TECHNICAL MANUAL

TELEGRAPH DISTORTION MEASURING SET,

TYPE TDMS5BV

(Basic Models)

NOMINAL SPEED RANGES: 50 - 70 - 90 - 170 - 190 BAUDS

(Mod. 2)

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TELEGRAPH DISTORTION MEASURING SET, TYPE TDMS5BV

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GENERAL DESCRIPTION

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CHAPTER 1

GENERAL DESCRIPTION

1. EQUIPMENT ILLUSTRATION

The Telegraph Distortion Measuring Set, Type TDMS5BV or TDMS5ABV is essentially a portable telegraph test signal generator incorporating a 2¾-inch diameter cathode ray tube for monitoring purposes.

The instrument is contained in an aluminium alloy case having front and rear doors which open to expose the various controls, output relay and coder.

The instrument operates from power supplies of 100 to 125, or 200 to 250 volts, 50 to 60 cycles a.c. and has a power consumption of 40 watts. In addition, telegraph battery supplies are required, these may be provided from the normal station batteries or local power units. In some cases dry batteries can be used to provide these supplies.

The TDMS5 can be combined with its TDMS6 counterpart to form a comprehensive telegraph distortion measuring equipment. Both instruments can be provided mounted in a housing designed for combined installation on an International 19-inch rack.

2. PURPOSE AND FACILITIES

The purpose of the instrument is to provide a comprehensive selection of accurately derived d.c. telegraph signals for use in setting up, routine maintenance and fault location of a v.f. telegraph system or network and associated d.c. telegraph equipment. Facilities are also provided for the rapid checking and adjustment of telegraph type relays.

The TDMS5BV provides limited facilities for shunt monitoring and checking of incoming double-current (polar) telegraph signals for speed and distortion. In respect of the TDMS-5ABV, these facilities are extended in that single-current (neutral) telegraph signals may be monitored.

Both instruments provide the following facilities:

(a) Production of perfect teleprinter test signals of variable known speed.

(b) Introduction of predetermined percentages of start element distortion into these signals.

(c) Testing start-stop receiving mechanisms, including regenerative repeaters, for margin.

(d) Testing telegraph type relays for neutrality, transit time and contact bounce.

In conjunction with the TDMS6BV, or 6ABV, the instrument provides very comprehensive testing facilities for the optimum operation of equipment and systems.

3. TYPES OF TEST SIGNAL

The following test signals can be generated by the instrument:

(a) Continuous 2:2 reversals.

(b) Continuous 1:1 reversals.

(c) Continuous Mark.

(d) Continuous Space.

(e) Repetition of a selected character, determined by the setting of five keys on the front panel.

(f) A test message of 100 characters. A switch on the front panel enables the operator to send a single or continuously repeated message.

These signals may be sent as perfect (less than 1% distortion), or given any predetermined start element distortion up to ±50%. The amount of distortion is continuously variable between these limits and is monitored on the cathode ray tube.

4. TELEGRAPH SIGNALLING SPEED

The test signals may be either 7, 7½ or 8 unit code and can be transmitted on any one of five nominal speeds in the range 40 to 200 bauds.

The basic speed range is centred on 50 bauds with a coverage of ±10 bauds. Any other four ranges may be chosen in addition to the basic range providing that:

(a) The maximum speed does not exceed 200 bauds.

(b) Each range covers ±10 bauds about the centre speed.

(c) Ranges centre on 10 baud intervals.

4.1. Speed Ranges

Any centre speed range between 50 and 190 bauds, in five ranges with the conditions stressed above, may be accommodated on the instrument. The 50 baud speed range is mandatory.

4.2. Calibration Accuracy

A calibration accuracy of ±1% or better; typical figures are:

Basic centre speed (50 bauds)	-	±0.10 bauds
Extreme ends of range (±10 bauds)	-	±0.40 bauds
Variation of speed with ±10% variation in mains voltage	-	Not greater than 0.2%.

4.3. Oscillator Stability

After a warm up period the oscillator stability is 1 part in 10^3 for long periods and 5 parts in 10^4 for short periods at an ambient temperature of 20°C. The maximum ambient temperature for continuous working of the equipment is 40°C, with degraded performance for short periods at 45°C.

4.4. Output Distortion

With the speed correctly set and a correctly adjusted output relay, the output distortion does not exceed 1% at 50 bauds and 2.5% at 200 bauds.

4.5. Neon Speed Indicator

A neon speed indicator is fitted to the front panel and this, in conjunction with the appropriate stroboscope tuning fork, enables the speed of the oscillator to be checked and adjusted.

5. VENTILATION

When the equipment is used in rooms where the ambient temperature is high, or where the ventilation is poor, it may be an advantage to remove the rear door of the portable case, or backpanel of the rack mounting case to increase the ventilation of the units.

When the equipment is not being used, the rear doors, or back panel should be replaced and the equipment stored in a dry location.

6. REFERENCE DATA

6.1. Nomenclature

Telegraph Distortion Measuring Set Type TDMS5BV or TDMS5ABV (Portable).

Telegraph Distortion Measuring Set Type TDMS5BV or TDMS5ABV (Rack Mounted).

6.2. Valve Complement (5BV or 5ABV)

Quantity 1	-	6X4	-	Rectifier
Quantity 1	-	6AQ5	-	Pentode
Quantity 2	-	12AX7	-	Double Triode
Quantity 13	-	12AU7	-	Double Triode
Quantity 1	-	DG-7-32	-	Cathode Ray Tube
Quantity 2	-	CC8L	-	Neon
Quantity 2	-	CC3L	-	Neon
Quantity 1	-	XC15	-	Neon
Quantity 1	-	XC12	-	Neon

6.3. Power Requirements

100 to 125, or 200 to 250 volts, 50 to 60 cycles a.c. 40 watts.

The equipment also requires normal telegraph battery supplies.

6.4. Additional (Optional) Items

(a) Stroboscope Tuning Fork of 91 cycles for 45.5 baud working.

(b) Stroboscope Tuning Fork of 100 cycles for 50 baud working.

(c) Stroboscope Tuning Fork of 150 cycles for 75 baud working.

(d) Relay Test Adaptor, Type RTA1 - enables a wide variety of telegraph type relays with differing bases to be tested.

(e) Telegraph Display Unit, Type TDU2 - used with the TDMS6, or combined equipments, to permit monitoring of voltage waveforms.

(f) Additional Coding Discs, with varied 100 character test messages, can be provided for use in the Test Message Coder, Type TDA-10, if required.

7. SHIPPING DETAILS

Overall Dimensions	Length	Width	Height
Portable 5BV or 5ABV	18¼-in. (46.4cm).	11¼-in. (28.5cm).	13½-in. (34.3cm)
Rack Mounted Version	19-in. (48.26cm)	19-in. (48.26cm)	14-in. (35.5cm.)

Net Weight -

TDMS5BV or TDMS5ABV - 38 lb (17.24 kg)

TDMS6BV or TDMS6ABV - 36 lb (16.33 kg)

Rack Mounted Version (Combined Equipment) - 68 lb (30.85 kg)

Number of Packages per complete Instrument - 1.

CHAPTER 2

CIRCUIT PRINCIPLES

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CHAPTER 2

CIRCUIT PRINCIPLES

1. GENERAL

The heart of the instrument is a high-stability variable oscillator which provides the circular trace for the cathode ray tube at twice the frequency of the speed in bauds, of the telegraph signal. It also provides drive, via a squaring stage, to a scale-of-two divider.

The scale-of-two provides pulses at a repetition rate equal to that of the elements of the signal it is required to generate. These pulses drive a distributor, which is basically an eight-point cyclic counter modified by feedback to give a count of seven. The pulses from the scale-of-two are also passed to a mark-setting valve, which, in the absence of action from the distributor, maintains the output toggle at mark.

The output from the seventh anode of the distributor is used to determine the length of the stop element:

For 2 unit stop element (8 unit code) - the seventh anode output is not used.

For 1½ unit stop element (7½ unit code) - the seventh anode output is fed back to the scale-of-two.

For 1 unit stop element (7 unit code) - the seventh anode output is fed back to the distributor.

Note that in the Mark position of the Signal Selector switch, the distributor is open-circuit in position 4 of the wafer S4H. This stops the distributor in such a position that switching either to 'KEYS' or 'CODER' from 'MARK', the start element is always produced first.

Each of the eight anodes of the distributor gives a pulse in turn. When undistorted signals are desired, the pulse from the first anode is applied to the space-setting valve which overrides the mark-setting valve and trips the output toggle to the space condition to produce the start element of the character to be transmitted.

The next five anodes give similar pulses corresponding to the five character elements of the signal. These pulses pass through gate circuits, the gates opened or closed by the setting of the Keys, or by the coder, so that only those pulses corresponding to elements which it is desired to transmit as space signals are passed. In the absence of pulses from the distributor to the space-setting valve, the mark-setting valve sets the output toggle to mark. Those pulses which are passed by the gate trip the space-setting valve setting the output toggle to space, thus any character may be set up by the coder, or keys, and transmitted.

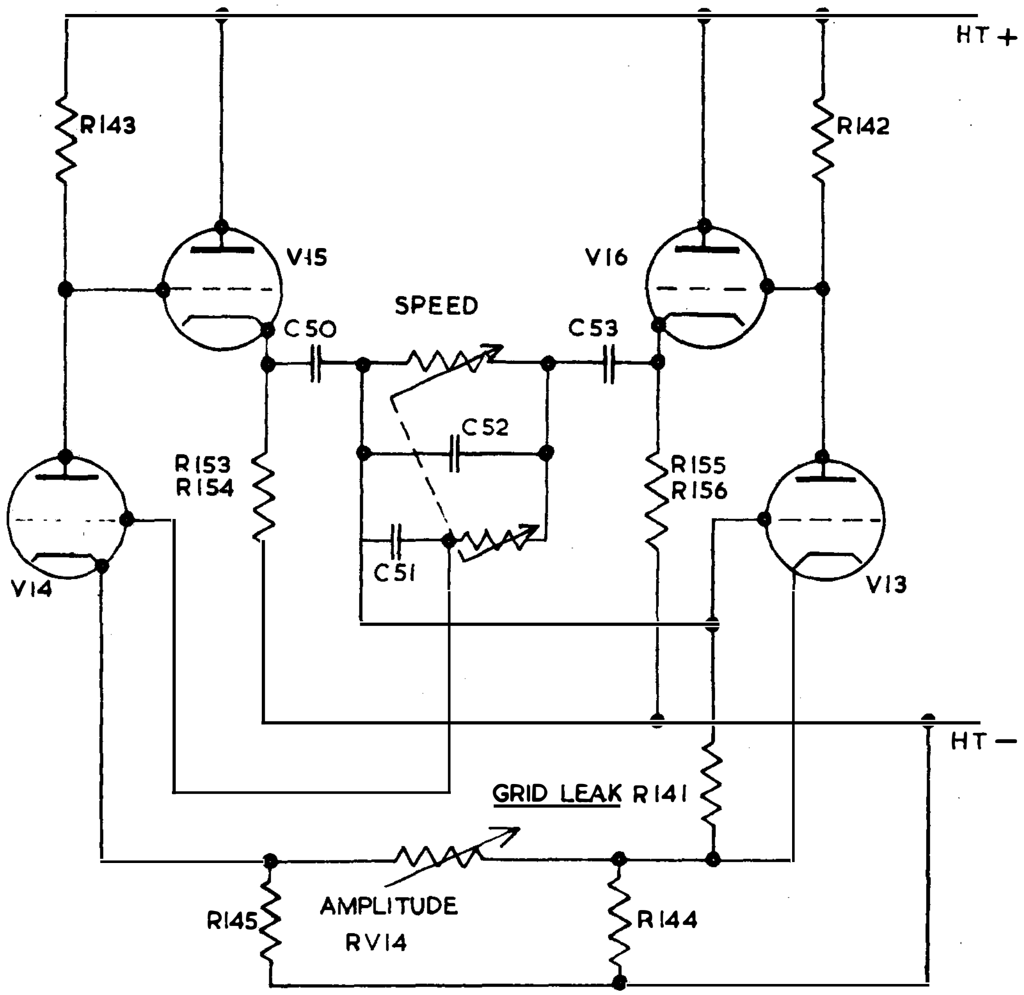
To produce long or short element distortion, it is necessary to vary the timing of the pulse which operates the space-setting valve to produce the start element. The method used is to take, instead of the negative pulse from the first anode of the distributor, the positive pulse from the fourth anode. This pulse is then passed to the distorter, where it is subjected to a variable delay, changed to negative polarity and passed to the space-setting valve as the start element pulse for the next character. By varying the delay, this start element pulse may be made up to 50% of an element early or late.

The output toggle drives an output relay which provides signals to the telegraph line, via an output filter network.

The signals to be displayed on the cathode ray tube presentation are selected by the Display switch. With the Display switch set to 'INPUT', signals from the input circuit are displayed. In the 'NORM. OUTPUT' position, internally generated signals taken from the output toggle are displayed. The 'BIAS' and 'TRANS. TIME' positions display signals taken from the contacts of a relay under test in the relay test socket, via the relay test circuits. Energising currents for the relay coils, in these tests, are derived from the output toggle. In the 'DIST. OUTPUT' position of the Display switch, the internally generated signals are displayed showing the percentage distortion introduced by the Distortion control.

2. OSCILLATOR (V13-V14-V15-V16)

The high-stability oscillator circuit used in the TDMS5BV and TDMS5ABV comprises valves V13-V14-V15-V16 and functions as a



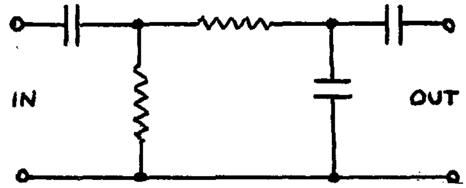
Basic Oscillator Circuit

resistance-capacity oscillator employing a zero phase-shift network.

To fully understand the operation of the oscillator, first basic principles should be considered.

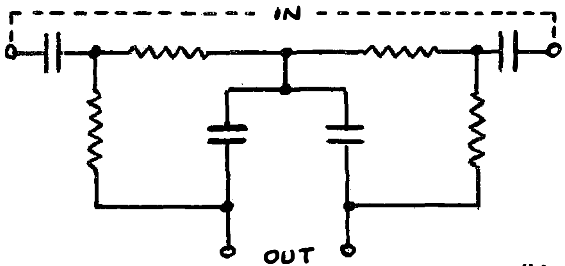
Sketch (a) shows a resistance-capacity network which gives an output in phase with the input at one frequency only.

If the output is amplified and fed back to the input, the circuit will oscillate. The oscillation will be at the frequency at which both output and input are in phase.



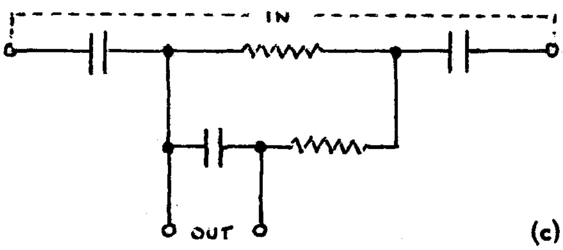
(a)

Since the instrument requires a push-pull output to drive the cathode ray tube deflector plates and at the same time give second harmonic cancellation, two such networks can be combined to give that shown in (b).



(b)

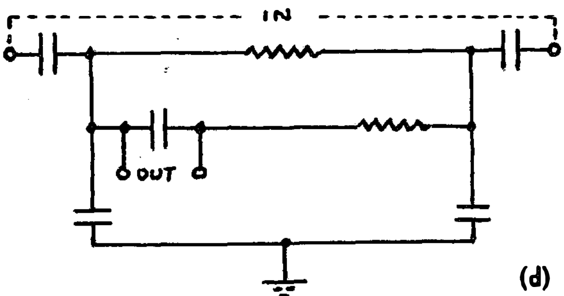
This may be simplified by re-arrangement and combination of components as shown in (c).



(c)

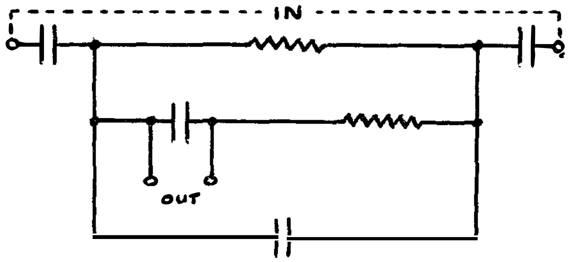
Used in this form, the gain of the amplifying valves would be much greater than the network attenuation.

Since only gentle oscillation is required in this application, additional attenuation is introduced to the network by the use of capacitive potential dividers of which the input feed capacitors form part. This gives the network shown in (d).



(d)

This again can be re-arranged and simplified to that shown in (e) which forms the basis of the circuit used in the instrument.



(e)

Provision is made for locking the oscillator to an external sinewave signal by a synchronizing circuit consisting of RV5-R140-C40. Variable resistors RV14 and RV15, connected between V13 and V14 cathodes, control the gain of the circuit and hence the amplitude of oscillation. These are shown on the main circuit diagram of Figure 2.

It is useful to note at this point that the two Amplitude controls, RV14 and RV15, control both the horizontal scan voltage applied to the cathode ray tube 'Y' plates and the oscillatory voltage fed to the quadrature amplifier and squarer circuits and therefore control the diameter of the circular display.

It should be noted that the cathode ray tube is mounted so that the 'Y' plates provide the horizontal scan and the 'X' plates the vertical scan, as opposed to normal oscilloscope practice.

3. QUADRATURE AMPLIFIER (V17-V18)

The quadrature amplifier comprises V17-V18 operating in push-pull. Voltages from the oscillator network are fed to the two grids and are in quadrature-phase to the voltage appearing across C51. The para-phase voltages appearing at V17 and V18 anode provide the vertical 'X' scan, which is therefore in quadrature-phase with the horizontal 'Y' scan and a circular trace results. The Shape preset RV17 controls the gain of the quadrature amplifier and therefore only affects the vertical scan. This enables adjustment for a perfectly circular trace.

4. SQUARER (V28-V29)

The squarer stage can be regarded as a two-stage over-driven cascade amplifier providing para-phase outputs at V28 and V29 anode. The squarer is driven by a sinewave from the cathode of cathode-follower valve V16 which is applied to V28 grid. Output from the squarer ultimately drives all circuits in the instrument concerned with the internal generation of test signals.

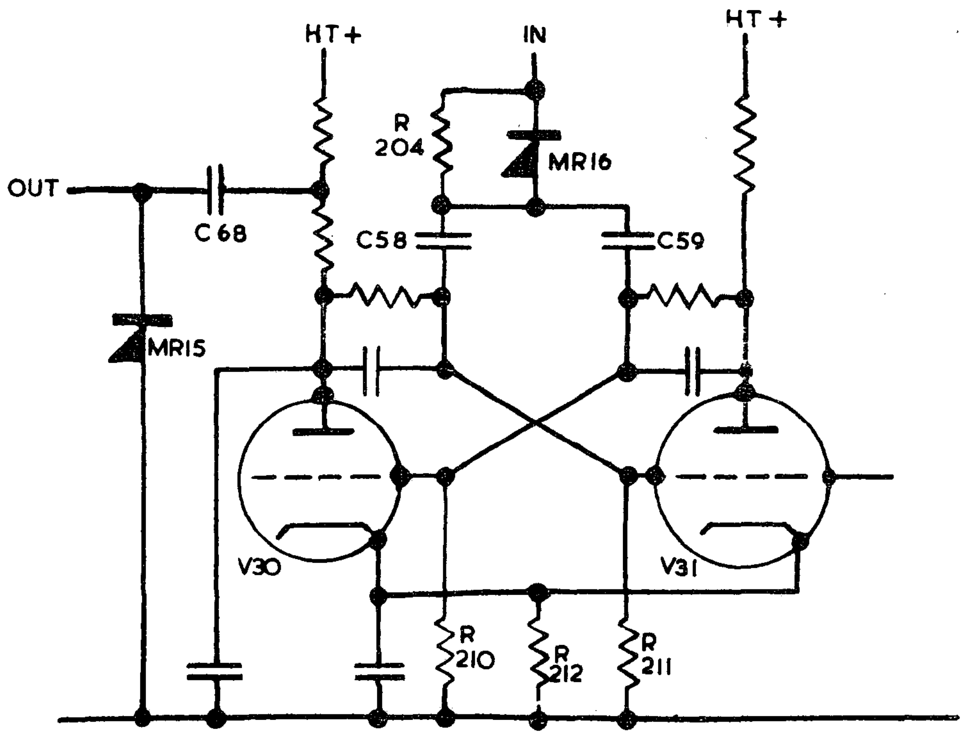
5. SCALE-OF-TWO (V30-V31)

The output from one anode of the squarer V29 is fed to a diode MR16 which allows only negative going pulses to pass. Negative going pulses of short duration are applied to the grid of both V30 and V31 by the action of C58-R211 and C59-R210.

Valves V30 and V31 form a bi-stable multivibrator such that when V30 is conducting, V31 is cut off by cathode bias developed across R212 and the low grid potential from V30 anode.

When the negative going pulses are applied to both grids, V30 will be driven beyond cut-off and its anode potential will rise. By regenerative action V31 will be forced into a fully conducting condition and V30 cut off. The low anode potential of V31 holds V30 grid beyond cut-off value and the circuit remains stable in this condition until the next negative going pulse is applied to both grids causing the reverse action to take place.

The voltage waveform appearing at V30 anode is therefore rectangular and at half the frequency of the oscillator. Output is taken from V30 anode load potential divider. MR15 ensures that only positive drive pulses are applied to the distributor.



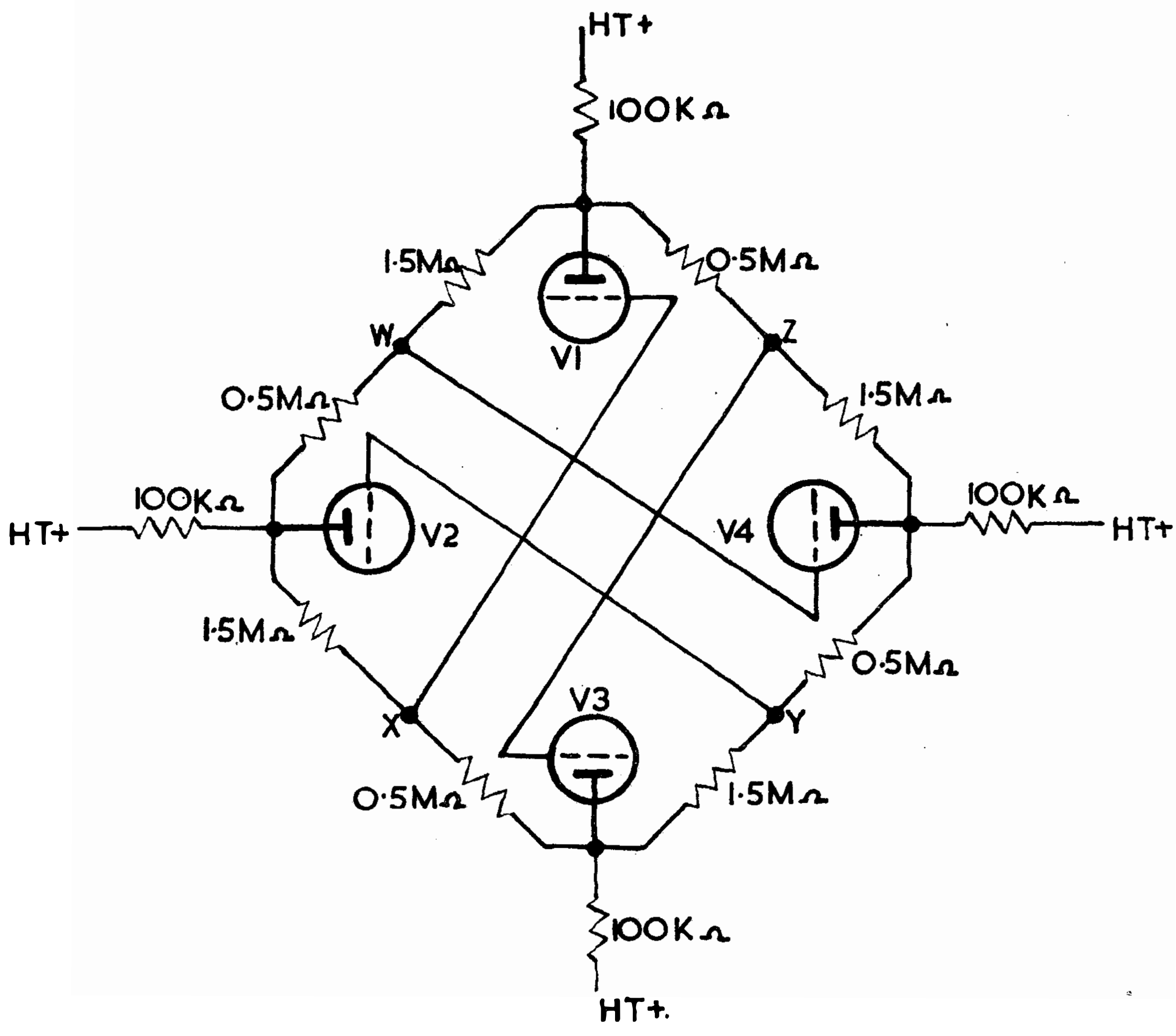
Scale-of-Two

6. DISTRIBUTOR (V19-V20-V21-V22-V23-V24 V25-V26)

The distributor is basically an eight-phase cyclic counter which can be modified by feedback to give a count of seven. In operation, four adjacent valves on the circuit diagram are conducting and the four opposite valves are cut off. On receipt of positive pulses at the combined grid circuit, the four conducting states become shifted together, one step at a time, giving a series of negative edges in rotation.

The operation of a cyclic counter of this type may be more readily understood by first considering an elementary circuit of similar type.

For the purpose of explanation, let it be assumed that the anode potential of any valve in the simplified four-phase circuit is 300 volts when cut off and 100 volts when conducting



Simplified Four-Phase Cyclic Counter

Let it also be assumed that V1-V2 are conducting and V3-V4 cut off. The potentials at points W, X, Y and Z will then be W=100; X=250; Y=300 and Z=150 volts. These are the valve grid potentials as indicated by the connections from these points to the four valve grids. (In a practical circuit only a fraction of these potentials would be obtained). Assuming now that the potential required at any of these points to maintain a valve conducting is 200 volts, V1-V2 will be conducting and V3-V4 cut off.

Now, if a 50-volt pulse is sumultaneously applied at all four points, Z will rise to 200 volts and V3 will conduct (V3 is in a 'preferential' condition compared with V4 since the potential at Z is greater by 50 volts than that at W). V3 anode will fall to 100 volts, causing Y to fall to 250 volts and X to 100 volts. V1 will cut off and the anode potential will rise to 150 volts and Z 300 volts.

V2-V3 are now conducting and V4-V1 cut off. V4 now occupies the 'preferential' position point W being at 150 volts compared with 100 volts at X. The next pulse therefore cuts on V4 and cuts off V2.

The circuit used in the instrument operates in this manner, but consists of eight valves instead of four. In this case let it be assumed that V20-V21-V22-V23 are cut off and V24-V25-V26-V19 conducting. This is the state at the end of a stop element, and can be seen in Figures 4, 5 and 6, under reference scale '0', V19 anode to V26 anode waveforms.

Following the same principle and assuming the same voltages, then the potentials at points Q, R, S, T, W, X, Y and Z are Q=250; R=300; S=300; T=300; W=150; X=100; Y=100; and Z=100 volts.

A 50-volt positive pulse to the distributor combined grid circuit raises point W to 200 volts and V20 cuts on, since V20 holds the 'preferential' position. At this instant V20 anode falls to 100 volts lowering point Q to 100 volts and R to 250 volts. The potentials are then R=250; S=300; T=300; W=300; X=150; Y=100; Z=100 and Q=100 volts, with V25-V26-V19-V20 conducting and V21-V22-V23-V24 cut off; V21 now holding the 'preferential' position. The distributor has stepped round one position in an anti-clockwise direction on the circuit diagram and now corresponds to the end of a start element. This is shown in Figures 4, 5 and 6, reference scale '2' V19 to V26 anode-waveforms.

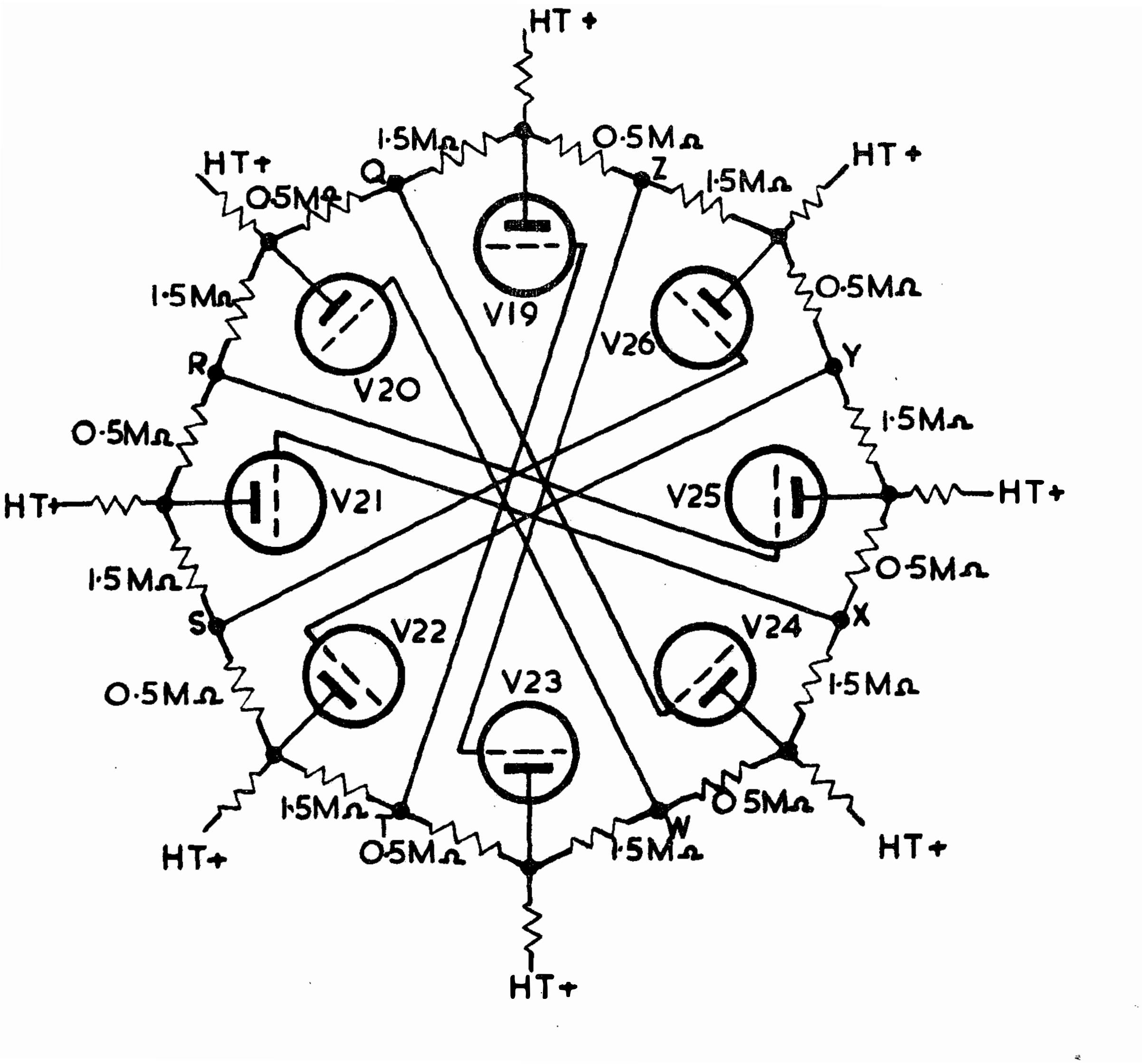
The process is continuously repeated, the distributor continuously stepping round one stage at a time for each positive pulse applied to the combined grid circuit.

The anode waveform of the eight distributor valves is obviously rectangular. The negative-going leading edges are, with the exception of V26, differentiated to form short pulses. These short pulses trigger all succeeding stages of the instrument.

The length of stop element is determined by the time taken by the distributor to change from the sixth to the eighth position. Where a stop element length of 1 unit only is required the differentiated negative pulse from V25 anode immediately cuts off V22 via link LK1. V26 cuts on so that the distributor steps from position 6 to position 8 on one pulse from the scale-of-two in the time of 1 unit. In effect, the distributor completes one revolution for 14 cycles of the oscillator.

To obtain a 1½ unit stop element, link LK1 is set so that the negative pulse from V25 anode is fed back to the scale-of-two valve V31 cutting on V30. The next pulse from the squarer, which arrives half a unit later in time, cuts off V30 feeding another positive pulse to the distributor. The distributor, under this condition, steps from position 6 to position 8 in the time of 1½ units, therefore completing one revolution for every 15 cycles of the oscillator.

For a 2 unit stop element, no feedback is applied and the distributor makes its normal count of 8, changing from position 6 to position 8 in the time of 2 units completing one revolution for every 16 cycles of the oscillator.



Eight-Phase Cyclic Counter Circuit

7. GATING CIRCUITS, CODER & KEYS

7.1. Gating Circuits

The five negative-going edges from V20-V21-V22-V23-V24 anodes pass to gate circuits. The edges are differentiated and the positive-going pulses suppressed by rectifiers MR21-MR23-MR25-MR27-MR29. At this point, the negative pulses may be individually short-circuited by the action of Signal Selector S4, Coder or Keys. The unsuppressed pulses pass through rectifiers MR22-MR24-MR26-MR28-MR30 to space-setting valve V8. These rectifiers isolate the gates preventing an earth introduced to one gate being applied to the remaining four.

To obtain 2:2 or 1:1 reversals, the Signal Selector over-rides link LK1 so that the distributor provides a count of eight.

7.2. Coding Circuits

With the Signal Selector in the 'CODER' position, earth connections to the gates are controlled by the coder wiper contacts. The wipers make contact or not, depending upon the particular character code, with a series of metal segments printed on an insulated plate. Contact between wiper and metal segment provides a mark signal. Space is the condition where the wiper is on an insulated segment.

After transmission of a character, the disc is moved round one step bringing into position a new combination of metal and insulated segments. In this way a test message of up to 100 characters may be transmitted.

To give the disc rotational movement during the fifth character element, a coincidence gate consisting of MR17-MR18 gate out a negative pulse of one unit duration from the condition of V21 and V24 anodes at this period when V21 and V24 are simultaneously conducting. This is inverted by V10 and actuates the coder drive valve V9, which is normally held cut off by negative bias applied to the grid. V9 therefore steps the coder one position during the fifth element of each character. This can be seen by the coder waveforms shown on page 12,

7.3. Single Message Operation

Reference should be made to the simplified coder drive circuit shown on page 2-11. Assuming the coder to be held in the rest position at the end of the message corresponding to the 100th position of the disc, coder change-over switch contacts 8 and 18, printed on the coding disc, are closed. The initial conditions for single message operation are as described in the following paragraphs.

With the Signal Selector set to 'CODER' and Continuous/Single message switch S2 set to 'SINGLE MESSAGE' (contacts closed), V9 cathode load resistor is short-circuited to earth via S4J. V22 anode is held at low potential via neon N6, S4F, S2 and contacts 8 and 18, to earth. This holds the distributor so that V22-V23-V24-V25 are conducting and V26-V19-V20-V21 are cut off, this is the distributor steady mark state.

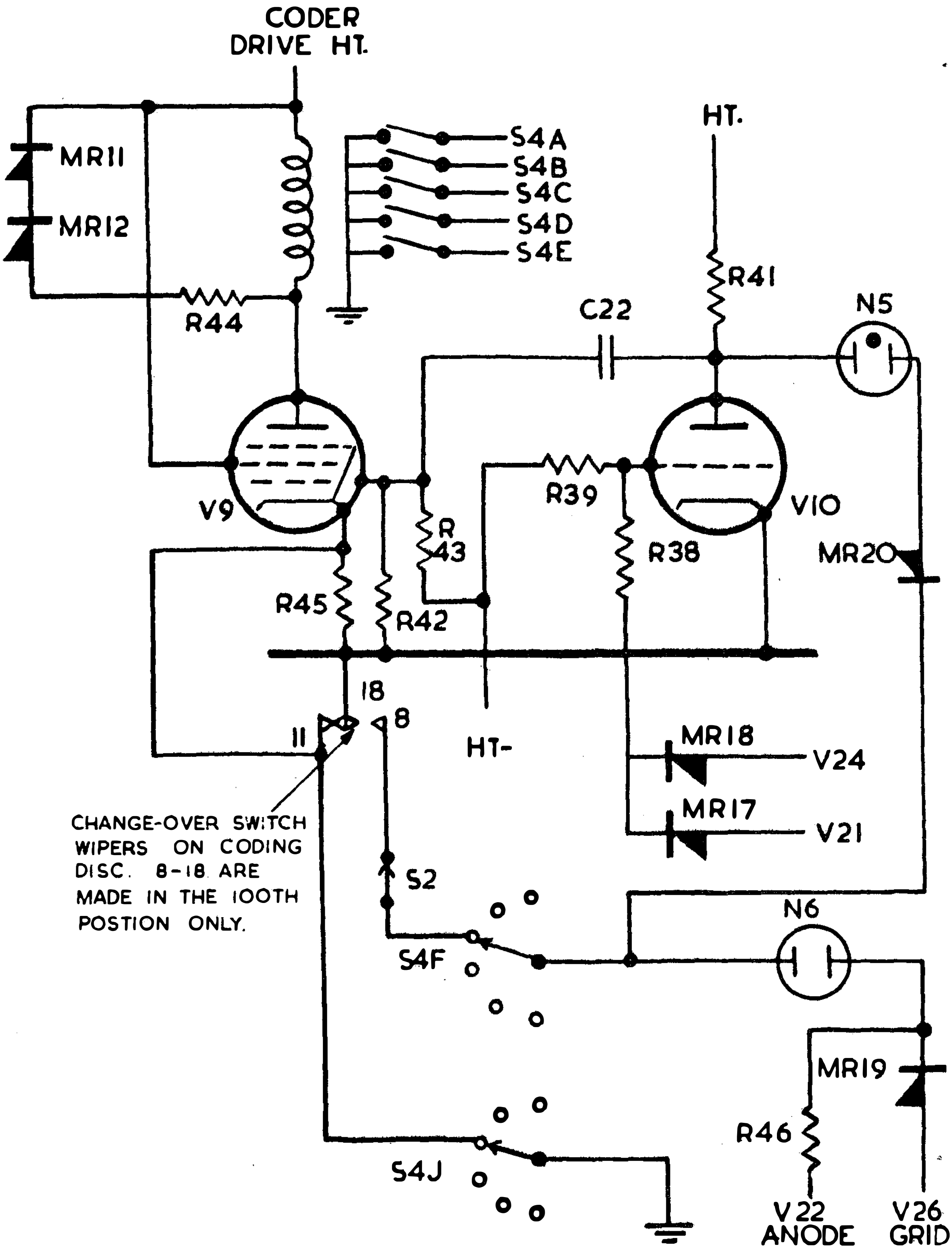
To transmit a single message, S2 is set to 'CONTINUOUS'. This breaks the neon hold circuit and the distributor starts. The first coincident negative rectangular excursion of V21 and V24 anode steps the coder one position.

When this happens the coder switch changes over closing contacts 18 and 11. The coder continues to operate until the end of the message S2 should now be returned to 'SINGLE MESSAGE' before the end of the test message is reached. At the 100th position of the coding disc, contact 18 changes over to 8. This applies the neon hold circuit and the distributor is held with the coder in the rest position until S2 is again set to 'CONTINUOUS'. Obviously, if S2 is left at 'CONTINUOUS', the test message will be continuously repeated.

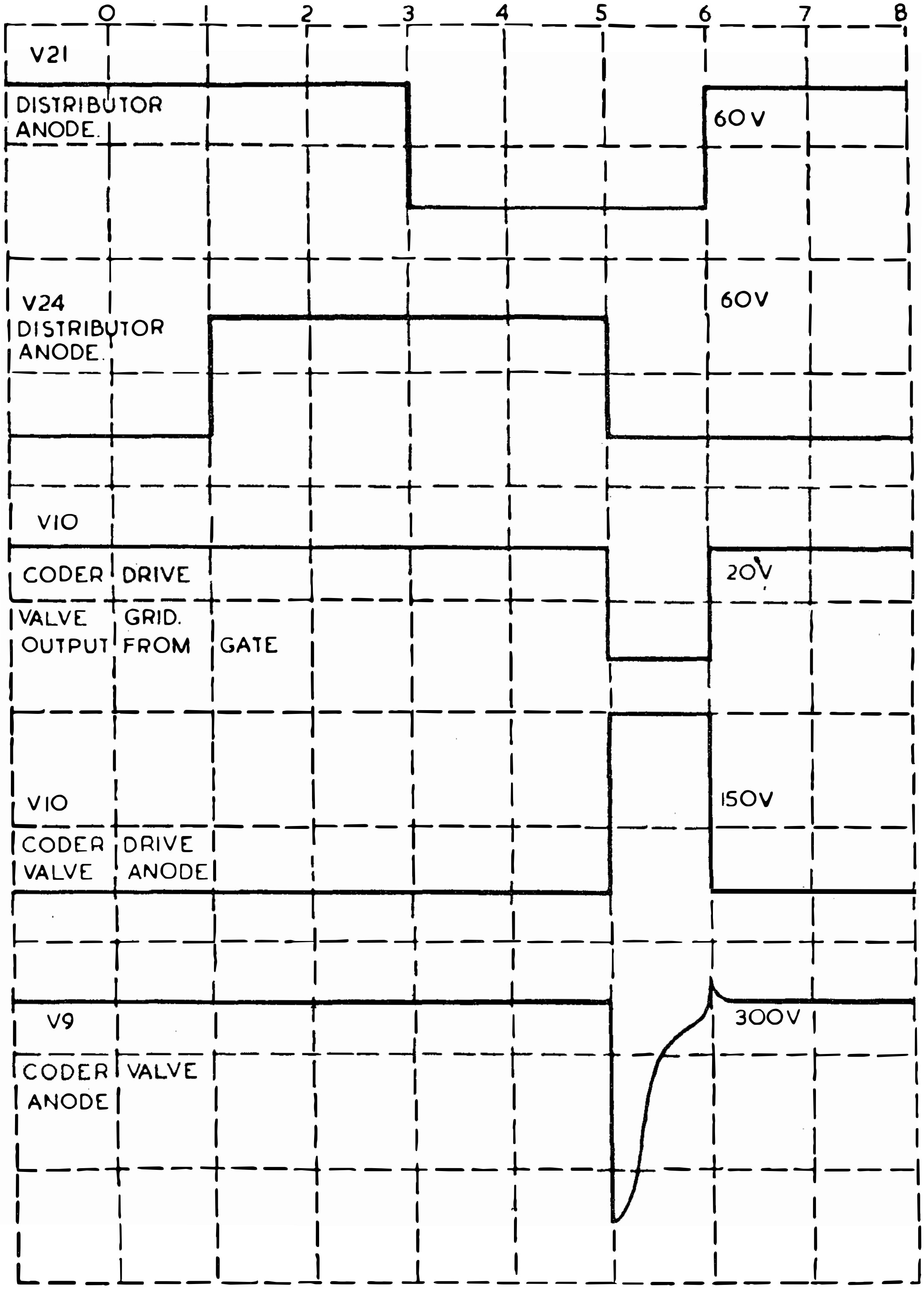
Another interesting feature of this circuit is that should the coder be operating and the Signal Selector turned to another position, such as 'KEYS', the selected output will be transmitted but the coder will continue to step on until it reaches the rest position at the end of the message, and V9 cathode load resistor is re-inserted by the change-over contacts.

The operation of the circuit is now as follows, assuming the coder to be in the middle of a test message and S2 set to 'CONTINUOUS'.

Contacts 18 and 11 are closed. If the Signal Selector is moved to either 'REVERSALS' or 'KEYS', V9 cathode load short-circuit to earth via S4J is removed, but V9 cathode remains at earth potential via contacts 11 and 18. When



Simplified Coder Drive Circuit



Coder Waveforms

(5BV/5ABV)

the coder reaches the 100th disc position, the coder switch changes over to 18 and 8 re-inserting V9 cathode load resistor cutting the valve off and preventing further stepping of the coder.

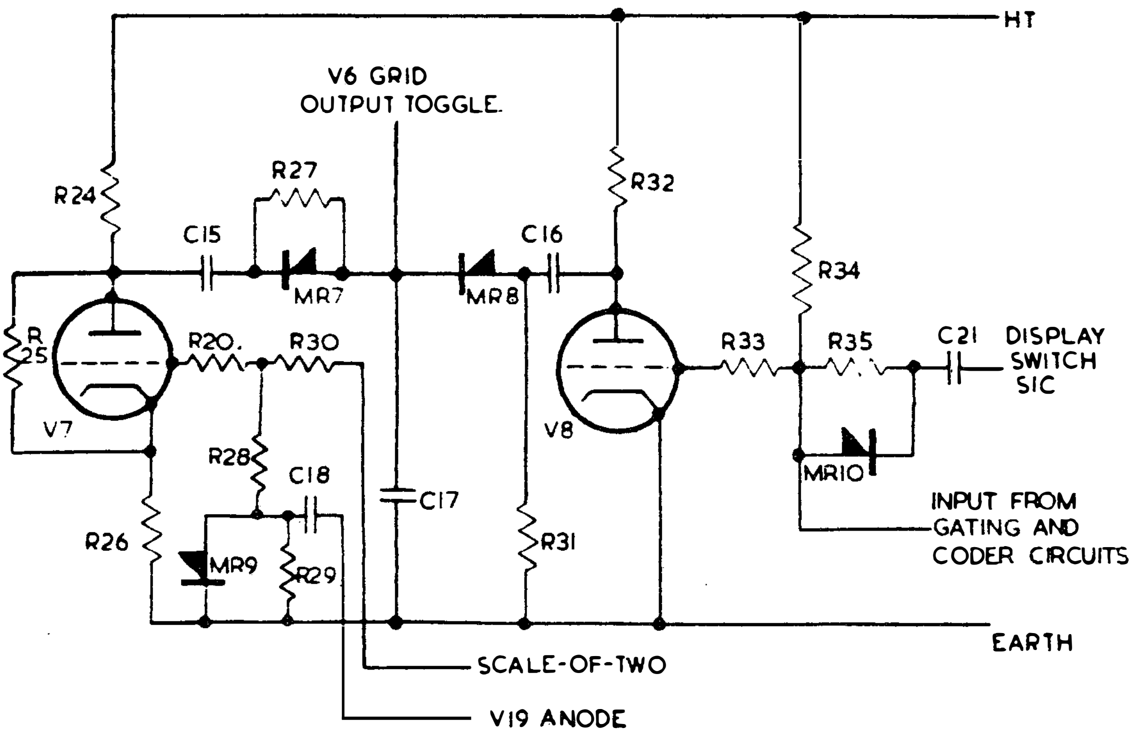
Rectifiers MR11-MR12 across the coder drive coil eliminate any possible over-shoot which might be present during operation.

At high speeds, it might be possible for the coder to over-ride the switch contacts in the 'SINGLE MESSAGE' position of S2 so that the coder disc goes round again. To overcome this effect, neon N5 is connected to V10 anode via MR20, S4F, S2 and contacts 8 and 18, so that at the end of the message V10 anode is earthed via the neon. This reduces the amplitude of the pulses at V10 anode below that necessary to drive V9. This inhibits any pulses which might otherwise operate the coder drive valve.

8. MARK & SPACE SETTING VALVES (V7-V8)

8.1. Mark Setting Valve (V7)

The mark setting valve is normally cut off by cathode bias produced by R25-R26 and its anode potential is normally high. A positive pulse from the scale-of-two cuts V7 on and the negative pulse produced at the anode is passed to the output toggle, the positive return pulse being suppressed by MR7.



Simplified Mark and Space Setting Valves

The mark re-setting pulse from the scale-of-two corresponding to the commencement of a normal start element is suppressed at V7 grid by the negative-going transition of V19 after differentiation across C18. MR9 suppresses positive pulses from V19 anode.

Suppression of the mark re-setting pulse is necessary so that long start element distortion can be introduced when the Display switch is set to 'DIST. OUTPUT'. This is dealt with further in section 11 of this chapter.

8.2. Space Setting Valve (V8)

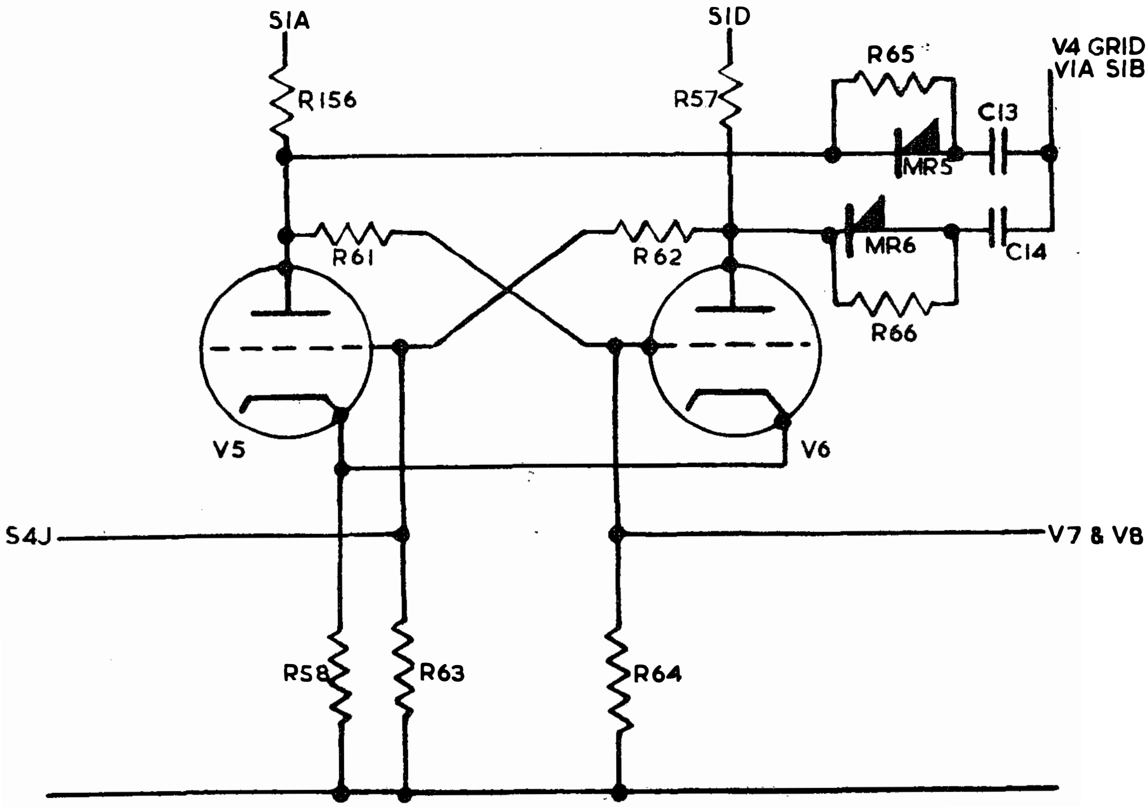
The space setting valve normally conducts heavily owing to R33-R34 being returned to h.t.+ and the absence of cathode bias. A negative pulse from V19 anode, via C21-MR10, or negative pulses from the gates, produce a large positive pulse at V8 anode which is differentiated across C16 and passed to the output toggle. MR8 suppresses the negative return pulses across C16.

9. OUTPUT TOGGLE (V5-V6) & OUTPUT RELAY

The output toggle is a bi-stable multivibrator circuit. The principle of operation will be readily understood from the scale-of-two. The circuit will only change-over to the opposite state when triggered by an external pulse.

For a mark element, V6 is cut off by a negative pulse from the mark setting valve applied to the grid, thereby making V5 conduct. For a space element, a predominating positive pulse from the space setting valve makes V6 conduct so cutting off V5.

With the Signal Selector set to 'SPACE', S4J extends an earth connection to V5 grid. This holds V5 cut off irrespective of incoming pulses from the mark setting valve and the output relay is held at space.



Simplified Output Toggle

With the Signal Selector set to 'MARK', negative pulses from V7 hold V6 cut off and the output relay is held at mark.

In the Display switch positions 'DIST. OUTPUT', 'NORM. OUTPUT' and 'INPUT' the output toggle drives the output relay, but in the 'TRANS. TIME' and 'BIAS' positions, the toggle output is fed to the relay test socket on the front panel so that an external relay under test is energised when plugged into the test socket.

10. OUTPUT FILTER NETWORK

The output filter network consists of spark quench circuits, interference suppressors and barretter lamps.

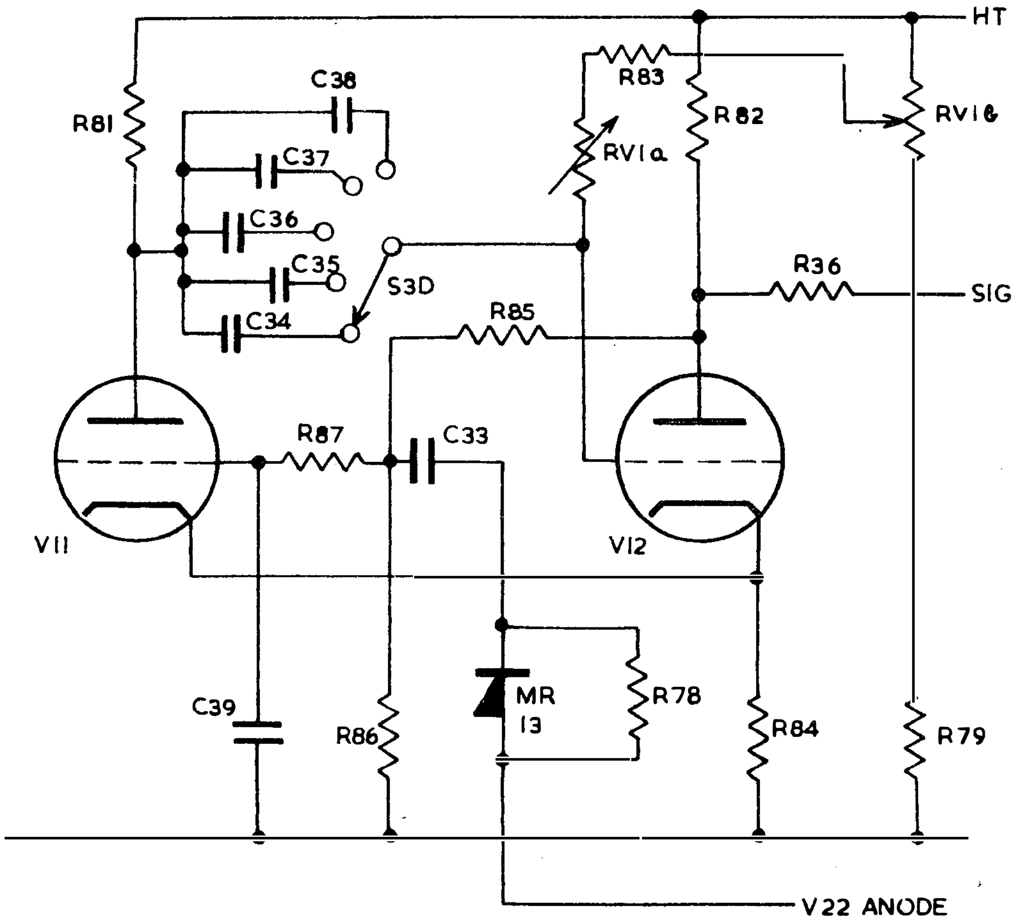
The spark quench circuit consists of R22-R23-C11-C12 and reduces the effects of sparking at the relay contacts.

Capacitors C8-C9-C10 suppress radio interference and barretter lamps LP1-LP2 limit the line current under short-circuit conditions.

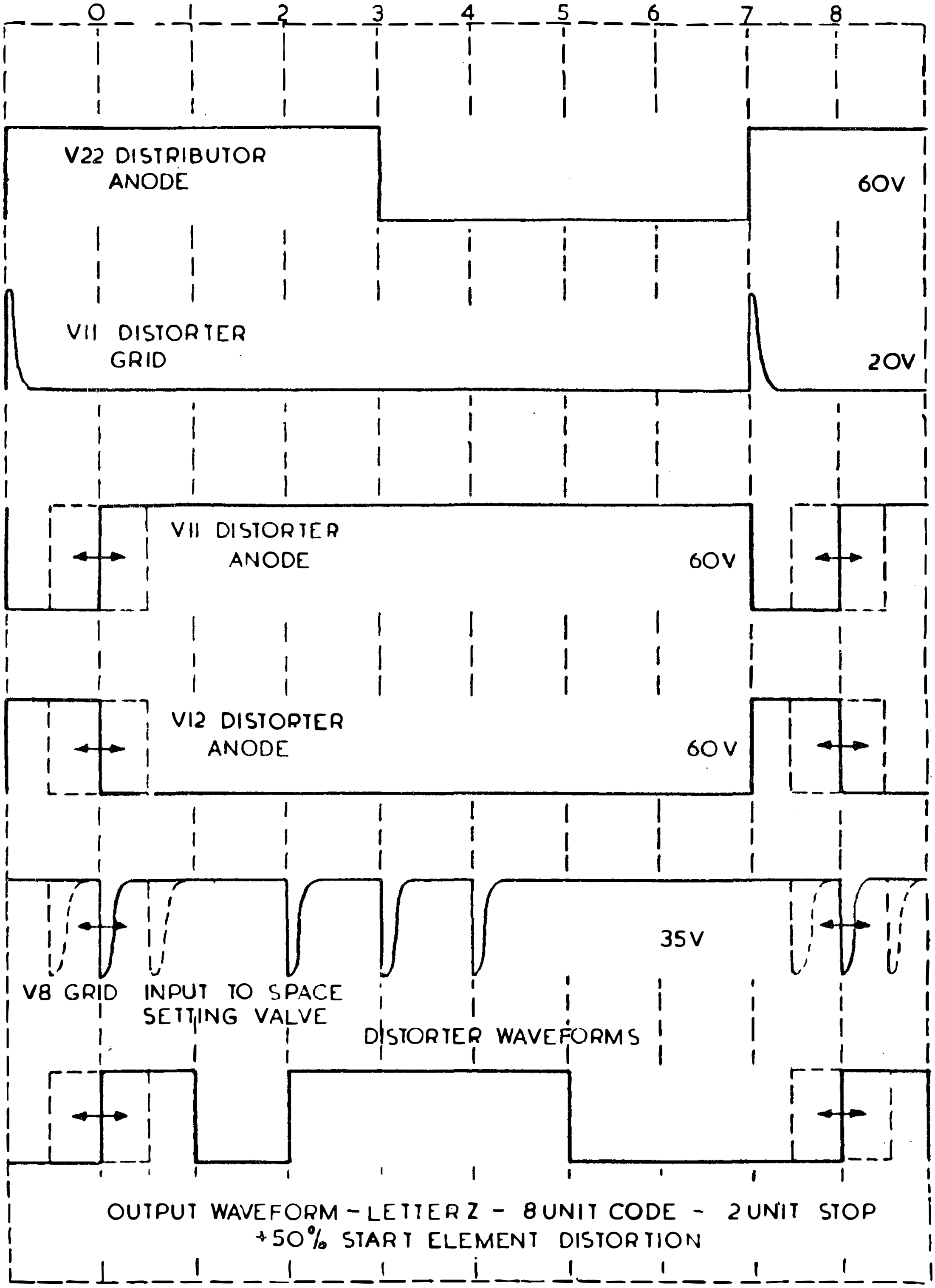
11. DISTORTER (V11-V12)

Positive transitions of V22 anode are passed via MR13-C33, to V11 grid. This corresponds in time to one element earlier than the normal start element pulse derived from V19. MR13 suppresses negative transitions from V22 anode.

V11-V12 form a mono-stable multivibrator circuit which, in the absence of external action will return to, or remain in the condition of V12 conducting and V11 cut off. A positive pulse applied to V11 grid cuts on V11 and cuts



Simplified Distorter Circuit



Distorter Waveforms

off V12. After a time delay set by RV1a-RV1b, the circuit returns to its original state. When V12 cuts on again, a negative pulse is fed via S1C to space-setting valve V8 grid.

S1C is part of the Display switch and disconnects the normal pulse from V19 anode in the 'DIST. OUTPUT' position. Thus the pulse corresponding to the beginning of the start element normally fed to the space setting valve has been removed and replaced by one of variable timing.

This is shown on the distorter waveform diagram on page 16.

The fine control RV1b (outer knob) gives a variation of approximately ±4% total on any setting of the coarse control RV1a.

12. DISPLAY VALVE (V4)

V4 grid resistor is returned to h.t. positive therefore the valve normally conducts heavily. Signals selected by Display switch wafer S1B are applied to V4 grid. These are negative pulses of sufficient amplitude to cut the valve off.

Positive pulses appearing at V4 anode are applied to the cathode ray tube grid causing a bright-up on the trace at that instant.

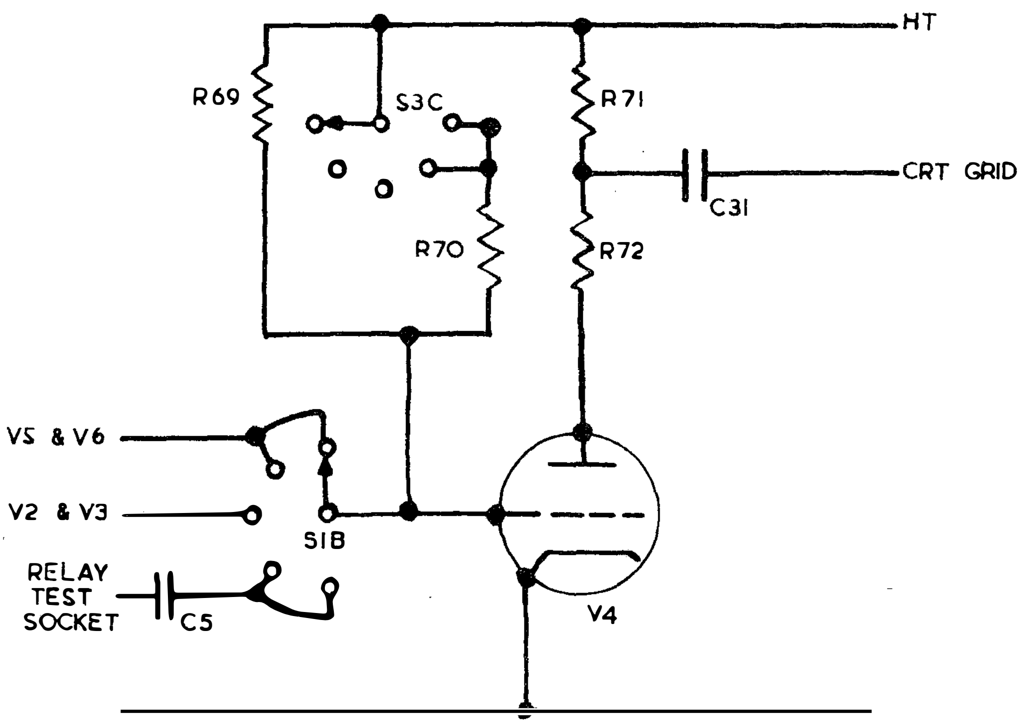
Since the negative input pulses selected by the Display switch are derived from both anodes of the input and output toggles, all transitions of a rectangular waveform are displayed.

13. RELAY TEST CIRCUITS

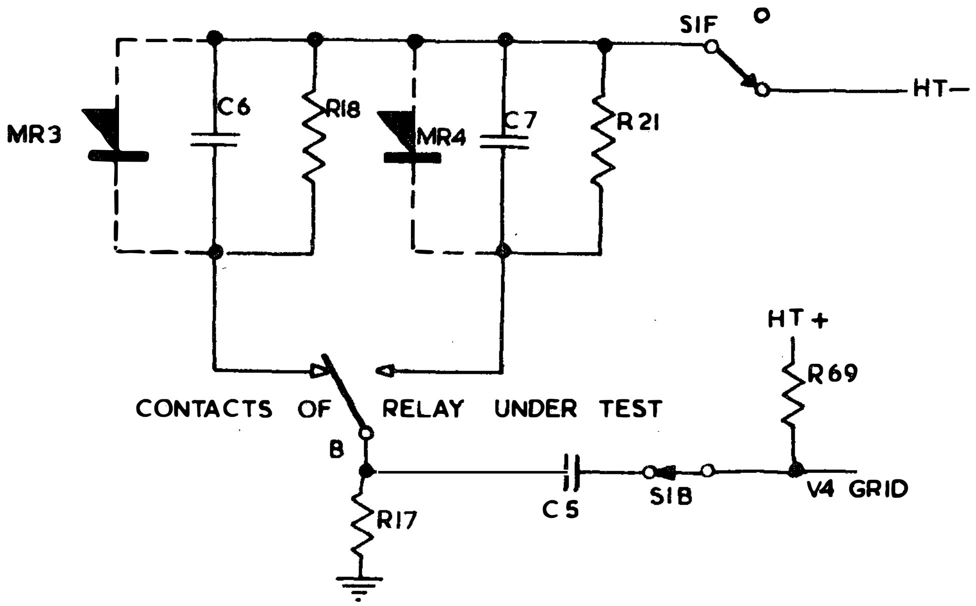
The relay under test is plugged into the relay test socket situated on the front panel. The relay coils are driven by the output toggle via Display switch wafers S1A and S1D in the 'TRANS. TIME' and 'BIAS' positions.

13.1 Bias Test Circuit

The relay bias test circuit may be simplified as shown on the next page.



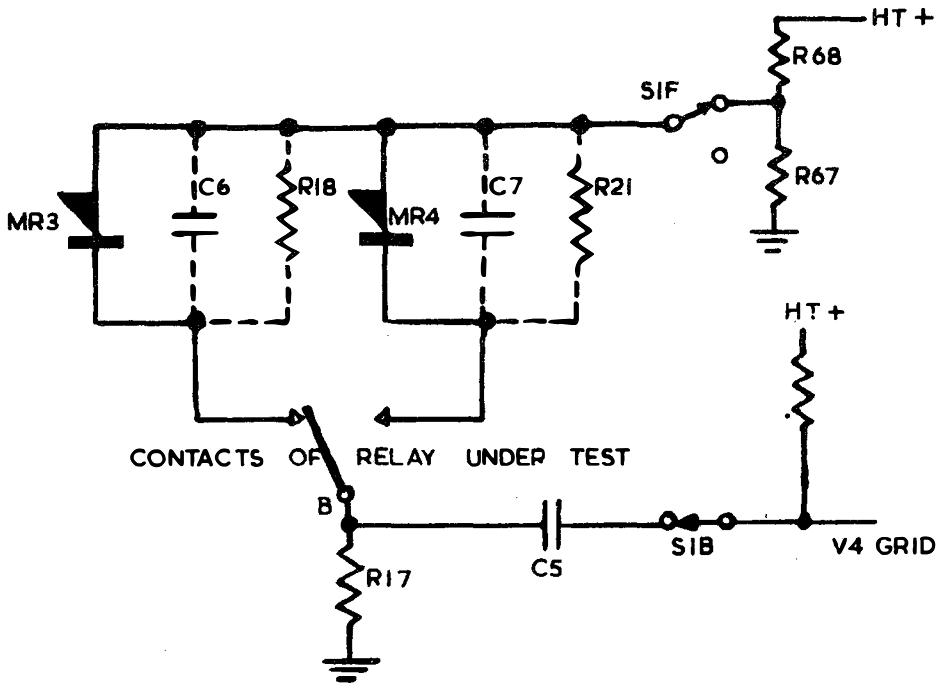
Simplified Display Valve



Relay Bias Test Circuit

With the Display switch set to 'BIAS', S1F applies a negative potential, derived from the negative h.t. rail, to the relay contacts via R18 and R21. MR3 and MR4 are non-conductive during bias testing and may be ignored.

When the relay tongue is in transit, C6 and C7 will discharge through R18 and R21 respectively, allowing the contacts to fall to the full negative potential. When the relay tongue makes contact with either static contact, the tongue



Relay Transit Time Test Circuit

potential falls to that of the contact, rapidly returning substantially to earth potential as the appropriate capacitor C6 or C7 charges through R17. This negative pulse is passed by C5 to display valve V4 grid producing a bright spot on the trace.

The time constants C6-R18 and C7-R21 are long enough to prevent complete discharge of the capacitors during contact bounce, but the pulse produced by the tongue again making contact after bouncing is much smaller than the original. Contact bounce is therefore not conspicuous on the Bias display.

13.2 Transit Time Test Circuit

The circuit for this test is shown on the previous page.

Display switch wafer S1F applies a positive potential via MR3 and MR4 to the relay static contacts. C6-R18 and C7-R21 may be disregarded since they are effectively short-circuited by the rectifiers during transit time testing.

When the relay tongue makes with either static contact, the potential at point B is raised almost to that of point A, due to the low forward resistance of the rectifiers. The display valve V4 is conducting and any positive potential which appears at the grid is absorbed by grid current flow and has no effect on the display.

When the tongue leaves a static contact, the potential at point B falls rapidly. This fall is fed via C5 to V4 grid cutting the valve off. Since V4 is now cut off, the grid circuit time constant is that of C5-R69, which is long enough to hold V4 cut off until the tongue again touches a static contact. When this occurs, the potential at point B again cuts on V4. Only when the tongue is in transit is V4 cut off, therefore transit time is displayed as a bright arc on the trace.

As the bright arcs due to transit time in both directions are superimposed, the display gives a true measurement of transit time only when the relay is correctly adjusted for bias (neutrality).

Since with this display, V4 is fully released and again cut off at each contact bounce, the effect of contact bounce shows up as one or more bright spots at the end of the transit time arc.

14. INPUT TOGGLE (V1-V2-V3)

The input toggle consists of switching valve V1 and bi-stable multivibrator circuit V2-V3. V1 is arranged to have a very short grid base to enable small values of input signal to completely cut the valve off or make it fully conduct.

The switching valve is directly coupled to the multivibrator, taking the place of V2 grid leak. A positive input to V1 cuts off V2 allowing V3 to conduct. A negative input causes the reverse condition. Since only a small potential is required to completely cut off V1, the input to the circuit must be balanced with respect to earth potential.

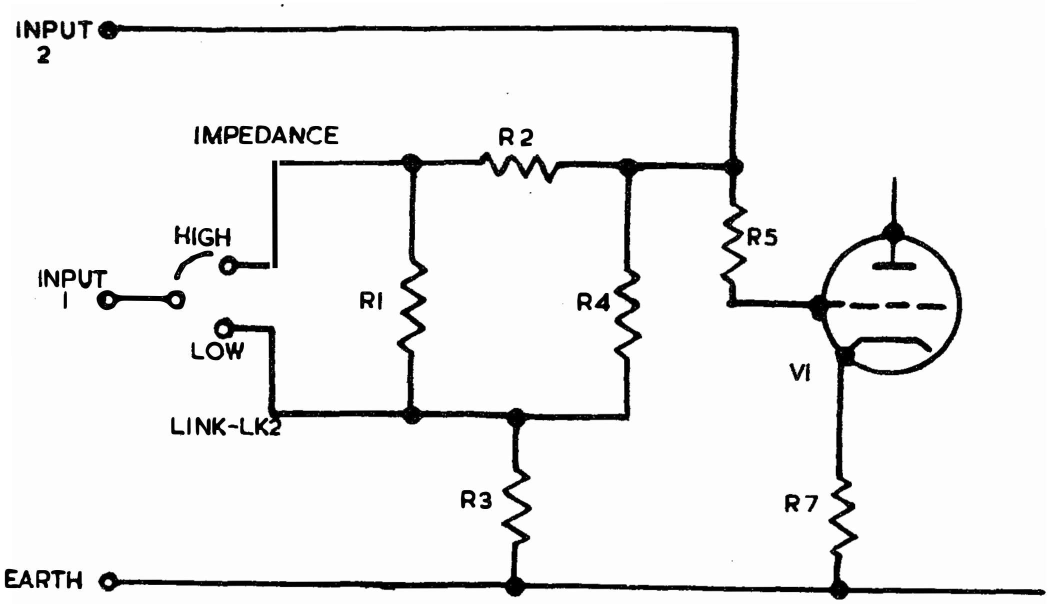
The anode waveforms of V2-V3 are rectangular. With the Display switch set to 'INPUT', negative pulses are passed to display valve V4 grid, while MR1-MR2 suppress the positive pulses. Each transition of the input is thus displayed as a bright spot on the trace.

15. INPUT CIRCUIT & ATTENUATOR

The 5BV and 5ABV models differ widely in respect of the signal input circuit. The 5BV models are designed for shunt monitoring of double-current (polar) telegraph signals only.

The 5ABV models incorporate a single-current to double-current converter circuit enabling these models to be used for monitoring of single-current (neutral) signals as an additional facility. This extra circuitry for single-current monitoring is necessary since the signal presented at switching valve V1 grid must be balanced with respect to earth potential.

15.1. 5BV Input Circuit



TDMS5BV Input Circuit

Signals applied between the Input 2 and Earth terminals pass direct to V1 grid. With the input impedance link LK2 set to 'HIGH', signals appearing between the Input 1 and Earth terminals pass via a 10:1 attenuator to V1 grid. With LK2 set to 'LOW', the attenuator is not in circuit.

The settings on input link LK2 with respect to the input impedance can be summarized as follows:

INPUT 1

HIGH impedance (200kΩ) LOW sensitivity.
LOW impedance (1kΩ) HIGH sensitivity

INPUT 2

HIGH impedance (200kΩ) HIGH sensitivity.

Therefore, between the Input 1 and Earth terminals, the impedance may be high or low according to Link LK2, while the input sensitivity is inverse to the impedance.

Between the Input 2 and Earth terminals, the impedance and sensitivity are both high.

The signals applied between the Input 1, or Input 2 and Earth terminals must be balanced with respect to earth potential in order to operate switching valve V1, and is intended for operation on double-current (polar) signals only with the instrument strapped across the circuit for shunt monitoring.

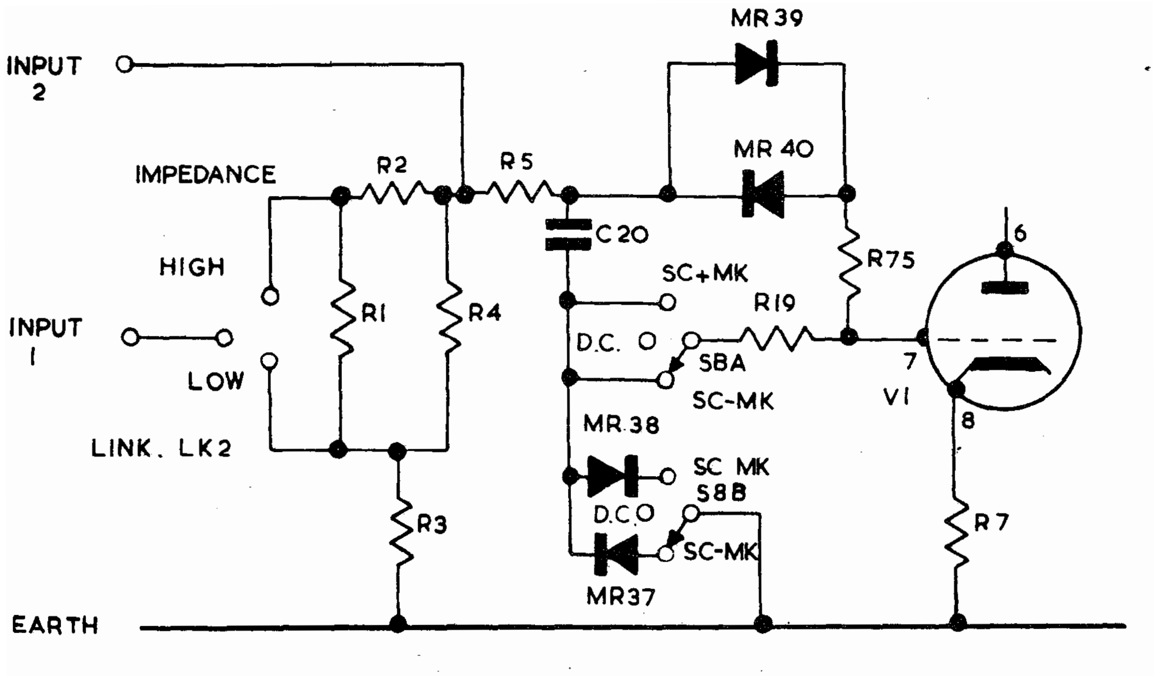
15.2. 5ABV Converter Circuit

In these models, a single-current to double-current converter circuit is incorporated between the input attenuator and switching valve V1.

The converter is designed to enable series (current) monitoring of single-current (neutral) signals and presents them as double-current (polar) signals at V1 grid.

The operation of the converter is controlled by the Input switch S8 which, in the centre position by-passes the converter allowing shunt monitoring of normal double-current signals.

Consider the converter circuit with the Input switch S8 set to 'S.C.–M' and the input impedance link LK2 set to 'LOW', resistor R3 is then the resistance inserted in the telegraph circuit for series monitoring and the voltage developed across R3 will be proportional to the line current.



TDMS5ABV Input Circuit

When a single-current negative mark signal is applied between the Input 1 and Earth terminals, MR37 conducts during the first negative signal element and a negative potential appears across C20 equal to the voltage appearing at the input end of R5. R75 and R19 form a potential divider across C20, the centre of which is connected to V1 grid. Consequently, a negative potential approximately equal to half the input voltage appears at V1 grid.

At the next signal transition when the current falls to zero, MR37 becomes non-conducting and R19, R75 and MR40 provide the only discharge path across C20.

The input end of R5 is now at earth potential; C20 has not changed its state of charge and a positive potential approximately equal to half the voltage across C20 appears at V1 grid.

Therefore the signal applied to V1 grid is a rectangular waveform balanced with respect to earth.

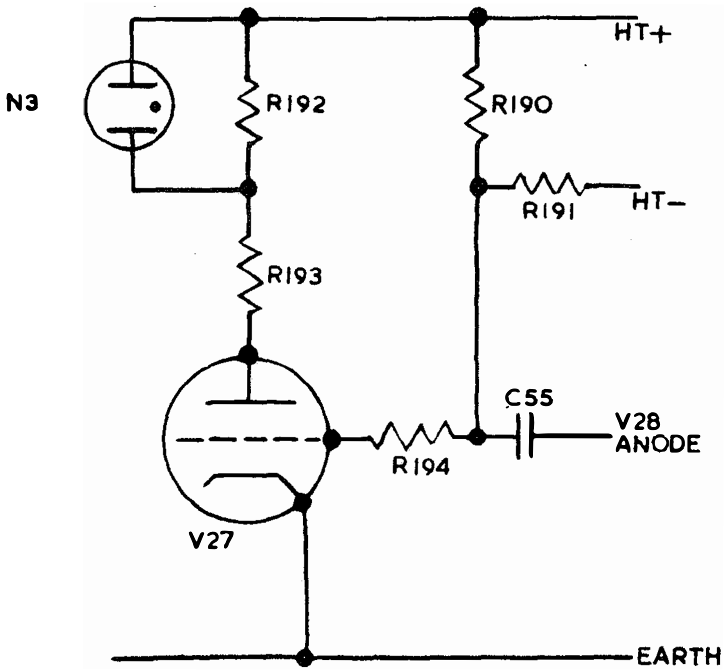
In the 'S.C.+M' position of the Input switch S8 and with a single-current positive mark signal applied to the input, the reverse action takes place and C20 charges to a positive potential via MR38 during the positive signal elements.

In any position of the Input switch S8, the impedance and sensitivity as determined by link LK2, or the Input 1 and Input 2 terminals are the same as given in 15.1.

16. SPEED STROBE CIRCUIT

To ensure reliable operation of speed indicator neon N3 over the entire instrument speed range, the neon is driven from a hard valve circuit.

The output from squarer stage V28 anode is fed via C55 and grid stopper R194 to indicator drive valve V27 grid. The grid is biased negative by R190-R191 so that the valve is normally cut off. Consequently there is no voltage drop across R192 and the neon cannot strike.



Simplified Speed Indicator Circuit

Due to the differentiating action of V27 grid circuit, a positive pulse from V28 anode cuts the valve on. The voltage drop across R192 then ionizes and strikes the neon.

The neon duty cycle is largely controlled by the time constants of V27 grid circuit. The neon is struck and extinguished once for every cycle of the oscillator and can be observed through the sight of a stroboscope tuning fork to check the oscillator frequency.

17. TEST MESSAGE CODER

The Test Message Coder, Type TDA10, supplied with the instrument provides the 100-character test message facility and is the subject of a separate Technical Manual.

Basically, the coder is a printed disc consisting of an insulated plate covered with a suitable metal which is etched to give five concentric tracks corresponding to the five elements of the Murray code.

The coding and switching contacts take the form of a contact wiper assembly attached to a moulded contact bridge so that the wiper tips bear lightly on the tracks of the printed image, making contact with a metallic or insulated segment. The metallic segments of the coding tracks are connected together and earthed through a coding earth return contact wiper.

The coding earth return and three switching contacts are grouped at the opposite end of the bridge and are aligned to concentric tracks near the centre of the disc.

The five coding contact wipers are aligned to tracks near the circumference of the coding disc, the first coding element being the inner of the five tracks and the fifth element the outer track.

Each coding contact is connected via the Signal Selector S4 to the coding gate controlling the pulses to space-setting valve V8 grid appropriate to the position of the element in the character. The five coding contacts are sampled sequentially and at the fifth element, the disc is stepped on to the next character by the action of the coder drive valve.

The actual test message on the disc supplied with the coder, together with its various carriage return, line feed and spacing tests is set out in Figure 7.

18. POWER PACK

The power pack in the 5BV and 5ABV/S models differs slightly in that the mains earth connection is isolated from the chassis in the 5ABV/S models.

18.1 5BV Series

The mains power supply is fed to the instrument via a three-way socket. The mains input circuit is switched by a double-pole On/Off switch S6 and protected by fuses F1, and F2, which are on the input side of the switch.

The mains transformer has two tapped primary windings which may be connected in series or parallel permitting operation on a.c. supplies of 100 to 125, 200 to 250 volts in 5-volt increments.

A fullwave valve rectifier V32 provides a +220 volt h.t. supply smoothed by C71-R185-C74. This supply is fed to all circuits in the instrument including the first and final anodes of the cathode ray tube. The h.t. line to the oscillator circuit is further smoothed by the action of R186-C75.

Metal rectifiers MR31-MR32 are connected to taps on the h.t. winding and provide a −150-volt supply, smoothed by C72-R183-C73 and fed to the oscillator, coder, relay test and speed indicator circuits.

Also connected across the transformer h.t. winding is a fullwave negative voltage-doubler network C76-C77-MR33-MR34-MR35-MR36-C79, the output of which is added to the −150-volt supply; the combined output of approximately −750 volts is smoothed by R184-C78 and fed to the cathode and grid of the cathode ray tube.

Three separate heater windings on the transformer provide the supplies to the rectifier valve, instrument valves and cathode ray tube heater. Since the cathode ray tube heater operates at the cathode potential of −750 volts, the winding providing this heater supply is specially insulated.

19. SINGLE-CURRENT SHUNT AND SERIES MONITORING

One disadvantage of the TDMS5BV is that the Input facility will only accept double-current (polar) signals, which restrict its use as a receiver, or as a complete loop tester, i.e. transmitter-receiver.

On the 5ABV and 5ABV/S models a passive single-current to double-current converter is incorporated for measurements on single-current positive, or negative mark systems. The telegraph signal is automatically sampled at its mid points, but it has the limitation that its use is restricted to signals which fall to zero volts or earth potential in the space condition. As the display is a continuous circular time-base, only signals which have a character length of an integral number of half-elements will be displayed satisfactorily.

19.1. 5ABV Models

This model is designed to shunt monitor single-current systems, i.e. the TDMS is connected right across the signalling loop to monitor the signal voltage. The input impedance should be set to HIGH (220kΩ) by means of LK2 (left-hand side panel).

19.2. 5ABV/S Models

This model is designed for series monitoring of single-current systems. In this case the instrument is connected in series with the signalling loop to monitor the signal current.

The mains transformer screen and mains earth connection are isolated from the chassis. This is essential because the Input terminals are not isolated and the chassis must therefore float to the full value of the telegraph line potential. Care must be exercised to ensure that the case and chassis are not earthed under these conditions.

In the standard model the value of input series resistance can be set to 1kΩ by means of link LK2 (LOW IMPEDANCE), but values down to 270Ω on a 60mA circuit should be satisfactory.

Shunt monitoring can also be used merely by setting LK2 to HIGH IMPEDANCE (220kΩ).

The models which have the mains earth isolated from the chassis for series monitoring are identified by the suffix "/S" after the type number, i.e. TDMS5ABV/S.

19.3. Conclusion

It should be noted that the explanations throughout the Manual refer to series monitoring, but the principle of operation of the single-current to double-current converter is the same for both shunt and series monitoring, the only difference being the manner in which a voltage is derived to operate the converter.

The single-current to double-current converter is described in this chapter, Page 2-20, Section 15.2, and Chapter 5, Page 5-10, Section 2.10.

CHAPTER 3

INSTALLATION

CONTENTS

CHAPTER 3

INSTALLATION

1. UNPACKING

The Telegraph Distortion Measuring Set comprises the items shown in Table A.

TABLE A

QUANTITY	DESCRIPTION	TYPE No.
1	Equipment	5BV or 5ABV
1	Coder	TDA10
1	Telegraph Relay	Carpenter
1	Mains Connector	Bulgin
1	Portable Case	
or		
1	Rack Mounting Two-Unit Case	

The portable instrument is housed in an aluminium alloy case having a door at the front and rear. The doors give access to the controls on the front panel and to the coder, relay, fuses and other controls mounted on the rear panel. Where the rack mounted installation is required, the TDMS5BV and TDMS6BV, or 5ABV and 6ABV, are despatched together in the rack mounting two-unit case.

2. PRELIMINARY INSPECTION

The Instrument and Technical Manual are packed in a cardboard carton which should be carefully opened and the items withdrawn.

After unpacking, the instrument should be carefully examined for any damage that might have occurred due to careless handling in transit.

The mains connector socket will be found secured to one of the front handles of the instrument. Remove this and connect a suitable length of 3-core cable as follows:

MAINS CONNECTIONS

RED lead to - L

BLACK lead to - N

GREEN lead to - E

Remove both front and rear door by undoing the snap fastener on the side. Open each door fully and lift to remove it from the hinges.

3. REMOVAL OF INSTRUMENT FROM CASE

Remove the eight 2 B.A. Phillips headed screws on the front panel and pull the instrument carefully forward.

Ensure that the valves are securely seated in their sockets and that the base of the cathode ray tube is firmly in position. Check that the relay and coder are firmly fitted in their respective sockets. The location of these items is shown in Figure 3.

The mains transformer tappings, on the rear panel, are set at the factory for a supply of 240 volts. If it is desired to use the instrument on a supply of a different voltage, the links should be set in accordance with the instructions given in Chapter 4.

Check that the mains fuses F1 and F2 are intact and firmly screwed into their holders.

The stop element selector link LK1, shown in Figure 3, should now be set to give the stop element length required.

This concludes the preliminary inspection. The instrument should now be returned to the case and the eight 2 B.A. screws replaced.

In the case of the portable equipment, the instrument is now ready for use.

4. REMOVAL OF CODER AND RELAY UNIT

To remove either the coder, or relay, insert a $\frac{3}{8}$-inch steel rod, or other suitable lever, through the appropriate aperture in the rear panel so that the tip is under the handle fixed to the coder, or relay cover. Gently ease the free end of the lever downward, at the same time guiding the unit with the other hand, until the unit is free.

Remove the cover securing screw at the base of the coder or relay. Grasp the base of the unit in one hand and gently pull the unit out of the cover.

In the case of the coder, care should be exercised to avoid damage to the moulded contact wiper assembly. Check that the coder is set to the rest position. The rest position is when the switching contact is open-circuit and can be identified by the insulated segment on the inner concentric track adjacent to one of the disc securing screws. The coder can be stepped by manual operation of the drive motor armature until the insulated segment is under the switching contact tip.

Replace the cover of both coder and relay, ensuring that the covers are firmly seated on the base prior to tightening the securing screw.

To replace either unit in the TDMS, ensure that the pins on the base of the unit are correctly aligned, replace the unit in the relevant socket and press firmly home. The locating pins on each base ensure that the units can only be inserted in the correct socket and the correct way round.

5. ASSEMBLY ON RACK (TWO-UNIT MOUNTING ONLY)

In the case of the rack mounted combined equipments, both the TDMS5BV and TDMS6BV should be removed from the housing assembly by removing the eight 2 B.A. Phillips headed screws from each front panel and withdrawing both units carefully from the housing.

Secure the housing assembly to the rack framework by means of eight screws of a suitable type for the rack. A washer under each screw head will protect the finish of the housing assembly.

The TDMS5BV should be internally inpected in accordance with this chapter and the TDMS6BV in accordance with Chapter 3 of the TDMS6BV Technical Manual.

Terminal blocks are provided on the rear panel of all instruments to enable connection to be made to the permanent wiring at the rear of each instrument instead of the front panel terminals when the instruments are rack mounted in the housing assembly.

The two instruments may now be replaced in the housing assembly on the rack and the front panel screws replaced.

CHAPTER 4

OPERATION

CONTENTS

CHAPTER 4

OPERATION

1. GENERAL

The controls provided on the instrument may be classified under four categories:

(a) OPERATOR CONTROLS - used during operation of the instrument.

(b) OPERATOR PRESET CONTROLS - adjusted by the operator in the general setting up of the instrument before use.

(c) FACTORY PRESET CONTROLS - set up by the manufacturer against specialized test equipment. Under no circumstances should the factory preset controls be altered unless such test equipment is available to ensure accurate adjustment.

(d) MISCELLANEOUS CONTROLS - controls and adjustments not covered in the above categories.

2. OPERATOR CONTROLS

These controls are those used during operation of the instrument and are all located in accessible positions on the front panel.

2.1. Mains On/Off Switch (S6)

This is a double-pole switch and controls the a.c. mains input supply to the instrument. It is mounted towards the bottom left of the front panel.

2.2. Range (S3)

This switch selects the nominal speed range required. In conjunction with the fine Speed control RV7, facilities are available for transmission or measurement of any telegraph signalling speed within the five speed ranges of the instrument.

The Range switch is the centre of the three knob controls to the left on the front panel.

2.3. Speed (RV7)

The fine Speed control provides for a ±10 baud adjustment of the nominal speed set by the Range switch S3. The fine Speed control is the uppermost of the three knob controls to the left on the front panel.

Both the fine Speed control and Range switch are calibrated directly in bauds.

2.4. Display (S1)

This is the lowest of the three knob controls on the right of the front panel. It selects the signals to be displayed on the cathode ray tube and has five positions:

SWITCH POSITION	DISPLAY
DIST. OUTPUT (Distorted Output)	The display indicates the distortion introduced on transmitted signal by the Distortion Control RV1a-RV1b.
NORM. OUTPUT (Normal Output)	The undistorted signal generated by the instrument is displayed.
INPUT	Incoming double-current (polar) signals are displayed.
TRANS. TIME (Transit Time)	Enables measurement of transit time and contact bounce of relay under test.
BIAS	Permits observation of neutrality (bias) of a relay under test.

The use of the input monitoring facility does not preclude the simultaneous sending of test signals. The instrument may thus provide a test signal to a circuit, the output of which may be monitored simultaneously via the input circuit, revealing any distortion present.

It is not possible to introduce distortion to the transmitted test signal when the Display switch is set to 'INPUT'. The signal transmitted is the same as with the switch in the 'NORM. OUTPUT' position.

When using the TDMS5BV as a sender and the TMDS6BV as a monitor receiver under start-stop conditions, it is possible to obtain an incorrect display when the Signal Selector is set to 'KEYS' and the Display switch set for 'DIST. OUTPUT'. This is due to the fact that the start-stop timebase of the TDMS6BV may be triggered by any mark-space transition. To ensure that the timebase is triggered by the start element only, two methods of setting up are given:

Method 1 - Turn the Signal Selector to 'MARK' and then back to 'KEYS'.

Method 2 - Set all the Keys on the TDMS5BV to 'MARK', then the character to be transmitted can be set by the Keys and the required percentage distortion introduced by the Distortion control RV1a- RV1b.

Either of these methods ensure that the start-stop timebase of the TDMS6BV is triggered by a start element.

2.5 Keys (K1 to K5)

These are the five switches situated centrally on the front panel immediately below the cathode ray tube bezel. The Keys enable a test character to be set up and transmitted when the Signal Selector is set 'KEYS'.

The five switches correspond to the five elements of the Murray code. By setting the individual Keys to 'MARK' or 'SPACE', in the necessary sequence, any character can be set up and continuously repeated.

In order to ensure synchronization between the transmitted signal and a start-stop receiving terminal, for example, a teleprinter or TDMS6BV, it is necessary to set the Signal Selector to 'MARK' and then back to 'KEYS'. This ensures that the receiving equipment is triggered by the first start element.

2.6. Signal Selector (S4)

The Signal Selector is a 6-position switch mounted uppermost to the right on the front panel. The switch selects the type of signal transmitted by the instrument as tabulated below:

SWITCH POSITION	OUTPUT SIGNAL
2·2	– Two-element continuous reversals.
1:1	– Single-element continuous reversals.
CODER	– Continuous 100-character test message coder, continuously repeated, or one complete message only.
MARK	– A continuous mark signal is transmitted.
KEYS	– Any desired character, set up on the five Keys continuously repeated.

With the Signal Selector set to either '2:2' or '1.1', the Display switch S1 must be set to 'NORM. OUTPUT' to prevent the introduction of distortion which would be meaningless.

2.7. Distortion (RV1a-RV1b)

This control is a twin concentric potentiometer which provides a coarse and fine control The control is fitted below the Signal Selector on the right of the front panel. The control is not calibrated since the percentage distortion is continuously and accurately shown on the cathode-ray tube display.

For a given setting of the Distortion controls, the actual amount of distortion is indicated on the display. Because of this, and since it is possible to obtain a minimum of 50% long and short start element distortion, it is necessary to determine the setting of the coarse Distortion control corresponding to zero distortion to avoid ambiguity. This is fully described in 6.2. of this chapter.

2.8 Continuous Coder/Single Message (S2)

This toggle switch is located at the bottom right-hand side of the front panel. The two positions are marked 'CONTINUOUS CODER' and 'SINGLE MESSAGE'. In the 'SINGLE MESSAGE' position, and assuming the coder to have completed one message, the distributor is held and the output will be a continuous mark. Then, to obtain a single message the switch must be set to 'CONTINUOUS MESSAGE' and returned to the 'SINGLE MESSAGE' position after the coder has started. The instrument should transmit one complete message and then stop, only starting again by operation of S2.

In the 'CONTINUOUS MESSAGE' position, the coder will continue to run until the switch is set to 'SINGLE MESSAGE' when the coder will stop at the end of the test message. The coder will always complete its cycle of operation and return to the rest position if the Signal Selector S4 is set to any other position, except 'SPACE' or 'MARK'. For example, if the Signal Selector is set to 'KEYS' during a test message transmission, the instrument will automatically transmit the character set up on the five Keys, but the coder will continue to run until it reaches the rest position at the end of the test message. The Signal Selector should always be operated so that the coder will stop in the rest position, thereby ensuring that the coder will always start at the beginning of the test message.

2.9. Input Switch (S8)

This is an additional 3-position toggle switch fitted only to 5ABV models. The purpose of the switch is to condition the single-current to double-current converter to accept either single-current positive mark, or single-current negative mark signals, or switch out the converter altogether so that the instrument accepts normal double-current signals.

The three positions of the switch are:

Toggle to the LEFT	- Single Current Positive Mark.
Toggle to the CENTRE	- Double Current
Toggle to the RIGHT	- Single Current Negative Mark.

The Input switch on the 5ABV models is located between the Sync. and Astig. preset control apertures on the front panel immediately above the relay test socket.

2.10. Input Terminals

The terminals marked Input 1, Input 2 and Earth are the telegraph input terminals for monitoring incoming signals.

2.10.1. Input 1 Terminal

An input impedance of 200kΩ or 1kΩ (200kΩ or 270Ω on 5EBV models) can be selected by means of a link on the left-hand side panel of the instrument. In the 'HIGH IMPEDANCE' position of the link, the instrument will operate on receipt of signals greater than 20 volts. In the 'LOW IMPEDANCE' position, the sensitivity of the instrument is increased by 10 times and will operate on signals greater than 2 volts.

2.10.2. Input 2 Terminal

This is a high-impedance-high-sensitivity input for use on signals of less than 20 volts. The input impedance is 200kΩ but the sensitivity is high.

2.11. Sync. Terminal

The Sync. terminal is provided so that the oscillator may be synchronized with a standard frequency sinewave source. External synchronization should not be used during speed measurement of incoming signals.

2.12. Transmitter Terminals

These are the four terminals to the lower right of the front panel. The external battery centre tap connects to the Earth terminal and the positive and negative connections to the Space and Mark terminals respectively for double-current (polar) negative mark signals. The signal output then appears between the Tongue and Earth terminals.

Any other form of keying, such as double current (polar) positive mark, or single-current (neutral) positive or negative mark, may be obtained by appropriate battery connections.

NOTE: The input and transmitter terminals are brought out to a 10-way terminal block mounted on the rear panel of the instrument. This block may be used for permanent wiring connections so that the front panel is maintained free of external wiring. In addition, the coder switching is brought out so that the coder can be operated from a remote position.

3. OPERATOR PRESET CONTROLS

These presets are adjusted by the operator prior to use. The Sync. (synchronization) and Astig. (astigmatism) presets are accessible through the front panel. Adjustment is by means of a small screwdriver after removal of the chromium buttons. The remaining operator preset controls are accessible from the back of the instrument without removing the case.

3.1. Focus, Brill, Sync. & Astig. (RV3, RV2, RV5 & RV4)

The Focus, Brilliance and Astigmatism presets follow conventional oscilloscope practice.

The Synchronization preset is provided to assist in achieving a stationary pattern on the display when measuring incoming signal distortion.

An external sinewave source of high stability is required.

3.2. Hor. Shift, Vert. Shift, Shape & Amp. (Coarse) (RV16, RV18, RV17 & RV14)

These presets form a vertical row on the rear panel of the instrument and are mounted in the above mentioned order with the Horizontal Shift uppermost.

The Horizontal and Vertical Shift presets follow conventional oscilloscope practice.

The Shape preset controls the height of the circular trace as opposed to the width. The Amplitude (coarse) preset, in conjunction with the Amplitude control on the front panel, controls both height and width and therefore controls the diameter of the circular trace enabling adjustment for convenient observation.

4. FACTORY PRESET CONTROLS

Presets RV8A-RV8B to RV12A-RV12B inclusive, situated on the left-hand side panel, control the oscillator circuits for the five nominal speed ranges and should on no account be disturbed.

5. MISCELLANEOUS ADJUSTMENTS

Listed under this heading are the remaining items on the front and rear panels of the instrument.

5.1. Link LK1

Located at the top of the rear panel, this 3-position link enables selection of a 1, 1½ or 2 unit stop element on the signal generated by the instrument.

5.2. Speed Indicator (N3)

Positioned below the Display switch on the front panel, this small neon indicator, when strobed by a tuning fork, enables extremely accurate oscillator speed adjustment.

Strike the appropriate stroboscope tuning fork on the palm of the hand to make the prongs vibrate. With the tuning fork vibrating, observe the Speed indicator neon through the sight at the end of the prongs of the fork. The speed indicator neon maybe seen to slowly light and extinguish and slowly relight if the oscillator speed is nearly correct. Carefully adjust the fine Speed control RV7 while still observing the neon through the strobe sight, until the neon appears to either remain alight or remain extinguished. The striking of the neon is then synchronized with the vibrations of the stroboscope tuning fork.

5.3. Mains Input Connection

Connection should be made to the 3-pin plug at the lower left of the rear panel. In accordance with standard practice the cable connecting the mains input supply terminates in a shielded 3-pin socket.

5.4. Mains Adjustment Panel

This adjuster is located at the lower edge of the rear panel and comprises six plug-in links. The two links to the left, as viewed from the rear of the instrument, give alternative positions corresponding to 100, 110 and 120-volt inputs. The centre pair of links makes provision for an increment of 5 volts to any of the tappings set by the left-hand links. The right-hand pair of links, when set to the 'X2' position, have the effect of doubling the settings made by the other links. The two links of each pair must ALWAYS be in corresponding positions.

Typical settings are given below:

110-Volt Input

1. Set BOTH left-hand links to '110V' position.
2. Set BOTH central links to position '0'.
3. Set BOTH right-hand links to the 'X1' position.

230-Volt Input

1. Set BOTH left-hand links to '110V' position.
2. Set BOTH central links to position '+5'.
3. Set BOTH right-hand links to the 'X2' position.

5.5. Fuses (F1 and F2)

The mains input supply is fused in both leads. These two 1¼-in. cartridge type 1-ampere fuses are at the lower right of the rear panel.

5.6. Relay Test Socket

The relay test socket is at the lower centre of the front panel and accommodates Carpenter 3E1 and 3N1 relays. The socket also accommodates the connection to Relay Adaptor Unit Type RTA1 when testing relays with differing bases.

6. OPERATION

The uses of the instrument are many and varied. Many applications will be peculiar to individual circumstances. The following instructions will therefore be confined to the method of setting up and using each function.

6.1. General Setting Up Before Use

(i) Set the mains adjustment links to that required by the mains power supply in use.

(ii) Set the Mains switch to 'ON' and allow a warm-up period. Most drift in the oscillator occurs in the first half-hour, full stability usually takes about two hours.

(iii) Adjust the Brilliance control so that the circular trace, or spot appears on the screen.

(iv) Adjust the Shape and Amplitude controls to give a circular display of approximately 2-in. in diameter.

(v) Adjust the Horizontal and Vertical Shift controls to centre the trace.

(vi) Adjust the Focus, Brilliance and Astigmatism controls until the trace is just visible.

6.2. Sending Function

(i) Make the general adjustments outlined in 6.1 allowing the instrument to warm up fully.

(ii) Set Link LK1 for 1, 1½ or 2 unit stop element as required.

(iii) Set the Range switch to the required nominal speed range and make final adjustments with the fine Speed control.

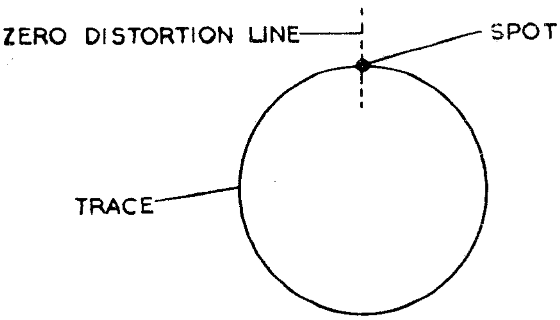
(iv) Set the Signal Selector for the type of signal it is desired to send.

(v) Connect an external telegraph battery to the Space, Mark and Earth terminals in a manner according to the telegraph system in use. The two methods most commonly used are illustrated in Section 7.

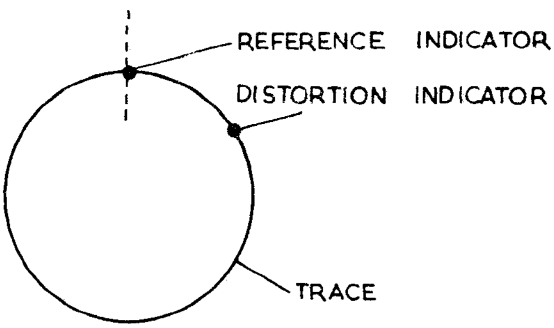
(vi) Connect the outgoing telegraph line between the Tongue and Earth terminals.

(vii) To monitor the outgoing signal, set the

Display switch to 'NORM. OUTPUT'. A bright spot should appear on the trace coincident with the zero distortion line on the graticule as illustrated below.



(viii) To introduce distortion to the transmission, set the Display switch to 'DIST. OUTPUT' and both coarse and fine Distortion control knobs to their central position (dots uppermost). A second spot will appear on the trace displaced from the zero distortion line. This is the Distortion Indicator.



Movement of the coarse Distortion control (nearest panel) will move the position of the Distortion Indicator on the trace. If the coarse Distortion control is moved towards the 'SHORT' start element position, The Distortion Indicator will move round the trace in a clockwise direction. If the coarse Distortion control is moved towards the 'LONG' start element position, the reverse will occur. The point of zero distortion is when the Distortion Indicator coincides with the Reference Indicator on the zero distortion line. The fine Distortion control (outer knob) gives approximately ±4% total variation on any setting of the coarse Distortion control (nearest panel).

(ix) The points of 50% long and 50% short start element distortion are also points of coincidence, these points being obvious from the position of the coarse Distortion control knob which will not be central. Normally, with the coarse Distortion control knob central, this should be the position for zero distortion on the basic range with the Range and Speed controls set for 50 bauds.

The display should show one spot only (Distortion and Reference Indicators coincident). As the speed is reduced to, say 45.5 bauds from 50 bauds, the Distortion Indicator will appear displaced to one side of the Reference Indicator. The Distortion controls (coarse and fine) should now be adjusted to obtain coincidence, zero distortion, by the shortest path on the display.

(x) Having determined the initial zero position, distortion may now be introduced to the transmitted signal by movement of the coarse Distortion control in the desired direction, final adjustment being made by means of the fine Distortion control. The percentage distortion introduced is read from the calibrated graticule on the display.

(xi) Any change made to the speed of the transmitted signal by adjustment of Range or fine Speed controls will have the effect of moving the Distortion controls. In such cases, the initial position should always be redetermined as explained in (ix) before distortion is again introduced to the transmission. This will avoid the possibility of error due to the Distortion Indicator being displaced by more than one revolution of the trace with respect to the Reference Indicator on the zero distortion line. The percentage distortion is always that indicated on the display irrespective of the telegraph speed.

The zero distortion position of RV1a-RV1b is that at which the delay in the distorter circuit produces a start element of the correct length. It is therefore possible to calculate the position of the Distortion Indicator for any telegraph speed within a given nominal speed range, as follows:

With the Range and Speed controls set for 50 bauds, the Display switch set to 'DIST. OUTPUT' and the Distortion controls adjusted for coincidence of the Reference and Distortion Indicator spots, the position of the coarse Distortion control will be central. This will now correspond to a start element of $\frac{1}{50}$ sec. = 20ms.

If the Speed control is altered to 40 bauds without re-adjustment of the Distortion controls, the Distortion Indicator will move anti-clockwise round the trace indicating long start element distortion.

The conditions are now - transmission speed 40 bauds and each element $\frac{1}{40}$ sec. = 25ms long. The delay in the distorter circuit corresponds to zero distortion at 50 bauds which is 20ms so that the start element will commence 5ms early and will therefore be 30ms long (5+25 = 30). Thus with a change in speed only, the display will correspond to $\frac{5}{25}$ x 100 = 20% long start element distortion.

In order to correct the start element distortion to zero for the new speed, reset the coarse Distortion control in the 'SHORT' start direction to obtain coincidence of the spots by the shortest path on the trace.

6.3. Distortion Measurement - Output Signal

With the instrument set up as in 6.2., the Reference Indicator spot will be coincident with the zero distortion line on the graticule. The Distortion Indicator will be displaced to the right or left of the Reference Indicator on the trace. The displacement of the Distortion Indicator gives the degree of distortion, a full 360° being equivalent to 50%. The calibrated graticule gives direct readings in terms of percentage distortion.

Displacement of the Distortion Indicator in a clockwise direction denotes short start element distortion, and displacement in an anti-clockwise direction denotes long start element distortion.

This facility is particularly useful for checking the margin of teleprinters.

6.4. Distortion and Speed Measurement - Incoming Signals

This facility functions on double-current (polar) incoming signals only.

(i) Make the general adjustments given in 6.1.

(ii) Set the Display switch to 'INPUT'.

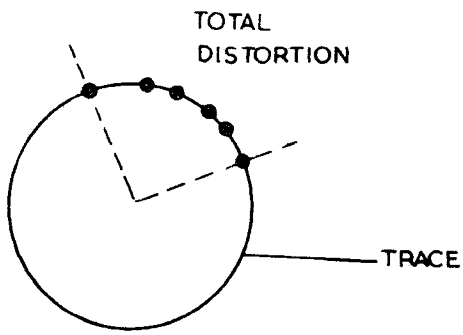
(iii) Set the Range switch to the nominal speed range required.

(iv) Connect the line carrying the signal to be monitored between the Input 1, or Input 2 and Earth terminals. A group of bright spots should now appear drifting round the cathode ray tube display.

(v) Adjust the fine Speed control until the spots remain stationary. The speed of the incoming signal is then read from the setting of the Range switch and fine Speed control.

(vi) In the absence of distortion, all the spots will be superimposed. Distortion will be indicated by displacement of the spots over an arc, the amount of distortion being directly measured as a percentage on the calibrated graticule.

A typical display is illustrated in the sketch -



It may be found helpful, in maintaining a stationary display while taking distortion measurements, to make use of the Sync. facility provided, an external sinewave source being needed.

6.5. Relay Testing - Bias (Neutrality)

(i) Make the general adjustments given in 6.1.

(ii) Set the Range switch to '50' bauds and the fine Speed control to '0', or the desired speed.

(iii) Set the Display switch to 'BIAS'.

(iv) Set the Signal Selector to '1:1' or '2:2' reversals.

(v) Plug the telegraph relay to be tested into the relay test socket on the front panel of the instrument. Adjust the relay as necessary until the tongue vibrates.

(vi) One or more spots should appear on the circular trace. The relay is bias free (neutral) when the spots coincide.

As a guide to the use of the instrument when setting up telegraph relays, the following procedure based on the Carpenter type relay may be of assistance, particularly when setting up the instrument's own relay.

(1) With the instrument operating as described above, set the relay bias magnet to its central position.

(2) Adjust the relay contacts until the tongue is vibrating and the two spots produced on the display are coincident.

(3) Keeping the two spots coincident, gradually adjust both contacts to reduce the gap between them until both spots just disappear. At this adjustment the relay tongue travel has been reduced to zero with the tongue in the neutral position.

(4) Withdraw each contact by an equal distance to give the correct tongue travel, for example, for a .002-in. tongue travel withdraw each contact .001-in. using the graduations on the side of the contact screw heads. Clamp one contact in this position, adjusting the other as required to obtain neutrality. The contact assembly is now in correct adjustment.

(5) Replace the relay cover and test again. Adjust the relay bias magnet for coincidence of the two stops on the cathode ray tube display. The relay is now correctly adjusted.

6.6. Relay Testing - Transit Time

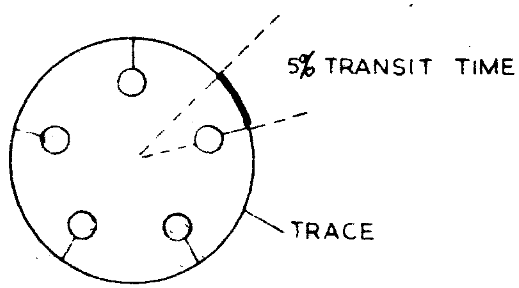
(i) Make the general adjustments as in 6.1.

(ii) Set the Range switch to '50' bauds and the fine Speed to '0' or as required.

(iii) Set the Display switch to 'TRANS. TIME'.

(iv) Set the Signal Selector to '1:1' or '2:2' reversals.

(v) Plug the relay to be tested into the relay test socket on the front of the instrument. A stationary display of the type shown in the sketch should now be seen on the cathode ray tube.



Since the timebase of the instrument completes two revolutions for each cycle of relay operation and, provided the relay is bias free (neutral), the length of the bright arc represents the transit time as a total operating time percentage.

(vi) At 50 baud working, the timebase of the instrument rotates at 100c/s. Each 360° scan of the cathode ray tube therefore represents 10mS. From this the actual transit and contact times may be deduced for 50 baud working, and similarly, for other speeds.

6.7. Relay Testing - Contact Bounce

Set up and test the relay for Transit Time as in 6.6. Contact bounce may be observed as additional bright spots near the ends of the transit time arc.

6.8. Operational Use of Signal Selector

The following information will enable the operator to fully understand the conditions that arise when using the Signal Selector switch.

(a) In the 'MARK' position, the distributor is held in a position corresponding to a stop element. When switching from 'MARK' to 'KEYS' or 'CODER', the start element is always produced first, thus ensuring synchronization with a distant printer. However, figures may appear instead of letters, or vice versa, depending upon the characters previously transmitted. To correct for this, the Keys must first be set to the letter-shift or figure-shift position as required.

(b) Switching from 'CODER' to 'MARK', the last character will be correctly produced, but when switching from 'KEYS' to 'MARK' the last character will occasionally be incorrect. This error will also generally occur when switching from 'CODER' to 'KEYS' or vice versa.

(c) In the 'SINGLE MESSAGE' position with the standard disc supplied with the coder, the 100th position is the coder rest position and is blank, but the instrument transmits a steady mark signal.

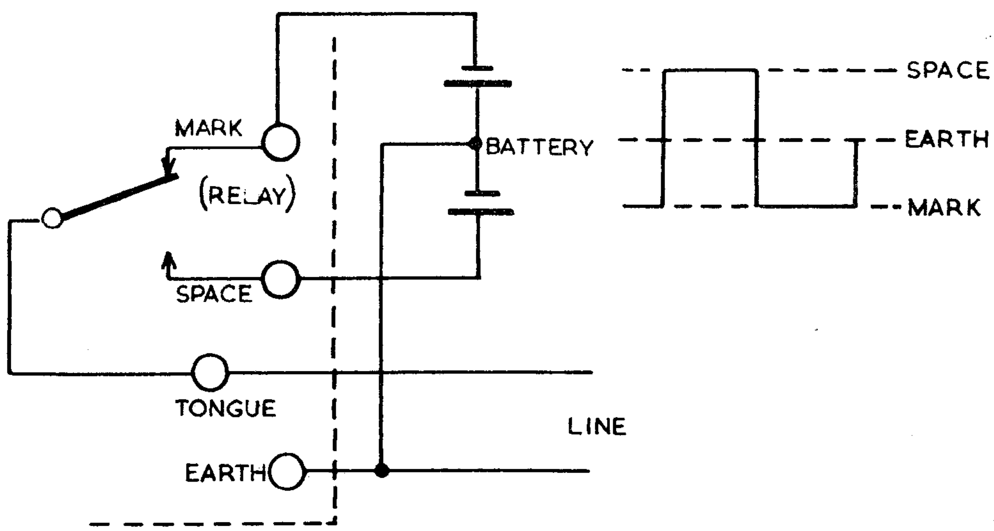
(d) To ensure that no distortion is introduced on any character, particularly when using reversals, ensure that the Display switch is set to 'NORM. OUTPUT".

(e) In the 'KEYS' position of the Signal Selector, the gates may be set to any desired character which will be repeatedly transmitted by the instrument.

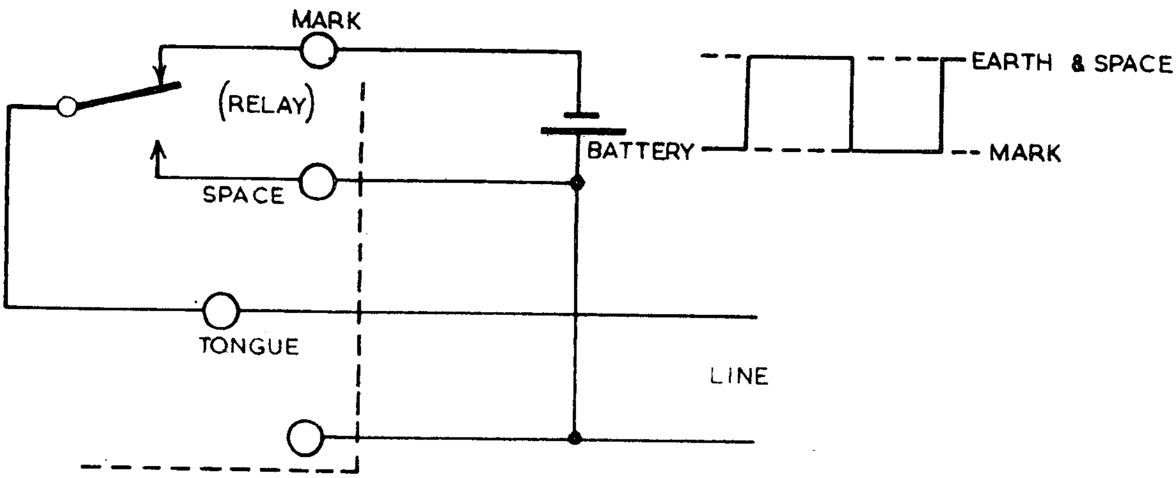
(f) In the 'MARK' and 'SPACE' positions of the Signal Selector, the gates are not used.

7. CONNECTION OF TELEGRAPH BATTERY

The two illustrations below show the method of connection of the telegraph battery for double-current (polar) negative mark systems and single-current (neutral) negative mark systems.



Double-Current (Polar) Negative Mark System



Single-Current (Neutral) Negative Mark System

CHAPTER 5

MAINTENANCE

CONTENTS

CHAPTER 5
MAINTENANCE

1. ROUTINE SERVICING

The transmitting and receiving equipments Type TDMS5BV or 5ABV and TDMS6BV or 6ABV are largely self checking where like pairs of equipments with identical speed ranges are in use. It is a relatively easy matter to ascertain that all facilities provided are functioning correctly and the following routine checks are advocated at regular intervals.

1.1. Speed Check

This is normally carried out on the basic speed range, the calibration of the fine Speed control RV7 should be checked using a stroboscope tuning fork in conjunction with the Speed neon indicator on the front panel.

Set the TDMS controls as follows:-

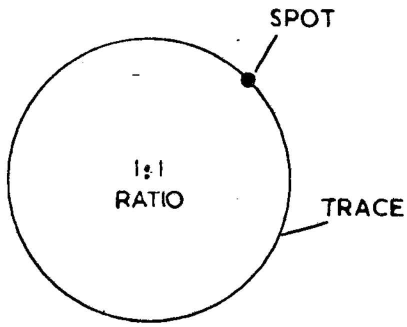
CONTROL	POSITION
Mains switch S6	'ON'
Display switch S1	'NORM. OUTPUT'
Range switch S5	'50'
Signal Selector S4	'MARK'
Speed Control RV7	'0'

Allow the instrument to warm up well so that the oscillator becomes fully stabilised.

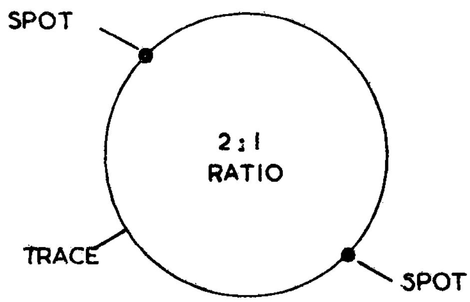
Strike the appropriate stroboscope tuning fork across the palm of the hand in a manner to make the prongs vibrate. With the tuning fork vibrating, observe the Speed indicator neon through the sight at the end of the prongs. The neon will be seen to slowly light and slowly extinguish and again slowly relight if the oscillator speed is nearly correct. Carefully adjust the fine Speed control, while still observing the neon through the strobe sight, until the neon appears to either remain alight or remain extinguished. The striking of the neon is then synchronized with the vibration of the stroboscope tuning fork.

An alternative method of checking the fine Speed control calibration is to feed a standard frequency of approximately 10 volts r.m.s. to the Input 2 terminal. In the case of 5ABV models, the Input switch S8 should be set to 'D.C.' for double-current input when employing this method.

With the standard frequency applied to the Input 2 terminal, the fine Speed control should be adjusted until the cathode ray tube display is stationary. It should be remembered that the oscillator frequency of the TDMS5BV or 5ABV is twice the baud speed as indicated on the controls. For example, for 50 baud working the oscillator frequency is 100 c/s, so that with the Speed controls set for 50 bauds and a sinewave input at 50 c/s a single spot should appear on the cathode ray tube circular trace. If a standard sinewave frequency of 100 c/s is applied, the display will show two spots displaced by 180° on the trace.



50 Bauds, 50 c/s



50 Bauds, 100 c/s

When the oscillator speed has been adjusted by either of the above methods, the fine Speed control RV7 should be precisely on the '0' position. If this is not the case, the five speed ranges of the instrument should be checked and adjusted as described in Section 2 of this chapter.

1.2. Output Relay

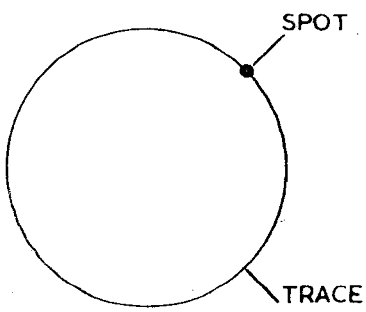
The output relay should be checked for bias (neutrality) and transit time. A simple routine bias check can be made without removing the relay from the instrument by connecting a telegraph supply (80 + 80 volts) to the Mark and Space terminals and connecting the Tongue terminal to the Input terminal of the instrument.

Set the instrument controls as follows:

CONTROL	POSITION
Mains Switch S6	'ON'
Range Switch S5	'50' or desired speed
Fine Speed RV7	'0'
Display Switch S1	'INPUT'
Signal Selector S4	'KEYS' or '1.1' or '2:2'

NOTE *The input switch S8 on the 5ABV models should be set to 'D.C.' for double-current operation.*

If the relay is bias free (neutral), two superimposed spots will appear as a single spot on the cathode ray tube display. If the two spots are displaced with respect to each other it indicates that the relay is biased and the amount of displacement of the spots indicates the percentage bias as read from the graticule scale.

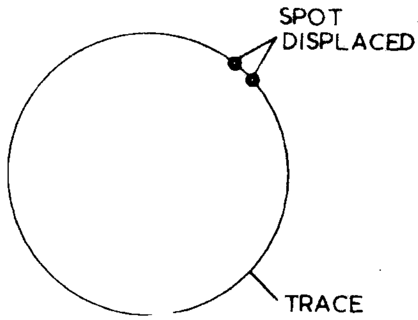


Bias Free Relay Display

This can be corrected by opening the rear door of the instrument and adjusting the relay bias magnet by means of a screwdriver inserted through the aperture in the rear panel.

Should this adjustment prove insufficient, the relay should be removed from the output relay socket and plugged into the test socket on the front panel and adjusted in accordance with the instructions given in Chapter 4, Sections 6.5. and 6.6. for a bias-free 2% transit time.

If this action is necessary, it might also be advisable to examine the contacts for cleanliness and any sign of pitting or other damage.



Display Showing Relay Bias

2. BENCH SERVICING

2.1. Test Equipment

The following items of test equipment are required to enable bench servicing and maintenance to be carried out on the equipment:

(1) Substandard Frequency Generator covering 20 to 400c/s.

(2) Multirange Testmeter of 20 000Ω/V Sensitivity, Avometer Model 8 or equivalent instrument.

(3) Oscilloscope.

(4) Wheatstone Bridge.

(5) Stroboscope Tuning Fork.

(6) TDMS6BV or 6ABV of compatible speed ranges.

(7) Standard Teleprinter.

(8) Telegraph Display Unit Type TDU2 of compatible speed ranges.

2.2. General

To remove the portable instrument from the case, first remove the mains socket from the back of the case. Remove the eight 2 B.A. securing screws from the front panel and carefully withdraw the instrument from the case.

If the instrument is reported to be functioning incorrectly, the fault should be isolated by use of the Voltage Analysis and the Waveform Charts given in Figures 4, 5 and 6. The waveform charts are idealized for guidance but a correctly adjusted and operated instrument should very closely approximate the depicted waveforms.

2.3. Valve Complement

Apart from the coder output valve V9 and the h.t. rectifier V32, the valves are all double-triodes.

VALVE	TYPE	FUNCTION
V1 VB(2)	½-12AU7	Input Switch
V2 VC(1)	½-12AU7	Input Toggle
V3 VC(2)	½-12AU7	Input Toggle
V4 VB(1)	½-12AU7	Display Valve
V5 VR(1)	½-12AU7	Output Toggle
V6 VR(2)	½-12AU7	Output Toggle
V7 VQ(2)	½-12AU7	Mark Setting Valve
V8 VQ(1)	½-12AU7	Space Setting Valve
V9 6AQ5	6AQ5	Coder Output
V10 VD(2)	½-12AU7	Coder Drive
V11 VA(1)	½-12AU7	Distorter
V12 VA(2)	½-12AU7	Distorter
V13 VE(2)	½-12AX7	Oscillator Amplifier
V14 VE(1)	½-12AX7	Oscillator Amplifier
V15 VF(2)	½-12AU7	Oscillator Cathode Follower
V16 VF(1)	½-12AU7	Oscillator Cathode Follower
V17 VG(2)	½-12AX7	Quadrature Amplifier
V18 VG(1)	½-12AX7	Quadrature Amplifier
V19 VP(1)	½-12AU7	Distributor
V20 VP(2)	½-12AU7	Distributor
V21 VN(1)	½-12AU7	Distributor
V22 VN(2)	½-12AU7	Distributor
V23 VM(1)	½-12AU7	Distributor
V24 VM(2)	½-12AU7	Distributor
V25 VL(1)	½-12AU7	Distributor
V26 VL(2)	½-12AU7	Distributor
V27 VD(1)	½12AU7	Speed Indicator Valve
V28 VJ(1)	½-12AU7	Squarer
V29 VJ(2)	½-12AU7	Squarer
V30 VK(1)	½-12AU7	Scale-of-two
V31 VK(2)	½-12AU7	Scale-of-two
V32 -	6X4	H.T. Rectifier

2.4. Voltage Analysis

The voltage appearing at some points in the circuit is dependent upon the position of certain of the controls. It is therefore essential that the controls be correctly set before proceeding with a d.c. analysis check.

The check should be made with an Avometer Model 8 (20 000Ω/V) or equivalent multi-range testmeter with similar ranges.

Ensure that the mains transformer selector taps are correctly set for the mains voltage in use, then set the instrument controls as follows:

CONTROL	POSITION
Mains switch S6	'ON'
Signal Selector S4	'MARK'
Display switch S1	'NORM. OUTPUT'
Range switch S5	'50'
Speed control RV7	'0'

Set the Amplitude control RV15 to its mid-position and then adjust the Focus, Astigmatism, Horizontal and Vertical Shift controls to obtain a properly centred circular trace. Adjust the Amplitude (Coarse) RV14 and Shape control to produce a 2-inch diameter circle.

Check that the voltage appearing at the check points quoted in the Voltage Analysis Table on Page 5-7 agrees within ±10% of the stated voltage.

2.5. Oscillator Calibration

The accuracy of subsequent speed measurement cannot exceed that of the substandard used for initial oscillator calibration and adjustment. It is therefore essential that a substandard frequency generator of extremely high accuracy, covering 20 to 400 c/s, be used when making these adjustments.

For all speed ranges up to and including 110 bauds, capacitor C65 is connected in parallel with C52 in the oscillator circuit. Above 110 bauds centre frequency this capacitor is switched out. The function of this network is that of a law corrector to ensure that the calibration of the fine Speed control holds over all speed ranges up to 200 bauds so that calibration errors at the extreme ends of the fine Speed control coverage shall not exceed ±0.4 bauds.

When C65 is switched out of circuit, on speed ranges above 110 bauds, the attenuation of the network is altered slightly. This will have an effect upon the shape of the circular time-base and the Shape control should be adjusted to effect the best compromise on the lowest and highest speed range of the instrument.

The following factory preset potentiometers control the various speed ranges:

Range 1 - RV8A-RV8B   Range 2 - RV9A-RV9B

Range 3 - RV10A-RV10B   Range 4 - RV11A-RV11B

Range 5 - RV12A-RV12B

2.5.1. Range 1 Calibration

This is the basic range and is normally 50 bauds. Any adjustment to this basic speed range affects the remaining four higher speed ranges.

(1) Switch off the set and set the Range switch S3 to 50 bauds.

(2) Using a Wheatstone bridge connected across the front section of the fine Speed control potentiometer, adjust the control for a value of 15.41kΩ.

(3) Adjust the dial of the fine Speed control so that the '0' reference is against the calibration mark. To achieve this it may be necessary to loosen the screws on the ball drive holding the potentiometer spindle.

(4) Set RV8A and RV8B to approximately mid-position. Switch on the set and allow a suitable warm-up period for the oscillator to stabilize.

(5) Feed in a 50 c/s signal from the substandard frequency generator to the Input 1 or Input 2 and Earth terminals. The terminal chosen and the setting of the impedance link LK2 for this adjustment

VOLTAGE ANALYSIS TABLE

All voltages are with respect to chassis unless otherwise stated.

DESCRIPTION	CHECK POINT	METER RANGE	VOLTAGE	REMARKS
Coder	X3L	1000V.	353	
H.T. + (Normal)	T6L	1000V.	220	
H.T. + (Oscillator)	M8L	1000V.	200	
H.T. –ve	X13L	–1000V.	–162	
E.H.T. –ve	Junc. R184-N1	–1000V.	–825	
V28 Anode	I38R	1000V.	152	
V6 Anode	M2R	1000V.	208	S4 set to Mark
V6 Anode	M2R	1000V.	82	S4 set to Space
V5 Anode	M4R	1000V.	208	S4 set to Space
V5 Anode	M4R	1000V.	82	S4 set to Mark
V30-V31 Cathode	P29R	250V.	40	
V29 Anode	M36R	1000V.	137	
V8 Anode	P6R	250V.	22	
V7 Anode	P8R	250V.	62	
V7 Cathode	P9R	100V.	9	
V28-V29 Cathode	P39R	250V.	58.5	
V5-V6 Cathode	T5R	100V.	35	
V30 Anode	X31R	1000V.	130	
V31 Anode	X32R	1000V.	130	
V18 Anode	P8L	1000V.	163)	(Taken with respect
V17 Anode	P9L	1000V.	165)	(to M8L.
V18 Cathode	P10L	1000V.	36)	
V17 Cathode	P11L	1000V.	36)	
V16 Cathode	P13L	250V.	233)	(Taken with respect
V15 Cathode	P14L	250V.	223)	to h.t. –ve at X13L
V14 Cathode	P16L	1000V.	36)	
V14 Anode	P17L	1000V.	146)	(Taken with respect
V13 Anode	P18L	1000V.	146)	(to M8L.
V3 Anode	P27L	1000V.	205	–80 volts to Input
V4 Anode	P21L	100V.	13	
V2 Anode	P29L	1000V.	49	
V12 Anode	P31L	250V.	62	
V11 Anode	P32L	250V.	197	
V2-V3 Cathode	T24L	250V.	31	
CRT Cathode	Pin 3	–1000V.	–640	
CRT 1st & 3rd) Anode)	Pin 8	1000V.	70	(Dependent upon (Astigmatism Setting.
CRT 2nd Anode	Pin 4	–1000V.	–525	(Dependent upon (Focus setting.
V27 Anode	M22L	250V.	170	
Heaters	Any Valve Pin 9	25V.a.c.	6.2V.a.c.	

should be in accordance with the requirements of the substandard frequency generator used.

NOTE *On 5ABV models, the Input switch S8 should be set for 'D.C.' for double-current input.*

(6) Adjust the Amplitude control if necessary, then adjust RV8A and RV8B until a stationary single spot display is obtained.

(7) Adjust the Shape and Amplitude controls as necessary to give a 2-inch diameter circle. Check that the timebase amplitude does not vary appreciably over the entire range of the fine Speed control.

NOTE *If the amplitude increases at +10 bauds relative to –10 bauds when the control is varied over this range, adjust either of the preset controls RV8A or RV8B to reduce the amplitude, then adjust the other control in the opposite direction to bring the oscillator speed back to 50 bauds.*

If the timebase amplitude decreases at +10 bauds, the reverse procedure should be applied. By making adjustments to these two preset controls in small steps it is possible to correct the oscillator calibration and at the same time maintain a 2-inch diameter timebase over the entire range of the fine Speed control. Having set up the basic range, RV8A, RV8B and the Amplitude control should not again be altered.

(8) Check that the maximum error at the ±10 baud points on the fine Speed control does not exceed ±0.4 bauds.

2.5.2. Calibration of Remaining Ranges

Switch to Range 2 and inject the required frequency from the substandard frequency generator.

With the fine Speed control set to '0', adjust RV9A and RV9B to give a 2-inch diameter trace and a stationary single spot display.

Carry out the same procedure on Range 3, 4 and 5, adjusting RV10A-RV10B, RV11A-RV11B and RV12A-RV12B as appropriate to the range.

At speeds over 110 bauds C65 is switched out of circuit and it is possible that the timebase amplitude will be excessive. It may be necessary therefore to adjust the appropriate ranging potentiometers so that the timebase can be seen on the screen.

Check each range at the ±10 baud points and ensure that the maximum error does not exceed ±0.4 bauds.

2.5.3. Synchronization Control

(a) Set the Display switch S1 to 'INPUT'.

(b) Set the Range control to the basic speed range (normally 50 bauds).

(c) Apply an appropriate sinewave signal between the Input 2 and Earth, and Sync. and Earth terminals (100 c/s for 50 bauds).

(d) Adjust the Sync. control RV5 and Amplitude control until the input display remains stationary over a wide variation of the fine Speed control setting.

2.5.4. Speed Indicator

Check the operation of the Speed indicator neon on each speed range.

2.6. Waveform Analysis

Using an oscilloscope connected between the appropriate test point and chassis, check that the waveforms at the following points agree within reasonable limits with the drawings shown in Figures 4, 5 and 6.

Figure 6 also shows the waveform voltages.

(a) Oscillator V16 cathode at P13L.

(b) Squarer V29 anode at M36R.

(c) Scale-of-Two at T30R for 1, 1½ and 2 Units stop element length at all speed ranges.

(d) Distributor input at P30R and V19 anode at E19R for 1, 1½ and 2 Unit stop element length at all speed ranges.

(e) Mark Setting Valve V7 anode at P8R.

(f) Space Setting Valve V8 anode at P6R.

(g) Output Toggle V6 grid at P4R;

V6 anode at X27R;
V5 anode at T27R;

2.7. Distorter

Set the controls as follows:

CONTROL	POSITION
Mains switch S6	'ON'
Range switch S5	'50'
Fine Speed control RV7	'0'
Signal Selector S4	'KEYS'
Display Switch S1	'DIST. OUTPUT'

Adjust the Distortion controls RV1a and RV1b to give zero distortion, then check that the coarse and fine control knobs are central (dots uppermost). Check that the zero distortion point on the coarse control RV1a is substantially central at the mid point of each speed range such that there is no ambiguity between zero and 50% distortion. It may be necessary to slightly adjust the coarse control knob on its spindle to obtain the best possible zero position for all five speed ranges. The fine control knob (RV1b - outer) should be adjusted on its spindle so that the dot is uppermost in the centre of its travel.

Check that it is possible to obtain ±50% distortion at all speed settings.

NOTE: When the Distortion controls are moved clockwise, the spot on the display will travel in an anti-clockwise direction indicating long start element distortion.

2.8. Signal Selector

Set the Display switch S5 to 'NORM. OUTPUT' and connect the oscilloscope 'Y' plate or Display Unit Type TDU2 to the Line terminal.

Connect the 80 + 80 volt supply:

+80 to Space terminal

−80 to Mark terminal

Centre Tap to Earth terminal

Check the operation of the Signal Selector as follows:

2.8.1. Mark and Space

(a) With the Signal Selector set to 'MARK', −80 volts should be sent to the line, as measured between the Line and Earth terminals.

(b) With the Signal Selector set to 'SPACE', +80 volts should be sent to the line.

2.8.2. Keys

Set the Signal Selector to 'KEYS' and all the Keys to 'M'. The waveform should be a single space element, the length of the mark, or stop element, will depend upon the setting of Link LK1.

Check the operation of each Key at all speed ranges.

2.8.3. Coder

(a) With the Signal Selector set to 'CODER' and the Continuous Coder/Single Message switch set to 'SINGLE MESSAGE', a continuous Mark signal should be sent to the line.

(b) With the Coder switch set to 'CONTINUOUS MESSAGE', a continuous test message should be sent to the line commencing from the rest position of the coder.

(c) Now connect a standard teleprinter to the Line terminal in addition to the oscilloscope. With the Coder switch set to 'SINGLE MESSAGE', one complete test message only should be transmitted to the line.

(d) Check that no spurious characters are printed, especially at the beginning and end of the test message.

(e) The Coder Type TDA-10 is the subject of a separate Technical Handbook which should be referred to if necessary. The Coder should be checked at all speeds available on the TDMS5 to ensure:

(i) Satisfactory Operation.

(ii) The correct information is transmitted, using a suitable receiving mechanism.

2.8.4. Reversals

(a) Set the Signal Selector to '2:2' and check that 2:2 reversals are correctly produced at all speeds.

(b) Set the Signal Selector to '1:1' and check that 1:1 reversals are correctly produced at all speeds.

2.9. Input Sensitivity (TDMS5BV)

Set the TDMS5BV controls as follows:

CONTROL	POSITION
Mains switch S6	'ON'
Range switch S5	'50'
Fine Speed control RV7	'0'
Display switch S1	'INPUT'

Check the input sensitivity as follows:

2.9.1. Squarewave

(a) Set the Input Link LK2 to 'LOW IMPEDANCE' and check that a 50 c/s double-current squarewave of 2.5 volts or less at the Input 1, or Input 2 terminals just gives a display.

(b) Set the Input Link LK2 to 'HIGH IMPEDANCE' and check that a 50 c/s double-current squarewave of 25 volts or less at the Input 1 terminals just gives a display.

2.9.2. Sinewave

(a) Set the Input Link LK2 to 'LOW IMPEDANCE' and check that a sinewave input at 50 c/s of 2 volts or less at the Input 1 or Input 2 terminal just gives a display.

(b) Set LK2 to 'HIGH IMPEDANCE' and check that a sinewave input of 50 c/s of 20 volts or less at the Input 1 terminal just gives a display.

2.10. Input Sensitivity (TDMS5ABV)

These models have a single-current to double-current converter, controlled by Input switch S8, which cuts out the converter when the instrument is required for monitoring double-current signals.

WARNING NOTE: Some TDMS5ABV models have the mains earth removed from the chassis so that the instrument may be used for single-current series loop monitoring. In this case NO EARTH CONNECTION SHOULD BE MADE TO THE CHASSIS SINCE UNDER THESE CONDITIONS THE CHASSIS FLOATS TO THE FULL VALUE OF THE TELEGRAPH LINE VOLTAGE.

Set the Input switch S8 to 'D.C.' and carry out the squarewave and sinewave sensitivity checks described in 2.9.1. and 2.9.2.

To check the single-current input sensitivity, a single-current telegraph signal having a variable voltage and a mark polarity set for either negative or positive with respect to earth. It is essential that the space potential is earth.

Now set the Input switch S8 to 'S.C.–M' or 'S C.+M', according to the single-current input signal to be used. The single-current input sensitivity should be half that for the double-current squarewave input sensitivity given in 2 9 1.

2.11. Relay Test Facility

To check the relay testing facility of the TDMS5, set the instrument controls as follows:

CONTROL	POSITION
Mains switch S6	'ON'
Range switch S5	'50'
Fine Speed control RV7	'0'
Signal Selector S4	'1:1'
Display switch S1	'BIAS'

Insert a relay into the relay test socket on the front panel. Vary the relay contacts and check that the correct display is obtained on both the 'BIAS' and 'TRANS. TIME' positions of the Display switch S1 at all speeds of the instrument.

Full instructions on relay testing are given in Chapter 4, Sections 6.5 and 6.6.

3. CATHODE RAY TUBE

If it is found necessary to change the cathode ray tube, the following procedure should be adopted.

3.1. Removal of Cathode Ray Tube

(i) Remove the instrument from the case.

(ii) Remove the connecting base from the cathode ray tube assembly.

(iii) Using a suitable screwdriver, unlock the four Dzus fasteners on the cathode ray tube bezel, by giving a ¼-turn anti-clockwise. Remove the bezel.

(iv) Lift out the cathode ray tube assembly via the top of the instrument.

(v) Remove the tube clamp on the mu-metal shield.

(vi) Depress the three rubber spigots holding the graticule scale and the rubber tube mount, at the same time pressing the cathode ray tube forward by means of the base.

(vii) The graticule scale complete with its mounting and cathode ray tube can now be removed from the mu-metal shield.

(viii) Remove the rubber packing ring from the base of the mu-metal shield.

3.2. Replacement of Cathode Ray Tube

(i) Place the rubber mount holding the graticule scale, over the screen of the cathode ray tube, ensuring that the key on the base of the tube is in line with the zero distortion line on the graticule scale.

(ii) Insert the cathode ray tube and graticule scale into the mu-metal shield so that the rubber spigot adjacent to the zero line on the graticule scale engages with the locating hole between the Dzus fasteners.

(iii) Press the graticule scale and cathode ray tube into the mu-metal shield until the three rubber spigots engage in their holes.

(iv) Press the cathode ray tube forward again by its base to ensure that the tube is firmly in the rubber mask, holding the graticule firmly in position.

(v) Refit the rubber packing ring and the tube clamp.

(vi) Refit the cathode ray tube assembly to the instrument.

(vii) Refit the cathode ray tube bezel and secure the four Dzus fasteners.

(viii) Refit the connecting base to the cathode ray tube.

(ix) Switch on the instrument and check that the cathode ray tube is in correct alignment so that the zero distortion display appears on the zero graticule line.

(x) If the zero distortion spot does not coincide with the zero graticule line, loosen the tube clamp slightly and rotate the tube within the assembly. The tube can be turned sufficiently to correct the error by means of the connecting base.

(xi) Check that the tube is now in alignment and tighten the tube clamp.

(xii) Refit the instrument in the case.

NOTE: The cathode ray tube 'Y' plates provide the horizontal deflection as opposed to normal oscilloscope practice.

CHAPTER 6

COMPONENTS LISTS

CONTENTS

KEY TO COMPONENT LOCATION

L	=	Left-Hand Tag Panel
R	=	Right-Hand Tag Panel
M3L - A5L	=	Left-Hand Tag Panel Pin M3 to Pin A5
M3R - A5R	=	Right-Hand Tag Panel Pin M3 to Pin A5
T2/L-T8/L	=	Inside Left-Hand Tag Panel Pin T2 to Pin T8
AR/R-AS/R	=	Inside Right-Hand Tag Panel Pin AR to Pin AS
B.P.	=	Back Panel
F.P.	=	Front Panel
P.C.	=	Power Chassis

1. STANDARD COMPONENTS TDMS5BV & TDMS5ABV

CIRCUIT REFERENCE	DESCRIPTION & TOLERANCE	MANUFACTURER	PART NUMBER	LOCATION
R1	Resistor 220kΩ ±10%	Erie Type 8	B625904	M39L-P39L
R2	" 2MΩ ±10%	Erie Type 8	B627206	P39L-T39L
R3	" (See Section 2)			
R4	" 220kΩ ±10%	Erie Type 8	B625904	T39L-X39L
R5	" *(47kΩ ±10% (100kΩ ±10%	Erie Type 8 Erie Type 8	B625051) B625503)	T28L-X28L
R6	" 1MΩ±10%	Erie Type 8	B626804	P27L-T27L
R7	" 15kΩ ±10%	Erie Type 8	B624451	M25L-P25L
R8	" 1MΩ ±10%	Erie Type 8	B626804	P26L-T26L
R9	" 100kΩ ±10%	Erie Type 8	B625503	M30L-P30L
R10	" 1MΩ ±10%	Erie Type 8	B626804	M29L-P29L
R11	" 1MΩ ±10%	Erie Type 8	B626804	M28L-P28L
R12	" 330kΩ ±10%	Erie Type 8	B626151	I29L-M29L
R13	" 100kΩ ±10%	Erie Type 8	B625503	M27L-P27L
R14	" 18kΩ ±10%	Erie Type 8	B624552	T24L-X24L
R15	" 4.7MΩ ±10%	Erie Type 8	B627629	E30L-I30L
R16	" 4.7MΩ ±10%	Erie Type 8	B627629	E27L-I27L
R17	" 15kΩ ±10%	Erie Type 8	B624451	A9R-E9R
R18	" 10MΩ ±10%	Erie Type 8	B628052	ASR-ATR
*R19	" 1MΩ ±10%	Erie Type 8	B626804	P.C.
R20	" 470kΩ ±10%	Erie Type 8	B626354	P10R-T10R
R21	" 10MΩ ±10%	Erie Type 8	B628052	ARR-ASR
R22	" 390Ω ±10%	Erie Type 8	B622451	P.C.
R23	" 390Ω ±10%	Erie Type 8	B622451	P.C.
R24	" 470kΩ ±10%	Erie Type 8	B626354	P8R-T8R
R25	" 220kΩ ±10%	Erie Type 8	B625904	M9R-P9R
R26	" 27kΩ ±10%	Erie Type 8	B624751	P9R-T9R
R27	" 4.7MΩ ±10%	Erie Type 8	B627629	I7R-M7R
R28	" 470kΩ ±10%	Erie Type 8	B626354	I10R-M10R
R29	" 4.7MΩ ±10%	Erie Type 8	B627629	E10R-I10R
R30	" 220kΩ ±10%	Erie Type 8	B625904	I10R-X10R
R31	" 1MΩ ±10%	Erie Type 8	B626804	M5R-P5R
R32	" 100kΩ ±5%	Erie Type 8	B625512	P6R-T6R
R33	" 470kΩ ±10%	Erie Type 8	B626354	P11R-T11R
R34	" 3.3MΩ ±10%	Erie Type 8	B627451	T11R-X11R
R35	" 4.5MΩ ±10%	Erie Type 8	B627629	I12R-M12R
R36	" 100kΩ ±10%	Erie Type 8	B625503	T30L-X30L
R37	" 220kΩ ±10%	Erie Type 8	B625904	A6R-E6R
R38	" 2.2MΩ ±10%	Erie Type 8	B627354	M23L-P23L
R39	" 2.7MΩ ±10%	Erie Type 8	B627351	P23L-T23L
R40	" 10MΩ ±10%	Erie Type 8	B628052	F.P.
R41	" 470kΩ ±10%	Erie Type 8	B626354	M24L-P24L
R42	" 10MΩ ±10%	Erie Type 8	B628052	P36L-T36L
R43	" 2.2MΩ ±10%	Erie Type 8	B627254	T23L-X23L
R44	" 2.2kΩ ±10%	Erie Type 8	B623402	T4L-X4L
R45	" 1MΩ ±10%	Erie Type 8	B626804	M37L-P37L
R46	" 82kΩ ±10%	Erie Type 8	B625401	I16R-M16R
R47	" (deleted)			
R48	" (deleted)			

CIRCUIT REFERENCE	DESCRIPTION & TOLERANCE	MANUFACTURER	PART NUMBER	LOCATION
R49	Resistor 220kΩ ±10%	Erie Type 8	B625904	P7R-T7R
R50	" 1MΩ ±10%	Erie Type 8	B626804	E17R-I17R
R51	" 1MΩ ±10%	Erie Type 8	B626804	E14R-I14R
R52	" 1MΩ ±10%	Erie Type 8	B626804	I17R-M17R
R53	" 1MΩ ±10%	Erie Type 8	B626804	I14R-M14R
R54	" 1MΩ ±10%	Erie Type 8	B626804	T18R-X18R
R55	" 4.7MΩ ±10%	Erie Type 8	B627629	E4R-I4R
R56	" 27kΩ ±1%	Erie Type 100	B624763	T22R-T27R
R57	" 27kΩ ±1%	Erie Type 100	B624763	X22R-X27R
R58	" 6.8kΩ ±10%	Erie Type 8	B624052	P5R-T5R
R59	" (deleted)			
R60	" (deleted)			
R61	" 1MΩ ±10%	Erie Type 8	B626804	M4R-P4R
R62	" 1MΩ ±10%	Erie Type 8	B626804	M2R-P2R
R63	" 330kΩ ±10%	Erie Type 8	B626151	P2R-T2R
R64	" 330kΩ ±10%	Erie Type 8	B626151	P4R-T4R
R65	" 4.7MΩ ±10%	Erie Type 8	B627629	T14R-X14R
R66	" 4.7MΩ ±10%	Erie Type 8	B627629	T13R-X13R
R67	" 150kΩ ±10%	Erie Type 8	B615705	A8R-E8R
R68	" 220kΩ ±10%	Erie Type 8	B625904	A7R-E7R
R69	" 1.2MΩ ±10%	Erie Type 8	B626901	P22L-T22L
R70	" 2.2MΩ ±10%	Erie Type 8	B627254	T22L-X22L
R71	" 39kΩ ±10%	Erie Type 8	B624952	T21L-X21L
R72	" 100Ω ±10%	Erie Type 8	B625503	P21L-T21L
R73	" 1MΩ ±10%	Erie Type 8	B626804	P.C.
R74	" 100kΩ ±10%	Erie Type 8	B625503	P.C.
* R75	" 1MΩ ±10%	Erie Type 8	B626804	P.C.
R76	" 47kΩ ±10%	Erie Type 8	B625051	P.C.
R77	" 470kΩ ±10%	Erie Type 8	B626354	P.C.
R78	" 4.7MΩ ±10%	Erie Type 8	B627629	T32L-X32L
R79	" 180kΩ ±10%	Erie Type 8	B625801	I10R-E10R
R80	" (deleted)			
R81	" 100kΩ ±10%	Erie Type 8	B625503	M32L-P32L
R82	" 100kΩ ±10%	Erie Type 8	B625503	M31L-P31L
R83	" (See Section 2)			
R84	" 33kΩ ±10%	Erie Type 8	B624851	P37L-T37L
R85	" 2.7MΩ ±10%	Erie Type 8	B627351	P30L-T30L
R86	" 1MΩ ±10%	Erie Type 8	B626804	T34L-X34L
R87	" 1MΩ ±10%	Erie Type 8	B626804	P34L-T34L
R88	" 33kΩ ±5%	Erie Type 8	B624862	M23R-P23R
R89	" 33kΩ ±5%	Erie Type 8	B624862	M21R-P21R
R90	" 100kΩ ±5%	Erie Type 8	B625512	A19R-E19R
R91	" 100kΩ ±5%	Erie Type 8	B625512	A21R-E21R
R92	" 100kΩ ±5%	Erie Type 8	B625512	A23R-E23R
R93	" 100kΩ ±5%	Erie Type 8	B625512	A25R-E25R
R94	" 100kΩ ±5%	Erie Type 8	B625512	A27R-E27R
R95	" 100kΩ ±5%	Erie Type 8	B625512	A29R-E29R
R96	" 100kΩ ±5%	Erie Type 8	B625512	A31R-E31R
R97	" 100kΩ ±5%	Erie Type 8	B625512	A33R-E33R
R98	" (deleted)			
R99	" (deleted)			
R100	" (deleted)			
R101	" 470kΩ ±5%	Erie Type 8	B626362	T19R-M19R
R102	" 470kΩ ±5%	Erie Type 8	B626362	I21R-M21R
R103	" 470kΩ ±5%	Erie Type 8	B626362	I23R-M23R
R104	" 470kΩ ±5%	Erie Type 8	B626362	I25R-M25R

CIRCUIT REFERENCE	DESCRIPTION & TOLERANCE		MANUFACTURER	PART NUMBER	LOCATION
R105	Resistor	470kΩ ±5%	Erie Type 8	B626362	I27R-M27R
R106	"	470kΩ ±5%	Erie Type 8	B626362	I29R-M29R
R107	"	470kΩ ±5%	Erie Type 8	B626362	I31R-M31R
R108	"	470kΩ ±5%	Erie Type 8	B626362	I33R-M33R
R109	"	1.5MΩ ±5%	Erie Type 8	B627058	E19R-I19R
R110	"	1.5MΩ ±5%	Erie Type 8	B627058	E21R-I21R
R111	"	1.5MΩ ±5%	Erie Type 8	B627058	E37R-I37R
R112	"	1.5MΩ ±5%	Erie Type 8	B627058	E25R-I25R
R113	"	1.5MΩ ±5%	Erie Type 8	B627058	E27R-I27R
R114	"	1.5MΩ ±5%	Erie Type 8	B627058	E29R-I29R
R115	"	1.5MΩ ±5%	Erie Type 8	B627058	E31R-I31R
R116	"	1.5MΩ ±5%	Erie Type 8	B627058	E33R-I33R
R117	"	470kΩ ±5%	Erie Type 8	B626362	E20R-I20R
R118	"	470kΩ ±5%	Erie Type 8	B626362	E22R-I22R
R119	"	470kΩ ±5%	Erie Type 8	B626362	E24R-I24R
R120	"	470kΩ ±5%	Erie Type 8	B626362	E26R-I26R
R121	"	470kΩ ±5%	Erie Type 8	B626362	E28R-I28R
R122	"	470kΩ ±5%	Erie Type 8	B626362	E30R-I30R
R123	"	470kΩ ±5%	Erie Type 8	B626362	E32R-I32R
R124	"	470kΩ ±5%	Erie Type 8	B626362	E34R-I34R
R125	"	1MΩ ±10%	Erie Type 8	B626804	I26R-M26R
R126	"	1MΩ ±10%	Erie Type 8	B626804	I28R-M28R
R127	"	1MΩ ±10%	Erie Type 8	B626804	I30R-M30R
R128	"	1.2MΩ ±10%	Erie Type 8	B626901	I32R-M32R
R129	"	1MΩ ±10%	Erie Type 8	B626804	I34R-M34R
R130	"	1MΩ ±10%	Erie Type 8	B626804	I20R-M20R
R131	"	1MΩ ±10%	Erie Type 8	B626804	I22R-M22R
R132	"	1MΩ ±10%	Erie Type 8	B626804	I24R-M24R
R133	"	(deleted)			
R134	"	(deleted)			
R135	"	(deleted)			
R136	"	(deleted)			
R137	"	(deleted)			
R138	"	(deleted)			
R139	"	(deleted)			
R140	"	1MΩ ±10%	Erie Type 8	B626804	I11L-M11L
R141	"	6.8MΩ ±10%	Erie Type 8	B627851	I18L-T19L
R142	"	220kΩ ±10%	Erie Type 8	B625904	I18L-P18L
R143	"	220kΩ ±10%	Erie Type 8	B625904	I17L-P17L
R144	"	56kΩ ±10%	Erie Type 8	B625201	T19L-X19L
R145	"	56kΩ ±10%	Erie Type 8	B625201	I16L-T16L
R146	"	1MΩ ±10%	Erie Type 8	B626804	I19L-M19L
R147	"	1MΩ ±10%	Erie Type 8	B626804	I16L-M16L
R148	"	3.3MΩ ±10%	Erie Type 8	B627451	E19L-I19L
R149	"	3.3MΩ ±10%	Erie Type 8	B627451	E16L-I16L
R150	"	470kΩ ±10%	Erie Type 8	B626354	A19L-E19L
R151	"	470kΩ ±10%	Erie Type 8	B626354	A16L-E16L
R152	"	2.2kΩ ±10%	Erie Type 8	B623402	A1L-A5L
R153	"	56kΩ ±10%	Erie Type 8	B625201	P14L-T14L
R154	"	56kΩ ±10%	Erie Type 8	B625201	T14L-X14L
R155	"	56kΩ ±10%	Erie Type 8	B625201	P13L-T13L
R156	"	56kΩ ±10%	Erie Type 8	B625201	T13L-X13L
R157A	"	(See Section 2)			
R157B	"	(See Section 2)			
R158A	"	(See Section 2)			
R158B	"	(See Section 2)			

CIRCUIT REFERENCE		DESCRIPTION & TOLERANCE	MANUFACTURER	PART NUMBER	LOCATION
R159A	Resistor	(See Section 2)			
R159B	"	(See Section 2)			
R160A	"	(See Section 2)			
R160B	"	(See Section 2)			
R161A	"	(See Section 2)			
R161B	"	(See Section 2)			
R162A	"	(See Section 2)			
R162B	"	(See Section 2)			
R163	"	(deleted)			
R164	"	(deleted)			
R165	"	(deleted)			
R166	"	(deleted)			
R167	"	(deleted)			
R168	"	(deleted)			
R169	"	(deleted)			
R170	"	270kΩ ±10%	Erie Type 8	B626052	M9L-P9L
R171	"	270kΩ ±10%	Erie Type 8	B626052	M8L-P8L
R172	"	56kΩ ±10%	Erie Type 8	B625201	P11L-T11L
R173	"	56kΩ ±10%	Erie Type 8	B625201	P10L-T10L
R174	"	1MΩ ±10%	Erie Type 8	B626804	I10L-M10L
R175	"	1MΩ ±10%	Erie Type 8	B626804	I7L-M7L
R176	"	10MΩ ±10%	Erie Type 8	B628052	E10L-I10L
R177	"	10MΩ ±10%	Erie Type 8	B628052	E7L-I7L
R178	"	470kΩ ±10%	Erie Type 8	B626354	A10L-E10L
R179	"	470kΩ ±10%	Erie Type 8	B626354	A7L-E7L
R180	"	100kΩ ±10%	Erie Type 8	B625503	P.C.
R181	"	10kΩ ±10%	Erie Type 8	B624253	P.C.
R182	"	10kΩ ±10%	Erie Type 8	B624253	P.C.
R183	"	11kΩ ±5%	Erg Type 58AW	B624304	P.C.
R184	"	180kΩ ±10%	Erie Type 8	B625801	P.C.
R185	"	4.3kΩ ±5%	Erg Type 18AW	B623755	P.C.
R186	"	2.2kΩ ±10%	Erie Type 8	B623402	P6L-T6L
R187	"	(deleted)			
R188	"	(deleted)			
R189	"	(deleted)			
R190	"	3.3MΩ ±10%	Erie Type 8	B627451	E21L-I21L
R191	"	1.5MΩ ±10%	Erie Type 8	B627051	I3L-M3L
R192	"	1MΩ ±10%	Erie Type 8	B626804	E22L-I22L
R193	"	33kΩ ±10%	Erie Type 8	B624851	I22L-M22L
R194	"	1MΩ ±10%	Erie Type 8	B626804	I21L-M21L
R195	"	(deleted)			
R196	"	100kΩ ±10%	Erie Type 8	B625503	E39R-I39R
R197	"	100kΩ ±10%	Erie Type 8	B625503	I36R-M36R
R198	"	1MΩ ±10%	Erie Type 8	B626804	P38R-T38R
R199	"	1MΩ ±10%	Erie Type 8	B626804	T38R-X38R
R200	"	12kΩ ±10%	Erie Type 8	B624351	P39R-T39R
R201	"	27kΩ ±10%	Erie Type 8	B624751	T39R-X39R
R202	"	1MΩ ±10%	Erie Type 8	B626804	E38R-I38R
R203	"	470kΩ ±10%	Erie Type 8	B626354	A38R-E38R
R204	"	3.3MΩ ±10%	Erie Type 8	B627451	M35R-P35R
R205	"	56kΩ ±5%	Erie Type 8	B625206	T30R-X30R
R206	"	100kΩ ±10%	Erie Type 8	B625503	T32R-X32R
R207	"	39kΩ ±10%	Erie Type 8	B624952	T31R-X31R
R208	"	1MΩ ±10%	Erie Type 8	B626804	T35R-X35R
R209	"	1MΩ ±10%	Erie Type 8	B626804	T37R-X37R
R210	"	270kΩ ±10%	Erie Type 8	B626052	P37R-T37R

CIRCUIT REFERENCE	DESCRIPTION & TOLERANCE		MANUFACTURER	PART NUMBER	LOCATION
R211	Resistor	270kΩ ±10%	Erie Type 8	B626052	T33R-X33R
R212	"	24kΩ ±5%	Erie Type 8	B624705	P29R-T29R
RV1A) RV1B)	Potentiometer	10kΩ + 2.5MΩ	AB Metals D37-4	B638009	F.P.
RV2	"	250kΩ	Morgan LHNAR25450	B634722	P.C.
RV3	"	250kΩ	Morgan LHNAR25450	B634722	P.C.
RV4	"	1MΩ	Morgan LHNAR10550	B635209	P.C.
RV5	"	1MΩ	Morgan LHNAR10550	B635209	P.C.
RV6	"	(deleted)			
RV7A) RV7B)	"	50kΩ+50kΩ	Colvern	B634244	F P
RV8A	"	10kΩ	Reliance	B633291	L
RV8B	"	10kΩ	Reliance	B633291	L
RV9A	"	10kΩ	Reliance	B633291	L
RV9B	"	10kΩ	Reliance	B633291	L
RV10A	"	10kΩ	Reliance	B633291	L
RV10B	"	10kΩ	Reliance	B633291	L
RV11A	"	10kΩ	Reliance	B633291	L
RV11B	"	10kΩ	Reliance	B633291	L
RV12A	"	10kΩ	Reliance	B633291	L
RV12B	"	10kΩ	Reliance	B633291	L
RV13	"	(deleted)			
RV14	"	10kΩ	Morgan LHNAR10350	B633286	B.P.
RV15	"	390Ω	A.T.E. (B) Ltd.	B104/1526	F.P.
RV16	"	1MΩ	Morgan LHNAR10550	B635210	B.P.
RV17	"	5kΩ	Morgan LHNAR50250	B633047	B.P.
RV18	"	1MΩ	Morgan LHNAR10550	B635210	B.P.
C1	Capacitor	100pF ±20% 500V.	Suflex HS	B601744	T27L-X27L
C2	"	100pF ±20% 500V.	Suflex HS	B601744	I28L-M28L
C3	"	100pF ±20% 500V.	Suflex HS	B601744	I30L-M30L
C4	"	100pF ±20% 500V.	Suflex HS	B601744	I26L-M26L
C5	"	.05μF ±20% 350V.	Dubilier 418	B605637	I3R-M3R
C6	"	470pF ±20% 500V.	Suflex HS	B602384	ATR-AUR
C7	"	470pF ±20% 500V.	Suflex HS	B602384	ASR-AVR
C8	"	.05μF ±20% 350V.	TCC CP35N	B605622	P.C.
C9	"	.05μF ±20% 350V.	TCC CP35N	B605622	P.C.
C10	"	.05μF ±20% 350V.	TCC CP35N	B605622	P.C.
C11	"	.05μF ±20% 350V.	TCC CP35N	B605622	P.C.
C12	"	.05μF ±20% 350V.	TCC CP35N	B605622	P.C.
C13	"	100pF ±5% 500V.	Suflex HS	B601745	P14R-T14R
C14	"	100pF ±5% 500V.	Suflex HS	B601745	P12R-T12R
C15	"	470pF ±20% 500V.	Suflex HS	B602384	M8R-P8R
C16	"	470pF ±20% 500V.	Suflex HS	B602384	M6R-P6R
C17	"	470pF ±20% 500V.	Suflex HS	B602384	P3R-T3R
C18	"	1500pF ±20% 500V.	Suflex HS	B603392	A11R-E11R
C19	"	.01μF ±25% 350V.	TCC CP32N	B604891	X38L-T38L
*C20	"	1μF 150V.	Hunts W49	B608075	P.C.
C21	"	470pF ±20% 500V.	Suflex HS	B602384	E12R-I12R
C22	"	.05μF ±20% 350V.	Dubilier 418	B605637	*(T17L-X17L (T25L-X25L
C23	"	(deleted)			
C24	"	1500pF ±20% 500V.	Suflex HS	B603392	A16R-E16R
C25	"	1500pF ±20% 500V.	Suflex HS	B603392	A15R-E15R
C26	"	1500pF ±20% 500V.	Suflex HS	B603392	M16R-P16R

CIRCUIT REFERENCE		DESCRIPTION & TOLERANCE	MANUFACTURER	PART NUMBER	LOCATION
C27	Capacitor	1500pF ±20% 500V.	Suflex HS	B603392	M15R-P15R
C28	"	1500pF ±20% 500V.	Suflex HS	B603392	P17R-T17R
C29	"	680pF ±10% 500V.	Suflex HS	B602707	A3R-E3R
C30	"	1500pF ±20% 500V.	Suflex HS	B603392	A5R-E5R
C31	"	.001μF ±20% 1000V.	TCC CP49W	B603293	P.C.
C32	"	0.5μF ±20% 350V.	Dubilier 418	B607239	P.C.
C33	"	2200pF ±10% 500V.	Suflex HS	B603587	T31L-X31L
C34A	"	(See Section 2)			
C34B	"	(See Section 2)			
C35A	"	(See Section 2)			
C35B	"	(See Section 2)			
C36A	"	(See Section 2)			
C36B	"	(See Section 2)			
C37A	"	(See Section 2)			
C37B	"	(See Section 2)			
C38A	"	(See Section 2)			
C38B	"	(See Section 2)			
C39	"	270pF ±20% 500V.	Suflex HS	B602030	T35L-X35L
C40	"	.01μF ±20% 500V.	TCC CP33S	B604914	M11L-M15L
C41	"	4700pF ±10% 500V.	Suflex HS	B603911	P21R-P25R
C42	"	100pF ±5% 500V.	Suflex HS	B601745	M26R-P26R
C43	"	100pF ±5% 500V.	Suflex HS	B601745	M28R-P28R
C44	"	100pF ±5% 500V.	Suflex HS	B601745	M30R-P30R
C45	"	100pF ±5% 500V.	Suflex HS	B601745	M32R-P32R
C46	"	100pF ±5% 500V.	Suflex HS	B601745	M34R-P34R
C47	"	100pF ±5% 500V.	Suflex HS	B601745	M20R-P20R
C48	"	100pF ±5% 500V.	Suflex HS	B601745	M22R-P22R
C49	"	100pF ±5% 500V.	Suflex HS	B601745	M24R-P24R
C50	"	(See Section 2)			
C51	"	(See Section 2)			
C52	"	(See Section 2)			
C53	"	(See Section 2)			
C54	"	0.5μF ±20% 350V.	Dubilier 418	B607239	AX/R-AY/Y
C55	"	680pF ±10% 500V.	Suflex HS	B602707	I4L-M4L
C56	"	150pF ±10% 500V.	Suflex HS	B601860	M38R-P38R
C57	"	(deleted)			
C58	"	100pF ±20% 500V.	Suflex HS	B601744	P35R-T35R
C59	"	100pF ±20% 500V.	Suflex HS	B601744	P36R-T36R
C60	"	470pF ±20% 500V.	Suflex HS	B602384	T34R-X34R
C61	"	470pF ±20% 500V.	Suflex HS	B602384	T36R-X36R
C62	"	.01μF ±10% 500V.	Suflex HS	B604907	M33R-P33R
C63	"	1500pF ±20% 500V.	Suflex HS	B603392	P30R-T30R
C64	"	18pF ±10% 500V.	Suflex HS	B600189	Valve V30
C65	"	(See Section 2)			
C66	"	(deleted)			
C67	"	(deleted)			
C68	"	(deleted)			
C69	"	(deleted)			
C70) C71)	"	8μF+8μF 500V.	Dubilier CT8850	B608501	P.C.
C72	"	8μF 350V.	Plessey CE4530/22	B608505	P.C.
C73	"	32μF 350V.	Plessey CE513/1	B609071	P.C.
C74	"	32μF 350V.	Plessey CE513	B609072	P.C.
C75	"	32μF 350V.	Plessey CE513	B609072	P.C.
C76	"	0.25μF 1000V.	Hunts L45	B606773	P.C.
C77	"	0.25μF 1000V.	Hunts L45	B606773	P.C.

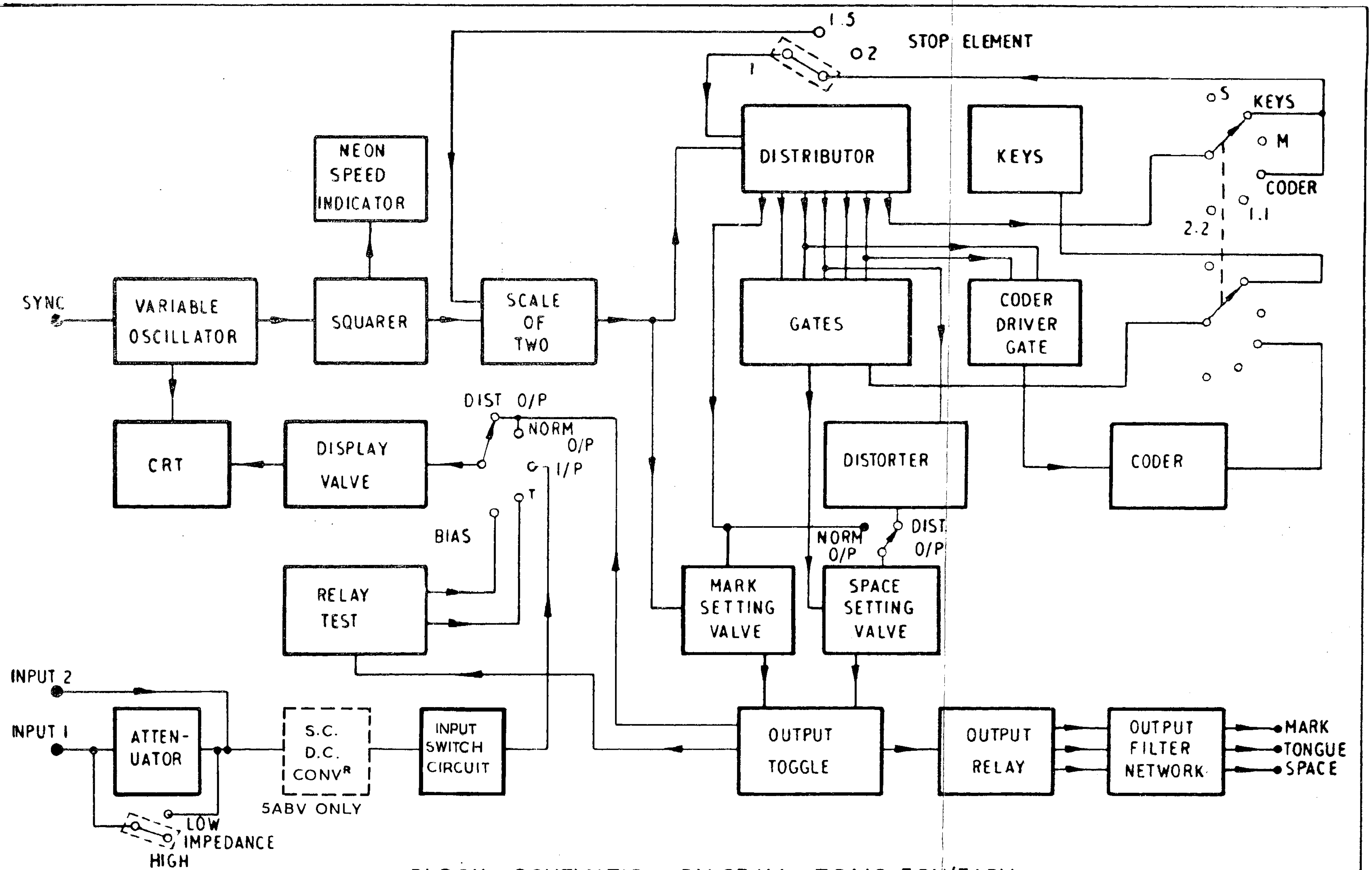
CIRCUIT REFERENCE	DESCRIPTION & TOLERANCE		MANUFACTURER	PART NUMBER	LOCATION
C78	"	0.25μF 1000V	Hunts P19	B606799	P.C.
C79	"	0.25μF 1000V.	Hunts L45	B606773	P.C.
MR1	Rectifier	Q1/5	S.T.C.	B710039	E30L-I30L
MR2	"	Q1/5	S.T.C.	B710039	E26L-I26L
MR3	"	36-K-3	Westinghouse	B710031	AS/R-AT/R
MR4	"	36-K-3	Westinghouse	B710031	AR/R-AS/R
MR5	"	Q1/5	S.T.C.	B710039	T15R-X15R
MR6	"	Q1/5	S.T.C.	B710039	T12R-X12R
MR7	"	Q1/5	S.T.C.	B710039	I8R-M8R
MR8	"	Q1/5	S.T.C.	B710039	I6R-M6R
MR9	"	Q1/5	S.T.C.	B710039	E9R-I9R
MR10	"	Q1/5	S.T.C.	B710039	I11R-M11R
MR11	"	Q8/5	S.T.C.	B710044	T3L-X3L
MR12	"	Q8/5	S.T.C.	B710044	P3L-T3L
MR13	"	Q1/5	S.T.C.	B710039	T33L-X33L
MR14	"	Q1/5	S.T.C.	B710039	E5R-I5R
MR15	"	Q8/5	S.T.C.	B710044	P28R-T28R
MR16	"	Q1/5	S.T.C.	B710039	M36R-P36R
MR17	"	Q1/5	S.T.C.	B710039	A22R-E22R
MR18	"	Q1/5	S.T.C.	B710039	A28R-E28R
MR19	"	Q1/5	S.T.C.	B710039	E35R-I35R
MR20	"	Q1/5	S.T.C.	B710039	P20L-T20L
MR21	"	Q1/5	S.T.C.	B710039	A18R-E18R
MR22	"	Q1/5	S.T.C.	B710039	E18R-I18R
MR23	"	Q1/5	S.T.C.	B710039	A13R-E13R
MR24	"	Q1/5	S.T.C.	B710039	E13R-I13R
MR25	"	Q1/5	S.T.C.	B710039	M18R-P18R
MR26	"	Q1/5	S.T.C.	B710039	M18R-T18R
MR27	"	Q1/5	S.T.C.	B710039	M13R-P13R
MR28	"	Q1/5	S.T.C.	B710039	I13R-M13R
MR29	"	Q1/5	S.T.C.	B710039	P19R-T19R
MR30	"	Q1/5	S.T.C.	B710039	T20R-X20R
MR31	"	14-D-46	Westinghouse	B710028	P.C.
MR32	"	14-D-46	Westinghouse	B710028	P.C.
MR33	"	36-MB-14	Westinghouse	B710029	P.C.
MR34	"	36-MB-14	Westinghouse	B710029	P.C.
MR35	"	36-MB-14	Westinghouse	B710029	P.C.
MR36	"	36-MB-14	Westinghouse	B710029	P.C.
*MR37	"	OA202	Mullard	B710082	F.P.
*MR38	"	OA202	Mullard	B710082	F.P.
*MR39	"	OA202	Mullard	B710082	P.C.
*MR40	"	OA202	Mullard	B710082	P.C.
T1	Mains Transformer		Gardener	B660277	P.C.
L1	Choke		A.T.E. (B) Ltd.	B105/0450	P.C.
L2	"		A.T.E. (B) Ltd.	B105/0450	P.C.
L3	"		A.T.E. (B) Ltd.	B105/0450	P.C.
LP1	Bulb		G.E.C. No. 11	B650208	P.C.
LP2	"		G.E.C. No. 11	B650208	P.C.

CIRCUIT REFERENCE	DESCRIPTION & TOLERANCE	MANUFACTURER	PART NUMBER	LOCATION
N1	Neon XC12	Hivac	B640395	P.C.
N2	" CC3L	Hivac	B640382	P.C.
N3	" CC8L	Hivac	B640348	F.P.
N4	" CC8L	Hivac	B640348	F.P.
N5	" CC3L	Hivac	B640382	T20L-X20L
N6	" XC15	Hivac	B640359	I15R-I16R
S1	Switch (Display)		B680313	F.P.
S2	" (Coder)	NSF 8370/B3	B680324	F.P.
S3	" (Range)		B680362	F.P.
S4	" (Signal Selector)		B680342	F.P.
S5	(deleted)			
S6	Switch (Mains)	NSF 8370/B3	B680324	F.P.
S7	(deleted)			
*S8	Switch (S.C./D.C.)	A.T.E. (B) Ltd.	B104/1610	F.P.
K1	Key Switch	NSF 8381/K7	B680315	F.P.
K2	" "	NSF 8381/K7	B680315	F.P.
K3	" "	NSF 8381/K7	B680315	F.P.
K4	" "	NSF 8381/K7	B680315	F.P.
K5	" "	NSF 8381/K7	B680315	F.P.
	Valves 12AU7 - Quantity 13		B640333	-
	Valves 12AX7 - Quantity 2		B640340	-
	Valves 6AQ5 - Quantity 1		B640384	-
	Valves 6X4 - Quantity 1		B640386	-
PLA	Mains plug (with socket)	Bulgin P73	B720322	B.P.
SKTA	Relay Socket	T.M.C.	B720272	B.P.
SKTB	" "	T.M.C.	B720272	F.P.
	Coder Socket		SA5-17372	B.P.
Knob (for Signal Selector)		A.T.E. (B) Ltd.	B740340	F.P.
Knob (for Display Switch)		A.T.E. (B) Ltd.	B740340	F.P.
Knob (for fine Speed control)		Crystalite	B740343	F.P.
Knob (for Range switch)		A.T.E. (B) Ltd.	B740340	F.P.
Knob (for Amplitude control)		A.T.E. (B) Ltd.	B740340	F.P.
Knob (for Focus control)		Crystalite	B740343	F.P.
Knob (for Brilliance control)		Crystalite	B740343	F.P.
Knob (for Distortion control)			B740375	F.P.
Knob (for Distortion control)			B740376	F.P.
Grub Screw for B740340			B361122	F.P.
Grub Screw for B740343			B361705	F.P.
Valve Retainers Quantity 15		McMurdo 7/6	B650282	-
" " Quantity 1		McMurdo 9/1A	B650248	-
Valve Holders (B9A) Quantity 15		McMurdo FM9/UC1/10P	B650197	-
" " (B7G) Quantity 2		McMurdo XM7/UC1/10P	B650096	-
Fuse Carriers (Mains) Quantity 2		Belling & Lee 356	B700006	B.P.
F1 Fuse 1A		Belling & Lee 1055	B700005	B.P.
F2 Fuse 1A		Belling & Lee 1055	B700005	B.P.
CRT Cathode Ray Tube		Mullard DG-7-32	B640383	
Relay (High Speed)		TMC 3N1Z	B690100	
Coder Type TDA-10		A.T.E. (B) Ltd.	B101/0361/*	

(*) Signifies coding disc fitted.

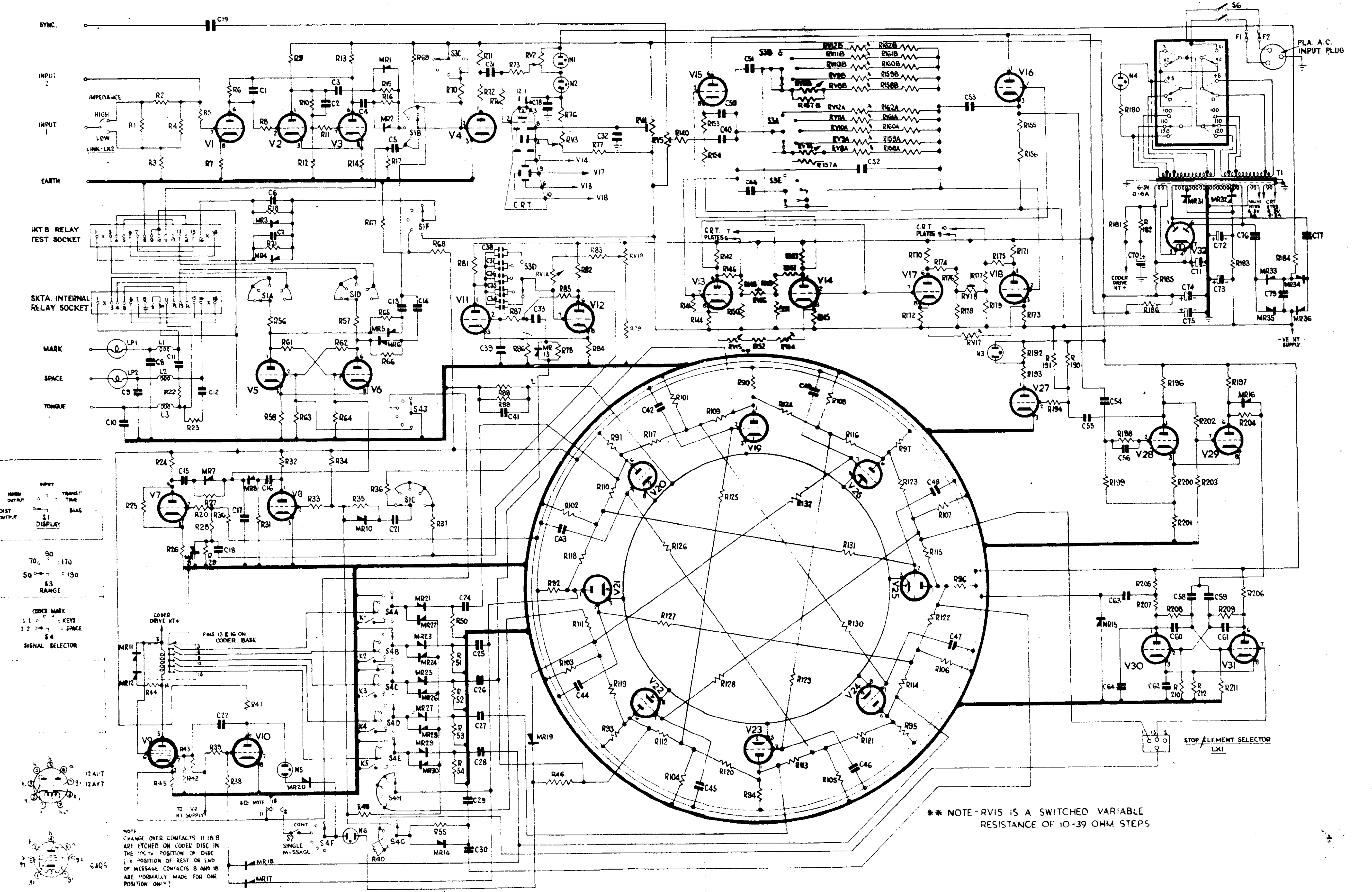
2. COMPONENTS RELATING TO TDMS5BV & TDMS5ABV

CIRCUIT REFERENCE	DESCRIPTION & TOLERANCE	MANUFACTURER	PART NUMBER	LOCATION
R3	Resistor 1kΩ ±5%	Painton P302	B623024	A22L-A29L
R83	" 330kΩ ±10%	Erie Type 8	B606151	I32L-E32L
R157A	" 130kΩ ±1%	Erie Type 108	B625654	F.P.
R157B	" 130kΩ ±1%	Erie Type 108	B625654	F.P.
R158A	" 42kΩ ±1%	Erie Type 108	B628361	AAL-ABL
R158B	" 42kΩ ±1%	Erie Type 108	B628361	ABL-ACL
R159A	" 142kΩ ±1%	Erie Type 108	B628131	ADL-AEL
R159B	" 142kΩ ±1%	Erie Type 108	B628131	AEL-AFL
R160A	" 70kΩ ±1%	Erie Type 108	B628130	AGL-AHL
R160B	" 70kΩ ±1%	Erie Type 108	B628130	AHL-AJL
R161A	" 20kΩ ±1%	Erie Type 108	B624613	AKL-ALL
R161B	" 20kΩ ±1%	Erie Type 108	B624613	ALL-AML
R162A	" 16kΩ ±1%	Erie Type 108	B624482	ANL-APL
R162B	" 16kΩ ±1%	Erie Type 108	B624482	APL-AQL
C34A	Capacitor .02μF ±5% 350V	Suflex HS	B605041	A30/L-E33/L
C34B	" .01μF ±5% 350V	Suflex HS	B604948	A30L-E33L
C35A	" .02μF ±5% 350V	Suflex HS	B605041	A32/L-E33/L
C35B	" 1500pF ±10% 500V	Suflex HS	B603396	A32L-E35L
C36A	" .01μF ±5% 350V	Suflex HS	B604948	A34/L-E37/L
C36B	" 6800pF ±5% 350V	Suflex HS	B604262	A34L-E37L
C37A	" 6800pF ±5% 350V	Suflex HS	B604262	A35/L-E38/L
C37B	" 2000pF ±10% 500V	Suflex HS	B603515	A35L-E38L
C38A	" 6800pF ±5% 350V	Suflex HS	B604262	A36/L-E39/L
C38B	" 1000pF ±10% 500V	Suflex HS	B603343	A36L-E39L
C50	" 5000pF ±1% 350V	J & M C33R	B604038	E2/L-E8/L
C51	" .02μF ±1% 200V	J & M C55R	B605114	T2/L-T8/L
C52	" .03μF ±1% 200V	J & M C55R	B605269	X2/L-X8/L
C53	" 5000pF ±1% 350V	J & M C33R	B604038	A2/L-A8/L
C65	" .002μF ±10% 500V	Suflex HS	B603515	T9L-X9L



BLOCK SCHEMATIC DIAGRAM TDMS 5BV/5ABV

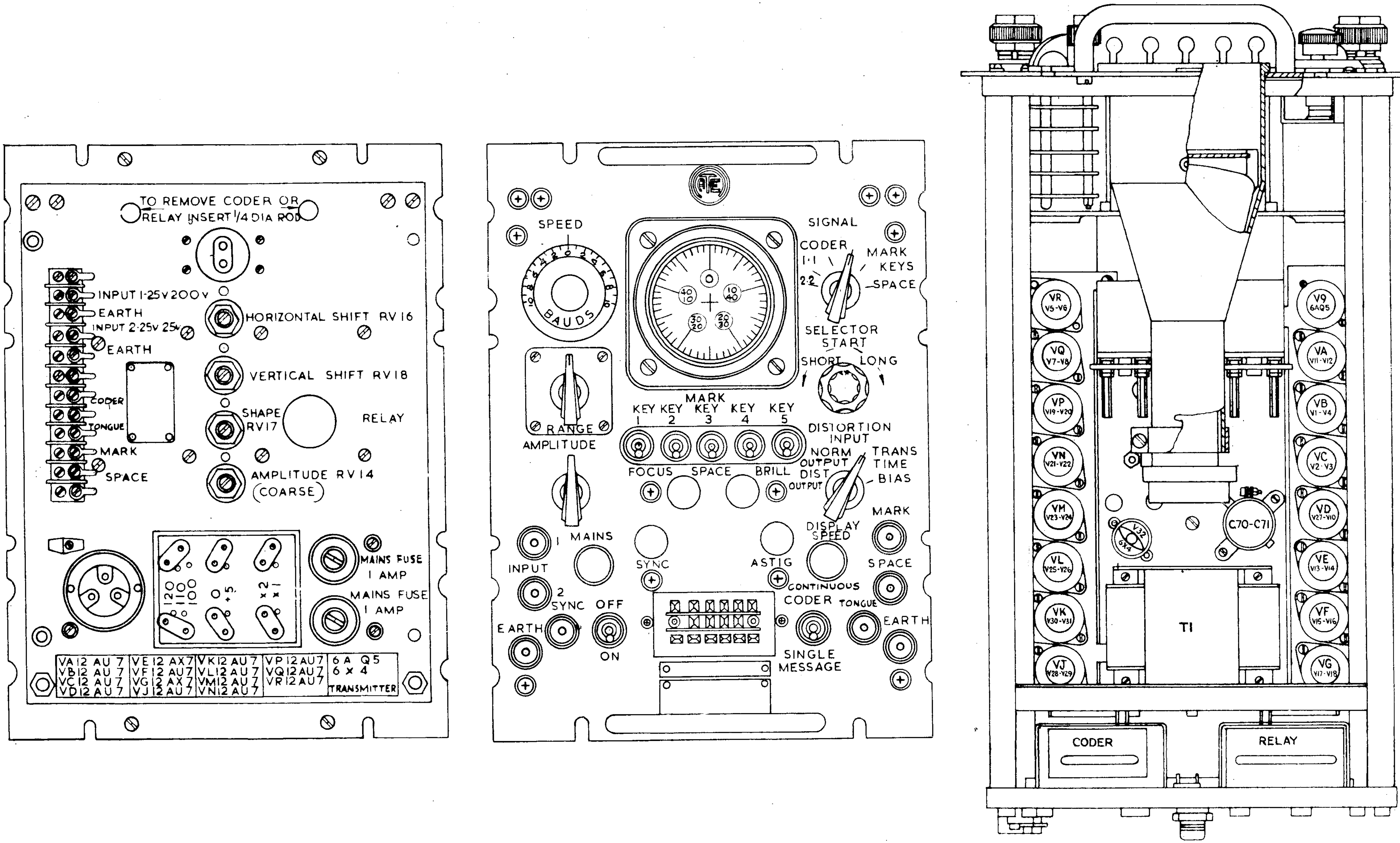
FIG. I.



T.D.M.S. 5BV. CIRCUIT DIAGRAM. MK.6

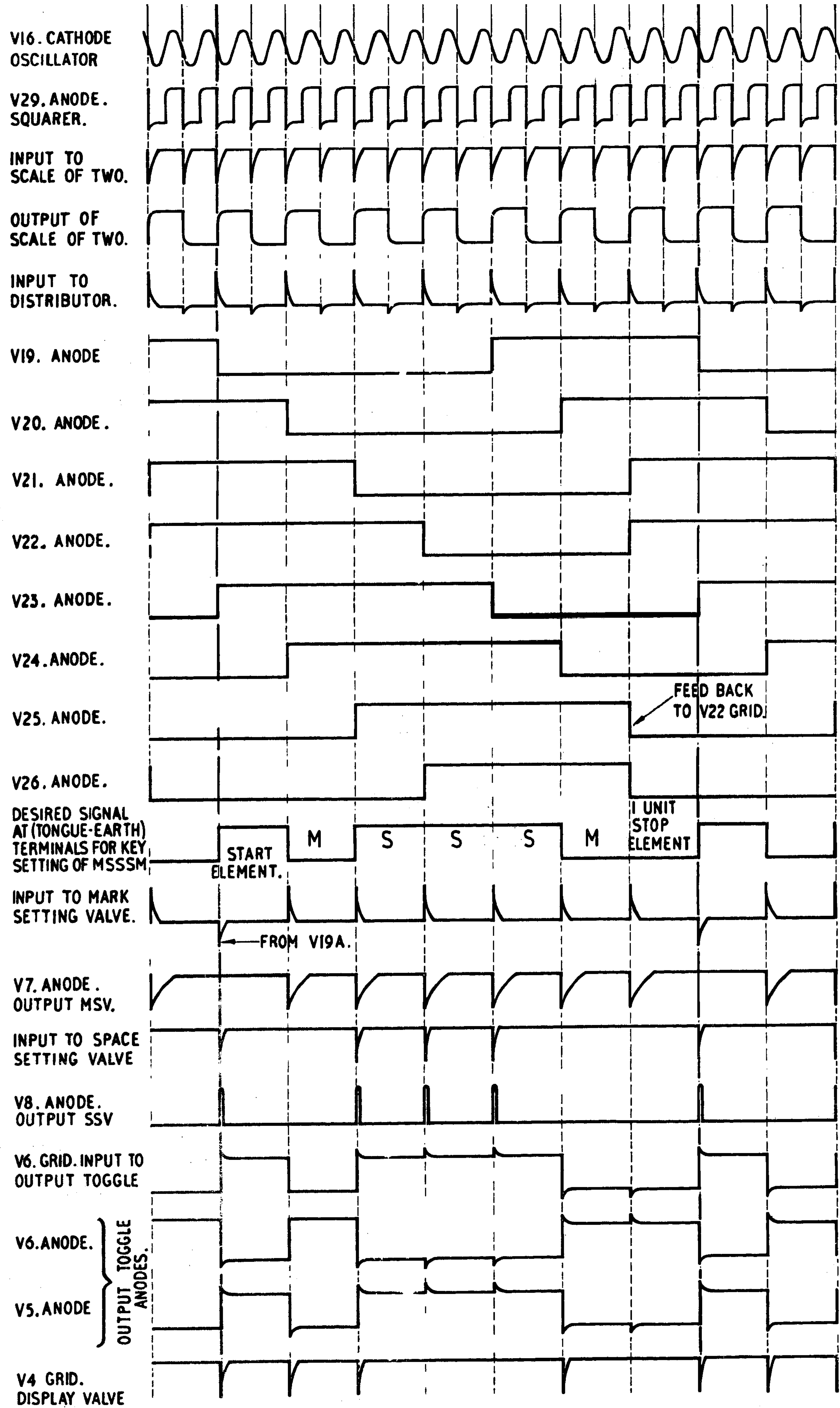
FIG. 2

CDB500/0050



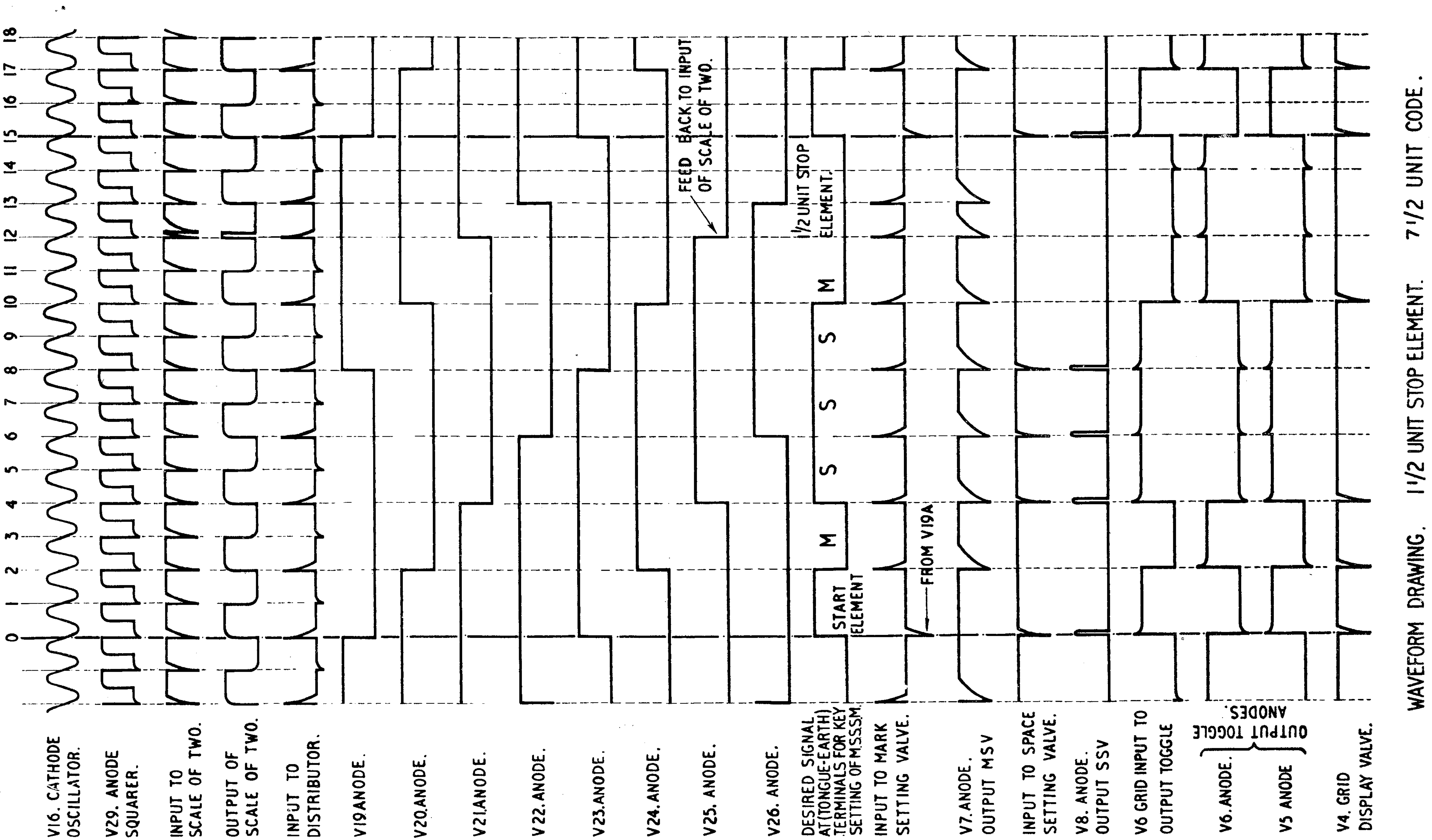
TDMS 5BV/5ABV — INSTRUMENT LAYOUT

FIG. 3



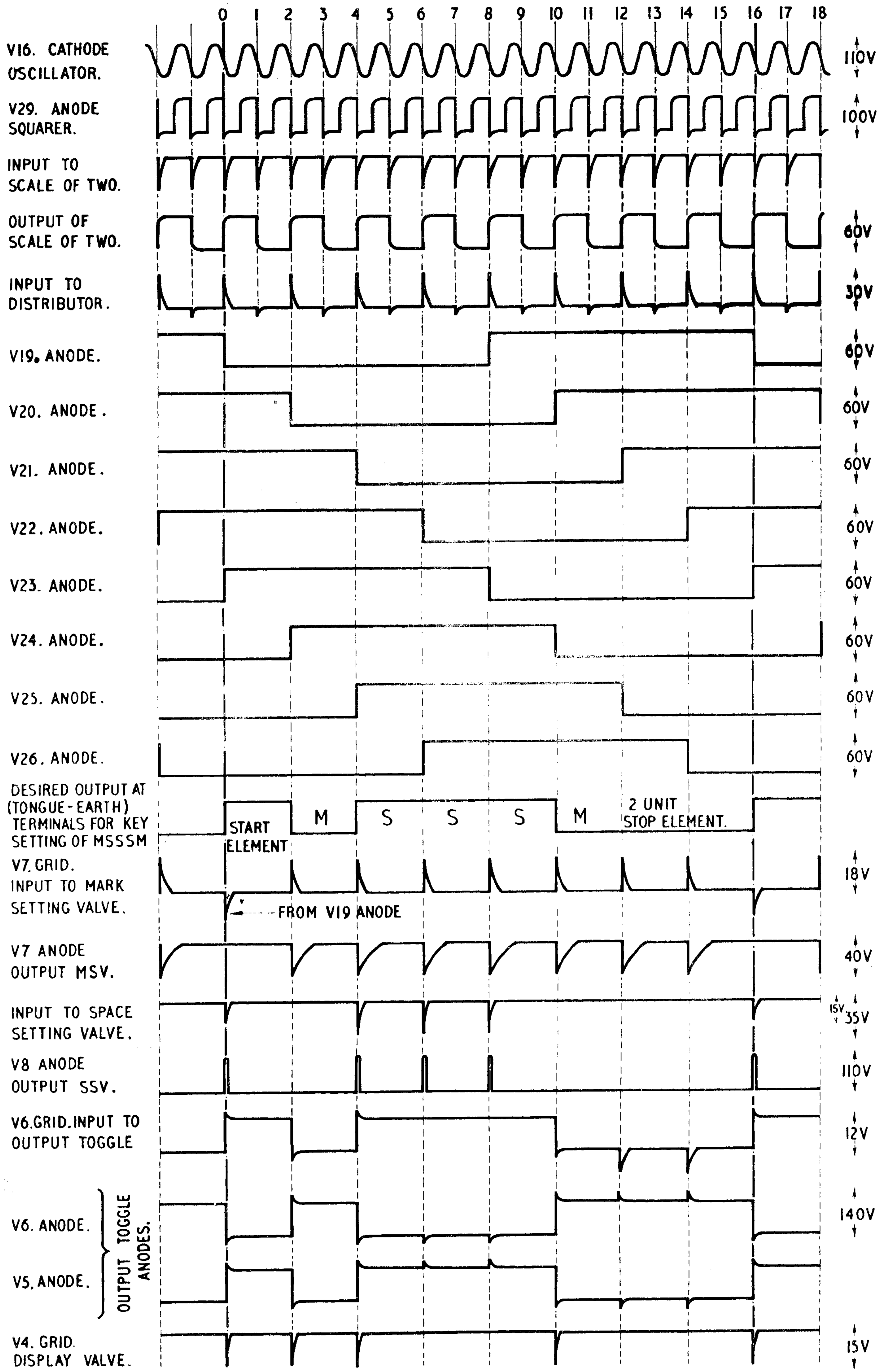
WAVEFORM DRAWING. 1 UNIT STOP ELEMENT. 7 UNIT CODE.

FIG. 4



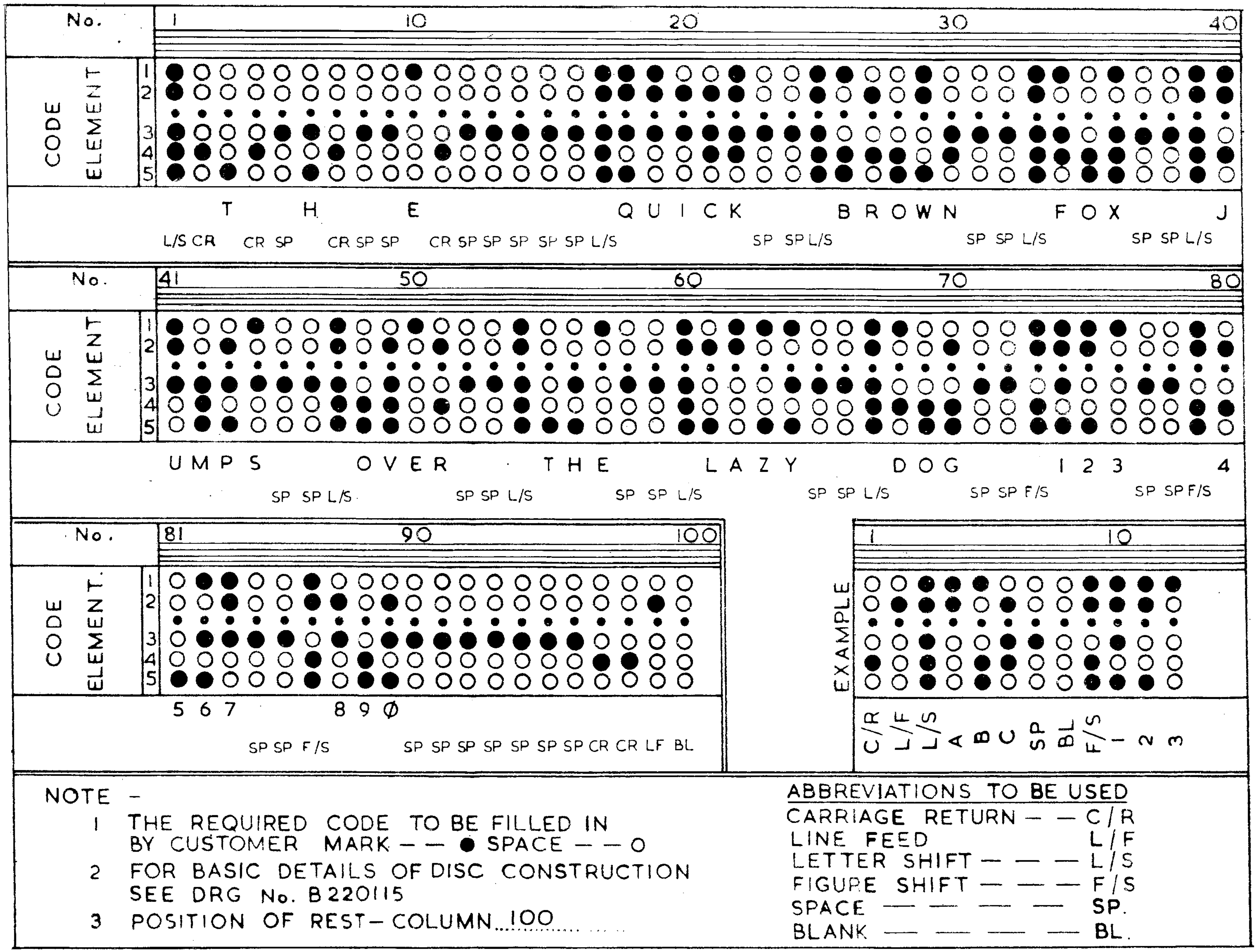
WAVEFORM DRAWING. 1 1/2 UNIT STOP ELEMENT. 7 1/2 UNIT CODE.
V16. CATHODE OSCILLATOR.
V29. ANODE SQUARER.
INPUT TO SCALE OF TWO.
OUTPUT OF SCALE OF TWO.
INPUT TO DISTRIBUTOR.
V19 ANODE.
V20. ANODE.
V21. ANODE.
V22. ANODE.
V23. ANODE.
V24. ANODE.
V25. ANODE.
V26. ANODE.
DESIRED SIGNAL AT (TONGUE-EARTH) TERMINALS FOR KEY SETTING OF M.S.S.S.M.
INPUT TO MARK SETTING VALVE.
V7. ANODE. OUTPUT MSV
INPUT TO SPACE SETTING VALVE.
V8. ANODE. OUTPUT SSV
V6 GRID INPUT TO OUTPUT TOGGLE
V6. ANODE.
V5 ANODE
OUTPUT TOGGLE ANODES.
V4. GRID DISPLAY VALVE.
FEED BACK TO INPUT OF SCALE OF TWO.
1/2 UNIT STOP ELEMENT.
START ELEMENT
M
S
S
S
M
FROM V19A
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

FIG. 5



WAVEFORM DRAWING. 2 UNIT STOP ELEMENT. 8 UNIT CODE.

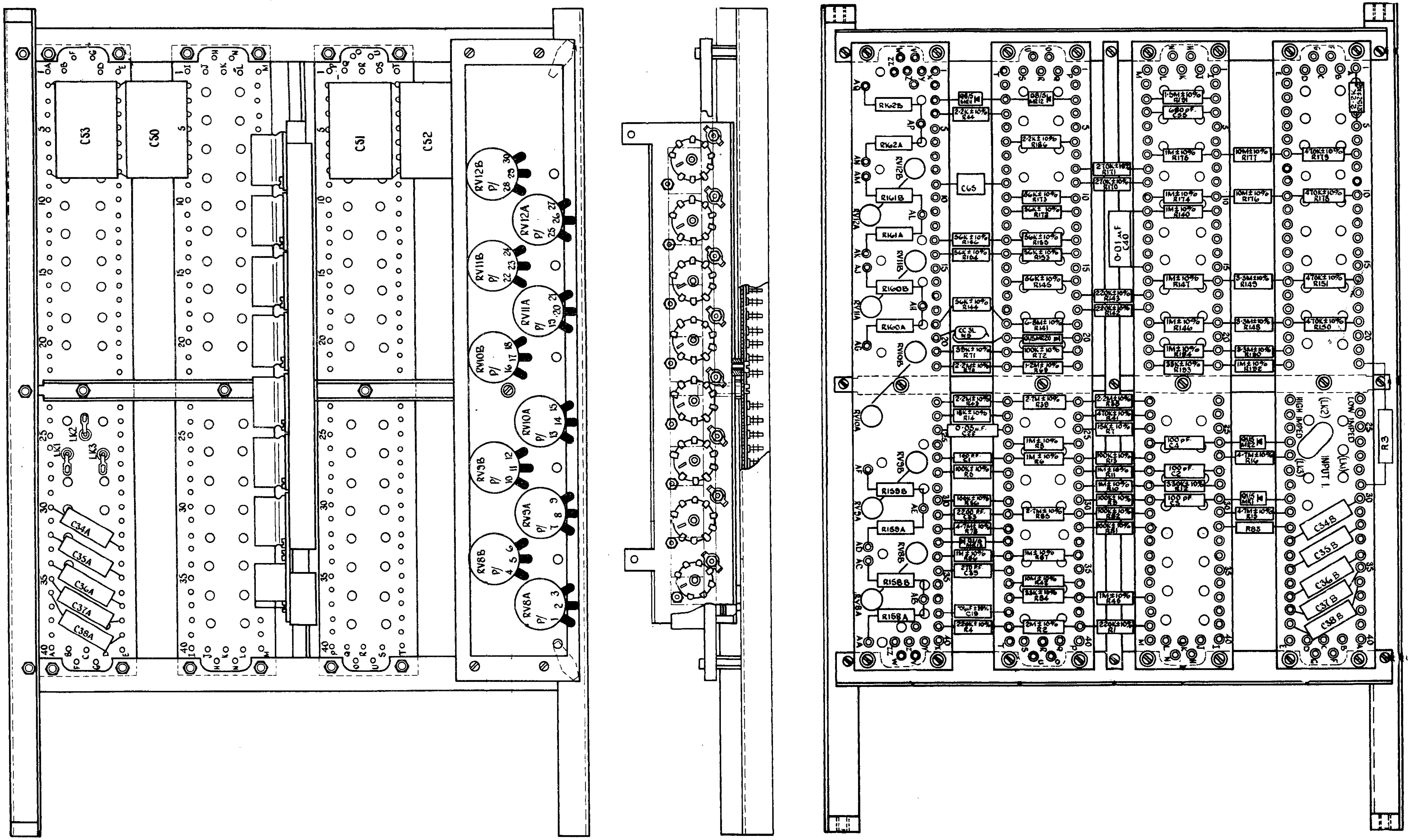
FIG. 6



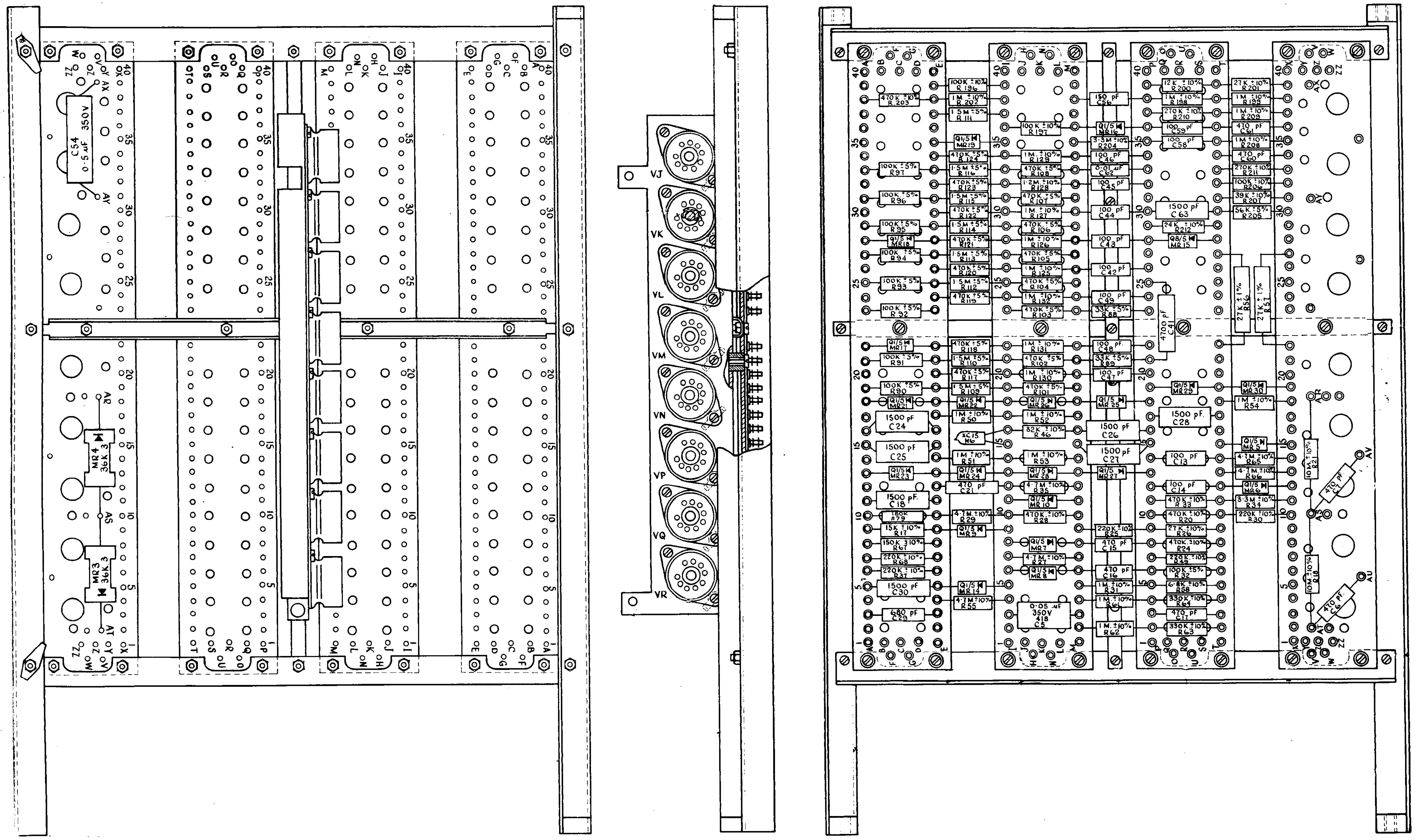
B990210/1

FORM FOR 100 CHARACTER CODING DISC -
PRINTED CIRCUIT - STANDARD

FIG. 7



TDMS5BV — LEFT-HAND SIDE PANEL (B104/1603) FIG. 8



TDMS5BV/5ABV — RIGHT-HAND SIDE PANEL (B104/1611) FIG.9