EKCO

ELECTRONIC EQUIPMENT

VIBRATING REED ELECTROMETER
TYPE N616A

TECHNICAL INSTRUCTIONS

EKCO ELECTRONICS LTD.
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57082

EKCO

VIBRATING REED ELECTROMETER

TYPE N616A

CONTENTS

SECTION 5. (Cont'd)

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VIBRATING REED ELECTROMETER

TYPE N616A

AMENDMENT LIST A.L.1.

Para.1.1. Page 1.
Amend range to read:- 10^{-8} to 10^{-15}.

Para.1.3. Page 1.
Amend 'Input resistors (ohms)' to read:- 10^{8},10^{10},10^{12} $\pm$10%, ratios matched to $\pm$5%.

Add:- Input time constants on 10^{8} 0.1 Sec.
" 10^{10} 0.5 "
" 10^{12} 1.0 "

Para.4.2. 5th para. on Page 7.
Amend 'feedback switch SW1. SW1.....' to read:- 'Input switch SW3. SW3.....'.

Spare Parts List. Pages 13,14 and 15.
RV1 is now Part No. C110107/19.
Add items marked * below.

Circuit Diagram. Fig.1. Amend as follows:-
* R58 is now 4.7K W.W. TG75. $\pm$5% Part No. C114157/77
* Add two diodes, D3 and D4, Type OA81, Part No. 57238. These are connected in series and connected across diodes, D1,D2, in the same polarity. The junction of D3,D4 is connected to the slider of RV10.
The bottom of RV10 is connected to chassis, not -105V.
* Fuses, FS2 and FS3, are now 2 Amp. (Part No. A13569/2) for 200-250V, and 3 Amp. (A13569/3) for 110-120V.
On valve V7, grid 2 is pin 9, not pin 4.
On valve V9, delete pin 8.
SW2A should be shown as a 7 position switch, making on position 7 (fully clockwise) only.
SW2B (7 position) requires a further (clockwise) contact which is connected to contact 6.
The leads to pin B and K of SK4 are now interchanged.

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AMENDMENT LIST A.L.2

C20 and R31 are now deleted.
RV1 is now 20K, Part No. C110107/9

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VIBRATING REED ELECTROMETER TYPE N616A

SECTION 1 GENERAL DESCRIPTION

1.1. PURPOSE

The N616A is intended primarily for the measurement of very small currents from ionisation chambers, but may also be used for measuring other small direct currents in the range 10^{-8} to 10^{-15} amperes, from sources which have a resistance to earth very much greater than the value of the input resistor selected in the N616A. (Preferably x100 but not less than x10).

1.2. DESCRIPTION

The instrument comprises two separate units, an electrometer head unit and an indicator unit, coupled together by two twelve way cables.

1.2.1. THE HEAD UNIT

Is a sealed and desiccated unit containing three input resistors with a press button selector switch, a vibrating reed type dynamic capacitor and an A.C. amplifier with a cathode follower. The latter provides a low impedance output to the indicator unit.

Power supplies for the head unit are derived from the indicator unit via plug and socket cable connections.

A co-axial plug is provided for the electrometer input or, alternatively, facilities are provided for bolting an ion chamber directly to the head unit.

1.2.2. INDICATOR AND POWER UNIT

The indicator chassis contains a discriminator, vibrating reed oscillator circuit and a power supply unit, and can be supplied either as a rack mounting unit or with an instrument case for bench use. A jack socket for the connection of an external recorder is provided.

1.3. ELECTRICAL CHARACTERISTICS

Mains input consumption	110-120V or 200-250V single phase A.C. 50-60 c/s. 40W approximately.
Ranges (millivolts)	0-3, 0-10, 0-30, 0-100, 0-300, 0-1000, 0-3000. In its most sensitive condition, the instrument gives a full scale reading for a current of .003 µµA.
Input resistors (ohms)	10^8, 10^{10}, 10^{12} all ±5%, matched. ±10% ratios

Input time constants on 10^8 0,1 Sec
" 10^{10} 0,5 Sec
" 10^{12} 1,0 Sec

Accuracy	±5%.
Electronic stability	Better than ±100 μV.
Outputs	For 100 mV potentiometric recorder.

1.4. PRINCIPLE OF OPERATION

The current to be measured is applied to the selected input resistor and the voltage developed across this resistor is applied, via a stand-off resistor to a vibrating reed type dynamic capacitor, the capacity of which is changed cyclically at a frequency of about 450 c/s. The resultant A.C. signal generated is proportional to the D.C. flowing in the input resistor.

The A.C. voltage is amplified, subsequently rectified and displayed on the indicator panel meter. A percentage of the output voltage is applied as negative feedback either to the earthy end of the input resistor or to the dynamic capacitor to provide drift stability.

1.5. COMPOSITION OF EQUIPMENT

The following items comprise a complete equipment.

	Qty.
Head Unit	1
Indicator Unit	1
12 way Cable	2
Mains Cable	1
Mark IV Socket (Co-axial)	1

1.6. DIMENSIONS AND WEIGHT

	Height	Width	Depth
Head Unit	7½ in.	6¼ in.	9¾ in.
Indicator Unit	7 "	19 "	13 "

SECTION 2 INSTALLATION

2.1. INITIAL INSPECTION

After unpacking, check the meter pointer for freedom of movement by means of the mechanical set zero screw, and re-set to zero. Remove the cover from the indicator unit and ensure that all valves are securely seated with their retainers correctly positioned.

The head unit is sealed and desiccated, and should not be disturbed unless found to be inoperative. (See para.5.7).

2.2. RACK MOUNTING

Although the N616A is normally fitted with an instrument case, it can be fitted into a standard 19 in. rack, being secured by the screws in the slots at each end of the front panel.

Front panel handles can be supplied. These fit, one each side of the front panel, via the holes masked by screws adjacent to the slots.

2.3. ION CHAMBER CONNECTION

The head unit is provided with an ion chamber mounting face which is normally covered by a plate carrying the co-axial input plug.

To fit an ion chamber, first detach the cover plate by releasing the two fixing screws and unsoldering the input plug connections. This exposes two $\frac{1}{4}$ in. 4UNC tapped holes on $1\frac{3}{4}$ in. centres for attaching a suitable chamber, which must be of the earthed type.

After bolting on the chamber, remove the cover plate on the front of the head unit immediately below the chamber face and solder the ion chamber connections to the input terminals. Replace the cover.

When the location of the chamber is remote from the head unit, a connecting cable must be used which should be anti-microphonic and of high insulation resistance.

A suitable co-axial cable is type PT11GM which has insulation resistance better than 10^{14} ohms when correctly prepared. A maximum length of 2 ft. may be used as additional length will affect the performance of the instrument. A socket to mate with the INPUT plug is supplied.

When using a cable connection, the cover on the chamber mounting face must be left in position or refitted as appropriate. Always replace the screwed plug cover when the INPUT plug is not in use.

2.4. RECORDER CONNECTION

If it is required to use a recorder, this must be of 100 mV sensitivity and high input impedance, and may be plugged into the RECORDER jack socket on the indicator rear panel.

2.5. MAINS INPUT

Before connecting to the mains, the transformer tappings should be set to the voltage of the local supply. Adjustment is made by the two insulated screws in the inset moulding on the rear panel.

A check should also be made to ascertain that the fuse-holders are fitted with fuses of the correct rating. Those fitted are 2 Amp. type for 200-250V operation. 3 Amp. type for 110-120V operation are supplied in a polythene bag with the instrument.

2.6. CABLE CONNECTIONS

A 6 ft. mains connector is supplied with a Mark IV plug termination at one end. This plugs into the three pin MAINS INPUT socket at the rear of the indicator unit.

The two twelve way cables have dissimilar plug and socket terminations and are used to connect the electrometer head unit to the indicator unit, via the appropriate plugs and sockets.

SECTION 3 OPERATION

3.1. GENERAL

For maximum zero stability the N616A should be left permanently switched on. When first switched on, or after long periods of disuse, the instrument should be left on for at least twenty-four hours to allow the zero to stabilise before taking a measurement.

3.1.1. RECOVERY TIME

When using the 10^{12} ohms input resistor it may be found that the instrument takes up to one minute to return to zero after operation of the INPUT press button switch or the SET ZERO control. This effect is caused by charges generated by subjecting the high insulation components to severe electrical or mechanical shocks.

3.2. OPERATING CONTROLS

The controls and their functions are listed below.

(a) INPUT SELECTOR SW1. (On head unit). A five section press button switch. Reading from the left the first three sections select the input resistor. The fourth section short circuits the input for setting the instrument zero. The fifth position open circuits the input to cater for an external load or for rate of charge measurements.

(b) RANGE IN MILLIVOLTS, SW2. A seven position rotary switch enabling the required meter range to be selected.

(c) MAINS SWITCH, SW4. A toggle switch controlling the mains input.

The following operating controls are located under a panel at the left of the indicator.

(d) INPUT, SW3. ION CHAMBER/VOLTAGE. Switches negative feedback to either the input resistors or the dynamic capacitor.

(e) SET ZERO, RV3. A fine control for setting the electrical zero of the instrument.

(f) INPUT POLARITY SWITCH SW5. This switch enables positive or negative inputs to be measured without reversing the input connections. With the INPUT switch SW3 at 'Voltage' a voltage applied across the input will be opposite to that indicated by the INPUT POLARITY switch SW5.

3.3. PRE-SET CONTROLS

See Section 5 for the adjustment of pre-set controls, all of which are factory pre-set and normally should not require re-adjustment.

(a) RV1. Zeros the discriminator.

(b) RV2. For the calibration of the meter ranges.

(c) RV4. Coarse SET ZERO control.

(d) RV5, RV6. These controls set the negative and positive H.T. lines to their nominal values.

(e) RV8. Balances the electrometer valve heater for minimum hum.

(f) RV7, RV9. These controls compensate the negative and positive H.T. lines against valve drift with mains variations.

(g) RV10. GAIN control.

3.4. OPERATION

When using an earthed ion chamber as the current source, either bolted directly to the head unit or connected by cable, switch the INPUT switch SW3 to the 'Ion Chamber' position.

Switch the INPUT press button switch to position 4 (short circuit) then adjust the SET ZERO control for zero reading on the meter.

Switch the INPUT POLARITY switch to the appropriate position.

Switch the RANGE switch to the 1 volt range, then select the input resistor required with its press button switch SW1. The sensitivity can then be increased progressively by means of the RANGE switch until the meter shows a suitable deflection.

NOTE: If the normal fluctuations of the meter reading when using the 10^{12} ohms resistor are too large in a particular case, a small capacitor of about 5 pF and of insulation exceeding 10^{14} ohms may be connected across the 10^{12} ohms resistor. This will provide integration of randoms on the input signals, but will also lengthen the response time of the instrument.

When using a low impedance source, the INPUT switch SW3 should be switched to the 'Voltage' position.

SECTION 4 — CIRCUIT SUMMARY

4.1. THE HEAD UNIT

The very small current output from an ionisation chamber is applied to one of three input resistors R1, R2, R3 which produces a D.C. voltage. R2 and R3 are shunted by high insulation capacitors which assist in speeding up the application of negative feedback when applied to the earthy end of the input resistor.

The voltage developed across the input resistor is applied via a stand-off resistor R4 to the anvil, or fixed plate, of a dynamic capacitor.

The anvil is provided with a threaded shank for variation of the air gap. This adjustment must not be interfered with, or irreparable damage may occur to either the anvil vibrating reed or both.

The A.C. output from the vibrating reed is fed via a coupling capacitor C4 and the pacifying network C3, R5 to the grid of the electrometer valve V1. This valve is operated at reduced potentials to raise the input impedance and, together with V2 and V3, is mounted to suppress microphony.

V2 is an amplifier with a tuned circuit L1, R13, R14, C8 as the anode load, to give preferential amplification to the resonant frequency of the vibrating reed.

Output from V2 is coupled via C10 to a cathode follower V3, and thence to the output plug via C13.

4.2. THE INDICATOR UNIT

The first valve in the indicator unit, V4, discriminates between positive and negative inputs. 450 c/s from the oscillator V5A is applied to V4 suppressor grid via C21, R32, and also to the control grid via the vibrating reed and the Head Unit. V4 is cut off by negative half cycles at the suppressor, conducting only on positive half cycles, the diode clamp V5 holding the suppressor at cathode potential during this period.

R30 provides a low impedance inspection point for the connection of an oscilloscope, to enable the waveform at V4 anode to be examined.

With no signal at the control grid of V4, the anode waveform should be an approximate square wave, due to the 450 c/s switching action at the suppressor. The valve is cut off during the upper half cycle of the square wave, the lower half cycle occurring when the suppressor swings positive and permits the valve to conduct. It is only during this period that the valve is controlled by the control grid.

When a sine wave from V3 is applied to the grid, the lower portions of the square wave are either augmented or reduced depending upon the amplitude and phase of the sine wave superimposed on them.

The output from V4 anode is integrated and directly coupled to a valve voltmeter circuit. Residual 450 c/s is filtered out by the network R28, R36, R50, C24, C25. R41 to R45 are multipliers for the meter and external recorder, which connects across the meter.

A feedback voltage is tapped off from V6 cathode via the CALIBRATION control RV2, and applied either to the input resistors or vibrating reed via the ~~feedback~~ input switch SW3. SW3 has three ganged sections for changing over the zero setting and feedback voltages, and also the phase of the reed maintaining oscillator V5A simultaneously.

A jack socket JK1 is provided to enable a calibrating voltage to be injected via the feedback line and CALIBRATION control RV2.

The set zero voltage is derived from the potentiometer chain R46 RV3, R47, R48, R53, R54, R49, RV4 and Zener diodes D1, D2.

4.3. THE POWER SUPPLY

Power supplies are derived from a mains transformer T1 and a full wave rectifier V13 feeding D.C. to a series control valve via the smoothing filter L3, C35, C36. Automatic regulation is provided by the series valve V11 controlled by the shunt amplifiers, V12A, V12B, in conjunction with a reference neon V10. The nominal output voltage is set by RV6, which is the variable element of the potentiometer network R77, R67, R68, R78, RV6, R69. A second neon V9 maintains V12A supply voltage at a constant potential of 90V above the stabilised H.T. line, enabling the cascode stabilising circuit to have a wider range of control.

V7 and V8 form a D.C. amplifier which maintains the ratio of the voltages above and below the cathode of V7 under operating conditions.

Additional stabilisation is effected by the potentiometers RV7, RV9, which compensate for the effects of variations in the valve heater voltages, due to mains fluctuations. Unstabilised +H.T. is fed to the reference neon V10 via R74, R75, RV7, RV9, so that the neon current alters in sympathy

with the unstabilised H.T. voltage variations. Variations in the reference voltage thus produced affect the bias of the amplifiers V8 and V12B in opposition to the effect caused by mains variations.

SECTION 5 MAINTENANCE

5.1. GENERAL

Queries relating to this instrument and requests for spare parts should be addressed to the nearest agent of Ekco Electronics Ltd., in your country, or to:-

Installation and Service Dept.,
Ekco Electronics Ltd.,
Southend-on-Sea, Essex.

5.2. VALVES AND EQUIVALENTS

Valve	Mullard	Mazda	U.S.A.	Brimar
V1,2	ME1400			
V3,5,6,12,	M8162		6060	6060
V4	6AS6		6AS6	
V7	EL84			
V8	EF91	6F12	6AM6	803
V9	90C1			
V10	83A1			
V11	EL360		6BQ6	
V13	CZ34		5X4	

NOTE: Owing to the fact that valves bearing a common type number are produced by a large number of U.S.A. manufacturers and that many of these are not available in Great Britain, we cannot guarantee that every American valve of a common type will operate as a direct replacement. If difficulty is experienced as a result of the foregoing, it may be due to one specific manufacturer's valve and other makes should be tried.

5.3. VALVE BASE DATA

Valve	1	2	3	4	5	6	7	8	9	TC	Base
ME1400	Met	H	A	G2	G3		H	K		G1	I.Oct.
6060	A"	G"	K"	H	H	A'	G'	K'	HCT		B9A
6AS6	G1	G1	K	H	H	A	G2	G3			B7G
EL84		G1	K-G3	H	H		A		G2		B9A
EF91	G1	K	H	H	A	IC	K				B7G
90C1	A	K	IC	K	A	IC	K				B7G
83A1											B7G
EL360	IC	H	IC	G2	G1		H	K-G3			I.Oct.
GZ34	IC	H		A1		A2		H-K			I.Oct.

5.4. VALVE ELECTRODE VOLTAGES (Average)

HEAD UNIT

Conditions:- All D.C. voltages on V1 and V2 are measured with a Null Deflection Bridge. V1 grid (top cap) is earthed.

Valve	Pin No.									
	1	2	3	4	5	6	7	8	9	T.C.
V1		4.5*	89	30			4.5*	1.4		
V2			68	67				3.2		
V3	215	-8	-5			215	-8	-5		

* RMS. Measured across pins 2 and 7.

INDICATOR UNIT

Conditions:- On full load (Head unit connected). Voltages marked * are with respect to -H.T. line. Voltages marked ∅ are RMS. The wiper of RV10 connected to earth.

Valve	Pin No.									
	1	2	3	4	5	6	7	8	9	T.C.
V4	-85	-82	-82		-9	50	-108			
V5	75	-105	-105			-108	-108	-82		
V6	215	-2	0			215	-2	0		
V7		-7	0				215	195		
V8	-23	-20			91	-20	110			
V9					215	300				
V10	-21	-105								
V11		215		520*	185		215	215		410
V12	185	120	123			123	-25	-23		
V13		540*		440 ∅*		440 ∅*		540*		

5.5. SETTING UP OF PRE-SET CONTROLS

5.5.1. TEST EQUIPMENT

The following test instruments will be required:-

(a) Testmeter, 20,000 ohms/volt.

(b) Variable mains supply.

(c) Oscilloscope.

(d) Valve voltmeter, input resistance 40 Megohms minimum.

(e) Decade voltage unit, variable in 1 mV steps, such as Ekco Type N659 or N660.

(f) Variable D.C. backing-off voltage source, to cover -105V to +215V.

5.5.2. SET +320V (RV6)

Connect the testmeter across the +215V and -105V lines, then adjust RV6 to read 320V on the meter.

5.5.3. SET -105V (RV5)

Connect the testmeter across the -105V line and chassis, then adjust RV5 to read -105V on the meter.

5.5.4. HEATER COMPENSATION (RV9)

Connect the testmeter, switched to the highest voltage range and in series with the variable D.C. backing-off supply, across the 215V line and chassis. Switch the meter range progressively downwards, at the same time adjusting the backing-off voltage until the meter balances at approximately mid-scale on the 1V range.

Using the variable mains supply, vary the mains input plus and minus 10% about its nominal value, then adjust RV9 for minimum meter deflection.

5.5.5. HEATER COMPENSATION (RV7)

Follow the procedure detailed in para.5.5.4. connecting the meter and backing-off supply between the -105V line and chassis, and adjusting RV7.

5.5.6. DISC. BALANCE (RV1)

With the head unit connected, short-circuit the wiper of RV10 to chassis and adjust RV1 for zero on the indicator meter.

5.5.7. HUMDINGER (RV8)

Connect the oscilloscope to the input side of C16 and adjust RV8 for minimum hum.

5.5.8. COARSE SET ZERO (RV4)

With the FINE ZERO control RV3 set to mid-travel and the push button switch in the 'Short Circuit' position, adjust RV4 for meter zero.

5.6. MEASUREMENT OF INPUT RESISTORS

As a current measuring instrument, the accuracy of the N616A will depend upon the accuracy with which the value of the selected input resistor is known.

Accurate measurement can only be carried out using a special high resistance meter, such as an EKCO N535. The N616A indicator unit meter may

then be adjusted, if desired, by the CALIBRATION control RV2 to indicate a convenient full scale voltage, such that its actual readings are equivalent to a known current at the input.

5.7. DISMANTLING THE HEAD UNIT

To obtain access to the electrometer circuit, remove the four screws around the flange of the head unit casting. The chassis, which is secured to the front section of the casting, can then be withdrawn to the extent of the leads connecting to the plug and socket.

The press button switch and input resistors are mounted on the front casting and, to obtain access, first unsolder the connection to the vibrating reed unit at the top of the casting.

Remove the four 4UNC screws securing the chassis front plate to the casting and draw the plate away from the casting sufficiently to allow access to two leads emerging from the bottom of the casting, which can then be unsoldered. The front casting is then free.

It is recommended that a small soldering iron and low temperature solder be used, otherwise soldering of components should be carried out as quickly as possible, using a heat sink, to avoid damage to the input resistors. See para.5.8. following.

When re-assembling the head unit, ensure that the sealing gasket is intact and correctly located.

5.8. CLEANLINESS OF INPUT COMPONENTS

Because of the necessity for very high insulation in the grid circuit of V1, care must be taken to prevent the entry of dust, dirt and moisture when the head unit is dismantled for servicing.

If any of the input resistors are changed, they should be held by their wire ends, not the glass body. The lead-out wires should not be bent where they emerge from the component and a heat sink, such as a pair of fine nosed pliers, should be used when soldering in position.

Any marks due to solder resin or fingerprints, etc. should be removed with trichlorethylene, then cyclohexane, using a clean camel hair brush. On no account should methylated spirit or carbon tetrachloride be used.

Insulating surfaces must not be scraped as the insulation properties depend upon maintaining a smooth surface.

5.9. DESICCATOR

A silica-gel desiccator is fitted to keep the head unit free from moisture and so maintain the high insulation of the input components.

When the indicator becomes pink it should be replaced or removed and baked at low heat until it turns blue.

SECTION 6 — SPARE PARTS LIST

6.1. HEAD UNIT

6.1.1. RESISTORS

Circuit Ref.	Ohms	%	Type	Part No.
R1	10^{12}	5	601	B48195/1
R2	10^{10}	5	601	B48195/2
R3	10^{8}	5	601	B48195/3
R4,5,21	10^{9}	20	Welwyn H12	C110368/1
R6	470K	5	Erie 108	92413D
R7	4.7M	5	Welwyn	92437N
R8	180K	5	Erie 108	92403D
R9	30K	5	Erie 108	92384D
R10,16	47K	5	Erie 108	92389D
R11	10M	10	RMA8	94110
R12	1M	5	Erie 108	92421D
R14	10K	20	RMA9	93019
R15	100K	5	Erie 108	92397D
R17	18K	5	Erie 108	92379D
R18	1M	5	RMA8	94231
R19	10K	5	W.W.TC/75	C114157/85
R20	200	5	RMA8	94377

6.1.2. CAPACITORS

Circuit Ref.	Capacity	%	Type	Part No.
C1,3	50 pF	10		B110283/4
C2	1000 pF	10		B110283/8
C4	10 pF	10	Suflex 500V	B110283/2
C5,6,10,11,13	0.1 µF	20	CP37N	C52661/1
C7	0.005 µF	25	CP31N	52657/1
C8	7500 pF	5	Polystrene GFC	B112748/11
C9	4 µF		SL74H 250V	C113647/20
C12,14	1 µF		SL75E 100V	C113647/7

6.1.3. OTHER COMPONENTS

Components	Circuit Ref.	Part No.
Press Button Switch	SW1	SA6336A
Vibrating Reed Modulator	-	SA6341/D
Ferroxcube Choke	L1	SA6339A

OTHER COMPONENTS (Cont'd)

Component	Circuit Ref.	Part No.
Plug, co-axial	PL1	56385
Plug 12 way	PL2	57315
Plug 12 way	PL3	57316
Valveholder, octal	V1 V2	B12857
Valveholder, B9A	V3	B11612/2

6.2. INDICATOR UNIT

6.2.1. RESISTORS

Circuit Ref.	Ohms	%	Type	Part No.
R26	100K	20	RMA9	93025
R27	10K	20	RMA8	94019
R28	270K	5	Erie 100	92407A
R29	91K	5	Erie 100	92396A
R30	6.8K	20	RMA8	94018
R31	4.7K	20	RMA8	94017
R32	100K	20	RMA8	94025
R33	220K	20	RMA8	94027
R34	22K	20	RMA10	96021
R35	22K	20	RMA8	94078
R36,71	3.3M	10	RMA8	94104
R37	750	1	Erie 108	92346F
R38	8.2K	5	W.W. T.G.75	C114157/83
R39	18K	1	Erie 108	92379F
R40	1.8K	1	Erie 108	92355F
R41	160	1	Erie 100	92330C
R42	560	1	Erie 100	92343C
R43	1.6K	1	Erie 100	92354C
R44	5.6K	1	Erie 100	92367C
R45	16K	1	Erie 100	92378C
R46,73	12K	5	W.W. T.G.138	C114178/87
R47,48	12	5	W.W. T.G.75	C114157/15
R49	6.8K	5	W.W. T.G.75	C114157/81
R50	10K	2	Erie 109	92373H
R51	1.8K	5	Erie 108	92355D
R53,54,57	1K	5	W.W. T.G.75	C114157/61
R55	33	5	Erie 109	92313G
R56	22	20	RMA9	93003
R58	43K	5	W.W. T.G.75	C114157/72
R59	10K	10	RMA8	94074
R60	220K	10	RMA8	94090
R61,62	2.2M	5	RMA8	94239
R63	100K	10	RMA8	94086
R64	10K	20	RMA9	93019
R65	1M	10	RMA9	93098
R66	120K	20	RMA8	94379

RESISTORS (Cont'd)

Circuit Ref.	Ohms	%	Type	Part No.
R67,68,77,78	10K	5	W.W. T.G.75	C114157/85
R69	6.8K	5	W.W. T.G.75	C114157/81
R70	120K	10	RMA9	93087
R72	56	10	RMA8	94047
R74	180K	20	RMA10	96352A
R75	68K	20	RMA8	94030
R76	10	20	RMA9	93001
R79	15	20	RMA9	93002
R80	10K	20	RMA9	93019

6.2.2. POTENTIOMETERS

Circuit Ref.	Ohms	Part No.
RV1,3	10K	C110107/15
RV2	450	C110107/17
RV4	25	C110107/16
RV5,7,9	1K	C110107/14
RV6	20K	C110107/9
RV8	100	C110107/13
RV10	100K	C110174/9

6.2.3. CAPACITORS

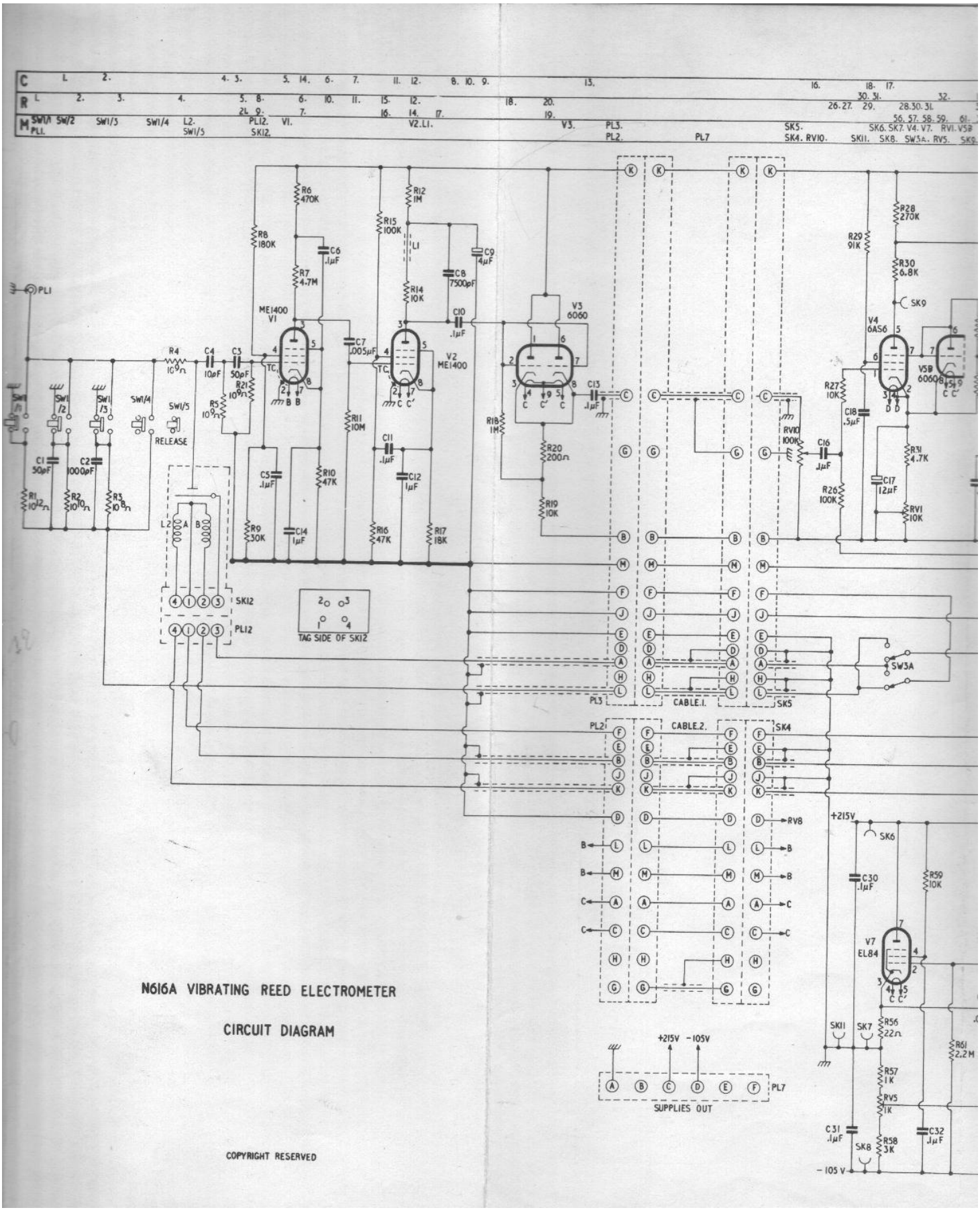
Circuit Ref.	Capacity	%	Type	Part No.
C16,19,21,23, 30,31,32,34	0.1 µF	20	CP37N	C52661/1
C17	12 µF	-	SL73D	C113647/4
C18	0.5 µF	20	CP47N	C52812/1
C20,22	0.05 µF	20	CP35N	C52660/1
C24	0.25 µF	20	CP48N	C52810/1
C25,35,36	4 µF	20	A46W1	C111627/14A
C33,38,39,40	0.001 µF	20	CP110N	C52674/1
C37	0.02 µF	20	CP33N	C52659/1
C41	4 µF	20	SL74H	C113647/20

6.2.4. OTHER COMPONENTS

Component	Circuit Ref.	Part No.
Switch, rotary	SW2	C113650
Switch, rotary	SW3	C113651
Switch, toggle	SW4 SW5	B110254/7
Socket, 12 way	SK4	56347
Socket, 12 way	SK5	57058
Socket, blue	SK8	B110175/8
Socket, black	SK7 SK11	B110175/1

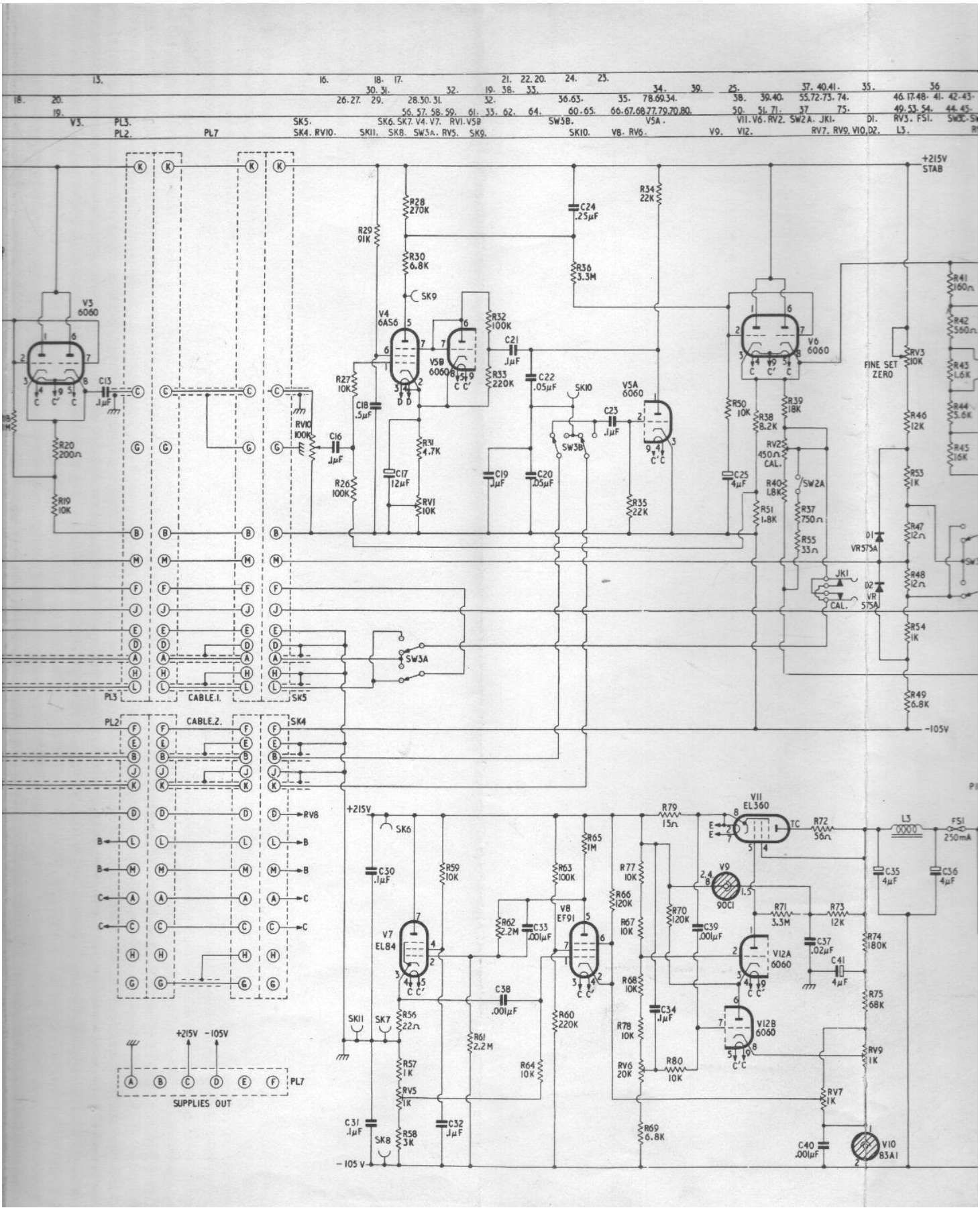
OTHER COMPONENTS (Cont'd)

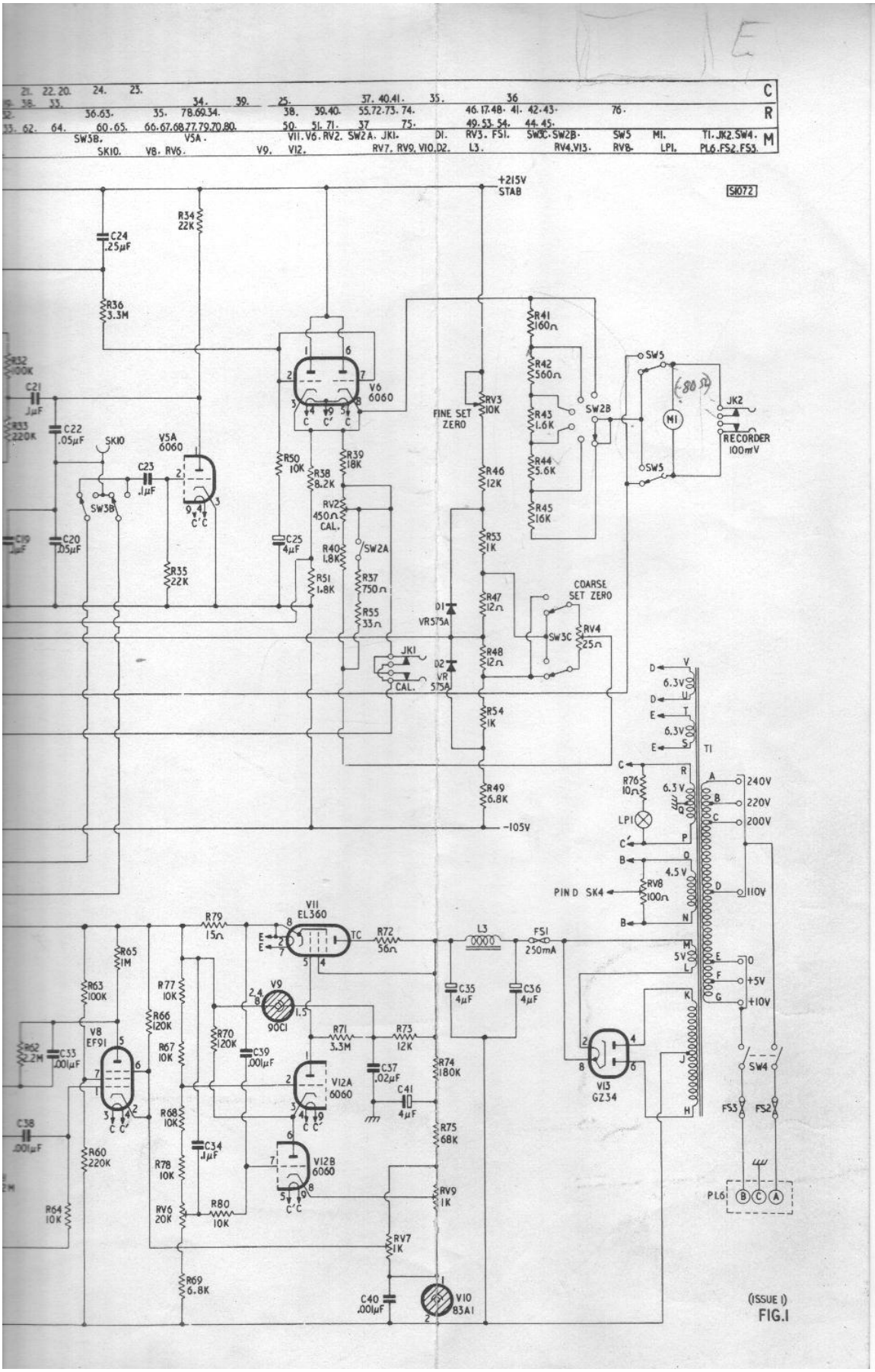
Component	Circuit Ref.	Part No.
Socket, red	SK6,SK9,SK10	B110175
Socket, Jack	JK1,JK2	A16448
Plug, 6 way	PL7	56419
Plug, 3 way	PL6	56121
Transformer, mains	T1	E113693
Choke, smoothing	L3	D113694
Meter	M1	B113662
Knob, (door)	-	DP15121/1
Knob Assembly	SW3	DP27778
Knob Assembly	RV3	DP27636E
Knob Assembly	SW2	DP27774A
Lampholder	LP1	B113633/2
Lamp	LP1	A5767
Zener Diode	D1,D2	57317
Fuseholder	FS1,2,3	B113043
Fuse, 250 mA	FS1	A13569/5
Fuse, 1 Amp	FS2,FS3	A13569
Valveholder, I.Oct.	V11,13	B12857
Valveholder, B9A	V5,6,7,12	B111612/1
Valveholder, B7G	V4,8,9,10	B111613/1
Valve Can, B9A	V5,6	B111777
Valve Can, B7G	V4	B111776/1
Valve Retainer, B9A (short)	-	B111614/1
Valve Retainer, B9A (long)	-	B111614/2
Valve Retainer, B7G	-	B111615/2



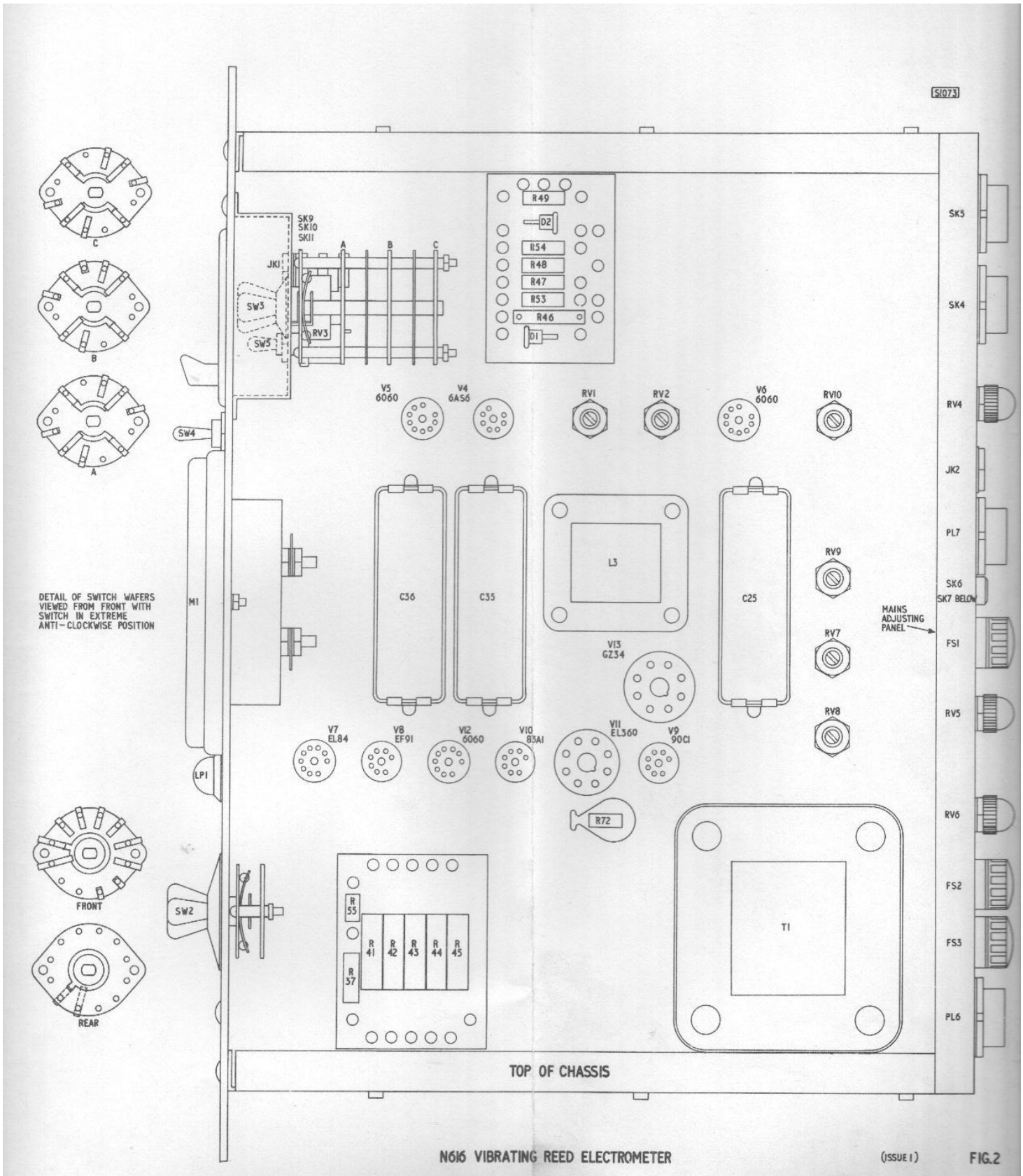
N616A VIBRATING REED ELECTROMETER

CIRCUIT DIAGRAM


+215V STAB
-105V
V3 6060
V4 6AS6
V5B 6060
V5A 6060
V6 6060
V7 EL84
V8 EF91
V9 90C1
V10 83A1
V11 EL360
V12A 6060
V12B 6060
FINE SET ZERO
CAL.
SW2A
SW3A
SW3B
JK1
D1 VR575A
D2 VR 575A
CABLE.1.
CABLE.2.
PL3
PL2
SK5
SK4
PL7
SUPPLIES OUT
+215V -105V
L3
FS1 250mA
TC

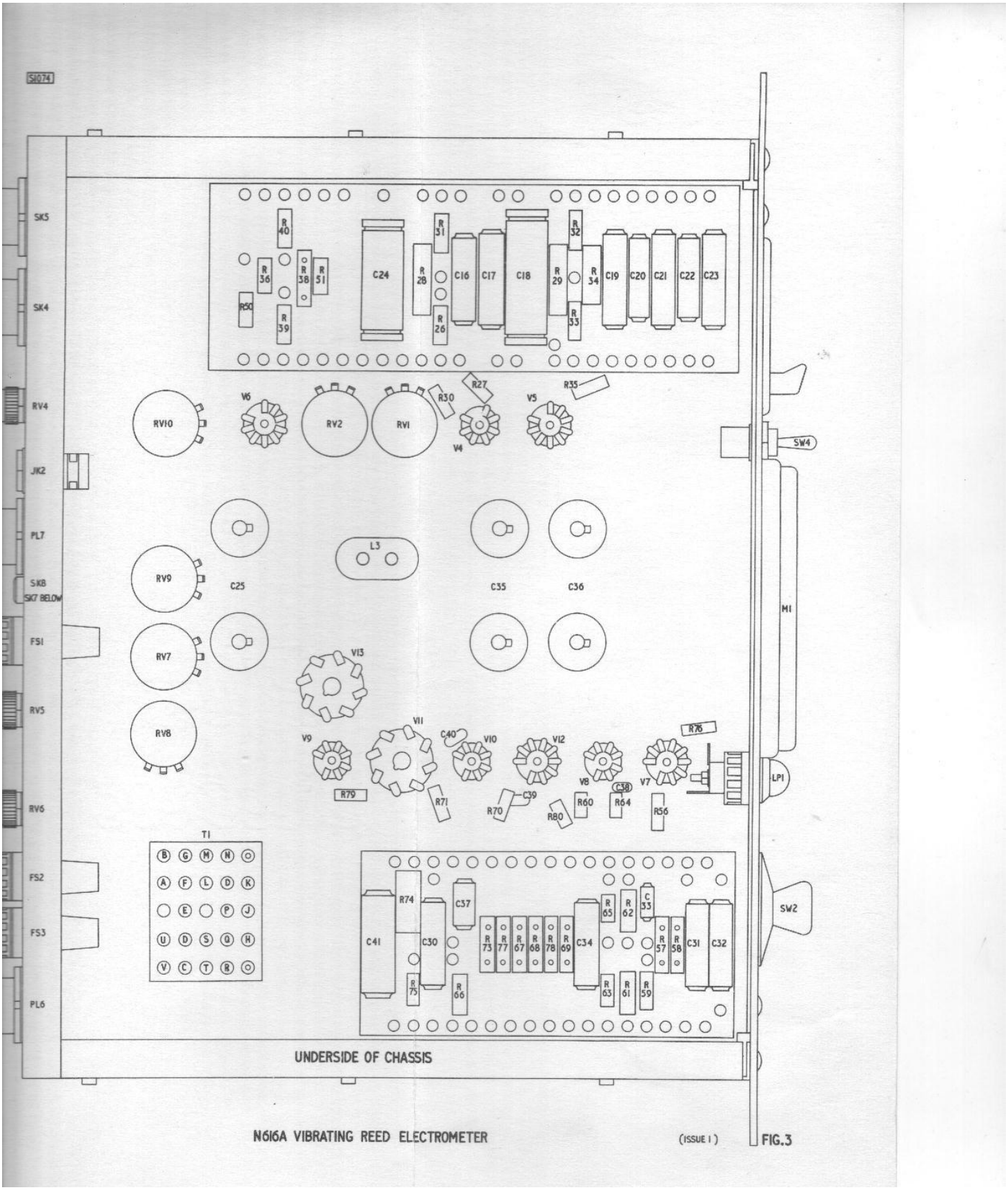

C
21. 22. 20. 24. 25. 34. 39. 25. 37. 40. 41. 35. 36
38. 33.
R
36. 63. 35. 78. 69. 34. 38. 39. 40. 55. 72. 73. 74. 46. 17. 48. 41. 42. 43. 76.
62. 64. 60. 65. 66. 67. 68. 77. 79. 70. 80. 50. 51. 71. 37 75. 49. 53. 54. 44. 45.
M
SW3B. V5A. VII. V6. RV2. SW2A. JK1. D1. RV3. FS1. SW3C. SW2B. SW5 MI. T1. JK2. SW4.
SK10. V8. RV5. V9. V12. RV7. RV9. V10. D2. L3. RV4. V13. RV8. LP1. PL6. FS2. FS3.
+215V STAB
SK072
R34 22K
C24 .25µF
R36 3.3M
R32 100K
C21 .1µF
R33 220K
C22 .05µF
SK10
V5A 6060
C23 .1µF
SW3B
C19 .1µF
C20 .05µF
R35 22K
V6 6060
R50 10K
R38 8.2K
R39 18K
RV2 450Ω CAL.
C25 4µF
R40 1.8K
R51 1.8K
SW2A
R37 750Ω
R55 33Ω
JK1 CAL.
FINE SET ZERO
RV3 10K
R46 12K
R53 1K
R47 12Ω
D1 VR 375A
R48 12Ω
D2 VR 375A
R54 1K
R49 6.8K
-105V
R41 160Ω
R42 560Ω
R43 1.6K
R44 5.6K
R45 16K
SW2B
SW5
(-80 SP)
MI
JK2
RECORDER 100mV
COARSE SET ZERO
SW3C
RV4 25Ω
T1
R76 10Ω
LP1
6.3V
4.5V
RV8 100Ω
PIN D SK4
240V
220V
200V
110V
0
+5V
+10V
SW4
FS3
FS2
PL6
V11 EL360
R79 15Ω
R72 56Ω
TC
L3
FS1 250mA
C35 4µF
C36 4µF
R65 1M
R63 100K
R62 2.2M
C33 .001µF
V8 EF91
R66 120K
R67 10K
R68 10K
R77 10K
R78 10K
R64 10K
R69 6.8K
C38 .001µF
R60 220K
C34 .1µF
R80 10K
RV6 20K
V9 90C1
R70 120K
C39 .001µF
R71 3.3M
R73 12K
V12A 6060
V12B 6060
C37 .02µF
C41 4µF
R74 180K
R75 68K
RV9 1K
RV7 1K
C40 .001µF
V10 83A1
V13 GZ34

(ISSUE 1)
FIG.1

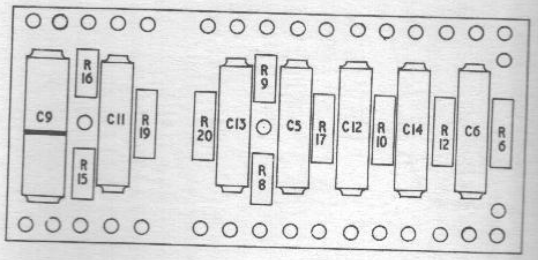


DETAIL OF SWITCH WAFERS VIEWED FROM FRONT WITH SWITCH IN EXTREME ANTI-CLOCKWISE POSITION

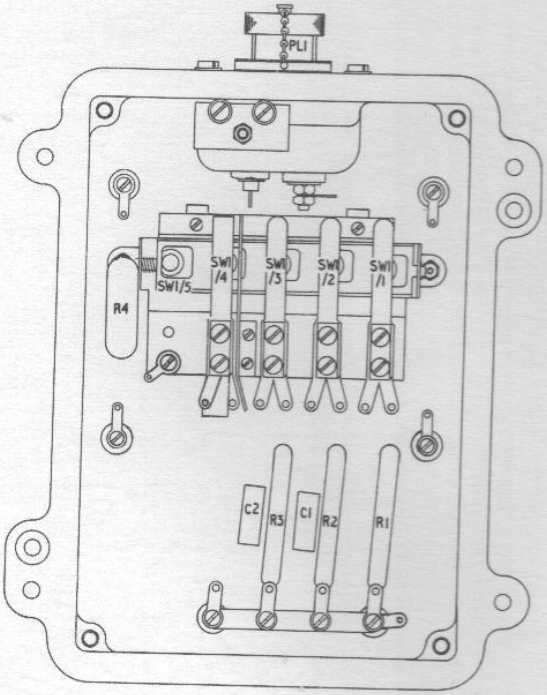
N616 VIBRATING REED ELECTROMETER (ISSUE 1) FIG.2

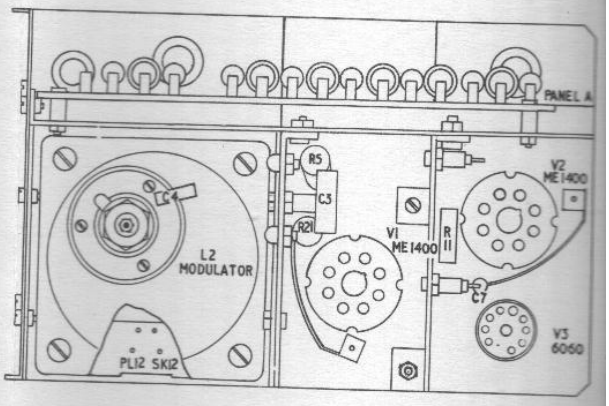


N616A VIBRATING REED ELECTROMETER (ISSUE 1) FIG.3

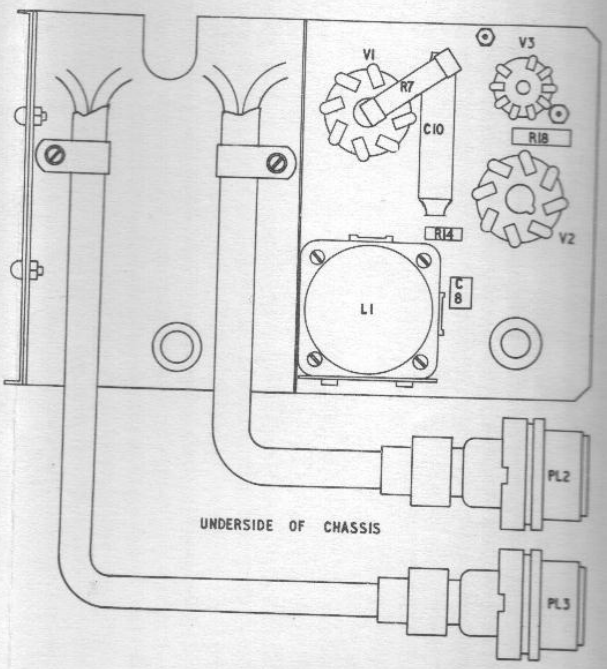


DETAIL OF TAG PANEL A





TOP OF CHASSIS



UNDERSIDE OF CHASSIS

HEAD AMPLIFIER

N616A VIBRATING REED ELECTROMETER FIG.4