INTRODUCTION

1. The Signal generator No 18 is an instrument providing an r.f. signal of accurately known frequency and amplitude in the range 1.5 to 220Mc/s in five bands. Its output can be unmodulated, frequency modulated or amplitude modulated. If required both frequency and amplitude modulation can be applied simultaneously.

2. The open circuit output voltage is variable by means of resistive step attenuators from 2µV to 200mV at 75Ω. With the 6dB terminating unit in circuit the output voltage is variable in the range 1µV to 100mV at both 52Ω and 75Ω. A plug-in 20dB attenuator pad extends the range down to 0.1µV at both impedances. The inclusion of a carrier on/off switch makes it possible for the generator output to be temporarily interrupted without affecting the output impedance.

BRIEF TECHNICAL DESCRIPTION

Electrical
(see Fig 1)

3. The signal generator consists of a variable frequency r.f. oscillator, V3 which covers the fundamental frequency range 4.5 to 9.16Mc/s. The output bands of 13.5 to 27Mc/s, 27 to 54Mc/s, 54 to 108Mc/s and 108 to 220Mc/s are obtained from a chain of four ganged harmonic multipliers V6, V8, V10 and V12 respectively. The setting of the frequency switch determines which of the multipliers acts as the output stage.

4. Output over the 1.5 to 13.5Mc/s band is obtained by applying a fraction of the 27 to 54Mc/s output from V8 to a single valve circuit V7 which combines the function of mixer and 30Mc/s oscillator. The output from this stage contains a difference frequency component which is utilized after filtering to provide outputs between 1.5 and 13.5Mc/s.

5. Incremental frequency adjustment is obtained by varying the d.c. bias to the valve V2.

6. Either internal or external a.f. modulation can be applied to the carrier. Internal modulation is derived from the 1000c/s oscillator V1.

7. For frequency modulation, the a.f. signal passes via the cathode follower circuit V5 to the reactance valve V2, not only through the variable tracking potentiometer, but also via a switched potentiometer system ganged to the range switch. By this means the ratio of a.f. input voltage to f.m. deviation is maintained constant at all frequencies on every band and is independent of the setting of either the range switch or tuning control. For high deviations the switched potentiometer system is by-passed thus allowing the deviation to be increased proportionally with increase in frequency multiplication.

8. Amplitude modulation, to a depth continuously variable up to 50°/o is applied to the highest frequency multiplier which is operating for the particular r.f. output band in use. This method helps to reduce the spurious frequency modulation often encountered when modulating an r.f. oscillator directly. Simultaneous f.m. and a.m., useful when investigating the performance of limiter stages, is also available.

9. The a.m. depth and f.m. deviation are measured directly on a moving coil micro-ammeter on the front panel used in conjunction with a valve rectifier V13.

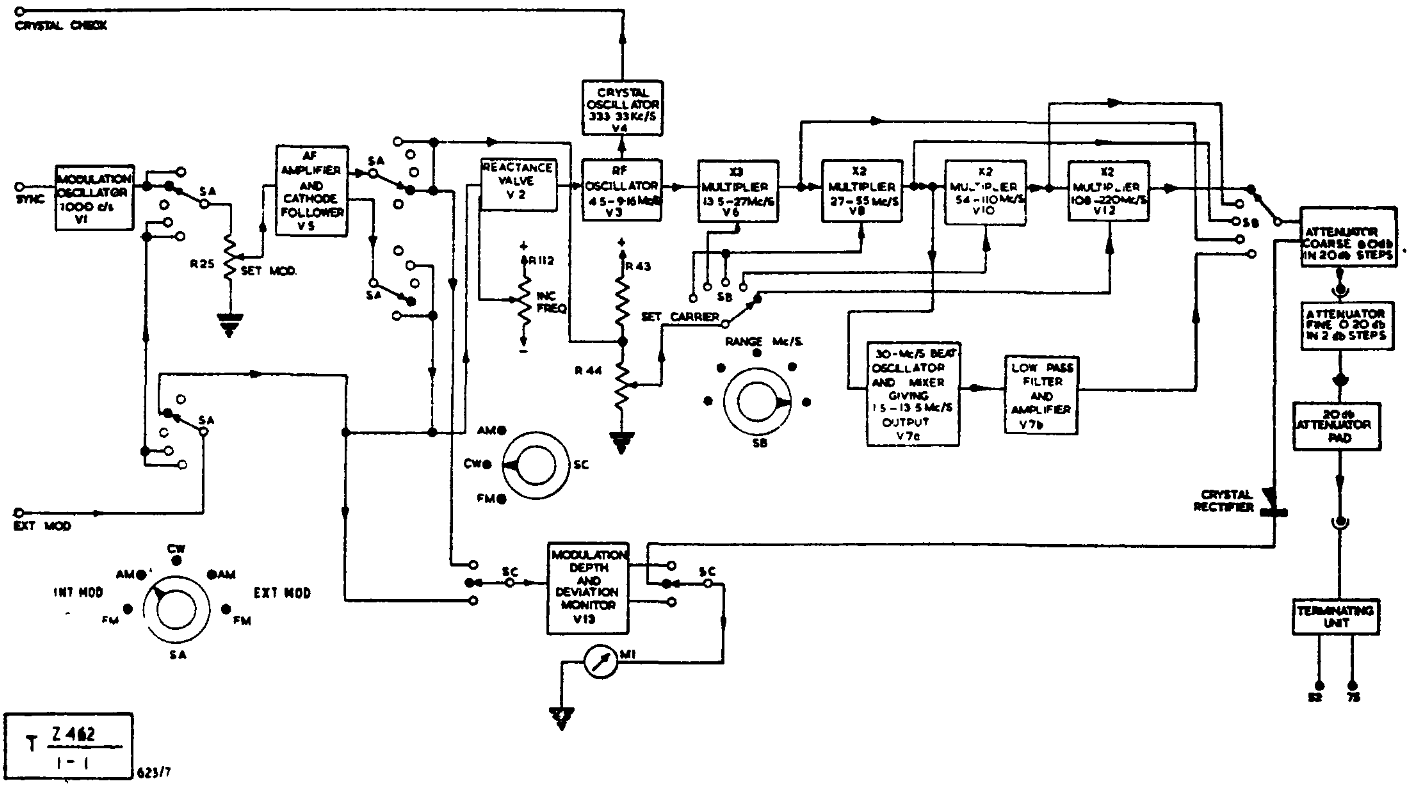

Fig 1 - Block schematic diagram

Power supply

10. The equipment may be operated from a 40 to 65c/s supply at either 100-150V or 200-250V in 10V steps. The total power consumption is approximately 78W.

Mechanical

11. The instrument is housed in an equipment case 20.1/2 in. wide 17 in. high and 13.1/2 in. deep. The total weight of the instrument and case is 78 lb. The mains lead and output cables are carried in the lid of the case and held by spring clips.

12. The instrument is built on the sub-assembly principle, most of the equipment being housed on three separate chassis. One carries the power supply, one the l.f. and monitoring circuitry and the other the r.f. circuitry.

13. The r.f. circuits are tuned by a ganged variable capacitor coupled to the main tuning dial by a pulley drive (see Fig 7).

DETAILED TECHNICAL DESCRIPTION

R.F. oscillator V3

14. The r.f. oscillator is a modified Hartley oscillator tunable over the range 4.5 to 9.16Mc/s. Tuning is accomplished by C34 a section of the main tuning capacitor. The oscillator is capacity coupled to the first multiplier circuit V6.

15. Oscillator output is fed via C33 to the grid of the crystal oscillator so that the calibration may be checked aurally against the crystal XL1.

Harmonic multiplier circuits

16. The anode circuits of frequency multipliers are tuned to the appropriate harmonic of the driving frequency on the grid. Each multiplier is over driven in the grid current region by the previous stage, therefore its anode current waveform will have a high harmonic content. The anode load when tuned to one of these harmonics offers the greatest impedance to that harmonic and the component of output voltage is correspondingly increased.

1st stage V6,	tuned to 3rd harmonic of V3	13.5-27Mc/s
2nd stage V8	tuned to 2nd harmonic of V6	27-54Mc/s
3rd stage V10	tuned to 2nd harmonic of V8	54-108Mc/s
4th stage V12	tuned to 2nd harmonic of V10	108-220Mc/s

Oscillator mixer circuit V7

17. Outputs on the 1.5-13.5Mc/s band are not obtained directly from harmonic multipliers (see Fig 2).

18. Output from V8, 27 to 54Mc/s, is fed via C44 to the grid of V7A which combines the action of the mixer and 30Mc/s fixed frequency oscillator. The variable frequency output from V8 is thus heterodyned and the output of V7A contains a difference frequency component which after filtering is applied to the grid of V7B. It is amplified and fed via T5 and a low pass filter consisting of L26, C94 and C95 to the attenuator.

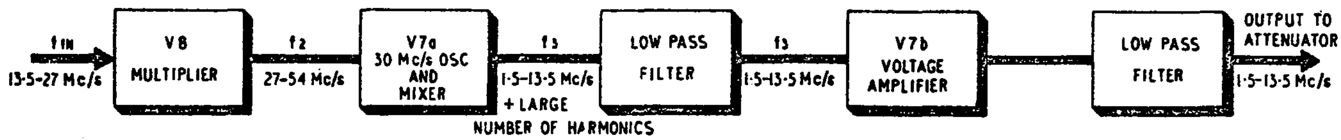

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Fig 2 - Block diagram of oscillator mixer circuit to give outputs of 1.5Mc/s to 13.5Mc/s

Output system

19. On ranges 1 and 2 output is taken from transformers T5 and T3 respectively to the switch SB and then via a screened lead to the attenuator.

20. On ranges 3, 4 and 5 output is taken from tappings on the r.f. coils L18, L22 and L23 to switch SB then via the screened lead to the attenuator.

Monitoring system

21. The meter M1 indicates carrier level, percentage modulation or frequency deviation depending on the positions of SA and SC. SC is spring loaded and always returns to the C.W. position. M1 will indicate carrier level for all positions of SA.

22. With SC in the C.W. position, the r.f. input to the attenuator is also fed via the crystal diode D, R71, R72, R70 and R121 to the meter M1, which indicates carrier level. This level is normally set to the SET R.F. mark on the meter by means of the SET R.F. potentiometer R44. The actual r.f. output is then indicated by the attenuator setting and is derived via two 75Ω resistive ladder networks in cascade.

23. The ±1dB points on either side of the SET R.F. mark allow for interpolation between the 2dB steps of the attenuator, fine adjustment being made by the SET R.F. potentiometer.

24. When SA and SC are switched to A.M. the output from V5 (now an a.f. amplifier) (see Fig 3), is fed via C54 to the diode V13 where it is rectified. The meter measures the d.c. voltage developed across R108 and the value of this voltage indicates the depth of modulation.

25. When SA and SC are switched to F.M. the output from the cathode of V5 is fed via C79 to the monitoring circuit where it is rectified. The meter measures the voltage developed across R64 and R65 and thus indicates frequency deviation.

Attenuator unit

26. The attenuator unit contains the OUTPUT VOLTAGE and MULTIPLY BY networks providing coarse and fine control respectively. The first network has a range of 80dB variable in 20dB steps. The second has a range of 20dB variable in 2dB steps.

27. The output from the second network is fed to a coaxial cable, permanently attached to the signal generator. The direct open circuit output obtainable from this cable, at a source impedance of 75Ω, is variable between 2µV and 200mV.

28. When the plug-on terminating unit is used the output is variable between 1µV and 100mV, with the source impedances either of 52 or 75Ω. The terminating unit has an insertion loss of 6dB.

29. With the 20dB attenuator pad interposed between the output cable and the terminating unit an output of 0.1µV is obtainable.

Crystal check oscillator

30. The crystal oscillator V4 is equivalent to a tuned anode tuned grid oscillator. To obtain oscillation the resonant circuit in the anode (L8 and C29) is tuned to a frequency higher than that of the crystal, so that the reactance in the anode circuit is inductive at crystal resonance.

31. The amplitude of oscillation is determined by the amount of inductive reactance in the anode-circuit and by the grid anode capacitance.

32. The r.f. oscillator V3 is coupled to the crystal oscillator V4 by C33. The CRYSTAL CHECK facility is obtained by insertion of high resistance headphones into the jack so marked. Insertion of the jack switches on the h.t. to V4.

33. The crystal calibrator has a fundamental frequency of 333.333kc/s and provides 14 check points on each of the four upper frequency bands. The heterodyne beats at check points may be heard in the headphones.

Modulation oscillator

34. The modulation oscillator V1 is a hybrid fixed frequency oscillator providing an a.f. signal of low distortion at a frequency of 1000c/s.

35. The oscillator supplies the modulation voltage for the internal modulation. Output is fed via the resistance capacitance network of C17, C18, R21, R24 to R25, the SET MOD control. When the signal generator is switched to F.M. resistor R21 is not in circuit.

36. When the modulated output of the signal generator is being checked on an oscilloscope the sweep can be synchronized by using the voltage developed across the SYNC and E terminals of the signal generator. This voltage is approximately 100V and the source impedance is 250kΩ. Output is taken from the junction of R3 and C8.

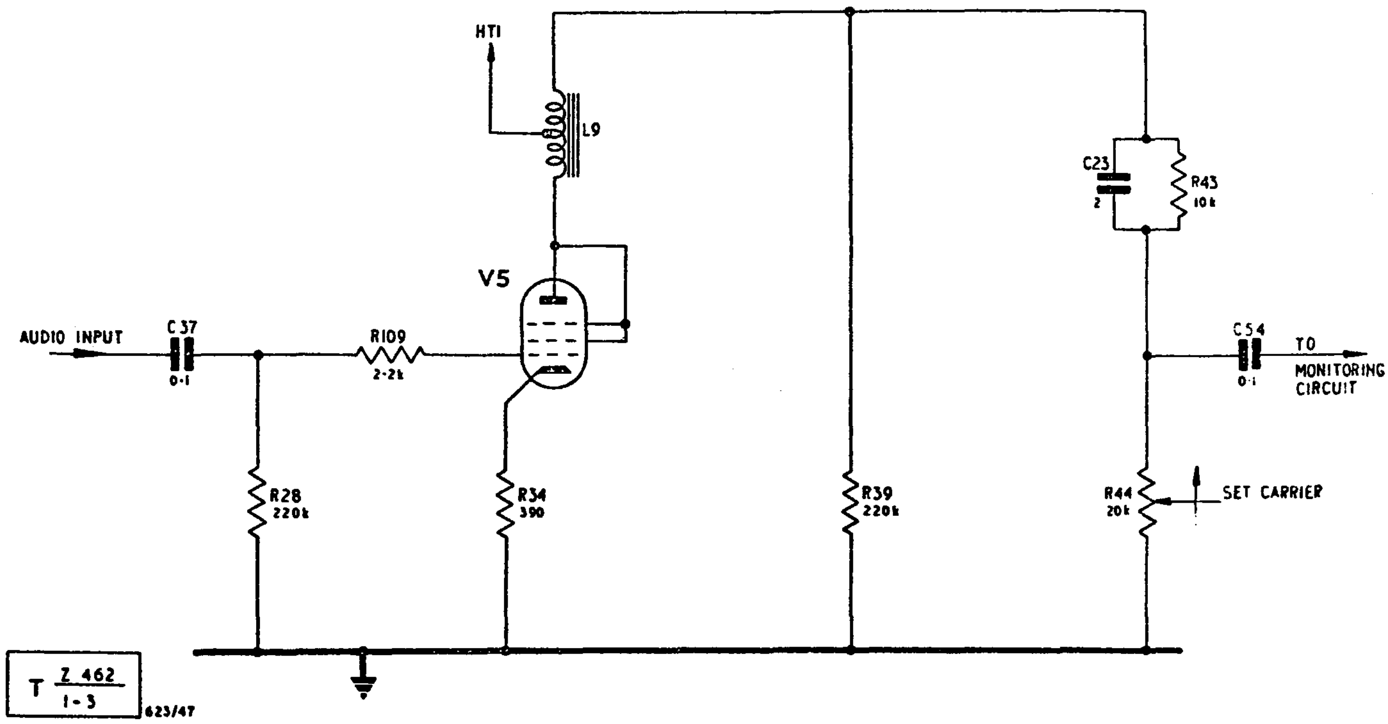

Fig 3 - V5 as an a.f. amplifier

A.F. amplifier and cathode follower
(Fig 3 and 4)

37. When the signal generator is switched to A.M. V5 is used as a voltage amplifier (Fig 3) with negative current feedback, introduced by the cathode bias resistor R34.

38. The audio signal from the oscillator valve V1 (Fig 2001a) is fed via C37 and R109 to the control grid of V5 where it is amplified and fed, via L9 an l.f. choke and C53, a by-pass capacitor, to R44. Setting of R44 controls both the d.c. supply and audio signal component to the screen of the appropriate final multiplier.

39. When the signal generator is switched to F.M. V5 becomes a cathode follower (see Fig 4). The switched potentiometer network is designed to keep the cathode load constant.

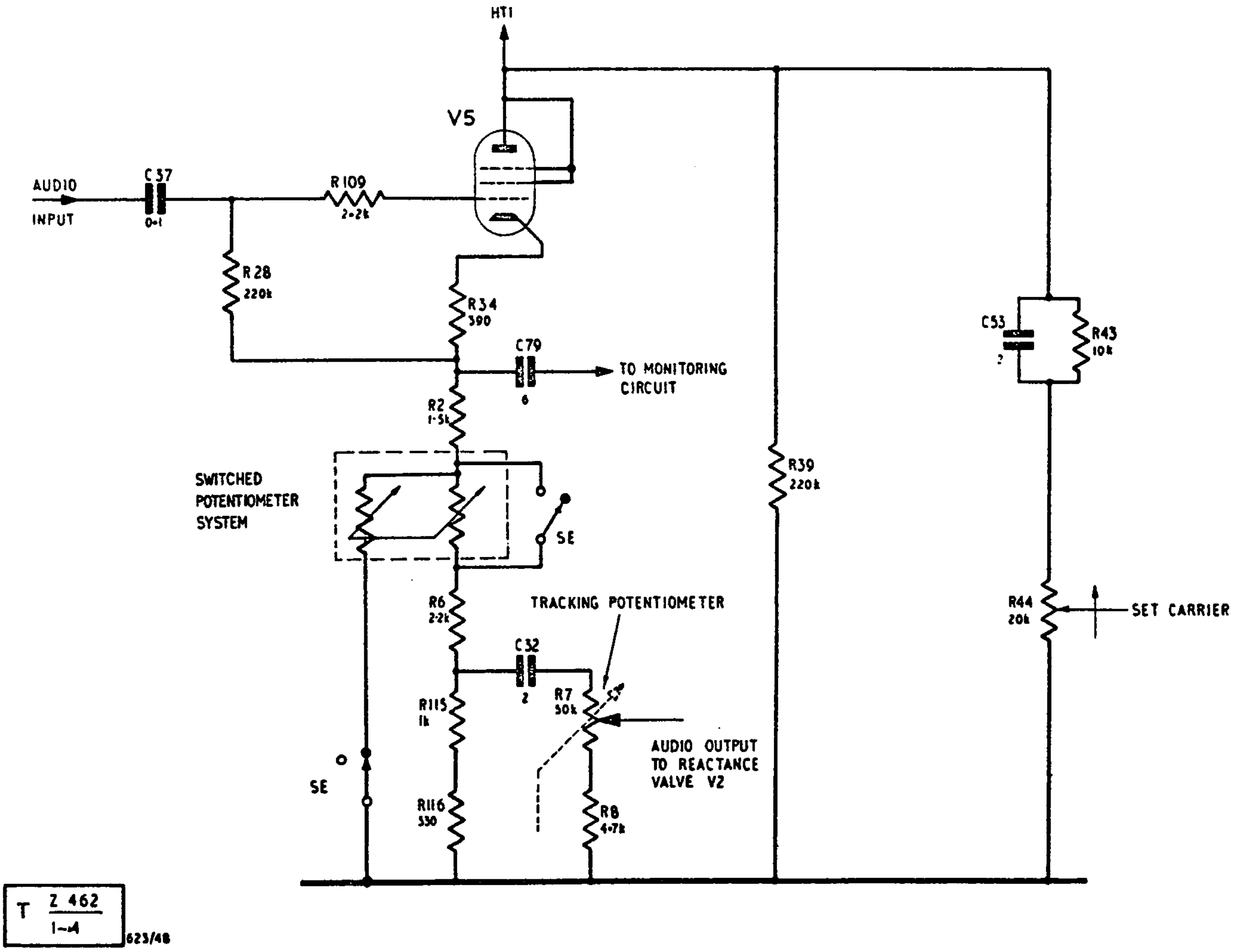

Fig 4 - V5 as a cathode follower

40. From the cathode follower circuit the a.f. signal is normally fed to the reactance valve V2, not only through the variable tracking potentiometer R7 but also via a switched potentiometer system ganged to the range switch. By this means, the ratio of a.f. input voltage to f.m. deviation is maintained constant at all frequencies on each band and is independent of either range switch or tuning control.

41. The normal deviation ranges on all carrier bands are 0 to 25kc/s or 0 to 75kc/s. Switching is provided however so that the switched potentiometer system can be bypassed. This allows the deviation to increase proportionally with increase in frequency multiplication. It gives a maximum deviation to the highest frequency band of 75 x 8 = 600kc/s. On the 13.5 to 27.5Mc/s band the maximum deviation obtainable is only 75kc/s.

Amplitude modulation

42. Depth of amplitude modulation is adjustable between 0 and 50°/o by operation of the SET MOD potentiometer R25. The voltage from either the internal or external a.f. oscillator is applied across the potentiometer system R24 and R25 to V5. Output from V5 via R44 (SET CARRIER potentiometer) is applied to the screen of the appropriate final multiplier to produce screen grid modulation.

43. This method of a.m. helps to prevent spurious f.m. which is frequently encountered when directly modulating an r.f. oscillator.

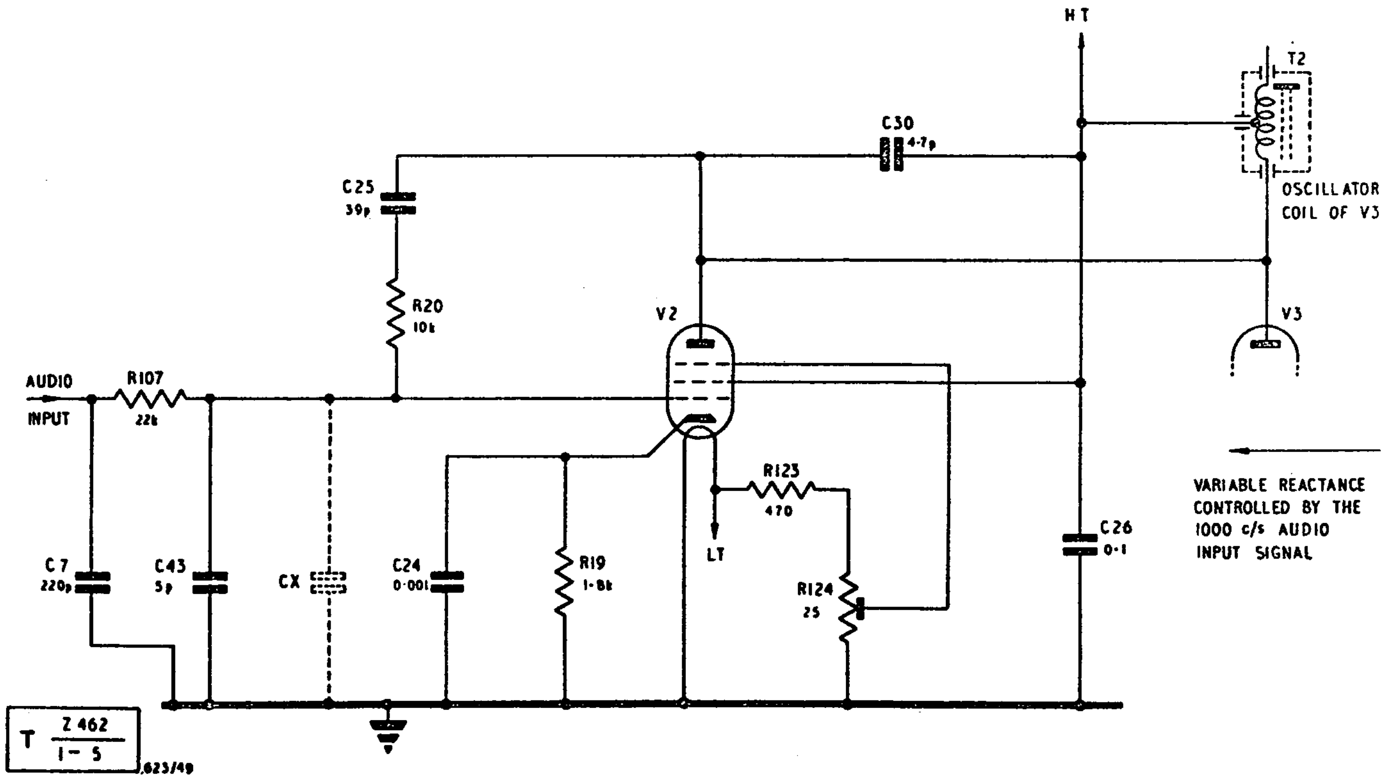

Fig 5 - Reactance valve circuit

Reactance valve V2

44. The reactance valve V2 (Fig 5) operates in the following manner. The control grid of V2 is connected to the V3 oscillator circuit T2, through resistor R20 and blocking capacitor C25. Cx represents the input capacitance of the reactance valve, aided in this case by C43 which increases the effective input capacitance.

45. The resistance R20 is large compared to the reactance of Cx plus C43 so the r.f. current through this path will be practically in phase with the r.f. voltage appearing at the terminals of the oscillator coil T2. However the voltage across C43 will lag the current by 90°.

46. The r.f. current in the anode circuit of V2 will be in phase with the grid voltage and consequently is 90° behind the current through C43, or 90° behind the T2 voltage. This lagging current is drawn through the T2 circuit and since the property of current lagging voltage is that of an inductance, the resonant frequency of the V3 oscillatory circuit will change; this will be in proportion to the amplitude of the lagging anode current of V2.

47. The a.f. voltage, fed to the control grid of V2 via R107 varies the mutual conductance of V2. This varies the r.f. anode current and consequently the frequency of the oscillator. R107 and C7 prevent r.f. components from the reactance valve circuit being fed back to the a.f. oscillator circuit.

48. To prevent spurious f.m., caused by mains ripple, the potentiometer network R123, R124 is connected across the heater supply so that a fraction of the 50c/s is fed via the slider on R124 to the suppressor grid of V2 in anti-phase to the ripple, so neutralizing it.

Incremental frequency control

49. Fine tuning is obtained by varying the grid potential of V2 by means of R112 which is the INCREMENTAL FREQUENCY control and part of the potential divider chain across the h.t. line (see Fig 6). Bias may be positive or negative according to the setting of R112.

50. The negative bias is obtained from the rectified voltage of V15 and this voltage is stabilized by V14. Varying R112 thus causes the bias on V2 to change, which in turn alters the gm of the valve. The value of the effective reactance of the valve is a function of the gm hence the frequency of oscillation of V3 is altered by a small amount.

I.F. amplifier
(Fig 2003)

51. The i.f. amplifier V16, a twin triode, provides additional gain between 1.5 and 6Mc/s with an approximate maximum output of 1V. This is to facilitate the alignment of external i.f. amplifiers.

52. The first triode of V16 is a voltage amplifier with 75Ω input matching via T1. Its output is RC coupled by R3 and C3 to the second triode stage acting as a cathode follower with low impedance output via T2 to match the coaxial line.

Power supply

53. The power supply system is made up of two parts, the positive supply coming

from a conventional full wave rectifier with capacitance input smoothing. The negative or bias supply comes from a voltage doubler circuit.

54. The system provides 230V unstabilized and 150V stabilized, the latter supplying the r.f. oscillator V3 and reactance valve V2. The rectified negative voltage from V15 stabilized by V14 provides biasing facilities as required.

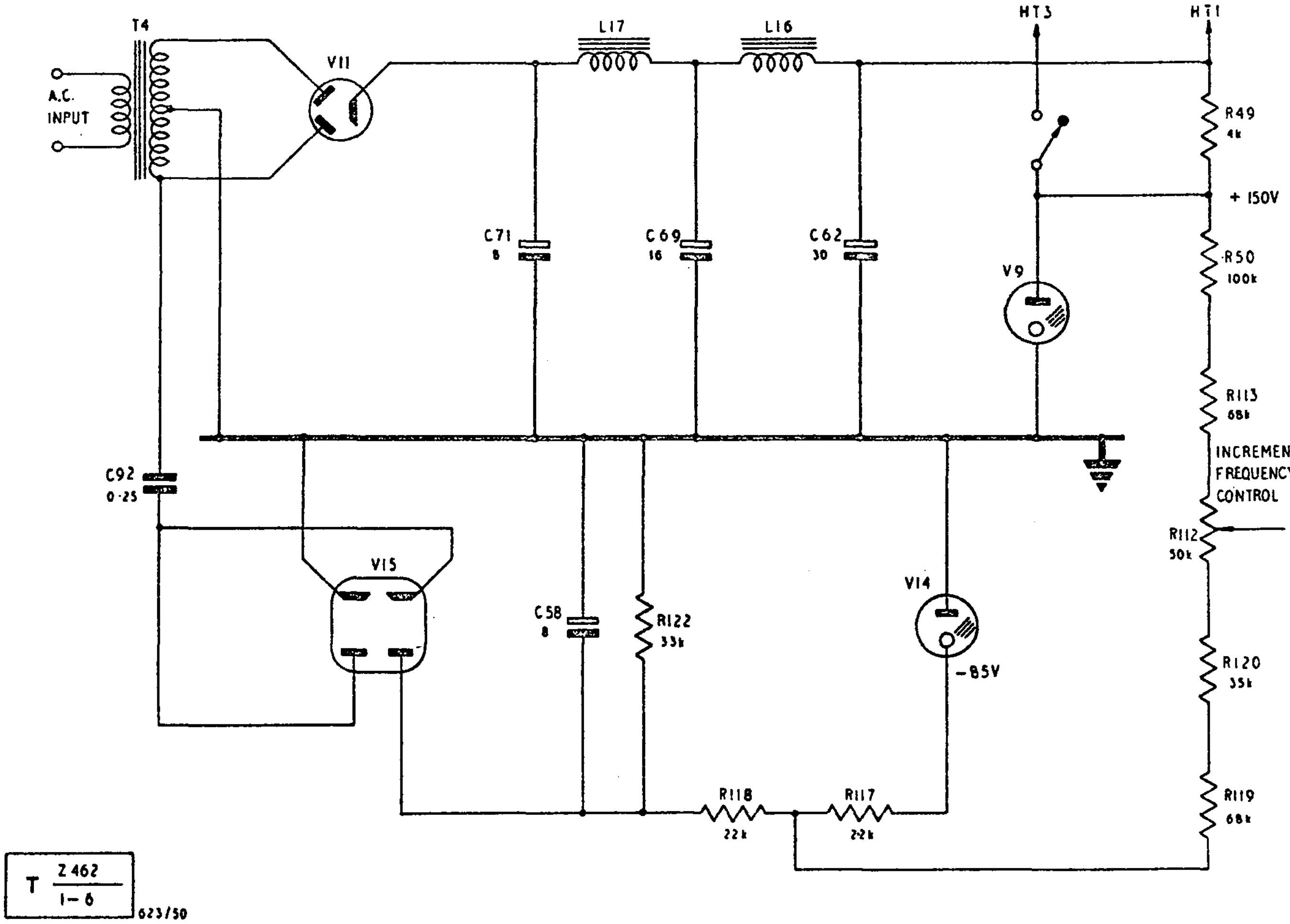

Fig 6 - Simplified circuit diagram showing biasing arrangement

MECHANICAL DESCRIPTION

Tuning mechanism
(see Fig 7)

55. The following components are all driven from the main tuning dial shaft and the location of these components and the drive mechanism is shown in Fig 7.

R.F. tuning capacitor	C34
1st multiplier tuning capacitor	C46
2nd multiplier tuning capacitor	C65
3rd multiplier tuning capacitor	C75
4th multiplier tuning capacitor	C81

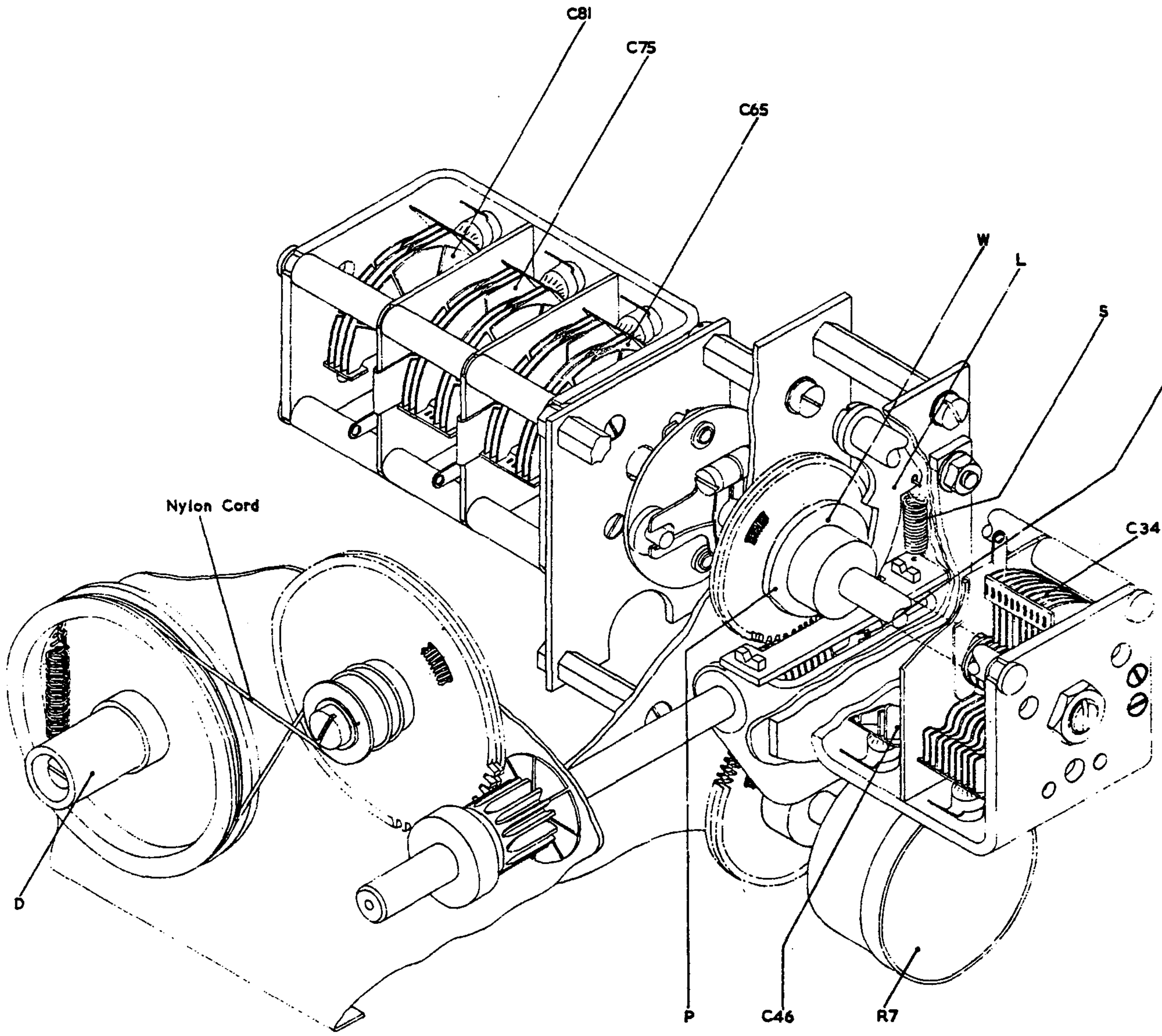

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Fig 7 - Cut away view of tuning mechanism

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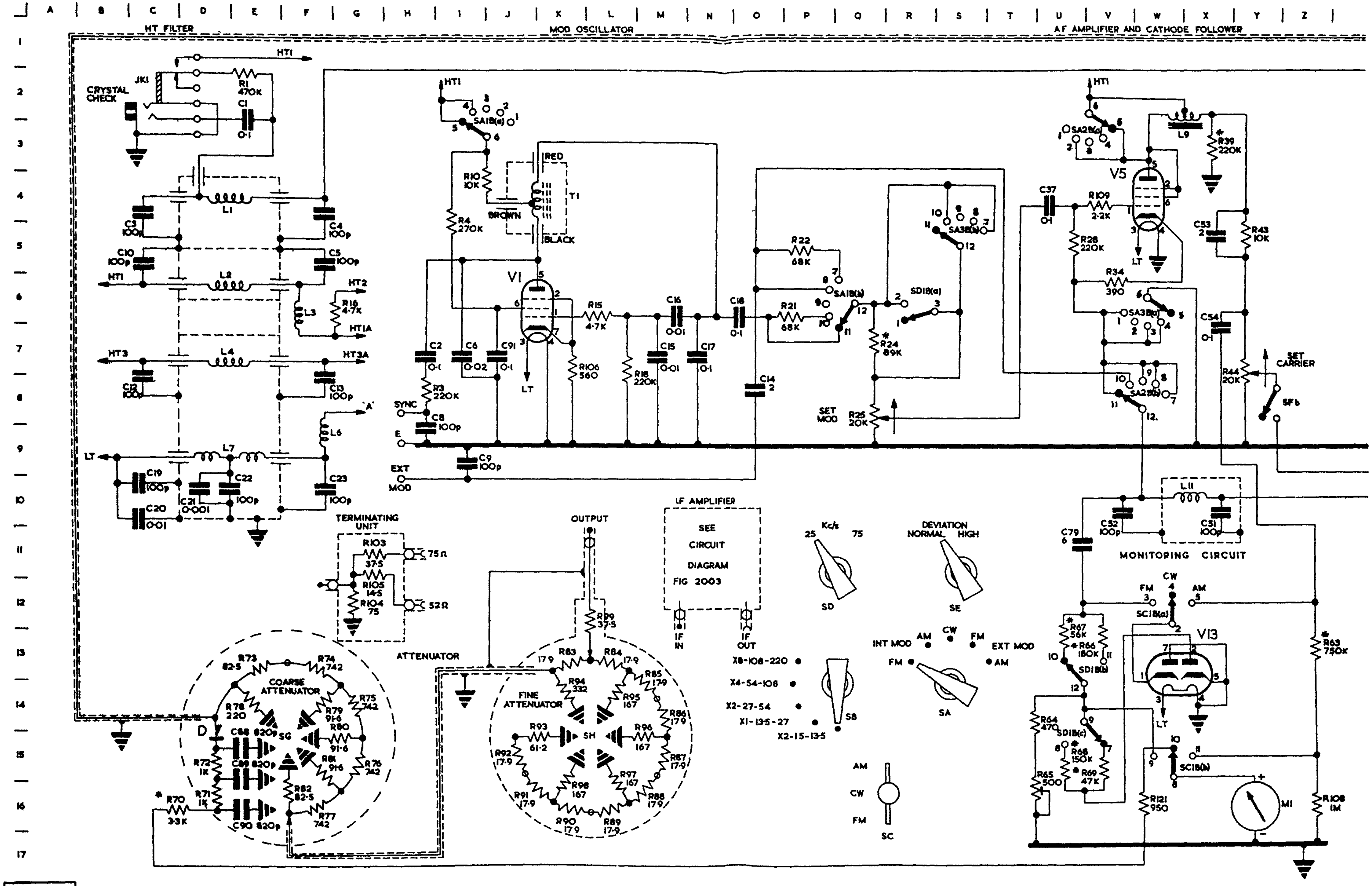

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Fig 2001a - Signal generator No 18 - circuit diagram

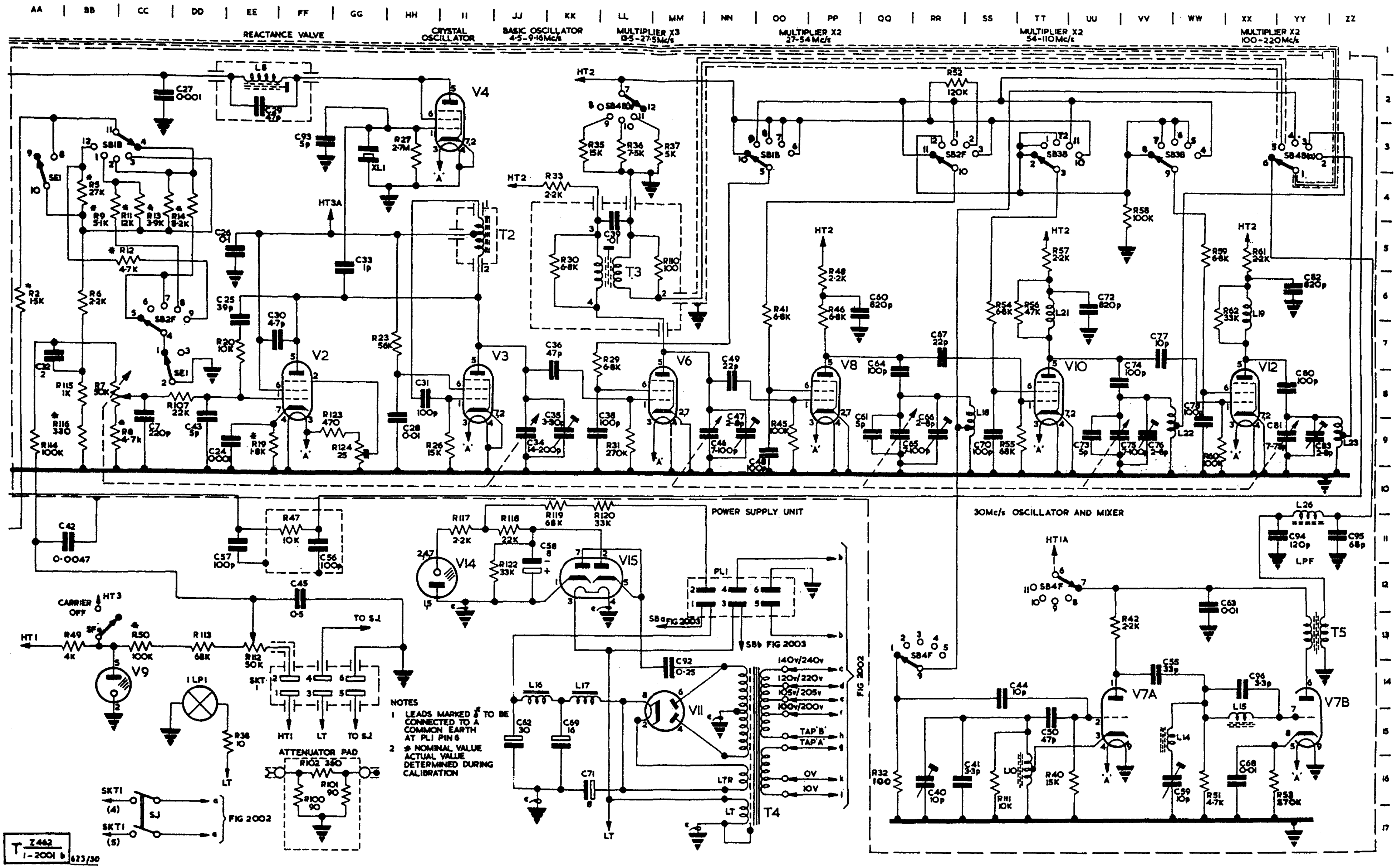

Fig 2001b - Signal generator No 18 - circuit diagram

Table 2004 - Power supply unit measurements

Note: Connect the instrument to an a.c. supply of 100-150V or 200-250V r.m.s. as applicable, with voltage selector correctly positioned.

Supply tested	Points measured across	Reading	Remarks
A.C. input	Primary tappings on transformer	With 240V a.c. supply, all primary taps should be within ±2°/o	Voltmeter, portable, electrodynamic, 5-range, 750V, sub-standard, No 1
H.T. (a.c.)	Secondary of transformer	250-0-250 ±5°/o	Instrument, testing, Avometer, model 8S, 28-range, equipment
L.T.	Secondary of transformer	6.3V ±5°/o	Instrument, testing, Avometer, model 8S, 28-range, equipment
Rectifier l.t.	Secondary of transformer	5.0V ±5°/o	Instrument, testing, Avometer, model 8S, 28-range, equipment
D.C. h.t. voltages H.T.1		250V ±10°/o	Instrument, testing, Avometer, model 8S, 28-range, equipment
H.T.3	Across V9	150V ±5°/o	Instrument, testing, Avometer, model 8S, 28-range, equipment
H.T.	Across V14	-85V ±5°/o	Instrument, testing, Avometer, model 8S, 28-range, equipment
Hum level	H.T.1	Less than 20mV	Using a wave analyser with suitable isolating capacitor

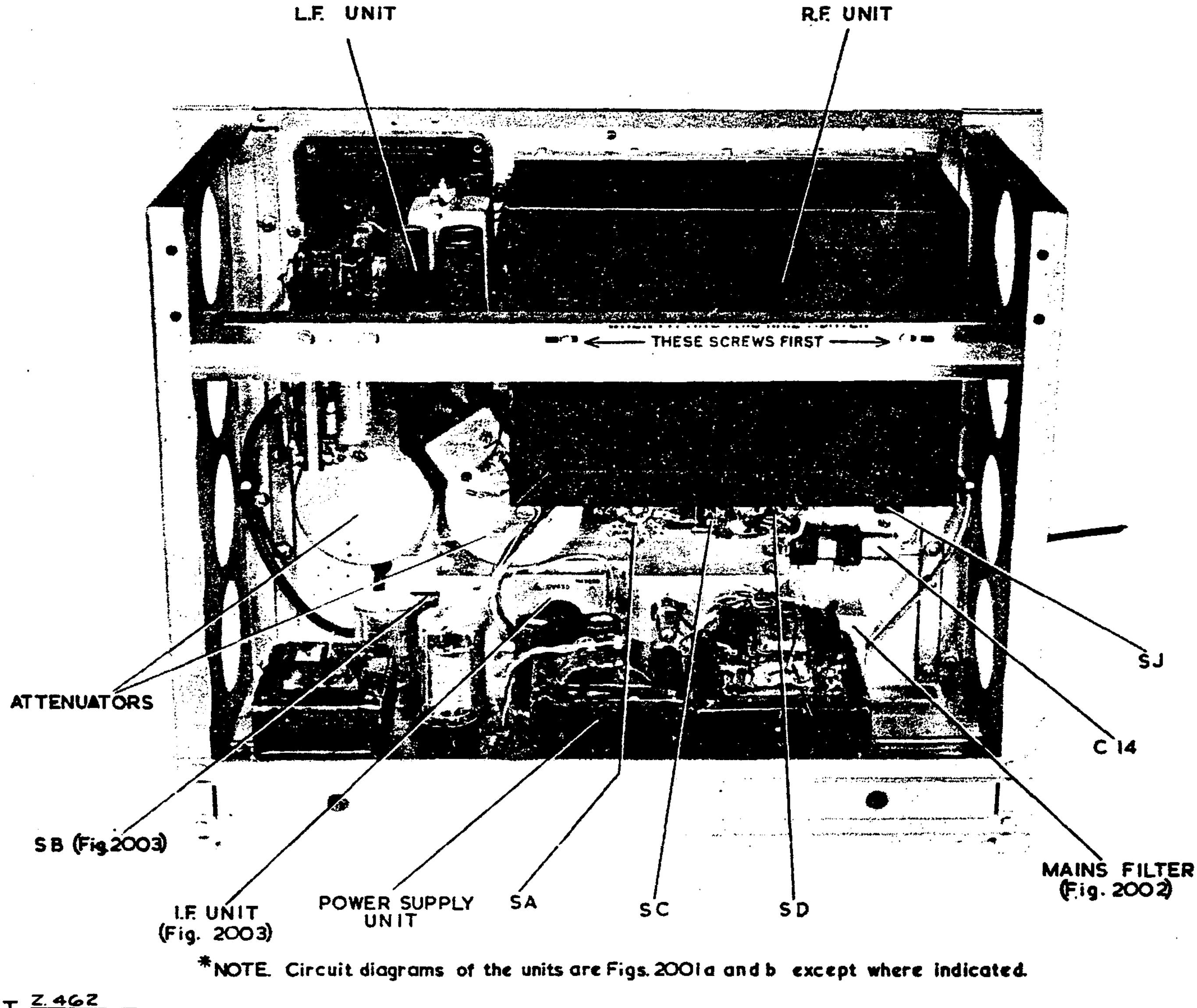

Fig 2005 - General rear view of the equipment

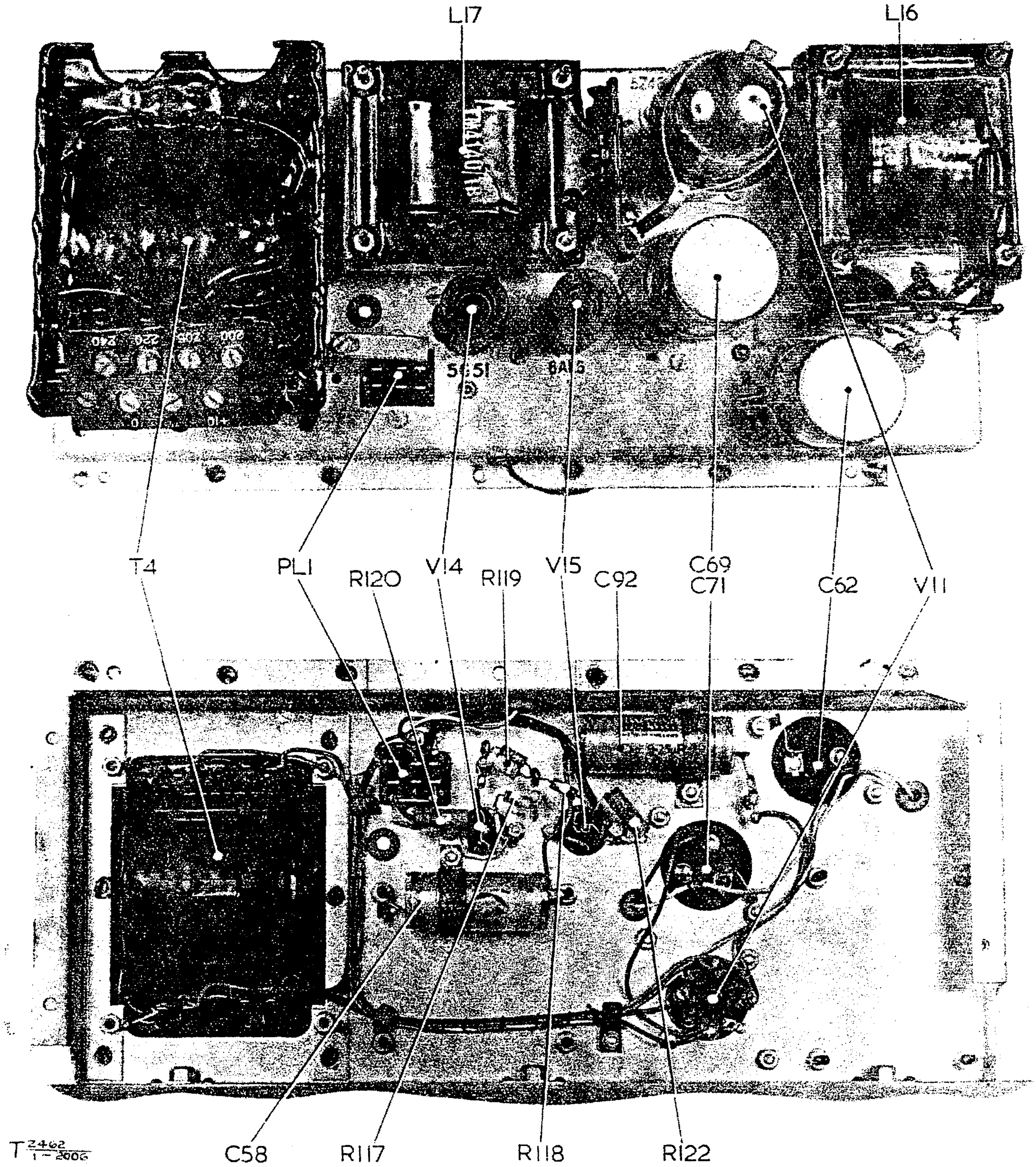

Fig 2006- Power unit

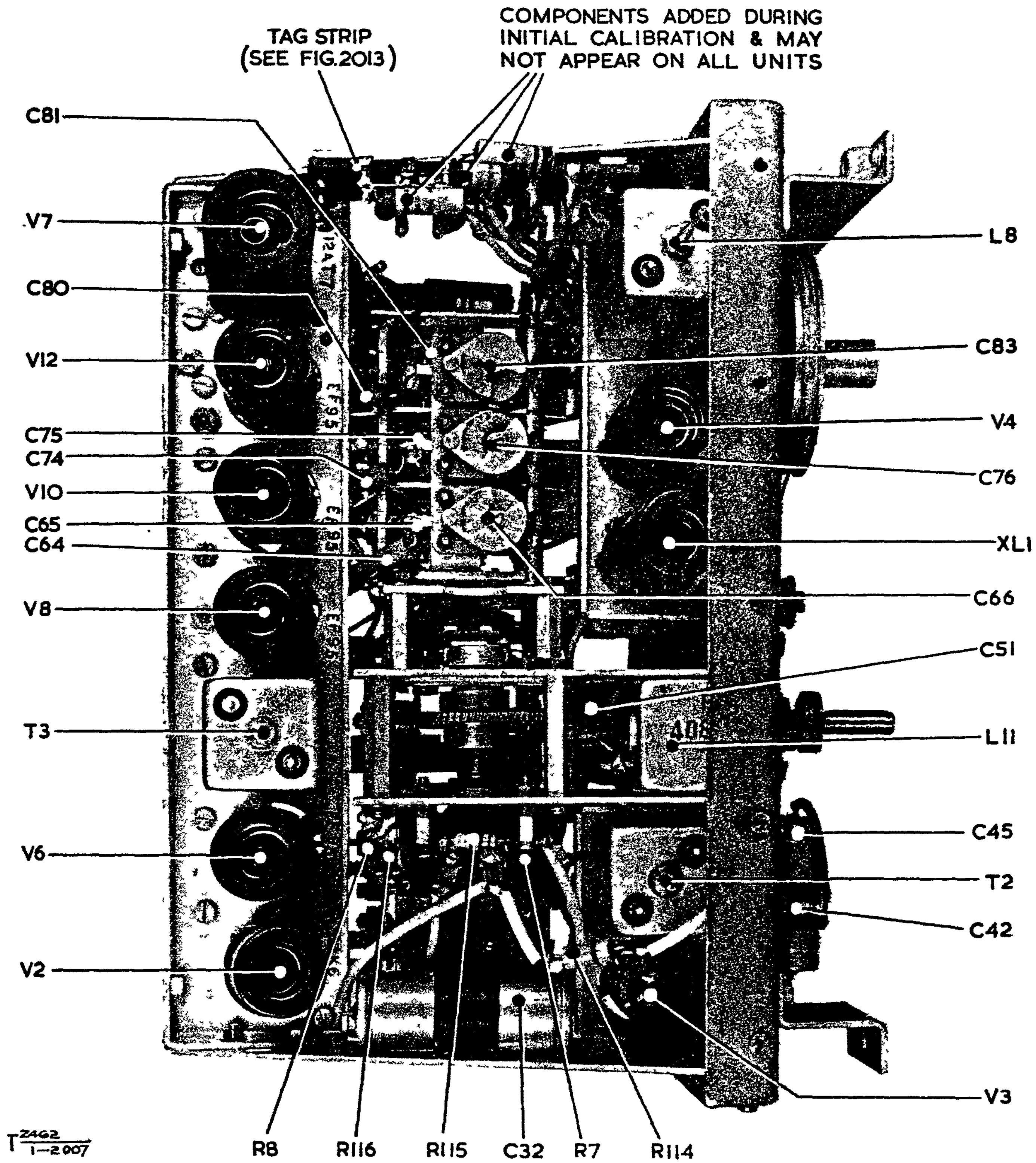

Fig 2007 - R.F. unit (top)

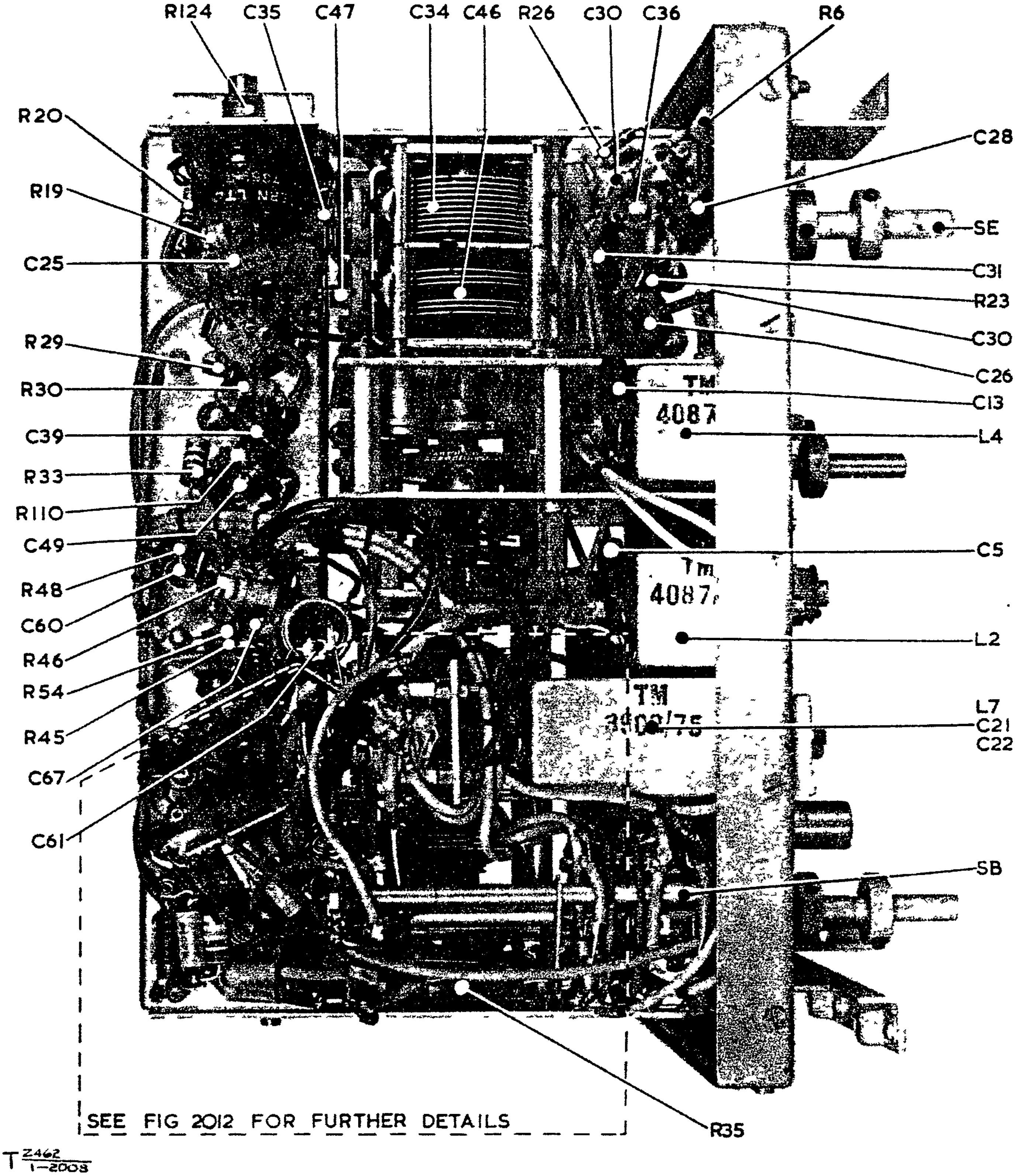

Fig 2008 - R.F. unit (underside)

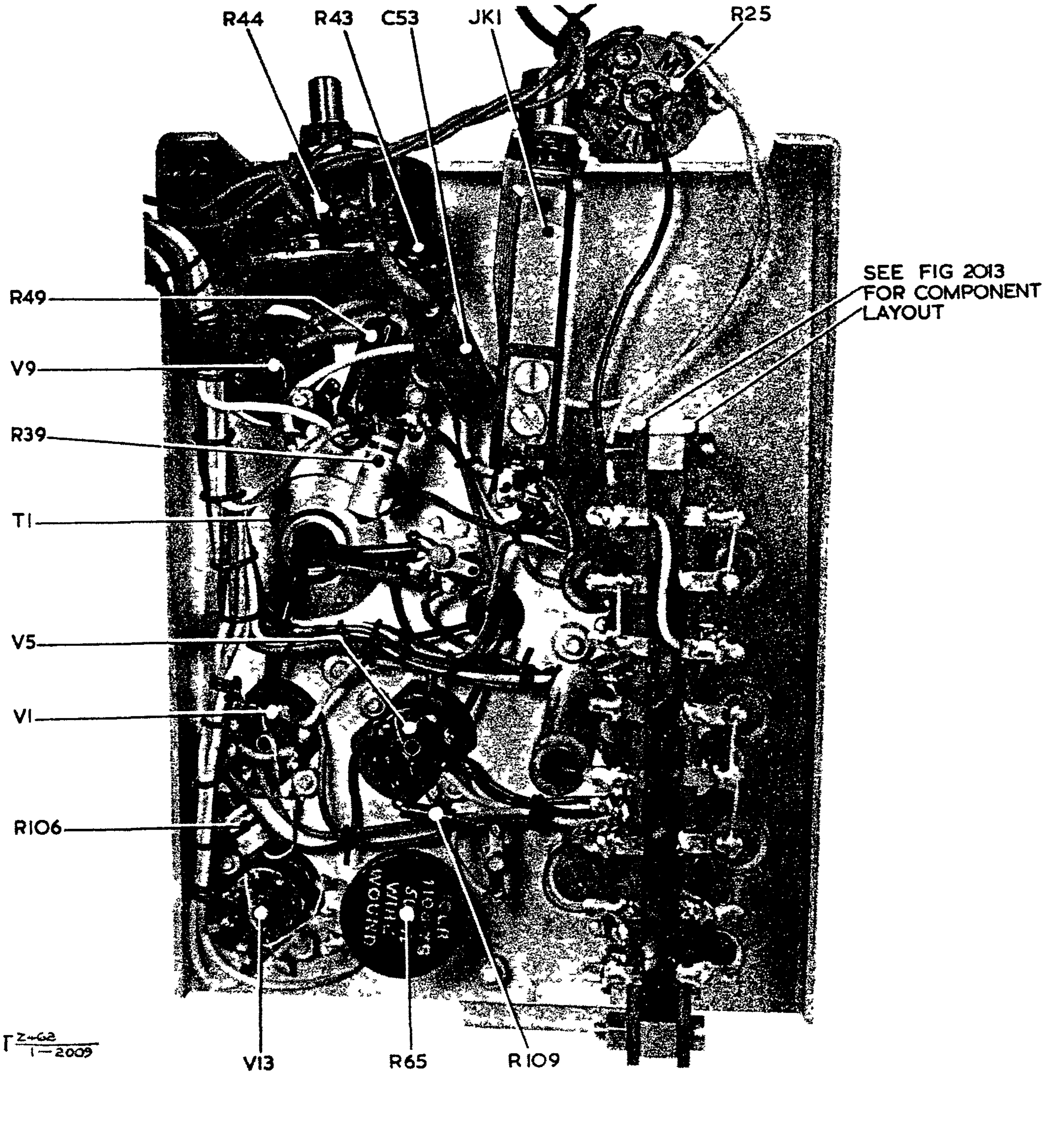

Fig 2009 - L.F. unit (underside)

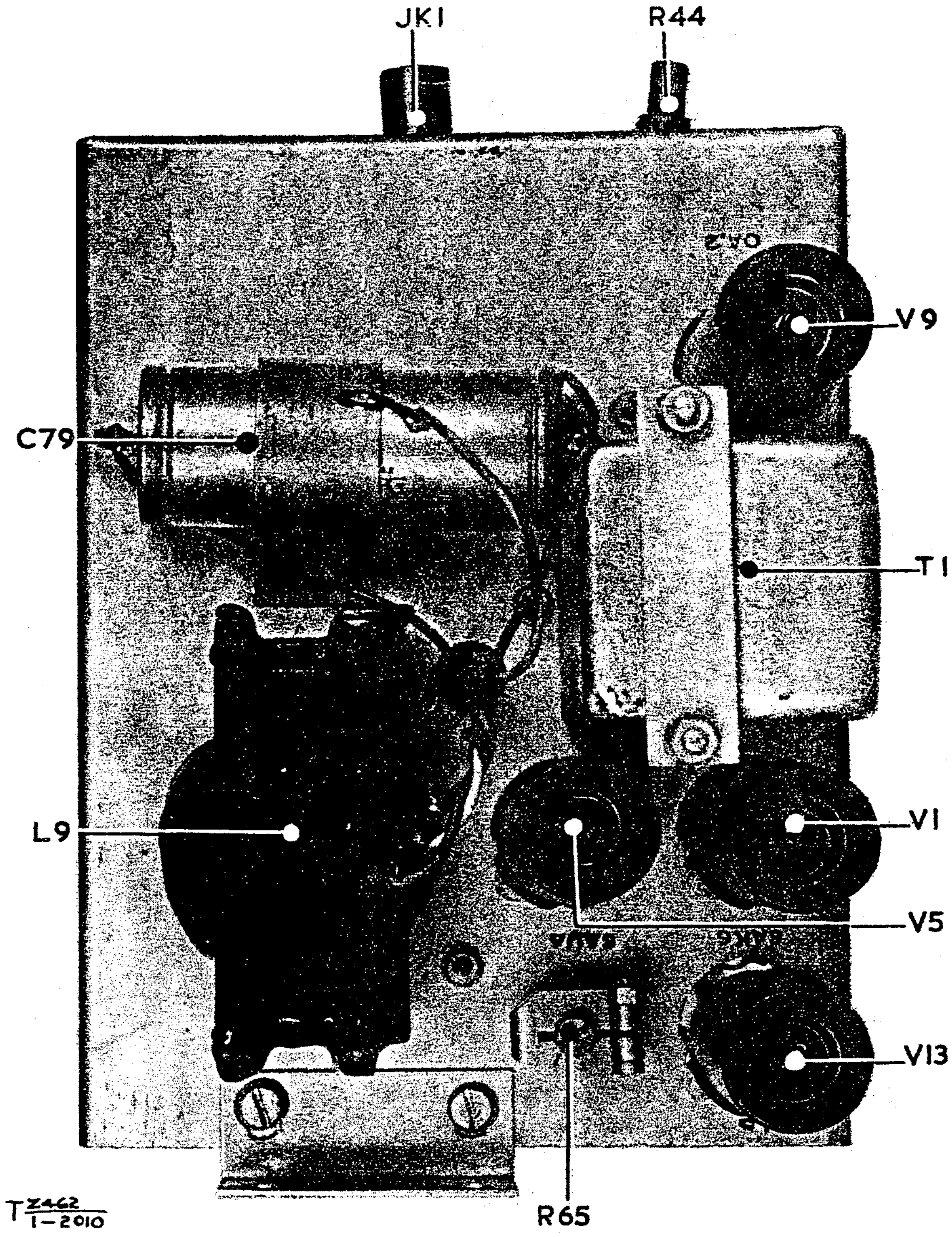

Fig 2010 - L.F. unit (top)

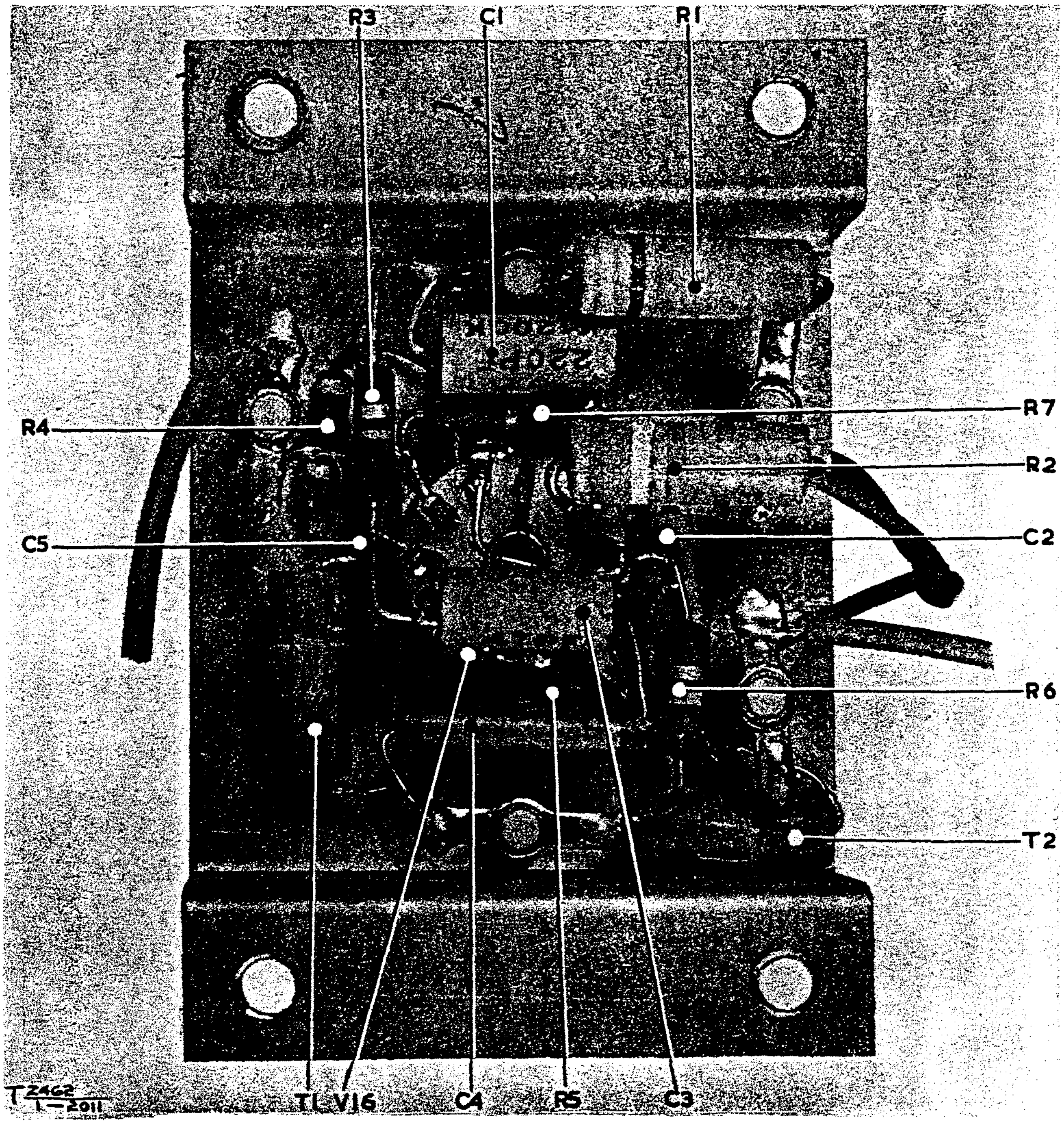

Fig 2011 - L.F. amplifier

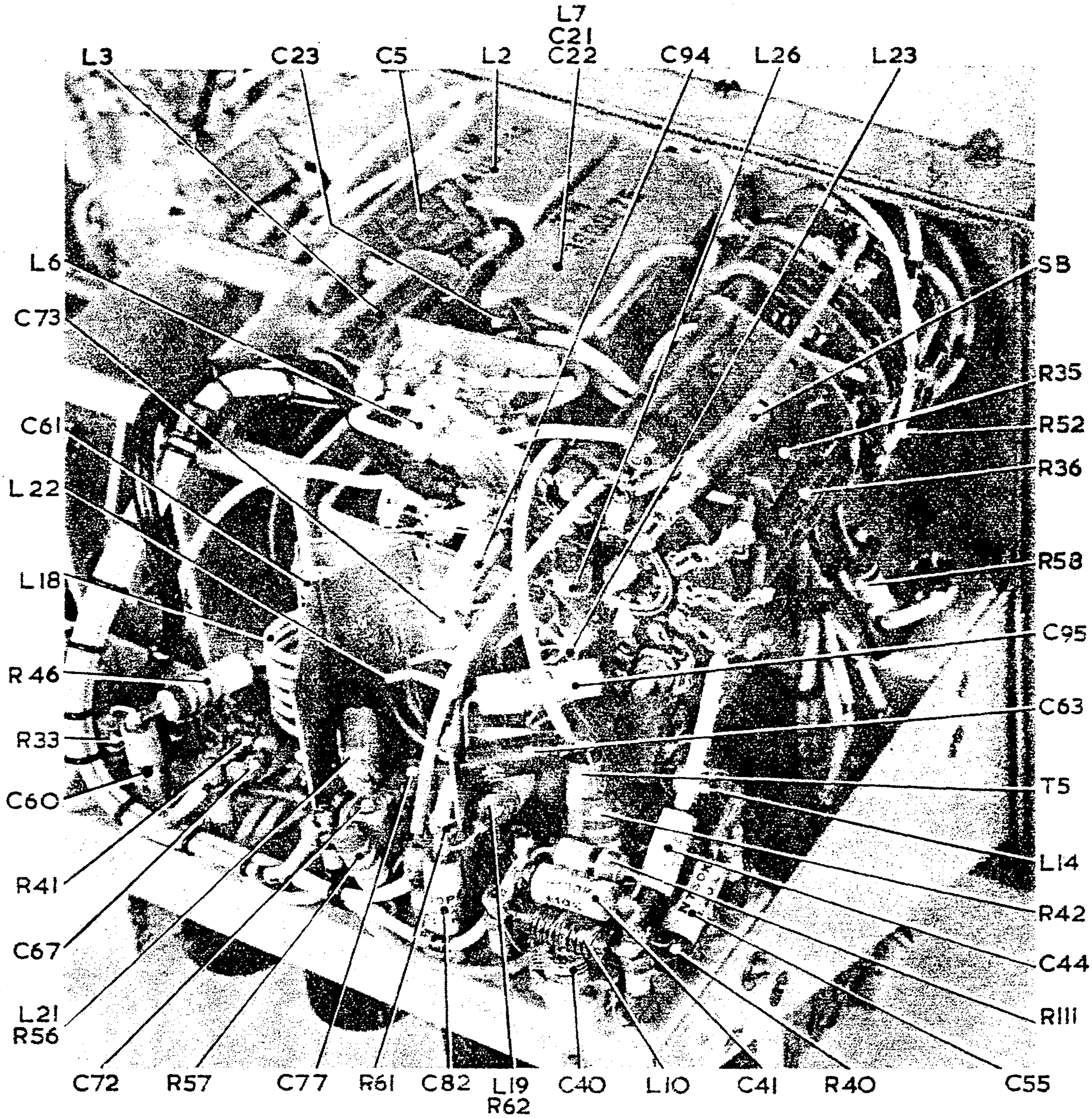

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Fig 2012 - Enlarged view of part of the r.f. unit

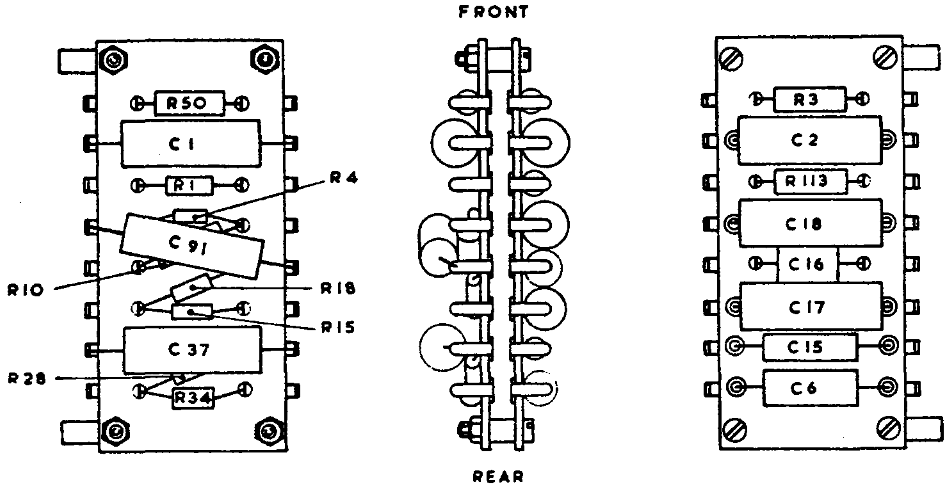

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Fig 2013 - L.F. unit - tag-strips (see Fig 2009)

NOTE
RESISTORS SHEWN THUS * WERE FITTED DURING THE INITIAL CALIBRATION AND MAY NOT APPEAR IN ALL EQUIPMENTS

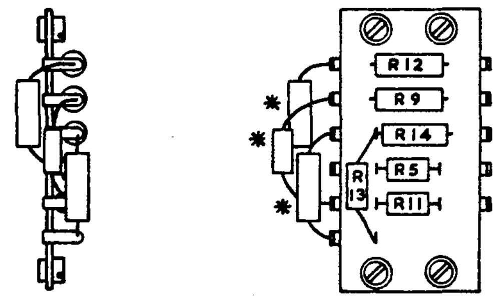

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Fig 2014 - R.F. unit - component layout on tag-strip (see Fig 2007)

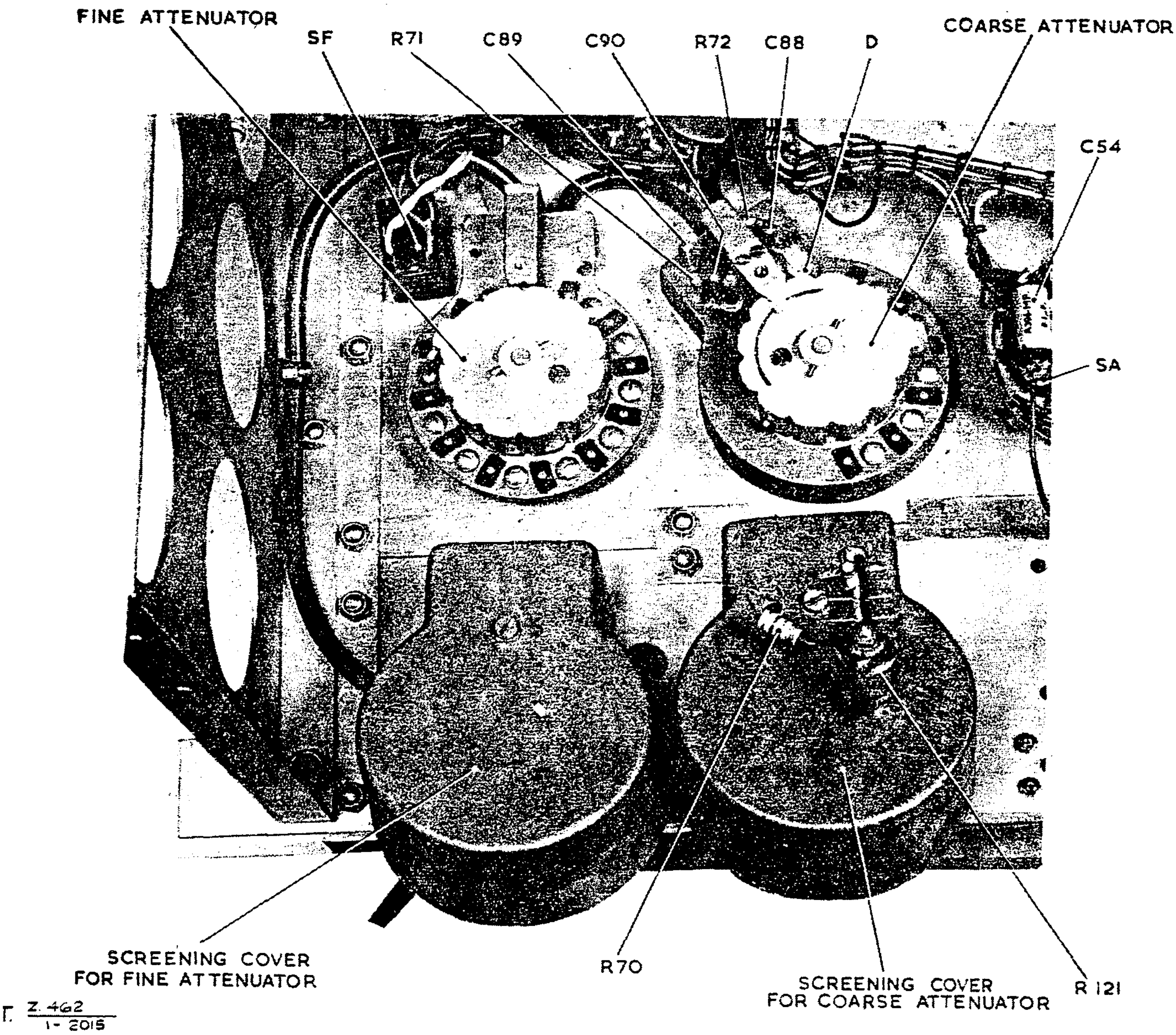

Fig 2015 - Attenuators (cover removed)

Tracking potentiometer R7
Tuning dial

56. To prevent excessive rotation of the dial a lever L rests on a cam W and in conjunction with the projection B rotation is limited. The cam has two different radii and the lever is kept in contact by a spring S. During tuning B rotates and when the lever comes in contact with point P on the cam, L moves and a hook on the end of L comes in contact with B thus preventing any further rotation.

Circuit layout and filtering

57. The instrument consists of sub chassis to facilitate maintenance. These are the r.f., a.f., p.s.u. and i.f. amplifier units. All r.f. circuits are completely enclosed within a metal cover, removalable for servicing purposes. The edge of the cover is fitted into spring contacts.

58. All connections through the chassis to and from the r.f. circuits are adequately filtered. The filters are complete units fitted in screening cans. The mains input is also filtered to eliminate any possibility of r.f. radiation via the mains. Details of the filters are as follows:-

L1 and L2 C1 to C4	- Mains filter (Fig 2002)	
L1, C3 and C4	- Output from crystal check circuit	Fig 2001a or b
L2, C5 and C10	- H.T. filter to V1, V4, V5, V6, V7, V8, V10, V12	
L4, C13 and C12	- H.T. filter to V2, V3	
L7, L8, C19 to C23	- L.T. filter	

Note: The next page is Page 1001

Table 2005 - Typical valve electrode potentials

Note: Switch to INT MOD AM, band 5, SET CARRIER to maximum and SET MOD to minimum

Valve	Cathode	Anode	Screen	Notes
1	1.3	250	50	
2	9	150	150	
3	-	150	75	
4	-	65	65	(With telephone plug inserted)
5	7.5	250	250	
	40			(On INT MOD FM)
6	-	90	135	
7A	-	250	-	Switch to range 1
7B	2.3	250	-	(1.5-13.5Mc/s)
8	-	100	110	
10	-	120	120	
12	-	125	130	

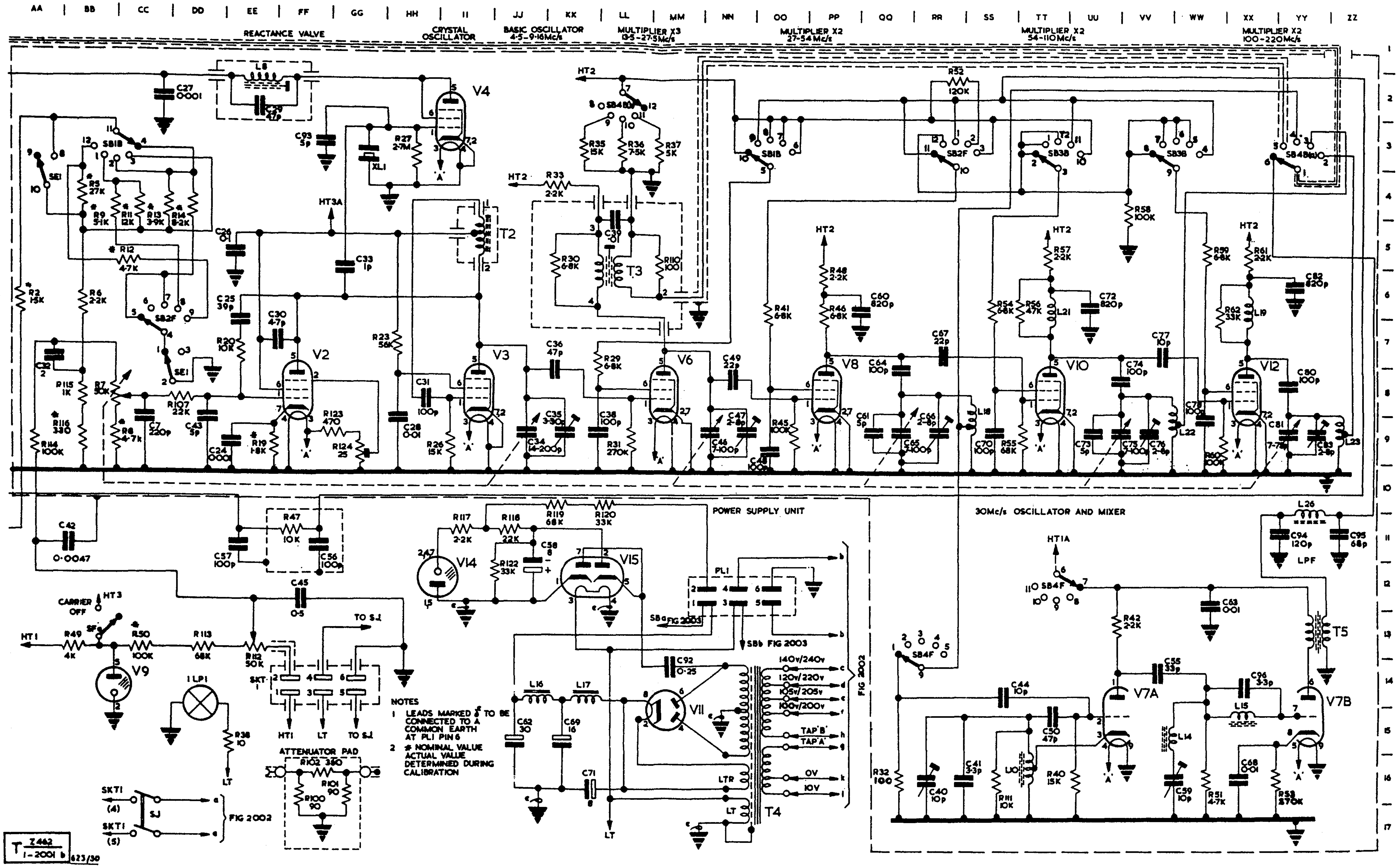

Fig 2001b - Signal generator No 18 - circuit diagram

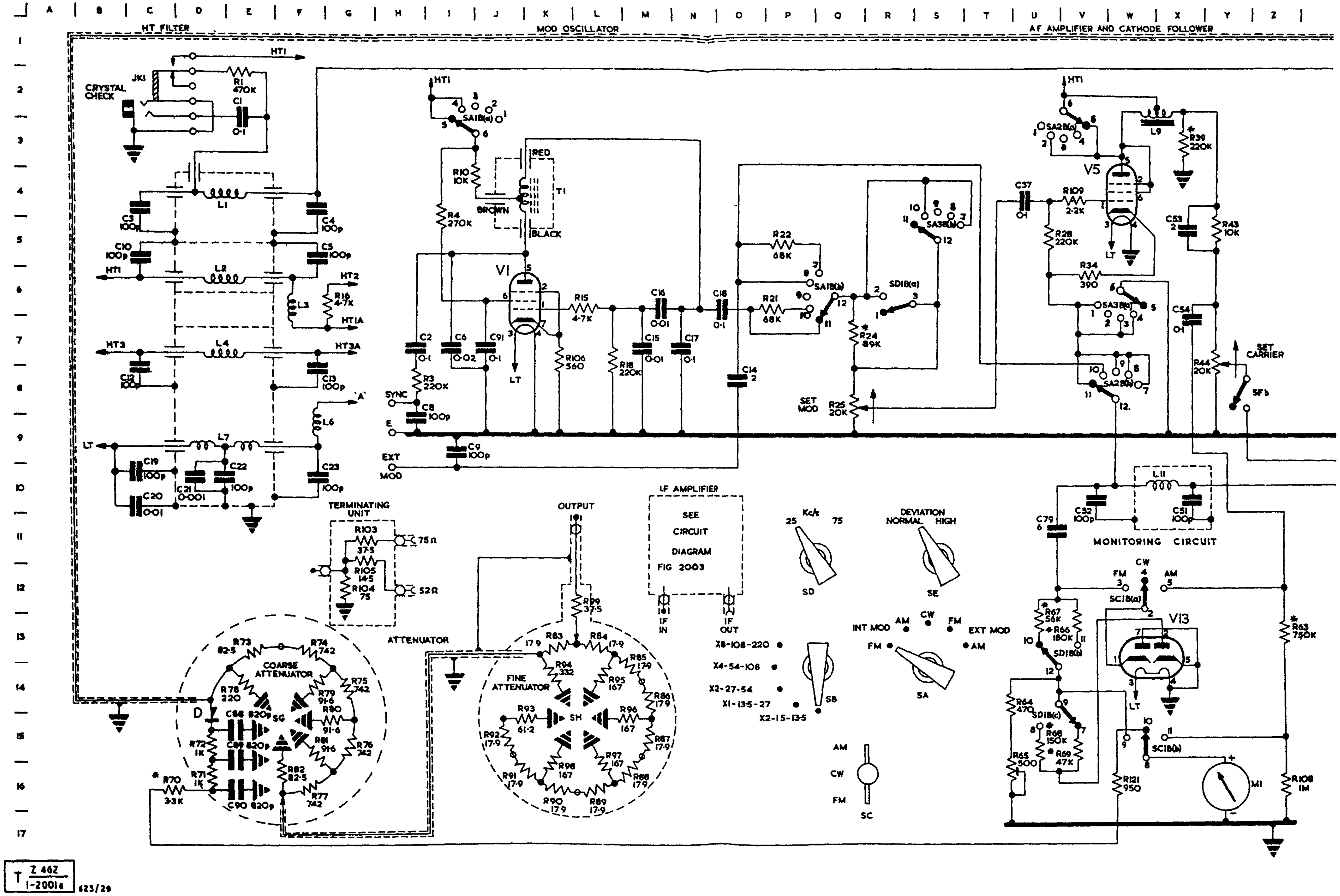

Fig 2001a - Signal generator No 18 - circuit diagram