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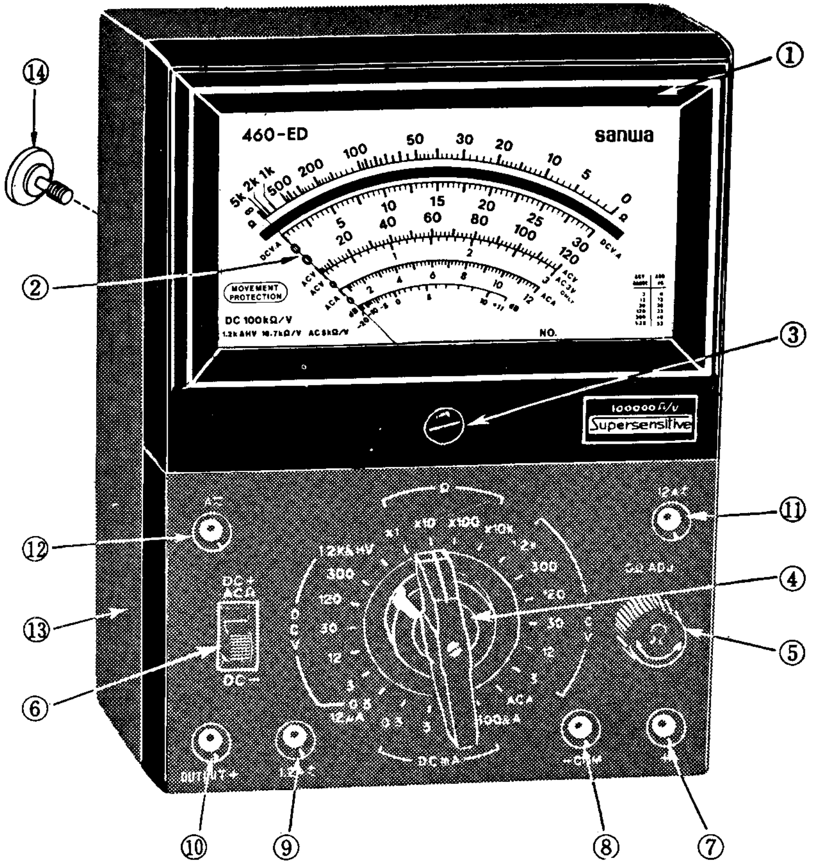
sanwa

460-ED
MULTITESTER

OPERATOR'S MANUAL



1 Indicator (detachable)
2 Pointer
3 Zero corrector
4 Range switch
5 0Ω adjuster
6 Polarity conversion switch
7 Positive (+) terminal
8 Negative (-) terminal
9 Positive terminal for 1.2A AC/DC
10 Positive OUTPUT terminal
11 Positive terminal for 12A AC/DC
12 Common negative terminal for ACA/DCA
13 Rear case
14 Rear bolt fixing indicator

PREFACE

THE TIMES of rapidly progressing electronic industry rigorously claims for the development of a high performance measuring instrument for research and experimental purposes. Availability of an instrument doing high accuracy measurement incurring minimum loss of current to the circuit being checked, is one. In answer to this intense requisition, SANWA now offers a supersensitive multitester 460-ED which will take rank in performance with an electronic voltmeter.

Besides the elevated sensitivity, the 460-ED is provided with wide range of measurement to meet the needs of extensive measurement in laboratories. The current ranges of 1.2A and 12A provided for both DC and AC will fulfil the requirement of comprehensive performing capacity expected of a multitester.

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Features and Benefits.

Negligible Current Loss. In voltage measurement, the loss of current the circuit being checked suffers due to the parallel effect of the meter connected is only 10μA at full scale. It is 1/5 ~ 1/20 of usual testers, and the instrument always affords correct reading.

Double Protection of the Indicator. Absorbing mechanical shock and vibration, the moving element of the indicator is supported by spring-loaded jewel bearings. Electrically, the silicon diode placed across the indicator circuit safeguards the moving coil from getting burnt on account of inadvertent overcurrent and sharp pulse voltage.

Polarity Conversion Switch. A turn of the switch measures positive and negative DC voltages. This measurement is indispensable for aligning FM and other elctronic circuits.

Current Ranges–1.2A and 12A. The unique equalizing transformer developed by SANWA has simplified the circuit design and advanced the performing ability of the instrument.

Detachable Indicator. A single bolt loosened allows the indicator to be detached from the body together with the scale dial. It facilitates the replacement of the indicator when damaged reducing time for repair.

In DC measurement, the reading is affected by the HF current present mixed. This interference is removed by a specific circuit provided.

1.2 Specifications.

Measurement Ranges Available.

DCV: (±)0.3 3 12 30 120 300 (100kΩ/V)
1.2k (16.6kΩ/V) 30k (w/HV probe)

DCA: (±)12μ 0.3m 3m 30m 300m 1.2 12 (300mV)

ACV: 3 12 30 120 300 1.2k (5kΩ/V)

ACA: 1.2 12 (300mV)

Ω:					
	Range -	×1	×10	×100	×10k
	Midscale -	40Ω	400Ω	4kΩ	400kΩ
	Maximum -	5kΩ	50kΩ	500kΩ	50MΩ

dB: −20～+63

Allowance.	±2% fsd for DCV.
	±3% fsd for ACV (5% for 3V)
	±2% fsd for DCA
	±2% of scale length for Ω
Frequency error.	±3% (50Hz～100kHz) for 30V AC & below
Batteries.	1.5 (UM-2)×1 & 9V (006P)×1
Size & Weight.	184×134×88mm & abt. 1.3kg

2 OPERATING INSTRUCTIONS

2.1 Zero Adjustment.

This is to adjust the pointer (2) to zero of the scale left by turning the corrector screw (3) located just below the scale dial. The pointer should be looked at from right over instead of at an angle so that it may exactly fall on its image in the mirror.

2.2 Replacement of Batteries.

If it is impossible on the ×1 range to place the pointer at zero of the top Ω scale by shorting together the + and −COM jacks and turning the 0Ω ADJ knob (5) full clockwise, the internal 1.5V cell has worn out needing replacement. If it is for the ×10 range, the 9V battery must be replaced. Exhausted batteries should be immediately replaced, or the electrolyte might leak to corrode the internal components and degrade the electrical performance of the instrument. When it is laid away unused, the batteries had better be taken out.

To replace the battery, the indicator block is first removed from the body by unscrewing the bolt on the back. The batteries are mounted lengthways in the rear case held down by a terminal spring plate. Give it a slight turn, and the batteries can be removed. When the indicator is put back in place, screw down the bolt tightly. Do it mindfully because this is a procedure characteristic to this instrument.

2.3 Accuracy and Range Selection.

Allowance for each measurement is given in the specifications, but the least erroneous reading is obtained by using a proper range. For voltage and current measurements, use a range which will allow the pointer to fall within the right hand half of the scale to read. For resistance, accurate reading is obtained around in the middle of the Ω scale.

2.4 Function of the Protection Circuit.

In Fig. 1 below the dotted line shows how an overvoltage applied to the indicator is suppressed by the zener effect of the silicon diode. Absence of the silicon protection will allow a high voltage inadvertently applied to a current or resistance range to hit the moving coil directly as shown by the true line. 100V input will instantly give rise to 50V in the coil circuit to burn it out along with a shunt, which the silicon diode puts down to about 0.8V. Formerly a selenium rectifier was used to effect this protection. Today a silicon diode is used instead.

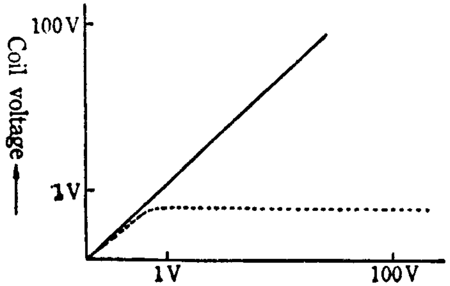


Fig. 1

Such a safety device might be dispensed with for an experiénced engineer, but it is not seldom that a tester is unguardedly impressed with a voltage or current beyond its capacity. On the other hand, sharp building-up voltages are often encountered while adjusting television and electronic circuits which may directly hit the moving coil of the indicator across internal capacitive insulation. The presence of a silicon diode would surely make slighter the damage that such a high sensitivity indicator may suffer. The protection device saves time and labour as well as money for repair.

When a circuit resistor is burnt on account of an accidental overload, it can readily be replaced to restore the instrument to normal performance. Fig. 2 and the table below will help locate the resistor subject to burn needing replacement. The resistor to be replaced should be of ±1% precision.

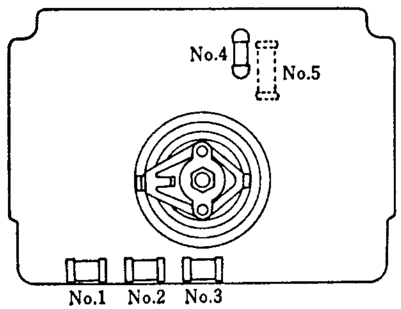


Fig. 2

Table.

Tester range	Resistor	R. S.
300mA DC	0.75Ω	R13
30mA DC	9Ω	R12
3mA DC	90Ω	R11
Ω ×10	405Ω	R31
Ω ×1	40Ω	R30

Refer to 4.3—List of Parts.

3 OPERATION

3.1 Measuring DC Voltage—V, kV.

The seven ranges provided cover practically all needs of DC voltage measurement. The overall input impedance of 100kΩ/V is the highest that can ever be expected of a multitester. It allows loss of current neglected for DC voltage measurement. Just see Fig. 3. In this circuit, the true voltage value at point P is 10V. A lossless tester or a voltmeter of infinite impedance would read this value. The 460-ED will read it 9.5V with -5% error. What will it be if measured by a pocket-size tester or by a so-called high-grade tester of 20kΩ/V? See the table below showing what big errors they read.

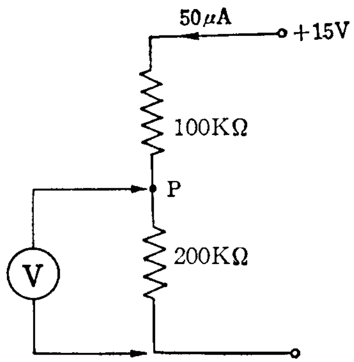


Fig. 3

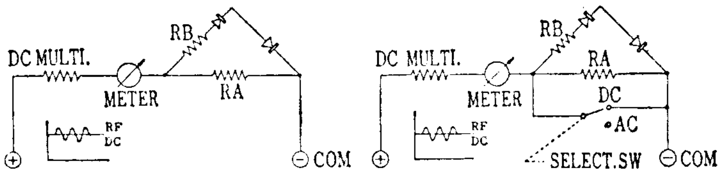
Measured by	Reading	Error
460-ED on 12V range	9.5V	−5%
20kΩ/V tester on 10V range	7.5V	−25%
Commonplace pocket tester	3.73V	−63%

The performance ability of a 100kΩ/V instrument is most eloquently demonstrated in the voltage measurement of a high impedance load. The 460-ED efficiently checks a voltage amplifying circuit, DC amplifier, switching circuit, oscillating circuit, AVC and AGC voltages of a transistor and electronic equipment. A voltage of which the circuit current is less than 100μA can be measured without disturbing the circuit condition.

3. 1. 1 Polarity Switch. The polarity conversion switch of the 460-ED saves the trouble of reversing the test lead connections when the pointer deflects to the opposite direction across zero. It is also used to determine the polarity of a DC voltage when a transistor, television or FM circuit is checked.

3. 1. 2 Disturbance of Non-linear Element. Fig. 4(A) on next page is the circuit of a tester for DC measurement where a double-element rectifier is used, and the circuit resistance RA is common with AC voltage measurement. This circuit will produce practically no error of indication so far as usual audio circuit is concerned, but for a circuit where HF current above 100kHz is present mixed, much of the current flows into the tester through the floating capacity of the switch, and the impedance on both sides of RA is reversed owing to the asymmetrical property of a diode. In consequence, the mean value current which should not be read on the meter remains indicated causing a big error because of the DC voltage which

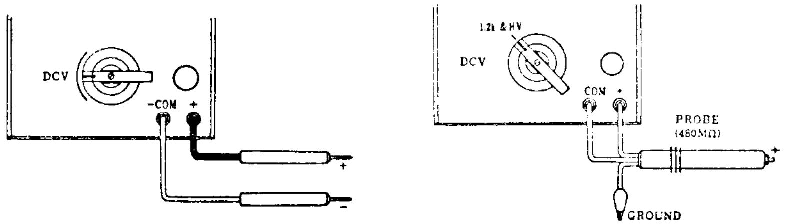
should not actually be read on the meter. It may occur for any range, and even the 1.2kV range will read big figures. By shorting RA by way of the selector switch as shown in (B), the 460-ED obtains correct DC voltage reading.



(A) Usual circuit. (B) 460-ED

Fig. 4

Fig. 5 (A) and (B) illustrate how the test leads are connected for DC voltage measurement. For the (B) connection of an HV probe, the range switch should be positioned at DC-1.2k & HV, and reading is noted on the black scale just below the mirror marked DCV•A.



(A) DC voltage (B) DC 30kV

Fig. 5

3. 2 Measuring DC Current-μA, mA, A.

The 460-ED has seven DC current ranges from 12μA through 12A. By virtue of the high sensitivity of the indicator, the instrument functions on its μA range as a bridge circuit galvanometer for checking semiconductor equipment. The mA and A ranges are generally used to measure circuit current, charging and discharging current of batteries, maintenance and inspection of DC power appliances and power transistor circuits.

Taking into account the reading error due to change of temperature, the terminal voltage drop is set at 300mV and error is kept down within 0.1%/°C.

Up to 300mA, the + and −COM jacks are used. For 1.2A and 12A, because of the insufficient capacity of the range switch, separate jacks are used leading the current direct to the shunts. For these measurements, the range switch is placed at the 300&A position. For the test lead connections, see Fig. 6 below.

Use the figures along the black arc just below the mirror marked DCV•A in common with DC voltage measurement.

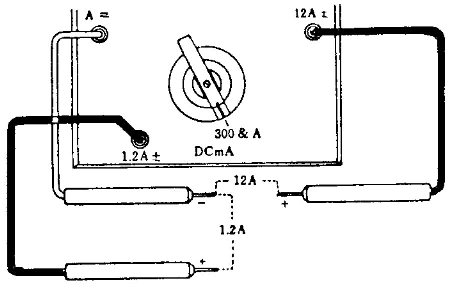


Fig. 6

3.3 Measuring AC Voltage–V, kV.

AC voltage is measured up to 1.2kV in six ranges the lowest range being 3V. The solid-state rectifier is

durable and eliminates chance of reading error due to deterioration. Furthermore, the good frequency characteristic covers in full the audio frequency zone so that the instrument may be used as a frequency monitor.

As a rule, the + and −COM jacks are used for AC voltage measurement. For 12V and upwards, the red scale third from the top is used reading the black figures above the arc in common with DC voltage measurement. For 3V alone, use the separate scale marked AC 3V ONLY reading the red figures beneath.

3.3.1 Volume Level.

Volume level in dB is measured just in the same way as AC voltage measurement reading the dB scale on the bottom instead. It directly reads up to +11dB for the 3V range. For other ranges, the quantities given in the ADD dB table on the right hand corner of the scale dial are added to the value obtained on the dB scale.

0dB is established at a voltage when 1mW is dissipated across a 600Ω line, which is approximately 0.775V. The dB scale of the 460-ED is graduated based on this reference, and the output voltage of a 600Ω line is denoted in decibel on the scale. For one and the same impedance, voltage comparison dB is equal to power comparison dB. For a circuit of which the load impedance is other than 600Ω, the dB value obtained on the meter is nothing but the value of an AC voltage expressed in decibel corresponding to the voltage range used. Such a value cannot be taken as a correct output level.

$$dB = 20 \log_{10} \frac{\text{ACV reading}}{0.775V}$$

The dB scale of the instrument is available to measure gain or loss in dB or compare frequency responses regardless of the circuit impedance. In these cases, the absolute value obtained is not an essential factor of comparison, but the variation of the dB value is.

In output voltage measurement, the impedance of the circuit being checked has much to do with reading. For a 600Ω line, however, it can be neglected because the impedance of the tetser is by far the bigger than the line impedance, though it is desirable to be within 1/5 of the impedance of the tester.

The imput impedance of the AC voltage range used to measure dB is obtained by multiplying the full scale reading of the range by the overall input impedance of the AC voltage range. For example, the input impedance of the 12V range of the 460-ED is: 12(V) × 5(kΩ) = 60(kΩ/V).

The true dB of a circuit of which the line impedance is other than 600Ω is obtained by adding to the reading for a 600Ω line the quantities given in the following table:

Impedance	Add dB
2kΩ	−5.2
1kΩ	−2.2
600Ω	0
500Ω	+0.8
300Ω	+3.0
200Ω	+4.8

Impedance	Add dB
150Ω	+ 6.0
75Ω	+ 9.0
50Ω	+10.8
16Ω	+15.8
8Ω	+18.8
4Ω	+21.8

3.3.2 AF Output Voltage.

This measurement is available to check only the AC portion of the voltage of a circuit where AC and DC voltages are present mixed as at the plate of an audio amplifier tube. In this measurement, the OUTPUT + jack (10) is used instead of the + jack. Across these terminals is placed a 0.1μF capacitor which blocks the DC portion and AC voltage alone is read on the meter.

Another use of reading output voltage is to confirm if there is horizontal signal at the grid of the horizontal amplifying tube of a television. Use the 30V range.

Similarly, for the synchronous detaching and synchronous amplifying circuits, the plate and the grid of the synchronous amplifying tube and the grid of the synchronous detaching tube are checked by turns to define the presence of input signal. Use the 12V range to check them. In any case, DC element is blocked by the 0.1μF capacitor and the presence of the signal is confirmed by the AC voltage read on the meter.

3.4 Measuring AC Current-A,

The 460-ED uses the shunts for 1.2A and 12A DC in common for 1.2A and 12A AC. This is the most noteworthy feature of the instrument. The limited space using a moving-coil type indicator necessitates the instrument to adopt a specific circuit design to make the scale characteristic uniform for reading 1.2A and 12A DC and AC with better temperature and frequency characteristics than a usual moving-iron type AC ammeter. These 2 ranges, in place of a moving-iron type instrument, check not only electrical home appliances, but also the equipment using AC as power.

For measurement, the range switch is rotated to the ACA position. Test lead connections are same for 1.2A and 12A DC. (Fig. 6)

Use the red scale second from the bottom marked ACA.

3.5 Measuring Resistance-Ω, kΩ, MΩ.

Of all ranges of a tester, the resistance range is most frequently used. Besides measuring resistance, the four ohm ranges check line continuity, short circuit, DC resistance of a transformer, etc.

Before taking a measurement, the pointer position should be confirmed to be on zero of the top Ω scale. (See 2.2) Every time the range switch is moved to another ohm range, the pointer needs adjustment.

For the ×1 range, the top Ω scale is read dirctly. For the ×10 range and upwards, readings on the scale are multiplied by the multiple of each range. The ×1 range may be used to measure resistance below 100Ω and to test continuity. The ×10 range will measure 100Ω level, the ×100 range kΩ level, and the ×10k range high resistance above 100kΩ up to 50MΩ.

3.5.1 Terminal Polarity for Resistance Measurement.

As the schematic diagram shows, the −COM jack furnishes positive voltage and the + jack furnishes negative voltage. It must be noted when checking polarized resistance units like semiconductors and the leakage of electrolytic capacitors.

3.5.2 Current Drain of the Internal Batteries.

Taking RX as the resistance being measured and RM the midscale reading for each range, the current the ×10k range consumes will be $\frac{9V}{RX+RM}$, and for the ×100 range and below, $\frac{1.5V}{RX+RM}$. Maximum current consumption of each resistance range will be as follows:

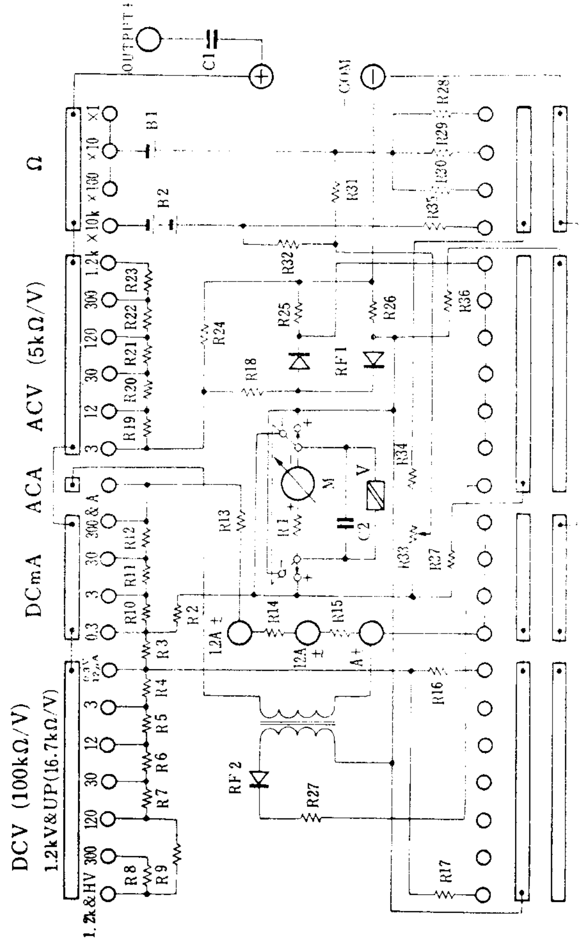
Range	Current drained
×1	Approx. 40mA
×10	〃 4mA
×100	〃 0. 4mA
×10k	〃 23μA

This table should be referred to when testing the continuity and resistance of a unit whose current or voltage capacity is limited.

(Specifications subject to change without previous notice)

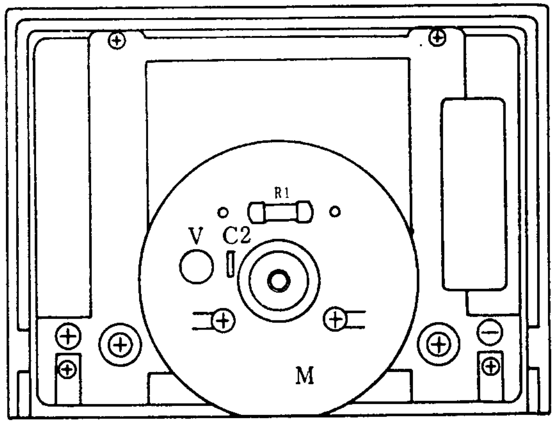
4 SUPPLEMENTARY DATA

4.1 Schematic Diagram

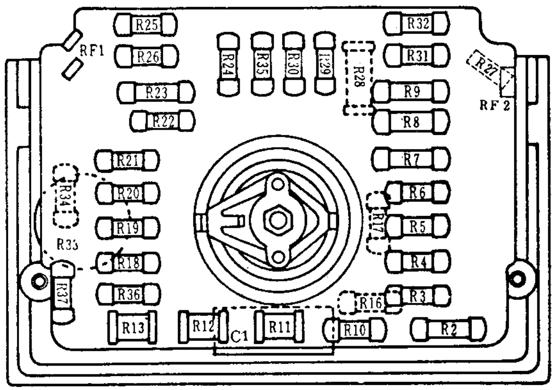


4. 2 Arrangement of Parts (Rear View)

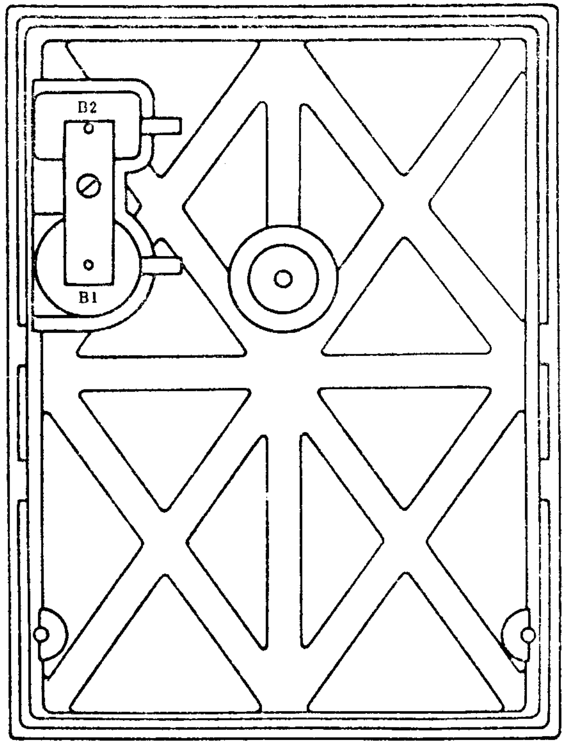
Indicator block.



Control block.



Rear case.



4.3 List of Parts

Part No.	Description	R. S.
EDR01	Resistor (4~6kΩ, film) for millivolt calibration	R1
EDR02	Resistor (19kΩ, film), series	R2
EDR03	Resistor (1kΩ, film) 0.3V DC multiplier	R3
EDR04	Resistor (270kΩ, film), 3V DC multiplier	R4
EDR05	Resistor (900kΩ, film), 12V DC multiplier	R5
EDR06	Resistor (1.8MΩ, film), 30V DC multiplier	R6
EDR07	Resistor (9MΩ, film), 120V DC multiplier	R7
EDR08	Resistor (10MΩ, film), 300V DC multiplier	R8
EDR09	Resistor (8MΩ, film), 1.2kV DC multiplier	R9
EDR10	Resistor (900Ω, film), 0.3mA DC shunt	R10
EDR11	Resistor (90Ω, film), 3mA DC shunt	R11
EDR12	Resistor (9Ω, film), 30mA DC shunt	R12
EDR13	Resistor (0.75Ω, wirewound), 300mA DC shunt	R13
EDR14	Resistor (0.225Ω, wire), 1.2A AC & DC shunt	R14
EDR15	Resistor (0.025Ω, wire), 12A AC & DC shunt	R15
EDR16	Resistor (150kΩ, film), 12μA DC shunt	R16
EDR17	Resistor (6kΩ, film), DC 1.2kV shunt	R17
EDR18	Resistor (11.1kΩ approx., film), 3V AC multiplier	R18
EDR19	Resistor (45kΩ, film), 12V AC multiplier	R19
EDR20	Resistor (90kΩ, film), 30V AC multiplier	R20
EDR21	Resistor (450kΩ, film), 120V AC multpilier	R21
EDR22	Resistor (900kΩ, film), 300V AC multiplier	R22
EDR23	Resistor (4.5MΩ, film), 1.2kV AC multiplier	R23
EDR24	Resistor (39kΩ approx., film), ACV sensitivity calibration	R24
EDR25	Resistor (20kΩ, film) for rectifier circuit	R25
EDR26	Resistor (20kΩ, film) for rectifier circuit	R26
EDR27	Resistor (14kΩ approx., film) for ACA calibration	R27
EDR28	Resistor (39.5Ω, film), ohm ×1 shunt	R28
EDR29	Resistor (405Ω, film), ohm ×10 shunt	R29

EDR30	Resistor (4.17kΩ, film), ohm ×100 shunt	R30
EDR31	Resistor (33kΩ, film), series	R31
EDR32	Resistor (550kΩ, film), ohm ×10k series	R32
EDR33	Potentiometer (100kΩ) for 0Ω adjustment	R33
EDR34	Resistor (170kΩ, film), shunt	R34
EDR35	Resistor (1.1MΩ, film), ohm ×10k shunt	R35
EDR36	Resistor (8kΩ, film), shunt	R36
EDR37	Resistor (20kΩ, film), AC series	R37
RF05	Germanium diode, 2 required	RF1
RF05	Germanium diode, 1 required	RF2
MO15	Meter movement (10μA)	M
EDSW1	Range selector switch w/resistor holder	
EDP1	Front panel (460-ED type)	P
B001	Dry cell (1.5V, UM-2)	B1
B006	Dry cell (9V, 006P)	B2
X017	Rear case (460-ED type, bakelite)	
T001	Terminal jack (pin type), 6 required	
K005	Knob for 0Ω adjuster	
K013	Knob for range selector switch	
V001	Varister	V
C001	Capacitor (paper)	C1
C050	Capacitor (ceramic)	C2
PSW1	Polarity switch	
L002	Test lead, pair	
R017	Meter movement base	
C017	Meter movement cover	
TR03	Transformer	

R.F. Reference symbol

89.11. 500S