MARCONI INSTRUMENTS

EB 868/1
2 - 8/54

OPERATING AND MAINTENANCE

HANDBOOK

for

UNIVERSAL BRIDGE

TYPE TF 868/1

CONTENTS

SCHEDULE OF PARTS SUPPLIED

1. One Universal Bridge Type TF 868/1 complete with attached mains lead and with valves and lamp as under:-

Valves:	One:	Type B65 Duo-Triode.
	One:	Type L63 Triode.
	One:	Type KTZ63 Pentode.
	One:	Type DH63 Duo-Diode/Triode.
	One:	Type EA50 Diode.
Lamp:	One:	6.5-volt, 0.3-amp, M.E.S., Pilot Lamp.

2. Two Jack Plugs, Igranic Type P40.

3. One Operating and Maintenance Handbook No. EB 868/1.

1. DESCRIPTION

1.1. GENERAL

The Universal Bridge Type TF 868/1 measures values of inductance from 1 μH to 100 henrys, capacitance from 1 μμF to 100 μF, and resistance from 0.1 ohm to 10 MΩ. Inductance or capacitance measurements can be made at either 1 or 10 kc/s; resistance measurements are made at d.c.

A feature of the instrument, is its employment of a single dial for the measurement of L, C, and R. This is accomplished by an ingenious mechanical design in which a system of partial masking of rotatable discs - which are viewed through windows cut in the main scale - automatically gives the dial the correct calibrations for any of the 21 different obtainable combinations of L-C-R and RANGE switch settings. In consequence, the dial is directly read without risk of confusion and without recourse to multiplying factors.

For inductance or capacitance measurements the measuring bridge is energized by the output from a valve oscillator, the out-of-balance voltage from the bridge being applied to the built-in selective amplifier-detector and moving-coil indicator; for resistance measurements the indicator is used directly as a centre-zero galvanometer, the necessary d.c. for the bridge being derived from the power pack supplying the oscillator and detector used for inductance and capacitance measurements.

1.2. DESIGN DETAILS

Basic Bridge Circuits. The choice of bridge is effected by an L-C-R switch which selects the required circuit. For resistance measurements the circuit elements are connected as a Wheatstone bridge while inductance is measured by comparison with capacitance, the use of a Maxwell or Hay circuit depending on the Q of the inductor under test. Capacitance is determined by a resistance ratio arm bridge in which the final arrangement again depends upon the losses of the test component - this choice of circuit for L and C measurements is discussed below in connection with the phase balance control.

The bridge is essentially designed for three-terminal capacitance measurements and the resistive ratio arm is capacitance-compensated (Brit. Pat. No. 629,395).

Phase Balance Control. This control, which is, of course, inoperative when measuring resistance, carries two scales - one marked in terms of Q, and the other in terms of tan δ - the scale in use depending on the setting of the Q-TAN δ change-over switch. It is this switch which selects the final arrangement of the "standard" arm of the bridge.

The Q scale is calibrated from 0 to 10 and the tan δ scale from 0 to 0.1; as Q = 1/tan δ, the two scales combine to give continuous cover for Q and tan δ from zero to infinity. For convenience, a chart is fitted to the top of the instrument and inter-relates tan δ, Q and power factor (sin δ or cos ϕ); it also gives effective series and effective parallel values. When using the instrument at 10 kc/s, the readings of the phase balance control are subject to a simple conversion factor of 10.

Oscillators. The 1- and 10-kc/s oscillators used for a.c. measurements employ a duo-triode valve, each section of the valve being coupled to a separate LC tuned circuit. The output of the oscillator in use - selected by means of a two-position panel switch - is fed via the variable AC BRIDGE VOLTS potentiometer control to a buffer amplifier; a screened and balanced transformer couples the buffer amplifier to the measuring bridge.

Balance Indicator Circuits. For d.c. resistance measurements the centre-zero panel meter is connected directly to the bridge; as balance is approached, a voltage limiting resistance is short-circuited by means of the key engraved PRESS FOR FINAL R BALANCE. A jack socket is provided for the substitution of an external meter, if required.

For the determination of inductance or capacitance, the out-of-balance voltage from the bridge is applied to an amplifier-detector with selective negative feedback and a.g.c.; the centre-zero panel meter is again used as balance indicator but in this case is backed off to have a left-hand working zero. The response is approximately logarithmic, the a.g.c. feature disposing of the need for any sensitivity control.

Inspection of the Functional Diagram included in this handbook shows that the negative feedback is obtained from the cathode of the second valve and is applied to the grid of the first via a shunt-connected, series-resonant LC circuit and a twin-T RC network; the twin-T is tuned to give maximum rejection at 1 kc/s; the LC circuit is tuned to 10 kc/s. Negative feedback to the first valve is therefore reduced to a minimum at these two frequencies and amplifier gain therefore peaks to a maximum at 1 and 10 kc/s.

The a.g.c. voltage derived from the diode rectifier following the second a.c. amplifier valve is applied to the grid of the first valve via the conducting path offered by one side of the twin-T network. This d.c. a.g.c. voltage, as well as determining the a.c. gain of the amplifier, fixes the mean anode current of the first valve. The magnitude of this current in turn fixes the mean volt drop across the chain of resistors in the anode circuit of the valve; the balance-indicating meter compares the mean potential at a tap on this chain of anode resistors, with a d.c. potential derived from an h.t./earth potentiometer. It is arranged in the setting up of the instrument, that with no a.c. out-of-balance voltage coming from the measuring bridge, the indicating meter reads at its left-hand working zero. It will be seen that the first stage thus has two functions: (i) as an a.c. amplifier handling the incoming signal from the measuring bridge, and (ii) as a d.c. voltmeter indicating in proportion to the magnitude of the rectified output from the second a.c. amplifier stage.

A jack socket is fitted for the attachment of head telephones as an alternative 1000-c/s balance indicator.

Test Terminals. The test terminals, which are common to all bridge arrangements, are separately insulated from earth, with the earth (guard) terminal between them to minimise direct capacitance. They are located so that the insulated low-capacitance top platform of the instrument may be used for the accommodation of small test components immediately adjacent to the bridge connections.

Power Pack. The power pack, which comprises a mains transformer, and a metal rectifier in a voltage doubling circuit with resistance-capacitance smoothing, supplies the valves in the oscillator and detector circuits; it also supplies the d.c. for resistance measurements.

The equipment can be operated from 100- to 125-volt or 200- to 250-volt, 40- to 100-c/s, a.c. mains supplies.

2. OPERATION

2.1. INSTALLATION

Unless otherwise specified, the Universal Bridge is normally despatched with its valves in situ, and with its mains input circuit adjusted for immediate use with 230- to 250-volt, 40- to 100-c/s a.c. mains supplies. As detailed in the Section which immediately follows, the instrument can, after adjustment, be operated from other supply voltages within the ranges 100 to 125 volts and 200 to 230 volts.

2.2. MAINS INPUT ARRANGEMENTS

The instrument is fitted with a mains transformer which has a double-wound primary; each section is tapped, the whole or part of the sections being connected in parallel for 100- to 125-volt operation or in series for 200- to 250-volt operation.

The three leads from each of the two primary sections are brought to screw-threaded eyelets on a tapping panel which is accessible after removal of a cover plate in the right-hand case handle recess. The appropriate interconnections between the primary sections are made by screwing to the tapping panel, one of the two plastic mouldings supplied for this purpose with the instrument. The two mouldings differ from one another in the way that their corner screws are internally linked. Each moulding has, near its top, a horizontal rectangular window; with a moulding screwed to the tapping panel, the figures framed by the window show the approximate centre of the mains voltage range over which the instrument can be operated with that particular moulding screwed at that position on the tapping panel.

One moulding shows "110 V" through its window when screwed to the left-hand side of the panel; it shows "120 V" when screwed to the right-hand side of the panel. With "110 V" showing through the window, the instrument can be used with mains supplies between 100 and 115 volts; with "120 V" showing, it can be used with supplies between 115 and 125 volts.

The other moulding shows either "220 V" or "240 V" when similarly screwed to the tapping panel. With "220 V" showing through the window, the instrument can be used with mains supplies between 200 and 230 volts; with "240 V" showing, it can be used with supplies between 230 and 250 volts.

In the case of "borderline" voltages, e.g., 230 volts, always choose the higher voltage range.

With one moulding screwed to the tapping panel to give the required mains voltage range, the moulding not in use should be screwed to the front panel of the instrument to form an escutcheon or surround to the rotating cover of the pilot lamp which forms part of the mains switch assembly; the figures then showing in the window of this moulding which is not in active use, indicate the general mains voltage range, either "100 V RANGE" or "200 V RANGE", for which the instrument has been set up by the screwing of the other moulding to the internal tapping panel.

2.3. GENERAL OPERATIONAL PROCEDURE

Check that the central mechanical zero of the meter is correctly set, then switch on the supply by rotating the pilot lamp cover; having noted that the lamp glows, allow a few minutes for the valves to warm up and stabilize.

With the L-C-R selector at L or C and the AC BRIDGE VOLTS control fully anti-clockwise to zero, adjust the screwdriver-operated preset SET ZERO FOR L AND C to bring the meter pointer to the "100" mark at the left-hand end of the scale - in actual operation the meter reads to the right with the application of an a.c. unbalance voltage from the bridge and therefore returns towards the left-hand "100" as balance is approached.

When making measurements, the component under test is connected between the HI and LO terminals at the top of the instrument, the selector is set to L, C or R as applies and - with the AC BRIDGE VOLTS control advanced in the case of capacitance or inductance measurements - the main controls balancing the bridge are adjusted to produce minimum deviation of the meter pointer from the working zero, i.e., the left-hand "100". In the case of resistance measurements, where the central zero is used, the sensitivity is increased as balance is approached by operating the spring-loaded PRESS FOR FINAL R BALANCE switch.

To keep the leads to the test terminals short, place small capacitors or resistors on the upper deck, the capacitance to frame at the deck being low; unscreened inductors, however, should be raised from the deck by a suitable non-metallic support. The EXT METER jack allows the substitution of a more sensitive external meter for the internal 100-0-100 μA meter when measuring resistances, while h.r. telephones may be plugged into the PHONES jack as an alternative 1000-c/s balance indicator when measuring inductances or capacitances.

2.4. MEASUREMENT OF RESISTANCE

Set the selector switch to R and, unless the value to be measured is already known approximately, set the BALANCE control to about mid-scale. Starting at the lowest resistance range, adjust the RANGE switch until the meter just crosses zero, then rotate the BALANCE control to centre the meter. After the pointer lies within the central pair of red lines, operate the PRESS FOR FINAL R BALANCE switch to obtain increased sensitivity for final balancing; in the case of resistors of very low value it is advisable to depress this switch throughout. By balancing the bridge with the remote ends of the connecting leads short-circuited, the residual resistance (R_o) of the circuit may be determined.

The reason for approaching balance from the lower ranges is that the out-of-balance current through the test component is thus restricted. The maximum dissipation can, however, never exceed about 0.7 watt even when balance is approached from the higher ranges; at balance the maximum dissipation is limited to about 0.2 watt. These dissipations relate to resistors of the order of 10 kΩ and are lower for other values.

When switched to R the PHASE BALANCE control is inoperative.

2.5. MEASUREMENT OF INDUCTANCE OR CAPACITANCE

Set the 2-position switch - which is situated below the RANGE control - to the required test frequency. Set the selector switch to L or C as applies and check that, with the AC BRIDGE VOLTS temporarily at zero, the meter pointer falls to the working zero at the left-hand "100" mark. With this check completed, advance the AC BRIDGE VOLTS control about half way.

The setting of the Q-TAN δ switch depends upon the losses of the particular component under test. For initial balance, set the PHASE BALANCE control to about mid-scale and switch to Q for inductors or tan δ in the case of capacitors. Set the main BALANCE control also to about mid-scale, unless the inductance or capacitance is already known approximately, and adjust the RANGE until the meter reading falls towards the left-hand zero; obtain final balance by adjusting the BALANCE and PHASE BALANCE controls alternately to obtain a sharp minimum indication on the meter, if necessary, changing over the Q-TAN δ switch.

Except where it may be desirable to keep the current through the test component as low as possible (e.g. when measuring the inductance of iron-cored coils) the AC BRIDGE VOLTS control should be advanced to obtain optimum overall sensitivity and discrimination at final balance.

At balance the main BALANCE dial is direct reading; whether this is the effective series or parallel value depends upon the setting of the Q-TAN δ switch and hence upon the "goodness" of the test component. With the switch at Q, the more likely condition when making measurements on inductors, the 0- to 10-Q scale of the PHASE BALANCE control is in use and, with the L-C-R selector at L, effective series inductance is measured. With the switch at tan δ, the more likely condition when making measurements on capacitors, the 0- to 0.1-tan δ scale of the PHASE BALANCE control is in use and, with the L-C-R selector at C, effective series capacitance is measured.

The PHASE BALANCE dial is calibrated at 1 kc/s and is direct reading at that frequency; when the test frequency is 10 kc/s the readings of the PHASE BALANCE dial must be multiplied as follows:-

For L:		For C:	
	Q x 10		tan δ x 10
	tan δ x 0.1		Q x 0.1

As $Q = 1/\tan\delta$ it will be appreciated that, in conjunction with the Q-TAN δ switch, the two scales combine to give a continuous range of both Q and tan δ from zero to infinity. However, it should be borne in mind that for inductors which, because their Q is greater than 10 at 1 kc/s or 100 at 10 kc/s, require the Q-TAN δ switch to be set to tan δ, it is the effective parallel inductance which is measured; in the same way it is the effective parallel capacitance which is measured in the case of capacitors when the Q-TAN δ switch is set to Q. For convenience, a chart is fitted to the top of the instrument inter-relating tan δ, Q and power factor (= sin δ or cos ϕ); it also interconverts effective series and parallel values ($L_p/L_s = \sec^2\delta = C_s/C_p$) which differ appreciably only for values of Q below 10, or values of tan δ above 0.1; at Q = 10 the difference is 1%.

When using the bridge at low values of Q, avoid running into the spurious balance at Q = 0; in this condition, with the main dial at zero, the oscillator is short-circuited.

2.5.1. Notes on Low Inductance Measurements.

When testing low inductances it will be found that the settings of the BALANCE and PHASE BALANCE controls are interdependent. This interdependence will, in general, be more noticeable at 1 kc/s than it is at 10 kc/s; therefore, when testing low inductances, use the higher test frequency unless, for a particular component, there is a specific requirement for test figures at 1 kc/s.

Where there is a marked interdependence of the BALANCE and PHASE BALANCE controls, it is advisable to check the first reading obtained. Make this check by approaching the balance point from the other side. That is to say, having noted the first settings, unbalance the bridge by turning the two controls farther on, then work back again to restore balance; the settings to be taken are those which give the smallest meter reading. The zero inductance (L_o) of the bridge is very small and may be neglected.

As previously noted, with both PHASE BALANCE and main BALANCE controls at 0 there is a spurious balance due to the fact that the oscillator output is short-circuited.

2.5.2. Notes on High Inductance Measurements.

To avoid errors in measurement, coils having a low natural frequency should not be tested at 10 kc/s. If their natural frequency is lower than about 5 kc/s, then even test results at 1 kc/s will be in error - inductance will appear high and magnification low.

For example, a coil of 50H effective series inductance, 20 micro-microfarads self-capacitance and Q = 10 at 1 kc/s, will appear, when measured at 1 kc/s, to have an inductance of approximately 51.5H and a Q of about 9.5. The natural frequency of such a coil is 5 kc/s.

These errors increase very rapidly as the natural frequency of the coil approaches the frequency of the oscillator and it is, of course, impossible to measure a coil which resonates below 1 kc/s as such a coil will have a capacitance reactance. The effective value of this capacitance may be measured with the bridge and will usually have a large power factor. The added capacitance C_o introduced by the bridge itself is less than 1 micro-microfarad - see note on residual capacitance below.

2.5.3. Notes on Capacitance Measurements.

Residual Capacitance. With the L-C-R selector switch set to C, the residual capacitance (C_o) of the bridge, is typically of the order of 1 µµF; when measuring very small capacitances, this value of C_o should be subtracted from the indicated capacitance.

The exact residual capacitance of a particular Universal Bridge is given by the difference between (i) the value of an accurately known small capacitance, and (ii) the indicated value when that same capacitance is measured on the Universal Bridge.

Three-Terminal Networks. The bridge arrangement is such that measurements can be made on capacitors forming part of a three-terminal capacitive network - for example, the capacitance to the screen of an insulated screened condenser can be eliminated from the capacitance measurement by connecting the screen to the E (guard) terminal of the bridge. In cases, however, where the unwanted capacitance is excessive, errors may be introduced into the capacitance and phase angle indications; for these errors corrections can be applied, as shown below.

Referring to the Functional Diagram it will be seen that unwanted capacitance between LO and E shunts the detector and has no significant effect - if, therefore, there is any choice, this should be made the larger unwanted capacitance. In the case, however, of capacitance between HI and E, it is the standard arm which is shunted; if this capacitance be C_g, the correction (to a close approximation) is

$$C = C_{ind} \left(1 + C_g/C_s\right)$$

where C_{ind} is the uncorrected bridge reading and C_s is the value of the standard capacitance = 0.1 µF. The phase balance may be corrected in a similar manner:-

$$\tan\delta = \tan\delta_{ind}/\left(1 + C_g/C_s\right)$$

$$Q = Q_{ind} \left(1 + C_g/C_s\right)$$

It should be noted that the foregoing deals with a situation where it is desired to measure the actual inter-electrode capacitance; in certain instances - such as condensers which are to be used with one side and the screen earthed - a truer representation of the operational conditions can be obtained if the screen and earthy side are both joined to the LO terminal. An actual earth connection must be omitted.

3. MAINTENANCE

3.1. GENERAL

The following items (for details see APPENDICES, page 24) are included in this handbook to assist in the maintenance of the Universal Bridge Type TF 868/1:-

- Functional Diagram.
- Complete Circuit Diagram.
- Supplementary Circuit Diagrams.
- Component Layout Illustrations:-
  - Front Panel.
  - General View from Rear.
  - Underside View of Chassis (Oscillator Section).
  - Underside View of Chassis (Detector and Power Unit Section).
  - Front and Rear Views of Range Switch Assembly.
  - Exploded View of Balance Dial Assembly.
- Spares Ordering Schedule with Circuit References.
- Valve Replacement Data Sheets.

Section 1, DESCRIPTION, of this handbook deals with the internal circuits of the Universal Bridge and is intended to be read in conjunction with the Functional Diagram; it is strongly recommended that the user should familiarize himself with the principles described in Section 1, and illustrated in the Functional Diagram, before commencing the adjustment or replacement of component parts of the instrument.

The Complete Circuit Diagram TDX 17701/1 shows all the electrical components contained in the instrument. The description of these components - their type, value, rating, etc. - is given in the Spares Ordering Schedule; the Schedule also lists certain selected mechanical components. The physical location of components is shown on the Component Layout Illustrations.

The Supplementary Circuit Diagrams TBX 23804/5/6 show the active components comprising the measuring bridge for each of the three different settings of the L-C-R switch S1. The use of these Supplementary Diagrams will facilitate analysis of the Complete Circuit Diagram.

3.2. REPLACEMENT OF VALVES AND PILOT LAMP

The types of valve used in the instrument, their base connections, and some guidance as to suitable alternatives if the types originally fitted are not readily available, are given in the Valve Replacement Data sheets. All of the valves are accessible after removing the instrument from its case and they may normally be replaced without special selection.

To gain access to the interior of the instrument remove the four countersunk screws which secure the domed feet on the underside of the case. The instrument can then be lifted from the case as a single complete unit.

The pilot lamp is accessible after removing the black plastic moulding which forms the surrounding escutcheon. With the escutcheon removed, the transparent amber cover can then be withdrawn; on replacing this cover, take care that the projection on its body is uppermost.

3.3. WORKING VOLTAGES

Measured with a Model 40 Avometer set to its highest convenient range, the power pack voltages should be of the following orders:

Mains Transformer, h.t. secondary:	133 V a.c. ± 10%
" " l.t. " :	6.3 V a.c. ± 5%
H.T. Rectified (junction C17/R38):	305 V d.c. ± 10%
H.T. Smoothed (C19):	280 V d.c. ± 10%

Valve electrode voltages are given in TABLE 1. All the voltages listed are quoted with respect to chassis and are subject to a tolerance of ± 20%; they should be measured with the Bridge balanced with a 0.1-μF capacitor connected across the HI and LO terminals, with the A.C. BRIDGE VOLTS control turned clockwise to maximum, and - except where otherwise stated - with S6 at 1 kc/s.

TABLE 1

Valve No.	Va	Vsc	Vk
V1A	65	-	-
V1B	35*	-	-
V2	260	-	9
V3	80	32	-
V4	100	-	15

* S6 at 10 kc/s

3.4. REPLACEMENT OF PRESET OR SPECIALLY SELECTED COMPONENTS

In the manufacturing data for the TF 868/1 certain of the components are either specified as being of the preset type or are designed for individual selection, the setting or selection of the components being carried out during the factory calibration of the instrument; in this way it is possible to ensure uniform attainment of the best operating characteristics of which the circuit is inherently capable.

The Description column of the Spares Ordering Schedule shows which of the components in the TF 868/1 are of the preset type; components which are individually selected are distinguished in that column by an asterisk mark.

If, in the course of servicing operations, it is necessary to replace any of these components, then, if the performance of the instrument is not to be impaired, it is necessary to repeat the factory calibration procedure by which the components were originally adjusted or selected.

Sections 3.5 to 3.5.10 give a range of tests by which the main points of the performance of the instrument can be checked; the sections also deal with the adjustment of preset components and with the choice of value for individually selected components. TABLE 2 lists the circuit reference numbers of both types of component together with the numbers of the sections in which their adjustment or selection is described.

It will be appreciated that it may sometimes be necessary to readjust a preset component, or reselect a selected component, even though that component itself has not been found faulty and replaced in initial servicing operations. To take an example: the selective amplifier-detector is tuned by a twin-T RC network to have maximum gain at 1 kc/s. This network comprises five resistors and three capacitors; all of the capacitors and three of the resistors are fixed components; the remaining two resistors, R33 and R34, are screwdriver-operated preset components. In manufacture, R33 and R34 are adjusted so that there is minimum transmission through the network at the true frequency of the "1-kc/s" oscillator. (By this means, when using the Bridge at 1 kc/s, the user is assured of having a detector precisely tuned to the exact frequency of the exciting oscillator - a condition which minimises the effect of components in the oscillator output, such as harmonic distortion or hum, which would otherwise tend to mask the balance point and make it indefinite). If, during service operations, any of the fixed components in the twin-T network are replaced - or indeed, if C2 or T4 which tune the oscillator are replaced - then it is likely that it will be necessary to redetermine the correct settings for R33 and R34 if the original performance of the Bridge is to be maintained.

It therefore follows that, in all servicing involving replacement of components, the user should consider carefully the possible effects on the performance of the section or sections involved; if preset or individually selected components form part of those sections then it may be necessary to readjust or reselect them although they themselves have not been found faulty.

TABLE 2

Preset or Selected Component	Section Describing Adjustment or Selection
R33	3.5.3.
R34	3.5.3.
R41	3.5.2.
R44	3.5.3.
R46	3.5.2.
(C6 (C7	3.5.6.
C22	3.5.7.
C23	3.5.7.
C24	3.5.7.
C25	3.5.7.
C26	3.5.7.
C27	3.5.7.

3.5. SCHEDULE OF TESTS

The following information is based on abstracts from the internal Factory Test Schedule TS 868/1.

3.5.1. Apparatus Required

(a) AvoMeter, Model 40.
(b) Valve Voltmeter, Marconi Types TF 428 (Series) or TF 958.
(c) Variable Attenuator, Marconi Type TF 338B.
(d) Beat Frequency Oscillator, Marconi Types TF 195 (Series) or TF 894 (Series).
(e) Wheatstone Bridge.
(f) Capacitance Standards.
(g) Inductance Standards.
(h) Resistance Standards.

(i) Distortion Factor Meter, Marconi Type TF 142E.
(j) Cathode-Ray Oscilloscope.
(k) Variac Transformer.
(m) 10- to 500-μμF Variable Air Capacitor.
(n) 5000-μμF ±1% Fixed Capacitor.
(o) 500-μμF ±1% Fixed Capacitor.
(p) 50-μμF ±1% Fixed Capacitor.
(q) 255-kΩ ±1% Fixed Resistor.
(r) 32-kΩ ±1% Fixed Resistor.
(s) 25.5-kΩ ±1% Fixed Resistor.
(t) 3.2-kΩ ±1% Fixed Resistor.
(u) 2.55-kΩ ±1% Fixed Resistor.
(v) 320-Ω ±1% Fixed Resistor.
(w) 100-0-100μA, Centre-Zero Meter.
(x) Standard Capacitance Bridge.
(y) H.R. Headphones.

3.5.2. Adjustment of Oscillators (Apparatus required:- Items b, d, i, and j)

Connect terminals 1 and 2 of transformer T2, to the X plates of the Cathode-Ray Oscilloscope and the output of the Beat Frequency Oscillator to the Y plates. Set the oscillator switch, S6, to 1 kc/s, and, using the Lissajous method check that the "1-kc/s" oscillator frequency is within the limits 975 to 1025 c/s.

Set the oscillator switch, S6, to 10 kc/s, and, again using the Lissajous method, check that the "10-kc/s" oscillator frequency is within the limits 9,750 to 10,250 c/s.

If either of the oscillator frequencies is outside the limits given above, then the complete oscillator tuning assembly comprising T4, C2 and C29 should be replaced.

Set the L-C-R switch to R and the AC BRIDGE VOLTS control to maximum. Using the Valve Voltmeter, note the voltage across pins 1 and 2 of transformer T2. Select a value for R41 to give a reading of between 9 and 11 volts with S6 at 1 kc/s. Select a value for R46 to give a reading of between 9 and 11 volts with S6 at 10 kc/s.

With the L-C-R switch still at R, connect terminals 1 and 2 of transformer T2 to the input of the Distortion Factor Meter. With the AC BRIDGE VOLTS control at maximum, check that the total distortion does not exceed 3.5% at 1 kc/s.

3.5.3. Detector Adjustments (Apparatus required:- Items, c, d, j, k, and y)

Using the Lissajous method, adjust the frequency of the Beat Frequency Oscillator to that of the TF 868/1 internal 1-kc/s oscillator. Switch off the TF 868/1. Unsolder the end of R21 which is connected to pin 2 of transformer T3. Without altering the frequency, apply a 10-volt output from the Beat Frequency Oscillator between the free end of R21 and chassis. Plug the headphones into the PHONES jack and adjust preset resistors R33 and R34 for a well-defined zero. Remove the phones. Connect the output of the Beat Frequency Oscillator to the Attenuator input, and connect the Attenuator output between the free end of R21 and chassis. Switch on the TF 868/1. Set the controls on the Beat Frequency Oscillator and the Attenuator to produce an input of 1 mV between R21 and chassis. Check that this input produces a deflection, on the TF 868/1 panel meter, of about 10 divisions.

Adjust the Beat Frequency Oscillator tuning control to indicate 10 kc/s and check that a 1-mV input between R21 and chassis produces a deflection of about 1 division.

Switch off the TF 868/1 and disconnect the Beat Frequency Oscillator and the Attenuator; resolder R21 to pin 2 of transformer T3. Interpose the Variac transformer between the mains supply and the mains plug of the TF 868/1 and switch the instrument on. Adjust the Variac output voltage to suit the maximum voltage of the TF 868/1 mains transformer setting in use; for example - if the moulding screwed to the mains transformer tapping panel is showing "240V" in its window, set the Variac to give an output of 250 volts. With the L-C-R switch set to either L or C, and with the AC BRIDGE VOLTS control at maximum, select a value for R44 which will limit the meter reading to between 90 and 100 on the right-hand half of the panel meter scale.

3.5.4. <u>Calibration of the main BALANCE dial</u> (Apparatus required:- Items a and e)

<u>Checking existing calibrated dial</u>. To check the calibration of the main BALANCE dial, unsolder the lead connecting R17 to the bridge earth, i.e., the earth point which is located immediately above the wafers of switch S1. Rotate the BALANCE control, R17, to its maximum anti-clockwise position. Using the AvoMeter, check that in this position of the control, the outer terminals of R17 are short-circuited together; also, ensure that the BALANCE dial pointer coincides with the zero calibration on the dial. Remove the AvoMeter and connect the outer terminals of R17 to the Wheatstone Bridge. Rotate the BALANCE control (and thus the pointer) clockwise. Check that the pointer coincides with the calibration mark corresponding to each setting of R17 which is a multiple of 10 ohms up to 500 ohms. Above 500 ohms, check that the pointer coincides with the calibration mark corresponding to each setting of R17 which is a multiple of 20 ohms up to 1080 ohms.

If a constant error exists all round the dial, adjust the pointer relative to the spindle of R17 to correct the calibration. To do this, remove the perspex covering window (121 on MP 868/1-6), and rotate R17 to its maximum anti-clockwise position. Slacken off the two socket set screws which lock the slow-motion drive to the spindle of R17, and set the pointer to the zero calibration on the dial. Tighten the socket set screws, thus locking the slow-motion drive to the spindle of R17. Replace the perspex covering window.

If, however, the error is not constant, it will be necessary to replace R17. When ordering a replacement for R17, it will be noted from the Spares Ordering Schedule that an uncalibrated BALANCE dial should also be ordered. Thus, when replacing R17, it will be necessary to fit and calibrate the new BALANCE dial.

Fitting and Calibrating Replacement Dial. When fitting R17, leave the side of the control which is normally connected to earth, temporarily disconnected. Also, when fitting the new BALANCE dial, the perspex covering window (121 on MP 868/1-6) and the felt pad (120 on MP 868/1-6) should not be fixed in position until the dial has been calibrated. With the window removed it will be found that the stationary outer portion of the slow-motion drive (122), is free to rotate and that the slow-motion facility has been lost. Therefore, to make full use of the slow-motion action the drive should be fixed, by means of the anchoring fork, in some convenient manner. Rotate the control until R17 is at its maximum anti-clockwise position, and set the pointer approximately in line with the left-hand edge of the box engraved RLC. Using the AvoMeter, check that the resistance of R17 is nominally zero ohms. With the control set in this manner, mark a line on the dial at a point coinciding with the position of the pointer. Rotate R17 (and thus the pointer) clockwise. Mark the dial for the new pointer setting when the resistance of R17 is 10 ohms, as measured on the Wheatstone Bridge. Repeat the procedure, marking the dial at every point which is a multiple of 10 ohms up to 500 ohms. Above 500 ohms, mark the dial at every point which is a multiple of 20 ohms up to 1080 ohms. Solder the earth lead to R17. The dial may now be removed for engraving, or marking in white ink.

3.5.5. Calibration of the PHASE BALANCE Dial (Apparatus required:- Items a and e)

Q scale. To check the calibration of the Q scale, disconnect the non-earthed lead from R15. Rotate the control to its maximum clockwise position and check that the cursor line coincides with the mark on the Q scale to the left of the zero Q calibration. This mark indicates the limit-of-travel of R15. If the cursor line does not coincide with the "limit-of-travel" mark, the calibration can be corrected by altering the position of the PHASE BALANCE dial relative to the control spindle. Connect the AvoMeter, switched to ohms, across R15, and very gradually rotate the control until the last point at which the AvoMeter reading is 0 ohms is reached; the cursor should now indicate zero Q on the dial. Remove the AvoMeter and connect the outer terminals of R15 to the Wheatstone Bridge. Check that the calibration of the Q scale is, for each appropriate resistance setting of R15, as given in TABLE 3, below.

TABLE 3

R15	
Q	R(Ω)
0.5	796
1.0	1592
1.5	2390
2.0	3190
2.5	3980
3.0	4780
3.5	5580
4.0	6370
5.0	7960
6.0	9560
7.0	11140
8.0	12770
9.0	14360
10.0	15920

If an error exists after the calibration checks and adjustments, R15 (and R14) should be replaced. This will in turn necessitate replacement of the PHASE BALANCE dial. When ordering a replacement for this ganged potentiometer assembly, it will be noted from the Spares Ordering Schedule that a calibrated PHASE BALANCE dial is also supplied.

TAN δ scale. The procedure for checking the TAN δ scale calibration is the same as that for the Q scale. Disconnect the non-earthed lead from R14 and, using the AvoMeter and Wheatstone Bridge, check the calibration of the TAN δ scale for each appropriate resistance setting of R14, as given in TABLE 4, below.

TABLE 4

R14	
TAN δ	R(Ω)
0.005	7.96
0.01	15.92
0.015	23.90
0.02	31.90
0.025	39.80
0.03	47.80
0.035	55.80
0.04	63.70
0.05	79.60
0.06	95.60
0.07	111.40
0.08	127.70
0.09	143.6
0.1	159.2

If it is necessary to replace R14 - because either R14 or R15 is faulty - the PHASE BALANCE dial must also be replaced. It will be noted from the Spares Ordering Schedule that a replacement R14/R15 potentiometer assembly is supplied complete with a calibrated dial.

3.5.6. Standard Capacitor (Apparatus required:- Item x)

Check that the value of the standard capacitor, C7, is 0.1 μF ± 0.25%; where C7 is padded by C6, confirm that the total capacitance is 0.1 μF ± 0.25%. C6 should not be greater than 1000 μμF.

3.5.7. PHASE BALANCE Adjustments (Apparatus required:- Items m and n)

Connect the 10- to 500-μμF variable air capacitor between the HI and LO terminals of the TF 868/1. Set the L-C-R switch to C, the Q-TAN δ switch to TAN δ, and the oscillator switch, S6, to 10 kc/s. Set the RANGE switch to the 0- to 100-μμF range and set the PHASE BALANCE control to indicate zero tan δ. Using the TF 868/1, set the variable air capacitor to approximately 50 μμF. After bringing the Bridge to a preliminary balance, adjust trimmer capacitor, C22, and the BALANCE control, R17, for zero or minimum meter reading. If, with C22 adjusted, it is impossible to obtain a balance at zero tan δ, select a new value for C23.

Set the variable air capacitor to its maximum of 500μμF and, with the RANGE switch turned to the 0- to 1000-μμF position, bring the Bridge to balance. With the PHASE BALANCE control indicating zero tan δ, adjust trimmer capacitor C24 and the BALANCE control, R17, for zero or minimum meter reading. If, with C24 adjusted, it is impossible to obtain a balance at zero tan δ, select a new value for C25.

Remove the variable air capacitor from between the HI and LO terminals and in its place connect a 5000-μμF high-quality fixed mica capacitor. Turn the RANGE switch to the 0- to 0.01-μF position and bring the Bridge to balance. After this, proceed to adjust the trimmer capacitor C26 and, if necessary, select a new value for C27, in a manner similar to that described for C24 and C25 in the preceding paragraph.

3.5.8. Measurement Accuracy (Apparatus required:- Items f, g, h, n, o, p, q, r, s, t, u, and v)

Using the inductance, capacitance, and resistance standards check that the measurement accuracy is within the following limits:-

L, C, and R: ±1% ±1/10th of one scale division, except in the case of the range extremes given below:-

Inductance: 1 to 100μH, ±5% ±1μH; 10 to 100 henrys, ±5%.

Capacitance: 1 to 100μμF, ±3% ±0.3μμF; 10 to 100μF, ±5%.

Resistance: 0.1 to 10 ohms, ±5% ±0.05 ohm; 5 to 10 MΩ, ±3%.

TAN δ

Connect the 255-kΩ resistor in series with the 50-μμF capacitor across the HI and LO terminals. Set the oscillator switch, S6, to 1 kc/s, the L-C-R switch to C, the RANGE switch to the 0- to 100-μμF range, and the Q-TAN δ switch to TAN δ. Adjust the TF 868/1 to balance and check that, under the above conditions, the tan δ reading is 0.08, ±10% ±0.002.

Remove the 255-kΩ resistor and replace it with the 32-kΩ resistor. With the controls set as above, check that tan δ is 0.01, ±10% ±0.002.

Set the RANGE switch to the 0- to 1000-μμF range. Using the 500-μμF capacitor in series with a 25.5-kΩ resistor, check that tan δ is 0.08 ±10% ±0.002. With the 500-μμF capacitor and the 3.2-kΩ resistor check that tan δ is 0.01 ±10% ±0.002.

Set the RANGE switch to the 0- to 0.01-μF range. Using the 5000-μμF capacitor and the 2.55-kΩ resistor, check that tan δ is 0.08 ±10% ±0.002. With the 5000-μμF capacitor and the 320-ohm resistor check that tan δ is 0.01 ±10% ±0.002.

The intermediate tan δ calibrations, for a given RANGE switch setting, can be checked by using different values for the series resistor; the value of the resistor may be calculated from the following expression.

$$R = \frac{\mathrm{TAN}\ \delta}{\omega C}$$

For example, to obtain a tan δ value of, say, 0.04 at 1000 c/s, using a 500-μμF capacitor, the value of the series resistor required is

$$\frac{0.04}{6.28 \times 10^{3} \times 500 \times 10^{-12}}$$

$$= 12{,}750 \text{ ohms.}$$

3.5.9. Phone Check (Apparatus required:- Item y)

At 1000 c/s, check that when using phones the discrimination is improved as compared with the meter.

3.5.10. External Meter Check (Apparatus required:- Item w)

Check the external meter circuit by connecting the 100-0-100 μA meter to jack, J2.

APPENDICES

VALVE REPLACEMENT DATA........................VRD 868/1: Two Sheets

COMPONENT LAYOUT ILLUSTRATIONS

- Front Panel..MP 868/1-1
- General View from Rear...............................MP 868/1-2
- Underside View of Chassis (Oscillator Section).......MP 868/1-3
- Underside View of Chassis (Detector and Power Unit Section)....................................MP 868/1-4
- Front and Rear Views of Range Switch Assembly........MP 868/1-5
- Exploded View of Balance Dial Assembly...............MP 868/1-6

SPARES ORDERING SCHEDULE WITH CIRCUIT REFERENCES....................SOS/868/1: Twelve Sheets

FUNCTIONAL DIAGRAM........................TBX 23815: Printed Version

BRIDGE CIRCUIT FOR INDUCTANCE MEASUREMENT..............TBX 23804: Printed Version

BRIDGE CIRCUIT FOR CAPACITANCE MEASUREMENT.............TBX 23805: Printed Version

BRIDGE CIRCUIT FOR RESISTANCE MEASUREMENT..............TBX 23806: Printed Version

COMPLETE CIRCUIT DIAGRAM................TDX 17701/1: Printed Version

SPARES ORDERING SCHEDULE NO. SOS/868/1, ISSUE 1

WITH CIRCUIT REFERENCES

for

UNIVERSAL BRIDGE TYPE TF 868/1

Applicable to Instruments Serial Nos:-

1719(01) to 1719(500)

When ordering replacement parts, please state: the quantity and type required, the number and issue of this Spares Ordering Schedule, and the SOS item number of the part required.

For example, to order a replacement for the 100-kΩ, 1/4-watt resistor, R2, quote:-

1 off, Resistor: SOS/868/1, Issue 1, Item 2.

SOS Item No.	Circuit Ref.	Description	Works Ref.
		RESISTORS	
1	R1	Composition, 330 Ω ± 10%, ½ W.	86-TF868/1
2	R2	Composition, 100 kΩ ± 20%, 1/4 W.	150-TF868/1
3	R3	Composition, 330 Ω ± 20%, 1/4 W.	88-TF868/1
4	R4	Carbon, Variable Log. Law, 100 kΩ, 2 W.	84-TF868/1
5	R5	Composition, 1 kΩ ± 20%, ½ W.	89-TF868/1
6	R6	Wire-Wound, 22 kΩ ± 10%, 10 W.	90-TF868/1

SOS Item No.	Circuit Ref.	Description	Works Ref.
		RESISTORS (continued)	
7	R7	Carbon, High Stability, 0.5 MΩ ± 1%, 1 W.	15-TM3961/1
8	R8	Wire-Wound, 50 kΩ ± 0.25%, 1 W.	14-TM3961/1
9	R9	Wire-Wound, Special Non-Inductive, 5 kΩ ± 0.1%.	13-TM3961/1
10	R10	Wire-Wound, Special Non-Inductive, 1 kΩ ± 0.1%.	12-TM3961/1
11	R11	Wire-Wound, Special Non-Inductive, 100 Ω ± 0.1%.	11-TM3961/1
12	R12	Wire-Wound, Special Non-Inductive, 10 Ω ± 0.1%.	10-TM3961/1
13	R13	Wire-Wound, Special Non-Inductive, 1.0 Ω ± 0.5%.	9-TM3961/1
14	(R14 (and (R15	Ganged potentiometers complete with individually calibrated PHASE BALANCE dial. Each potentiometer section is wire-wound, semi log law, 4 W. R14 is 160 Ω and R15 is 16 kΩ.	80-TF868/1 TB18685 + cal
15	R16	Wire-Wound, Special Non-Inductive, 100 Ω ± 0.1%.	91-TF868/1
16	R17	Wire-Wound, Variable, Graded, 1100 Ω; order item 124 also.	83-TF868/1
17	R18	Composition, 47 kΩ ± 20%, ½ W.	92-TF868/1
18	R19	Composition, 10 kΩ ± 20%, ½ W.	93-TF868/1
19	R20	Composition, 220 kΩ ± 20%, ½ W.	94-TF868/1
20	R21	Composition, 47 kΩ ± 20%, ½ W.	95-TF868/1
21	R22	Wire-Wound, Preset, 10 kΩ ± 10%, 2 W.	82-TF868/1
22	R23	Composition, 220 kΩ ± 20%, ½ W.	94-TF868/1
23	R24	Composition, 47 kΩ ± 20%, ½ W.	95-TF868/1
24	R25	Composition, 2.2 MΩ ± 20%, ½ W.	96-TF868/1
25	R26	Composition, 180 kΩ ± 20%, ½ W.	97-TF868/1

SOS Item No.	Circuit Ref.	Description	Works Ref.
		RESISTORS (continued)	
26	R27	Composition, 2.2 kΩ ± 20%, ½ W.	98-TF868/1
27	R28	Composition, 15 kΩ ± 20%, ½ W.	99-TF868/1
28	R29	Composition, 1.5 MΩ ± 20%, ½ W.	100-TF868/1
29	R30	Composition, 1.5 MΩ ± 20%, ½ W.	100-TF868/1
30	R31	Composition, 100 kΩ ± 20%, ½ W.	87-TF868/1
31	R32	Composition, 47 kΩ ± 20%, ½ W.	95-TF868/1
32	R33	Wire-Wound, Preset, 100 kΩ ± 10%, 3 W.	81-TF868/1
33	R34	Wire-Wound, Preset, 100 kΩ ± 10%, 3 W.	81-TF868/1
34	R35	Composition, 47 kΩ ± 20%, ½ W.	95-TF868/1
35	R36	Composition, 100 kΩ ± 10%, ½ W.	133-TF868/1
36	R37	Composition, 100 kΩ ± 20%, 1/4 W.	150-TF868/1
37	R38	Wire-Wound, 1 kΩ ± 5%, 2 W.	103-TF868/1
38	R39	Wire-Wound, 50 kΩ ± 0.25%, 1 W.	14-TM3961/1
39	R40	Composition, 2.2 kΩ ± 20%, ½ W.	85-TF868/1
40	R41	Composition, 220 kΩ*, 1/4 W.	78-TF868/1
41	R42	Carbon, High Stability, 0.5 MΩ ± 1%, 1 W.	15-TM3961/1
42	R43	Wire-Wound, Special Non-Inductive, 5 kΩ ± 0.1%.	13-TM3961/1
43	R44	Composition, 27 kΩ*, ½ W.	118-TF868/1
44	R45	Composition, 10 Ω ± 20%, ½ W.	127-TF868/1
45	R46	Composition, 330 kΩ*, 1/4 W.	132-TF868/1

* Nominal value; actual value determined during calibration.

SOS Item No.	Circuit Ref.	Description	Works Ref.
		RESISTORS (continued)	
46	R47	Composition, 330 Ω ± 20%, 1/4 W.	88-TF868/1
47	R48	Composition, 150 kΩ ± 20%, ½ W.	135-TF868/1
48	R49	Composition, 6.8 kΩ ± 20%, 1 W.	136-TF868/1
		CAPACITORS	
49	C1	Electrolytic, 8 µF + 50% - 20%, 350 V d.c.	107-TF868/1
50	C2	Paper, 0.05 µF ± 25%, 350 V d.c.	5-TM4811
51	C3	Paper, 0.01 µF ± 20%, 350 V d.c.	110-TF868/1
52	C4	Paper, 0.1 µF ± 20%, 350 V d.c.	111-TF868/1
53	C6 and C7	C7 is Mica, High Stability, 0.1 µF + 0% - 1%, 350 V d.c.; C6 is Mica, High Stability, selected to bring C6 + C7 to 0.1 µF ± 0.25%.	108-TF868/1 105-TF868/1
54	C8	Paper, 0.01 µF ± 20%, 350 V d.c.	110-TF868/1
55	C9	Paper, 0.1 µF ± 20%, 350 V d.c.	111-TF868/1
56	C10	Mica, 0.0002 µF ± 15%, 350 V d.c.	112-TF868/1
57	C11	Paper, 0.1 µF ± 20%, 350 V d.c.	111-TF868/1
58	C12	Mica, 0.0002 µF ± 15%, 350 V d.c.	112-TF868/1

SOS Item No.	Circuit Ref.	Description	Works Ref.
		CAPACITORS (continued)	
59	C13	Paper, 0.01 μF ± 20%, 350 V d.c.	110-TF868/1
60	C14	Mica, 0.004 μF ± 10%, 350 V d.c.	113-TF868/1
61	C15	Mica, 0.001 μF ± 10%, 350 V d.c.	114-TF868/1
62	C16	Mica, 0.001 μF ± 10%, 350 V d.c.	114-TF868/1
63	C17	Electrolytic, 8 μF + 50% - 20%, 350 V d.c.	107-TF868/1
64	C18	Electrolytic, 8 μF + 50% - 20%, 350 V d.c.	107-TF868/1
65	C19	Electrolytic, 8 μF + 50% - 20%, 350 V d.c.	107-TF868/1
66	C21	Electrolytic, 8 μF + 50% - 20%, 350 V d.c.	115-TF868/1
67	C22	Air, Preset, 3 - 30 μμF.	19-TM3961/1
68	C23	Ceramic, 1 μμF*, 750 V d.c.	20-TM3961/1
69	C24	Air, Preset, 3 - 30 μμF.	19-TM3961/1
70	C25	Ceramic, 3 μμF*, 750 V d.c.	21-TM3961/1
71	C26	Air, Preset, 3 - 30 μμF.	19-TM3961/1
72	C27	Ceramic, Neg. Temp. Coeff., 15 μμF*, 750 V d.c.	22-TM3961/1
73	C28	Paper, 0.1 μF ± 25%, 350 V d.c.	146-TF868/1
74	C29	Mica, 0.002 μF ± 5%, 350 V d.c.	6-TM4811
75	C30	Paper, 0.01 μF ± 20%, 350 V d.c.	110-TF868/1
76	C31	Mica, 0.002 μF ± 5%, 350 V d.c.	5-TM4812
77	C32	Paper, 0.01 μF ± 20%, 350 V d.c.	110-TF868/1

* Nominal value; actual value determined during calibration.

SOS Item No.	Circuit Ref.	Description	Works Ref.
		TRANSFORMERS AND INDUCTORS	
78	T1	Mains Transformer.	TM3965
79	T2	Bridge Input Transformer.	TM3964
80	T3	Bridge Output Transformer.	TM3963
81	T4	Oscillator Transformer. Includes Items 50 and 74.	TM4811
82	L1	Filter Inductor.	TM4812
		VALVES, VALVE HOLDERS, AND RETAINERS	
83	V1	6SN7, Double Triode.	139-TF868/1
84		Holder for V1.	65-TF868/1
85	V2	L63, Triode.	123-TF868/1
86		Holder for V2.	65-TF868/1
87		Screen Assembly for V2.	145-TF868/1

SOS Item No.	Circuit Ref.	Description	Works Ref.
		VALVES, VALVE HOLDERS, AND RETAINERS (continued)	
88	V3	KTZ63, Pentode.	124-TF868/1
89		Holder for V3.	65-TF868/1
90		Screen and Retainer Assembly for V3	45-TF868/1 152-TF868/1 153-TF868/1 154-TF868/1
91		Top Cap Connector for V3.	67-TF868/1
92	V4	DH63, Double-Diode Triode.	122-TF868/1
93		Holder for V4.	65-TF868/1
94		Top Cap Connector for V4.	67-TF868/1
95	V5	EA50, Diode.	125-TF868/1
96		Holder for V4.	66-TF868/1
97		Retainer for V5.	48-TF868/1
98		Top Cap Connector for V5.	131-TF868/1
		RECTIFIER	
99	RECT. 1.	H.T. Rectifier, Selenium.	73-TF868/1

SOS Item No.	Circuit Ref.	Description	Works Ref.
		LAMP	
100	PL1	6.5 V, 0.3A, M.E.S. Pilot Lamp.	126-TF868/1
		METER	
101	M1	100-0-100 μA, 2000 Ω Nominal, Moving Coil.	TM3970/3
		PLUGS, SOCKETS, AND CONNECTING LEADS	
102	J1	PHONES, Jack Socket.	76-TF868/1
103		Plug to fit Item 102.	138-TF868/1
104	J2	EXT METER Jack Socket.	76-TF868/1
105		Plug to fit Item 104.	138-TF868/1
105/1		Mains Lead Assembly.	TM-2560AQ
		SWITCHES	
106	S1	Rotary, 9 pole, 3 position, 3 wafer.	TC23164
107	S2	Rotary, 3 pole, 7 position, 3 wafer.	TC23162
108	S3	Toggle, 2 pole, 2 position.	74-TF868/1

SOS Item No.	Cir-cuit Ref.	Description	Works Ref.
		SWITCHES (continued)	
109	S4	Toggle, 2 pole, 2 position changeover, biased to one position.	75-TF868/1
110	S5	Rotary, 2 pole, 2 position; included in Item 154.	TB-17742
111	S6	Toggle, 2 pole, 2 position changeover.	149-TF868/1
		KNOBS, DRIVES, and DIALS	
112		Knob, for LCR switch, S1.	62-TF868/1
113		Knob, for RANGE switch, S2.	60-TF868/1
114		Knob, for A.C. BRIDGE VOLTS control, R4.	60-TF868/1
115		Knob, for PHASE BALANCE control, R14/R15. The PHASE BALANCE dial is included in Item 14.	61-TF868/1
116		Cursor, for PHASE BALANCE dial.	TD17711/7
117		Felt Pad for PHASE BALANCE dial.	TB18684/2
118		Complete BALANCE dial assembly comprising Item 16 and Items 119 to 142, inclusive.	

SOS Item No.	Circuit Ref.	Description		Works Ref.
		KNOBS, DRIVES and DIALS (continued)		
119		Knob.		63-TF868/1
120		Felt Pad.		TB18684/1
121		Perspex Window.		TE17645/2
122		Slow Motion Drive.		72-TF868/1
123		Pointer.		TD17711/4
124		Dial (Uncalibrated).		TE17645/6
125		Shim Washers (small), set of eight.		TB6775/211
126		L.C.R. Shutter Disc.	To identify these parts see illustration MP 868/1 - 6	TE17645/7
127		Shim Washers (medium), set of six.		TB6775/212
128		Range Disc.		TE17645/9
129		Shim Washers (large), set of three.		TC17652/1
130		Bearing Bush.		TE17645/14
131		Stiffener Plate.		TE17645/10
132		Housing.		TD17643
133		Fixing Brackets, set of five.		TE17645/15
134		Circlip.		20-TM3960
135		Range Disc Pulley.		TB-22703/2
136		Drive Cord		TB18892

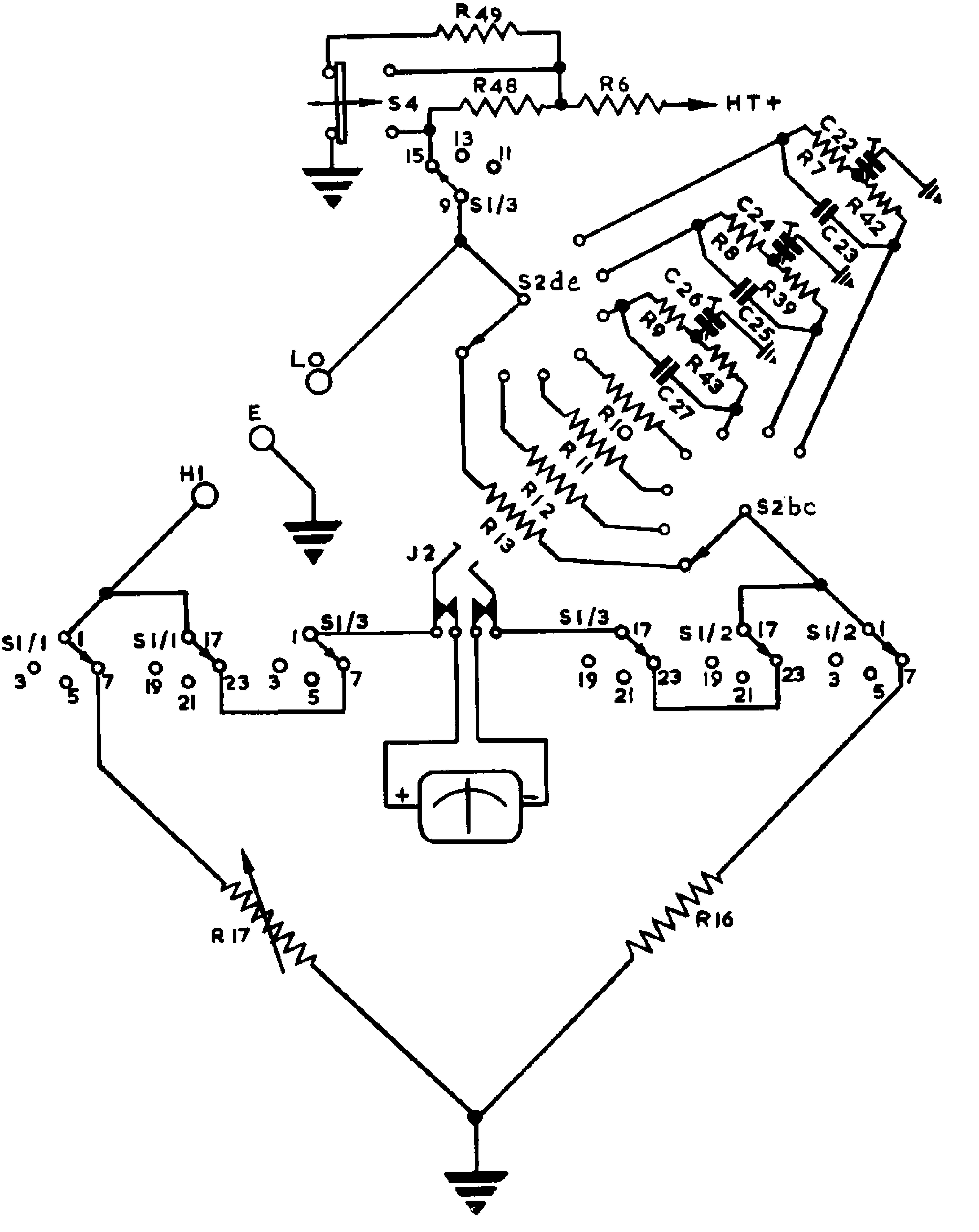
SOS Item No.	Circuit Ref.	Description		Works Ref.
		KNOBS, DRIVES and DIALS (continued)		
137		Range Switch Pulley.	To identify these parts see illustration MP 868/1 - 6	TB22703/1
138		L.C.R. Shutter Disc Lever.		TB17644/2
139		Pair of Linking Bars.		TB17645/5
140		L.C.R. Switch Lever.		TB17644/1
141		Shoulder Screws, set of four.		TC17652/4
142		Drive Cord Tension Spring.		TB15342/12
		MISCELLANEOUS		
143		Complete Case Assembly comprising Items 144 to 150 inclusive.		
144		Case. Included in Item 143.		TE17641
145		Handle. Two included in Item 143.		32-TF868/1
146		Pocket, left-hand. Included in Item 143.		35-TF868/1
147		Pocket, right-hand. Included in Item 143.		36-TF868/1
148		Case Foot. Four included in Item 143.		TA11420
149		Mains Transformer Cover Plate complete with captive screw retainer. Included in Item 143.		TD17745/2 TB12197/3

SOS Item No.	Circuit Ref.	Description	Works Ref.
		MISCELLANEOUS	
150		Flexible Sleeve, to fit mains lead hole in case. Included in Item 143.	58-TF868/1
151		Panel.	17-TF868/1
152		Abridged Operating Instructions Plate.	25-TF868/1
153		Dome Nut Guard for SET ZERO control.	TA-7342/3
154		Lampholder/Mains Switch Assembly.	TM4000
155		110-120 V Escutcheon. Included in Item 154.	TC17744/1
156		220-240 V Escutcheon. Included in Item 154.	TC17744/2
157		Lampholder. Included in Item 154.	TM3974
158		Switch Arm. Included in Item 154.	TB17741/1
159		Pilot Lamp Cover. Included in Item 154.	6-TM4000
160		Set of Three Hexagonal Wrenches for Socket Set Screws, Sizes 2, 4, and 6BA; complete in linen bag.	144-TF868/1
161		Operating and Maintenance Handbook.	EB 868/1

PREPARED	DATE
APPROVED	DATE

BRIDGE CIRCUIT FOR RESISTANCE MEASUREMENT

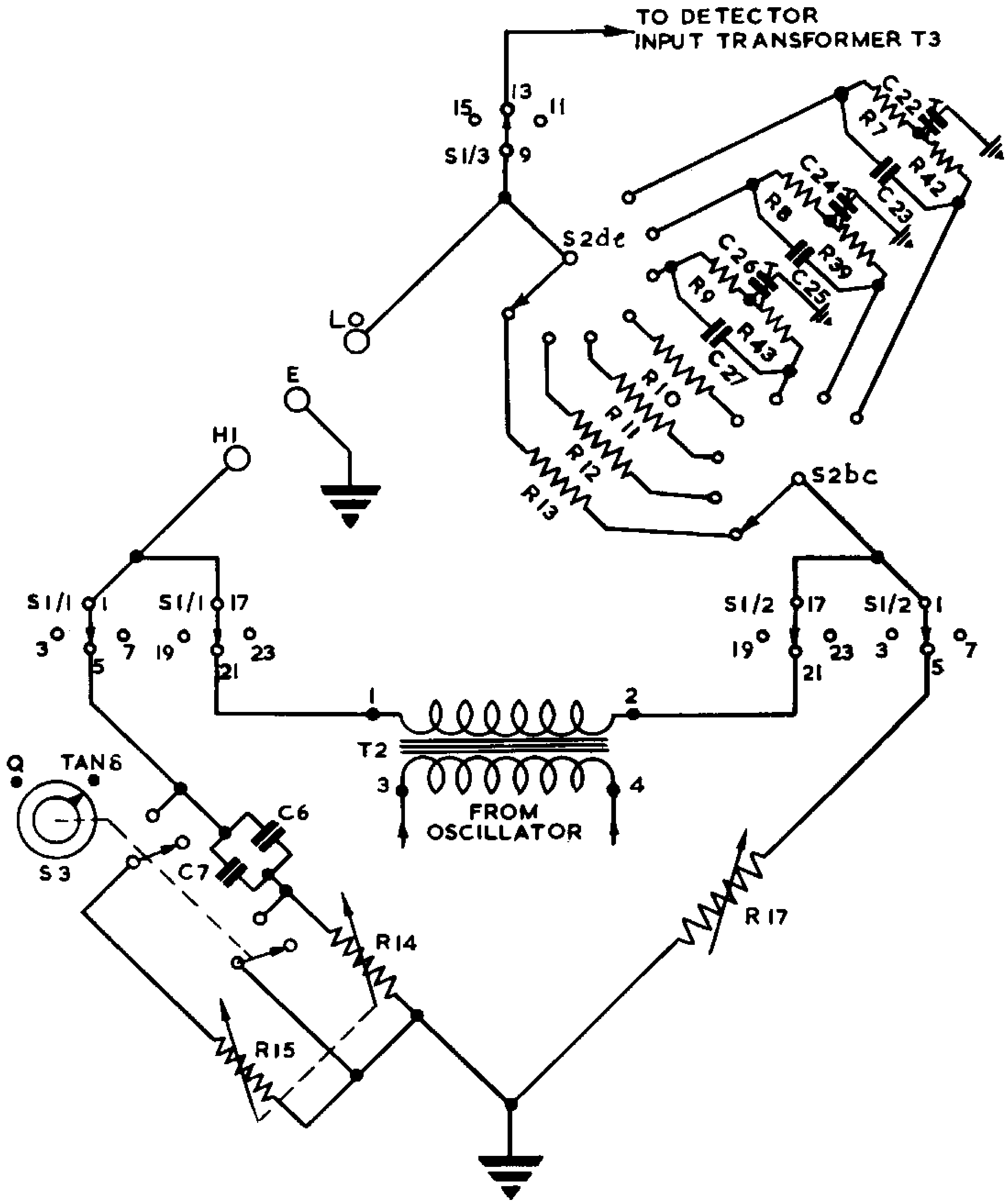
MARCONI INSTRUMENTS LIMITED							
DRN	G.S.	DATE	15.5.54	CHKD	W.R.C.	ISSUE	1
STOCK LIST		TF 868/1		DRG No.		TBX 23806	



RESISTANCE BRIDGE

BRIDGE CIRCUIT FOR CAPACITANCE MEASUREMENT

MARCONI INSTRUMENTS LIMITED							
DRN	G.S.	DATE	15.5.54	CHKD	W.R.C.	ISSUE	I
STOCK LIST		TF 868/I		DRG No.		TBX 23805	



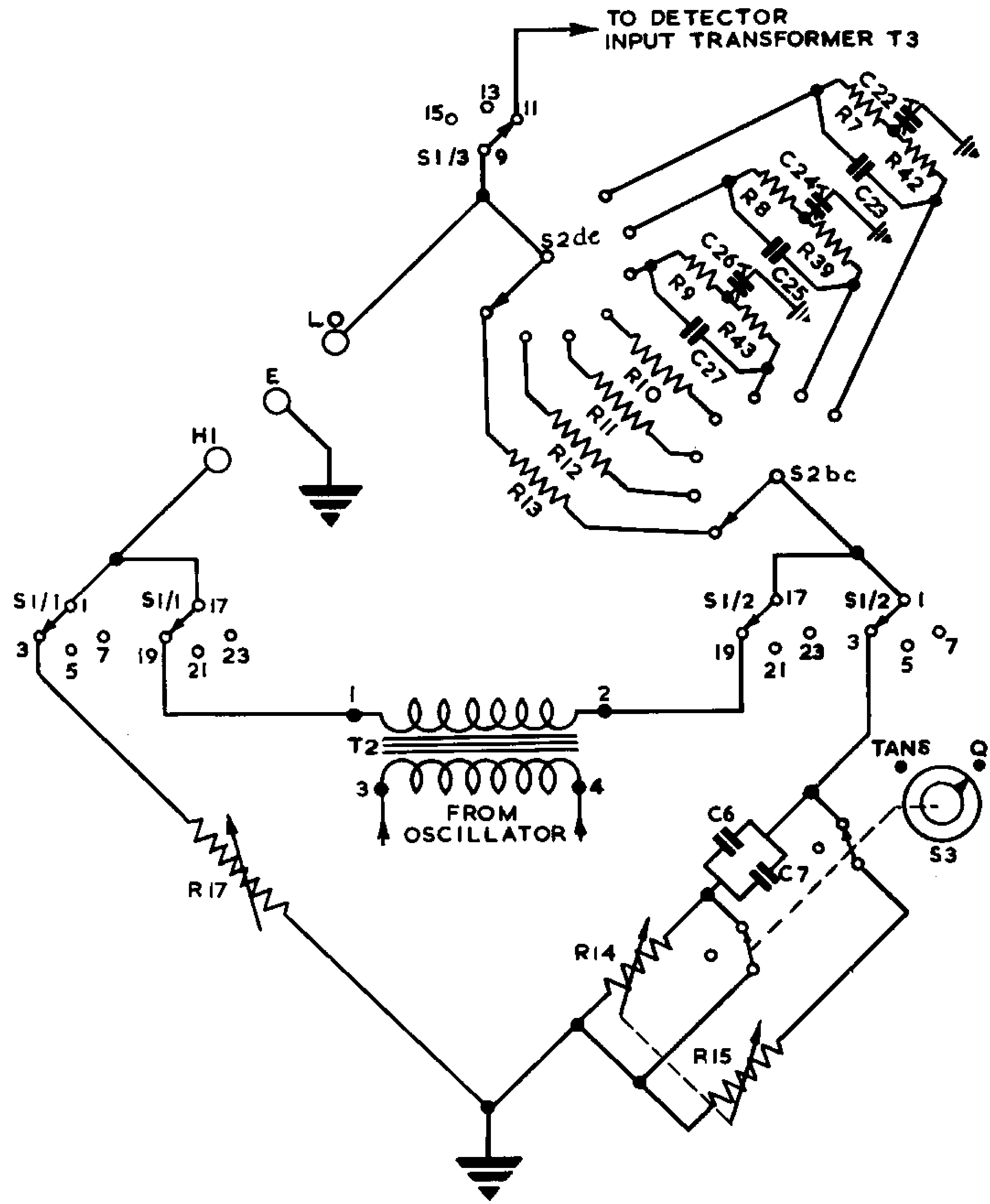
CAPACITANCE BRIDGE

BRIDGE CIRCUIT FOR INDUCTANCE MEASUREMENT

MARCONI INSTRUMENTS LIMITED

DRN	G.S.	DATE	15.5.54	CHKD	W.R.C.	ISSUE	1

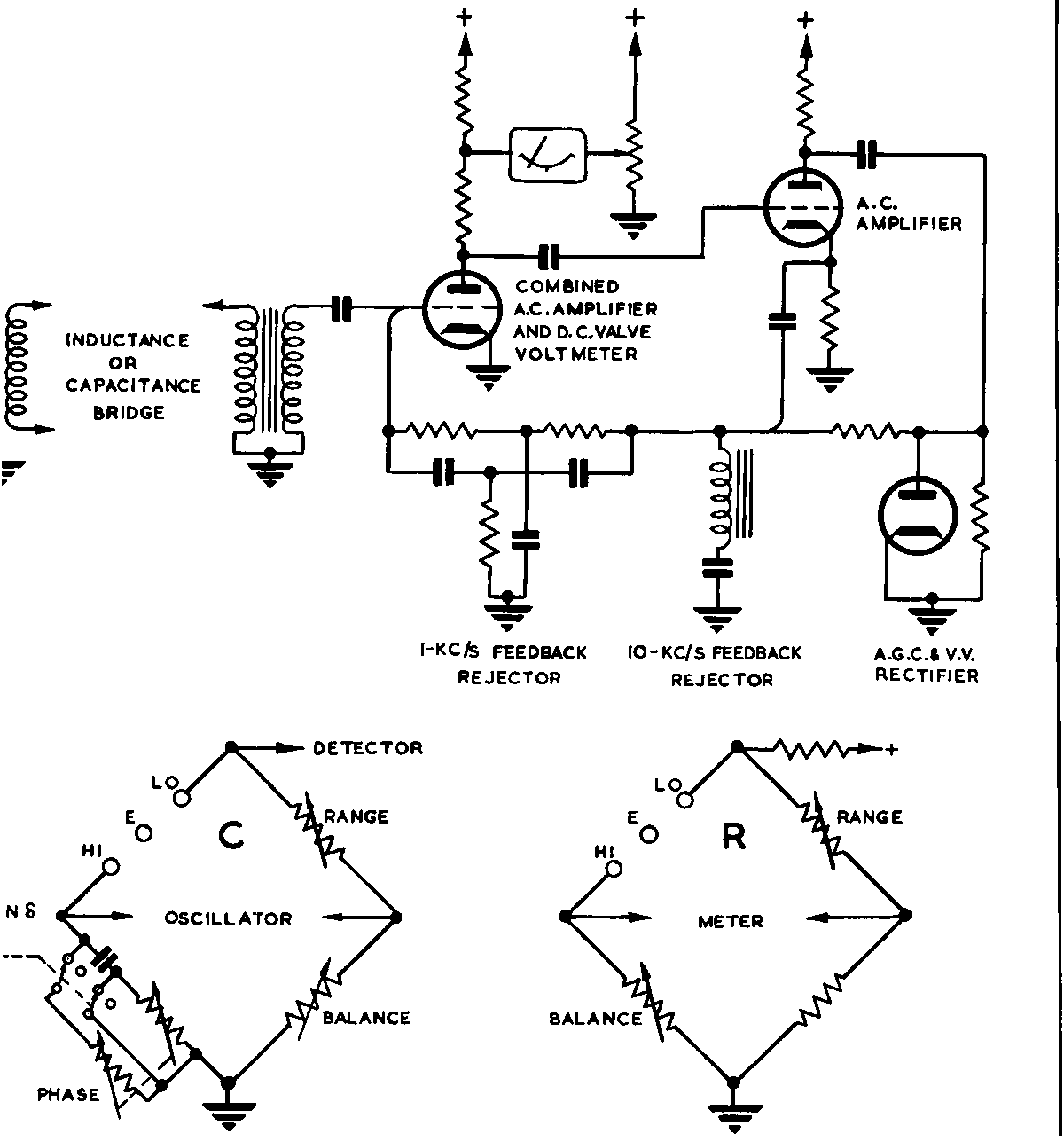
STOCK LIST	TF 868/1	DRG No.	TBX 23804



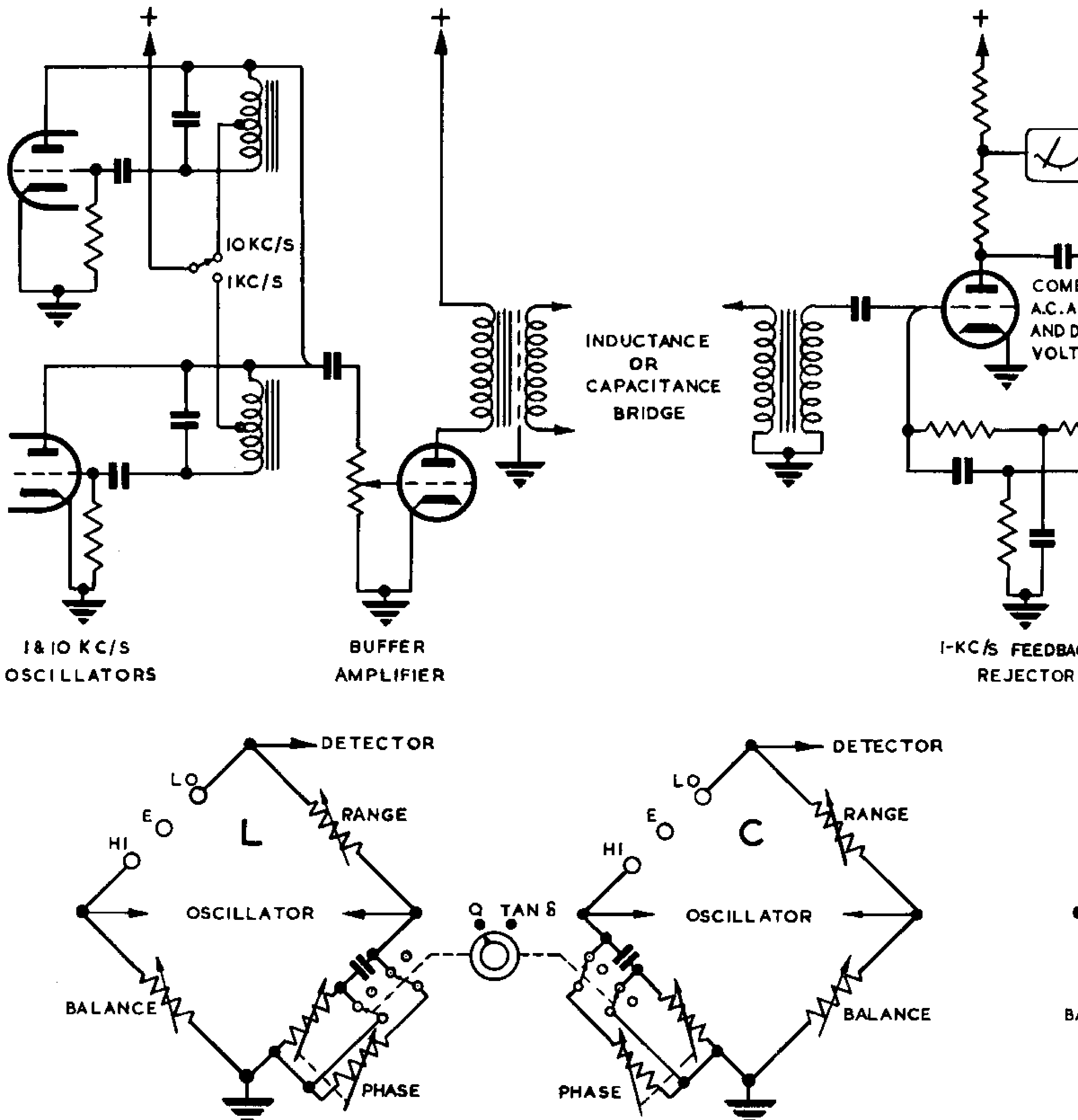
INDUCTANCE BRIDGE

FUNCTIONAL DIAGRAM

MARCONI INSTRUMENTS LIMITED							
DRN	G.S.	DATE	18.5.54	CHKD	G.S.	ISSUE	1
STOCK LIST		TF 868/1		DRG No.		TBX 23815	



FUNCTIONAL DIAGRAM

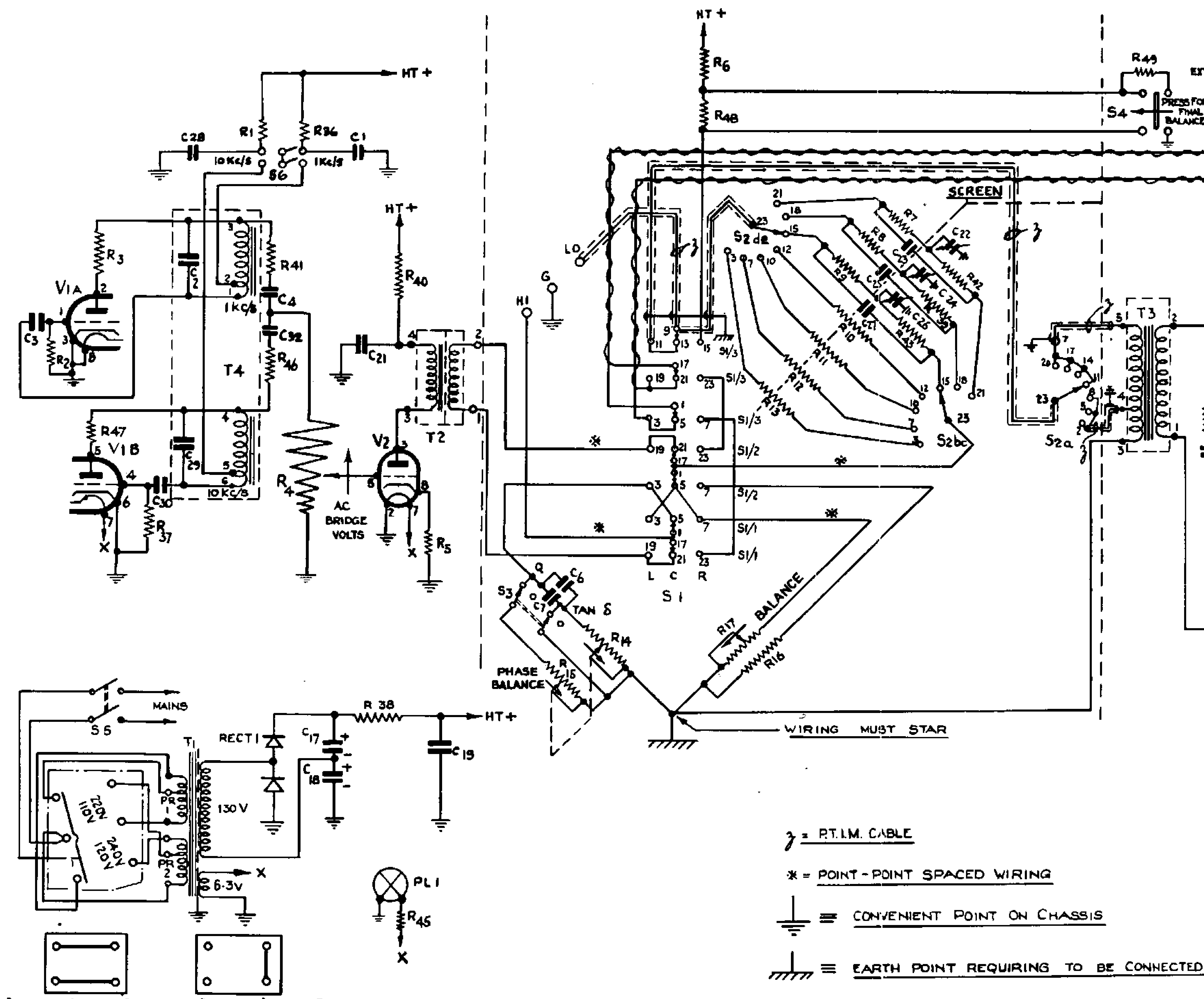


FUNCTIONAL DIAGRAM

CIRCUIT DIAGRAM

MARCONI INSTRUMENTS LIMITED

DRN	W.R.N.	DATE	16.5.53	CHKD	A.H.	ISSUE	6
STOCK LIST		TF 868/1		DRG No.		TDX 17701/1	



CONNECTIONS OF 110, 120V. ESCUTCHEON

CONNECTIONS OF 220, 240V ESCUTCHEON

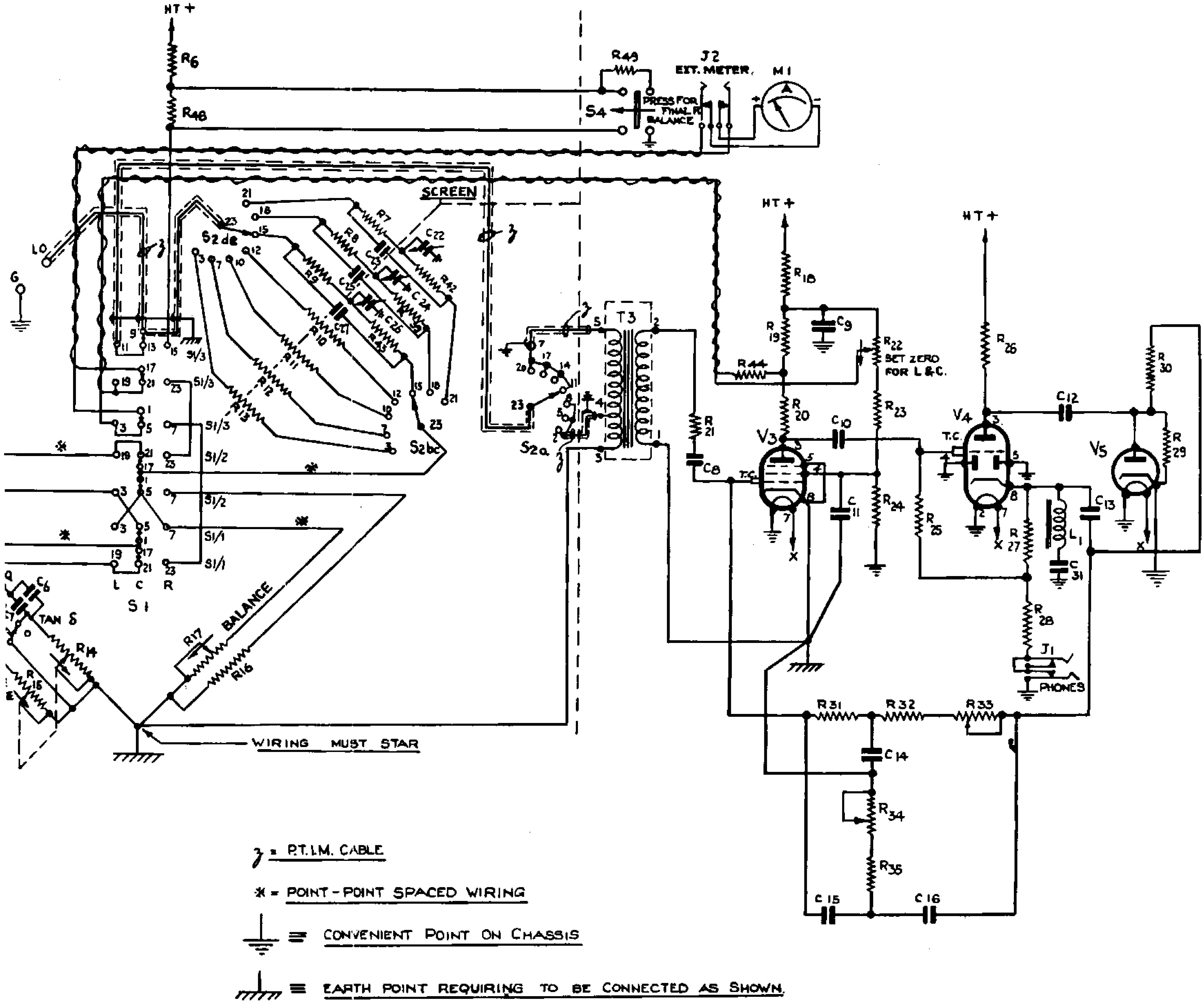
ʒ = P.T.I.M. CABLE

✻ = POINT-POINT SPACED WIRING

⏚ ≡ CONVENIENT POINT ON CHASSIS

⏚ ≡ EARTH POINT REQUIRING TO BE CONNECTED

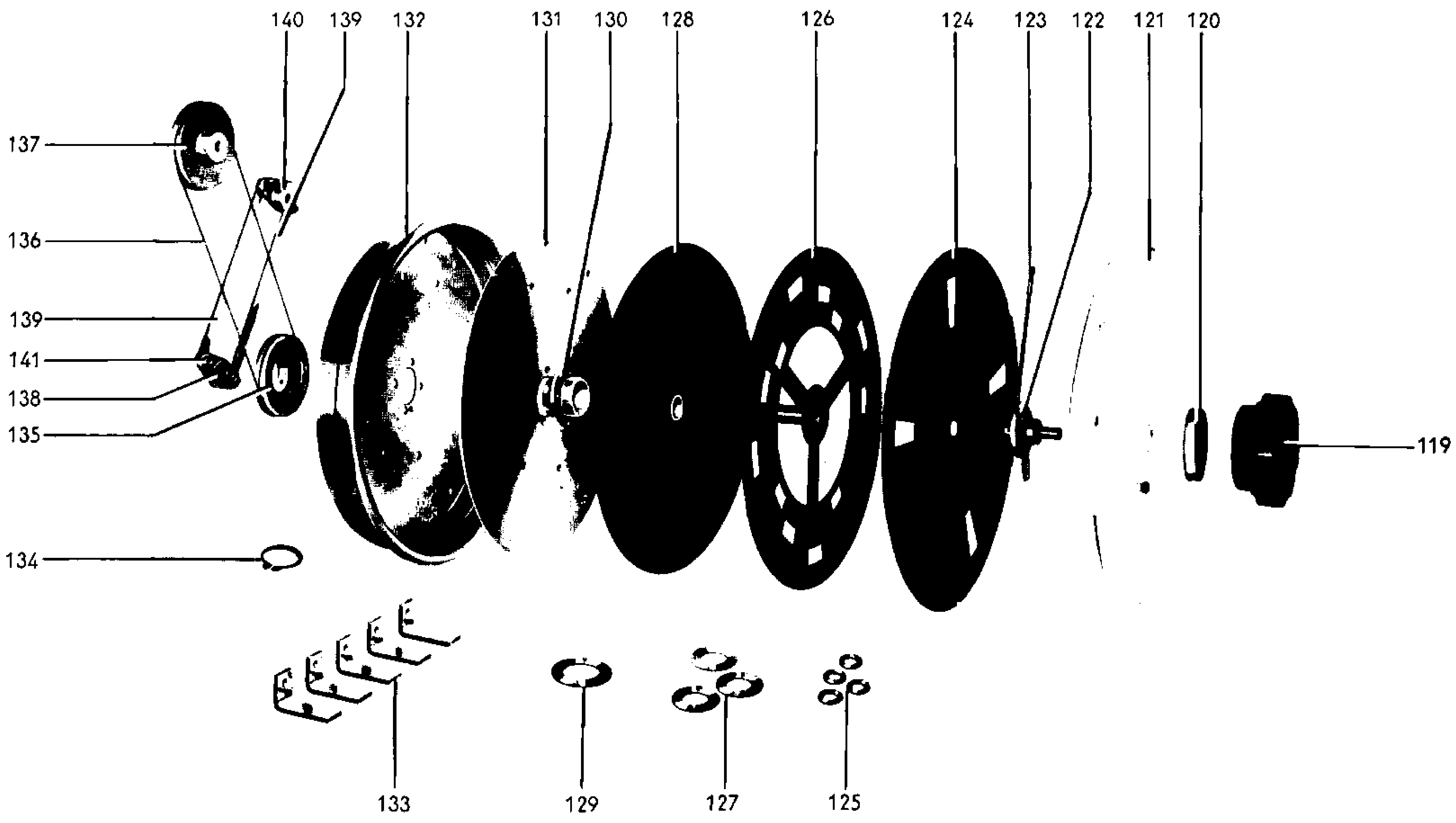
CIRCUIT DIAGRAM



CIRCUIT DIAGRAM

EXPLODED VIEW OF BALANCE DIAL ASSEMBLY

MARCONI INSTRUMENTS LIMITED							
DRN	W.R.C.	DATE	12.7.54	CHKD	P.E.D.	ISSUE	1
STOCK LIST		TF 868/1		DRG No.		MP 868/1—6	



EXPLODED VIEW OF BALANCE DIAL ASSEMBLY

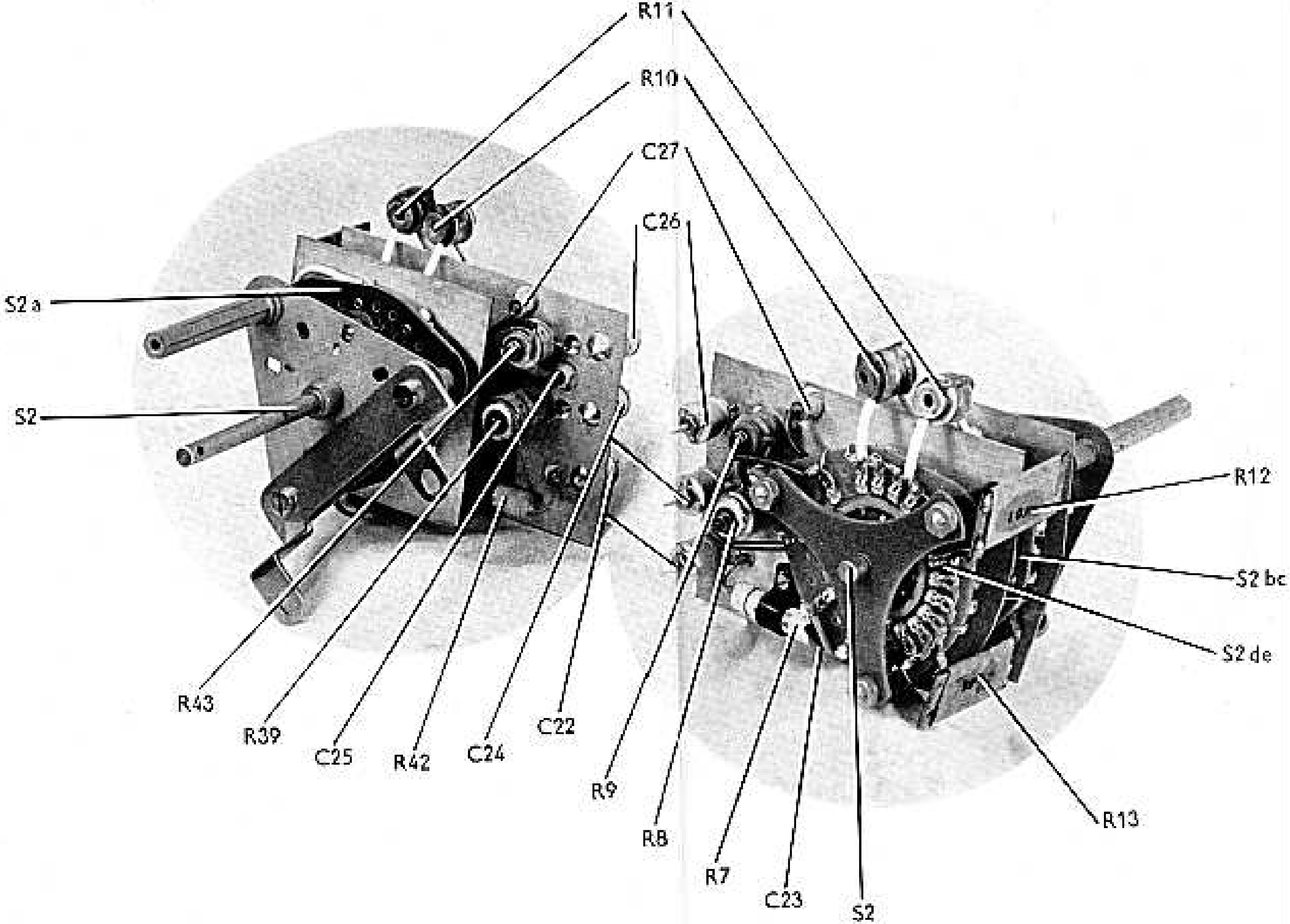
The parts depicted in this illustration are annotated with their appropriate SOS Item Numbers as given in SPARES ORDERING SCHEDULE No. 868 I.

Three types of Shim Washer (125, 127 and 129) are displayed; in the complete working assembly, Washer 125 goes between parts 124 and 126, 127 between parts 126 and 128, and 129 between parts 128 and 130.

FRONT AND REAR VIEWS OF RANGE SWITCH ASSEMBLY

MARCONI INSTRUMENTS LIMITED

DRN	W.R.C.	DATE	12.7.54	CHKD	D.P.E.B.	ISSUE	1
STOCK LIST		TF 868/1		DRG No.		MP 868/1—5	



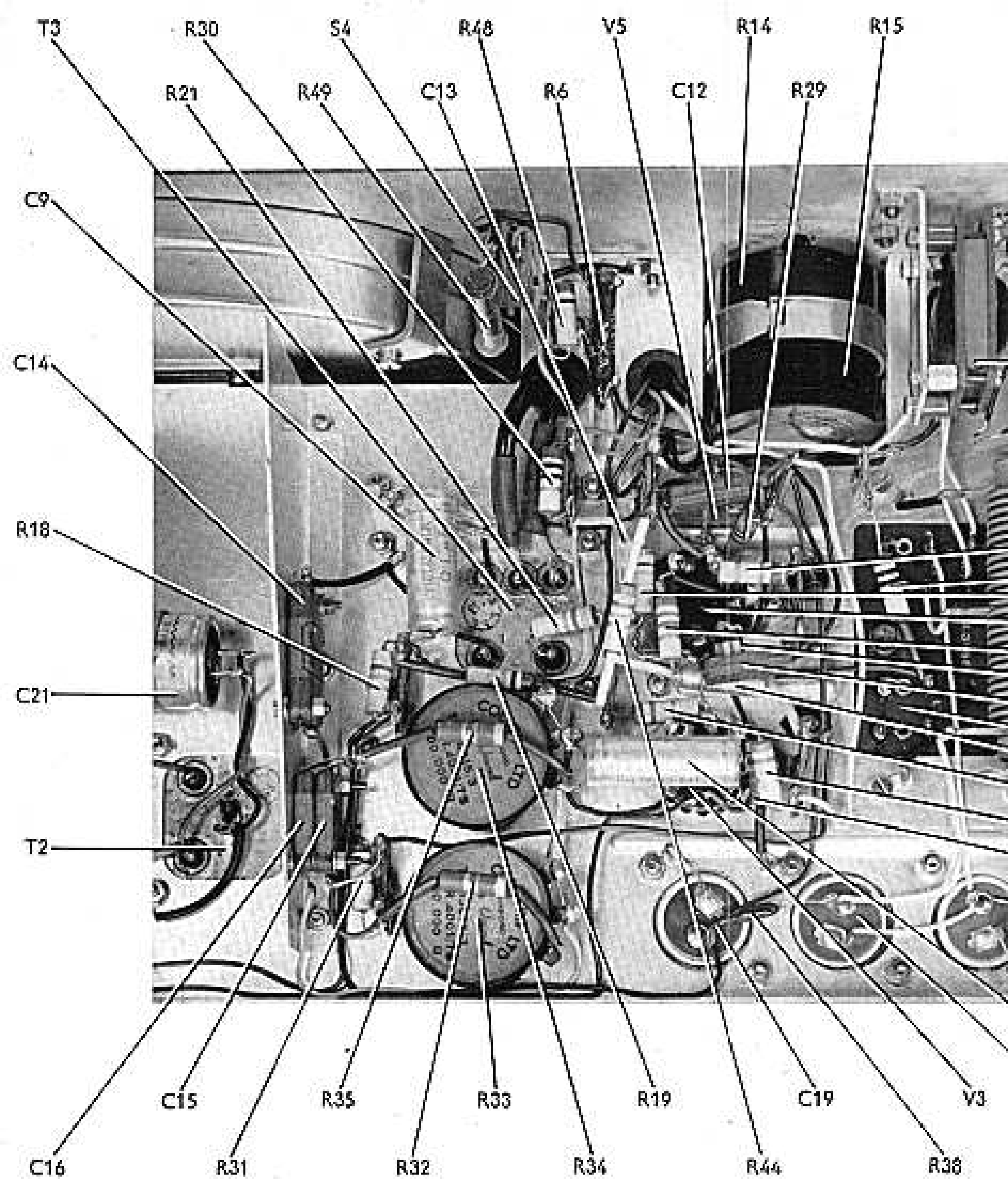
FRONT AND REAR VIEWS OF RANGE SWITCH ASSEMBLY

UNDERSIDE VIEW OF CHASSIS

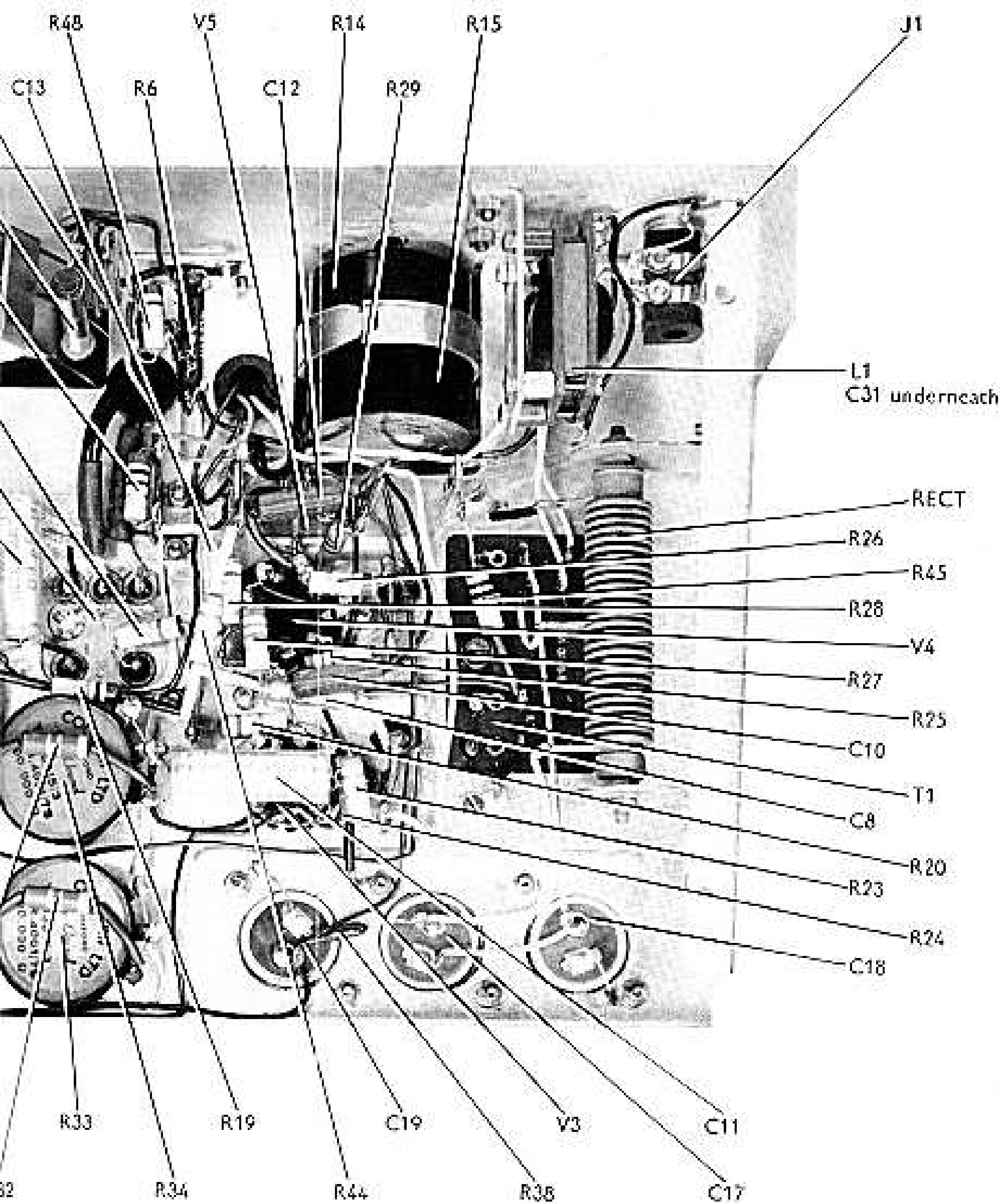
(DETECTOR AND POWER UNIT SECTION)

MARCONI INSTRUMENTS LIMITED

DRN	W.R.C.	DATE	12.7.54	CHKD	D.P.E.B.	ISSUE	1
STOCK LIST		TF 868/1		DRG No.		MP 868/1—4	



UNDERSIDE VIEW OF CHASSIS
(DETECTOR AND POWER UNIT SECTION)



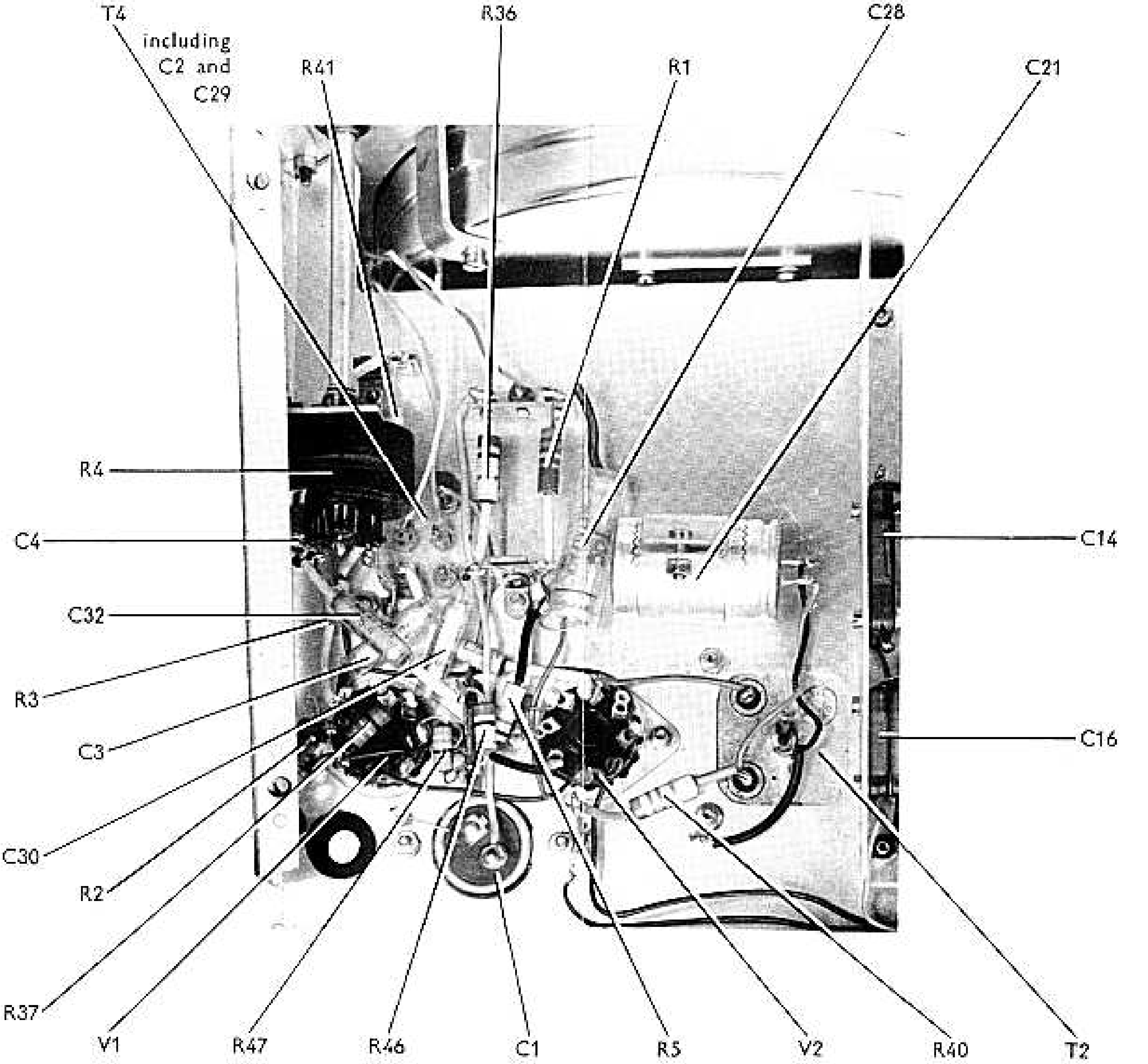
UNDERSIDE VIEW OF CHASSIS

(DETECTOR AND POWER UNIT SECTION)

UNDERSIDE VIEW OF CHASSIS

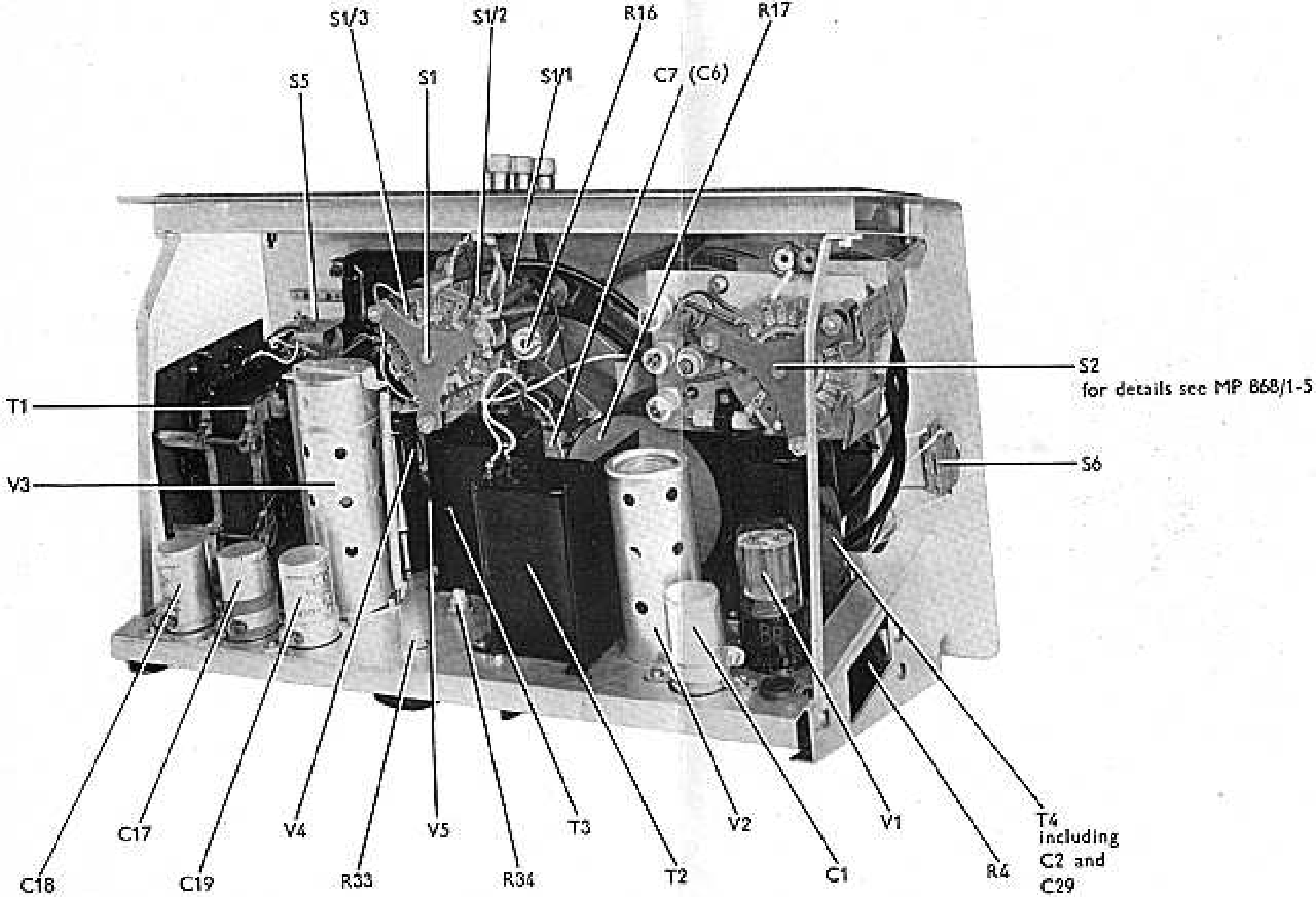
(OSCILLATOR SECTION)

MARCONI INSTRUMENTS LIMITED							
DRN	W.R.C.	DATE	12.7.54	CHKD	D.P.E.B.	ISSUE	1
STOCK LIST		TF 868/1		DRG No.		MP 868/1—3	


T4
including
C2 and
C29
R36
R41
C28
R1
C21
R4
C4
C32
R3
C3
C30
R2
R37
V1
R47
R46
C1
R5
V2
R40
T2
C14
C16

GENERAL VIEW FROM REAR

MARCONI INSTRUMENTS LIMITED							
DRN	W.R.C.	DATE	12.7.54	CHKD	D.P.E.B.	ISSUE	1
STOCK LIST		TF 868/1		DRG No.		MP 868/1 — 2	

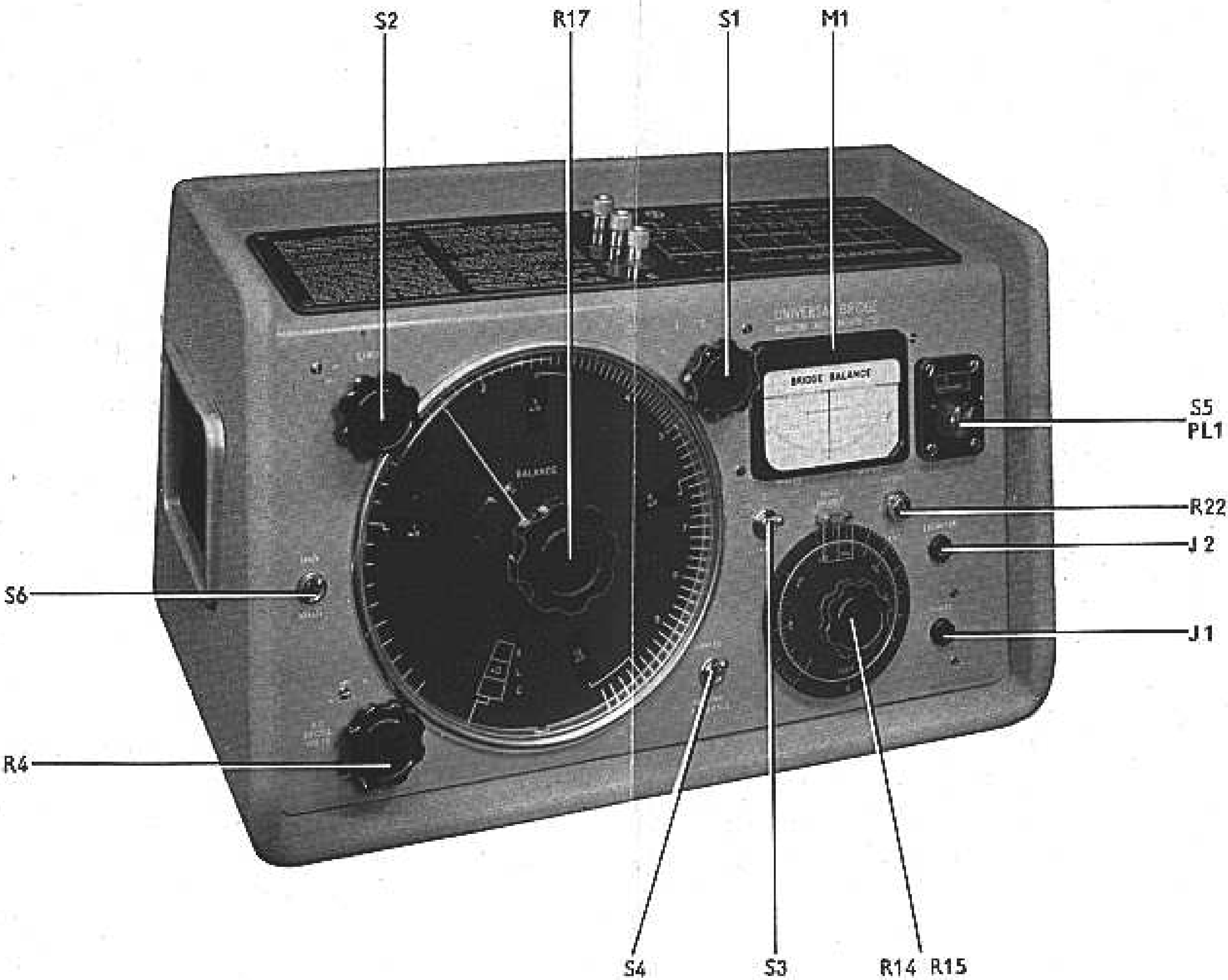


GENERAL VIEW FROM REAR

FRONT PANEL

MARCONI INSTRUMENTS LIMITED

DRN	W.R.C.	DATE	12.7.54	CHKD	D.P.E.B.	ISSUE	1
STOCK LIST		TF 868/1		DRG No.		MP 868/1—1	


S2
R17
S1
M1
BRIDGE BALANCE
BALANCE
S5
PL1
R22
J 2
J 1
S6
R4
S4
S3
R14 R15

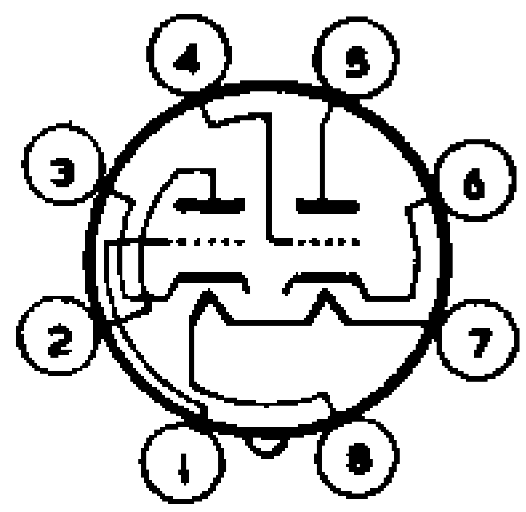
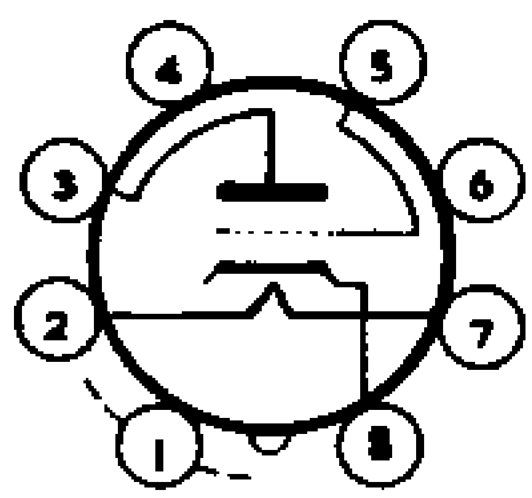
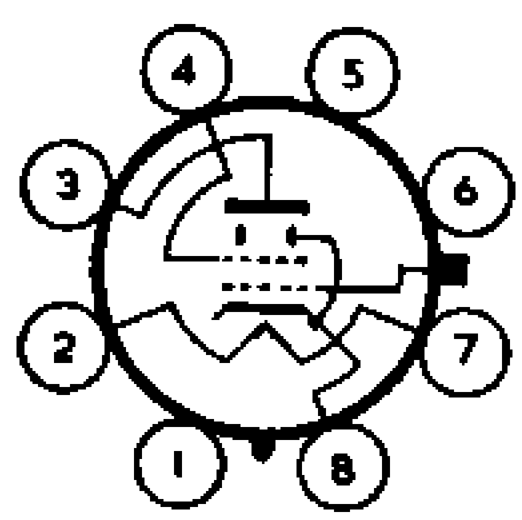
FRONT PANEL

VALVE REPLACEMENT DATA

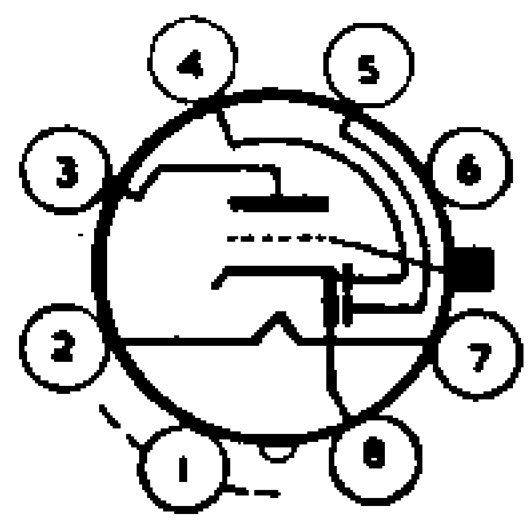
FOR

UNIVERSAL BRIDGE Type TF 868/1

Any valve which becomes faulty should preferably be replaced by a valve of the type originally supplied in the instrument and designated in the following table. If this is not possible, the additional data given by the table may be used as a guide to suitable alternatives.

Valve	*British Commercial Equivalent*	*British Services Designation*	*Base*	*U.S. Equivalent*
V1 DOUBLE TRIODE MARCONI B65	6SN7GT	CV278 CV1988	INTERNATIONAL OCTAL 	6SN7GT
V2 TRIODE MARCONI L63	6J5G 6J5GT	CV1067 CV1932 CV1934	INTERNATIONAL OCTAL 	6J5G 6J5GT
V3 TETRODE MARCONI KTZ63	6J7G* 6J7GT*	CV1074 CV1935* CV1937*	INTERNATIONAL OCTAL 	6J7G* 6J7GT*

*This valve is a pentode with its suppressor grid brought out to pin 5. The KTZ63 (CV1074) is a kinkless tetrode with pin 5 blank and with its beam-forming electrodes strapped internally to cathode (pin 8) as shown on the base diagram. In the TF 868/1, pins 5 and 8 of V3 holder are strapped together so that the 6J7G/GT (CV1935 and CV1937) can be used as an alternative to the KTZ63.

Valve	*British Commercial Equivalent*	*British Services Designation*	*Base*	*U.S. Equivalent*
V4 DOUBLE DIODE TRIODE MARCONI DH63	6Q7G 6Q7GT	CV587 CV589	INTERNATIONAL OCTAL 	6Q7G 6Q7GT
V5 DIODE MULLARD EA50	SD61 6D1	CV1092	MINIATURE 3-PIN (B3G)