D. M. E. (INDIA)

TECHNICAL INSTRUCTIONS

DESCRIPTION TELS. R. 08

RADAR A. A. No. 1 Mk. II RECEIVER

GENERAL DESCRIPTION

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RADAR A. A. No. 1 Mk. II RECEIVER

General Description

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GENERAL DESCRIPTION OF APPARATUS AND ITS FUNCTION

1. The A. A. No. 1 Mk. II Receiver comprises the following units :—

(*a*) Three combinations of ultra-short wave dipole aerials for the determination of range, bearing and elevation respectively.

(*b*) An ultra-short wave receiver covering a frequency range of 55 to 85 Mc/s (5·46 to 3·53 meters) and having a band-width suitable for the reception of short pulses of carrier.

(*c*) Three cathode ray tubes connected to the output of the common receiver but used respectively for observations of range, bearing and elevation.

(*d*) Time-base equipment, for each of the above tubes.

(*e*) Calibrating equipment for adjusting the time-base scales.

(*f*) Potentiometer equipment for making accurate measurements on this calibrated time scale, with which is associated transmission equipment for accurately passing out the potentiometer readings (with appropriate corrections) to a remote receiving dial system.

(*g*) A goniometer operating in conjunction with the elevation aerials for determining angular elevation ; a similar transmission gear being incorporated for passing out elevation readings.

(*h*) Rotating-disc shutter mechanism by which the bearing and elevation cathode ray tubes are only exposed to view when registering their appropriate functions.

(*i*) The necessary power units, power distribution, metering and subsidiary arrangements for the above.

(*j*) A cabin mounted on a mobile trailer which houses all the above apparatus including the aerial systems. Mechanical gear, incorporating a transmission device for conveying cabin bearing azimuth readings similar to that used in the range and elevation sections, enables the cabin to be rotated bodily about a vertical axis.

2. The function of the equipment may be briefly summarised as follows :—

A transmitter, located in the immediate vicinity of the receiver, sends out short pulses of carrier. By means of a " locking cable " each carrier pulse at the transmitter is caused to start a time-base stroke on the receiving C.R. tubes. Accordingly any " echoes " received from stationary objects in the neighbourhood appear on the tube screens in fixed positions relative to the start of the time-base. It is therefore possible to determine the range of any such object by timing the interval between the leading edge of the transmitted pulse (which appears at the left-hand end of the time-base trace) and that of the echo pulse.

Accuracy of Determinations Obtainable with Equipment

3. *Range* ±50 yards between 2,000 yards and 14,000 yards.

Bearing ± 1°.

Elevation ± 1° between 15° and 47° elevation under favourable conditions, *i.e.*, level site for radius of 50 yards and freedom from local obstructions. Readings obtainable between 10° and 60°.

The Function of the Cathode Ray Tubes

(Figs. 1, 8 and 43)

4. The right hand tube is employed for this ranging operation, with which is associated the potentiometer and its transmission gear. The potentiometer applies a shift voltage to the time-base trace by means of which any given echo signal is brought on to a cross-wire marking the electrical zero of the tube. The time interval corresponding to this echo is directly deducible from the potentiometer setting. As a range accuracy of ± 50 yards (inclusive of all errors) is required over the range of the main potentiometer (2,000 to 14,000 yards) and ± 200 yards over the extended range (14,000 to 30,000 yards), considerable attention to detail in design has been called for AND IS LIKEWISE REQUIRED IN THE MAINTENANCE OF BOTH ELECTRICAL AND MECHANICAL UNITS AND IN THE OPERATION OF THE EQUIPMENT.

5. The middle tube is employed for determining the bearing corresponding to any particular echo and the left hand tube is employed for determining the elevation of this echo. Both these tubes are mounted behind a disc shutter mechanism (see below).

6. One single receiver suffices for the functions of all three tubes which are permanently connected to the pulse output of the receiver, the range aerial being permanently connected to the R.F. signal input of the receiver (see figs. 34 and 43). The bearing and elevation aerials, however, are connected through the phasing box and goniometer respectively to a motor driven switch, by means of which the signals from them are combined with those from the range aerial alternately in rapid succession in the cycle given below for any single revolution of the switch.

7. *Sector of revolution.*	*Inputs supplied to receiver.*
1st 90°	Range aerial output + resultant from E aerials.
2nd 90°	Range aerial output + resultant from B aerials.
3rd 90°	Range aerial output — resultant from E aerials.
4th 90°	Range aerial output — resultant from B aerials.

It will be seen that the switch not only gives a change-over every 90° but also gives a reversal every 180°.

Optical Viewing Technique

8. In order that the bearing and elevation tubes shall be visible only while working on their own respective functions a disc rotates in front of each tube, both being driven at the same speed as the rotary switch and each having two apertures of 45° placed symmetrically on opposite sides of their centres. The discs are so synchronised with the motor driven R.F. switch that the bearing tube is only visible while the bearing aerials are connected to the receiver and the elevation tube is only visible while the elevation aerials are connected to the receiver.

Image Splitting Arrangement

9. A small rotary drum switch which is synchronised with the disc gear provides electrical pulses which give the pictures on the bearing and elevation tubes a small bodily displacement in the direction of the time-base every alternate half revolution. Everything seen on these two tubes appears double, and by the additional artifice of having orange and green colour filters in the opposite windows of each disc one of each pair of images appears orange while the other appears green.

Determination of Direction

10. The whole cabin is rotated until the aerial system is broadside-on to the incoming signal, when the orange and green pulses appear of equal height. If the cabin is swung slightly clockwise the green pulse increases in amplitude while the orange one decreases. If the cabin is swung anti-clockwise the reverse occurs.

Determination of Elevation

11. The goniometer handle is turned until orange and green pulses on the elevation tube appear of equal amplitude at which setting the elevation of the incoming signal is read. If the goniometer handle is turned slightly clockwise from this position the green pulse will increase in amplitude and the orange one will decrease. If the handle is turned anti-clockwise the reverse occurs.

Searching

12. In making a preliminary search for targets of unknown direction, reception is carried out on the Upper Elevation and Range Aerials combined by turning the colour discs to show green on the E. tube, setting the Elevation Scale to 20° (giving maximum coupling in the goniometer to Upper E. aerial) and turning " R.Ae." switch on the phasing box to " ON ". By means of the " TRANSMITTER INDICATOR " switch the operator in the transmitter cabin may be signalled to switch the transmitter to the Upper, or SEARCH aerial instead of the Lower, or FOLLOW, the latter being much more sharply beamed.

13. It is also possible, however, to use the Lower transmitter aerial for searching since the Mark II Transmitter cabin can be rotated and has an A.C.C.E.—operated dial controlled by the bearing A.C.C.E.'s at the receiver cabin; thus the transmitter operator can rotate his cabin to keep it always turned on the same bearing as the receiver cabin.

Determination of Sense

14. This is carried out on the elevation tube by closing and opening a reflector aerial located in front of the upper elevation dipole. When the system is oriented in the right sense for the incoming signal the pulse image on the tube will be reduced in amplitude when the sense (reflector) aerial circuit is closed. It is important when making the sense determination to use the Upper Elevation Aerial only. As in paragraph 12 preceding, the colour discs are turned to expose the E tube through the green filter and the Elevation scale set to 20°, but the " R.Ae " switch on the phasing box must be set to " OFF." If this latter point is disregarded, incorrect sense will be indicated for targets at elevations above 20°.

15. IN ORDER THAT THE EQUIPMENT SHALL INDICATE ACCORDING TO THE FOREGOING CONVENTIONS IT IS NOT ONLY MOST IMPORTANT THAT THE AERIAL POSITIONS ARE ACCURATE PHYSICALLY BUT THAT ALL AERIAL CABLES, SOCKETS, SWITCHES ETC., SHOULD BE CONNECTED UP IN THEIR CORRECT SENSE (see fig. 34).

16. As there is usually more than one echo pulse on the screen at a time, it is necessary to have absolute correlation between the corresponding echoes on the three tubes. This is automatically effected by means of the potentiometer arrangements which are such that a signal appearing on the zero cross-wires of the Range tube appears also on the cross-wires of the Bearing and Elevation tubes (this simple correlation applies only at the electrical zeros of the tube screens and not at any other part of the screens).

Power Requirements

17. The complete receiving equipment is operated from a 220V. 50 cycle supply. The current taken with everything running normally is about 7·0 amps.

18. A safety device is provided in the form of four gate-switches which cut off the mains supply to H. T. units inside the rack when either of the four detachable back panels are removed from the rack. Auxiliary supplies, such as 50 volt circuit, soldering iron, and fan points are not affected.

Arrangement of Units

19. The equipment is divided into numbered units for convenience of general handling. Fig. 1 provides a key to the location, titles and numbering of the various units. The following schedule summarises the units and their main functions.

SCHEDULE OF UNITS—THEIR TITLES, NUMBERING, FIG. NOS. AND FUNCTIONS

UNIT REF. NO.	CIRCUIT OR FIG. NO.	DESCRIPTION	REMARKS
IA/1	24	C.R.T. Power Supply Unit . .	3,000 V. and heater supplies for all three tubes. Also Variac for mains voltage regulation.
IA/2	16	Bearing and Elevation Time-Base Power Supply.	4,000 V. and screen supplies for time-base.
IB	26	Control and Signal Selector Unit .	Contains control switches, fuses, circuits for A. V. C. and signal selector pulses.

UNIT REF. NO.	CIRCUIT OR FIG. NO.	DESCRIPTION	REMARKS
IC	28	Goniometer Unit	Goniometer, goniometer gearing and transmitters for elevation readings.
ID	22	Elevation C.R.T. Unit . . .	Cathode ray tube for elevation with focusing system.
IE	44	Spares Compartment . . .	Also houses motor and starting switch for disc mechanism.
IIA/1	16	Range Time-Base Power Supply .	4,000 V. and multivibrator H.T. supplies for range time-base.
IIB	14	Time-Base Unit	Includes T.B. unit for range and T.B. unit for bearing and elevation.
IIC	18	Calibrator Unit	Besides calibrator circuits includes delayed switching relay and cathode follower valves of time-bases in IIB.
IID	20	Range and Bearing C.R.T. Unit .	Cathode ray tube for bearing as well as focusing systems for bearing and range tubes.
IIE/1	7	Receiver I.F. Unit . . .	Attached to back of hinged panel.
IIE/2	10	I.F. Power Supply . . .	Fixed in rack near back behind I.F. unit.
IIIA	42	50 volt Transformer . . .	Inside rack. For lighting and operating A.C. Control Elements.
IIIB & IIIC	11, 12a, b & c	Potentiometer	Potentiometer, gearing and transmitters for range readings.
IIID	20	Range C.R. Tube	Range tube only. Associated circuits in IID.
IIIE/1	3	Receiver R.F. Unit . . .	Attached to back of hinged panel.
IIIE/2	5	R.F. Power Supply . . .	Fixed in rack near back behind R.F. unit.
IVC/1	3	Bearing Unit	Bearing gearing and transmitters for bearing readings.
IVC/2	..	Desk Panel	Immediately behind wooden uniting flap.
IVD/1	..	Telephone Box.	
IVD/2	..	Bearing Dial Panel . . .	Bearing dial only.
IVE	..	Spares Compartment.	
..	33b	Disc Mechanism	In front of panels ID and IID. Includes R.F. rotary switch and image splitting switch.
..	30c	Telescope	On extension projecting through L.H. end of rack.

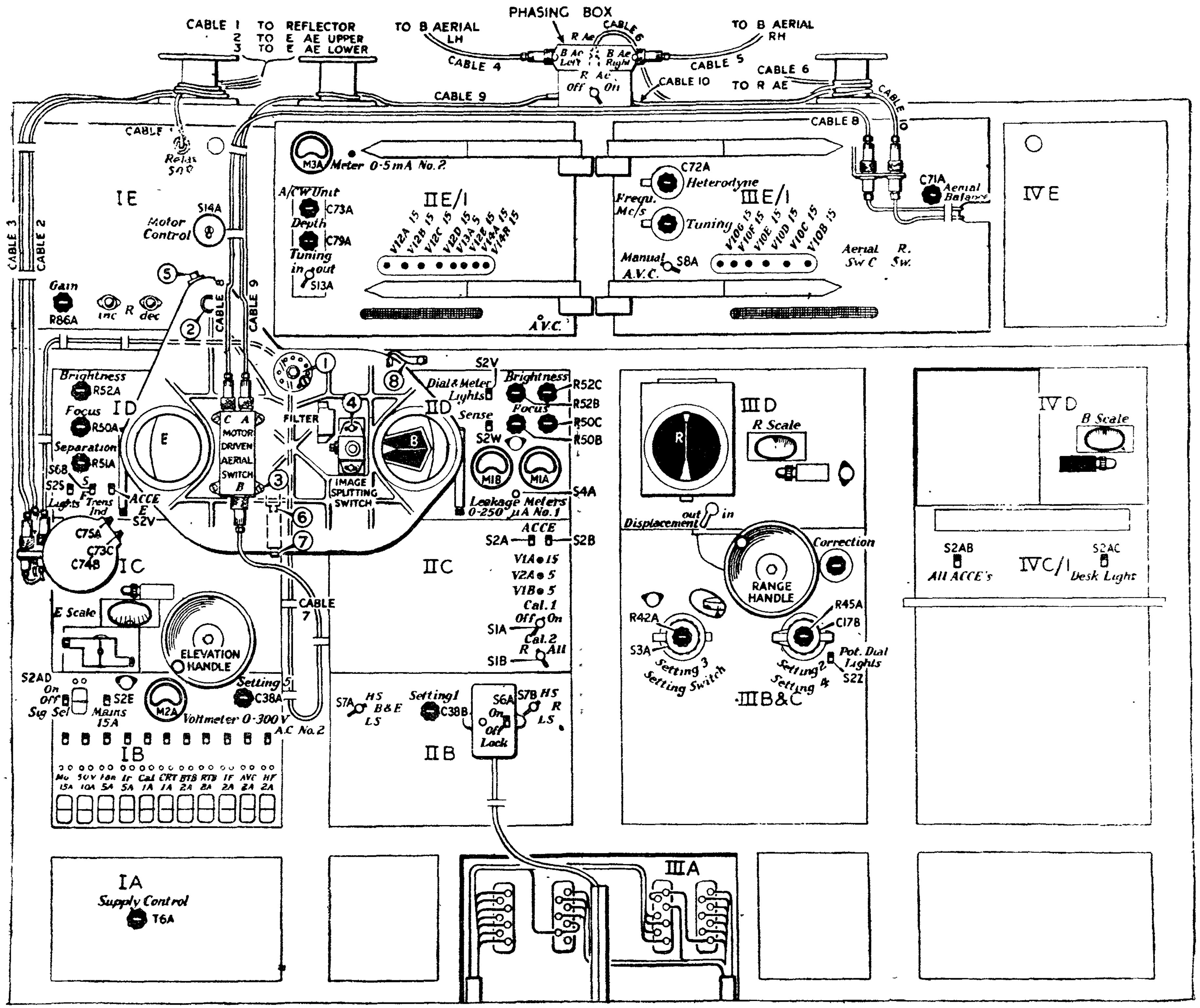
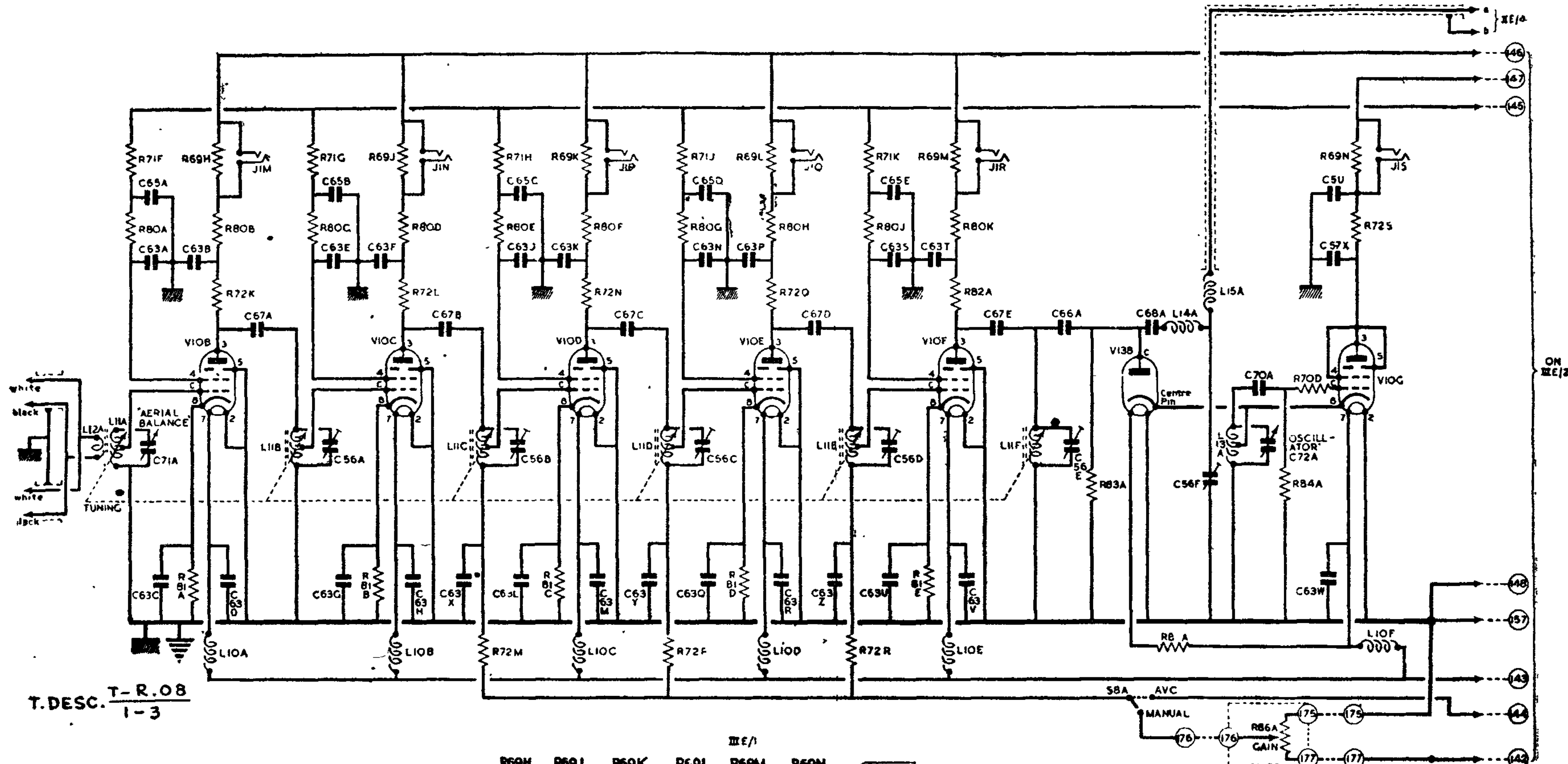
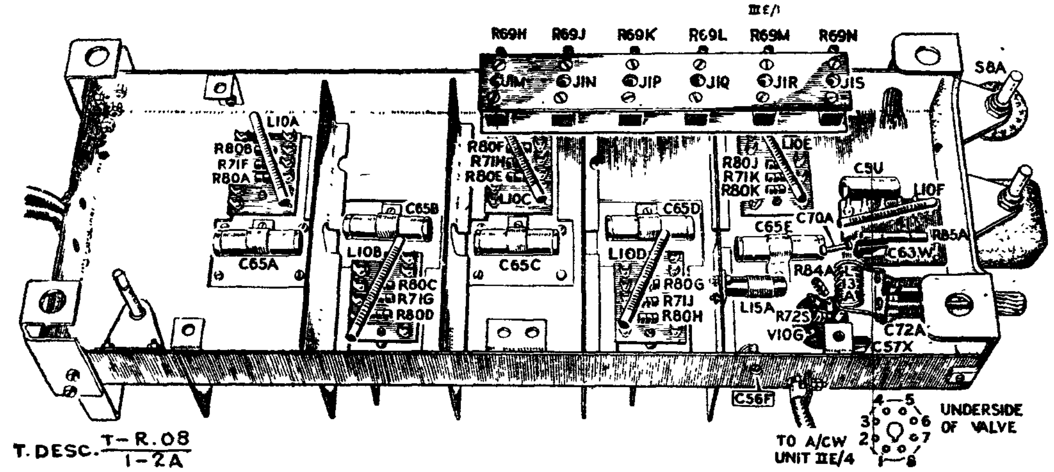


Fig. 1. Front view showing controls and positions of units

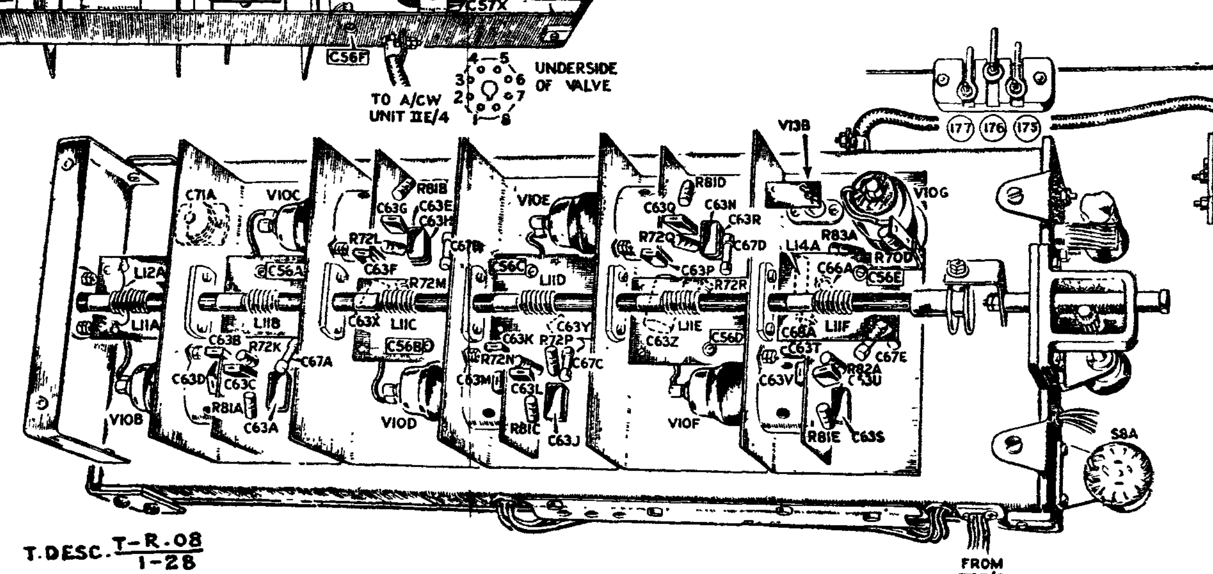


T.DESC. $\frac{\text{T-R.08}}{\text{1-3}}$



T.DESC. $\frac{\text{T-R.08}}{\text{1-2A}}$

FIG. 3 CIRCUIT OF R.F. UNIT III E/1



FIGS. 2A & B RECEIVER R.F. UNIT WITH SCREENS REMOVED

T.DESC. $\frac{\text{T-R.08}}{\text{1-2B}}$

	V10 ARP21	V13 ARD2	
C5 0·05 mfd.	450 V.	R80 2,000 ohms	5% 1/4 W.
C56 3-20 mmfd. Air Trimmer		R81 200 „	5% 1/4 W.
C57 0·001 mfd. Mica	500 V.	R82 1,500 „	5% 1/4 W.
C63 0·0005 mfd.	500 V.	R83 10,000 „	5% 1/4 W.
C65 0·1 mfd.	350 V.	R84 23,000 „	5% 1/4 W.
C66 10 mmfd. 2%	500 V.	R85 10 „	5% 1 W.
C67 0·0001 mfd. 2%	500 V.	R86 1,000 „ Potentiometer	
C68 25 mmfd. 2%	500 V.	L10 Heater Filter Choke.	
C70 50 mmfd. 2%	500 V.	L11 R.F. tuning coil.	
C71 4·5-50 mmfd. Air variable.		L12 Aerial coupling coil.	
C72 4·5-79·5 mmfd. „ „		L13 Oscillator coil.	
R69 7·5 ohms 5%		L14 Filter Choke.	
R70 100 „ 5% 1/4 W.		L15 Band pass filter coil.	
R71 5,000 „ 5% 1/4 W.		J1 Meter Jack	
R72 1,000 „ 5% 1/4 W.		S8 S.P.D.T.	

NOTE.—All limits ± 15% unless otherwise indicated.

Circuit Diagrams

21. The schedule of circuits on pages 3 and 4 together with the interconnection diagram fig. 44 defines the electrical arrangement of the equipment. The block schematic fig. 43 is added by way of clarification ; in this figure all power supplies are omitted for simplicity. All terminals for inter-unit connections are numbered in the circuit diagrams, corresponding numbers on any two different units being connected together. Terminals for inter-unit connections are shown in the circuit diagrams as small circles with their numbers inside them ; this applies to the small 4 BA terminals carried on moulded blocks. Double rings represent highly insulted terminals on individual pillars, while squares represent terminals of condensers used direct for inter-unit connections.

Coding of Components

22. Each component has a code identification of three letters which is not repeated anywhere else. The first letter indicates whether the component is a condenser, resistance, valve, etc., the next figure indicating the type and value and the last letter distinguishing between individual components of identical types and value. For example, R10 is always a 50,000 ohm 2 watt resistance, but as this value may occur at several places in the equipment we find R10A, R10B, R10C, etc. Each circuit diagram carries its own list of components with their electrical values.

RADIO RECEIVER, GENERAL

(Figs. 2-10)

NOTE.—The following instructions apply to Receivers up to and including Serial No. 1339 only. Separate instructions have been issued for all subsequent Serial Nos. as considerable modifications have been made.

23. This superheterodyne receiver covers a frequency band of 55 to 85 Mc/s and uses R. F. as well as I. F. amplification. The over-all band-width is of the order of 3·5 Mc/s so that signal pulses of one or two microseconds duration will be sufficiently faithfully reproduced.

24. The complete receiver is divided into two units, namely, the R.F. Amplifier Unit carried on the back of a hinged panel to the right of the main rack near the top, and the I. F. Amplifier Unit similarly carried on a hinged panel to the left (see fig. 1).

25. This sub-division involves breaking the circuit at the band-pass coupling between the output of the diode mixer on the R.F. Unit and the grid input circuit of the I.F. Unit. As this circuit is made by spring contacts only when both doors are closed the receiver will not function correctly if either door is open. An important point is that this connection between the two units forms part of the coupling capacity of the band-pass circuit and should therefore not be interfered with in any way.

26. R.F. and I.F. units each have their individual power supplies.

27. Two small electric cooling fans are provided situated in the R.F. and I. F. receiver compartment respectively, for reducing the temperature rise due to the heat generated in the operation of these units over long periods. Each fan is supported below a ventilation grill in the top of the compartment. The motors, which are operated at the mains voltage, are connected in parallel with the mains inputs to receiver power units IIE/2 and IIIE/2 so that they start up whenever the receiver units are switched on.

R. F. UNIT TYPE IIIE/1

(Circuit fig. 3. Chassis figs. 2a, 2b.)

28. This unit houses five stages of tuned radio-frequency amplification followed by an oscillator and diode mixer.

Permeability Tuning Arrangements

29. The six signal-frequency tuning circuits are permeability-tuned by cores all carried coaxially on one long rod which can be moved longitudinally in and out of their respective coils by a rack and pinion device controlled from the front panel (see fig. 2). Near to each iron dust core section is a small copper ring section which has the effect of increasing over-all tuning range. When the iron cores are fully inserted in their respective coils, maximum inductance is reached, while a minimum inductance somewhat less than that of the coil alone is reached when the iron cores are right out and the copper sections entered a short distance. A tuning

range of 55 to 85 Mc/s is thus obtained without band switching.

R.F. Coupling

30. Each R.F. stage anode is shunt-fed through a 1,000 ohm resistance, R72K, R72L, etc., which also acts as an effective damping load in parallel with the succeeding tuned circuit, thus maintaining a sufficiently flat response characteristic throughout the amplifier. The gain control, which may be either manually or A.V.C. operated according to the position of switch S8A (figs. 2A and 3). obtained by variation of the bias voltage applied to the grids of the last three R.F. valves. A.V.C. voltage is derived from the final pulse output from the I.F. unit in conjunction with the signal selector system in unit IB. The manual "GAIN" control (R86A) itself is mounted remotely on panel IE to be conveniently accessible to the operator of the elevation controls.

Alignment of Tuned Circuits

31. Small pre-set trimming condensers in parallel with each tuning coil enable the circuits to be lined up to give adequate ganging over the tuning range (C56A, C56B, C56C. etc., figs 2a and 3). The alignment of the intervalve tuned circuits is a factory adjustment which normally should require no further attention. In the event however, of replacement or repair of a coil or condenser, necessitating re-alignment, the following procedure is adopted :—

(*a*) Open the receiver doors and bridge the spring contacts temporarily with clip leads (this may affect stability).

(*b*) Connect AVC line to chassis.

(*c*) Disconnect blue (oscillator H. T.) lead. Connect 250 μA meter in mixer diode load R83A circuit (not No. 2 meter jack for V13A). To do this it is necessary to unsolder the earth end of R83A.

Check coils to ensure that the dust core, or the copper ring occupies exactly the same position relative to each coil, except L11A which should be 1/8″ nearer to the oscillator end of the chassis. Disconnect the V10B grid lead and inject 86·5 Mc/s into this valve. Set the tuning rod for minimum inductance (copper ring to centre of coil) using L11F as reference. Adjust all trimmers C56 A.B.C.D. and E, for maximum output. Check that range coverage is from 55-85 Mc/s.

Adjustment of Oscillator

32. Reconnect blue Osc. H. T. lead leaving the signal generator connected to V10B grid, inject a modulated or unmodulated signal at 32·2 Mc/s or 64·4 Mc/s with a pair of phones connected in place of the diode meter in series with R83A (the use of an absorption wave meter is the alternative). Release the worm on the oscillator drive, and turn the condenser control fully clockwise until a beat note is heard with the condenser vanes approx. 1/3 engaged. Holding the tuning spindle and the condenser, lock the worm on the shaft.

Reset the signal generator to 21·8 or 43·6 Mc/s and turn the oscillator tuning control anti-clockwise to the opposite end of its travel. Adjust the spacing of the turns on the oscillator coil until another beat is heard. It is necessary to repeat the above operations to obtain the required oscillator range coverage. For unit serial numbers after and including No. 1340, the following procedure is to be adopted.

(*a*) Connect signal generator between V10F grid and earth (having first disconnected existing grid lead.)

(*b*) Connect amplifier provided for the purpose between earth end of R83A and earth. (An absorption wavemeter is the alternative method.)

(*c*) Set R. F. tuning dial to 55 Mc/s, and inject 48·5 Mc/s by means of signal generator, with attenuator at maximum output.
Release the worm on the oscillator drive and turn condenser control fully clockwise until a beat note is heard with the condenser vanes approximately 1/4 engaged. Holding the tuning spindle and the condenser lock the worm on the shaft, making sure that the oscillator dial is in the maximum clockwise position.
Rest the signal generator to 63·0 Mc/s and reset. R.F. dial to this frequency. Turn the oscillator tuning control anti-clockwise to the opposite end of its travel. Adjust the spacing of the turns on the oscillator coil until another beat is heard. It is necessary to repeat the above operations to obtain the required oscillator range coverage.

Sensitivity of R.F. Unit

33. This may be checked after alignment as above by applying an unmodulated signal generator to successive grids (removing the grid cap in question) and inserting a D.C. micrometer in series with the load resistance R83A of the diode V13B (fig. 3). The following results should be obtainable :—

FREQUENCY Mc/s	VALVE GRID INJECTED AT	INJECTED VOLTAGE	DIODE (V13B) CURRENT INCREASE ABOVE STANDING CURRENT
55	V10B	3 mV	100 microamps
70	,,	3·5 mV	100 ,,
85	,,	6·2 mV	100 ,,
55	V10C	15·9 mV	100 ,,
70	,,	10 mV	100 ,,

FREQUENCY Mc/s	VALVE GRID INJECTED AT	INJECTED VOLTAGE	DIODE (V13B) CURRENT INCREASE ABOVE STANDING CURRENT
85	V10C	17·8 mV	100 Microamps
55	V10D	28 mV	100 „
70	„	26·5 mV	100 „
85	„	47·5 mV	100 „
55	V10E	100 mV	110 „
70	„	100 mV	100 „
85	„	100 mV	85 „
55	V10F	100 mV	40 „
70	„	100 mV	35 „
85	„	100 mV	35 „

Valve V13A diode load resistance R83A is disconnected and microammeter inserted in series with resistance to E. Also disconnect H. T. + to V10G to obtain these figures.

OSCILLATOR

34. This is tuned by a separate control labelled "OSCILLATOR" on the front right-hand panel (fig. 1) and operates at a lower frequency than would normally be required, harmonics being used to beat with the incoming signals.

35. For a signal frequency of 55 Mc/s the 2nd harmonic of the oscillator is used and is kept 9·5 Mc/s on the low frequency side of the signal. For signal frequencies of 60-85 Mc/s the 3rd harmonic of the oscillator is used and is kept 9·5 Mc/s different, but on the high frequency side of the signal.

36. Thus the fundamental frequency of the oscillator must cover an overall band of at least 22·75 to 31·5 Mc/s, and in order to allow for variation of valve capacity, drift, etc. the actual coverage is 21·8 Mc/s to 32·2 Mc/s.

37. The "OSCILLATOR" control is calibrated in terms of signal frequency every 5 megacycles. If the oscillator valve is changed the calibration of the "OSCILLATOR" dial may be affected.

This description of the functioning of the oscillator applies only to units after and including Serial No. 1340.

(*a*) The oscillator operates on second harmonic only over the whole band, and is kept 9·5 Mc/s on the high frequency side of the signal.

(*b*) Thus the fundamental frequency must cover an overall band of at least 32·25 to 47·25 Mc/s but in order to allow for variation of valve capacity, drift, etc., the actual coverage is from 31·5 to 48·5 Mc/s.

(*c*) The "oscillator's control is calibrated in terms of signal frequency every 5 megacycles. If the oscillator valve is changed the calibration of the oscillator dial may be affected.

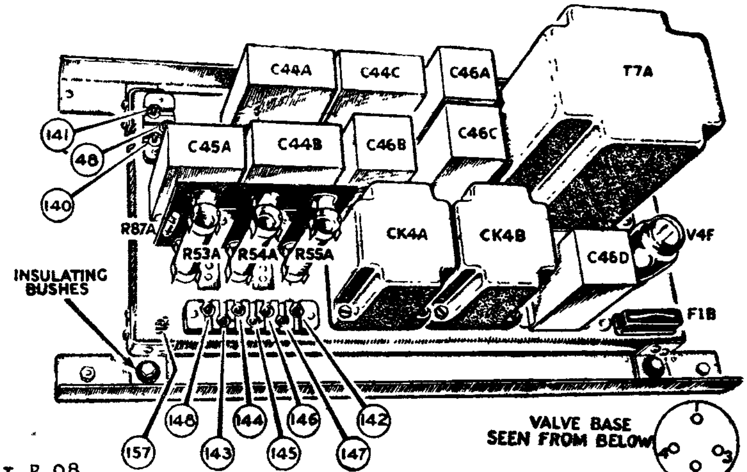
Currents and Voltages in R.F. Unit IIIE/1

38. *Currents* :

VALVE TEST JACK	METER USED	METER READINGS	ACTUAL CURRENT	CONDITIONS OF TEST
V10B	M3A (0-5mA)	2 mA	6 mA	70 Mc/s Gain at Max.
V10C	„	1·9 mA	5·7 mA	„
V10D	„	1·8 mA	5·4 mA	„
V10E	„	1·7 mA	5·1 mA	„
V10F	„	2·2 mA	6·6 mA	„
V10G	„	4 mA	12 mA	Oscillating
V10G	External		38 mA	Not Oscillating.

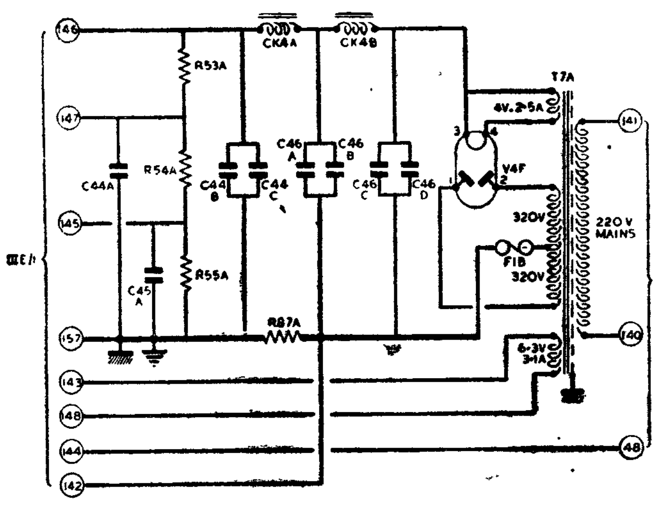
39. *D. C. Voltages.*

TEST POINTS	VOLTMETER LOADING
R.F. anodes (V10B, C, D, E. F) to chassis	+280 volts.
R.F. screens (V10B, C, D, E, F) to chassis	+85 „
R.F. cathodes (V10B, C, D, E, F) to chassis	+1·3 „
Oscillator anode (V 10 G) to chassis, oscillating	+147 „
Oscillator anode (V10G) to chassis, not oscillating	+103 „



T.DESC. T-R.08 / 1-4

FIG 4 POWER SUPPLY UNIT III E 2 FOR R.F UNIT



T DESC. T-R.08 / 1-5

FIG. 5 CIRCUIT OF UNIT III E/2

V4 AU3

C44	8 mfd.	400 V.	R55	2,500 ohms 2%
C45	8 mfd.	250 V.	R87	50 „ 5% 1 W.
C46	4 mfd.	500 V.	CK4	9H 100 mA D.C.
R53	2,400 ohms	2%	T7	Mains transformer.
R54	1,080 „	2%	F1	0·5 A.

NOTE.—All limits are ± 15% unless otherwise indicated.

R.F. POWER SUPPLY UNIT III E/2.

Circuit fig. 5, chassis fig. 4

40. This is near the back of the compartment which houses the R.F. Unit itself and provides :—

(a) 6·3 volts A.C. for cathode heaters.
(b) 325 volt output for anodes of R.F. valves (terminal 146).
(c) 115 volt output for screens of R.F. valves (terminal 145).
(d) 170 volt output for anode of oscillator valve (terminal 147).
(e) 5 volt output for grid bias (terminal 142).

41. The circuit is conventional. A single transformer T7A has three secondaries for rectifier heater, receiver heaters and H. T. respectively, the full-wave rectifier valve V4F, which provides sufficient current and voltage for all outputs, being followed by two stages of smoothing commencing with paper reservoir condensers C46C/D. The resistances R53A, R54A, R55A constitute the voltage divider network.

42. A 500 mA fuse F1B in series with the centre tap of the H.T. winding of the transformer protects the H.T. supply from overload.

3. The negative end of the H.T. on this power unit connects to chassis, but the chassis itself is isolated from earth by insulating bushes where the angle-feet are bolted to the main supporting members. Thus the only actual earth for this unit is at the R.F. Unit.

I.F. UNIT II E/1

(Circuit fig. 7. Chassis figs. 6a, 6b)

44. This unit comprises five stages of I.F. amplification, and a diode second detector feeding two independent L. F. output amplifier valves. One of these output valves operates the Range cathode-ray tube, the other operating the Bearing and Elevation tubes as well as the A.V.C. circuits.

45. Inter-stage couplings are simple tuned circuits composed of inductances adjusted by brass plungers and parallel fixed condensers. Each I.F. amplifier anode is shunt-fed through a resistance such as R21N which also acts as a shunt damping resistance for the tuned circuit following it.

46. The gain of the I. F. amplifier can be adjusted by means of the variable resistance R66A which controls the bias of the first two I. F. stages. This is an internal pre-set adjustment to bring the I. F. gain to a fixed pre-determined level (see below) when the unit is first put into commission and is locked at its setting by the screw in the metal clamp which grips the spindle of the variable resistance.

47. On all equipments the two fixed resistances R84B and R73F are replaced by a single variable potentiometer R101A having a total resistance of 100,000 ohms (see fig. 6C). This is adjustable by means of a screw driver through a hole provided in the bottom right-hand corner of the front panel of unit IIE/1. See fig. 6C. The output network composed of R101A, C68B and R30AA is not actually on the I. F. Unit chassis but is located on a paxolin panel on the fixed part of the main rack just beneath the I.F. Unit. This panel also carries a pair of phosphor bronze contact springs which complete the output circuits when the door is closed.

Anti-C.W. Unit

IIE/4

48. This unit is incorporated in the I. F. unit which is at the right-hand end looking from the back (see figs. 6a, 6b) and is essentially a rejector network operating in the I.F. band to give a high attenuation at one frequency which is adjustable by condenser C79A. Thus the carrier of an interfering C.W. signal can be very much reduced in proportion to the required pulse signal. Electrically the unit is in series with the screen lead connecting the input of the I.F. Unit to the output of the R.F. Unit. The switch S13A (figs. 6b and 7) cuts the unit out of operation when desired. Inject a modulated or unmodulated signal either from a signal generator or a test oscillator and set the manual gain control to give a reading of 250 μA on the diode meter.

Check that when the A/CW unit is switched in and tuned for maximum cut, that the current falls to approx. 10 mA.

Staggering of I. F. Circuits

49. To obtain the necessary width of frequency response the intervalve tuning coils are adjusted by means of their screw plungers. With unmodulated input to V12A the circuits are tuned (using V13A Jack) for maximum output as follows.

L9A	with	input	of	9·25	Mc/s.
L8B	,,	,,	,,	8	Mc/s
L7B	,,	,,	,,	11	Mc/s
L8A	,,	,,	,,	8	Mc/s
L7A	,,	,,	,,	11	Mc/s

Band Width of I. F. Unit:

50. With an unmodulated input at 9·5 Mc/s, applied to the grid of V12A, and an increase in diode (V13A) current of 65 microamperes, the input should be increased by 6 db and the frequency varied on each side of 9·5 Mc/s to restore the increase to 65 microamperes.

51. The difference between the two new readings, i.e. the band-width, should not exceed 4·2 Mc/s. Similarly the band-width at20 db down must not be greater than 5·6 Mc/s. Under the above conditions the response curve should be flat from 8·25 Mc/s to 10·75 Mc/s within 3db,-1db with respect to the input at 9·5 Mc/s. To adjust the Band pass filter, connect a ·001 μF condenser temporarily across the I.F. input terminals and inject a signal at 8·2 Mc/s into the V13B anode lead (with the lead disconnected from the diode).

Adjust C56F and G for maximum output.

Overall Band Width of Complete Receiver

(Unit III E/1 coupled to Unit II E/1).

52. First set I.F. gain control as follows: Tune Receiver to 70 Mc/s and set R.F. gain control to max. Note the amount of noise on the Range Cathode Ray tube, open the I.F. panel door and adjust R66A so that the noise is reduced to approx. 1/4".

The I.F. door must be closed before signals or noise will appear on the range tube.

53. The band-width for a reduction in sensitivity of 6 db must be within the limits of 3·0 Mc/s to 3·6 Mc/s at 70 Mc/s and 85 Mc/s. For a reduction of 20 db the band-width must be within 4·2 Mc/s to 4·5 Mc/s at 70 Mc/s, and within 4·3 Mc/s to 4·5 Mc/s at 85 Mc/s.

V12 ARP 19

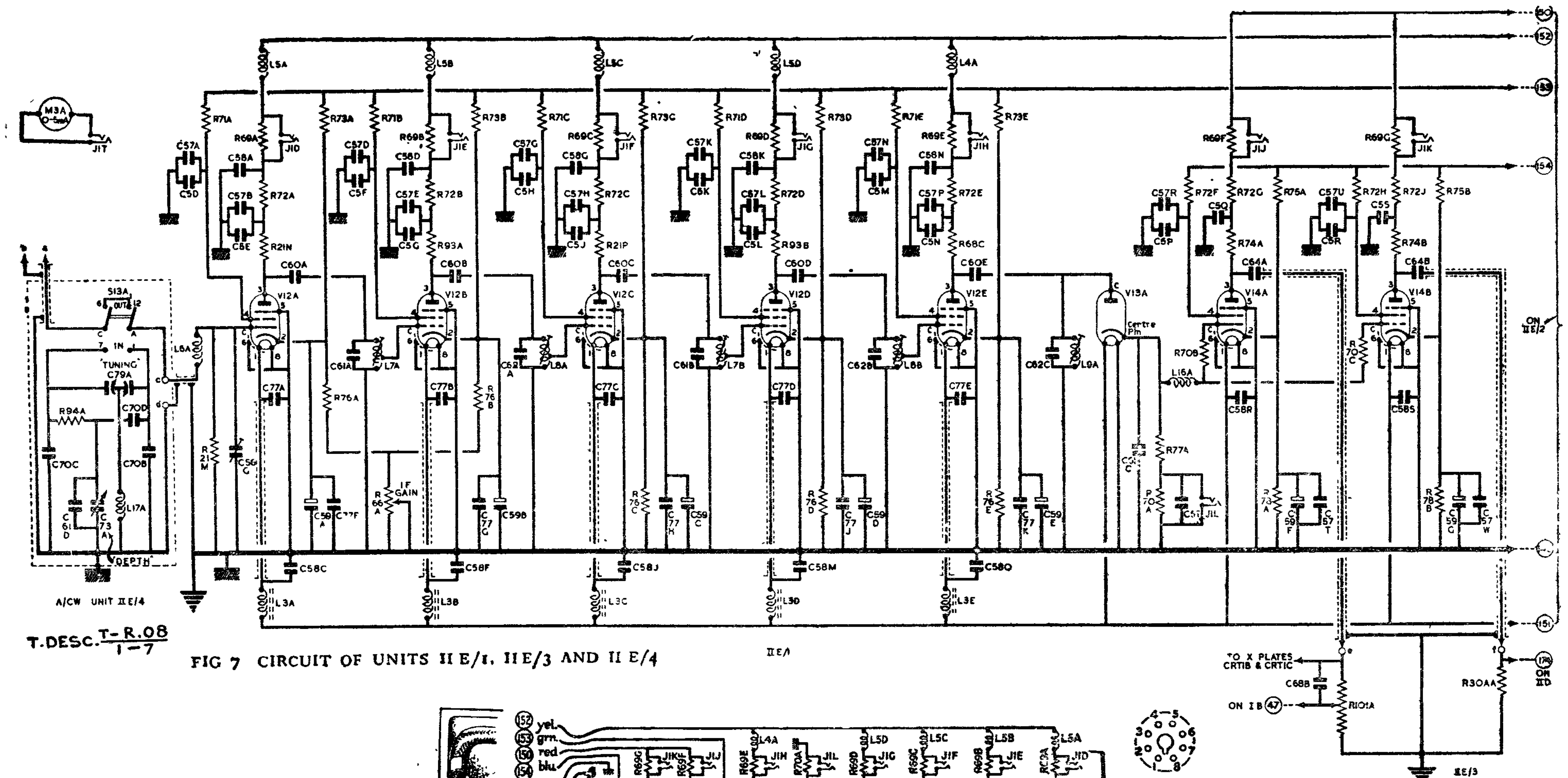
C5	0·05 mfd.		450 V.
C56	3-20 mmfd. Air trimmer.		
C57	0·001 mfd.	Mica	500 V.
C58	0·002 mfd.	„	500 V.
C59	50 mfd. 12 V. Electrolytic.		
C60	0·0005 mfd.		500 V.
C61	15 mmfd. 2%		500 V.
C62	20 mmfd.		500 V.
C64	0·005 mfd.		750 V.
C68	25 mmfd. 2%		500 V.
C70	50 mmfd. 2%		500 V.
C73	4·5-50 mmfd. Air variable.		
C77	0·05 mfd. 5%		
C79	2-22·5 mmfd. each section, air variable.		
R21	5,000 ohms 5% 1/2 W.		
R30	0·5 megohm 5% 1/4 W.		
R66	1,000 ohms Potentiometer.		
R68	3,500 „ 5% 1/2 W.		
R69	7·5 „ 5%		
R70	100 „ 5% 1/4 W.		
R71	5,000 „ 5% 1/4 W.		
R72	1,000 „ 5% 1/4 W.		

V13 ARD 2

V14 ARP 20.

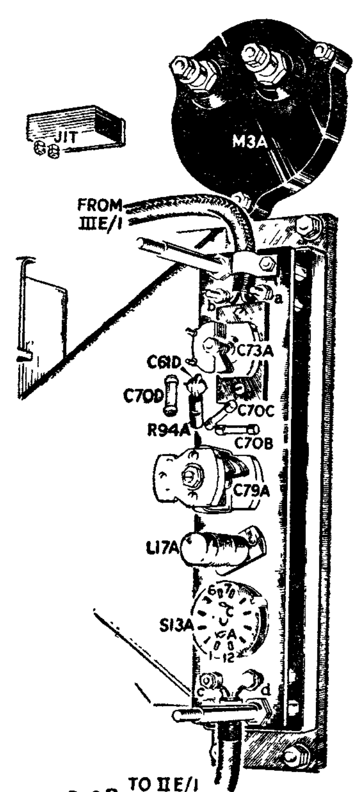
R73.	0·1 megohm 5% 1/4 W.
R74	10,000 ohms 5% 6W.
R75.	50,000 „ 5% 1 W.
R76	160 „ 5% 1/4 W.
R77	6,000 „ 5% 1/4 W.
R78	500 „ 5% 1/4 W.
R93	4,000 „ 5% 1/2 W.
R94	10 „ 5% 1/2 W.
R101	·1 Meg. variable.
L3	Heater Filter Choke.
L4	H.T. „ „
L5	H.T. „ „
L6	Band-pass „ Coil.
L7	I.F. tuning coil
L8	„ „ „
L9	„ „ „
L16	Filter choke
L17	A/CW Filter coil
J1	Meter jack
S13	D.P.D.T.
M3	0-5 mA D.C.

NOTE.—All limits ± 15% unless otherwise indicated.



T.DESC. T-R.08 / 1-7

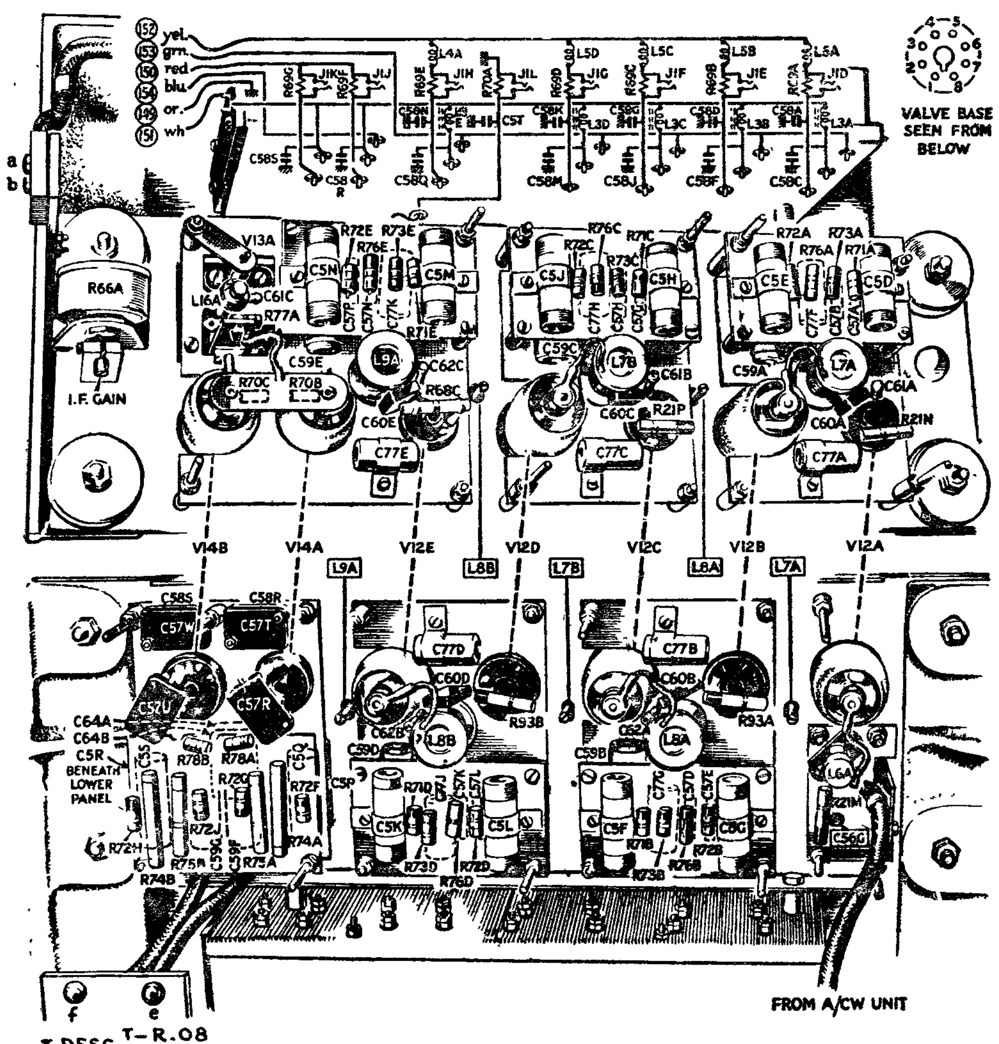
FIG 7 CIRCUIT OF UNITS II E/1, II E/3 AND II E/4



TO II E/1

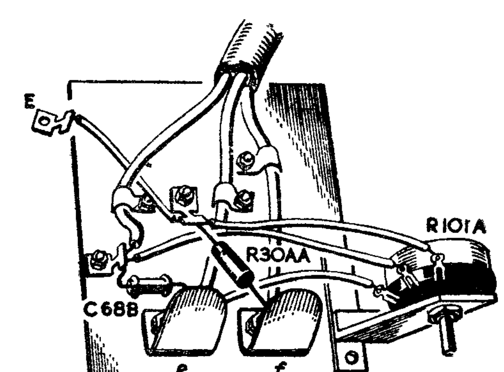
T.DESC. T-R.08 / 1-6B

FIG. 6B A/CW UNIT (II E/4)



T.DESC. T-R.08 / 1-6A

FIG. 6A RECEIVER I.F. UNIT II E/1 WITH SCREENS REMOVED



UNIT IIE/3

T.DESC. T-R.08 / 1-6C

FIG. 6C UNIT II E/3

Overall Sensitivity

(Unit III E/1 coupled to Unit II E/1).

54. See that the receiver is tuned to the station operation frequency before the following check is made by plugging a 250 microampere meter from No. 1 Meter position into No. 2 Meter position and connecting by the plug lead to jack V13 A to read the 2nd diode output current.

55. A known adjustable R.F. voltage is applied from a signal generator to one of the two input cables to the receiver (Unit IIIE/1), the other cable being loaded with an 80 ohm non-reactive resistance. (If this latter cable is made the Range Aerial feeder to the Phasing Box, the 80 ohm loading is provided automatically in the Phasing Box when the R.Ae. switch on it is set at "OFF").

56. The input voltage for an increase of 50 µA diode current is noted and should be within the limits indicated below for various frequencies. Check that it is possible correctly to tune in signals at :—55, 60, 65, 70, 75, 80, and 85 Mc/s, and that settings of all tuning controls are within ± 1·0 Mc/s inclusive and within ± 1·5 Mc/s at 55 and 85 Mc/s.

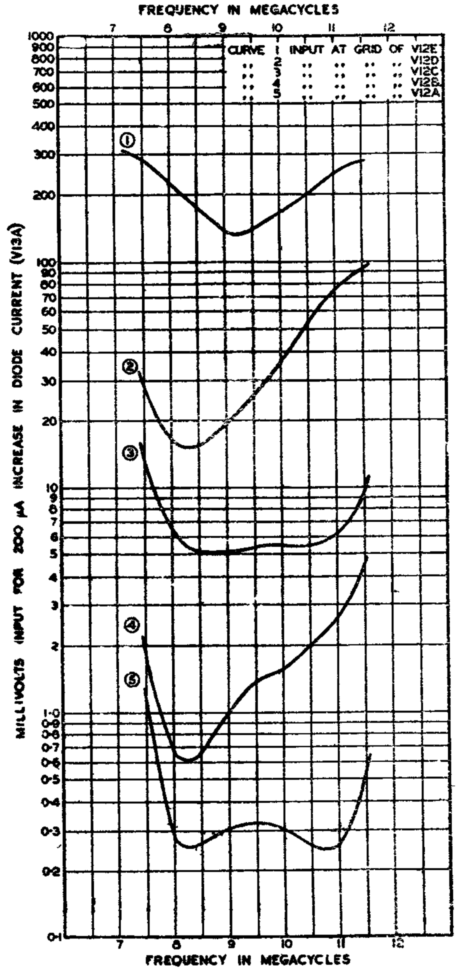
Frequency in Mc/s	55	60	65	70	75	80	85
Microvolts input	22-45	35-47	35-50	40-65	45-75	85-135	160-260

Currents and Voltages on Unit II E/1.

57 *D. C. Voltages :*

TEST POINTS.	VOLTMETER READING.
I.F. anodes (V12A, B, C, D, E) to chassis. Gain max.*	+230 volts
I.F. screens (V12A, B, C, D, E) to chassis. Gain max.*	+209 „
Output stage anodes (V14A, B) to chassis. No signal	+332 „
Output stage screens (V14A,B) to chassis. No signal	+158 „
I.F. cathodes (V12A, B, C, D, E) to chassis	+2 „
Output stage cathodes (V14A,B) to chassis	+5·1 „

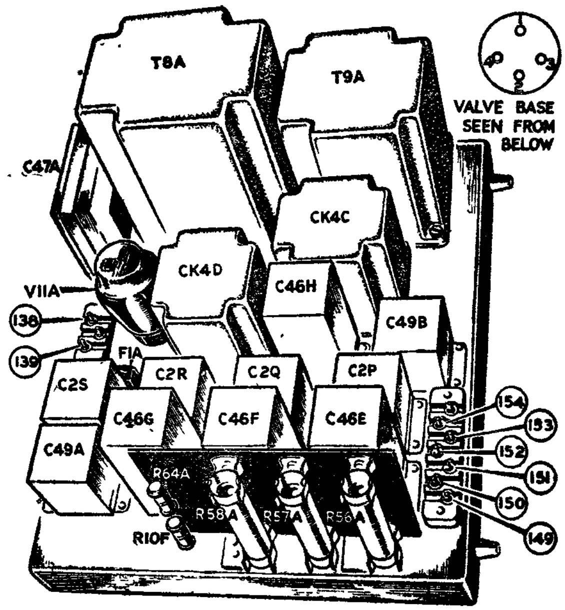
*The pre-set gain control R66A is normally set back somewhat to bring the overall gain in the I.F. amplifer within the required limits, so that V12B standing current will in general be less than indicated above. It is not practicable to give a fixed figure for this normal working current, however, as it may vary over wide limits depending upon the liveliness of the rest of the amplifier.



T DESC. T-R08 / I—8

Fig 8 Curves showing I.F. Gain at Various Stages.

VALVE TEST JACK	METER USED	METER READING	ACTUAL CURRENT	CONDITIONS OF TEST
V12A	M3A (0-5 mA)	2·8 mA	8·4 mA	Present Gain at Max.
V12B	„	2·55 mA	7·65 mA	„
V12C	„	3 mA	9 mA	Normal. No Signal.
V12D	„	2·7 mA	8·1 mA	„ „
V12E	„	2·8 mA	8·4 mA	„ „
V14A	„	2·2 mA	6·6 mA	„ „
V14B	„	2·15 mA	6·45 mA	„ „
V13A	M1B (0·250µA)	15µA.		„ „



T.DESC. T-R.08 / 1-9

FIG. 9. POWER SUPPLY UNIT 11 E/2 FOR I.F. UNIT.

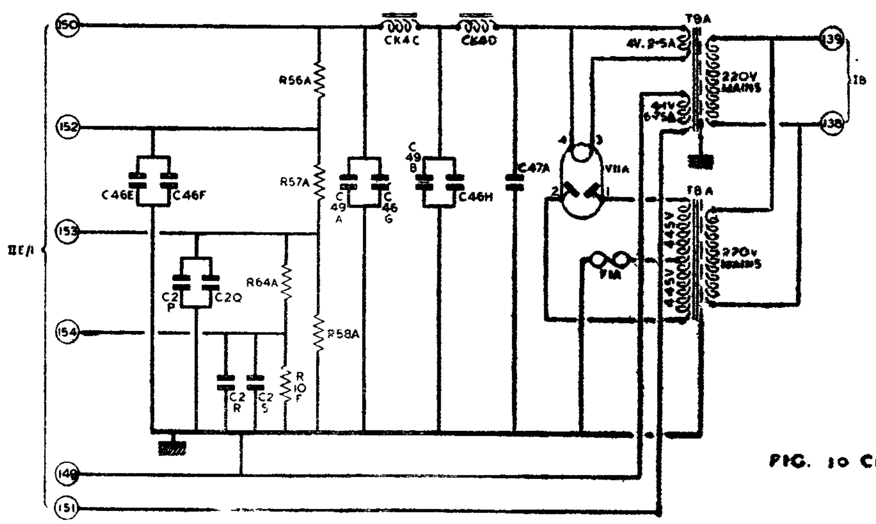


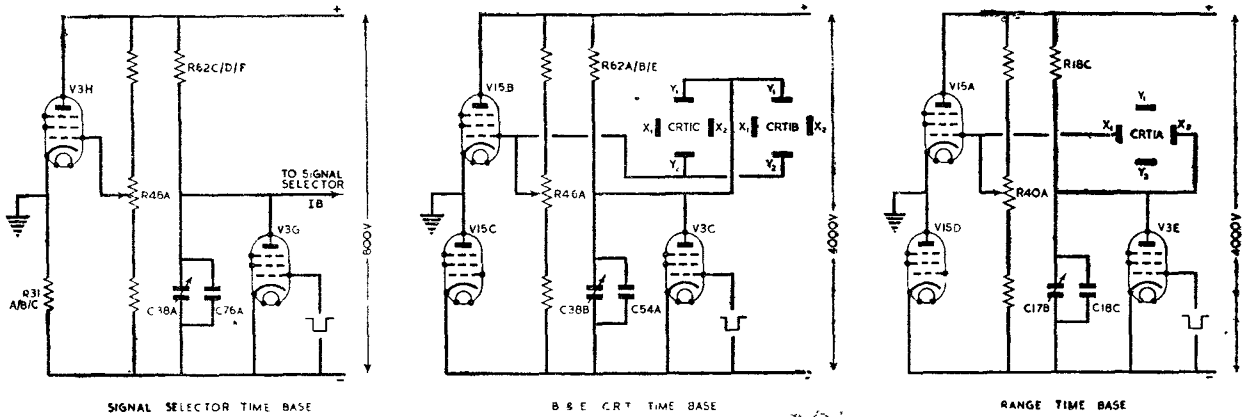
FIG. 10 CIRCUIT

T DESC. T-R 08 / 1-10

V11 AU1

C2	4 mfd.	400 V.
C46	4 mfd.	500 V.
C47	4 mfd.	1,000 V.
C49	2 mfd.	500 V.
R10	50,000 ohms	5% 2 W.
R56	1,500 ,,	2% 20 W.
R57	800 ,,	2%
R58	6,000 ohms	2%.
R64	5,000 ,,	5% 2 W.
CK4	9 H	100 mA D.C.
T 8	Mains transformer	
T9	,, ,,	
F1	0·5 A.	

NOTE.—All limits are ± 15% unless otherwise indicated.



T.DESC $\frac{\text{T-R.08}}{\text{1-11A}}$

FIG 11A SIMPLIFIED SCHEMATIC OF POTENTIOMETER AND TIME BASE

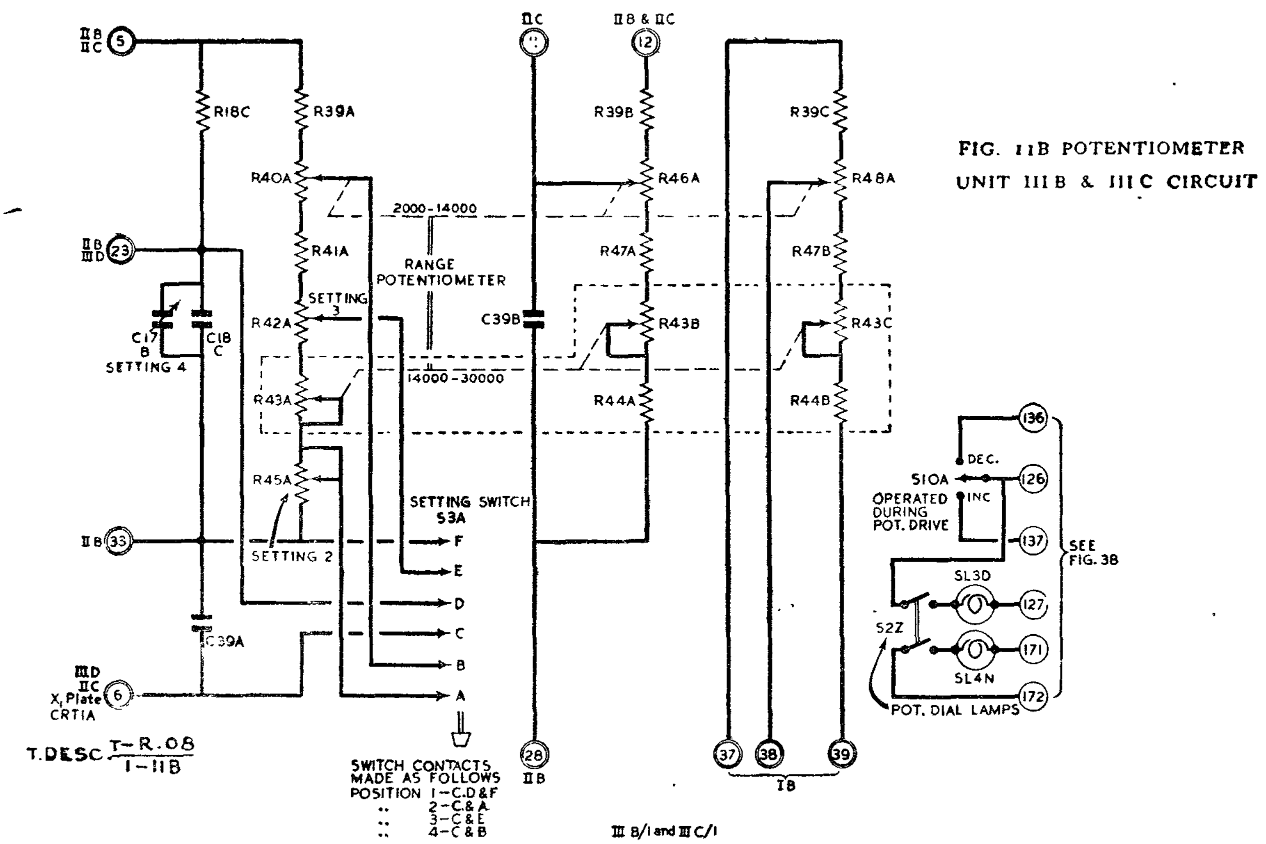


FIG. 11B POTENTIOMETER UNIT III B & III C CIRCUIT

T.DESC $\frac{\text{T-R.08}}{\text{1-11B}}$

C17	7·5-41 mmfd. Air Variable		
C18	55 mmfd. ± 1 mmfd.		4,000 V.
C39	0·01 mfd.		4,000 V.
R18	760,000	ohms	20 W
R39	1,197,976	,,	4 bobbins
R40	660,825	,,	80 ,,
R41	106,300	,,	1 bobbin
R42	34,899	,,	8 bobbins
R43	1,594,154	,,	22 ,,
R44	2,000	,,	

R45	7,500	ohms	5 bobbins
R46	660,825	,,	40 ,,
R47	141,200	,,	1 bobbin.
R48	660,825	,,	40 bobbins.
S2	D.P.D.T.		
S3	Multi-contact, special		
S10	Special		
SL3	50 V 25 W.		
SL4	6·3 V. 0·25 A.		

I.F. POWER SUPPLY UNIT TYPE IIE/2

(Circuit fig. 10, Chassis fig. 9).

58. This is located near the back of the compartment of the main rack which houses the I.F. Unit itself and provides :—

(*a*) 4·1 volts A.C. for cathode heaters (terminals 149, 151)

(*b*) 310 volt output for I.F. anodes (terminal 152)

(*c*) 250 volt output for I.F. screens (terminal 153)

(*d*) 480 volt output for L.F. anodes (terminal 150)

(*e*) 180 volt output for L.F. screens (terminal 154)

59. The circuit is conventional, separate transformers being used for L.T. and H.T.

The L.T. transformer T9A has two separate windings rated at 4·1 V. 6·85 amps and 4 V. 2·5 amps for receiver cathodes and rectifier filament respectively.

60. The H.T. transformer T8A has a centre-tapped secondary, a 500 mA fuse F1A being included in series with the centre tap to protect the supply from overload.

61. The full-wave rectifier valve, V11A, provides sufficient current and voltage for all outputs and is followed by two stages of smoothing commencing with paper reservoir condensers (C49B, C49C). Resistances R56A, R57A, R58A, R64A and R63A, serve to subdivide the total voltage into the outputs required.

62. One side of the receiver L.T. winding and negative H.T. are connected to the chassis and earthed to the main rack.

WARNING

63. As all heaters are also returned to earth in the I.F. unit itself great care must be taken that the L. T. interconnection between the two units is correctly made or a dead short-circuit will occur across the L.T. transformer winding.

POTENTIOMETER IIIB & IIIC AND TIME-BASE ARRANGEMENTS—GENERAL

(figs. 11a, 11b.)

64. The simplified schematic fig. 11a shows the basic arrangement of the time-base and potentiometer circuits. (N.B. The various components indicated in fig. 11a are for practical reasons distributed in various units of the equipment. Their physical location can be seen from the chassis views and circuit diagrams of individual units). The cathode ray tubes are operated with their final anodes at earth potential. The electrical zero of the tube refers to the condition with all plates at earth potential.

65. The Range time-base, consists of a resistance condenser charging circuit, R18C, C17B and C18C, the condenser being kept discharged except during the time-base stroke by means of a valve V3E connected across it. The grid of V3E is supplied with a negative square-wave voltage from Unit IIB/2 such that the grid is taken well beyond cut-off for periods of the order of 250 microseconds. During these cut-off periods the condenser charges exponentially towards the H.T. supply voltage (4,000 V).

66. By means of the potentiometer any given part of the time-base trace can be brought on to the zero cross-wire of the tube, and when this is done the time interval from the start of the stroke is given by the expression :—

$$t = T \log_e \frac{R1}{Ro}$$

Where Ro is the total resistance of the potentiometer winding and R1 is the resistance included between slider and positive end of potentiometer. T is the time constant of the charging circuit, *viz.* the product of the charging resistance Rc and the charging capacity Cc (inclusive of all stray capacities).

67. It may help in the understanding of this part of the equipment to remember that there are two variables with the same exponential law. Firstly there is the time-base in which a voltage varies exponentially with time. Secondly there is the potentiometer in which a voltage varies exponentially with angular setting. The two voltages are equated at the cathode ray tube. Thus the potentiometer angular setting itself becomes a measure of the time difference between the arrival of the locking pulse *via* cable and the reflected echo *via* radio.

68. The design of the potentiometer is based on a time constant T = 166·7 microseconds, the grading being exponential so that the time interval or range readings are linearly related to the setting of the potentiometer shaft. The circuit is adjusted to this required time constant by means of a trimmer condenser C17B connected across the main charging condenser C18C.

69. The potentiometer applies the appropriate D.C. potentials to the deflector plates of the cathode ray tube because the slider is always within a few volts of earth potential wherever it is set. It is not permissible to earth the slider direct as this might result in a small current flowing *via* slider, earth, C. R. T. deflector plates and stray leakage paths; the potentiometer will only follow its potential distribution law accurately as long as absolutely no current flows out of the slider. Two valves V15A and V15D are therefore used in series across the extremes of the main potentiometer to form an auxiliary potentiometer. The junction of cathode of V15A to the anode of V15D is taken to earth, the slider arm of the potentiometer being taken to the control grid of V15A. The pentode characteristics of V15D are employed to make the system practically a constant current one. V15A functions on the "cathode follower" principle, the grid and cathode always remaining within a few volts of each other and no grid current being taken. In this manner the two valves act as an automatic "guard" potentiometer, always bringing the slider arm of the main potentiometer to effective earth potential without using a direct earth connection to the slider itself.

70. The time-base and potentiometer system for the Bearing and Elevation tubes is similar to that for the Range, employing a total voltage of 4,000. Separate power supply units for the time-bases are used. It is most important that the insulation to earth of time-base chassis, power supplies and potentiometer circuits should be of a very high order.

71. The time-base and potentiometer system for the Signal Selector and A.V.C. system is similar to the

other two except that only 800 volts is used and that the lower section of the valve potentiometer is a simple fixed resistance R31A/B/C instead of a second valve.

Potentiometer Unit III B-Electrical

(Circuit fig. 11b)

72. The Potentiometer Unit consists essentially of three similar concentric "main" potentiometers with ganged sliders together with three ganged "sub-potentiometers" which are really variable resistances in series with the main potentiometers to increase their range.

73. The Potentiometer tank, in addition to housing all resistances of the potentiometers themselves, also houses the time-base resistance and condensers for the Range section. The resistance R18C is 0·76 megohm, wire-wound, while the capacity is made up of a silvered mica fixed condenser C18C of 55 μμF capacity in parallel with a variable condenser C17B of 82 μμF maximum capacity in oil.

74. The time-base resistances and capacities for the Bearing-Elevation and Signal Selector sections are on other units.

75. Referring to the detailed circuit fig. 11b it will be seen that it also differs from the simplified schematic of fig. 11a by the addition of the following features :—

(*a*) Condensers C39A, C39B from the potentiometer sliders to negative H. T. lines. These provide relatively low impedance paths for mains and time-base frequencies. (In the case of the signal-selector potentiometer the condenser is connected externally on Unit I B).

(*b*) A subsidiary variable resistance R43 of 1,594,154 ohms in 64 steps to give extended range readings beyond the range of the main potentiometer.

(*c*) A subsidiary potentiometer R42A (in Range potentiometer section only) of 34,899 ohms in 24 steps. ("SETTING 3").

(*d*) A variable resistance R45A ("SETTING 2") of 7,500 ohms in 15 steps (at the bottom of range potentiometer only).

(*e*) A 4-way sequence switch ("SETTING SWITCH"). The function of these controls may now be described, bearing in mind the following external connections :—
terminal 23 to X2 plate (sweep plate)
terminal 6 to X1 plate
terminal 33 to 4,000 V, negative line.

76. In position 1 of the switch both X plates of the tube are connected together to potentiometer slider and therefore are both brought to earth potential. The cathode ray tube spot thus appears on its electrical zero and in this position the cross wires on the Range tube are set up. (The corresponding zero for Bearing and Elevation tubes is obtained by switching off the 4,000 V. supply for the time-base of these tubes).

77. In position 2 and with the 7,500 ohm variable resistance ("SETTING 2") set at zero (clockwise on front control), the X2 sweep plate is released from earth potential and in the absence of any synchronising drive to the II B unit the spot moves to the right of the cross-wires by the amount corresponding to the standing anode voltage on the time-base valve (order of 4 V.). By now increasing the setting of the 7,500 ohm variable resistance, shift is applied which brings the spot back to the cross wire. The control knob ("SETTING 2") is now clamped at this position and will normally not require further adjustment. The potentiometer chain proper is now constituted by the resistances above the 7,500 ohm variable.

78. In position 3 of the switch the subsidiary potentiometer R42A ("SETTING 3") shifts the time-base commencement to the left by an amount corresponding to a range of 0 to 500 yards. This position is provided in anticipation of being able to measure directly the difference between the delay times of the radio route, including receiver, and the locking-cable route, a difference which has to be applied as an equivalent Range correction in the transmitted readings. (Up to the present this has not proved a practical process and the delay difference has to be inferred by other means.)

79. The above three positions do not affect conditions on the Bearing and Elevation C. R. tubes. In positions 1 and 2 the potentiometer valves on the Range side do not function. In position 4 of the switch the circuit is in the normal operating condition as depicted in the simplified schematic in fig. 11a. In this position the first procedure is to apply a 163·86 kc/s calibrating signal and to adjust the time constant of the charging circuits until the calibration marks correspond accurately with the 1,000 yard intervals seen on the main potentiometer dial. In practice this means that the first available calibrator pulse (leading edge) is pulled on to the cross-wire and the dial reading noted; the Range Potentiometer handle is then turned anti-clockwise until the trace is shifted by 10 calibrator intervals; the Potentiometer dial reading should then have increased by precisely 10,000 yards. The time-constant control knob ("SETTING 4") must be adjusted until this is the case and when finally set should be clamped in position and the adjustable index moved opposite the zero of the time-constant dial. The calibration on the latter now allows a "ballistic correction" up to +10% or —5% to be applied to the Range readings. Note that the positive correction must correspond to reduction of condenser, *i.e.* to stretching of the time-base scale.

80. For accurate setting up the internal scales directly on the potentiometer shafts should be used. They can be illuminated and are visible through a small window in the front panel of unit IIIB/C.

81. When the time-constant on the Range side has been correctly set, the Bearing and Elevation side can be dealt with in a similar manner (SETTING 1) by putting the switch S1B on Unit IIC to the position marked "ALL". (For adjustment of third time-base see paras. 211-215 on Signal Selector Unit IB). All three time-bases should be checked against the Calibrator Unit each day.

Extended Range

82. The main potentiometer sections, such as R40A on the Range side, give a range from 2,000 to 14,000 yards. The Range is extended up to 30,000 yards by the variable resistance R43A, sometimes referred to as the Subsidiary Potentiometer, which is a 1,594,154 ohm resistance, variable in 64 steps, in series with the

lower side of the main potentiometer. While the main potentiometer is being used between 2,000 and 14,000 yards the extended range resistance is kept short-circuited. As soon, however, as the slider of the main potentiometer has reached the extreme positive stud (14,000 yards) the extended range resistance is introduced stud by stud in such a manner as to continue the potential rise at the main slider in the same exponential law until the potential corresponding to 30,000 yards range is reached.

83. There is one dial for the Range Potentiometer visiable at the front panel, which is calibrated continuously in yards from 2,000 to 30,000. The change-over of drive from the main potentiometers to the subsidiary potentiometers at the 14,000 yard' point is accomplished by mechanical means in the gearing associated with the Potentiometer and is described in a later section.

84. From 2,000 to 14,000 yards the main potentiometer studs give steps of 50 yards, whereas between 14,000 and 30,000 yards the subsidiary potentiometer studs give steps of 250 yards.

Resistance Values of Potentiometer Bobbins

(See fig. 11b.)

85. The resistance of the bobbins constituting the potentiometer rings are given in tables in this section. Values of fixed resistances will be found in the component list attached to fig. 11b.

86. All resistance elements are wire-wound on moulded bobbins and adjusted to close limits.

87. The three main potentiometers take the form of three concentric rings of bobbins and contact studs. The outer ring is the Range potentiometer and is composed of 80 bobbins each of which is divided into 3 tapped sections, giving 240 steps with a total of 241 contact studs.

88. In the case of the middle and inner rings, which are associated respectively with the Bearing-Elevation time-base and the Signal Selector time-base, extreme accuracy is not so important and the range is covered for each ring by 40 bobbins and 121 studs. Apart from the difference in size of step, all three rings obey the same over-all law of resistance against angular position of the contact arm.

89. The fixed resistances immediately above and below the main potentiometer serve to set the correct limits to the range covered. With the extended-range potentiometers shorted out, the total effective resistance between extremes of each potentiometer chain is exactly 2 megohms (excluding the compensating resistance R45A already referred to).

90. The three extended range potentiometers are identical with each other as regards construction and resistance. Each consists of a ring of 22 bobbins and 65 contact studs. Each bobbin is wound with 3 tapped sections except the last which has only one section wound : thus there are effectively 64 sections.

91. The following tables give the details of the resistance potentiometer windings at each step.

TABLE "A"

SUBSIDIARY POTENTIOMETER R42A TOTAL RESISTANCE 34,899 ohms.

Measure between terminal 6 and 33 on the unit III B/C (fig. 11b), with SETTING SWITCH at position 3 and SETTING 2 knob fully clockwise. Range dial at less than 14,000 yards.

STUD No.	TOTAL RESISTANCE (± 40 ohms)	PER BOBBIN RESISTANCE (± 6 ohms)
1	0	
2 3 4	1465 2930 4395	4395
5 6 7	5857 7319 8781	4386
8 9 10	10240 11699 13158	4377
11 12 13	14614 16070 17526	4368
14 15 16	18979 20432 21885	4359
17 18 19	23334 24783 26232	4347
20 21 22	27678 29124 30570	4338
23 24 25	32013 33456 34899	4329

TABLE "B".

MAIN POTENTIOMETER OUTER RING (R40A).

Measure between terminals 6 and 33, Unit III B/C (fig. 11b) SETTING SWITCH at Position 4, SETTING 2 knob fully clockwise. See fig. 1.

RANGE IN YARDS	RESISTANCE (±260 ohms).	STUD No.	BOBBIN No.	RESISTANCE PER BOBBIN (± 15 ohms).
2000	141,199	1		
2050	144,592	2	1	10179
2100	147,985	3		
2150	151,378	4		
2200	154,752	5	2	10122
2250	158,126	6		
2300	161,500	7		
2350	164,856	8	3	10068
2400	168,212	9		
2450	171,568	10		
2500	174,906	11	4	10014
2550	178,244	12		
2600	181,582	13		
2650	184,901	14	5	9957
2700	188,200	15		
2750	191,539	16		
2800	194,840	17	6	9903
2850	198,141	18		
2900	201,442	19		
2950	204,725	20	7	9849
3000	208,008	21		
3050	211,291	22		
3100	214,556	23	8	9795
3150	217,821	24		
3200	221,086	25		
3250	224,333	26	9	9741
3300	227,580	27		
3350	230,827	28		
3400	234,057	29	10	9690
3450	237,287	30		
3500	240,517	31		
3550	243,729	32	11	9636
3600	246,941	33		
3650	250,153	34		
3700	253,347	35	12	9582
3750	256,541	36		
3800	259,735	37		
3850	262,912	38	13	9531
3900	266,089	39		
3950	269,266	40		
4000	272,425	41	14	9477
4050	275,584	42		
4100	278,743	43		

TABLE " B "—*contd.*

RANGE IN YARDS	RESISTANCE (± 260 ohms).	STUD No.	BOBBIN No.	RESISTANCE PER BOBBIN (± 15 ohms).
4150	281,885	44	15	9426
4200	285,027	45		
4250	288,169	46		
4300	291,294	47	16	9375
4350	294,419	48		
4400	297,544	49		
4450	300,652	50	17	9324
4500	303,760	51		
4550	306,868	52		
4600	309,958	53	18	9270
4650	313,048	54		
4700	316,138	55		
4750	319,212	56	19	9222
4800	322,286	57		
4850	325,360	58		
4900	328,417	59	20	9171
4950	331,474	60		
5000	334,531	61		
5050	337,571	62	21	9120
5100	340,611	63		
5150	343,651	64		
5200	346,674	65	22	9069
5250	349,697	66		
5300	352,720	67		
5350	355,727	68	23	9021
5400	358,734	69		
5450	361,741	70		
5500	364,732	71	24	8973
5550	367,723	72		
5600	370,714	73		
5650	373,688	74	25	8922
5700	376,662	75		
5750	379,636	76		
5800	382,594	77	26	8874
5850	385,552	78		
5900	388,510	79		
5950	391,451	80	27	8823
6000	394,392	81		
6050	397,333	82		
6100	400,259	83	28	8778
6150	403,185	84		
6200	406,111	85		
6250	409,020	86	29	8727
6300	411,929	87		
6350	414,838	88		

TABLE "B"—*contd.*

RANGE IN YARDS	RESISTANCE (± 260 ohms)	STUD No.	BOBBIN No.	RESISTANCE PER BOBBIN (± 15 ohms)
6400	417,732	89	30	8682
6450	420,626	90		
6500	423,520	91		
6550	436,397	92	31	8631
6600	429,274	93		
6650	432,151	94		
6700	435,013	95	32	8586
6750	437,875	96		
6800	440,737	97		
6850	443,583	98	33	8538
6900	446,429	99		
6950	449,275	100		
7000	452,106	101	34	8493
7050	454,937	102		
7100	457,768	103		
7150	460,583	104	35	8445
7200	463,398	105		
7250	466,213	106		
7300	469,013	107	36	8400
7350	471,813	108		
7400	474,613	109		
7450	477,398	110	37	8355
7500	480,183	111		
7550	482,968	112		
7600	485,737	113	38	8307
7650	488,506	114		
7700	491,275	115		
7750	494,029	116	39	8262
7800	496,783	117		
7850	499,537	118		
7900	502,276	119	40	8217
7950	505,015	120		
8000	507,754	121		
8050	510,478	122	41	8172
8100	513,202	123		
8150	515,926	124		
8200	518,635	125	42	8127
8250	521,344	126		
8300	524,053	127		
8350	526,747	128	43	8082
8400	529,441	129		
8450	532,135	130		
8500	534,815	131	44	8040
8550	537,495	132		
8600	540,175	133		

TABLE "B"—*contd.*

RANGE IN YARDS	RESISTANCE (± 260 ohms)	STUD No.	BOBBIN No.	RESISTANCE PER BOBBIN (± 15 ohms)
8650	542,839	134	45	7992
8700	545,503	135		
8750	548,167	136		
8800	550,817	137	46	7950
8850	553,467	138		
8900	556,117	139		
8950	558,753	140	47	7908
9000	561,389	141		
9050	564,025	142		
9100	566,646	143	48	7863
9150	569,267	144		
9200	571,888	145		
9250	574,495	146	49	7821
9300	577,102	147		
9350	579,709	148		
9400	582,301	149	50	7776
9450	584,893	150		
9500	587,485	151		
9550	590,064	152	51	7737
9600	592,643	153		
9650	595,222	154		
9700	597,786	155	52	7692
9750	600,350	156		
9800	602,914	157		
9850	605,464	158	53	7650
9900	608,014	159		
9950	610,564	160		
10,000	613,101	161	54	7611
10,050	615,638	162		
10,100	618,175	163		
10,150	620,697	164	55	7566
10,200	623,219	165		
10,250	625,741	166		
10,300	628,249	167	56	7524
10,350	630,757	168		
10,400	633,265	169		
10,450	635,760	170	57	7485
10,500	638,255	171		
10,550	640,750	172		
10,600	643,231	173	58	7443
10,650	645,712	174		
10,700	648,193	175		
10,750	650,661	176	59	7404
10,800	653,129	177		
10,850	655,597	178		

TABLE "B"—*contd.*

RANGE IN YARDS	RESISTANCE (± 260 ohms)	STUD No.	BOBBIN No.	RESISTANCE PER BOBBIN (± 15 ohms)
10,900 10,950 11,000	658,051 660,505 662,959	179 180 181	60	7362
11,050 11,100 11,150	665,400 667,841 670,282	182 183 184	61	7323
11,200 11,250 11,300	672,709 675,136 677,563	185 186 187	62	7281
11,350 11,400 11,450	679,977 682,391 684,805	188 189 190	63	7242
11,500 11,550 11,600	687,206 689,607 692,008	191 192 193	64	7203
11,650 11,700 11,750	694,396 696,784 699,172	194 195 196	65	7164
11,800 11,850 11,900	701,546 703,920 706,294	197 198 199	66	7122
11,950 12,000 12,050	708,756 711,018 713,380	200 201 202	67	7086
12,100 12,150 12,200	715,728 718,076 720,424	203 204 205	68	7044
12,250 12,300 12,350	722,760 725,096 727,432	206 207 208	69	7008
12,400 12,450 12,500	729,755 732,078 734,401	209 210 211	70	6969
12,550 12,600 12,650	736,711 739,021 741,331	212 213 214	71	6930
12,700 12,750 12,800	743,629 745,927 748,225	215 216 217	72	6894
12,850 12,900 12,950	750,510 752,795 755,080	218 219 220	73	6855
13,000 13,050 13,100	757,352 759,624 761,896	221 222 223	74	6816

TABLE "B"—*concld.*

RANGE IN YARDS	RESISTANCE (± 260 ohms)	STUD No.	BOBBIN No.	RESISTANCE PER BOBBIN (± 15 ohms)
13,150 13,200 13,250	764,156 766,416 768,676	224 225 226	75	6780
13,300 13,350 13,400	770,924 773,172 775,420	227 228 229	76	6744
13,450 13,500 13,550	777,655 779,890 782,125	230 231 232	77	6705
13,600 13,650 13,700	784,348 786,571 788,794	233 234 235	78	6669
13,750 13,800 13,850	791,005 793,216 795,427	236 237 238	79	6633
13,900 13,950 14,000	797,626 799,825 802,024	239 240 241	80	6597

TABLE "C".

Main Potentiometer, Middle and Inner Rings (R46A & R48A)

*Between terminals 11 and 28 for middle ring. Between terminals 38 and 39 for inner ring.

RANGE IN YARDS	*RESISTANCE (± 550 ohms).	STUD No.	BOBBIN No.	RESISTANCE PER BOBBIN (± 30 ohms)
2,000	143,200	1		
2,100 2,200 2,300	149,967 156,734 163,501	2 3 4	1	20301
2,400 2,500 2,600	170,195 176,889 183,583	5 6 7	2	20082
2,700 2,800 2,900	190,203 196,823 203,443	8 9 10	3	19860
3,000 3,100 3,200	209,991 216,539 223,087	11 12 13	4	19644
3,300 3,400 3,500	229,564 236,041 242,518	14 15 16	5	19431

TABLE "C"—*contd.*

RANGE IN YARDS	RESISTANCE (± 550 ohms)	STUD No.	BOBBIN No.	RESISTANCE PER BOBBIN (± 30 ohms)
3,600 3,700 3,800	248,924 255,330 261,736	17 18 19	6	19218
3,900 4,000 4,100	268,072 274,408 280,744	20 21 22	7	19008
4,200 4,300 4,400	287,011 293,278 299,545	23 24 25	8	18801
4,500 4,600 4,700	305,743 311,941 318,139	26 27 28	9	18594
4,800 4,900 5,000	324,270 330,401 336,532	29 30 31	10	18393
5,100 5,200 5,300	342,595 348,658 353,721	32 33 34	11	18189
5,400 5,500 5,600	360,719 366,717 372,715	35 36 37	12	17994
5,700 5,800 5,900	378,647 384,579 390,511	38 39 40	13	17796
6,000 6,100 6,200	396,378 402,245 408,112	41 42 43	14	17601
6,300 6,400 6,500	413,915 419,718 425,521	44 45 46	15	17409
6,600 6,700 6,800	431,260 436,999 442,738	47 48 49	16	17217
6,900 7,000 7,100	448,415 454,092 459,769	50 51 52	17	17031
7,200 7,300 7,400	465,384 470,999 476,614	53 54 55	18	16845
7,500 7,600 7,700	482,168 487,722 493,276	56 57 58	19	16662
7,800 7,900 8,000	498,769 504,262 509,755	59 60 61	20	16479

TABLE "C"—*contd.*

RANGE IN YARDS	RESISTANCE (± 550 ohms)	STUD No.	BOBBIN No.	RESISTANCE PER BOBBIN (± 30 ohms)
8,100 8,200 8,300	515,188 520,621 526,054	62 63 64	21	16299
8,400 8,500 8,600	531,428 536,802 542,176	65 66 67	22	16122
8,700 8,800 8,900	547,490 552,804 558,118	68 69 70	23	15942
9,000 9,100 9,200	563,375 568,632 573,882	71 72 73	24	15771
9,300 9,400 9,500	579,088 584,287 589,486	74 75 76	25	15597
9,600 9,700 9,800	594,629 599,772 604,915	77 78 79	26	15429
9,900 10,000 10,100	610,002 615,089 620,176	80 81 82	27	15261
10,200 10,300 10,400	625,206 630,236 635,266	83 84 85	28	15090
10,500 10,600 10,700	640,242 645,218 650,194	86 87 88	29	14928
10,800 10,900 11,000	655,116 660,038 664,960	89 90 91	30	14766
11,100 11,200 11,300	669,828 674,696 679,564	92 93 94	31	14604
11,400 11,500 11,600	684,379 689,194 694,009	95 96 97	32	14445
11,700 11,800 11,900	698,771 703,533 708,295	98 99 100	33	14286
12,000 12,100 12,200	713,005 717,715 722,425	101 102 103	34	14130
12,300 12,400 12,500	727,084 731,743 736,402	104 105 106	35	13977

TABLE "C"—*concld.*

RANGE IN YARDS	RESISTANCE (± 550 ohms)	STUD No.	BOBBIN No.	RESISTANCE PER BOBBIN (± 30 ohms)
12,600 12,700 12,800	741,010 745,618 750,226	107 108 109	36	13824
12,900 13,000 13,100	754,783 759,340 763,897	110 111 112	37	13671
13,200 13,300 13,400	768,405 772,913 777,421	113 114 115	38	13524
13,500 13,600 13,700	781,879 786,337 790,793	116 117 118	39	13374
13,800 13,900 14,000	795,205 799,615 804,025	119 120 121	40	13230

TABLE "D".

Extended Range Potentiometer Section (R43A)

*This is measured between terminals 6 and 33 Unit III B/C (fig. 11b) with SETTING SWITCH at Position 3 and knobs of SETTINGS 2 and 3 fully clockwise to cut out R42A and R45A.

The extended range potentiometers R43B and R43C belonging to the middle and inner rings cannot be checked by themselves externally but can be measured in series with R44, R47 and R46 between terminals 11 and 28 (or 38 and 39). In this case 804,025 ohms must be added to the resistance value given in this table.

RANGE IN YARDS	* RESISTANCE	STUD No.	BOBBIN No.	RESISTANCE PER BOBBIN (± 90 ohms).
14,000	0	1		
14,250 14,500 14,750	18,576 37,152 55,728±90 ohms	2 3 4	1	55,728
15,000 15,250 15,500	74,821 93,914 113,007±180 ohms	5 6 7	2	57,297
15,750 16,000 16,250	132,632 152,257 171,882±270 ohms	8 9 10	3	58,875
16,500 16,750 17,000	192,053 212,224 232,395±360 ohms	11 12 13	4	60,513
17,250 17,500 17,750	253,127 273,859 294,591±450 ohms	14 15 16	5	62,196
18,000 18,250 18,500	315,901 337,211 358,521±540 ohms	17 18 19	6	63,930
18,750 19,000 19,250	380,424 402,327 424,230±630 ohms	20 21 22	7	65,709

TABLE "D"—*contd.*

RANGE IN YARDS	RESISTANCE	STUD No.	BOBBIN No.	RESISTANCE PER BOBBIN (± 90 ohms).
19,500 19,750 20,000	446,743 469,256 491,769±720 ohms	23 24 25	8	67,539
20,250 20,500 20,750	514,908 538,047 561,186±810 ohms	26 27 28	9	69,417
21,000 21,250 21,500	584,969 608,752 632,535±900 ohms	29 30 31	10	71,349
21,750 22,000 22,250	656,981 681,427 705,873±990 ohms	32 33 34	11	73,338
22,500 22,750 23,000	730,999 756,125 781,251±1080 ohms	35 36 37	12	75,378
23,250 23,500 23,750	807,076 832,901 858,726±1,170 ohms	38 39 40	13	77,475
24,000 24,250 24,500	885,270 911,814 938,358±1260 ohms	41 42 43	14	79,632
24,750 25,000 25,250	965,641 992,924 1,020,207±1350 ohms	44 45 46	15	81,849
25,500 25,750 26,000	1,048,250 1,076,293 1,104,336±1440 ohms	47 48 49	16	84,129
26,250 26,500 26,750	1,133,159 1,161,982 1,190,805±1530 ohms	50 51 52	17	86,469
27,000 27,250 27,500	1,220,430 1,250,055 1,279,680±1620 ohms	53 54 55	18	88,875
27,750 28,000 28,250	1,310,130 1,340,580 1,371,030±1710 ohms	56 57 58	19	91,350
28,500 28,750 29,000	1,402,328 1,433,626 1,464,924±1800 ohms	59 60 61	20	93,894
29,250 29,500 29,750	1,497,093 1,529,262 1,561,431±1890 ohms	62 63 64	21	96,507
30,000	1,594,194±1980 ohms	65	22	32,763

N.B.—A section on bobbin 22 is wound to 2,000 ohms in the case of bearing and Signal Selector rings. This section, which is not included in the above figures, corresponds with R44A and R44B in fig. 11b and forms a fixed part of the potentiometer chains.

Notes on Winding Potentiometer Bobbins

92. Although it is strongly recommended that any defect internal to the Potentiometer tank shall be dealt with by sending the complete unit (IIIB & C) back to the factory, circumstances may arise where defects in individual bobbins must be dealt with on the spot. The following information would enable a bobbin to be repaired or re-made in a case of necessity.

93. *Wire.*—46 S.W.G. double-silk covered Eureka wire is used in all bobbins in the potentiometer system (Except R18C).

94. *Spare Bobbins.*

94. *Spare Bobbins.*	*Maker's Part No. of Unwound Bobbin*
Main potentiometer, 25 stud switch (R42A)	All 100,090 D
Main potentiometer, 16 stud switch (R45A)	All 100,090 D
Main potentiometer, outer ring (R40A) :—	
Odd numbered bobbins (Nos. 1, 3, etc. to 79)	100,090 B
Even numbered bobbins (Nos. 2, 4 etc. to 80)	100,090 C
Main potentiometer, middle ring (R46A)	All 100,090 CY
Main potentiometer, inner ring (R48A)	All 100,090 CZ
Ext. range potentiometer (R43A, B, C)	All 100,124 B
Fixed resistance sections R39A, B, C	All 100,079 A
(*N.B.*—R39 is made up of 3 bobbins of 300,000 ohms each and 1 of 297,976 ohms, all in series).	
Fixed resistance section R41A . .	100,079 D
Fixed resistance section R47A, B .	Both 100,079 A
Fixed resistance sections R44A, B (end bobbins ext. ring pot.) . . .	Both 100,124 B

95. Time-base charging resistance R18C, 0·76 megohm. As this uses a special former wound with wire-wound resistance tape and is the only one of its kind in the equipment it is suggested that a complete spare wound resistance should be obtained, Maker's Part No. 100,096A.

Adjusting and Checking Resistance Bobbins

96. A useful bridge for dealing with single bobbins is a reliable make of normal resistance bridge having decade dials for units, tens, hundreds and thousands of ohms and ratio arms for multiplying or dividing by 1, 10, 100 and 1000. Such a bridge, in conjunction with a mirror galvanometer and adjustable shunt, may be used for measuring up to 0·99 megohms. The accuracy of the bridge must be at least 0·1 per cent.

97. If only one or two bobbins in any one potentiometer chain are replaced by new ones made to within 0·1 per cent. of the specified value, the accuracy of the potentiometer as a whole will not be noticeably affected. If, however, a larger portion of the bobbins, say more than 15, were replaced in this way a cumulative error might be built up which would bring the total resistance at certain studs outside the limits allowed. In such a case the only course would be to replace completely the electrical section of the potentiometer (*i.e.* the part inside the tank).

98. The most critical individual bobbins for replacement are the 300,000 ohm bobbins constituting R39A, the limits specified being $\pm$30 ohms *i.e.* 0·01 per cent. It would, however, be just permissible to replace one of these by a bobbin accurate to 0·1 per cent.

99. A small percentage error in resistance between any potentiometer stud and the negative end, or in total potentiometer resistance, means approximately a corresponding percentage error in Range reading. Precautions should be taken that a new bobbin is thoroughly dry throughout before inserting in the potentiometer.

100. Only an approved non-corrosive soldering flux should be used in making joints in the potentiometer system.

Potentiometer Unit, IIIB and IIIC, Mechanical Arrangements

(figs. 12a, 12b and 12c).

101. The following electrical parts of the potentiometer are housed in the cast metal oil-filled tank :—

Outer ring R40A, 241 studs.	Range potentiometer	(660,825 ohms).
Middle ring R46A, 121 studs.	Bearing and Elevation potentiometer	(660,825 ohms).
Inner ring R48A, 121 studs.	Signal Selector potentiometer	(660,825 ohms).
Extended Range Potentiometer R43A, 65 studs.	Range	(1,594,194 ohms).
Extended Range Potentiometer R43B, 65 studs.	Bearing and Elevation	(1,594,194 ohms).
Extended Range Potentiometer R43C, 65 studs.	Signal Selector	(1,594,194 ohms).
Subsidiary Potentiometer R42A, 25 studs.		(34,899 ohms).
Variable Resistance R45A, 16 studs.		(7,500 ohms).
Range time-base resistance R18C		(0·75 megohm).
Range time-base condenser, fixed C18C		(55 $\mu\mu$F).
Range time-base condenser, variable, C17B		(41 $\mu\mu$F max. in air).
Setting switch.		

Fixed Resistances

102. Various fixed resistances in potentiometer chains (R39A, R41A, R39B, R37A, R44A, R39C, R47B, R44B) and by-pass condensers C39A, C39B are carried on a paxolin panel suspended from the cast metal lid of the tank near the front panel end by six insulating pillars. The extended range potentiometers form a group separately suspended from the lid near the back (narrow) end of the tank.

103. All control shafts are brought via flexible couplings to extensions passing through the lid to the gearing above. The gearing associated with the Potentiometer is mainly carried by the cast-iron tray supported on top of the tank lid by cast iron pillars.

Oil Filling

104. The correct oil level is above the joint between the lid and the top edge of the tank; it is therefore most desirable not to disturb or loosen this joint in any way unless it is absolutely unavoidable and certainly not before removing the oil from the tank.

NOTE.—A screw-plug for emptying will be found near the bottom of the tank at the back.

105. Before the potentiometer tank is filled at the factory precautions are taken to dry out all the resistance bobbins and to remove moisture and dust from the oil used. This is an additional reason for subsequently opening the potentiometer tank as little as possible.

106. *Oil.*—See General Notes on Insulation, page 68.

Tank Breathing Tubes

(See fig. 12b.)

107. In order to equalise the pressure inside the potentiometer tank with the atmospheric pressure outside, a number of tubes are provided, which enter the coupling-shaft necks on the lid just above the oil level (see fig. 12b). These tubes unite in a common output to the atmosphere via a Silica Gel Transformer Breather, size S (fig. 12c), which allows the free passage of air but removes any moisture which might enter with air from outside. This type of breather is provided with an oil seal which ensures that the Silica Gel is not in contact with the external atmosphere when no breathing is taking place.

108. The Silica Gel desiccating crystals are visible through a window in the outer container and as long as they remain deep blue in colour they are in an active, water absorbing condition. When the Silica Gel charge becomes saturated with moisture the colour changes to a whitish pink and must be changed for an active one and the saturated charge reactivated.

Changing the Silica Gel Charge

109. To change the charge, unscrew the wing nuts and remove the lower portion of the breather. The inner container can then be removed for reactivation.

Reactivating The Silica Gel Charge

110. The container can should be heated in an oven to a temperature of approximately 300°F for a sufficient length of time to ensure that the whole of the mass of gel attains the specified temperature and the blue colour has been restored right through.

Potentiometer Gearing

(figs. 12a, 12b, and 12c)

111. *The Functions of the Potentiometer Gearing*

(*a*) To drive the Main and Extended Range Potentiometers in the right sequence from the operators handle.

(*b*) To drive the main Range Scale in correct relation to the potentiometers.

(*c*) To drive a pair of A.C. Control Elements for transmitting the Range readings to a distant point.

(*d*) To provide for a "Displacement Correction" for the distance between transmitter and receiver, to be automatically applied to the information sent out by the A.C.C.E.'s.

(*e*) To permit a manually adjusted zero correction for locking-cable and receiver delay to be applied to the information sent out by the A.C.C.E.'s ("Correction Knob").

Fig. 12a is a schematic diagram of the gear trains. It includes the gearing associated with the Bearing Scale as this is interconnected with the Potentiometer Gearing at the Displacement Corrector described later.

Component Markings

(In fig. 12a)

112. Each gear wheel is marked with the number of teeth and each shaft with the yards range represented by one complete revolution as well as an arrow showing the direction of rotation for *increase* in range. The numbers in circles are for reference to the various gear wheels etc., in the description.

Main and Extended Range Potentiometer Drive

(See fig. 12a)

113. The Range Potentiometer Handle, drives through a two ratio gear box connecting spur gears 1, 2, 3 and 4. When the handle is pulled out toward the operator a step-down of 4 to 1 in speed is obtained; when the handle is pushed in a step-up of 4 to 1 is obtained.

114. The horizontal out-going shaft from the gear-box drives by worm 5 and worm-wheel 6 (fig. 12a), the body of Differential Gear No. 1. From this point onwards the motion is transmitted either to the vertical main potentiometer shaft or to the vertical extended range potentiometer shaft, according to the section of range being covered, in the following manner :—

115. When the body of a differential gear is driven it tends to impart equal motion to both its out-going shafts. If one of these shafts is locked the motion will be transmitted to the other at twice the speed. One vertical outgoing shaft of Differential No. 1 drives the main potentiometer slider arm direct and Interlocking disc No. 1 (fig. 12a) through steel bevel gears 11 and 12 and the diagonal shaft connected to gear 12. The other outgoing shaft of Differential No. 1 drives the extended range potentiometer wiper arms and Interlocking disc No. 2 (14) through bevel gears 15, 16, 17 and 18. The interlocking discs are so geared and phased with respect to the potentiometers that while the slider of the potentiometer is anywhere between the 2,000 yard and 14,000 yard settings (studs 1 to 241) the periphery of Inter-locking Disc No. 1 is free to slide in the slot in the periphery of Disc No. 2 while preventing Disc No. 2 from moving. When the slider of the main potentiometer reaches the 14,000 yard setting (241st stud) the projecting stop on Disc No. 1 prevents its travelling any further by engaging with the face of Disc No. 2. Further, the slot in the periphery of Disc No. 1 is now presented to Disc No. 2 in such a manner

that the latter is free to rotate. From this point onwards the main potentiometer shaft is locked, and the drive from the handle is imparted via the differential to the extended range potentiometer shaft only.

Potentiometer Handle and Stops

116. The operating handle of the Potentiometer is connected to the input shaft of the gear box by a safety friction device which can slip when the limit of travel is reached, thus reducing the possibility of damage to the mechanism by over turning.

117. The whole range of operation of the Potentiometer requires 80 revolutions of the outgoing shaft of the gear box and the number of revolutions possible is limited to this figure by a stop device in the gear box. This consists of an idling gear wheel 68 (81 teeth) engaging with 3 (80 teeth). Each wheel has a projecting stop near its periphery, which meet and prevent further motion at either extremity of an interval of 80 revolutions.

Potentiometer Drive Indicator Lamps

118. A cam-operated switch S10A (figs. 11b and 32) located on gear box is operated by the rotation of the Potentiometer drive shaft from the gear box in such a manner that one or other of the two 6 V. lamps on panel IE lights according to the direction in which the potentiometer handle is being turned. While the Range scale (Panel IIID) is showing a decrease in range the green lamp lights ; the red lamp lighting when the Range is being increased. This tells the operator at the Elevation controls whether to expect an increase or decrease in Elevation reading, according to whether the target is approaching or receding.

Main Range Scale Drive

119. The main Range scale 67 (fig. 12a), which is driven from Differential No. 1 body via gears 19, 20, 39, 40, 41 and 42 is directly calibrated in yards continuously from 2,000 to 30,000 yards. The operator works his Range Potentiometer handle continuously over the whole of this range, the change-over between potentiometers at 14,000 yards being done for him automatically in the manner described.

Range A.C. Control Elements

120. The Range readings obtained with the Potentiometer can be transmitted to a distant point by means of a pair of A.C. Control Elements incorporated in the Potentiometer gearing.

The low-speed A.C.C.E., covering a range of 2,000 to 30,000 yards is driven in a fixed relation to the Range scale through gears 21 and 22.

Correction Knob

121. The high-speed A.C.C.E., covering 2,000 yards per revolution, is driven from the main potentiometer shaft through gears 23, 24, Differential No. 2, 33, 34 and 35 (fig. 12a). The purpose of Differential No. 2 is to advance or retard the rotation of the high-speed A. C. C.E. with respect to the main potentiometer shaft by means of the CORRECTION KNOB. A worm 30 engages with a worm gear 29 on the body of the differential which is thus held stationary against any drive coming from the main potentiometer shaft via gears 23 and 24. All the motion is passed via the internal gears 25, 26, 27 and 28 of the differential to the outgoing shaft to gear wheels 33, 34 and the high-speed A.C.C.E. If, however, the CORRECTION KNOB is turned worm 30 is rotated, by way of gears 32 and 31, imparting a rotary displacement to the body of Differential No. 2 and giving an advance or retardation in phase of the high-speed A.C.C.E with respect to the main potentiometer shaft, according to the direction in which the CORRECTION KNOB has been turned. The CORRECTION KNOB thus allows range readings to be transmitted with a pre-determined small additive correction.

Range Displacement Correction Mechanism

122. Since the radio pulse transmitter and receiver are separated by an appreciable distance, the reading obtained direct from the Potentiometer gives the range R of the target as measured from the mid-point of the line joining the transmitter and receiver. To convert this distance to the distance as measured from the receiver itself a correction must be applied. If the distance between transmitter and receiver is d, the angle between the line joining them and the direction of the target β°, and the elevation of the target at the receiver a°, then the corrected range becomes

$$RC = R + \frac{d}{2} a \cos \beta$$

In practice a is taken as an arbitrary mean value of 41°, 25′, as a first approximation, giving $\cos a = 0 \cdot 75$. The correction to be applied then becomes $0 \cdot 375 \cos \beta$

123. It will be seen therefore that the displacement correction varies with the bearing of the signal and is zero when the direction of signal is at right-angles to the line joining transmitter and receiver.

124. This Range displacement correction is applied to the information sent out by the high-speed A.C.C.E. by imparting a slight angular displacement to the body of the A.C.C.E from the Bearing gearing (also illustrated in fig. 12a) associated with the rotation of the cabin.

125. A worm 38, coupled to the horizontal shaft which transmits the Bearing readings, drives a worm wheel 37 at cabin rotation speed. A crank-arm 63 is attached to this worm wheel, its pivot being moveable along a diameter of worm wheel 37 and adjustable by a traversing screw 36 against an engraved displacement scale calibrated up to 200 yards. Thus the stroke of the crank-arm is adjustable from zero, when the pivot is at the centre, to a maximum when the pivot is near the periphery of the worm wheel. The other end of the crank-arm, which executes an approximately linear motion for small excursions, moves to a cosine law with respect to the rotation of the worm wheel 37 and therefore with respect to the bearing shafts. This end of the crank-arm carries a pivot which engages with and drives plate 62 which is in turn attached to the rotatable housing of the high-speed A.C.C.E., the correction being applied by advancing or retarding the stator with respect to the rotor.

126. The Range displacement correction mechanism can be thrown in or out of operation by means of the turn-button lever ("RANGE DISPLACEMENT ") on the front panel of the Potentiometer Unit. When this lever is thrown to the " OUT " position the movement is transmitted via pinion 60 and rack 61 to a guiding member 64 which disengages the pivot of crank-arm 63 from plate 62 and at the same time locks plate 62 in a fixed position by a dowel on its under-side by engaging with a recess in member 64. In this condition the high-speed A.C.C.E. stator is in a fixed position with no drive from the Bearing side.

Setting of Range Displacement Corrector

127. The distance in yards between transmitter and receiver cabins on their site, and in their actual respective working positions, must be ascertained. Set the RANGE DISPLACEMENT lever to "IN" and rotate the receiver cabin until the vertical edge at the corresponding side of the transmitter cabin is sighted on the cross-wires of the telescope associated with the Elevation mechanism. The maximum correction is now required.

128. Slacken locking screw 68 (fig. 12c) and turn traversing screw 36 until the indicator mark of the traversing block is at the reading on the engraved scale corresponding to the distance in yards between the transmitter and receiver. Lock in this position by tightening screw 68.

129. Disengage adjustable coupling 57 (fig. 12a and 31) by undoing the knurled clamping screw 72 until the worm 70 can be disengaged from the worm wheel 71. Rotate displacement corrector worm wheel 37 (fig. 12a and 12c) by turning the shaft of worm 38 until the pivot of crank-arm 63 is at the farthest point of its travel from worm 38. This position can be found exactly by aligning the engraved marks on the big end of crank-arm 63 and the pivot-collar rotating inside.

130. Re-engage worm 70 and worm wheel 71 of coupling 57. A final fine adjustment may be carried out here by rotating worm 70 in the required direction before finally tightening the clamping screw 72 and locking with the knurled nut.

Internal Pre-Set Adjustment in Potentiometer Gearing

131. *Adjustable Coupling, Main Potentiometer.*

This is marked 43 on figs. 12a and 12b, its purpose being to permit an adjustment of a few degrees, in the main potentiometer shaft with respect to the shaft carrying internal scale 65 and the rest of the gearing. A steel tongue projecting radially from the lower potentiometer shaft is held by two opposing set screws mounted in the part of the coupling attached to the upper shaft which goes to the gearing. After slackening off the lock-nuts of the set screws the latter may be turned so that one is withdrawn from the tongue while the other is screwed further home against the tongue until it is again held firmly without play between the set screws. This locks the lower shaft in a new position with respect to the upper shaft. It is most important that there should be no possibility of play and the lock-nuts must be tightened again properly after the adjustment is completed.

132. *Adjustable Coupling, Extended Range Potentiometer.*

This is marked 44 in figs. 12*a* and 12*b*, its purpose being to permit an adjustment of a few degrees in the extended range potentiometer shaft with respect to the upper shaft carrying Interlocking Disc No. 2. The method of adjustment is the same as in the case of the main potentiometer coupling described in the preceding para.

133. *Adjustable Coupling, Interlocking Disc No. 2.*

This is marked 45 in figs. 12a and 12b, its purpose being to permit an adjustment of a few degrees between Interlocking Disc No. 2 and the vertical shaft proceeding from it to the gearing. The method of adjustment is the same as in the case of the main potentiometer coupling described above.

134. *Internal Potentiometer Scales.*

These two scales, marked as 65 and 66 in figs. 12*a* and 12b, can both be set independently of the rest of the mechanism. In each case there will be found three small clamping plates bearing on the upper edge of the scale ring. By slackening off the hexagon-headed bolts through the tops of these clamping plates the scale ring is left free to be set at any desired position. The clamping bolts must all be carefully tightened up again after the required adjustment has been made.

135. *Procedure for Setting Potentiometer Arms to Gear Box (See fig. 12a).*

The angular position of Interlocking Disc No. 2 divides the total available turns of the gear box between main and extended range potentiometers. Proceed as below, noting that the settings of the Interlocking Disc and the potentiometer arms are critical.

(*a*) Starting from full clockwise position of Potentiometer with the handle in the *low speed position* (*i.e.* pulled out) turn anti-clockwise 138·6 revolutions (138 turns plus 216°).

(*b*) With handle in this position adjust Interlocking Disc No. 2 (horizontal disc) by means of coupling 45 to the exact change-over point, *i.e.* when the slots in both discs are accurately in line.

(*c*) Adjust angular position of brush arm on main potentiometer by means of coupling 43 to give equal overlap on opposite end studs when turning from maximum clockwise position of handle to change-over position of interlocking discs (*i.e.* 2,000 yards to 14,000 yards).

(*d*) Adjust angular position of brush arm on extended range potentiometer by means of coupling 44 to give equal overlap on opposite end studs when turning from change-over position of interlocking discs to maximum anti-clockwise position of handle (*i.e.* 14,000 yards to 30,000 yards). The total amount of overlap on all four studs should be equal. If necessary readjust Interlocking Disc No. 2 and angular positions of potentiometer arms (coupling 43 and 44) to give this result.

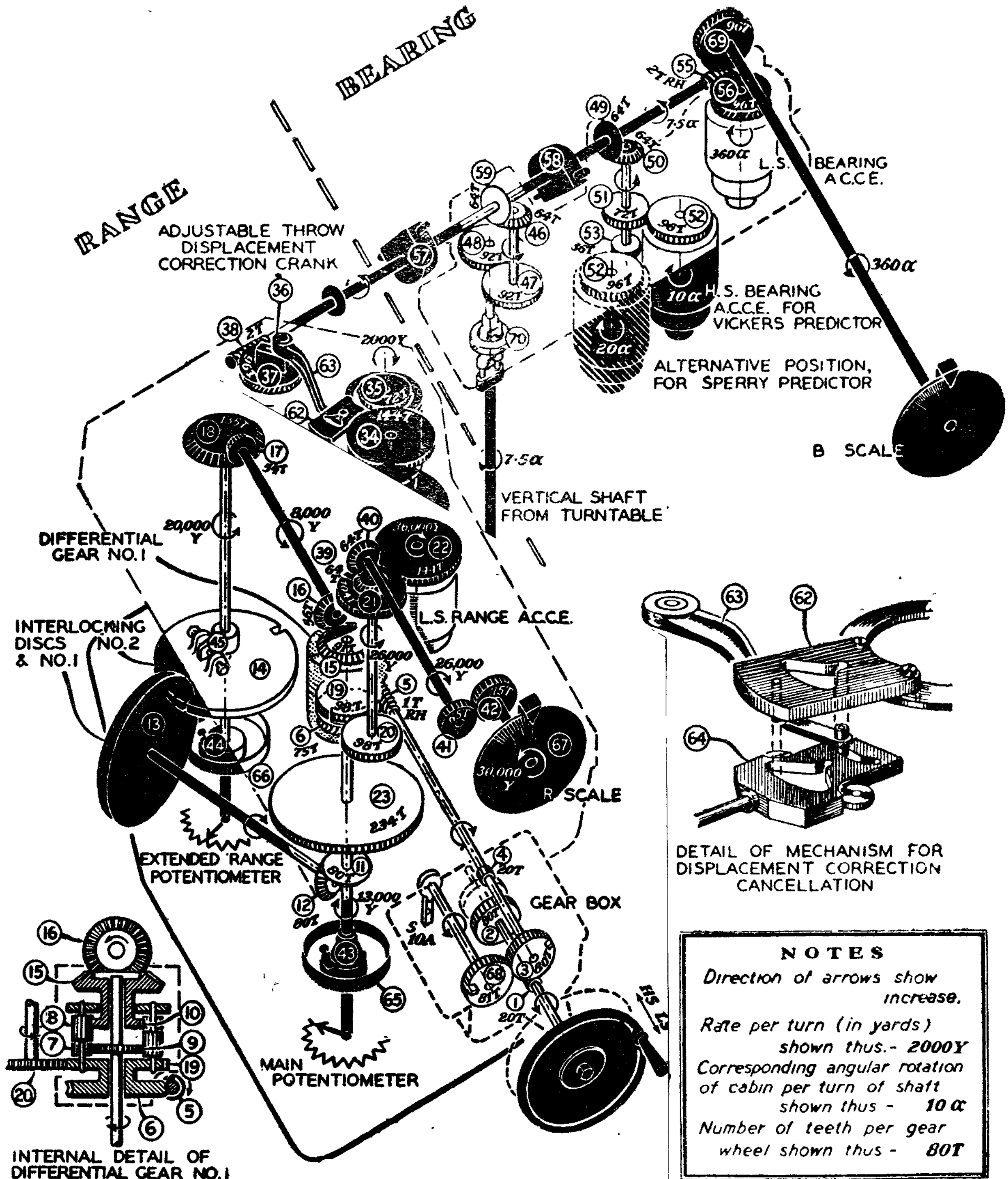
(*e*) (*i*) With interlocking discs set accurately to change-over position adjust drum scales on both potentiometers to read 14.

(*ii*) Set " R. Scale " (front panel Unit IIID) to read 14 by adjusting pointer and, if necessary, by re-meshing gears.

136. *Checking Electro-Mechanical Setting of Main and Extended Range Potentiometers.*

The main work in making the positions of the wiper arms on the contact studs line up with the mechanism and scales is essentially a factory adjustment which is carried out before the Potentiometer is enclosed in its tank. A check, and possibly re-adjustment, for small discrepancies may, however, be made by either of the following two procedures.

(*a*) When the Calibrator Unit II C is available the simplest method is to check against this. Switch the Calibrator Unit to give the usual series of calibrating pips on the Range tube screen and check that the time-base control, SETTING 4, is properly adjusted (see para. 79)



NOTES

Direction of arrows show increase.

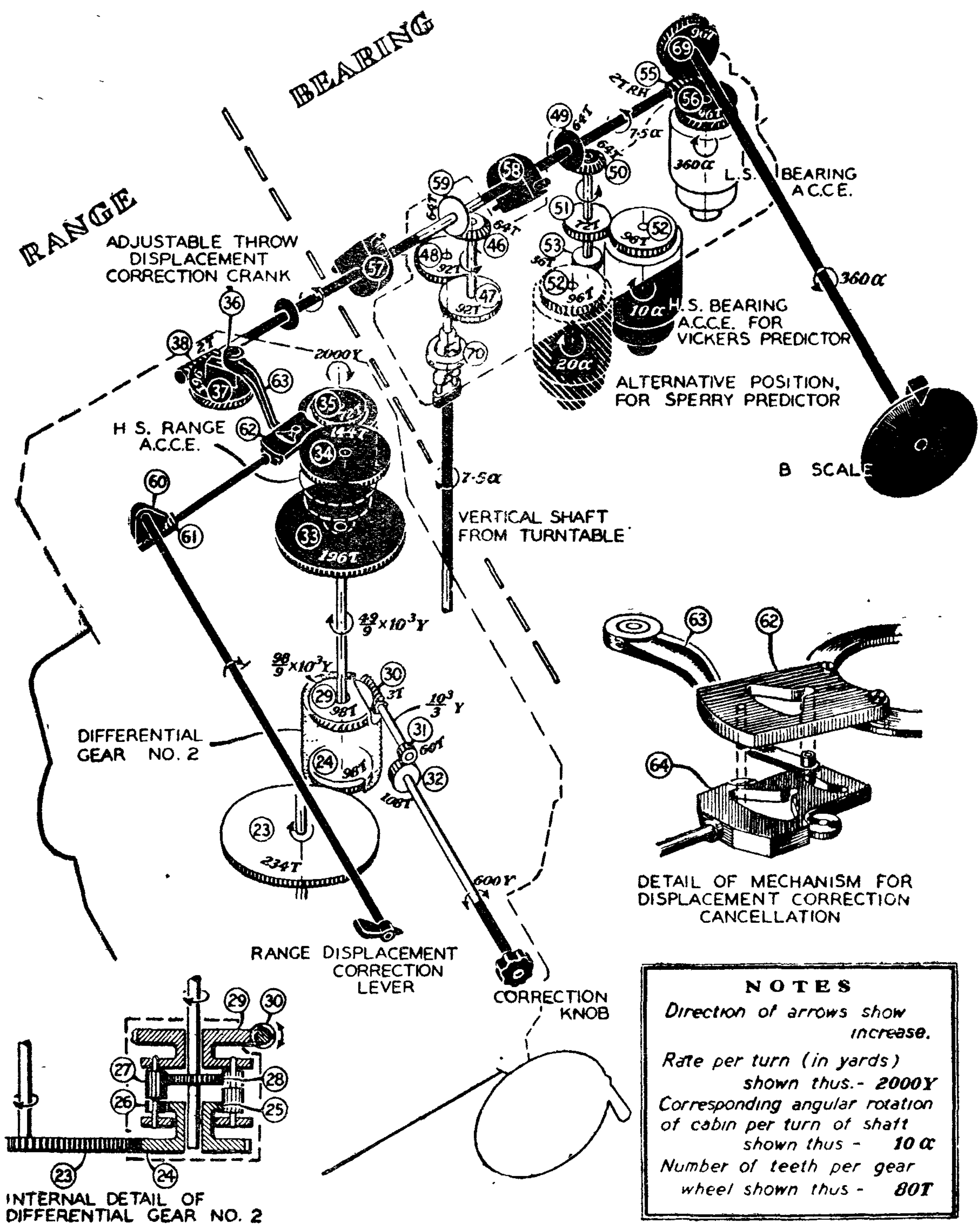
Rate per turn (in yards) shown thus.- ***2000Y***

Corresponding angular rotation of cabin per turn of shaft shown thus - ***10 α***

Number of teeth per gear wheel shown thus - ***80T***

T. DESC. $\frac{T-R.08}{1-12A}$

FIG. 12A POTENTIOMETER GEARING SCHEMATIC DIAGRAM



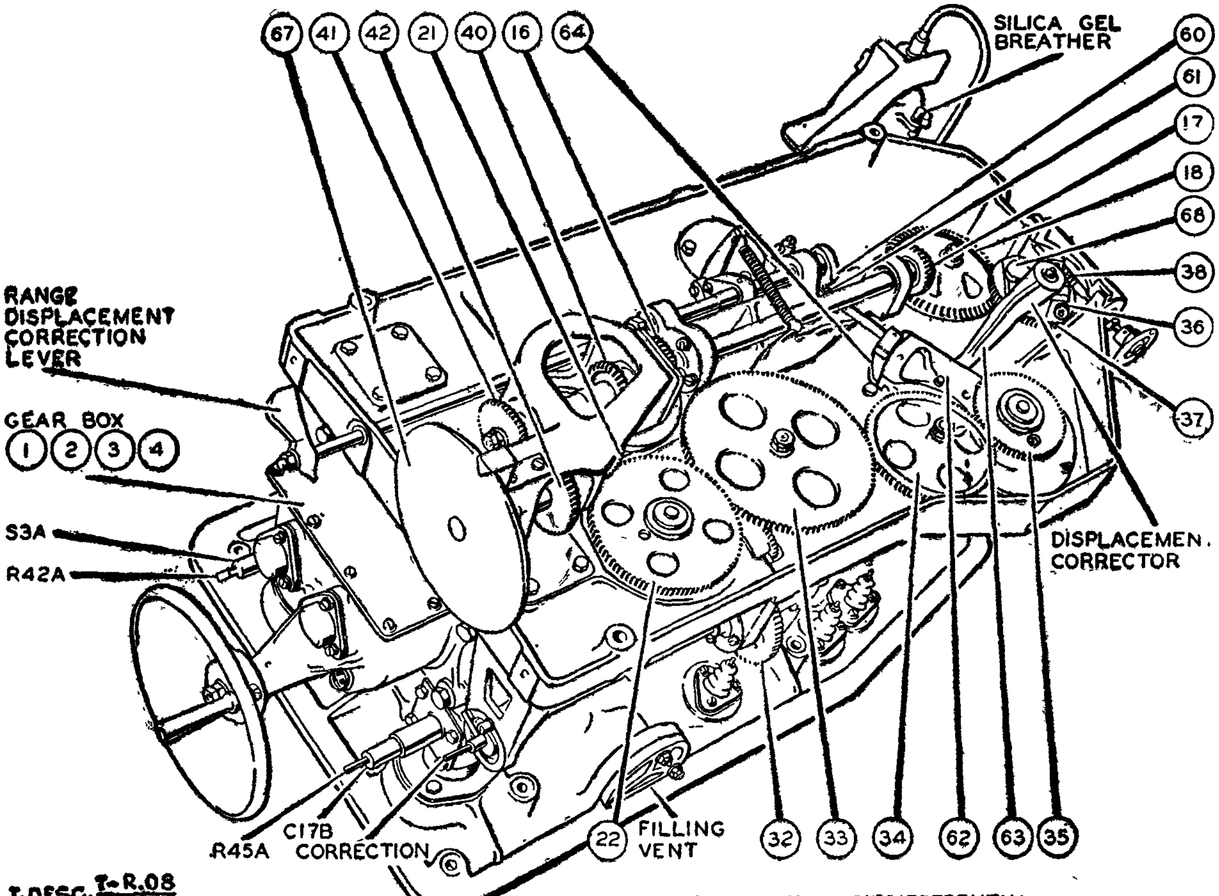
NOTES

Direction of arrows show increase.

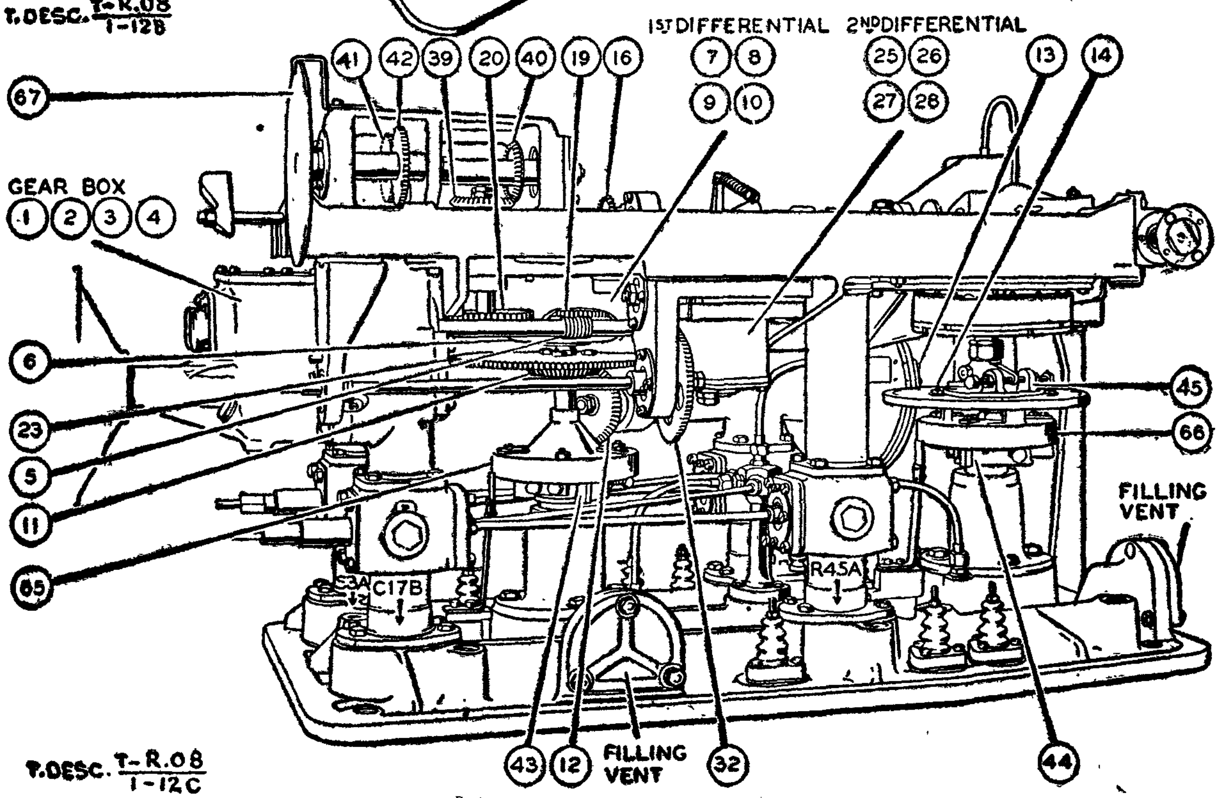
*Rate per turn (in yards) shown thus.- **2000Y***

*Corresponding angular rotation of cabin per turn of shaft shown thus - **10 α***

*Number of teeth per gear wheel shown thus - **80T***

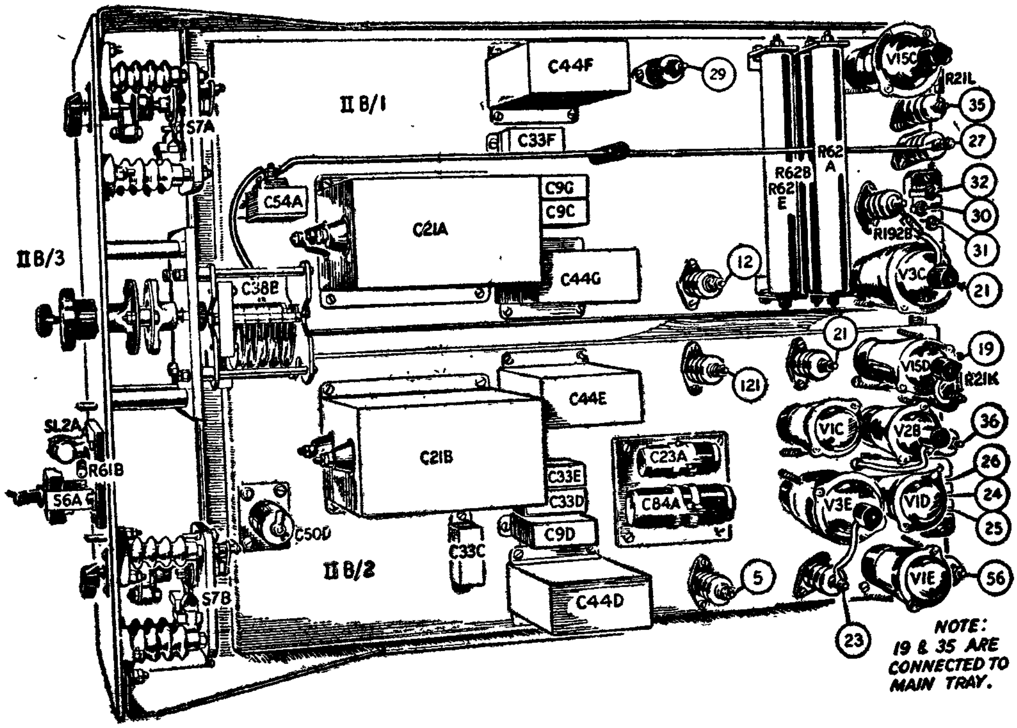


T.DESC. $\frac{\text{T-R.08}}{\text{1-12B}}$

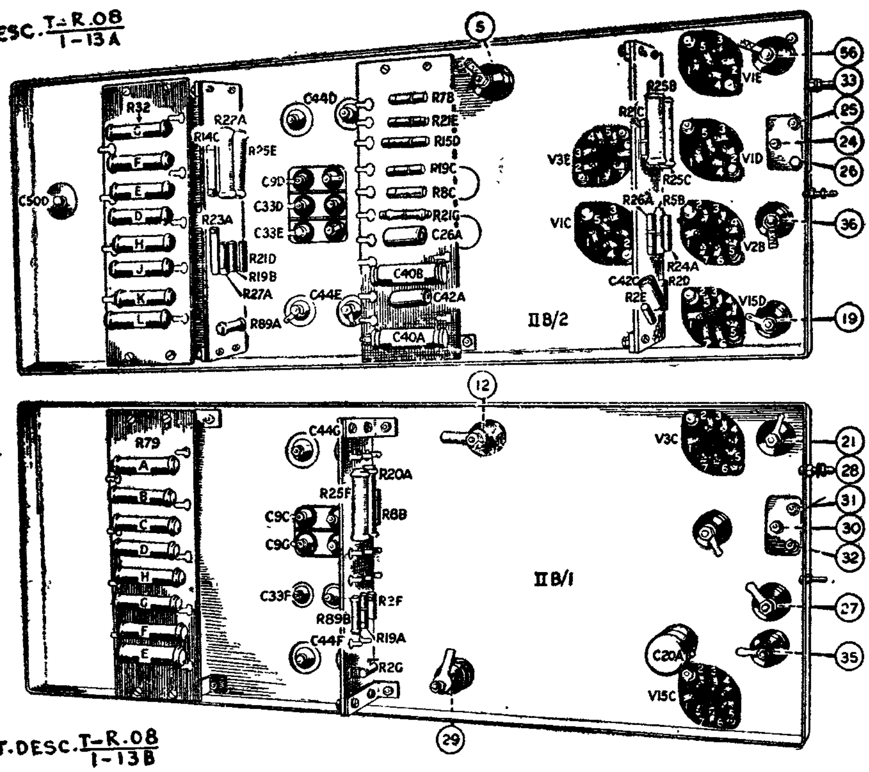


T.DESC. $\frac{\text{T-R.08}}{\text{1-12C}}$

FIGS. 12B & C POTENTIOMETER GEARING. A.C.C.E.'S HAVE BEEN OMITTED FOR CLARITY

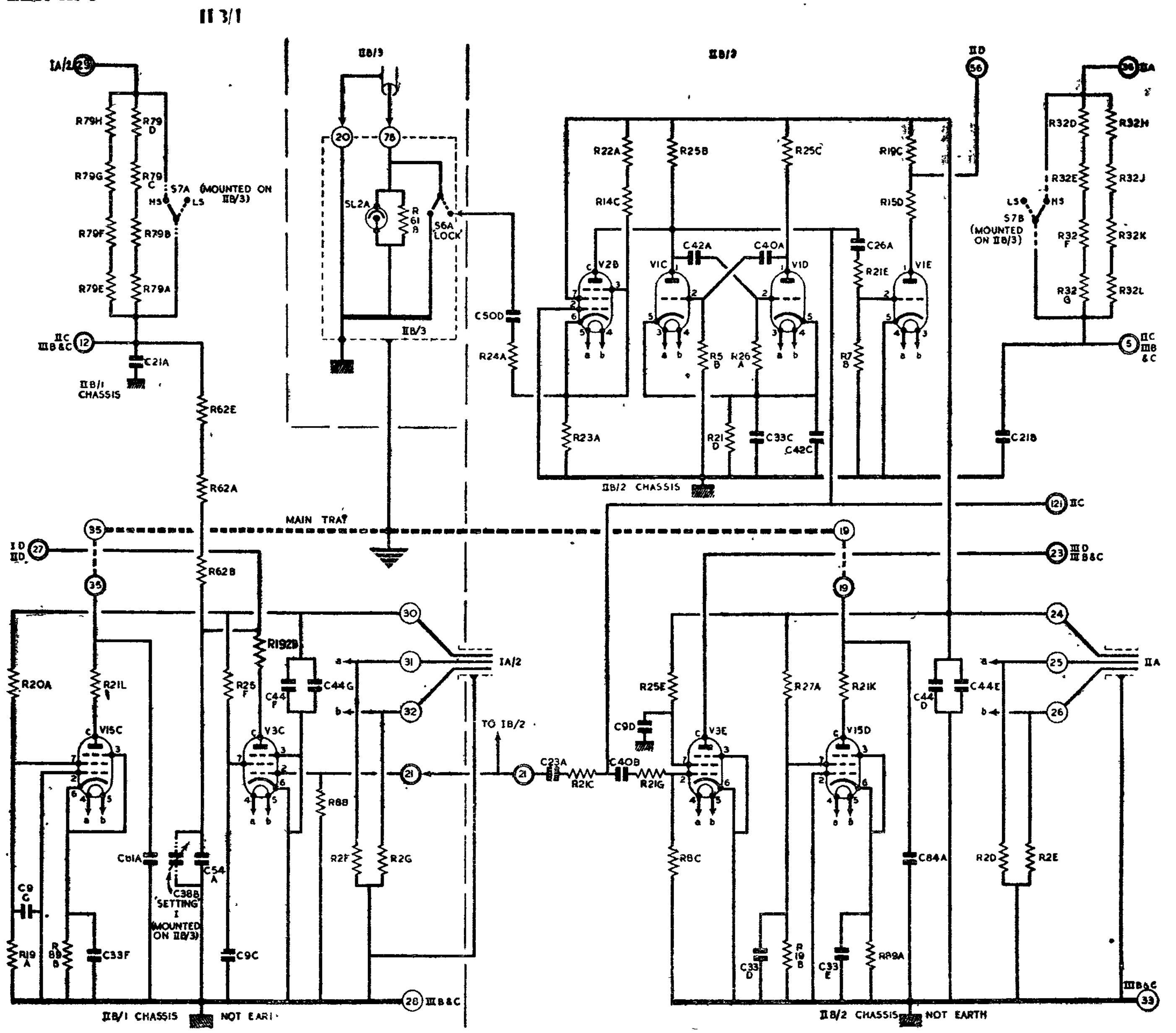


T.DESC. T-R.08 / 1-13A



T.DESC. T-R.08 / 1-13B

FIGS 13A & B TIME BASE UNIT II B



T.DESC. T-R.08 / I-14

Fig. 14.—Circuit of Unit IIB

V1 AR 17 | V2 ARP 23 | V3 ARP 26 | V15 APR 33

C9	1 mfd.	400 V.	R2	100 ohms	5% 1/2 W.	R26	50,000 ohms	5% 1/2 W.
C21	1 mfd.	4,000 V.	R5	20,000 ohms	5% 1/2 W.	R27	75,000 ohms	5% 1/2 W.
C23	0·001 mfd.	4,000 V.	R7	0·1 megohm	5% 1/2 W.	R32	0·75 megohm	5% 2 W.
C26	0·005 mfd.	450 V.	R8	0·25 megohm	5% 1/2 W.	R61	100 ohms	5% 1 W.
C33	0·1 mfd.	250 V.	R14	20,000 ohms	5% 1 W.	R62	253,333 ohms	(3 in series ·76 megohm ± 5,000 ohms)
C38	18-71 mmfd.	Air var.	R15	0·1 megohm	5% 1 W.			
C40	0·1 mfd. 10%	500 V.	R19	10,000 ohms	5% 1/2 W.			
C42	0·0023 mfd.	5%	R20	75,000 ohms	5% 2 W.	R79	1 megohm	5% 2 W.
C44	8 mfd.	400 V.	R21	5,000 ohms	5% 1/2 W.	R89	800 ohms	5% 1/2 W.
C50	0·01 mfd.	4,000 V.	R22	40,000 ohms	5% 2 W.	R192	50 ohms	1/4 W.
C54	78 mmfd.	±1 mmfd.	R23	2,000 ohms	5% 1 W.	S6	D.P.D.T.	
C81	0·01 mfd.		R24	500 ohms	5% 1/2 W.	S7	S.P.D.T.	
C84	0·034 mfd.	4,000 V.	R25	20,000 ohms	5% 2 W.	SL2	Neon discharge cartridge.	

Note.—All limits are ± 15% unless otherwise indicated.

Turn the potentiometer handle throughout its range starting from the fully clockwise position and noting readings on internal potentiometer scales 65 and 66 (fig. 12a). At 3 on the main potentiometer scale the upper peak of the leading edge of the 3rd calibrator pip from the left should lie on the cross-wire. Proceeding to, say, the 12th pip, this should lie similarly on the cross-wire when the internal scale reads 12. Remember that each stud on the main potentiometer represents 50 yards and each calibrator pip 1,000 yards, exactly 20 studs should be traversed between consecutive pips between 2,000 and 14,000 yards. Continuing past the 14,000 yard change-over point, the 15th pip should lie on the cross-wire as described above, when the internal extended range potentiometer scale reads 15. Check also that the 29th pip lies on the cross-wire when the scale reads 29. Between 14,000 and 30,000 yards each stud of the extended range potentiometer represents 250 yards so that only 4 studs are traversed between consecutive calibrator pips Tables B and D give stud number against yardage for both potentiometers on the Range side and it is quite possible by careful observation to count the individual stud jumps on the Range tube throughout the entire range as the Potentiometer handle is slowly turned.

(*b*) Where a Calibrator Unit is not available but there is a means of accurately measuring high resistances the following method may be adopted :—

Put SETTING SWITCH at Position 4 and turn SETTING 2 fully clockwise to cut out the 7,500 ohm resistance R45A. Measure resistances on D.C. between terminals 6 and 33 and read range on internal potentiometer scales. The following table gives the resistance values which should be obtained if the wiper arms are resting correctly on the right studs for the settings given. If necessary adjust couplings 43 and 44 (figs. 12a and 12b) as described in preceding paras. to achieve these results.

137.

POTENTIOMETER DRUM DIAL SETTINGS	RESISTANCE OHMS.	LIMITS OHMS.
Main Potentiometer 3 .	208,008	±260
,, ,, 6 .	394,392	±260
,, ,, 9 .	561,389	±260
,, ,, 12 .	711,018	±260
Extended Range Potentiometer 15.	876,845	±470
Extended Range Potentiometer 22	1,483,451	±1220
Extended Range Potentiometer 29.	2,266,948	±2060

R. E. & B. TIME-BASE UNIT IIB

(Circuit fig. 14, Chassis figs. 13a and 13b.)

138. This unit provides time-base voltages for Range Bearing and Elevation cathode ray tubes. It is sub-divided into two sub-chassis:—II B/2 for Range time-base and II B/1 for Bearing and Elevation time-base. Both sub-chassis are highly insulated from earth by insulating pillars supporting them in the main tray. Certain controls are brought out to the front panel which is designated II B/3.

Range Time-Base IIB/2

139. This is the left-hand of the two sub-chassis, looking into the back of the rack. It contains six valves :—V2B, a screened pentode valve acting as a synchronising pulse amplifier ; V1C and V1D, two triodes acting as a Kipp relay ; V1E, a triode amplifier supplying blacking-out voltage for the fly-back of the Range C.R. tube ; V3E, a screened pentode functioning as time-base keying valve ; V15D, a screened pentode functioning as the lower valve of the Range automatic valve potentiometer. (see also page 15 and fig. 11a).

140. In the absence of input at the grid of V2B the Kipp relay stands in the condition of V1D at zero grid voltage and passing full anode current while V1C is cut off. When the cathode input of V2B receives a negative pulse from the locking cable the anode of this stage passes on a negative pulse to the anode of V1C and the grid of V1D (Note that the grid-cathode input of V2B is inverted). This causes the Kipp relay to change over to the reversed condition of V1C passing the full anode current and V1D being cut off. This condition is maintained for a time determined by the time-constant of C42A and R26A, which the Kipp relay reverts to its original condition and holds there indefinitely until the receipt of a further negative pulse on the grid of V2B. (For the waveform produced by the Kipp relay see fig. 45b., page 79).

141. When the Calibrator Unit is being used the negative pulses are applied directly to the anode of V1C via terminal 121, the valve V2B only being used for locking pulses derived from transmitter through the locking cable. The valve V3E is connected in parallel with the charging condenser C17B and C18C of the Range time-base (located with charging resistance R18C in the potentiometer case) and the time-base stroke occurs when its grid is taken to cut-off by means of the Kipp relay. This valve is of the KT44 type but is subject to the requirement that it should withstand an anode voltage of 4,000 V. and should cut off at this voltage to an anode current of 50 μA with a grid bias of not more than—65 volts (with 50 V. on screen). For this reason the valves for this stage are specially selected and marked with the distinctive coding A.R.P. 26.

High-Speed Low-Speed Switch

142. On the underside of this chassis is mounted a panel with eight ·75 megohm resistances (R32D, R32E etc.) connected in series-parallel to give an effective resistance of 1·5 megohm. This resistance is in series with the 4,000 V. supply to the Range potentiometer and time-base system and can be short-circuited out by the highly insulated switch S7B located on the front panel on the right (as seen from the front). With the switch closed (H.S.) the full normal H.T. voltage of

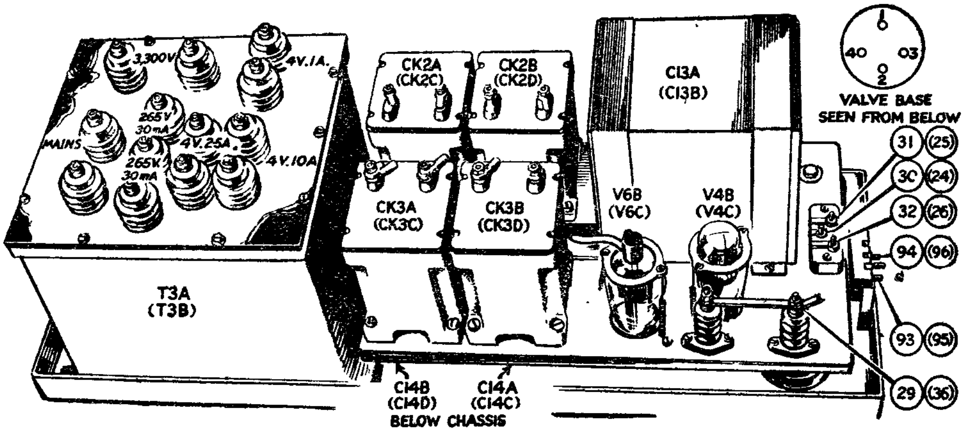
4,000 V. is applied to the time-base system and the full velocity and length of spot sweep is obtained on the tube. With the switch open (L.S.) the voltage applied to the time-base system is reduced to about 1,100 volts and the velocity and length of sweep correspondingly reduced. This latter condition is useful in searching since the whole picture is compressed along the direction of the time-base and a greater part of the entire range can be inspected at once.

Locking Switch

143. The locking cable enters the unit via a switch S6A on the front panel which permits the cable lock to be disconnected at will as, for instance, when tests are to be made with the Calibrator Unit. Associated with this switch is a 100 ohm line terminating resistance R61B and a protective neon cartridge SL2A in parallel with the line.

144. The circuit conditions of the Potentiometer necessitate the chassis of II B/2 being highly insulated from the ground. Leads 75, 21, 121 and 56 which are not highly earth insulated are stopped off with high insulation condensers C50D, C23A, C51A, C40B, C51D, some of which are accommodated on other units. Connections to other units are made with stiff self-supporting wires with the double object of obtaining a maximum air-insulation as well as a definite and constant stray capacity.

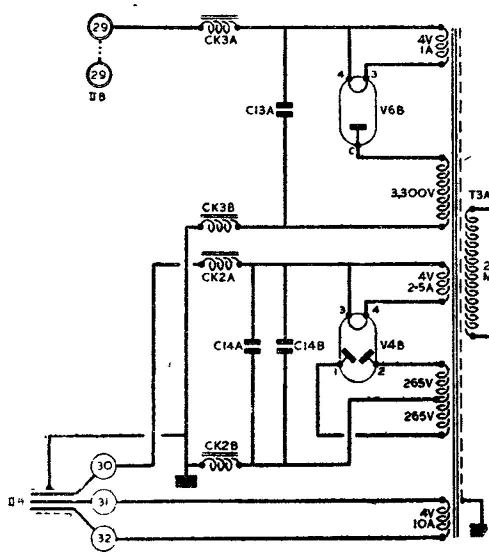
145. Condenser C84A holds the chassis at a steady potential with respect to earth for A.C. and pulse voltages without affecting the D.C. potentials supplied by the Potentiometer.



T.DESC. T-R.08 / 1-15

FIG. 15 TIME BASE POWER SUPPLY UNITS I A/2 AND II A

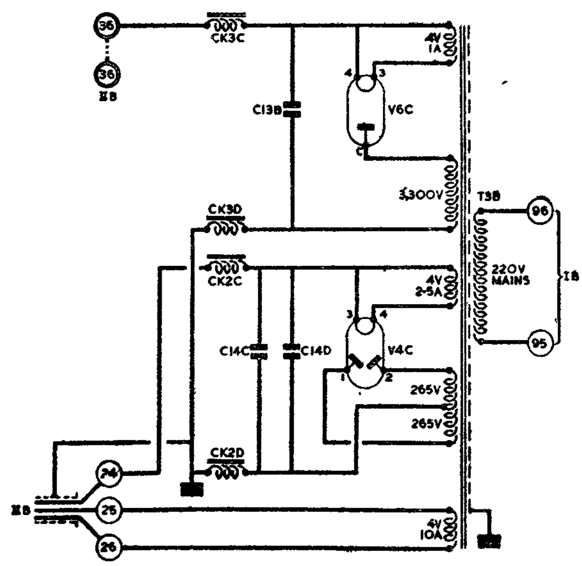
Note: Numbers in brackets refer to Unit II A. Others to I A/2



T.DESC. T-R.08 / 1-16A

IA/2

FIG. 16A (IA/2)



T.DESC. T-R.08 / 1-16B

IIA

FIG. 16B (II A)

V4 AU3

V6 AU5

CK2 45 H 30 mA D.C.
CK3 100 H 30 mA D.C.
T3 Mains transformer.

C13 1 mfd. 5,000 V.
C14 2 mfd. 10% 400 V.

NOTE —All limits are ± 15 % unless otherwise indicated.

Bearing and Elevation Time-Base II B/1

146. This is the right-hand of the two sub-chassis, looking into the back of the rack. It contains two valves :—V3C, a screened pentode functioning as time-base keying valve; V15C, a screened pentode functioning as the lower valve of the automatic valve potentiometer (see also page 15 and fig. 11a).

147. The grid of V3C receives negative pulses via terminal 21 from the Kipp relay in sub-chassis II B/2 (see preceding para.). In parallel with this valve is the charging capacity made up of C54A and C38B. The fixed silvered mica condenser C54A is located on the chassis II B/1 while the variable air condenser C38B is on the front panel of II B/3 and controlled by the knob labelled "SETTING 1". The charging resistance R62A/B/E is in this case located on the II B/1 chassis.

148. As in the Range time-base II B/2 a High-Speed Low-Speed switch S7A is provided in parallel with a group of resistances R79A, R79B etc. totalling 1 megohm on a panel below the deck. This switch will be found on the left of the front panel (as seen from the front). Its function is the same as in unit II B/2. The effective voltage in the low-speed condition in Unit II B/1 is approximately 800 V. on the potentiometer and time-base valve.

149. It will be noted that the time-base II B/1 operates both Bearing and Elevation C.R. tubes together, and is in synchronism with the Range time-base since it is driven from the same Kipp relay.

150. The insulation for D.C. of sub-chassis II/B/1 from earth must be high as in the case of II B/2 and stiff, self-supporting wires are used for interconnection to other units for this reason. Condenser C81A holds the chassis at a steady potential with respect to earth for A.C. and pulse voltages without affecting the D.C. potentials supplied by the Potentiometer.

TIME BASE POWER SUPPLY UNITS II A AND I A/2

(Circuit figs. 16a, 16b, Chassis fig. 15)

151. These two units are identical in construction and electrical design, II A supplies the Range time-base unit II B/2, I A/2 supplying the Bearing and Elevation time-base unit II B/1. A description of II A will suffice for both units.

152. Unit II A/1 consists of a highly insulated compound filled transformer T3B with two H.T. secondary windings and three L.T. windings. One set of windings in conjunction with a rectifier valve V6C, condenser C13B and chokes CK3C and CK3D forms a half-wave rectifier system giving a D.C. output of 4,000 volts at 8 mA. The supply is used for the Range potentiometer and time base valve V3E.

153. Another set of windings in conjunction with rectifier valve V4C, condensers C14C, C14D and chokes CK2C and CK2D form a full-wave rectifier system giving a D.C. output of 250 volts at 26 mA. This supply is used for anodes and screens of valves V2B, V1C, V1D, V1E and the screens of V3E and V15D on chassis II B/2.

154. The negative sides of the D.C. outputs of these two rectifier systems are taken to the metal sub-chassis of the unit which is highly insulated from earth by four insulating pillars. (See page 68 for further notes on insulation). A stiff brass strip links this power unit chassis to the chassis of II B/2 and forms a common negative return. Three insulated leads running along this strip form the interconnection for the two cathode-heater supply leads and the positive of the 250 volt H. T. supply from II A to II B/2. The positive connection of 4,000 V. supply is made with a stiff copper wire link between terminals 36 on the two units.

Normal Currents and Voltages

155. *Unit II A*

E.H.T. supply	Voltage on load (between terminals 33 & 36 on II B/2) . . .	4150 volts.
E.H.T. supply	Normal load current .	7·2 mA.
H.T. supply	Voltage on load (between terminals 24 & 33 on II B/2) . . .	250 volts.
H.T. supply	Normal load current .	26 mA.

156. *Unit I A/2*

E.H.T. supply	Voltage on load (between terminals 28 & 29 on II B/1) . . .	4100 volts.
E.H.T. supply	Normal load current .	8·0 mA.
H.T. supply	Voltage on load (between terminals 28 & 30 II B/1) . . .	290 volts.
H.T. supply	Normal load current .	16 mA.

CALIBRATOR UNIT IIC

(Circuit fig. 18, Chassis figs. 17a and 17b)

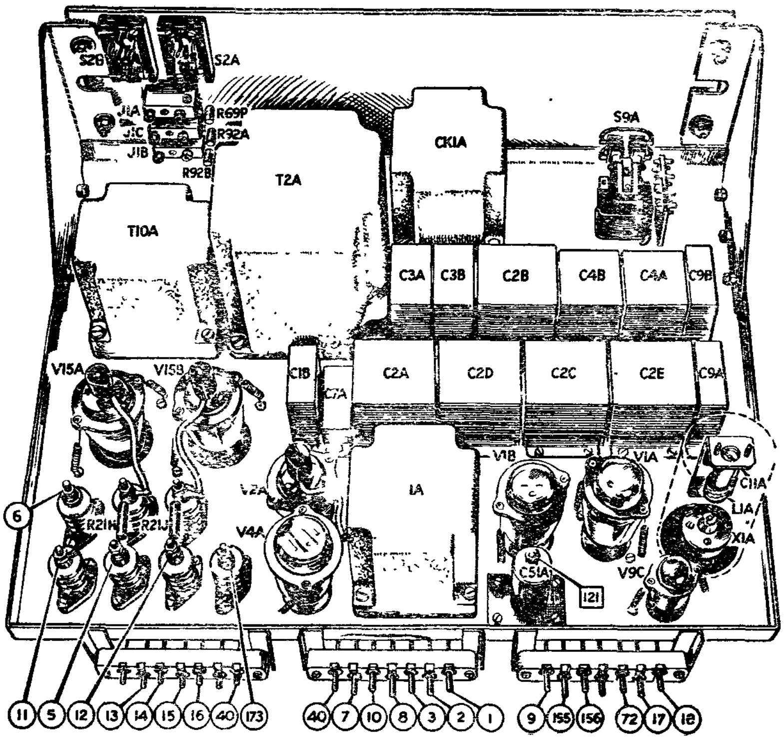
157. The Calibrator Unit comprises a 3-valve circuit together with its own power supply, two cathode follower valves and a delayed switching relay with its associated diode.

158. The first valve, V1A, is a crystal oscillator (frequency 163·86 kc/s) connected in the conventional manner with the crystal in the grid circuit. The coil L1A and condenser C11A (both mounted in a coil-can above the chassis) form a permeability-tuned anode circuit. The tuning is not critical; the setting should be with the iron core screwed in (high inductance setting) as far as is consistent with infallible starting of the oscillator when switch S1A is operated.

159. The second valve, V1B, is a blocking oscillator having a frequency in the neighbourhood of 400 cycles and a waveform of pulse character (see fig. 45 curves "f" and "h").

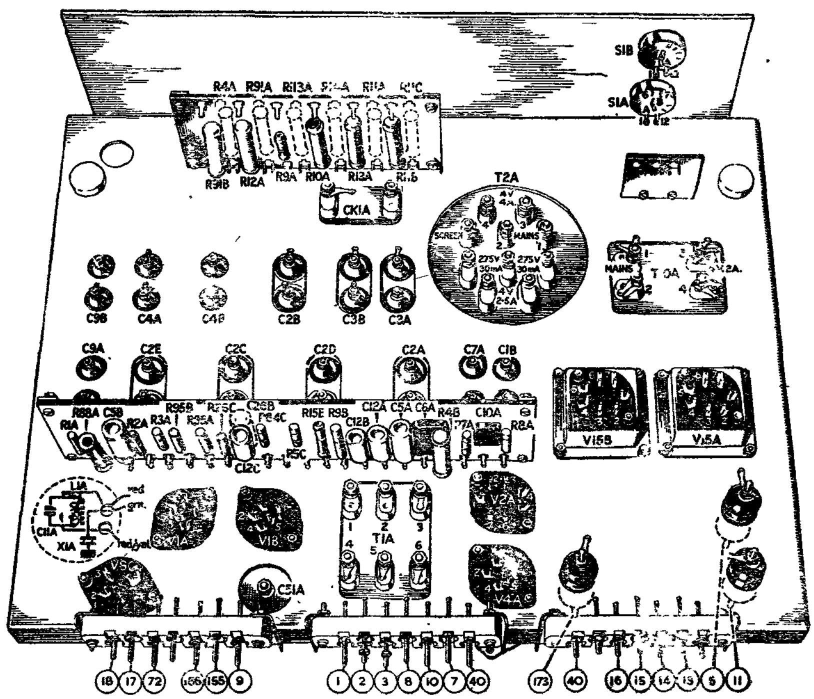
160. The third valve, V2A, has the full crystal oscillator output applied to its grid and the blocking oscillator output (fig. 41 curve "g") applied to its suppressor which is also heavily negatively biased. The anode current is cut off by the suppressor except during the pulse of the blocking oscillator. The final calibrator output from V2A is shown in fig. 45a.

161. A 2-pole 2-way switch S1A labelled "CAL.1", mounted on the front panel, performs the following function :—In the "ON" position H.T. is applied to all valves and the circuit functions as described, the output voltage of V2A being applied to the Y1 plate of the Range tube (CRT 1A Terminal 3). When 'CAL.2" switch (SIB) is set at "All" the output of V2A is also applied through series condensers to the X1 plate of the Bearing tube and the X2 plate of the Elevation tube (CRT1B & CRTIC terminals 2 and 1).



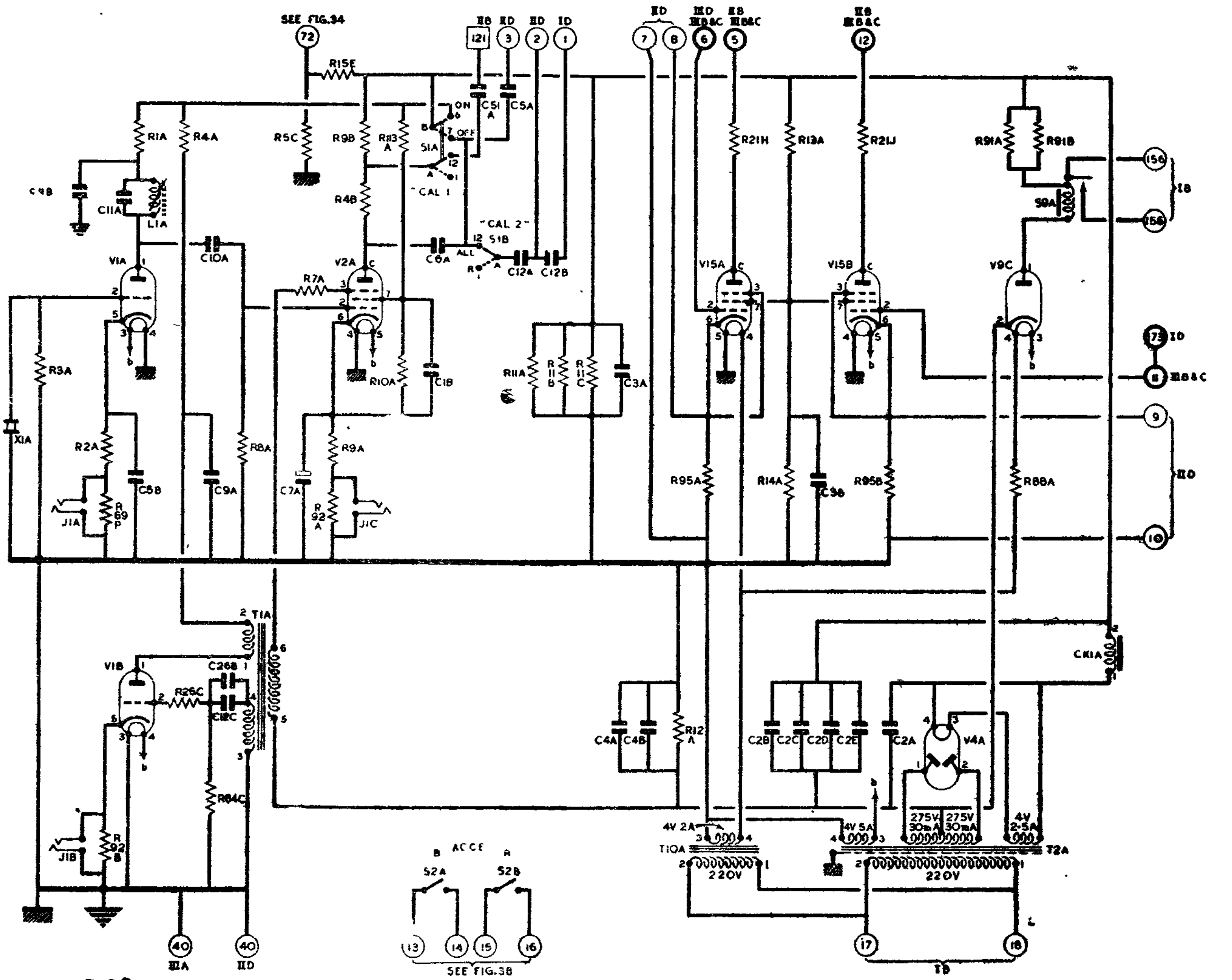
T.DESC. $\frac{\text{T-R.08}}{\text{1-17A}}$

FIG. 17A CALIBRATOR UNIT II C



T.DESC. $\frac{\text{T-R.08}}{\text{1-17B}}$

FIG. 17B UNDERSIDE OF UNIT II C



T.DESC. $\frac{T-R.08}{1-18}$

FIG. 18 CIRCUIT OF UNIT II C

V1 AR 17 V2 ARP. 23 V4 AU 3 V9 ARD 4 V15 ARP 33

C1	1 mfd.	250 V.	R4	10,000 ohms	5% 1/2 W.	R91	40,000 ohms	5% 2 W.
C2	4 mfd.	400 V.	R5	20,000 ohms	5% 1/2 W.	R92	50 ohms	5% 1/4 W.
C3	2 mfd.	400 V.	R7	0·1 megohm	5% 1/2 W.	R95	26 ohms	5%
C4	4 mfd.	250 V.	R8	0·25 ohms	5% 1/2 W.	R113	25,000 ohms	5% 2 W.
C5	0·05 mfd.	450 V.	R9	5,000 ohms	5% 1 W.	L1	0·652-1·186 mH	
C6	0·0002 mfd.	750 V.	R10	50,000 ohms	5% 2 W.	X1	163·86 kc/s ± 50 cycles	
C7	25 mfd. 40 V. Electrolytic		R11	60,000 ohms	5% 2 W.	CK1	45 H 30 mA D.C.	
C9	1 mfd.	400 V.	R12	2,000 ohms	5% 2 W.	T1	Blocking osc. transformer	
C10	0·001 mfd.	500 V.	R13	0·1 megohm	5% 2 W.	T2	Mains transformer	
C11	0·0005 mfd. 5%	500 V.	R14	20,000 ohms	5% 1 W.	T10	Mains transformer	
C12	0·01 mfd. 5%	500 V.	R15	0·1 megohm	5% 1 W.	S1	S.P.D.T.	
C26	0·005 mfd. 5%	450 V.	R21	5,000 ohms	5% 1/2 W.	S2	D.P.D.T.	
C51	0·001 mfd.	4,000 V.	R26	50,000 ohms	5% 1/2 W.	S9	Relay	
R1	1,000 ohms 5%	1/2 W.	R69	7·5 ohms.	5%	J1	Meter jack.	
R2	100 ohms 5%	1/2 W.	R84	23,000 ohms	5% 1/4 W.			
R3	2 megohms 5%	1/2 W.	R88	6·7 ohms				

NOTE.—All limits are ± 15% unless otherwise indicated.

When the switch is set at " R " the Bearing and Elevation tubes are disconnected from V2A, the calibrator pulses appearing on the Range tube alone but at somewhat increased amplitude.

162. A further tapped down portion of this calibrator output voltage is applied through terminal 121 as a synchronising signal to Unit II B/2 and causes the time base to fire on the first calibrator pulse of each group. In this condition the locking signal from the locking cable is removed by opening switch S6A on the front panel of Unit II B. In the " OFF " position of the calibrator switch, H.T. is removed from both crystal oscillator and blocking oscillator circuits. The Y1 plate of the Range tube is earthed in the A.C. sense through condenser C5A.

163. Two other valves, V15A and V15B, belong electrically to other units (II B/1 and II B/2) but are conveniently housed on the Calibrator Unit from which they derive their heater and screen supplies. On this unit are also a relay S9A and an indirectly heated diode V9C, forming a delayed switching system which will ensure that the mains inputs to the 4,000 volt power packs (I A/2 and II A/1) cannot be completed until the cathodes of V15A and V15B have had time to heat up to their emission point. The diode cathode-anode path is in series with the winding of relay S9A and a series resistance R91 A/B across the H.T. supply of the Calibrator Unit. The 4 volt heater of the diode is supplied from an 8 volt source (4 volt windings of T2A and T10A in series) in series with a suitable fixed resistance R88A. This gives a time lag in the heating up of the diode cathode. The total delay of the relay system is about 20 seconds and the current through the relay about 10 milliamperes when the steady state is reached.

Average Currents and Voltages in Unit IIC

164. *Jack Readings*

VALVE TEST JACK	METER USED	METER READING	ACTUAL CURRENT	CONDITIONS OF TEST
V1A	M3A (0—5mA)	1·8	5·4 mA	Oscillating
V1A	„	4·4	13·2 mA	Not Oscillating
V1B	„	4	4	Normal
V2A	„	2·7	2·7	Normal

165. *Voltages*

Positive H. T. line to chassis	258 volts.
Negative bias line to chassis	50 volts.
Heaters	3·8—4·0 volts.
Crystal oscillator output (measured with oscillograph on anode of V1A) . .	40 V. peak to peak.
V2A output (measured with oscillograph on terminal 1)	40 V. peak to peak.

Alterations included in later Equipments

Note that the alteration of R5A, R7D to R26C, R84C, and the addition of C26B modifies the pulse form off the blocking oscillator so that the number of calibrator pulses available is increased to at least 50. Thus by counting the pulses beyond the thirtieth (30 000 yds.) an approximate range determination up to 50,000 yds. can be obtained.

In addition R10B value has been changed to R113A to improved stability of calibrator pulses, and R5C added to reduce still further interference from the Image Splitting switch.

RANGE AND BEARING C.R.T. UNITS IID AND IIID

(Circuit fig. 20, Chassis fig. 19)

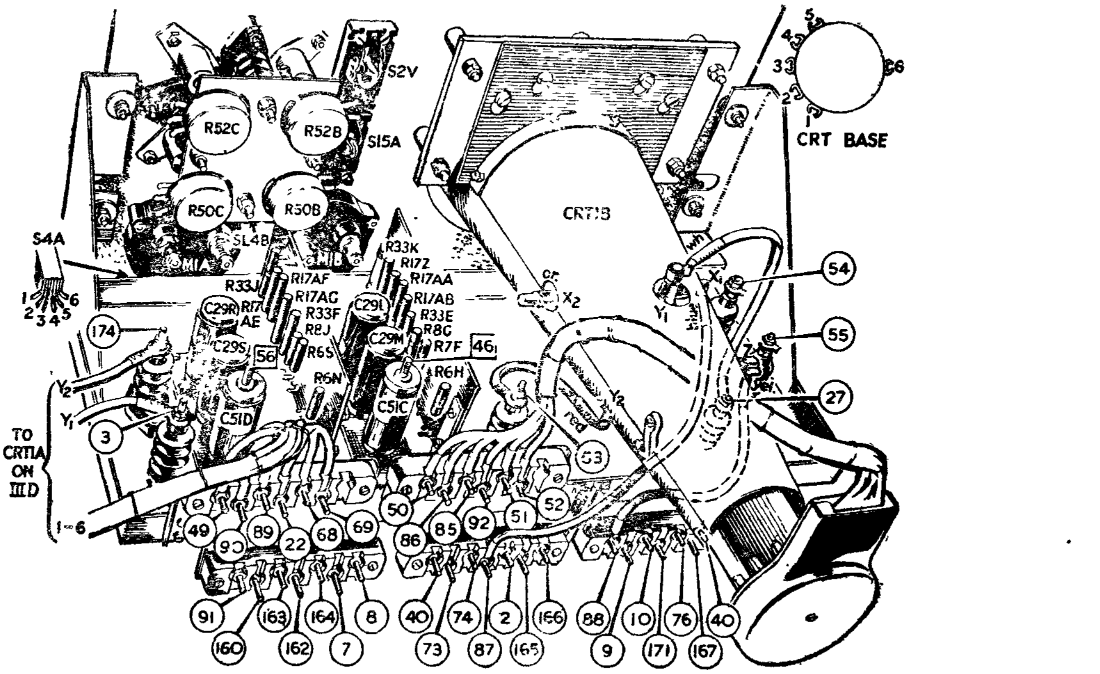
166. These two units are conveniently dealt with together as the focussing and coupling circuits for both cathode ray tubes are located in II D unit, the III D unit carrying only the Range tube itself as a matter of suitable panel layout.

167. Each C.R.T. is an A.C.R.I. cathode ray tube mounted in a Mumetal screen. The resistances comprising the tube control networks are carried on two group boards, with the exception of the variable sections which take the form of potentiometers for brightness and focussing control, carried on an insulated panel and manually adjustable by knobs on the front panel of the unit.

168. First and third anodes are connected together externally and are near to earth potential. The cathodes and heaters are approximately 3,000 V. negative to ground and the focussing anode A2 is approximately 2,500 V. from ground.

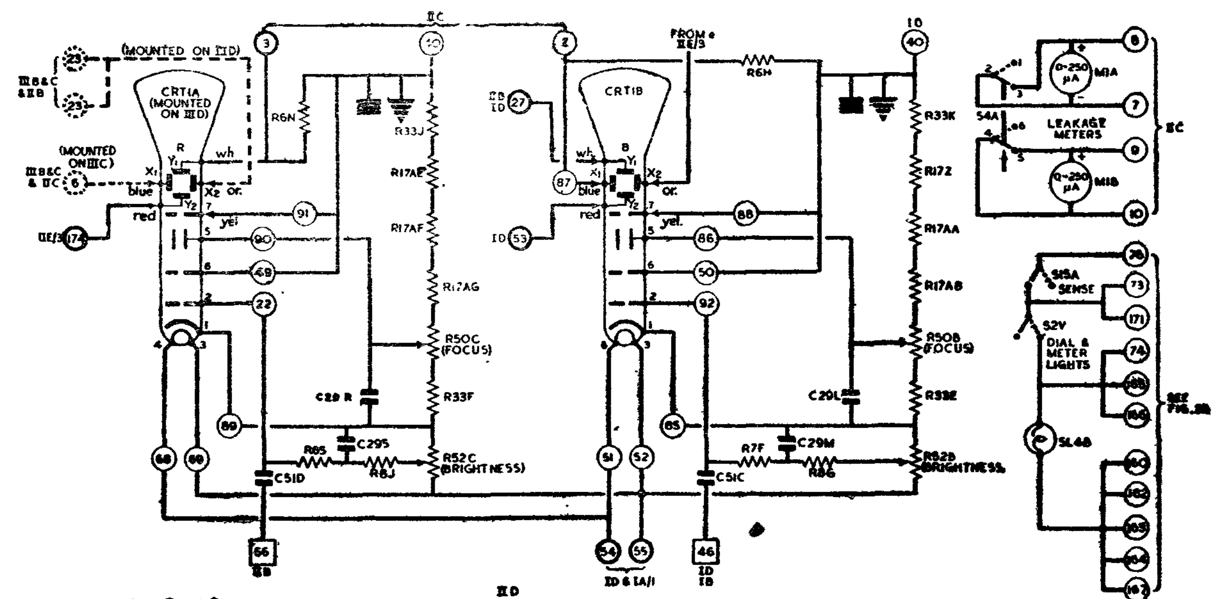
169. The fly back trace on the Range tube (CRT1A) is suppressed by a suitable blacking out pulse derived from valve VIE in unit IIB/2 via the coupling condenser C51D and terminal 56. Actually the whole trace is normally blacked out by turning back the " BRIGHTNESS " control, the pulse from V1E being positive during the forward sweep which is thereby restored to brightness.

170. In the case of the Bearing tube no attempt is made to black out the fly back but short positive pulses from unit I B can be applied to the grid via terminal 46 and condenser C51C for brightening up a small section of the trace. The pulses, referred to as " Signal Selector " pulses, are timed to pick out the particular pulse under observation and have a duration somewhat greater than that of the pulse from the transmitter. As these "Signal Selector" pulses are superimposed on the steady bias provided by the manual bias control



T. DESC. T-R.08 / 1-19

FIG. 19 BEARING C.R.T. UNIT II D.

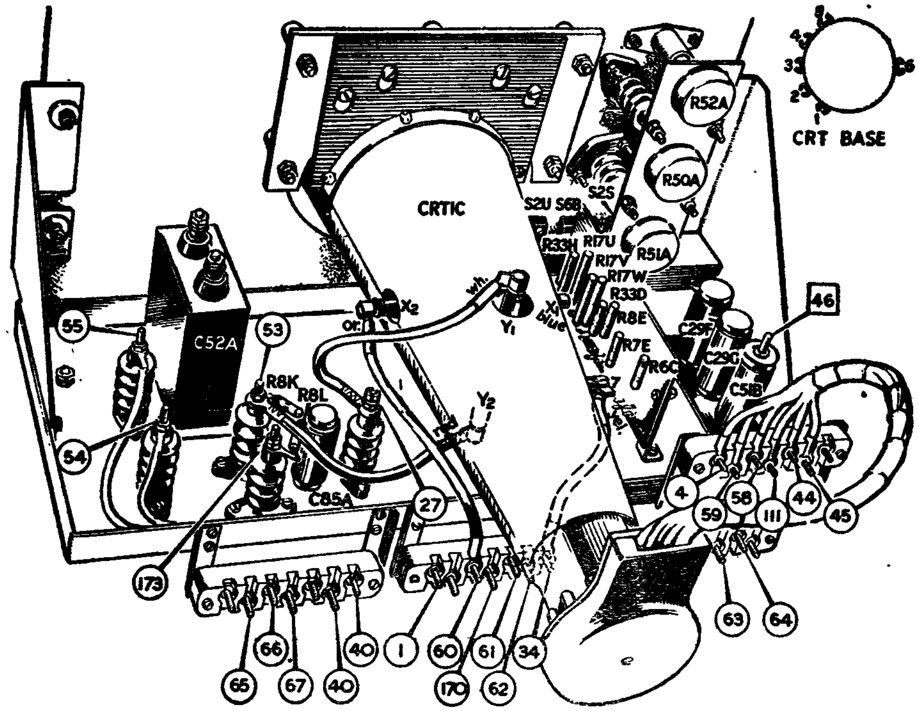


T. DESC. T-R.08 / 1-20

FIG 20 CIRCUIT II D

CRT1 ACR1

C29 0·1 mfd.	1,000 V.	R50 1 megohm Potentiometer.
C51 0·001 mfd.	4,000 V.	R52 0·1 megohm Potentiometer.
R6 1 megohm	5% 1/2 W.	M1 0-250 micro-amps.
R7 0·1 megohm	5% 1/2 W.	S2 D.P.D.T.
R8 0·25 megohm	5% 1/2 W.	S4 D.P.D.T. Spring return
R17 1 megohm	5% 1 W.	S15 D.P.D.T. Spring return.
R33 0·5 megohm	5% 1/2 W.	SL4 6·3 V. ·25 A.



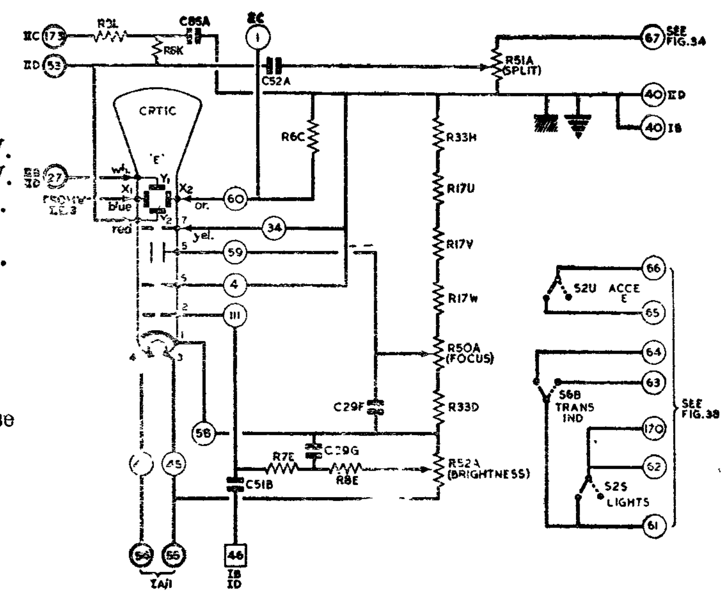
T.DESC. T-R.08 / 1-21

FIG. 21 ELEVATION C. R. T. UNIT ID

CRT1 ACR1

C29	0·1 mfd.	1,000 V.
C51	0·001 mfd.	4,000 V.
C52	0·1 mfd.	4,000 V.
C85	1 mfd.	
R6	1 megohm	5% 1/2 W.
R7	0·1 megohm	5% 1/2 W.
R8	0·25 megohm	5% 1/2 W.
R17	1 megohm	5% 1 W.
R33	0·5 megohm	5% 1/2 W.
R50	1 megohm Potentiometer.	
R51	50,000 ohms Potentiometer.	
R52	0·1 megohm Potentiometer.	
S2	D.P.D.T.	
S6	D.P.D.T.	

NOTE.—All limits are ±15% unless otherwise indicated.



T.DESC. T-R.08 / 1-22

FIG. 22 CIRCUIT OF UNIT ID

it is found best to turn the manual control back until the main part of the picture nearly or just disappears; more bias is required with the signal selector than without.

171. The deflector plates of the Range tube (IIID) are so connected that the time base is horizontal with the spot traversal from left to right and the signal pulse deflection is in an upward direction. (Viewing from front of tube).

172. The deflector plates of the Bearing tube (CRT1B) are so connected that the time-base is vertical with the spot traversal from bottom to top and the signal pulse deflection is in a horizontal direction to the left. A further input to the Bearing tube CRT1B is a picture-shifting pulse applied to the Y2 plate and derived from a commutator associated with the disc and rotary switch mechanism. This pulse intermittently displaces the whole picture along the direction of the time-base as described in another section (see paras. 276—280).

173. A microammeter, M1A, with a full scale deflection of 250 μA without external shunts is mounted on the front panel of unit IID, and electrically connected to valves V15A and V15B in unit IIC. Resistances R95A and R95B located in Unit IIC act as meter shunts when M1A is used in this position, reducing the sensitivity to 2·5 mA for full scale deflection. These meters, which register the total cathode return current in V15A and V15B are normally short circuited by a press-switch S4A on the front panel of unit IID and read only when this switch is pressed.

174. Switch S2V controls all the 6 volt panel lights of the equipment, exempting the red and green lights associated with the potentiometer. Switch S15A, which is self-returning, operates the switching relay on the reflector aerial by completing the 50 volt A.C. circuit to the relay.

Normal Currents And Voltages

175. C.R. tube heaters	4V.—1A.
H.T. across full, C.R.T. supply (terminals 55 & 40)	3,200 V.
Voltage across brightness potentiometer	60 V.
Voltage across focus potentiometer	600 V.

ELEVATION C.R.T. UNIT ID

(Circuit fig. 22, Chassis fig. 21)

176. This unit, as regards tube supply network, brightness and focusing controls, grid input arrangements and applied voltages in general, is a complete replica of the Bearing C.R.T. section of Unit IID.

177. The only difference is that the pulse deflection is to the right of the vertical sweep instead of to the left.

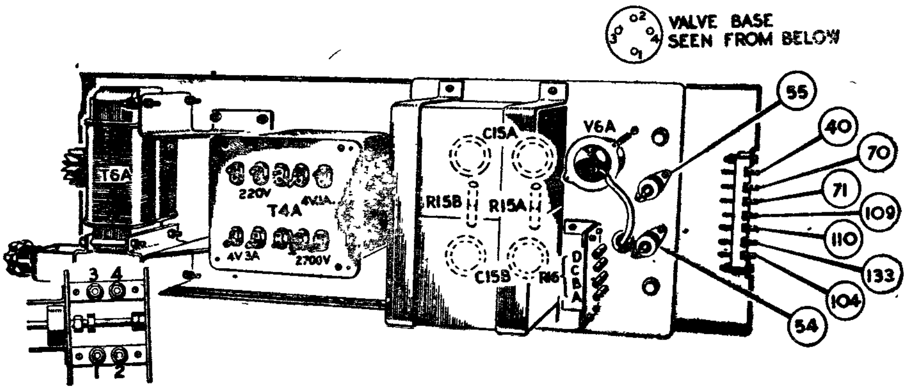
178. The components for the image splitting (see paras. 276—280) are housed in this unit and serve both Elevation and Bearing C.R. tubes. These components comprise a 0·1 μF pulse coupling condenser (C52A) and a "SPLIT" control potentiometer R51A which is located immediately below the focusing and brightness controls.

Switch S2S controls the 50 volt general lighting of the equipment.

Switch S6B controls the 50 volt "Upper and Lower" lights at the transmitter.

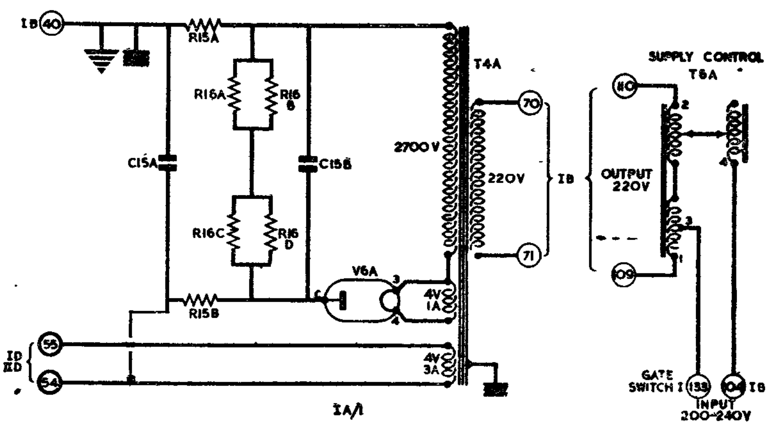
Switch S2U controls the 50 volt A.C. supply to the Elevation A.C. Control Elements.

179. Normal currents and voltages are the same as with Bearing and Range tubes (see paras. 166—175 on Units IID & IIID).



T.DESC. T-R.08 / 1-23

FIG. 23 C.R.T. POWER SUPPLY UNIT I A/1



T.DESC T-R.08 / 1-24

FIG. 24 CIRCUIT 1/A1

V6 AU5

C15 0·5 mfd.	5,000 V.	R16 10 megohms	5% 1 W.
R15 0·1 megohm	5% 1 W.	T4 Mains transformer	T6 Variac

NOTE.—All limits are ± 15% unless otherwise indicated.

C. R. T. POWER UNIT I A/1

(Circuit fig. 24, Chassis fig. 23)

180. This unit which supplies all three cathode ray tubes, consists of a transformer T4A, a half wave rectifier valve V6A, with a smoothing system made up of condensers C15A, C15B and resistances R15A and R15B. Resistance R16A, B, C, and D form a shunt path across the H. T. supply which serves to discharge the condensers when the unit is switched off.

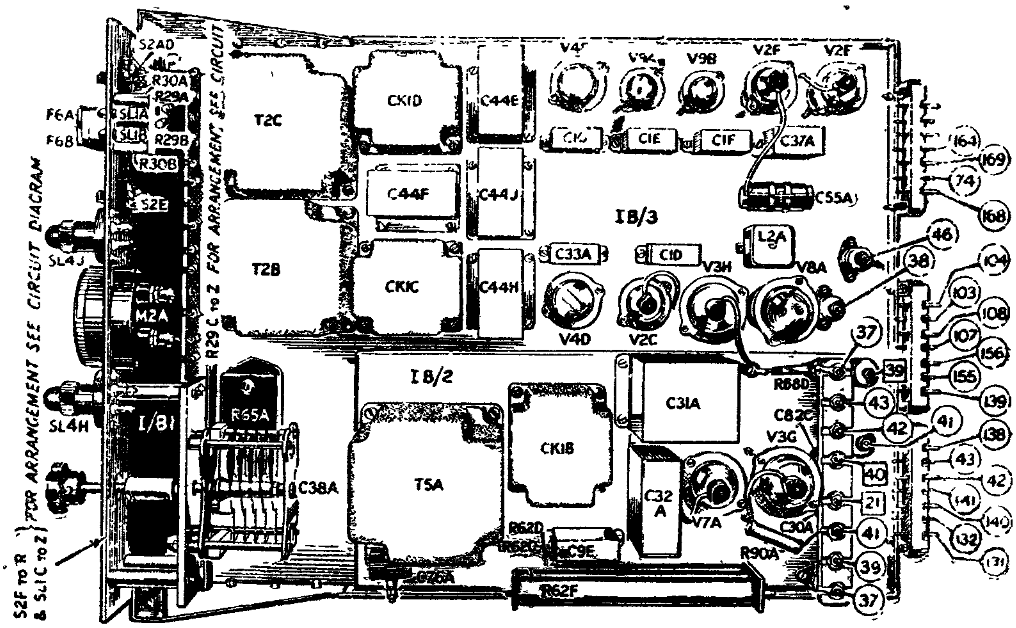


FIG. 25A CONTROL AND SIGNAL SELECTOR UNIT I B TOP VIEW

T.DESC. T-R.08 / 1-25A

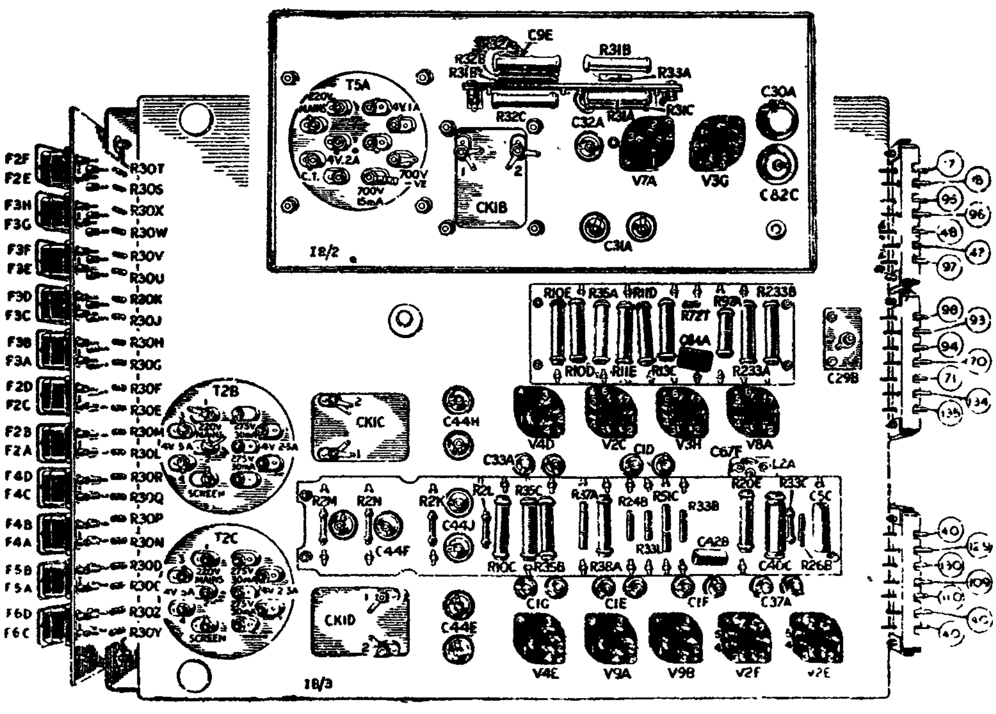


FIG. 25B UNDERSIDE OF CHASSIS

T DESC. T-R.08 / 1-25 B

181. The voltage of the H. T. supply on load is approximately 3,000 V. the positive output being connected to chassis and earth. In addition to the H. T. secondary winding of the transformer T4A and the 4V. rectifier filament winding there is a separate 4 V. winding to supply the cathode heaters of the three cathode ray tubes. One side of this latter winding (terminal 55) is made common with the negative output of the H. T. circuit. Thus the C.R.T. heaters have a mean D. C. potential of 3,000 V. negative to earth.

182. Located on Unit I A/1 for convenience is also a "Variac" voltage regulating transformer T6A. With an A.C. mains voltage on the primary (transformer terminal 3 and 4) of any value between 200 and 240 volts the output voltage on load (transformer terminals 1 and 2) can be brought to a standard fixed value of 220 volts for all mains transformer primaries in the equipment.

183. The only exception is the 50 volt transformer T11A in Section IIIA (see page 5). The latter, together with Disc Motor, Fan and Soldering Iron Points, work direct from the uncontrolled mains.

184. The regulating knob of the "Variac" is brought out on the front panel of I A/1.

Normal Voltages Of Unit IA/1

185. H. T. output voltage at normal load (between terminal 55 and chassis) 3,200V. L. T. voltage on load to C.R.T. heaters (between terminals 54 and 55) 4·1 V.

SIGNAL SELECTOR AND POWER DISTRIBUTION UNIT I B

(Circuit fig. 26 Chassis figs. 25a, 25b)

186. This unit contains mains switches, fuses and meter for controlling various sections of the equipment, together with circuits for producing "Signal Selector" pulses and A.V.C. voltage timed from the locking pulse and potentiometer systems.

Power Distribution Panel I B/1

187. This is the front panel of Unit IB of which a front view may be seen in fig. 1, electrical circuits being shown in fig. 26.

188. A switch S2E marked "MAINS" controls the mains input to T6A the Variac regulating transformer (see section on Unit IA/1 page 46) and is therefore a master switch for Calibrator, C.R.T., Bearing Time-Base, Range Time-Base, A.V.C. and Receiver Units. The 15 amp. double fuse-block beside this switch is in the mains input to the whole equipment. There is no isolating switch for these fuses which remain alive as long as the external mains cable is plugged into the socket on the cabin chassis. The two neon pilot lamps above the fuse block glow as long as the fuses are intact and there is a mains feed to the cabin.

189. The eleven double-pole switchs in a row below the "MAINS" switch control the mains inputs to the various circuits indicated. Beneath each switch is a pair of neon pilot lamps and a double-fuse-block, on the dead side of the switch. The pilot lamps light when the switch above them is on (lever down), provided that the fuses are intact. If a pilot lamp fails to light this is an indication that the fuse immediately below it has blown or is missing.

190. Each fuse-block has its current rating indicated and fuse cartridges of the correct rating should be inserted in the holders.

191. A moving-iron voltmeter M2A, reading 0-300 volts is connected across the output side of the Variac transformer to indicate when the output voltage has been brought to exactly 220 volts by the "SUPPLY CONTROL" knob on the panel below. The external series resistance for this meter is accommodated on the main chassis behind the panel.

192. As mentioned above the supplies for the various receiving circuit chassis derive a controlled voltage via the Variac transformer. The other items, namely Disc Motor, 50 volt transformer, Fan and Soldering Iron points are connected directly to the mains through the 15 amp. fuse.

193. The load on the 220 V. A. C. mains is as follows:—

Current taken with all sections including lights, A.C.C.E.'s. and disc motor, 7·0 amps. Current taken by disc motor alone while running, 2·6 amps. (momentary starting current is considerably higher).

194. In series with the mains input to the Variac transformer are the four gate-switches, which may be mentioned here although they are not located on Unit IB itself. They consist of two-pole sockets mounted along the back of the rack and so placed that each is closed by a two-pin shorting plug incorporated in one of the four detachable back-panels. Thus if either of the back panels is removed the supply to the various chassis carrying H. T. is broken. It should be noted that even then, certain points inside the equipment are still alive at mains voltage (see figs. 24, 26 and 44)

195. The knob labelled "SETTING 5" at the top right-hand corner of the panel controls variable condenser C38A belonging to the Signal Selector time-base V3G (fig. 26). The adjustment of this knob is dealt with below.

196. A switch S2AD at the top left-hand corner of the panel and labelled "SIG.SEL" serves to cut out the "Signal Selector" pulse applied to the Bearing and Elevation C.R. tubes when not required.

SIGNAL SELECTOR UNIT I B/2 & I B/3

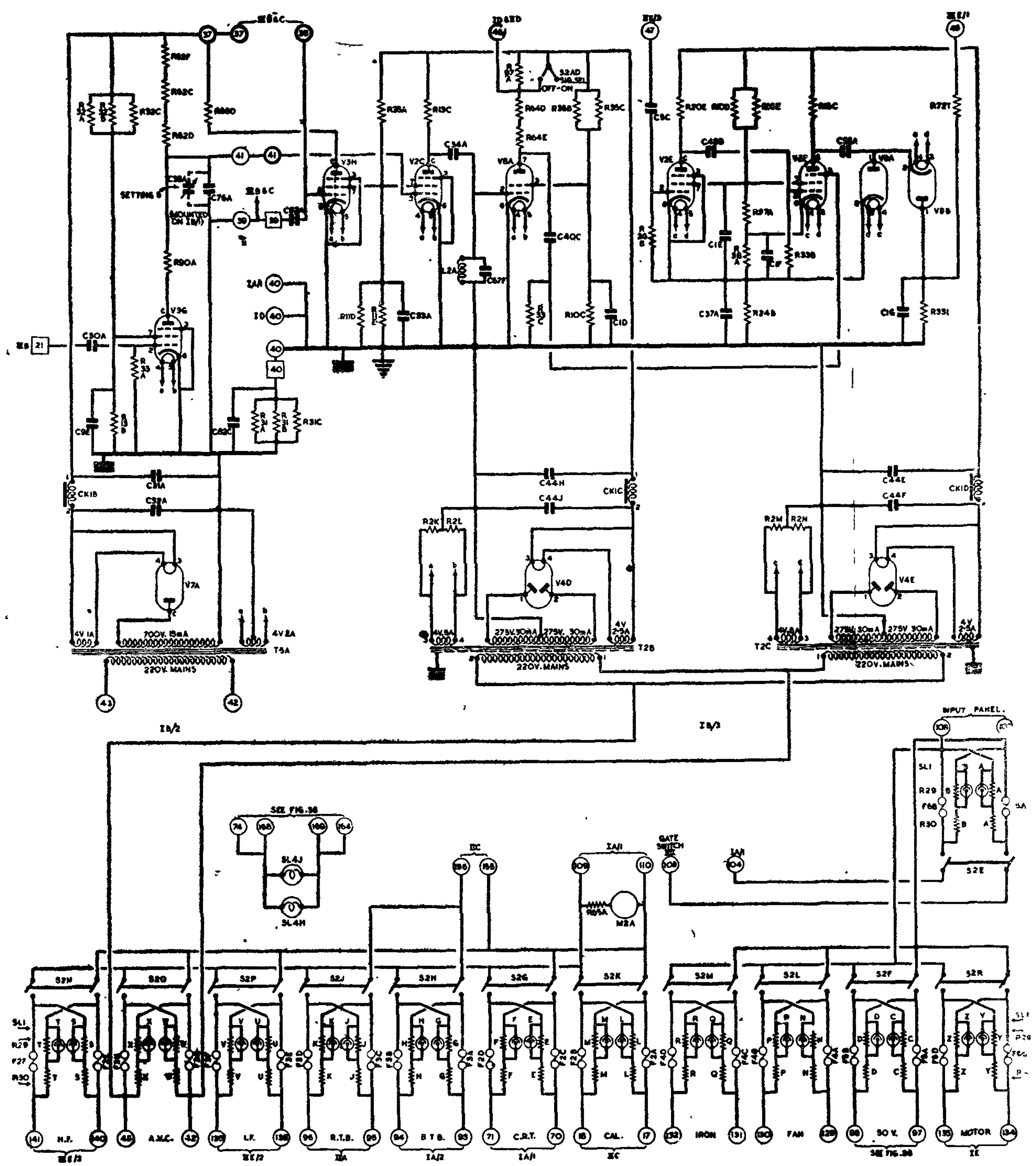
197. The function of this unit is to provide timed pulses which allow the A.V.C. system to operate only over a pre-determined section of the time-base sweep cycle, and which also may be used to brighten up the trace on the Bearing and Elevation tubes at the mid-point to which the observed pulses are brought.

Production of Signal Selector Pulse

198. A time-base valve V3G, mounted on the insulated chassis I B/2 is provided with its own power supply consisting of transformer T5A, rectifier valve V7A, choke CK1B and condensers C31A and C32A, giving a D.C. H.T. voltage of 800.

199. In the anode circuit of V3G is a 0·76 megohm charging resistance (R62 C/D) and in shunt with the valve is a charging capacity composed of fixed condenser C76A and variable condenser C38A. The latter is controlled by a knob on the front panel labelled "SETTING 5".

200. The grid of V3G, which is operated at zero bias, receives negative square-bottomed pulses via terminal 21 from the Kipp relay on Unit II B/2. During



T.DESC. T-R.08 / 1-26

FIG. 26. CIRCUIT OF UNIT I B

C1 1 mfd.	250 V.
C5 0·05 mfd.	450 V.
C9 1 mfd.	400 V.
C30 0·005 mfd.	4,000 V.
C31 4 mfd.	1,500 V.
C32 2 mfd.	1,500 V.
C33 0·1 mfd.	250 V.
C34 50 mmfd.	450 V.
C37 2 mfd.	250 V.
C38 18-71 mmfd.	Air variable.
C40 0·1 mfd.	500 V.
C42 0·0023 mfd. 5%	
C44 8 mfd.	400 V.
C55 0·4 mfd.	500 V.
C67 0·0001 mfd. 2%	
C76 0·0001 mfd.	±1 mmfd.
C82 0·1 mfd.	1,000 V.
R2 100 ohms	5% ½ W.
R10 50,000 ohms	5% 2 W.
R11 60,000 ohms	5% 2 W.
R13 0·1 megohm	5% 2 W.
R15 0·1 megohm	5% 1 W.
R20 75,000 ohms	5% 2 W.
R24 500 ohms	5% ½ W.
R26 50,000 ohms	5% ½ W.
R29 1 megohm	5% ¼ W.
R30 0·5 megohm	5% ¼ W.
R31 0·3 megohm	5% 2 W.
R32 0·75 megohm	5% 2 W.
R33 0·5 megohm	5% ½ W.
R35 30,000 ohms	5% 2 W.
R37 25,000 ohms	5% 1 W.
R38 25.000 ohms	5% 2 W.
R62 253,333 ohms (3 in series ·76 megohm ±5,000 ohms).	
R64 5,000 ohms	5% 5 W.
R65 9,400 ohms	½%
R68 3,500 ohms	5% ½ W.
R72 1,000 ohms	5% ¼ W.
R90 20,000 ohms	5% 2 W.
R97 1,000 ohms	5% 2 W.
L2 30 mH	
CK 1 45 H 30 mA D.C.	
T2 and T5 Mains transformers	
M2 0-300 V. A.C.	
S2 D.P.D.T.	
SL1 Neon signal lamp	
SL4 6·3 V. ·25 A.	
F2 1 A	
F3 2 A	
F4 5 A	
F5 10 A	
F6 15 A	

Note: All limits ± 15% unless otherwise indicated.

the period of cut-off produced by these pulses the condensers C38A, C76A charge up exponentially through resistance R62C/D/F producing a series of sweep-voltage cycles of the same law as, and in synchronism with, those produced by valves and V3E and V3C in the Range and Bearing Time-Base Units. Exact alignment of exponential law is obtained by adjusting variable condenser C38A.

201. Cathode return and negative H.T. supply of V3G are taken to the insulated chassis. Chassis and positive H.T. (terminals 39 and 37) are connected across the inner potentiometer ring (R48A) of unit III B the slider of which goes to the grid of V3H which, in conjunction with resistance R31A/B/C forms an automatic potentiometer similar to those described in connection with the other two time-bases (see also fig. 11a).

202. Since the slider of the potentiometer is always at earth potential (within a few volts), the chassis of I B/2 must always be negative in potential with respect to earth by an amount determined by the setting of the slider. Hence the anode of V3G will, during each upward sweep pass through zero or earth potential at a certain instant during its excursion determined by this potentiometer setting.

203. Connected directly to the anode of V3G via terminal 41 is the grid of a pentode V2C in section I B/3. As the cathode of the latter valve is returned to earth its grid will have a large negative potential during the early part of the upward sweep of V3G, during which time the anode circuit of V2C will pass no current. At the instant when the anode of V3G passes through zero potential V2C suddenly becomes conductive and a square voltage-pulse is developed across the anode load resistance R13C. This pulse, which is negative in sense, is illustrated in fig. 45j. It is, however, of too long duration for the purpose for which it is required. The pulse is therefore passed by coupling condenser C34A to the grid of another valve V8A having a resonant circuit made of inductance L2A and condenser C67F between grid and cathode. The square pulse from V2C impacts this circuit, tending to make it "ring" *i.e.* execute a train of damped oscillations at the frequency of the circuit. The first half-wave of the train is fully developed as there is little damping, but the second half wave which is positive, is accompanied by heavy damping due to grid current (since the valve is operated at zero grid bias) and together with the rest of the wave train is thus suppressed, leaving only the first half-wave as an isolated pulse of about 4 microseconds duration. This pulse appears in amplified form in positive sense across the anode load resistance of V8A. (For wave-form see fig. 45k).

204. This "Signal Selector" pulse always occurs when the spots of the three cathode ray tubes are passing through the tube zero positions at the centres of the screens since all three potentiometers are driven together and have identical laws, all three sweep circuits being adjusted to the same time-constant.

205. By tapping down the anode load resistances R97A, R64D and R64E of V8A a proportion of the Signal Selector pulse voltage is taken off via terminal 46 to the brightness control grids of the B and E tubes in Units I D and II D. This causes any pulse image which is brought to the cross-wires of the B & E tubes to be made brighter than the rest of the trace. A switch S2AD on the front panel of Unit I B cuts off the Signal Selector pulse from the tubes by short circuiting the tapped-down section R97A in the anode load resistance of V8A.

A. V. C. System

206. With a rapidly-moving target there are large variations in received signal amplitude due partly to general change in distance and partly to rapid periodic fading caused by interference effects familiar on ultra-short wavelengths. Some form of automatic gain control is therefore necessary, particularly where the Bearing and Elevation tubes are concerned.

207. The operator is interested normally only in the pulse which has been brought to the centre cross-wires of the cathode ray tubes by the turning of the Potentiometer handle. This pulse alone should, by its instantaneous amplitude, control the gain of the receiver in such a way that this amplitude is held within reasonable limits to a constant value. There will however, be other pulses and general noise effects appearing on other parts of the time-base and these should obviously have no influence on the operation of the A.V.C. system.

208. The system which accomplishes this is formed by valves V2E, V2F, V9A and V9B in section I B/3. Valves V2E and V2F form a two-stage resistance-coupled amplifier to the input terminal 47 of which a part of the pulse output voltage from the receiver is applied. The suppressor of the second valve V2F has, however, a negative backing-off voltage of about 50 V. derived from potential divider and cathode resistance R38A applied through resistance R33C, with the result that there is normally no signal output from V2F. The suppressor of V2F is also coupled by condenser C40C to the anode of V8A from which it derives positive signal selector pulses (described in preceding section) which are sufficient in amplitude for about 4 microseconds to overcome the backing-off voltage at the suppressor. Hence for this short period of time the two-stage amplifier becomes operative and any pulse arriving at the input of V2E will appear amplified at the anode of V2F. The anode of the latter is coupled by condenser C55A to a pair of diodes V9A and V9B which rectify the pulses, passing them to output load resistance R33L shunted by condenser C1G where they are converted into a substantially smooth negative D.C. voltage with respect to earth. This voltage is passed via terminal 48 and terminal 144 on Unit IIIE/2 to the R.F. Unit IIIE/1 of the receiver where it is applied as A.V.C. voltage to the control grids of the 3rd, 4th and 5th R.F. stages.

209. A delay voltage *i. e.* the voltage which must be exceeded before the A.V.C. can come into action, is derived across resistance R24B which carries the cathode currents of V2E and V2F.

210. It will be noted that A.V.C. is only obtained if the Signal Selector pulse arrives at the same time as the signal pulse. The amount of A.V.C. control obtained may be controlled by the adjustable potentiometer R101A behind 11A/1 panel (see figs. 6B and C page 12). By turning this control clockwise the A.V.C, action is increased, *i. e.* the signal output is held at a lower mean level. The setting of this control is left largely to the discretion of the operator who should aim at maintaining a pulse height on his tube screens of about ¾ of an inch.

Setting Up Signal Selector Time-Base

211. It is most important that the Signal Selector time-base shall be correctly adjusted so that the Signal Selector, or brightening up pulse occurs always at the middle of the B and E tubes irrespective of the Range potentiometer dial setting.

212. The adjustment is made on "SETTING 5" control (fig. 1) which varies C38A of the charging capacity associated with the sweep valve V3G. It is assumed that the cross-wires of the B and E tubes have already been set at the tube zero (position of spot with B and E time-base supply IA/2 switched off) and that the B and E time-base has been lined up (SETTING 1) with the Calibrator and Range time-base. The Calibrator Unit is switched on to all three tubes and the Potentiometer handle is turned until the R. Scale reads 30; this brings the 30th Calibrator pip on to the Cross-wire of the Range tube. SETTING 5 is now adjusted until the Signal Selector pulse lies symmetrically about the cross-wire of the B tube where it should brighten up the 30th calibrator pip on this tube. On turning the Potentiometer handle to bring the R. Scale to the other extreme (2) of its travel, the Signal Selector pulse should remain on the cross-wire. If it does not, some trial re-adjustments of SETTING 5 will be required until a setting is found where the Signal Selector pulse appears in the same position at both necessary extremities of the potentiometer travel.

213. At the best setting a small drift will be found near the middle part of the potentiometer travel but this may be ignored as the Signal Selector pulse has sufficient margin of width to include the whole of the signal pulse at this part of the range.

214. The position of the Signal Selector pulse should always be observed while the Potentiometer handle is stationary; during rapid travel of the potentiometer slider there is momentary additional displacement due to the charging or discharging of C82A.

215. If by adjustment of SETTING 5 the Signal Selector pulse can be immobilised, as described at a position not at the electrical centre of the tube, the fault lies elsewhere; no more can be done with SETTING 5. The trouble may be due to V3G or the resistance value of R90A which controls the effective starting voltage of the sweep circuit.

Power Supplies on Unit IB

(For transformer voltages see table on page 72)

216. *Time-base Power Supply*

This provides H.T. and heater current for valve V3G and comprises transformer T5A, rectifier valve V7A, smoothing condensers C31, C32A and smoothing choke CK1B. H.T. voltage (between terminals 37 and 39) on load 870 volts.

217. *Signal Selector Stage Power Supply.*

This provides H.T. and heater current for the pulse-forming valves V2C and V8A as well as heater current and screen voltage for the cathode follower valve V3H. It comprises transformer T2B, rectifier valve V4D, smoothing condensers C44H, C44J and smoothing choke CK1C.

H.T. voltage (between terminals 46 and 40 with S2AD at "OFF") on load 265 volts.

218. *A.V.C. Amplifier Power Supply.*

This provides H. T. and heater current for valves V2E, V2F, V9A and V9B, and comprises transformer T2C, rectifier valve V4E, smoothing condensers C44E, C44F and smoothing choke CK1D.

H.T. voltage (between + H.T. end of R20E and chassis) on load 340 volts.

ELEVATION MEASURING EQUIPMENT

General Description of Method

219. The method of determining the angular elevation of a received wave is based on the fact that a horizontal dipole aerial at a given height above ground level has different sensitivities to wave-fronts arriving at different angles of elevation with respect to ground. The law connecting sensitivity with elevation depends upon the height of the dipole above ground level and the wavelength used, since the total effect at the dipole is the resultant of the directly received wave and reflected wave from the ground. Thus two dipoles at different heights above ground level will have different relative sensitivities at various angles of elevation, so that by comparing their output at a calibrated goniometer the elevation angle of the incident wave may be determined.

220. In the equipment the lower and upper Elevation aerials are fixed at heights of one wave-length and one-and-a-half wavelengths respectively above ground (see fig. 35). The calculated vertical polar diagrams of the individual aerials are shown in fig. 27. These are based on the assumption of a perfectly level and perfectly conducting ground as well as freedom from disturbing objects in the vicinity and, although these conditions are not completely attained in practice, experience shows that the curves are quite closely followed.

221. Each of the two Elevation aerials is connected by a screened feeder cable to one of two sets of stator windings, mutually at right-angles, in the Goniometer (fig. 34). These stators are carefully screened electrostatically, giving a pair of purely electromagnetic fields at right-angles to each other.

222. A rotor winding, located symmetrically with respect to the stators, has a variable inductive coupling with the resultant field. In making observations the rotor is always turned to give zero output; at this angular setting the components of the fields from the stators are equal and opposite so that the angular setting of the rotor gives a measure of relative fields induced in the two stators and therefore of the relative signal voltages produced in the two elevation aerials.

223. Owing to the form of the polar diagrams of the two aerials and the way in which they combine the angular setting of the Goniometer for zero output is not equal, or even proportional to, the angle of elevation of the incoming signal wave. The law connecting the two is a complex one and it is not possible to use ordinary constant-ratio gearing between Goniometer rotor coil shaft and the direct-reading elevation scale. The Goniometer is therefore driven through a cam having a configuration which gives the rotor the correct rate of progression at all settings of the elevation scale. The calibration of the latter may therefore be uniformly spaced and the mechanism becomes suitable for sending out information via the A.C. Control Elements.

224. The output of the Goniometer rotor coil is taken to the Motor Driven R.F. Switch and thence to the receiver where it is combined with the output of the

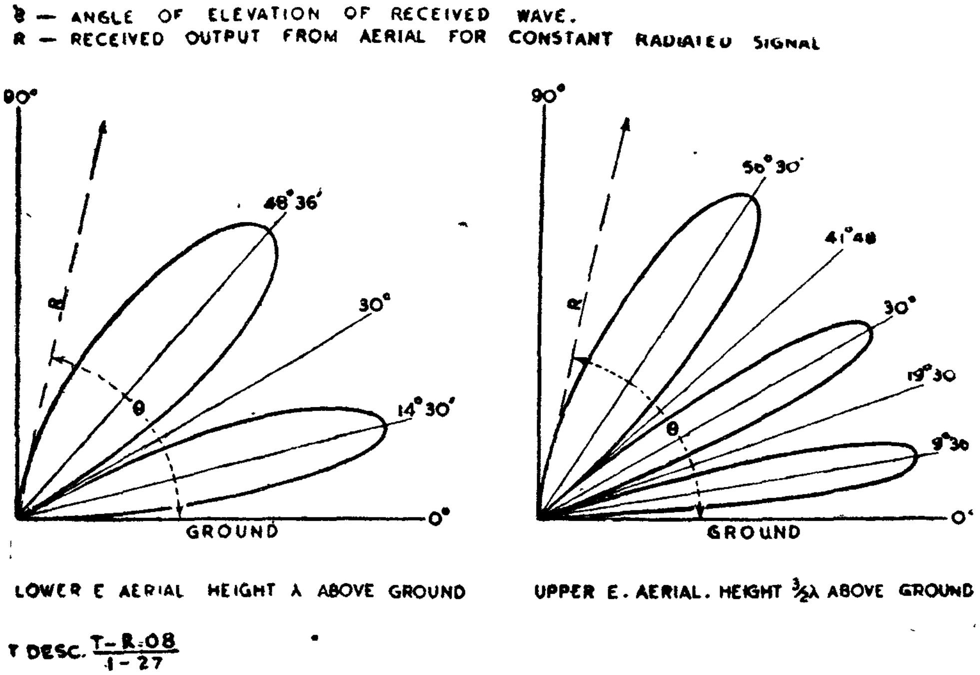


FIG. 27 VERTICAL POLAR RECEPTION DIAGRAMS

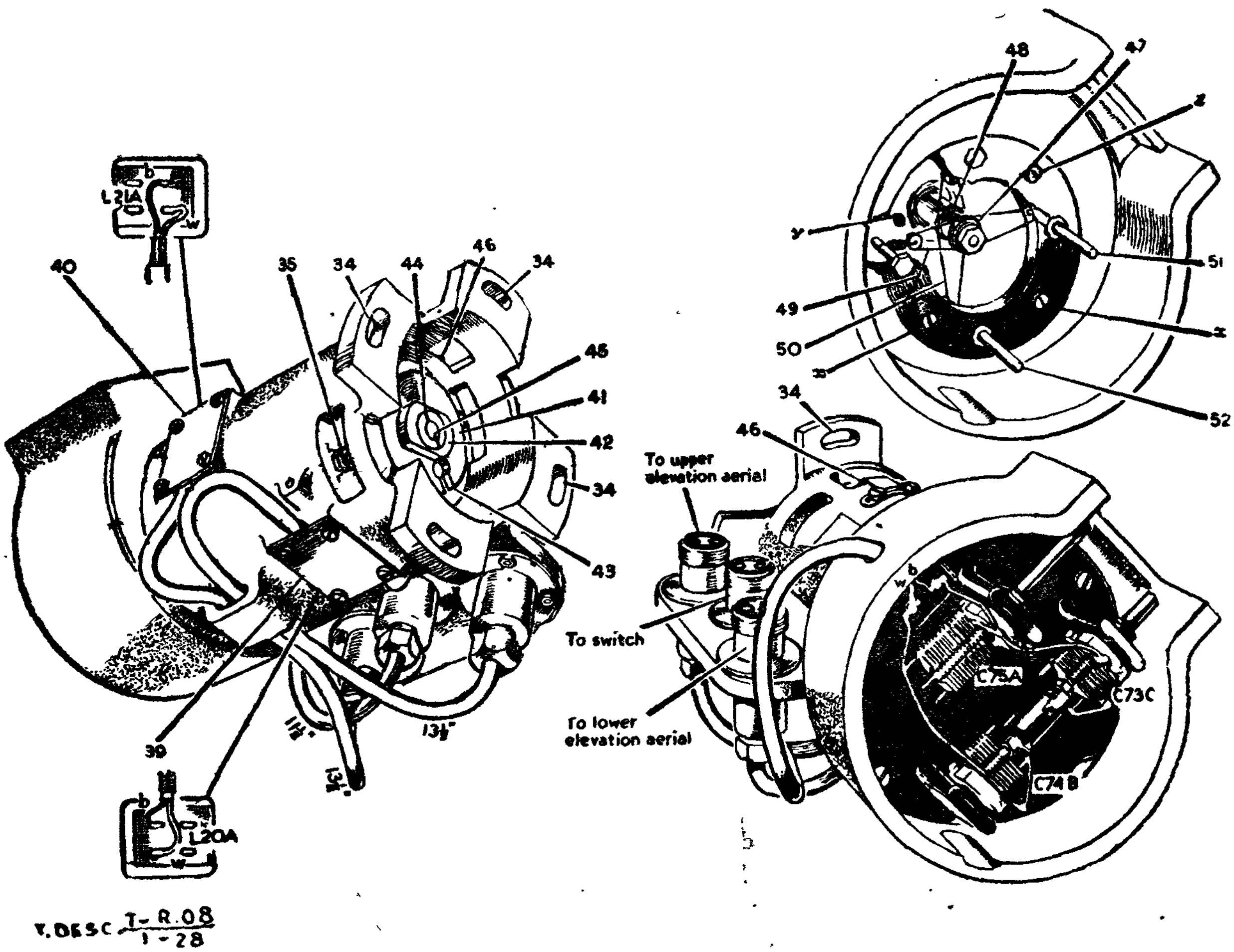


FIG. 28 GONIOMETER UNIT 1 C

Range aerial (as described in paras. 6 and 7) in such a manner that if the Goniometer is a little way offset to one side of the null point the Elevation signal adds to the Range signal, if however, the Goniometer is off the other side of the null point the Elevation signal subtracts from the Range signal.

Ambiguity Possible In Elevation Observation

225. A warning may be given here that for signals received from certain elevations there are two settings of the Elevation Scale which give a balance. For example, a ground signal having an elevation of 0° will give a balance with the Elevation Scale set to 37°.

226. The reason for this is that both Elevation aerials have more than one lobe between 0° and 90° of their vertical polar reception curves (see fig. 27), necessitating a rotation of the Goniometer rotor of considerably more than 180° to cover elevations between 0° and 90°. Thus some of the Elevation balance points are covered twice, one of the two rotor balance positions being reversed by 180° with respect to the other.

227. In operation the wrong balance points on the E. Scale are easily recognised by the fact that the colour-following sequence is reversed *i.e.* the orange pulse increases in amplitude instead of the green one on turning the Elevation Handle clockwise beyond the balance point.

Goniometer

(Circuit, see fig. 34. Mechanical Details fig. 28).

228. The rotor and stator windings are totally enclosed in a cast metal casing (fig. 28) bolted through four holes 34 to plate 33 on the front of the cam box (fig. 30A). These holes are elongated to permit a slight adjustment of the Goniometer body about its axis.

229. The rotor winding is carried on a shaft running in ball-bearings and carrying a brass driving disc 41; this disc has a slot 43 which engages with the driving pin on scale disc 27 (fig. 30A) from which the Goniometer rotor derives its drive. When the Goniometer is in position the disc 27 is within the base of the Goniometer casing, the degree scale on its edge being read against the pointer 46.

230. The connections from the rotor are taken via two small grooved slip-rings 47 and 48 (fig. 28) and spring tensioned contact wires 49 and 50 which locate in the slip-ring grooves. The slip-rings should be kept free from dirt but may have a sparing amount of thin grease.

231. The stator windings are housed within the body of the casing and are not visible in the illustrations; they should require no attention. One possible adjustment may, however, be mentioned here for completeness, namely, a small rotational adjustment of the upper Elevation stator coil assembly with respect to the lower Elevation coils.

(*a*) Slack of heads of slotted rods ("X") situated between 51, 52, etc.

(*b*) Insert copper, aluminium or ebonite rod in hole "Y", find screening plate behind slip ring and tap gently round.

(*c*) Retighten slotted rods ("X").

It should be noted that this adjustment has been most carefully attended to in the factory and should not be touched again without some very definite reason. For method of setting see page 53. The lower Elevation stator assembly is not adjustable.

232. Three variable condensers C75A, C74B and C73C (fig. 27B) housed in the part of the casing nearest the operator, form an adjustable tuning and impedance-matching coupling between the rotor coil and the cable to the switch socket. C75A is in parallel with the cable while C74B and C73C are ganged together and each in series with a lead from the cable to the Goniometer slip-rings. The knobs of these condensers are protected against accidental disturbance by a cover. By slacking two small cheese-headed bolts on the front of the goniometer casing, the cover may be manœuvered clear of the knobs.

233. The electrical connections of the Goniometer and their relation to the aerial and receiver circuits will be found in fig. 34. Three feeder cable sockets are carried on the Goniometer body and it is essential that the length of cable from the sockets to the connecting tags of the stator and rotor windings as well as their sense of connection should be correct.

234. Each socket has a large and a small plug-hole, and the two wires inside the cable are distinguished by a black and white covering so that there is no ambiguity. The connections of the cables to the sockets will be clear from fig. 34, while the views in fig. 28 show how the other ends of the cables connect to the tag panels in the Goniometer. The tags for the upper Elevation stator will be found under Plate 39 (fig. 28), those for the lower Elevation stator under Plate 40 and those for the rotor in the compartment containing the variable condensers. The cable lengths are as follows:—

Stator windings to (outer) sockets $13\frac{1}{2}$ inches$\pm\frac{1}{8}''$.
Rotor winding to (middle) socket $13\frac{1}{2}$ inches$\pm\frac{1}{8}''$.
when lead feeder is used.

235. The cable is cut off to these lengths first and the braiding and insulation is then stripped back by just the necessary amount, the socket being connected and assembled as indicated in fig. 36. The metal braiding is earthed to the socket as shown.

Elevation Gearing and A.C. Control Elements

(Schematic diagram fig. 29. General views figs. 30a and 30b)

236. The Elevation handle operates through a gear box containing seven gear wheels 1, 2, 3, 4, 5, 6 and 28 (fig. 30a). When the Elevation handle is pulled out towards the operator a 2 : 1 reduction in speed of the output shafts of the gear box in respect to the handle is obtained, giving a slow operation. When the Elevation handle is pushed in, a 2 :1 increase in speed is obtained giving a fast operation. The idling gear wheel 28 with 91 teeth carries a stop which engages with a similar stop on wheel 3 which has 90 teeth; this arrangement allows the output shaft of the gear box to be rotated through 90 turns between two limiting stop positions.

237. The output shaft of the gear box drives shaft 29 through bevel gears 7 and 8. One end of shaft 29 is coupled to bevel 9 in the cam box which drives bevel 10 and shaft 30, the latter carrying a worm 11 driving shaft 31 through worm wheel 12. Shaft 31 carries both elevation scale 13 and cam 14 so that as the Elevation scale is rotated at a constant rate the Goniometer rotor is driven round according to its special law through

cam follower arm 15 and gear wheel 16. The roller on cam follower arm 15 is always maintained in contact with the cam 14 by a spring loading device 34 on the front of the cam box (see fig. 30a). Shaft 29 carries also a worm 17 driving worm wheel 18 coupled to gear wheels 19 and 21 driving low-speed and high-speed A.C.C.E.'s through gear wheels 20 and 22. It will be seen from the shaft speeds indicated in fig. 29 that one revolution of the low-speed A.C.C.E. represents 180° change in elevation, while one revolution of the high-speed A.C.C.E. represents 10° change.

238. A disc 27, carried on the shaft which drives the Goniometer, the edge being a drum scale in degrees, indicates the actual angular setting of the Goniometer rotor. Disc 27 also carries a dowel pin projecting from its front face which engages with the slot 43 (fig.28) in the driving disc 41 of the Goniometer when bolted in position to plate 33 [fig. 30 (a)].

Telescope Mounting and Adjustments

(Fig. 30C)

239. On the extreme end of shaft 29 is a bevel 23 driving bevel 24, shaft 32 and worm 25 which in turn drives the large quadrant gear 26 attached to a horizontal shaft projecting through a weather-proof joint in the wall of the cabin and carrying a small external telescope.

240. This telescope which is rotated in a vertical plane is in exact step with the elevation scale.

It has a pair of cross-wires in the focal plane of the eye-piece and is used for training purposes and certain setting-up operations.

241. The telescope is mounted on a horizontal cast iron arm 48 bolted to the end of the main rack and projecting through a hole in the cabin wall, the telescope itself being outside the cabin.

242. The horizontal shaft passing through arm 48 takes a drive from the elevation mechanism (see fig 29.) inside the equipment via the large sector gear 26 and worm 25, the rate of rotation of this horizontal shaft being the same as that of the Elevation Scale. A clamp 47, tightened by means of a wing nut, holds the body of the telescope to the horizontal shaft and at right angles to it. The eyepiece of the telescope is at right-angles to its body and in line with the horizontal shaft.

243. A pair of knife-edges 46 on the telescope carrier are machined to be accurately on a line parallel with the telescope axis and can be used for rough sighting instead of the telescope itself.

244. Two adjustments of the telescope carrier should be noted.

Firstly, the two screws 43 at the ball-and-socket joint permit a lining-up of the telescope so that its axis is exactly perpendicular to the plane containing the Bearing and Elevation aerials. To make an adjustment, one of screws 43 is slackened and the other tightened so that ball-and-socket joint is drawn round in the requisite direction. (The shaft inside has a universal flexible coupling at this point). After the operation both screws 43 must be in tension and their locknuts carefully tightened.

245. Secondly, the tongue and set-screw device 45 allows a final small adjustment (± 3°) of the telescope axis to make its angle of elevation agree exactly with the reading on the Elevation Scale. To make an adjustment, the clamping screws 44 and the locking nuts of 45 are slackened. One of the two opposing set screws 45 (only one visible in figure) is screwed back while the other is screwed further home in order to vary the relative position at which the steel tongue between them is held.

246. This adjustment gives a small angular variation between the telescope carrier and the horizontal shaft. After it has been completed the locking nuts as well as the clamping screws 44 should be tightened, care being taken that no play is left between screws 45 on the steel tongue.

247. Before these adjustments are carried out, however, the relative positions must be made approximately right by correct meshing of worm 25 and sector gear 26. This is done by turning the Elevation Handle so that the Elevation Scale reads 45° and then meshing sector gear 26 so that its middle tooth engages with the middle spiral of worm 25.

248. The final adjustments of the telescope should be made during the operations of setting up the cabin and its bearing system. This is covered in the book of Operational Instructions.

Checking and Adjustment of Goniometer System

Important

249. Do not alter, or even loosen, any adjustment until it is quite certain that some re-setting is necessary.

Correct Assembly of Goniometer Drive

250. The brass drive disc 41 (fig. 28) of the Goniometer has a central boss carrying a deep slot 44 in which is located a pin passing through the rotor shaft, and locking the driving disc to it. A small V-shaped nick 45 will be found on the end of the rotor shaft and this should be towards the slot 43 when the pin is inserted, thus ensuring the right relationship between the rotor winding and driving mechanism. The nut 42 retains the pin in position.

Relative Setting of the Two Stators

251. The two stator windings should produce fields exactly at right angles to each other. To check this a signal of the same frequency as that on which the equipment is to operate, either from a signal generator or from an aerial, is injected at the lower Elevation aerial socket, the upper Elevation socket being left disconnected.

252. The middle, or rotor socket is connected in the normal way through the Motor-driven Switch and cables to the receiver. The Goniometer is rotated by turning the handle until minimum signal is reached; this point, which should be sharp within a fraction of a degree, is read on the drum scale against pointer 46 (fig. 28). The signal injection should then be transferred to the upper Elevation socket and the Goniometer rotated until a point of minimum signal is again found. This point should be exactly 90° different from the first; if it is not, it is made so by slightly rotating the upper Elevation stator assembly as described in para. 231.

IMPORTANT NOTE.

If the signal is obtained from an oscillator outside the equipment via the aerial system, the No. 10 feeder should be removed from the receiver socket and the R aerial switched off. If any signal reaches the receiver from any source other than the gonio the point of minimum signal found from rotating the rotor of the gonio may not be 90° from that obtained when the other input socket is used.

This applies to any tests of the gonio in which it is rotated for minimum output.

Setting of Goniometer with Respect to Elevation Scale Electrical Test

253 (a). Inject a test from a modulated signal generator at the "upper elevation aerial" socket of the goniometer—leaving the lower aerial socket disconnected.

(b) Turn the Elevation Handle until 270° on the gonio scale (27) is seen through the window.

(c) Zero should be at 270°±·3°.

(d) Reject the above with generator signal fed into the "Lower" aerial socket. Zero should be at 360°±·30° and 180°±·3°.

254. A final check on the Goniometer in conjunction with the aerial system is obtained with both Elevation Aerials plugged into the Goniometer and using a field oscillator or other remote source of radiated signal at zero elevation. If the conditions in para. 253 cannot be obtained and it is obvious that the drum (27) scale pointer has been moved, then the pointer should be set to give the condition in para. 253.

It must be remembered that the pointer has been very accurately set at the factory and that an error in the conditions set out in para. 253 probably means that the gonio is faulty and requires replacement.

255. The minimum diode current now occurs when the Goniometer drum scale (27) is set at 240°±2·5° (about 37° on E. Scale). See section on Setting up Procedure for Equipment using Test Oscillator" (page 77). If the above conditions are satisfactory the gonio is in order and it must now be adjusted so that when the gonio drum dial is set to the following figures on the E dials the correct reading ± ·2° is obtained as shown in the table below.

Gonio drum dial	Elevation dial	Gonio drum dial	Elevation dial
62.	0°	278·5	30·0°±0·2°
60·5	2°	267·5	32·5° „ „
57·7	5°	253·5	35·0° „ „
55·6	7·5°	234·5	37·5° „ „
50·6	10·0°±0·2°	209·5	40·0° „ „
44·5	12·5° „ „	179·5	42·5° „ „
34·5	15·0° „ „	160·0	45·0° „ „
14·0	17·5° „ „	146·3	47·5° „ „
346	20·0° „ „	139·0	50·0° „ „
320	22·5° „ „	134·8	52·5° „ „
302·5	25·0° „ „	132·0	55·0° „ „
289·5	27·5° „ „	129·5	60·0° „ „

If the above figures are not obtained :—

1. Slack off the 4 bolts holding the gonio at holding 34 (fig. 28, page 51).
2. See that the E scale is reading 50°.
3. Rotate the body of the gonio until the drum scale (27) reads 139°.
4. Recheck with the above table.

256. The small adjustments provided in the Goniometer fixing and the drum scale pointer should be quite sufficient so long as nothing has been done to upset the meshing of the various driving gears.

Colour Discs and Rotary Switch Mechanism

257. These are located outside the main framework in front of the panels of units I D and II D (fig. 1) their function in the equipment is described in paras. 8 and 9. The disc shafts are driven by chain and sprocket from a motor housed within the main framework behind Panel IE.

Motor

258. This is a 1/3 h.p. single phase self-starting induction motor with a centrifugally operated starting winding. Its running speed is approximately 1,400 r.p.m.

259. To start the motor it is necessary to switch on the "MOTOR" switch on IB panel. It is also necessary to operate the 3-position tumbler switch on I E panel. This switch is "OFF" in its centre position; to start, move it to the upper position for about 2 seconds and then move it straight to the bottom position and leave. Two-step starting is thus obtained through starting resistance 99A/B at the back of I E panel. Although the motor is of a type which may be started direct by immediate application of full mains voltage to its terminals, two-step starting is provided to prevent sudden stress on the driven mechanism. The motor circuit will be found in fig. 44.

Electrical Tests of Motors

260. A resistance of about 4·0 ohms may be expected across motor terminals 1 and 3 with the motor connected. This value varies about 0·25 ohms on either side as the motor is hand turned in any position of the starting switch.

Resistance readings to earth from all wires and terminals should be infinity.

With the motor disconnected and all leads off their terminals, resistance readings from lead to lead and lead to earth should be infinity except:—

Internal lead Brown/Blue to internal lead Brown/Black which should be approx. 5·0 ohms ± 0·5 ohms on hand rotation.

Internal Yellow leads should give approx. 16 ohms varying about 1·0 ohms on rotation.

With the motor connected the following AC voltages may be expected across terminals 1 and 3 (orange an red leads).

Motor switch "central"	NIL volts.
Motor switch "up"	160 volts.
Motor switch "down"	230 volts. (mains voltage)

Mechanical Maintenance of Motors

261. Keep motor interior free from dust, moisture and oil.

Removal of End-Shield. To remove the rotor it is necessary to remove the driving-end end-shield only; there is no necessity to remove the other end-shield.

When removing the end-shield it is both unnecessary and inadvisable to disturb the lubricator wick or the internal arrangements of the bearing housing.

When reassembling sleeve bearing machines make certain that the tongues of the end thrust washers fit properly in the slots of the shaft collars before inserting the rotor. When reassembling the end-shields see that they seat properly on the spigot, tighten up all nuts thumb tight, finishing by screwing nuts tightly in pairs *diagonally.*

If for any reason the spring, plug and wick have been removed from the bearing, when replacing, the wick should be pressed into contact with the shaft before replacing the spring and plug.

OPEN CIRCUITING SWITCH. The condition of the contacts should be inspected occasionally and they should be cleaned if found to be dirty.

Spare Parts. When ordering new parts give name-plate data and motor number.

BEARING LUBRICATION. Sleeve bearings are fully charged with oil sufficient for at least two years' operation. At the end of this period it is desirable to remove the screw plug at the top of the bearing, and slowly feed a good machine oil into the bearing until oil is observed at the overflow hole. The motor will then have sufficient lubricant for another two years'. *Don't forget to oil both bearings.*

Ball Bearings are charged with grease sufficient for at least twelve months' working under normal conditions. Providing no leakage of grease takes place, the bearings will run for a much longer period without replenishment. Inspect the bearing caps occasionally to ascertain whether leakage has taken place ; replenish with a good ball-bearing grease if any signs of leakage are apparent. Care should be taken to exclude dust and grit when refilling.

Colour Discs

(Fig. 1).

262. These are housed in the cast casing in front of panels I D and II D. Two discs of equal diameter rotate in the same direction (clockwise), the left hand half of one obscuring the E tube and the right hand half of the other obscuring the B tube. Each disc has a pair of diametrically opposed windows covering a 45° sector, the two windows in each pair carrying respectively orange and green colour filters.

263. The driving shaft of each disc carries a sprocket wheel, a common chain passing round these two sprockets and a third near the top of the casing which takes a direct drive from the motor through a flexible coupling. As all three sprocket wheels are of the same dimensions the discs rotate at the same speed as the motor, *i.e.* approximately 1,400 r.p.m. A fourth sprocket wheel carried on an adjustable arm bears on the chain and acts as a tensioning jockey. The tension of the chain should not be too tight, but should be tight enough to ensure that the chain remains securely in engagement with the sprocket wheels and does not whip against the sides of the case while running. Adjustment is made by removing the knurled locking screw in disc 1 (fig. 1) and rotating the disc; it is then locked by replacing the locking screw, using the most suitable of the holes provided round the edge of the disc. The sprockets are so engaged with the chain that the Colour Discs are exactly 90° out of phase, *i.e.* the windows of one Disc are in a horizontal line while those in the other Disc are in a vertical line. (For complete details of phasing see table in fig. 34, page 63).

LUBRICATION OF CHAINS :—All models marked with "G" in white paint near the filler cap of the disc chain drive mechanism will have graphited mineral jelly (Wakefield grade 458x) instead of oil filling. This is to prevent oil leakage into the colour filters in warm locations. The jelly should be applied to the chain through the oil filler hole.

264. A knurled extension 2 of the driving shaft projects from the casing and enables the Disc mechanism to be rotated slowly by hand for checking purposes. Provision is made for lubricating the chain and sprockets. A heavy lubricating oil should be used. To insert oil the filling plug 5 (see fig. 1) at the top of the casing should be removed as well as the plug on the overflow pipe 7 at the back of the casing near the bottom. Pour oil in the filling hole at the top until it just begins to flow out of the overflow pipe. Allow time for any excess oil to drain out by the overflow pipe and replace both plugs. This ensures having the correct level of oil in the bottom of the chain compartment. A draining plug 6 will be found beside the entry of the overflow pipe into the chain compartment. The lubrication should remain satisfactory for long periods without attention.

265. The whole casing of the Disc mechanism is supported by a bracket on the main frame-work through rubber mounting. It is necessary therefore to earth the casing to the main framework by the flexible connection 8 ; should the Disc mechanism be detached for any purpose it is important to replace this connection when the mechanism is replaced.

Motor Driven Switch

(figs. 1, 33 and 34).

266. The function of the Motor Driven Switch is to connect the input of the receiver alternately to the outputs of the Goniometer and Phasing Box as described on page 2.

267. The switch is secured to the front of the disc casing by four knurled-headed captive screws 3. By undoing these screws and removing the cable plugs the switch may be removed bodily as a unit. When the switch is in position, it derives its drive from a slot in a coupling on the projecting end of the Elevation colour disc shaft, engaging with a pin projecting from a disc on the end of the switch shaft. When assembling the switch on the Disc casing, make sure that the pin and slot engage properly before tightening up the securing screws 3.

268. All bearings in the Motor Driven Switch have ball races and require no lubrication beyond the grease originally in them. The two gear wheels may occasionally have a trace of grease applied to their teeth. Anything which might result in oil or grease being thrown about inside the switch must be rigorously avoided.

269. The electrical part of the switch consists of four oscillating tongues a, b, c, d, working between eight fixed contacts, e, f, g, h, j, k, l, m (see figs. 33 and 34). The correct contact sequence is most important as are all sequences associated with the Disc mechanism. The correct order of operation is shown in the table accompa-

nying fig. 34. Fig. 33 shows the actual physical location of the various contacts using the same reference letters a, b, c, etc. as in fig. 34.

270. The fixed contacts e, f, g, h, j, k, l, m, are carried on adjusting screws which alter to a small extent the period of make and break. By screwing in a contact the duration of make for that contact is slightly increased and the duration of break is decreased; unscrewing the contact has the reverse effect.

Adjustment and Cleaning of Motor Driven R. F. Switch and Image Splitting (D. C.) Switch

(See fig. 33A and fig. 33B, page 62)

271. Motor driven switches which are dirty or out of adjustment may cause flutter on the pulse on Bearing and Elevation tubes. This should be checked with the discs stopped to ensure that the flutter is not due to other causes. If the D.C. switch is at fault the flutter will show only on the orange pulse on both bearing and elevation tubes since the switch is open during the green pulse.

Remove cover from D.C. switch and wipe commutator with a rag dipped in Rectified Benzine. *Do not use petrol.*

If both orange and green pulses flutter, or if flutter is only on one colour or one tube, clean the R.F. switch contacts. Use a pipe cleaner or narrow strips of stout paper dipped in the grease solvent, given above.

On no account must emery paper or abrasives be used on the contacts.

Check the adjustment of the switch as follows :—

To indicate contact :—An input is required either from a signal generator in which case the diode output meter (jack in V13A) is used, or from a local echo, in which case indication is seen on the range tube. If the signal generator is used it must of course be tuned to the frequency which the receiver is set up for, and should be fed into either the right hand (A) or bottom (B) socket of the motor driven switch dependent on whether the bearing or elevation contacts are being adjusted.

To adjust Bearing Contacts (Upper Half of Switch).

272. Set Range Aerial switch to "off" and unplug connector 7 from switch and remove cover.

(*a*) Rotate disc gear clockwise until orange filter has just passed the elevation tube. Adjust top right hand contacts ("f" and "h" fig. 33) to "make" (indication on output meter or range tube). Be sure that *both* contacts "make". The pulse height or meter reading will slightly increase when both contacts are made. Turn the disc gear back and forth slightly to ensure that the two contacts "make" at approximately the same moment.

(*b*) Rotate disc clockwise and check that contacts open *before* the elevation tube is exposed through the green filter.

(*c*) Set disc gear so that green filter has just passed the elevation tube and adjust the left hand upper contacts to make (e and g fig. 33) as above.

(*d*) Ensure that these contacts open before the elevation tube is exposed through the orange filter.

To adjust Elevation Contacts (lower half of switch).

273. With Range Aerial switch at "off" remove connector 9 from switch and replace connector 7.

(*a*) Rotate disc gear until orange filter has just passed the bearing tube. Adjust bottom right hand contacts ("m" and "k" figs. 33A and 33B) to make. Ensure that *both* contacts "make".

(*b*) Rotate disc gear and check that contacts open before the bearing tube is exposed through the green filter.

(*c*) Rotate discs until green filter has just passed the bearing tube and adjust bottom left hand contacts to "make" (contacts j and l fig. 33A and 33B).

(*d*) Ensure that the contacts open before the bearing tube is exposed through the orange filter. To summarise :—The exact angle of the discs at which the switch contacts open or close is not very critical excepting that the *bearing* (upper half) contacts must be open circuit whilst the *elevation* tube is exposed, and the elevation (lower half) contacts open whilst the bearing tube is exposed.

Checking R.F. Switch.

274. Replace all connectors and run the disc gear to see if the flutter is cured. If not, apply sideways pressure with the fingers to the moulded rocker arm at the end which forms the pivot for the moving switch blade, taking care not to touch any metal part of the switch, and observe if this effects a cure.

If a cure is effected the switch is faulty and must be replaced at the earliest possible moment.

As a temporary measure only the following expedient may be tried :—

Slacken the bolts holding the brass plate forming the bearing for the pivot of the moving switch blades (one of each of these also secures the pig-tail from the moving switch blades), push the plate very slightly to one side and tighten bolts. This puts the bearing very slightly out of line, but in so doing prevents the pivot from forming bad contact by partly floating in the bearings.

The switch must be replaced as soon as possible as the above method will only be effective for a short time.

275. Always replace the screening cover of the switch, complete with all screws, after opening for examination or adjustment.

Image Splitting Switch

(figs. 1 and 34)

276. The function of the Image Splitting Switch is to produce a small bodily displacement of the time base images on the E and B tubes each alternate half revolution of the disc mechanism as described on page 3.

277. The switch, which is of a continuously rotary type, is driven from the shaft of the Bearing colour disc by a pin-and-slot coupling similar to that used for the Motor Driven R. F. Switch. A revolving drum of insulating material carries a brass segment extending round 180° of the surface. Two small carbon brushes, side by side, bear on the drum so that for one half of a revolution they are connected together and for the other half revolution they are open-circuited.

278. The outgoing leads from the two carbon brushes pass to a filter unit in a small metal box, mounted nearby, which serves to suppress the interference generated by the periodic interruption of a D.C. supply at the brushes.

BEARING MECHANISM

(Schematic fig. 12a, General view fig. 31)

281. Determination of bearing is made by bodily rotation of the cabin with its aerial system as described on page 3. The cabin is rotated manually by the handles on the Traversing Column projecting from the floor. The traversing column carries its own bearing scale with adjustable pointer and has a two-speed gear lever on its side whereby the cabin may be rotated rapidly or slowly.

282. A vertical shaft at the rear of the equipment is coupled to the turntable mechanism and transmits the rotational motion up to the internal bearing mechanism.

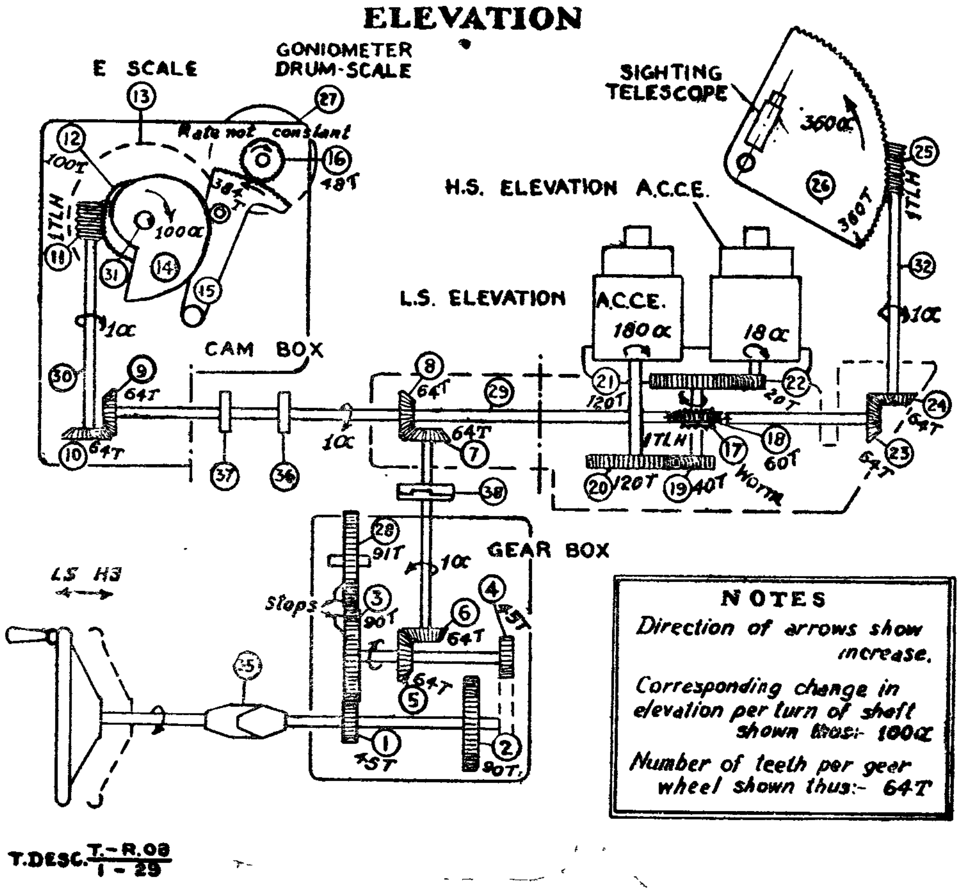


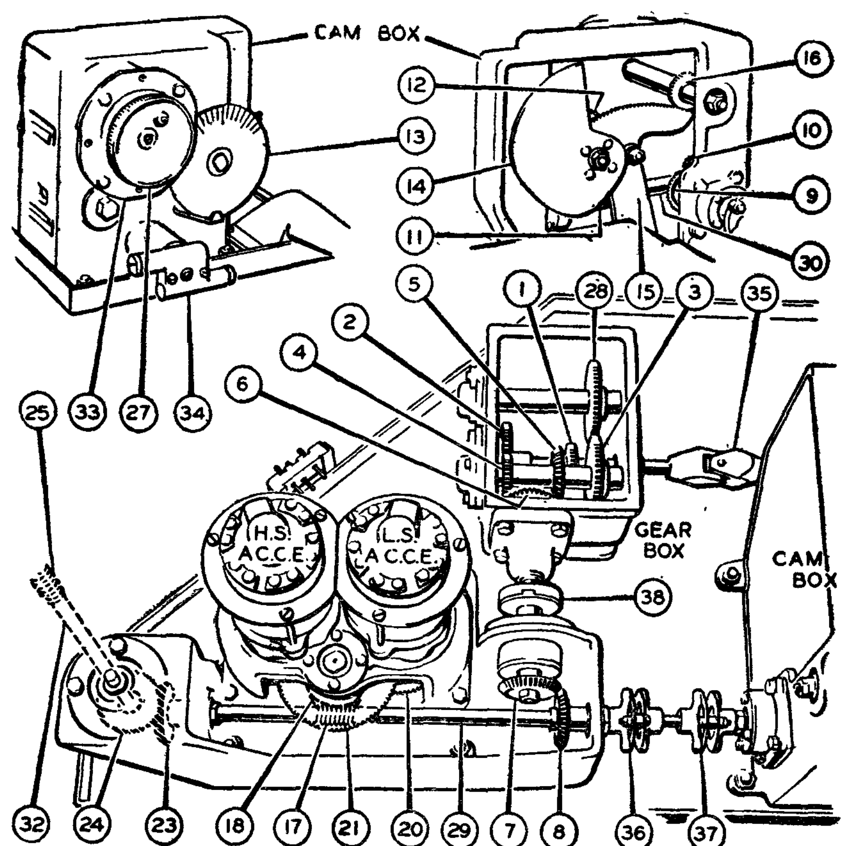
FIG. 29 ELEVATION GEARING SCHEMATIC DIAGRAM.

279. Two bolts, 4, hold the Splitting Switch to the Disc casing ; slotted holes allow for a small rotational adjustment of the switch. As the interference caused by make and break at the brushes is not entirely suppressed by the filter it is advisable to set the switch so that the make and break occur at positions of the Colour Discs when neither E or B tube is exposed. If this is done any residual interference which may get through to the receiver will not be visible on the E and B screens when the discs are in operation. After a long period of use the carbon brushes may wear and need replacing. They can be removed, complete with springs, by unscrewing the moulded caps of the brush holders.

280. The bearings of the Splitting Switch have ball races and do not require lubrication.

283. The functions of the bearing mechanism are to operate a direct reading bearing scale at panel IV D (fig. 1), to drive a pair of A.C. Control Elements for transmitting the information electrically and to operate the Displacement Correction device. (See section on Potentiometer Gearing page 30). Fig. 12a shows the gearing schematically, being incorporated in the same diagram as the range gearing, since the two are interconnected by the Displacement Corrector.

284. The vertical shaft from the turntable drives a horizontal shaft through gears 48, 47, 46 and 59. This horizontal shaft carries a worm 55 driving a worm wheel 69 directly coupled by a shaft to the Bearing Scale. Worm 55 also drives worm wheel 56 which is on the shaft of the low speed A.C. Control Element.



T.DESC. T-R.08 / 1-30A

FIG. 30A ELEVATION GEARING

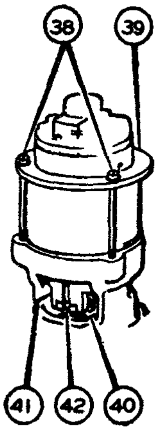
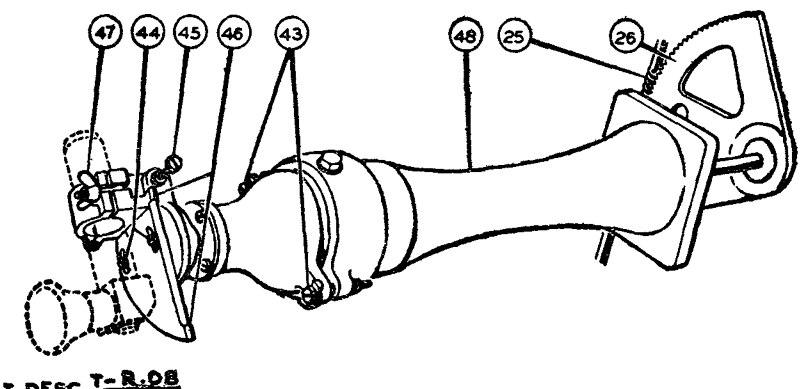


FIG. 30B A.C.C.E. FIXING

T.DESC. T-R.08 / 1-30B

FIG. 30C TELESCOPE MOUNTING



T.DESC T-R.08 / 1-30C

285. Another bevel gear 49 on the horizontal shaft transmits the drive through bevel 50 and gear wheels 51 and 53 to a high speed A.C.C.E. for either Vickers or Sperry predictors. Since the H.S. A.C.C.E. has to be driven at different speeds for the two different types of predictor, two alternative holes are provided in the casting (fig. 31). Gear wheel 51 drives the Vickers and gear wheel 53 drives the Sperry A.C.C.E. The same gear wheel 52 on the A.C.C.E. itself is used in either case. It is marked with a V and engraved 0° to 10° on one face, the other face being marked with an S and engraved 0° to 20°. This gear wheel is assembled to the A.C.C.E. with the marking uppermost which corresponds to the predictor in use.

286. The bearing scale makes one complete revolution for one complete revolution of the cabin.

287. From the shaft speeds indicated in fig. 12a it will be seen that the low-speed A.C.C.E. makes one complete revolution for one revolution of the Bearing Scale and cabin.

288. For the Vickers predictor the high-speed A.C.C.E. makes one revolution for every 10° on the Bearing Scale, and for the Sperry it makes one revolution every 20° on the Bearing Scale.

PHASING BOX

(Circuit fig. 34. General view fig. 1. Internal views, figs. 32a and 32b)

291. The Phasing Box forms the junction point between the two bearing aerials. The feeder cables from these aerials are plugged into the sockets either side of the Phasing Box (fig. 32a) which are bridged across by a pair of parallel brass slider bars inside the box. A double sliding block makes a separate contact with each bar, the two contacts being connected to the conductors of Cable 9, the other end of which goes to the motor driven R.F. switch.

292. The slider is made free to move by slackening the hexagon-headed bolt; it should be made only just slack enough to permit movement, as the various parts of the slider may come apart if the bolt is unscrewed too far. This bolt must be tightened again after the final adjustment has been made. This adjustment is provided for final exact equalization of phase at the balance point of the outputs from the two bearing aerials when setting up at a given frequency. Most of the balance is achieved in the first instance by careful cutting of the bearing aerial feeders to the correct equal lengths and disposing them symmetrically.

293. A switch S12A, illustrated in fig. 32b with

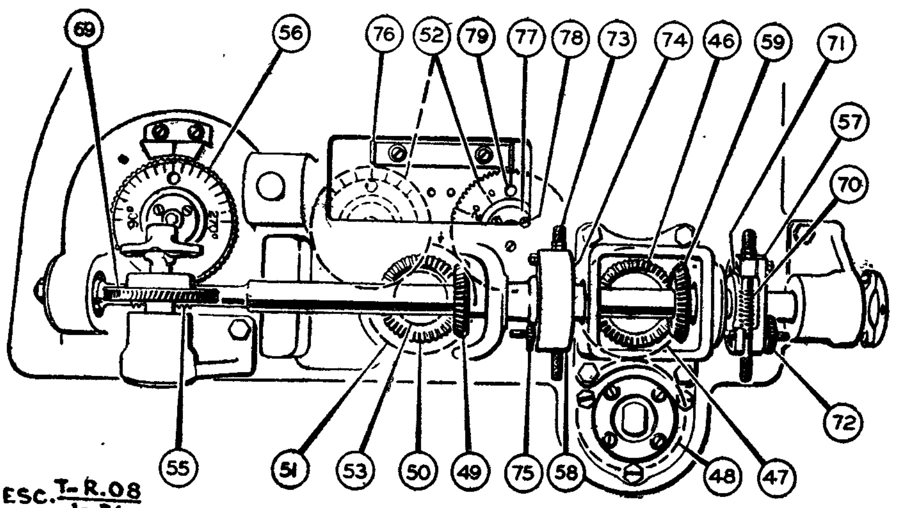


FIG. 31 BEARING GEARING AND A.C.C.E.'s.

289. Adjustable coupling 58 allows the Bearing Scale to be set with relation to the turntable. For large adjustments the coupling can be completely disengaged by unlocking the screw retaining the worm so that the worm can be thrown out of mesh with the worm wheel. For small or fine adjustments the screw may be just slackened enough to allow the worm to be rotated by a small knurled extension. The locking screw must be carefully tightened up again after the adjustment has been made. This adjustment can only be made when setting up the cabin on its working site as the Bearing Scale has to set at 0° when the cabin is facing true north.

290. The other adjustable coupling 57 is for correct phasing of the Displacement Corrector and is dealt with in the section on Potentiometer Gearing.

Electrical connections of A.C. Control Elements are given in fig. 42, page 69.

Lubrication:

See page 74.

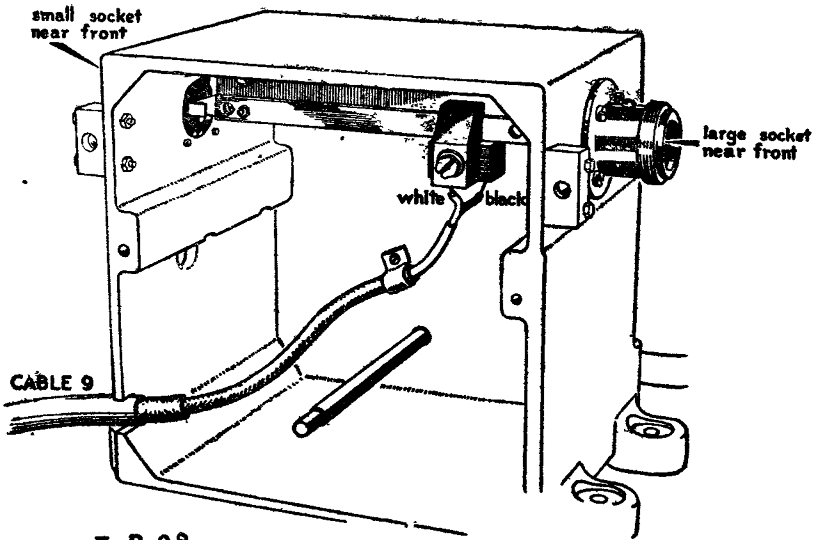
cover removed, for disconnecting the range aerial from the receiver when making sense determinations, is mounted on the back of the Phasing Box and has its own screening cover. The range aerial feeder cable is plugged in at the socket mounted on the switch, whilst cable 10 to the receiver is permanently connected. When the switch disconnects the aerial, it throws an 80 ohm dummy load R96A across the cable to the receiver. A turn-button lever on the Phasing Box front panel operates S12A.

294. Fig. 34 shows the sense in which the Phasing Box socket and cables must be connected.

AERIAL SYSTEM

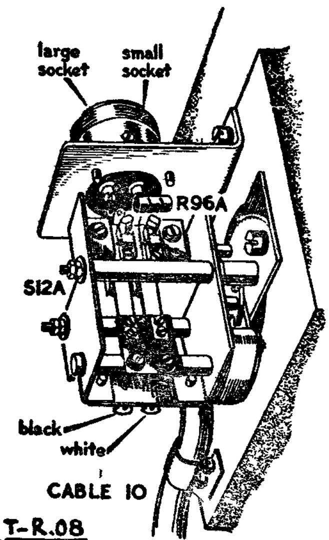
Circuit

295. Fig. 34 shows the connections of the aerials and immediately associated circuits. It is essential that all dipoles, plugs and sockets, feeder cables, etc. should be connected in the sense indicated in this diagram. A reversal at any one point in the R.F. system will result in incorrect observations.



T.DESC. T-R.08 / 1-32A

FIG. 32A INTERIOR OF PHASING BOX



T.DESC. T-R.08 / 1-32B

FIG. 32B RANGE AERIAL SWITCH

296. Items such as the motor driven R.F. switch, the goniometer and the phasing box are dealt with in separate sections.

Heights and Spacing of Aerials

297. Fig. 35 shows the simple theoretical heights and spacings of the various aerials in relation to the wavelength used. Slight deviations from these simple relationships may occur in practice owing to certain necessary corrections. Therefore, the aerial system must always be set to the pre-determined markings referred to below. Any change in operating frequency necessitates a change in all the aerial positions.

Markings for Aerial Heights and Spacings at Various Frequencies

298. To facilitate accurate setting up of the aerials at a number of alternative working frequencies "Datum Marks" have been placed on the supporting structures.

299. D.M.E. (I.) T. I. Maintenance Tels. R. 14 dated 8-12-43 outlines the method of indicating the Datum Marks.

300. The information tabulated in para. 302 shows the movement of the various dipole battens from the Datum marks. As these marks are ¼" wide and as the setting of the aerials is critical to within ¼ inch it is essential that the correct edge of the mark be used. This is outlined in I.S.S. Secret Circular letter G.L. 38.

301. The dipole position for each frequency is detailed as a movement of the dipole from the datum mark. Thus the figures quoted in para. 302 will be measured from the *upper* edge of the datum mark to the *lower* edge of the dipole supporting batten, in the case of Bearing and Elevation dipoles and from the edge of the datum mark *remote from* the ladder to the edge of the batten *nearest to the ladder* in the case of the reflector.

In the case of the Range dipole the measurement must be made from the *upper* edge of the datum mark on the ladder to the *upper* edge of the datum mark on the frame supporting the Range dipole batten.

302. Aerial Height settings (3 in line system—0·5λ)

Frequency in Mc/S.	Code letter	Movement of Aerials from appropriate Datum Mark				
		Upper Elevation	Reflector	Lower Elevation	Bearing	Range
58	A	+4'1"	+4¼"	+2'7¼"	=	+1'5"
61	B	+2'10¼"	+3"	+2'1"	To be set in line with range aerial by sighting along aerial tubes.	+1'0"
64	C	+1'9¾"	+2"	+1'3¾"		+7½"
67	D	+7"	+1"	+7¼"		+3¼"
70	E	—3"	0	+4¼"		0
76	F	—1'11"	—1¾"	—10¾'		—6½"
73	H	—1'0"	—¾"	—5¾"		—3½"
55	G	+5'5"	+5¾"	+3'6¾"		+1'10½"
79	J	—2'8"	—2¼"	—11¾"		—9½"

(b) Aerial Height Settings (0·6 lamba system).

Frequency in Mc/s.	Code letter	Movement of Aerials from appropriate Datum Mark				
		Upper Elevation	Reflector	Lower Elevation	Bearing	Range
58	A	+4′1¼″	+4¼″	+2′2″	+1′9″	+1′5″
61	B	+2′10¼″	+3″	+1′7″	+1′3″	+1′0″
64	C	+1′9¾″	+2″	+1′3¾″	+9½″	+7½″
67	D	+11¼″	+1″	+3½″	+4½″	+3¼″
70	E	0	0	0	0	0
76	F	—1′8″	—1¾″	—10¾″	—8″	—6½″
73	H	—9″	—¾″	—6¾″	—4¼″	—3½″
55	G	+5′1″	+5 5/8″	+3′2¾″	+2′3″	+1′10¼″
79	J	—2′4″	—2 7/16″	—1′1¾″	—11¼″	—9¼″

Key—

Elevation, bearing and range aerials . . . . . +indicates a vertical movement upwards.
—indicates a vertical movement downwards.

Reflector . . . . +indicates a horizontal movement away from ladder.
—indicates a horizontal movement towards the ladder.

The range aerial has one fixed horizontal spacing from the cabin for all frequencies ; this is indicated on it's supporting bracket.

Dipole Adjustment

303. Each dipole rod has a telescopic adjustment and graduations on the extensible section corresponding to various working frequencies in megacycles. By slackening the wing-nut on the outer tube, the inner tube is slid in or out until the graduation line corresponding to the required frequency is level with the end of the outer tube ; the wing-nut must then be properly retightened. This adjustment must be made on all the dipole rods in the aerial system whenever the frequency is altered.

Cable-to-Aerial Connectors

304. These must be securely clamped to the dipole rods with the brass label engraved TOP uppermost.

R. F. Plugs and Sockets

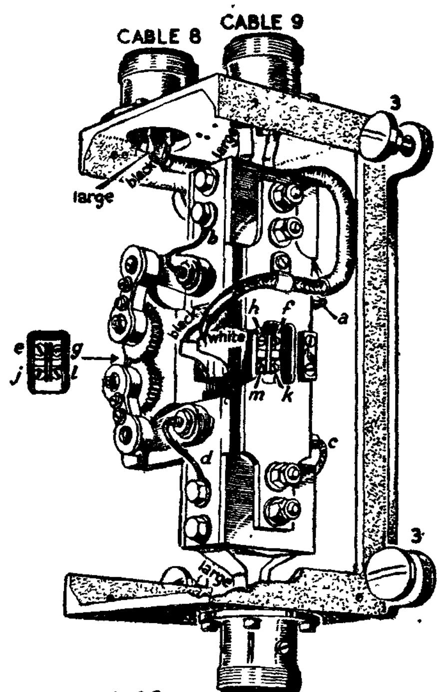
305. Fig. 36A and B show the method of assembling and connecting the plugs and sockets to the feeder cables. The plugs are of a non-reversible design, having a large and a small pin. Care should be taken when soldering the wires of the cable to the lugs, at the back of the pins, to apply the heat to the end of the wires for the least time consistent with making a sound joint as the special insulation material is readily fused by heat. The time for the soldering operation is kept to a minimum by thoroughly cleaning the ends of the wires before-hand. The sealing compound used is Henley Plastic Compound S. 3350. Seal up the cable where it leaves the back of the sleeve with a small quantity of the compound as well as filling the spaces in the main body of the plug as indicated in the diagram. The grease-gun hole is no longer provided. Before screwing the guide spring on to the sleeve, bind the lead sheathing with thin string (No. 6 waxed flax is suitable) where it enters the sleeve. When the guide spring is screwed home on the sleeve it should grip the cable tightly through the string binding. Cables with any fractures in the lead sheathing should not be used.

IMPORTANT. Where lead-covered cable is used for the short lengths on the Goniometer, the lengths are all 13½ in. and not as given on page 52 para. 234, and fig. 28 (page 51). The other two short lengths of cable on the R.F. Unit (111E/1) door should be replaced only with the same type of cable as fitted and *the same mechanical length.* All other cables are cut to electrical lengths, and should be replaced only by authorised spares.

306. In the R.F. feeder cable employed, the individual coverings of the two conductors are respectively coloured black and white. Throughout the system, the black-covered conductor goes to the large plug pin or socket hole. It is important to earth the metal braiding to the body of the plug or socket as shown.

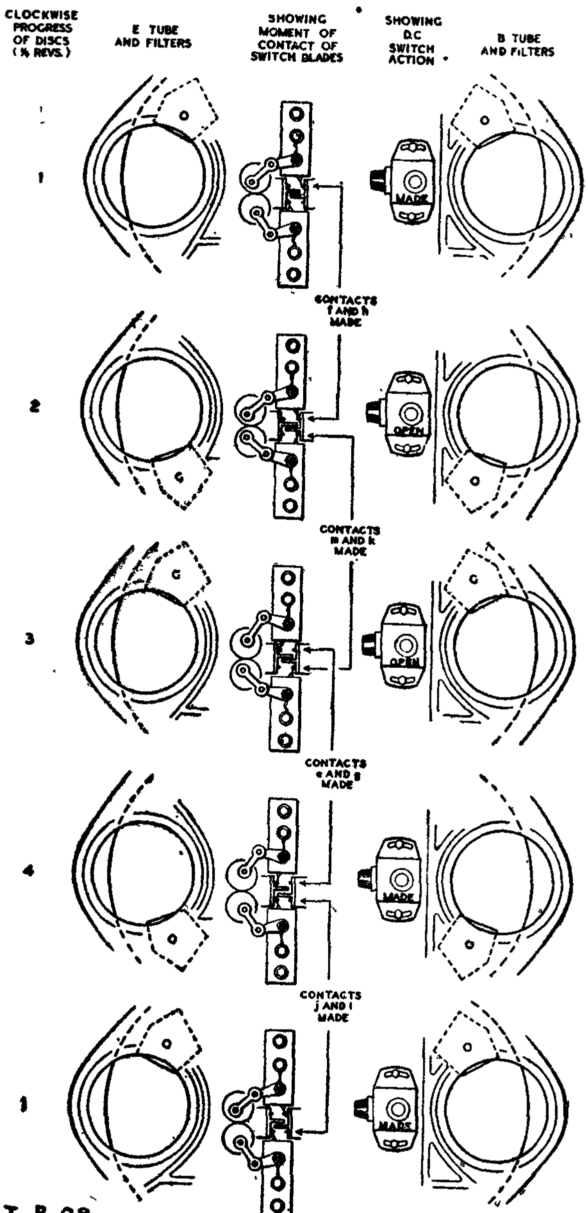
Sense Aerial Switch Box.
(see 36C).

307. This is located near the mid-point of the sense dipole, being fixed to the wooden batten carrying the dipole. The box, which is of cast metal, has a watertight lid and contains a 50 volt A.C. operated relay,



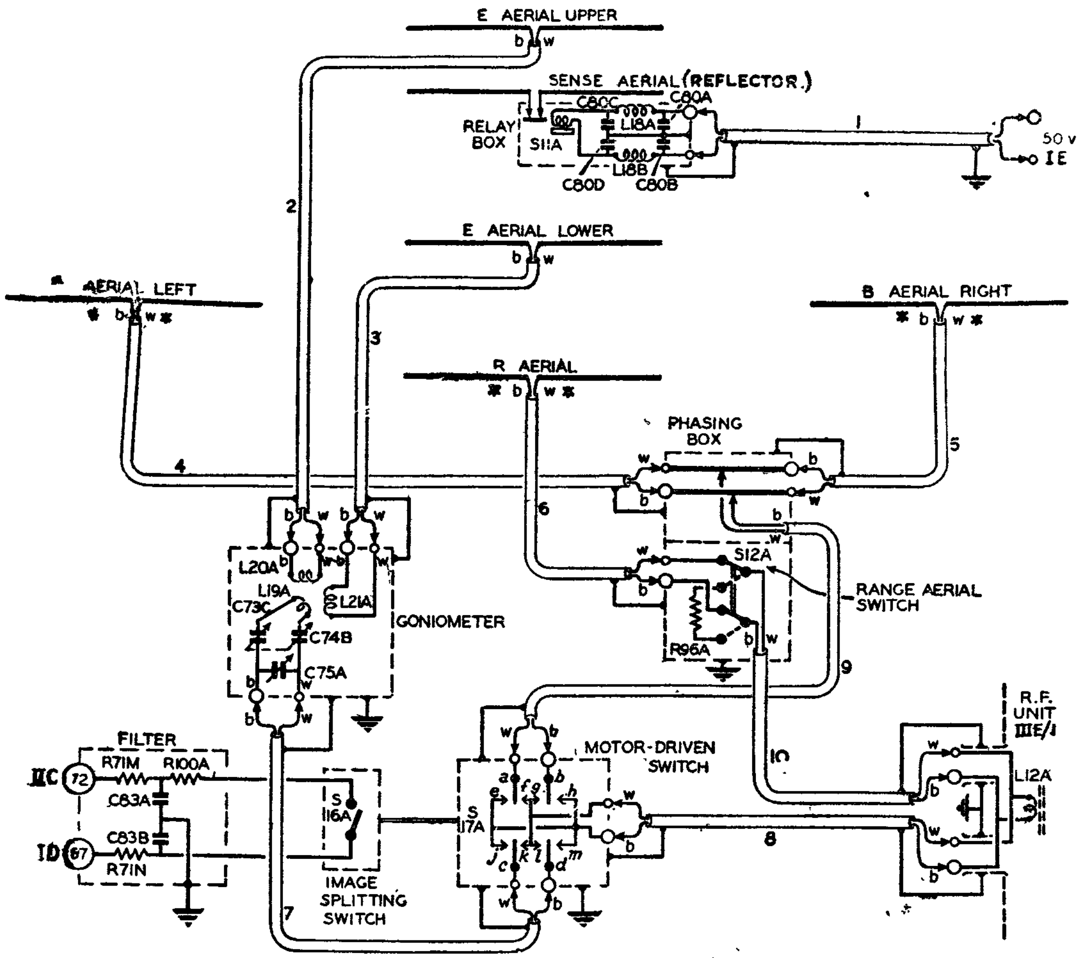
T.DESC. $\frac{\text{T-R.08}}{\text{1-33A}}$

FIG. 33A. MOTOR DRIVEN R.F. SWITCH.



T.DESC. $\frac{\text{T-R.08}}{\text{1-33B}}$

FIG. 33B. MOTOR DRIVEN R.F. SWITCH CYCLE OF OPERATIONS SHOWING CONTACT PERIODS AND ASSOCIATED COLOUR DISC POSITIONS.



VIEW FROM OPERATOR'S SIDE LOOKING FORWARD

KEY TO SEQUENCE OF MOTOR-DRIVEN SWITCH, IMAGE SPLITTING SWITCH, AND COLOUR DISCS.

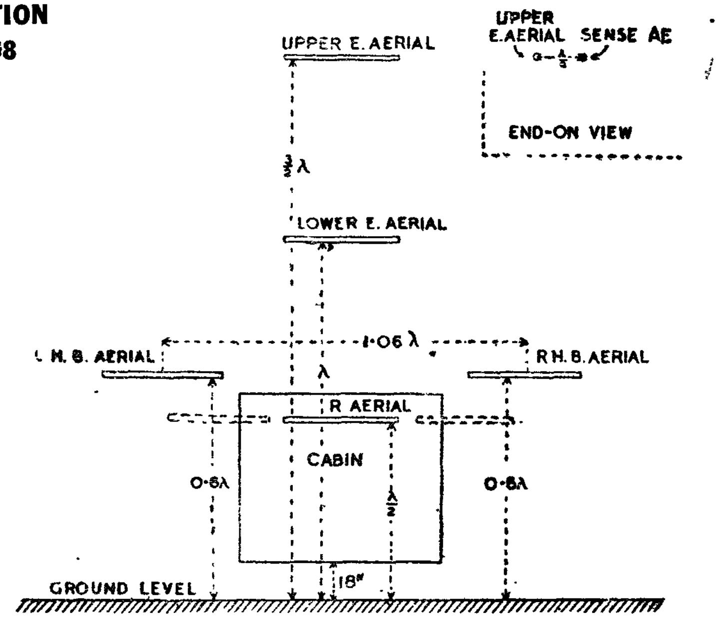
Quarter rev.	Motor-driven switch connections.	Tube exposed by colour discs E	B	Image splitting switch.
1st.	(a) (b) (e) (f) (g) (h) (j) (k) (l) (m) (c) (d)	O	●	CLOSED
2nd.	(a) (b) (e) (f) (g) (h) (j) (k) (l) (m) (c) (d)	●	O	CLOSED
3rd.	(a) (b) (e) (f) (g) (h) (j) (k) (l) (m) (c) (d)	G	●	OPEN
4th.	(a) (b) (e) (f) (g) (h) (j) (k) (l) (m) (c) (d)	●	G	OPEN

Tube obscured ●
Tube showing orange O
Tube showing green G

T-R.08 / 1-34

FIG. 34 AERIAL SYSTEM & IMMEDIATELY RELATED CIRCUITS.

C73 4·5-50 mmfd, Air variable
C74 4·5-50 mmfd. ,, ,,
C75 6-120 mmfd. ,, ,,
C80 0·001 mfd. 4,000 V.
C83 0·01 mfd. 350 V.
R71 5,000 ohms 5% ¼ W.
R96 80 ohms 5% ¼ W.
R100 300 ohms 5% ¼ W.
L18 Filter choke
L19, L20, L21 Goniometer
S11 50 V. Relay
S12 D.P.D.T.
S16 Image splitting } Motor driven
S17 R.F. }
SL4 6·3 V. ·25 A.

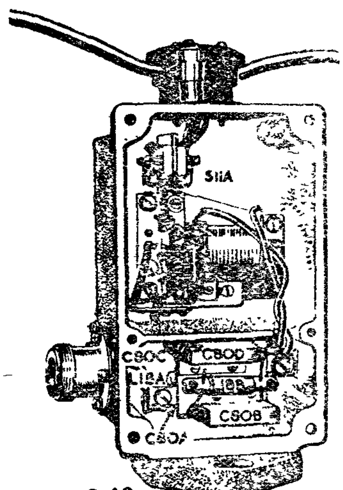


VIEW FROM OPERATOR'S SIDE LOOKING FORWARD

λ = Operating wavelength of equipment.

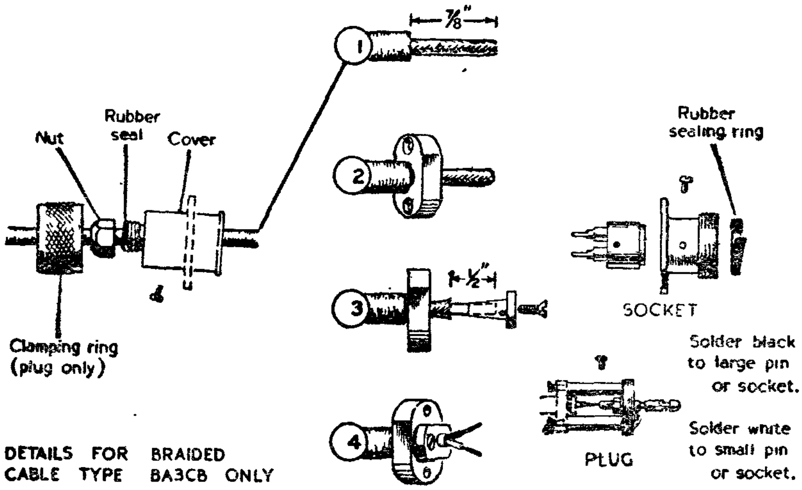
FIG 35 THEORETICAL HEIGHTS & SPACINGS OF AERIALS
(Practical figures will be slightly different)

T.DESC. $\frac{\text{T-R.08}}{\text{1-35}}$



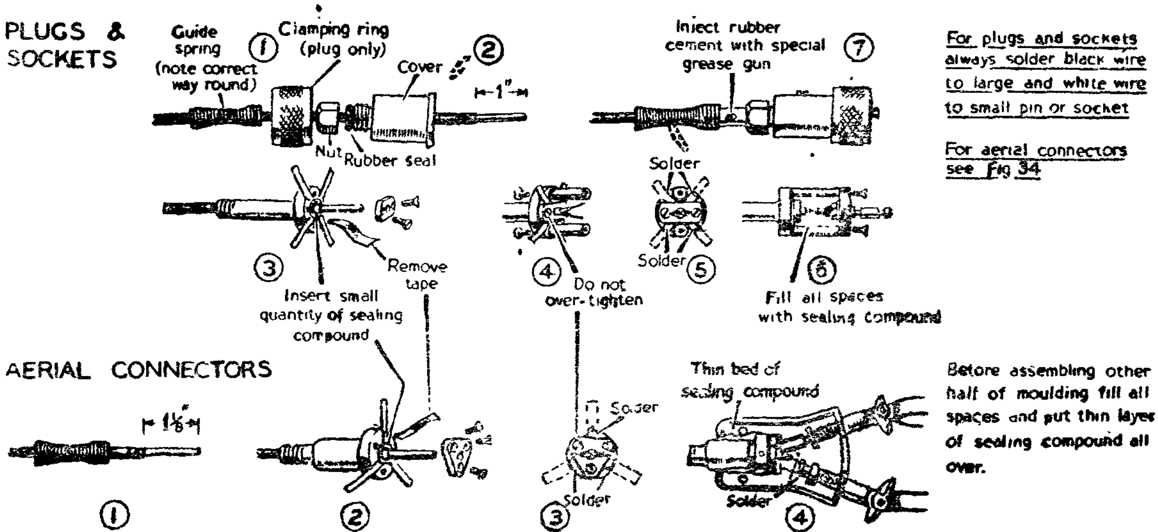
T DESC $\frac{\text{T-R.08}}{\text{1-36C}}$

FIG 36 C SENSE AERIAL SWITCH BOX



T.DESC. $\frac{\text{T-R.08}}{\text{1-36A}}$

FIG 36A ASSEMBLY OF PLUGS AND SOCKETS FOR R.F. CABLES



T.DESC $\frac{\text{T-R 08}}{\text{1-36B}}$

FIG. 36B. USING LEAD COVERED CABLE TYPE BA3TLH

the contacts of which connect the inner ends of the dipole rods together in the " make " condition.

308. The 50 volt supply to the relay enters the box at a socket, taking a plug and cable similar to those used for the aerial feeders. The lower end of the cable inside the cabin is plugged into a socket provided on panel IE (fig. 1) of the receiver equipment. Although the cable is not an H.F. feeder it should be cut to the prescribed length and always secured in its proper position so that any effect it may have upon the aerial system is kept constant.

309. Should it be necessary to open the lid of the relay box to make any inspection or adjustment, the lid should subsequently be carefully replaced with its cork gasket and all the retaining screws tightened to make it water-tight since the box is exposed to all weathers.

MAIN INPUT TERMINAL PANEL AND SLIP RINGS

(Connections, figs. 37 to 41)

310. All incoming electrical connections from the equipment inside the cabin enter by means of a set of slip-rings beneath the floor of the cabin. Such connections include :—

Main 50 cycle 220 volt power supply. 50 volt supply.
Telephone leads. Earth return lead.
Output leads of A.C. Control Elements Locking cable.
" Transmitter Indicator " signalling leads to transmitter cabin.

311. The input terminals for incoming connections to the rack will be found in the recess (section IIIA) at the bottom of the rack (see fig. 1). Slip-ring connections terminate at a V-shaped terminal panel which is exposed by lifting the trap in the middle of the cabin floor. Fig. 37 shows the interconnections between these two panels.

312. The locking cable alone does not pass through these panels but comes straight through the floor from a special low capacity slip-ring section to the locking switch on the front panel of Unit IIB.

Cable Junction Boxes

There are two types of Junction Boxes.

1. The eight or fifteen way multi contact type (see figs. 38 and 39).

2. The Telephone Junction Box which provides two simple terminals and will not be dealt with further.

Multi Contact Type :—

In certain cases one box is used, in others two may be used, but they are of exactly the same construction and all contacts are numbered. The wires from these boxes pass to the main contact drum in the well of the cabin, accessible through a trap down in the cabin floor below the centre of the equipment panel (see fig. 40).

Removal of Contact Boxes :—

1. Remove clips holding cable to frame.
2. Remove four bolts (A fig. 38) securing contact box to frame.
3. Move box to convenient position.
4. Remove eight countersunk cover securing screws (B fig. 38).
5. Remove cover (C fig. 38) *taking care not to damage jointing.*

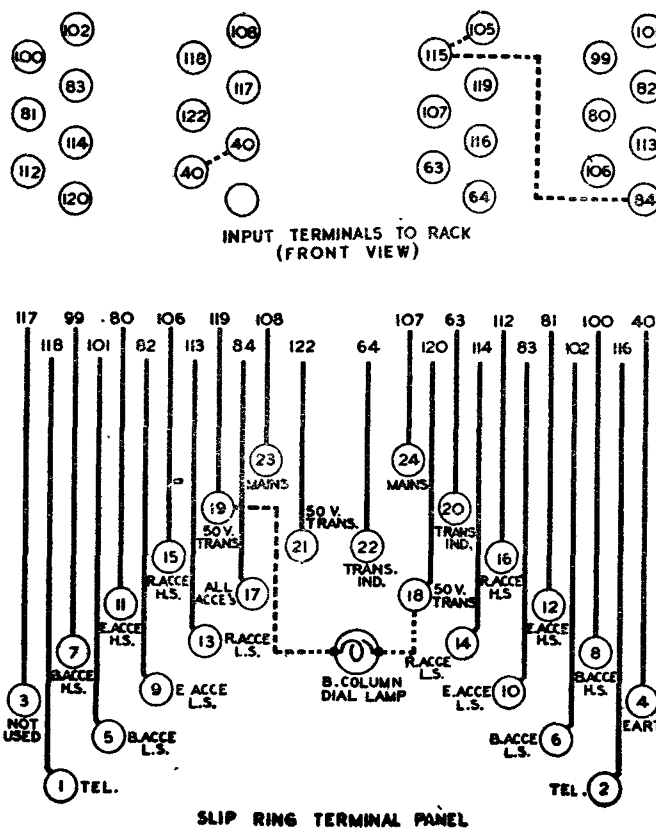
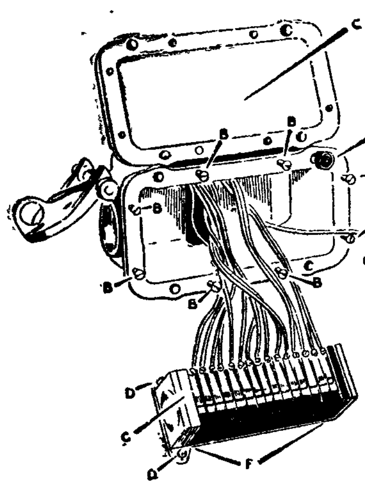


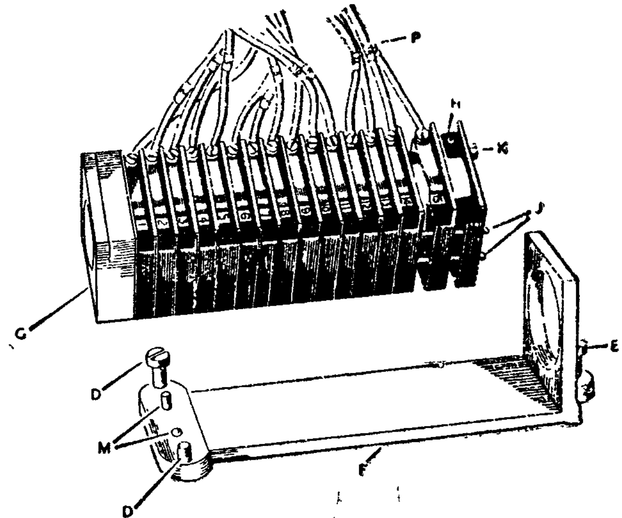
FIG. 37 INPUT AND SLIP RING CONNECTIONS

T.DESC. T-R.08 / 1-37



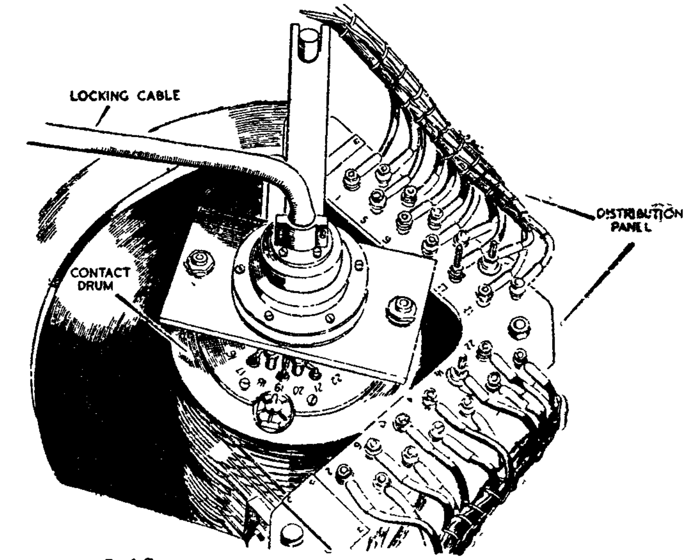
T.DESC. T-R.08 / 1-38

FIG. 38



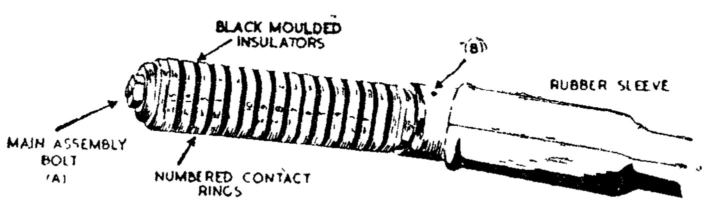
T.DESC. T-R.08 / 1-39

FIG. 39



T DESC. T-R.08 / 1-40

FIG. 40



T. DESC. T-R 08 / 1-41

6. Remove three contact block securing screws (D and E fig. 38) which hold contact block in box—and earth lead is attached to one of these screws (E fig. 38).

7. Slide out contact unit.

Construction of Contact Unit (See fig. 39) :—

Contact blocks are built up in a two part aluminium frame.

1 aluminium base end piece (F fig. 39).

1 aluminium end piece (G fig. 39).

The contact blocks are standard bakelite mouldings (H fig. 39), on which are mounted the numbered copper contact strips.

In certain cases these moulded blocks are used for packing only, as at H (fig. 39).

The contact units are held to the aluminium end piece (G) by screwed rods (J fig. 39) and nuts (K fig. 39). There are two nuts to each rod.

The aluminium base and end piece unit (F) is held to the end piece by the counter sunk screws (M).

WARNING. In certain localities it may be necessary periodically to " dry out " boxes. Care must be taken to see that any drying device used does not damage the cable entering the box by over heating. The insulation resistance should not be less than 15 megohms to earth.

The External Cable Contactor (fig. 41) :—

This consists of a series of numbered standard size segments secured by a locking nut, the individual wire of the cable being accessible after releasing the sleeve screws (B).

The numbering of the segments coincides with contacts on the contact blocks, (figs. 38 and 39), also see Table A.

The connexion from the terminals on the Distribution panels (fig. 40) to interior of the instrument are shown in fig. 37, page 65.

Arrangement of Connections :—

Each wire end of the cable entering the box is numbered on a small linen sleeve (fig. 39).

This number corresponds to the contact strip on the block.

The cable wires make contact to the main contact drum via the ring of numbered terminals shown at (fig. 40).

IMPORTANT NOTE.

These numbers may *not* coincide with the numbers of the block strips or cable wires (see Table A).

TABLE A

CONTACT DRUM NOS.	15 WAY BOX NOS.	8 WAY BOX NOS. (This may be a 15 Way box with 7 contacts unused)	4 WAY LEAD NOS.	DIST. PANEL TERMINAL NOS.	FUNCTION
1			18	118	Phone
2			19	116	,, (common)
3			20	117	,,
4				40 (24)	EARTH
5	1	1		101	BLS 1
6	2	2		102 (Or)	BLS 2
7	3			99	BHS 1
8	4			100	BHS 2
9	5			82	ELS 1
10	6			83 (Wh)	ELS 2
11	7			80	EHS 1
12	8			81	EHS 2
13	9			113	RLS 1
14	10			114	RLS 2
15	11			106	RHS 1

CONTACT DRUM NOS.	15 WAY BOX NOS.	8 WAY BOX NOS. (This may be a 15 Way box with 7 contacts unused).	4 WAY LEAD NOS.	DIST. PANEL TERMINAL NOS.	FUNCTION
16	12			112	RHS 2
17	13	3		84 105, 115	Common magslip. 3
18	14	4		120	X common
19	15	5		119	Y common
20		8		63	Ind (TX) lamps SEARCH
21		7		122	Ind (TX) lamps COMMON
22				664	Ind (TX) lamps FOLLOW
23				108	MAINS
24				107	"

50 VOLT AND 6 VOLT CIRCUITS AND TRANSFORMER

(fig. 42 opposite)

313. General lights, desk lights, A.C. Control Elements and reflector relay are operated on 50 volts A.C. Miscellaneous small panel lights are operated on 6 volts A.C. The power for these circuits is supplied by transformer T11A (in Section IIIA of the rack) which has a 50 volt secondary tapped at 6 volts.

314. Fig. 42 is a circuit diagram of the 50 volt and 6 volt wiring system separated out from the various units for clearness. The 50 volt lamps are 25 watt, S.B.C. fitting.

315. The lamps for the 6 volt circuit are rated at 6·3 volts 0·25 amps with miniature screw fitting. They fit into holders with transparent domes and are capable of being plugged into the sockets provided at various points on the panels.

GENERAL NOTES ON INSULATION

316. Any insulation troubles that may arise will almost certainly be due to surface leakage introduced by moisture condensation. This can be avoided to a very great extent by providing a small amount of heat in the cabin when the equipment is not in use. If a permanent mains supply to the equipment is available this heater should be electric.

317. An electric heater may be connected at the mains socket which is outside the rack at the back and is controlled by the "Iron" switch. Even the normal 50 V. lighting has been found sufficient to produce a very great improvement.

318. The prevention of moisture condensation in this way is very strongly recommended, as not only are the critical insulation paths kept high, but also the possibility of insulation breakdown of high voltage transformers is greatly reduced.

319. If insulation trouble is encountered in the critical paths, viz :—

IA/2 or IIA insulated chassis to earth,

IIB/1 or IIB/2 chassis to earth,

Potentiometer networks to earth,

the question of surface leakage due to moisture should be investigated first of all. The various insulators in question should be carefully dried and cleaned. These insulators are :—

Moulded insulators supporting IA/2 and IIA chassis

" " " IIB/1 " IIB/2 "

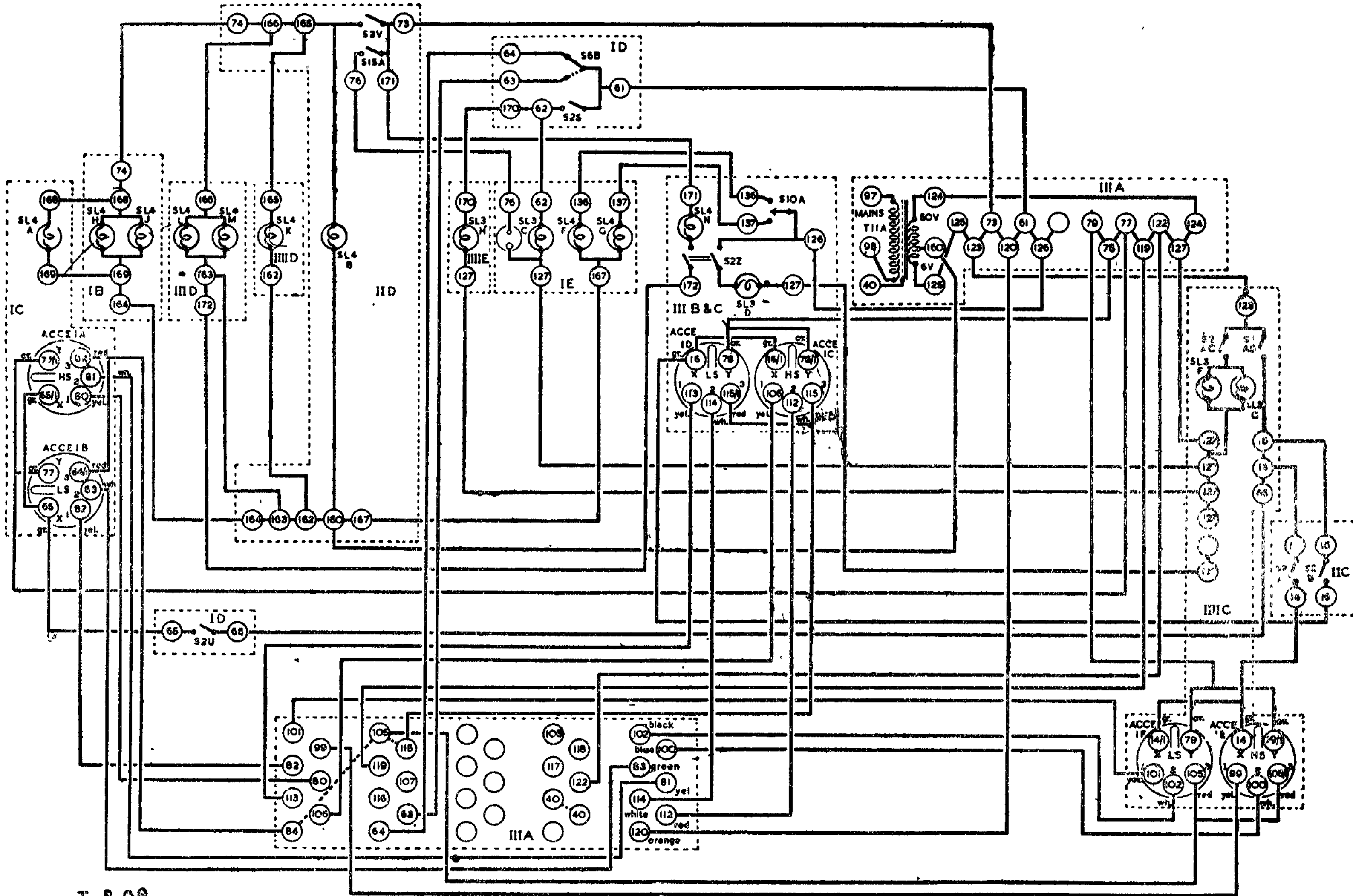
Surfaces of condensers C50D, C23A, C51D, C84A

Moulded insulators on E.H.T. transformers T3A and T3B.

Moulded insulators on Potentiometer.

320. If this does not effect a cure, the units should be disconnected so as to localise the fault, and the various circuits "meggered" to earth. A 2,000 V Megger reading to 10,000 megohms is desirable. The insulation for any one circuit to earth must exceed 1,000 megohms.

321. In the event of low insulation being traced to the Potentiometer, and this not being due to surface leakage, a change of oil is called for. This is effected by opening both the filling vents and draining plug, the old oil being collected at the latter in some wide-mouthed vessel of adequate capacity. Allow the old oil time to drain away as completely as possible before replacing the draining plug and pouring in fresh oil at the filling vents.



T.DESC. T–R.08 / 1–42

T11 Mains transformer
S2 D.P.D.T.
S6 D.P.D.T.
S10 Special

S15 D.P.D.T. spring return.
SL3 50 V. 25 W.
SL4 6.3 V. .25 A.

FIG. 42 50 VOLT AND 6 VOLT CIRCUITS

322. The volume of oil required for the Potentiometer is 8½ to 9 gallons and the correct grade is Silvertown E.T.B. 30 (to B.S.S. 148).

POSSIBLE FAULTS AND THEIR REMEDIES

323. In the event of a fault occurring which renders the equipment non-operative, the first procedure is to decide whether the fault is located in the top section (radio receiver), lower section, or external to the equipment.

324. The functioning of the lower section may be checked immediately by throwing the CAL.I. switch on the calibrator panel to the ON position and switching off R.F. and I.F. units. The tubes should then show a time-base sweep with calibration signals on the Range tube (SETTING SWITCH in position 4). If so, this clears the whole of the lower section except for the locking cable connection, Unit IB and the mains supplies to the radio receiver.

325. If the lower section functions normally in the calibrating condition but no time-base trace is obtained on switching over to OFF (CAL. I switch), the fault is either in the CAL. I switch on IIC or in the locking cable connections, or due to close-down of the transmitter; the latter is by far the most likely. The functioning of the transmitter can be at once checked by switching on the receiver units (R.F. and I.F.) with the time-base calibrator-operated, when the "ground ray" should be seen to float across the trace. It should be possible to distinguish the genuine transmitter pulse from that of the oscillator by virtue of its much higher amplitude.

326. Normal functioning of the radio receiver units is indicated with considerable certainty if the receiver shows a normal noise performance. Loss of signals without loss of noise indicates a fault in the aerial, feeder cables or input transformer circuit.

Receiver Faults

327. In the event of loss of gain as seen by the absence of signals *and* noise, the first procedure is to check the valve currents by plugging into the various top section jacks in turn. The power supply unit voltages should also be checked with a suitable test voltmeter. If jack currents and power supply unit voltages are normal a mechanical inspection should be made of Units IIE/1 and IIIE/1. Irregular jack-current readings may arise as follows :—

328. (Abbreviations :—" Dis. " Disconnected, open circuit. " S. C. " Short-circuited, insulation broken down.)

JACK POSITION	READING	FAULT
Any anode jack.	Zero at all gain settings.	Heater dis., cathode dis., or vacuum in valve gone due to air leak. Change valve.
Any anode jack.	Current high or previous anode resistance overheating.	Ceramic coupling condenser C60 or C67 S.C.
V10 B	Nil	C65A or C63A S.C. R71F or R80A Dis. L10A Dis.
V10 B	Low	Valve low emission.
One of V10 C, D, E, F, G.	Nil or low	Treat as for V10 B and equivalent components.
V10 G	High	C57X S.C. Valve grid dis. or S.C. to earth or heater. Oscillation in V10G can be checked by noting that its anode current rises when its grid is touched with a finger or shorted to earth.
All anode jacks in Unit IIE/1	Nil	Check as for similar state on Unit III E/1. Check L3A, B, C, D, E.
V12A	Nil or low	S. C. :— C58C, C57A, C5D, Dis. :—R21N, R72A, L5A, R71A. Valve failure or low emission.
V12B, C, D, E.	Nil or low	As for V12A in equivalent components.
V13A	Nil	S. C. :—C61C. Dis. :—R77 A, L9A. Valve failure.

JACK POSITION	READING	FAULT
V13A	High. (Above 2·0 mA or more than is normally due to set noise or signal).	S. C.:—C60E. V14A extremely soft or faulty. Set self oscillating or receiving C. W. interference (these latter items vary the current with GAIN control unless self-oscillation is at or after V10 G).
V14A, B.	Nil	(Caution:—Jacks for these valves are about 400V. above earth and care should be taken in handling the plug lead).
		S. C.:—C57R or U, C5P or R, C58R or S, C5Q or S.
		Dis:—R72F or H, R72G or J, R74A or B, R78A or B.
		For other abnormal currents check continuity in grid circuits.

329. *Faults observable on C.R.T. Screens*:

SYMPTOM	CHECK
Trace not on screen but light obtainable and varies with Brightness Control.	C64A or B possibly S. C.
Broad trace varying with gain control. Broad trace, but not varying with gain control.	Due to interference or instability. Try the following, noting the effect of each step:—Remove oscillator V10G, Switch off R.F. unit IIIE/1. If the fault is thus confined to the I.F. unit remove V13A or short the grids of V14A and V14B to earth. This checks ripple in power supply from IIE/2.
General liveness of Unit II/1	Connect a few feet of insulated wire to the input of I.F. amplifier. This can be done by opening door of Unit IIIE/1 and connecting to the non-earthy contact tongue on the left hand wall of the compartment. Pick up of S.W. stations on the air should show as a series of wave forms on the C.R.T. trace and indicate a general signal level on the meter when plugged into the jack of diode V13A.

330. *Faults in Lower Section*:

SYMPTOM	CHECK
No trace on any tube	Turn setting switch to Position 1 and potentiometer to 2,000 yards, and manipulate brightness knobs. If no spot is obtainable fault is in C.R.T. power unit IA/1 (3000 V.).
Spot obtainable but no time base trace on either side.	If not already done, switch off receiver units and throw CAL. 1 switch to "ON" on IIC. If still no trace verify that calibration output exists as seen by vertical line on Range tube, and by low value of V1A cathode current. If this is O.K. the fault lies in absence of 4000 V.H.T. on Unit IIA or its 290 V. H. T.

SYMPTOM	CHECK
Calibrator Signal missing.	Note V1A cathode current; if this is high, crystal oscillator has failed to start. This can usually be cured by a sharp mechanical jar on IIC panel. If this fails, a slight re-adjustment of the dust core plunger in L1A may help.
Calibrator Signal missing, though crystal oscillator O.K.	Fault in IIC unit subsequent to crystal stage. Check cathode currents, and possibly blocking oscillator output with an oscillograph.
C. R. Tube dim and violently defocussed.	Leak or breakdown from negative end of C.R.T. network to earth. Probably in transformer T4A heater winding to earth.
Tube will not "back off" on BRIGHTNESS Control.	Leakage on C.R.T. network or tube base due to moisture. Fault will cure itself when set warms up. Also possible leak or breakdown on C51D on Unit III D.
Tube will not focus.	Possibly due to very bad leakage or a resistance dis. in C.R.T. network.
Focus varies with setting of Range Potentiometer.	Probably due to bad leakage from positive 4000 V. line to earth.
Return stroke of Range tube not blacked out.	Fault on IIB/2 unit, probably valve V1E.

MAINS TRANSFORMERS AND SMOOTHING CHOKES:

331. For convenience of reference the accompanying tables give data on currents, voltages and winding resistances useful in checking all transformers and smoothing chokes in the equipment. Approximate D.C. resistances are given in cases where they are not too low to be measured with an ordinary test set.

Mains Transformer Data.

CIRCUIT CODE NO. OF TRANS.	UNIT USED ON	WINDING	NOMINAL VOLTAGE & CURRENT		NORMAL VOLTAGE ON LOAD	CURRENT AT NO LOAD	CURRENT AT NORMAL LOAD	D.C. RESISTANCE
			Volts	Amps	Volts	Amps	Amps	Ohms
T2	I B/3 II/C	Primary	220			0·09		18
		Sec. L.T.1.	4	5	4·1		5·0	
		Sec. L.T. 2.	4	2·5	4·1		2·56	
		Sec. H.T.	275-0-275	0·03	275-0-275		0·011	264
T3	IA/2 IIA	Primary	220			0·035	0·61	5·95
		Sec. H.T.	265-0-265	0·03	265-0-265		0·031	209
		Sec. E.H.T.	3300		3200		0·0107	4650
		Sec. L.T. 1.	4	1·0	4·1		1·0	
		Sec. L.T. 2.	4	2·5	4·1		2·5	
		Sec. L.T. 3.	4	10	4·1		8·2	
T4	I A/1	Primary	230			0·14	0·3	22·8
		Sec. E.H.T.	2700		2550		0·0041	3640
		Sec. L.T. 1.	4	1·0	4·1		1·0	
		Sec. L.T. 2.	4	3·0	4·1		3·0	
T5	I B/2	Primary	220			0·14		30
		Sec. L.T. 1.	4	2·0	4·1		2·0	
		Sec. L.T. 2.	4	1·0	4·1		1·0	
		Sec. H.T.	700		700		0·016	400

CIRCUIT CODE NO. OF TRANS.	UNIT USED ON	WINDING	NOMINAL VOLTAGE & CURRENT		NORMAL VOLTAGE ON LOAD	CURRENT AT NO LOAD	CURRENT AT NORMAL LOAD	D. C. RESISTANCE
			Volts	Amps	Volts	Amps	Amps	Ohms
T6	I A/1	Primary Sec.	200-240 220			0·5 at 240 V.	4·0	
T1	II C	Terminals 1-2 „ 3-4 „ 5-6	Not a mains transformer					430 430 800
T7	III E/2	Primary Sec. L.T. 2. Sec. H.T.	220 4 320	 2·5 0·095	6·3 4·2 320	0·17	0·4	
T8	II E/2	Primary Sec. H.T.	220 445-0-445		 445-0-445	0·16	 0·089	10 163
T9	II E/2	Primary Sec. L.T. 1 Sec. L.T. 2	220 4 4	 6·9 3·75	 (3·9 at IIE/1) (4·3 at IIE/2) 4·0	0·075	 7·0 3·74	18·6
T10	II C	Primary Sec. L.T.	220 4	 2	 4·1	0·07	 2·0	
T11	III A	Primary Sec. (whole) Sec. (6v. section)	220 50 5·5		 50·5 5·5	0·65	 14·0 2·5	

Smoothing Choke Data

CIRCUIT CODE NO. OF CHOKE	UNIT USED ON	NOMINAL INDUCTANCE Henries	D.C. CURRENT mA	D.C RESISTANCE Ohms
CK1	IB, IIC	45	30	1,060
CK2	IA/2, IIA	45	30	1,060
CK3	IA/2, IIA	100	30	2,140
CK4	IIE/2, IIIE/2	9	100	170

REMOVAL OF UNITS FROM RACK

332. In the event of a fault being definitely located to a unit it will in most cases be preferable to remove the unit complete and replace it with a spare. The faulty unit can then be repaired at the appropriate Depot. The equipment has been designed to facilitate the exchange of units as far as possible.

333. The procedure for removing a unit is as follows in the cases of Units IA/1, IA/2, IB, IC, ID, IIA, IIB, IIC and IID.

(*a*) Disconnect cable forms at terminals, taking care not to drop nuts and washers into inaccessible parts of the equipment.

(*b*) Remove any stiff self-supporting wires interconnecting units.

(*c*) Remove the ¼ inch Hex. bolt securing the front panel to the rack.

(*d*) Remove the bolts securing the tray of the unit to the runners near the back.

(*e*) The unit can now be withdrawn horizontally from the rear of the equipment.

334. The remaining units require special handling as follows :—

IIE/1 AND IIIE/1 : These are both on hinged doors. Swing out, remove supply cable at power unit, disconnect input and output leads and lift panel off hinges. The panels with their units attached are very heavy and it is advisable for two men to take the weight.

IIE/2 AND IIIE/2: These two units are inside the rack and are removed from the back by taking off the detachable panels which will be found there. Each of these units is held down to its supporting runners by two bolts at the back, the front being located by two horizontal dowel pins. It is only necessary to unscrew the two bolts and withdraw the unit through the back.

IIID: This unit cannot be removed while the Potentiometer Unit IIIB and C is in position. It carries so little, however, which is not readily accessible in situ that the question of its removal is not likely often to arise.

IIIB AND C: To remove this unit, which comprises the Potentiometer and all its gearing, it is necessary to remove the Range Displacement Corrector knob, the shaft of which passes through the panel of Unit IIID above. The six large bolts securing the potentiometer tank to the runners must be removed as well as the front panel fixing bolts. This is a very heavy unit to move, requiring three or four men, and it is advisable to fix up a substantial runway out of the back of the equipment with wooden planks or beams.

REMOVAL OF EQUIPMENT FROM CABIN

335. Disconnect mains from cabin at external plug. Disconnect all cables to aerial system, all connections between input terminals in recess IIIA and slip-ring well, copper strip earth connection into well, locking cable to panel IIB and plug connections to cabin fan. Remove protective bracket of locking cable. Remove central detachable panel of cabin wall. Remove phasing box and bollards from top of rack, disconnect radius rods at each end of rack and remove that part of the telescope mounting which projects through the side of the cabin. Uncouple and remove rising shaft at rear of equipment between turntable and bearing gearing. Remove the 32—5/16″ bolts holding the angle feet of the rack down to the rubber mounting on the floor of the cabin.

336. By levering the rack up and inserting stout planks under the rollers the whole may be withdrawn on its rollers through the back of the cabin.

The weight of the rack complete with its contents is approximately 22 cwt.

INTER-UNIT WIRING

(Fig. 44)

337. The general inter-unit wiring employs flexible V.I.R. cables grouped and laced wherever possible into convenient cable-forms. These cable-forms are cleated to the framework and are so arranged that the cable ends naturally lie close to their appropriate terminals. To facilitate connecting up correctly the terminals in each block carry a distinguishing colour code, each cable end being coloured similarly to the terminal to which it connects.

338. A number of connections are made in stiff self-supporting wire where high insulation or constant capacity is essential. Each wire carries a label showing the reference numbers of the terminals to which it connects. When replacing these stiff wires after removing them for any purpose care should be taken to see that no wire comes within a quarter of an inch of any other wire, chassis or member of the framework; they should not even come in contact with the rubber covering of the cable-forms.

339. Fig. 44 shows diagrammatically the inter-unit connections as seen from the back of the rack.

Lubrication

340. Gears in the potentiometer, bearing and elevation mechanisms should be liberally greased. Mobilgrease No. 2 is suitable.

341. Ball-races are lubricated in the first instance with Price's Antifreeze grease and should require no further attention.

342. For the gear boxes in the range and bearing mechanism a light machine oil is used. The range gear box is filled to the level of the filling plug.

343. In the case of the elevation gear box it is recommended that the filling plug be ignored and the oil introduced by removing the top plate. The oil level should be just more than sufficient to reach the teeth of the smaller gear wheel on the lower shaft.

344. For the chain drive of the colour discs a heavy lubricating oil is recommended; the method of lubricating is described on page 55.

All models marked with G near the filler cap of the disc chain drive mechanism will have graphited mineral jelly (Wakefield grade 458X) instead of oil filling. This is to prevent leakage on to the colour filters in warm locations.

The jelly should be applied to the chain through the oil filler hole.

CHANGING AND SETTING OF A. C. CONTROL ELEMENTS

Insertion and Removal of A.C. Control Elements

345. Front panel switches controlling A.C.C.E.'s should be switched off and the cables in question disconnected. The cable ends are colour-coded and the A. C. C. E. terminals numbered, the order of connections being shown in fig. 42, page 69.

346. Fig. 30b shows how an A.C.C.E. is held in position; it may be removed bodily by taking out the three long bolts 38 and removing clamping ring 39. It is also necessary in the case of Range and Bearing A.C.C.E.'s to remove the gear wheel attached to the rotor shaft. This is done by taking out the three countersunk screws holding the clamping disc and withdrawing the gear wheel from the boss on which it is located. A typical view is given in fig. 31 where 52 is the A.C.C.E. gear wheel, 77 the clamping disc and 78 the three countersunk clamping screws.

347. In the case of the Elevation A.C.C.E.'s these may be removed direct, as there is a dog-coupling which disengages readily and does not impede withdrawal. If the A.C.C.E. is being replaced by another, the upper dog section must be transferred to the new A.C.C.E. This dog section is held to the rotor shaft by a clamping disc and three screws as in the case of the driving gear wheels in the case of Range and Bearing A.C.C.E.'s.

Setting Range A.C. Control Elements

348. *H. S. A. C. C. E.*

Set R. Correction dial to read O.

Disengage Displacement Corrector by turning "Displacement" lever on front panel to "Out". Set main potentiometer to read 2 on the internal drum scale (seen through window in front panel), loosen screws clamping stator (*i.e.* body) A. C. C. E. and rotate stator until the setting pin (provided with equipment) can be inserted through the hole in the gear wheel, the slot in the flange of the rotor and the boss on the stator. Check to see that the A. C. C. E. gear on the top deck of the gearbox is pinned correctly to the rotor.

Tighten clamping screws of stator and remove setting pin.

349. *L. S. A. C. C. E.*

Connect a receiver indicator box by means of its 4-way cable and plug to the appropriate socket on the cabin chassis. The L. S. A. C. C. E. must be energised with its 50 V. supply by closing the Range A. C. C. E. switch on the front panel and the switch under the desk lamp.

Set the main Potentiometer to read "2" on the internal scale—checking to see that the A. C. C. E. gear is pinned to the rotor. Loosen screws clamping stator and rotate the stator (*i.e.* body) of the A. C. C. E. until the receiver indicator reads 2000.

Setting Bearing A.C. Control Elements

350. *H. S. and L. S. A. C. C. E.'s*

Remove electrical connections from H.S. A.C.C.E. and remove cast iron housing from main bed by unscrewing the four hexagon bolts. Lower the housing complete with A.C.C.E.; as there are two well fitting dowel pins, a little careful coaxing may be necessary to get the housing away. While the H.S. A.C.C.E. is thus removed, set the L.S. A.C.C.E. to 0°. To do this, disengage adjustable coupling 58 (figs. 31 and 12a), set the L.S. A.C.C.E. to 0° by rotating the horizontal worm shaft and insert the 1/8" diameter bent setting pin provided through the hole in gear wheel 56, the slot in the flange, and the boss on the body of the A.C.C.E. If necessary, temporarily slacken the three screws of the clamping disc which secures this gear wheel.

Turning to the H.S. A.C.C.E., slacken three screws 78 holding the clamping disc 77 to gear wheel 52; also slacken the three long bolts holding the body clamping ring. Set the adjustable index marker 76 to its mid position by loosening the two screws holding it. Rotate the A.C.C.E. body to bring the boss opposite the index marker and fix in this position by tightening the three long bolts of the clamping ring. Adjust rotor and gear wheel 52 until the 1/8" diameter straight setting pin provided can be inserted through the hole in the gear wheel, the slot in the rotor flange and the hole in the boss. Tighten up the three screws of the gear wheel clamping plate.

Bolt the cast housing of the H.S. A.C.C.E. in position again with the four bolts. Very slight rotation of the horizontal shaft may be necessary to bring the teeth into mesh. It will not be necessary, however, to remove the setting pin from either A.C.C.E.

Adjust and clamp the index marker of the H.S. A.C.C.E. to correspond with zero on the wheel and remove both setting pins.

Setting Elevation A.C. Control Elements

351. The H.S. and L.S. A.C.C.E.'s in the elevation system are set to their zero positions when the mechanism is set for an elevation of 45°. Remove connections and clamping rings from both H.S. and L.S. A.C.C.E.'s. Each can be now removed, carrying with it the upper part 41 (fig. 30b) of the rotor coupling which is held to the rotor flange by a clamping disc and three screws, the same as those found holding the driving gear wheels in the case of Bearing and Range A.C.C.E.'s. Slacken these three screws and turn the coupling piece 41 with respect to the rotor flange until a setting pin will simultaneously pass through the vertical slot 42 on the outside of coupling piece 41 and the radial slot in the rotor flange. Re-tighten the three screws of the clamping disc and remove setting pin.

Rotate the Elevation Handle until the Elevation Scale reads exactly 45°. This should bring the lower part 40 of each A.C.C.E. coupling to the position indicated in fig. 30b, the end carrying the slot appearing at the opening of the cast housing. Replace each A.C.C.E. in its appropriate position, engaging the couplings so that the slotted ends line up (see fig. 30b). Do not disturb the setting of the elevation mechanism in this process; turn the A.C.C.E. rotor by the amount requisite for proper engagement. Turn the body of the A.C.C.E. until the position is found where the bent setting pin can be inserted along slot 42, through slot in rotor flange and into the hole in the boss on the stator body. Clamp A.C.C.E. in position by tightening the three long bolts 38 through the clamping ring 30. Treat both L.S. and H.S. A.C.C.E.'s in this manner and replace electrical connections.

SETTING UP PROCEDURE FOR EQUIPMENT USING TEST OSCILLATOR

352. The following is the procedure adopted when an oscillator is used for setting up and checking the Bearing and Elevation systems. These operations should be carried out under the close supervision of the R./I.E.M.E. officer responsible for maintenance in 1st Echelon.

E. F. Alignment

Ideally, there should be zero output from the goniometer search coil when the operator is on target, and the two pulses on the elevation tube would then be of equal size. In practice, the input signals are rarely exactly in phase, so that the condition of zero signal output is seldom realised and there is a residual signal. This residual will cause inequality of the pulses unless it is in quadrature with the phase of the range signal. The object of the E. F. alignment is to adjust the trimmers on the goniometer to obtain this condition.

(A) *Apparatus required*

An Oscillator E.R.A. No. 2 (WY. 0051) giving just sufficient output to enable the frequency to be measured with the Wavemeter GL/T No. 3 (ZC 2129). The feeder to the dipole should be as short as possible.

(B). *Procedure.* Using a C.W. field oscillator.

(*i*) The Oscillator E.R.A. No. 2 must be set accurately to within 0·1 mc/s of the working frequency, using the wavemeter GL/T No. 3 which will be removed from the transmitter and set up on the platform outside.

(*ii*) The oscillator will be set up at least 200 yards from the receiver and as high as possible above the level of the mat. The oscillator aerial should be horizontal and broadside on to the receiver.

(*iii*) With the set in its normal operating condition, turn the gain switch to manual, insert the jack plug into V13A socket and turn the gain control fully anti-clockwise. Insert the microammeter leakage meter in place of the milliammeter and adjust the gain control to give a workable deflection. Adjust "TUNING" and "AERIAL BALANCE" controls for maximum diode current and tune the "OSCILLATOR" control to give the response in the middle of the I. F. band.

(*iv*) Turn the range aerial switch to "OFF" and disconnect the range feeder from its aerial. Unplug No. 10 feeder from the receiver and connect the 100 ohm resistance across the receiver socket. Turn the discs by hand to expose the bearing tube and rotate the cabin until the forward minimum is found. The cabin should be held in this position throughout the adjustments.

(*v*) Turn the discs to expose the elevation tube and turn the elevation handle to 20° angle of sight. Adjust the goniometer trimmers and aerial balance controls in repeated succession for maximum diode current. Clamp the aerial balance control.

(*vi*) Rotate the elevation handle until a minimum is found at about 240° on the *goniometer scale*. Note the precise reading on the goniometer scale with first the green and then the orange colour in front of the elevation tube. If there is any difference, set to the mean value and hold in this position.

(*vii*) Re-connect the range aerial feeder to its aerial and turn the range aerial switch to "ON". Reconnect No. 10 feeder to the receiver. Set the gain control to give a deflection of 150 microamps on the meter. Turn the discs and check that this reading of 150 microamps is maintained when either the green or orange colour is in front of the elevation tube. If it is not, turn the discs to obtain the lower of the two readings and adjust the lower goniometer control to increase the meter reading slightly. The adjustment required is very small, but very critical, and a position will be found at which the diode current is the same whichever colour is in front of the elevation tube. (The upper goniometer control may be used as a fine adjustment.)

Some care is necessary in making this adjustment as an excessive movement of the goniometer trimmer will so reduce the signal from the goniometer that discrimination will be seriously impaired. To check this, rotate the elevation handle so that the goniometer scale reading is increased by 20° (as read on the goniometer scale and not the elevation dial). Set the discs to that colour which gives the greater diode current reading and adjust the gain to give a diode current of 150 microamps. Rotate the discs until the other colour is in front of the elevation tube and note the diode current reading. In most cases the value will be about 50 microamps but if it is greater than 85 microamps, the adjustments have not been performed correctly and the procedure must be repeated from 4.

8. When a satisfactory discrimination has been obtained, the goniometer trimmers and aerial balance will be locked and not altered unless the whole phasing operation is to be repeated.

353. BEARING ALIGNMENT

(*a*) *Apparatus required*

A. C. W. lightweight oscillator ERA No. 2. (WY.0051). Care must be taken that the two halves of the dipole are in the same straight line.

Where possible, the same oscillator should always b used for this operation.

N.B.—The following procedure must be used for D. F. alignment and phasing only, *not* for tuning for constant following even on the bearing side; this must be done with the oscillator some hundreds of yards away if an oscillator is used for this adjustment.

(*b*) *Positioning the oscillator*

(*i*) The oscillator should be placed between 20 and 40 yards away from the receiver with its dipoles not less than 4′ 6″ above ground level at the receiver.

(*ii*) If a mat is present, the height of the oscillator dipole should be not less than 4′ 6″ above mat level.

(*iii*) The oscillator and dipole should be arranged as follows:—

The dipole must be horizontal. This will be checked with a spirit level.

The two halves of the dipole must be in the same straight line.

The dipole should be perpendicular to the line joining its centre to the receiver. A visual check is sufficient.

The oscillator must be tuned to within $\pm 0{\cdot}1$ Mc/s of the working frequency using the wavemeter GL/T No. 3.

Use the smallest stable output of the oscillator which can be observed on wavemeter No. 3. This means the High Tension may be reduced to 45 volts or even less.

A datum mark must be fixed 4 ft. 9 inches from the centre of the oscillator on the right hand side (looking towards the receiver).

(*c*) *Alignment procedure*

Errors are likely to be caused during this process by persons standing near the oscillator and/or receiver dipoles. Accordingly, all persons not immediately concerned in the process should be either under the mat or seated in the cabin. The H. F. switch must be clean, and in good working order.

(*i*) With the receiver in its normal operating condition, insert the jack plug into V. 13A socket and turn the gain control fully anti-clockwise. Insert the microammeter leakage meter in the place of the milliammeter. Switch on the bearing A.C.C.E. and arrange for an observer stationed at the predictor to record the bearing transmitted from the receiver as required.

(*ii*) Turn the range aerial switch to "OFF," turn the discs to expose the bearing tube and rotate the cabin until the forward minimum in diode current is found. Hold the cabin in this position.

(*iii*) Turn the discs to expose the elevation tube and rotate the elevation handle until minimum diode current is found. Turn the range aerial switch to "ON" and set the gain to give a current of 150 microamps. Rotate the discs until the opposite colour is in front of the elevation tube, and note the diode current. If it is not 150 microamps adjust the position of the elevation handle until an equal diode current is obtained whichever colour disc is in front of the elevation tube. Maintain the elevation handle in this position.

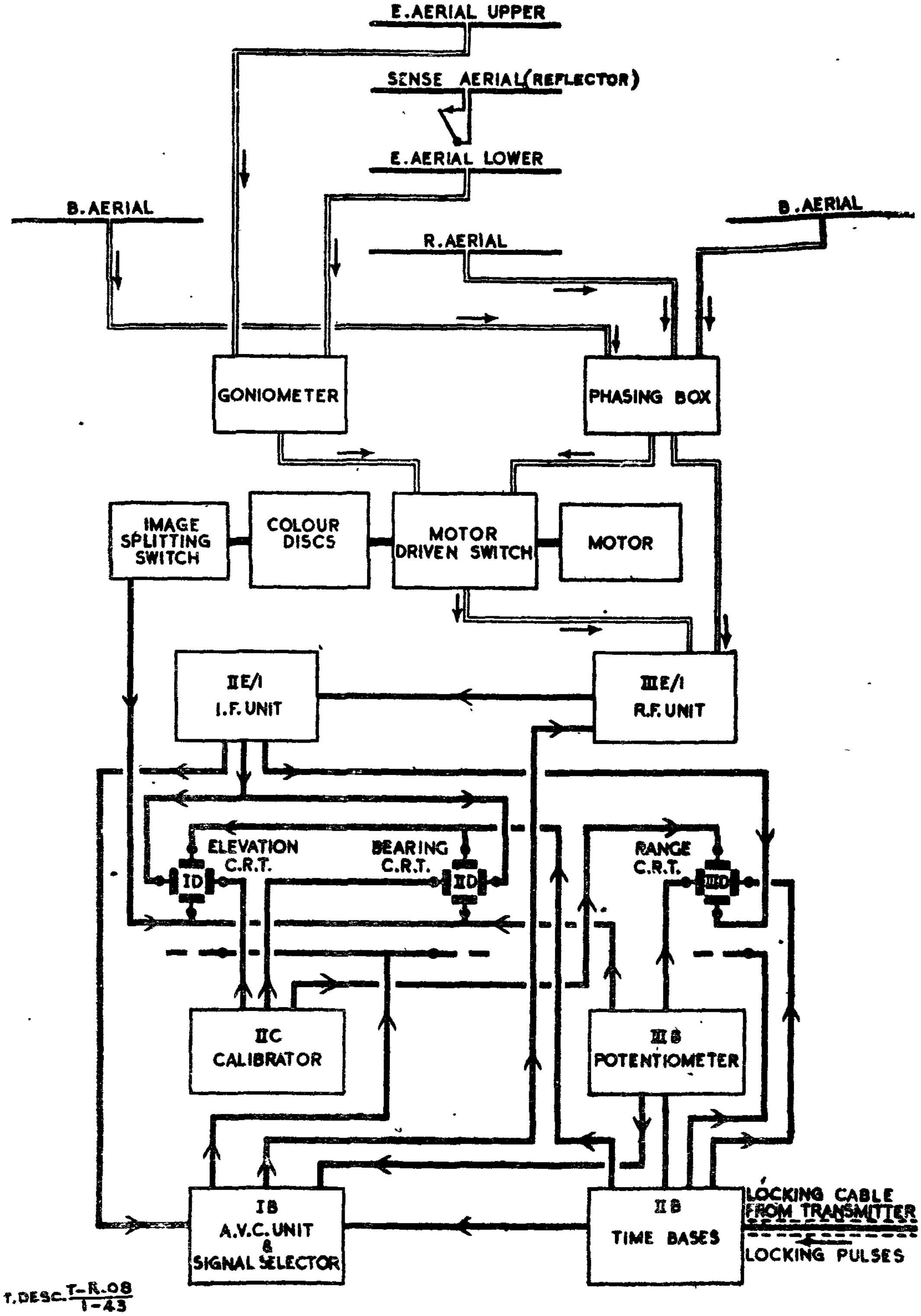
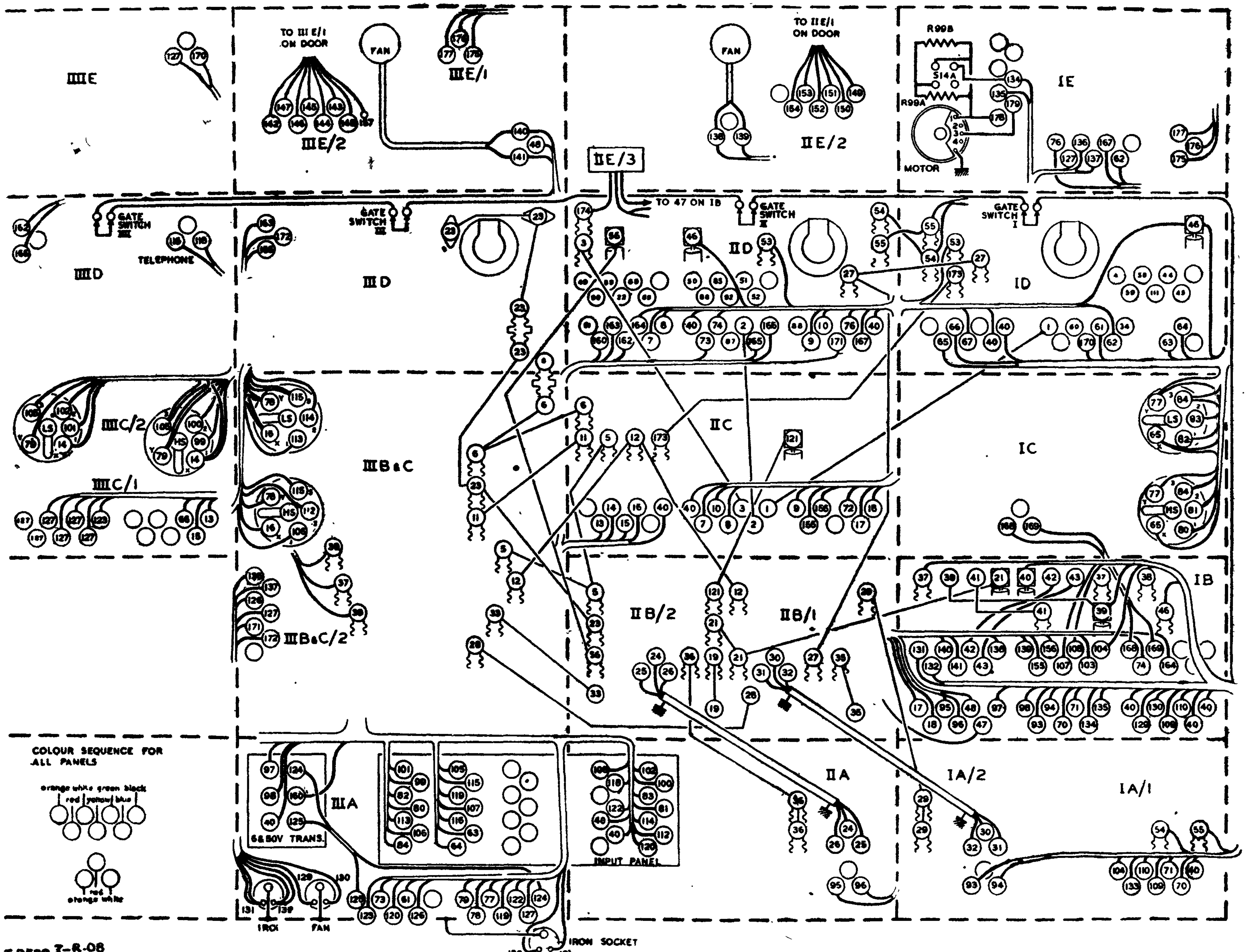


Fig. 43 Radar A. A. No. 1 Mk. II receiver type 3032, block schematic diagram



T. DESC. I-R-08 / 1-44

FIG. 44 TERMINAL INTER-CONNECTIONS

Note: Terminals shown with small numbers have wires which are part of the unit. Terminals without numbers have no wires

UNIT I E

R99 3 ohms Motor Starting Resistance
S14 Special (3 position).

(*iv*) Rotate the discs to expose the bearing tube and adjust the bearing of the receiver until an equal diode current is obtained whichever colour is in front of the bearing tube.

(*v*) The receiver is held in this position and the bearing reading taken from the predictor. Repeat the procedure described under (*iv*) several times until a reliable mean value of the bearing is obtained.

(*vi*) Set the receiver on the mean bearing obtained above and turn the elevation handle to bring the oscillator dipole on to the telescope crosswire. Slacken the clamping screws on the telescope and adjust until the datum mark [see (*b*) (*iii*) page 78] is on the crosswire. Clamp the telescope in this position. Turn the cabin off bearing and back again several times and confirm that the datum mark does appear on the crosswires of the telescope when the cabin is on bearing.

(*vii*) The telescope is now aligned with the electrical axis, and the receiver will now be realigned with the predictor. The Unit Commander will be informed that this is necessary.

354. *Routine Checks*

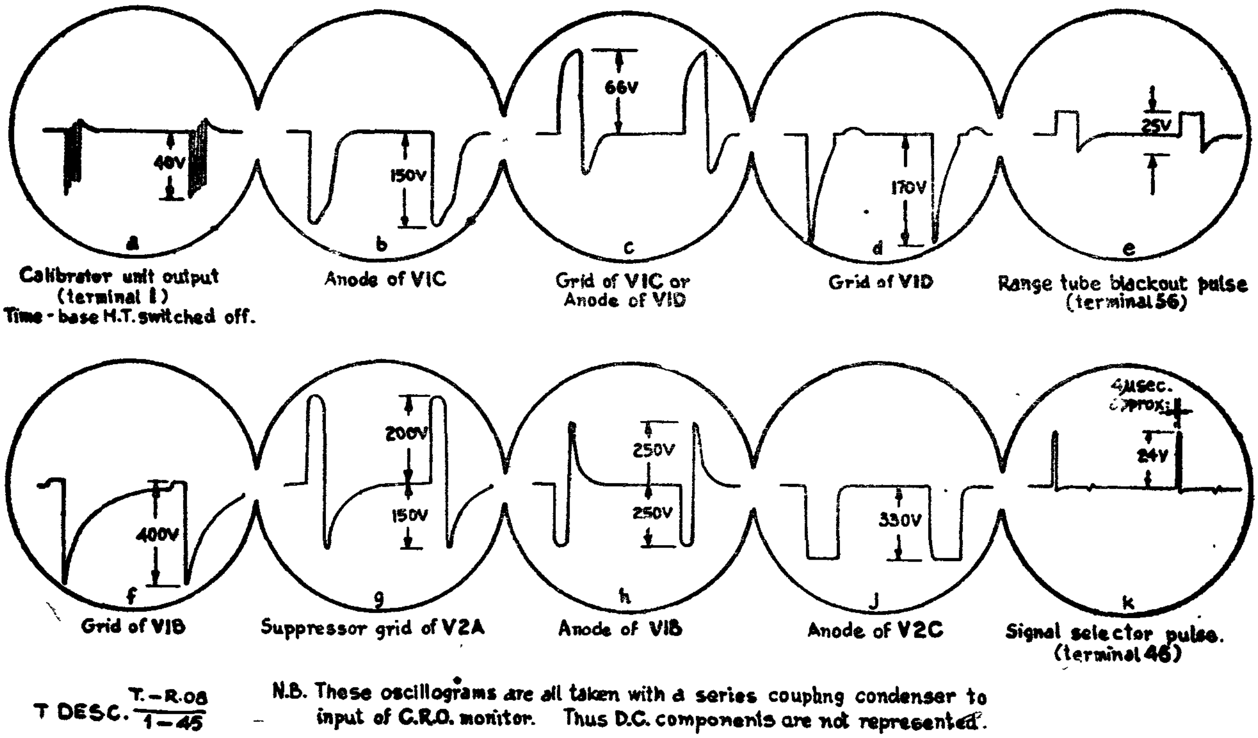
(*a*) A weekly check should be made to ensure that the gonio position as obtained in para. 352 (*b*) (*vi*) is the same as that giving equal readings with either colour in front of the elevation tube when the range aerial is connected. If this is not the case, the complete E.F. alignment procedure must be repeated.

(*b*) Elevation discrimination should also be checked and recorded in the log. The E. F. alignment procedure will be repeated if the value is not within the limits given in para. 352 (b) (*vii*). Bearing discrimination should be checked at the same time.

With the oscillator positioned as in para. 352 (*b*) (*ii*), find the true electrical bearing of the oscillator, by rotating the discs to expose the bearing tube, and adjust the bearing of the receiver until an equal diode current is obtained whichever colour is in front of the bearing tube.

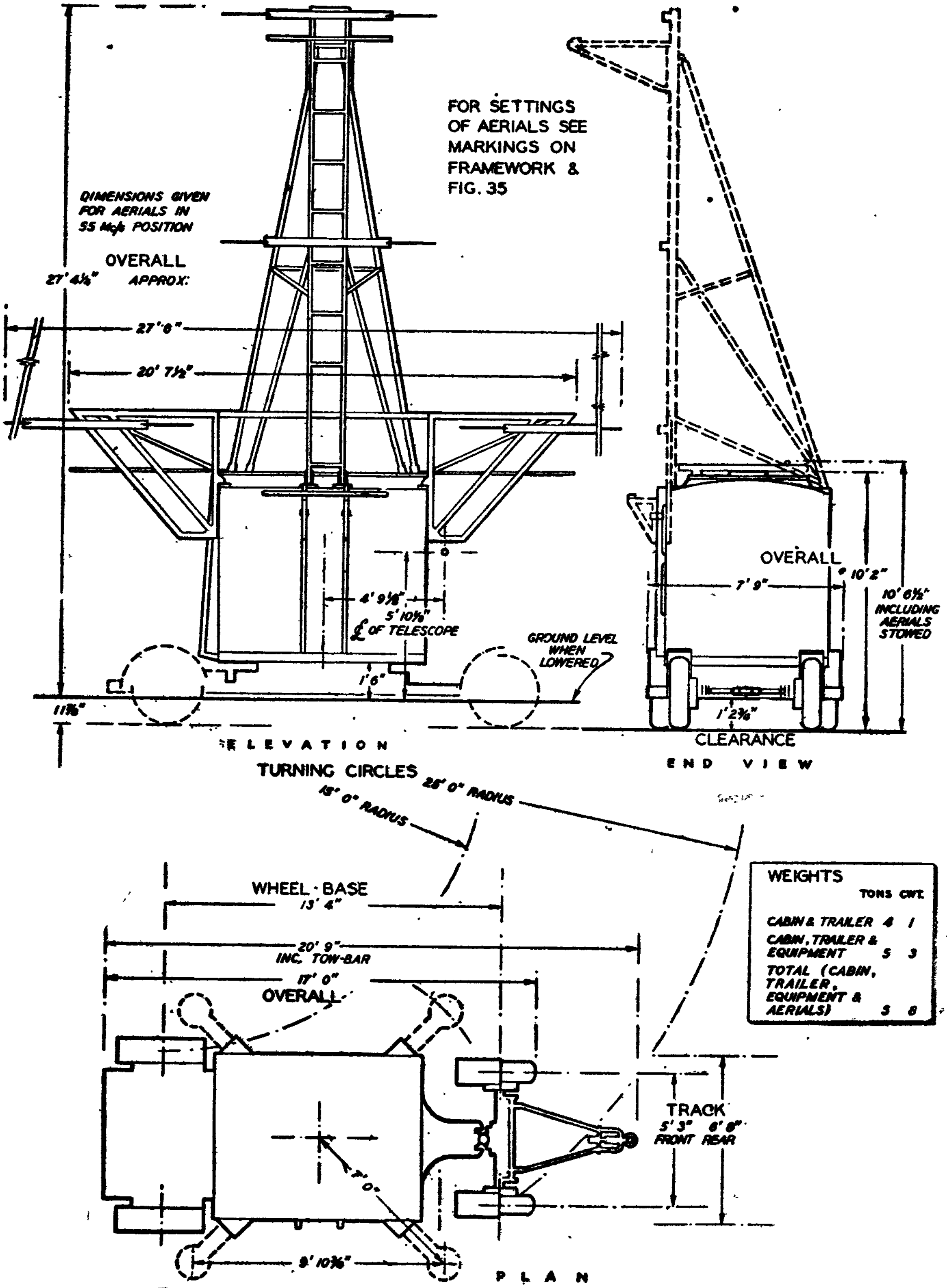
Rotate the cabin 5° clockwise. Expose green on the bearing tube and adjust the gain to give 150 microamps diode current. Expose orange on the bearing tube. The diode current should not be greater than 65 microamps in the case of equipment with the bearing dipoles at 0·6 Lambda, or 75 microamps in the case of equipments modified as in I. S. S. Circular letter G. L. No. 6, dated 9th July 1942.

(*c*) If either the elevation or bearing discrimination is unsatisfactory, an inspection of the feeders should be made, particularly Nos. 8 and 9.



N.B. These oscillograms are all taken with a series coupling condenser to input of C.R.O. monitor. Thus D.C. components are not represented.

FIG. 45 WAVE-FORMS AT VARIOUS POINTS.



T. DESC. T-R.08 / 1-46

FIG. 46 DIMENSIONS AND WEIGHTS OF COMPLETE EQUIPMENT

INDEX

END

(51553/123/2/M. G.-M. E. 12)

D. M. E. (INDIA)

TECHNICAL INSTRUCTIONS

DESCRIPTION TELS. R.07

RADAR A.A. No. I Mk. II TRANSMITTER

GENERAL DESCRIPTION

ISSUE I, 3RD MAY, 1944

RADAR A. A. No. 1 Mk. II TRANSMITTER

General Description

[*Based on R. A. O. C. Technical Maintenance Handbook, Transmitter Type G. L. Mk. II*]

CONTENTS

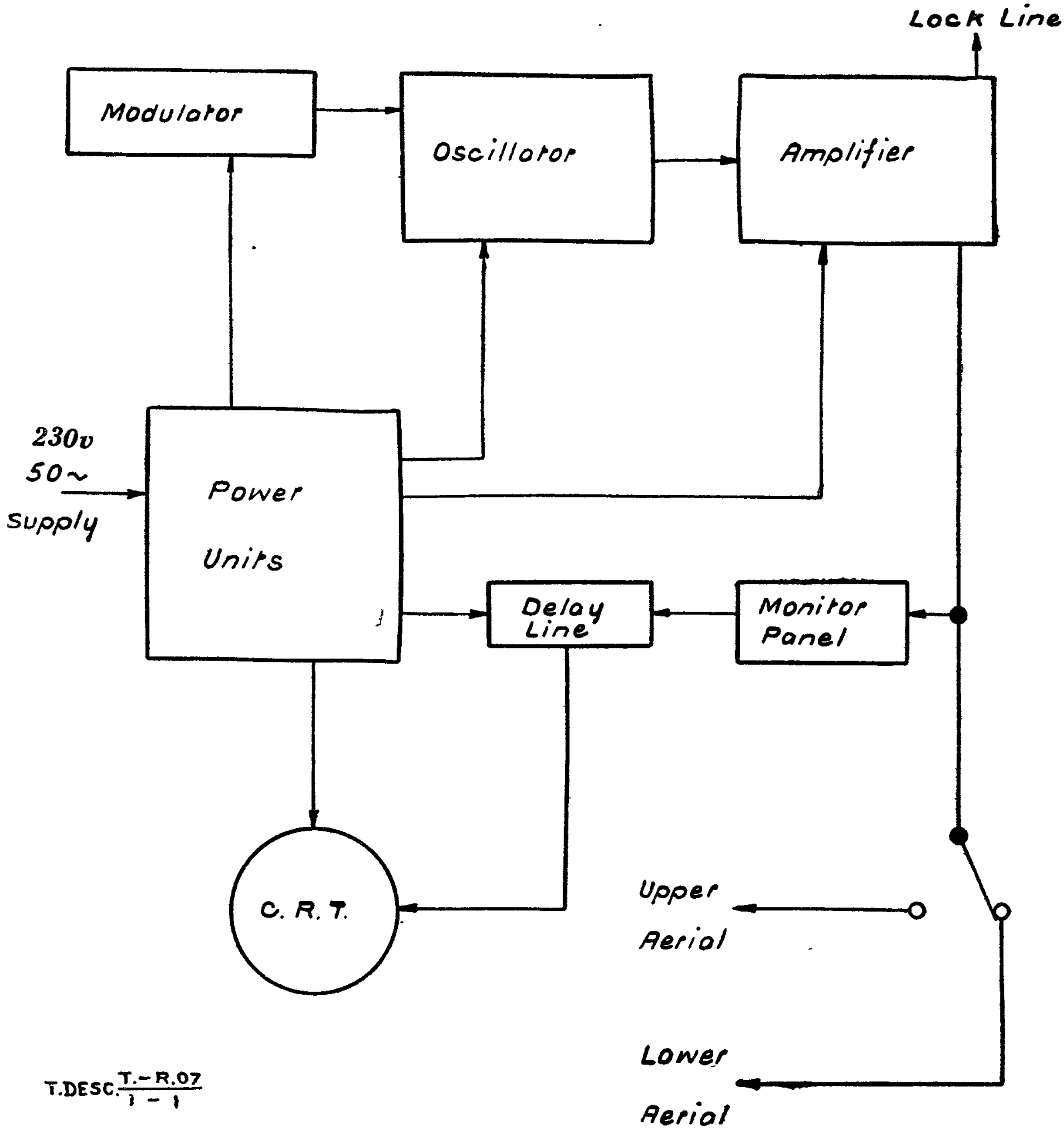


Fig. 1.—Block Schematic of Transmitter

GENERAL DESCRIPTION

Function.

1. The A. A. No. 1 Tx. Mk. II is a ground-station transmitter designed for the transmission of short pulses of continuous wave emission having a recurrence frequency adjustable between the limits of 1,000 c/s. and 2,200 c/s. and a pulse width of the order of 1 microsecond.

2. The transmitter is capable of operation on any frequency between 54 Mc/s. and 86 Mc/s. (5½ to 3½ metres). A cathode ray tube is supplied for checking pulse shape and duration. The power is obtained from a single phase 230 volt 50 cycle supply.

Layout and Principal Features of Set

3. The transmitter is housed in a cabin fixed to a turntable on a four wheeled trailer.

4. The transmitter assembly is carried on a framework mounted inside the cabin on leaf springs. The electrical circuits are completely enclosed, but access may be obtained by removal of the panels. These may be removed by undoing the hand fasteners, and unlocking the safety lock with a key from the nest below the isolator switch at the right hand side of the transmitter. These keys cannot be withdrawn from the nest except with the isolator switch in the OFF position, and the keys cannot be removed from the panels except with the panels locked in place (See para. 26). To permit rapid removal the left hand upper front panel is not provided with a safety lock, but it controls a switch which breaks a control circuit and switches off the transmitter when the panel is removed.

5. The block schematic diagram of the complete transmitter is shown on page 2. Under the control of the modulator the master oscillator produces short pulses of radio frequency power which are amplified by the amplifier unit and passed on to the aerial. The output is also fed through an attenuator to a rectifier, and thence through a delay network to the cathode ray tube. Suitable power supplies are provided.

6. Two aerial systems are provided, a single dipole held on a vertical ladder above the cabin and a directional beam held on a framework extending from each side of the cabin. The cabin may be rotated by handles on the traversing control column in the cabin in front of the transmitter, so that the beam is directed in any direction. A Magslip Receiver mounted on the traversing control column and controlled from the receiver indicates the direction of this receiver.

Modulator

7. The modulator is housed in the upper left hand compartment of the transmitter assembly. A complete spare unit is carried in case of failure, the spare unit being accommodated in the same compartment and above the working unit. A door is provided in the front panel for access to the preset controls of the modulator unit. It is important that this door should not be left open when access to the controls is not required.

8. The modulator circuit (fig. 19) consists essentially of a variable frequency square wave oscillator, the output of which is converted into a pulse form by means of a high-pass filter. The pulses are amplified until they finally pass to the R.F. oscillators as an 800 volt positive peak pulse superimposed on a steady 900 volt negative bias. The grid bias of the R.F. oscillator valves is thus reduced to a relatively low value for a short period (about 15 microseconds) at a frequency between 1,000 and 2,200 times per second. A saw-tooth generator operating at a frequency of about 4 c/s. periodically varies (within fairly narrow limits) the recurrence frequency of the modulation pulses applied to the R.F. oscillator. This is known as a "Wobbulator" circuit.

9. Flash arcs sometimes occur in the master oscillator valves, causing the whole H.T. (up to 20 kv.) to be applied momentarily to the grid circuit. In order to reduce the possibility of damage, an MU2, a gas filled diode, is connected across the modulator output, and has the effect of by-passing to earth any positive voltage surges.

350 volt and C.R.T. Power Units

10. This power unit is situated in the bottom of the Monitor Compartment. It supplies 350 volts H.T. for the A.R.P. 19 valves in the modulator and 3,000 volts H.T. for the cathode ray tube. The circuit of this unit is shown in fig. 17. The unit is easily removable from the transmitter as all connections to the unit are made by three multi-point plugs. The 350 volt supply is provided from a full wave A.U.3A rectifier and the 3,000 volts from a half wave A.U.8 rectifier, the positive side of the supply being earthed. Fig. 17 also shows the circuits of the Brightness and Focus controls connected to plug No. 1.

Master Oscillator Stage.

11. The master oscillator stage is situated in the upper central part of the assembly, the front and back panels being removable. Windows are provided in the panels to allow the valves to be seen when in operation.

12. The oscillator circuit (fig. 16) consists of two V.T.98 valves in push-pull. Both grid and anode circuits are tuned with parallel resonant lines (lechers), which are bent to form an arc of a circle. This permits adjustment of length, and hence of resonant frequency by means of sliding shorting bars (fig. 4) attached to insulating arms pivoted at the centre of the circle. The sliding shorting bars on the oscillator grid and anode lechers are controlled by the square spindles accessible through the left hand holes in the oscillator grid and anode compartments respectively. The square shafts on the right are provided for locking the controls in position. Provision is also made for locking the sliding shorting

bars onto the lechers (fig. 4). The correct setting of the oscillator anode tuning is indicated by a dial on the panel.

13. The V.T.98 valves used are fitted with air-cooled anodes. The anode has a brass diffuser fitted externally, through which air is drawn by means of a fan. The hot air is led from the valves through hollow insulating glass supports past the fan (directly under the master oscillator compartment) and through a flexible pipe to an outlet in the cabin wall. A vane-operated mercury switch in the air stream switches off the whole set in the event of failure or blockage in the cooling system.

14. The modulator output is fed to the centre tap of the grid lecher, through a grid leak of 0·25 megohms. The average working value of the bias is about 900 volts negative which is great enough to prevent anode current from flowing. Thus the valves are normally quiescent, oscillating only when this bias is reduced by the modulation pulse. When the modulation pulse reduces the bias to zero, the valves oscillate, the amplitude of the oscillations building up rapidly. Grid current flows and the 0·0003 mfd. condenser charges up, due to rectification of the oscillation. This bias paralyses the oscillation about one microsecond after its onset and, before the condenser can discharge through the 0·25 megohm resistance sufficiently for oscillation to re-commence, the modulation pulse ceases and the 900 volt negative bias is restored. The resultant R.F. pulse passed to the amplifier stage is thus of much shorter duration than the modulation pulse. The process is not that of true modulation, but the modulator provides a timing pulse to control the "squegging" of the master oscillator. During each R.F. pulse the anode current is drawn from the 0·002 microfarads condenser, which rapidly becomes discharged and the inclusion of the 100,000 ohm resistance in the anode circuit prevents the anode current from exceeding a safe value for a sufficient period to do any damage to the valves.

Amplifier Stage

15. The power amplifier stage is situated in the upper right hand side of the assembly and is reached through panels at front and rear, the covers having windows to permit inspection when working.

16. The amplifier circuit (fig. 16) consists of two V.T.98 valves in push-pull, the anode circuit being a curved lecher. The R.F. output from the filament choke of the master oscillator stage is fed through condensers to the filaments of the amplifier stage. The 1,000 v. negative bias supply is fed through an R.F. choke to the grids of the amplifier valves which are connected together and earthed through a condenser. The output circuit consists of a tuned lecher connected between the two anodes. The anode circuit lecher is tuned by a sliding shorting bar, while the aerials are fed through condensers from tappings sliding on the anode lechers. The shorting bar and aerial tappings are controlled by the left hand spindles of the two pairs, accessible through holes in the amplifier compartment panel. The right hand spindles of the two pairs are provided for locking the sliders in position. The anodes of the amplifier valves are earthed through four condensers in parallel in series with a 10 ohm resistance. Negative locking pulses are obtained from a tapping point on this resistance and are fed through a concentric feeder to be receiver for locking the Kipp Relay. The cooling of the amplifier valves is similar to that of the oscillator valves (See para 13). The aerial change-over switch is controlled by a handle above the operator's seat. The transmitter output is fed to the upper dipole with the handle in the upper position, and to the lower aerial array with the handle in the lower position.

L. T. Supply Circuits.

17. The supply to the V.T.98 filaments is obtained from two transformers, one for each pair of valves, the filaments being connected in series. The currents in the filament circuits are controlled by the OSC. FILAMENTS & AMP. FILAMENTS rheostat handwheels in the lower front panels. When starting up, the full filament voltage is not applied directly to the cold filaments, but series resistances are provided in the primary circuit of the filament transformers, which are short circuited by a time delay relay only after the filaments have partially heated up on the lower voltage supply.

Grid Bias Supply Circuits

18. Two full wave rectifier circuits each using two C.V.20 valves provide 1,000 volts supplies with the positives earthed. One of these rectifiers provides the bias for the master oscillator circuit, which is also one of the modulator H.T. supplies, and the other supplies the amplifier bias. Access to both these rectifiers may be obtained by removal of the rear panel below the modulator compartment. A small window is provided in this panel for viewing the cathodes of these valves while in operation.

H. T. Supply Circuits

19. The H.T. rectifier circuit supplying the master oscillator and amplifier valves includes two C.V.19 valves. The output voltage may be adjusted by means of a tapped auto-transformer in the primary circuit of the main H.T. transformer, the tapping being controlled by the MAIN H.T. handwheel on the lower front panel. Positions 1 to 14 on the handwheel represent voltages of about 6 to 23·5 kV. in steps of about 1 kV. each. Position 15 to 16 should not be used. Access to the main H.T. rectifier may be obtained by removal of the rear panel below the amplifier compartment and a small window is provided in this panel for observing the filaments of the C.V.19 valves when in operation.

Aerial System

20. Two aerial systems are provided. One consists of a single horizontal half-wave dipole with matching stubs attached to its centre, carried on a

ladder supported above the cabin. The other system consists of an arry of four horizontal half-wave dipoles, each with matching stubs, the dipoles being arranged in line in front of a wire netting screen carried on the lower aerial supporting frame. The dipoles and stubs have extensible end pieces, graduated in inches and tenths, and the fixed parts of the stubs are also graduated in inches and tenths for setting the position of the feeder tapping point.

Monitor Unit

21. The transmitter is monitored by observation of the rectified R.F. pulse as seen on a cathode ray tube type A.C.R.8, having a time base synchronised with modulator oscillator. The monitor circuit is shown in fig. 18. The monitor tube receives its supply potentials from the 350 v. and C.R.T. power unit (fig. 17) through plug No. 3.

Control Circuits

22. The 230 volt input is fed through the isolator switch and the supply and control fuses to the control circuits which control the switching of the supplies to the transmitter. Before any power can be applied to the transmitter, four sets of contacts, namely isolator switch auxiliary contacts, fan auxiliary switch contacts, modulator interlock contacts and overload relay No. 1 (O/LI) must be closed. The isolator switch auxiliary contacts are controlled by the isolator switch. When the isolator switch is switched off, these contacts open before the contacts in the main supply leads, and by breaking the contactor circuits, switch off the transmitter and so ensure that the isolator switch will only have to break the current passing to the fan motor. The fan auxiliary switch is closed by an air vane in the fan outlet, and thus closes only when the fan is working, so that power cannot be applied without proper cooling for the valves. The modulator interlock is closed only when the modulator front panel is in position. The overload relay O/LI operates to break the circuit if the current taken by the transmitter exceeds a safe value.

23. Air heaters are provided to warm the air entering the transmitter when the filaments are not switched on. When the heaters are in use all the panels should be in position to prevent overheating of the heaters due to air not being drawn through them. The heater circuit is broken when the FILAMENT ON button is pressed and *vice versa*.

24. Contactor No. 1 controls the supply of current to the filament transformers for the oscillator and amplifier valves and the main H.T. rectifier valve. Contactor No. 1 also controls the supply or current to the filament transformers for the amplifier bias and modulator H.T. rectifiers, to the modulator unit, and *via* plug No. 2 to the 350 volt and C.R.T. power unit. When the FILAMENTS ON button is pressed contactor No. 1 closes. After a time delay of 20 seconds the time delay T/D1 operates and closes contactor No. 3. This short circuits the resistance in series with the primary circuits of the filament transformers for the oscillator, amplifier and main H.T. rectifier valves so that the full voltage is then applied to these valves. At the same time current is fed to the primary windings of the bias H.T. transformers. After a further time delay of 15 seconds the time delay T/D3 operates. If the amplifier bias and modulator rectifiers are operating, the contacts of the bias rectifier under voltage relays will be closed (Mod. N/V and GB N/V), the green FILAMENT indicator lamp will light and the hour meter will start working.

25. The supply to the primary windings of the main H.T. transformer may now be switched on by pressing the H.T. ON button. An overload current in the circuit of the primary of the main H.T. transformer operates the overload relay O/LA which breaks the circuit of No. 4 contactor operating coil.

SCHEDULE OF TESTS TO ENSURE CORRECT OPERATION OF MECHANICAL INTERLOCKING APPARATUS AND THE ASSOCIATED ELECTRICAL SWITCHING

26. With the exception of the front cover of the modulator compartment, all the covers on the transmitter are mechanically interlocked with the isolator switch to prevent access to the transmitter when it is in operation. The modulator front cover is provided with an electrical interlock.

27. The operation of the mechanical interlocking apparatus and associated electrical switching is checked in the following manner:—

(a) See that the interlock keys are in their correct positions on the right hand side of the transmitter, the flat portion of each key being horizontal. Move the isolator switch to the ON position, and check that none of the keys can now be removed from its socket. Switch to OFF, remove one of the keys and note that the isolator switch cannot now be moved from the OFF position. Repeat this check by removing one key at a time until all seven keys have been checked.

(b) Check that when any one of the covers is unlocked, the key remains in the lock and cannot be removed from the lock until the cover is again in the locked position.

(c) Check that the shorting sticks in the oscillator and amplifier valve compartments are connected to chassis, and that the main H.T. is earthed through the bleeder resistance when the isolator switch is in the OFF position. This can be checked by taking the resistance from the amplifier anodes to frame, which should not exceed 27,000 ohms.

(d) With all covers and keys in position, check that the transmitter can be switched on, that when the filaments ON push button is pressed, contractor No. 1 closes, and that when the heaters ON push button is pressed, contactor No. 1 opens, and contactor No. 2 closes. Remove the modulator front cover and check that the transmitter can be switched on but that contactor No. 1 will not close when the filaments ON push button is pressed.

REPLACEMENTS AND ADJUSTMENTS

28. The transmitter consists of a brass R.F. framework mounted on top of and bolted to a steel framework which carries the equipment for the power supply to the R.F. circuit. The whole is resiliently mounted on a spring base and all doors are interlocked to prevent access to the transmitter when the isolator switch is closed.

As the transmitter is built up in sub-assemblies, access to any particular part for the purpose of repair work presents no difficulty. In general the assembly or dismantling of the sub-assemblies is quite straightforward, but the following points may require further explanation:—

Contractor Panel

29. The contactor panel (fig. 2) may be fitted with either time delay switches or motor sequence switch. In the former case, the contactor panel comprises four contractors, two time delay switches, two under-voltage relays, and three over-current relays, the whole being mounted on a panel. In the latter case, the time delay switches are replaced by a motor sequence switch.

30. Before mounting on the panel, the time delay mechanisms are individually tested as follows:—

(a) The knurled knob on the top of the mechanism is turned to the position of maximum delay, *i.e.*, as far as possible in an anticlockwise direction. A weight of 4½ oz. is hung from the link of the mechanism and this weight must be sufficient to pull through and trip the timer.

(b) With the timer still in position of maximum delay a 1 lb. weight is hung from the link. When the mechanism has tripped, the weight and timer link are lifted up to the limit of their travel and allowed to drop suddenly. The timer mechanism should latch and then pull through in the usual way.

31. The fingers on the motor sequence switch should have 1/16″ lift and 1/16″ wipe. Check that with the switch in operation there is always a surplus torque, starting from any position, of 1 oz. at 5/8″ radius.

32. Contactor No. 1 is fitted with blow-out coil and arc-chutes, one set of normally-open auxiliary contacts, one set of normally-closed auxiliary contacts and a time delay switch. With the main contants open, the gap between the contact tips should be 7/16″±1/32″. This gap may be adjusted by tightening or slackening the screws which fasten the moving contact assembly to the shaft. Tightening the front screw will increase the gap; tightening the rear screw will decrease it.

33. The auxiliary contacts should be adjusted so that the moving contacts touch each of the fixed contacts simultaneously. The wipe on the auxiliary moving contacts should be 1/8″±1/32″ and is defined as the distance which the shaft carrying the moving contact arm moves after the moving contacts have touched the fixed contacts. The fixed contacts are adjusted by releasing the locknut, screwing the contact stem either up or down as required and retightening the locknut.

34. Care should be taken to see that the flexible braid connecting the main moving contact with the corresponding terminal stem hangs in its natural position.

35. The time delay switch is adjusted by turning the small knurled knob on top of the timer. Rotation in a clockwise direction decreases the delay and in an anti-clockwise direction increases it. The links at the bottom of the timer mechanism should be quite free in both the open and closed positions and the timer should trip when the moving contacts are not less than 1/32″ from the fixed contacts. The moving and fixed contacts should touch simultaneously. The wipe on the time delay contacts should be the same as that on the auxiliary contacts, namely, 1/8″±1/32″.

36. Contactor No. 2 is fitted with arc-shield, one set of normally-open auxiliary contacts and one set of normally-closed auxiliary contacts. Contactor No. 3 is fitted with arc shield and time delay switch. Contractor No. 4 is fitted with arc shield and auxiliary contacts. These three contactors are adjusted in the same manner as Contractor No. 1.

37. When mechanical adjustments have been made in accordance with the foregoing instructions, the contactors should operate within the following limits:—

	Minimum	*Maximum*
Pick up volts .	. 138 volts	195 volts
Drop off volts .	. 57 ,,	80 ,,

Time delay switches should be adjusted to the following limits:—

	Minimum	*Maximum*
TD 1	. 18 secs.	25 secs.
TD 3	. 13 ,,	18 ,,

The over-current and under-voltage relays are set to operate at the required current by turning the hexagon nut at the bottom of the coil to the required position as shown by the three calibration points. There should be a gap of at least 1/32″ between the rocking bar and the moving contact arm in the two-coil relays and between the push rod and moving contact arm on the single-coil relays.

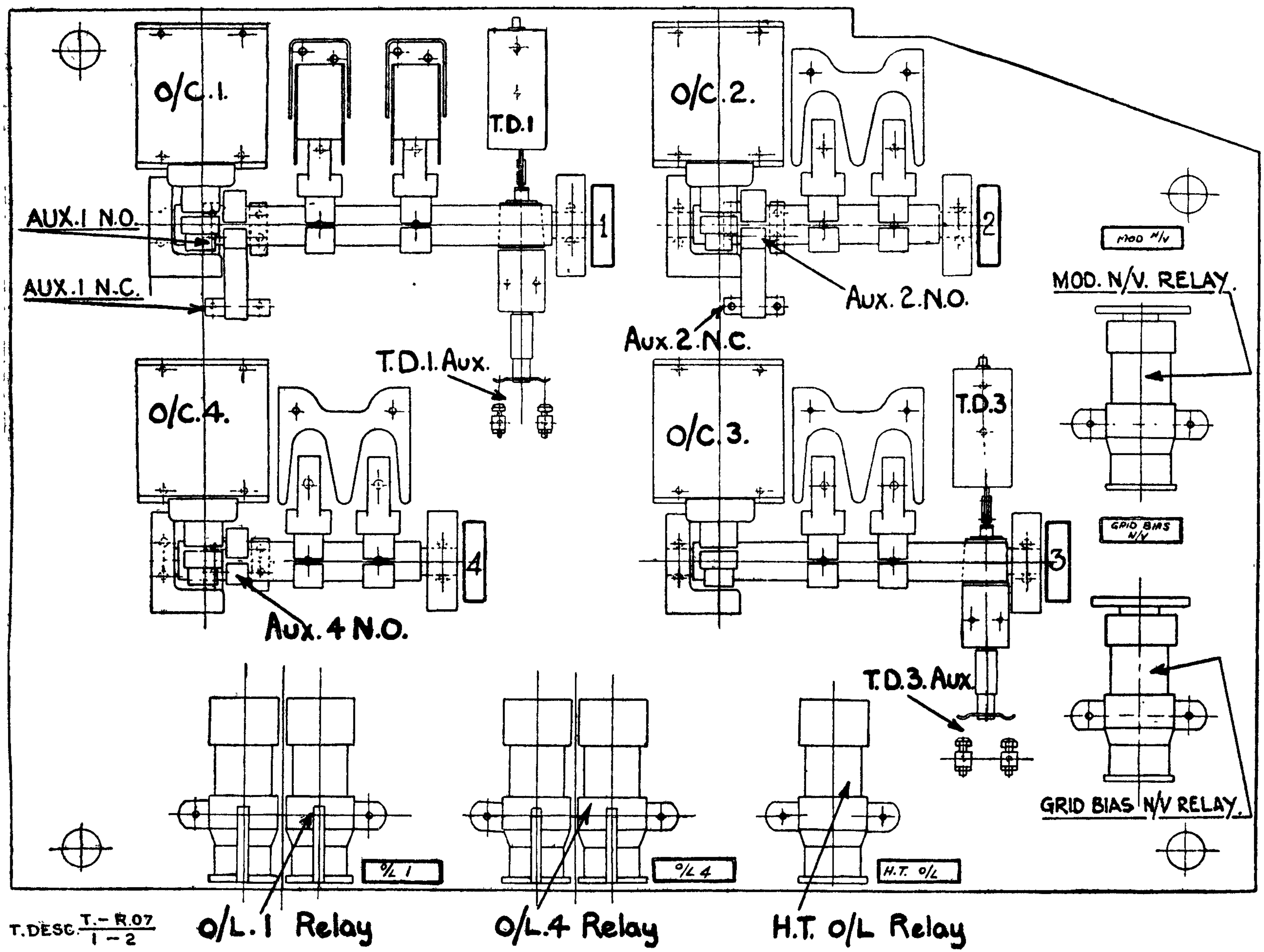


Fig. 2.—Assembly of Contactor Panel (see fig. 13 for Schematic)

The relays should be set to operate at the following current values:—

Over-current relay No. 1 set to trip at 60 amps.

Over-current relay No. 4 set to trip at 30 amps.

H.T. over-current relay set to trip at 220 m.amps.

Grid Bias under-voltage relay	Pick up 57 milliamps. Drop off 40 milliamps.
Modulator under-voltage relay	Pick up 100 milliamps. Drop off 40 milliamps.

These figures should be correct within ±10 per cent.

38. All contacts including auxiliary contacts and relay contacts should be kept clean. The only fault likely to occur is the burning of the contractor contacts. If these contacts are not too badly burned to require renewal they may be cleaned up with a fine scratch brush.

39. In the case of contactor No. 1, the arc-chute must be removed before the main contact tips can be removed. Raise the arc-chute and pull forward to remove it. The contact tips can then be removed and replaced by new ones, attention being given to contact alignment. When fitting new contact tips care should be taken to see that the shoulder on the contact tip is hard against the stop.

In the case of contactors Nos. 2, 3, 4 the arc-shield is removed by unscrewing the two screws at the front of the shield and pulling forward. The contact tips may then be removed in the same way as contractor No. 1.

40. If at any time it is required to renew the operating coils on the contactors, the procedure is as follows:—

Disconnect coil leads. Remove the four 2 BA screws holding the coil and magnet frame to the pedestal. Bring the magnet forward and slide it off the plunger. This allows the magnet assembly to remain on the shaft ready for re-assembly. Take out the split pin and remove the two guide clips. The coil can then be removed. Replace with a new coil and re-assemble guide clips and split pin. Fit the plunger back into the magent frame and screw back onto the pedestal.

41. The plunger assembly on the time delay switch should be kept clean and oil should not be used as this may become sticky and in extreme cases prevent the contactor from dropping out.

42. The contactor panel should withstand a pressure test of 2 kV. A.C. for one minute between all wiring and metal parts.

Removal of Motor

43. The fan and motor is situated at the rear of the transmitter. To remove the assembly it is first necessary to remove the outer ring of bolts which connect the fan outlet to the rear panel on the transmitter. The rear panel may then be removed, giving full access to the fan and motor assembly. Disconnect the wiring which runs along the base of the assembly at the front and pull the wiring to the left. Remove the nuts from the studs connecting the fan inlet to the elbow connection. Unscrew the two bolts securing the motor assembly to the power unit chassis, when the fan and motor may be pulled out complete on its baseplate. As the removal of the fan and motor assembly is such a simple matter, it is advisable to remove the complete assembly from the transmitter when it is desired to inspect the motor or regrease the bearings.

44. The motor must be kept clean and dry. Any deposit from a dusty or dirty atmosphere should occasionally be blown out.

The ball bearings are packed with a good quality high melting point grease (Prices Bermolene). Remove outer bearing caps every 2,000 hours, and examine bearings and grease. If necessary, add a small quantity of grease, or if grease is dirty, dismantle motor and wash out the bearings with petrol, thoroughly dry and re-pack with grease before re-assembly. (The quantity of grease used should be sufficient to fill the bearing to about 2/3 to 3/4 of its capacity.)

45. Should the motor be dismantled for any reason examine the contacts of the centrifugal switch and clean with fine glass or sand paper if necessary.

46. When re-assembling the motor in the transmitter, care should be taken to see that the flap switch is free to move. and that the leads to the mercury switch are in their correct positions.

No. 1 Tuner

47. The Bowden cable should be wiped from time to time with an oily rag to prevent the cable from rusting. If, at any time, the cable should break, renewal is made as follows:—

Remove the graduated dial at the front of the tuner when the cable attachments become easily accessible. Turn the tuner shaft as far as possible in an anti-clockwise direction and lock in that position. The ends of the cable are anchored to two bolts which are screwed into bosses inside the drum. Remove the bolt anchoring the spring end of the cable. The cable can then be unwound from the drum and shaft. Remove the bolt anchoring the other end of the cable and then disconnect the cable ends from the cable. Take a new piece of cable 46″ long and solder each end to prevent fraying of the cable. Screw the two pieces of the adjustable stop as close together as possible (See fig. 3). Push one end of the cable through the end of the adjuster remote from the cable securing screw, make a small loop sufficient to take the hook on the spring, thread the cable back through the adjuster and lock in position with the securing screw. If the cable drum has

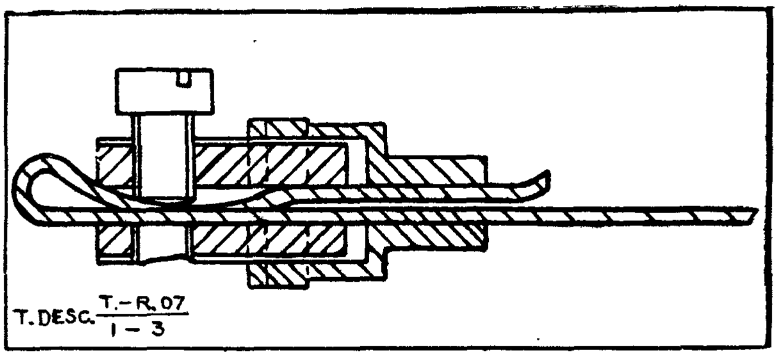


FIG. 3 Cable End Assembly

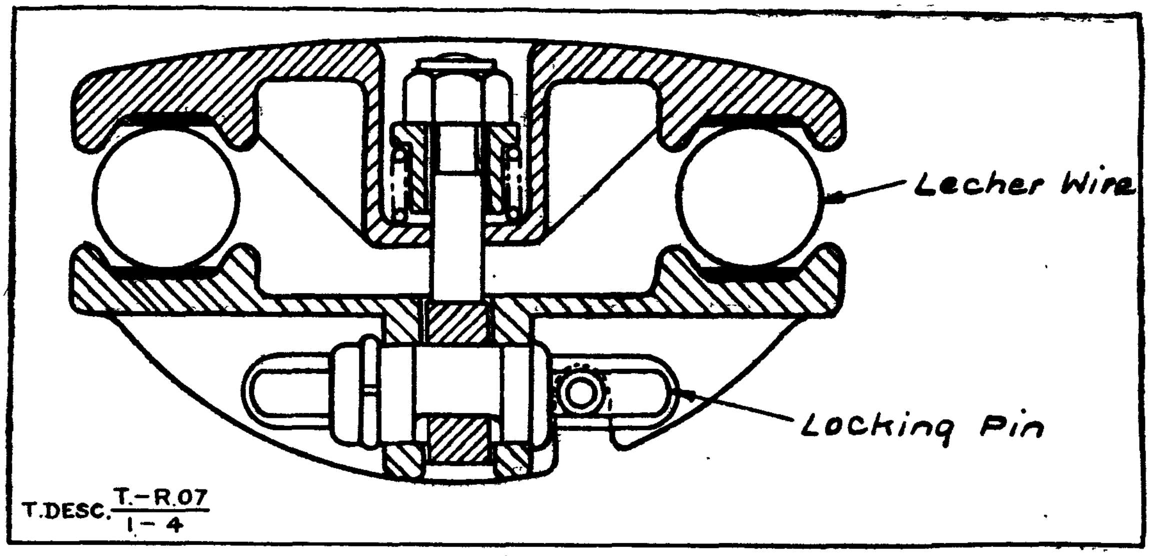


FIG. 4 Lecher Finger Assembly

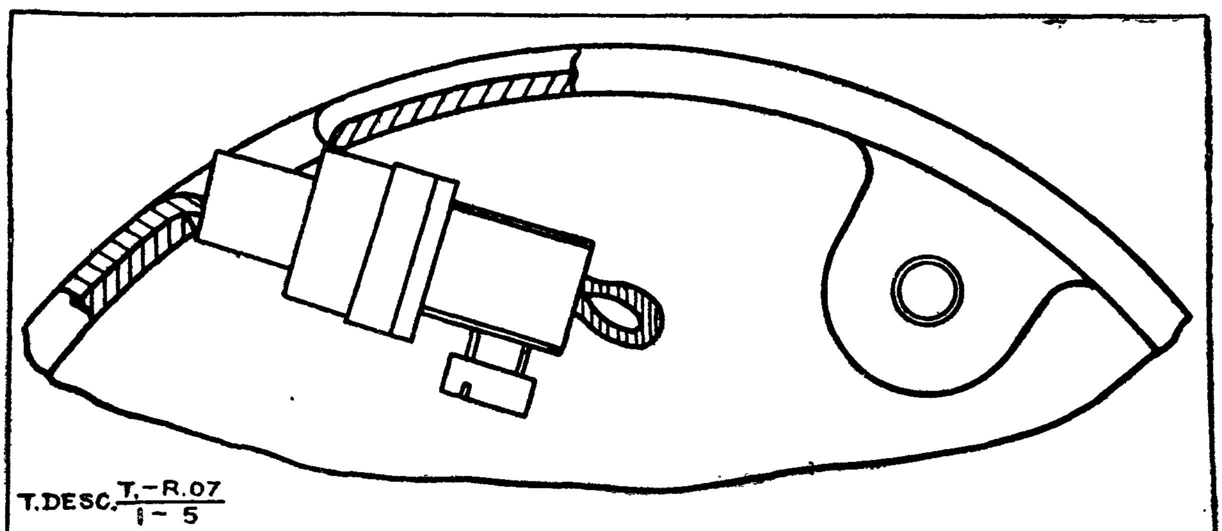


FIG. 5

been moved during the above operations, it should be turned as far as possible in an anti-clockwise direction and locked in that position. Place the adjuster inside the drum so that it hangs over the lip of the cut-out and holds that end of the cable in place while the remainder is being attached (See fig. 5). Set the driving shaft so that the two holes are to the right, the top one being a few degrees off top centre. The cable should lie in the back groove on the drum and should be wound round the shaft in an anti-clockwise direction, starting at a point about 4¾ turns to the rear of the hole, passing through the hole and going once round the shaft before passing onto the front groove on the drum. The other cable end may now be temporarily connected to the free end of the cable and a loop made as before, which is held in position by the anchoring bolt. By trial and error adjust the loop until the wire is fairly tight and then lock the anchor bolt and finally tighten up the cable securing screw. Cut off the excess cable and solder the end so cut. Attach the spring onto the adjuster and fix in position by means of the corresponding anchor bolt. Replace the graduated dial.

48. If the lecher fingers require renewal, this is simply effected by unscrewing the nut on the outside of the finger assembly (See fig. 4). This enables the outer contact to be lifted off together with spring and slider. The inner contact may then be removed. When fitting new lecher fingers care should be taken that the locking pin is at the front.

49. The lecher fingers are locked to the lecher wires by turning the locking pin a half-turn in a clockwise direction. If the lecher fingers have been locked to the lecher wires after the transmitter has been set to its correct frequency, it is of the utmost importance that the fingers be unlocked before attempting to tune the set to another frequency. It it also important to check that the locking device on the tuner drum is free before rotating the tuner controls.

No. 2 Tuner

50. In general, the above remarks also apply to Tuners Nos. 2 & 3. As, however, the drives are different in these cases, the following differences arise :—

When replacing a cable the driving shaft should be turned as far as possible in a clockwise direction and locked in that position. Place the adjuster inside the drum so that it hangs over the lip of the cut-out as before. The driving shaft should be set with the holes to the left, the lower one being a few degrees off the bottom centre. Bring the cable round the drum in an anti-clockwise direction to the front groove, wind round the shaft in a clockwise direction starting at a point about 4½ turns from the hole, thread through the hole and wind round the shaft once before passing back to the drum.

No. 3 Tuner

51. There are two independent drives on No. 3 Tuner, one for the shorting arm and one for the tapping arm. The drive for the shorting arm is similar to that on No. 1 Tuner, with the exception that the cable required is only 40″ long. The drive to the tapping arm involves the use of two separate lengths of cable, one 27″ long and one 45″ long. Renewal of this drive is made as follows.

Turn the left-hand drum as far as possible in a clockwise direction, and the right-hand drum as far as possible in an anti-clockwise direction and lock it in that position. Fix the adjuster to one end of the 27″ cable and place it inside the L.H. drum to hang over the lip of the cut-out as before. Take the cable round the drum in a clockwise direction in the back groove and round the R.H. drum in an anti-clockwise direction. Connect the other cable end and make a loop as before and attach to the anchor bolt. Connect an adjuster to one end of the 45″ cable, and place it over the lip in the cut-out on the R.H. drum. Take the cable round the drum in an anti-clockise direction in the front groove. Set the driving shaft with the holes to the right, the top hole being a few degrees off top centre. Wind the cable round the shaft in an anti-clockwise direction starting at a point four complete turns to the rear of the hole. pass through the hole, and wind round the shaft once more before taking it to the L.H. drum. Complete the connecting up of the other ends of the cables as before.

Loaded Ebonite

52. Various parts of the transmiter are made of loaded ebonite and as this material tends to shrink after exposure in a damp tropical climate any screws or bolts, etc., used in clamping together loaded ebonite parts or attaching such parts to the various sub-assemblies, should be tightened up from time to time to take up this shrinkage.

This applies particularly to the tuners.

Voltage Regulator

53. The only parts of the regulator subject to wear and liable to require renewal after being in service for some time are the fixed and moving contacts.

54. If the moving contacts require renewal, the regulator sub-assembly need not be removed from the transmitter, the procedure being as follows :—.

Take off the indicator disc. Lift the contact springs off the pressure pin, taking care that the fixed contacts are not damaged by the free ends of the springs. This may be prevented by covering the fixed contacts with a thin sheet metal cover. Take out one of the split pins in the pressure pin and withdraw the latter. The moving contacts, balance lever and moulded insulating bushes, may then be removed. It may be found that the two moving contacts are not quite the same, the outer one being pointed at one end. When replacing these contacts, it is immaterial whether the inner one is pointed or

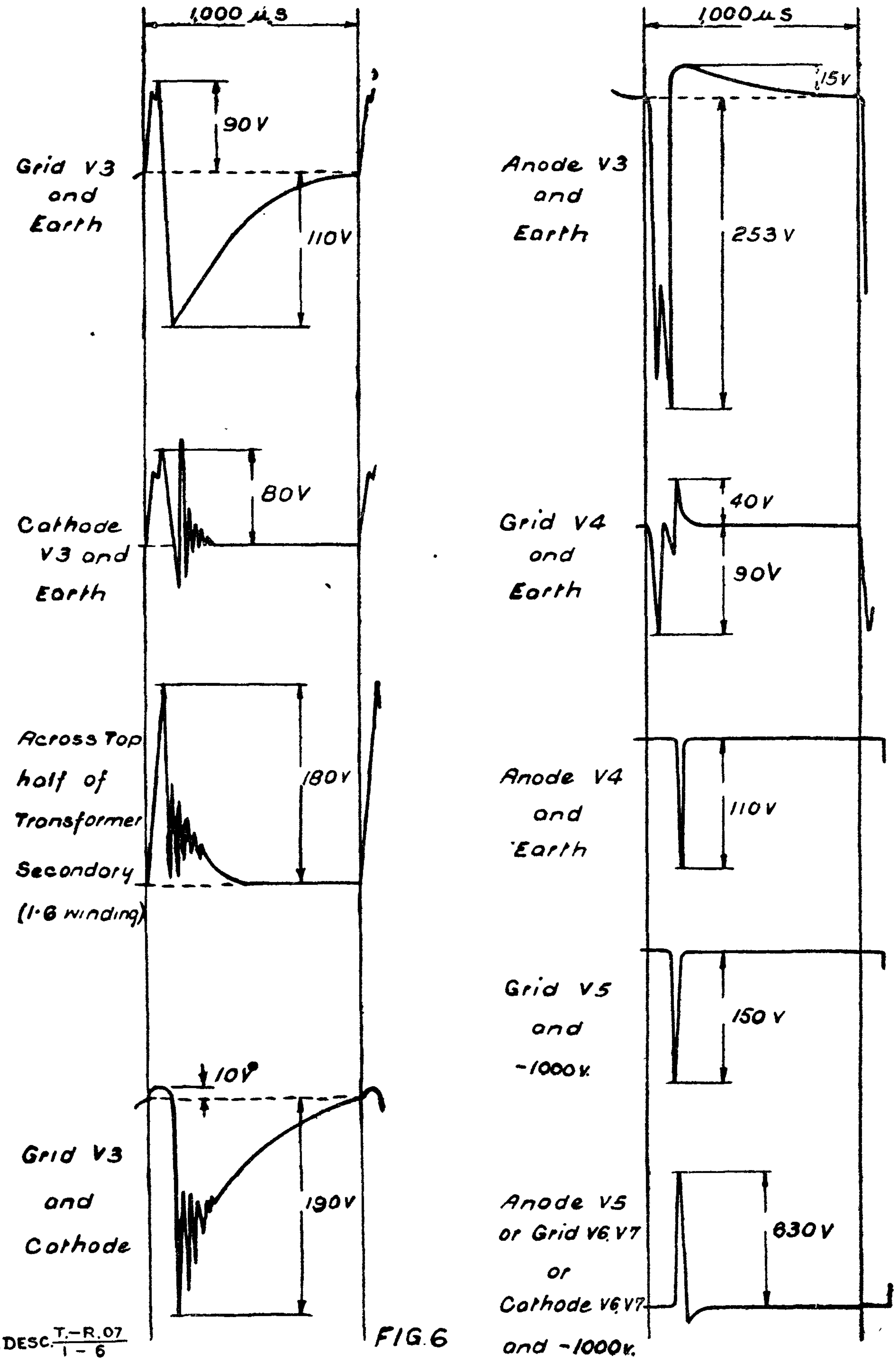

1,000 µs
90 V
Grid V3 and Earth
110V
80V
Cathode V3 and Earth
Across Top half of Transformer Secondary (1·6 winding)
180V
10V
Grid V3 and Cathode
190V
1000 µs
15V
Anode V3 and Earth
253 V
40V
Grid V4 and Earth
90V
Anode V4 and Earth
110V
Grid V5 and -1000V.
150 V
Anode V5 or Grid V6, V7 or Cathode V6, V7 and -1000V.
630V

FIG. 6

not, but the outer must be pointed and the pointed end must be on the outside. Place the inner contact in position with its insulating bush and hold in position with one end of the balance lever while placing the outer contact and its insulating bush in position. Holding the balance lever in position, replace the pressure pin and secure with split pin. Replace the contact spring arms between the washers on the pressure pin.

55. If the fixed contact assembly requires renewal, it is necessary to remove the regulator sub-assembly from the transmitter, the procedure being as follows:—

Disconnect the wires connecting the regulator to the rest of the transmitter and take out the four screws bolting the regulator baseplate to the baseplate of the L.H. Chassis. Lift the regulator sub-assembly out of the transmitter. Take off the indicator disc. Disconnect the wires from the rear of the fixed contact plate to the L.F. Choke. The remaining wires from the fixed contacts to the auto-transformer need not be removed if the contacts are only being cleaned up, but if a new fixed contact assembly is being fitted, it will, of course, be necessary to disconnect all the wiring at the rear of the contact plate. Take out the four bolts holding the auto-transformer to the baseplate and move the auto-transformer to one side to enable the regulator equipment to be dismantled. Remove the sprit pin at the front of the operator shaft and take off the sealing bell and shouldered collar. Remove the two long tension springs at the rear and the operator shaft may then be withdrawn. Remove the moving contacts as described previously and remove the contact springs from the moving contact carrier. Take out the taper pin at the rear which holds the notching wheel on to the main spindle. Take off the notching wheel and thrust bearing and draw out the main spindle. The fixed contacts are then accessible for cleaning up. To do this lay a piece of fine sandpaper on the contacts and place a fine flat file across it to keep the sandpaper flat while rubbing the contact surfaces. The equipment is re-assembled in the reverse order from dismantling, except in the case of the moving contacts. The pressure pin, balance lever insulating bushes and moving contacts are assembled before the contact springs are fitted. The fixed contacts should be protected as previously, when fitting these springs. The R.H. spring is placed on the extended boss and the straight part of the spring gripped by a pair of pliers and turned in a clockwise direction against the torsion of the spring. Force the straight part of the spring into the slot and replace the split pin. The regulator sub-assembly is then ready for re-assembling in the transmitter.

D. C. Lock Unit

56. The D.C. Lock Unit is built up in two alternative ways as follows:—

(a) Two banks of three resistances in series, each resistance being 15 ohms, giving an overall resistance of 10 ohms.

(b) Two banks of four resistances in series, each resistance being 20 ohms. giving on overall resistance of 10 ohms.

As only the 15th ohm. resistances are supplied as spares, it would be necessary to replace a bank of 4-20 ohm. resistances by a bank of 3—15 ohm. resistances should a 20 ohm. resistance break down.

TESTING OF MODULATOR

Connections

57. The modulator is removed from the transmitter before testing. Power units of 1,000 volts, 3,000 volts and 350 volts and a Cossor oscillograph type 3339 are required for testing purposes. The modulator is connected up to the power units, a frequency control potentiometer of 50,000 ohms. is connected across the frequency control terminals of the modulator, and a switch connected in the primary side of the 1,000 volt transformer. A resistance of 100,000 ohms. is connected between the MU2 valve and earth. This resistance has a tapping point such that the resistance between the anode and the tapping point is 80,000 ohms. This tapping point is connected to one of the Y plates (Y1) of the C.R.T. and the earth terminal on the oscillograph is connected to the −1,000 volts terminal of the modulator.* A 0-200 mA. milliammeter is inserted in the +1,000 v. feed to the modulator and a 0-50 mA. milliammeter in the +350 v. feed. The time base on the 3339 C.R.T. is switched off and the time base terminal on the modulator connected to XI on the C.R.T. The X plates of the C.R.T. are shunted by a small capacity (about 75 picofarads) condenser, which reduces the sensitivity of the tube in the X direction.

NOTE.—At the end of each operation, the frequency control should be returned to the L.F. position, that is at 80 on the dial.

Recurrence Frequency

58. Set the FREQUENCY MOD. control to the OFF position. Switch on the 230 volts supply to the heaters, etc., but leave off the 1,000 volts supply to the anodes of the output valves. When the anode current of the 350 volts supply reaches about 18mA., switch on the 1,000 volts supply.

59. The modulator must cover a range of recurrence frequency from 1,000 c/s. to 2,200 c/s. without "Wobbulation" *i.e.*, with FREQUENCY MOD. control switched off. It is first set to give a recurrence frequency of 1,000 c/s. with the frequency control potentiometer at the 80 mark on the dial. and then checked that the frequency at O on the dial is greater than 2,200 c/s. This is done as follows:—

60. Set the frequency control to 80. Disconnect the Y1 plate from the tapping point of the output potentiometer and connect this Y1 plate to a Beat

*** Care should be taken as the case of the oscillograph is then at 1000v negative with respect to earth.**

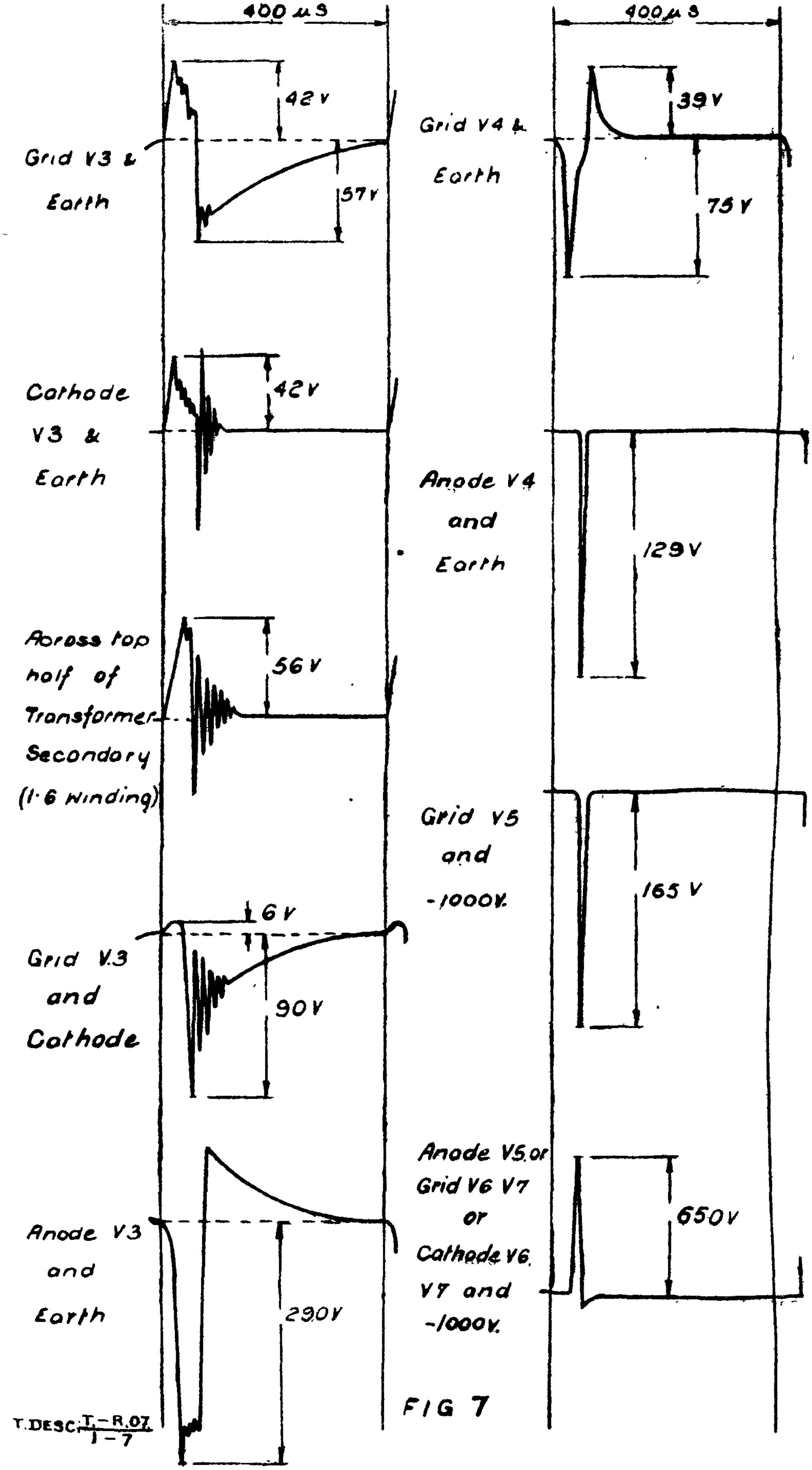

400 µS
42 V
Grid V3 & Earth
57 V
Cathode V3 & Earth
42 V
Across top half of Transformer Secondary (1·6 winding)
56 V
Grid V.3 and Cathode
6 V
90 V
Anode V3 and Earth
290 V
400 µS
Grid V4 & Earth
39 V
75 V
Anode V4 and Earth
129 V
Grid V5 and -1000V.
165 V
Anode V5 or Grid V6 V7 or Cathode V6, V7 and -1000V.
650 V
T.DESC. T.-R.07 / 1-7

FIG 7

Frequency Oscillator. Set the B.F.O. to 1,000 c/s. and adjust the FREQUENCY SET control until a single stationery image is seen on the tube. The modulator is then set to give a recurrence frequency of 1,000 c/s. at 80 on the dial. Turn the frequency control to O. Adjust FREQUENCY TRIM for maximum recurrence frequency, *i.e.*, maximum length of trace on the tube. Adjust the B.F.O. until one stationery or nearly stationery line is seen on the tube. The recurrence frequency as indicated on the B.F.O. should then be greater than 2,200 c/s. The recurrence frequency may also be measured in the following way, which is not, however, as convenient as the method already described:—

61. Connect the lead from the tapping point on the resistance between the anode of the MU2 and earth to one of the Y plates (Y1) on the C.R.O. The time base is adjusted until several complete cycles of waveform (3 if the time base frequency is 1/3 the recurrence frequency) are obtained on the screen For the most accurate results "Sync" should not be used, but the time base frequency should be adjusted till a stationary or slowly drifting trace is obtained. The other Y plate (Y2) of the C.R.O. is connected to the B.F.O. The frequency of the B.F.O. is adjusted until the number of complete cycles is the same as the number obtained from the modulator and the trace is moving in the same direction at the same speed. The reading on the B.F.O. then gives directly the recurrence frequency.

62. An alternative method of measuring recurrence frequency is as follows:—

Connect the lead from the tapping point of the output potentiometer to the Y plate (Y1) of the C.R.T. and adjust the time base so that three waveforms are visible on the trace. Connect the B.F.O. to the magnetic deflection coils on the C.R.T. and adjust the frequency of the B.F.O. so that one waveform from the modulator appears on each cycle of the B.F.O. waveform. The frequency registered by the B.F.O. is then equal to the recurrence frequency. The "Sync" control may be used in this method.

Current Readings and Output

63. Return the frequency control to 100 and check that the 1,000 volt feed current is between 130—150 mA. and the 350 volt feed current between 18—24 mA. Set the frequency control to O and check that the 1,000 volt feed current is between 140—160 mA. and the 350 volt feed current between 23—29 mA.

64. Connect the tapping point on the resistance between the MU2 anode and earth to the Y plate and check that the output is greater than 600 volts. Calibration of the tube is effected as follows:—

Disconnect the modulator time base, and connect the tapping point on the output potentiometer to the Y plate. Measure the length of the vertical line on the tube. Remove the lead to the Y plates and connect up a source of D.C. Adjust the voltage until the vertical shift of the spot shown on the screen is equal to the length of the line measured previously. This D.C. voltage, when multiplied by the potentiometer ratio, is equal to the output voltage of the modulator.

Miscellaneous Tests

65. Check that the MU2 valve operates by shorting the output skid to earth momentarily. A blue glow is seen inside the valve. It may be necessary to mask the Cossor S.130 to see this clearly.

66. Check that the horizontal shift control operates satisfactorily.

67. Connect the Y plate (Y1) on the C.R.T. to the B.S.E. terminal on the modulator, and to the "Sync" terminals on the oscillograph. Connect the Earth terminal on the oscillograph to the −1,000 volt terminal on the modulator. The voltage as indicated on the C.R.T. is the B.S.E. voltage and should be about one thirtieth of the output voltage as measured previously (para. 64), *i.e.*, about 25 volts. The back stroke eliminator may be checked when the modulator is in the transmitter by reducing the brightness and noting that the spot disappears before the trace.

Frequency Modulation

68. Frequency modulation is checked as follows:—
The output of the modulator is connected to a valve voltmeter as shown in fig. 9. Set the frequency control to 80 and turn the FREQUENCY MOD. control to its maximum. Check that the output of the modulator is stable. Increase the recurrence frequency until the trace is just about to become unstable and record value of current obtained. Instability is shown by the picture on the tube collapsing and the milliammeter pointer flicking to a lower current value. Switch off the FREQUENCY MOD. control and adjust the recurrence frequency by means of the frequency control until the ammeter reading is the same as noted before. Connect the modulator output to a B.F.O. and measure the recurrence frequency. This is the value of recurrence frequency at which the modulator becomes unstable on frequency modulation and it should not be less than 1,000 c/s.

Waveforms

69. Diagnosis of Obscure Fault on the modulator can be aided by observing the waveforms of voltages existing at various stages in the circuit.

70. In most cases the waveforms are measured between certain potential points and earth. For these cases the terminal marked "E" on the C.R.T. is connected to the frame of the modulator and one of the Y plates (Y1) is connected to the appropriate point of the circuit. Where the waveforms are taken between two points in the circuit the Y plate is connected to one point and the "E" terminal to the other. The sweep frequency is adjusted to be a submultiple of the recurrence frequency. "Sync" may be used to prevent drift of the trace.

By comparison of the waveforms of the suspected modulator with the respective typical waveforms shown in fig. 6, 7 & 8, the locality of the faults

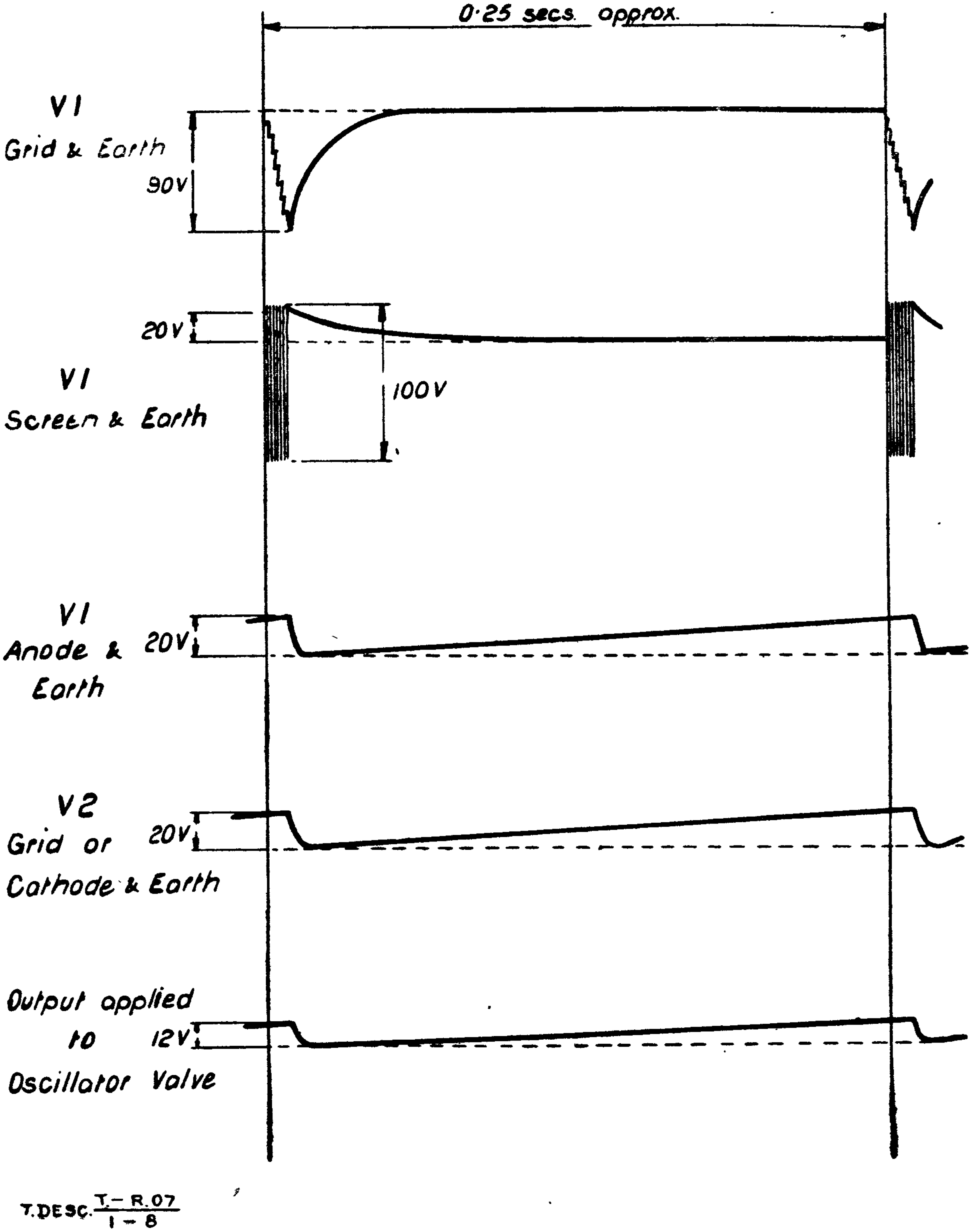

0·25 secs. approx.
V1
Grid & Earth
90V
20V
V1
Screen & Earth
100V
V1
Anode & Earth
20V
V2
Grid or Cathode & Earth
20V
Output applied to Oscillator Valve
12V
T. DESC. T.– R.07 / 1 – 8

Fig. 8

can be ascertained. It will be noted that the typical waveforms have been expressed in terms of voltage along the Y axis and time along the X axis. Calibration in respect of these quantities will, therefore, have to be carried out.

71. In cases where the peak voltage is greater than can be applied with safety to the Y plates of the C.R.O., reduction of voltage is obtained by the use of a suitable potentiometer consisting of non-inductive resistances having a total value of approximately one megohm.

72. The waveforms shown in figs. 6 and 7 are taken between the various points shown, with the FREQUENCY MOD in the OFF position. The first four waveforms in fig. 8 show the waveforms which are produced in the saw-tooth generator circuit whether the switch S1 fig. 19 is closed or open. The last waveform in fig. 8 is that developed across the resistance R.44 and this voltage is only applied to the square wave oscillator when the switch S1 is open, *i.e.*, FREQUENCY MOD switched on.

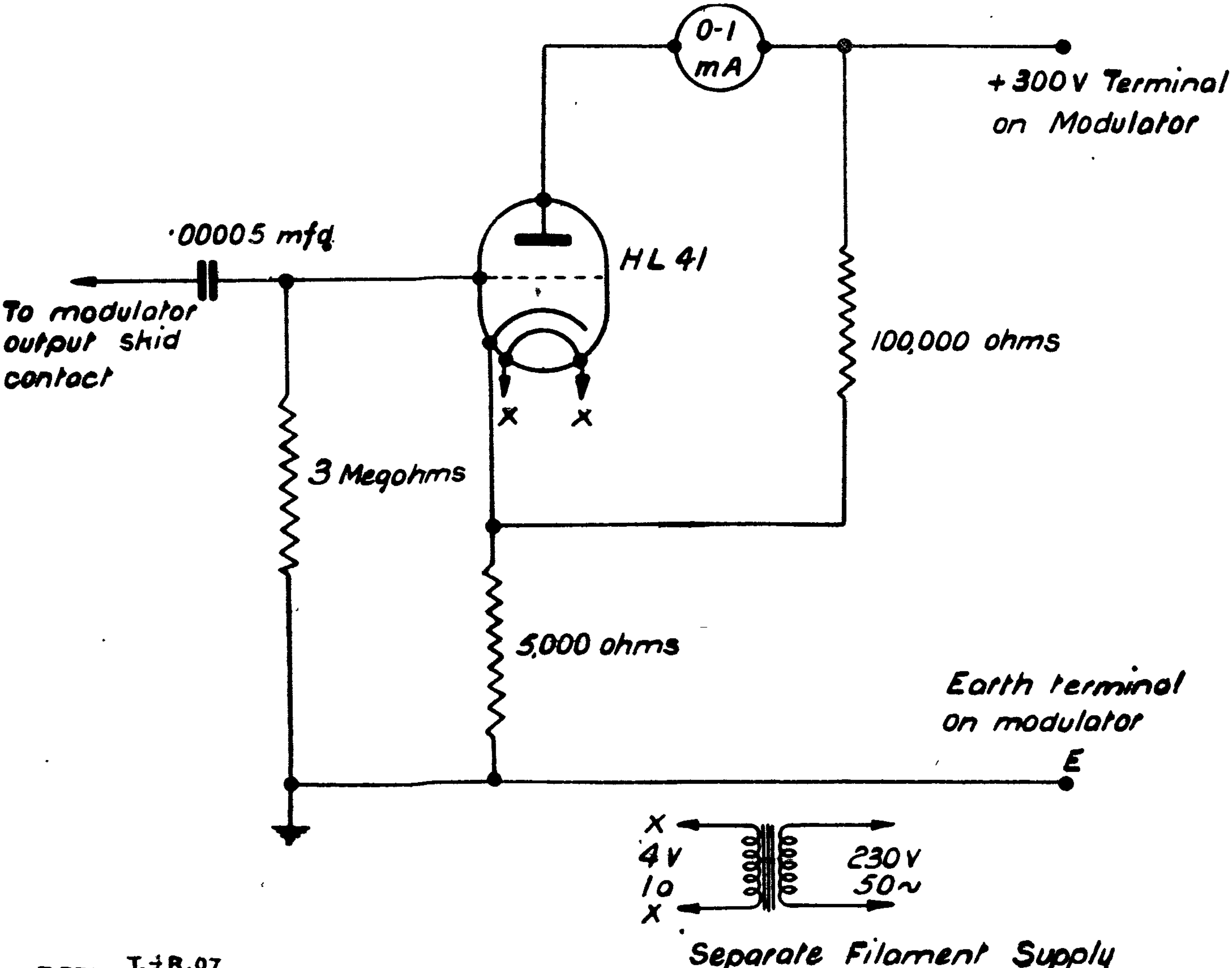


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Fig. 9.—Valve Voltmeter

73. TYPICAL MODULATOR TEST RESULTS

—	Cycles per Second	1,000 v. feed (mA)	350 v. feed (mA)	Output	Back Stroke Eliminator
Low Frequency . . .	990	130	21/22	Satisfactory	Satisfactory
High Frequency . . .	2,900	140	27/28	Satisfactory	Satisfactory

Output voltage 650 volts.

74. Table of currents and voltages at output of modulator power unit when under load of modulator :—

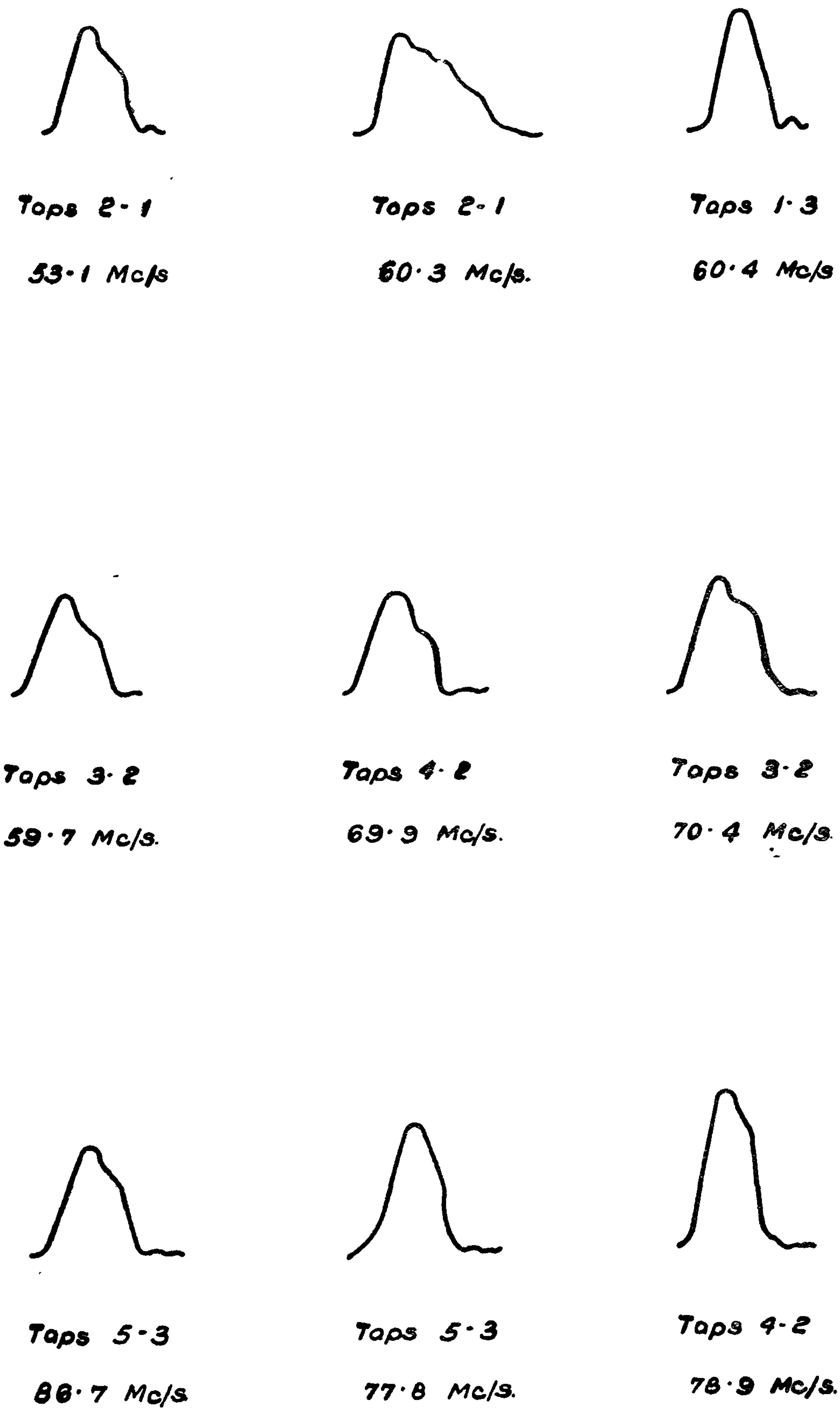
(a) Under normal operating conditions.

(b) Under static conditions with first valve of modulator removed.

Output	Normal Operating Conditions		Static Conditions	
	Current	Voltage	Current	Voltage
1,000 v	140 mA	1,000 v	140 mA	990 v
300 v	22 mA	335 v	22 mA	330 v

H. T. voltage . . 21·5 kV.

Supply voltage . . 235 v.



T.DESC. $\frac{T.-R.07}{1-10}$

FIG. 10

TESTING Mk. II TRANSMITTER

75. See that all valves are in position and connections tight.

See that the modulator is in position and remove its oscillator valve.

See that the plugs are in position in the modulator and C.R.T. power units.

Check the zeros of all meters.

Wind all control handles fully anti-clockwise.

Connect the transmitter to a 230 v. 50 cycle supply, the earth terminal in the transmitter being connected to the supply earth.

Move the isolator switch to the ON position, and the fan will start up and run.

Insert a O/50 A. sub-standard ammeter in the filament lead to the oscillator valves (See fig. 16). To do this it will be necessary to remove the front cover of the No. 2 tuner compartment.

Press the filaments ON button.

Contactor 1 will close and after 20 secs. contactor 3 will close. After a further 15 secs., the filament ON indicator lamp (green) will light.

The limits on the time delay switches are as follows:—

	Minimum	Maximum
TD 1 . .	18 secs.	25 secs.
TD 3 . .	13 „	18 „

Check that the filament currents increase when contactor 3 closes. Adjust the filament current to the oscillator valves, by means of resistance R.25 to 35 amps as shown on the sub-standard ammeter. Enter the reading shown on the oscillator filament ammeter on the label affixed to the meter glass.

Remove the O/50 A. sub-standard ammeter in the filament lead of the oscillator valves and connect it in the filament lead of the amplifier valves (See fig. 16). Set the amplier filament ammeter by means of resistance R.26 and enter the reading on the corresponding label as before.

Switch off and remove the sub-standard ammeter.

See that all covers are locked and keys in position.

Switch on, press the filaments ON button and wait until the filaments ON indicator lamp lights.

Check the following meter readings:—

Amplifier grid bias voltage. This should be 1,050v. ±10 per cent.

Oscillator grid bias voltage. This should be 1,050 v. ±10 per cent.

Remove one fuse off each of the grid bias power units, i.e., F.33 off transformer T12 and F30 off transformer T2, and check the power units for operation.

Set the H.T. regulator in position 1 and press the H.T. ON button. Contactor 4 closes and the H.T. indicator lamp (red) lights.

Turn the regulator to position 16. The H.T. voltage should then be 23 kV. ± 5 per cent.

Check the following:—

Remove the cover of the modulator compartment and note that all the contactors trip out. Replace the cover and close all the contactors as before.

Press down the flap switch in the fan outlet and note that all the contactors trip out. The contactors should trip when the flap falls about 5/8″ from its normal operating position.

With the filaments ON note that on pressing the heaters ON push button the filament contactor drops out. Press the filaments ON button and note that the heaters contactor drops out. Check that the heaters heat when the heaters ON push button is pressed.

Switch to OFF and replace the oscillator valve in the modulator.

Set the cathode coil taps on terminals 2 and 1.

Switch to ON.

See that the wobble control on the modulator is switched off.

Set the filament currents to the settings noted previously.

Set the oscillator anode dial to 54 and tune the amplifier anode and oscillator grid until an approximately triangular picture is obtained on the cathode ray tube on the transmitter and the frequency is less than 54 megacycles as measured on a wavemeter.

The regulator should be set to maximum and the shape of the picture on the C.R.T. should not show any increase after the maximum. Typical pictures are shown in fig. 10.

Repeat the above tests at a frequency greater than 60 Mc/s.

Change the cathode coil taps to 3 and 2 and repeat at frequencies less than 60 Mc/s. and more than 70 Mc/s.

Change taps to 4 and 2 and repeat at frequencies less than 70 Mc/s. and more than 78 Mc/s.

Change taps to 5 and 3 and repeat at frequencies less than 78 Mc/s. and more than 86 Mc/s.

These tests should be performed with the recurrence frequency potentiometer set at 80. This corresponds to a recurrence frequency of 1,000 c/s which may be checked as follows:—

Disconnect the lead from the delay line to the Y plate of the C.R.T. in the transmitter and connect one lead of the B.F.O. to this Y plate. The other lead from the B.F.O. should be earthed to the transmitter framework. Set the frequency control to 80 and the B.F.O. to 1,000 c/s. Adjust the "Frequency Set" control until a single stationary image is obtained on the screen. The modulator is then set to give a recurrence frequency of 1,000 c/s. at 80 on the frequency control.

The width of the picture on the transmitter monitor can be measured by means of the calibration shift device. The picture is positioned by means of the X shift to the right of the vertical line on the cathode ray tube, the start of the pulse being on the line and the "Calibration" switch in position "O". Move the "Calibration" switch to position "1" and the picture on the screen will move to the left a distance equivalent to one microsecond. From this shift the width of the picture can be determined.

Check on any one frequency that the output is the same with the second modulator in circuit.

Readings of meters should be taken at all frequencies.

Typical results of the above tests are given below.

TEST RESULTS

76. Supply voltage 235 v H. T. voltage 21·2kV

Taps	f	Bias Volts Osc.	Bias Volts Amp.	Osc Ia	Amp Ia	Osc Ig	Amp Ig	Dial Settings D1	Dial Settings D3	Dial Settings D4
1—2	53·4	1,000	1,070	14 mA.	15·5 mA.	2·5 mA.	0	2·5	5·1	8·0
	60·2	1,020	1,080	10 mA.	18 mA.	3 mA.	0	7·0	7·6	8·8
2—3	59·7	1,030	1,100	9 mA.	16 mA.	2·5 mA.	0	6·0	8·0	11·25
	70·1	1,040	1,100	7·5 mA.	10·0 mA.	3·0 mA.	0	13·3	13·3	14·15
2—4	69·8	1,020	1,090	7·5 mA.	13·0 mA.	2·5 mA.	0	11·75	12·7	14·0
	78·5	1,030	1,100	8 mA.	13 mA.	2·5 mA.	—1·5 mA.	15·5	15·7	17·0
3—5	77·8	1,030	1,100	7·5 mA.	12·5 mA.	2·5 mA.	—1·5 mA.	15·0	15·8	16·6
	86·4	1,020	1,090	8 mA.	15 mA.	3·0 mA.	—1·5 mA.	18·1	17·25	17·9

77. Table of primary currents of all transformers with 230 volts A. C. applied :—

(a) With normal secondary loads.

(b) With secondaries open circuited.

Diagram Ref.	Style No.	Primary Current	
		Normal Secondary Load	Secondary open circuited
T 1	200,854	6·0 amps.	4·0 amps.
T 1a	200,852	2·4 ,,	0·047 ,,
T 2, T 12	200,864	1·1 ,	0·034 ,,
T 2a, T 12a	200,864	0·12 ,,	0·026 ,,
T 3 (a) and (b)	200,851	2·9 ,,	0·037 ,,
T 5	200,849	6·0 ,,	0·055 ,,
T 6—9	200,870	0·06 ,,	0·046 ,,
T 13	201,054	0·21 ,,	0·125 ,,
T 14	201,053	0·0622 ,,	0·033 ,,
T 16	200,943	0·14 ,,	0·093 ,,
T 17	201,929	0·075 ,,	0·05 ,,
T 1 (Mod.)	201,134	0·263 ,,	0·084 ,,

78. Table of currents in each independent 230 volts circuit :—

(a) Under normal operating conditions.

(b) Under static conditions when the first valve of the modulator has been removed.

	Circuit	Current	
		Normal Operating Conditions	Static Conditions
1	Supply to Transmitter at fuses F 1 and F 2	18·1 amps.	14·6 amps.
2	,, ,, Fan Motor at fuses F 7 and F 8	2·8 ,,	2·9 ,,
3	,, ,, Heaters at fuses F 9 and F 10	8·9 ,,	9·0 ,,
4	,, ,, Auto-Transformer	6·5 ,,	3·0 ,,
5	,, ,, Main H. T. Transformer	6·5 ,,	3·0 ,,
6	,, ,, Grid Bias H. T. Transformer at F 15 and F 16	1·9 ,,	2·0 ,,
7	,, ,, Main Filaments at fuses F 12 and F 14	9·6 ,,	9·6 ,,
8	,, ,, Grid Bias filaments at fuses F 17 and F 18	0·25 ,,	....
9	,, ,, Modulator and C. R. T. at fuses F 19 and F 20	0·56 ,,	0·55 ,,
10	,, ,, Control circuits at F 11 and F 12	0·73 ,,	0·74 ,,

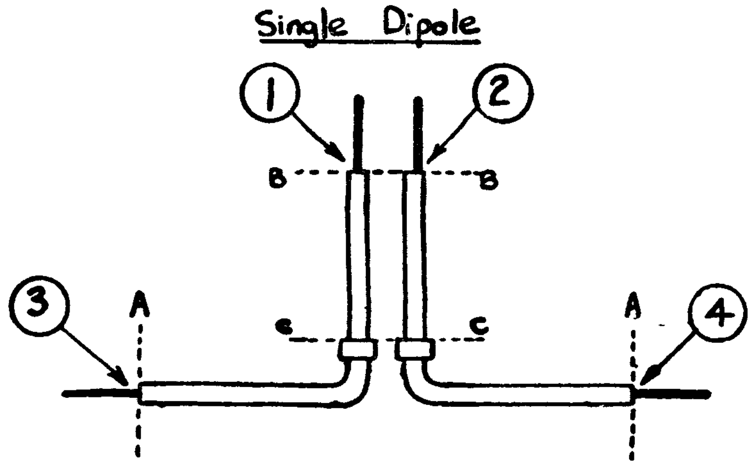
The above results were obtained at 22 kV. (Tap 15) and a supply voltage of 225 volts.

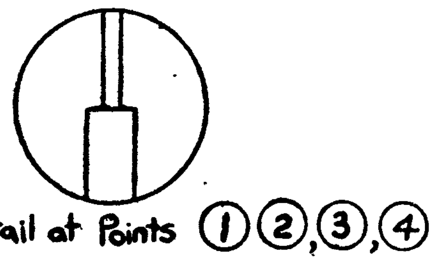
DIPOLE AND STUB LENGTHS AND TAPPING SETTINGS

79. This table shows the readings to be obtained at A, B and C as shown in fig. 11 opposite

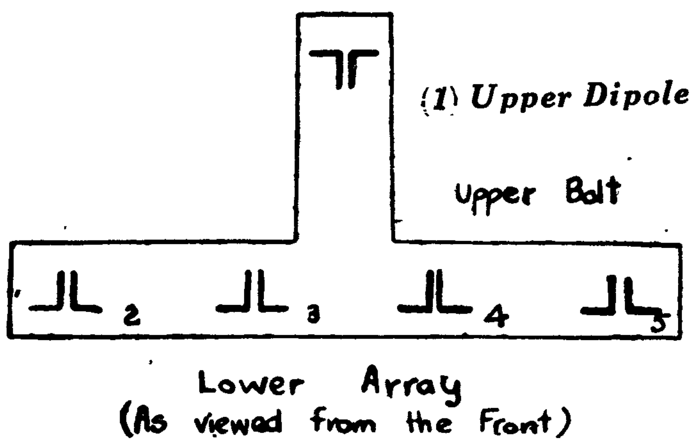
Frequency in Mc/sec.	Upper Dipole (No. 1)			Outer Array Dipoles (Nos. 2 and 5)			Inner Array Dipoles (Nos. 3 and 4)		
	Dipole	Stubs	Feeder Clip	Dipole	Stubs	Feeder Clip	Dipole	Stubs	Feeder Clip
	A	B	C	A	B	C	A	B	C
55	0·0	9·0	9·8	2·3	2·0	10·9	2·3	4·6	11·5
58	2·5	21·9	10·7	4·0	10·1	14·0	4·0	15·1	13·0
60	5·0	19·8	11·0	6·0	11·5	14·0	6·0	14·6	13·7
61	7·5	20·0	9·4	7·5	12·0	13·4	7·5	16·0	13·4
64	11·0	18·5	11·2	11·0	10·75	13·5	11·0	12·5	14·0
65	9·0	18·0	14·5	11·0	12·3	13·8	11·0	13·6	14·0
67	9·3	20·4	14·2	11·5	15·8	14·5	11·5	15·5	14·0
70	14·5	15·7	10·0	14·9	15·6	11·0	14·9	15·2	9·2
73	18·0	21·5	6·0	18·0	20·0	9·0	18·0	20·0	8·0
76	21·3	22·0	7·0	21·4	18·3	11·4	21·4	20·5	11·0
82	22·0	19·2	9·1	22·0	20·5	11·6	22·0	20·0	10·8
85	*	20·4	5·0	*	22·0	8·0	*	21·5	7·5

* The inner parts of the dipoles must be entirely removed when working on 85 Mc/s. To remove the inner parts, loosen the clamping thumb screws and the retaining grub screws.





Positions of Dipoles



Mc/s.	54·5 to 56	57/59	60/63	64/67	68/71	72/76	77/83	84/86
Hole	13	12	11	10	9	8	7	6

Positions of Upper Fixing Bolt
(Holes counted from the lowest)

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Fig. 11

PHASING OF THE FOLLOW DIPOLE ARRAY

80. To ensure that the follow dipole array is phased correctly the following procedure should be adopted:—

81. Check that the filler cap on each of the four feeder boxes secured to the junction box is uppermost; the small red cement spot on the feeder sealing box is facing upwards when the feeder is connected to the dipole.

82. Remove the lid from the junction box and connect two 1.5 volt cells to the terminal stem inside the box, in the manner indicated in figs. 12 (a) and (b).

83. Test each feeder terminal block, using an Avometer. Pay strict attention to polarity. THE POLARITY OF THE BLOCK TERMINALS MUST BE AS SHOWN IN FIG. 12(B).

84. When the correct polarity has been determined, the dipoles, feeder terminal blocks and junction box feeder terminals, will be marked with a red "+" for the positive connection, and a black "—" for the negative connection, for the purpose of future reference. The method of marking is indicated in fig. 12(b).

PRESSURE TESTS

General

85. Pressure tests as defined below are carried out in course of manufacture to ensure the general soundness of inspection and wiring. Should it be suspected that the insulation of wiring or components has been impaired due to any cause, the following tests should be carried out.

86. Tests should be carried out without any valves being inserted. Neither the modulator nor its power pack should be in position. All fuses should be in position.

The following wires should be disconnected:—

(a) The earth wires to Transmitter main earth terminal. Connections marked 98 at this point should be wired together, and connections marked 198 should also be wired together but kept separate from 98.

(b) Connections 94 and 98 at the high frequency chokes.

(c) Connections to condensers C13, C12, C2 and C55.

1,000 Volt Pressure Test

87. Withdraw fuses 3, 4, 7 and 8.

Connect together the following points:—

(a) Top terminals of Condenser Bushings C14, C15 and C16.

(b) Top terminals of Condenser Bushings C17, C18 and C19.

(c) Terminals 82, 83, 84 and 85 on transformers T3a and T3b.

(d) Primary terminals of T6, wires 36 and 37 and connect to 198.

(e) Lower terminals of fuses 3, 4, 7 and 8.

88. With switch plugs and equipment lighting switches closed, megger between wire 198 and earth with 500 v. megger. Minimum reading 50 megohms.

89. With switch plugs and equipment lighting switches open, pressure test from wire 198 to earth at 1,000 v. R.M.S. for one minute.

2,000 v. Pressure Test

90. Withdraw fuses 3, 4, 7 and 8.

Connect together the following wires:—

(a) "Filaments On" Indicator Transformer T7 wires 101, 102, 22 and 98.

(b) "Heaters On" Indicator Transformer T9 wires 48, 49, 129 and 98.

(c) "H.T. On" Indicator Transformers T8 wires 32, 33, 56 and 98.

(d) Terminals on Transformers T2 and T2a.

(e) Terminals on Transformers T12 and T12a.

(f) All terminals at the back of the contactor panel.

(g) All terminals on Modulator finger panel.

(h) Isolator switch L.T. terminals.

Megger between wiring and earth. Minimum reading 15 megohms.

Pressure test between wiring and earth at 2,000v. R.M.S. for one minute.

20,000 v. Pressure Test.

91. (a) Disconnect connections 62 and 61 to condenser C1.

(b) Remove resistance R3 from its clips.

(c) Disconnect the Ceramic condensers.

Pressure test between oscillator anode and connections to same and earth at 20,000 volts for one minute.

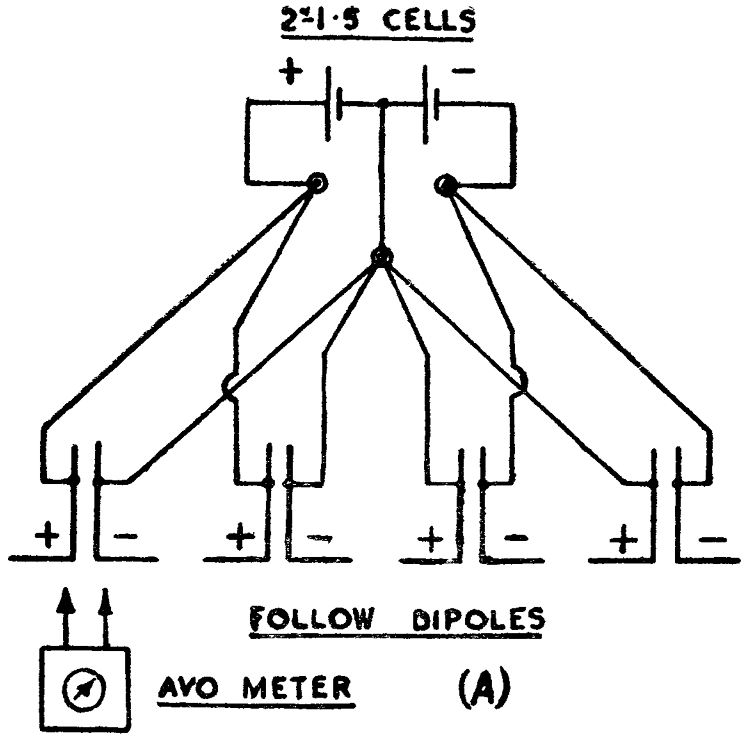
Replace R3 and remove R2.

Pressure test between amplifier anode and connections to same and earth at 20,000 v. R.M.S. for one minute.

5,000 v. Pressure Test

92. Connect together terminals on Plug No. 1 and pressure test to frame at 5,000 v. for one minute.

Pressure test between oscillator grid lechers and squegger unit to earth at 5,000 v. R.M.S. for one minute.



(A)

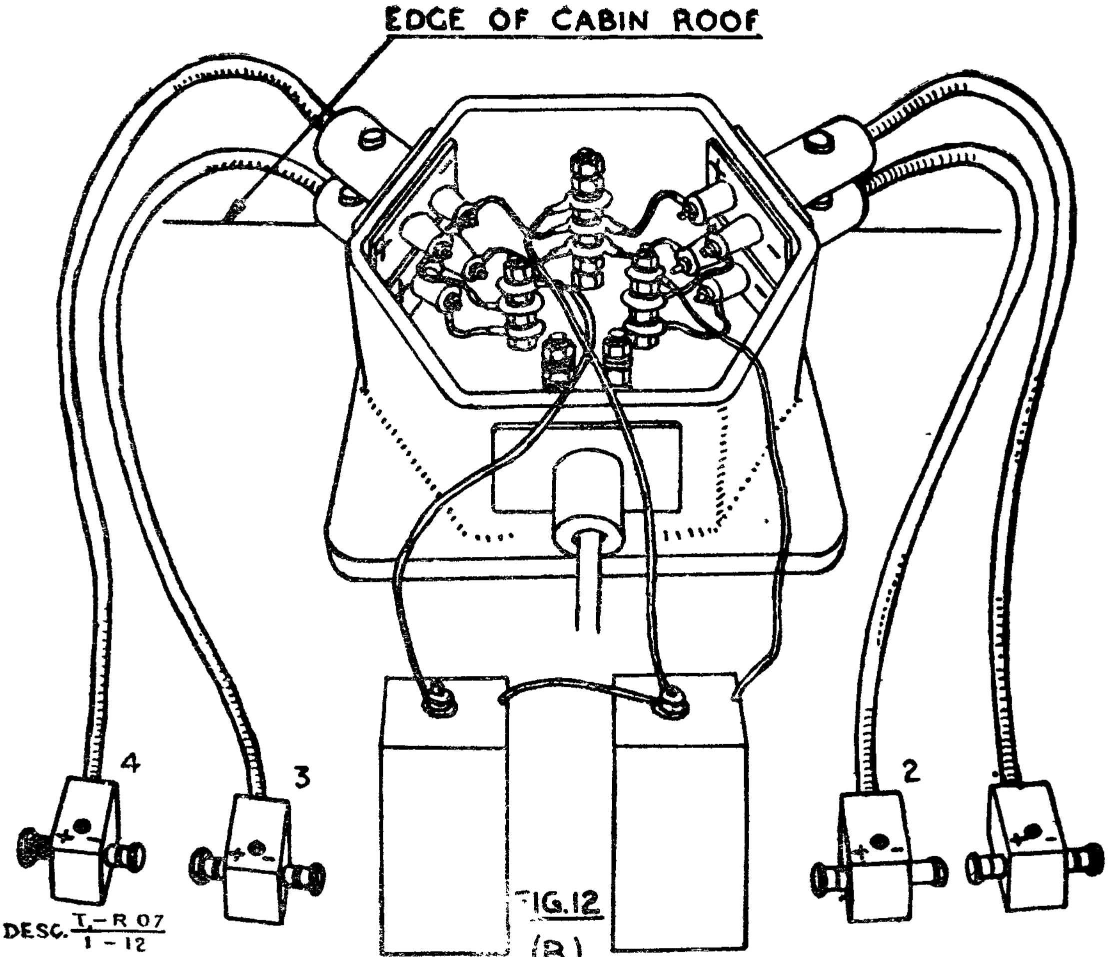


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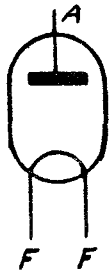
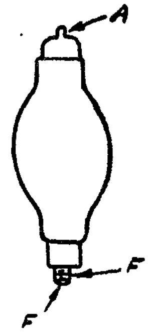
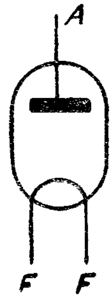
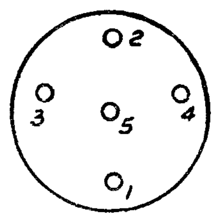
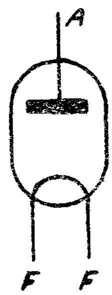
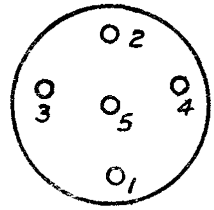
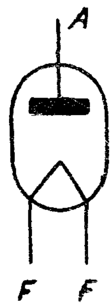
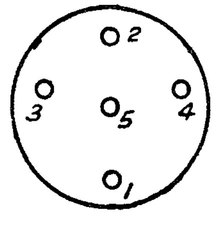
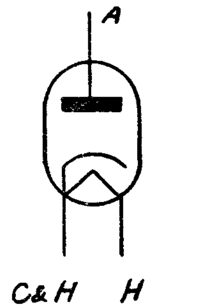
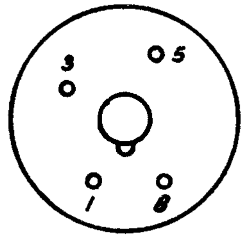
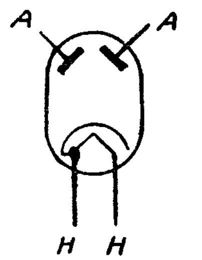
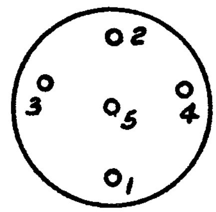
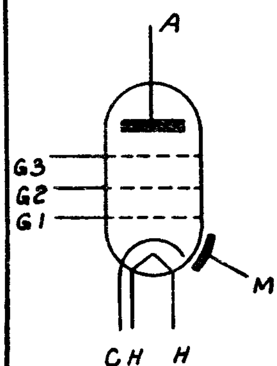
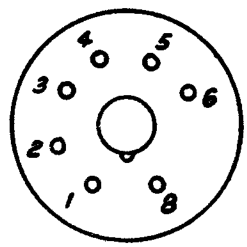
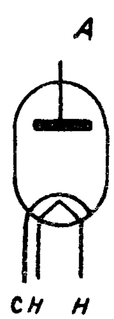
FIG.12
(B.)

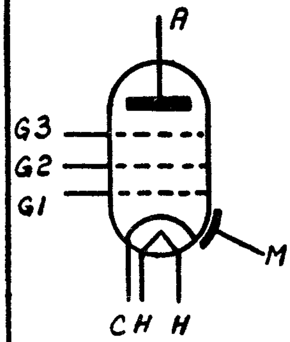
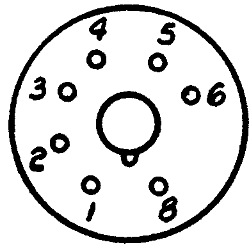
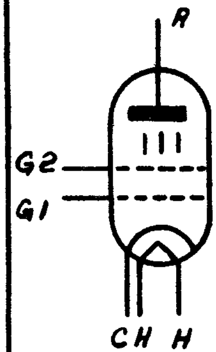
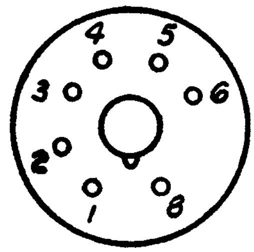
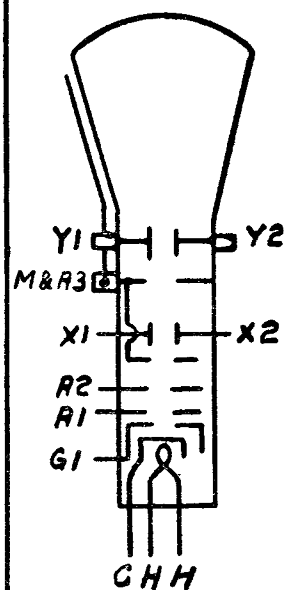
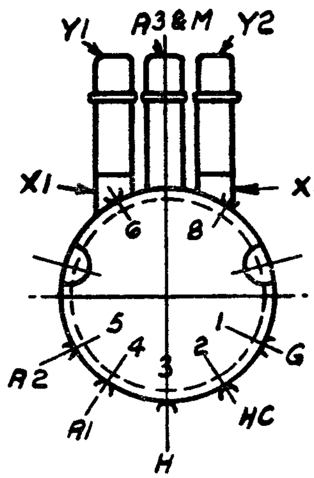
VALVE BASE CONNECTIONS (SHEET 1)

Type	Pin	Electrode	Schematic	Base
C.V. 19 (V.1901)				
C.V.20 (V.1906)	1 2 3 4 CAP	- - F F A		
A.U.5 (V.1907)	1 2 3 4 CAP	- - F F A		
MU 2	1 2 3 4 CAP	- - F F A		

VALVE BASE CONNECTIONS (SHEET 2)

Type	Pin	Electrode	Schematic	Base
A.U.8. (U.22)	1 3 5 8 CAP	H & C - - H A		
AU.3A (U.U.5)	1 2 3 4	A A H & C H		
A.R.P. 19 (S.P. 41.)	1 2 3 4 5 6 8 CAP	H C A G 2 G 3 M H G1		
A.R.D.2 (D.1)				

VALVE BASE CONNECTIONS (SHEET 3)

Type.	Pin.	Electrode	Schematic.	Base.
C.V.21. (VP.41)	1 2 3 4 5 6 8 CAP	H C A G2 G3 M H G1		
V.T.127. (V.1111)	1 2 4 5 8 CAP	H C G2 G1 H A		
A.C.R.8. (V.1026)	1 2 3 4 5 6 8	G H&G H A.1. A2 X1 X2.		

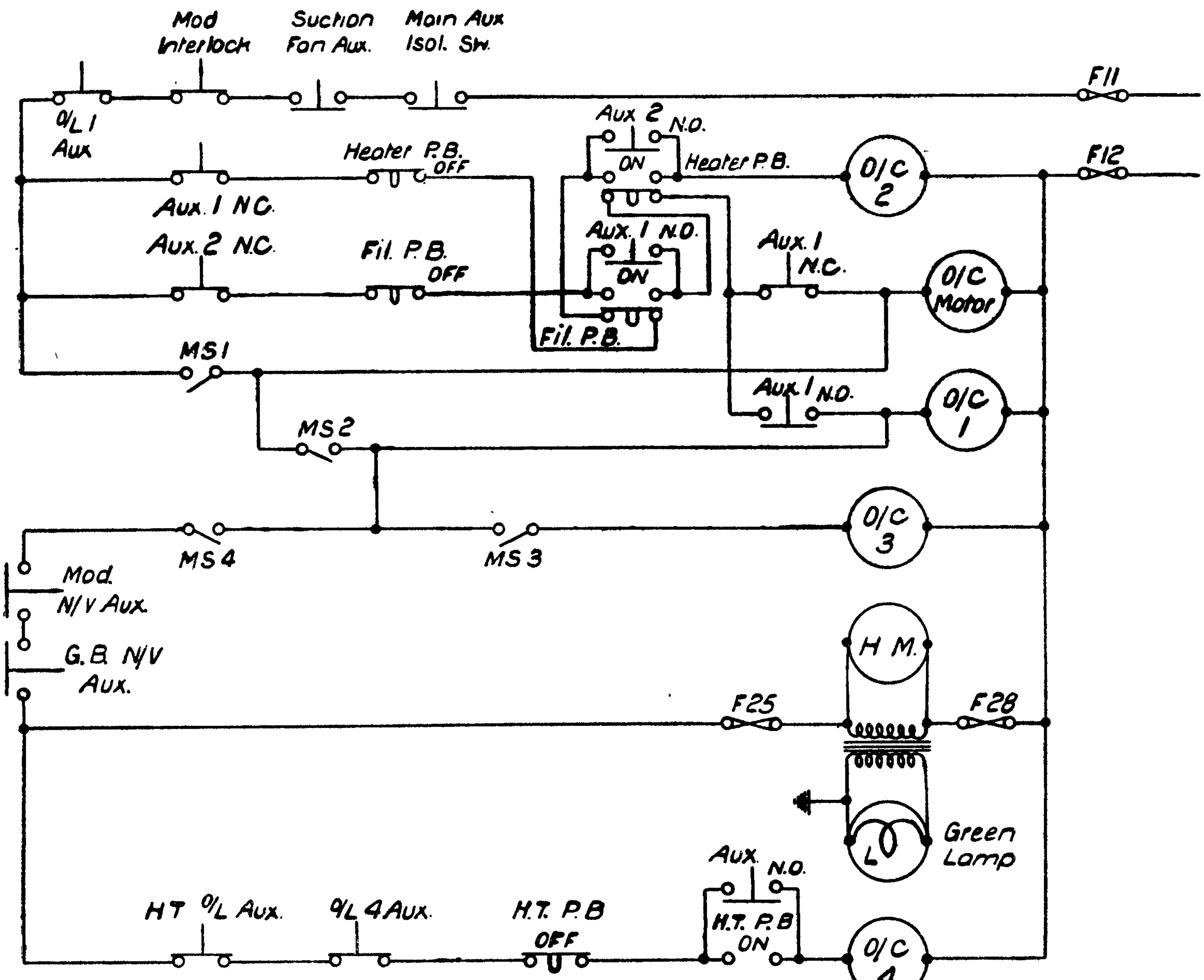


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Fig. 14 Control Circuit using Motor Sequence Switch

Diagram References for Circuit of power Supply Controls

Diagram Reference	Component	Diagram Reference	Component
T1	230 v. /19·5 kV·-0-19.5 kV. . .	F13 } F14 }	0.124" Copper Wire 15 amps.
T1a	„ /16·5 v.		
T2	„ /865,775,690-0-690,775,865 v. .		
T2a	„ /4 v.	F15 } F16 }	0.024" Allotin 5 amps.
T3a	„ /17·75 v.		
T3b	„ /17·75 v.		
T5	„ /57·5-230 v.	F17 } F18 } F21 } F22 } F23 } F24 } F25 } F26 }	0.0148" Allotin 2 amps.
T7	„ /11 v.		
T8	„ /11 v.		
T9	„ /11 v.		
T12	„ /865,775,690-0-690,775,865 v. .		
T12a	„ /4 v.		
T18	„ /225,237,248 v.		
R16	17·5 ohms. Resistance . . .		
R17	17·5 „ „		
R25	10 „ Variable Resistance . .	M9	Calibrated 0/25 kV. D.C.
R26	10 „ „ „ . .	M11	Hour Meter.
F7 } F8 }	0·018" Copper Wire 25 amps. .	0/C	Contractor Operating Coil.
		0/L	Overcurrent Relay.
F9 } F10 }	0·0124" „ „ 15 amps. .	L	Indicating Lamp.
		P.B.	Push Button.
F11 } F12 }	0·024" Allotin 5 amps. . .		

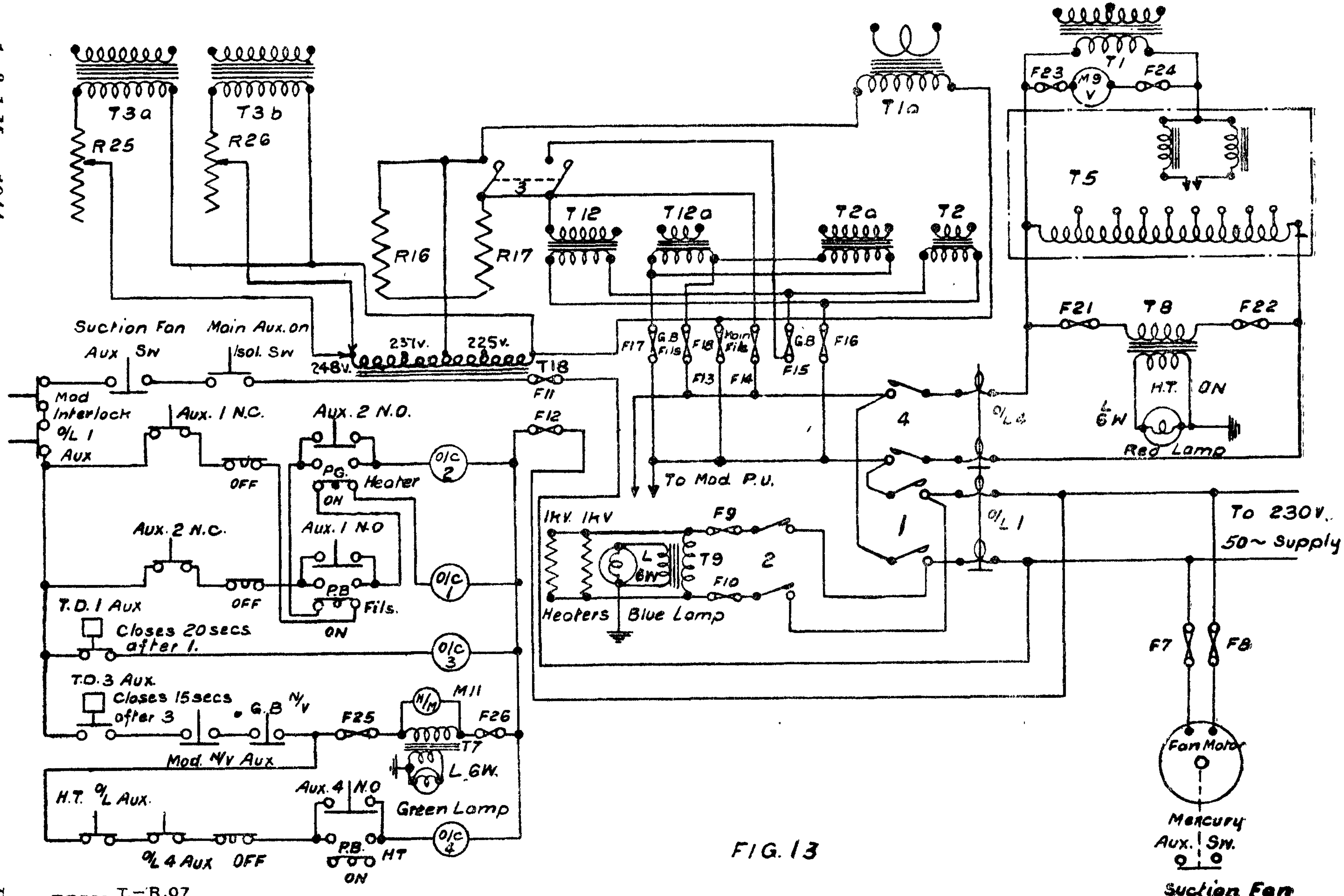


FIG. 13

T.DESC. T.-R.07 / 1-13

CIRCUIT OF POWER SUPPLY CONTROLS

Diagram References for Isolator Switch & Power Supply Circuits

Diagram Reference	Component	Diagram Reference	Component
T1	230 v./19·5 kV-0-19·5 kV.	C12, C13	2 mfd. 500 v. D. C. Wkg.
T1a	,, /16·5 v.		
T2	,, /865,775,690-0-690,775,865 v.	C14, C15, C16, C17, C18, C19	0·004 mfd. Condenser Bushings.
T2a	,, /4 v.		
T3a	,, /17.75 v.		
T3b	,, /17.75 v.		
T6	,, /11 v.		
T10	Current Transformer 50/5	C54	0·1 mfd. 2,000 v. D. C. Wkg.
T11	Current Transformer 50/5	HFC 5-10	6 turns 1¾" O.D. (3/16" dia. Copper Wire)
T16	230 v./12 v.		
LFC1	10 Henry Choke	F1, F2	0·040 " Copper Wire 80 amps.
R1	2,000 ohms. 150/180 watts.		
R2	25,000 ,, 150/180 ,,	F3, F4	0·0124" ,, ,, 15 ,,
R3	(2×50,000) ohms. 300/360 watts.		
R5	12,000 ,, 150/180 ,,	F5, F6	0·0148" Allotin 2
R6	100 ,, 2 ,,		
R7	100 ,, 2 ,,	F30, F31	500 mA. Cartridge Fuse
R10	800 ,, 50/60 ,,		
R11	(3×500,000) ,, 6 ,,	G1, G2	Gas Discharge Tube
R14	800 ,, 50/60 ,,	M1	0-50 A. Ammeter
R15	(3×500,000) ,, 6 ,,	M2	0-50 A. ,,
C1	2.25 mfd. 25 kV. D.C. Wkg.	M4	0-75 mA. Milliammeter
C2	2 mfd. 500 v. ,, ,,		
C3	10 mfd. 1,500 v. ,, ,,	M7	0-1,500 v. Voltmeter
C4	4 mfd. 1,500 v. ,, ,,	M10	0-300 v. ,,
C6	2 mfd. 1,000 v. ,, ,,	L	Indicating Lamp
C7	0.0001 mfd. 5,000 v. D.C. Test	O/L	Overcurrent Relay
C9, C11	0.1 mfd. 500 v. ,, Wkg.	P.B.	Push Button

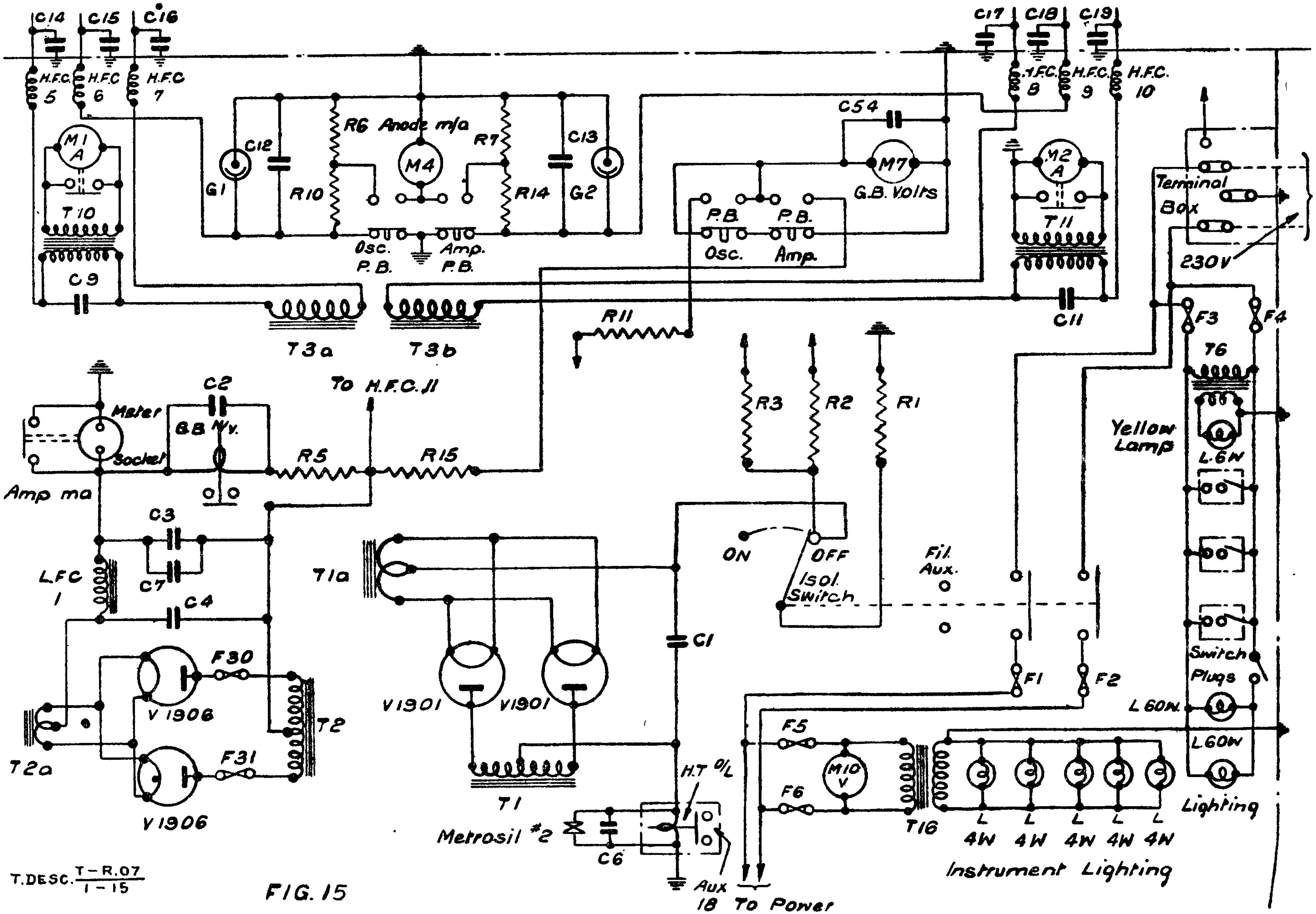
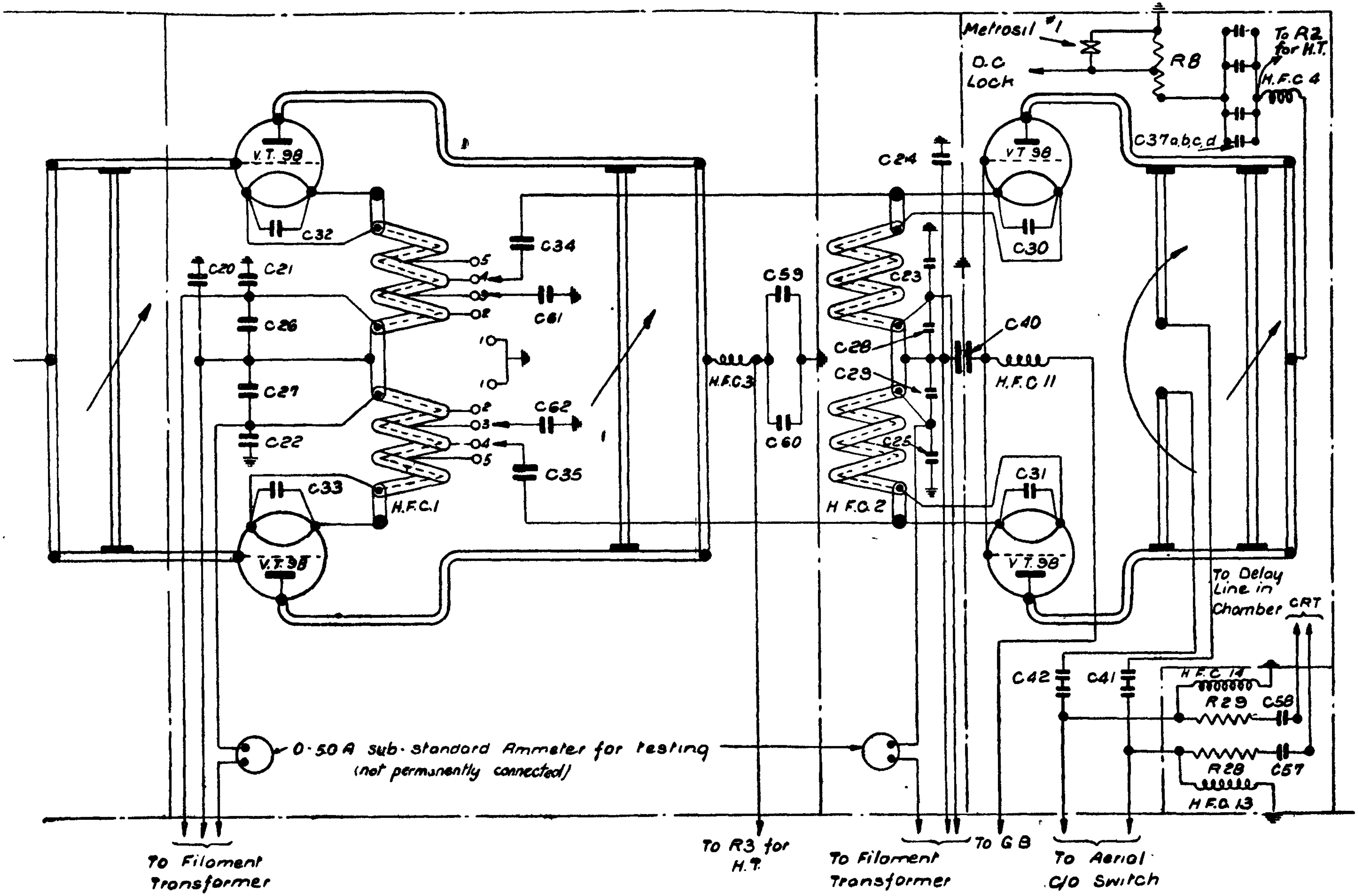


FIG. 15

ISOLATOR SWITCH & POWER SUPPLY CIRCUITS

Schematic References for R. F. Circuit

Diagram Reference	Component
R8	2 sets in series of 3—15 ohms 2 watt in parallel (6 Total) or 2 sets in series of 4—20 ohms 2 watt in parallel (8 Total)
R28	(5 × 200 ohms.) 10 watt. Resistance
R29	(5 × 200 ohms.) 10 ,, ,,
C20—C25	0·004 mfd. Condenser Bushing
C26—C29	100 mmfd. Ceramic Condenser
C30—C33	0·0001 mfd. Mica ,,
C34 & C35	0·001 mfd. 5 kV D. C. Wkg. Condenser
C37a—d	0·0015 mfd. 25 kV D. C. ,, ,,
C40	0·0004 mfd. approx. each side of earth (Built up on screen)
C41 & C42	0.00025 mfd. 25 kV D. C. Wkg. Condenser
C57 & C58	50 mmfd. Ceramic Condenser
C59 & C60	0·001 mfd. 25 kV D. C. Wkg. Condenser
C61 & C62	0·0001 mfd. Mica Condenser.
HFC 1 & 2	9 turns 3·625″ O.D. (0.5″ O.D. × 0.375″ I.D. Copper Tube)
HFC 3	6 turns 1·75″ O.D. (0.125″ dia. Steel Wire)
HFC 4	6 turns 1·75″ O.D. (0.125″ dia. Steel Wire)
HFC 11	6 turns 1·75″ O.D. (0.125″ dia. Copper Wire)
HFC 13 & 14	20 turns 0·75″ O.D. (24s S. W. G. D. S. C.)



T. DESC. $\frac{T-R.07}{1-16}$ FIG 16 RF CIRCUIT

References for Schematic Diagram of Modulator Power Supplies

Diagram Reference	Component	Diagram Reference	Component
T12	230 v/865, 775, 690-0-690, 775, 865	C49, C50	0·25 mfd. 4,000 v. D. C. Wkg.
T12a	„ /4 v		
T13	„ /270-0-270, 4 v.	C51	0·1 mfd. 1,000 v. „ „
T14	„ /2 v. 2,500 v. 4 v.	C52	0·1 mfd. 2,000 v. „ „
R12	(6 × 42,000) ohms. 12 watts	C53	0·5 mfd. 400 v. „ „
R18	2,000,000 ohms. Potentiometer	C55	2 mfd. 500 v. „ „
R19	500,000 ohms. Potentiometer	C56	0·1 mfd. 500 v. „ „
R20	1 megohm 1 watt		
R21	500,000 ohms 1 „		
R22	(2 × 1,000,000) ohms 2 „	LFC2, LFC3	10 Henry 250 mA. D. C.
R23	(4 × 750,000) „ 4 „		
R24	250,000 „ 2 „		
R27	50,000 ohms. Potentiometer	LFC4, LFC5	10 Henry 50 mA. D. C.
R30	1 megohm 2 watts.		
C38	0·0003 mfd. 10 kv. D. C. Wkg.	F32, F33	500 mA. Cartridge Fuse
C39	0·001 mfd. 5 kV. „ „	F34, F35, F36	250 mA. Cartridge Fuse
C43	4 mfd. 1,500 v. „ „		
C44, C45	10 mfd. 1,500 v. „ „		
C46, C47, C48	8 mfd. 400 v. „ „		

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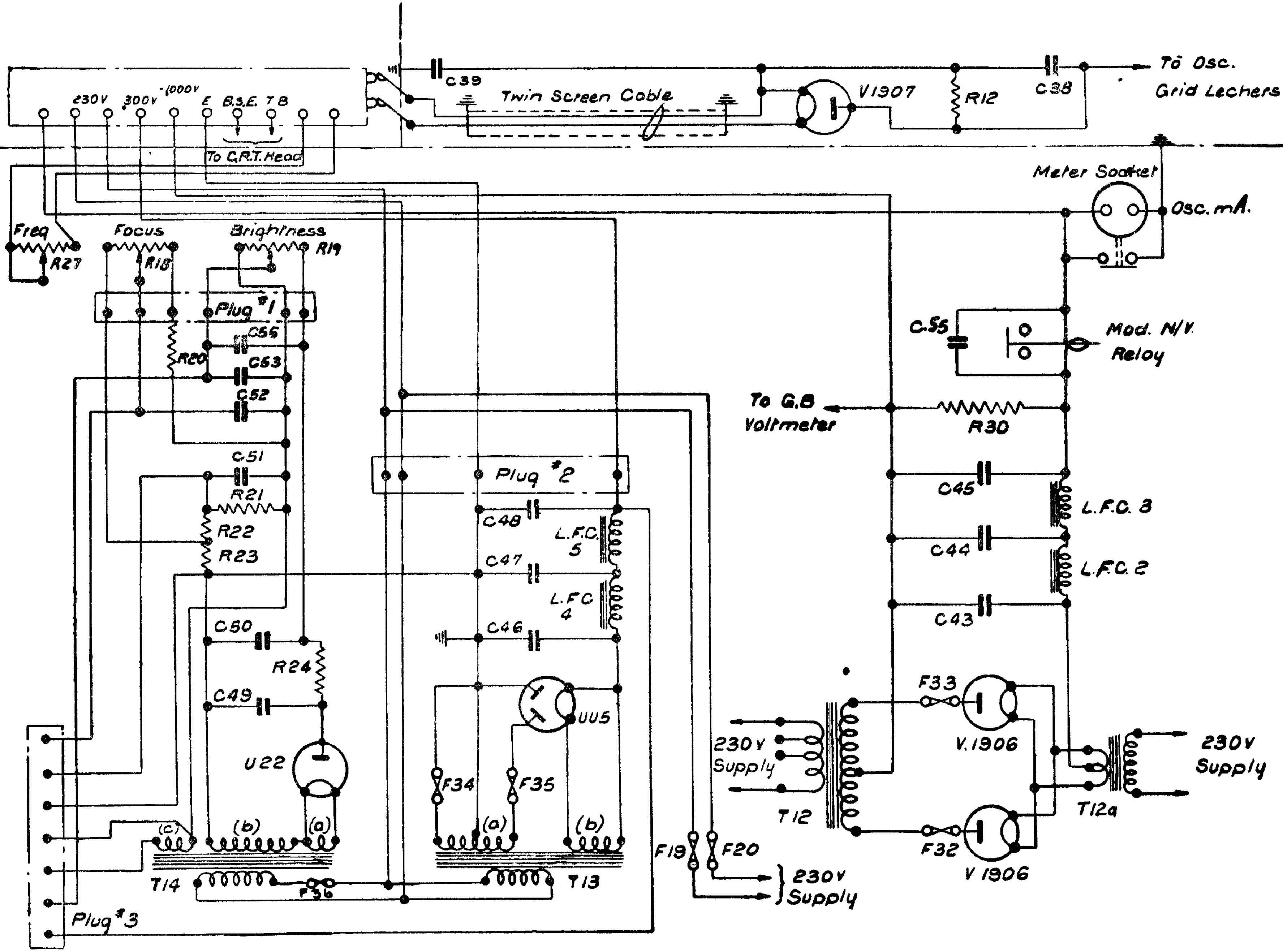

T DESC. T-R.07 / 1-17

FIG 17 SCHEMATIC DIAGRAM OF MODULATOR POWER SUPPLIES

References for Delay Line & C. R. T. Head Schematic

Diagram Reference	Component	Diagram Reference	Component
R 31, 32, 35	20,000 ohms. ½ watt.	C 63	100 mmfd. 500 v. D.C. Wkg.
R 33	500,000 ,, ½ ,, ...	C 64	0·003 mfd. 3,500 v. ,, ,,
R 34	300,000 ,, ½ ,, ...	C 65 & 66	25 mmfd. 500 v. ,, ,,
R 36	50 ,, ½ ,, ...	C 67	0·001 mfd. 350 v. ,, ,,
R 37	3,000,000 ,, ½ ,, ...	C 68	50 mmfd. 500 v. ,, ,,
R 38	2,500 ,, 1 ,, ...	C 69	20 mmfd. 500 v. ,, ,,
R 39	1,500 ,, ½ ,, ...	C 70	15 mmfd. 500 v. ,, ,,
R 40 & 41	100 ,, 1 ,, ...	C 71—93	32 mmfd. 500 v. ,, ,,
HFC 15—18	Eddystone Type 1011	C 94 & 95	0·001 mmfd. 350 v. ,, ,,
HFC 19—34	113 turns # 36 S.W.G. 186 microhenries± 5%	T 17	230 v./4 v.
HFC 35—42	113 ,, # 36 S.W.G. 186 microhenries± 5%		

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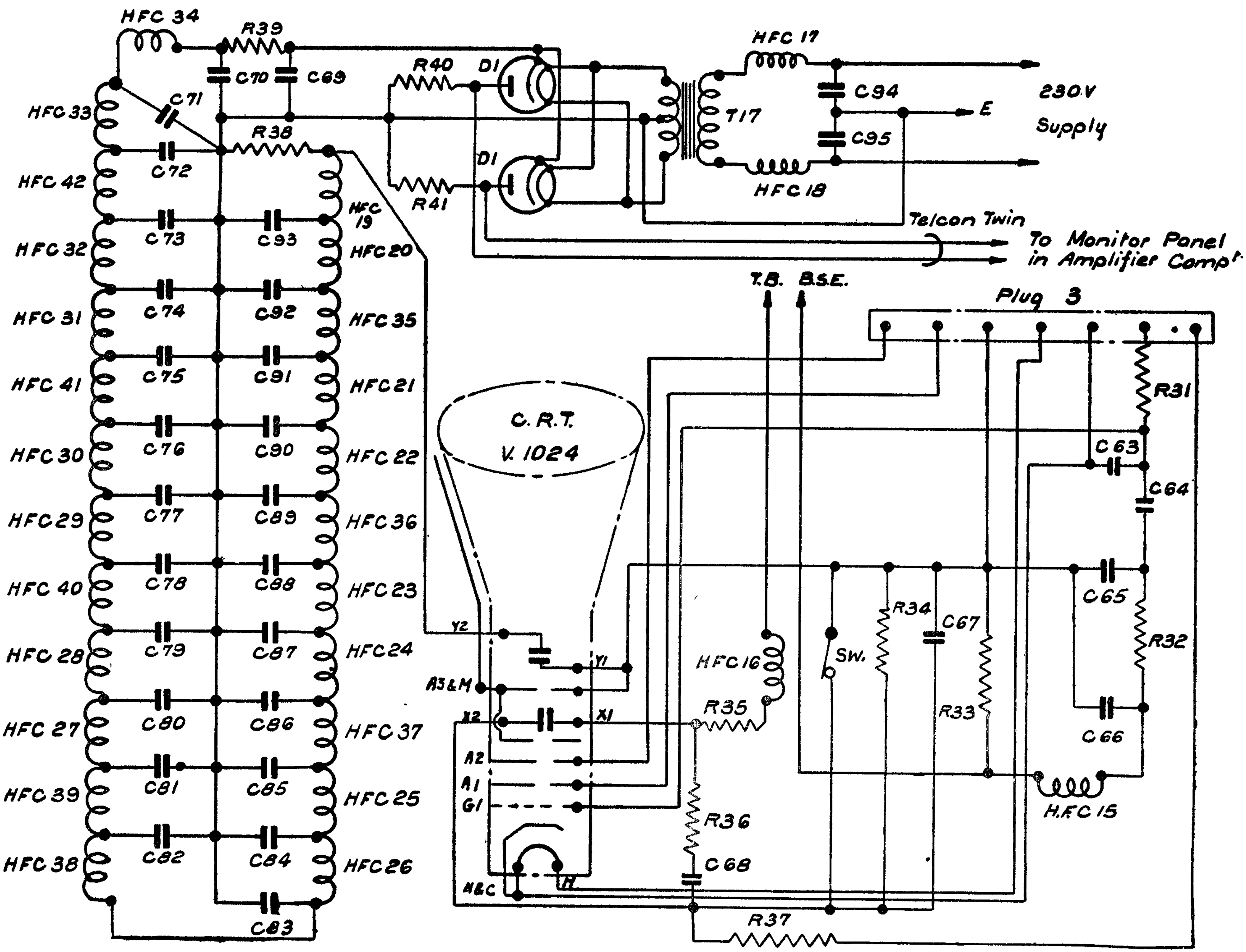


T.DESC. T-R.07 / 1-18

FIG. 18 DELAY LINE & C.R.T. HEAD

References for Modulator Schematic Diagram

Dia. Ref.	Component	Dia. Ref.	Component
R1	5 megohms ½ watt Resistor	R42	500,000 ohm 2 watt Resistor (Variable)
R2	3×3 ,, ½ ,, ,,	R43	1,000 ,, 2 ,, ,, (,,)
R3	7 ,, 2 ,, ,,	R44	500 ,, 1 ,, ,,
R4	2 ,, ½ ,, ,,	R45	5,000 ,, ½ ,, ,,
R5	20,000 ohms ½ watt ,,	C1	·01 mfd. Condenser Type "M" 350 v. wkg.
R6	600 ,, ½ ,, ,,	C2	·1 ,, ,, ,, MTB 500 v. ,,
R7	20,000 ,, 1 ,, ,,	C3	·1 ,, ,, ,, MTB 500 v. ,,
R8	200 ,, ½ ,, ,,	C4	·002 ,, ,, ,, "M" 350 v. ,,
R9	20,000 ,, ½ ,, ,,	C5	·0001 ,, ,, ,, "M" 750 v. ,,
R10	1,000 ,, 2 ,, ,, (variable)	C6	·01 ,, ,, ,, "MTB" 1,500 v. ,,
R11	30,000 ,, 2 ,, ,,	C7	·1 ,, ,, ,, MTB 500 v. ,,
R12	50,000 ,, 2 ,, ,,	C8	·006 ,, ,, ,, "M" 350 v. ,,
R13, 15	100,000 ,, ½ ,, ,,	C9	·1 ,, ,, ,, MTB 500 v. ,,
R14	10,000 ,, 1 ,, ,,	C11	·05 ,, ,, ,, 111 TFX 1,000 v. ,,
R16	200 ,, ½ ,, ,,	C12	·002 ,, ,, ,, "M" 350 v. ,,
R17	50,000 ,, 2 ,, ,,	C14	·01 ,, ,, ,, MTB 1,000 v. ,,
R18	5,000 ,, ½ ,, ,,	C15	·001 ,, ,, ,, "M" 750 v. ,,
R19	50,000 ,, ½ ,, ,,	C16	·01 ,, ,, ,, MTB 1,000 v. ,,
R20	10,000 ,, 100 ,, ,,	C17	·01 ,, ,, ,, MTB 1,000 v. ,,
R21	200 ,, ½ ,, ,,	C18	·002 ,, ,, ,, "M" 350 v. ,,
R22	100 ,, ½ ,, ,,	C19	·01 ,, ,, ,, MTB 1,000 v. ,,
R23	40,000 ,, 40 ,, ,,	L1	Quench Coil 10 microhenries 23 ohms per section
R24	200 ,, ½ ,, ,,	L2	Choke 5·6 microhenries 1·3 ohms D.C. Resist.
R25	100 ,, ½ ,, ,,	V1-V4	Valve Type SP. 41
R26	3,000 ,, 8 ,, ,, (4×12,000) 2 watt.	V5	,, ,, V. 1111
R27, 28	100 ,, 2 ,, ,,	V6	,, ,, ,,
R29	200 ,, ½ ,, ,,	V7	,, ,, ,,
R30	50,000 ,, 2 ,, ,,	V8	,, ,, VP. 41
R31	100 ,, ½ ,, ,,	V9	,, ,, MU. 2
R32	50 ,, ½ ,, ,,	V10	Voltage Stabilizer Cossor S. 130
R33	100,000 ,, ½ ,, ,,		Sec. No. 1 4v. 3·5 amps. C.T. To —1,000 v.
R34	250,000 ,, ½ ,, ,,		for V5 & V8.
R35	100,000 ,, 8 ,, ,, (±5%)		Sec. No. 2 4v. 6 amps. C.T. To Earth.
R36	250,000 ,, 4 ,, ,,	T1	For V1—V2—V3 & V4.
R37, 39	1 megohm 1 ,, ,,		Sec. No. 3 4v. 4·5 amps. C.T. Not used.
R38	250,000 ohms 2 ,, ,,		For V6 & V7.
R40	50,000 ,, 2 ,, ,, (variable)	T2	Transformer Ferranti OPM1c
R41	50 ,, 2 ,, ,,	S1	Switch mounted on R43.

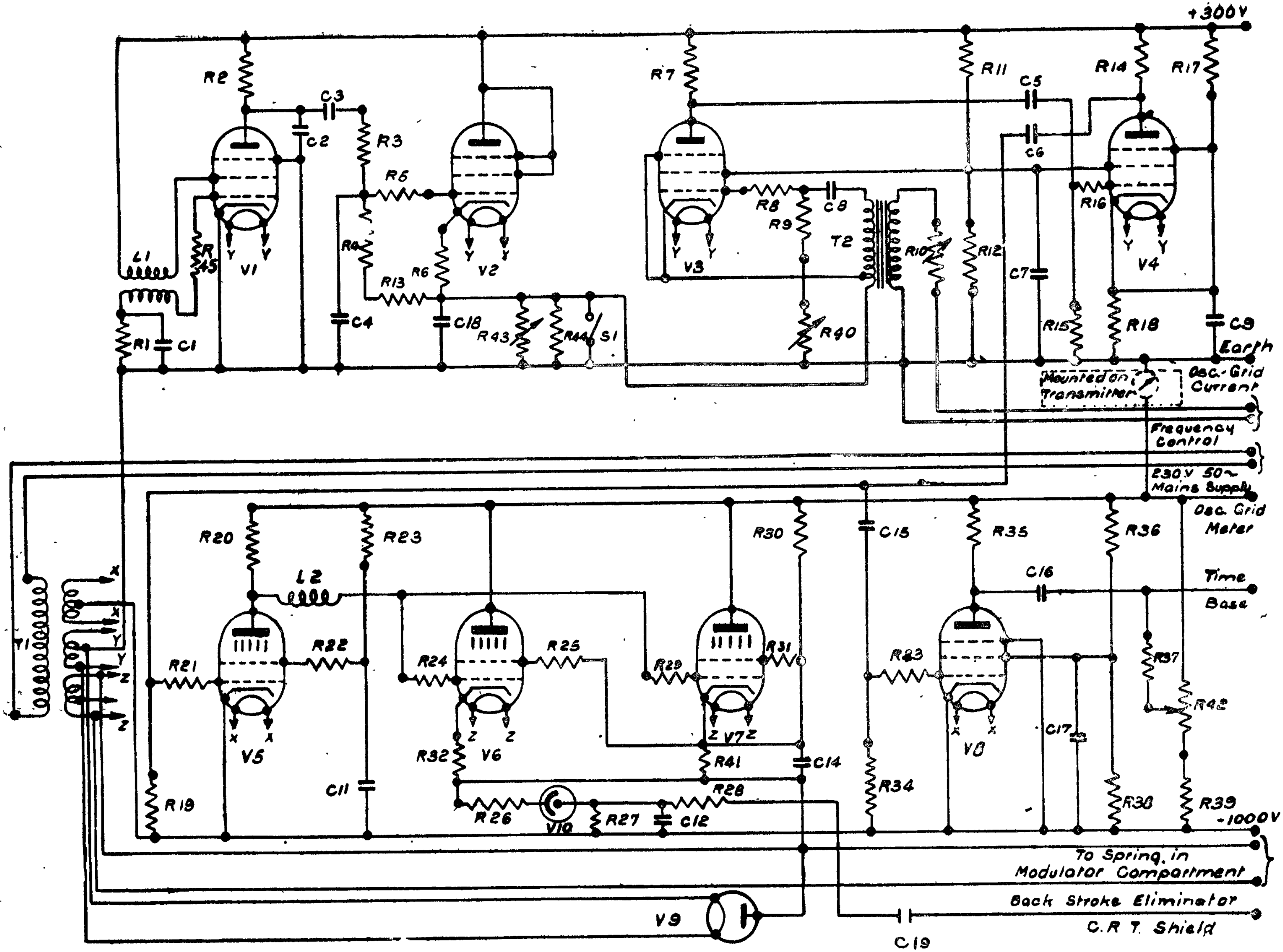


FIG.19 SCHEMATIC DIAGRAM OF MODULATOR

T DESC $\frac{T.-R.07}{1-19}$

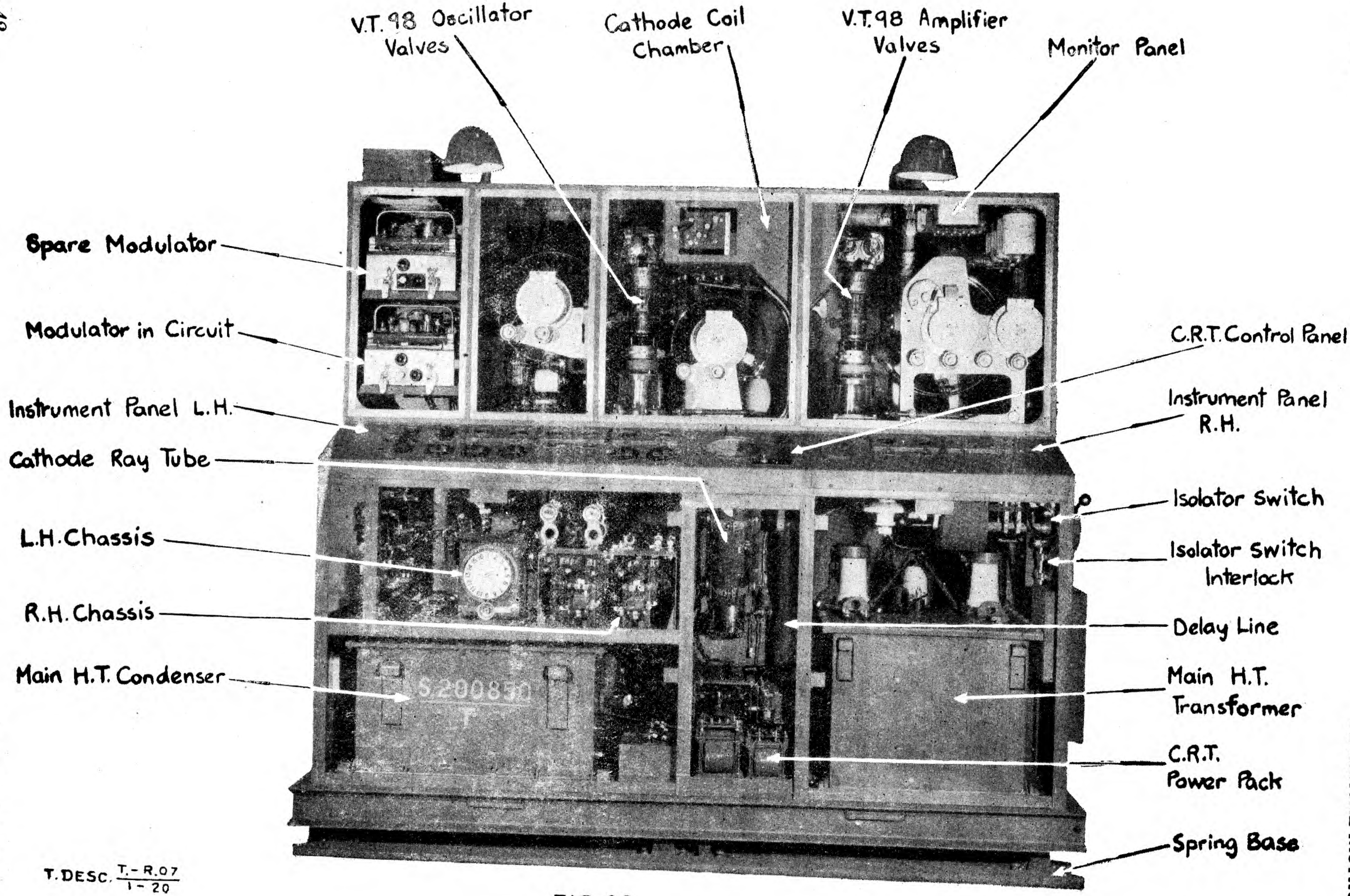
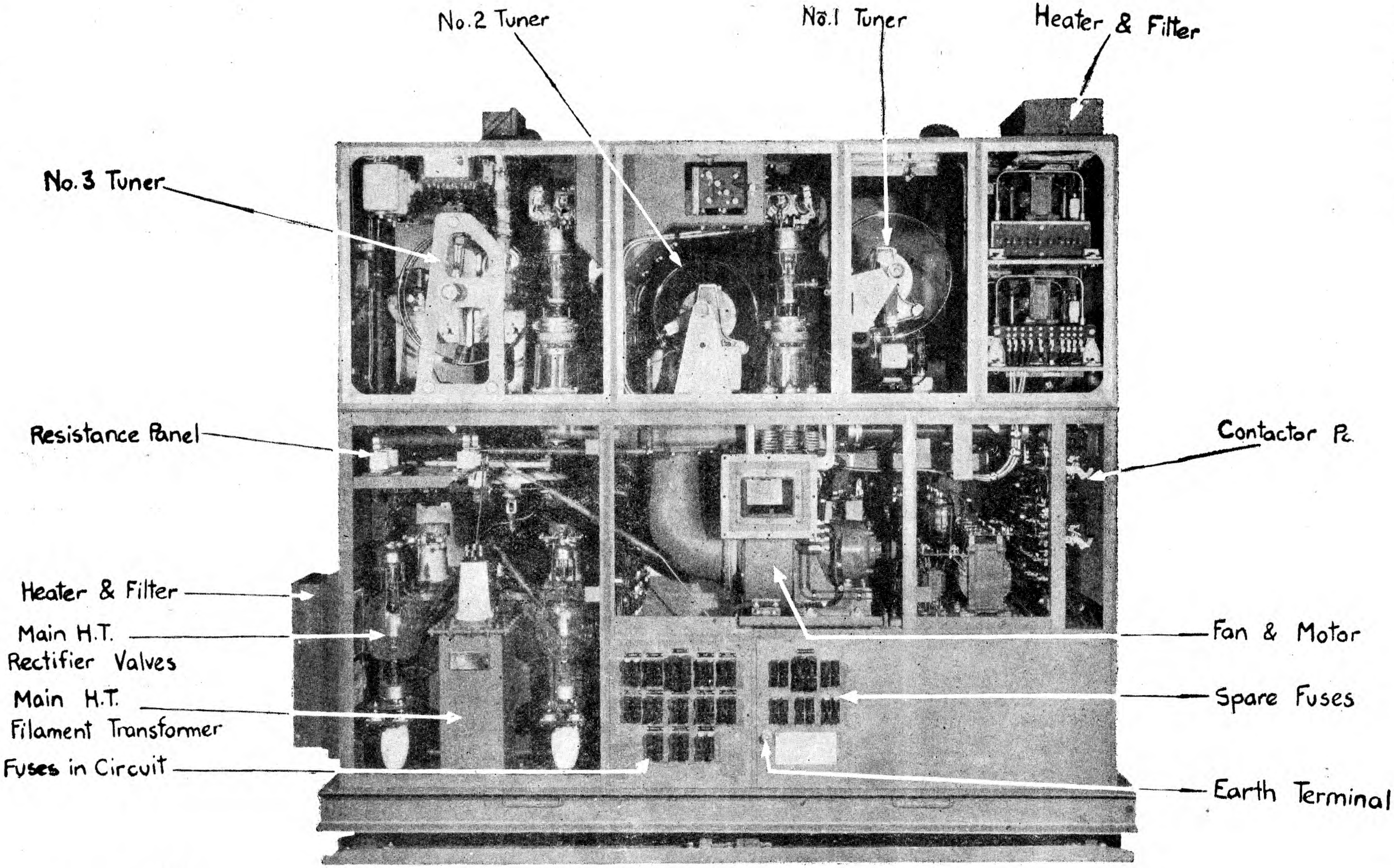


FIG. 20

T. DESC. $\frac{T.-R.07}{1-20}$



T. DESC. $\frac{\text{T.-R.07}}{\text{1 - 21}}$

FIG. 21

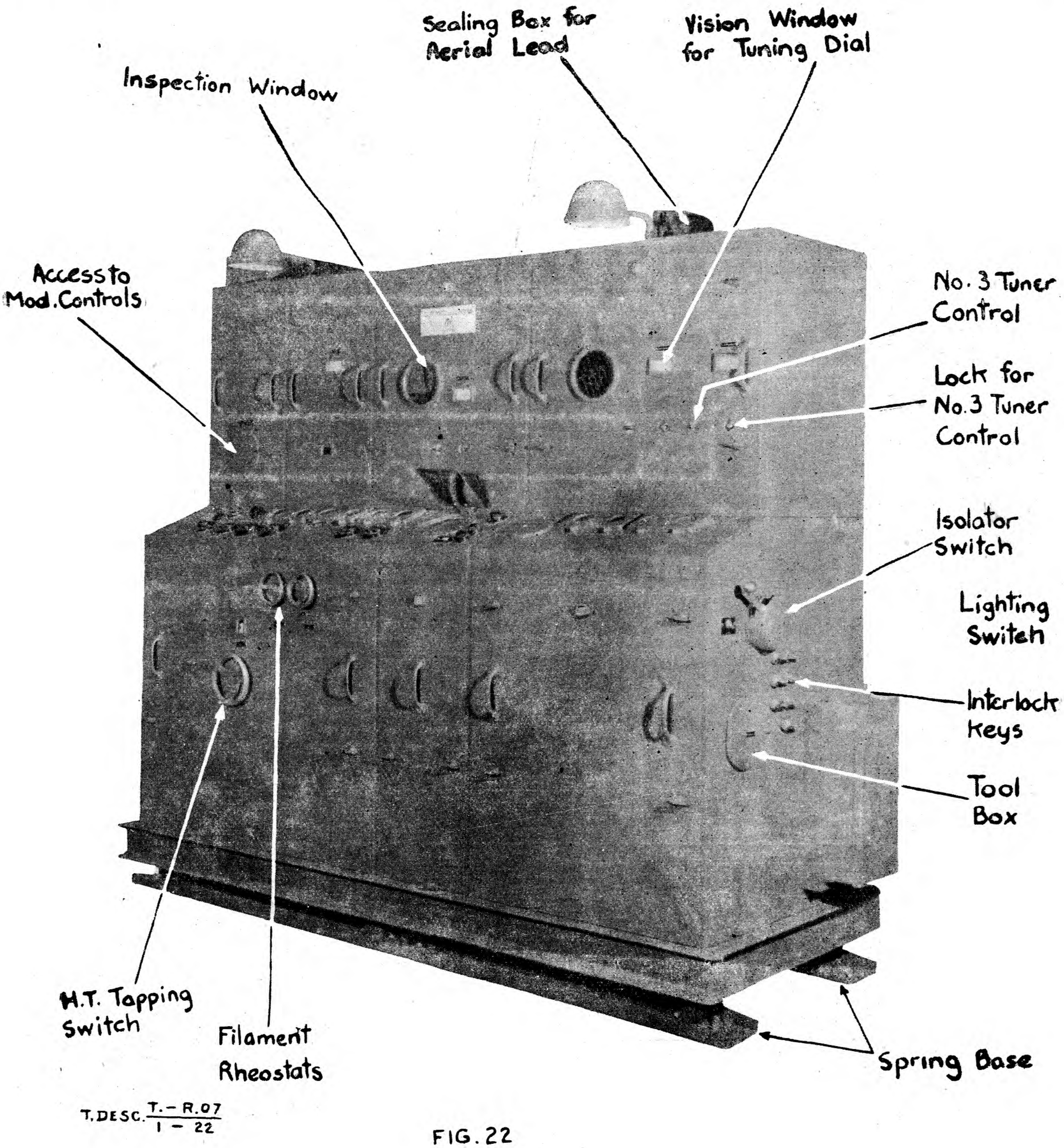

Sealing Box for Aerial Lead
Vision Window for Tuning Dial
Inspection Window
Access to Mod. Controls
No. 3 Tuner Control
Lock for No. 3 Tuner Control
Isolator Switch
Lighting Switch
Interlock Keys
Tool Box
H.T. Tapping Switch
Filament Rheostats
Spring Base
T. DESC. T.–R.07 / 1–22

FIG. 22

END