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ACR7D Mk. 2

GENERAL AND TECHNICAL INFORMATION

BY COMMAND OF THE DEFENCE COUNCIL

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Chapter 1

SCANNER 9933 AND MOUNTING 9931

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Introduction

1. Scanner 9933 is a parabolic part cylinder which is fed by a horn from the radar head in use. The scanner is rotated at 20–24 rev/min by a 1 h.p. motor through reduction gearing, its tilt is adjustable from −2 deg. to +12 deg. and the polarization of the transmitted beam is continuously variable from linear through circular to linear.

2. The scanner and radar head housing are fitted on mounting 9931 which contains the turning gear, bearing transmitter and slipring and brush assembly. The radar head housing, which rotates with the scanner, contains the two radar heads 8045 and the switch unit 8050 (Chap. 2).

3. The scanner turning motor is controlled by the SCANNER switch on the control unit 9935 on desk 9930. The scanner rotates the bearing transmitter; this is a small two-phase generator which supplies current to the bearing receivers in the indicators c.r.t. 8059. Scanner 9933 and mounting 9931 are shown in fig. 1.

SCANNER AND WAVEGUIDE SYSTEM

4. The scanner consists of the aerial system, the radar head housing, the tilt mechanism and the variable polarization mechanism.

Aerial

5. The aerial system consists of a reflector and feed. The reflector is a 14 ft. parabolic part cylinder, curved in both planes, which gives a horizontal beam width of 0·68 deg. and a vertical beam width of 2·8 deg. at the half power points. The system has a gain of approximately 41 dB when linearly polarized.

6. The reflector is fed by a horn which is connected via the variable polarizer and a waveguide run to the radar head housing. In the radar head housing, switch unit 8050 operates a waveguide switch, so that the horn is connected to r.f. head A or B.

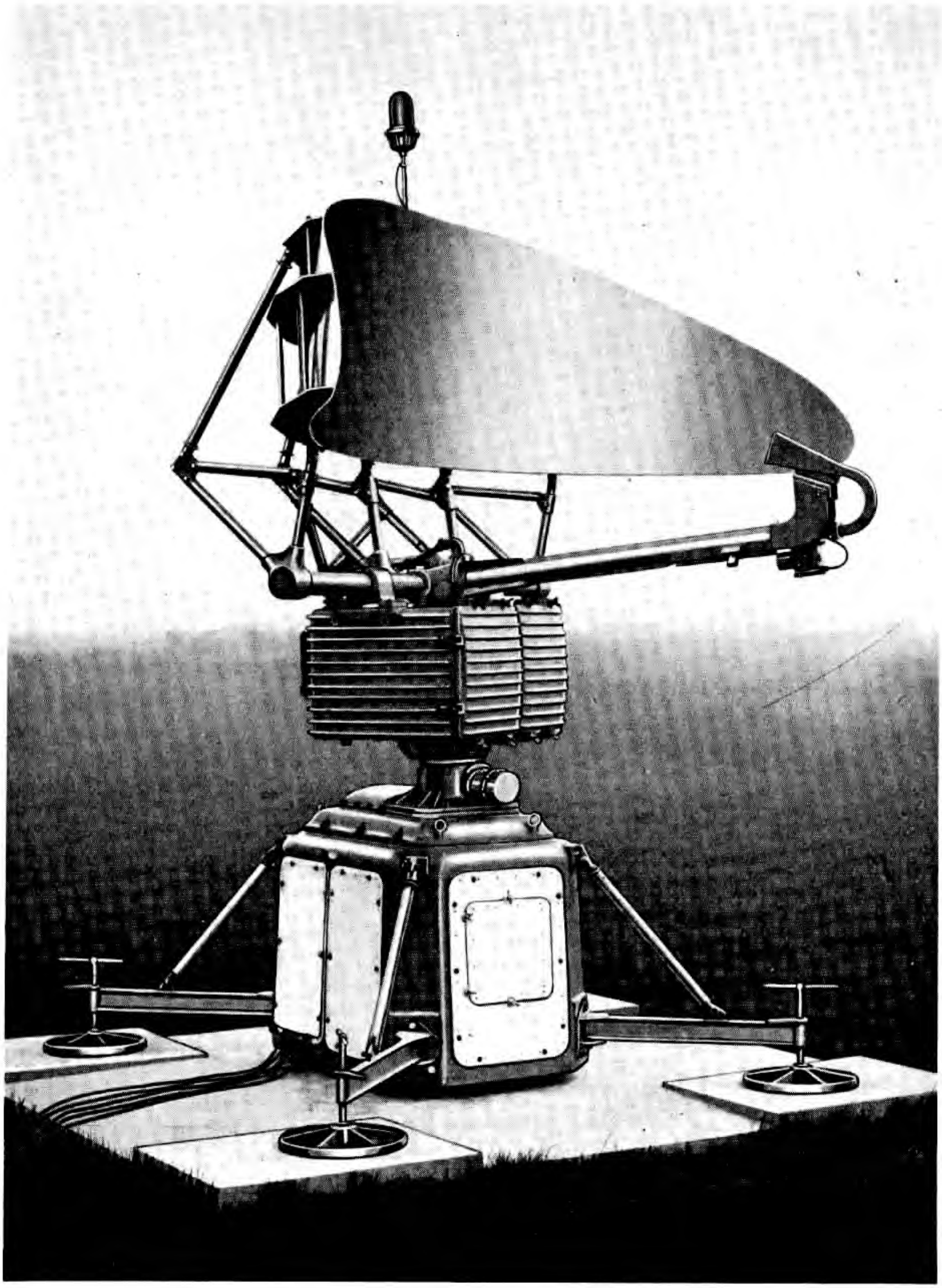

Fig. 1. Scanner and mounting ACR7D Mk. 2

Variable polarization

General

7. Regions of precipitation, rain, hail or snow, show up on microwave radar as distinct echoes. Rain, especially, can often obscure large areas of a p.p.i. display with a solid paint and this is particularly true of X-band (10,000 Mc/s) equipment. For this reason, air surveillance radar has often been designed to work on S-band (3,000 Mc/s) which is less seriously affected, the lower definition on the longer wavelength being accepted as the price of reduced vulnerability to weather conditions. However, by using circularly polarized transmission, X-band radar can 'see' through the heaviest rainstorm and follow a moving target through regions which would be completely obscured with normal plane-polarized transmissions.

8. There are operational advantages to be obtained from making the polarization continuously variable under the control of the operator, rather than either making it circular or linear and providing the operator with a simple alternative between circular and linear.

Principle of polarization

9. The diagram of fig. 2 shows linearly-polarized waves produced by a single dipole and by combining the waves produced by two dipoles at right angles. (Dipoles are shown for simplicity, but the diagrams apply equally to waves launched from waveguides.) A linearly-polarized wave can be represented in space, at a given point in time, by a simple sine wave; the displacement of the wave from the axis at any point represents the electric field strength at that point, and the direction of displacement is the direction of polarization. As this wave advances through space it will cause the field at any point to alternate, maintaining its direction.

10. If two waves of equal amplitude are produced at the same point, having their directions of polarization at right angles, and being displaced in phase by a quarter cycle, the results can be represented as shown in fig. 3. The top diagram of fig. 3 is a representation of the two component waves in space, at a given point in time; the lower diagram shows the direction of the resultant field at various points in space, at a given point in time. The arrows representing field strength form a spiral pattern which can be thought of as travelling forward through space at the speed of light without rotation and causing, at any point along its path, a field which rotates but maintains a constant amplitude.

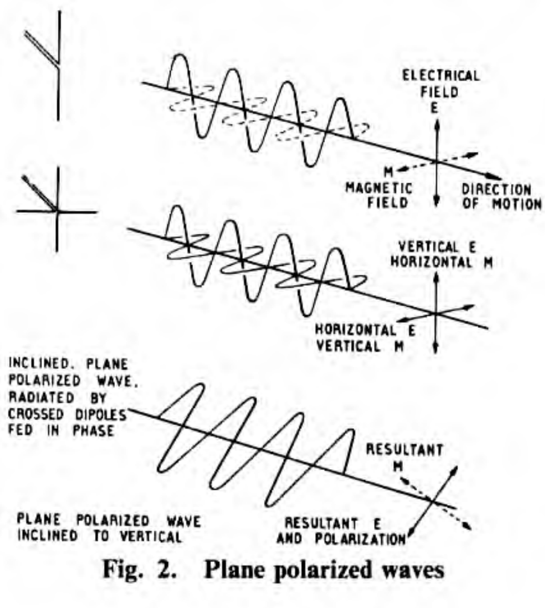

Fig. 2. Plane polarized waves

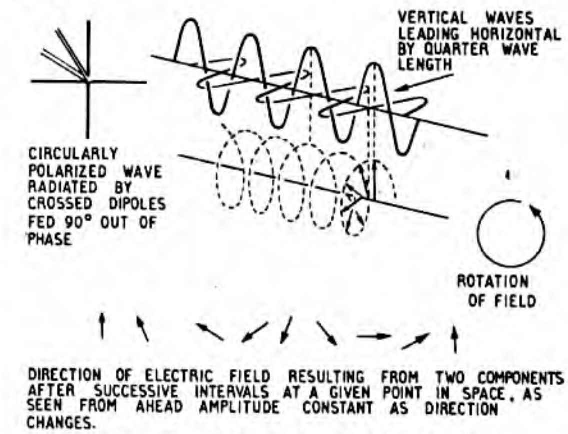

Fig. 3. Circularly polarized waves

11. When the amplitude of the two component waves are unequal, or when the phase difference is not a quarter cycle, the electric field varies in strength as it rotates. This constitutes elliptical polarization, and linear polarization can be thought of as an extreme case of this, when the ellipse has become so elongated that it has collapsed into a straight line. Compare this with the trace produced on a cathode ray tube when two sine waves applied to the X and Y plates are varied in phase and amplitude.

12. When a radio wave is reflected from a surface, there is a change in phase. A plane reflector produces a simple phase change of 180° but more

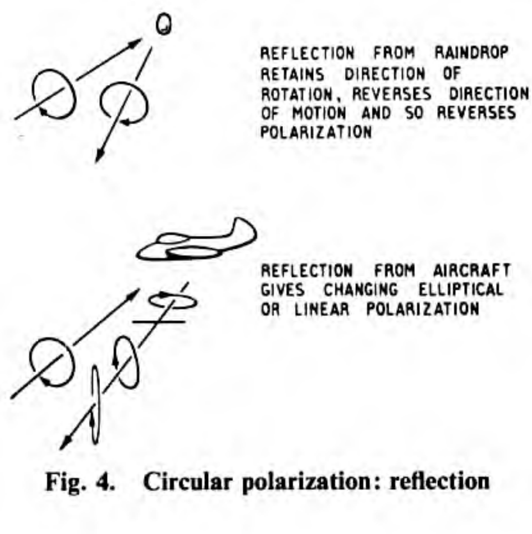

Fig. 4. Circular polarization: reflection

complicated surfaces produce more elaborate effects and it is this which permits radar discrimination against raindrops. A raindrop has a shape which is very nearly spherical and will reflect a circularly polarized wave without changing the type of polarization, although its direction of travel is reversed. An aircraft, in contrast to this, will change the pattern of the transmitted wave, returning an echo signal with elliptical or plane polarization which changes as the aircraft aspect alters (fig. 4).

13. The receiving system can consequently be made to reject rain echoes whilst accepting those from wanted targets by variation of the polarization.

14. Hailstones and snow flakes are more or less symmetrical in form and are roughly circular in at least one section. Circularly polarized waves will be reflected from them with predominantly circular polarization and some discrimination can be made against them. The effect is not as marked as with rain and is less with snow than with hail. A useful improvement in target visibility is nevertheless obtained in regions of clutter. Variable polarization provides a means of discriminating against interfering signals, reducing them to a tolerable level or removing them altogether by suitable adjustment of the equipment.

Transmission

15. Variable polarization in the ACR7D Mk. 2 is produced as follows (fig. 5). The rectangular waveguide, running from the transmitter-receiver to the scanner, is flared out into a square section on edge. There is a smooth transition to a second square section guide at 45° to the first and in this the E vector retains its previous direction so it now extends diagonally across the guide and can be resolved into two mutually perpendicular components. At this point the guide contains a flat distrene vane supported in the waveguide on two pillars which can be raised or lowered by a small reversible electric motor. This vane acts mainly on the component of electric field parallel to it, and causes displacement between the two components,

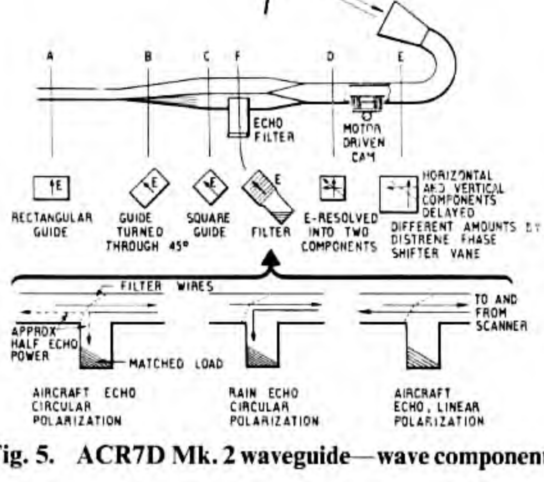

Fig. 5. ACR7D Mk. 2 waveguide—wave components

the magnitude of which depends on the position of the vane. The vane is shaped in such a way as to cause the least possible mismatch.

16. The radar operator, controls from control unit 9935, the motor driving the phase shifter. Its position is shown on an indicating meter on the control unit. By suitable adjustment, the polarization can be continuously varied from linear, through elliptical, to circular and on through elliptical, to linear again.

17. The provision of continuous variation of the vane position, rather than two fixed positions, makes it possible to allow for change in frequency, the effect of ground reflections at various angles of scanner tilt, and the effect of the horn and reflector, which themselves introduce slight differential phase-shifts.

Reception

18. A Faraday screen type filter, consisting of fine parallel wires, is placed across the waveguide in the edgewise square section. Outward travelling waves pass without disturbance through the wires crossing the guide because they are everywhere perpendicular to the E vector. The waves pass on to the remainder of the waveguide system where they are converted to circular polarization.

19. Returning echoes which are still circularly polarized pass back through the same system and undergo similar phase shifts which turn the circularly polarized waves back into plane polarized ones. A wave which has been reflected an odd number of times has its polarization reversed and behaves as follows, (this is the important practical case of single reflection from raindrops). On the way out, the horizontal component suffers a 90 degree phase delay compared with the vertical one; on the way back, the delay occurs again so that the horizontal component undergoes 180 degrees of retardation altogether, and this restores linear polarization at 90 degrees to that of outward bound waves. The direction of the E vector is now along the wires of the filter, which appears to the wave as a solid reflecting surface. The shape of the filter is arranged to direct the wave into a side arm of the waveguide. This is terminated with a matched load which absorbs all the power entering the arm.

20. Waves which have suffered an even number of reflections have their polarization unchanged; the waveguide and phase shifter system convert them back into linear polarization in the original direction and they are passed by the filter (they are not important in practice).

21. It should be noted that the filter is not essential to the operation of the system as the rectangular waveguide will reject rain echoes. At the frequency of the radar, the waveguide will transmit only the transverse electric mode, *i.e.* the electric field must lie across the guide, parallel to the short sides. A wave at right angles to this will not be admitted.

22. If the filter were not present however, this power would be reflected back towards the scanner and standing waves would be set up in the square waveguide section, causing a deterioration in performance. The filter ensures that unwanted signals are safely absorbed.

23. The foregoing description applies to echoes reflected from raindrops and other objects having simple geometric shapes *i.e.* echoes which retain their circular polarization. Echoes from aircraft and other bodies of complicated shape, are generally returned with polarization which is no longer circular but has become elliptical or linear. Passage through the waveguide will then convert them to some other elliptical or linear, polarization, and this can be resolved into two components, one along and one across the filter wires. The component directed along the wires will be reflected into the side arm and absorbed; the other across the wires will be passed into the receiving system.

24. For any particular echo, the two components can have any relative amplitudes, but the average of a large number of echoes will give average amplitudes which are the same; half of the power will thus pass through the filter while the other half will not. Even with targets as complicated as aircraft, however, some circularly polarized waves are reflected, and these are suppressed along with the unwanted rain echoes, so that the reduction in target echo power tends to be more than 3dB.

25. In this manner, the unwanted echoes from rain are reduced by 20 to 30dB while the wanted echoes from aircraft and other targets are reduced by about 3dB, although the amount may be anything up to 8dB. It should be noted that this loss of wanted signals only occurs on circular polarization. It does not take place with linear polarization, which is used in clear weather to obtain maximum range.

Polarizer mechanism

26. The waveguide feed between switch unit 8050 and the horn contains the variable polarizor mechanism (fig. 6). This mechanism consists of a phase shifter vane in the waveguide; the insertion of the vane into the guide is controlled by a small reversible motor. The phase shifter vane is attached by two rods to a small platform which bears on an eccentric cam. Springs between the waveguide and the platform keep the latter in contact with the cam which is rotated by the motor via a chain of worm gears. Control of the motor is effected by the POLARISOR switch, on control unit 9935, which connects the 230V 50 c/s mains supply to the motor when set in either of its two operating positions. According to the direction in which the switch is operated, capacitor C103 on junction panel 14539 is connected in series with one or other of the two motor windings; the sense of connection of the capacitor determines the direction of rotation of the motor.

27. The eccentric cam also drives the shaft of a potentiometer via a spring loaded follower carrying a rack which engages a pinion gear on the potentiometer shaft. This potentiometer forms part of a metering circuit, the remainder of which is located in control unit 9935; the operation of this circuit is described in para. 32.

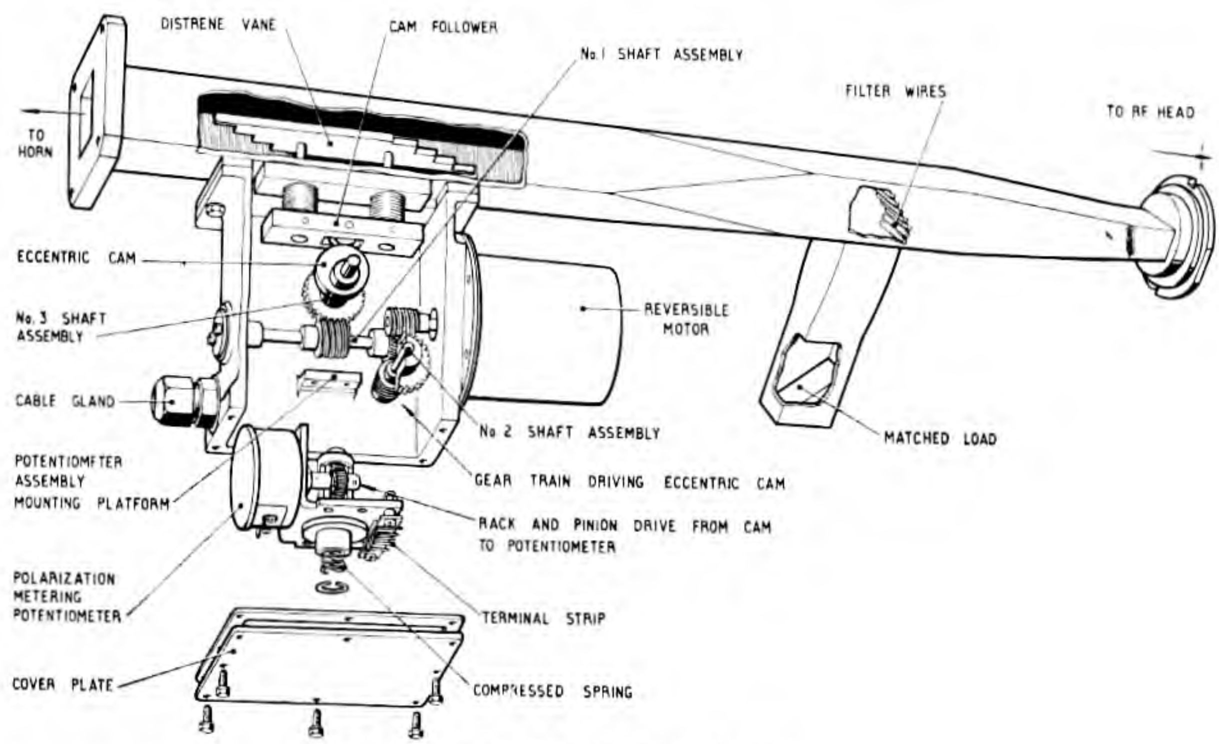

Fig. 6. Polarization mechanism

Operational use

28. The polarization is under the direct control of the radar operator. Linear polarization is normally used, but when rain, snow or hail are falling, the polarization is adjusted to produce optimum cover. The polarization indicator shows the physical position of the motor-driven phase shifter and is calibrated in arbitrary units. It is necessary to calibrate each installation by trial and error adjustment under operational conditions. The indicator readings are noted for the two positions giving minimum return from rain and maximum return from targets in the clear. The operator can then switch from one to the other as circumstances require. If the precipitation echoes do not disappear on switching over to the usual setting for circular polarization, some slight re-adjustment of the polarization control may give an improvement.

29. If interference from other radars is causing trouble, trial and error adjustment of the polarization control should yield some improvement.

Tilt mechanism

30. The tilt drive mechanism is shown in fig. 8 and the electrical circuit in fig. 9. When the TILT switch on control unit 9935 on desk 9930 is set to ◀one of its operating positions, the 230V 50 c/s mains supply is connected to the coil and contacts

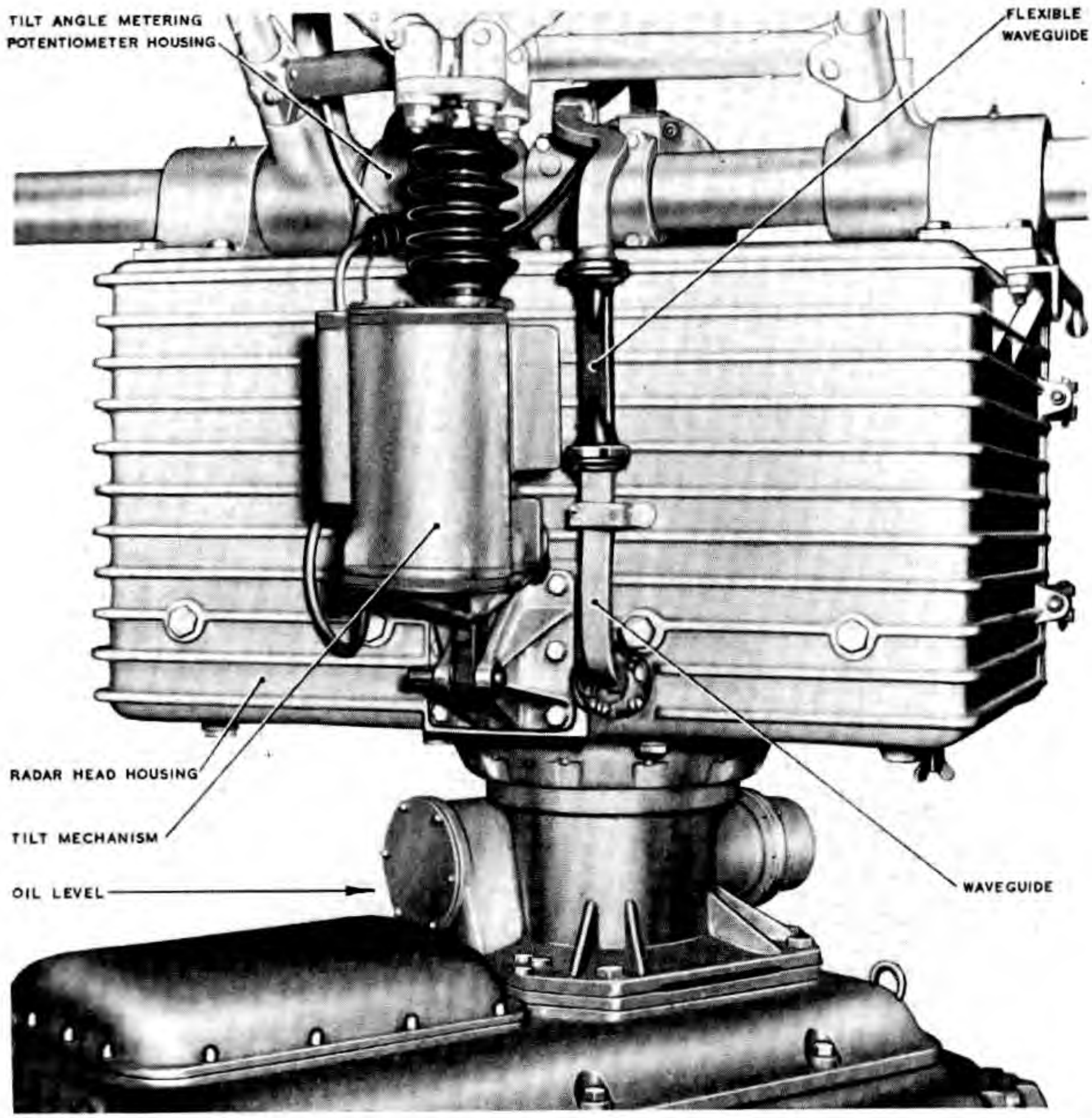

Fig. 7. Scanner 9933 rear

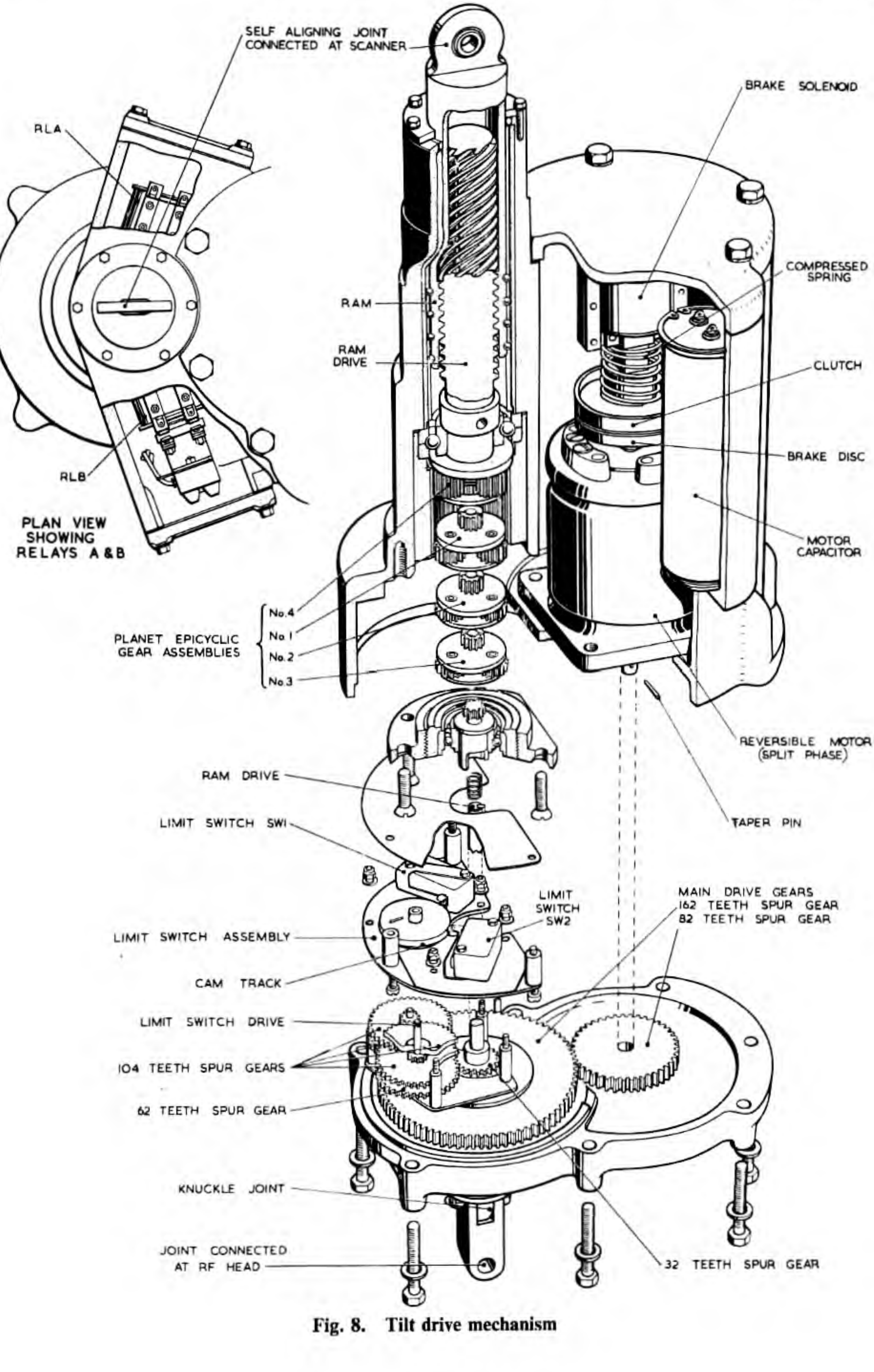

Fig. 8. Tilt drive mechanism

of either RLA or RLB in the tilt drive mechanism. RLA/1 or RLB/1 energizes the solenoid; this releases the brake on the motor shaft. RLA/2 or RLB/2 supplies both windings of the reversible motor.

31. When RLA is energized (TILT switch up), C1 is in series with the supply to one winding and the motor turns, drives the gearing, pulls the ram inwards and tilts the aerial upwards. When RLB is energized (TILT switch down) C1 is in series with the other winding so the motor turns in the opposite direction and tilts the aerial downwards.

32. The angle of tilt continues to change until the supply is disconnected, either by returning the TILT switch to its centre position, or by the operation of the appropriate limit switch (+12 or −2 deg.). The solenoid then de-energizes and the brake prevents further change of tilt angle.

33. The tilting portion of scanner 9933 rotates, via gears, the shaft of a potentiometer located on the radar head housing (fig. 10). This potentiometer forms part of a metering circuit in control unit 9935, the operation of which is described in para. 34.

Aerial tilt and polarization metering circuit

34. The metering circuit located in control unit 9935 consists of M1, VR3, VR5, VR4, VR6, R3, R4, R14 and SW13. When the switch is set in its clockwise position the meter M1 gives an arbitrary indication of the polarization of the transmitted beam on the green scale. In this condition R3, the potentiometer (which is connected as a variable resistor) in the variable polarization mechanism, R4 and VR6 form the four arms of a bridge circuit. The −300V line from the receiver in the channel selected by the MASTER CHANNEL switch on control unit 9935, is applied to the bridge at the junction of R3 and R4; the junction of VR6 and the potentiometer in the polarization mechanism is connected to chassis. Meter M1 and its associated multiplier VR5 are connected across the bridge between the junction of R3 and the potentiometer in the polarization mechanism and the junction between R4 and VR6. The function of VR6 is to balance the network and this control is set so that the meter indicates zero when minimum voltage is present at the junction of R3 and the potentiometer in the polarization mechanism. The multiplier VR5 is set so that the meter indicates 20 when the voltage is at a maximum. When the METERING switch is set counter-clockwise, R4 is replaced by R14, VR6 by VR4, VR5 by VR3 and the potentiometer in the polarization mechanism by the potentiometer associated with the tilt mechanism. In this mode of operation VR4 is set so that the meter indicates −2 deg. when the scanner is fully depressed and VR3 is set for a meter indication of +12 deg. when the scanner is fully elevated.

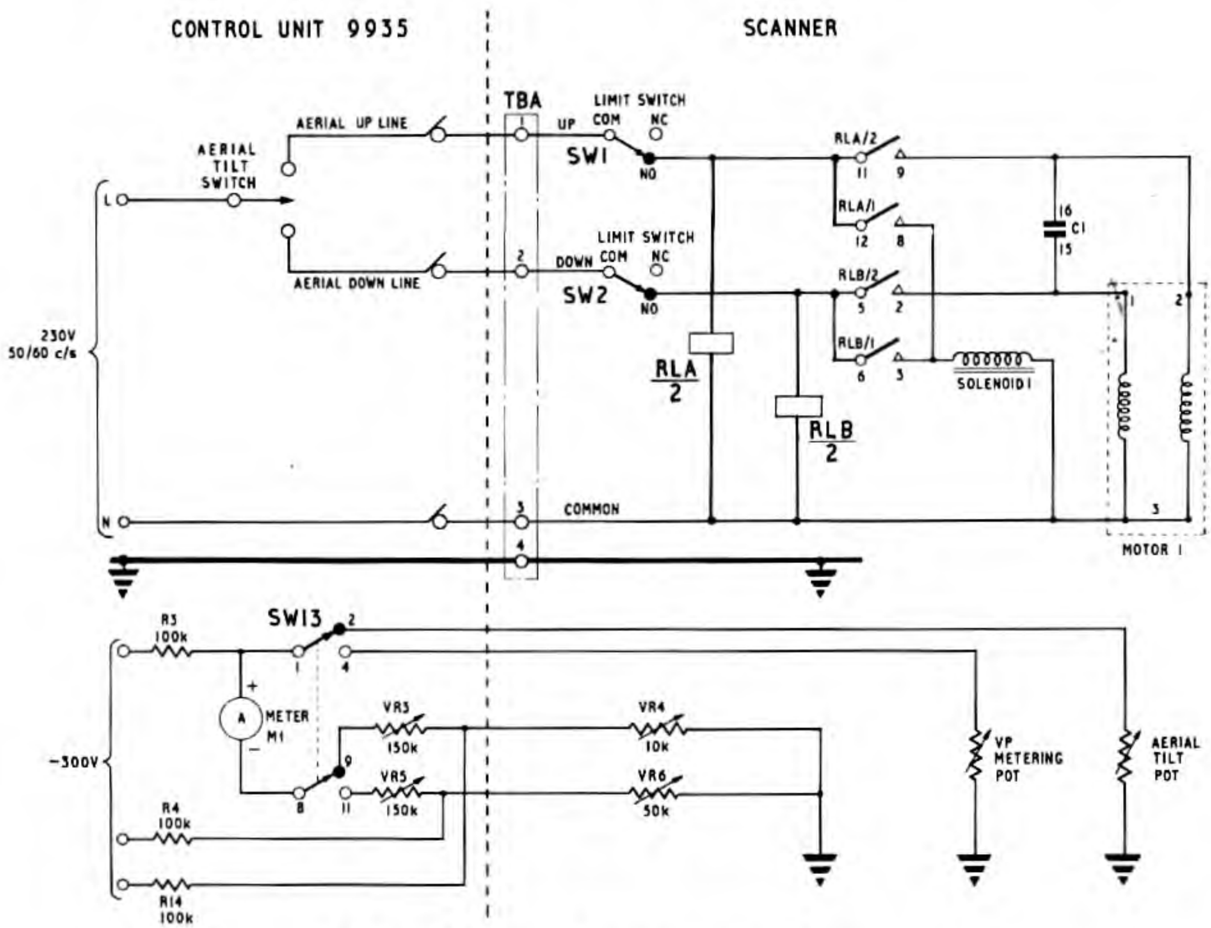

Fig. 9. Tilt drive and metering: electrical circuits

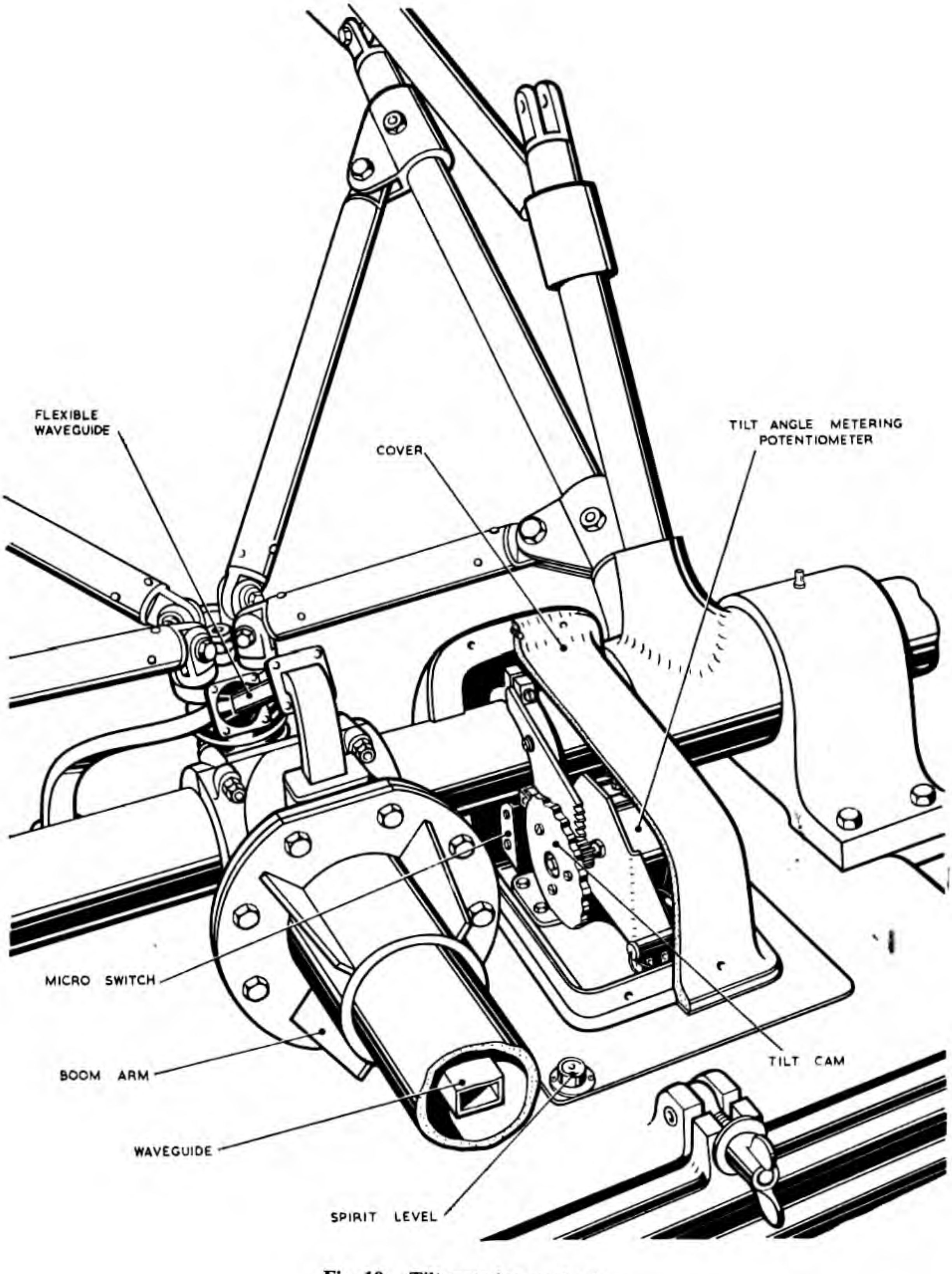

Fig. 10. Tilt metering mechanism

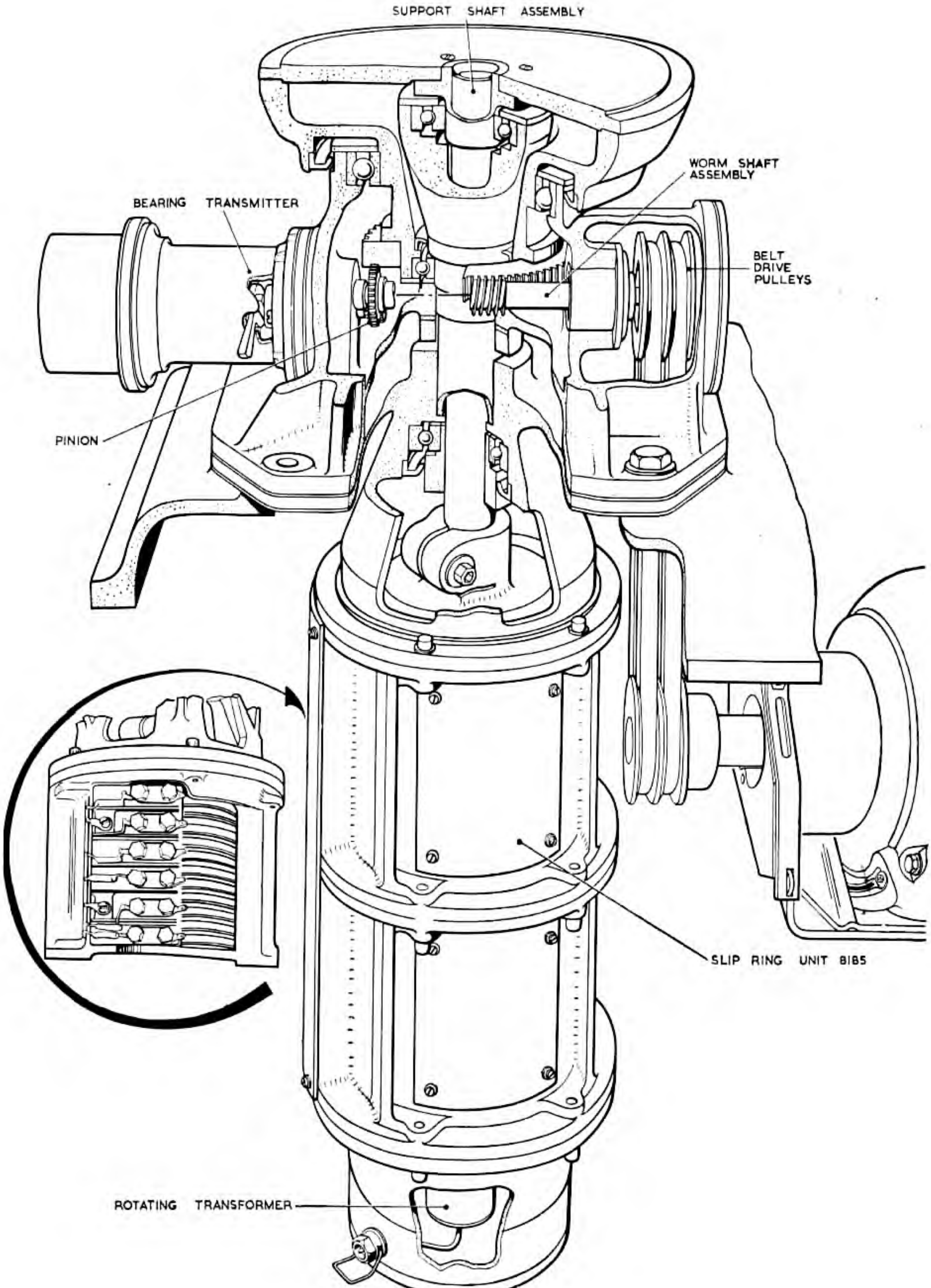

Fig. 11. Turning gear and slipring unit

MOUNTING 9931

General

35. Mounting 9931 contains the following assemblies:—

Turning gear 9932

Junction panel 14539

Amplifier 8052

36. The junction panel is described in Chapter 4 and amplifier 8052 in Chapter 5. The turning gear contains the driving motor, the support shaft assembly, the worm-shaft assembly and pinion shaft for the bearing transmitter drive, together with slipring unit 8185. A general view of the turning gear is given in fig. 11. It is fully described in A.P.2899AF.

Turning motor

37. A circuit diagram of the turning motor is given in fig. 12. It is a 50/60c/s a.c. motor of the capacitor start, inductor-run type and is rated as follows:—

Voltage	*Cycles/sec.*	*Rev./min.*	*Starting current*	*Full-load current*
230/255	50/60	1425/1700	40 amps	7·2 amps

Note . . .

The full-load current of 7·2 amps will only be reached in a very high wind.

38. The turning motor is switched on and off by a 230V relay situated on the junction panel. The energizing voltage is controlled by the SCANNER switch on control unit 9935 on desk 9930. The drive is taken by two belts to a gearbox which rotates the scanner through reduction gearing at approximately 24 rev./min.

Gearbox 8182

39. Gearbox 8182 is a sub-unit of turning gear 9932. The two belts from the turning motor drive the wormshaft assembly (fig. 11). The worm engages the worm-wheel and so rotates the support shaft assembly, to which are fitted the radar head housing and scanner. The rotation of the support shaft also rotates the slipring.

40. A spur gear fitted on the wormshaft engages the gear wheel of the pinion shaft, which thus rotates. The pinion shaft is coupled to the bearing transmitter, the output from which is fed to indicators c.r.t. 8059. The operation of the bearing transmitter is described in para. 41.

41. For lubrication, the gearbox is filled with oil up to the level of the screw shown in fig. 7, so that the worm, the gearing, and the ballraces on the pinion shaft and the lower ballraces of the support shaft assembly are partially immersed. When the wormshaft rotates the worm acts as a paddle and splashes oil up to the upper ballraces of the support shaft assembly.

42. For 50 revolutions of the wormshaft the scanner completes one revolution and the rotor of the bearing transmitter completes 180 revolutions. The gear ratios are as follows:—

Wormshaft to wormwheel (support shaft) 50 to 1

Wormshaft (spur gear) to pinion shaft 1 to $3\frac{3}{5}$

Bearing transmitter

43. The timebase on each indicator c.r.t. 8059 rotates in synchronism with the scanner, so that targets are represented on their correct bearings. This is obtained by using a two-phase synchronous transmission system. As described in para. 37, the scanner turning motor drives by belts a shaft carrying a worm for rotating the scanner; this shaft also drives, through spur gearing, the rotor of a small two-phase generator known as the bearing transmitter.

44. This rotor has two poles and is energized via two sliprings by an 80V d.c. supply from the junction panel. The stator has two poles per phase and the output is 110V to 150V at about 72 c/s (180 cycles per revolution of the scanner). A capacitor is connected across each phase in each indicator to improve the power factor of the load and thereby decrease loading of the a.c. generator.

45. A line common to both phases is earthed and two phase leads pass via the CHANNEL switch on control unit 9935 to one or both indicators. Each indicator contains a two-phase synchronous motor, the bearing receiver, which is connected to the two phase leads and earth. This motor drives the deflection coils around the c.r.t. neck through a worm and wheel drive with a reduction gearing of 180 to 1, so that the c.r.t. timebase rotates in step with the scanner.

Slipring unit 8185

46. The slipring unit connects the radar head and scanner to the other units of the equipment. There are 23 sliprings, the shaft of which is fitted to the radar head housing and scanner support shaft assembly. The scanner turning motor drives the support shaft assembly, and thus the sliprings, through belts and gearing.

47. The slipring housing also contains the rotating transformer, which feeds the i.f. output from the radar head in use via switch unit 8050 to amplifier 8052. The rotating transformer is situated at the bottom of the slipring unit and is rotated by the same shaft as the sliprings. Its position is shown in fig. 11.

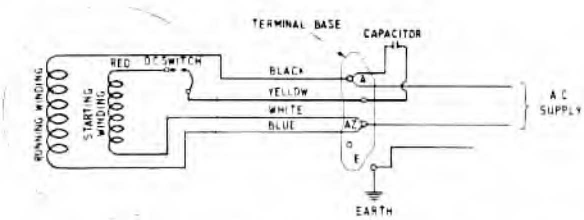

Fig. 12. Turning motor circuit

48. The sliprings carry the following supplies:—

Slipring	*Supply*
1	Trigger pulse
2	Crystal earth
3	80V, 1,000 c/s live
4	80V, 1,000 c/s neutral
5	Klystron cathode —300V
6	Tilt meter
7	Pulse length
8	Klystron reflector —450V
9	+50V, d.c.
10	+250V, d.c.
11	Switch unit change over voltage 1
12	Switch unit change over voltage 2
13	Scanner neutral
14	Obstruction light
15	Earth
16	Crystal current
17	Tilt Up line
18	Tilt Down line
19	Tilt Common
20	Heater live
21	Variable polarizor motor 230 a.c.
22	Variable polarizor motor common
23	Variable polarizor indicator.

Chapter 2

SWITCH UNIT 8050

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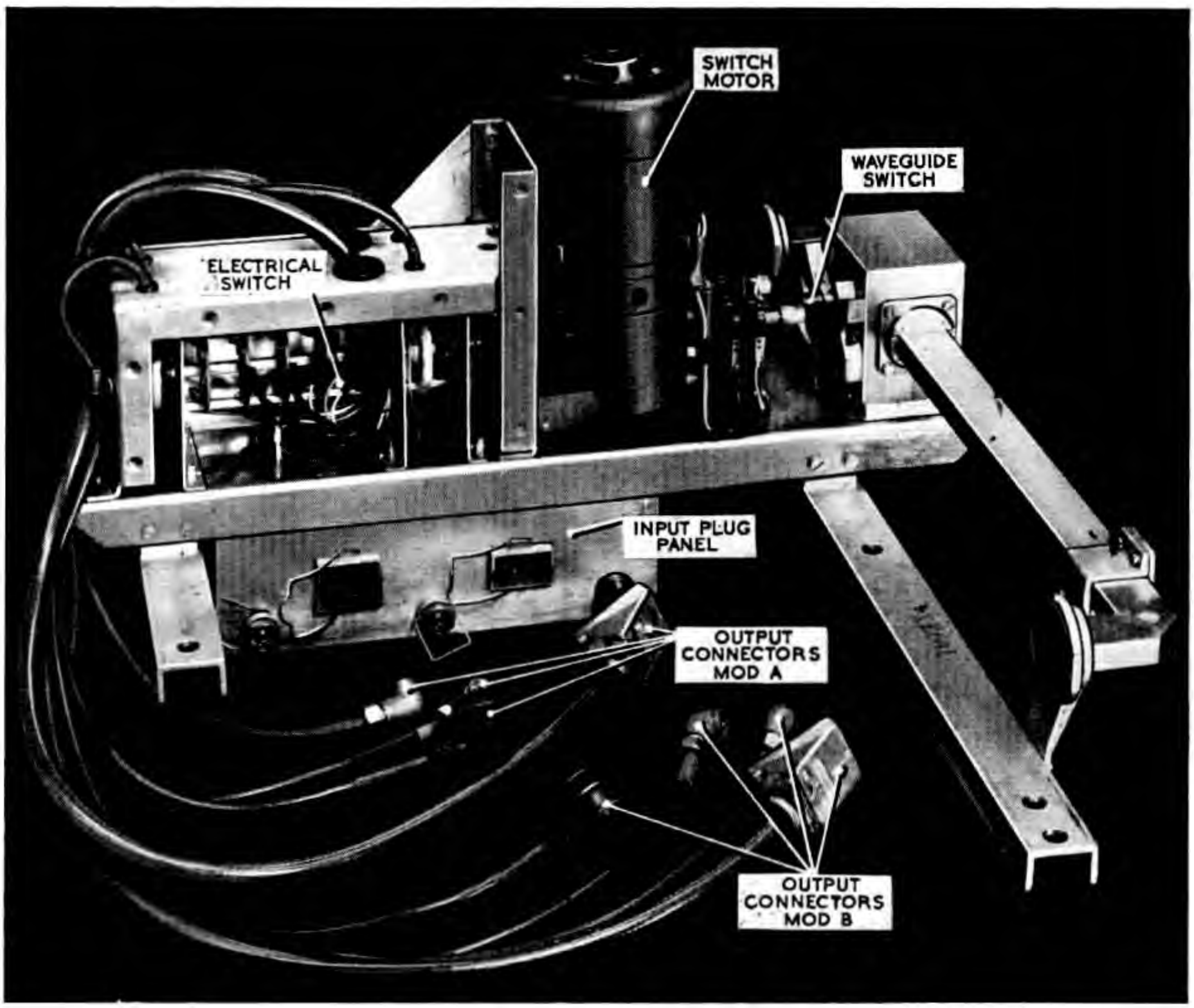

Fig. 1. Switch unit 8050

INTRODUCTION

1. Switch unit 8050 (fig. 1) is situated in the radar head housing between the two radar heads. When the equipment is switched on, one radar head is in use and the other is on standby with valve heater voltages supplied but no h.t. voltages. The radar head required for use is selected by the R.F. HEAD switch on control unit 9935 on desk 9930, and switching is effected by switch unit 8050.

2. The switch unit has two functions, one of which is to connect the h.t. power supplies and control lines to the radar head in use, and the other, to switch the waveguide so that the output from the correct radar head is connected to the scanner horn.

3. The switch unit is driven by a 230V a.c. motor, the power to which is controlled by the R.F. HEAD switch on the control unit. There are five plugs on the panel underneath the rotary switch. The two coaxial plugs, and a 12-pole plug are used with the electric switch, the 8-pole plug is the power input to the switch motor and the 3-pole plug is the 80V, 1000 c/s input plug. These five plugs are connected to the slipring assembly.

4. The eight connectors shown in fig. 1 go to the radar heads A and B. The connector terminations are all sockets of which two coaxial, one 12-pole and one 3-pole connect to each radar head.

CIRCUIT DESCRIPTION

5. Switch unit 8050 has two sections, the electrical switch and the waveguide switch. A circuit diagram of the switch unit is given in fig. 2. The 80V 1000 c/s supply is not switched, but is fed out via the 3-way connector to the valve heater transformers in the two radar heads.

Electrical switch

6. The electrical switch is a two-position rotary switch, which has seven wafers. Wafers 1 and 7 are ceramic, and are used with the coaxial connectors carrying the trigger pulse and i.f. outputs. Wafers 2 and 6 are identical and are used with the 12-way connectors.

7. The electrical switch connections are as follows:—

Wafer	*Circuit Ref.*	*Rotor pin*	*Mod. A pin*	*Mod. B pin*	*Function*
1	a	3	6	11	Trigger pulse
2	b	1	5	10	50V positive
2	c	3	6	11	250V positive
3	d	1	5	10	Klystron cathode
3	e	3	6	11	Klystron reflector
4	f	1	5	10	Pulse length
4	g	not used			
5	h	1	5	10	Crystal
5	j	not used			
6	k	not used			
6	l	not used			
7	m	3	6	11	I.F. output

8. In the two 12-way connectors to the two radar heads, pins 11 are connected together. These carry the priming voltage for the TR cell and thus both TR cells are kept primed, even though the power supply in one radar head is disconnected. Fig. 2 shows the switch unit connected to radar head B; all h.t. relays and supplies in radar head A are disconnected, but the TR cell in A is kept primed by the voltage from B.

Waveguide switch

9. The transmitter output is fed from the radar head in use via the waveguide switch to the hog-horn feeding the scanner. The waveguide switch works in conjunction with the electrical switch and is driven by the same motor.

10. It is arranged that the waveguide switch operates after supplies have been disconnected from one radar head and before they have been switched through to the other. Hence the waveguide channel is open to the correct magnetron before it starts to oscillate.

11. It can be seen from fig. 1 that switching is effected by a cam which is geared to the switch driving motor. As the cam rotates it changes the position of the waveguide switch arm, which is held against the limit stops by a spring.

Switch motor

12. The switch motor is a split-field 230V a.c. motor geared to the electrical and waveguide switches. The mains input to the motor is controlled by the R.F. HEAD switch on the control unit and is fed to the motor via the 8-pole plug on the panel underneath the electrical switch.

13. One side of the mains input voltage is fed directly to the switch motor and the other side is fed from the R.F. HEAD switch through one of the limit switches. When the R.F. HEAD switch position is changed power is fed to the motor through the closed limit switch and the motor rotates. When the switching movement has been completed the motor drives against the limit switch. The switch opens and breaks the power line to the motor, which then ceases to rotate.

14. If the R.F. HEAD switch position is again changed, power is fed through the second limit switch until the switching movement is completed but in the opposite direction.

15. The direction of operation of the motor is determined by the sense of connection of the capacitor, and hence by the direction in which the R.F. HEAD switch is operated. This switch connects the mains supply live line to either the RF CO1 or the RF CO2 line, thereby determining whether or not the capacitor is connected in series with the auxiliary or main winding of the motor.

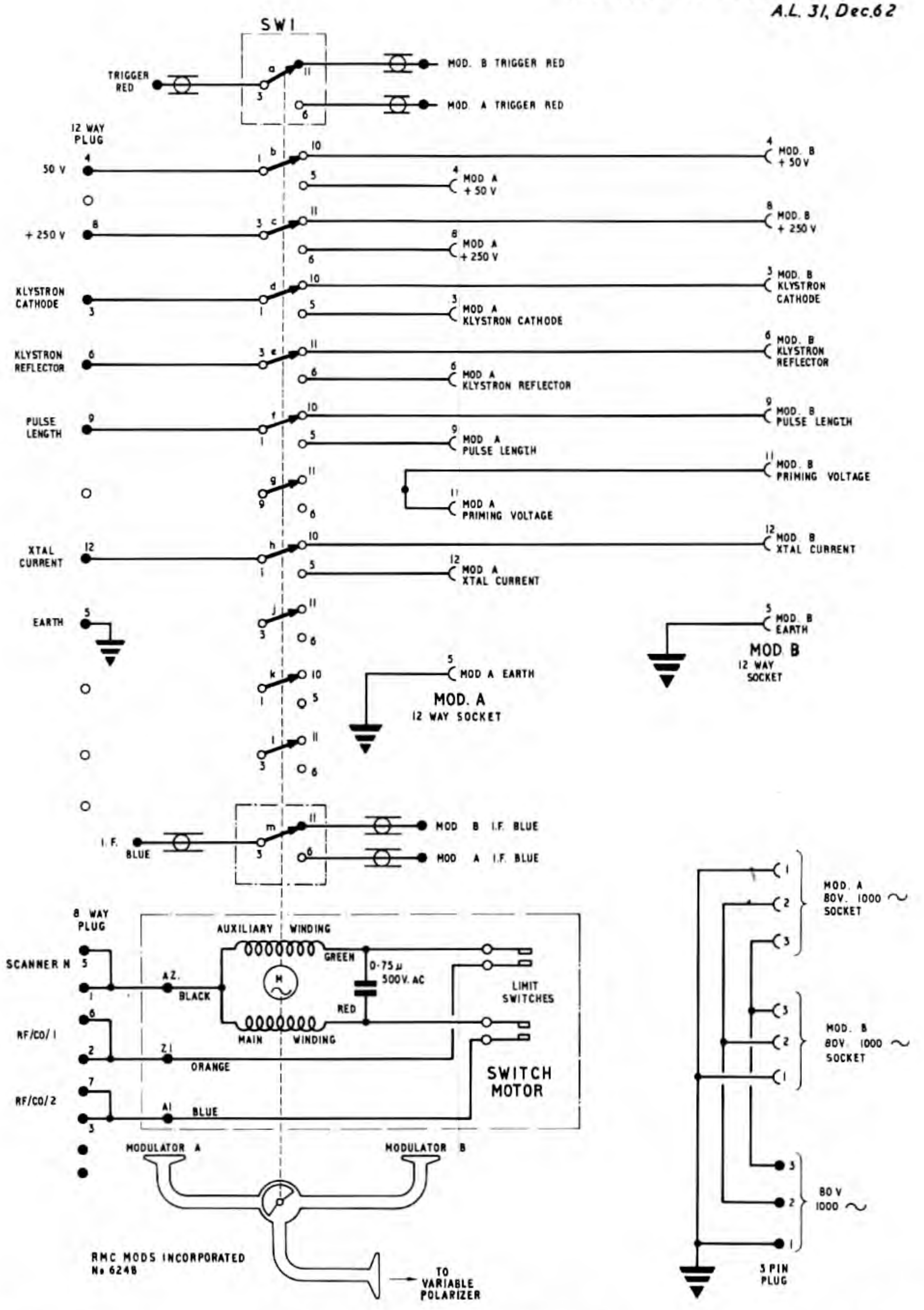

Fig. 2 Switch unit 8050 : circuit Fig. 2

7871 280900 756 4/63 P.P. 925-2

Chapter 3

RADAR HEAD 8045

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INTRODUCTION

1. Two radar heads 8045 are situated in the radar head housing and they rotate with the scanner. When the equipment is switched on, one radar head is in use and the other is on standby, with valve heater voltages supplied, but without h.t. The required radar head is selected by the R.F. HEAD switch on control unit 9935 on desk 9930 and switching is effected by switch unit 8050, which is also situated in the radar head housing.

2. Each head has two sections, one for transmitting, and one for receiving. The transmitting section consists of a modulator and a magnetron transmitter, together with power supply circuits on the main chassis. The receiving section contains the crystal mixer, local oscillator and pre-amplifier, this section is mounted on one side of the main chassis.

3. The p.r.f. of the transmitted pulse is 1000 p.p.s. and the pulse duration is either 0·1 microseconds or 0·5 microseconds. The required pulse duration is selected by the PULSE LENGTH switch on the control unit. General views of the radar heads are given in fig. 1 to 3 and the circuits in fig. 4 and 5.

CIRCUIT DESCRIPTION

Modulator

4. The transmitting section of the radar head is known as the modulator. Two blocking oscillators and a class C amplifier form the modulator proper, the output from which is used to trigger the magnetron. A circuit diagram of the modulator is given in fig. 5. The power supply circuits are also shown in fig. 5 and are described in para. 36.

Synchronized blocking oscillator

5. The first stage in the modulator is a blocking oscillator V30. The synchronizing voltage is 400V, 1000 c/s a.c. derived from the power supply transformer T21. The 400V a.c. is fed through resistor R59 and capacitor C66 to the anode of the diode, V31. The cathode of this diode is at earth potential and on the positive half cycle of the a.c. input, it conducts.

6. When V31 conducts, it places the grid line of the blocking oscillator at earth potential and thus permits it to oscillate. The current through V30 rises rapidly to saturation value due to the positive feedback through transformer T25 in its anode

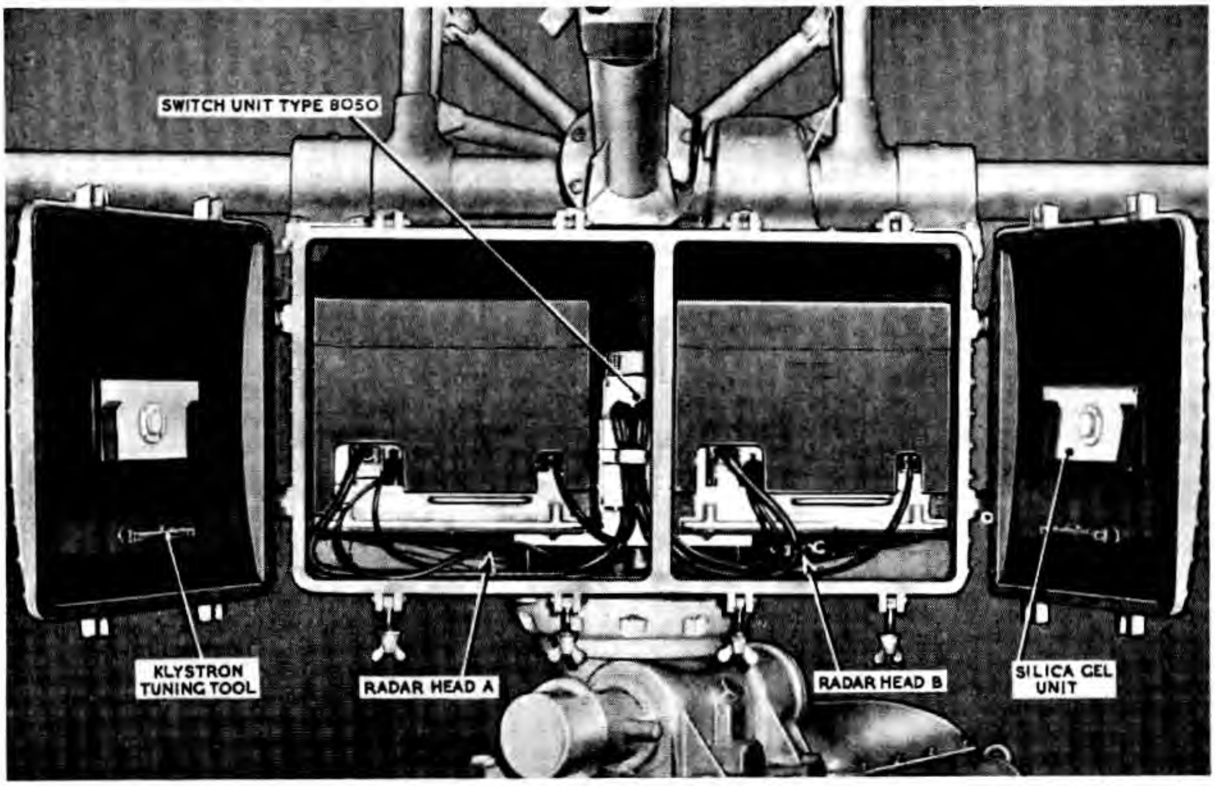

Fig. 1. Radar head 8045 in housing

and grid circuits. Hence grid current flows and capacitor C65 is charged negatively. This action reduces the grid potential.

7. As the grid goes negative due to charging C65, it reduces the flow of anode current and hence the grid is made more negative by the feedback through T25. The valve is thus very rapidly driven to cut off and the large negative charge on C65 starts to leak away through the resistors R57 and R58.

8. Before the charge on C65 has been reduced sufficiently for V30 to conduct again, the negative half-cycle of 400V a.c. input is fed through R59 and C66 to the anode of V31. The diode is cut off by the negative input, which is thus fed to the grid of V30 through R57 holding it cut off until the next positive cycle of the 1000 c/s synchronizing voltage.

9. The output of the synchronized blocking oscillator is a square positive pulse, 80V in amplitude and one microsecond in duration at a p.r.f. of 1000 c/s (*i.e.* one pulse per cycle of a.c. input). This output is taken from the cathode of V30 and used to trigger the second blocking oscillator V23. A second output is also taken from the cathode through R53 to PL22 to provide a synchronizing pulse for test gear. The link (LK2) in the cathode lead of V30 is used for testing purposes during manufacture.

Triggered blocking oscillator

10 ◀The triggered blocking oscillator is normally held cut off by a bias of approximately 150 volts negative on its grid obtained from the 600V negative line at the slider of VR21. The 80V triggering pulse from V30 is fed to the grid of V23 and reduces the bias thus permitting it to conduct. VR21 allows adjustment of the bias to provide stable operation.▶

11. The PULSE LENGTH switch on control unit 9935 on desk 9930 selects either SHORT (0·1 μs) or LONG (0·5 μs) pulses. When set to SHORT, the pulse length relay RL22 in the modulator is not energized and the triggering pulse from V30 is fed through C35 and transformer T26 to the grid of V23 via RL22/3. When set to LONG, the relay is energized and the pulse is fed through C36 and T27.

12. With the PULSE LENGTH switch set to SHORT, the triggering pulse from V30 is fed through C35 and T26 to the grid of V23; this reduces the bias and the valve conducts. Due to the positive feedback from anode to grid via C32, C33 and T26, the current through the valve rises rapidly, driving the grid positive and causing grid current to flow.

13. The flow of grid current charges C35 negatively which reduces the current through V23 and very rapidly the valve is cut-off. The charge on C35 starts to leak away through the grid leak R81 and R50, but it cannot discharge sufficiently for V23 to conduct again, before the 1μs triggering pulse ends.

14. The valve thus conducts for 0·1 μs and is held cut off for 0·9 μs by the negative charge on C35.

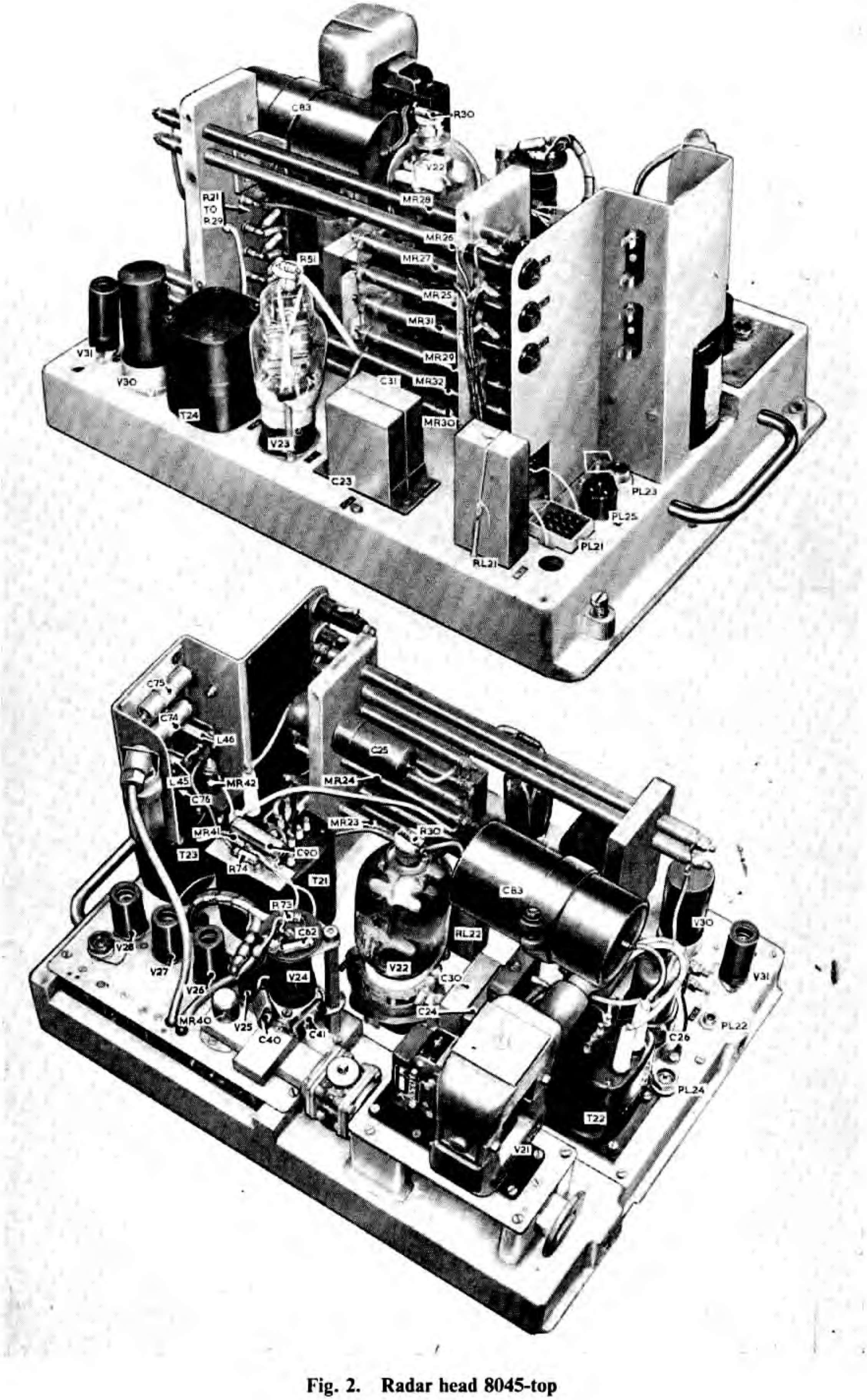

Fig. 2. Radar head 8045-top

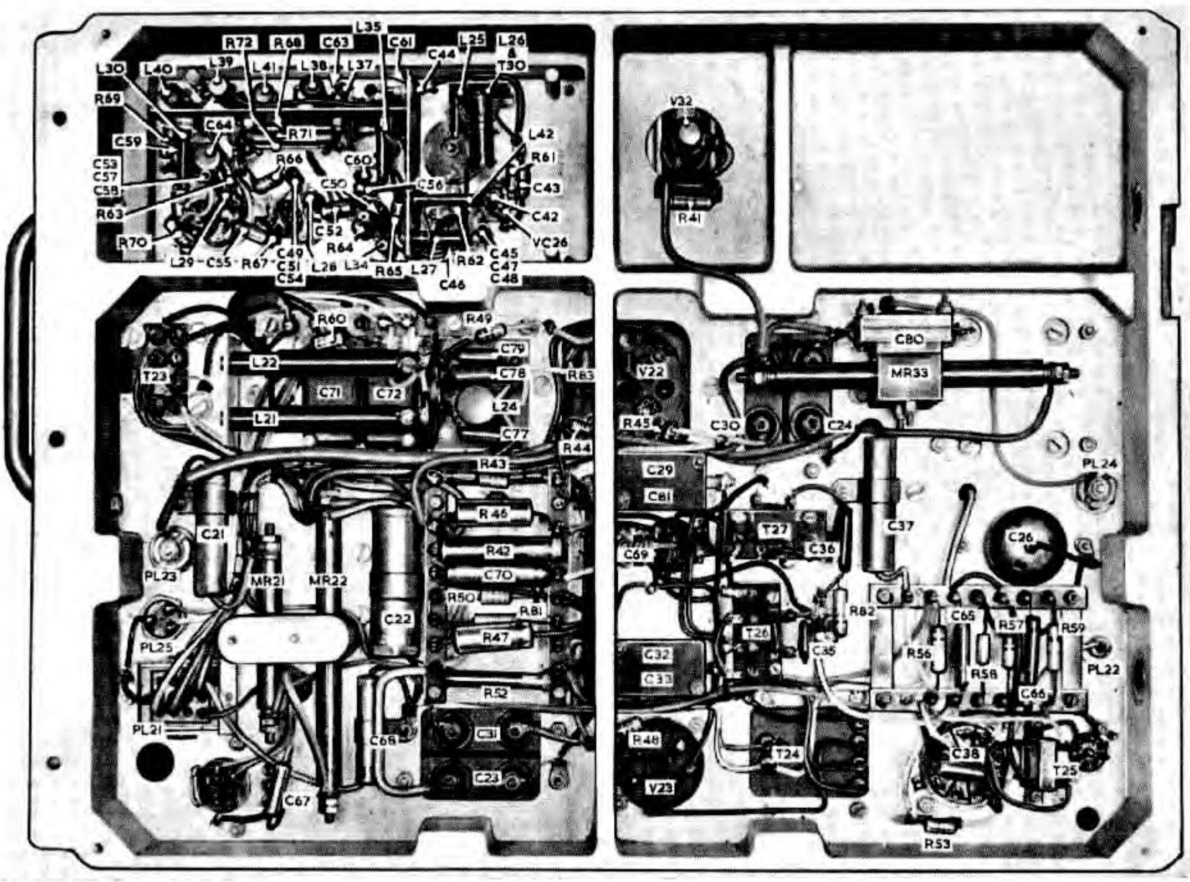

Fig. 3. Radar head 8045—underside

When C35 is fully discharged V23 is held cut off by the −150V bias on its grid until the arrival of the next triggering pulse from V30.

15. A third winding on T26 takes the output from V23 anode to the grid of V22 via RL22/1. The action of the triggered blocking oscillators V23 is the same when the PULSE LENGTH switch on control unit 9935 on desk 9930 is set to LONG, but the time constant of the grid circuit is changed so that the valve operates for 0·5 μs and is cut off for 0·5 μs of the triggering pulse by the charge on C36.

Class C amplifier

16. The next stage, V22, is a class C power amplifier with its anode supplied from the 10 kV h.t. line from the power supply transformer T21 and its grid biased by −600V. The output from V23 is fed from either T26, or T27, (depending upon the position of RL22/1), through C 29 and C81 to the grid of V22. The applied pulse is amplified and slightly narrowed by V22 and the output is taken from the anode at about 7kV, through C83 to the cathode of the magnetron V21, which oscillates for the pulse duration. The power for the transmitter is derived from C83 which, between pulses, recharges from the 10kV line via resistor chain R21–R29 and R31–R40.

Trigger

17. A reduced output is taken from V22 cathode across the 10-ohm load R49 (and R83, if the distance between the scanner and operations room exceeds 750 yds). This output is fed through a delay line consisting of C77, C78, C79 and L24, and via PL23 and the scanner sliprings, to receiver R9934 to operate the swept-gain circuit. It is passed through a further delay line in the receiver to indicator c.r.t. 8059, where it is used to synchronize the time-base and range markers. The output from V22 anode developed across R40, in the resistor chain in the modulator (R31 to R40), is fed to PL24 which is a test point for monitoring purposes.

Transmitter

18. The transmitting valve V21 is a magnetron with an oscillatory frequency in the band 9375 ±30 Mc/s. The negative-going pulse from the anode of V22 causes it to oscillate for a period of 0·1 μs or 0·5 μs depending upon the position of the PULSE LENGTH switch on control unit 9935 on desk 9930. The peak power output is 25kW and the p.r.f. is 1000 p.p.s. The power is fed via a length of waveguide, through the waveguide switch in switch unit 8050 and the circular polarizing section to the horn feeding the scanner.

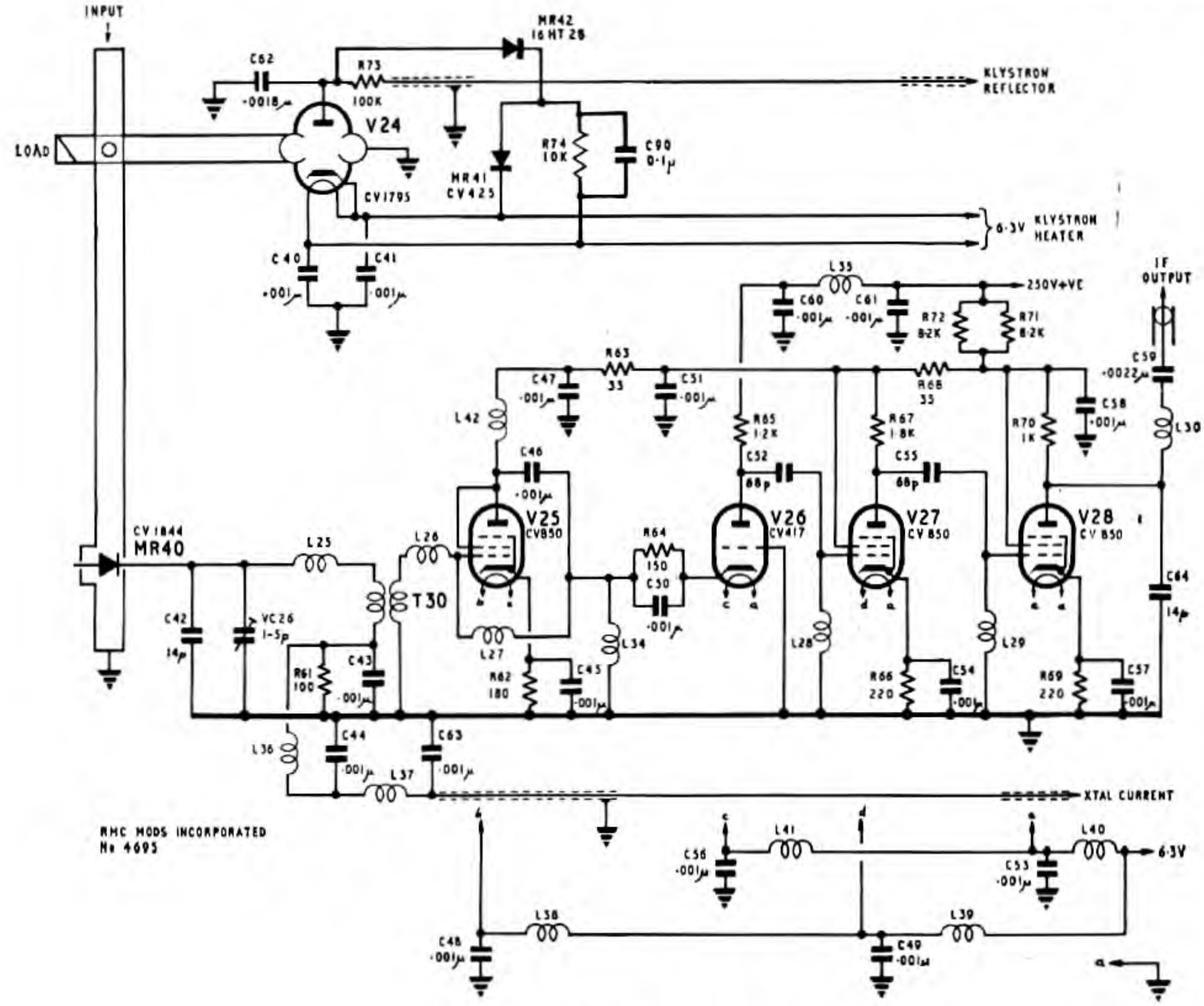

Fig. 4. Pre-amplifier circuit

T.R. cell

19. A single aerial system is used for transmitting and receiving and electronic switching is provided to isolate the receiver crystal mixer from the transmitter output while the magnetron is oscillating. The switching is performed by the T.R. cell V32 (CV 1923) which consists of a tuned resonant chamber filled with low-pressure gas.

20. When the magnetron begins to oscillate, some of its output passes down the receiving waveguide section and causes high-amplitude resonance in the cell. This ionizes the gas which acts as a short-circuit and reflects the oncoming waves. The distance between the T.R. cell and waveguide junction is arranged so that the wave reflected by the cell arrives at the junction in phase with those coming from the magnetron.

21. When the magnetron ceases to oscillate, the radar is in the receive condition; the gas deionizes, and allows received signals to pass to the crystal mixer unhindered. The magnetron branch of the waveguide is of such a length that it presents a high impedance at this junction and absorbs none of the received signal. An electrode connected to the −900V supply projects into the T.R. cell to help ionization.

Pre-amplifier

22. The receiving section of the radar head is known as the pre-amplifier and contains the crystal mixer, local oscillator and pre-amplifier proper. A circuit diagram is given in fig. 4.

Local oscillator

23. The local oscillator V24 is a velocity modulated klystron, which produces oscillations at a frequency differing by 29·5 Mc/s from the magnetron frequency. These oscillations are fed via a directional coupler to the crystal mixer, which is also fed with the received signals from the T.R. cell.

24. Coarse tuning of the local oscillator frequency is provided by a mechanical control on the klystron; this adjusts the size of the resonant cavity. Fine control is effected by varying the klystron reflector voltage by means of a potentiometer on control unit 9935 on desk 9930. There are two potentiometers available, TUNING A and TUNING B which control the klystron frequency in radar head A and radar head B, respectively. The purpose of MR41 and MR42 and their associated components is to ensure that the klystron reflector is never positive with respect to its cathode so that the local oscillator will function correctly no matter how the R.F. HEAD switch and the various channel switches on the control unit are employed.

Crystal mixer

25. After passing through the T.R. cell the received signals arrive at the crystal mixer, where they are combined with the continuous waves from the local oscillator to form an i.f. of 29·5 Mc/s. The mixer uses a silicon crystal CV1844.

26. The r.f. component of the mixer output is short circuited to earth by the crystal holder capacitance. A fraction of the d.c. component is fed via a noise filter to the crystal meter on control unit 9935 on desk 9930 to permit monitoring of local oscillator output and crystal performance. The i.f. component at 29·5 Mc/s is passed through the T network of L25, L26 and T30 to the grid of V25.

27. The T network has a band-pass characteristic. A tightly-coupled transformer T30 is used instead of a single inductor to provide d.c. isolation of the crystal and the grid circuit of V25. The whole arrangement is flatly tuned, by C42, VC26 and stray capacitances, to 29·5 Mc/s.

I.F. input circuit

28. The i.f. input circuit consists of a triode-connected pentode V25 with neutralization, followed by a grounded-grid triode V26. This circuit is used to achieve a high signal-to-noise ratio with good stability.

29. The properties of a grounded-grid triode are that its input impedance is low, and that the circuit is very stable. The low input impedance results from the fact that the input is to the cathode; and the stability, from the fact that the grid acts as an earthed screen between input and output circuits, thus eliminating energy transfer due to the interlectrode capacitance of the valve.

30. The circuit of the grounded-grid triode V26 is thus very stable and has sufficient gain to swamp the noise originating in the following amplifier stages. However, to make its own noise contribution to the circuit as small as possible, the impedance, when looking back from the cathode of V26, must be high; the neutralized amplifier V25 provides this high impedance. The inductor L42 is untuned and forms the anode load of V25.

31. The low input impedance of V26 loads V25 heavily, and reduces its gain considerably. With such heavy loading and low gain there is no tendency for V25 to oscillate even without neutralization, but extra stability is provided by the neutralizing inductance L27 which, with the anode grid capacity, resonates at the i.f. of 29·5 Mc/s.

32. The main function of L27, however, is to make the output impedance of V25 as high as possible, which in turn makes the noise contribution of V26 very small. The input circuit is thus stable and the noise from both valves is at a low level. The coupling inductor L34 is flatly tuned to 29·5 Mc/s and thus presents a high impedance to the i.f. signal, which is fed to the cathode of V26 via R64 and C50. The inductor L35, and capacitors C60 and C61 form an i.f. filter to prevent i.f. feedback to the power supply.

Stagger-tuned amplifier

33. The input circuit is followed by two amplifiers V27 and V28. To obtain the required bandwidth of 11 Mc/s, staggered-tuning is used in these valve circuits. The output from the grounded-grid triode is developed across the inductor L28 in the grid circuit of V27. Inductor L28 is tuned with the circuit capacitances to about 23·8 Mc/s.

34. The amplified signal from the anode of V27 is fed through capacitor C55 to the grid of the second amplifier V28. The coupling inductor L29 to the grid circuit of V28 is tuned to resonate with the grid capacitances at about 35·8 Mc/s.

35. The output circuit at the anode of V28 consisting of inductor L30 and associated capacitors, is flatly tuned to the i.f. of 29·5 Mc/s. The i.f. output is fed to a series tuned, rotating transformer situated in the centre of the slipring assembly, from where it is fed to the line amplifier 8052.

Power supplies

36. The circuit of the power supplies is shown on the modulator circuit in fig. 5. The incoming power to the radar head is 80V, 1000 c/s and it is fed via PL25 and two 3A fuses F22 and F23 to the primary windings of the transformers.

Modulator

37. The incoming 80V supply energizes the transformers T22, T23 and T24. These are all heater transfromers. T22 provides 6·3 volts for the magnetron heater. T23 has two secondary windings, one provides 6·3 volts for the klystron in the pre-amplifier circuit and the second winding provides 6·3 volts for the other valves in the pre-amplifier, for the diode V31 and for the synchronized blocking oscillator V30 in the modulator.

38. Transformer T24 also has two secondary windings; one winding provides 26 volts for the heater of the class C amplifier, V22. The other secondary winding of T24 provides 4 volts for the heater of the triggered blocking oscillator V23.

39. The 80V supply is also fed via contacts 1, 2 and 3 of RL21, the 2A fuse F21 and contact 4 of RL22 to the primary of transformer T21. Relay

RL21 is the standby relay: when the STANDBY/OPERATIONAL switch on control unit 9935 is set to OPERATIONAL, the standby control line is connected to the 50V supply and energizes RL21 of the radar head in use via switch unit 8050, leaving RL21 of the other radar head not energized; however, when the switch is set to STANDBY, neither RL21 is energized.

40. ◀When RL21 is not energized the radar head is on standby with heater voltages supplied but without h.t. voltages. When RL21 is energized power is applied via RL22/4 to the primary of T21 and tappings on the secondary of T21 feed rectifiers producing modulator h.t. voltages of, approximately, +10kV, +1·4kV, +1kV, +450V and −600V. T21 also supplies the 400V a.c. trigger for the synchronized blocking oscillator.

41. The correct value of magnetron current can be obtained by altering the primary circuit of the modulator h.t. transformer T21. On long pulse RL22 is energized and RL22/4 connects the supply to a tap on T21. This tap may be the 75V, 80V, 85V or 90V tap as determined on test.

42. On short pulse (RL22 de-energized) RL22/4 connects the supply to the 90V tap of T21 via R85. R85 consists of three resistors in series, any or all of which can be shorted out by soldered links giving a choice of eight values of resistance between zero and 28 ohms. The value which gives the correct magnetron current is chosen on test▶.

43. The 10kV supply is provided by rectifiers MR25 to MR28, MR29 to MR 32 and capacitors C25 and C26 which form a voltage-doubler network. When the earthy end of T21 secondary is positive with respect to its other end, current flows through the rectifier MR29 to MR32; this current charges C25 to the peak value of the secondary voltage, which is added to the further charge on the capacitor when the transformer polarity reverses. Hence C25 is charged to double the applied voltage; this voltage is passed through rectifiers MR25 to MR28 and charges C26 to approximately 10kV. The other voltages provided by the modulator are obtained by conventional half-wave rectifier circuits.

44. Together with the standby control line the remaining power supplies to the unit are only connected to the radar head in use. Switching is carried out by switch unit 8050, situated between the two radar heads and controlled by the R.F. HEAD switch (control unit 9935). These supplies are the +250V for the pre-amplifier h.t., −300V for the klystron cathode and −400V to −516V for the klystron reflector.

45. The 50V line for energizing the pulse length relay RL22, the sync pulse output to indicator c.r.t. 8059, the i.f. output and crystal current output are also connected by switch unit 8050 only to or from the radar head in use. The switch unit also operates a waveguide switch to connect the horn to the magnetron waveguide of the radar head in use.

Pre-amplifier

46. The 250V positive supply for the pre-amplifier h.t. and the 300V negative supply for the klystron cathode are obtained from one of the receivers R9934. Selection of the receiver to provide these voltages is made by the MASTER CHANNEL switch (control unit 9935).

47. The klystron reflector is provided with 400 to 516V negative from the slider of the appropriate tuning control on control unit 9935. The reflector voltage also comes from the receiver selected by the MASTER CHANNEL switch.

48. The heater supplies for the pre-amplifier are obtained from TR23 in the modulator circuit (*para.* 37). The heaters of the pre-amplifier circuits of both radar heads are supplied when the equipment is switched on, but only the radar head in use receives the h.t. and klystron voltage, as described in para. 42. I.F. chokes L38 to L41 are included in the 6·3V supply to the pre-amplifier heaters which are decoupled by the capacitors C48, C49, C53 and C56; similarly inductors L21 and L22 are included in the supply to the klystron heater, which is decoupled by C40 and C41. Inductors L21 and L22 are shown on the modulator circuit (fig. 5).

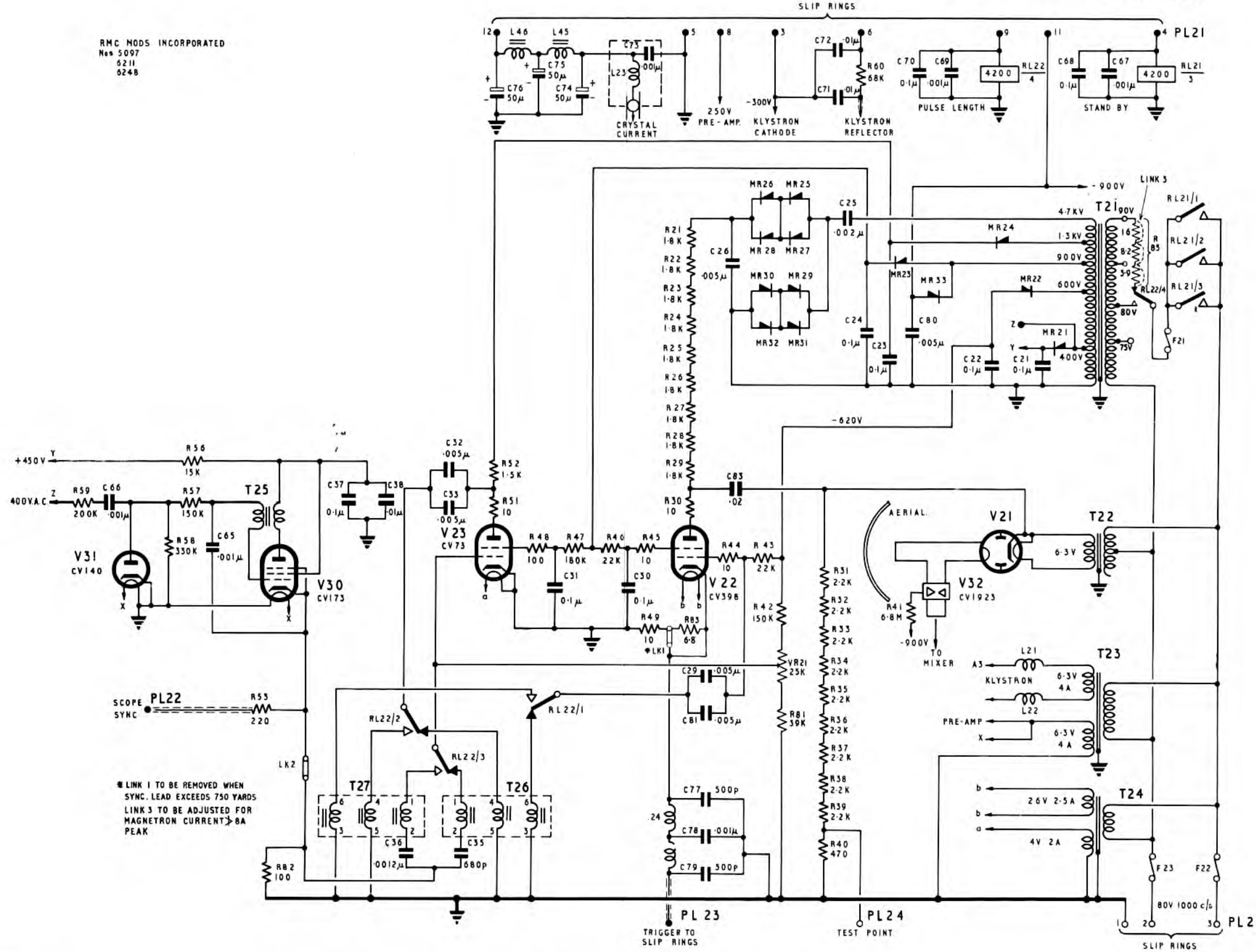

Fig. 5 Modulator circuit Fig. 5

Chapter 4

(Completely revised)

JUNCTION PANEL 14539 and SCANNER BASE WIRING

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Introduction

1. Junction panel 14539 (fig. 1) bears a transformer panel to control the 50 c/s and 1000 c/s supplies, two five amp power points for servicing equipment and a junction tagboard. Most of the cables within the scanner base are terminated and interconnected on the junction tagboard but some are connected directly to the transformer panel and others connect the junction tagboard to the transformer panel (Sect. 5, Chap. 2, fig. 5). The cable connections to the junction tagboard and transformer panel are given by tables 1 and 2 and the transformer panel circuit in fig. 2.

80V supplies

2. The 80V 1000 c/s supply from power unit 8278 is stepped up to 135V by the 80V auto-transformer under desk 9930 and fed to mounting 9931 via the 4 core black cable. From plug panel orange the 1000 c/s supply is taken via the junction tagboard to the transformer panel. On the transformer panel (fig. 2), variac T100 and voltmeter M104 are used to adjust it to 80V 1000 c/s to feed amplifier 8052 and sliprings 3 and 4 for the radar heads. MR103 and C103 produce an 80V d.c. supply for the bearing transmitter rotor.

230V supply

3. There are two terminal strips on plug panel orange; one, TSA, has seven terminals and the other, TSB, has five. They are used for 50 c/s power supply connections between the 4 way blue plug, junction panel 14539, the power points, the heater switch and heaters and the scanner isolating switch.

4. The 500V 50 c/s balanced supply lines (AC250/1 and AC250/2) from the mains auto-transformer come into mounting 9931 on the 4 pole blue plug. AC 250/1 from 4 pole pins A and B and AC 250/2 from pins C and D are connected to transformer T101 on the transformer panel via TSB/1 & TSB/2 respectively and the red and blue cores of a four core cable.

*T*101

5. Auto-transformer T101 which provides the 240V 50 c/s mains supply for use in the scanner mounting. The 240V NEUTRAL line is taken from the centre (OV) terminal of T101 and the other output tap is selected to provide the 240V LIVE line.

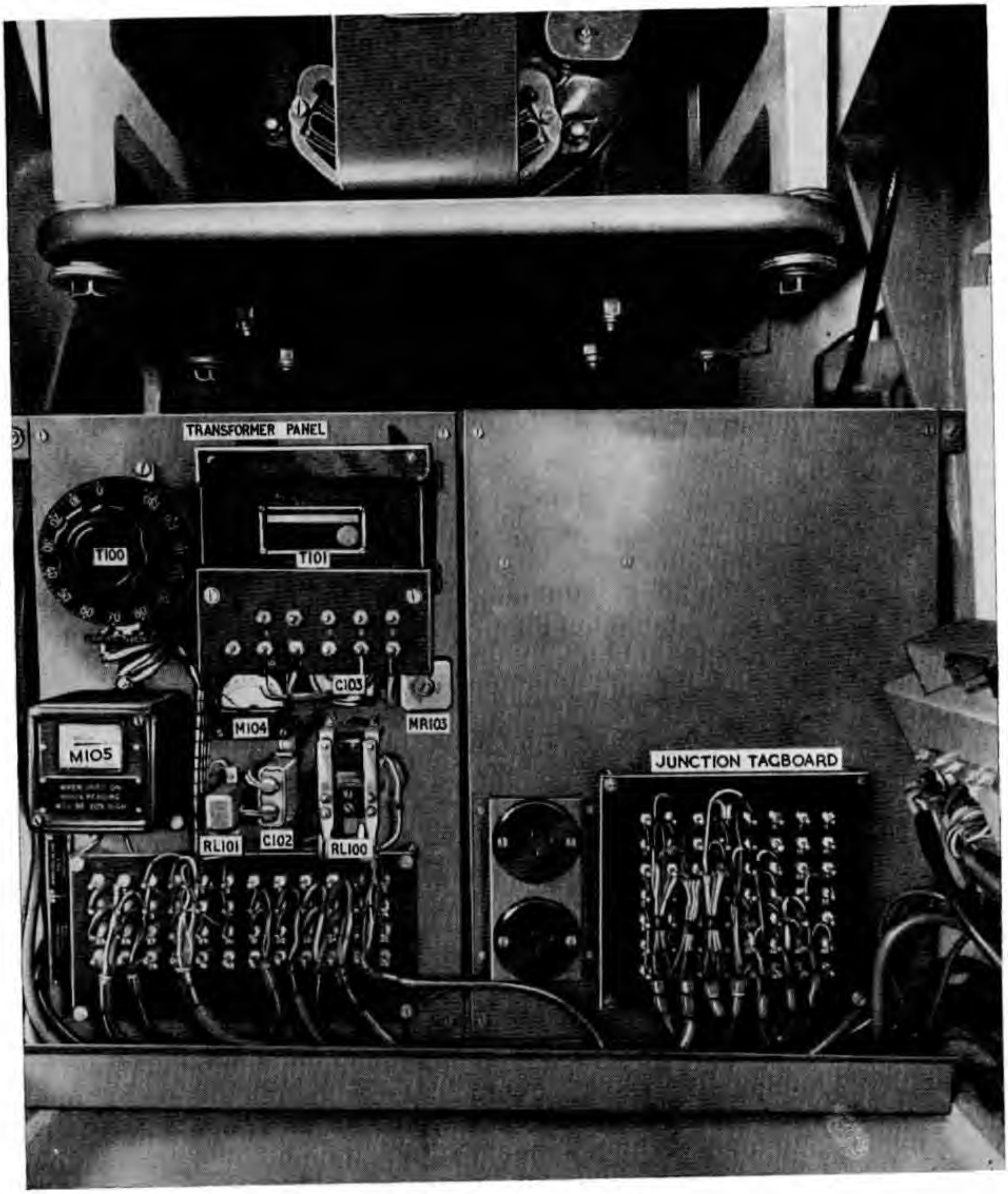

Fig. 1. Junction panel 14539

6. From transformer T101 240V LIVE and 240V NEUTRAL are taken, via the yellow and green cores and TSB/3 and TSB/4, to TSA/6 and TSA/7 for distribution to the power points, heater switch and scanner isolating switch. The heater switch feeds the heaters via TSA/2 and TSA/3 and the scanner isolating switch returns the supply as SCANNER LIVE and SCANNER NEUTRAL to the transformer panel (terminals 13 and 25) via TSA/4 and TSA/5 and junction tagboard tags 39 and 47.

7. From JTB 47, SCANNER NEUTRAL is also fed to slipring 13 and is the neutral line for the switch unit motor, the radar head anti-condensation heater and the obstruction light. The live lines to these three items are not switched by the scanner isolating switch; the first is supplied from the heater switch and the other two are separately supplied from the mains auto-transformer live line via switches on control unit 9935.

Relays and hour meter

8. On the transformer panel, RL100 feeds the mains supply to the scanner turning motor when energized by a 230V a.c. supply (SMS1 and SMS2) from the SCANNER ON/OFF switch on control unit 9935. The mains supply is also applied by RL101 to the hour meter. RL101 is energized by the 50V d.c. supply produced by the receiver selected by the MASTER CHANNEL switch when the RADAR switch on control unit 9935 is set to ON.

Variable polarizer

9. Capacitor C103 (fig. 2) is used to determine the direction of operation of the motor in the variable polarizer mechanism. It is connected in series with one or other of the two windings of the motor according to the direction in which the POLARIZER switch on control unit 9935 is operated.

TABLE 1

Junction tagboard connections

From plug panel orange	Core colour	Tag	Core colour	Destination
18 pole (A)	Red	1		Junct. tag (2)
18 pole (B)	Blue	2	Red	Slipring (17)
18 pole (C)	Green	3		Junct. tag (9)
12 pole (A)	Red	4	Red	Amp. 8052 (6)
			Red	Slipring (10)
12 pole (B)	Blue	5	Yellow	Slipring (16)
		6		
		7		
		8		
18 pole (D)	Yellow	9	Blue	Slipring (18)
				Junct. tag (3)
18 pole (E)	White	10	Green	Slipring (19)
				Junct. tag (11)
18 pole (F)	Black	11		Junct. tag (10)
12 pole (C)	Green	12	White	Slipring (6)
12 pole (D)	Yellow	13	Brown	Trans Pan. (5)
		14		
		15		
		16		
18 pole (G)	Brown	17		
2 pole (A)	Red			
18 pole (H)	Violet	18		
2 pole (B)	Blue			
18 pole (J)	Orange	19	Yellow	Slipring (14)

TABLE 1—(contd.)

Junction tagboard connections

From plug panel orange	Core colour	Tag	Core colour	Destination
12 pole (E)	White	20	Blue	Slipring (9)
			Red	Trans Pan. (3)
12 pole (F)	Black	21	Yellow	Amp. 8052 (1)
White 4 pole (A)	Red	22	Red	Tel. (L)
		23		
Black 4 pole (A)	Red	24	Red	Trans Pan. (14)
				Junct. tag (32)
18 pole (K)	Pink	25	Yellow	Trans Pan. (4)
18 pole (L)	Lt. green	26	White	Trans Pan. (16)
18 pole (M)	Grey	27	Blue	Trans Pan. (15)
12 pole (G)	Brown	28	Blue	Amp. 8052 (5)
12 pole (H)	Violet	29	Green	Amp. 8052 (4)
White 4 pole (B)	Blue	30	Blue	Tel. (C)
		31		
Black 4 pole (B)	Blue	32	Red	Trans Pan. (14)
				Junct. tag (24)
18 pole (N)	Red/Bu	33	Green	Trans Pan. (27)
18 pole (O)	Red/G	34	White	Slipring (11)
18 pole (P)	Red/Y	35	Black	Slipring (12)
12 pole (J)	Orange	36	Green	Slipring (7)
12 pole (K)	Pink	37	Black	Slipring (2)
White 4 pole (C)	Green	38	Green	Tel. (M)
TSA (4)	Red	39	Red	Trans Pan. (13)
Black 4 pole (C)	Green	40	Blue	Trans Pan. (26)
				Junct. Tag (48)
18 pole (Q)	Red/W	41	Brown	Slipring (21)
18 pole (R)	Red/Bl	42	Violet	Trans Pan. (17)
18 pole (S)	Red/Br	43	Orange	Not terminated
12 pole (L)	Lt green	44	Brown	Slipring (23)
12 pole (M)	Grey	45	Violet	Not terminated
White 4 pole (D)	Yellow	46	Yellow	Tel. (E)
TSA (5)	Blue	47	Violet	Slipring (13)
			Blue	Trans Pan. (25)
Black 4 pole (D)	Yellow	48	Blue	Trans Pan. (46)
				Junct. tag (40)
		49	Grey	Slipring (15)
		49 to 56	Braids	Earth

TABLE 2

Transformer panel: connections

Tag	Core Colour	Destination
1		
2		
3	Red	Junct. tag (20)
4	Yellow	Junct. tag (25)
5	Brown	Junct. tag (13) Trans Pan. (36)
6	Pink	Not terminated
7		
8		
9		
10		
11	Red	7 way T.B. (1)
12	Yellow	7 way T.B. (4)
13	Red	Junct. tag (39)
14	Red	Junct. tag (32)
15	Blue	Junct. tag (27)
16	White	Junct. tag (26)
17	Violet	Junct. tag (42)
18	Lt. green	Not terminated
19	Red	Amp. 8052 (2)
20	Red	Slipring (22)
21	Red	Slipring (3)
22	Red	Turn. Mtr. (A)
23	Blue	7 way T.B. (2)
24	White	7 way T.B. (5)
25	Blue	Junct. tag (47)
26	Blue	Junct. tag (48)
27	Green	Junct. tag (33)
28	Black	Junct. tag (51)
29	Orange	Not terminated
30	Grey	Not terminated
31	Blue	Amp. 8052 (3)
32	Blue	Not terminated
33	Blue	Slipring (4)
34	Blue	Turn. Mtr. (AZ)
35	Green	7 way T.B. (3)
36	Black	7 way T.B. (6) Trans Pan. (5)
37 to 48	Braid	Earth

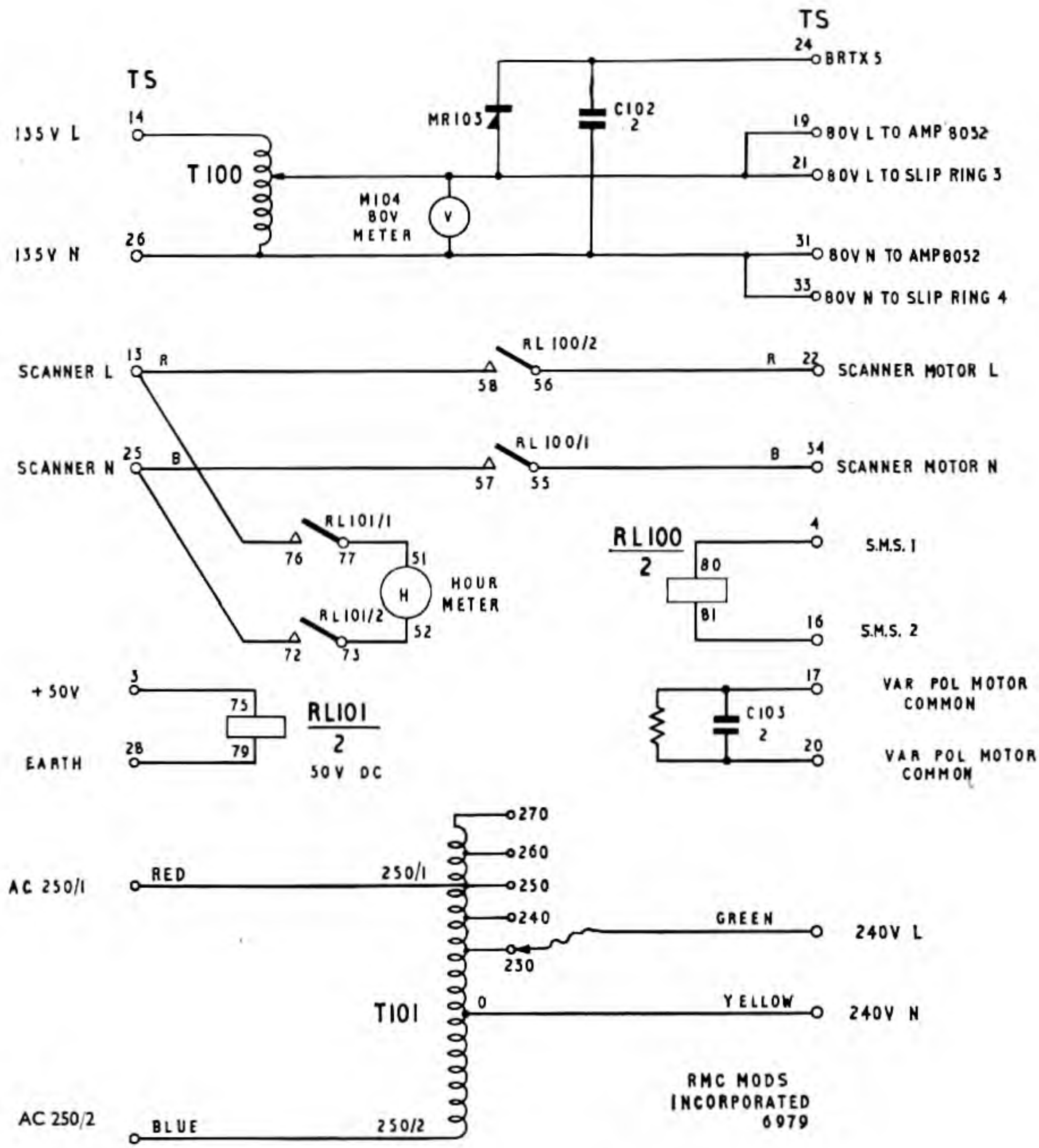

Fig. 2. Transformer panel circuit

Chapter 5

AMPLIFIER TYPE 8052

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INTRODUCTION

1. Amplifier Type 8052 consists of two 3-stage line amplifying units, one of which is in use at a time, together with a heater transformer and two switching relays. The line amplifier in use is selected by the AMP A/AMP B switch on desk Type 9930. It is fitted in the scanner mounting and connected between the i.f. output of the rotating transformer from the radar head and the long run of i.f. cable.

2. The function of amplifier Type 8052 is to boost the i.f. signal to compensate for the loss along the i.f. line, because, if the cable run between the scanner position and the control room is greater than 200 yards, the attenuation of the signal becomes appreciable. By means of a two-position link, each line amplifier may be set to compensate for a cable run of either 200 to 600 yards, or 600 to 1000 yards.

3. If the line amplifier in use is set to compensate for a cable run of 200 to 600 yards the overall gain is about 14 dB at 29·5 Mc/s; this rises with frequency at the rate of 0·2 dB per Mc/s throughout the i.f. band, thus giving an overall gain of about 13 dB at 24·5 Mc/s and 15 dB at 34·5 Mc/s. This variable gain compensates for the rise in cable attenuation as the frequency increases.

4. If the line amplifier in use is set to compensate for the cable run of 600 to 1000 yards the overall gain is about 25 dB at 29·5 Mc/s, and the rise is 0·4 dB per Mc/s. This gives a gain of about 23 dB at 24·5 Mc/s and 27 dB at 34·5 Mc/s. To

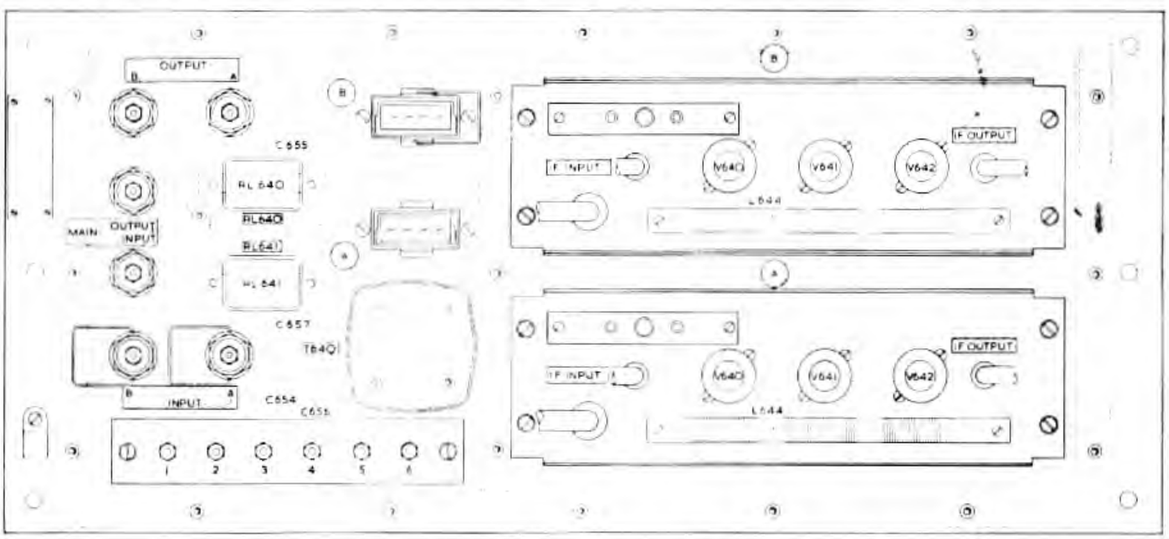

Fig. 1. Amplifier Type 8052—top

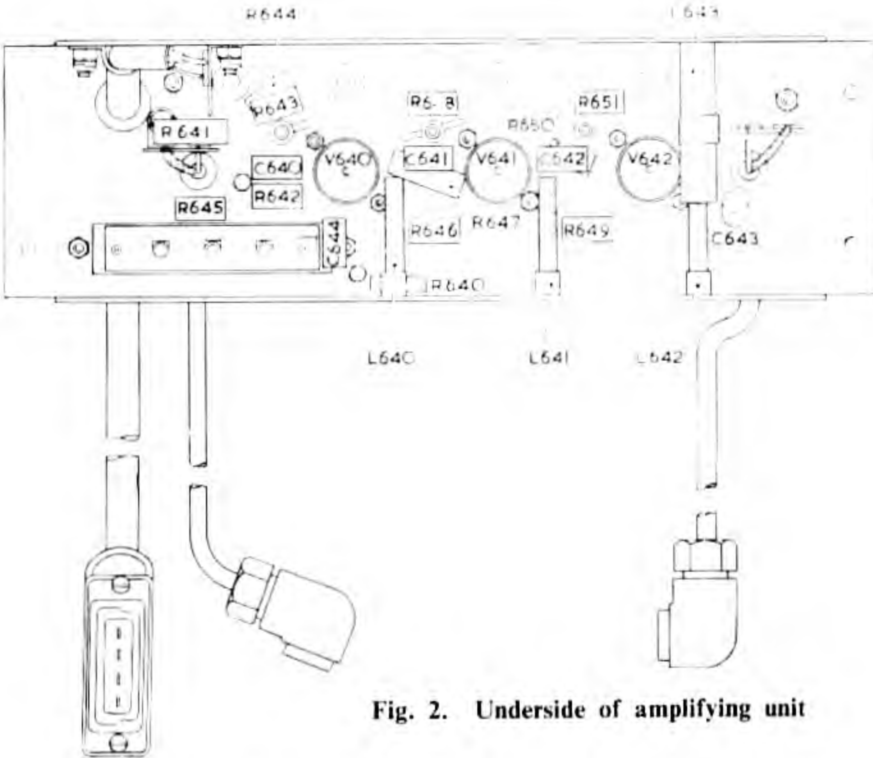

Fig. 2. Underside of amplifying unit

obtain the required bandwidth of 11 Mc/s, staggered tuning between stages is used. Amplifier Type 8052 is shown in fig. 1 and the underside of one amplifying unit is shown in fig. 2.

CIRCUIT DESCRIPTION

5. The two line amplifiers A and B are identical and the circuit description is given with reference to amplifier A. A circuit diagram is given in fig. 3.

Amplifier

6. The i.f. input is fed into amplifier 8052 via the relay contacts of RL641A and if the AMP A/AMP B switch on desk 9930 is set to AMP A it is fed to the grid of V640 in line amplifier A. The input cable is terminated by the 75 ohm resistor R641.

7. The two-position link is in the cathode circuit of V640 and selects either C647 or R645. With C647 in circuit the valve has a low gain and the amplifier is set to compensate for 200 to 600 yards cable run. With R645 connected the valve has a high gain, and the amplifier compensation is for 600 to 1000 yards cable run.

8. With C647 in circuit, bias for V640 is obtained by the voltage drop across the cathode resistor R643. The resistor has a high value (4·7k) and hence the voltage drop is large and V640 is heavily biased; this limits the current through the valve, which thus has a low gain. The cathode resistors R643 and R644 are fully by-passed by the capacitors C644 and C647 in parallel.

9. In the other position of the cathode link R645 is connected in parallel with R643; this reduces the bias on V640 and thus increases the gain. Capacitor C647 is also taken out of circuit and the effective value of the by-pass capacitor (C644) is thus reduced to 33 pF. The cathode resistors are thus incompletely by-passed and this gives a gain/frequency characteristic which rises 0·2 dB per Mc/s.

10. The amplified output at the anode of V640 is coupled to the grid of the next stage V641 by inductor L640, capacitor C641 and resistor R647. The coupling network is tuned to a frequency of 23·8 Mc/s.

11. The signal is further amplified by V641 and the output fed to the grid of the last valve V642. The coupling network between V641 and V642 consists of inductor L641, capacitor C642 and resistor R650 and is tuned to 35·8 Mc/s.

12. The third stage V643 has its output flatly tuned to 29·5 Mc/s. Inductor L642 is self-resonant at this frequency, whereas L643 is tuned by the valve and stray capacities. The output is taken from a tapping on L643 to the relay contacts RL640B, whence it is fed out to the long cable run to the control room.

13. The grid leak of V641 (R647, 1·5k) is lower than that of V642 (R650, 1·8k) and this makes the Q of the coupling between V640 and V641 lower than that between V641 and V642. The staggered tuning and unequal Q of the couplings give the required bandwidth of 11 Mc/s and a response which rises at 0·2 dB per Mc/s, not taking into account the effect of V640 cathode circuit. When capacitor C644 is not in parallel with C647 (i.e., in the 600—1000 yards link position) the cathode circuit introduces a further rise of 0·2 dB per Mc/s, giving a total rise of 0·4 dB per Mc/s.

Power supplies

14. Transformer T640 supplies 6·3V a.c. for the heaters of both line amplifiers. It is energized by the 80V 1000 c/s incoming supply from the scanner mounting. The h.t. line (250V positive) is supplied by the receiver unit of the master channel selected by the MASTER CHANNEL switch on desk 9930 and is fed to amplifier 8052 via relay contacts RL640A.

Relay operation

15. The AMP A/AMP B switch on desk 9930 connects the 50V positive supply from the receiver unit of the master channel in use to terminal 4 or 5 of amplifier 8052. If the switch is set to AMP A, terminal 5 is at 50V positive and relay RL640 is energized; contact RL640A connects the h.t. line (terminal 6) and contact RL640B connects the i.f. output cable to amplifier A. Relay RL641 is not energized, so the i.f. input is also connected to amplifier A.

16. If the AMP A/AMP B switch is set to AMP B, terminal 4 is at 50V positive and relay RL641 is energized; this connects the i.f. input to amplifier B and, as RL640 is not energized, the h.t. and output lines are also connected to amplifier B. In Fig. 3, RL640 and RL641 are shown with the equipment switched off, that is, with neither relay energized.

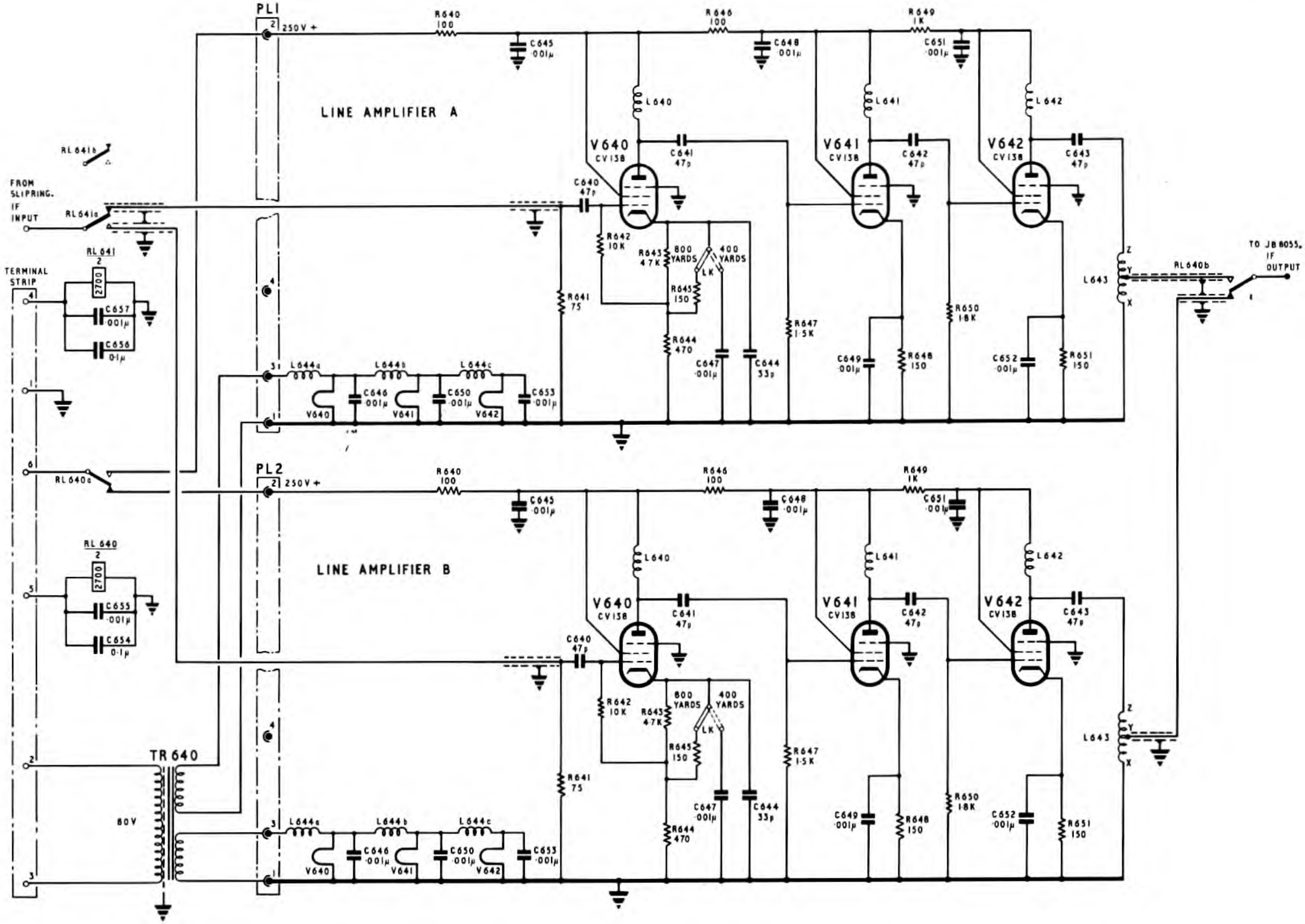

Fig.3 Amplifier Type 8052: circuit Fig.3