MODEL 116

VOLT-AMMETER

INSTRUCTION MANUAL

KIKUSUI ELECTRONICS CORP.

Power Requirements of this Product

Power requirements of this product have been changed and the relevant sections of the Operation Manual should be revised accordingly.
(Revision should be applied to items indicated by a check mark ☑.)

☐ Input voltage

The input voltage of this product is _____ VAC,
and the voltage range is _____ to _____ VAC. Use the product within this range only.

☐ Input fuse

The rating of this product's input fuse is _____A, _____VAC, and _____.

WARNING

- To avoid electrical shock, always disconnect the AC power cable or turn off the switch on the switchboard before attempting to check or replace the fuse.
- Use a fuse element having a shape, rating, and characteristics suitable for this product. The use of a fuse with a different rating or one that short circuits the fuse holder may result in fire, electric shock, or irreparable damage.

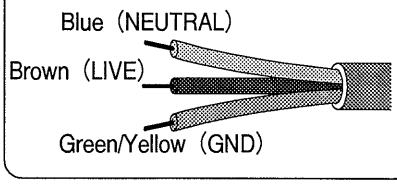
☐ AC power cable

The product is porvided with AC power cables described below. If the cable has no power plug, attach a power plug or crimp-style terminals to the cable in accordance with the wire colors specified in the drawing.

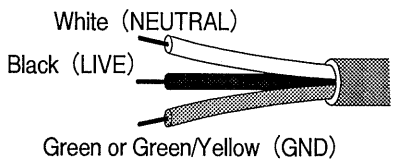
WARNING

- The attachment of a power plug or crimp-style terminals must be carried out by qualified personnel.

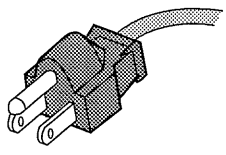
☐ Without a power plug



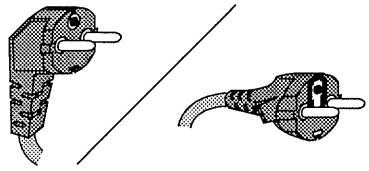
☐ Without a power plug



☐ Plugs for USA



☐ Plugs for Europe



☐ Provided by Kikusui agents

Kikusui agents can provide you with suitable AC power cable.
For further information, contact your Kikusui agent.

☐ Another Cable _____

 Kikusui Part No. Z9-000-027 IB001681

KIKUSUI

C O N T E N T S

1. GENERAL

Kikusui Electronics' MODEL 116 VOLT-AMMETER is a high sensitive DC voltmeter designed for measuring small DC voltage and current, and for using as a DC amplifier.

By using ICs, the MODEL 116 is compact and light-weight, and consuming low power.

The input resistance of each measuring voltage range is 11MΩ constant and the full scale is 1.5 mV ~ 500 V. The current range is 1.5 μA ~ 50 mA. They are divided into 10 ranges respectively in 1.5 - 5 - 15 steps.

As DC amplifier, this instrument enables to take out from the output terminal provided at the rear side of the panel 1.5 V output voltage to the input value of the full scale at each of the above voltage and current ranges.

This Model has an automatic polarity circuit and light emitting diode inserting in a meter indicates the input signal polarity (+ or -) by lighting.

2. SPECIFICATIONS

Type	Volt-ammeter
Model	MODEL 116
Power Supply	AC 100V 50/60 Hz approx. 3 VA (Changeable to 110V, 117V or 220V by changing of internal wiring)
Dimensions	138W x 159H x 280D mm
(maximum)	(140W x 190H x 325D mm)
Weight	Approx. 2.2 kg
Meter	Scale length Approx.100mm
	Full scale 1 mA Scale 15/50
Accessories	MODEL 973R test prod 1
	Instruction manual 1
Ambient temperature	5 ~ 35 °C
Ambient humidity	Less than 85%

DC Voltmeter

Polarity	Automatic indication (By electronic circuit) Polarity of + or – is indicated by lighting of light emitting diodes inserted in a meter.
Range	0 ~ ±15/50/150/500 mV 1.5/5/15/50/150/500 V 10 ranges
Input resistance	11 MΩ at all ranges (With MODEL 973R)
Input capacitance	Less than 2pF (With MODEL 973R)
Accuracy	± 3% of full scale
Max. input voltage	DC component only 500V A signal in with AC component is included 500V peak

DC Ammeter

Polarity	Automatic indication (By electronic circuit) Polarity of + or – is indicated by lighting of light emitting diodes inserted in a meter .
Range	0 ~ ±15/50/150/500 μA 1.5/5/15/50 mA 10 ranges
Voltage drop	At all ranges 15 mV at full scale
Accuracy	± 3% of full scale

Maximum Input Current

RANGE	Maximum allowable continuous current
1.5μA	5 mA
5 μA	10 mA
15 μA	15 mA
50 μA	35 mA
150 μA	50 mA
500 μA	100 mA
1.5mA	150 mA
5 mA	350 mA
15 mA	0.5 A
50 mA	1.0 A

DC Amplifier

Gain	(At 15 mV range)	100
Accuracy		± 3%
Output Voltage	(At full scale)	± 1.5 V ± 3%
Output Resistance		Approximately 1kΩ ± 5%

3. OPERATION

3.1 Explanation of Front Panel

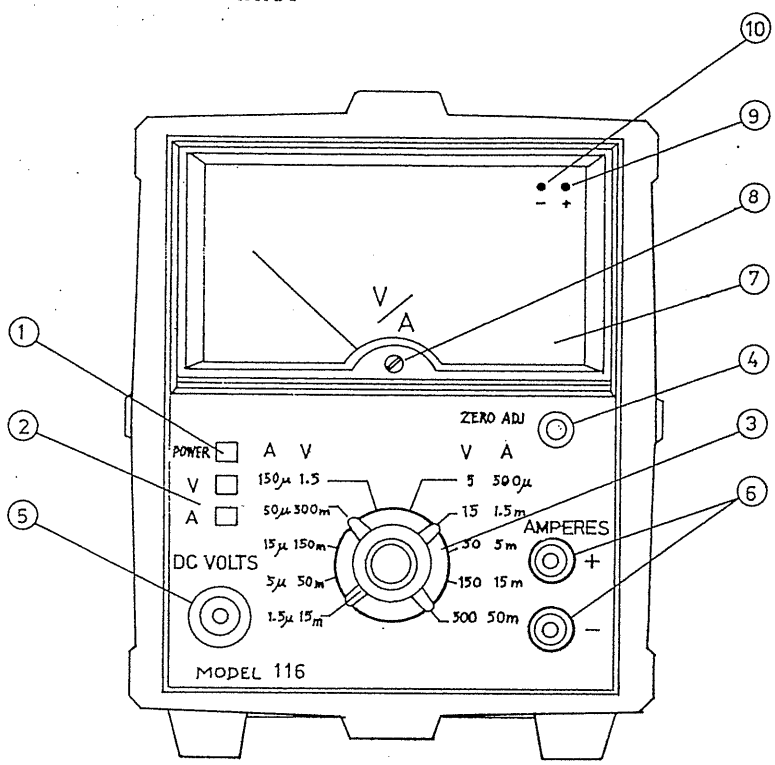


Fig. 3-1 Front Panel

① POWER — A push-button switch for turning on and off line power. When it is pressed, the switch is locked so as to turn on power. Power supply is turned off, when it is pressed again.

② Function Selector V A — The V or A switch ② shall be used by setting to either position corresponding with the use, when this instrument is used as a voltmeter or an ammeter.

③ Range Switch — Rotary switch in the center of panel. Letters around the knob signify the full scale value of voltage (black) or current (red) at the setting range. When turning clockwise, full scale is switched to higher value than before setting

④ ZERO ADJ — This knob shall be used for performing the zero adjustment of the meter and output terminal voltage or for compensating the offset of the measuring voltage.

⑤ DC VOLTS terminal

This is the terminal for measuring voltage, and the measurement must be made by using the Model 973R test prod that is provided with this instrument.

⑥ AMPERES terminals They are the terminals for measuring current, and provided at the lower part on the right of the panel. The black terminal is connected to the case.

⑦ Meter Full scale is 15 and 50, and either scale shall be read the range selected.

⑧ Meter zero adjuster Control for mechanical adjustment of meter. The control ⑧ must be adjusted, after the POWER is turned off.

⑨ ⑩ Polarity indication LED

The LED ⑨ lights, when the polarity of input signal is positive against the ground (connected to chassis).
When the polarity of input signal is negative against ground, the LED ⑩ lights.

3.2 Explanation of Rear Panel

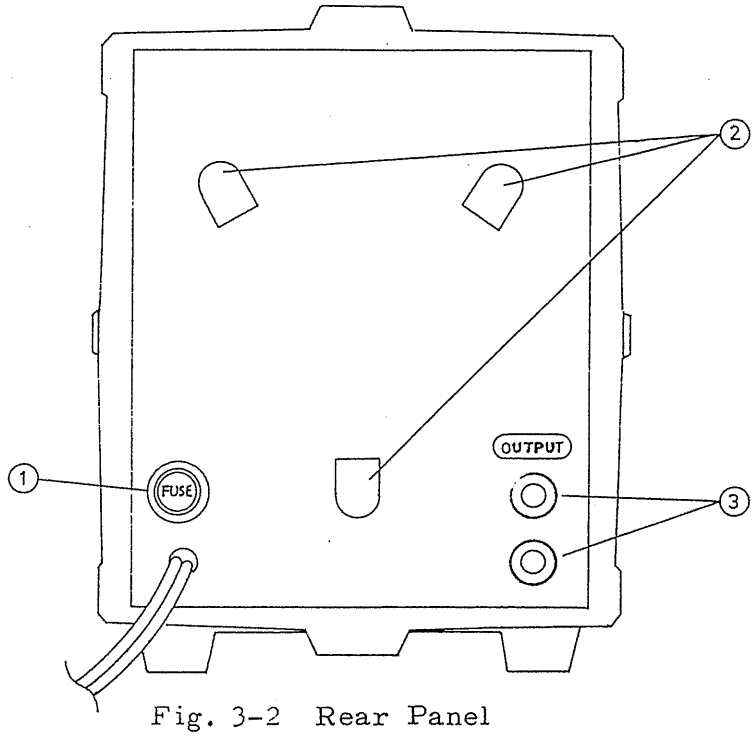


Fig. 3-2 Rear Panel

① FUSE

This is connected in the primary circuit of the power transformer. The fuse is removable by turning the bracket counterclockwise.

② Cord Retainer

The power cord is wound on this retainer for store or transfer.

③ OUTPUT terminals

These are the OUTPUT terminals to be used when this instrument is utilized as a DC amplifier, and the black terminal serves as ground (connected to chassis).
It enables to obtain 1.5 V output voltage in positive or negative polarity(same polarity as input signal) to the full scale input value at the voltage range or current range.

3.3 Preparations for measurement

1) Turn off the POWER ① on the front panel.

2) Confirm that the meter pointer indicates the zero scale.

If it does not indicate the zero , adjust the meter zero adjuster ⑧ so that it indicates the zero.

3) Connect the power plug to the line supply (100V 50Hz or 60Hz).

4) Set the function switch ② to V (voltage measurement) or A (current measurement) to be desired.

5) Turn the POWER ① on, and the polarity indication LED ⑨ or ⑩ in the meter lights.

6) Confirm that the meter pointer indicates the zero scale.

If it does not indicate the zero , adjust the ZERO ADJ knob ④ so that it indicates the zero.

3.4 Measurement of DC voltage

1) Connect the test prod to DC VOLTS terminal.

2) Set the function selector to V.

3) Read the meter indication by the scale of 15 or 50, and multiply it by the appropriate value in Table 3-1

Range	Scale	Multiple	Unit
± 15. mV	15	x 1	mV
± 50 "	50	x 1	"
±150 "	15	x 10	"
±500 "	50	x 10	"
± 1.5 V	15	x 0.1	V
± 5 "	50	x 0.1	"
± 15 "	15	x 1	"
± 50 "	50	x 1	"
± 150 "	15	x 10	"
± 500 "	50	x 10	"

Table 3-1

4) Select an appropriate range for measurement.

Connect the alligator clip to one of the circuit to be measured, and touch the other end with the test prod.

3.5 Measurement of DC current

1) The measurable current range of this instrument is 1.5 μA ~ 500mA at full scale. From the view of maintaining the accuracy, be carefull so that no overcurrent flows, since the current measuring circuit is not provided with a protective circuit.

2) Push the button A of the function selector ② .

3) Connect the AMPERES terminals to the circuit, and read the values by a method shown in Table 3-2 .

Range	Scale	Multiple	Unit
1.5μA	15	x 0.1	μA
5 "	50	x 0.1	μA
15 "	15	x 1	μA
50 "	50	x 1	μA
150 "	15	x 10	μA
500 "	50	x 10	μA
1.5mA	15	x 0.1	mA
5 "	50	x 0.1	mA
15 "	15	x 1	mA
50 "	50	x 1	mA

Table 3-2

3.6 Utilization as DC amplifier

This instrument can be operated as a DC amplifier by using the OUTPUT terminals ③ on the rear panel (black terminal is connected to ground .).

This is designed so that the output voltage at the full scale in each of the voltage and current ranges is +1.5 V or -1.5 V (Same polarity as input signal), and the gain of each voltage range is shown in Table 3-3 .

Voltage Range	Gain
15 mV	x100
50 "	x 30
150 "	x 10
500 "	x 3
1.5 V	x 1
5 "	x 0.3
15 "	x 0.1
50 "	x 0.03
150 "	x 0.01
500 "	x 0.003

Table 3-3

1) Effect by load

When the resistance of the load connected to the output terminal is more than 100kΩ, the specified gain is obtained. However, when the load is less than 100kΩ, the output voltage is reduced as per the following equation depending upon the load.

$$\text{Output Voltage} \fallingdotseq \frac{R_1}{1 + R_1} \times Eo$$

Eo : Output Voltage at no load R_1 : Load resistance (kΩ)

2) Frequency characteristics at no load

Fig. 3-1 shows an example of the frequency characteristics of this instrument at no load, when this instrument is used as an amplifier.

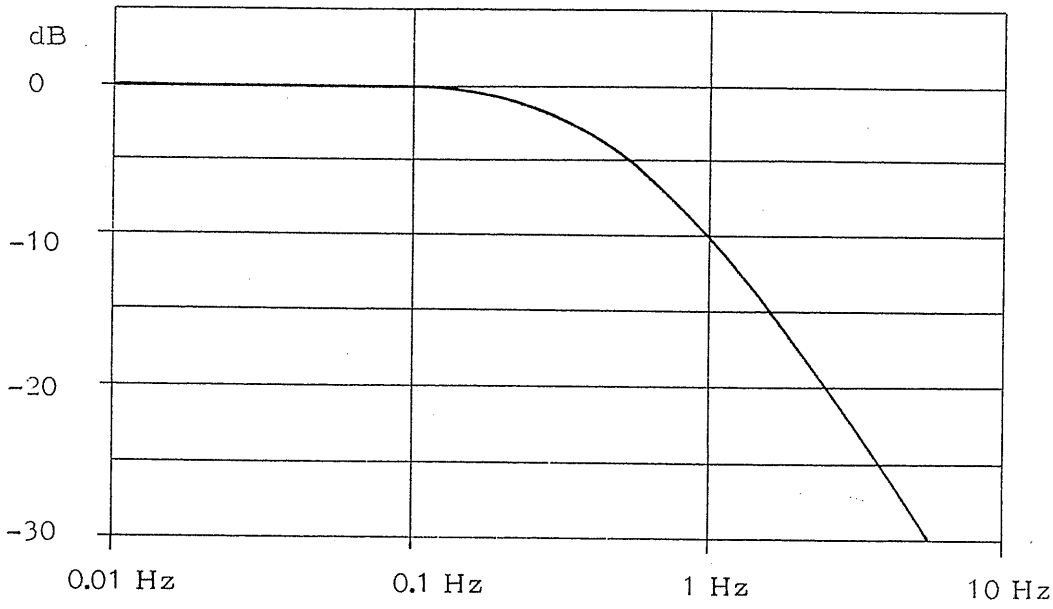


Fig. 3-1

3.7 Change of Line Supply Voltage

This instrument can be operated at the line supply of 110V, 117V, or 220V by altering the gray wire connected to the AC 100V pattern (It is printed on the main printed circuit board A1) to the pattern of the voltage desired (110V, 117V, 220V and so on are printed on the printed circuit board.).

4. Principle of Operation

4.1 Outline

Input signal is amplified by the input amplifier employing FET via an attenuator, and the output is applied the meter via automatic polarity control circuit. Its circuit operates so that meter pointer moves in one direction for both positive and negative input signal.

Current measurement is performed by measuring the voltage drop across the resistor (0.3Ω ~ 10 kΩ) for current detecting.

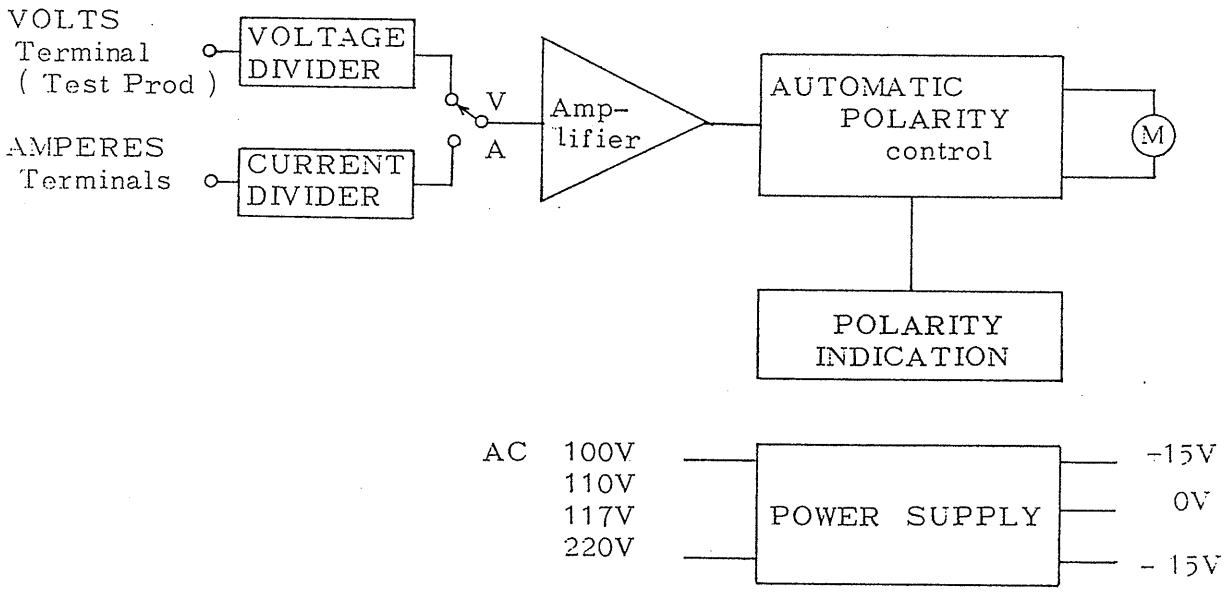


Fig. 4-1

4.2 Voltage Divider

The output of the voltage divider is approximately 136mV (at 15mV range and the range more than 150mV), and 45.5 mV (at 50mV range) at full scale input (at 15mV and 50mV range, the amplifier gain is altered.).

4.3 Current Divider

It is the resistor for current detecting in which current flows on current measurement. The voltage drop a cross the current divider is approximately 15mV at full scale input in all ranges.

4.4 Amplifier

The signal is amplified on high gain and same polarity by a direct coupled circuit of two stage employing IC as shown in Fig. 4-2. On voltage measurement, the amplifier gain is changed in 15mV and 50mV range. In the range more than 150mV. input signal is applied to the amplifier via voltage divider.

On current measuring, the input to the amplifier is 15mV for full scale input in all ranges.

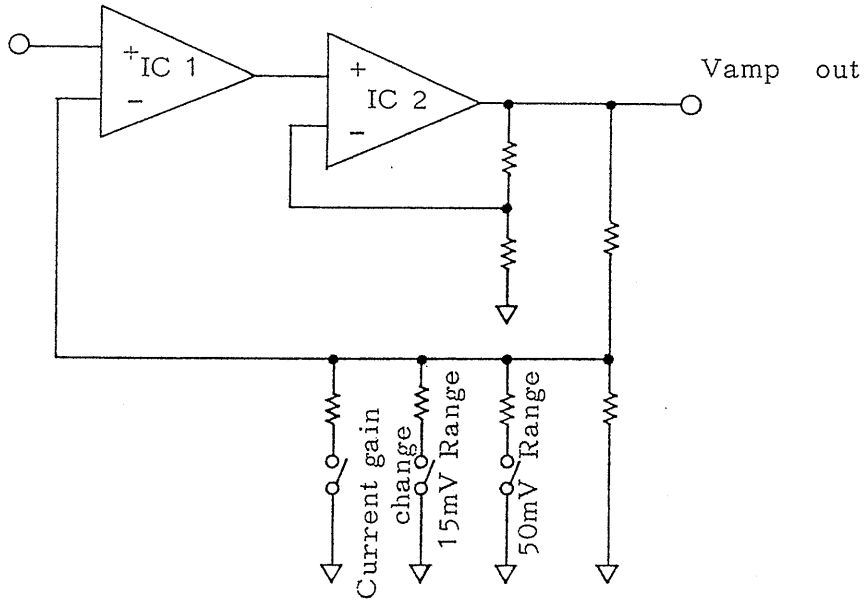


Fig. 4-2 The principle of the amplifier

4.5 Automatic polarity control

Current flows as continuous line for positive polarity input and dotted line for negative polarity input, as the positive input of differential amplifier MC 3 is grounded, as shown in Fig. 4-3. The current in a meter flows in one direction for both positive and negative input.

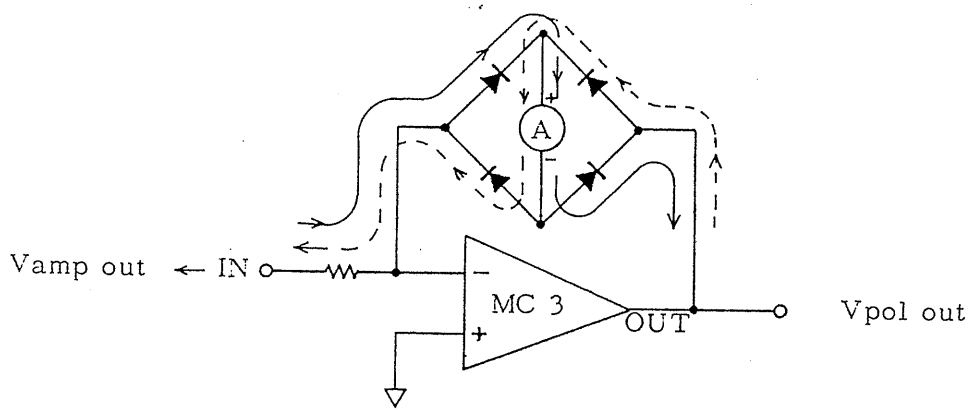


Fig. 4-3

4.6 Polarity Indication

The differential darlington amplifier is connected to the output of the MC 3 for polarity indication.

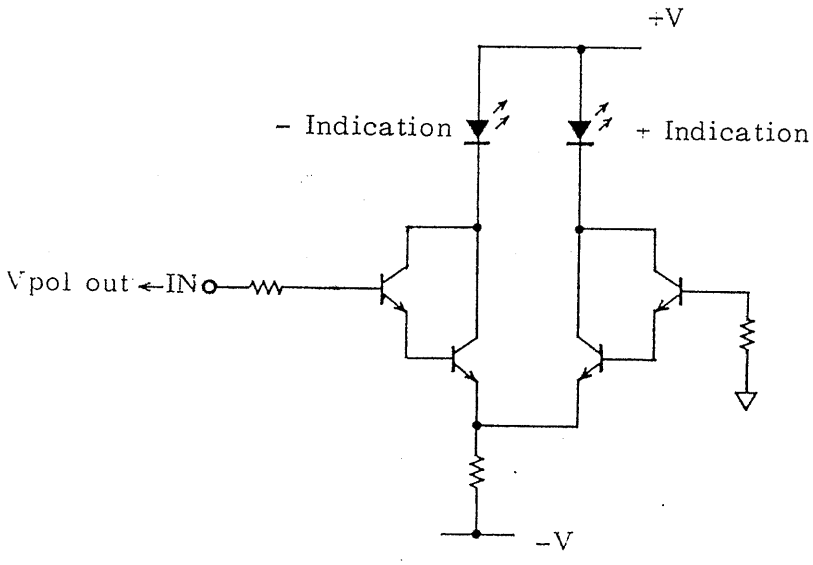


Fig. 4-4

5. MAINTENANCE

5.1 Internal Inspection

Case can be removed by turning two plastics screws (black and white) counterclockwise approximately 180° on the top and the bottom of the case It will separate into two pieces.

The location of each part is shown in Fig. 5-1.

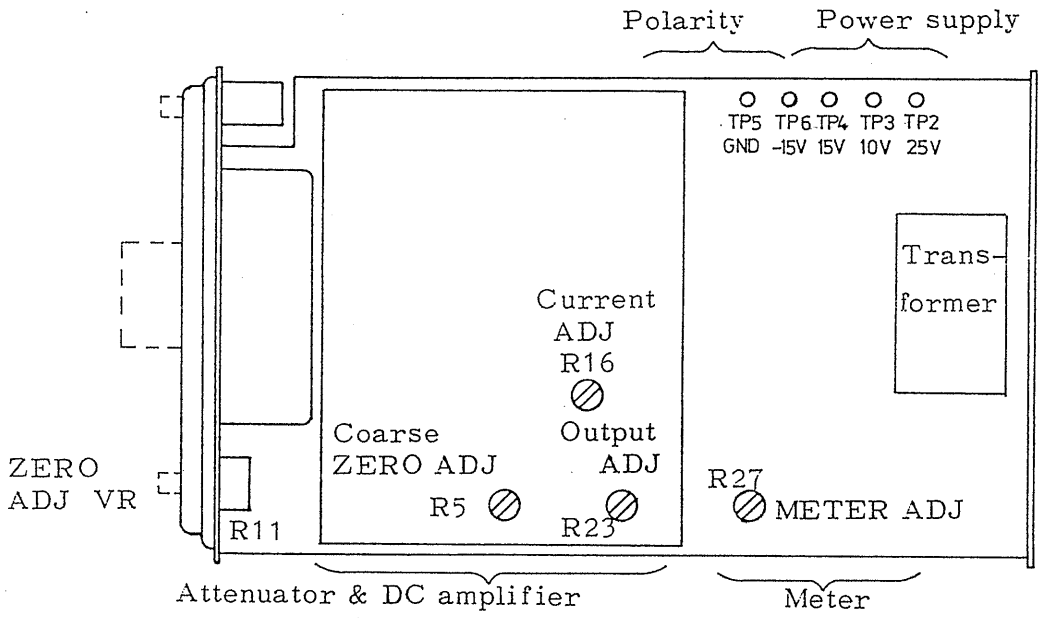


Fig. 5-1 Top View

5.2 Adjustment and Calibration

Make adjustment and calibration in order of following procedure.

1) Check of power supply

Check the voltage between following test point and ground (TP5) by Table 5-1.

Check Point	Potential difference to GND
TP2 +25V Power supply	23 ~ 33V
TP3 +10V " "	7 ~ 17V
TP4 +15V " "	13 ~ 17V
TP6 -15V " "	-13 ~ 17V

(The value at no input signal)

Table 5-1

2) Meter mechanical zero adjustment

Adjust the meter zero adjuster (⑧ in Fig. 3-1) so that the meter pointer indicates the zero scale.

3) Adjustment of output terminal voltage and voltage range.

- o Set the function selector (② in Fig. 3-1) to V, and set the range switch (③ in Fig. 3-1) to 15V.
- o Connect Model 973R prod to the VOLTS terminal with the input shorted. Adjust the ZERO ADJ control R11 (the ZERO ADJ on front panel) so that the meter pointer indicates exactly zero.
- o Connect a DC voltmeter to the output terminals so that a red terminal is high impedance side of a DC voltmeter and a black termianl is low impedance side. Apply exact +1500V to the input of the prod, and adjust the OUTPUT ADJ control R23 (Refer to Fig. 5-1).

  Adjust the METER ADJ R29 (Refer to Fig.5-1) so that the meter pointer indicates exactly fullscale.

  Change the input voltage to -1500V, and check that output voltage and meter indication is correct.

4) Adjustment of current range

- o Set the function selector (② in Fig. 3-1) to A,and set the range switch (③ in Fig.3-1) in the 500μA range (same position as 5V range).
- o Adjust the ZERO ADJ control R11 (the ZERO ADJ ④ on front panel) so that meter pointer indicates exactly zero at no input signal.
- o Connect a current calibrator to the AMPERES terminals,and apply 500μA. Adjust the CURRENT ADJ control R16 (Refer to Fig. 5-1) so that meter pointer indicates exactly full scale.

5) Adjustment of COARSE ZERO

- o Set the function selector (② in Fig. 3-1) to A, and set the range switch (③ in Fig. 3-1) in optional range.
- o Adjust the ZERO ADJ control R11 on front panel to the center position with no input to the AMPERES terminals, and adjust the COARSE ZERO control R5 so that indication of meter pointer is nearest to zero.
- o Adjust the ZERO ADJ control on front panel so that meter pointer indicates exactly zero.

5.3 Repair

Prior to delivery out of our factory, this instrument has been carefully assembled and adjusted, and been subjected to inspection under severe control. But if a trouble ever happens due to a casual accident or termination in the respective parts, this section shall be referred.

(1) The meter pointer does not move.

Symptoms	Possible trouble	Repair
Polarity indication LEDs do not light.	Power cord or plug is broken	Replacement
	Fuse is open	"
	Power switch is defective	"
	Breaking of wire of power transformer (Secondary voltage is not detected)	"
	Power supply circuit is defective	Refer to 5.2 1)
Polarity indication LED lights. o Output voltage is correct	Meter circuit is defect	Replacement
	MC 3 is defective	"
o Output voltage is incorrect	MC 1 or MC 2 is defective	"

(2) It is impossible to indicate zero for meter pointer with no signal input.

Symptoms	Possible trouble	Repair
It is impossible to indicate zero for meter pointer on power off.	Meter is defective	Replacement
It is impossible to move meter pointer by the ZERO ADJ on power on.	R11 (the ZERO ADJ on front panel) is defective.	"
It is impossible to indicate zero for meter pointer by the ZERO ADJ, for the variable range of the ZERO ADJ is narrow	Maladjustment of scale zero	Refer to adjustment of COARSE ZERO. (5.2 5)).

3) Meter pointer indicates over-scale.(on shorting input terminal)

Symptoms	Possible cause	Repair
Output voltage = 0V	MC3 is defective.	Replacement
Outpuy voltage is more than ±1.6V.	Input circuit is defective.	"
	MC1 or MC2 is defective.	"

4) Meter pointer indication is moved by impulse.

Symptoms	Possible cause	Repair
Output voltage is unchanged.	Meter pointer is Mechanically broken	Replacement of meter
Output voltage is also changed with impulse.	Rotary switch is defective.	Replacement of rotary switch

5) Meter indication is incorrect.

Symptoms	Possible cause	Repair
Meter indicates different value by the time measured.	Meter is deffective.	Replacement
Meter indication is incorrect for both of voltage and current measurement.	Maladjustment of zero	Check zero adjustment
Output voltage is correct.	Meter is deffective	Replacement
	Maladjustment of R27 (METER ADJ)	Readjustment of R27
Output voltage is incorrect	Maladjustment of R23 (OUTPUT ADJ)	Readjustment of R23
Meter indication is incorrect for all ranges output voltage is correct,	Maladjustment of R27 (METER ADJ)	Readjustment of R27
	(Adjust current range after adjusting R27.)	
Output voltage is incorrect.	Maladjustment of R23 (OUTPUT ADJ)	Readjustment of R23
	(Adjust voltage range and current range after adjusting R23.)	
Current range is incorrect in all ranges.	Maladjustment of R16	Replacement of R16
A part of voltage range or current range is incorrect.	Attenuator is incorrect	Replacement of defective resistor