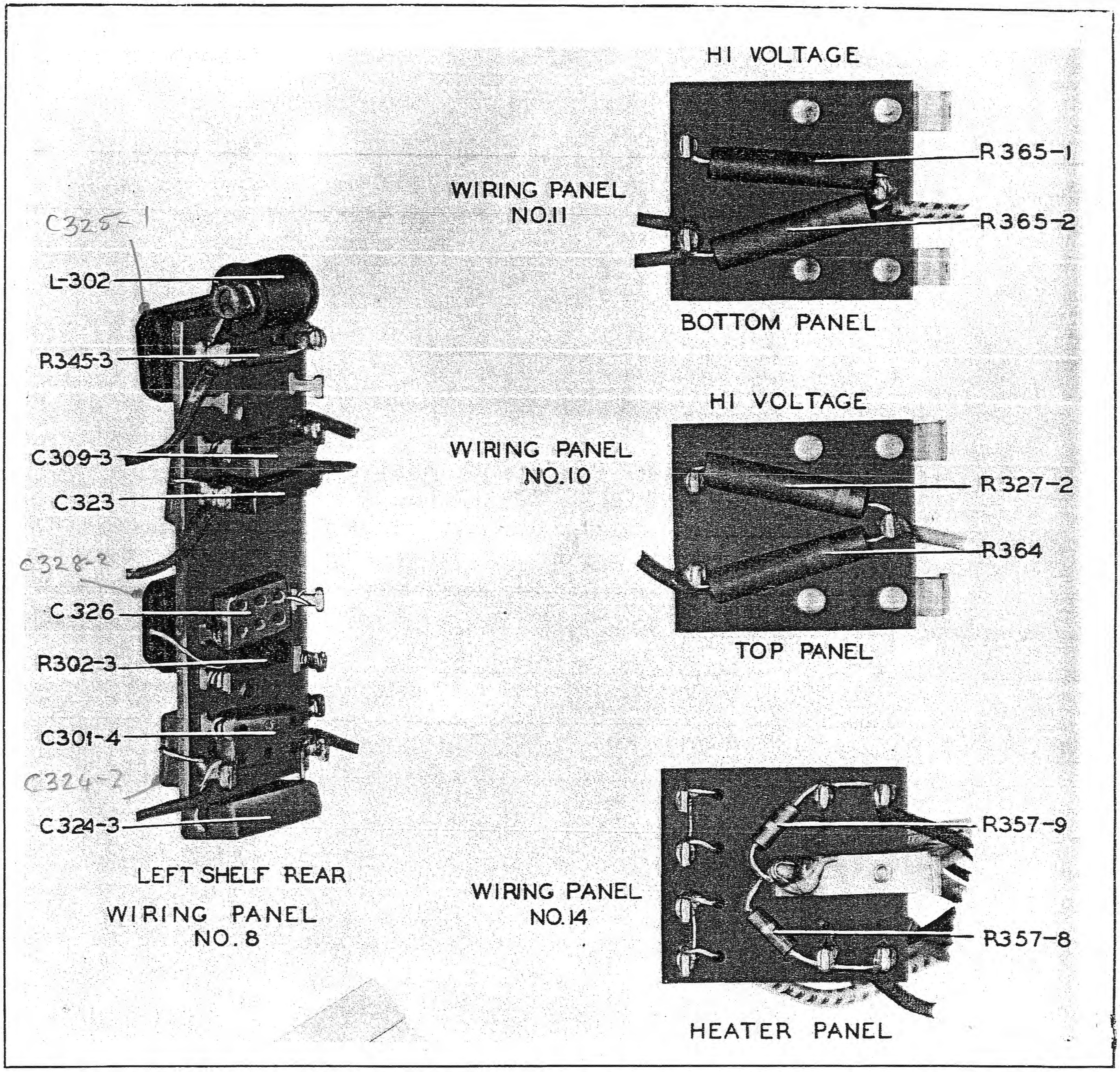


Figure 8-58. Indicator ★ID-6B/APN-4—Panels No. 8, 10, 11, and 14, Wiring Panel Detail (Late)

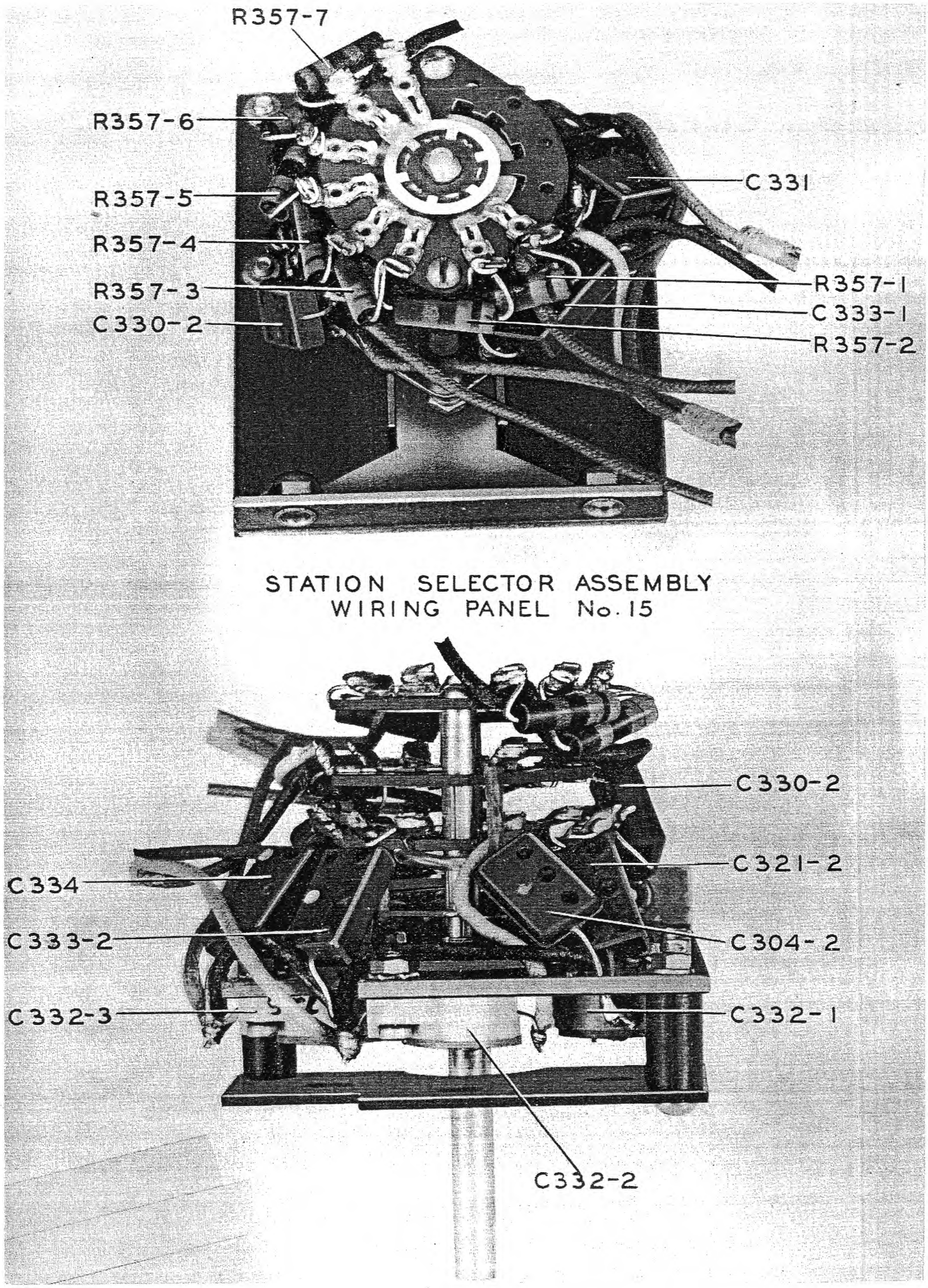


Figure 8-59. Indicator ★ID-6B/APN-4—Panel No. 15, Wiring Panel Detail (Late)

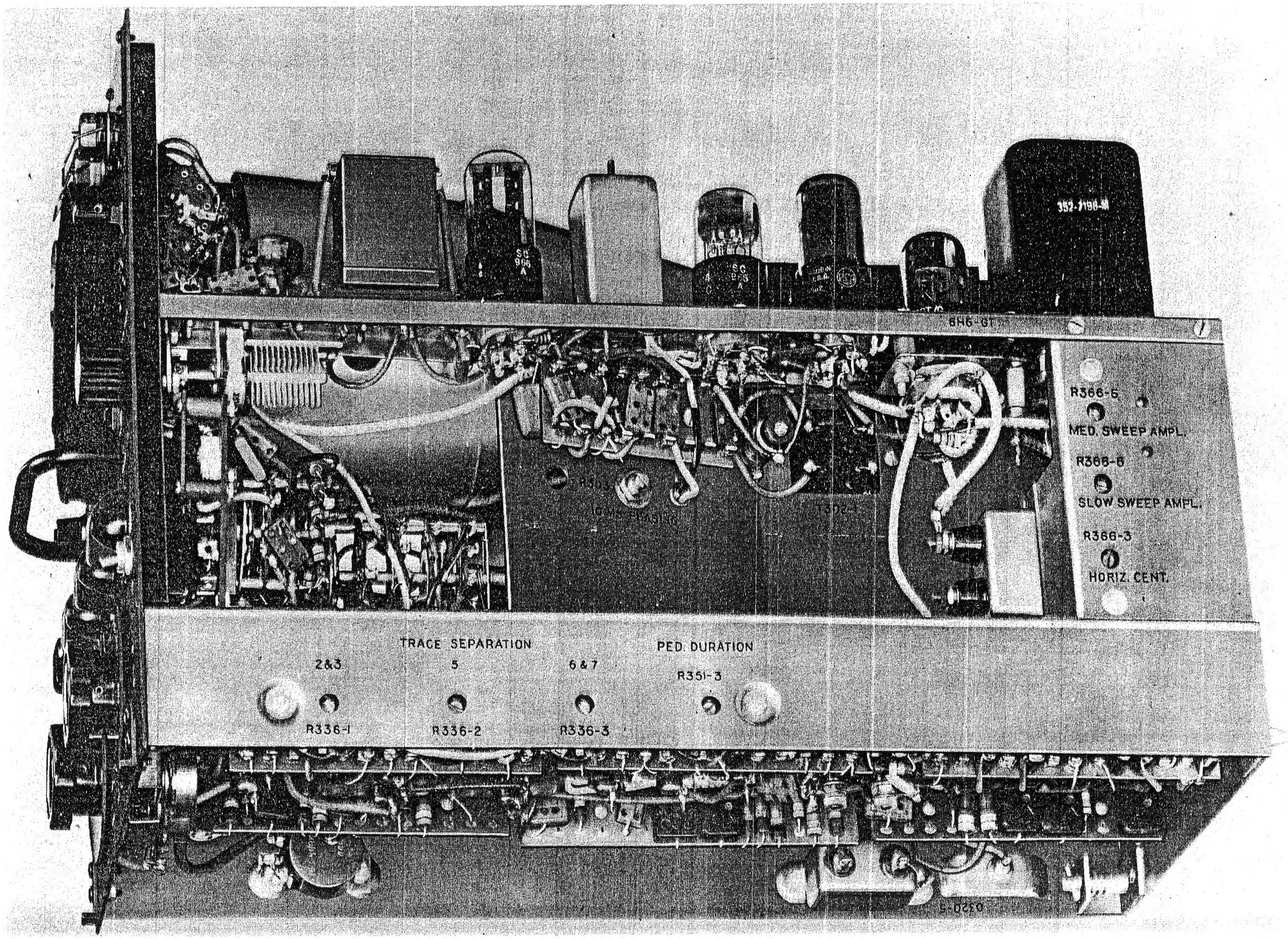


Figure 8-60. Indicator ★ID-6B/APN-4—Right Side View, Showing Location of Auxiliary Controls (Late)

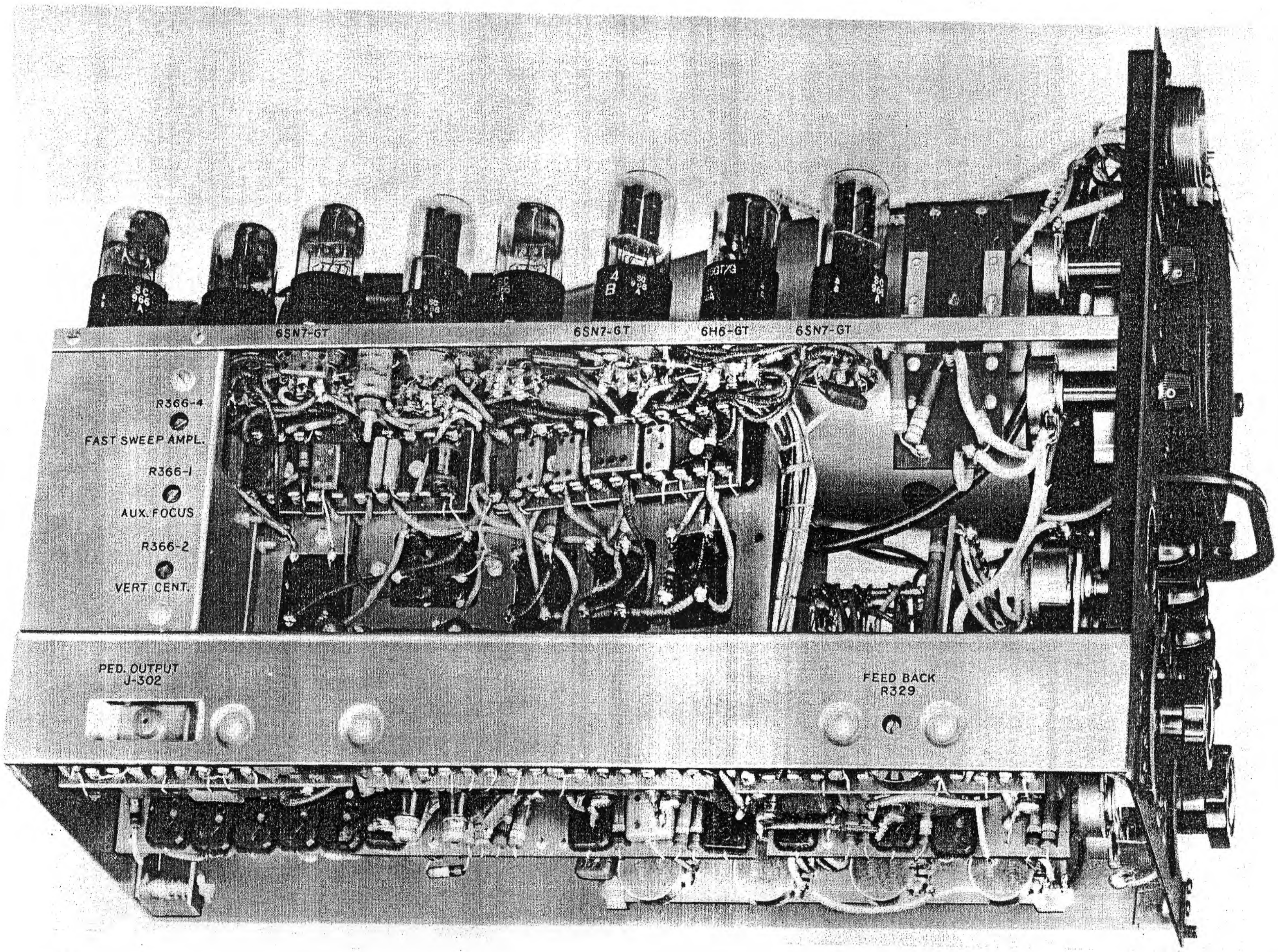
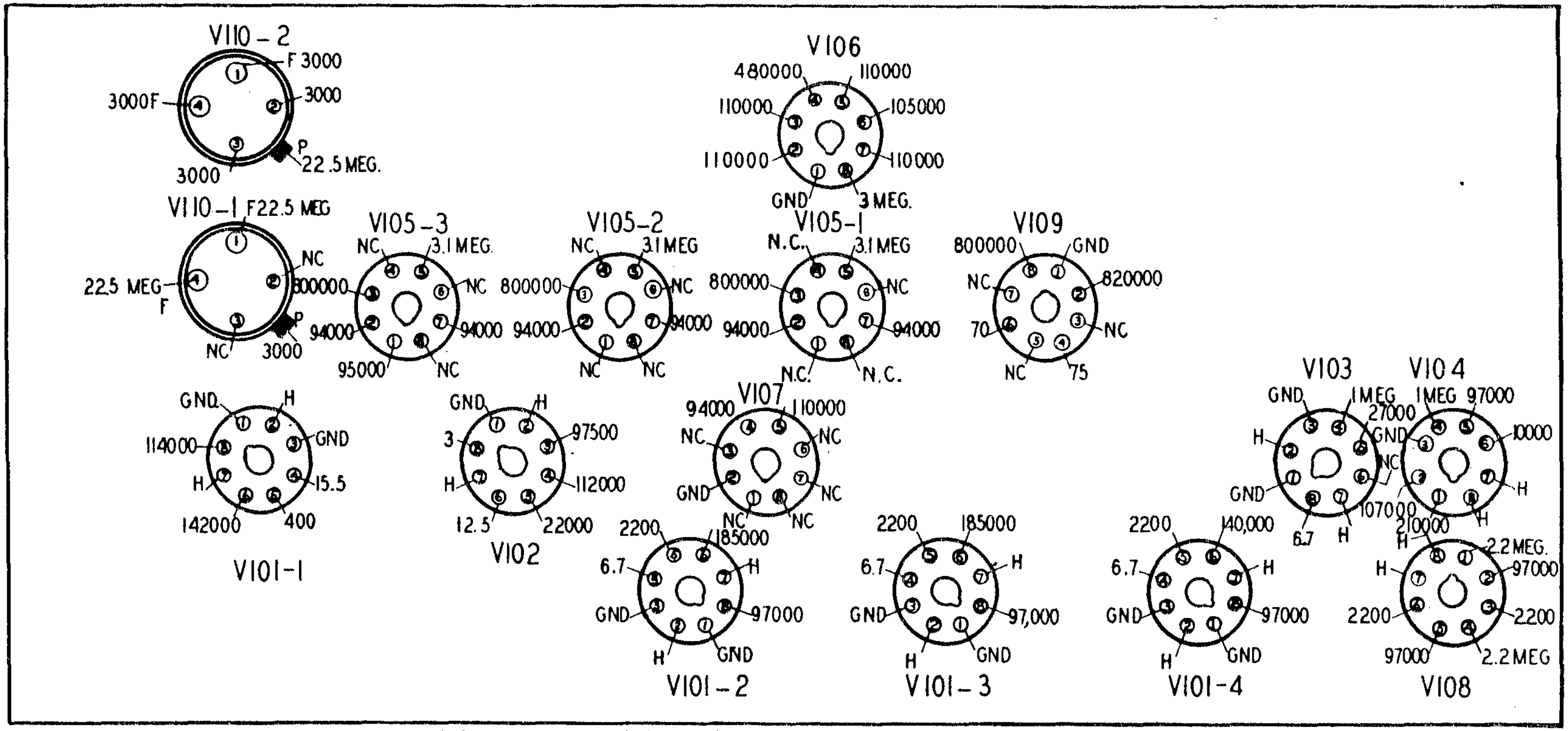


Figure 8-61. Indicator ★ID-6B/APN-4—Left Side View, Showing Location of Auxiliary Controls (Late)



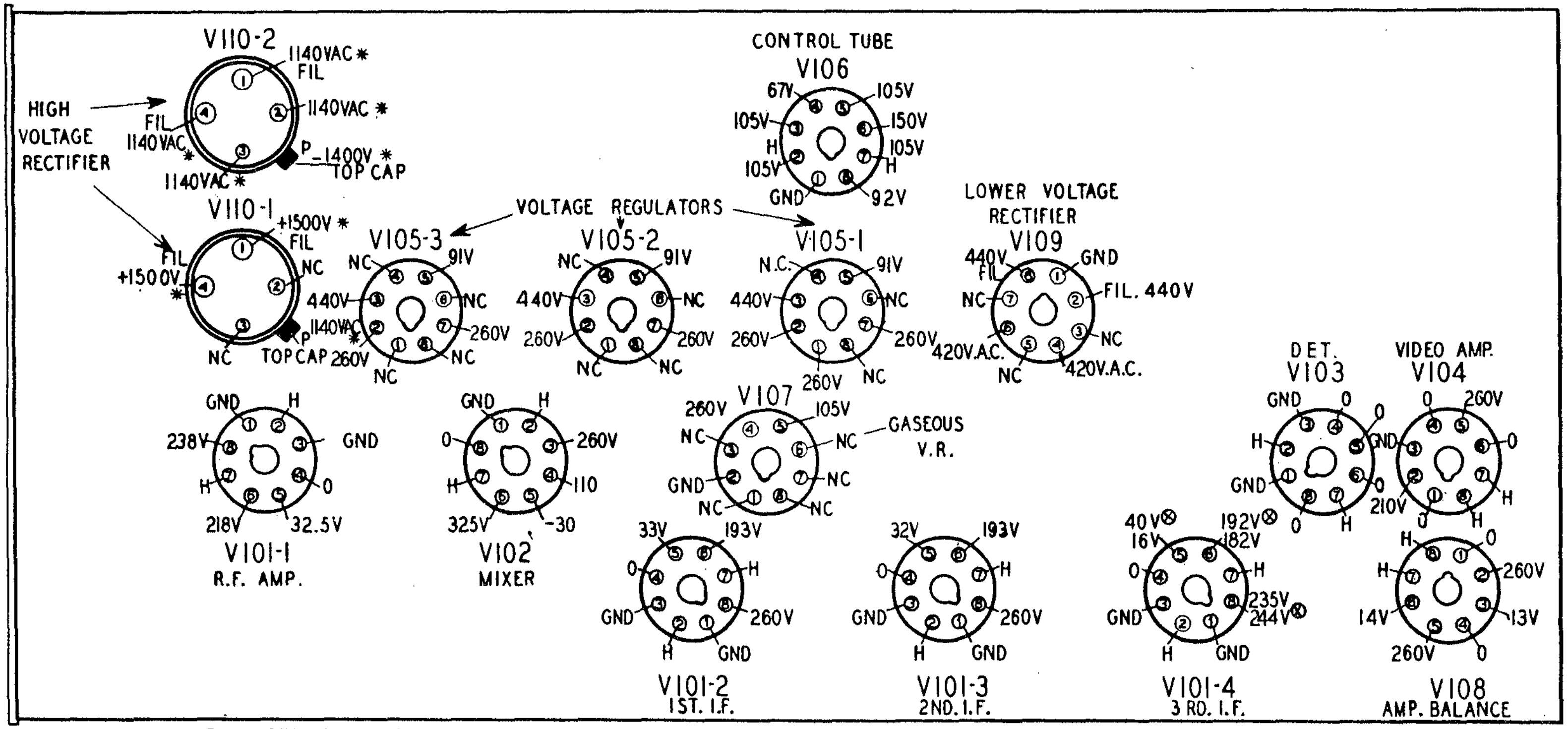
NOTE: GAIN CONTROL R374 LOCATED IN INDICATOR AT MAXIMUM GAIN POSITION.

LEGEND:
FIL. = FILAMENT
GND. = GROUND
H = HEATER
N.C. = NO CONNECTION
P = PLATE

FIGURE
RESISTANCE MEASUREMENTS: SOCKET TERMINALS TO GROUND, RECEIVER ★R-9 A/APN 4

Figure 8-62. Radio Receivers ★R-9A/APN-4 and ★R-9B/APN-4—Resistance Measurements Socket Terminals to Ground (Late)

FRONT PANEL



NOTE: GAIN CONTROL R 374 LOCATED IN INDICATOR AT MINIMUM GAIN POSITION. AMP. BALANCE CONTROL AT CENTER POSITION
VOLTAGES MEASURED WITH 1000 OHM/V METER

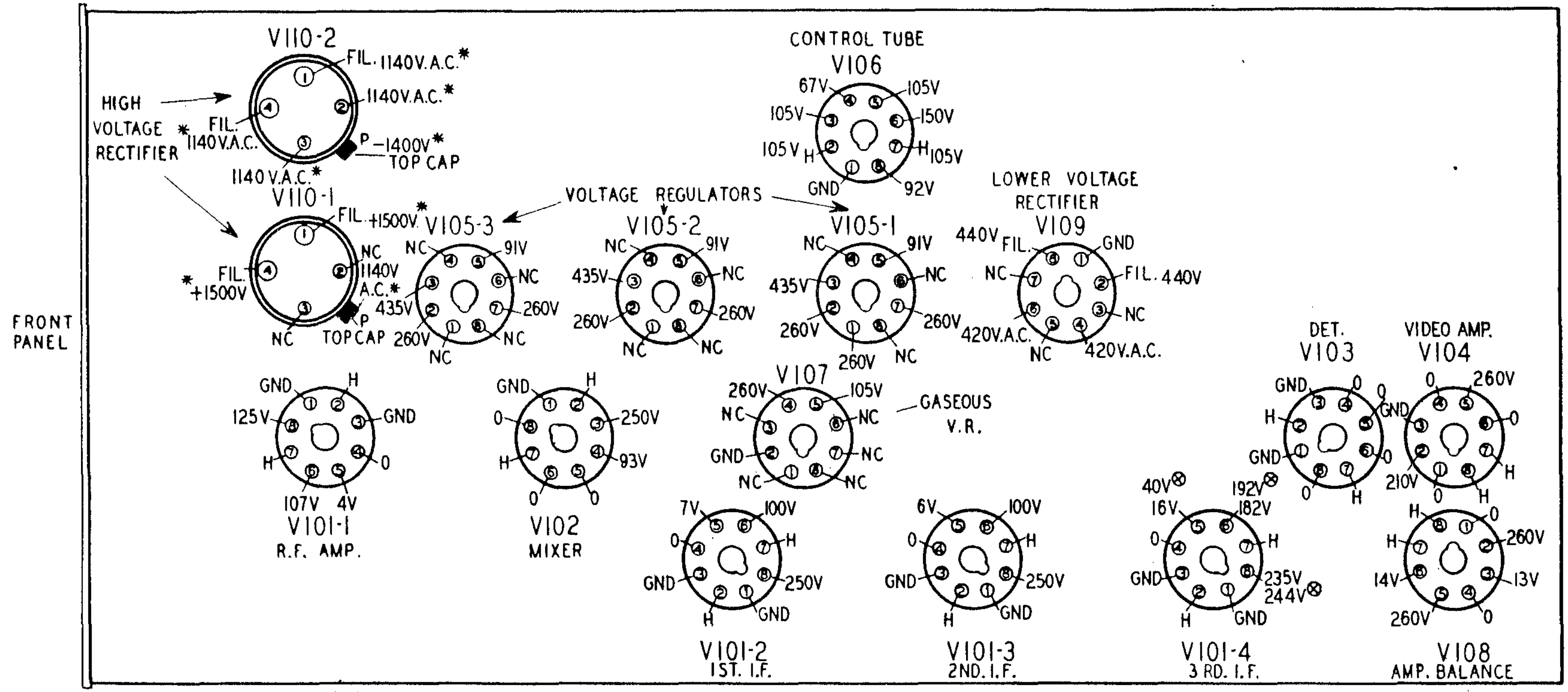
ALL VOLTAGES ARE TAKEN ON 500 VOLT SCALE EXCEPT THOSE INDICATED BY ASTERISKS.

FIGURE SOCKET BASE VOLTAGES, RECEIVER UNIT *R-9A/APN-4

LEGEND:

FIL = FILAMENT
GND = GROUND
H = HEATER
⊗ = AMP. BAL. AT MAX. POS.
NC = NO CONNECTION
P = PLATE

Figure 8-63. Radio Receivers ★R-9A/APN-4 and ★R-9B/APN-4—Socket Base Voltages, Minimum Gain, 1000-Ohm-Per-Volt Meter (Late)



NOTE: GAIN CONTROL, R374, LOCATED IN INDICATOR AT MAXIMUM GAIN POSITION. AMP. BALANCE CONTROL AT CENTER POSITION.
VOLTAGES MEASURED WITH 1000 OHM/V METER.

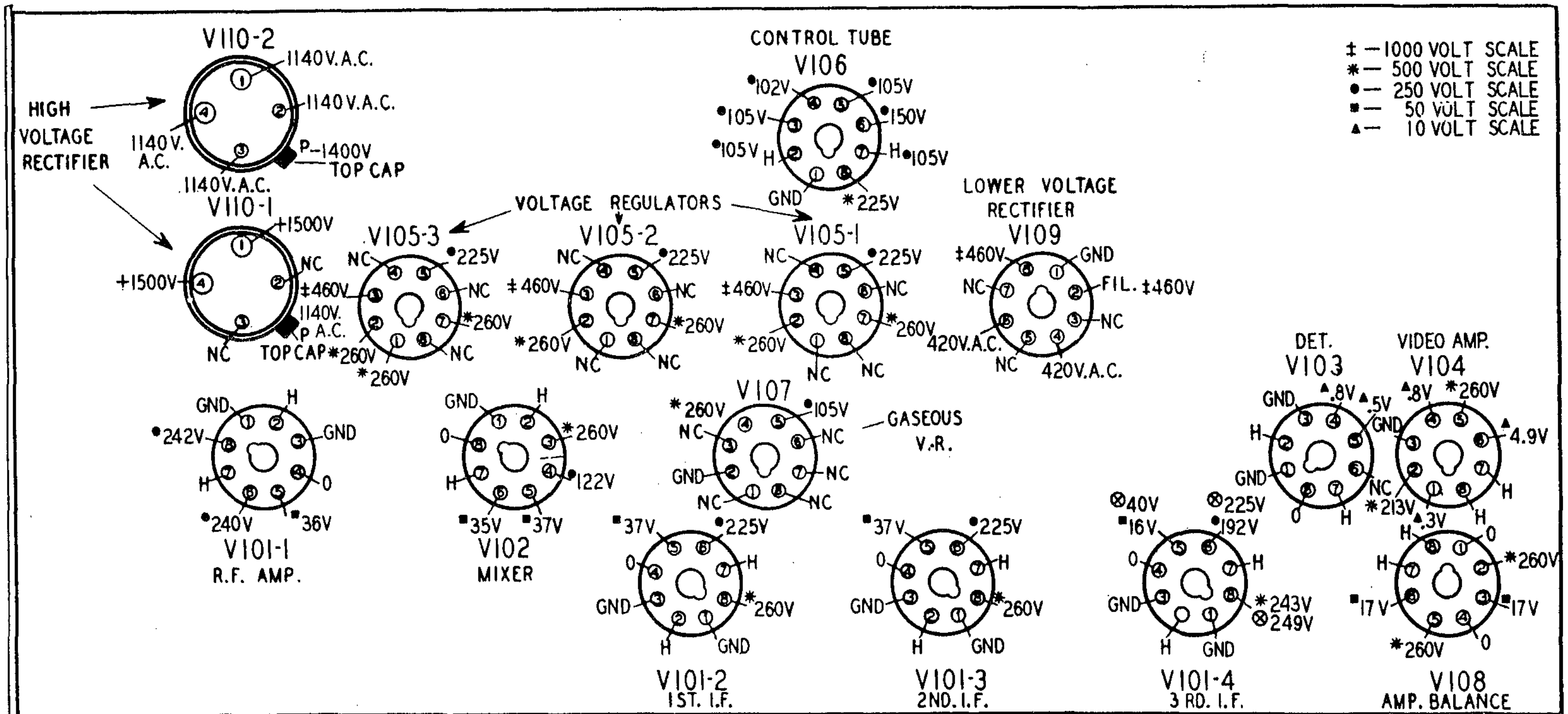
ALL VOLTAGES ARE TAKEN ON 500 VOLT SCALE EXCEPT THOSE INDICATED BY ASTERISKS.

FIGURE SOCKET BASE VOLTAGES, RECEIVER UNIT*R-9A/APN-4

LEGEND:

FIL = FILAMENT
GND = GROUND
H = HEATER
⊗ = AMP. BALANCE AT MAX. POSITION
NC = NO CONNECTION
P = PLATE

Figure 8-64. Radio Receivers ★R-9A/APN-4 and ★R-9B/APN-4—Socket Base Voltages, Maximum Gain, 1000-Ohm-Per-Volt Meter (Late)



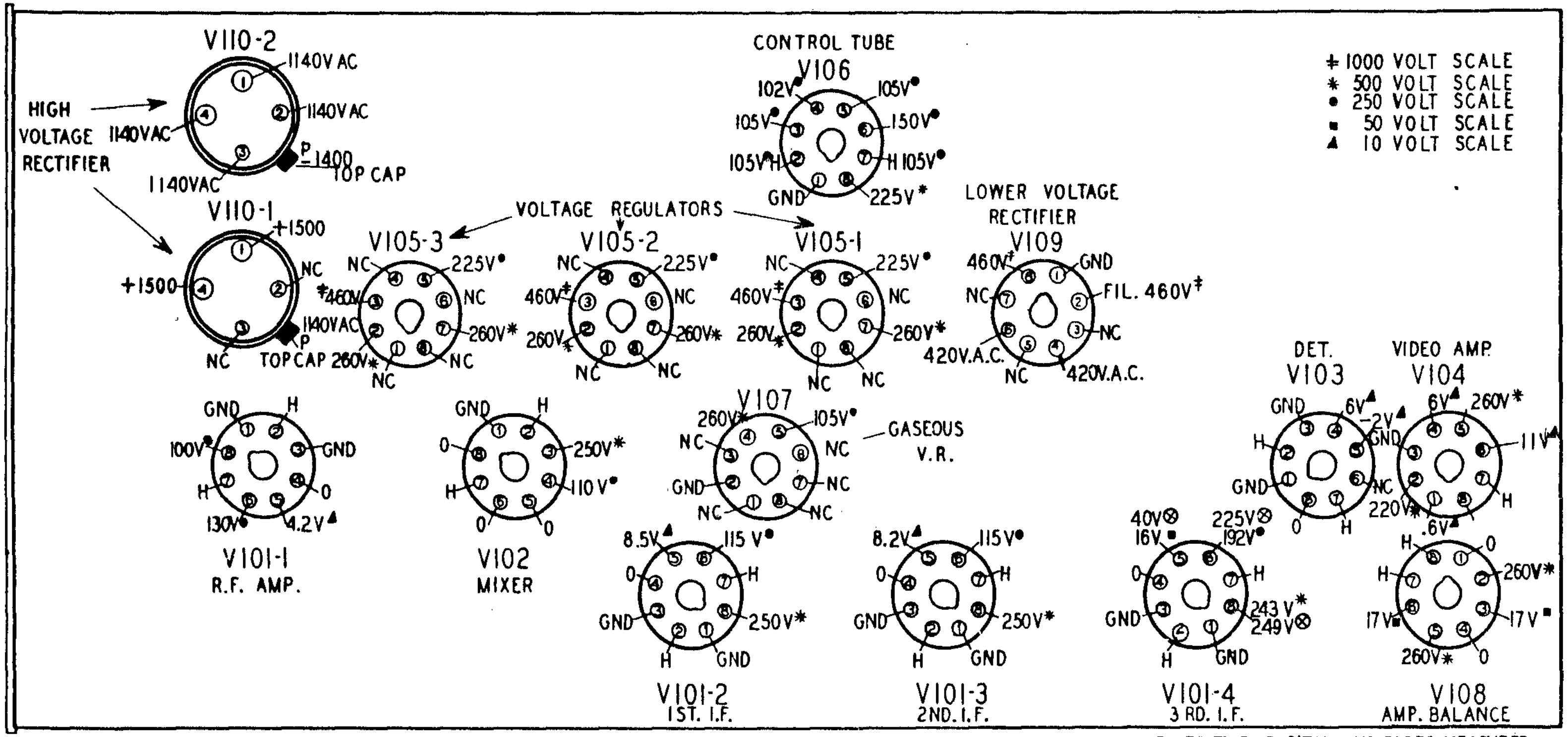
NOTE: GAIN CONTROL, R374, LOCATED IN INDICATOR AT MINIMUM GAIN POSITION. AMP. BALANCE CONTROL AT CENTER POSITION.
VOLTAGES MEASURED WITH 20,000 OHM/V. METER.

FIGURE SOCKET BASE VOLTAGES, RECEIVER UNIT *R-9A/APN-4

LEGEND:

FIL.= FILAMENT
GND= GROUND
H = HEATER
⊗= AMP. BALANCE AT MAX. POSITION
NC= NO CONNECTION
P = PLATE

Figure 8-65. Radio Receivers ★R-9A/APN-4 and ★R-9B/APN-4—Socket Base Voltages, Minimum Gain, 20,000-Ohm-Per-Volt Meter (Late)



NOTE: GAIN CONTROL R 374 LOCATED IN INDICATOR AT MAXIMUM GAIN POSITION. AMP. BALANCE CONTROL AT CENTER POSITION. VOLTAGES MEASURED WITH 20,000 OHM/V METER.

FIGURE SOCKET BASE VOLTAGES, RECEIVER UNIT *R-9 A/APN-4

LEGEND:
FIL = FILAMENT
GND = GROUND
H = HEATER
⊗ = AMP. BAL. AT MAX. POS.
NC = NO CONNECTION
P = PLATE

Figure 8-66. Radio Receivers ★R-9A/APN-4 and ★R-9B/APN-4—Socket Base Voltages, Maximum Gain, 20,000-Ohm-Per-Volt Meter (Late)

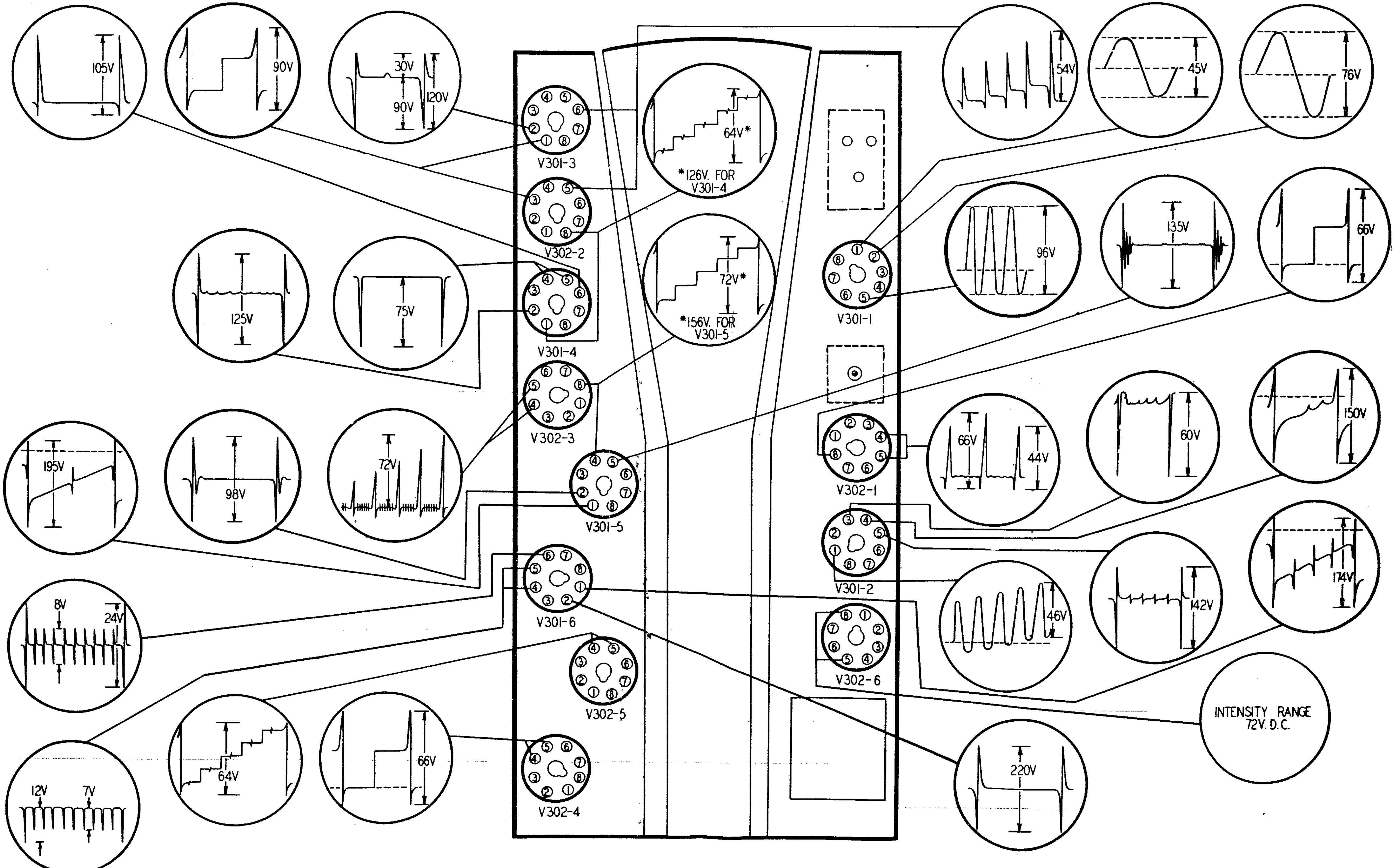


Figure 8-67. Indicator *ID-6B/APN-4—Upper Deck Wave Forms (Late)

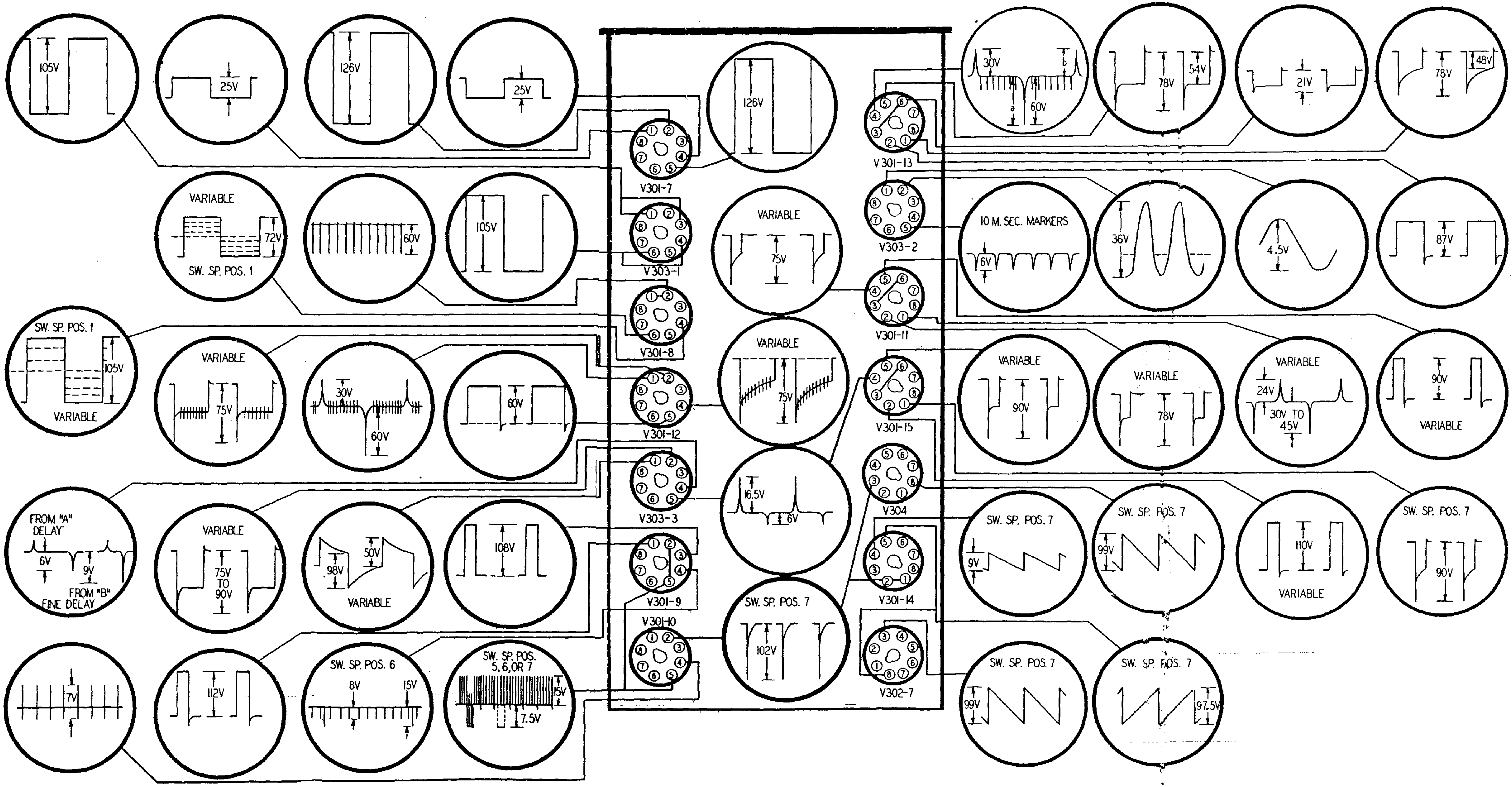


Figure 8-68. Indicator ★ID-6B/APN-4—Lower Deck Wave Forms (Late).

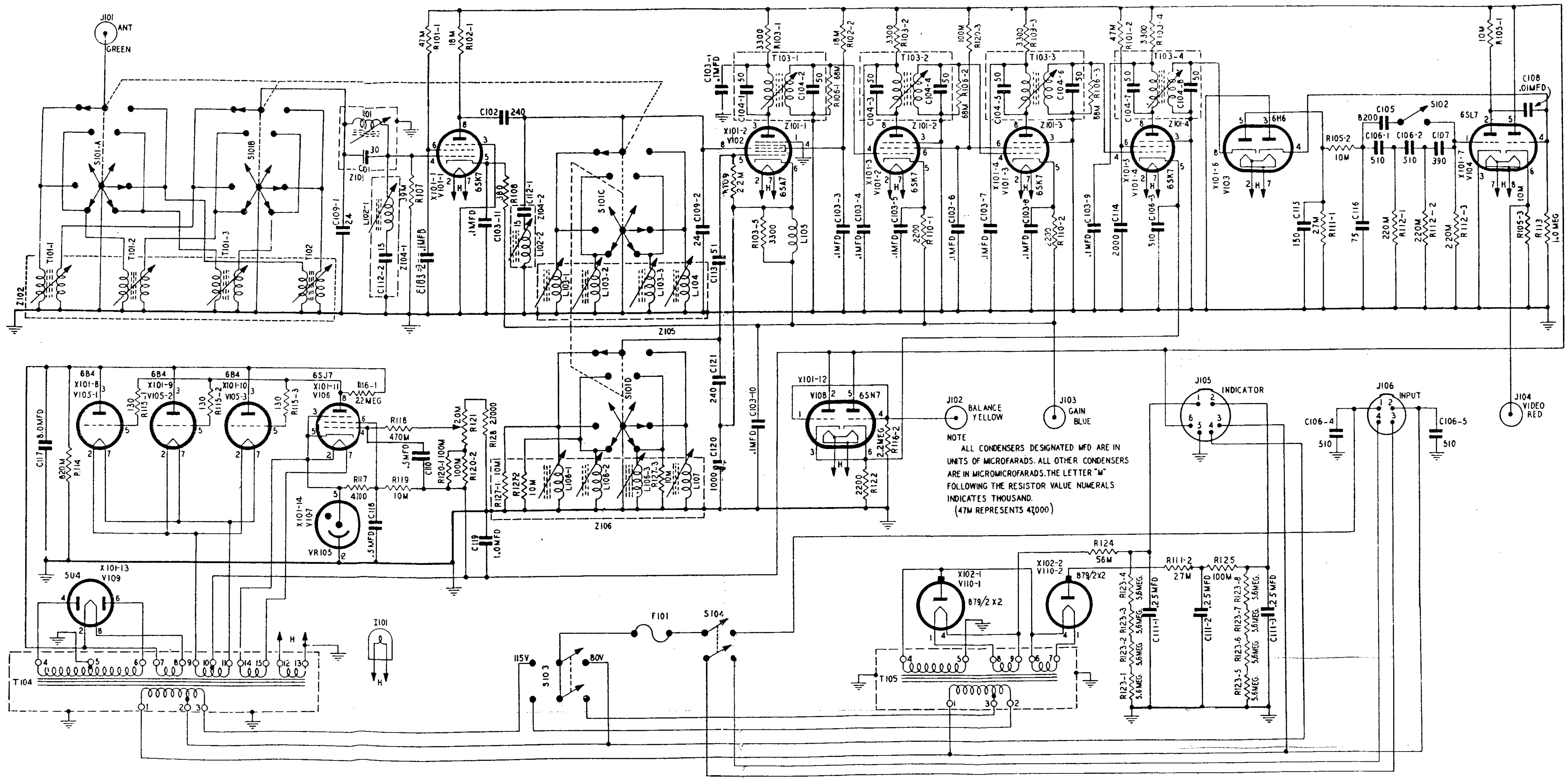


Figure 8-69. Radio Receiver ★R-9B/APN-4 (Modification IV)—Complete Schematic (Late)

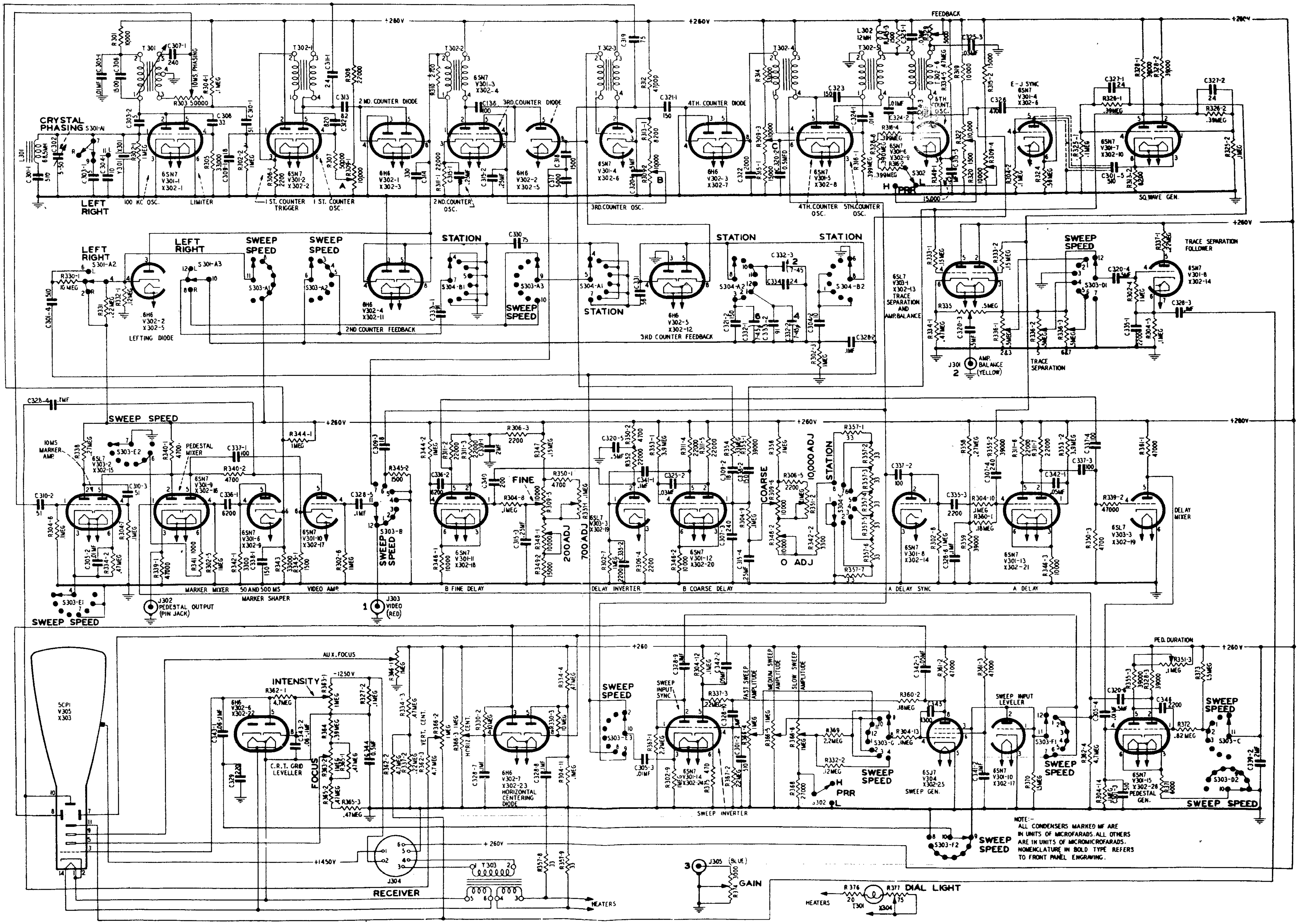


Figure 8-70. Indicator ★ID-6B/APN-4—Complete Schematic (Late)