The

50-RANGE UNIVERSAL

"AVOMETER"

Regd. Trade Mark

ELECTRICAL MEASURING INSTRUMENT

Model 7

BRITISH
MADE

M.2A

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MODEL 7

This instrument which embodies certain improvements developed in 1942, has 50 ranges and is absolutely self-contained. It is very simple to operate and almost impossible to damage electrically. A short description of its construction and capabilities will show that it is in fact a most versatile instrument and all its ranges of measurement are obtained accurately and directly, with no external apparatus. Auxilliary gear can, however, be supplied to extend the limits of measurement.

CONSTRUCTION

The instrument consists of a moulded panel, on the inside of which are mounted the whole of the switching apparatus, resistances, shunts, transformer, rectifier, etc., and the moving coil. The panel fits into an attractively finished strong moulded case, the joint being completely dust-proof, and a leather carrying strap is provided for portability. The entire switching of the resistances, shunts, transformer, etc., is accomplished automatically by means of two switch knobs on the panel, each being plainly marked so that the range in use appears opposite an arrowhead. As no external apparatus is needed only two terminals are required to connect the instrument for any test, leads fitted with interchangeable spring clips and prods being provided for this purpose.

OPERATION

The left hand switch knob governs the D.C. ranges and the right hand the A.C. ranges. The switching is so interlocked that it is only possible to obtain D.C. readings by setting the D.C. switch to a range and rotating the A.C. switch to the position marked D.C. A similar procedure is necessary when making an A.C. measurement and the instrument is therefore protected from damage in the event of both switches being left on ranges when making a test, as while in this condition there is no circuit through the meter. Should A.C. be passed through the instrument when it is set to a correct range value of D.C., or vice versa, no pointer indication will be produced, but no damage will result. It is thus possible to determine whether a source is A.C. or D.C., since pointer deflection can only be produced with switches set for the same type of measurement as the source. An A.C. overload, however, if inadvertently applied to a D.C. range will produce a forward indication of the pointer, this being part of the protective system.

An automatic cut-out is fitted which completely eliminates the inconvenience and expense of replacing fuses. If an overload is applied to the meter, the cut-out knob springs from its normal position in the panel, thus breaking the circuit, and has only to be depressed to make the instrument again ready for use. The mechanism functions if the acceleration of the moving coil due to overload is excessive. This may even release the cut-out before the pointer has traversed one third of the scale length. A reverse overload of somewhat higher value may also operate it, but the user is warned against carelessness. This feature gives almost complete protection to the entire meter, only failing in the very worst cases, such as the mains being connected across the meter when it is set to a current range. The knob should never be re-set with the leads connected to an external circuit, and the cause of its operating should be rectified before re-connecting.

The movement consists of an aluminium former wound with copper wire and supplemented with constantan. In order to reduce the temperature error to negligible proportions. the coil is connected in series with an automatic compensator which operates between 40° and 90° F. The coil is pivoted on hardened and highly polished steel points, between conical sapphire jewels, and swings in a gap energised by a powerful well-aged cobalt steel magnet, this ensuring constancy in the meter. Two phosphor-bronze hairsprings are fitted for the purpose of conveying current to the moving coil, and tortionally for the return of the pointer to zero. A special type of pointer is fitted enabling very fine readings to be taken and the whole movement is perfectly balanced and considerably damped so that the pointer quickly comes to rest.

The scale plate has six scales, each approximately 5″ in length, the top being for resistance measurements and is marked 0—10,000. The second is for current and voltage measurements, both A.C. and D.C. and is marked 0—100 with divisions almost $\frac{1}{16}$″ apart. The third scale is calibrated in eight major steps of 50 volts giving a full scale deflection at 400 volts, these markings again being sub-divided into ten divisions of 5 volts each. This scale is only used in conjunction with the 400 volt range marked on the switch knob. These scales are individually calibrated and hand marked to agree with the readings of standard instruments. The lower scales are provided for capacity, power and decibels respectively, these being 0.01 mfd. to 20 mfd., 1 m.W. to 2 watts (the internal load impedance being 5,000 ohms) and -15 to + 16 decibels (about a reference level of 50 m.W.) The dial has an untarnishable mirror to prevent parallax errors. With two exceptions, each successive range as indicated by the switch knobs is ten times the value of the previous one, thus avoiding the use of awkward multiplying constants with their possible mathematical errors. The 400 volt A.C. and D.C. range has been introduced so that it, and its associated 200 volt range (press-button), may be employed for extremely accurate measurements of mains voltage. The other exception is the 2 m.A. range.

By pressing the button which is, incidentally, only intended for use when measuring current and voltage, the normal full scale value as shown by the switch knob is halved, and consequently, twice the normal length of pointer deflection is produced with a given input, the meter resistance being unchanged. In cases where only small pointer deflection is produced on normal ranges, it is obviously of great service in obtaining more easily read indications.

The normal instrument zero is that used for D.C., the pointer being displaced slightly on A.C. This change of zero (which increases on ÷ 2 ranges) is to compensate for small inevitable errors on A.C. It is produced by a minute current drawn from the 1½ volt cell used for resistance measurements, and the normal setting for cell deterioration on resistance tests is such as to maintain the accuracy on A.C. The correction advised on the earlier model when measuring on ÷ 2 A.C. ranges, is no longer necessary.

The meter is guaranteed accurate to B.S. first grade limits on D.C. and on A.C. from 25 to 2000 cycles. The enormous width of measurement covered by this instrument is well illustrated by the D.C. voltage ranges, where the ratio of the largest to the smallest calibrated indication is two million to one. Furthermore, owing to the accuracy of calibration, and the great care taken in the manufacture of the various parts, the limits of error laid down for first grade instruments are not even approached. Audio-frequency voltages and currents can be measured quite successfully, because although first grade limits are not claimed above 2 kc/s the meter is reasonably accurate up to 10 kc/s.

METHOD OF MEASURING VOLTAGE

When measuring voltage it is merely necessary to set to the appropriate range, and connect the leads across the source of voltage to be measured. On every normal range except the 10 volt A.C., the instrument will consume 2 m.A. for full scale deflection, and proportionately less for smaller deflections. Using the press-button, the current consumed for any deflection is halved, the resistance being unaffected. In the case of the 10 volt A.C. range, full scale deflection consumes 20 m.A. and 10 m.A. in the two cases.

METHOD OF MEASURING CURRENT

To measure current, the instrument is set to a suitable range, and connected in series with the apparatus being tested. Should it be desired to extend the D.C. current ranges beyond the normal limit of the meter, the 2 m.A. D.C. range can be used as a millivoltmeter of 100 m.V. full scale in conjunction with external shunts. A.C. current ranges can be extended by means of external transformers used in conjunction with a current range on the meter. Special shunts and transformers are made for use in association with the meter and the ÷ 2 button gives an additional range to the normal one. (See sheet No. M.15.)

METHOD OF MEASURING RESISTANCE

When used as an ohmmeter, the 1½ volt cell in the instrument furnishes the current for making the test on the two lower resistance ranges. Before making a test it is advisable to check, and if necessary, to adjust for any change in the battery voltage or resistance, and a simple and rapid method of doing so is explained in the working instructions on a plate permanently attached to the underside of the instrument. To make any resistance tests on either of the above ranges, it is only necessary after adjustment to connect the leads across the article under test, and its resistance will be indicated instantly on the top scale. When the battery is ultimately exhausted beyond the limits of compensation, a new one should be inserted, care being taken to tighten the terminals firmly. The dimensions of the cell must not exceed $1\frac{1}{4}''$ x $1\frac{1}{4}''$ x $3\frac{5}{8}''$.

The 1 megohm range involves the use of two 4½ volt standard flash-lamp batteries, which are housed in the battery compartment. Before testing on this range, the leads should be joined together and knob Q withdrawn from the panel and rotated in a clockwise direction until the pointer indicates zero ohms. When set, resistance measurements can be made by connecting the leads across the article. Always reset knob Q to its normal position in the panel before resuming tests. Extension of resistance ranges can be effected with the aid of A.C. or D.C. mains or other source of voltage, used in conjunction with the 100 or 400 volt ranges. Adjustment for supply voltage is carried out by connecting the leads to the source and using knob Q as before. This gives compensation from two-thirds to two and a half times the value of the voltage range employed, and it is safe and correct to use the 100 volt range even when the testing voltage is as high as 250 volts. When set, the unknown resistance is connected in series with the meter and the supply, its value being that shown on the ohms scale multiplied by 1000 or 4000 respectively. Reset knob Q after use. Special care should be exercised when using the mains, and the article under test should not be handled while the voltage is switched on. It should be realised that resistance tests must not be attempted on apparatus already carrying current.

Resistances down to 0.01 ohm can be tested with the aid of the resistance range extension unit. (See sheet No.M15)

METHOD OF MEASURING CAPACITY

Capacity from 0.01 mfd. to 20 mfd. can be measured directly with the aid of an A.C. supply after a preliminary setting of voltage. With the switch set for capacity, the leads should be connected to an A.C supply between 65 and 250 volts 50 cycles, when knob Q can be used to bring the pointer to the " INF " capacity mark. Supply frequencies other than 50 cycles can be used though it will affect the voltage limits but it is important that 250 volts is not exceeded. When set, the condenser under test is connected in series with the supply and the meter, and its capacity can be read direct, within commercial limits. The operator is warned not to handle the condenser and leads while the voltage is applied, and should remember to return knob Q after use. The internal condenser should be discharged by joining the leads together.

Although electrolytic condensers are sometimes tested using the capacity scale in the normal way, it is advisable to polarise independently through a choke of at least 50H or resistance of 50,000Ω (as there is an internal series condenser) and not use more than, say, 100 V. A.C.

Calculations of capacity using a low A.C. voltage in conjunction with a current range may be employed in this case a series polarising voltage being feasible.

METHOD OF MEASURING POWER & DECIBELS

The power and decibel range uses the meter as a subsitute for the output load, and gives a maximum reading of 2 watts the load impedance being 5000 ohms. The corresponding decibel scale is calibrated from - 15 to + 16 db, the reference level (Odb) being 50 m.W. The 10V and 100V A.C. ranges can be used as power ranges of 200 m.W. their impedances being 500 and 50,000 ohms respectively.

The A.C. position marked with a spot (31.5 m.A.) is for extension of power and decibels up to 20 watts and + 26 db in conjunction with external resistances.

An accessory is available for use with the meter to enable direct reading to be made on power or decibel scales. The power box from 500 ohms to 15,000 ohms (capable of providing at least three intermediate impedances between any value and twice the amount) gives ranges of 200m.W., 2W and 20 watts with corresponding decibel values.

Ranges and relevant data are as follows :—

50 RANGES with ONE INSTRUMENT

D.C. CURRENT

Range.	Value per division.
0- 1 mA	10μA
0- 2 ,,	20 ,,
0- 5 ,,	50 ,,
0- 10 ,,	100 ,,
0- 50 ,,	500 ,,
0-100 ,,	1 mA
0-500 ,,	5 ,,
0- 1 Amp.	10 ,,
0- 5 ,,	50 ,,
0- 10 ,,	100 ,,

D.C. VOLTAGE

Range.	Value per division.
0- 50 mV (1 mA range)	0.5 mV
0- 100 mV (2 mA range)	1 ,,
0- 500 mV	5 ,,
0- 1 Volt	10 ,,
0- 5 ,,	50 ,,
0- 10 ,,	100 ,,
0- 50 ,,	500 ,,
0- 100 ,,	1 Volt
0- 200 ,,	2 ,,
0- 400 ,,	5 ,,
0- 500 ,,	5 ,,
0-1000 ,,	10 ,,

A.C. CURRENT

Range	Value per division.
0- 5 mA	50μA
0- 10 ,,	100 ,,
0- 50 ,,	500 ,,
0-100 ,,	1 mA
0-500 ,,	5 ,,
0- 1 Amp.	10 ,,
0- 5 ,,	50 ,,
0- 10 ,,	100 ,,

A.C. VOLTAGE

Range.	Value per division.
0- 5 Volts	50 mV
0- 10 ,,	100 ,,
0- 50 ,,	500 ,,
0- 100 ,,	1 Volt
0- 200 ,,	2 ,,
0- 400 ,,	5 ,,
0- 500 ,,	5 ,,
0-1000 ,,	10 ,,

RESISTANCE

Range.	First indication.	
0- 10,000 ohms	0.5 ohms	using internal 1½ volt cell.
0-100,000 ,,	5 ,,	
0- 1 megohm	50 ,,	using internal 9-volt battery.
0-10 ,,	500 ,,	using external source of A.C. or D.C. voltage.
0-40 ,,	2000 ,,	

CAPACITY

	First Indication
0 to 20 mFd.	0.01 mFd

POWER AND DECIBELS

Impedance	Range	First Indication	0 = 50 mW
500 ohms	0 to 200 mW	0.1 mW	- 25 to + 6 db
5,000 ohms	0 to 2 W	1 mW	- 15 to + 16 db
50,000 ohms	0 to 200 mW	0.1 mW	- 25 to + 6 db

The ranges of Current, Voltage, Resistance, Power and Decibels can all be extended by external accessories manufactured by the Company.

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ELECTRICAL MEASURING INSTRUMENT

British Pat. Nos. 200977, 404015, 423199, 464867, 476681-2-3, 476738, others pending.

Overall size : 8" × 7¼" × 4½" Net Weight : 6¾ lbs. (including leads).

Home Trade, carriage paid. Export Trade, F.O.B. English port. Packing free. Cases charged at cost.

Strong Leather Cases for above, with Carrying Handle and Shoulder Strap can be supplied.

Sole Proprietors and Manufacturers :

THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO. LTD.

Winder House, Douglas Street, London, S.W.1.

Telephone : Victoria 3404-9

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3M.9.48.