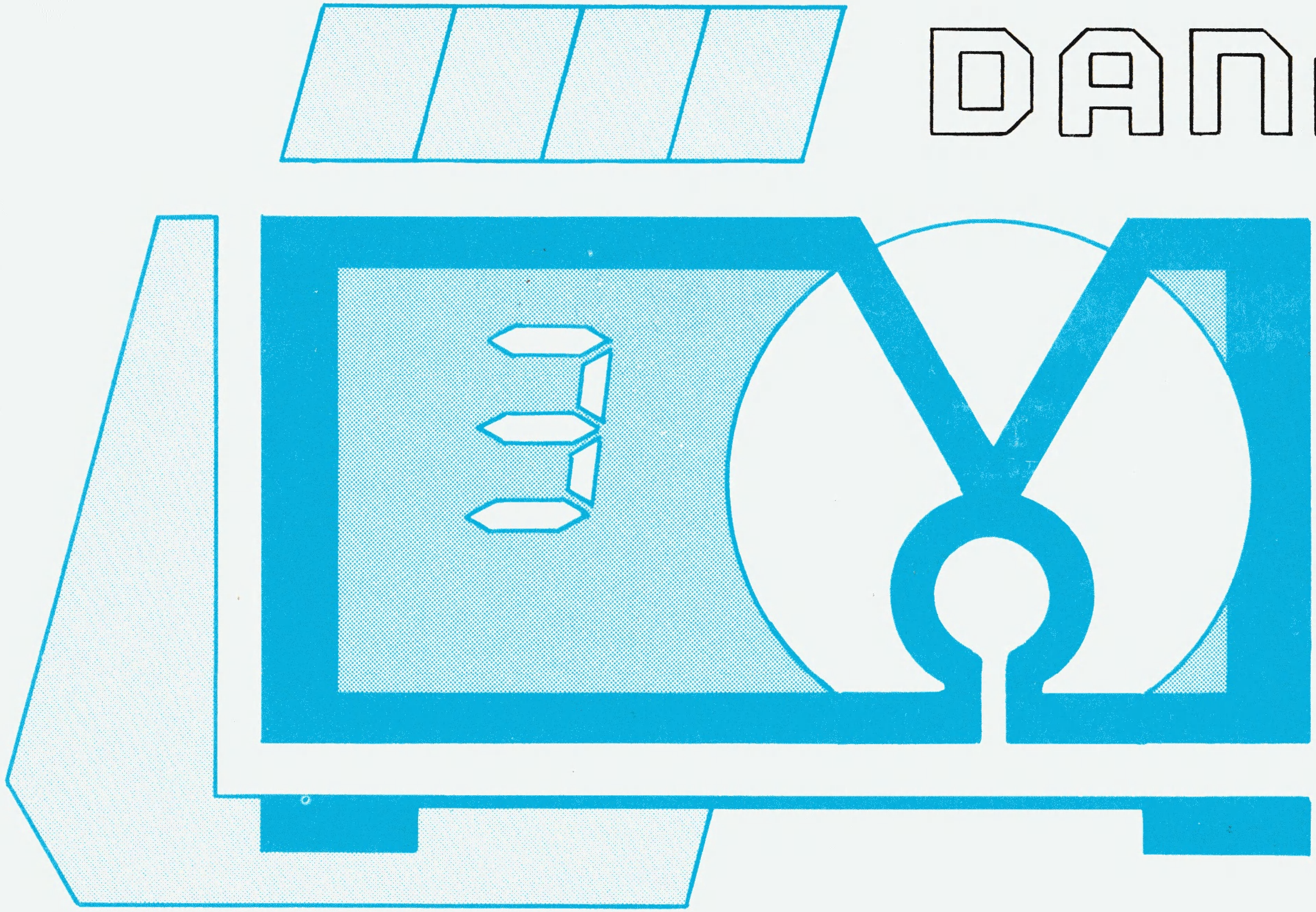
INSTRUCTION MANUAL

DANAMETER



RACAL-DANA

PUBLICATION NO. 980464A

RACAL-DANA MODEL
2000A
DANAMETER

PUBLICATION DATE: JANUARY 1979

WARRANTY

Within one year of purchase, Racal-Dana Instruments will repair or replace your instrument, at our option, if in any way it is defective in material or workmanship (battery excluded). All parts and labor charges will be paid by Racal-Dana Instruments. Contact your local Dealer in the event service is required.

SERVICING INSTRUCTIONS

1. Before seeking assistance check that:
   a. The battery is more than 6 volts.
   b. The fuse is good and of the proper type and size.

2. Repair of this unit can be accomplished on an exchange basis or a repair and return basis. Contact your nearest sales representative for the plan that best suits your needs. Since there are several options, including a 24-hour procedure, it is important to get the proper instructions.

TABLE OF CONTENTS

Section	Title	Page
1	**General Description**	**1-1**
1.1	General	1-1
1.3	Features	1-2
1.9	Specifications	1-4
2	**Operation**	**2-1**
2.1	Unpacking	2-1
2.3	General Description	2-1
2.7	Measurements	2-6
2.8	General	2-6
2.10	Overload	2-7
2.13	Procedures	2-8
2.15	RF Probe (84)	2-16
2.18	High Voltage Probe (82)	2-18
2.21	High Voltage Probe (83)	2-20
2.24	AC Current Shunt Set (86)	2-23
2.27	Decibels	2-23
2.30	Diode and Transistor Check	2-25
3	**Theory of Operation**	**3-1**
3.1	General	3-1
3.15	Integration	3-5

TABLE OF CONTENTS continued

Section	Title	Page
4	**Maintenance**	**4-1**
4.0	Maintenance	4-1
4.1	Battery Replacement .	4-1
4.3	Fuse	4-1
4.5	Calibration	4-2

LIST OF ILLUSTRATIONS

Figure	Title	Page
2.1	Front Panel	2-2
2.2	Rear Panel	2-3
2.3	Battery Replacement	2-5
2.4	Diode Curve	2-26
2.5	Transistor Checks	2-27
3.1	Danameter Simplified Drawing	3-2
3.2	Integrator Output	3-5
4.1	Calibration Points	4-7
4.2	Schematic, Danameter	4-9
4.3	Layout, Danameter	4-10

LIST OF TABLES

Table	Title	Page
1.1	Danameter Specifications	1-3
2.1	DC Volts	2-9
2.2	AC Volts	2-11
2.3	DC Current	2-13
2.4	Resistance	2-15
2.5	RF Voltage (With RF Probe Accessory)	2-17
2.6	High Voltage (With 5 KV High Voltage Accessory)	2-19
2.7	High Voltage (With 50 KV High Voltage Accessory)	2-21
2.8	AC Current (With AC Current Shunt Set)	2-22
2.9	Decibel Conversion Chart	2-24
4.1	Required Equipment	4-5
4.2	Calibration Procedure	4-6
4.3	Parts List	4-11

1.1 GENERAL.

1.2 Your Danameter solid state volt-ohm-microamp meter is designed for the engineer, technician, and hobbyist who requires a rugged, portable, accurate, and reliable measurement tool. The Danameter is capable of performing a wide assortment of measurement functions and is equally useful on the bench or in the field. Measurement capabilities include dc volts from 1 millivolt to 1000 volts, ac volts from 1 millivolt to 700 volts RMS, resistance from .1 ohm to 199.9 megohms and dc current from 10 nanoamps to 2 amps. With accessories the capacity of the instrument is expanded to include RF voltage with frequency measurements to 200 MHz and high voltage dc measurements to 50,000 volts. Built with state-of-the-art LSI circuitry and housed in a virtually unbreakable Cycolac T case, your Danameter will provide you with years of reliable service.

1.3 FEATURES.

1.4 Fully Portable. Operates up to one full year on a single 9-volt (transistor radio type) dry battery. A switch position is provided to measure the battery voltage. The instrument is extremely light, weighing only 1 pound and operates at full accuracy at any angle. A handy carrying case is available.

1.5 Easy to Operate. One switch selects off/on, battery test, and all functions and ranges. Input leads are never required to be moved for a special range, function, or polarity.

1.6 Digital Display. Liquid crystal readout provides large easy to read numbers and decimal placement as well as automatic polarity indication on DC volts and current measurements.

1.7 High Input Resistance. Ten megohms on all d.c.v. ranges and two megohms on all a.c.v. ranges insures higher measurement accuracy in high impedance circuits and minimizes affecting circuit operation when measurements are being taken.

1.8 Overload Protection. Instrument accepts overload voltages of 250V dc or RMS ac on all ohms and dc current ranges, 250V dc or 1000V peak ac on all ac volt ranges, and 1000V dc or peak ac on all dc volt ranges. Positive overload indication is provided on the display.

1.9 SPECIFICATIONS.

1.10 Specifications are given in table 1.1.

Table 1.1 - Danameter Specifications

GENERAL	
Operating Temp. Range:	0 to +50°C
Storage Temp. Range:	–40°C to +65°C
Operating Humidity Range:	0 to 75% R.H.
Size:	7-1/2" wide x 4" high x 2-1/4" deep
Weight:	1 pound with battery
Battery Type:	(1) standard 9V Dry Transistor battery Neda #1604
Battery Life:	1 year typical, 8 hrs./day
Shock:	Withstands 5 foot drop onto concrete floor

Table 1.1 - Danameter Specifications (continued)

DC	
Ranges:	2, 20, 200V, 1 KV
Overload Protection:	1000V DC or peak AC, all ranges
Accuracy:	2V 1 year, ±5°C ±(.5% of reading + 1 digit) typically, ±(.2% of reading + 1 digit) 20, 200V, 1 KV 1 year, ±5°C ±(.75% of reading + 1 digit) typically, ±(.2% of reading + 1 digit)
Polarity:	Automatic
Temperature Coefficient:	0°C to 15°C, 35°C to 50°C ±(.025% of rdg + .05 digit)/°C
Input Resistance:	10 Megohms, all ranges
NMR:	50 dB Min. at or near 60 Hz
Settling Time:	Typically, ≤1 sec.

NOTE

Unless otherwise stated, all performance specifications are guaranteed for a period of 1 year.

AC	
Ranges:	2, 20, 200V, 1 KV
Overload Protection:	1000V peak Max., all ranges (250V DC Max.)
Accuracy: (From 45 Hz)	2V 1 year, ±5°C to 2 kHz ±(2.5% of reading + 2 digits) typically, ±(.3% of reading + 2 digits) to 1 kHz 20, 200V, 1 KV 1 year, ±5°C to 5 kHz ±(2.5% of reading + 2 digits) typically, ±(.6% of reading + 2 digits) to 1 kHz
Input Resistance:	2 Megohms
Input Capacitance:	50 pF
Settling Time:	Typically, less than 2 seconds

OHMS	
Ranges:	200Ω, 20 KΩ, 2 MΩ, and 200 MΩ
Overload Protection:	250V DC or VRMS AC, all ranges
Accuracy:	200Ω 1 year, ±5°C ±(3.5% of reading + 3 digits) typically, ±(.9% of reading + 2 digits) 20 KΩ 1 year, ±5°C ±(1.5% of reading + 2 digits) typically, ±(.3% of reading + 2 digits) 2 MΩ 1 year, ±5°C ±(3.5% of reading + 1 digit) typically, ±(.9% of reading + 1 digit) 200 MΩ 1 year, ±5°C ±(8% of reading + 1 digit) typically, ±(5% of reading + 1 digit)

OHMS (continued)	
Max. Current Through Unknown:	1 milliampere
Voltage Across Unknown for Full Scale Indication:	200Ω, 20K – 200 mV 2M, 200M – 2V

CURRENT (DC)	
Ranges:	20 μA, 2 mA, 200 mA, and 2A
Accuracy:	20 μA, 2 mA, 200 mA, 2A 1 year, ±5°C ±(2% of reading + 2 digits) typically, ±(.8% of reading + 2 digits)
Settling Time:	Typically, ≤1 sec.
Voltage Burden:	.25V maximum up to 1/2 amps
Overload Protection:	250V DC or VRMS, all ranges (5 sec. max. 20 μA range)

Table 1.1 - Danameter Specifications (continued)

OPTIONS

1. MODEL 84 R.F. PROBE	
Accuracy: ±5°C, 6 mos.	(0 to 25V RMS Input) 1 kHz to 10 MHz ±(1% Input + 50 mV) 10 MHz to 100 MHz ±(12% Input + 50 mV) 100 MHz to 200 MHz ±(30% Input + 50 mV)
Input Impedance:	1.6 MΩ shunted by 7 pF nominal
Maximum Input:	125V rms AC 60 - 400 Hz, 250V DC
2. MODEL 82 HI VOLTAGE PROBE	
Accuracy:	(0 - 5 KV, 0 to 50°C) ±2% of input with 10 MΩ DMM load
Maximum Input:	5 KV DC
Input Resistance:	900 MΩ nominal
Division Ratio:	1000:1

OPTIONS

3. MODEL 83 HI VOLTAGE PROBE	
Accuracy:	(0 - 50 KV, 0 to +50°C) ±5% of input with 10 MΩ DMM load
Maximum Input:	50 KV DC
4. MODEL 86 AC CURRENT SHUNT SET	
Resistance Values: **(Current Ranges)**	1.0 Ohm (0 - 1A) 1 Kohm (0 - 2 mA)
Accuracy:	Same as 2V A.C. range
Overload without Damage	20 mA on 2 mA range 1A on 1A range, continuous 2A on 1A range, 2 minutes max.

2.1 UNPACKING.

2.2 Your Danameter comes complete with battery and input probes. If either is missing or damaged notify your dealer immediately. Read the General Description to familiarize yourself with the instrument before attempting to install battery.

2.3 GENERAL DESCRIPTION.

2.4 Front Panel. The front panel of the Danameter is shown in figure 2.1. Important features of the front panel are listed in the following paragraphs.

a. Readout. The readout, located at the top left corner of the Danameter, is an easy-to-read, 4-digit, numeric display that also provides decimal, polarity, and overload indication.

b. Range/Function Switch. The range/function switch is a rotary 18-position control, located on the right side of the instrument. This control selects four ranges of DC

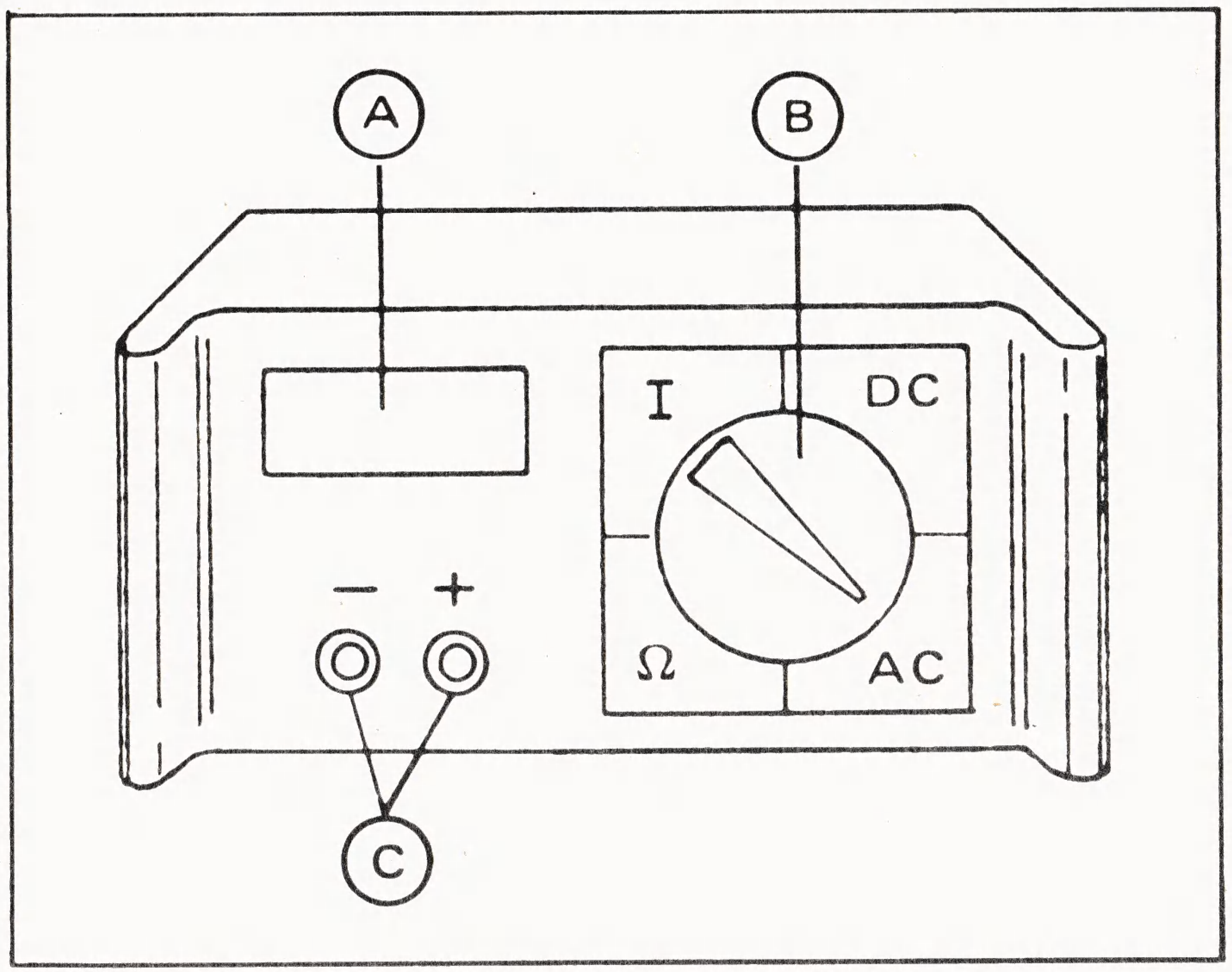


Figure 2.1 - Front Panel

volts, four ranges of AC volts, four ranges of resistance measurements, four DC current measurement ranges, a battery test position, and OFF. The switch may be rotated in either direction.

c. Input Jacks. Only two input jacks are required for all Danameter functions and ranges. These are located at the bottom left corner and marked + and –; the red probe is connected to the + Jack and the black probe is connected to the – Jack. For measurements of DC voltage and current, the black probe (– Jack) is considered the reference; the Danameter display indicates + when measuring a signal more positive than the black probe and – when measuring a signal more negative than the black probe.

2.5 Rear Panel. The rear panel of the Danameter is shown in figure 2.2. Important features of the rear panel are listed in the following paragraphs.

a. Bail. The bail is located in the upper portion of the rear panel and allows the instrument to be positioned at 45° and 75° angles

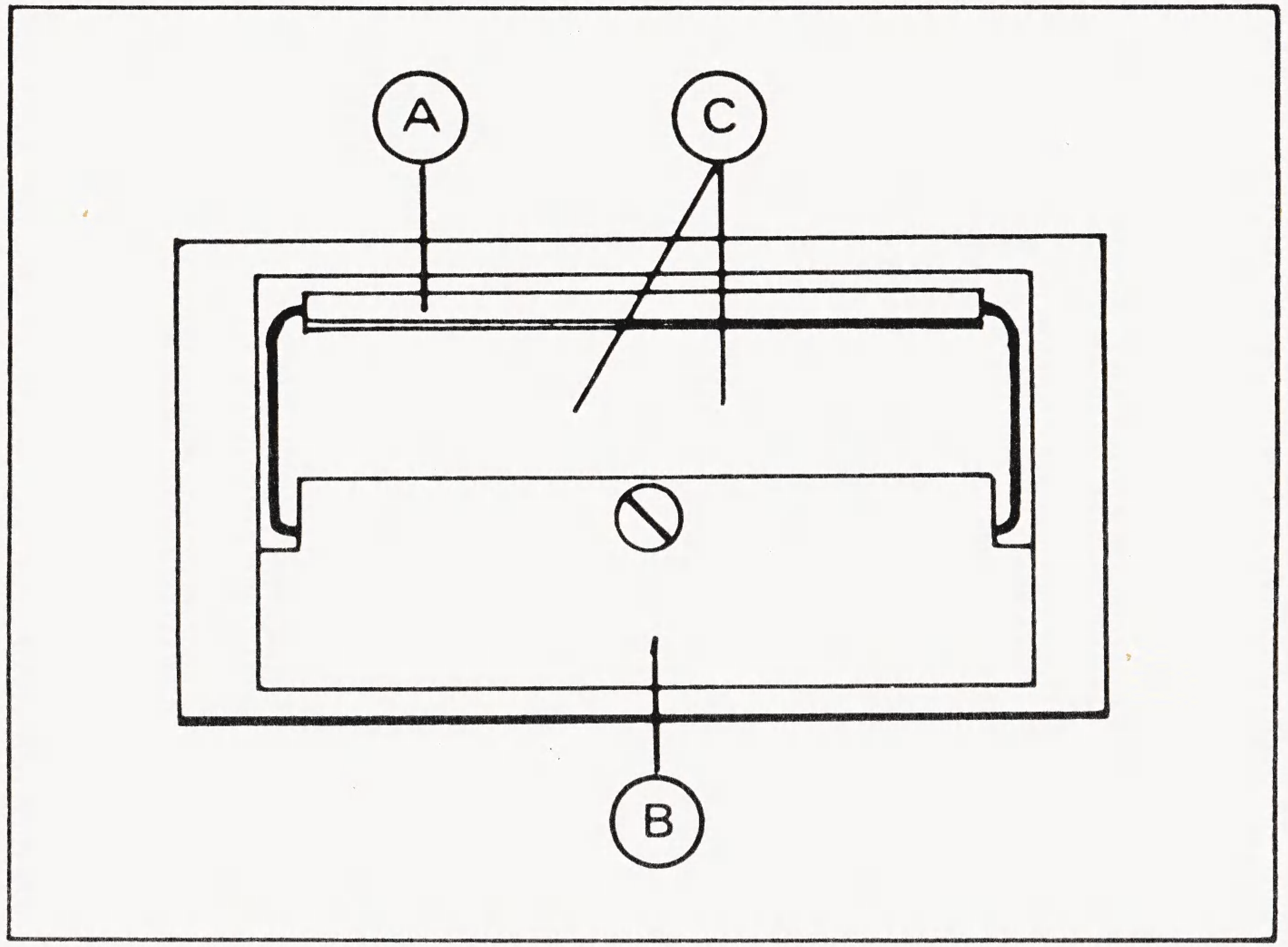


Figure 2.2 - Rear Panel

from the normal upright position. The bail can also be used as a handle to facilitate 2-hand operations.

b. Battery and Fuse Compartment. The battery and fuse compartment is located at the bottom of the rear panel. Both the battery and fuse are accessible by loosening the captive screw located in the center of the rear panel and sliding the cover towards the top of the instrument.

c. General Information Labels. General information about the Danameter is printed on the labels located on the upper portion of the rear panel. These labels describe battery type, fuse type, test voltages for the battery, and general cautions.

2.6 <u>Battery Installation</u>. The instrument is equipped with a 9-volt, transistor radio type dry battery which will provide about 1 year of service. A mercury or alkaline 9 volt replacement battery may be used with essentially equal service life.

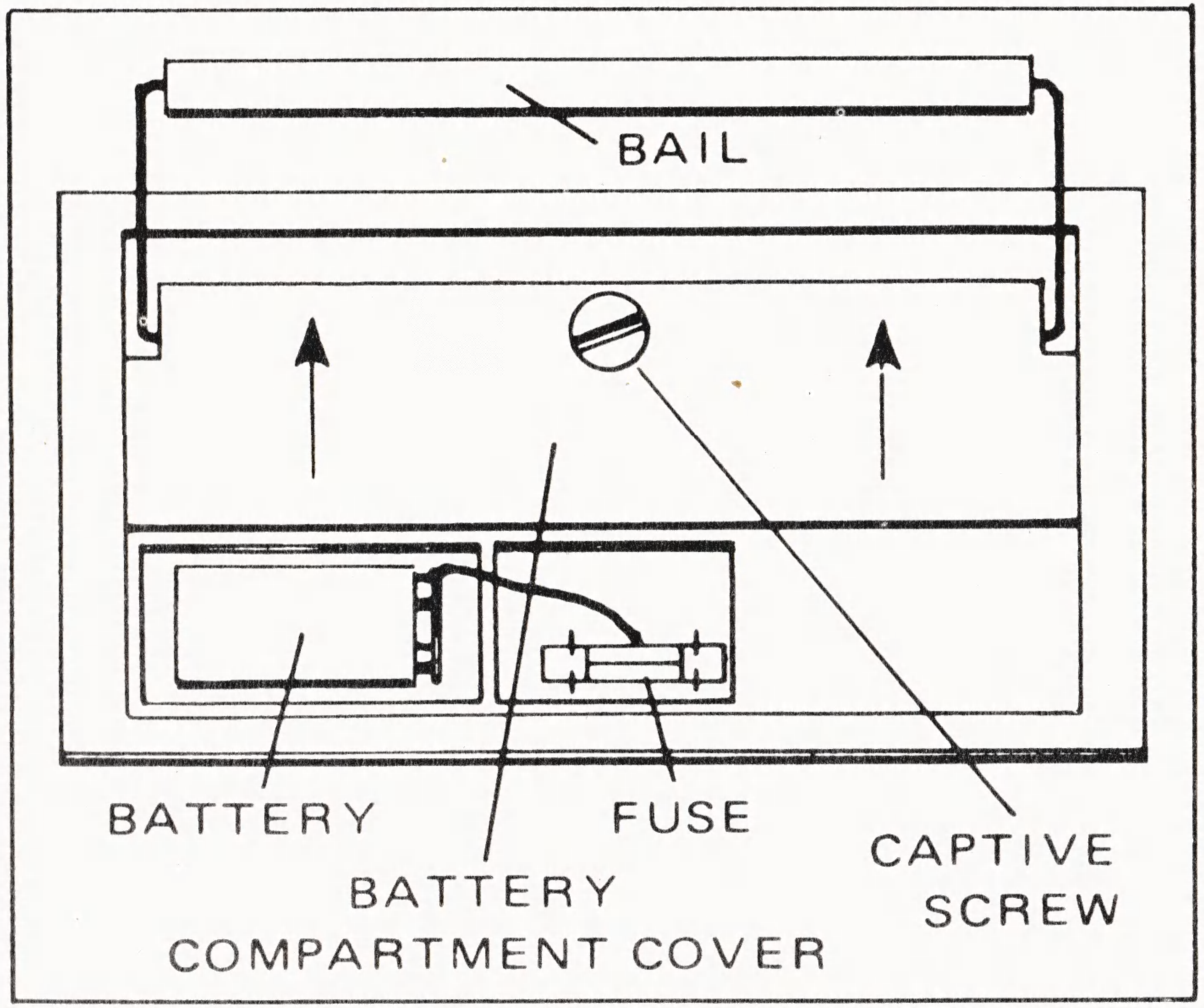


Figure 2.3 - Battery Replacement

When installing or replacing the battery, observe the following procedure (see figure 2.3).

a. Set the Danameter switch to OFF.

b. Loosen the captive screw located in the center of the back panel; swing the bail out and away from the back panel; slide the battery compartment cover up. The battery compartment cover and bail assembly can now be removed.

c. Match battery connector with mating terminals on battery and press. If properly aligned, connector will snap on easily. If not, recheck alignment.

d. Replace battery and fuse cover; tighten captive screw.

e. Set switch to TEST; a readout of greater than 600 indicates your Danameter is capable of making accurate measurements. A new battery will indicate from 800 to 1100.

2.7 MEASUREMENTS.

> *WARNING*
>
> *Exercise extreme caution when working near sources of high voltage. This includes any voltage measurements requiring the use of 200V or 1000V DC or AC ranges.*

2.8 General.

2.9 Standard measurement capabilities of the Danameter include DC and AC voltages, DC currents, and resistance. These standard measurements utilize the probes provided with the instrument; with the black probe occupying the – input jack and the red probe occupying the + input jack.

2.10 Overload.

2.11 Overload is a built-in capability that protects the Danameter against damage and permits probing of unfamiliar circuitry where an overload condition may be encountered. An overload condition exists whenever the input signal to the Danameter is larger than the range selected and is indicated as OL on the display. For example, with the 200 Mohms range selected and the input leads open, the display reads OL since the input signal (infinite resistance) is greater than the 200 Megohm capability of the range.

2.12 The Danameter is protected by limiting the amount of current that is permitted to flow through it. The DC and AC volt ranges, most Ohms and 20 μA ranges are protected due to their high input impedance. The three higher DC current ranges and the 200Ω range are protected by a 2-1/2 amp fast-blow fuse in the

Danameter that blows when an excessive current is applied.

> ***WARNING***
>
> *Do not rotate selector switch through dc CURRENT or OHMS ranges when a signal capable of producing an overload is applied to the input (e.g., 110 volts AC). Instantaneous fault currents well in excess of the fuse rating can occur resulting in severe damage to both the equipment under test and the Danameter's switches.*

2.13 Procedures.

2.14 Tables 2.1 through 2.4 provide information for measuring on each function. In each case the sequence is the same:

1. Select appropriate range.

2. Connect test leads to circuit as shown.

3. Read value on display.

Table 2.1 - DC Volts

FULL SCALE INPUT	RESOLUTION	MAXIMUM INPUT:
±1.999V	1 MILLIVOLT	DC ± 1000 VOLTS
±19.99V	10 MILLIVOLT	AC 1000V PEAK (700V RMS)
±199.9V	100 MILLIVOLT	INPUT RESISTANCE:
±1000V	1 VOLT	10 MEGOHMS

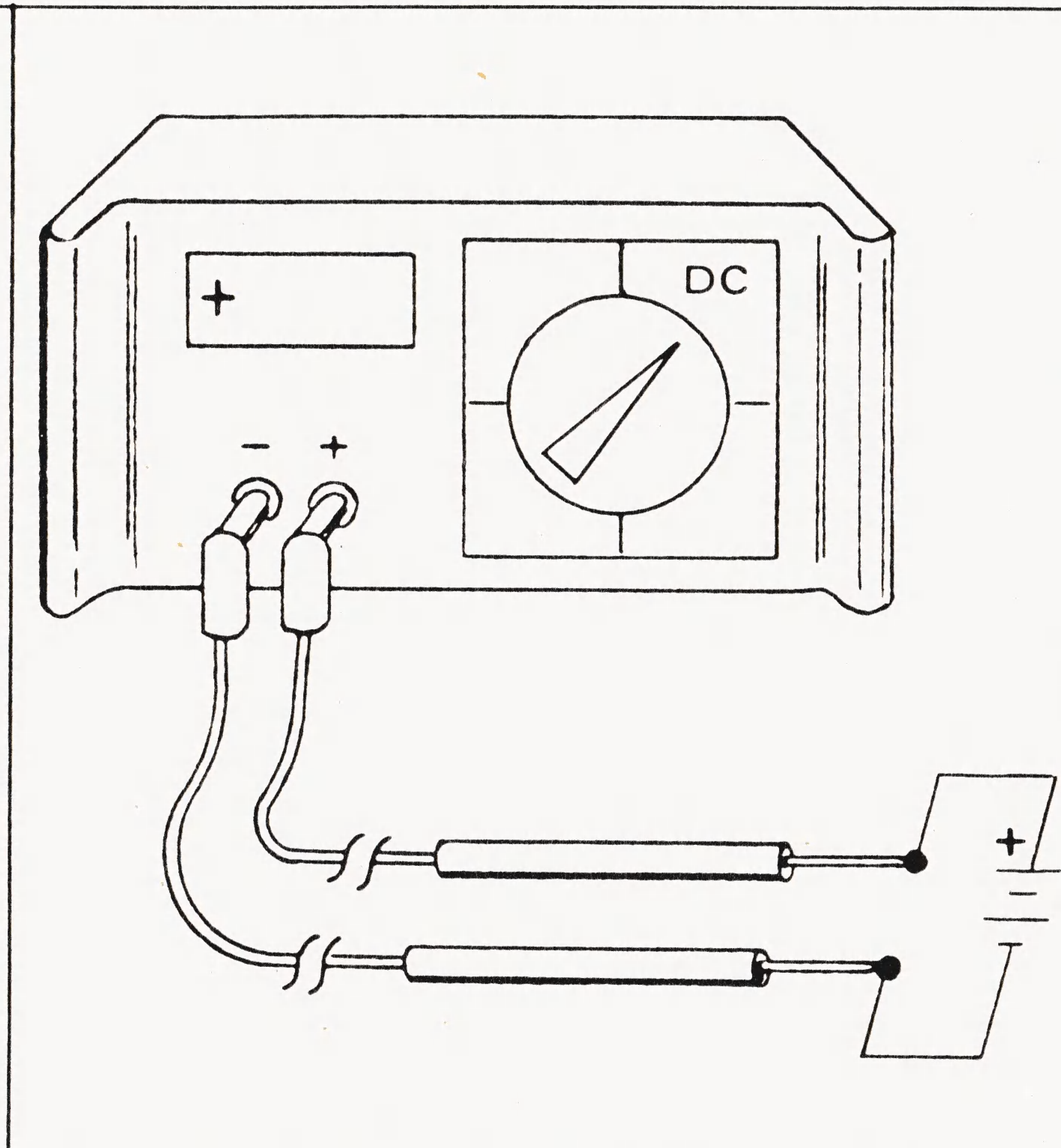
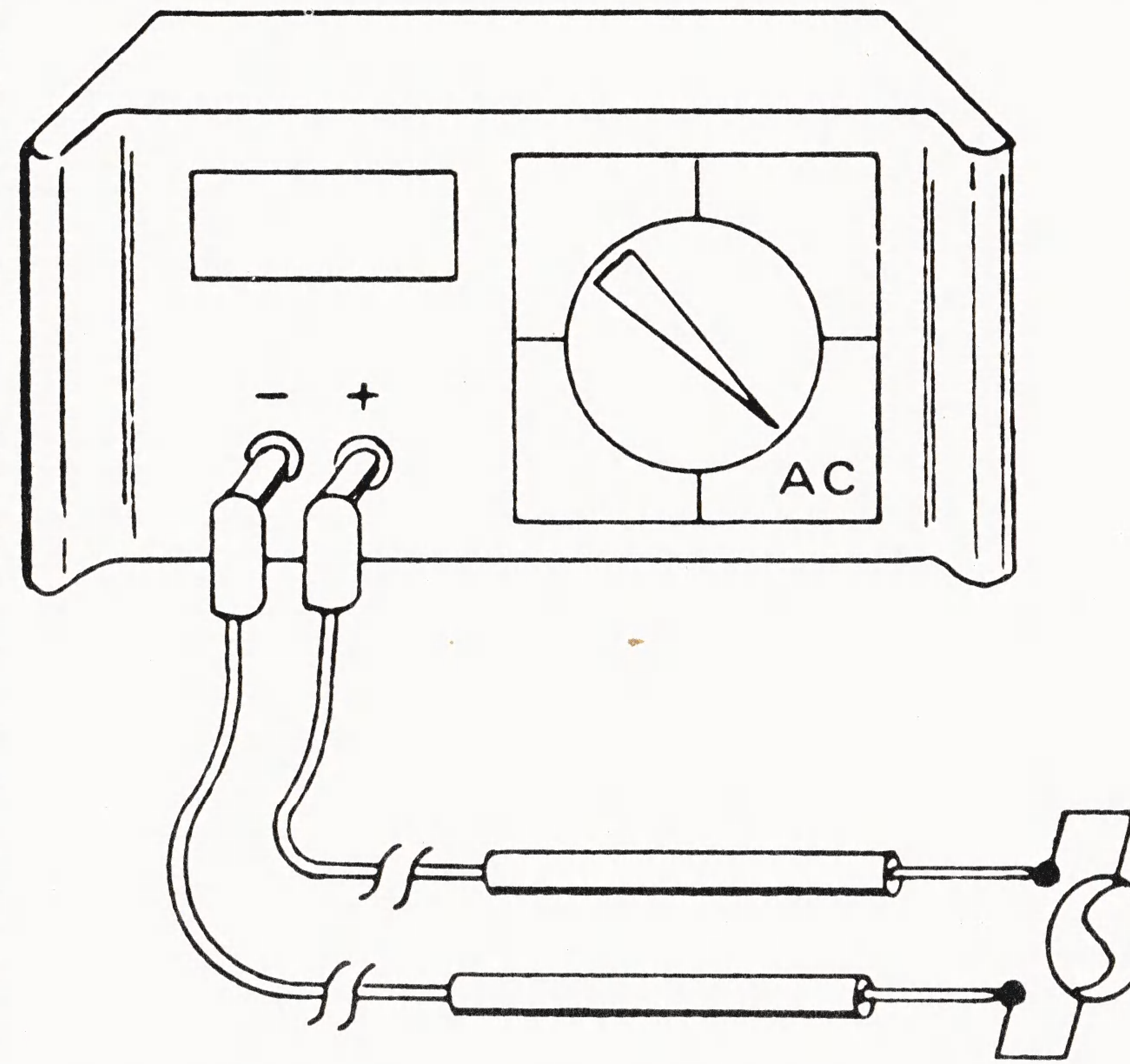


Table 2.2 - AC Volts

FULL SCALE INPUT	RESOLUTION	FREQ *	MAXIMUM INPUT:
1.999V	1 MILLIVOLT	45 Hz to 2 kHz	AC 1000V PEAK (700V RMS) DC ± 250 VOLTS
19.99V	10 MILLIVOLT	45 Hz to 5 kHz	
199.9V	100 MILLIVOLT		INPUT IMPEDANCE:
700V	1 VOLT		2 MEGOHMS



*INDICATES HIGHEST MEASURABLE FREQUENCY WITH SPECIFIED ACCURACY MEASURES TO 10 kHz ON ALL RANGES.

Table 2.3 - DC Current

FULL SCALE INPUT	RESOLUTION	MAXIMUM INPUT:
±19.99 uA	10 nA	WITHSTANDS 250V DC OR RMS AC FOR 5 SECONDS
±1.999 mA	1 μA	FUSE PROTECTED TO: 250 VDC 250 VRMS AC
±199.9 mA	100 μA	
±1.999A	1 mA	

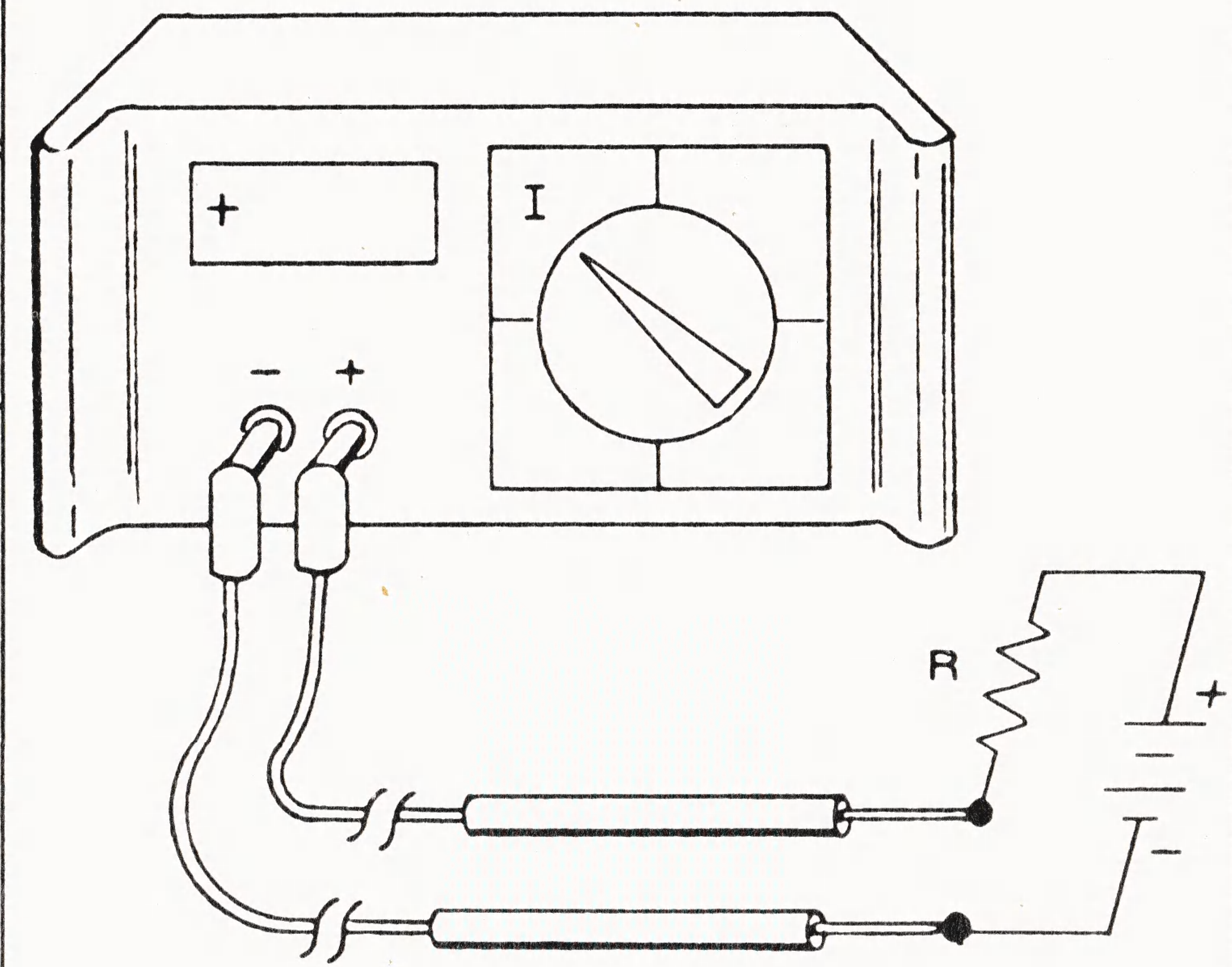
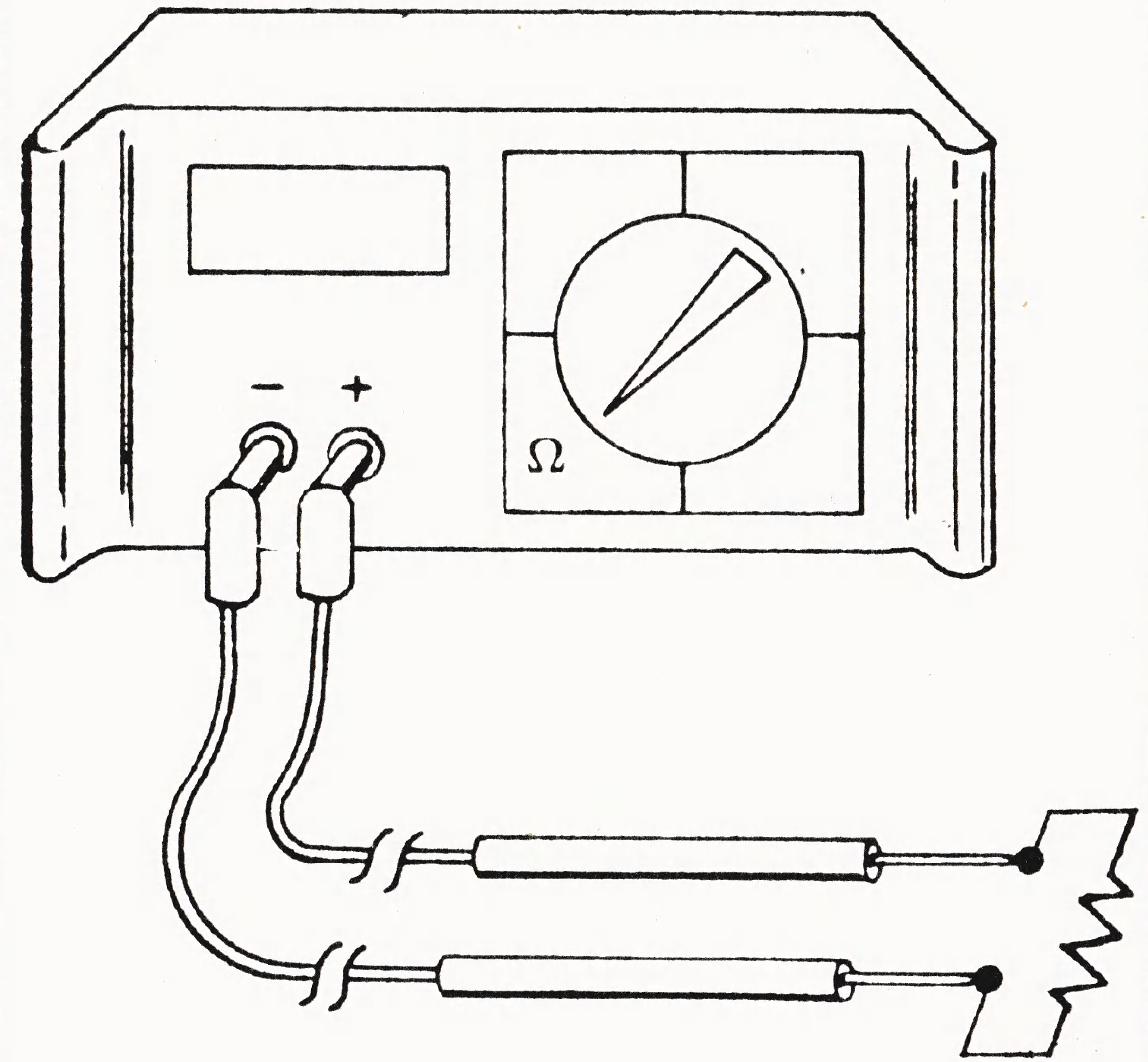


Table 2.4 - Resistance

FULL SCALE INPUT	RESOLUTION	CURRENT THROUGH UNKNOWN	MAXIMUM INPUT:
199.9Ω	100 mΩ	1 MILLIAMP	250 VDC
19.99 KΩ	10Ω	10 MICROAMPS	250 VRMS AC
1.999M	1 KΩ	1 MICROAMP	
199.9M	100 MΩ	10 NANOAMPS	



TO EXTEND BATTERY LIFE, DO NOT LEAVE DANAMETER IN RESISTANCE FUNCTION, WHEN NOT IN USE.

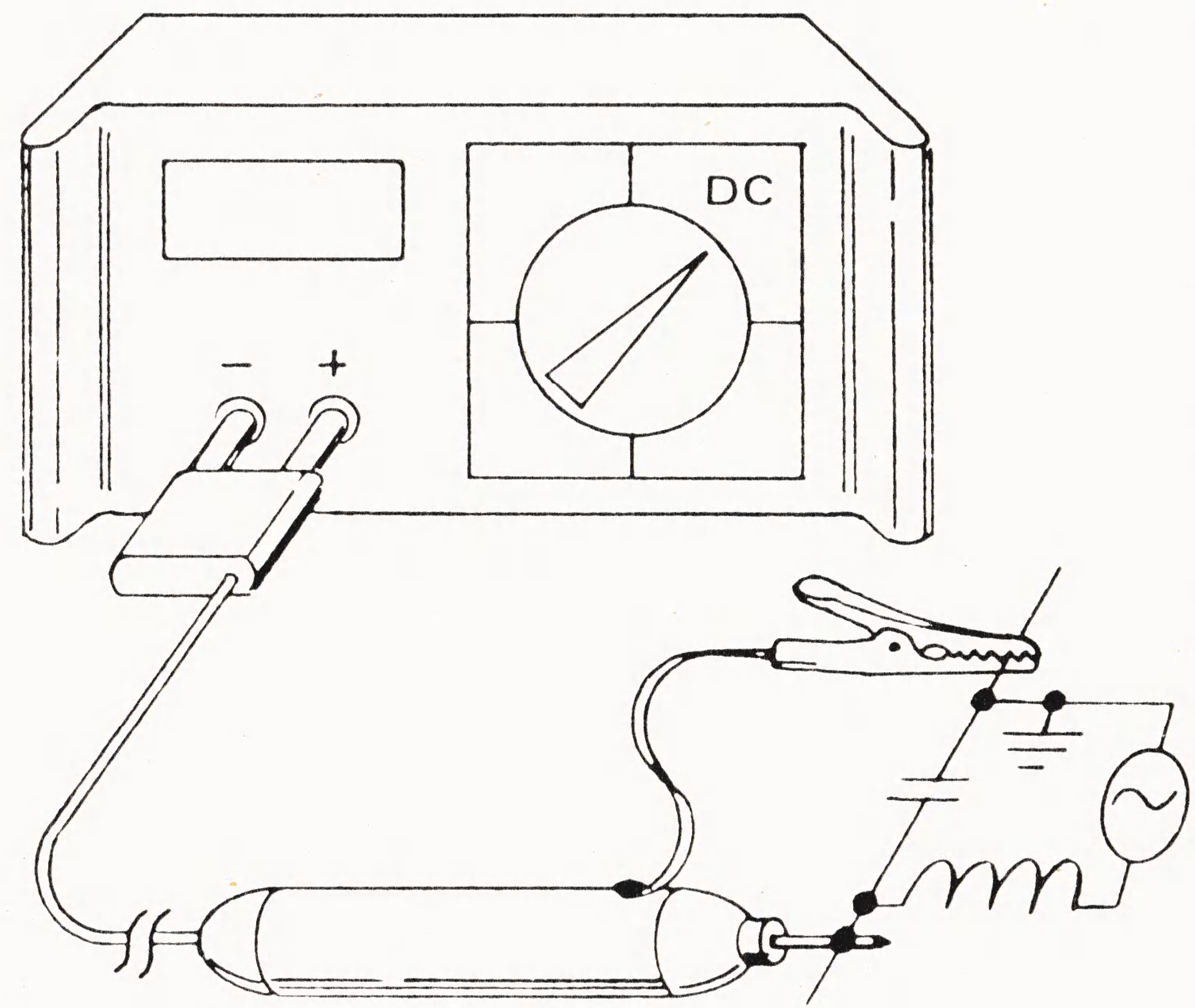
2.15 RF Probe (84).

2.16 The RF probe accessory extends the ac measuring capability of the Danameter to 200 MHz. The AC probe replaces the standard input probes and the polarity indications on the RF probe connector should be matched with the indications on the Danameter front panel. The probe is a peak sensing, RMS calibrated device and converts the ac input to an equivalent dc level which is then measured by the dc function of the meter. The probe accurately measures RF voltage up to 25 volts RMS from 1 kHz to 200 MHz. The probe is clamp protected for voltages to ±250V dc or RMS ac without damage to the probe.

2.17 As shown in table 2.5, the shield clip is connected to the RF ground portion of the circuit being measured and the tip of the probe is held to the 'HOT' side of the RF circuit. The dc equivalent of the RF output is read on the Danameter display (the 2 VDC, 20 VDC, or 200 VDC ranges are used; 1V RMS = 1 VDC).

Table 2.5 - RF Voltage (With RF Probe Accessory)

FREQUENCY RANGE	ACCURACY
1 kHz - 10 MHz	± (1%r+0.5%F.S.) ON 20V RANGE
10 MHz - 100 MHz	±1 dB
100 MHz - 200 MHz	±3 dB
MAXIMUM READING: 25 VOLTS RMS	
INPUT IMPEDANCE: 1.6 MΩ	



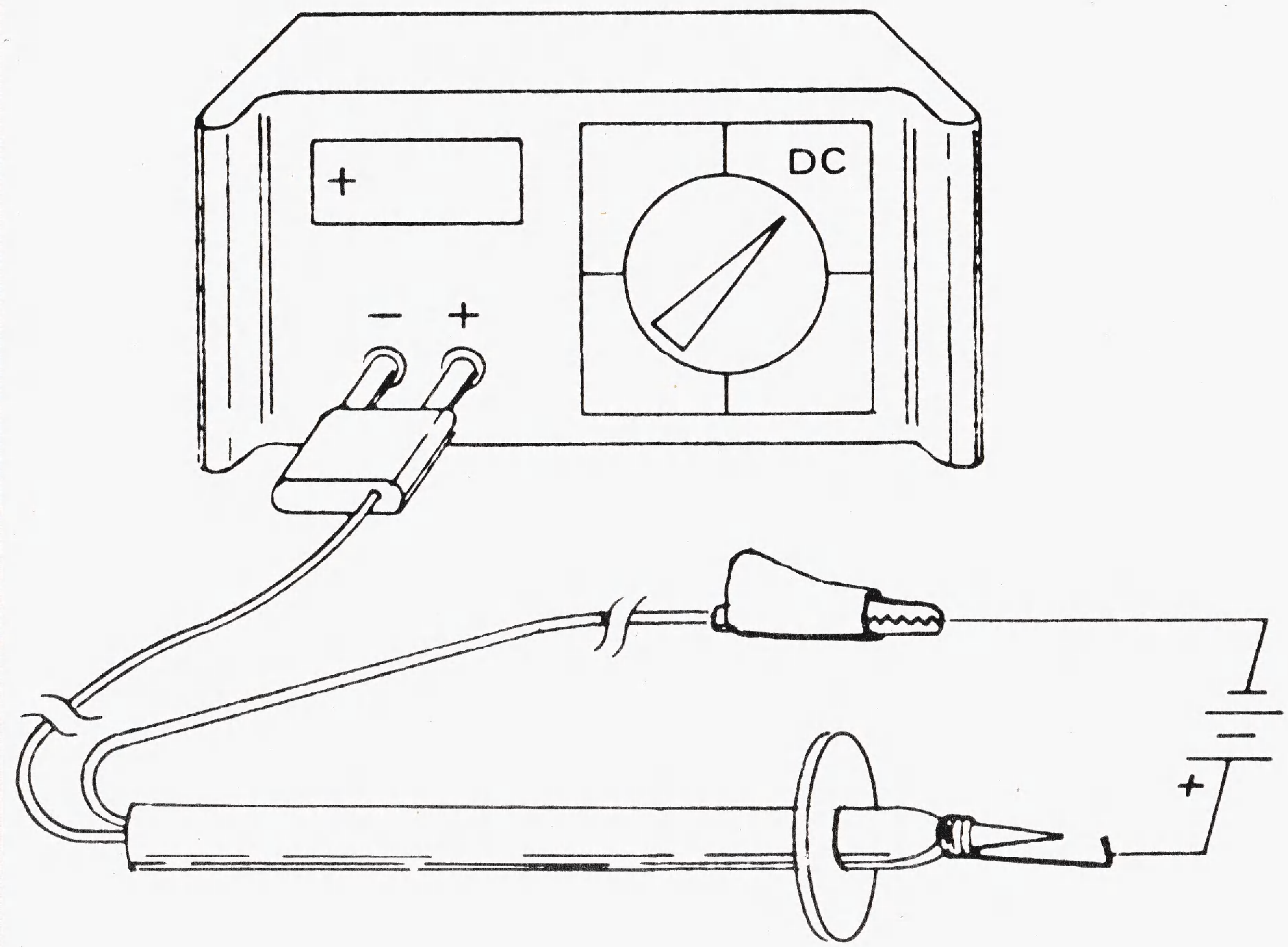
2.18 High Voltage Probe (82).

> *DANGER*
>
> *The High Voltage Probe is used for measuring potentially lethal voltage levels. Always remove power to and discharge the source before connecting or removing the High Voltage Probe from the source.*

2.19 The Danameter can be used to measure dc voltages to 5,000 volts with the use of the High Voltage accessory. This probe replaces the standard input leads and polarity indications on the High Voltage Probe connector must be matched with the indications on the Danameter for proper polarity indication.

2.20 As shown in table 2.6, the black lead of the High Voltage Probe is always connected to the grounded or low side of the source. The probe is a precision 1000:1 voltage divider; a maximum input of +5,000 volts is read as +5.0 volts on the 20 DCV scale. The 2V and 20V ranges are normally used; 1 KV measured equals 1V on the Danameter.

Table 2.6 - High Voltage (With 5 KV High Voltage Accessory)

MAXIMUM INPUT: 5 KV ACCURACY: ±2% INPUT RESISTANCE: 900 MΩ	

2.21 High Voltage Probe (83).

> *DANGER*
>
> *The High Voltage Probe is used for measuring potentially lethal voltage levels. Always remove power to and discharge the source before connecting or removing the High Voltage Probe from the source.*

2.22 The Danameter can be used to measure dc voltages to 50,000 volts with the use of the High Voltage accessory. This probe replaces the standard input leads and polarity indications on the High Voltage Probe connector must be matched with the indications on the Danameter for proper polarity indication.

2.23 As shown in table 2.6, the black lead of the High Voltage Probe is always connected to the grounded or low side of the source. The probe is a precision 1000:1 voltage divider; a maximum input of +50,000 volts is read as +50.0 volts on the 200 DCV scale. The 2V, 20V, and 200V ranges may be used; 1 KV measured equals 1V on the Danameter.

Table 2.7 - High Voltage (With 50 KV High Voltage Accessory)

<table>
<tr><td>MAXIMUM INPUT:
50 KV

ACCURACY: ±5%

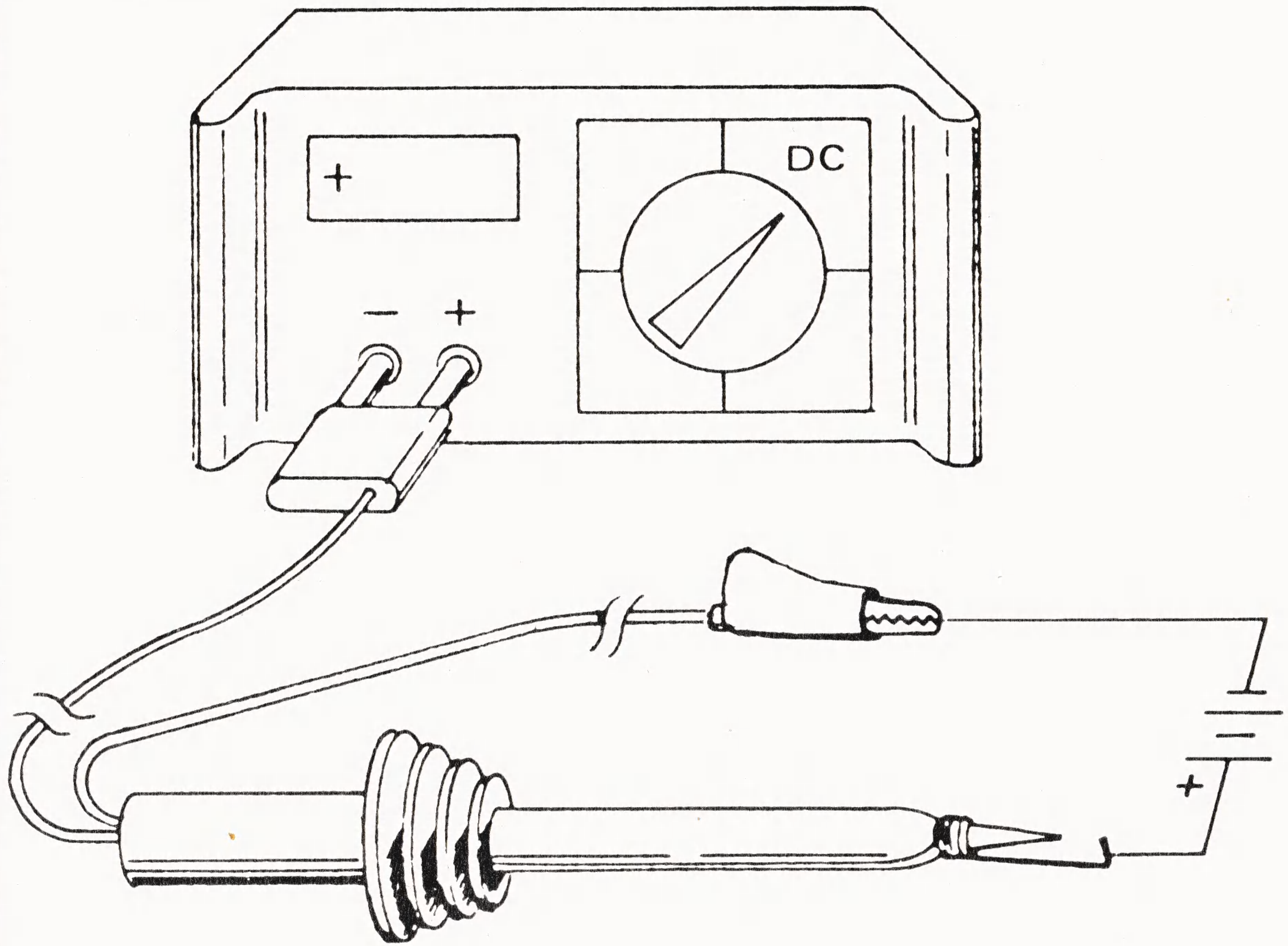
INPUT RESISTANCE:
900 MΩ</td><td>
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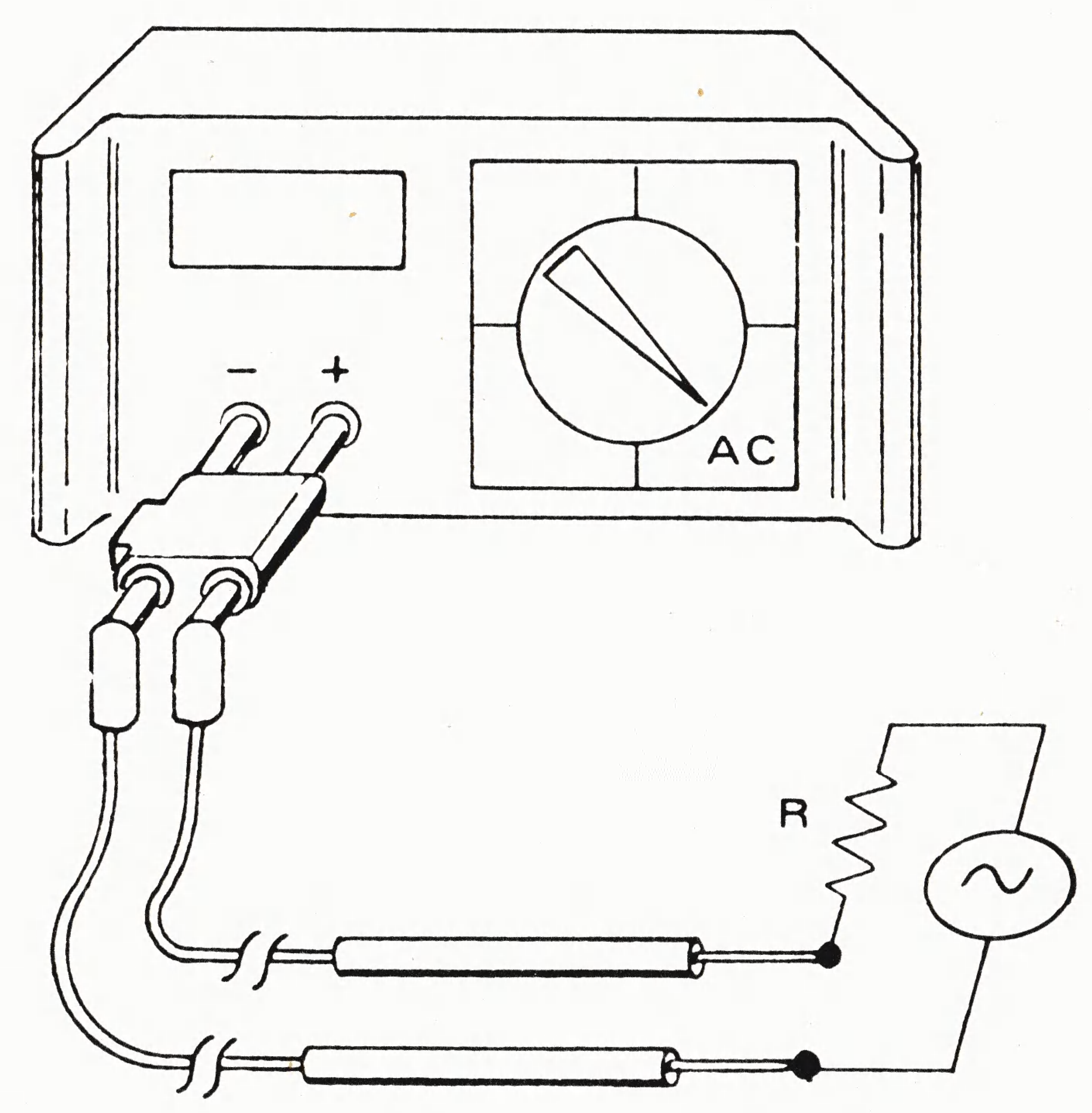
Table 2.8 - AC Current (With AC Current Shunt Set)

FULL SCALE INPUT	RESOLUTION	MAXIMUM INPUT
1.999 mA	1 μA	20 mA
1 AMP	1 mA	2 AMPS FOR 2 MIN MAX.



2.24 AC Current Shunt Set (86).

2.25 The AC Current Shunt Set consists of two color coded precision current shunts. Each shunt consists of a precision resistor wired across two combination "banana" plug/jacks and are molded in plastic. The shunts are used on the AC 2V range and provide ac current measurements of 0 to 2 milliamps (orange shunt) and 0 to 1 amp (black shunt).

2.26 As shown in table 2.8, the banana plugs of the shunt fit directly into the Danameter input jacks. The input cable or leads plug into the jacks of the current shunt.

2.27 Decibels.

2.28 The gain and accuracy of electronic equipment is often expressed in dB or decibels. The dB is the logarithm of the ratio of two electrical signals; normally a certain amount of power across a fixed resistance is used as a reference and denoted as 0 dB. One of the most common of this standard defines 0 dB as 1 milliwatt into 600 ohms and is used for our example.

Table 2.9 - Decibel Conversion Chart

2.29 A conversion chart for converting AC voltage measurements to dB is provided in table 2.9.

2.30 Diode and Transistor Check.

2.31 The Danameter is particularly useful for checking diode and transistor junctions. This is a common 'first pass' approach in looking for bad components when troubleshooting electronic equipment. The low current and open terminal voltage produced by the meter during resistance measurements virtually eliminates the possibility of damage to low-power semiconductor junctions, a danger prev lent in many types of analog meter

2.32 Diodes exhibit a characteristi curve similar to the one shown in fig ure 2.4. The figure illustrates that meas urements taken in the forward direction (– Lead to K and + Lead to A) have a much lower value than measurements taken in the reverse direction (typically 100 times lower or more). The meter reading in the forward direction does not reflect an actual value of resistance; the diode is a non-linear device and the reading reflects the voltage drop at a fixed current. The measurement in the reverse

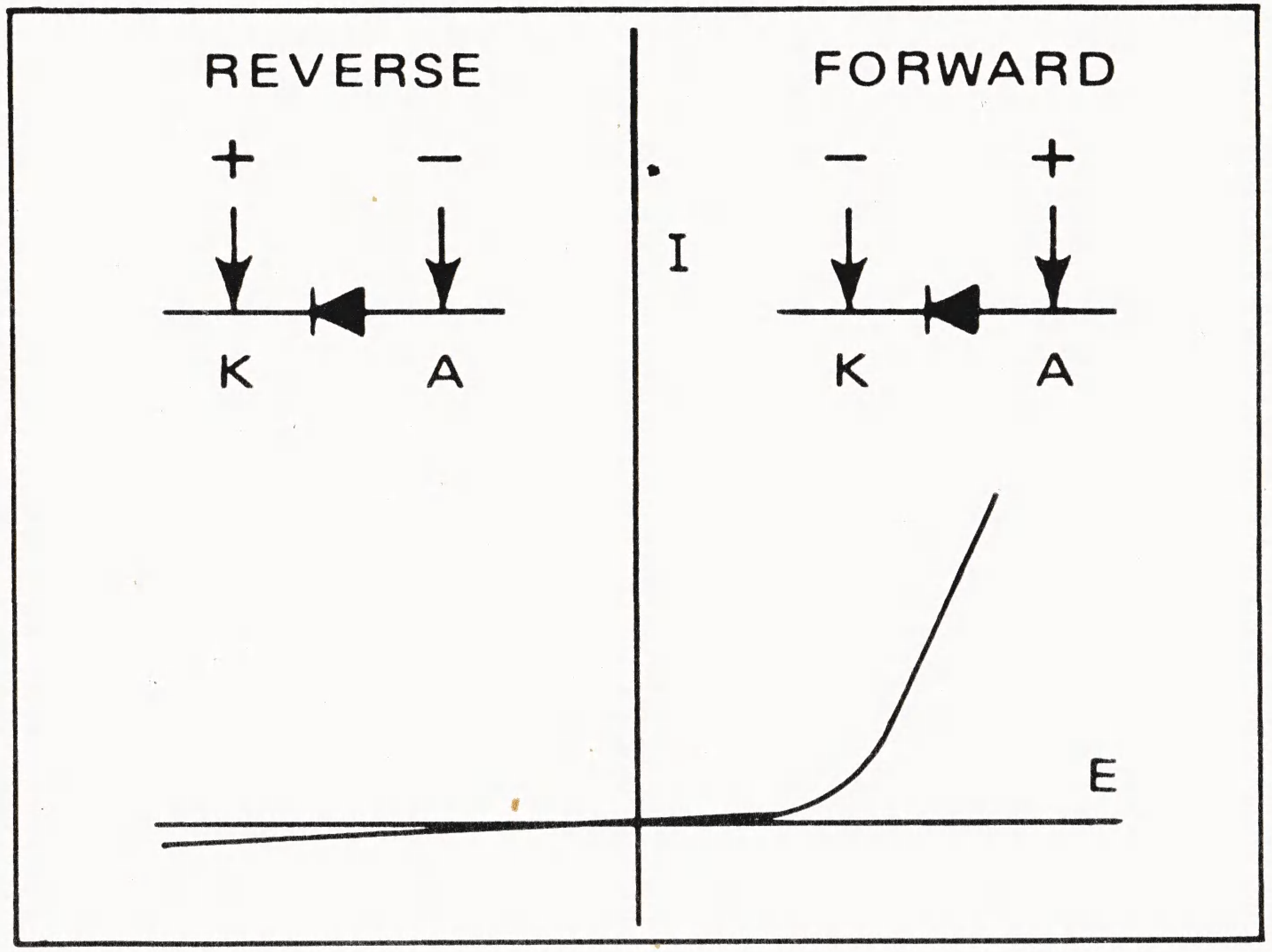


Figure 2.4 - Diode Curve

direction is due to leakage, it is linear, and usually of less interest than the forward characteristic (unless the meter reading is unusually low, indicating the device is bad).

2.33 For measuring junctions, the 2 Mohm resistance range is used. Actual readings vary, depending on the type of device. The normal range of readings taken on the 2M range is shown below.

2.34 Transistors are checked in the same manner as diodes by measuring the

Material	Forward Reading	Reverse Reading
Silicon	.250 to .550	OL

two diode junctions formed between the base and emitter and the base and collector. To complete the test of transistors, measurements across the collector and emitter are taken in both directions, to determine if a short is present. Meter lead connections to diodes and transistors are shown in figure 2.5.

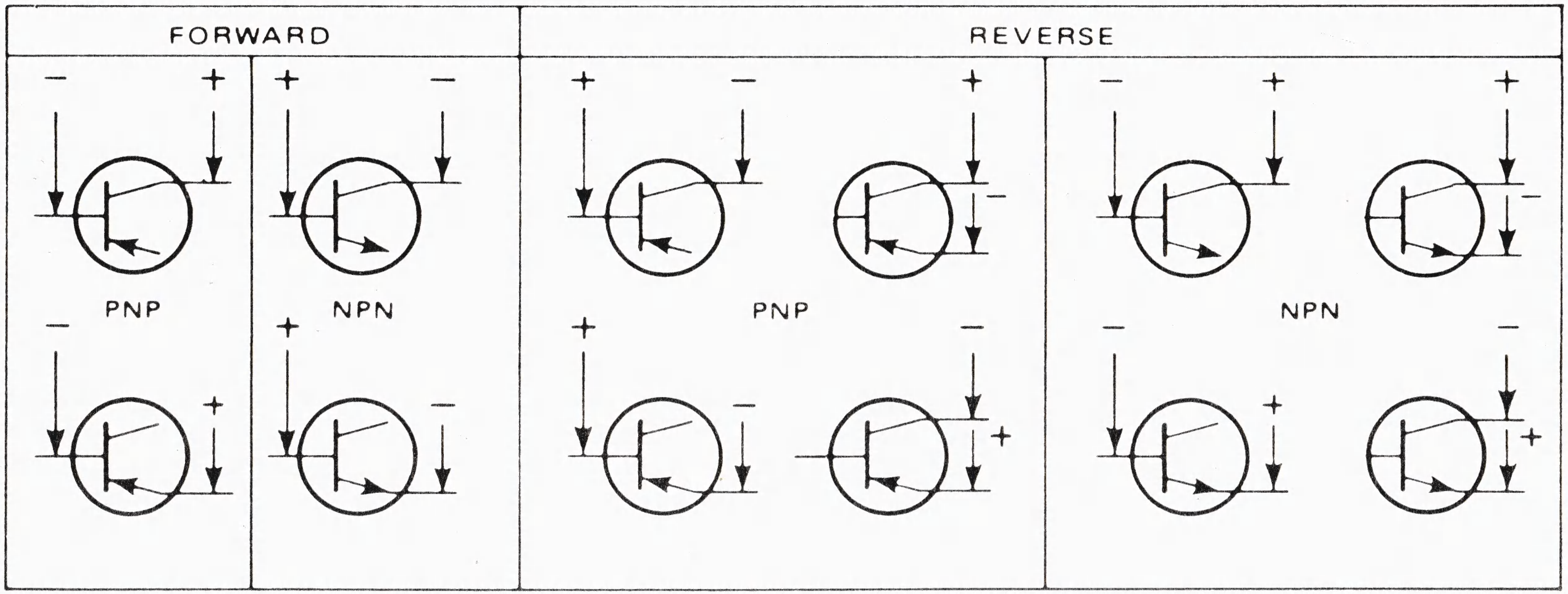


Figure 2.5 - Transistor Checks

3.1 GENERAL.

3.2 Mechanically, the Danameter is a completely self contained solid-state, Volt-Ohm-Milliampmeter with all active components contained in two Large Scale Integration (LSI) devices. Electrically, the Danameter converts a signal at its input jacks to a number at its display window, by a process called Dual-Slope Integration. Integration identifies the process as one in which the value of the input signal is converted to a proportional period of time; the amount of time produced is measured and displayed. Dual-slope identifies the type of integration and is so called because of the characteristic electrical output of one of the circuits used in this process.

3.3 The following discussion serves to identify and describe the major portions of the circuitry used in the instrument, shown simplified in figure 3.1.

3.4 Signal Conditioning. This circuitry modifies the input signal when required to make it compatible with the measurement circuitry. These modifications include:

Figure 3.1 - Danameter Simplified Drawing

converting AC, resistance, and current inputs to a DC voltage level, scaling the input signal on the higher voltage ranges, and filtering the signal to attenuate any accompanying noise.

3.5 Voltage to Current Converter. This circuitry converts the conditioned input signal to a proportional amount of positive current for use during the measurement cycle.

3.6 Reference Voltage. It is generated by a stable 1.2 volt diode, used as the primary reference source for the Danameter.

3.7 Reference Current Generator. This circuit converts the reference voltage to a stable and accurate negative current for use during the measurement cycle.

3.8 Integrator. This circuit converts currents applied to it to a voltage ramp. The direction of the ramp is dependent on the polarity of the current; the slope of the ramp is directly proportional to the amount of current. The input of the integrator is switched to either the voltage-to-current converter or the reference current generator by the control logic. Basically, the integrator converts the input signal into a proportional time period.

3.9 Zero Crossing Detector. This circuit monitors the output of the integrator and initiates a signal when the integrator output returns to its starting point.

3.10 Clock. The clock generates an 8 kHz square wave output used to advance the counter.

3.11 Counter. The counter is a digital circuit that is continually advanced by the clock, linearily counting from 0000 to 3999 and overflowing back to 0000. The counter measures the time period of the integrator and provides the timing required by the logic.

3.12 Control Logic. The control logic circuitry receives inputs from the counter and the zero crossing detector and from this data, controls the switching of the integrator input and the strobing of the latch.

3.13 Latch. The latch is a storage circuit for the counter. Upon command from the control logic, the latch stores the number of counts accumulated in the counter.

3.14 Display. This includes a decoder/AC driver circuit and the liquid crystal display. The decoder/driver circuitry converts the count information stored in the latch to a 7-segment code for use by the display assembly. The information stored in the latches appears as a number in the display window.

3.15 Integration.

3.16 Integration is a two phase process and is shown graphically in figure 3.2. The first phase is called signal integration. This is a clock and counter controlled time period of 125 ms, or the time required for the counter to advance from 3000 to 0000 (1000 counts). During this period the conditioned signal from the input is converted to a proportional

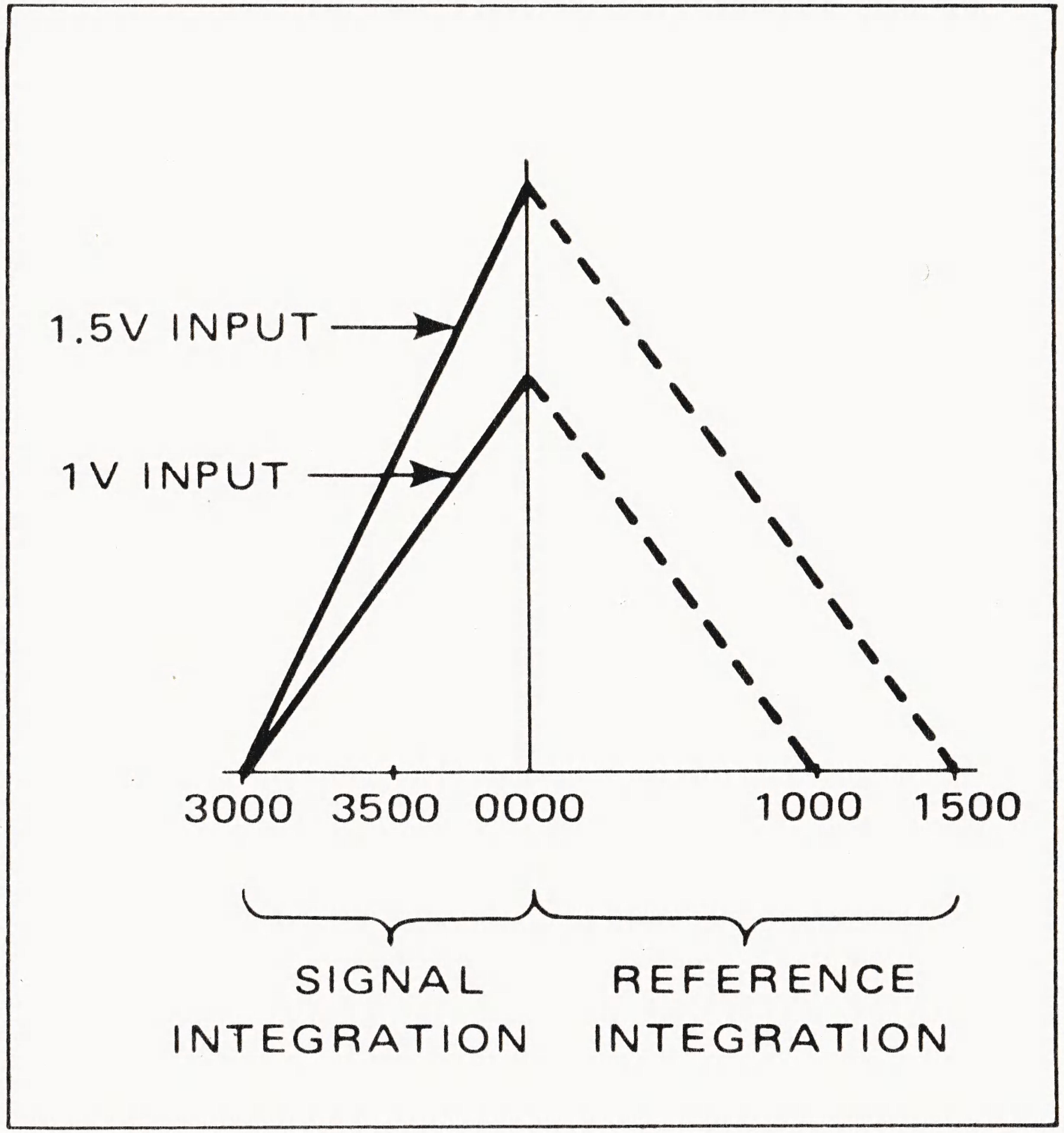


Figure 3.2 - Integrator Output

amount of positive current and fed to the integrator, resulting in a linearly increasing voltage potential. The rate of the increase is directly proportional to the input signal.

3.17 The second phase begins when the counter reaches 0000; the conditioned and converted input signal is removed from the integrator and replaced by a fixed amount of negative current. This reference current causes the output of the integrator to decrease at a fixed linear rate. When the output of the integrator returns to its original level, the zero crossing detector generates a signal that:

a. Disconnects the integrator from the reference current generator.

b. Commands the latches to store the setting of the counter.

The counter does not stop when the zero crossing detector signal is produced; it continues to advance until it reaches 3000 which starts a new measurement cycle. The information stored in the latches is converted to numbers on the display and is an accurate representation of the input signal.

4.0 MAINTENANCE.

4.1 Battery Replacement.

Suitable replacement batteries are:

Burgess 2U6	Panasonic 006P
Eveready 216	Ray-O-Vac 1604

or equivalent.

4.2 Battery replacement is covered in paragraph 2.6.

4.3 Fuse.

4.4 The fuse provides overload protection on some DC current ranges and is electrically in series with the – input lead. The fuse is located next to the battery and access to the fuse is the same as described in paragraph 2.6. The fuse is a type 3AG/AGC 2.5 Amp, 250 volt.

CAUTION

Do not substitute a different value or a slo-blow type fuse in this instrument.

4.5 Calibration.

4.6 Calibration returns the operation of your Danameter to its original specifications and is performed when the highest measurement accuracy is required. Calibration is available through your dealer. For those who desire to perform their own calibration and possess the necessary equipment, the following information is provided.

4.7 ACCESS TO CALIBRATION POINTS.

4.8 To calibrate the Danameter it is first necessary to remove the back cover. This is accomplished as follows:

1. Set Danameter control switch to OFF.

2. Loosen captive screw on battery cover.

3. Swing bail away from back of instrument and slide cover up.

4. Remove mounting screw at center of back.

5. Remove battery and fuse. Lift off back and guide battery cable through hole in back cover. Reconnect battery and fuse.

4.9 REQUIRED EQUIPMENT.

4.10 Equipment required to fully calibrate the Danameter is shown in table 4.1. The types of equipment listed is for reference only and equipment with suitable characteristics may be substituted.

4.11 CALIBRATION PROCEDURE.

4.12 Referring to table 4.2, select the function and range on the Danameter, connect the input leads across the standard, and adjust the control for the required reading for each step. Calibration points are shown in figure 4.1. (NOTE: use a mirror placed in front of the Danameter to facilitate adjustment.)

4.13 Reassemble the Danameter by reversing the procedure of paragraph 4.11. (Insure Danameter is "OFF" when installing battery.)

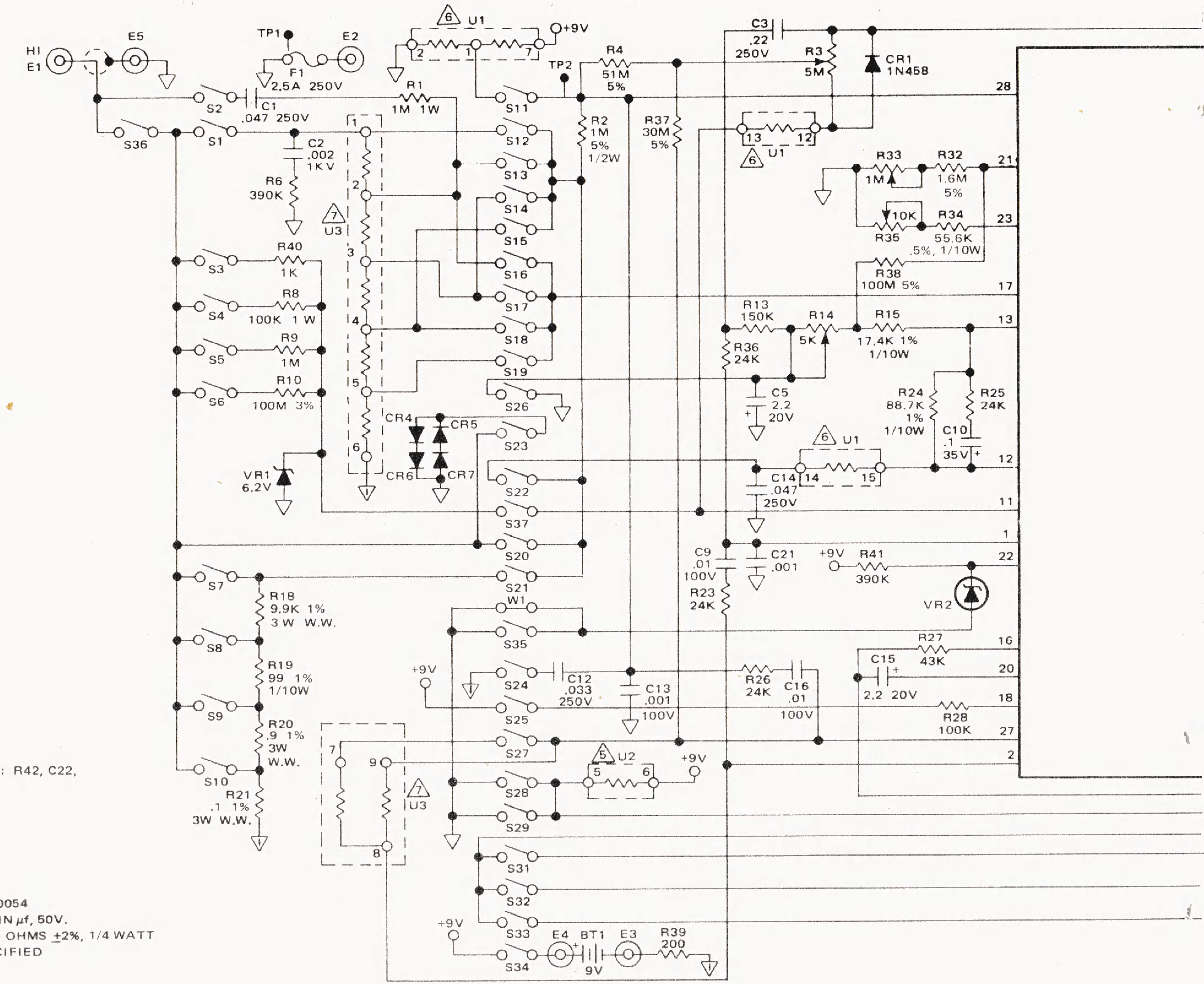
Table 4.1 - Required Equipment

Name	Required Accuracy	Recommended Type
DC Standard AC Standard DC Current Standard Resistance Standard	.05%	ROTEK AC/DC Precision Calibrator Model 310
Adjustment Screwdriver (Jewelers $\leq$ .060")	—	—
Cliplead $\approx$ 6" long	—	—

Table 4.2 - Calibration Procedure

Switch Setting	Hookup or Input	Adjust	For Readout of:
1. 200 mA	Jumper between TP1 & TP2	R30	Zero with alternate + and – sign
	Remove jumper	R3	
2. 2 VDC	DC Standard +.001 volt	R33	+.001 (±1 digit)
	DC Standard +1.900 volts	R35	+1.900 (±1 digit)
3. 20 VAC	AC Standard 19.00V @ 400 Hz	R14	19.00 (±2 digits)
4. 20KΩ	Ohms Standard 19.00 KΩ	R5	19.00 (±2 digits)

Figure 4.1 - Calibration Points



8. LAST REF DESIGNATORS USED: R42, C22, CR10, VR2, S37, U5

⚠7 DANA P/N 010848

⚠6 DANA P/N 010846

⚠5 DANA P/N 010847

3. ALL DIODES ARE DANA P/N 210054
2. ALL CAPACITOR VALUES ARE IN μf, 50V.
1. ALL RESISTOR VALUES ARE IN OHMS $\pm 2\%$, 1/4 WATT
NOTES: UNLESS OTHERWISE SPECIFIED

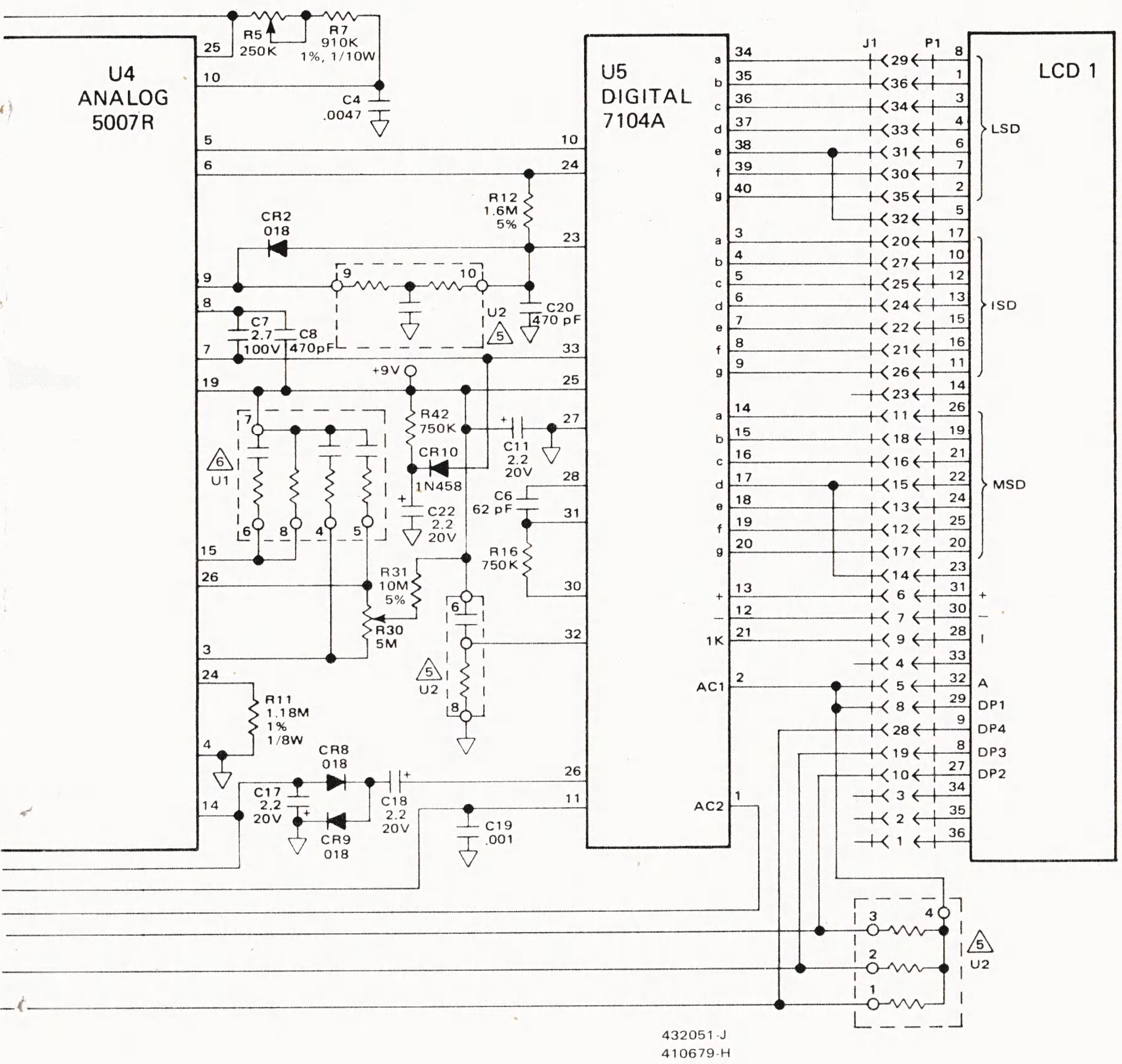


Figure 4.2 - Schematic, Danameter

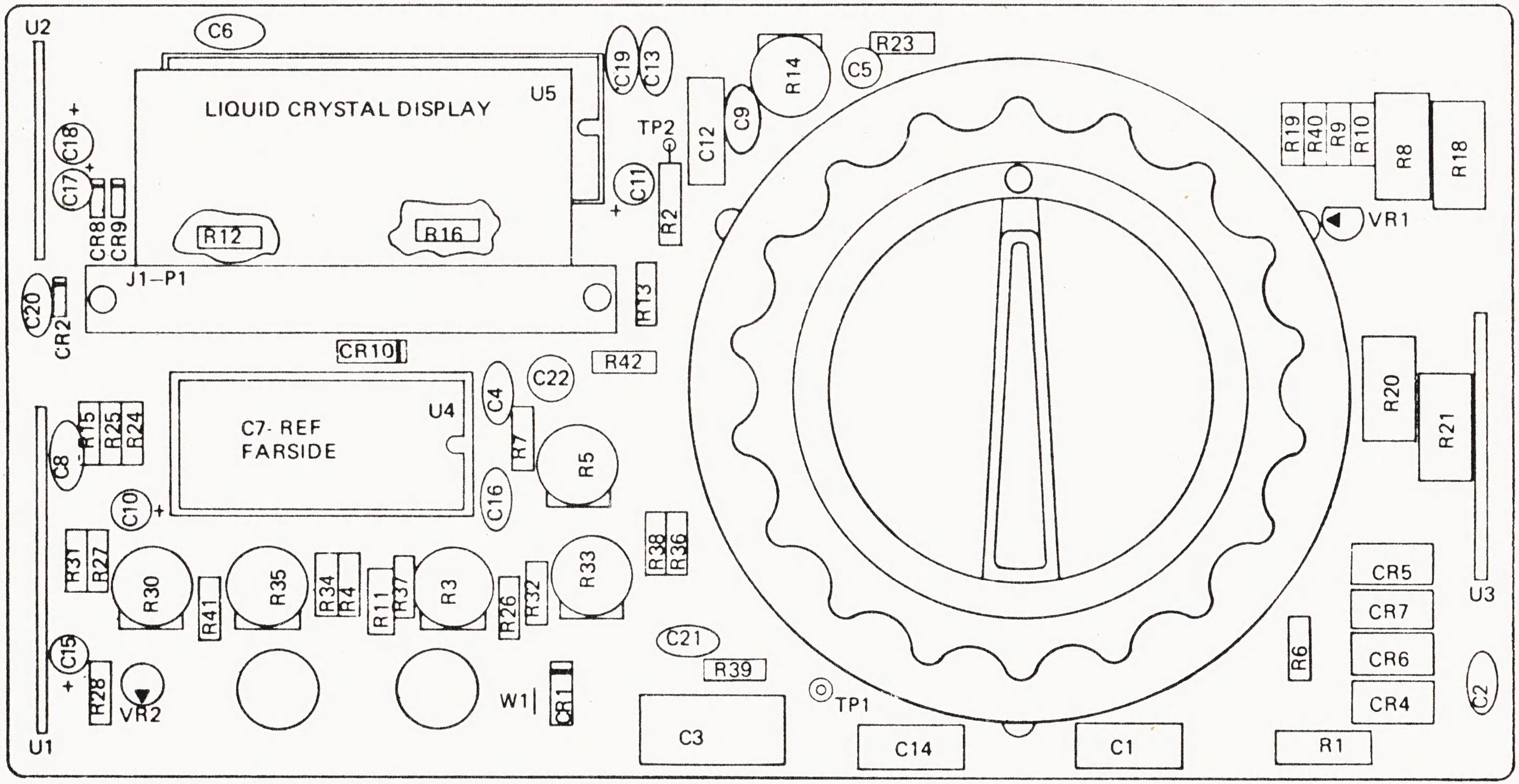


Figure 4.3 - Layout, Danameter

Table 4.3 - Parts List

REF DESIG	P/N	DESCRIPTION				
C1	120321	CAP	MYLAR	.047 µF	250 V	±10%
C2	100109	CAP	DISC	.002 µF	1 KV	+50%–20%
C3	120322	CAP	MYLAR	.22 µF	250 V	±10%
C4	100110	CAP	DISC	4700 pF	50 V	±20%
C5	110166	CAP	TANTA	2.2 µF	20 V	±20%
C6	100105	CAP	DISC	62 pF	50 V	±5%
C7	120323	CAP	MYLAR	2.7 µF	100 V	±10%
C8	100117	CAP	DISC	470 pF	50 V	±20%
C9	120332	CAP	POLYFILM	0.01 µF	100 V	
C10	110168	CAP	TANTA	.1 µF	35 V	
C11	110166	CAP	TANTA	2.2 µF	20 V	±20%
C12	120320	CAP	MYLAR	.033 µF	250 V	±10%
C13	120330	CAP	POLYFILM	.001 µF	100 V	±20%
C14	120321	CAP	MYLAR	.047 µF	250 V	±20%
C15	110166	CAP	TANTA	2.2 µF	20 V	±20%
C16	120332	CAP	POLYFILM	0.01 µF	100 V	
C17	110166	CAP	TANTA	2.2 µF	20 V	±20%
C18	110166	CAP	TANTA	2.2 µF	20 V	±20%

Table 4.3 - Parts List (continued)

REF DESIG	P/N	DESCRIPTION				
C19	100108	CAP	DISC	.001 μF	50 V	±10%
C20	100117	CAP	DISC	470 pF	50 V	±20%
C21	100108	CAP	DISC	.001 μF	50 V	±10%
C22	110166	CAP	TANTA	2.2 μF	20 V	±20%
CR1	210058	DIODE	1N458			
CR2	210056	DIODE	MODIFIED	018		
CR4	210054	DIODE	RECTIFIER	3 A	50 V	
CR5	210054	DIODE	RECTIFIER	3 A	50 V	
CR6	210054	DIODE	RECTIFIER	3 A	50 V	
CR7	210054	DIODE	RECTIFIER	3 A	50 V	
CR8	210056	DIODE	MODIFIED	018		
CR9	210056	DIODE	MODIFIED	018		
CR10	210058	DIODE	1N458			
VR1	220071	DIODE	ZENER	1N5850	6.2 V	±10%
VR2	220076	DIODE	REF ZENER			
J1 — P1	453895	CONNECTOR-LIQUID XTAL				
LCD1	920663	LIQUID XTAL DISPLAY				

Table 4.3 - Parts List (continued)

REF DESIG	P/N	DESCRIPTION				
R1	010855	RES	CARBON FILM	1 M	± 2%	1 W
R2	010844	RES	CARBON FILM	1 M	± 5%	1/2W
R3	040292	POT	CERMET	5 M	±30%	
R4	001876	RES	CARBON COMP	51 M	± 5%	1/4W
R5	040295	POT	CERMET	250 K	±20%	
R6	010852	RES	CARBON FILM	390 K	± 2%	1/4W
R7	010947	RES	METAL FILM	909 K	± 1%	1/10W
R8	010838	RES	CARBON FILM	100 K	± 2%	1 W
R9	010843	RES	CARBON FILM	1 M	± 2%	1/4W
R10	001886	RES	CARBON COMP	100 M	± 3%	1/4W
R11	010887	RES	METAL FILM	1.18 M	± 1%	1/8W
R12	001871	RES	CARBON COMP	1.6 M	± 5%	1/4W
R13	010839	RES	CARBON FILM	150 K	± 2%	1/4W
R14	040293	POT	CERMET	5 K	±20%	
R15	010883	RES	METAL FILM	17.4 K	± 1%	1/10W
R16	010853	RES	CARBON FILM	750 K	± 2%	1/4W
R18	020665	RES	WIREWOUND	9.9 K	± 1%	3 W

Table 4.3 - Parts List (continued)

REF DESIG	P/N	DESCRIPTION			
R19	010832	RES	METAL FILM	99 OHM	± 1% 1/10W
R20	020666	RES	WIREWOUND	.9 OHM	± 1% 3 W
R21	020664	RES	WIREWOUND	.1 OHM	± 1% 3 W
R23	010835	RES	CARBON FILM	24 K	± 2% 1/4W
R24	010885	RES	METAL FILM	88.7 K	± 1% 1/10W
R25	010835	RES	CARBON FILM	24 K	± 2% 1/4W
R26	010835	RES	CARBON FILM	24 K	± 2% 1/4W
R27	010851	RES	CARBON FILM	43 K	± 2% 1/4W
R28	010893	RES	CARBON COMP	100 K	± 2% 1/4W
R30	040292	POT	CERMET	5 M	±30%
R31	001817	RES	CARBON COMP	10 M	± 5% 1/4W
R32	001871	RES	CARBON COMP	1.6 M	± 5% 1/4W
R33	040291	POT	CERMET	1 M	±20%
R34	010884	RES	METAL FILM	55.6 K	± .5% 1/10W
R35	040288	POT	CERMET	10 K	±20%
R36	010835	RES	CARBON FILM	24 K	± 2% 1/4W
R37	001820	RES	CARBON COMP	30 M	± 5% 1/4W

Table 4.3 - Parts List (continued)

REF DESIG	P/N	DESCRIPTION			
R38	001819	RES	CARBON COMP	100 M	± 5% 1/4W
R39	010915	RES	CARBON FILM	200 OHM	± 2% 1/4W
R40	010834	RES	CARBON FILM	1 K	± 2% 1/4W
R41	010852	RES	CARBON FILM	390 K	± 2% 1/4W
R42	010853	RES	CARBON FILM	750 K	± 2% 1/4W
U1	010846	RES	MODULE, ANALOG		
U2	010847	RES	MODULE, DIGITAL		
U3	010848	RES	MODULE, ATTENUATOR		
U4	230188	ANALOG 5007R			
U5	230179	CMOS	DIGITAL	7104A	
W1	500022	BUSS WIRE		22 GA	

RACAL-DANA INSTRUMENTS LTD.
Duke Street
Windsor, Berkshire SL4 1SB, England
Telephone: Windsor (07535) 69811
Telex: 847013

RACAL-DANA INSTRUMENTS INC.
18912 Von Karman, P.O. Box C-19541
Irvine, California 92713, U.S.A.
Telephone: (714) 833-1234
Twx: 910-595-1136, Telex: 67-8341

RACAL

RACAL-DANA INSTRUMENTS S.A.
91 Route de Gardes
92 Meudon-Bellevue, France
Telephone: 027-7575
Telex: 842 200207