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TESTERS PERFORMANCE 105 AND 106

GENERAL AND TECHNICAL INFORMATION

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Ministry of Defence

FOR USE IN THE
ROYAL AIR FORCE

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PERFORMANCE TESTERS 105 AND 106

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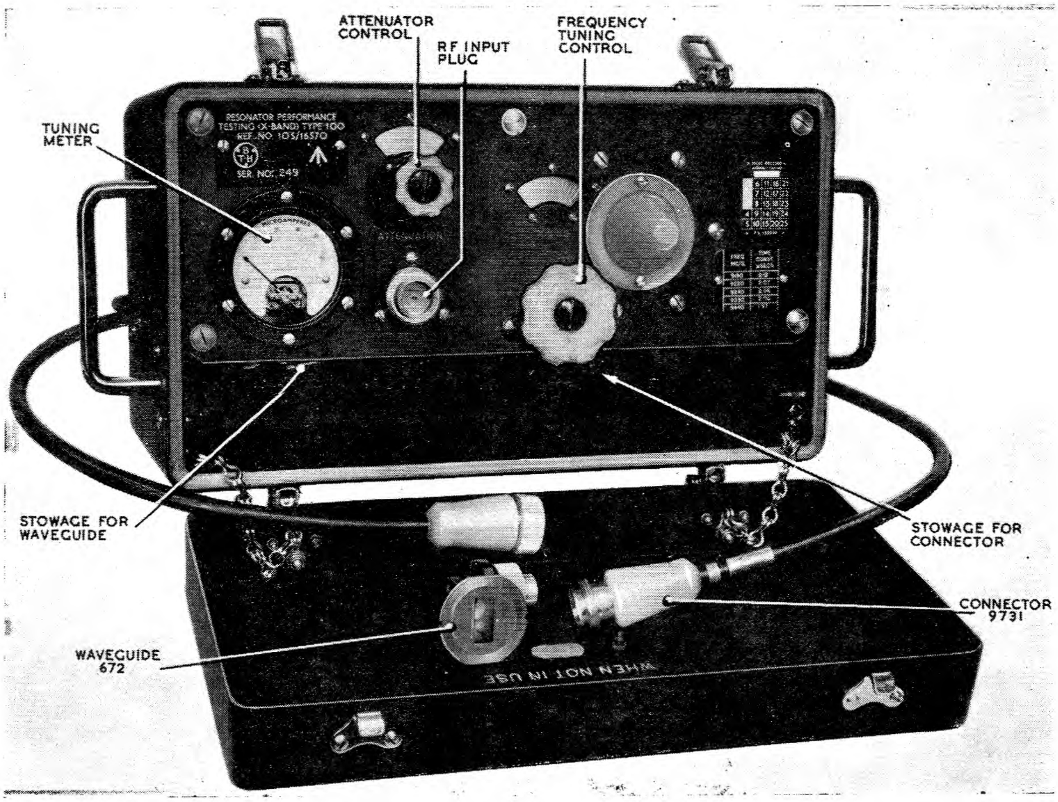
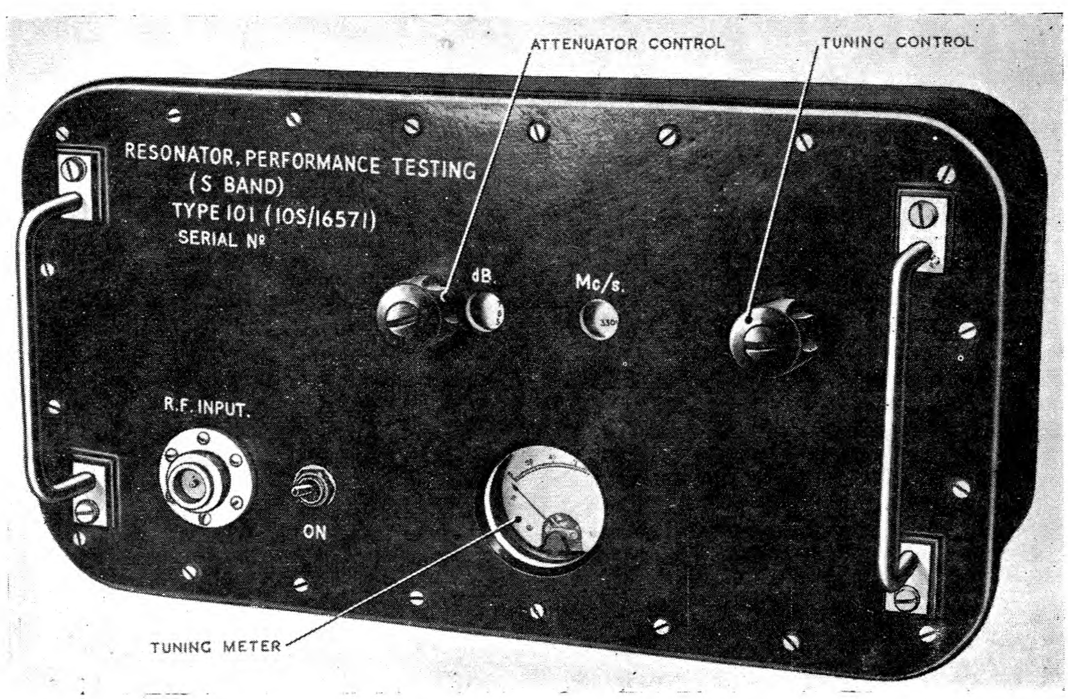


Fig. 1. Resonator, performance testing (X-band) 100—General view



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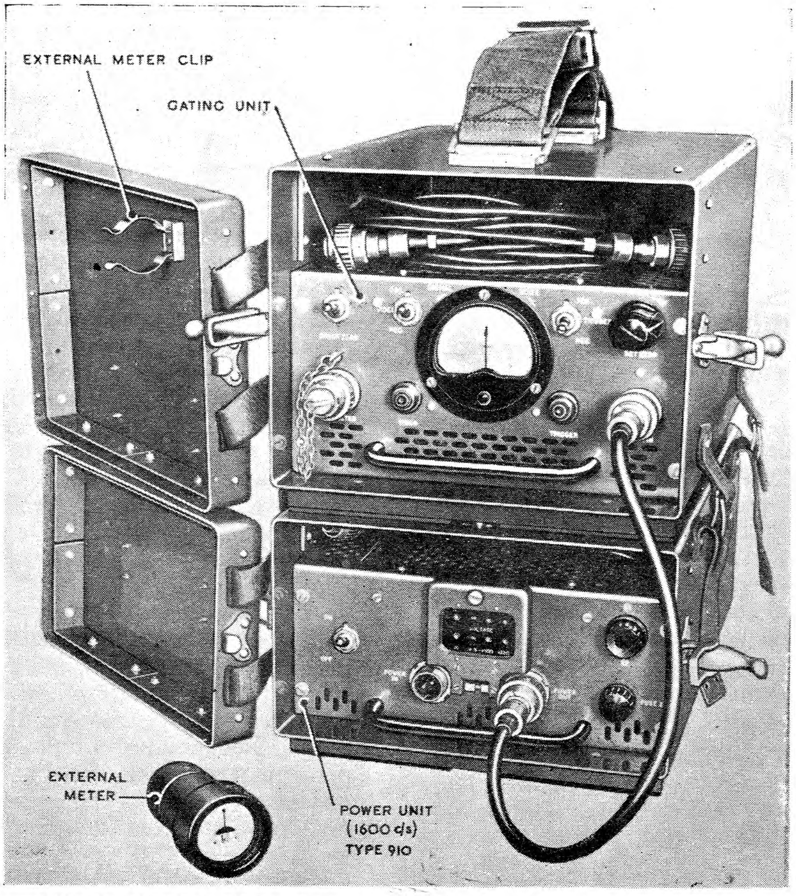


Fig. 3. Gating unit and power unit (1,600 c/s) 910—General view

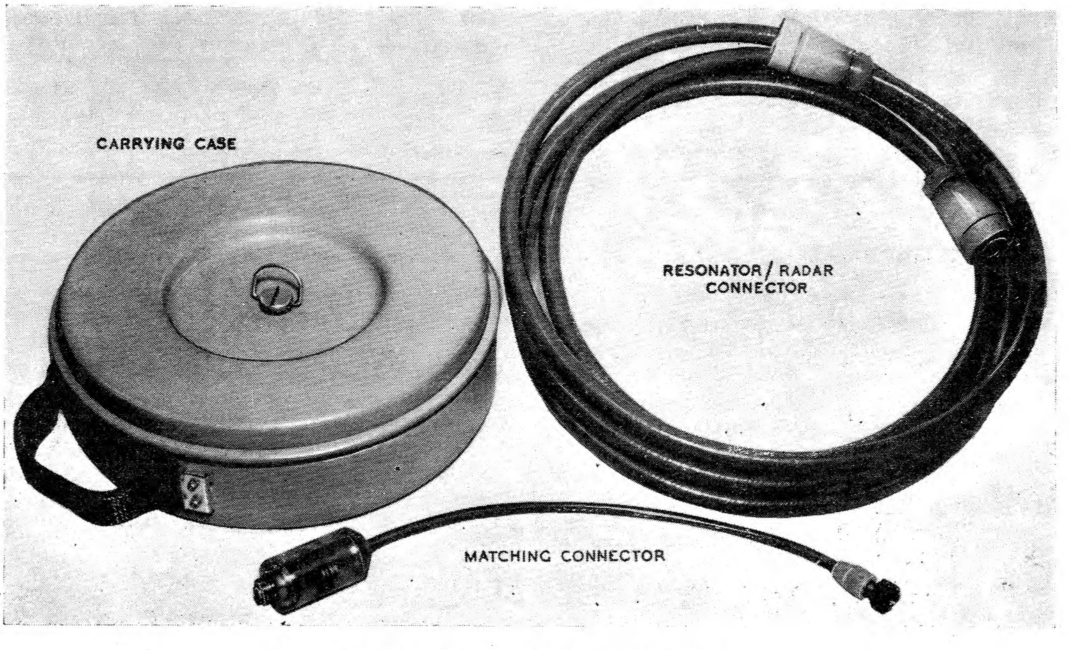


Fig. 4. Connector kit, 10HA/13593

operating at PRFs of 400 to 2000 PPS.

INTRODUCTION

General

1. Performance testers 105 and 106 use echo boxes to obtain the overall performance figure (*para.* 5) of X-band and S-band radar equipments. They are not intended to give an accurate absolute measurement but will measure deviations from a standard to an accuracy of ± 2 dB. The testers are most useful for the measurement of the day to day performance of radar equipments and variations in that performance can be measured with greater accuracy than that stated above. It is therefore possible to observe a falling off in performance enabling preventive maintenance to be carried out.

A.L.1

2. The performance testers may be used to measure the performance of equipment set up on the bench or to check the equipment after installation in an aircraft; they may also be used as wavemeters and magnetron spectrum analysers. An experienced technician will also find the testers useful for TR cell tuning, checking AFC systems and as a guide to magnetron output.

3. The main items of equipment which make up the testers are given in Table 1; general views are given in fig. 1, 2, 3 and 4. Power unit (50 c/s) 911 (*Stores Ref.* 10K/17446) is an additional item and may be used instead of power unit (1,600 c/s) 910 where a 50 c/s supply is available. Its dimensions are $15 \times 9\frac{1}{2} \times 8\frac{1}{2}$ in. and it weighs 27 lb. Views of this alternative unit and a circuit diagram are given in fig. 23 to 26.

4. The gating unit and power unit have canvas carrying straps; normally the two units are fastened together by straps fitted to the sides of the power unit and buckles fitted to the sides of the gating unit. When the units are in use, their front covers hinging on canvas straps can be folded back and clipped on the side of the units.

PRINCIPLES

Performance figure

5. The maximum range at which a radar equipment will detect a target is determined by:—

(1) transmitter power
(2) receiver noise factor
(3) aerial gain
(4) effective reflecting area of the target
(5) a propagation factor.

Of the above, those most likely to change and which can be remedied by maintenance staff are (1) and (2).

6. The receiver noise determines the minimum detectable echo signal which is conventionally defined as that signal at the receiver input terminals which gives a signal to noise ratio of unity at the receiver output terminals, i.e., the echo signal whose amplitude is equal to the receiver noise level.

7. If the transmitter power is increased or the receiver noise factor decreased then the maximum range of the equipment will be improved. Hence the ratio (transmitter power) $\div$ (noise power of the receiver) gives an overall performance measurement of a radar equipment and is called the performance figure. Being the ratio of two powers it is usually expressed in decibels and for modern radars is of the order of 140 to 200 dB.

8. Fig. 20 shows graphically the effect of decreased performance on radar range; e.g., a decrease in performance figure of 6 dB reduces the maximum radar range obtainable by 30 per cent.

General

9. The operation of the performance testers is shown schematically in fig. 5.

10. The pulse from a radar transmitter is attenuated by a directional coupler in the radar

TABLE 1

Main items of equipment

Stores Ref.	Item	Dimensions Inches	Weight lb.	Remarks
	TESTER PERFORMANCE 105			
10S/16570	Resonator, performance testing (X-band) 100	$15 \times 8 \times 10$	15	Complete with connector and waveguide to coax. transformer.
10D/18931	Gating unit	$15 \times 9\frac{1}{2} \times 8$	18	Complete with two moulded and two miniature connectors.
10K/17445	Power unit (1,600 c/s) 910	$15 \times 9\frac{1}{2} \times 6$	12	Complete with input connector.
	TESTER PERFORMANCE 106			
10S/16571	Resonator, performance testing (S-band) 101	$18 \times 10 \times 7$	20	
10D/18931	Gating unit	$15 \times 9\frac{1}{2} \times 8$	18	Common unit.
10K/17445	Power unit (1,600 c/s) 910	$15 \times 9\frac{1}{2} \times 6$	12	Common unit.
10HA/13593	Kit, connector	10 dia. $\times$ 3	3	Resonator/radar and matching connectors in carrying case.

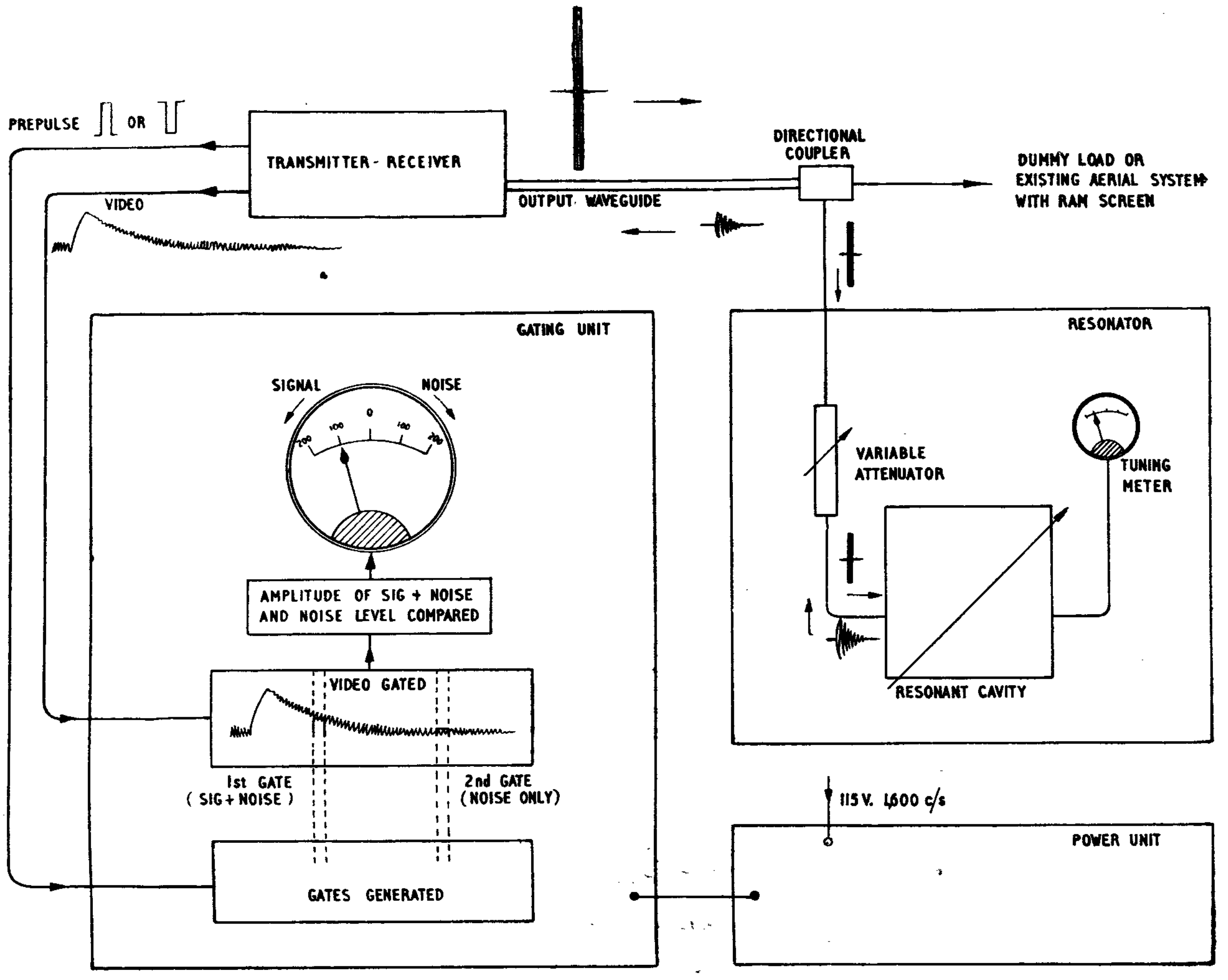


Fig. 5. Performance testers 105 and 106—schematic

waveguide system and fed to a resonator (echo box). In the resonator a calibrated attenuator introduces a variable attenuation before the pulse finally excites a resonant cavity. A meter measuring the crystal current of a detector coupled to the cavity indicates when the cavity is tuned to resonance.

11. When the transmitter pulse ends, free oscillations in the cavity continue for approximately 20 μS but decay exponentially due to losses in the cavity walls. This oscillatory power is fed back to the radar receiver via the variable attenuator and directional coupler and the output of the receiver is fed to a gating unit. This unit generates two gates ; the first occurs 10μS after the transmitter pulse and samples the decaying cavity signal and noise, the second occurs 20 to 30 μS later and samples the receiver noise only. Their ratio is measured and the variable attenuator in the resonator is adjusted until the receiver output signal/noise ratio is a standard value. A ratio of 2 : 1 is chosen and this is indicated when the meter on the gating unit reads zero.

12. The main sources of attenuation in the system are :—

(1) that occurring between the transmitter-receiver and the resonant cavity, due to the RF output waveguide, directional coupler, connectors, and the coupling between the variable attenuator and the cavity. This acts on the signal twice.

(2) that due to the build up and decay of oscillations in the cavity during the period after the commencement of the transmitter pulse before the first gate operates ; it is a function of transmitter pulse length.

(3) that due to the variable attenuator.

13. Of the above, all but the variable attenuator loss are fixed in value and may or may not be known. The variable attenuator is calibrated in decibels to indicate its two-way attenuation and this figure is added to that of the total fixed losses (if known) giving the overall performance figure.

14. If the fixed attenuation is not known, it will not be possible to ascertain the absolute overall performance figure unless the average of several installations is taken as a standard, but the performance testers will still reveal, by change of attenuator setting, any decrease or increase in the overall performance of a given equipment.

15. The exact method of use will vary slightly depending on the radar under test. Full details are given in the A.P. or servicing instructions dealing with specific equipments. However, general information on setting up and operating the testers is given below.

OVERALL PERFORMANCE MEASUREMENT

Setting up

16. (1) Before a performance test is made it is essential that the radar aerial is set so that no permanent echoes are received. Generally echoes are present and therefore a dummy load or RAM screen will be required.

(2) Ensure that the radar equipment can be controlled from a point adjacent to the performance tester, connecting up an alternative control unit if necessary.

(3) If not already fitted, fit the directional coupler, as recommended in the A.P. or servicing instructions for the equipment, in the waveguide run from the transmitter-receiver; terminate it with a dummy load or use a RAM screen to absorb radiation from the aerial.

Note . . .

Suitable waveguide items for use with low power X-band equipments will be found in test set 32.

(4) Connect the resonator by its coaxial connector to the directional coupler.

WARNING

When using the X-band resonator, check that the serial numbers of the resonator, connector and waveguide-to-coaxial transformer agree, because these items are calibrated together. First connect the transformer to the directional coupler; then connect the cable to the transformer and ensure that it is in a relaxed condition before connecting the other end to the resonator. Acute bends or twisting of the cable will produce inaccurate results.

(5) After checking the setting of the supply voltage tapping on the front panel of power unit 910 connect a suitable supply to the POWER IN plug.

Note . . .

It may be necessary to make up a connector in place of the connector B 22/21A/1 (Stores Ref. 10HA/13875) supplied.

(6) Connect the supply lead provided between the power unit and the gating unit.

(7) If the gating unit external meter is not being used *check that the chained socket is connected to the* EXT METER *plug.*

(8) Connect pre-pulse and video outputs (which may be either positive or negative) from the transmitter-receiver to the TRIGGER and VIDEO sockets on the gating unit using the coaxial connectors provided.

Note . . .

A matching connector, part of connector kit 10HA/13593, is provided for use with installations, e.g., AI Mk. 17 where the amplitude of the pre-pulse is greater than 100V (Mod. 3891). It is essentially a T-section attenuator made up of two 56 ohm and one 18 ohm resistors moulded on to one end of a short length of coaxial cable (fig. 4).

(9) Note the polarity of the pre-pulse *edge* which is coincident with the commencement of the transmitter pulse and set the TRIGGER switch accordingly.

(10) Note the polarity of the video signal and set the VIDEO switch accordingly.

(11) Switch on power supplies and allow the equipment to warm up for 10 to 15 mins.

Operation

17. (1) Adjust the attenuator control on the resonator to read zero, and the tuning control to give maximum deflection of the tuning meter.

Note . . .

(a) When using the S-band resonator the amplifier switch should be put to the ON *position for the period of tuning.*

(b) When using the X-band resonator it is possible to obtain a maximum at the lower end of the tuning scale when the transmitter is tuned to the higher frequency end. Therefore always tune for the maximum reading which has the sharpest response.

(2) Set the attenuator control to maximum.

(3) Turn the receiver gain control to zero and switch to AFC control.

(4) With CHECK ZERO switch depressed, adjust the gating unit SET ZERO control to centre the meter.

Note . . .

When using a new unit or when using a unit with a radar whose p.r.f. differs from that for which the unit is adjusted it may be necessary to carry out a zero adjustment as follows :—

(a) Remove the chassis from the unit.

(b) Adjust the SET ZERO *control until it is approximately central in its travel.*

(c) With CHECK ZERO *switch depressed, centre the meter by adjusting RV1.*

(d) Replace the chassis in the unit.

(5) Increase the receiver gain until the gating unit meter reads in the NOISE direction to the figure quoted in the A.P. or servicing instructions, or to a definite figure between 100 and 200. This figure must then be used for subsequent measurements.

(6) Adjust the attenuator on the resonator until the gating unit meter reads zero.

Note . . .

Owing to the characteristics of noise the meter needle fluctuates. Hence the attenuator should be adjusted until the fluctuations are approximately equal about zero.

(7) Record the reading of the attenuator dial. This is a measure of the overall performance of the radar.

(8) Repeat the above operations and obtain an average of three attenuator readings.

Note . . .

All operations should be done as quickly and *as accurately as possible to ensure that the transmitter frequency has not drifted during the measurement.*

(9) Because the resistivity of the metal conducting surface of the cavities varies with temperature, the Q factor and the natural frequency will vary. Therefore, as measurement of overall performance depends on the Q of the resonant cavities, a correction is required so that under given temperature conditions the measurement can be related to those under normal condition, i.e., room temperature. The correction shown in the top graph of fig. 21 should be added algebraically to the attenuator reading obtained in (8).

Reversion

18. (1) Switch OFF power unit 910 and the radar equipment.

(2) Remove the connectors and stow in the places provided in the units.

(3) Return the radar equipment to normal, then check that it operates satisfactorily.

USE AS WAVEMETER OR MAGNETRON SPECTRUM ANALYSER

19. (1) Connect the resonator to the equipment under test as in para. 16.

(2) With the radar transmitter switched on, tune the resonator for maximum deflection on the tuning meter.

WARNING

To prevent damage to the detector crystal, always adjust the attenuator to ensure that the meter needle does not exceed full scale deflection.

(3) To obtain the frequency in Mc/s multiply the tuning scale reading by ten. The cavity frequency will vary with temperature ; the lower graph of fig. 21 shows the necessary correction.

(4) For spectrum analysis, turn the tuning control to a position well below the resonance point. Then, turning the control slowly back through resonance to a position above the resonance point, plot the tuning scale readings against the meter readings.

CHECKING AFC, TR CELLS, AND MAGNETRON OUTPUT

20. After carrying out an overall performance measurement with the receiver in AFC control, a similar measurement with the receiver in manual control will show up any falling off in AFC performance.

21. TR cells may be checked for optimum performance by carrying out an overall performance measurement and then tuning the TR cell for an increase of the gating unit meter reading in the signal direction.

22. Any falling off in magnetron output will be shown up by the maximum reading obtainable on the tuning meter from one performance test to the next provided that the same resonator is used on all occasions. When using the X-band resonator the magnetron can be considered unserviceable if the next maximum on either side of the tuning point exceeds 20 per cent. of that reading.

RESONATOR PERFORMANCE TESTING (X-BAND) 100

Introduction

23. The resonator receives an attenuated transmitter signal from a directional coupler in the radar waveguide run. The signal is passed via a piston attenuator to a resonant cavity which is tuned to the transmitter frequency ; resonance is indicated by a meter which is operated by the crystal current of a detector coupled to the cavity. The oscillations set up in the cavity return via the same path to the radar receiver. The tuning range of the instrument is 9180-9440 Mc/s.

GENERAL DESCRIPTION

24. A general view of the unit is given in fig. 1 ; an interior view is given in fig. 6.

25. Connection to the unit is made by means of a moulded connector (Stores Ref. 10HA/15880), the other end of which is connected to the directional coupler by means of a waveguide-to-coaxial transformer (Stores Ref. 10B/18232). The RF input plug and the piston attenuator are moulded to either end of a short length of lossy cable which introduces an attenuation of approximately 8 dB ; the whole assembly is attenuator unit 6366 (Stores Ref. 10L/16420).

Attenuator unit 6366

26. The piston is made of aluminium, black anodized, and its movement inside the bore of the outer aluminium body is controlled by the attenuator control knob on the front panel of the unit through a rack and pinion. The polythene covered inner conductor of the cable moulded to one end of the piston passes through the hollow centre of the piston ; it is then bent to form a square shaped loop whose position with respect to a slot in the wall of the cavity resonator determines the degree of attenuation introduced by the unit. The attenuation is indicated on a dial fitted to the attenuator control spindle ; the dial is calibrated in dB and indicates the two-way value of attenuation. The attenuator unit is secured to the cavity resonator by means of four finger tight screws.

WARNING

The unit is machined to close tolerances and together with the control is set up during manufacture. Consequently no unauthorized personnel should attempt to remove or adjust the unit.

Cavity resonator

27. The resonator is an aluminium cavity with an internal copper sleeve and its internal dimensions determine its resonant frequency. The control spindle is geared to alter the position of an aluminium plate which acts as an end wall of the cavity and thus alters the resonant frequency which is indicated on a dial viewed from the front of the main unit. The dial reading is accurate to

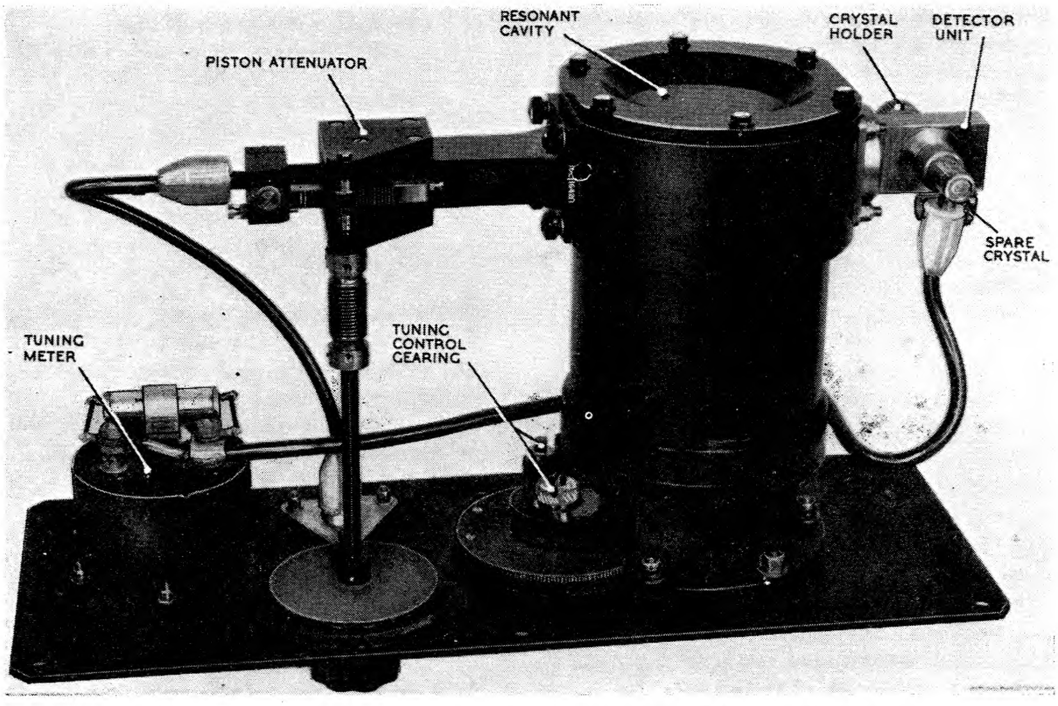


Fig. 6. Resonator, performance testing (X-band) 100—Interior view

±5 Mc/s. All interior surfaces of the cavity are copper plated by a special process which results in a Q factor of the order of 60,000. (Further details of cavity resonators will be found in A.P.1093E, Chap. 5).

WARNING

The end plate securing bolts which are painted red should not be removed unless the unit is to be re-calibrated.

Detector unit

28. This is a crystal valve detector and is bolted to the side of the cavity wall. The crystal, which is a specially selected CV2258, is made accessible by the removal of a knurled cap ; a spare crystal is housed in a clip on the side of the detector unit. The output is fed directly to the tuning meter and is smoothed by a 50 μF capacitor connected across the meter.

Construction

29. The unit is not fully sealed but is nevertheless moisture-proof. A gasket is fitted between the outer aluminium case and the lid. The lid is secured by four fasteners and should be replaced when the instrument is not in use. The meter is completely sealed and the remaining items are suitably treated to prevent the ingress of moisture. All components are mounted on the aluminium front panel which is held in position by six $\frac{1}{4}$ BSF x $\frac{5}{8}$ in. pan-headed screws.

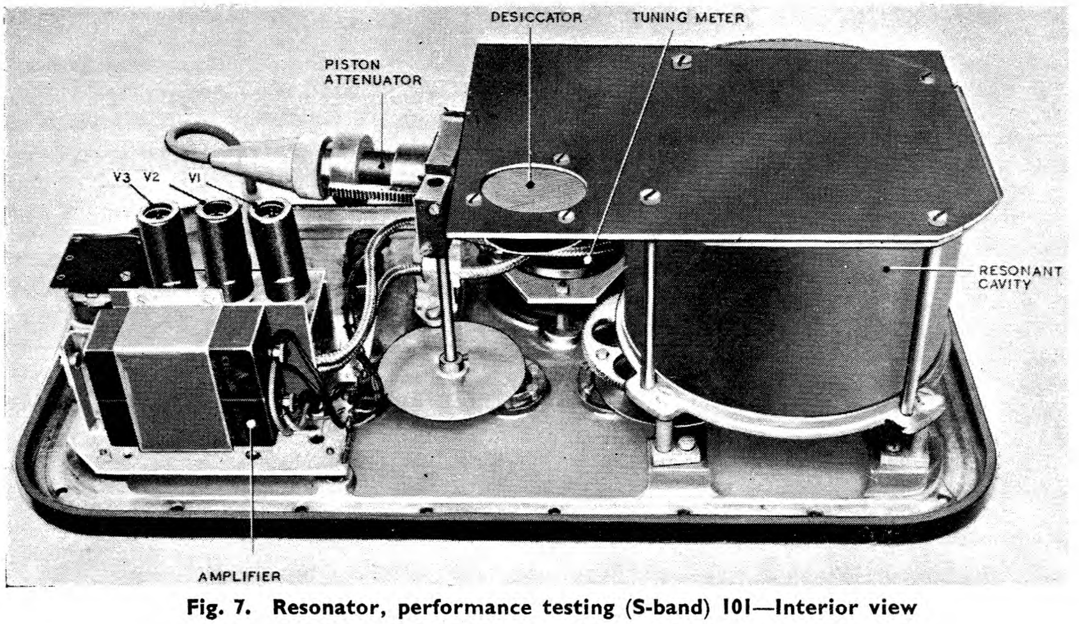


Fig. 7. Resonator, performance testing (S-band) 101—Interior view

A space is provided below the panel for stowing the connector and the waveguide-to-coaxial transformer. These items are calibrated together with the unit and bear the same serial number as the unit. A change of connector may cause an error in attenuation reading of $\pm 1\frac{1}{2}$ dB.

WARNING

The attenuator, resonator and detector unit are machined to very close tolerances and if any are removed re-calibration of the whole unit will be necessary.

RESONATOR, PERFORMANCE TESTING (S-BAND) 101

Introduction

30. The S-band resonator is similar to the X-band model in principle. The transmitter signal from the directional coupler in the radar waveguide run is passed via a piston attenuator to a resonant cavity and the cavity oscillations are fed back via the same path to the receiver; the crystal current of a detector coupled to the cavity deflects a tuning meter located on the front panel of the unit thus giving an indication of resonance. The dimensions of the attenuator, cavity and detector are of course different, and the output of the crystal detector is amplified by a battery operated amplifier before being passed to the tuning meter. The tuning range of the instrument is 3260-3340 Mc/s.

GENERAL DESCRIPTION

31. A general view of the unit is given in fig. 2; an interior view is given in fig. 7.

32. Connection is made to the unit at the R.F. INPUT double bulkhead plug on the front panel. Coupling to the piston attenuator (attenuator unit 4247, Stores Ref. 10L/16208) is made by a short moulded connector (Stores Ref. 10HA/13418).

Attenuator unit 4247

33. Details of the unit are given in fig. 8.

34. Movement of the black anodized aluminium piston inside the outer nickel plated brass tube is controlled by a knob on the front panel of the main unit through a rack and pinion. This controls the distance between a coupling loop and a slot in the wall of the cavity resonator. The distance determines the degree of attenuation which is indicated on a dial, calibrated in dB to give the two-way value.

35. The conductor between the coaxial input plug and the coupling loop is made in two sections. At the join, one section is tapped 10-BA and the other section is threaded 10-BA. Between these two sections is held a resistor (Stores Ref. 10W/19461) which is in the form of a carbon coated, laminated-fibre-glass disc. This is used to match the line thus preventing reflections and maintaining a good voltage standing wave ratio.

36. The unit is fixed to a flange on the cavity resonator (resonator unit, Stores Ref. 10S/16612) by six 8-BA screws.

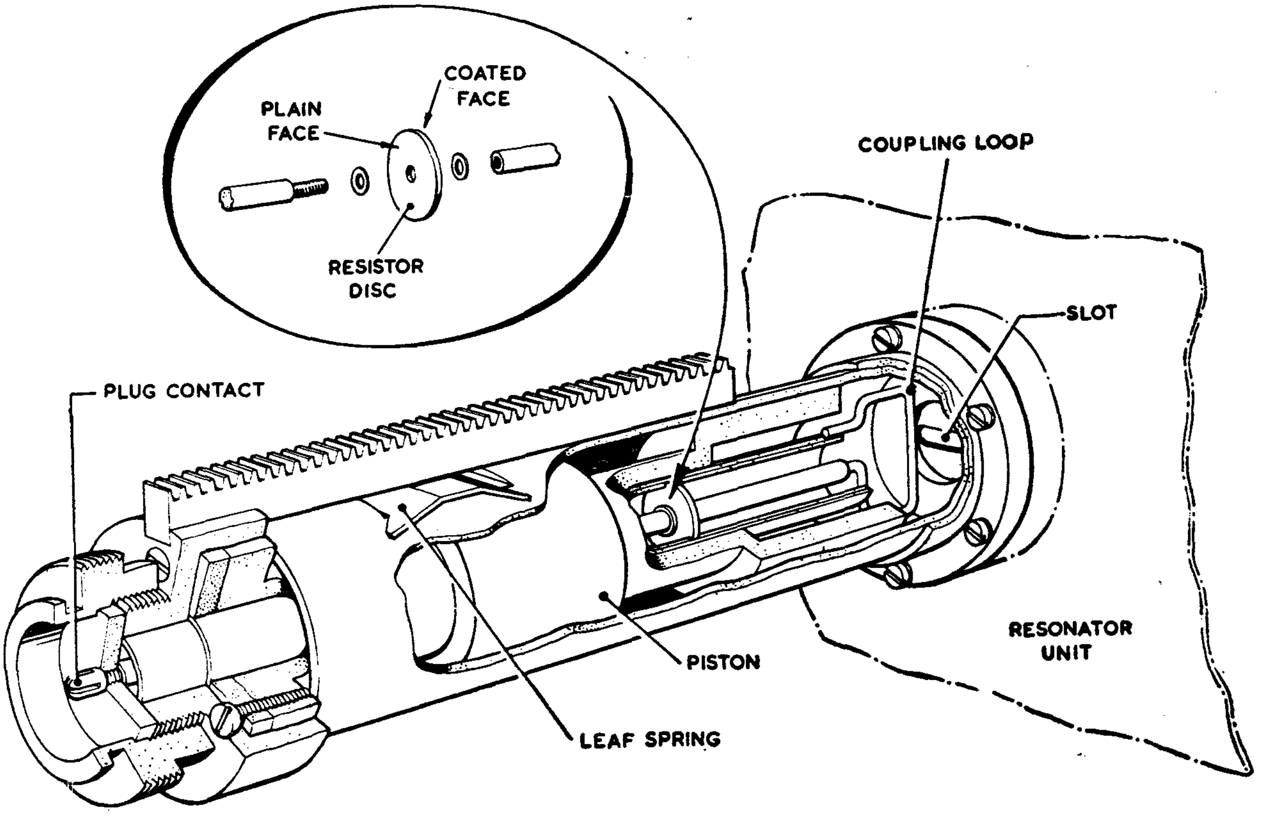


Fig. 8. Attenuator unit 4247—mechanical details

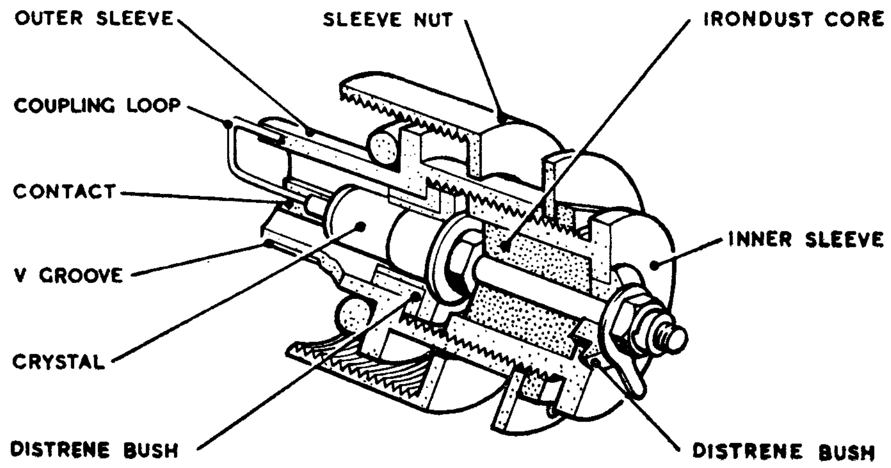


Fig. 9. Detector unit 4248—mechanical details

Resonator Unit

37. The resonator is a brass cylinder whose internal dimensions determine its resonant frequency. The control spindle alters the position of an internal plate which acts as the end wall of the cylinder and thus alters the resonant frequency. The interior of the cavity is polished and silvered resulting in a Q factor of approximately 40,000. The control spindle has an integral pinion which, meshing with a spur wheel, drives a shaft on which a dial is fitted. The dial, viewed from the front of the main unit, is calibrated in frequency. (Further details of cavity resonators will be found in A.P.1093E, Chap. 5).

Detector unit 4248

38. The mechanical construction of the detector unit (Stores Ref. 10S/16611) is given in fig. 9.

39. A single loop couples RF energy from the cavity, via a slot in the cavity wall, to a crystal valve. The unit is located in a union, soldered to the cavity wall, by a " V " groove in its outer sleeve and a key pin in the union ; when the sleeve nut is screwed up securely, correct coupling is ensured. One end of the coupling loop is soft soldered to the outer sleeve, the other end is soft soldered to a contact which locates the probe of the crystal. Connection is made to the body of the crystal by a contact which passes through a dust-iron core and through an insulating bush in the end face of the inner sleeve where it is held by a stiff-nut. The dust-iron core fills the space between the contact and the inner sleeve, which is at earth potential, and by-passes any stray RF energy which would otherwise give an erroneous reading on the tuning meter.

40. The output from the detector unit is insufficient to give a reading on the tuning meter directly. It is therefore amplified in amplifying unit 4246 (Stores Ref. 10U/16835).

Amplying unit 4246

41. A circuit diagram of the unit is given in fig. 10.

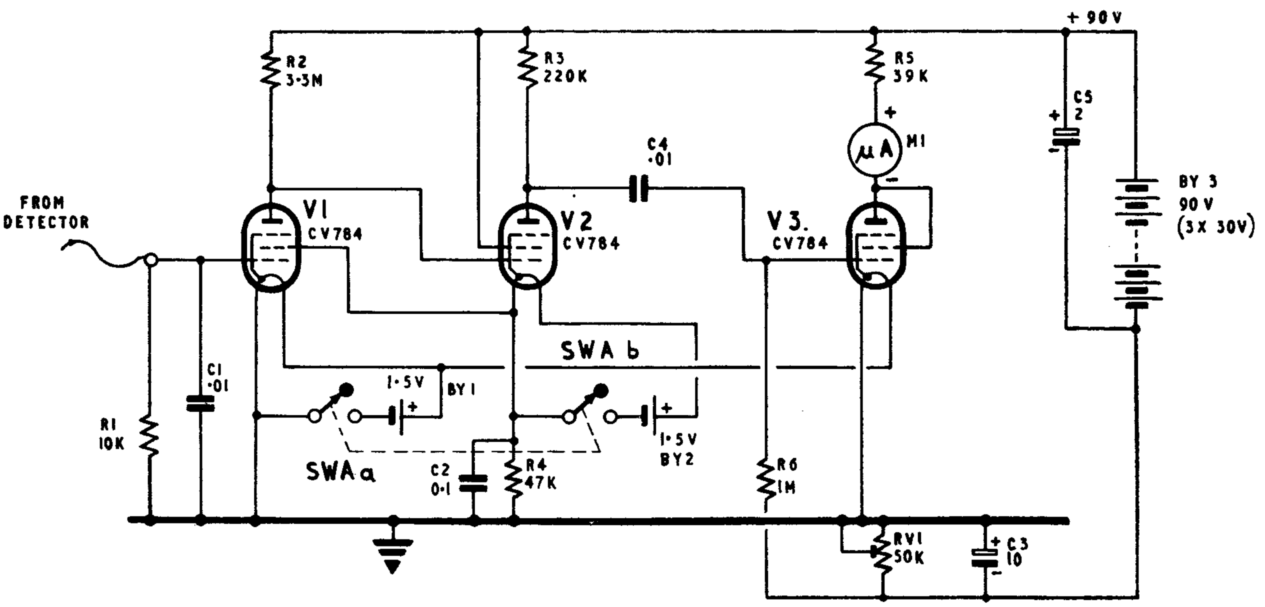


Fig. 10. Amplifying unit 4246—circuit diagram

42. Valves V1 and V2 form a " starved " direct coupled two stage amplifier. A pentode is said to be starved if its screen voltage is lowered below about 10 per cent of the HT supply and its anode load is increased well above conventional values. Under these conditions, although the mutual conductance of the valve is decreased, the amplification factor is greatly increased and stage gains much larger than usual are obtainable.

43. The anode of V1 is directly coupled to the grid of V2. A feedback connection from the cathode of V2 to the screen of V1 helps to stabilize the circuit and also provides the necessary low screen potential for V1. The output from V2 is coupled via capacitor C4 to the grid of an anode bend detector V3. A microammeter M1 indicates the anode current of V3 and is the resonator tuning meter. The pre-set potentiometer RV1 sets the bias on V3 and is adjusted initially to give an anode current of 20μA under no-signal conditions which ensures that the valve is working on the bend of its anode characteristic. If the batteries are changed RV1 should be re-adjusted as necessary. (Valves V1. V2 and V3 are diode-pentodes but the diode portion is not used).

44. The unit is supported on four resilient mounts on the back of the front panel of the resonator. The meter and switch are not supplied as part of amplifying unit 4246; they are mounted separately and their connections to the amplifying unit are made by flexible leads. When changing the filament batteries BY1 and BY2 care should be taken to enure that the leads are correctly reconnected.

Construction

45. All components are mounted on the rear of the cast aluminium front panel. In order to prevent the ingress of moisture, which would cause tarnishing of plating and the general deterioration of the components, the unit is fully sealed. A neoprene gasket is fitted between the front panel and the outer aluminium case, which is secured by twenty $\frac{3}{16}$ W. cheese-headed screws. Spindle sealing rings are used on the two control spindles and gaskets are used between the front panel and the three windows, the amplifier on/off switch and the R.F. INPUT plug. As an added precaution against moisture, a desiccator is fitted internally and is visible on the front panel of later models.

GATING UNIT

GENERAL

46. Views of the unit are given in fig. 3, 17, 18 and 19.

47. Blocking oscillators are used to produce two gating pulses each of 3 μS duration, one occurring 10 μS after and the other approximately 30 to 40 μS after the commencement of the transmitter pulse. The duration of the pulses is determined mainly by the transmission time of a delay network in the grid circuit of the blocking oscillators. The two pulses gate the receiver output, signal and noise appearing in the first gate and noise only in the second gate, and after rectification DC voltages proportional to the amplitude of the signal in each gate are obtained. These two voltages are compared with each other and give a reading on a centre zero meter. The circuit is so arranged that the meter indicates zero when the output in the first gate is twice that in the second gate.

48. Meter unit 4077 (Stores Ref. 10AF/540) and a 15 ft. connector (Stores Ref. 10HA/13430) are provided for use when conditions are such that it is impossible to operate the gating unit and the resonator adjacent to one another. Its meter is connected in parallel with that on the gating unit and the movements are duplicated. The meter unit is normally stowed in the clip provided on the inside of the cover, and the connector is normally stowed, with other connectors, in the space above the gating unit chassis.

CIRCUIT DESCRIPTION

49. A circuit diagram of the unit is given in fig. 22 and waveforms appearing at different points in the circuit are given in fig. 11 and 12.

Gate generating valves

50. A positive or negative step pulse of approximately 20V amplitude, one edge of which coincides with the commencement of the transmitter pulse, is required to trigger the gating unit. This edge determines the timing sequence of the unit and must produce a positive pulse at the grid of V1B. The trigger pulse therefore is applied to the grid of a polarity selector valve V1A via socket SK1 (TRIGGER). This valve acts either as an inverter or a cathode follower depending on the setting of the selector switch SW1 (TRIGGER) and the pulse is then passed via the differentiating circuit C2, R5 to the grid of V1B.

1st blocking oscillator

51. During inactive periods the grid of V2A is held at approximately −15V by the resistors R19 and R20 across the −150V line; the cathode is earthed, and the valve is cut off.

52. The circuit is triggered by the positive pulse applied to the grid of V1B. V1B conducts, producing a drop in voltage at its anode and consequently also at the anode of V2A. This drop is inverted by TR1 and drives the grid of V2A above cut off causing its anode to fall still further. The action is cumulative, rapidly driving the grid positive and reducing the anode potential to approximately 20V. The large grid current flowing through TR1 and R19 produces a negative voltage step at the junction of R19 and DN1 which travels down the delay line DN1. It is reflected at the open circuited end with no change of sign and returns up the line producing a further negative step at the input end which cuts off the valve. The anode of V2A rises rapidly to HT, positive over-swing which might re-trigger the action being prevented by the

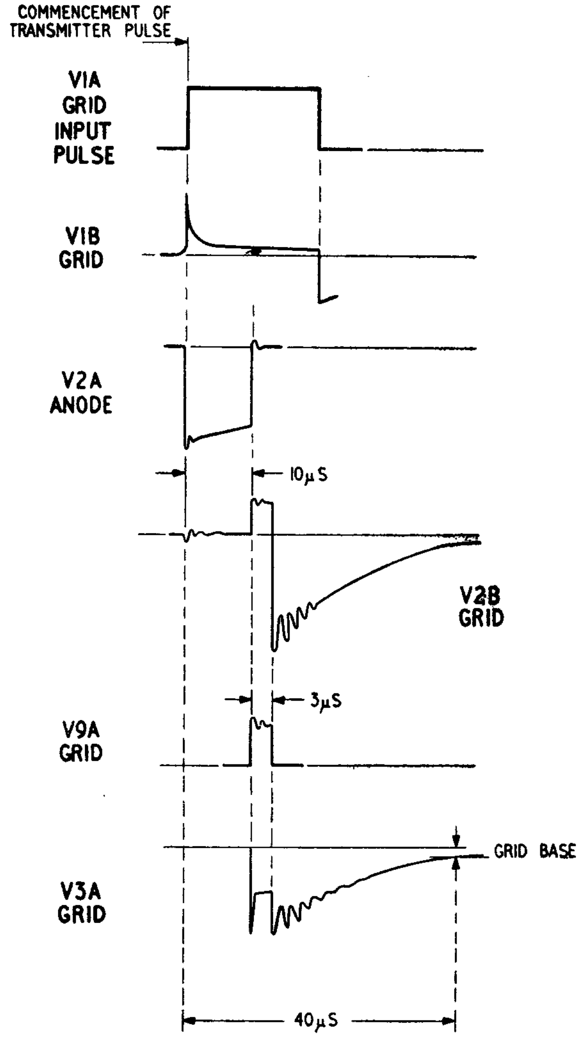


Fig. 11. Gating unit—Waveforms A

crystal diode V17 and resistor R38. The delay line recharges to −15V through R19 and R20 and the circuit awaits the arrival of the next triggering pulse.

53. The double transit time of the delay line is 10 μS; therefore the output at the anode of V2A is a negative pulse of large amplitude and 10 μS duration. This is differentiated by C3, TR2 and R8 and fed to the grid of a 2nd blocking oscillator V2B.

2nd blocking oscillator

54. The grid of V2B is normally held at approximately −15V by the resistors R8 and R9 across the −150V line; the cathode is earthed and the valve is cut off. The differentiated back edge of the pulse at the anode of V2A drives the grid of V2B positive and thus initiates the cumulative action as in V2A. The delay line DN2, acting in the same manner as DN1, determines the duration of the output pulse which is 3 μS. The crystal diode V16 prevents multiple action.

55. The tertiary winding of transformer TR2 inverts the negative pulse at the anode of V2B and the positive 3 μS pulse is then fed to the grid of V9A. As the blocking oscillator was triggered by the back edge of the pulse from V2A anode, the 3 μS pulse is delayed by 10μS on the radar transmitter pulse. The negative pulse at the secondary of TR2 is fed via capacitor C4 to the grid of V3A which together with V3B forms the 3rd blocking oscillator.

3rd blocking oscillator

56. V3A is normally conducting but is cut off on the arrival of the negative pulse at its grid. V3A and V3B anodes therefore rise to HT potential and the circuit is ready for triggering. After 3 μS the grid of V3A commences to rise, the time of the rise depending on the charging time of delay line DN2 to −15V, and is approximately 20-30 μS. After this time V3A starts to conduct again, the circuit is triggered and an output pulse is produced. The pulse duration is 3 μS, being determined by the delay line DN3 as previously described for DN1 and DN2.

57. A positive pulse of 3 μS duration therefore is produced from the tertiary winding of TR3 approximately 30 to 40 μS after the commencement of the radar transmitter pulse, and is fed to the grid of V9B.

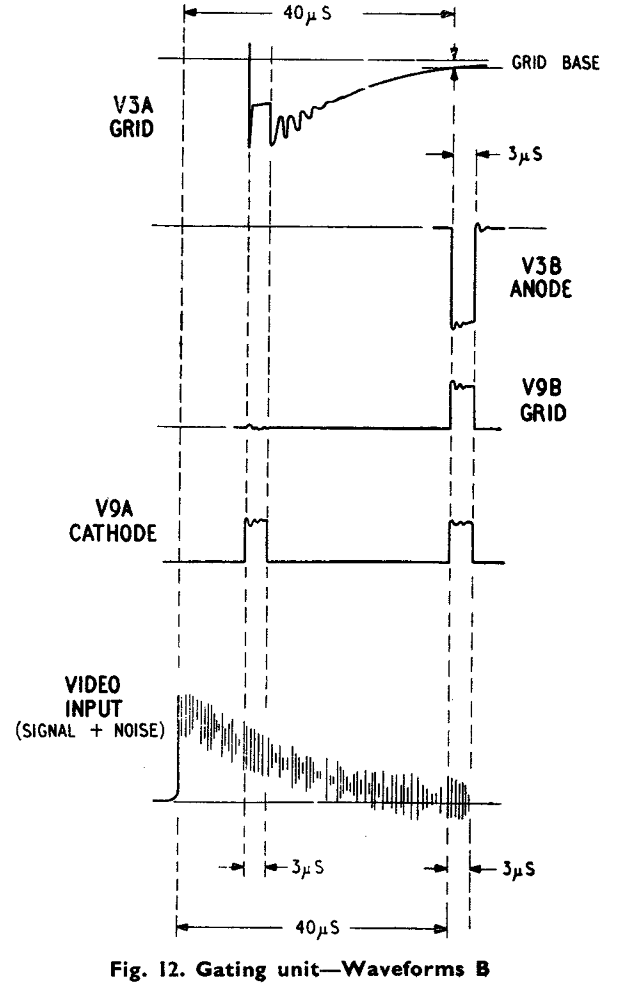


Fig. 12. Gating unit—Waveforms B

Gating and comparison valves

58. The video signals from the radar receiver are fed into the unit at SK2 (VIDEO). If positive, SW2 (VIDEO) is put to POS and they are connected via C9 to the grid of the cathode follower V5A. If negative, SW2 is put to NEG and they are inverted by TR4 before being fed via C9 to the grid of V5A (*Mod.* 3864/3). In either case, therefore, there is a positive output from the cathode of V5A, which is fed via C10 to the grid of V7.

59. The diode V6 (CV2384, *Mod.* 3771/2) is a DC restorer. It is biassed to a suitable point by the grid leak R23 which has been kept as high as practicable for good DC restoration. Owing to the characteristics of V6, however, restoration takes place at a point slightly more negative than −150V ; the diode is temporarily biassed to this point by switching R22 (390K) in parallel with R23 when checking the zero of the unit. This ensures that the positive-going pulses on the grid of V7 always commence from the same optimum potential.

Gating valves

60. The amount of current which flows through the two halves of valve V9 is determined by the grid potential of V7 and is therefore proportional to the video signal strength.

61. The grids of V9 are normally at approximately −12V ; the cathodes are held at earth by the diode V8B, and the valve is cut off. When a gating pulse from TR2 or TR3 is fed to a grid of V9, the appropriate half of the valve conducts ; the cathode of V9 and the anode of V7 rise ; V8B cuts off, and the anode current of V7 is drawn through the conducting half of V9. Hence a current pulse proportional to the signal and noise at V7 grid 10 μS after the commencement of the transmitter pulse flows through V9A. Similarly a pulse flows through V9B proportional to the receiver noise only at V7 grid 30 to 40 μS after the commencement of the transmitter pulse.

62. The current through V9 causes the anode potentials of V9A and V9B to fall ; diodes V10B and V10A conduct charging capacitors C13 and C11. If C13 receives twice the charge received by C11 during the gating periods, i.e., the signal

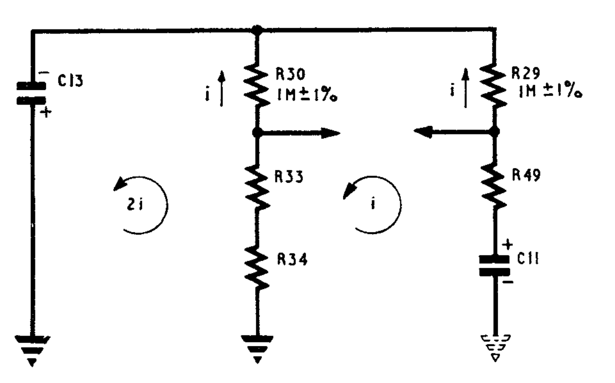


Fig. 13. Discharge paths of C11 and C13

and noise after 10 μS is twice the noise after 30 μS then the average discharge current flowing into the junction of R29 and R30 will consist of equal contributions from C11 via R29 and from C13 via R30. (*fig.* 13). Since R29 and R30 are of equal value the voltage drop across each will be equal and the junction of R29 and R49 will be at the same potential as the junction of R30 and R33. Potentiometer RV2 (SET ZERO) is provided so that the circuit following can be balanced ; the potential at the centre of its travel is effectively that at the junction of R32 andR33.

63. V5B with its cathode load R24 and RV1 is in parallel with the signal and noise gate valve V9A. Its anode current charges C13, irrespective of the current through V9A, by a fixed amount and increases the mean voltage at the junction of R29 and R49. This voltage varies with p.r.f. as the mean current varies and therefore by adjusting the preset potentiometer RV1, V9A and V9B may be balanced under no-signal conditions for a given p.r.f. as detailed in para. 17 (4). The voltage variation at the junction of R24 and R49 due to change of p.r.f. could be taken up by making RV2 cover a greater voltage range than that for which the circuit is designed. This would however make the setting of RV2 too coarse for the balancing of the comparison valves.

Comparison valves

64. The potentials of the wiper of RV2 and the junction of R29 and R49 are applied to the grids of the comparison valves V11A and V11B (R35 and C15 form a smoothing circuit). These valves have identical anode and cathode loads and hence the meter connected between their cathodes indicates any unbalance in the circuit.

65. Under no-signal conditions the circuit is balanced by RV2, i.e., the grid potentials of V11A and V11B are made equal and no current flows through the centre-zero meter. When the video signal is applied to the unit and the signal to noise ratio is unity the grid potentials of the comparison valves will again be the same and the meter reads zero.

Note . . .

*When balancing the gating unit, SW3 (*CHECK ZERO*) should be depressed. As mentioned in para. 59 this sets the bias on V6 to the point at which DC restoration takes place. Hence, when the video signals are applied, the sig/noise ratio is always measured with respect to this point.*

66. The metal rectifier MR1 provides meter damping and some protection when large voltage differences exist on the cathodes of V11. The connection to the external meter is made at PL2, both meters then being in circuit ; when the external meter is not in use SK3 should be connected to PL2.

67. The preset potentiometer RV3 is a sensitivity control ; it is set during the manufacture of the unit and should not normally require re-adjustment.

68. Valves V12A and V12B provide a degree of negative feedback to prevent drift, to allow unselected valve changes to be made, and generally to stabilize the circuit.

Supplies

69. Power supplies to the gating unit enter at plug PL1. These are ± 230V and 6.3V and are derived from power unit (1,600 c/s) 910 or power unit (50 c/s) 911. Only the former is supplied as part of performance testers 105 or 106 but general views and a circuit diagram of the 50 c/s power unit are given in fig. 23 to 26. The two units operate similarly.

70. Supplies of ±150V, stabilized by the neon valves V13 and V14, are derived from the ±230V lines and —12V is derived from a tapping between the —150V stabilized line and earth.

POWER UNIT (1,600 c/s) 910

GENERAL DESCRIPTION

71. A general view of the unit is given in fig. 3; internal views of the chassis are given in fig. 15 and 16; a circuit diagram is given in fig. 14.

72. An input connector (Stores Ref. 10HA/13875) is supplied with the unit and is normally stowed in the space provided above the chassis.

73. The power unit is suitable for operation at 80V or 115V at frequencies between 1,000 c/s and 2,000 c/s. The input supply to the unit is fed through the 2-pole plug PL1 switch SW1, and fuse FS1 to the primary of transformer TR1. Suitable tappings to the transformer primary are made by screwing plugs into the appropriate positions on a board located under a hinged cover on the front panel.

74. The secondary windings of the transformer supply 6·3V at 0·6A and 6·3V at 3·6A for heaters, and 220V to each of two full-wave rectifiers V1 and V2. V1 produces approximately +230V on full load smoothed by C1, L1 and C2. V2 produces approximately —230V on full load smoothed by C3, L2 and C4. The outputs are taken to the pins of the 6-pole socket SK1.

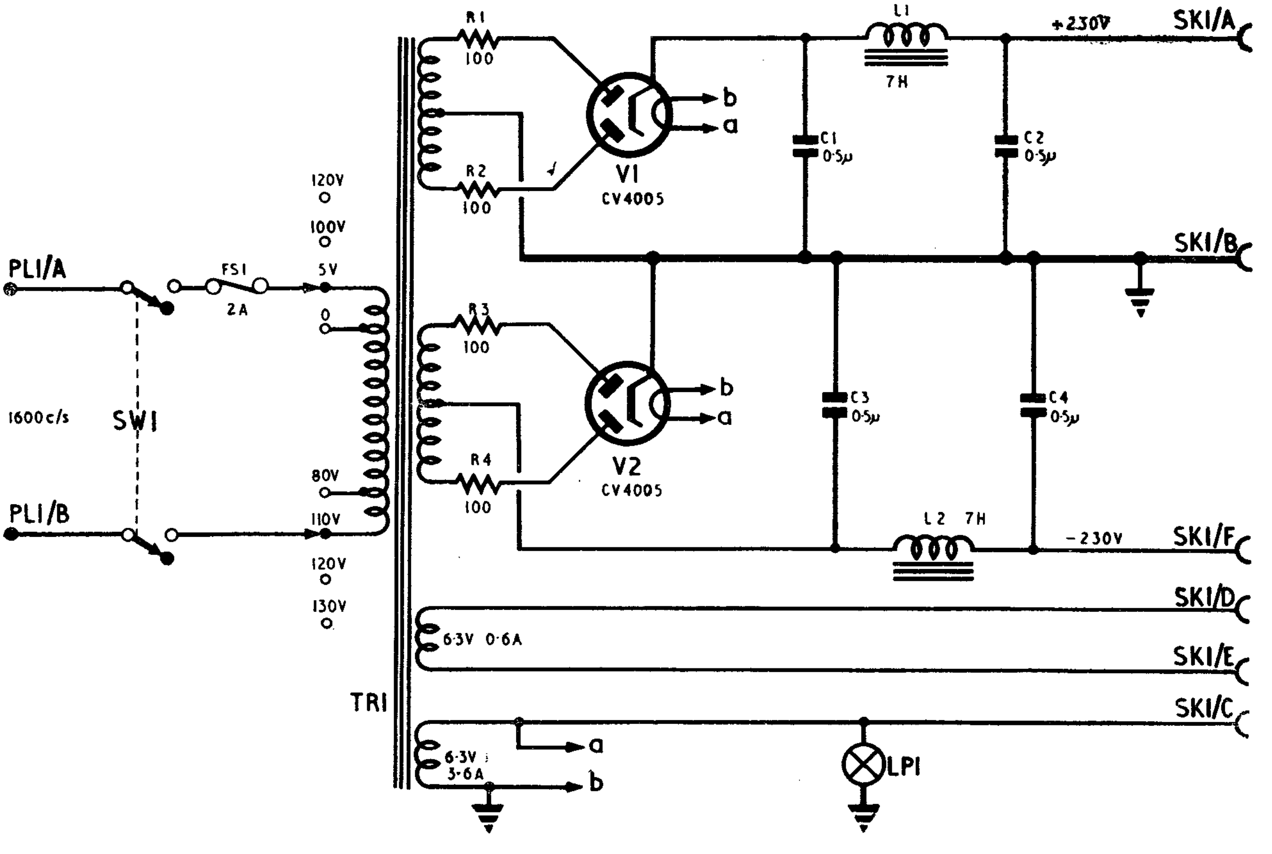


Fig. 14. Power unit (1,600 c/s), Type 910—circuit diagram

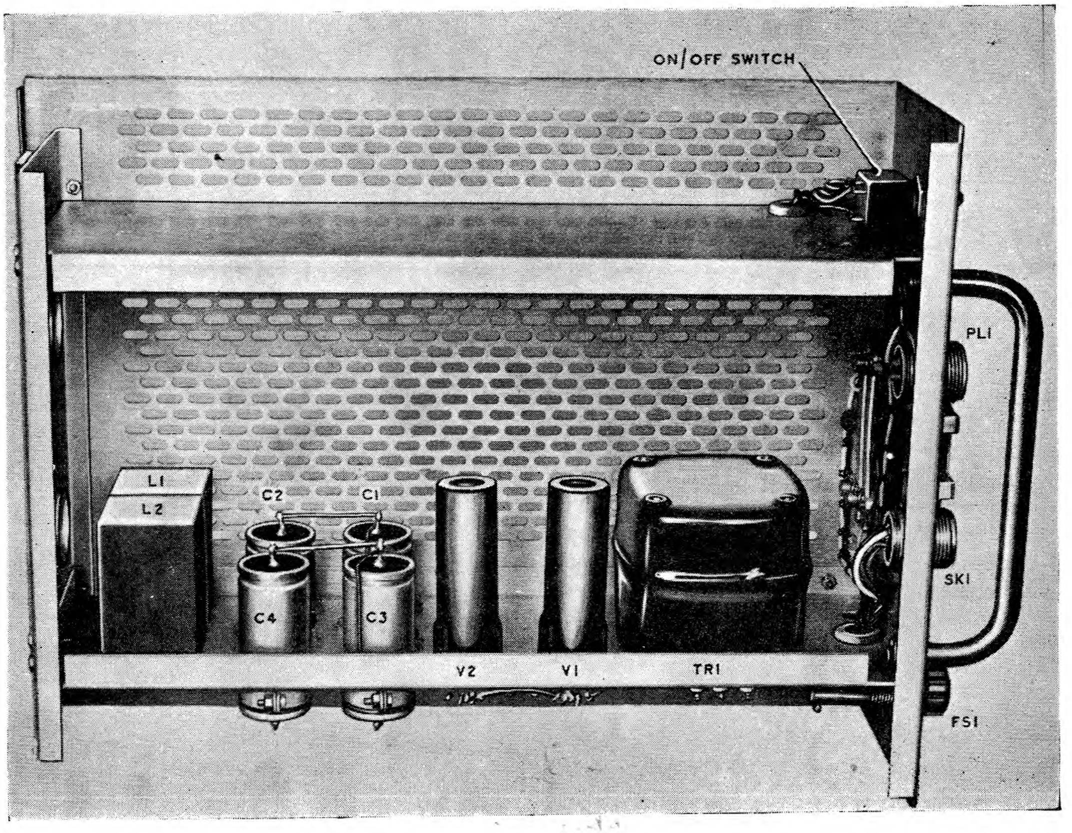


Fig. 15. Power unit (1,600 c/s), Type 910—bottom view

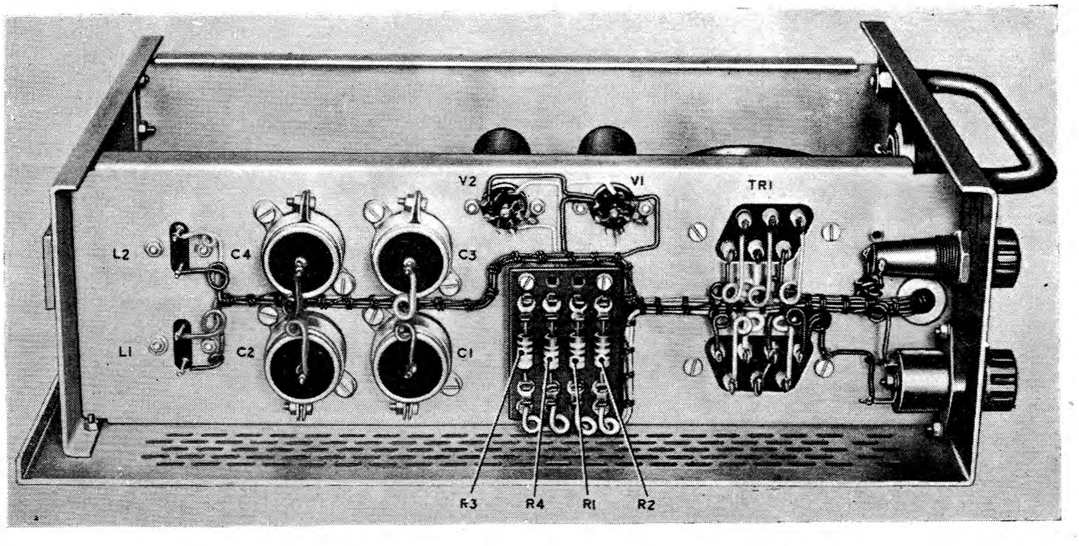
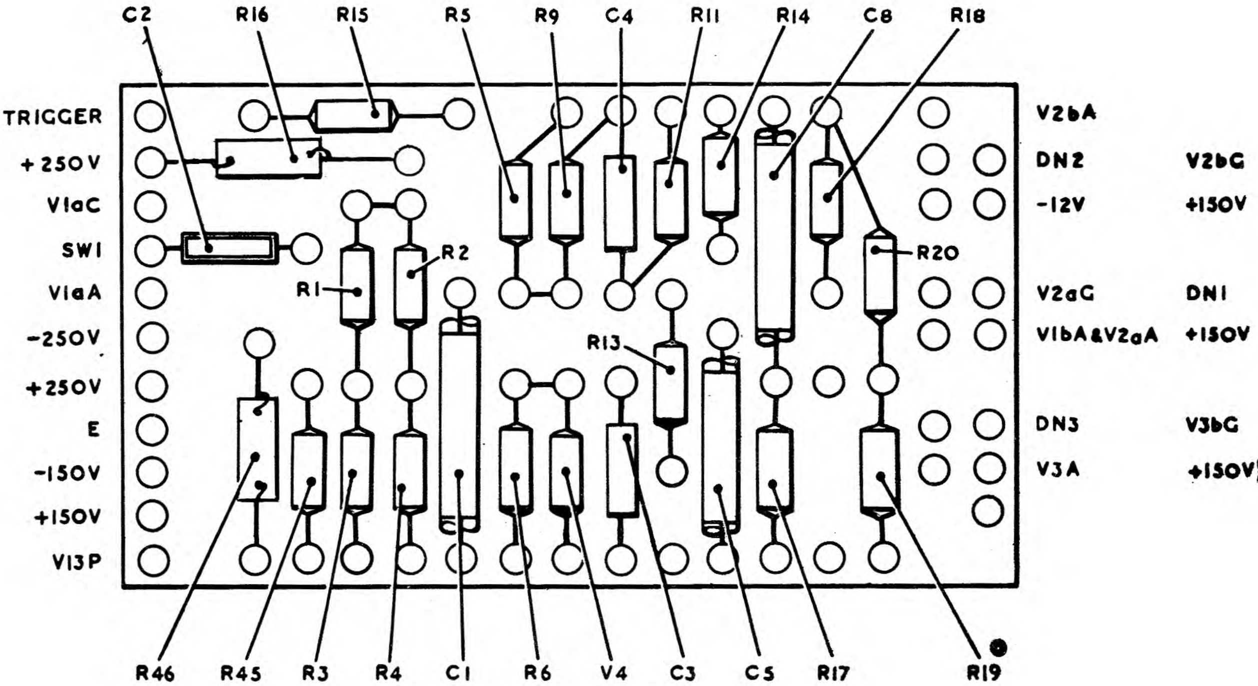


Fig. 16. Power unit (1,600 c/s), Type 910—right-hand view



TAG BOARD "A"

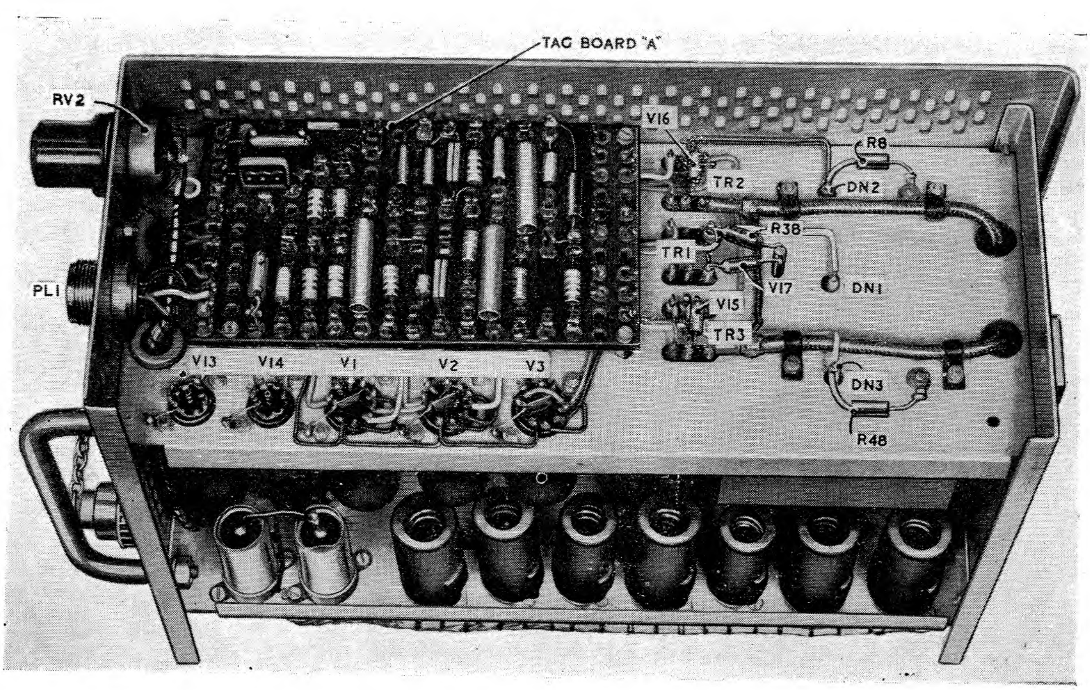
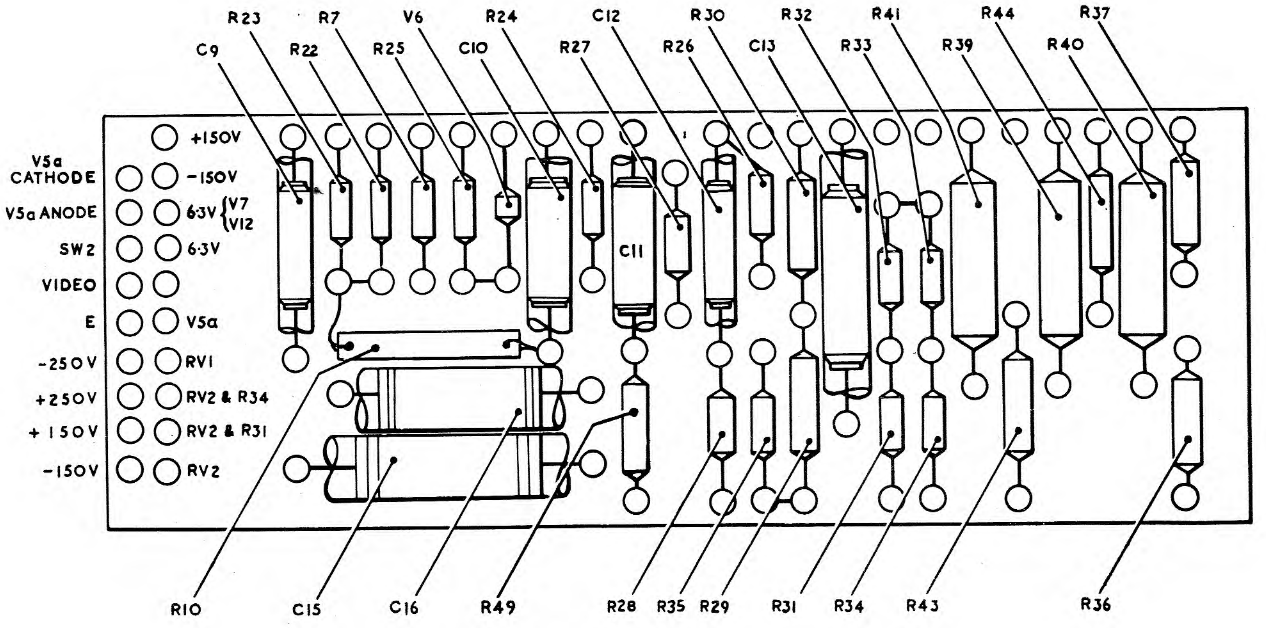


Fig. 17. Gating unit—right-hand view



TAG BOARD "B"

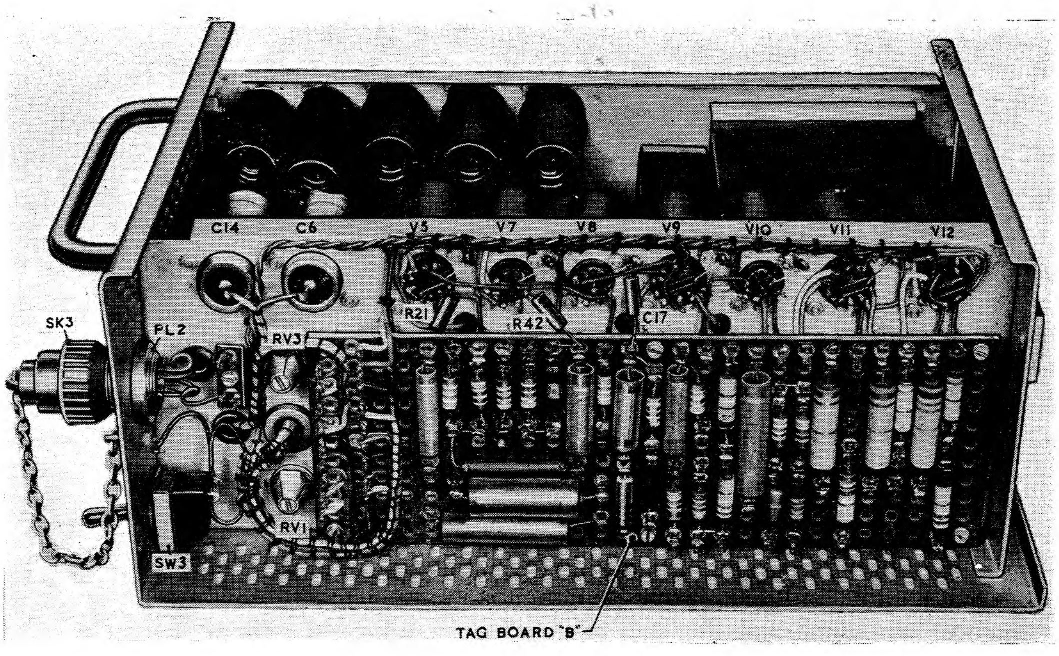


Fig. 18. Gating unit—left-hand view

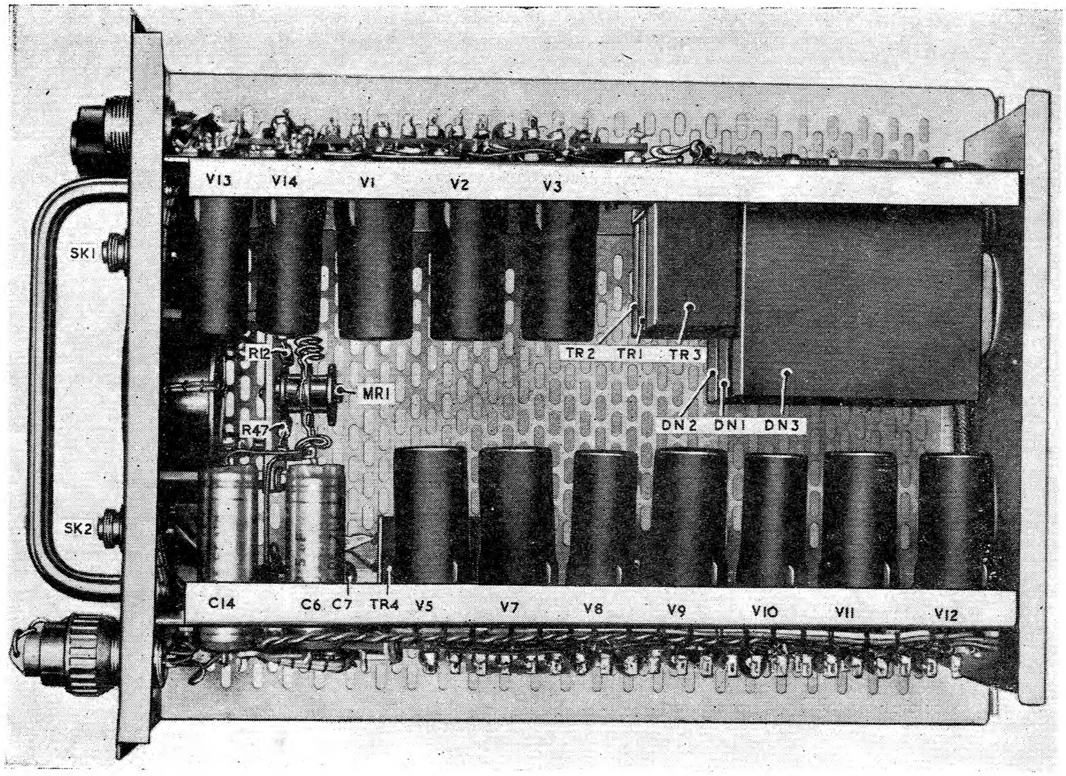


Fig. 19. Gating unit—bottom view

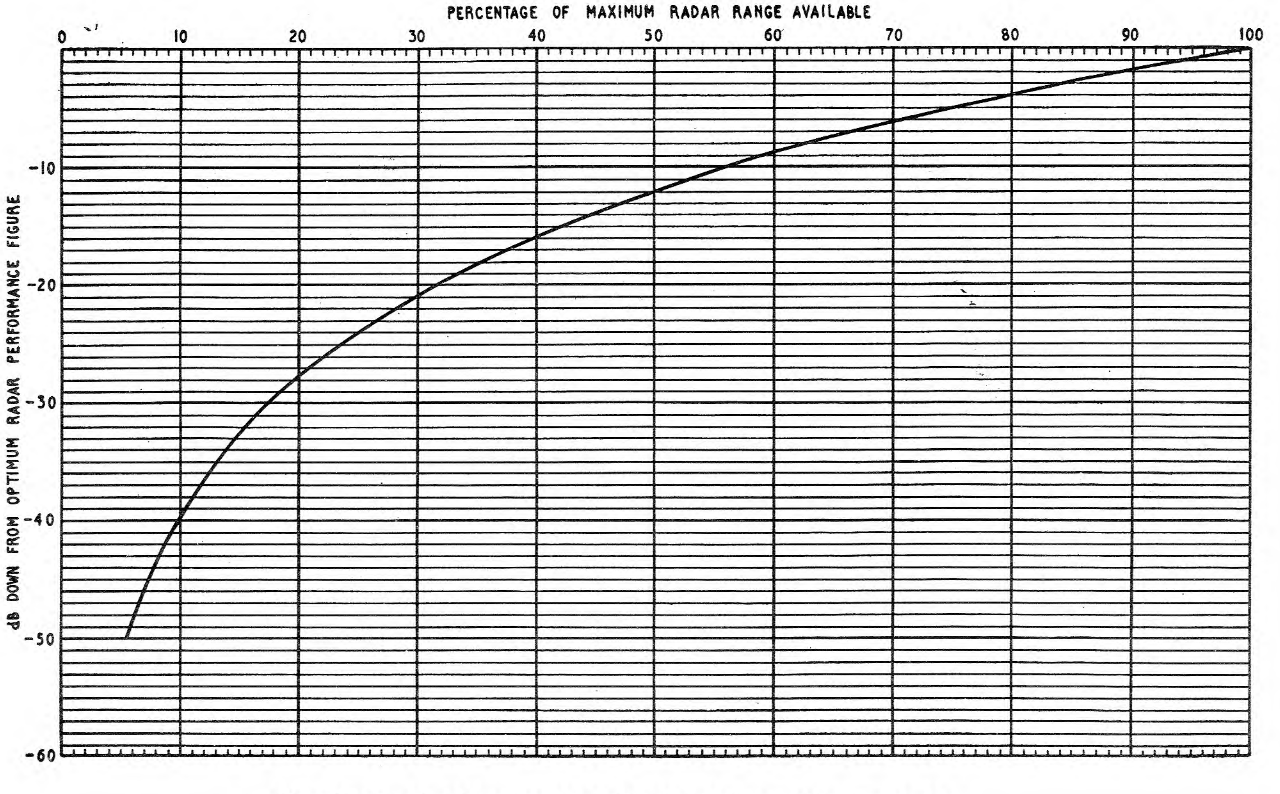


Fig. 20. Graph of performance figure versus maximum range

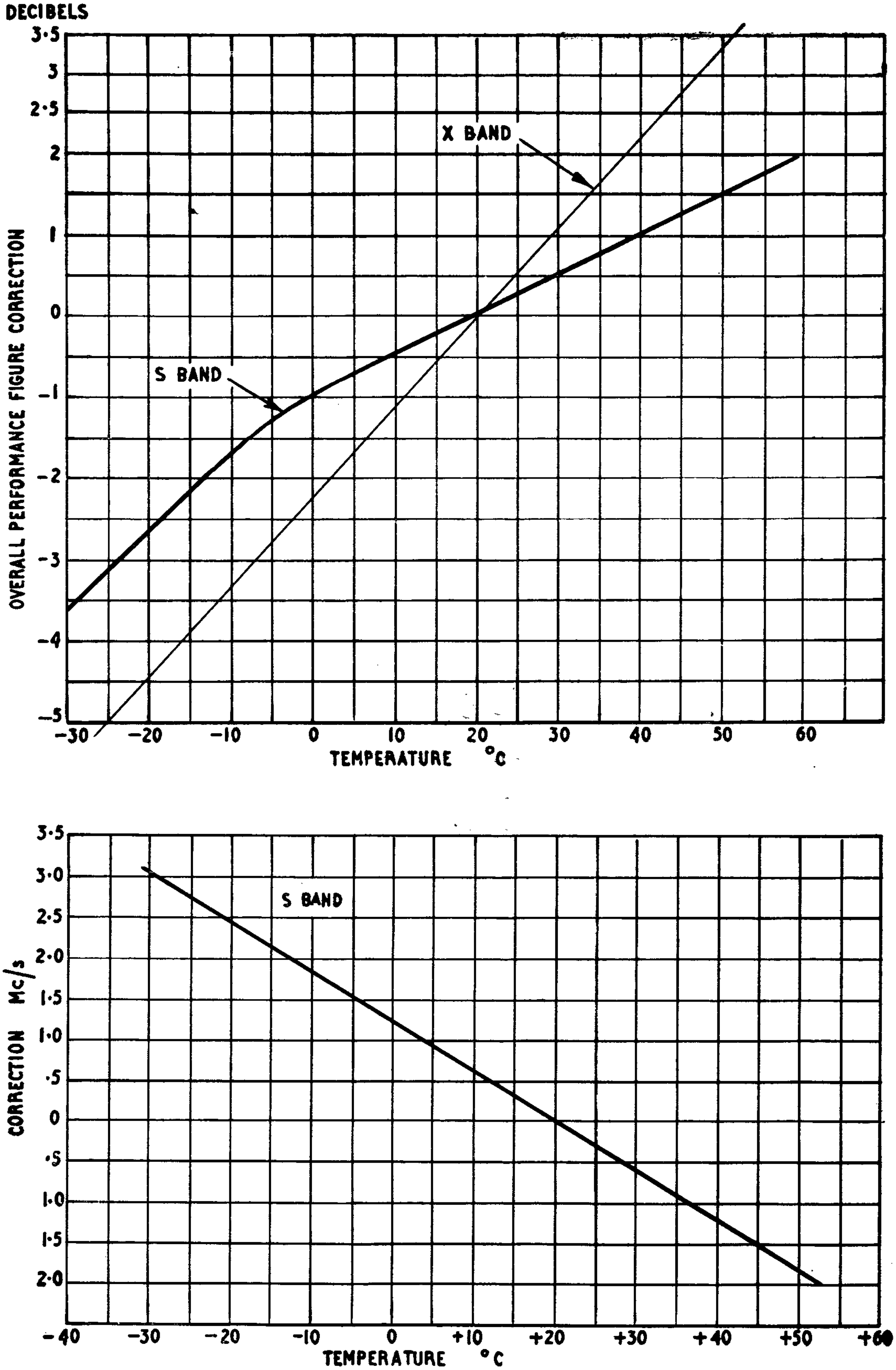


Fig. 21. Correction graphs

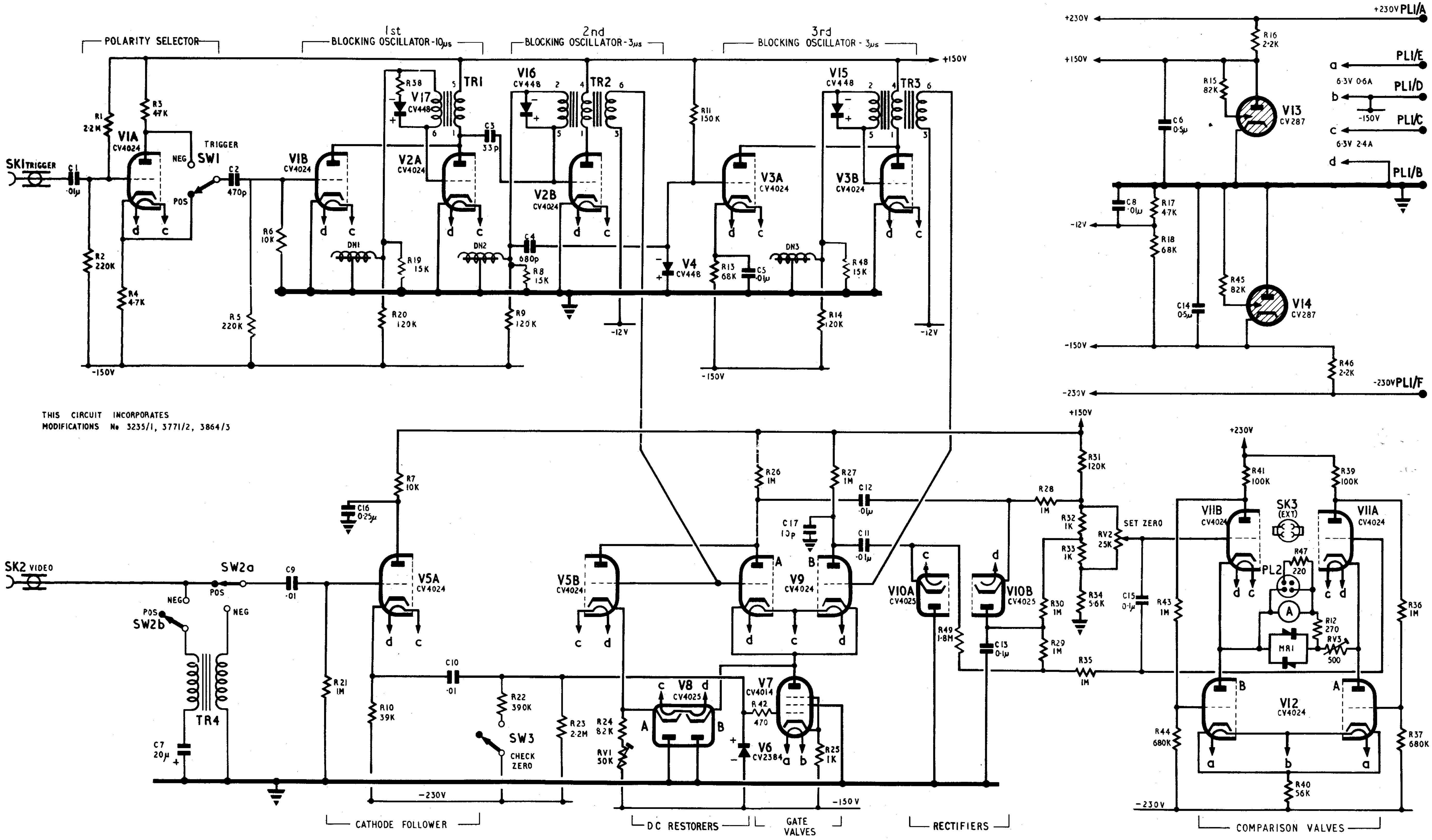


Fig. 22

Gating unit-Circuit diagram

Fig. 22

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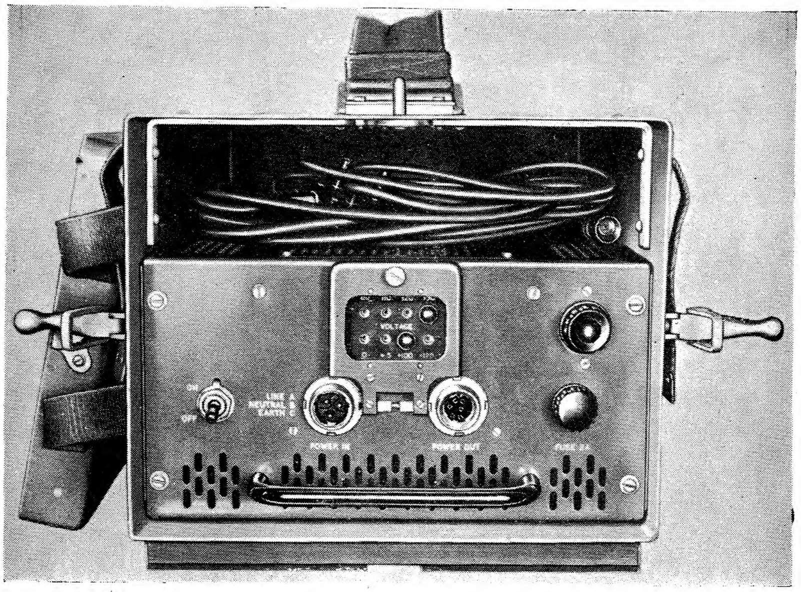

Fig. 23. Power unit (50 c/s) Type 911—front view

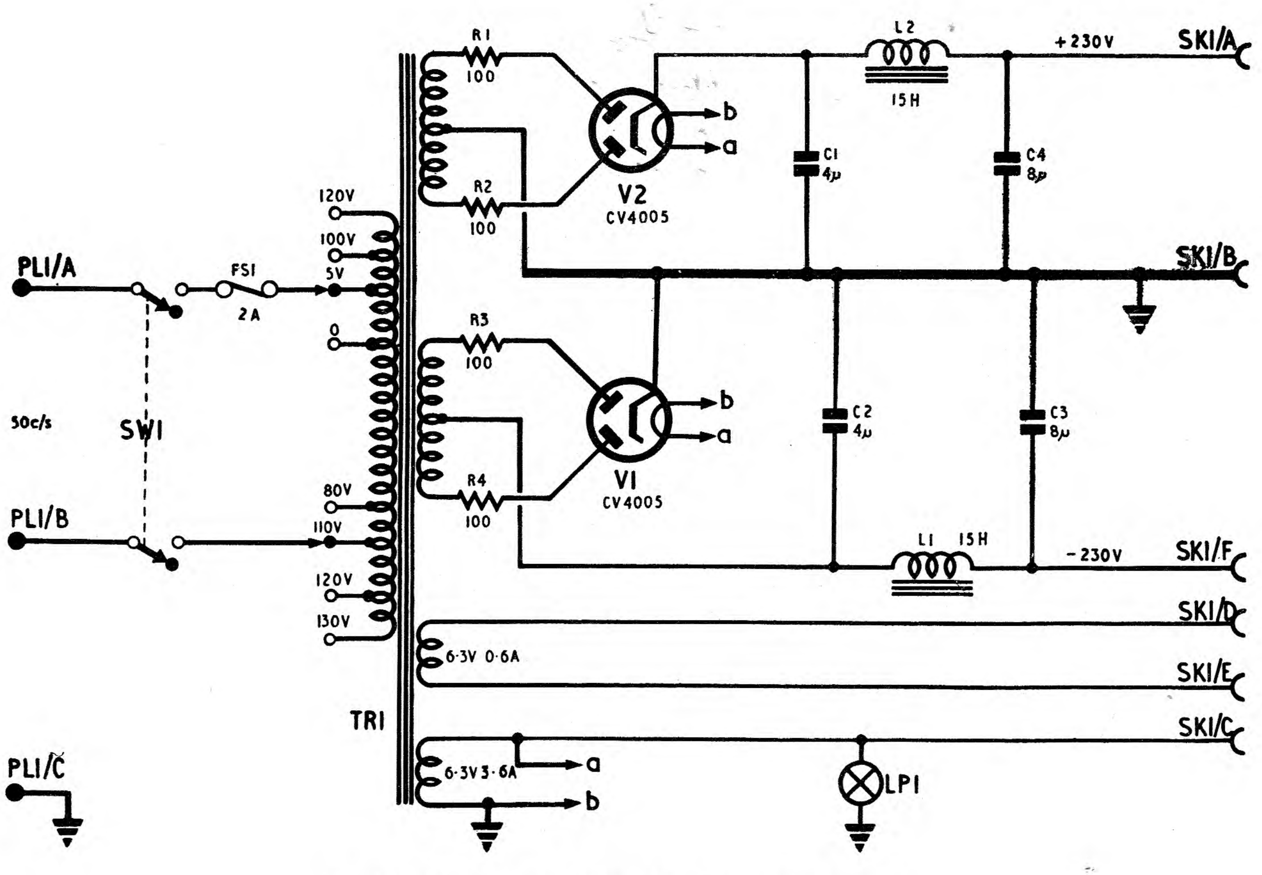

Fig. 24. Power unit (50 c/s) Type 911—circuit diagram