but one that is damaged may look like this:—

All versions of the Multiminor were fitted with identical pivots, but instruments manufactured since March, 1964 are fitted with pivots of differing lengths. This facilitates easier assembly of the moving coil system, these pivots are a suitable replacement for all multiminors.

Pivots are most difficult to replace, for the coil assembly can easily be broken during this operation, unless suitable pivot extraction equipment is available. Where replacement is necessary, consider the replacement of the moving coil assembly or movement as a whole rather than its repair.

Following examination of the pivots, the jewels should now be checked. Remove each jewel screw in turn, and if a microscope is available (having a magnification of x100), mount the jewel screw in a jig with the jewel uppermost, illuminate it well and examine. Cracks and depressions can now be detected, but the operator must be skilled in the interpretation of what he sees. If the jewel appears to be faulty in any way, it should be discarded.

Another means of detecting a faulty jewel is to take a fine needle ground to the sharpest possible point, and with it, feel gently around the jewel recess using a circular motion, virtually no pressure whatever must be placed on the needle during this test, for it should be so sharp that the slightest pressure from the fingers will blunt its point. The recess in a good jewel is conical and rounded at its extreme base, and therefore, no resistance to the needle point will be felt if the jewel is in good order. If however, the jewel is cracked, or the polished surface shattered, these symptoms will be detected quickly by the sensation of roughness transmitted to the fingers.

8. Instrument Reads Low on all Ranges.

When an instrument is subjected to severe shocks, (such as it may receive during transit), it sometimes happens that individual turns of the hairsprings become caught up upon one another causing the instrument to read low. Upon opening the instrument, the confused appearance of the hairspring(s) will at once be apparent. A non-ferrous pin should be inserted between the turns of the hairspring nearest its centre, and guided to follow the turns outwards in a rotary motion towards the periphery of the spring. The turns will be automatically released unless the hairspring has been badly deformed. A slightly damaged hairspring can sometimes be renovated with the aid of a small pair of tweezers, but really badly deformed spring will have to be replaced.

The same symptom may be caused by hairs on the hairsprings, or individual turns of a hairspring sticking together, due to the presence of dirt or some viscous substance. The offending deposit should be removed by Genklene or Carbon Tetrachloride, care being taken to ensure that drops of the liquid do not fall upon the scale plate where they may cause discolouration.

9. Indicating Pointer out of Balance.

The moving coil is perfectly balanced when the instrument leaves the factory, but very severe overload or mechanical shock may cause it to become unbalanced. The balance can be regarded as being satisfactory if the needle moves from its position of rest by less than 1% of the maximum scale value, when the instrument is held in any position within 45° from horizontal. If the pointer moves outside this limit, withdraw the movement and re-adjust the balance weights, first for horizontal and then for vertical balance. It may be necessary to soften the old shellac securing the balance weights, and pressure from a small, moderately heated soldering iron wiped clean of solder, will usually enable the weights to be moved. Fresh shellac may be required to re-lock the balance weights, but only a minimum amount should be employed, and all spirit evaporated by the application of gentle heat from the soldering iron. If the moving coil assembly has been changed, the new assembly will require balancing as set out above. (It is important to note that abnormal balance behaviour can be due to damaged pivots), whilst errors in vertical balance are often due to a bent pointer. In the latter case correct balance can be restored by bending the pointer from its "root" back to its correct position.

The balancing of an instrument movement calls for a high degree of skill, and once again, we advise that whenever trouble is experienced with the movement, the whole assembly should be replaced, and the original unit returned to the factory for servicing.

10. Servicing the Printed Circuits.

Since the introduction of the Multiminor, there have been a number of variations in the shunt board assembly, these range from a fully printed circuit shunt board to a board wound in a conventional manner.

The latest printed circuit shunt board is a combination of printed circuit and a winding, and is interchangeable with all the shunt boards previously incorporated in Multiminors.

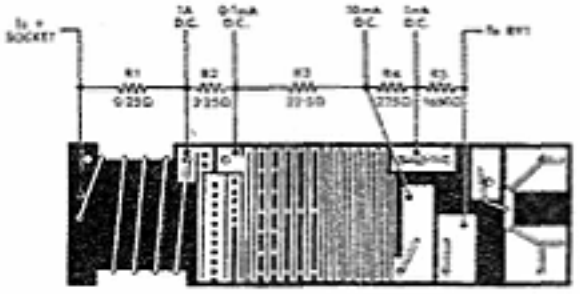


Figure 1. (See note on page 23).

When servicing the printed circuit, care should be taken to ensure that the minimum of solder is used, as excessive solder may cause part of the printed resistor to be short circuited.

The printed circuit switch on later instruments has been modified. The 113 ohms section has been removed and is replaced by a separate resistor. When fitting a later type of switch plate the 113 ohms resistor should be connected between the contact arm for the ohms potentiometer knob spindle and the negative battery contact. The potentiometer arm is then connected by means of a short length of wire to the switch plate. Figure 2 shows the connections to the switch plate.

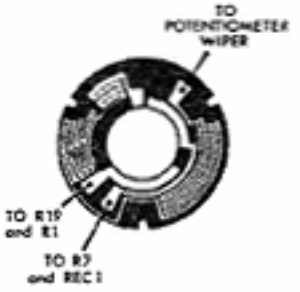


Figure 2.

11. Flash Testing.

Before leaving the factory every Multiminor is subjected to a flash test by applying 3000 volts r.m.s. 50 c/s, for one minute between the terminals and the case fixing screws. It is advisable that a corresponding test should be given to the instrument after repair.

When reboxing the instrument after repair, particular care must be taken to ensure that the screws used are no greater in length than those which were originally supplied. The use of incorrect screws can cause the breakdown of an instrument on flash test.

12. Limits of Accuracy.

When repairing an instrument your object should be to make it meet the same electrical specification as a new instrument. The limits of accuracy are given in Table 1.

Whilst Table 1 gives the accuracies at frequencies up to 2 kc/s, the Multiminor maintains a high degree of accuracy at audio frequencies.

Resistance

Owing to the nature of the scale it is difficult to define the accuracy over its whole range. It may however, be taken as being within ±3% of the reading at the centre of the scale increasing to ±10% of the reading at deflections corresponding to 10% and 90% of full scale deflection.

13. The Appearance of the Repaired Instrument.

Having ensured that the instrument is perfect both electrically and mechanically, do not be content to return it to the customer in a dirty condition. Thoroughly clean the components, and wipe out the inside of the case, taking particular care that no small particles of iron or foreign substances are left within the instrument. Fit the case to the panel using the original screws. It is so important that ranges are clearly marked that should the fillings be defaced, they should be removed and replaced with cellulose paint applied by means of a very fine brush or mapping pen. The paint should be left to dry, and then rubbed with a rag slightly damped with methylated spirit. The surplus paint will then be removed without destroying the surface of the fillings.

This general brightening up of the instrument will usually have a most profound psychological effect on the owner of the instrument and immediately conveys to him the correct impression that his meter has received careful and painstaking attention.

NOTE: A special self adhesive Range Switch Escutcheon is available for Multiminors Models 1 & 2.

TABLE 2 FAULT FINDING

Symptoms	Possible Cause
No reading on any range.	Leads open circuit or intermittent; circuit fault. It is useful in diagnosis to note whether current flows in the circuit on current or voltage ranges when no pointer indication is given. Another instrument will of course be required for this test.
Low reading on all ranges.	Hairspring turns caught up or stuck together. This fault is sometimes associated with change of zero.
Ohms ranges inoperative, irregular or intermittent.	Cell not making satisfactory contact. Rheostat winding tarnished. Intermittend connection on leads can be diagnosed on a resistance range (preferably the lowest).
No reading on voltage ranges above a determined value.	An open circuit in a resistor chain beyond the last working range.
No reading on an isolated current, voltage or resistance range.	Suspect a faulty connection between the switch contact and the shunt or multiplier.
Pointer checked in its movement at one particular point on the scale.	Grain of dust or other foreign body fouling the movement, possibly in the gap.
Small pointer stick irrespective of the pointer deflection.	Blunted pivots, or possibly damaged jewels.
Movement out of jewels.	Excessive shock has depressed one of the jewels. The moving coil should be removed and the pivots and jewels examined for possible damage. The coil should then be re-swung, and both jewel screws lowered a minute amount in order that further shock will cause the moving coil former to touch the concentrator before either pivot can leave its jewel.
Instability of reading.	Examine printed circuit unit and switch contacts, and check for pressure of contacts.
Ohms zero varies shortly after being set.	Examine cell, potentiometer strip and brush arm for correct pressure.
Correct reading on d.c., but low a.c. readings.	Suspect faulty rectifier. Determine if component is faulty by substitution.

TABLE 3

PART NUMBERS OF COMPONENTS WHICH ARE NOT COMMON TO ALL INSTRUMENTS

COMPONENT	MODELS 1 & 1A	MODELS 2 & 2A	MODEL 4
Front panel Moulding	21125–A	21125–B	21125–H
Metal Case	21131–A	21131–B	21131–C
Range Switch Knob	21128–1	21128–2	21128–4
Switch Ring	40584–A	40584–B	40584–A
Ohms Zero Knob	11155–A	11155–AX	11155–B
Movement Zero Adjuster	15306–1	15306–2	15306–3
Movement Assembly Complete	40629–A	40629–B	40629–H
Movement Case	40628–1	40628–2	40628–4
Scaleplate	Model 1; 15302 – 4 Model 1A; 15302 – 9	Model 2; 15302 – 4 Model 2A; 15302 – 9	15302–11
Range Switch Cap	15315–1	15315–2	15315–1
Negative Battery Contact	15312–1	15312–1	15312–3
Instruction Book	10072–227	10072–227	10072–319

PLATE 2 INTERIOR OF INSTRUMENT

Item No.	*Description*	*Circuit Ref.*	*Part No.*
1	Resistor Board		21132–1
2	Resistor 73kΩ ± 1%	R13	12049–628
3	Resistor 150kΩ ± 1%	R15	12049–665
4	Battery Contact (Negative)		See Table 4
5	Ohms Zero Wiper		15310–2
6	Resistor 1.3kΩ ± 20%	R14	12049–630
7	Resistor 113Ω ± 1%	R8	12049–746
†8	Ohms Potentiometer Strip	RV1	15309–A
9	Battery Contact (Positive)		15313–1
10	Sprung Contact		15311–1
11	Printed Circuit Switch	R6, SA2	21134–1
12	Selector Switch Arm		21130–2
13	Resistor 24kΩ ± 1%	R10	12049–654
14	Resistor 11.36kΩ ± 1%	R9	12049–657
15	Selector Switch Cap		15315–1
16	Moulded Switch Ring	SA1	See Table 4
17	Resistor 9.35kΩ ± 1%	R11	12049–658
18	Resistor 15kΩ ± 1%	R12	12049–656
19	Shunt Board Assembly (for details see page 16)	R1, R2, R3	21133–G
20	Movement Assembly (60μA, 1667Ω including R19)	M1	See Table 4
21	Resistor 750kΩ ± 1%	R16	12049–659
22	Resistor 1.5 MΩ ± 1%	R17	12049–661
23	Resistor 7.5 MΩ ± 1%	R18	12049–660

†See note on page 23.

INTERIOR OF INSTRUMENT PLATE 2

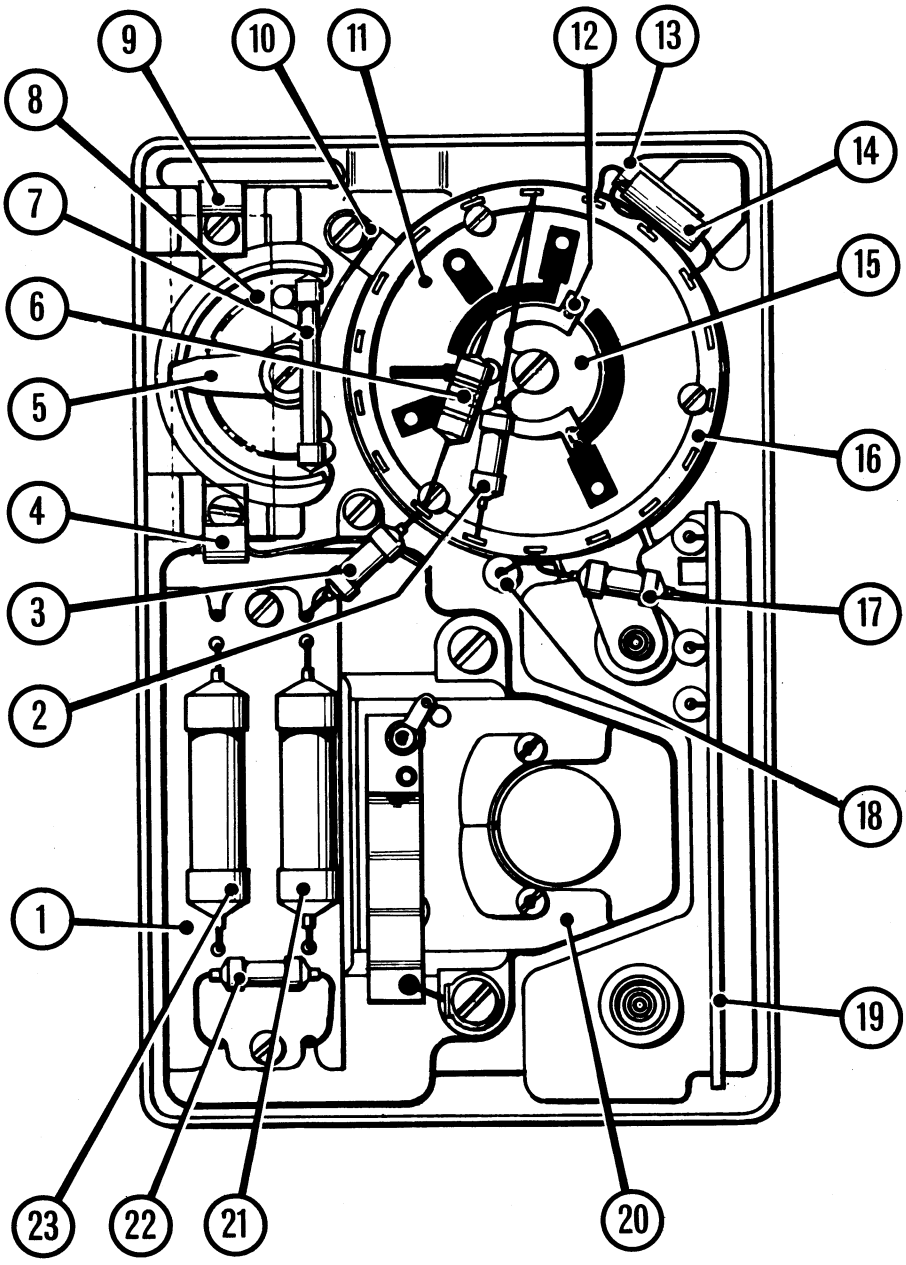
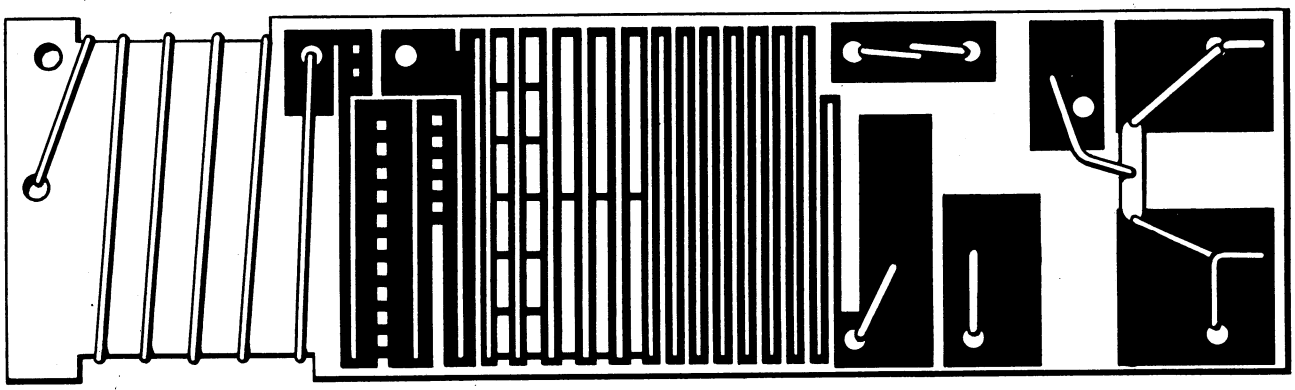


PLATE 3 PRINTED CIRCUIT BOARD

Item No.	*Description*	*Circuit Ref.*	*Part No.*
1	Printed Circuit Shunt Board	R1,R2,R3	21133–G
2	Resistor 225Ω ± 1%	R4	12049–623
†3d	Resistor 1650Ω ± 1%	R5	12049–620
†3b	Resistor 1450Ω ± 1%	R5	12049–115
4	Rectifier Type M15	R1,R2	12049–620
5	Resistor 286Ω ± 1%	R7	12049–617

†see Note on Page 23

PRINTED CIRCUIT BOARD PLATE 3



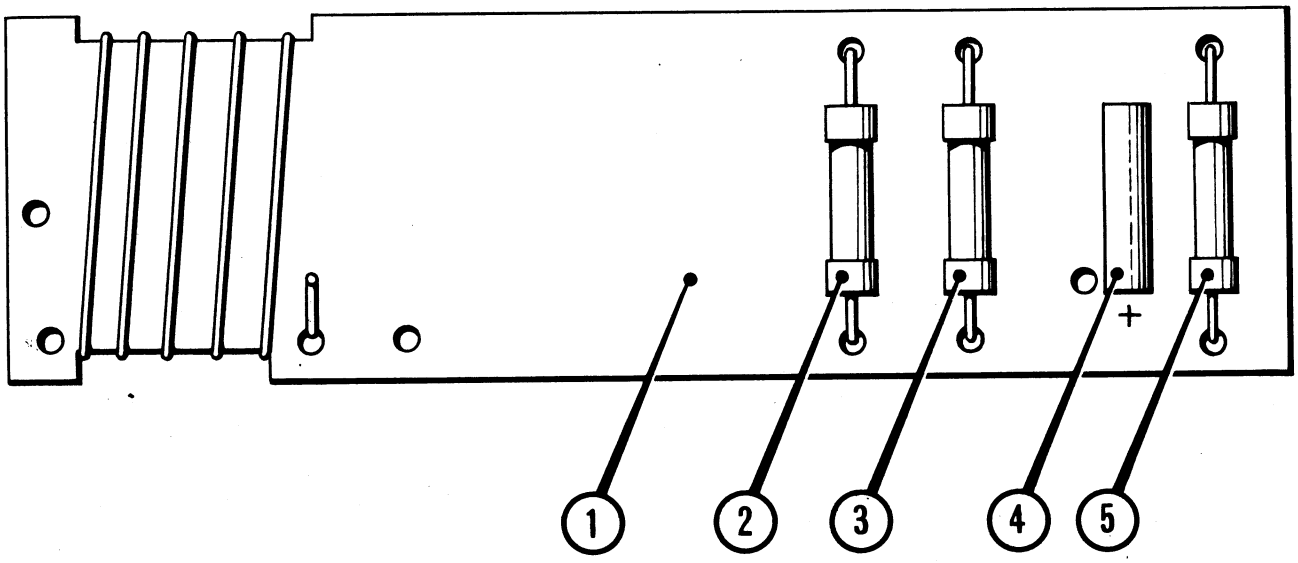


PLATE 4 MOVEMENT ASSEMBLY

Item No.	*Description*	*Circuit Ref.*	*Part No.*
1	Scaleplate		See Table 2
2	Zero Adjuster		15299–2
3	Moving Coil complete with items 7,8 & 10		21124–A
4	Jewel Screw		10184–A
5	Swamp	R19	15323–A
6	Inspection Cover		15298–1
7	Pivot Short (Top)		10158–2
8	Hairspring		10075–16
9	Movement Case		See Table 2
10	Pivot Long (Bottom)		10158–4

MOVEMENT ASSEMBLY PLATE 4

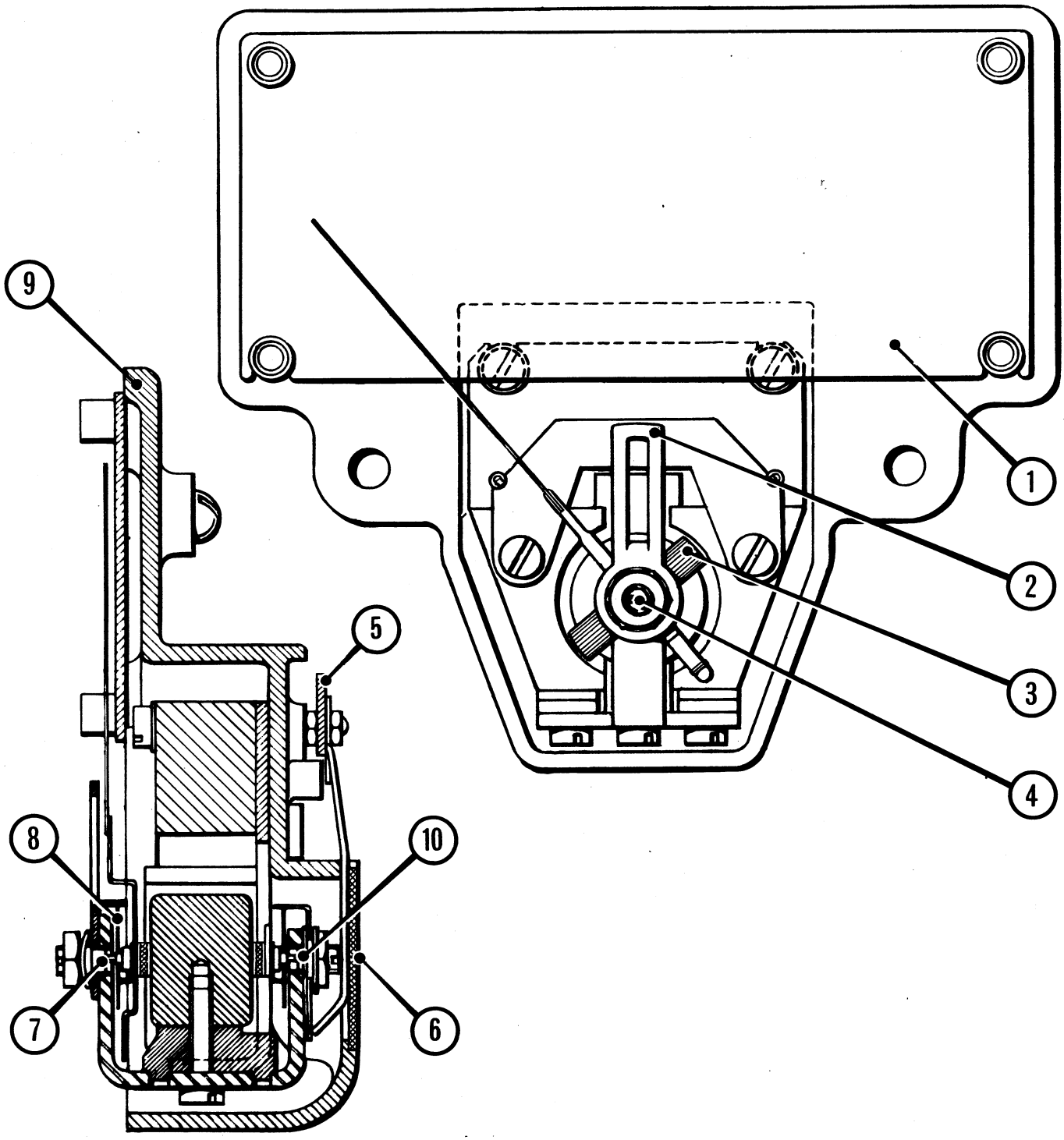


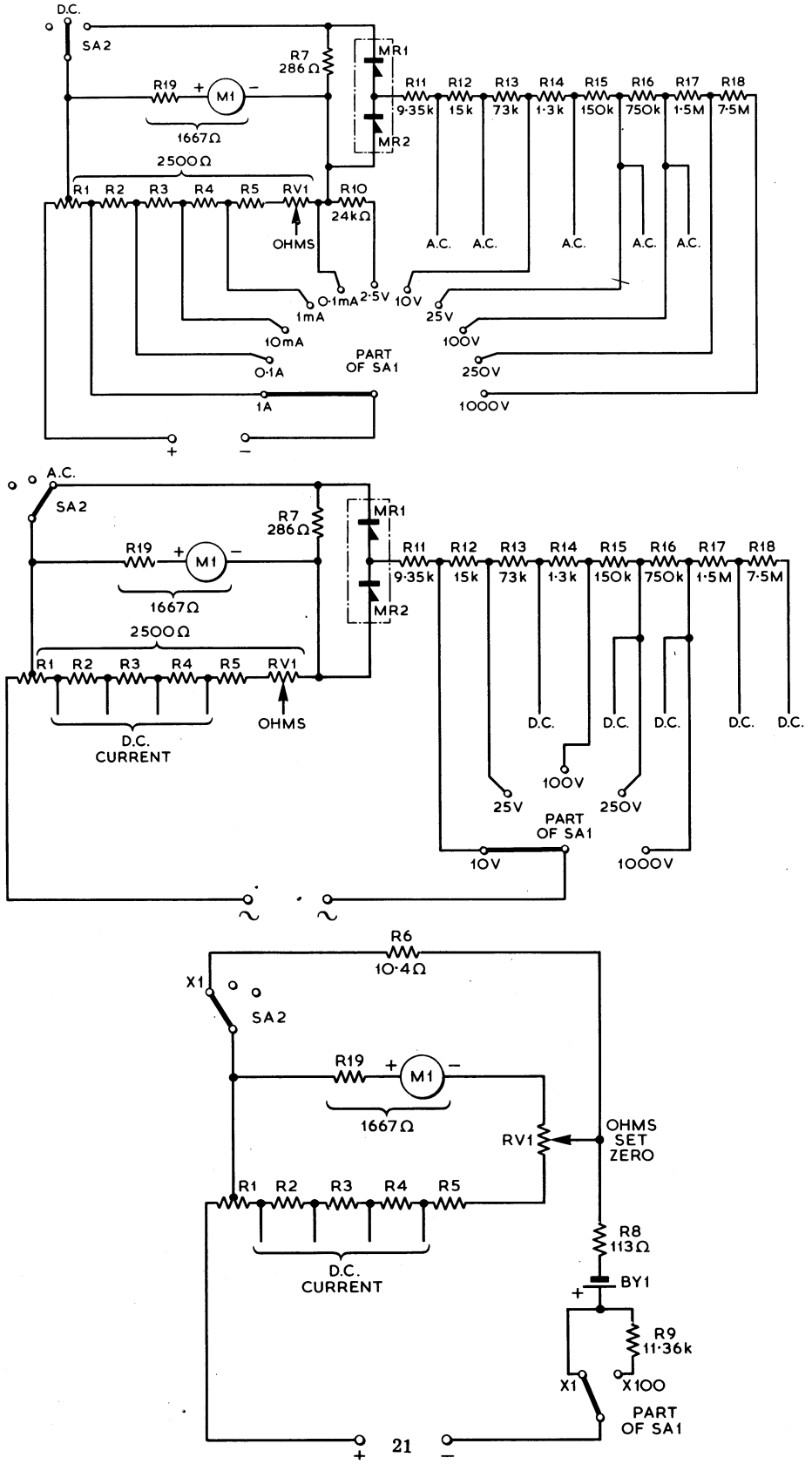
PLATE 5 ACCESSORIES (NOT ILLUSTRATED)

(SUITABLE FOR ALL MODELS)

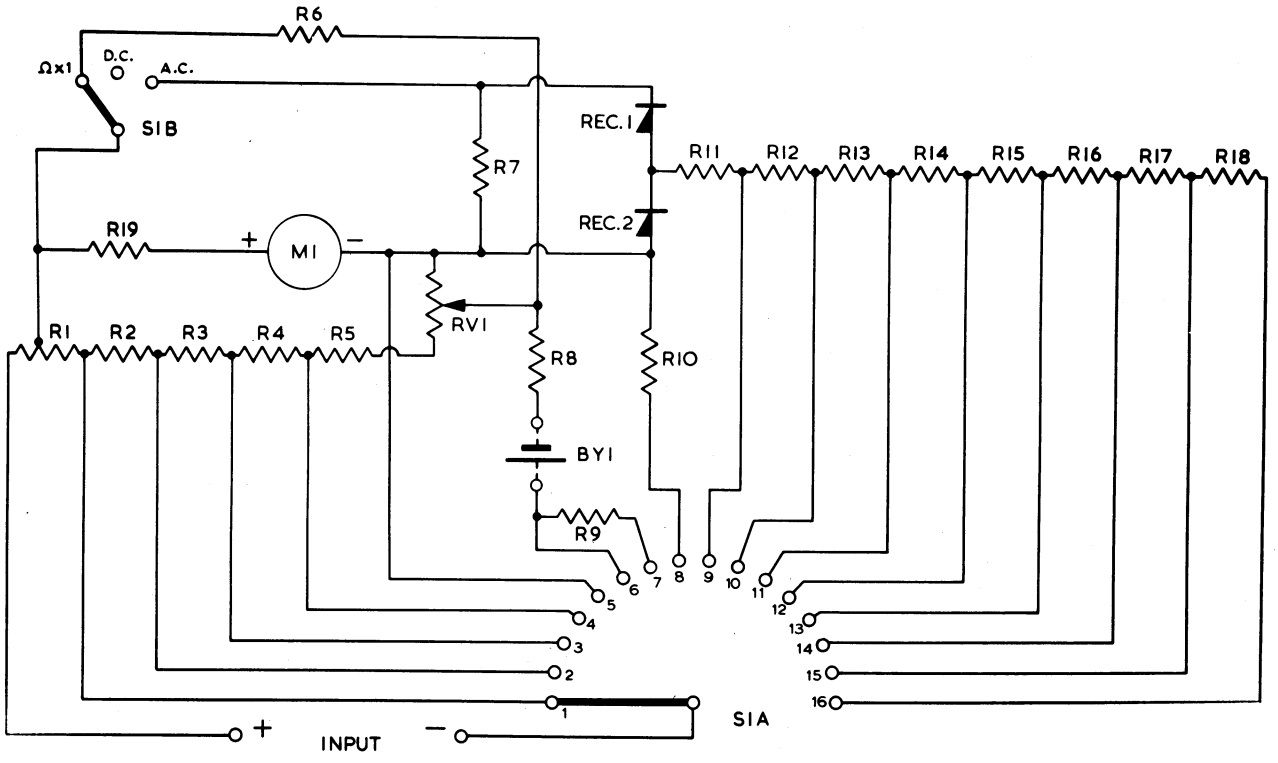
Item No.	*Description*	*Circuit Ref.*	*Part No.*
1	Connecting Lead Red		21126–C
2	Connecting Lead Black suitable for all models . .		21126–D
3	Prod Red		11588–C
4	Prod Black		11588–C
5	Pair of Crocodile Clips		11029–A
6	Pair of Long Reach Safety Clips Mk2 (suitable for Item 1 and 2)		21509–A
7	2 Amp Shunt		15505–D
8	5 Amp Shunt		15505–C
9	10 Amp Shunt		15505–B
10	25 Amp Shunt		15505–A
11	2,500 Volt Multiplier		21162–A
12	Leather Carrying Case to accommodate instrument, Leads, Prods & Clips only)		40635–1
13	Leather Carrying Case suitable for instrument, Leads, Prods & Clips together with Long Reach Safety Clips Voltage Multiplier and shunt		40635–3
14	Plastic Carrying Case		40767–1
15	Items 1, 2, 3, 4, 5, Supplied as a set		16103–X

60 μA; 1667 Ω ⇒ 100 mV drop.

SIMPLIFIED CIRCUITS OF THE MULTIMINOR PLATE 6



CIRCUIT DIAGRAM OF MULTIMINOR MK 4 PLATE 7



CIRCUIT DIAGRAM OF MULTIMINOR Mk 4 PLATE 7

TABLE OF COMPONENTS

Ccf. Ref.	Description	Remarks	Ccf. Ref.	Description	Remarks	Switch Positions	Range
R1	0.25Ω	Part of shunt Board Assembly	R14	1.3KΩ	± 20%	1	1A d.c.
R2	2.25Ω		R15	150KΩ	± 1%	2	0.1A d.c.
R3	22.5Ω		R16	750KΩ	± 1%	3	10mA d.c.
			R17	1.5MΩ	± 1%	4	1mA d.c.
R4	225Ω	± 1%	R18	7.5MΩ	± 1%	5	0.1mA d.c.
†R5	1450Ω	± 1%	R19	Swamp	See M1	6	Ω × 1
R6	10.4Ω	± 1%	†RVI	800Ω	± 1%	7	Ω × 100
R7	286Ω	± 1%	REC 1	Part of Westing-		8	2.5V d.c.
R8	113Ω	± 1%	REC 2	house Type M15		9	10V a.c.
R9	11.36KΩ	± 1%	M1	60μA, 1667Ω		10	25V a.c.
R10	24KΩ	± 1%		including R19		11	10V d.c.
R11	9.35KΩ	± 1%	†BY1	1.5V cell		12	100V d.c.
R12	15KΩ	± 1%				13	250V a.c./25V d.c.
R13	73KΩ	± 1%				14	1000V a.c./100V d.c.
			S1A	Range Switch		15	250V d.c.
			S1B			16	1000V d.c.

BEFORE

†NOTE: ON INSTRUMENTS MANUFACTURED [redacted] SEPT. 1964 THE VALUE OF R5 AND RVI IS [redacted] AND [redacted] RESPECTIVELY

1650Ω 600Ω

OTHER SERVICE MANUALS AVAILABLE

AVO METER MODEL 7 MKS I & II

AVO METER MODEL 8 MKS I & II

AVO METER MODEL 8 MK III

AVO METER MODEL 8 X

AVO METER MODEL 9 MK II

AVO METER MODEL 9 SX

AVO METER MODEL 40 MKS I & II

ELECTRONIC TEST METER MK IV

VALVE CHARACTERISTIC METER MK III

VALVE CHARACTERISTIC METER MK IV

VALVE TESTER TYPE 160

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Part No. 10072/397.