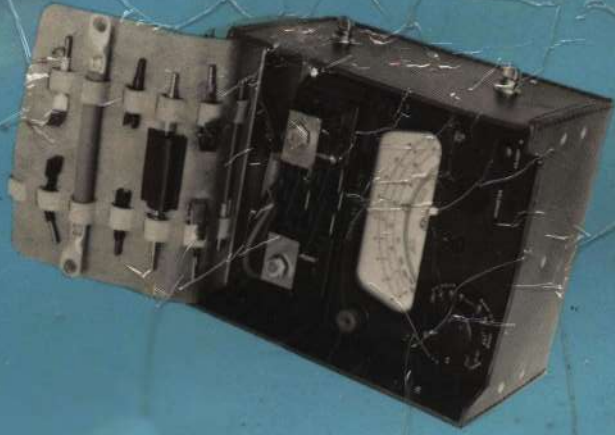


# Operating Instructions

# AVOMETER Test Set Model 12S

corrected schematic



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# OPERATING INSTRUCTIONS

## TABLE OF RANGES

D.C. Voltage	D.C. Current	A.C. Voltage
36V	36A	360V
18V	3.6A	90V
9V		18V
3.6V	External Shunt (180A)	9V

External Shunt\* External Shunt (360A)

## Resistance

0-1000  $\Omega$  (25  $\Omega$  mid scale)

0-10000  $\Omega$  (250  $\Omega$  mid scale)

\* The "Ext. Shunt" position corresponds to 90mV f.s.d. 180A or 360A external shunts are available as optional accessories.

## Sensitivity

D.C. Voltage Ranges 200 $\Omega$ /V = 5 mA f.s.d.

A.C. Voltage Ranges 90 $\Omega$ /V = 11 mA f.s.d.

## WARNING

When measuring voltage on live circuits make sure that the meter is NOT switched to a current (Amps) or resistance (Ohms) range. This mistake can cause injury to the operator.

# OPERATING INSTRUCTIONS

## DESCRIPTION

The instrument is supplied in an ever-ready leather carrying case, complete with accessories, which may include either a 180A or 360A shunt or both, these are used for heavy d.c. current. Range switching is accomplished by using a single switch knob, connections to the instrument being made by means of two terminals. Provision is made for polarity reversal without the need for transposing positive and negative leads. A high degree of overload protection is inherent in the circuit itself by the use of generously rated components. Further protection is provided for the movement by the use of silicon diodes which by-pass current during a period of over-load.

## DESIGN AND CONSTRUCTION

The moulded front panel is used to support the meter movement, range and "reverse moving coil" switches together with the associated voltage multipliers, shunts, etc. The range switch is of a generous and robust design, the silver-plated contacts being arranged to "make before break" on adjacent positions. The case of the instrument, which is of a similar material to the panel, includes a compartment which houses the 1.5V cell used for continuity

and resistance measurements. The "ever-ready" type leather case has been designed to house the instrument, and its accessories together with the instruction book.

## ACCURACY

For the greatest accuracy the instrument should be used in a horizontal position. The instrument meets the requirements laid down in Section 6 of the British Standards Specification 89/1954 for industrial portable instruments, having a scale length of 5". These are:—

### D.C. Voltage and Current:

± 1% of f.s.d. between 10% and full-scale deflection.

### A.C. Voltage:

± 2.25% of f.s.d. between 25% and full-scale deflection.

Owing to the nature of resistance scales, it is not possible to quote percentage accuracy for the whole range. As a guide, however, readings will be within ± 3% of indication around mid-scale, increasing to ± 10% of indication at deflections corresponding to 10% and 90% of the arc traversed by the pointer.

## OPERATING INSTRUCTIONS

### SCALING

Three basic scales are provided, each approximately 5" (12.7 cm) in length, the outer one (90 divisions), being for voltage and current measurements and is marked 0-9 and 0-18. The centre scale is also for use on voltage and current, but is scaled with 72 divisions and marked 0-36. The inner scale is for resistance and continuity only, and is scaled 0-1000  $\Omega$ , with the first indication being 0.5  $\Omega$ .

### READING THE SCALEPLATE

Due to limited space available on the scale plate, it is not possible on a multi-range instrument to provide individual scales for every switch position. It is, therefore, necessary for the operator on the 90V a.c. and 360V a.c. ranges to use a basic scale, i.e. 0-9 or 0-36, and multiply his readings by a factor of 10. With the 3-6V d.c. range, the scale marked 0-36 should be used and readings this time divided by a factor of 10. It follows that the remaining ranges (except with the external shunt) may be read directly on the scale appropriate to the range chosen. The ohms range position chosen ( $\times 1$  or  $\times 100$ ) indicates the multiplication factor required to the reading indicated on the ohms scale.

### OPERATION OF THE INSTRUMENT

The instrument can be used in the leather case after removal of the lid, the latter being so designed that it can be unobtrusively attached to the underside of the case if so desired.

For greater accuracy use the instrument face upwa.d. If necessary, set the pointer to the left-hand zero by means of the screw marked "Z" which is situated on the front panel of the instrument.

The red lead should be attached to the positive (red) terminal, and the black lead to the negative (black) terminal.

Set the range switch to the correct position for the type of measurement to be made before connecting the leads to the circuit. If in doubt as to the magnitude of current or voltage to be measured, switch to the highest range, and then to a lower range, until a suitable meter deflection is obtained. Under these conditions, it is not necessary to break the circuit when switching ranges.

Exercise care before connecting the meter to a circuit or switching on a supply, for although a high degree of protection is inherent in the design, a prolonged heavy overload could cause damage. Severe momentary overloads can be accepted without damage, but care should

## OPERATING INSTRUCTIONS

be taken to avoid such misuse. Should the pointer swing very hard across the scale, remove leads IMMEDIATELY. Never disconnect the circuit by turning the range switch to a blank position.

For d.c. measurement, the red terminal is normally positive. Some tests may involve reversing the input polarity, in which case the indication can still be obtained without transposing leads, merely by depressing the reverse moving coil button marked "Rev. M.C."

### Warning

*Except in the case of low-voltage circuits, it is dangerous to make connections to live apparatus. The user is advised wherever possible to make a habit of connecting the instrument whilst the circuit is dead.*

### CURRENT MEASUREMENTS

Current measurements up to 36A d.c. are accomplished by connecting the instrument (set to a suitable range) in series with the circuit, i.e. in such a way that the entire current passes through the instrument. For currents in excess of 36A d.c., having first connected a suitable external shunt in series with the circuit under test (with the lead provided if required), connect the instrument (set to the range marked EXT. SHUNT) to the small studs situated

at each end of the shunt. The instrument will then take a small fixed proportion of the current flowing in the circuit under test and thus indicate the total current. The 360A shunt is used in exactly the same way as described above, but is not rated for continuous operation at maximum current, and should therefore not be used for periods longer than one minute at maximum current.

### RESISTANCE AND CONTINUITY

Before carrying out resistance or continuity measurements the ohms zero must be checked and adjusted if necessary. This is carried out by setting the range switch to a resistance range and joining the leads together, after which the pointer can be brought to the ohms zero (i.e. full scale), by means of the "ADJUST OHMS" knob.

When the cell voltage has fallen, due to use or age, it may not be possible to adjust the pointer to zero, or even if this can be accomplished the pointer indication may gradually fall. In such a case the 1.5V (SP2 or 1EC R20) cell which is housed in a compartment on the under-side of the meter should be removed and replaced by a similar cell inserted in the same direction. After insertion, adjust ohms zero as described above.

To measure resistance the two leads should be connected

## OPERATING INSTRUCTIONS

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across the component under test. It is important that anything being tested is not already carrying current, nor should the leads be connected across any source of voltage, e.g. the battery or dynamo when running.

Although most components are substantially constant as regards resistance, some vary considerably with temperature, e.g. lamps, etc., so that resistance tests only indicate continuity, and the readings obtained cannot be used to calculate wattage. The resistance of other devices, such as rectifiers, varies according to the voltage applied and the direction of current. When such tests have to be made using the resistance ranges, it should be noted that the polarity which appears at the terminals of the meter will be reversed from that shown on the panel (i.e., the positive terminal has a negative potential).

### **Warning**

*Under normal conditions the internal cell will operate satisfactorily for a very long period but it should, nevertheless, be examined from time to time, since a discharged cell may develop a leak and thus damage the instrument. If it is anticipated that the instrument will not be used for any length of time it is strongly advised that the cell be removed.*

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## ACCESSORIES

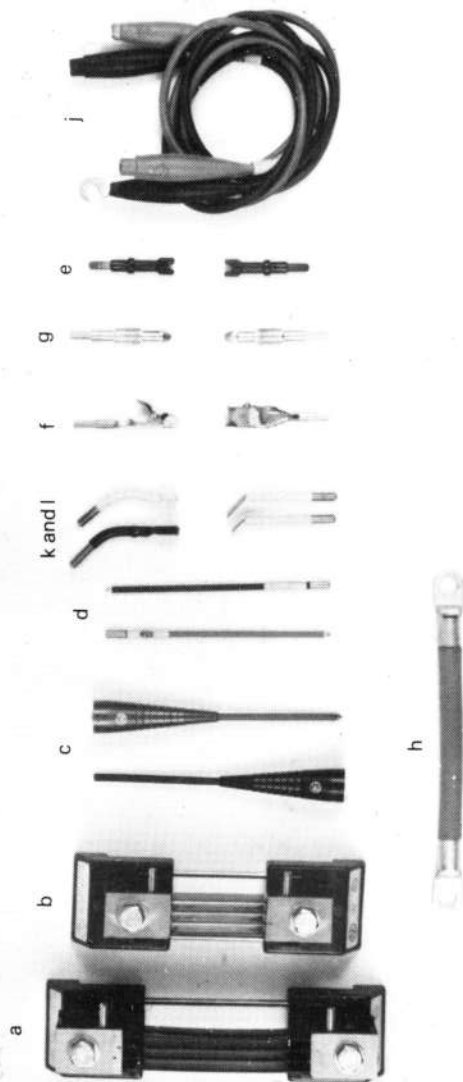


Fig. 1—Accessories



## ACCESSORIES

### ACCESSORIES AND THERE USES

In order to ensure the maximum versatility of use for the instrument, THORN EMI Instruments Limited have included a range of accessories, some of which are to assist in solving special problems encountered when making measurements on automobiles. The description and use of these accessories follows, and should be used in conjunction with Fig. 1 and the appropriate items.

*Item a.*

**180A Shunt:** The method of using the shunts has already been described under the paragraph headed "Current Measurements" and, when required, the shunt should be used in conjunction with the extension lead provided (Item *h*).

*Item b.*

**360A Shunt:** This is an alternative to the 180A shunt described above and is used in the same manner.

*Item c.*

**Long Reach Safety Clip Mk.2** Supplied in pairs, one black, one red, which can be inserted into the standard test leads (Item *j*) and will be found extremely useful for gaining access to contacts and wires in inaccessible positions. In the closed position 'prod' measurements may be made in the

normal manner, a sharp steel point easily pierces varnish on printed circuit boards or soldered joints. By retracting the moulding using thumb and forefinger, a hook end is exposed which may be used as a clip to accommodate conductors up to 0.125" (3.2 mm) in diameter.

*Item d.*

**Test Prods:** These are included in addition to the Long Reach Safety Clips where quick measurements may be required with a moderately heavy current consumption and are adequately rated when using the internal ranges of the instrument. They should not, however, be used in conjunction with external shunts.

*Items e, k and l*

**Voltage Regulator Clips and Spade Connectors:** These have been specially designed to assist in making connections to terminal boxes of the type found on voltage regulators, where terminals are in very close proximity to one another. They reduce the possibility of leads shorting which could, in some cases, produce burning out of the unit under test. These will, no doubt, be found particularly useful when adjusting voltage regulators.

**Note:** It is realised that these clips will not fit all makes and types of regulators.

## ACCESSORIES

### *Item f.*

**Holdtite Clips:** These are a pair of moderately heavy duty clips which are capable of carrying heavy currents for sustained periods and should always be used in preference to the Long Reach Safety Clips when making connections for heavy current measurements.

### *Item g.*

**Battery Piercing Prods:** With current production, manufacturers of motor vehicle batteries are supplying accumulators where the "bus-bars" linking the individual cells are totally enclosed, to reduce the risk of corrosion and sulphation. Cases frequently arise when it is desirable to test individual cells, when it is suspected that they are faulty. With this new type of accumulator, it is often difficult to gain access to the individual "bus-bars" to check each cell in turn. Most batteries do, however, have a small depression over each cell termination and the object of the prods is that they may be pushed into this depression, piercing the material, thus making contact without causing damage to the battery as a whole. A chuck is incorporated to facilitate easy replacement of damaged prod needles, two of which are included. Additional quantities are available, Part No. 3322-701. To avoid the

possibility of corrosion the needles should be wiped after use.

### *Item h.*

**Extension Lead:** For use with shunts (see Items a and b).

### *Item j.*

**Hook-ended Leads:** These are the standard leads provided with the instrument, one end of each providing termination to the meter terminals; the other, a socket, accepts all the various accessories referred to already, with the exception of Items a, b and h.

**Note:** Although the instrument has been carefully designed for the automobile industry where a considerable amount of rough usage is anticipated, the instrument should be carefully handled and not be subjected to gross overloads.

### **Weight and Dimensions**

Approx. Weight: 8lbs (3.60 kg).

Approx. Dimensions:  $9\frac{1}{2}'' \times 9\frac{1}{2}'' \times 5\frac{1}{4}''$   
(245 × 235 × 125mm)

## **INSTRUMENT REPAIRS AND SPARE PARTS**

The manufacturer's service and spare parts organisation for AVO instruments:—

### **THORN EMI Instruments Limited Parts and Service Centre,**

Archcliffe Road,  
Dover,  
Kent CT17 9EN, England  
Tel. Dover (0304) 202620  
Telex: 96283 Avomeg G

#### **Approved Repair Companies**

A number of independent instrument repair companies in the U.K. have been approved for repair work on most AVOMETER instruments, using genuine AVO spare parts. Their names and addresses are listed in the Warranty Booklet supplied with each new instrument.

#### **Overseas**

Instrument owners outside Great Britain should consult the Appointed Distributor/Agent for their country regarding spare parts and repair facilities. The Distributor/Agent will advise on the best course of action to take. Names and addresses of Overseas Distributors/Agents are given in the Warranty Booklet supplied with each new instrument.

If returning an instrument to Britain for repair, it should be sent, freight pre-paid, to the Parts and Service Centre at the address shown opposite. A copy of the Invoice and of the Packing Note should be sent simultaneously by airmail to expedite clearance through the U.K. Customs.

A repair estimate showing return freight and other charges will be submitted to the sender, if required, before work on the instrument commences.

**NEW AVO INSTRUMENTS ARE GUARANTEED FOR 12 MONTHS FROM THE DATE OF PURCHASE BY THE USER.**

## SCHEDULE OF SPARE PARTS

FRONT PANEL ASSEMBLY 50127/A						
Item	Quantity	Part No.	Description			Contact (Located on Panel under Item 4)
1	1	3876-422	Front Panel Bare	19	1	6150-024
2	1	40026/S	Movement Assembly (See page 13 for breakdown details)	20	1	3627-108
3	1	3867-405	Window Glass	21	2	3344-504
4	1	21321/A	Leaf Switch Assembly	22	1	3828-302
5	1	6220-178	Resistor Board Assembly (See page 13 for breakdown details)	23	1	3177-204
				24	1	3155-517
				25	1	23148-906
				26	1	3672-707
6	1	15536/A	Red Terminal Complete	27	1	3672-706
7	1	15536/B	Black Terminal Complete	28	1	6340-010
8	1	3816-502	Black Terminal Cap	29	2	3634-709
9	1	3816-503	Red Terminal Cap	30	1	3218-202
10	1	3153-302	Ohms Zero Knob	31	1	3675-502
11	1	3674-105	Ohms Zero Brush Arm	32	1	3873-104
12	1	16113/A	Ohms Zero Resistance Strip (RV1)	33	1	3527-301
13	1	21428/A	Shunt Strip (R1)	34	1	3828-314
16	4	25252-185	Tag			
17	4	5151-510	Rubber Sleeve for Item 16			
18	4	3412-128	Spacing Pillar for Items 17 and 18			

# SCHEDULE OF SPARE PARTS

## \*MOVEMENT ASSEMBLY 40026/S (CALIBRATED) RESISTOR BOARD ASSEMBLY 6220-178

Item	Quantity	Part No.	Description	Item	Quantity	Part No.	Description	Circuit Reference
1	1	3284-111	Scale Plate	1	1	3836-466	Board	
2	1	30006/AC	Movement Bobbin (R16) (adjust to suit movement)	2	1	3645-310	Support Bracket, left hand	
3	1	5390-018	Movement Frame	4	1	26448/336	Resistor 600Ω	R12†
4	1	6230-010	Jewel Screw Top	5	1	26448/958	Resistor 810Ω	R13
5	1	20673/G	Jewel Screw Bottom	6	1	26834/339	Resistor 700Ω	R8*
6	1	20672/G	Moving Coil Assembly	7	1	26451/554	Resistor 1080Ω	R9
7	2	28468/511	Rectifier, type 10D8 (MR2, MR3)	8	1	26454/016	Resistor 3600Ω	R11
				9	1	26452/616	Resistor 1800Ω	R10
				10	1	30006/YH	1-02Ω Bobbin	R4†
				11	1	26455/321	Resistor 6500Ω	R14
				12	3	26455/764	Resistor 8-1kΩ	R15
				13	1	30006/BJ	13-97Ω Bobbin	R3
				14	1	30006/CJ	8Ω Bobbin	R7
				15	1	26446/406	Resistor 240Ω	R6
				16	1	30006/EJ	23-5Ω Bobbin	R5
				17	4	28413/211	Diode OA95	MR1
				18	1	27215/502	Potentiometer 150Ω	RV2

### \*Important Note:

Unless facilities are available for expert repair it is considered advisable to return this complete assembly to our works for servicing.

† was 740Ω \* was 710Ω † was 1-11Ω

# SCHEDULE OF SPARE PARTS

## CASE ASSEMBLY 40599/D

Item	Quantity	Part No.	Description				
1	1	3883-304	Case, Bare	8	1	6220-008	Long reach safety Clip Mk 2 (Black)
2	1	3876-204	Battery Cover	9	1	6220-009	Long reach safety Clip Mk 2 (Red)
3	4	5190-100	Rubber Foot	10	1	3361-705	Voltage Reg. Clip Red
5	2	21151-560	Rivet (Secures Items 3, 4 and 8 to Case)	11	1	3361-704	Voltage Reg. Clip Black
6	2	3666-108	Shaped Battery Contact	12	1	21341-2	Shunt Ext. Lead
7	2	3513-426	Flat Contact (Fixed to Battery Box)	15	1	6320-145	Instrument Case, Leather
8	1	271-139	Instruction Plate	16	1	6170-267	Instruction Book
10	2	21153-827	Rivet (Secures Items 1 & 8)	17	1	6220-257	180A Shunt
				18	1	6220-258	360A Shunt
				19	1	6130-064	Female Spade Connector (High Current)
				20	1	6130-065	Female Spade Connector (Low Current)
				21	1	6150-043	Spade Connector (Low Current)
				22	1	6150-042	Spade Connector (High Current)
				23			

## ACCESSORIES

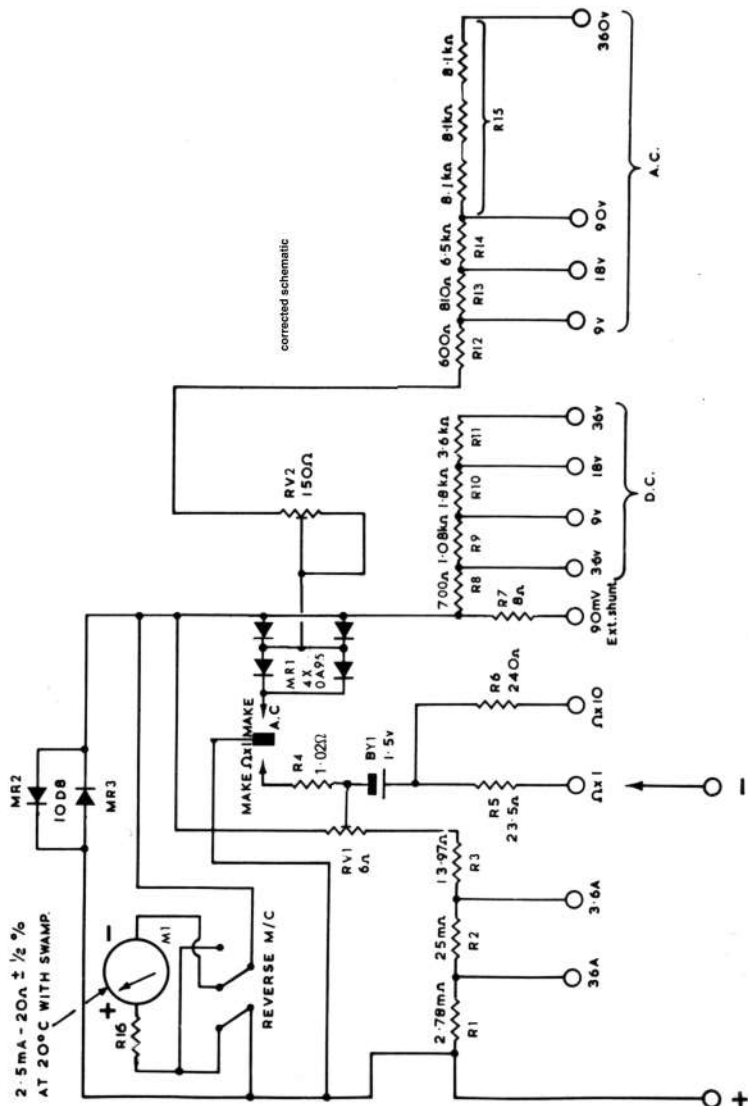
Item	Quantity	Part No.	Description
1	1	20913/J	Meter Lead Black
2	1	20913/K	Meter Lead Red
3	2	6120-003	Holdtite Clip
4	1	45012/B	Red Prod
5	1	45013/B	Black Prod
6	2	16192/A	Battery Piercing Prod Assembly (complete)
7	2	3322-701	Prod Needles for Item 6

# COMPONENTS LIST

CCT Ref.	Description	Remarks
R1	2.78 milli-ohms	
R2	25 milli-ohms	
R3	13.97Ω	± 0.25%
R4†	1.02Ω	
R5	23.5Ω	± 0.5%
R6	240Ω	± 0.5%
R7	8Ω	± 0.25%
R8*	700Ω	± 0.3%
R9	1080Ω	± 0.3%
R10	1800Ω	± 0.3%
R11	3600Ω	± 0.3%
R12†	600Ω	± 1%
R13	810Ω	± 0.5%
R14	6500Ω	± 0.5%
R15	3 × 8.1kΩ	± 0.5%
R16	Swamp Bobbin	Adjust to suit Mvt
RV1	6Ω	
RV2	150Ω	
MR1	4xOA95	
MR2	10 D8	Internl. Rectifier
MR3	10 D8	Internl. Rectifier
M1	Meter Movement	2.5mA f.s.d.
BY1	Battery 1.5V	Ever-Ready SP2

\* was 710Ω † was 740Ω ‡ was 1.11Ω

# CIRCUIT DIAGRAM







# **THORN EMI Instruments Limited**

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**A THORN EMI company**  
**This instrument is manufactured in the United Kingdom**  
**The company reserves the right to change the specification or design without prior notice**  
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