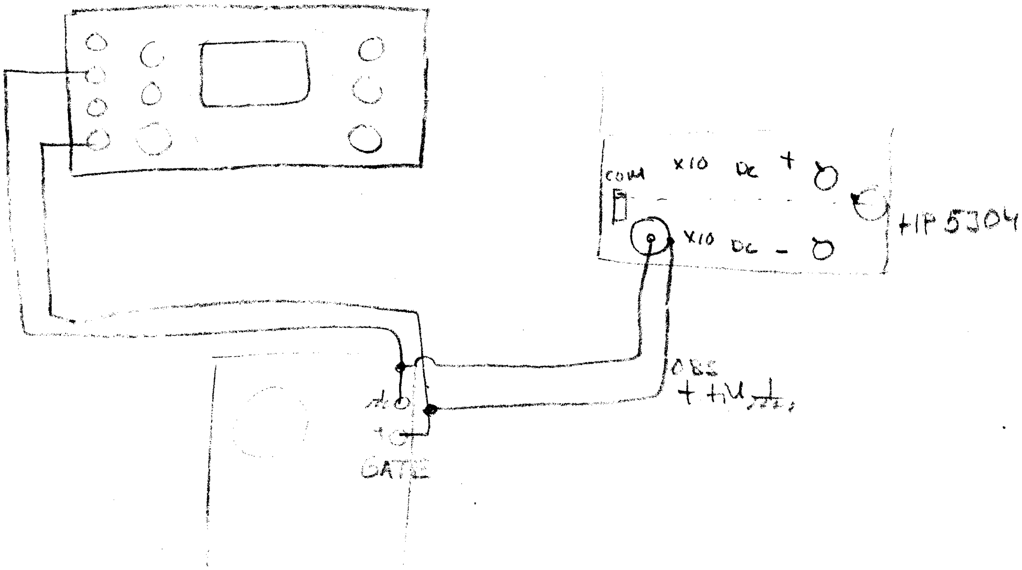
ELECTRONIC INSTRUMENTS LTD

CHRONOTRON SERIAL 25014


COM
X10 DC +
X10 DC -
HP 5304
OBS
GATE

ELECTRONIC INSTRUMENTS LTD.

TELEPHONE: RICHMOND 4917
CABLES: ELECTRON, RICHMOND SURREY

Makers of quality measuring instruments and scientific apparatus

17, PARADISE ROAD
RICHMOND · SURREY

The CHRONOTRON Millisecond Meter

SERVICE MANUAL

1. Introduction page 1
  1.1 Applications
  1.2 Principle of operation

2. Operating instructions page 3
  2.1 Preliminary
  2.2 General operating procedure

3. Methods of Connection page 4
  3.1 Operation with terminals
  3.2 Operation with Jack Socket (5)

4. Measurement of very short pulses page 5
  4.1 Time delays in input lead
  4.2 Precautions to reduce such delays

5. General operating notes page 6
  5.1 Setting-up procedure
  5.2 Operation with Terminals 1 to 4
  5.3 Operation with Jack Socket (5)
  5.7 Timing a.c. signals
  5.8 Timing successive pulses
  5.9 Timing between pulses

6. Circuit Operation page 8

7. Accessory Units page 8

8. Maintenance page 9

Specification page 10

Appendix - Diagram of connections
  Circuit
  Component values

DIRECTORS:
A.C.W. NORMAN, O.B.E.
P. GOUDIME, M.A.
E.J. TUCKER, F.C.I.S.
THE HON. T. H. HAZLERIGG
G. I. HITCHCOX, A.M.I.E.E.

ELECTRONIC INSTRUMENTS LTD.

TELEPHONE: RICHMOND 4917
CABLES: ELECTRON, RICHMOND SURREY

Makers of quality measuring instruments and scientific apparatus

17, PARADISE ROAD
RICHMOND · SURREY

The CHRONOTRON Millisecond Meter

Models 25A and 25B

Patents applied for

1. INTRODUCTION

The CHRONOTRON is a self-contained direct reading instrument for the measurement of time intervals in the millisecond and microsecond regions. It is robust and portable and is intended for either laboratory or workshop use. Its operation is extremely simple, and, either by itself or supplemented by the Photocell Unit or by one of the Pulse Units, almost every kind of timing problem can be solved.

There are three different models :

Range	MODEL 25A	MODEL 25B	MODEL 25C
1	0- 4 milliseconds	0- 40 milliseconds	0- 40 microseconds
2	0- 10 milliseconds	0-100 milliseconds	0-100 microseconds
3	0- 40 milliseconds	0-400 milliseconds	0-400 microseconds
4	0-100 milliseconds	0- 1 second	0- 1 millisecond
5	0-400 milliseconds	0- 4 seconds	0- 4 milliseconds
6	0- 1 second	0- 10 seconds	0- 10 milliseconds

IMPORTANT This instruction booklet refers only to Models 25A and 25B, which are identical in operation and appearance, and which differ only in their time ranges. Model 25C, which covers the microsecond region, necessarily differs from the other two, and is described in a supplementary booklet.

1.1 Applications

The following are only a few of the many timing problems for which the CHRONOTRON is being used in various fields :

a. Testing switches, fuses, overloads and circuit-breakers
b. Timing telephone relays and selector dials
c. Timing the operation of contactors and thermostats
d. Measuring viscosity
e. Timing the speed of projectiles
f. Measuring the speed of vehicles on a short distance base
g. Testing and adjusting camera shutters
h. Measuring the incidence and duration of light-flashes for photographic or signalling purposes
i. Investigating human reaction times.
j. Tracing the propagation of vibrations in materials
k. Checking industrial process times
l. Testing industrial timing controls, e.g. for welding operations

1.2 Principle of operation

The incoming signal, however it is produced, 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 is automatically measured by a d.c. valve voltmeter directly calibrated in units of time. The meter reading is dead-beat and decays very slowly, allowing ample time for observation. The timing capacitor is specially selected and combines a very high insulation resistance with a very low soakage factor, and it is carefully aged over several temperature cycles to ensure permanent stability.

The CHRONOTRON is self calibrating and accurately determined internal resistors are used as the reference standard. The calibration procedure completely covers the effects of changes of valves or of variations in either mains voltage or frequency.

2. OPERATING INSTRUCTIONS

2.1 Preliminary

The CHRONOTRON is despatched with all valves in position, ready for immediate use. The mains plug and the jack plug are packed separately and are attached to the instrument. Before switching on, the mains adjustor plug must be set to the correct operating voltage; in general, it is desirable that the instrument should be earthed, but see paragraph 5(d).

2.2 General operating procedure

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

b. The RANGE switch is set so that the expected time interval will occupy a fairly high position on the meter scale.

c. The OPERATING switch is turned to SET ZERO and the meter adjusted to read zero by the SET ZERO knob. <u>This adjustment holds good for all ranges</u>.

d. The OPERATING switch is next set to CALIBRATE and the pointer adjusted to the red mark by the CALIBRATE knob. <u>This adjustment must be repeated whenever the range is changed</u>.

e. During the above operations, the RED panel light shows. Setting the OPERATING switch to OPERATE causes the GREEN light to appear and the instrument is now ready to time.

f. To clear the reading for the next timing operation, return the OPERATING switch to SET ZERO and hold it there for a few seconds before returning it to OPERATE.

2.3 Two important notes

It is essential that the SET ZERO and CALIBRATE controls are set up in the order shown above, and when the test circuit is connected to the Terminals, the Jack Plug <u>must</u> be withdrawn from its socket or the CHRONOTRON will not time.

3. METHODS OF CONNECTION

The uses of the CHRONOTRON are so many and so varied that it is impossible to do more than suggest the general operating principles and to describe a few typical cases.

This important distinction should be noted. The use of the 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 Jack Socket (5) 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.

3.1 Operation with terminals

The input circuit of the CHRONOTRON under these conditions is shown in figure 1 on page 11; 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 2 to 7 should be self-explanatory; they illustrate the six possible combinations of contacts.

The resistance of a nominal "short-circuit" should be less than 50 ohms; any parallel leakage resistance across a nominal "open-circuit" should be greater than 100 000 ohms.

3.2 Operation with Jack Socket (5)

The input circuit under these conditions is shown in figure 11 page 11. 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 great, is timed with full accuracy.

The applied negative voltage should not exceed 300, or some damage may be caused to the input valve; the accidental application of a positive voltage will cause no damage, but the instrument will not time. For a.c. operation see section 5.7 described on page 7.

Figures 12 to 15 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 12 on page 11 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 13 page 11 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 condenser must be introduced so that the change of voltage operates the CHRONOTRON. The capacitance of this condenser in microfarads should be equal to, or greater than, the expected time interval in seconds. It will be realised that the insertion of a condenser 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; condenser coupling is always used in cases where any pre-timing voltage exists.

4. MEASUREMENT OF VERY SHORT PULSES

4.1 Time delays in input lead

When measuring very short pulses, under 2 milliseconds, 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. In the Model 25C this trouble is avoided by providing an impedance converter probe at the end of the input lead which may therefore be screened and of any desired length.

4.2 Precautions to reduce such delays

In the ordinary Models 25A and 25B the following simple precautions should be noted. It should be clearly emphasised that these precautions are only necessary on Jack Socket ('live' circuit) operation and then only when the source resistance of the signal to be timed exceeds 20 000 ohms, and in any case only necessary when this signal is less than 20 milliseconds.

a. Unnecessary input capacitance should be avoided as far as possible; screened leads should not be used unless absolutely necessary.

b. 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.

c. Unnecessarily high signal voltages should be avoided; ideally the signal should lie between -4 and -10 volts.

d. In cases where these precautions cannot be adequately applied, the signal source should be followed by a cathode follower circuit acting as an impedance converter.

5. GENERAL OPERATING NOTES

5.1 Setting-up procedure

It is essential when setting up the instrument that the SET ZERO and CALIBRATE controls are adjusted in the order given in section 2.2 page 3.

5.2 Operation with Terminals 1 to 4

The internally generated test supply is approximately 14 volts; short circuit current is limited to 10 milliamps under any conditions. The terminals must never be connected to a 'live' circuit, that is, one including either a voltage or a potential drop.

Insertion of the jack plug into Jack Socket (5) automatically disconnects the Terminals (1 to 4), it follows that on terminal operation <u>the jack plug must be withdrawn</u>.

5.3 Operation with Jack Socket (5)

The parallel input resistance is 2 megohms. The input voltage should lie between 3 and 300 with the tip of the jack negative to the sleeve. Incorrect polarity will cause no damage, but the instrument will not time.

5.4 Earthing

Terminal 4 and the sleeve of the Jack Socket (5) are both connected to the case of the instrument which may be earthed either through the EARTH terminal or by the third pin on the mains socket. In general, earthing of the instrument is desirable unless the conditions of the input circuit should prevent it.

5.5 Overload in time

An overload in time should be avoided wherever possible, but it can cause no permanent damage to the instrument.

5.6 Long waiting period between operations

If long periods are expected to elapse between timing operations the instrument should be left in the SET ZERO position, switching to OPERATE when a reading is due to be taken.

5.7 Timing a.c. signals

Unless an a.c. signal is rectified by some suitable full-wave rectifier, the CHRONOTRON will summate the negative half-cycles only.

5.8 Timing successive pulses

If a series of successive pulses is applied to the CHRONOTRON the meter will normally indicate the total time. Where summation is not required the PULSE SELECTOR UNIT should be used; it is described in section 7 on page 8.

5.9 Timing between pulses

Normally the CHRONOTRON indicates the duration of the input pulses and not the interval between their arrival. Where this is required to be measured the DOUBLE PULSE UNIT should be used; it is described in section 7 page 9.

6. CIRCUIT OPERATION

The circuit diagram will be found in the appendix.

In the absence of a signal, the pre-amplifier valve V1 is fully conducting; its anode, and therefore the grid of V3 which is coupled through R23, is held relatively negative to the cathode of V3, holding V3 completely non-conductive. Any timing signal, however generated, cuts V1 completely off, and V3 becomes conductive to an extent partly determined by whichever cathode resistor R27 to R32 has been selected by the RANGE switch and partly by its grid voltage which is determined by the CALIBRATE control R25 acting through V2.A.

Conduction of V3 allows the timing current to flow, from the junction of R2 and R3, into the timing condenser C1, through the diode V4, and back to HT- through the temporarily conductive V3. At the end of the timing period, this current instantly stops when V3 again becomes non-conductive.

The charge introduced into C1, and therefore the voltage developed across it, is proportional to the interval during which the timing current has flowed. The potential across C1 is read by a balanced d.c. valve voltmeter, of which the electrometer valve V4 forms one arm; its value is read on the meter which can be directly calibrated in units of time.

7. ACCESSORY UNITS

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

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

The 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 is necessarily a complete one, and reject all subsequent pulses.

The DOUBLE PULSE UNIT is used for measuring the time interval between the arrivals of two successive pulses, which may be generated either in the same circuit or in two 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.

8. 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.

Failure of V1 (EF37A) will result in full scale meter readings on either the CALIBRATE or the OPERATE positions, whether any input signal is applied or not. Failure of either V2 (EB91) or V3 (EF37A) would make it impossible to calibrate the instrument correctly, although the SET ZERO control would still operate quite normally; total failure of either valve would prevent the CALIBRATE control from having any effect at all. Failure of V4 (EF37A) would cause the meter to read full scale in all positions of the OPERATING knob, including SET ZERO; the SET ZERO control would have no effect at all. With the failure of V5 (VR-150) both the SET ZERO and CALIBRATE controls would operate abnormally and all CALIBRATE readings would be very much too high. With failure of V6 (GZ32 or 5Z4G) the meter would not read at all under any conditions.

Excessive zero drift in the SET ZERO position may be due to V4 or, much more rarely, either V2 or V3. Excessive decay - downwards drift of reading as distinct from drift of zero - is due to failure of either V4 or of the timing condenser C1.

The CHRONOTRON is protected by a 1-amp fuse plug which forms part of the mains voltage adjustor at the rear of the instrument; rupture of this fuse is indicated by failure of both pilot lamps.

SPECIFICATION MODELS 25A and 25B

	25A	25B
Ranges	0 - 4 milliseconds	0 - 40 milliseconds
	0 - 10 milliseconds	0 -100 milliseconds
	0 - 40 milliseconds	0 -400 milliseconds
	0 -100 milliseconds	0 - 1 second
	0 -400 milliseconds	0 - 4 seconds
	0 - 1 second	0 - 10 seconds

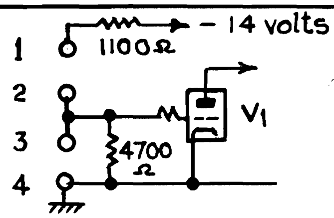
Accuracy	two shortest ranges ±2% of full scale all other ranges ±1% of full scale
Terminal operation	Internal test supply approximately -14 volts between terminals 1 and 4; current limited to 10 milliamps
Jack Socket operation	Input resistance 2 megohms; no internal test supply. Minimum input -3 volts; maximum input -300 volts.
Overload	Overload in time causes no permanent damage
Earthing	Terminal 4 and the ring of the Jack Socket are earthed to the EARTH terminal and to the case, which can be earthed through the third pin of the mains socket.
Valves	Three EF37A (or 6J5); one EB91 (or 6AL-5); one VR-150/30, one GZ32 (or 5Z4-G)
Power supply	110 to 250 volts a.c. only; 40 to 100 c/s. Power consumption 55 watts.
Output Socket	accessible through the back of the case provides supplies for the accessory units.

SM25/1
GF31

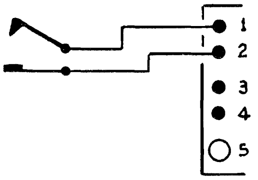
February 1951

OPERATION FROM 'DEAD' INPUT CIRCUITS USING TERMINALS 1-4

1 Input Circuits of the Chronotron



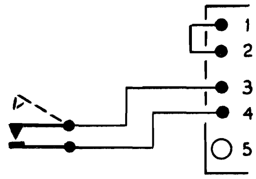
2



close to START

open to STOP

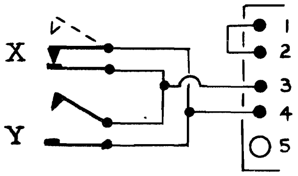
3



open to START

close to STOP

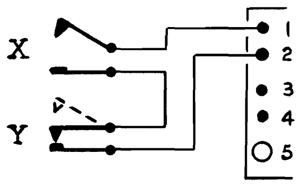
4



open 'X' to START

close 'Y' to STOP

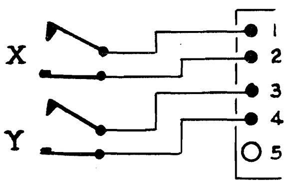
5



close 'X' to START

open 'Y' to STOP

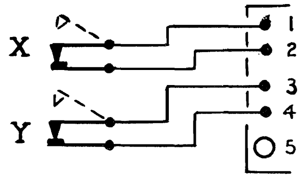
6



close 'X' to START

close 'Y' to STOP

7



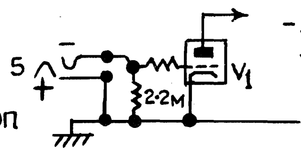
open 'Y' to START

open 'X' to STOP

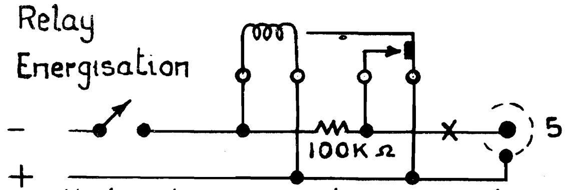
OPERATION FROM 'LIVE' INPUT CIRCUITS USING JACK SOCKET-5

11 Input Circuits of the Chronotron

signal Input -3 to -300 volts d.c.

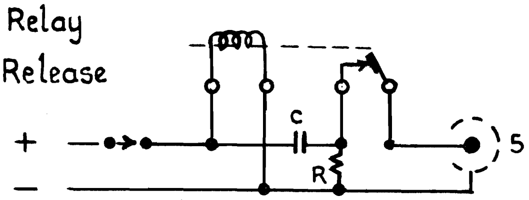


12 Relay Energisation



with breaking contacts insert at X

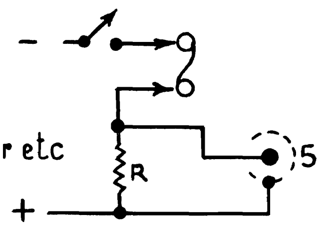
13 Relay Release



C = 2 mfds R = 2·2 M Ω

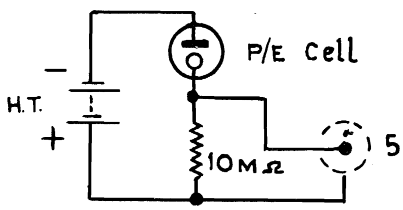
14 Rupturing Time of Fuse

Contact Breaker etc



PD across R must exceed 4 v

15 Timing Interval of Light



CHRONOTRON - MODEL 25A

COMPONENT VALUES - DRAWING NO. 25001 Issue 5

RESISTORS

Component	Value(ohms)	Tol.%	Rating (watts)	Type
R1	3300	5	10	Wirewound
R2	150	10	$\frac{1}{2}$	Carbon
R3	150	-	-	Wirewound potentiometer
~~R3a~~	~~400~~ 680	~~-~~	~~-~~	~~" " preset~~
R4	~~220~~ 520	10	2	Carbon
R5	220	10	$\frac{1}{2}$	Carbon
R6	3300	10	$\frac{1}{2}$	Carbon
R7	2200	10	$\frac{1}{2}$	Carbon
R7a	8200	10	$\frac{1}{2}$	Carbon
R8	150	10	$\frac{1}{2}$	Carbon
R9	27M	20	$\frac{1}{2}$	Carbon
R10	2200	1	$\frac{1}{2}$	Carbon high stability
R11	5100	1	$\frac{1}{2}$	Carbon high stability
R12	20K	1	$\frac{1}{2}$	Carbon high stability
R13	50K	1	$\frac{1}{2}$	Carbon high stability
R14	200K	1	$\frac{1}{2}$	Carbon high stability
R15	500K	1	$\frac{1}{2}$	Carbon high stability
R16	10K	10	2	Carbon
R16a	10K	10	2	Carbon
R17	1100	10	$\frac{1}{2}$	Carbon
R18	~~220~~ 330	10	$\frac{1}{2}$	Carbon
R19	330	10	$\frac{1}{2}$	Carbon
R20	1100	10	$\frac{1}{2}$	Carbon
R21	330	10	1	Carbon
R22	330K	10	$\frac{1}{2}$	Carbon
R23	330K	10	$\frac{1}{2}$	Carbon
R24	1100	10	$\frac{1}{2}$	Carbon
R25	1K	-	-	Wirewound potentiometer
R26	4700	10	$\frac{1}{2}$	Carbon
R27	220	10	$\frac{1}{2}$	Carbon
R28	1500	10	$\frac{1}{2}$	Carbon
R29	10K	10	$\frac{1}{2}$	Carbon
R30	33K	10	$\frac{1}{2}$	Carbon
R31	150K	10	$\frac{1}{2}$	Carbon
R32	330K	10	$\frac{1}{2}$	Carbon
R33	33K	10	$\frac{1}{2}$	Carbon
R34	2.2M	10	$\frac{1}{2}$	Carbon
R36	2000	5	10	Wirewound
R37	520	10	2	Carbon
OBS R38	1	5	-	Wirewound
R39	7	5	-	Wirewound

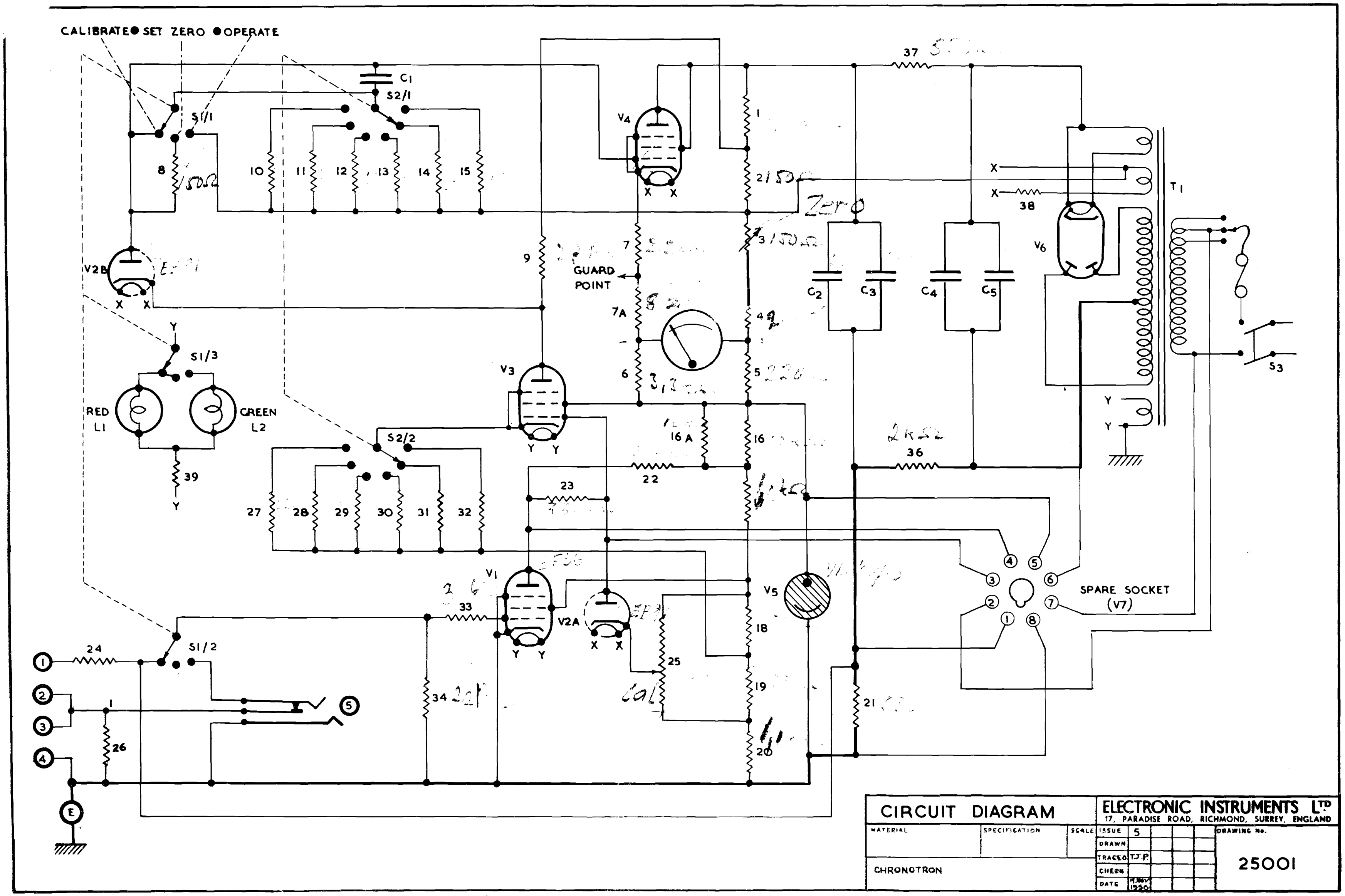
CONDENSERS

Component	Value	Tol. %	Working V.	Type
C1	1 Mfd (M25A) 4 Mfd (M25B)	1	300	Special high stability
C2	2 Mfd	20	600	Paper
C3	2 Mfd	20	600	"
C4	2 Mfd	20	600	"
C5	2 Mfd	20	600	"

Valves

V1	EF36 or EF37 or 6J7-GT
V2	EB91 or 6AL5
V3	EF36 or EF37 or 6J7-GT
V4	EF36 or EF37 only
V5	VR150/30
V6	5Z4-G

L1 L2	Two 6 volt M.E.S. Bulbs 0.3A


CALIBRATE
SET ZERO
OPERATE
C1
S2/1
S1/1
V4
S1/3
RED
L1
GREEN
L2
S2/2
S1/2
V1
V2A
V2B
V3
V5
V6
T1
S3
GUARD POINT
SPARE SOCKET (V7)
CIRCUIT DIAGRAM
ELECTRONIC INSTRUMENTS LTD
17, PARADISE ROAD, RICHMOND, SURREY, ENGLAND
MATERIAL
SPECIFICATION
SCALE
ISSUE 5
DRAWN
TRACED T.J.P.
CHECK
DATE
DRAWING No.
25001
CHRONOTRON