OPERATING INSTRUCTIONS

MODEL 25E Chronotron Millisecond Meter

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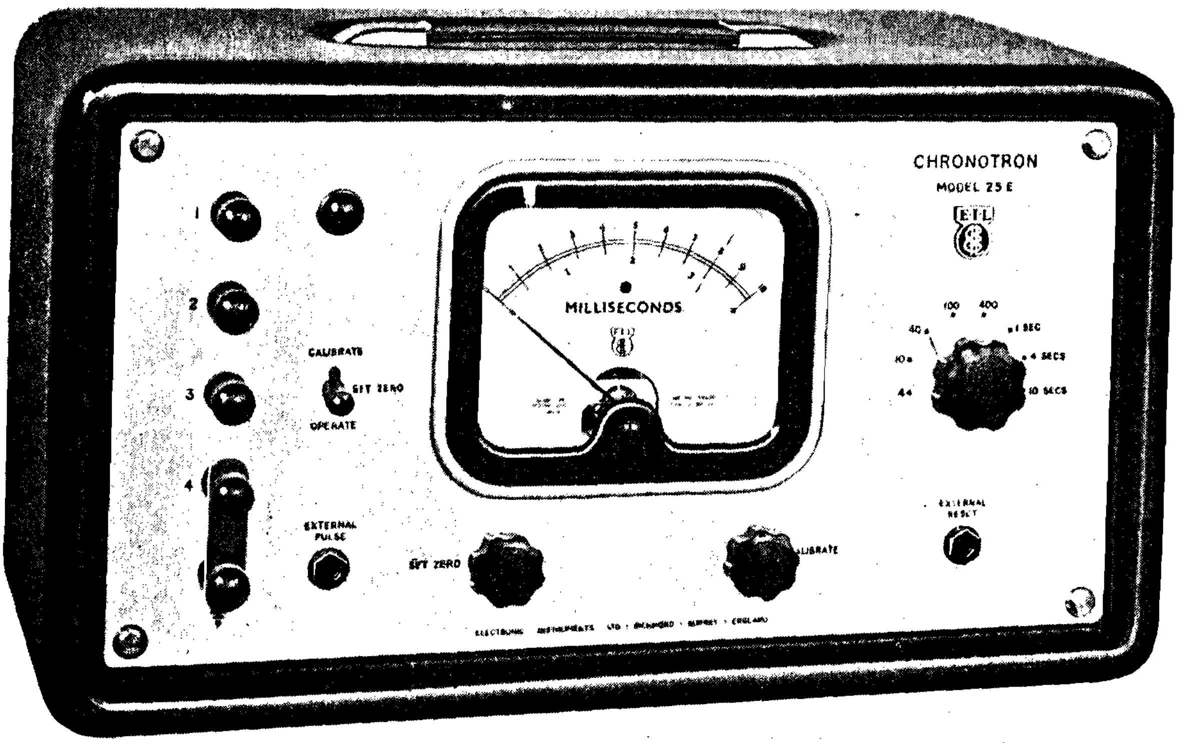
CHRONOTRON
MODEL 25 E
MILLISECONDS
CALIBRATE
SET ZERO
OPERATE
EXTERNAL PULSE
SET ZERO
CALIBRATE
EXTERNAL RESET

MODEL 25E

THE MODEL 25E CHRONOTRON MILLISECOND METER
INSTRUCTIONS & SERVICE MANUAL

1. GENERAL DESCRIPTION

The Chronotron Millisecond Meter, Model 25E is a self-contained direct-reading instrument intended for the measurement of short time intervals with good accuracy. The Chronotron has eight ranges:–

0–4 milliseconds	0–1 second
0–10 milliseconds	0–4 seconds
0–40 milliseconds	0–10 seconds
0–100 milliseconds	
0–400 milliseconds	

The incoming signal causes a constant current to charge a precision capacitor. At the end of the timing period this capacitor is isolated electronically, and the voltage developed across it measured by a valve voltmeter directly calibrated in units of time. The reading is displayed on a 5-inch moving coil meter. The meter reading is dead-beat and decays very slowly, allowing ample time for observation.

The timing capacitors are selected for high insulation resistance and low dielectric absorption, and are carefully aged over several temperature cycles to ensure permanent stability. Accurately-determined internal resistors are used as reference standards.

2. PRELIMINARY INSTRUCTIONS

The CHRONOTRON is despatched with all valves in position, ready for immediate use. The jack plugs are packed separately and the package is attached to the instrument. Before switching on, the mains adjuster plug must be set to the correct operating voltage.

2.1 Earthing

The case of the instrument should always be earthed, using either the third core of the mains lead or the Earth Terminal on the front panel. Whenever it is possible, the input circuit should also be earthed; this can conveniently be done by connecting the link attached to the Earth Terminal to Terminal 4, which is permanently connected inside the instrument to the 'earthy' side (the sleeve) of the EXTERNAL PULSE Jack Socket.

Where non-earthed operation is essential, the link may be left open; in such cases it may be thought desirable to connect a large capacitance, e.g. $2\mu F$ between the Earth Terminal and Terminal 4, the 'earthy' side of the input circuit, to prevent a.c. pick-up. Such a capacitance can not be used in cases where it can affect the timing operation – e.g., where both 'live' and 'earthy' sides of the input change in potential relative to earth.

2.2 Methods of connection

The uses of the CHRONOTRON are so many and so varied that it is impossible to do more than outline the general operating principles and to describe a few typical cases. (See Fig. 1 Page 4.)

The following distinction should be noted. The use of Terminals 1 to 4 is confined to 'dead' or passive circuits, in which there is no voltage or potential drop, and therefore the necessary test voltage is provided by the CHRONOTRON itself. The use of the EXTERNAL PULSE socket is confined to 'live' or active circuits which actually present a voltage to the CHRONOTRON, and therefore no additional voltage need be provided by the instrument.

3. OPERATING INSTRUCTIONS

3.1 *General operating procedure*

(a) The instrument is switched on and left for two or three minutes to warm up.

(b) The operating key is set to SET ZERO and the meter adjusted to read zero by the SET ZERO knob. *This adjustment holds good for all ranges.*

(c) The operating key is next moved to CALIBRATE and the pointer adjusted to the red mark by the CALIBRATE knob. *This adjustment also holds good for all ranges.*

(d) The range switch is set so that the expected time interval will occupy a fairly high position on the meter scale.

(e) During the above operations only the amber meter light is lit. Moving the operating key down to OPERATE causes the green lamp to light as well and the instrument is now ready to time.

(f) To clear the reading, after timing, return the operating key to SET ZERO and leave it there until the next operation.

(g) If after setting up the Chronotron as described above, the operating key is left at OPERATE, readings on the meter can be cleared by pressing a pear-switch or push-button (normally open) connected to the EXTERNAL RESET socket. Such operation may often be found more convenient. Initial adjustment of the SET ZERO and the CALIBRATE knobs *must always be carried out by using the operating key on the panel.*

Note:– It is essential when setting up the instrument that the SET ZERO and CALIBRATE controls are adjusted in the order given above. This is so because operation of the SET ZERO control effects the calibration setting, whilst operation of the CALIBRATE control does not affect the zero setting. Before commencing a series of readings it is always advisable to recheck zero and recalibrate.

3.2 *Operation using terminals 1 - 4*

The input circuit of the CHRONOTRON under these conditions is shown in figure 1(1) on page 4; it will be seen that the general principle is that a connection between Terminals 1 and 2 initiates the timing operation, which can be stopped either by breaking this connection or by short-circuiting the signal at terminals 3 and 4.

From this, figures 1(2) to 1(7) should be self-explanatory; they illustrate six possible combinations of contacts. The terminals must never be connected to any 'live' circuit – that is, one including a voltage source of any kind.

The resistance of a 'short-circuit' must not exceed 300 ohms and any parallel leakage across an 'open-circuit' must not be less than 100,000 ohms. The unloaded voltage of the internal test supply is –14V; current is limited to 3 mA under any circumstances.

Remember to remove any plug from the External Input jack socket, or the CHRONOTRON will not time. Insertion of this plug automatically disconnects Terminals 1 to 4.

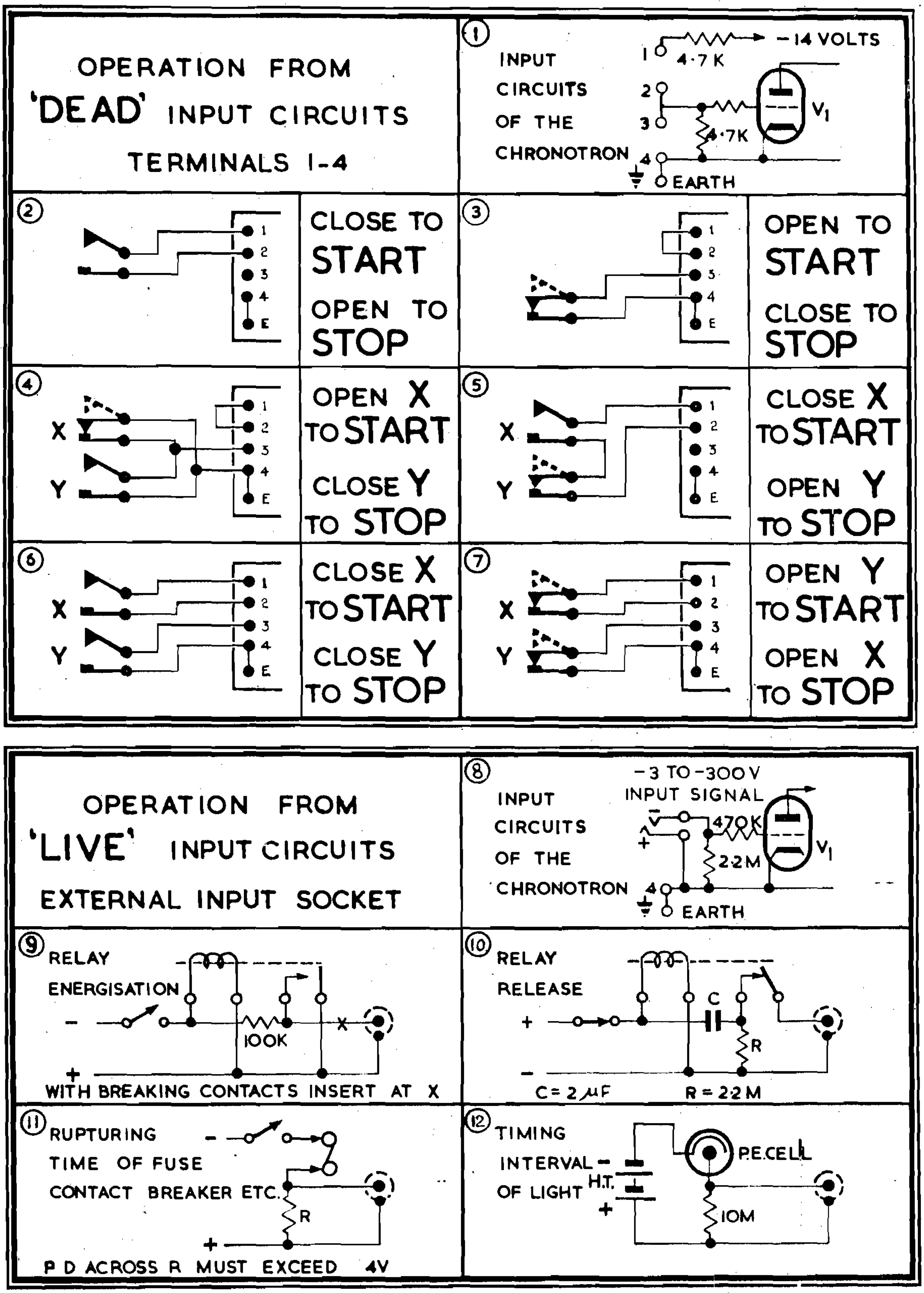

FIG. 1. METHODS OF CONNECTION

3.3 Operation using the external pulse socket

The input circuit under these conditions is shown in figure 1(8), page 4. The general principle is that with any applied *negative* voltage less than 1.0, nothing happens; with *negative* voltages between 1.0 and 3.0, the action of the instrument is indeterminate; the duration of any *negative* voltage greater than 3.0, no matter how much greater, is timed with full accuracy. Input resistance is 2.2 megohms.

The applied negative voltage should, however, not exceed 300V, or damage may be caused to the input valve. The application of a positive voltage will cause no damage, but the instrument will not time. For operation from a.c. signals see Section 4.3.

Figures 1(9) to 1(12) show several typical methods of measuring voltages generated in live circuits. It may be helpful to take two of these applications in detail.

In figure 1(9) it is required to time the interval between the application of the energising voltage to a relay and the operation of its contacts which may normally be either closed or broken. The actual energising voltage is used to operate the CHRONOTRON, and the contacts either disconnect or short-circuit this voltage, as the case may be. The resistor is introduced so that short-circuiting the CHRONOTRON input does not also short-circuit the power supply.

Figure 1(10) shows the opposite case where it is desired to measure the interval between the disconnection of the energising voltage and the return of the contacts to their normal position. In this case the relay voltage starts at some real value before disconnection, and ends at zero after disconnection and the capacitor must be introduced so that the *change* of voltage operates the CHRONOTRON. The capacitance in μF should be equal to, or greater than, the expected time interval in seconds. It will be realised that the insertion of a capacitor converts the cessation of a real positive voltage into a temporary negative-going voltage and it is this latter component which actually operates the CHRONOTRON.

The other figures are self-explanatory; capacitor coupling is always used in cases where any pre-timing voltage exists.

4. OPERATING NOTES

4.1 Overload in time

An overload in time should be avoided wherever possible, but it cannot cause any permanent damage to the instrument.

4.2 Waiting periods between operations

If long periods are expected to elapse between timing operations, the operating key should be left in the SET ZERO position and returned to OPERATE when a reading is to be taken.

4.3 Timing a.c. signals

Unless an a.c. signal is rectified by some suitable full-wave rectifier, the CHRONOTRON will respond to the negative half-cycles only, indicating the total time during which the negative signal exceeds about −2½V.

5. MEASUREMENT OF VERY SHORT PULSES

5.1 Time delays in input lead

When measuring very short pulses, under 10 m.sec, a difficulty may arise in that the self capacitance of the input leads may delay the actual presentation of the pulse to the CHRONOTRON; an error may thus be caused which is in no way due to the instrument itself.

5.2 Precautions to reduce such delays

In the standard Model 25E the following simple precautions should be noted. It should be clearly emphasised that these precautions are only necessary on External Pulse ('live' circuit) operation and then only when the source resistance of the signal to be timed exceeds 50,000 ohms, and in any case only when the input signal is shorter than 10 m.sec.

(a) Unnecessary input capacitance should be avoided as far as possible; screened leads should only be used if essential.

(b) Unnecessarily high signal voltages should be avoided; ideally the signal should lie between –4 and –10V.

(c) The resistance of the signal source should be kept as low as possible; if conditions allow, it may be artificially reduced by connecting a low resistance across the input lines.

(d) In exceptional cases the use of a cathode-follower as an impedance converter may be considered.

6. ACCESSORY UNITS

Three supplementary units are available which further extend the applications of the CHRONOTRON.

The B25 PHOTOCELL UNIT includes a vacuum cell and a mains operated impedance converter circuit; its output can either be fed directly through its own screened lead into the External Pulse socket of the CHRONOTRON, or it can be used to operate the Double Pulse Unit, described below.

The C25 PULSE SELECTOR UNIT is used when the input signal is presented in two or more successive pulses; one special case is the inevitable first bounce before relay contacts finally close. It can (a) measure the first pulse and reject all others, or (b) reject the first pulse and measure all later pulses, or lastly (c) it can reject the first pulse, measure the second pulse which in the case of a train of pulses is necessarily a complete one, and reject all subsequent pulses.

The D25 DOUBLE PULSE UNIT is used for measuring the time interval between the arrivals of two successive pulses, normally generated in independent circuits. Both the starting and stopping pulses may be of either polarity, any component of the unwanted polarity being decisively rejected.

The PHOTOCELL UNIT, the PULSE SELECTOR UNIT, and the DOUBLE PULSE UNIT all derive their power supplies from the CHRONOTRON itself through the outlet socket at the rear of the instrument. The detailed operation of these three units is fully described in their respective manuals.

7. MAINTENANCE

The CHRONOTRON is a robust and reliable instrument and no routine maintenance is necessary. The valves used are standard non-selected types and are operated under conditions which ensure an almost indefinite life; it should be emphasised that replacements must be of the specified types.

If V1 (EF37A) fails, operation on SET ZERO and CALIBRATE will be normal, but on moving OPERATE the meter will travel past full scale whether any input signal is applied or not. If either V2 (EB91) or V3 (EF95) fails, this time the meter will not move away from its zero position on OPERATE, no matter how large an input signal is applied. Failure of the d.c. voltmeter valve V4 (EF37A) will cause the meter to read full scale on any position of the operating key. Failure of the neon tube V5 (150C4) will cause the CALIBRATE reading to be grossly high. Failure of V6 (EB91), used here as an H.T. rectifier, will prevent the meter from reading at all; failure of the other rectifier V7 (EZ90) will prevent both calibration and timing, though on SET ZERO the instrument will act normally.

Failure of either the mains supply or the mains transformer itself is shown by the pilot lamps not lighting.

8. COMPONENT SCHEDULE

RESISTORS

Note: When ordering spares from Electronic Instruments Limited please quote the E.I.L. Part No.

Circuit Ref.	*Value (ohms)*	*Rating (watts)*	*Tolerance*	*Type*	*E.I.L. Part No.*
R1	100k	2	10%	Carbon	R119
R2	4.7k	½	10%	Carbon	R46
R3	4.7k	½	10%	Carbon	R46
R4	2.2M	½	10%	Carbon	R98
R5	470k	½	10%	Carbon	R86
R6	220k	½	10%	Carbon	R80
R7	22k	2	10%	Carbon	R117
R8	4.7k	½	10%	Carbon	R46
R9	4.7k	½	10%	Carbon	R46
R10	220k	½	10%	Carbon	R80

RESISTORS (Contd.)

Circuit Ref.	*Value (ohms)*	*Rating (watts)*	*Tolerance*	*Type*	*E.I.L. Part No.*
R11	2.2M	½	10%	Carbon	R98
R12A	47M	½	10%	Carbon	R99
R12	47k	1	1%	High stability	R190
R13A	10M	½	10%	Carbon	R104
R13	120k	1	1%	High stability	R198
R14	300k	1	1%	High stability	R207
R15	1.2M	1	1%	High stability	R206
R16	3M	1	1%	High stability	R209
R17	12M	2	1%	High stability	R268
R18	30M	2	1%	High stability	R265
R19	2.2k	½	10%	Carbon	R42
R20	2.2M	½	10%	Carbon	R98
R21	47k	2	10%	Carbon	R118
R22	100	½	10%	Carbon	R19
R23A	130	3	0.1%	Precision	25052E
R23	574	3	0.1%	Precision	25053E
R24A	5k	3	0.1%	Precision	25054E
R24	5k	3	0.1%	Precision	25054E
R25	330	2	10%	Carbon	R130
R26	330	2	10%	Carbon	R130
R27	2.2k	10	5%	Wirewound	R358
R28	2.2k	½	10%	Carbon	R42
R29	47k	½	10%	Carbon	R64
R30	220	½	10%	Carbon	R24
R31	220	½	10%	Carbon	R24
R32	12.5k	1	5%	High stability	R183
R34A	10k	3	5%	Wirewound	R354
R34	2.2k	10	5%	Wirewound	R358
R35	22k	2	10%	Carbon	R117
R36	4.7k	½	10%	Carbon	R46
R37	22k	½	10%	Carbon	R60
R38	100k	½	10%	Carbon	R74
R39	100	½	10%	Carbon	R20
R40	100	½	10%	Carbon	R20
R41	10	½	10%	Carbon	R8
R42	10	½	10%	Carbon	R8
R43	10	½	10%	Carbon	R8
R44	10	½	10%	Carbon	R8
R45	Selected	½	10%	Carbon	–

POTENTIOMETERS

Circuit Ref.	*Value (ohms)*	*Rating (watts)*	*Tolerance*	*Type*	*E.I.L. Part No.*
RV1	1k	2	10%	Linear Potentiometer	P78
RV2	10k	2	10%	Linear Potentiometer	P74

VALVES

Circuit Ref.	*Type*	*Manufacturer*	*Equivalent*	*E.I.L. Part No.*
V1	EF37A	Mullard	6J7	V34
V2	EB91	Mullard	6AL5	V10
V3	EF95	Mullard	6AK5	V48
V4	EF37A	Mullard	6J7	V34
V5	150C4	Mullard	OA2	V49
V6	EB91	Mullard	6AL5	V10
V7	EZ90	Mullard	6X4	V47

CAPACITORS

Circuit Ref.	*Value (μF)*	*Working Voltage*	*Tolerance*	*Type*	*E.I.L. Part No.*
C1	1	250	±1%	Precision paper	C45
C2	3	250	±1%	Precision paper	C46
C3	8	500	−20% +50%	Electrolytic	C82
C4	0.02	500	±20%	Paper	C43
C5	2	500	−20% +50%	Electrolytic	C88
C6	8	500	−20% +50%	Electrolytic	C82
C7	0.001	500	±2%	Polystyrene	C30

OTHER COMPONENTS

Circuit Ref.	*Description*	*E.I.L. Part No.*
M	Meter: 500 μA Non-linear calibration	M17
Relay	500 ohm coil, 2 c.o. contacts	R304

9. SPECIFICATION

Ranges	0–4 milliseconds; 0–10 milliseconds; 0–40 milliseconds; 0–100 milliseconds; 0–400 milliseconds; 0–1 second; 0–4 seconds; 0–10 seconds
Accuracy	On the two lowest ranges ±2% of full scale; on all other ranges ±1% of full scale.
Operation using terminals	
Internal signal	–14V, current limited to 3mA.
'Short circuit' resistance	Should be less than 300 ohms.
'Open circuit' resistance	Should be greater than 100,000 ohms.
External pulse operation	
Input resistance	2.2 Megohms.
Signal level	Should be more than 3V negative. (Positive signals ignored).
Maximum peak input	±300V.
Power supply	100–120V and 200–250V a.c. 40–60 c/s.
Power consumption	30VA.
Valves	Two EF37A or 6J7; one EF95 or 6AK5; Two EB91 or 6AL5; one 150C4 or OA2; One EZ90 or 6X4.
Size	17½ x 9 x 10½ inches (44 x 23 x 26 cm.).
Weight	27 lb. (12.2 kg.).
Accessory units available	B25 Photocell Unit; C25 Pulse Selector Unit; D25 Double Pulse Unit

Manufactured under Pat. Nos. 654649 and 654675.

SM.25E/3.

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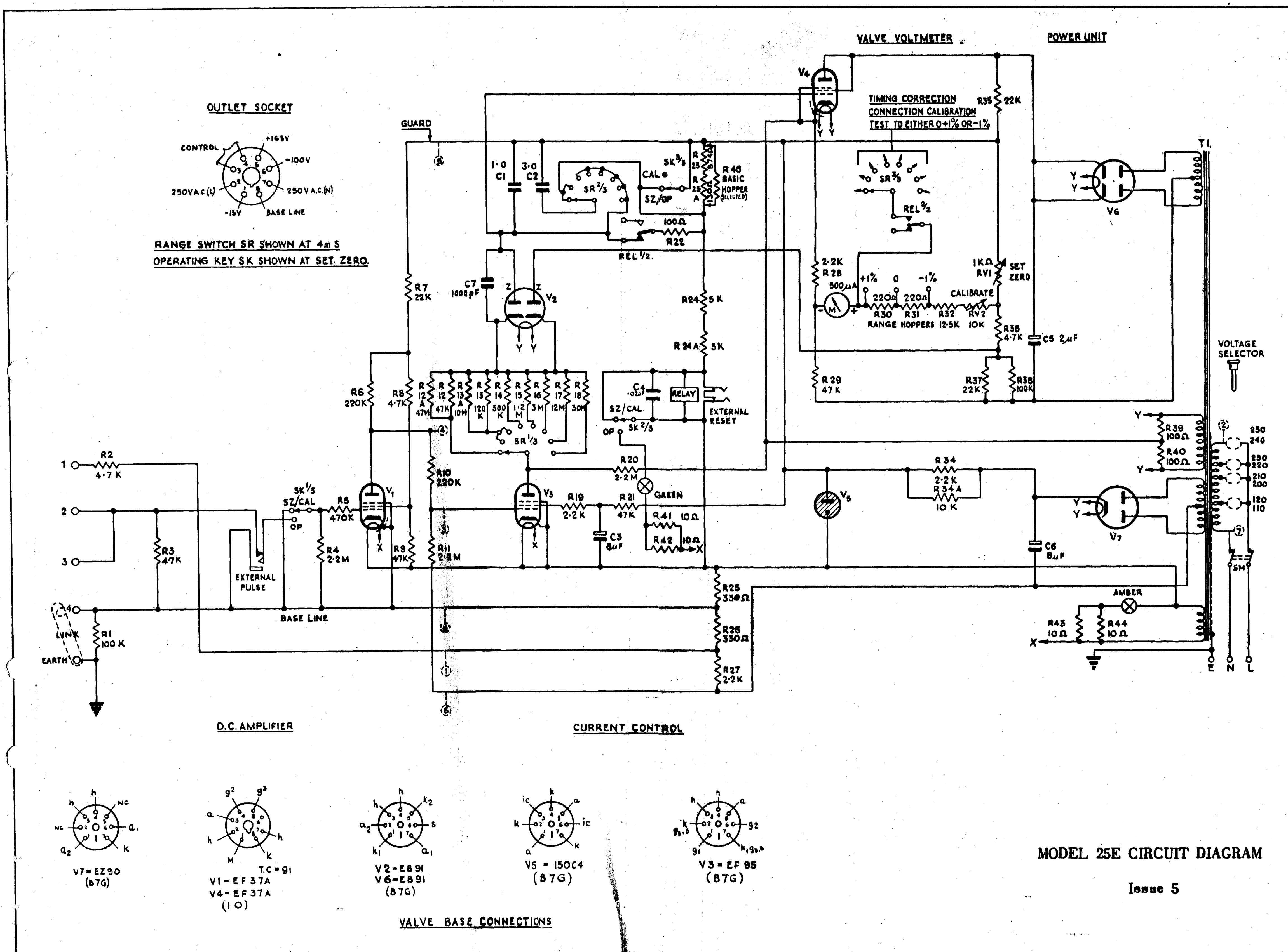
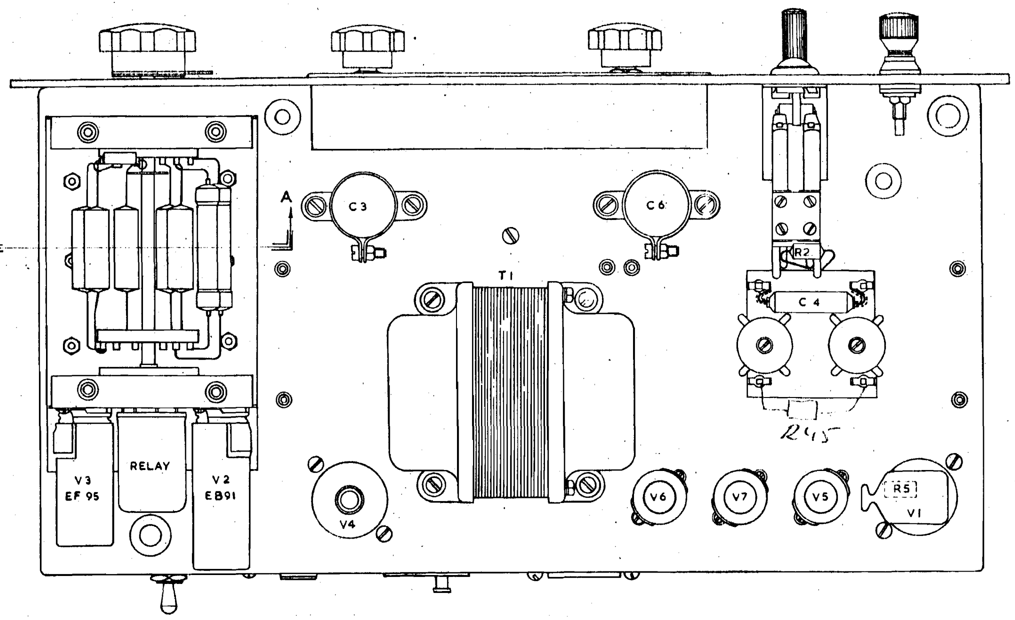


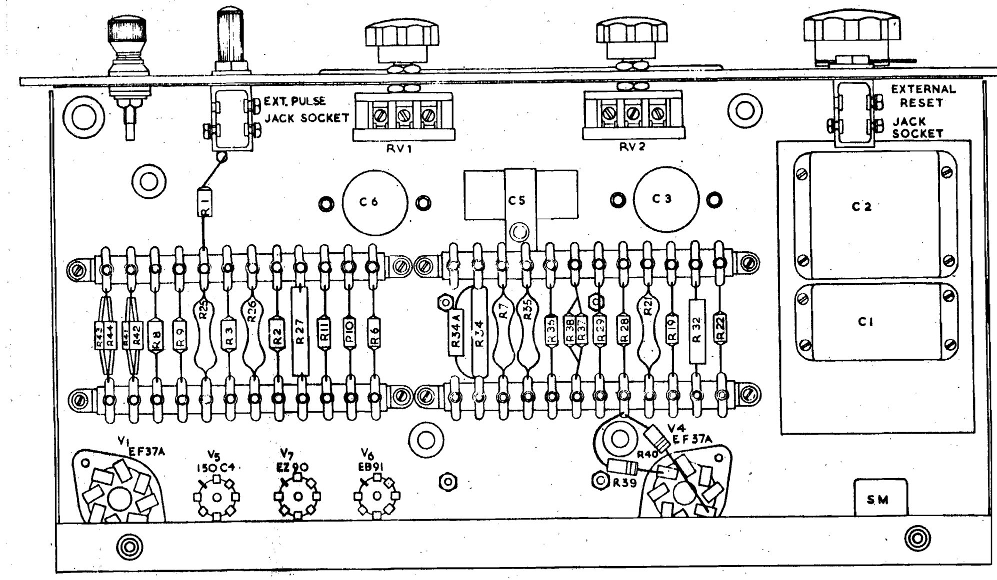
MODEL 25E CIRCUIT DIAGRAM

Issue 5

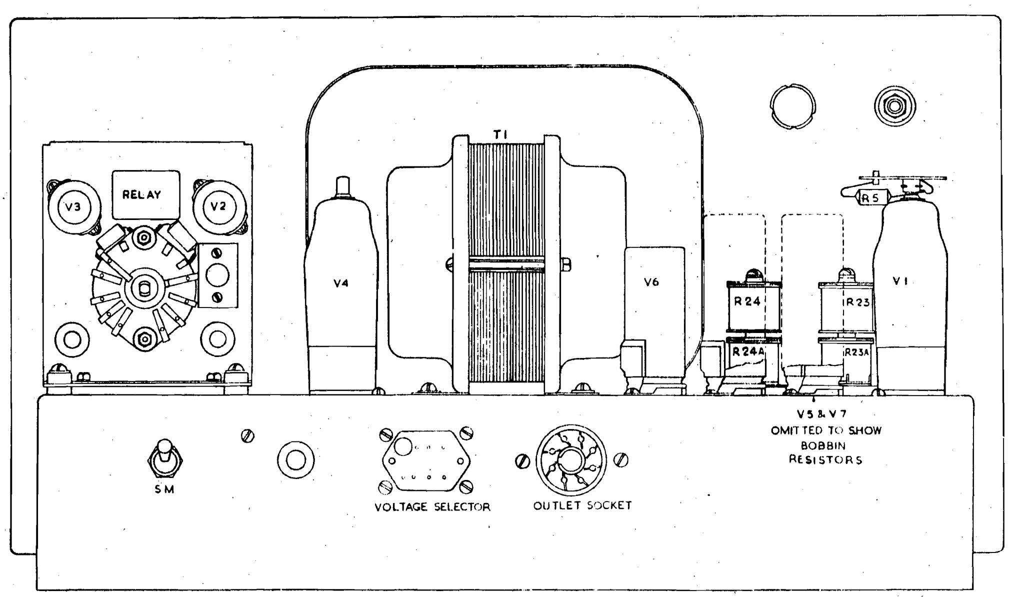
Fig. 2.



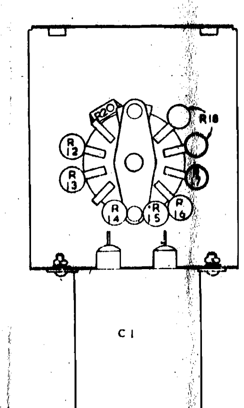
VIEW OF TOP OF CHASSIS



VIEW OF UNDERSIDE OF CHASSIS



VIEW OF REAR OF CHASSIS



SECTION THRO' A-A

MODEL 25E COMPONENT LAYOUT

Issue 2

Fig. 3.

SERVICE CENTRES

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