NOISE GENERATOR CT.513

GENERAL AND TECHNICAL INFORMATION

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MINISTRY OF DEFENCE

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Chapter 1

GENERAL DESCRIPTION

(Completely Revised)

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INTRODUCTION

1. Noise generator CT513 (Type M30) is a wide-range instrument providing high-level uniform-spectrum random noise (i.e. white noise) over the audio frequency and lower radio frequency ranges, from 30Hz to 5MHz.

2. Among the principal uses of this instrument are the investigation of interference and cross-talk on multi-channel carrier systems, the testing of filter networks and the measurement of loudspeaker and microphone responses.

3. A front view of the instrument, showing the operating controls, is given in fig. 1. The function of each control is listed in Table 1.

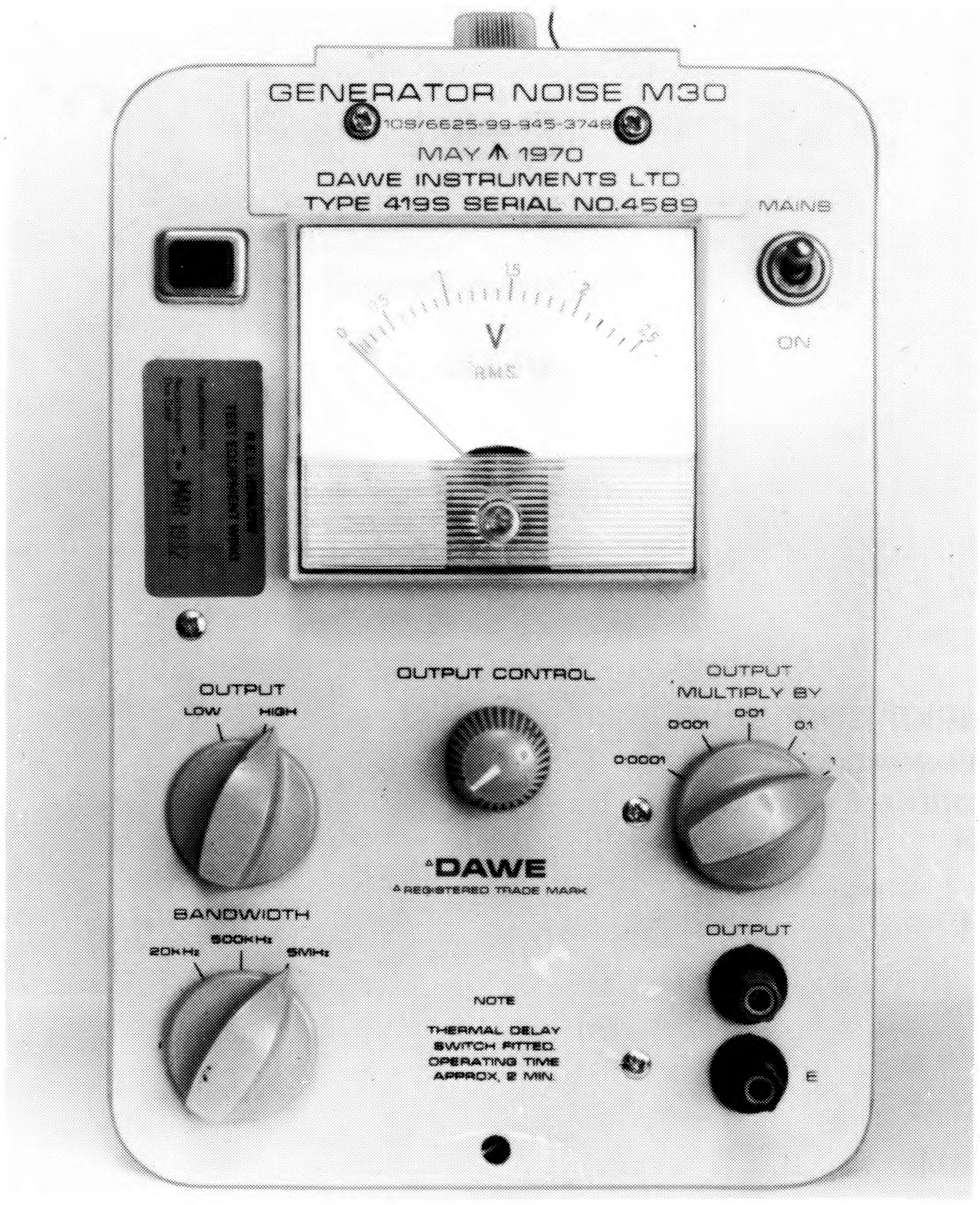

Fig. 1 Front view

4. The frequency range of 30Hz to 5MHz is covered in three bands:

20KHz	This extends from 30Hz to 20KHz
500KHz	This extends from 30Hz to 500KHz
5MHz	This extends from 30Hz to 5MHz

5. The generator is a self-contained unit housed in a portable metal case. It consists of a thyratron oscillator and a wide-band amplifier with output control and metering. The built-in power unit operates either from 110V or 200-250V a.c. mains at frequencies between 50 and 60Hz.

CIRCUIT DESCRIPTION

THYRATRON NOISE GENERATOR (Fig. 2)

6. The noise source in the instrument is the thyratron V2, which is placed in a transverse magnetic field to damp the oscillations usually produced by a gas discharge and also to minimise the decrease in noise level at the high frequency end of the spectrum. The orientation of the permanent magnet, used to produce this transverse field, is adjusted for optimum noise output. This normally means that pin 7 of V2 is located adjacent to the north pole of the magnet.

Note . . .

The valve used in the V2 position is specially selected and aged.

WIDE-BAND AMPLIFIER

7. The noise signal from V2 is fed into a two-stage wide-band amplifier, using valves V3 and V4, with three alternative shaping networks between V3 and V4. The selection of the appropriate shaping network is controlled by the BANDWIDTH switch S2, which has three positions marked 20K , 500K and 5M . In the 20KHz and 500KHz positions, low-pass filters with gradual cut-off characteristics above 20KHz and 500KHz respectively are switched into the circuit. The shaping network for the 20KHz band consists of R10, R15 and L3 in conjunction with C8 and C10, whilst that for the 500KHz band consists of R11, R16 and L2 in conjunction with C9. In the 5MHz position a shaping network consisting of L1, R12, R13, R14, C6 and C7 is switched in to compensate for a peak in the noise output of the thyratron at 700KHz and a fall in level at the higher frequencies, thus providing a reasonably uniform spectrum output up to 5MHz.

OUTPUT CONTROL

8. The LOW/HIGH OUTPUT switch S1, when set to the LOW position, introduces the filter network R5, C3 between C2 and the grid of V3, giving a 10:1 attenuation of the noise output of the thyratron at the input to the wide-band amplifier. The OUTPUT CONTROL R24 is a continuously variable control in the anode circuit of V4 to enable the output voltage to be adjusted accurately by reference to the meter M1. The output then passes to the network R29, R31, R34, C20 to C22, where the OUTPUT MULTIPLY BY switch S3 taps off the output voltage multiplied by 0.0001, 0.001, 0.01, 0.1 or 1.0.

OUTPUT METER

9. The meter M1, which indicates the output voltage directly, is calibrated to read the RMS value of the white noise voltage at the OUTPUT terminals. It has a 0–100μA movement but the scale is calibrated 0–2.5V RMS; D1 and D2, both CV425, rectify the a.c. output from the amplifier. The pre-set potentiometer R26 is provided for adjustment of the meter calibration.

POWER SUPPLIES

10. The mains input transformer T1 has two primary windings, one 110V and one 130V, the latter tapped at 90V and 110V. For operation on a 110V supply, the selector switch S5 parallels the 110V winding and the 110V section of the 130V winding and connects them to the supply. For operation on 200V, 220V or 240V supplies, S5 connects the 110V winding in series with the 90V, 110V or 130V winding respectively and connects them to the supply.

11. The h.t. supply is derived from a full-wave rectifier V5, with a conventional double-section choke-capacitor smoothing circuit. The h.t. feed to the thyratron is connected via a thermal delay switch V1, which prevents damage to the thyratron when the generator is first switched on.

12. The heater supply to the thyratron is critical. There are two different build standards of equipment in use, with different heater circuit configurations. In some equipments the supply from the 19V transformer winding is current controlled by the barretter V6, and the voltage is set accurately to 6.1V by the pre-set potentiometer R33. In the other equipments the supply is rectified by the encapsulated bridge rectifier RT1 and controlled by a regulator circuit consisting of transistor VT1 and reference diodes D3 and D4. The voltage is again set by potentiometer R33. When fitted, the regulator circuit also supplies the heaters of valves V3 and V4, so on these equipments one of the 6.3V windings is omitted from the transformer.

13. A further difference between the two standards of equipment described in para.12 is in the arrangement of the mains indicator lamp LP1, which is either a 6V filament lamp or a neon indicator. (See fig.2)

Note . . .

The build standard of any given equipment must be determined by inspection.

TABLE 1 OPERATING CONTROLS

Control	Function
MAINS ON	Mains on/off switch
OUTPUT LOW/HIGH	Coarse control of output voltage. In the LOW position, a 10:1 attenuator is switched into circuit.
OUTPUT MULTIPLY BY	Medium control of output voltage. Switches in one of four attenuators. Front panel meter reading is multiplied by the switch setting.
OUTPUT	Continuously variable fine adjustment of output voltage, indicated by the front panel meter.

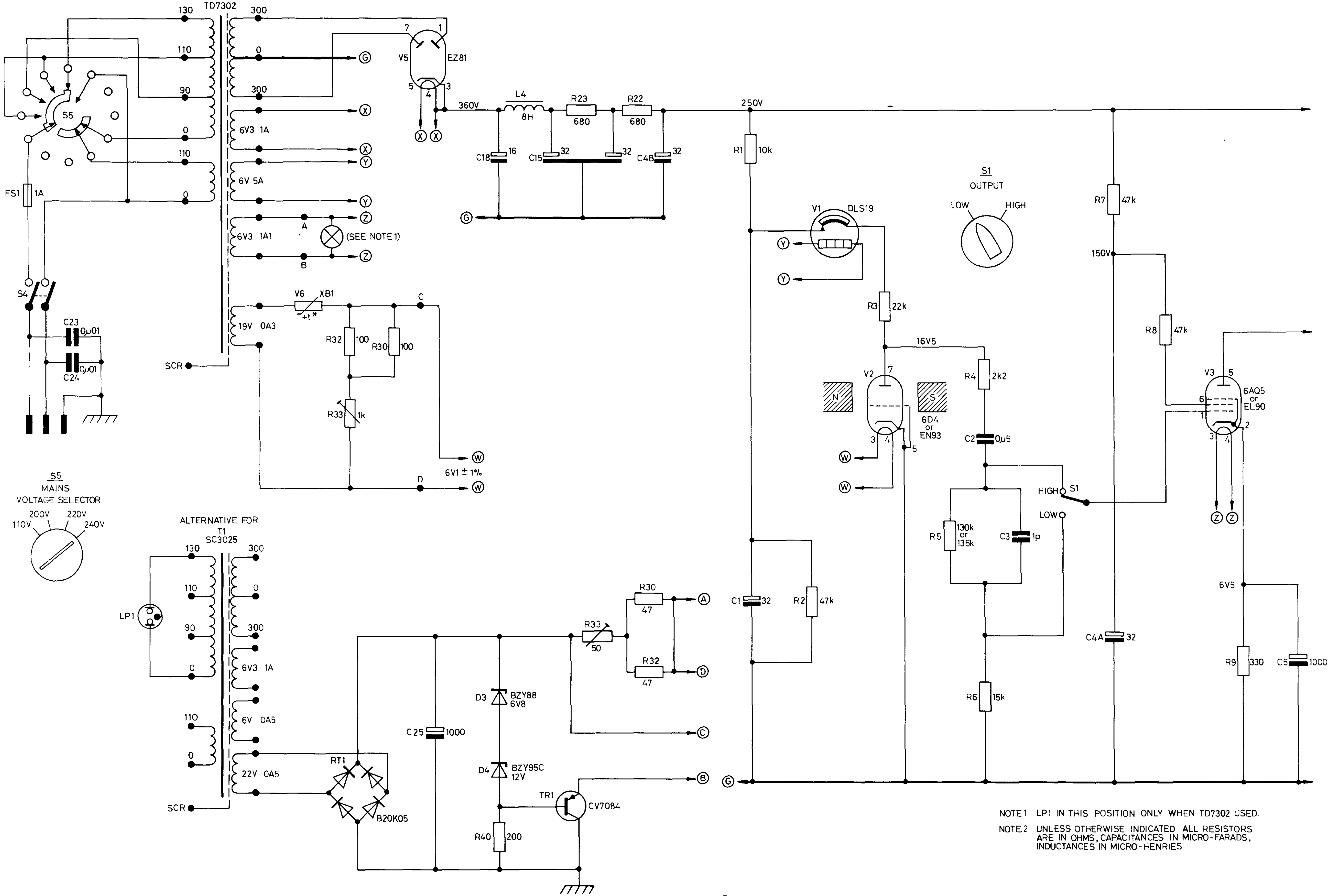

Fig. 2 Noise generator CT513: circuit diagram (Sheet 1 of 2)

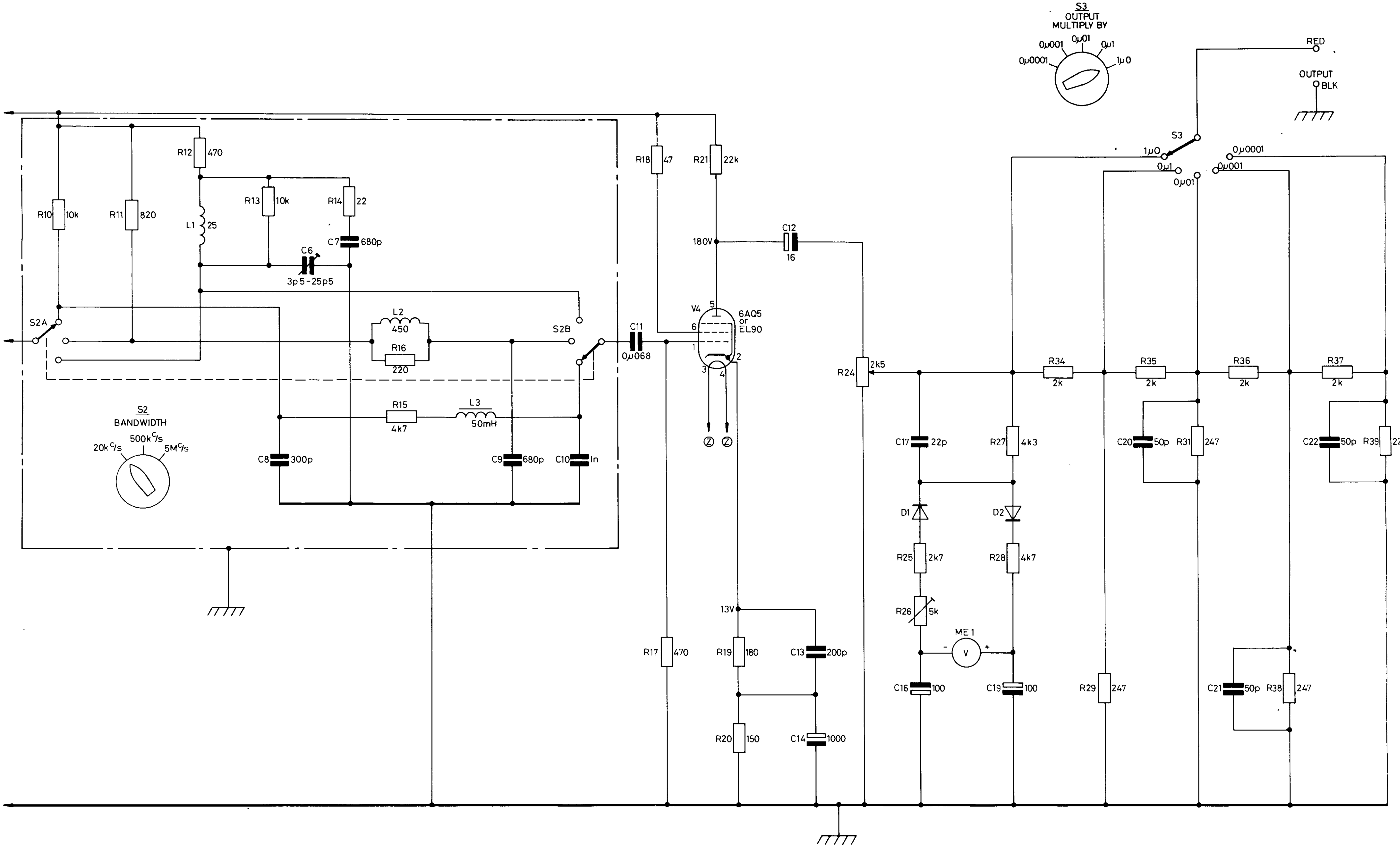

Fig. 2 Noise generator CT513: circuit diagram (Sheet 2 of 2)

Chapter 2

OPERATION

CONTENTS

PREPARATION FOR USE

POWER SUPPLY

1. Before connecting the instrument to a mains supply, it must be ensured that the mains selector switch S4 (see Chap. 3 fig. 3) is set for the correct a.c. voltage. For power supplies other than that quoted on the label it will be necessary to remove the Mk. 7 mains connector plug from the instrument and set the mains selector switch to the required a.c. supply voltage by means of the screwdriver adjuster thus made accessible. The switch adjuster is located on the rear panel behind a sliding shutter which covers it when the mains connector is attached to the instrument, thus preventing the switch adjustment being changed whilst the supply is connected.

2. When the equipment is first installed, a mains plug suitable for connection to the available power point must be fitted to the free end of the 3-core mains connector cable. The connections are:–

Plug pin	*Connector core colour*
Mains (line)	Brown
Mains (neutral)	Blue
Earth	Green/Yellow

VALVES

3. The valves are normally supplied fitted in their holders. A check on this may be made by removing the two side covers as detailed in Chap. 3.

OPERATING PROCEDURE

SWITCHING ON

4. With the MAINS/ON switch in the OFF position, connect the 3-pole socket of the mains connector cable to the corresponding Mark 7 plug, PL1, on the rear panel and connect the other end to the A.C. mains supply. Switch on the mains supply and set the MAINS/ON switch to the ON position, whereupon the pilot lamp should light.

WARMING–UP PERIOD

5. When the instrument is first put into operation, or after it has been standing idle for a long time, it should be run for ten to fifteen minutes before use. This time is required for the thermal delay switch, which protects the thyratron, to operate and for the valve heaters to warm up.

6. The instrument, when in normal daily use, will be ready for operation two or three minutes after switching on. This period is required, as described in para. 5, for protection of the thyratron and for the valve heaters to warm up.

BANDWIDTH SETTING

7. The BANDWIDTH switch should be set to the required frequency band. The engraved figures indicate the upper frequency limit for which the noise level is uniform.

OUTPUT CONTROLS

8. The required setting of the LOW/HIGH OUTPUT control will depend on the location of the instrument and the degree of hum which can be tolerated. In the design of the amplifier stages, a compromise has been reached between the provision of a high r.m.s. noise level at the output terminals and the unavoidable limitations of the peak excursions of the input voltage to the amplifier, which could, in theory, be infinite. In the LOW position of the LOW/HIGH OUTPUT control, this effect is less pronounced due to the introduction of a 10:1 attenuator between the thyratron valve and the amplifier input. The LOW position of this control also reduces the radiation of noise from the instrument which may, in some instances, cause interference to other r.f. equipment operating nearby. However, to minimise the hum level on all ranges, it is generally advisable to use the HIGH position of the LOW/HIGH OUTPUT control.

9. The continuously variable OUTPUT control is provided so that the output voltage can be accurately adjusted by reference to the panel voltmeter.

10. The voltmeter reading is only strictly true for a purely resistive load. A reactive load connected to the output terminals will affect the frequency spectrum of the noise power available and will degrade the accuracy of the voltmeter indication.

GENERAL OPERATING NOTES

11. When the 5 MHz bandwidth is used, the leads to the load should be made as short as possible to minimise the stray shunting capacitance which will reduce the level of the high frequency components of the noise output.

12. The hum level in the output is well below the average output voltage and its effect is least in the 20 KHz range, which has the highest energy level for a given bandwidth. A typical value of measured hum on this range is 20 mV r.m.s.

13. The hum will not normally be noticeable unless a sharply tuned analyser is used at, or near, the mains frequency. In these circumstances the increase in the analyser output, due to hum, should be taken into account when interpreting measurements.

14. Since the output is taken from a potentiometer, the source impedance varies with the potentiometer setting. When the output is varied from maximum to minimum the source impedance varies from 800 ohms through a maximum of about 1600 ohms to nearly zero when the potentiometer is at its minimum setting.

APPLICATIONS

A.F. CHECKS

15. For testing wide-range a.f. amplifiers and for making acoustical checks, the 20 KHz bandwidth is used. If an external power amplifier is used to supply more power to the device under test, care should be taken to avoid clipping; the noise output from the external amplifier should be analysed to ensure that the spectrum is uniform over the required frequency band. The white noise signal may be used for the determination of critical bandwidths.

INTERFERENCE TESTS

16. On the 500 KHz and 5 MHz bands white noise can be used for interference tests, filter tests and cross-talk investigations on multi-channel carrier telephony systems. The signal resembles the normal interfering signals encountered in communications systems and can be applied to test the susceptibility of the systems to interference, or for training operators to communicate through interference.

17. When a noise signal at a higher frequency than 5 MHz is required, the output from the noise generator can be used to modulate an r.f. carrier. Using the two sidebands resulting from normal modulation systems, a noise band of 10 MHz can be obtained, 5 MHz on each side of the carrier. For interference tests on receivers, the noise generator can be used to modulate a standard signal generator.

18. The wide frequency range of the generator facilitates rapid testing of elaborate filter networks or quick determination of the natural resonances in complex structures.

NOISE ANALYSIS

19. The generator may be used in conjunction with suitable wave analysers for noise analysis purposes. If measurements of noise are made by more than one analyser, the results obtained should first be referred to a common bandwidth preferably to an ideal one cycle band.

20. For noise analysis in the 500 KHz and 5 MHz bands, it will usually be necessary to extend the range of the analyser equipment. The normal procedure is to heterodyne the noise signal with an external oscillator and measure the intermediate frequency at a constant setting of the analyser. The effective bandwidth for noise will be twice the bandwidth of the analyser at the particular setting unless the means are provided to suppress one of the sidebands from the mixer. The effective bandwidth of the tuned circuit.in the mixer section should be much broader than the effective bandwidth of the analyser which follows the mixer.

Chapter 3

SERVICING

(Completely revised)

CONTENTS

INTRODUCTION

1. Before any servicing work is undertaken on this instrument, reference should be made to A.P.3158, Vol. 2 wherein the limitations on first and second line servicing of electronic test equipment are laid down. The description, in this chapter, of servicing operations is not to be taken as authorizing their performance at any stage of servicing other than indicated in A.P.3158, Vol. 2.

ACCESS

2. Access to the chassis is gained as follows

2.1 Unscrew the quick-release fasteners immediately above the nameplates at the bottoms of both front and rear panels.

2.2 Remove the metal bezels by grasping the bottom edges and pulling forwards and upwards. Remove the side covers by grasping the top edges and pulling out-wards.

2.3 If required, remove the cover over switch S2 and its associated components by removing two 4BA screws from the bottom edge.

VALVES

3. To replace valves, the instrument side covers must first be removed as detailed in para. 2. The valves, with the exception of the thyratron V2, are standard type; the thyratron must be one which has been specially selected and aged. It may also be necessary to select V3 and V4 if minimum mains frequency hum in the output is required on the 20 KHz range.

THYRATRON HEATER VOLTAGE

4. If it becomes necessary to replace the thyratron, the heater voltage must be checked (pins 3 and 4) and, if necessary, reset to 6.1V a.c. by means of the potentiometer R33. This voltage must be within ± 1 per cent. of the figure quoted; an accurate valve voltmeter should be used to avoid loading the circuit.

Sputtering of the thyratron

5. Over certain ranges of heater voltage, some thyratrons will 'sputter'. This sputter can often be detected by watching the meter indication on the 20KHz range; under normal conditions, the meter reading fluctuates 2 or 3 per cent. but, when sputtering occurs, there may be fluctuations of 10 per cent. or more. The sputtering is more readily detected by observing the noise pattern on an oscilloscope or by listening to the noise with a sensitive pair of headphones. The thyratron heater voltage should be adjusted slightly by means of the potentiometer R33 so that this sputtering does not occur. Some selection of the thyratron may be necessary to find one that is free from sputtering.

NOISE OUTPUT LEVEL

6. The output noise should be analysed to ensure a uniform noise spectrum within the limits quoted in the Leading Particulars. The noise spectrum and rms output voltage can be modified by adjusting the orientation of the magnet. This must be adjusted for minimum variation in the spectrum level, particularly between 500KHz and 5MHz, with a rms output of at least 1V. The noise spectrum at the high frequency end of the 5MHz range can be adjusted to some extent by the trimmer capacitor C6.

METER CALIBRATION

7. The meter, which is a rectifier type, has been calibrated to read the rms value for white noise. If a pure sine wave is applied to the meter, the reading will be 13 per cent. higher than the reading of a voltmeter calibrated to read rms values of a sine wave. If, for any reason, the meter is suspected of being inaccurate, the lead to the slider of potentiometer R24 (fig.1) should be disconnected and a sinusoidal signal of exactly 1V rms at 1KHz applied to the OUTPUT terminals. The meter should then indicate 1.13V; if necessary, the potentiometer R26 (fig.2) should be adjusted to obtain the correct indication.

PILOT LAMP

8. To change the pilot lamp, the left-hand cover must be removed. It is essential to replace the lamp by one of the same type i.e. 6V filament or 110V neon type.

FUSE

9. The fuse is carried in a holder with screw cap, on the rear panel. For a 200-250V supply a 1A fuse must be fitted, for a 100-125V supply a 2A fuse must be fitted.

VOLTAGE CHECKS

10. The approximate voltages to chassis at various points are shown on the circuit diagram, Chap. 1, fig.2. These are measured with a 20,000 ohms/volt voltmeter.

REPLACEMENT OF COMPONENTS

11. Equipments in service may differ on components fitted, circuit configuration and wiring layout. The principle variation is shown in the circuit diagram and affects the mains transformer and valve heater supply circuit. There is no interchangeability between these components, e.g. the transformer marked TD7302 must be used when V6 is fitted, whereas the transformer marked SC3025 must be used when RT1 is fitted, and similarly for the other components. Elsewhere the replacement of components by modern equivalents may result in changes in appearance. There are no distinguishing equipment modification or type numbers; the standard of any given equipment must be determined by inspection, and replacement components must be equivalent to those removed.

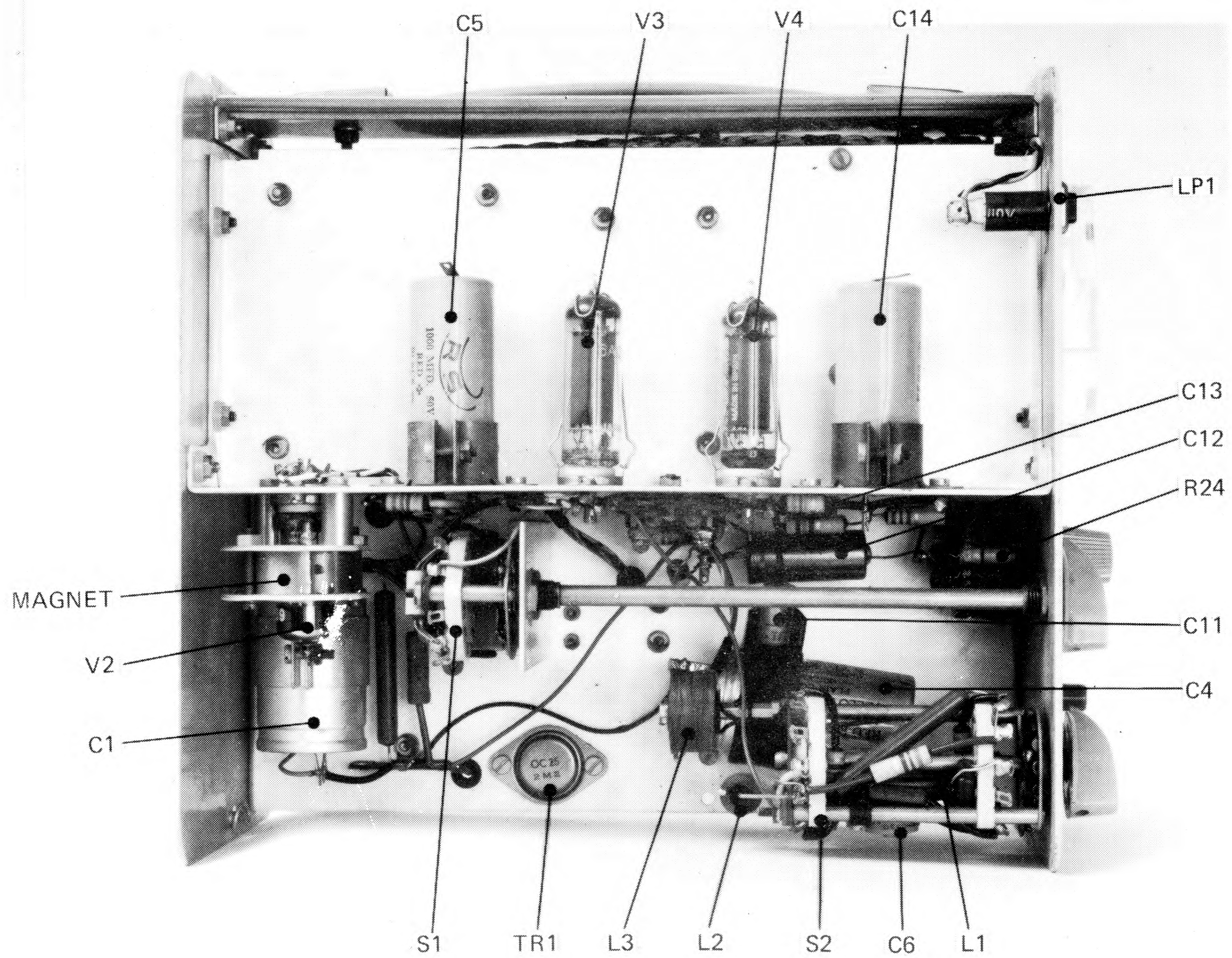

Fig. 1 Left hand side view, with cover removed

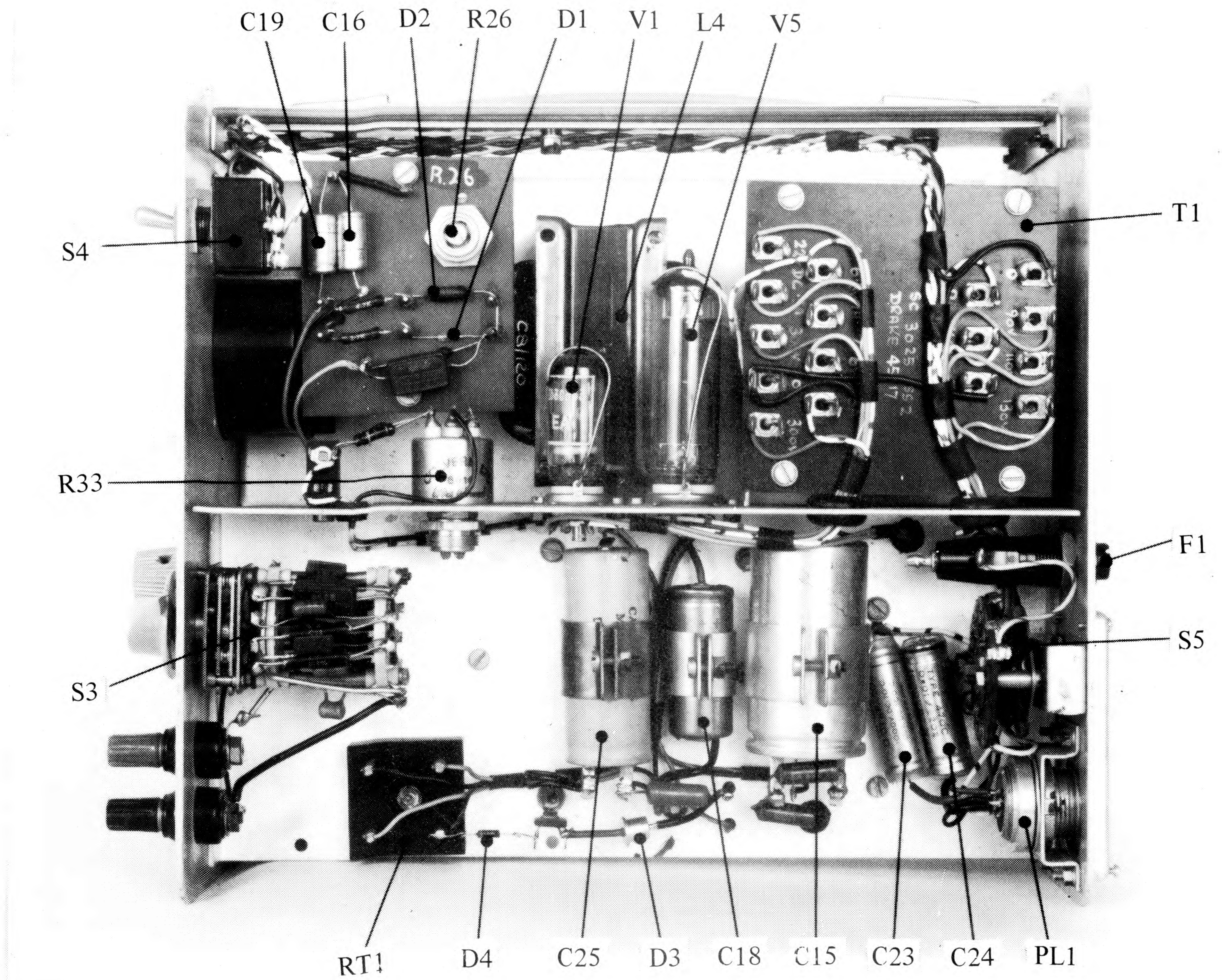

Fig. 2 Right hand side view, with cover removed

Fig. 3 Fuse, mains voltage selector switch and power input plug