

- METRIX -

## WORKING INSTRUCTIONS

For

MODEL 477

MILITIMETER

S/N 4116 (366)

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Parts List

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Fig. 1 : Basic circuits

Fig. 2 : Complete Schematic  
Diagram

## INTRODUCTION

The METRIX Model 477 Multimeter is a rugged, accurate instrument designed for laboratory and other exacting applications. Its meter and other components are protected from current and voltage overloads by a trip-free overload protection system. Its 49 ranges of : resistance and capacity, and AC and DC voltage and current give it a versatility not usually found in such a compact instrument.

## FEATURES

1. Large, easily readable, uncluttered dial.
2. Precision d'Arsonval movement has spring-backed jewel bearings and flexing end stops for extra ruggedness.
3. Pivots are rustproof and non-magnetic.
4. Shielded magnetic circuit is insensitive to stray fields.
5. Mirror scale and knife edge pointer eliminate parallax error.
6. Easily accessible separate battery compartment prevents damage to internal components from leaking batteries.
7. Hinged carrying handle can be locked to support the 477 in an inclined position.
8. Solid construction and quality components- for example, military approved potentiometer and switches - assure long, trouble-free service.
9. Overload relay is trip-free, i.e. even if the reset button is held down, the relay will not reset until the fault condition has been removed.

# TECHNICAL SPECIFICATIONS

## DC VOLTAGE

Ranges : 0-0.5 - 1.6 - 5 - 16 - 50 - 160 - 500 - 1600 volts - 0.3 volt range for use with external shunt.

Sensitivity : 20,000 ohms per volt.

Accuracy : 1.5 %

## AC VOLTAGE

Ranges : 0-1.6 - 5 - 16 - 50 - 160 - 500 - 1600 volts

Sensitivity : 9000 ohms per volt on 1.6. volt range  
7000 ohms per volt on 5 volt range  
6330 ohms per volt on higher ranges

Accuracy : 2,5 %

## dbm

Ranges : -6 to +6 dbm direct reading, with 5 additional ranges to +56 dbm.

Zero level : 1 mw or 0,775 volt across 600 ohms

## DC CURRENT

Ranges : 0-50 - 160 - 500  $\mu$ a  
0-1.6 - 5 - 16 - 50 - 160 - 500 ma  
0-1.5 - 5 amp

Voltage drop : from 210 mv on 160  $\mu$ a range to 480 mv on 5 amp range. 500 mv on 50  $\mu$ a range.

## AC CURRENT.

Ranges : 0-160 - 500  $\mu$ a  
0-1.6 - 5 - 16 - 50 - 160 - 500 ma  
0-1.6 - 5 amp

Voltage drop : from 600 mv on 160  $\mu$ a range to 1.5 v on 5 amp range

Accuracy : 2,5 %

## RESISTANCE.

Ranges :  $\Omega \times 1$  - 1 ohm to 5 kilohms  
 $\Omega \times 100$  - 100 ohms to 500 kilohms  
 $\Omega \times 10 \text{ k}\Omega$  - 10 kilohms to 50 megohms

CAPACITANCE

Ranges :

$\mu\text{f} \times 1 - 1 \mu\text{f}$  to 100  $\text{nf}$   
 $\mu\text{f} \times 0.01 - 0.01 \mu\text{f}$  to 1  $\mu\text{f}$   
 $\mu\text{f} \times 0.001 - 0.001 \mu\text{f}$  to 0.1  $\mu\text{f}$

FREQUENCY ERROR, 20-20,000 cps

up to 50 volt range, 5 % max.  
 160 and 500 volt ranges, 10 % max.

NET WEIGHT

5 lbs. 8 oz.

DIMENSIONS

9 3/8" x 6 9/16" x 4" including handle

ACCESSORIES AVAILABLE

| <u>DESCRIPTION</u>                      | <u>PART NUMBER</u> |
|---|--------------------|
| Resistance box, 5000 $\Omega$ AC and DC | HA 469             |
| High-voltage probe, 16 KV DC            | HA 455             |
| High-voltage probe, 16 KV AC            | HA 454             |
| High-voltage probe, 30 KV DC            | HA 453             |
| Clip-on transformer, 1000/1 ratio       | AM 15              |
| Shunt, 15 amp                           | HA 478             |
| Shunt, 30 amp                           | HA 479             |
| Shunt, 75 amp                           | HA 480             |
| Shunt, 150 amp                          | HA 416             |
| Leather carrying case                   | AE 36              |

## WORKING INSTRUCTIONS

### GENERAL NOTES.

Before making any measurements, set the pointer to zero with the zero-adjust screw of the meter.

Take the following precautions whenever measuring high voltages : Disconnect or switch off the voltage source, connect the 477 to the circuit under test, then reconnect the source. Do not touch the 477 while the voltage is applied. After taking the reading, disconnect the source and make sure the meter reads zero before disconnecting the 477. This procedure is also recommended when measuring lower voltages if the operator is standing on moist ground or if he is likely to come in contact with grounded metallic objects.

For greatest accuracy, select the range immediately above the value to be measured. If the approximate value is unknown, begin with the highest range and switch to a lower range if necessary.

While the 477 can be used in any position, the most accurate readings are obtained when the meter face is in a horizontal plane.

If the meter reads downscale on DC measurements, reverse the test leads.

In case of an overload, the protection system will disconnect the meter from the circuit under test.

In most cases, the overload relay will trip. Correct the trouble and press the red reset button.

On some ranges, such as 500 ma, 160 ma, 50 ma, and  $\Omega \times 1$ , the fuse may blow. Remove the screw holding the battery compartment cover. Slip the burned out fuse from under the spring clips and replace it with a spare. Spare 1.5 amp. fuses (Bussmann GMA  $1\frac{1}{2}$  or equivalent) will be found in the battery compartment.

If the fuse blows, it may remain slightly conductive and since the instrument is very sensitive, an indication may be given when reading a voltage. This indication will be unstable and greatly in error.

A voltage somewhat greater than full scale applied when on the 160, 500, and 1600 volt AC or DC ranges will not trip the relay, but the meter will not be damaged.

Do not exceed 1000 volts between the "+" and "-CON." jacks, or 3000 volts at the 1600 volt AC and DC jacks.

Be careful never to connect the test leads across a voltage source when the range switch is set to a current range. While the fuse will protect most of the ranges, the 1.6 and 5 amp ranges are not protected and the instrument may be seriously damaged.

The overload protection system does not protect the following ranges :

0.3 volt DC, 1.6 amp AC and DC, and 5 amp AC and DC.

#### DC VOLTAGE, 0.3 V RANGE.

This range is intended for use with external 300 mv shunts to extend the DC current range of the 477. (see paragraph "DC Current up to 150 amp") Naturally, this range can be used without a shunt to measure voltage directly.

Set the AC - DC switch to "DC".

Set the range switch to any position in the voltage sector.

Plug the black test lead into the "-CCM." jack, and the red test lead into the "0.3 V DC" jack.

To read directly in millivolts, read the black scale 0-160 and multiply by 2.

#### DC VOLTAGE UP TO 500 V.

Set the AC - DC switch to "DC".

Set the range switch to the desired range in the voltage sector.

Plug the black test lead into the "-CCM." jack, and the red test lead into the "+" jack.

Read the black scales 0-50 and 0-160.

| <u>RANGE</u> | <u>SCALE</u> | <u>MULTIPLY READING BY</u> |
|--------------|--------------|----------------------------|
| 0.5 volts    | 0 - 50       | 1/100                      |
| 1.6 volts    | 0 - 160      | 1/100                      |
| 5 volts      | 0 - 50       | 1/10                       |
| 16 volts     | 0 - 160      | 1/10                       |
| 50 volts     | 0 - 50       | 1                          |
| 160 volts    | 0 - 160      | 1                          |
| 500 volts    | 0 - 50       | 10                         |

NOTE : In case the DC voltage to be measured has an AC component of greater amplitude superimposed upon it, the reading indicated will not be the true value. The overload circuitry includes a diode connected across the meter. This diode will therefore rectify part of the AC voltage and the meter will read slightly less. In these rare cases, the AC component may have to be suppressed in order to obtain an accurate reading.

DC VOLTAGE, 1600 V RANGE.

Set the AC-DC switch to "DC".

Set the range switch to "500 VOLTS."

Plug the black test lead into the "-COM." jack, and the red test lead into the "+ 1600 V DC " jack.

Read the black scale 0-160 and multiply by 10.

DC VOLTAGE, 5000 V RANGE.

An external resistance box (HA 469) is available which permits measuring voltage up to 5000 volts.

Set the AC-DC switch to "DC".

Set the range switch to "500 VOLTS."

Connect the upper jack of the resistance box to the "+ 1600 V DC" jack of the 477.

Plug the black test lead into the "-COM." jack of the 477, and the red test lead into the "500 V DC" jack of the resistance box.

Read the black scale 0-50 and multiply by 100.

The additional error introduced by the resistance box does not exceed 3 %.

DC VOLTAGE UP TO 30,000 V.

Two high-voltage probes are available which permit measuring DC voltage up to 16 KV (HA 455) and 30 KV (HA 453), but only from low-power sources.

Always make sure the probe is clean, as dust may impair the insulating properties of the surface.

Check the continuity between the guard ring and the black banana plugs by means of the resistance range of the 477. Resistance should not be higher than 10 ohms.

Work in a dry place and on an insulating mat.

Avoid all bodily contact with any metallic objects which may be grounded.

Naturally, the other precautions observed when working with high voltages apply here also.

Set the AC - DC switch to " DC ".

Set the range switch to " 500 VOLTS."

Insert the metal plug at the end of the coaxial cable into the " + 1600 V DC " jack and the banana plug of the short black lead into the " -COM." jack.

Connect the other black banana plug to the negative (cold) side of the source by means of an alligator clip.

Switch on the source and touch the point under test with the tip of the probe.

To read directly in kilovolts, read the black scale 0-160 as follows :

|             |   |                                |
|-------------|---|--------------------------------|
| 16 KV probe | - | divide by 10                   |
| 30 KV probe | - | divide by 10 and multiply by 2 |

The additional error introduced by the probes does not exceed 5 %.

#### AC VOLTAGE UP TO 500 V.

Set the AC - DC switch to "AC".

Set the range switch to the desired range in the voltage sector.

Plug the test leads into the "-COM." and " + " jacks.

Read the red scales 0 - 50 and 0 - 160.

| <u>RANGE</u> | <u>SCALE</u> | <u>MULTIPLY READING BY</u> |
|--------------|--------------|----------------------------|
| 1.6 volts    | 0 - 160      | 1/100                      |
| 5 volts      | 0 - 50       | 1/10                       |
| 16 volts     | 0 - 160      | 1/10                       |
| 50 volts     | 0 - 50       | 1                          |
| 160 volts    | 0 - 160      | 1                          |
| 500 volts    | 0 - 50       | 10                         |

**NOTE :** The pointer will always move in the correct direction whichever way the test leads are connected; however, for voltage measurements at frequencies above 60 cps, it is recommended that the "-COM." lead be connected to the grounded (cold) side of the circuit under test. In this way, stray capacity between the instrument case and ground will be minimized. This is particularly important at the higher frequencies.



AC VOLTAGE, 1600 V RANGE.

Set the AC-DC switch to "AC".

Set the range switch to "500 VOLTS".

Plug the test leads into the "-COM." and "1600 V AC" jacks.

Read the red scale 0-160 and multiply by 10.

AC VOLTAGE, 5000 V RANGE.

An external resistance box (HA 469) is available which permits measuring voltage up to 5000 volts.

Set the AC-DC switch to "AC".

Set the range switch to "500 VOLTS".

Connect the upper jack of the resistance box to the "1600 V AC" jack of the 477.

Plug the test leads into the "-COM." jack of the 477, and the "5000 V AC" jack of the resistance box.

Read the red scale 0-50 and multiply by 100.

The additional error introduced by the resistance box does not exceed 3 % at 60 cps.

AC VOLTAGE, 16,000 V RANGE.

A high - voltage probe is available which permits measuring AC voltage up to 16 KV (HA 454) but only from low-power sources.

For precautions concerning the use of high-voltage probes, see paragraph "DC Voltage up to 30,000 V".

Set the AC - DC switch to "AC".

Set the range switch to "500 VOLTS".

Insert the metal plug at the end of the coaxial cable into the "1600 V AC" jack and the banana plug of the short black lead into the "-COM." jack.

Connect the other black banana plug to the grounded (cold) side of the source by means of an alligator clip.

Switch on the source and touch the point under test with the tip of the probe.

To read directly in kilovolts, read the red scale 0-160 and divide by 10.

The additional error introduced by the probe does not exceed 5 % at 50 cps.

#### AF VOLTAGE UP TO 500 V.

This facility is used whenever it is desired to measure an AC Voltage which is superimposed on a DC voltage such as the signal appearing at the plate of an AF amplifier.

To measure such a voltage, connect a low leakage type (500-1500 V) capacitor in series with the test leads to block the DC component. Although the internal impedance of the 477 is high, an error is introduced by the use of this series capacitor, mainly on the 1.6 and 5 volt ranges, and at low frequencies.

If a 1.0  $\mu\text{f}$  capacitor is used, its reactance will be :

$$X = \frac{1}{\omega C} = \frac{1}{6.28 \times 10^{-6} f} = \frac{1.59 \times 10^5}{f}$$

where  $f$  = frequency in cps

The resistance of the instrument is :

9000 ohms per volt on the 1.6 volt range or,

$$9000 \times 1.6 = 14,400 \text{ ohms}$$

7000 ohms per volt on the 5 volt range or,

$$7000 \times 5 = 35,000 \text{ ohms, etc...}$$

The total impedance of the circuit is given by :

$$Z = \sqrt{R^2 + X^2}$$

The true voltage will then be given by applying the correction factor :

$$= \frac{\sqrt{R^2 + X^2}}{R}$$

Example :  $f = 60 \text{ cps}$ ,  $R = 14,400 \text{ ohms}$  (1.6 volt range)

$$= \frac{\sqrt{(1.44 \times 10^4)^2 + (2.66 \times 10^3)^2}}{1.44 \times 10^4} = 1.02$$

The reading should then be multiplied by 1.02

Set the AC - DC switch to "AC".

Set the range switch to the desired range in the voltage sector.

Plug the black test lead into the "-COM." jack, one lead of the capacitor into the " + " jack, and the other to the red banana plug by means of an alligator clip.

Connect the black test lead to the grounded (cold) side, and the red test lead to the above-ground (hot) side.

Read the red scales 0-50 and 0-160.. (See paragraph "AC Voltage up to 500 V" for scale multiplying factors.)

#### dbm.

The dbm ranges can be used to measure absolute voltage levels directly in dbm, or by taking the difference in readings between input and output terminals of amplifiers, filters, attenuators, etc., the gain or attenuation in db can be obtained.

The zero reference level is 1 milliwatt or 0.775 volt across 600 ohms.

For measurements using a reference of 6 milliwatts across 500 ohms, subtract 7 db from each reading.

Use the same procedure as for AC voltage. If necessary, add a series capacitor as described in the preceding paragraph.

To measure dbm, read the black "dbm" scale as follows :

On the 1.6 volt range the readings are direct.

| <u>Range</u> | <u>Add to Reading</u> |
|--------------|-----------------------|
| 5 volts      | 10 db                 |
| 16 volts     | 20 db                 |
| 50 volts     | 30 db                 |
| 160 volts    | 40 db                 |
| 500 volts    | 50 db                 |

#### DC CURRENT UP TO 500 ma.

Set the AC-DC switch to "DC".

Set the range switch to the desired range in the current sector, (the 50  $\mu$ a DC position being the same as for 0.5 volt DC).

Plug the black test lead into the "-COM." jack, and the red test lead into the " + " jack.

Read the black scales 0-50 and 0-160.

| <u>RANGE</u> | <u>SCALE</u> | <u>MULTIPLY READING BY</u> |
|--------------|--------------|----------------------------|
| 50 a         | 0 - 50       | 1                          |
| 160 a        | 0 - 160      | 1                          |
| 500 a        | 0 - 50       | 10                         |
| 1.6 ma       | 0 - 160      | 1/100                      |
| 5 ma         | 0 - 50       | 1/10                       |
| 16 ma        | 0 - 160      | 1/10                       |
| 50 ma        | 0 - 50       | 1                          |
| 160 ma       | 0 - 160      | 1                          |
| 500 ma       | 0 - 50       | 10                         |

#### DC CURRENT UP TO 5 AMP

Set the AC-DC switch to "DC".

Set the range switch to any position in the current sector.

Plug the black test lead into the "-COM." jack, and the red test lead into either the " + 1.6 A DC " or " + 5 A DC " jacks, depending on the range desired.

Read the black scales 0-50 and 0-160.

| <u>RANGE</u> | <u>SCALE</u> | <u>DIVIDE READING BY</u> |
|--------------|--------------|--------------------------|
| 1.6 amp      | 0 - 160      | 100                      |
| 5 amp        | 0 - 50       | 10                       |

#### DC CURRENT UP TO 150 AMP

External shunts are available which permit measuring DC current up to 15 amp (HA 478), 30 amp (HA 479), 75 amp (HA 480), and 150 amp (HA 416).

As these shunts have a voltage drop of 300 millivolts, the 0.3 volt DC range of the 477 is used. Bear in mind that this range is not protected against overload.

Set the AC-DC switch to "DC".

Set the range switch to any position in the voltage sector.

Connect the desired shunt in series with the circuit under test by means of the large current terminals.

Using the special test leads supplied with the shunt, connect the small potential terminals of the shunt to the "-COM." and " + " jacks of the 477, respecting the polarity.

Read the black scale 0 - 160 as follows :

|               |   |                                 |
|---------------|---|---------------------------------|
| 15 amp shunt  | - | divide by 10.                   |
| 30 amp shunt  | - | divide by 10 and multiply by 2. |
| 75 amp shunt  | - | divide by 2.                    |
| 150 amp shunt | - | read directly.                  |

The ampere ratings of the shunts are nominal. Actual fullscale reading are 16, 32, 80, and 160 amp respectively.

#### AC CURRENT UP TO 500 MA

Set the AC-DC switch to "AC".

Set the range switch to the desired range in the current sector.

Plug the test leads into the "-COM." and " + " jacks.

Read the red scales 0-50 and 0-160.

| <u>RANGE</u> | <u>SCALE</u> | <u>MULTIPLY READING BY</u> |
|--------------|--------------|----------------------------|
| 160 $\mu$ a  | 0 - 160      | 1                          |
| 500 $\mu$ a  | 0 - 50       | 10                         |
| 1.6 ma       | 0 - 160      | 1/100                      |
| 5 ma         | 0 - 50       | 1/10                       |
| 16 ma        | 0 - 160      | 1/10                       |
| 50 ma        | 0 - 50       | 1                          |
| 160 ma       | 0 - 160      | 1                          |
| 500 ma       | 0 - 50       | 10                         |

#### AC CURRENT UP TO 5 AMF.

Set the AC - DC switch to "AC".

Set the range switch to any position in the current sector.

Plug the test leads into the "-COM." jack, and either the "1.6 A AC" or "5 A AC" jacks, depending on the range desired.

Read the red scales 0-50 and 0-160.

| <u>RANGE</u> | <u>SCALE</u> | <u>DIVIDE READING BY</u> |
|--------------|--------------|--------------------------|
| 1.6 amp      | 0 - 160      | 100                      |
| 5 amp        | 0 - 50       | 10                       |

NOTE : Do not use the 5 amp AC range for more than 5 minutes continuously.

### AC CURRENT UP TO 1000 amp

A clip-on transformer (AM 15) with a ratio of 1000/1 is available which permits measuring AC current up to 1000 amp.

Set the AC - DC switch to "AC".

Set the range switch to the 50 ma, 160 ma, or 500 ma range as required.

Using the special test leads supplied with the transformer, connect the jacks of the transformer to the "-COM." and "+ " jacks of the 477.

To read directly in amperes, read the red scales 0-50 and 0-160.

For the 1000 amp range, set the range switch to any position in the current sector and connect the transformer to the "-COM." and "1.6 A AC " jacks.

Read the red scale 0-160 and multiply by 10.

NOTE : Although the full-scale reading on the highest range is 1600 amp, the transformer should not be applied to circuits carrying over 1000 amp. Do not use the transformer for ranges lower than 50 amp.

### RESISTANCE.

Before making a measurement, be sure that the resistance is not connected to a source of voltage, otherwise the reading will be incorrect, and if the voltage is sufficiently high, the overload relay will trip.

Set the AC - DC switch to "R".

Set the range switch to the desired range in the resistance-capacitance sector.

Plug the test leads into the "-COM." and "+ " jacks.

Short circuit the test prods, and set the pointer to the zero of the green "OHMS" scale by means of the zero-set potentiometer marked "0  $\mu$ f".

Separate the test prods and connect them to the resistance to be measured.

If possible, select a range which gives a reading in the center portion of the scale.

The zero adjustment should be checked each time the range is changed.

Read the green "OHMS" scale and multiply by the factor of the selected range.

NOTE : Do not leave the range switch on a resistance range when the 477 is not in use, as the test prods may touch accidentally and be left in contact, thereby exhausting the batteries.

When the resistance ranges can no longer be zeroed, the batteries should be replaced. The 1.5 volt battery is used for the  $\Omega \times 1$ , and  $\Omega \times 100$  ranges, while the 15 volt battery is used for the  $\Omega \times 10 \text{ k}$  range. To replace the batteries, remove the screw holding the battery compartment cover.

Observe the polarity marked on the inside of the case.

1.5 volt battery  
15 volt battery

### CAPACITANCE.

Before making a measurement, be sure that the capacitance is not connected to a source of voltage, otherwise the reading will be incorrect, and if the voltage is sufficiently high, the overload relay will trip.

Set the AC - DC switch to " $\mu\text{f}$ ".

Set the range switch to the desired range in the resistance-capacitance sector.

Plug the test leads into the "-COM." and "+ " jacks.

Plug the power cord into the " 127 V AC ", or " 220 V AC " receptacle of the 477, depending on the approximate voltage of the available 60 cps power.

Short-circuit the test prods, and set the pointer to the infinity mark ( $\infty$ ) of the blue " $\mu\text{f}$ " scale by means of the zero-set potentiometer marked " $\Omega \mu\text{f}$ ."

Separate the test prods and connect them to the capacitance to be measured.

If possible, select a range which gives a reading in the center portion of the scale.

The infinity adjustment should be checked each time the range is changed.

Read the blue " $\mu\text{f}$ " scale and multiply by the factor of the selected range.

NOTE : The open-circuit voltage appearing at the test prods of the 477 is isolated from the power line, and does not exceed 40 volts. Therefore, there is no shock hazard to the operator.

## PARTS LIST

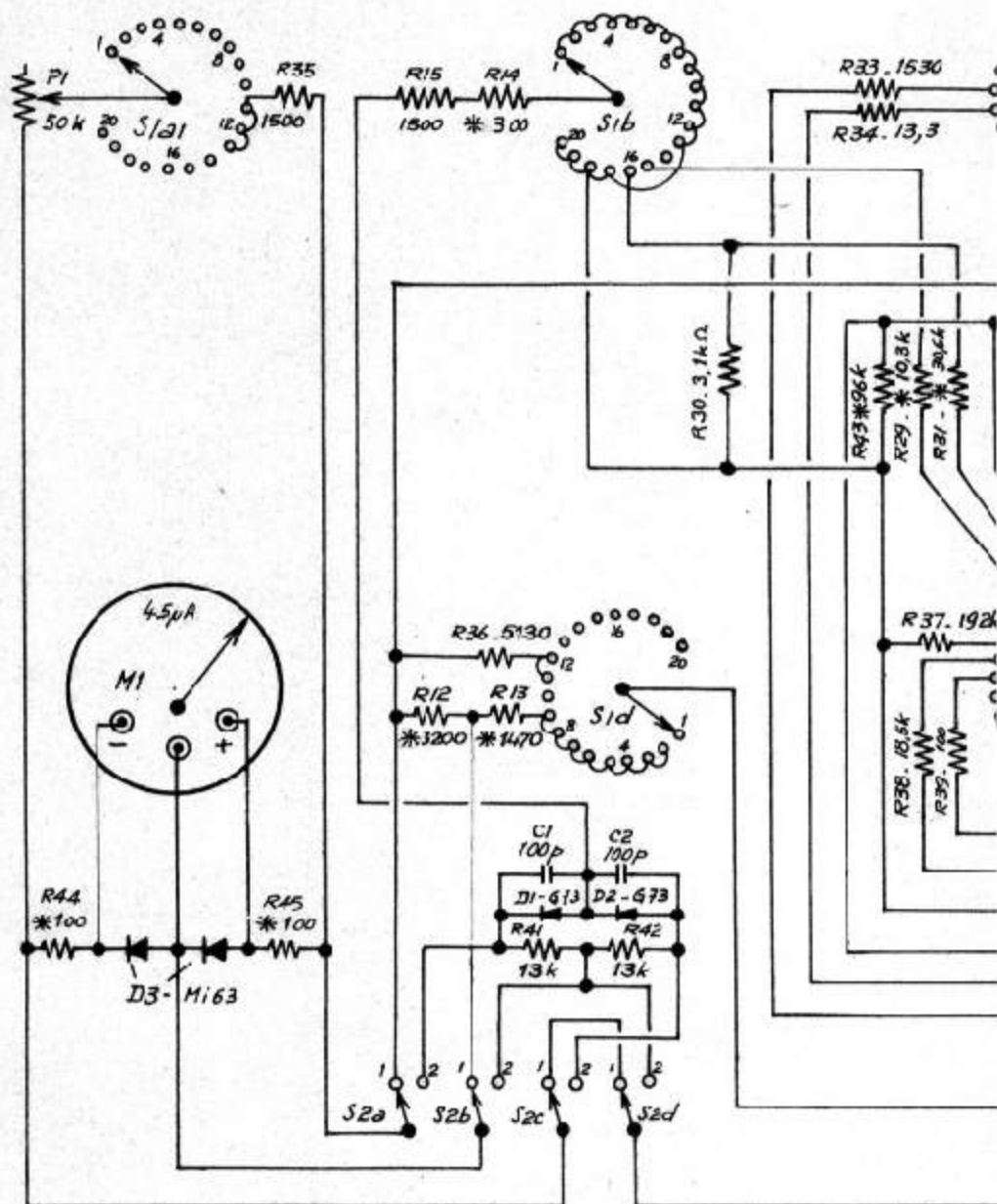
| SYMBOL N°        | DESCRIPTION   | PART NUMBER |
|------------------|---|-------------|
| <u>REGISTORS</u> |   |             |
| R1               | 0.0948 ohm $\frac{1}{2}\%$                            | LE 103      |
| R2               | 0.205 ohm $\frac{1}{2}\%$                             | LE 153      |
| R3               | 0.648 ohm $\frac{1}{2}\%$                             | LE 105      |
| R4               | 2.05 ohms $\frac{1}{2}\%$                             | LE 106      |
| R5               | 5.48 ohms $\frac{1}{2}\%$                             | LD 173      |
| R6               | 20.5 ohms $\frac{1}{2}\%$                             | LD 174      |
| R7               | 54.8 ohms $\frac{1}{2}\%$                             | LD 175      |
| R8               | 205 ohms $\frac{1}{2}\%$                              | LD 176      |
| R9               | 648 ohms $\frac{1}{2}\%$                              | LD 177      |
| R10              | 2050 ohms $\frac{1}{2}\%$                             | LD 178      |
| R11              | 5480 ohms $\frac{1}{2}\%$ 1/4 W.                      | 477/R11     |
| R12              | approx. 3200 ohms 1% $\frac{1}{2}$ W. 50 $\mu$ s adj. | 477/R12     |
| R13              | 1470 ohms DC ma adj.                                  | 477/R13     |
| R14              | approx. 300 ohms AC ma adj.                           | LD 181      |
| R15              | 1500 ohms 2% temp. comp.                              | LD 180      |
| R16              | 8560 ohms $\frac{1}{2}\%$ 1/4 W.                      | 477/R16     |
| R17              | 21.6 K $\frac{1}{2}\%$ 1/4 W.                         | 477/R17     |
| R18              | 68.4 K $\frac{1}{2}\%$ 1/4 W.                         | 477/R18     |
| R19              | 216 K $\frac{1}{2}\%$ $\frac{1}{2}$ W.                | 477/R19     |
| R20              | 684 K $\frac{1}{2}\%$ $\frac{1}{2}$ W.                | 477/R20     |
| R21              | 2.16 meg $\frac{1}{2}\%$ $\frac{1}{2}$ W.             | 477/R21     |
| R22              | 6.84 meg 1% 1 W.                                      | 477/R22     |
| R23              | 10 meg 1% 1 W.  | 477/R23     |
| R24              | 11.6 meg 1% 1 W.                                      | 477/R24     |
| R25              | 216 K $\frac{1}{2}\%$ $\frac{1}{2}$ W.                | 477/R25     |
| R26              | 900 K 1% $\frac{1}{2}$ W.                             | 477/R26     |
| R27              | 3.06 meg 1% 1 W.                                      | 477/R27     |
| R28              | 9.9 meg 1% 2 W.                                       | 477/R28     |
| R29              | approx. 10.3 K 1% $\frac{1}{2}$ W. 1.6 V. AC adj.     | 477/R29     |
| R30              | 3100 ohms 1% 1/4 W.                                   | 477/R30     |
| R31              | approx. 30.6 K 1% 1/4 W 5 C. AC adj.                  | 477/R31     |
| R32              | 233 K 1% $\frac{1}{2}$ W.                             | 477/R32     |
| R33              | 1530 ohms 1% 1/4 W.                                   | 477/R33     |
| R34              | 13.3 ohms $\frac{1}{2}\%$                             | LD 182      |
| R35              | 1500 ohms $\frac{1}{2}\%$ $\frac{1}{2}$ W.            | 477/R35     |
| R36              | 5130 ohms 1% 1/4 W.                                   | 477/R36     |
| R37              | 192 K 1% 1/2 W.                                       | 477/R37     |
| R38              | 18.5 K 1% 1/4 W.                                      | 477/R38     |
| R39              | 100 ohms $\frac{1}{2}\%$                              | LD 184      |
| R40              | 4.88 K 1/2% 1/4 W.                                    | 477/R40     |
| R41              | 13 K $\frac{1}{2}\%$ 1/4 W.                           | 477/R41     |
| R42              | 13 K $\frac{1}{2}\%$ 1/4 W.                           | 477/R42     |
| R43              | approx. 96 K 1% 1/4 W. V AC adj.                      | 477/R43     |
| R44              | approx. 100 ohms meter res. adj.                      | LD 215      |
| R45              | approx. 100 ohms meter res. adj.                      | LD 215      |
| R46              | varistor  | 477/R46     |



| <u>SYMBOL N°</u>     | <u>DESCRIPTION</u>                                   | <u>PART NUMBER</u> |
|----------------------|--|--------------------|
| <u>CAPACITORS</u>    |  |                    |
| C1                   | 100 pf ceramic 500 V 10 %                            | 477/C1             |
| C2                   | 100 pf ceramic 500 V 10 %                            | 477/C2             |
| C3                   | 22 pf ceramic 500 V 10 %                             | 477/C3             |
| C4                   | 22 pf ceramic 500 V 10 %                             | 477/C4             |
| C5                   | 4.7 pf ceramic 500 V 10 %                            | 477/C5             |
| C6                   | twisted solid wire                                   |                    |
| <u>POTENTIOMETER</u> |  |                    |
| P1                   | 50 K 20 %  | UA 232             |
| <u>RECTIFIERS</u>    |  |                    |
| D1                   | germanium diode                                      | 477/D1             |
| D2                   | germanium diode                                      | 477/D2             |
| D3                   | selenium diode                                       | 477/D3             |
| <u>MISCELLANEOUS</u> |  |                    |
| F1                   | 1.5 amp fuse, bussmann GMA 1 $\frac{1}{2}$ or equiv. | AA 44              |
| D                    | overload relay                                       | QA 46              |
| T1                   | power transformer                                    | LA 162             |
| V1                   | neon lamp  | 477/V1             |
| M1                   | dual-coil microammeter 45 $\mu$ a, 90 $\mu$ a        | NA 746             |
| S1                   | range switch   | KE 318             |
| S2                   | AC - DC switch                                       | KE 284             |
| <u>BATTERIES</u>     |  |                    |
| B1                   | 1.5 V, Eveready 950 or equiv.                        | AL 11              |
| B2                   | 15 V, Eveready 411 or equiv.                         | AL 10              |

| Pos. | SWITCH S1                      |
|------|--------------------------------|
| 1    | OFF                            |
| 2    | 500 mA AC.DC                   |
| 3    | 160 mA AC.DC                   |
| 4    | 50 mA AC.DC                    |
| 5    | 16 mA AC.DC                    |
| 6    | 5 mA AC.DC                     |
| 7    | 1,6 mA AC.DC                   |
| 8    | 500 $\mu$ A AC.DC              |
| 9    | 160 $\mu$ A AC.DC              |
| 10   | 0                              |
| 11   | $\mu$ F x 1 $\Omega$ x 1       |
| 12   | $\mu$ F x 0,01 $\Omega$ x 100  |
| 13   | $\mu$ F x 0,001 $\Omega$ x 10k |
| 14   | 6,5 V 50 $\mu$ A DC            |
| 15   | 1,6 V AC DC                    |
| 16   | 5 V AC DC                      |
| 17   | 16 V AC DC                     |
| 18   | 50 V AC DC                     |
| 19   | 160 V AC DC                    |
| 20   | 500 V AC DC                    |

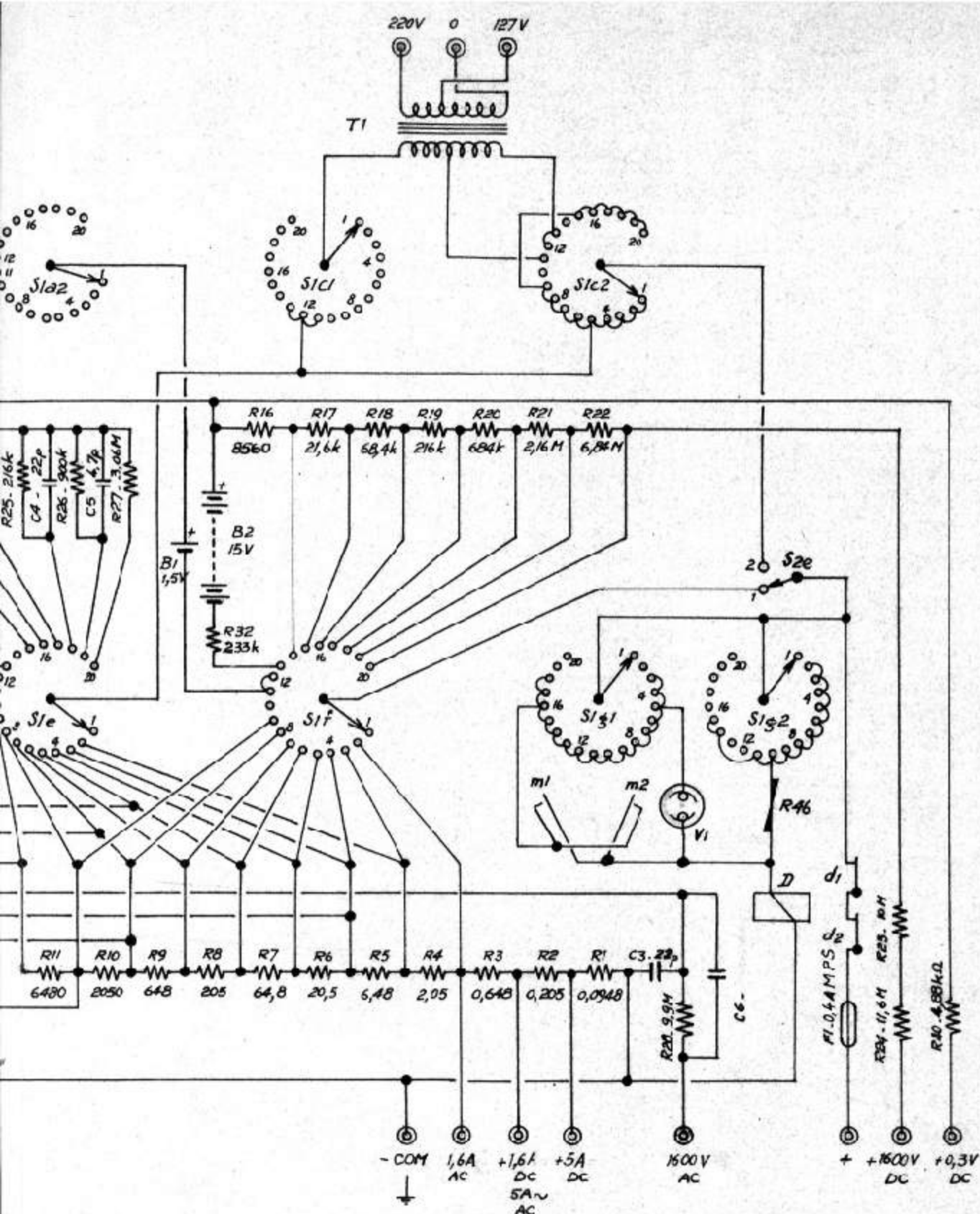
| Pos. | SWITCH S2   |
|------|-------------|
| 1    | DC $\Omega$ |
| 2    | AC $\mu$ F  |



$M_1$  and  $M_2$  END STOPS OF METER M1

$d_1$  and  $d_2$  Contacts of relay D

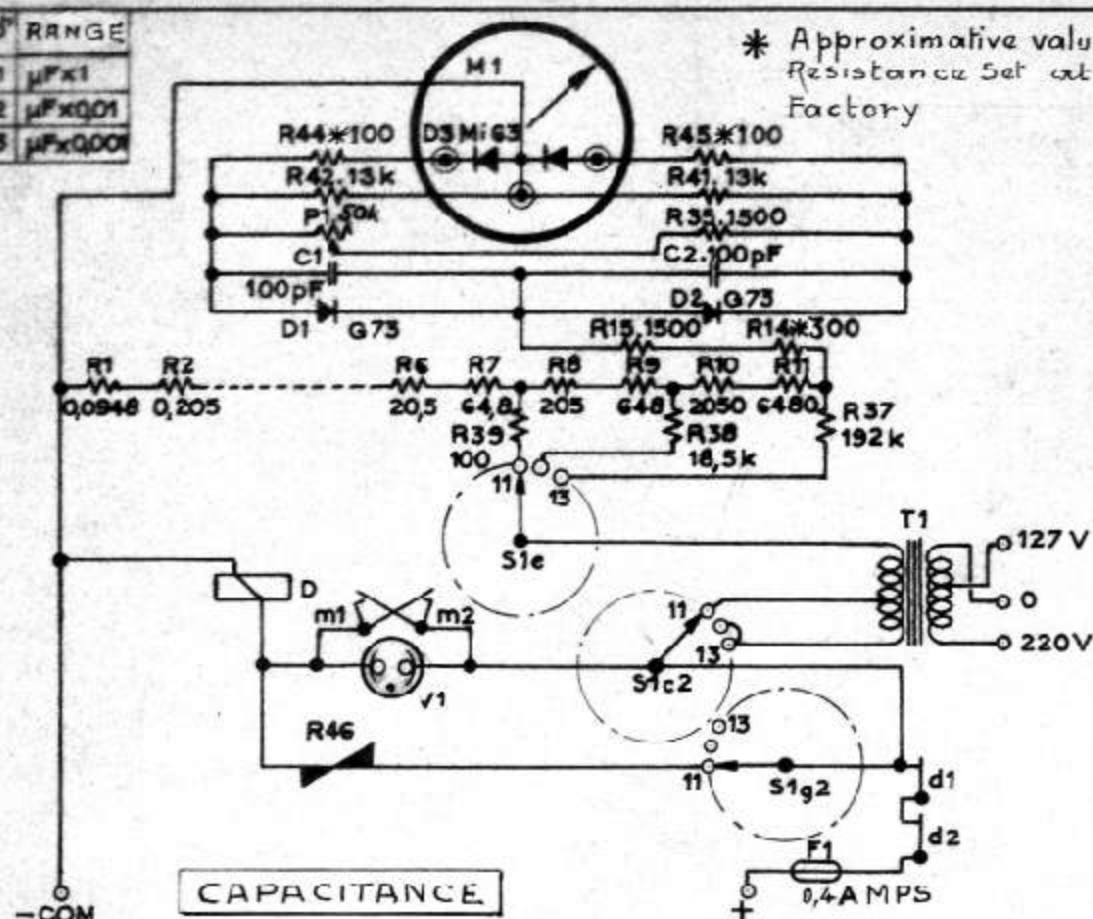
\* approx. value. Resistance Set at Factory



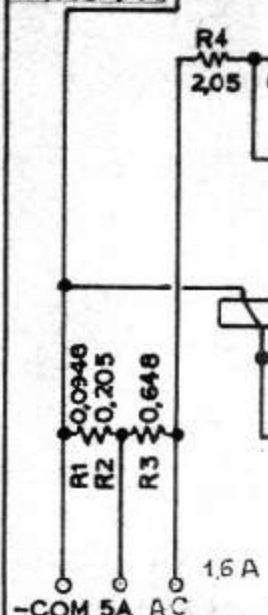
MULTIMETER TYPE 477-METRIX.  
COMPLETE SCHEMATIC DIAGRAM

| RANGE                   |
|-------------------------|
| 11 $\mu F \times 1$     |
| 12 $\mu F \times 0.01$  |
| 13 $\mu F \times 0.001$ |

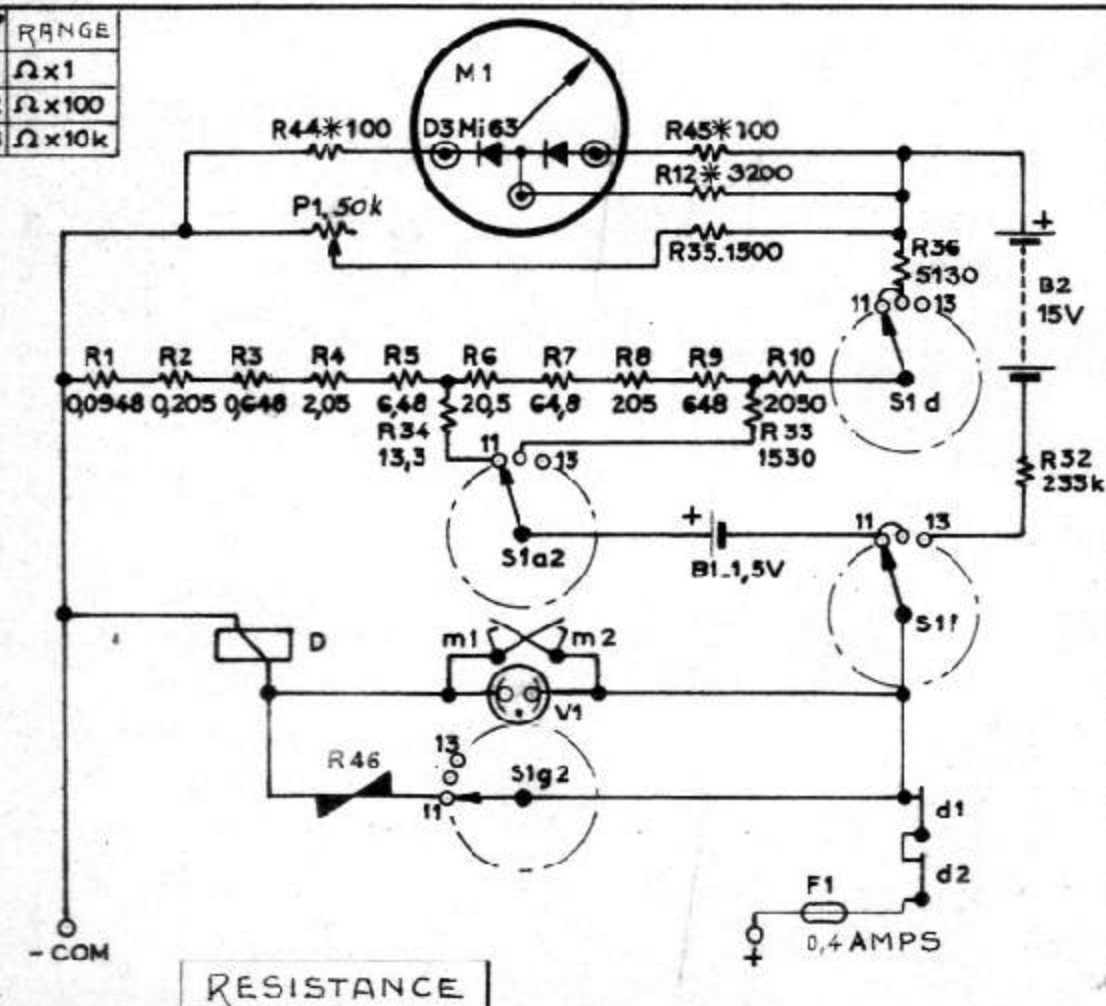
\* Approximative value  
Resistance Set at  
Factory



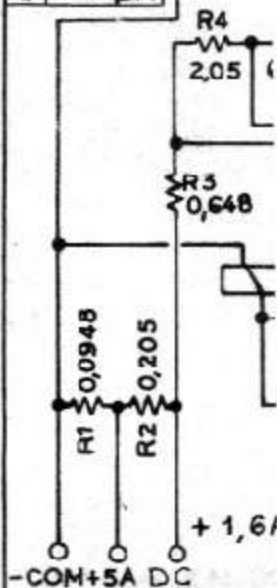
| RANGE         |
|---------------|
| 2 500 mA      |
| 3 160 mA      |
| 4 50 mA       |
| 5 16 mA       |
| 6 5 mA        |
| 7 1.6 mA      |
| 8 500 $\mu A$ |
| 9 160 $\mu A$ |



| RANGE                  |
|------------------------|
| 11 $\Omega \times 1$   |
| 12 $\Omega \times 100$ |
| 13 $\Omega \times 10k$ |

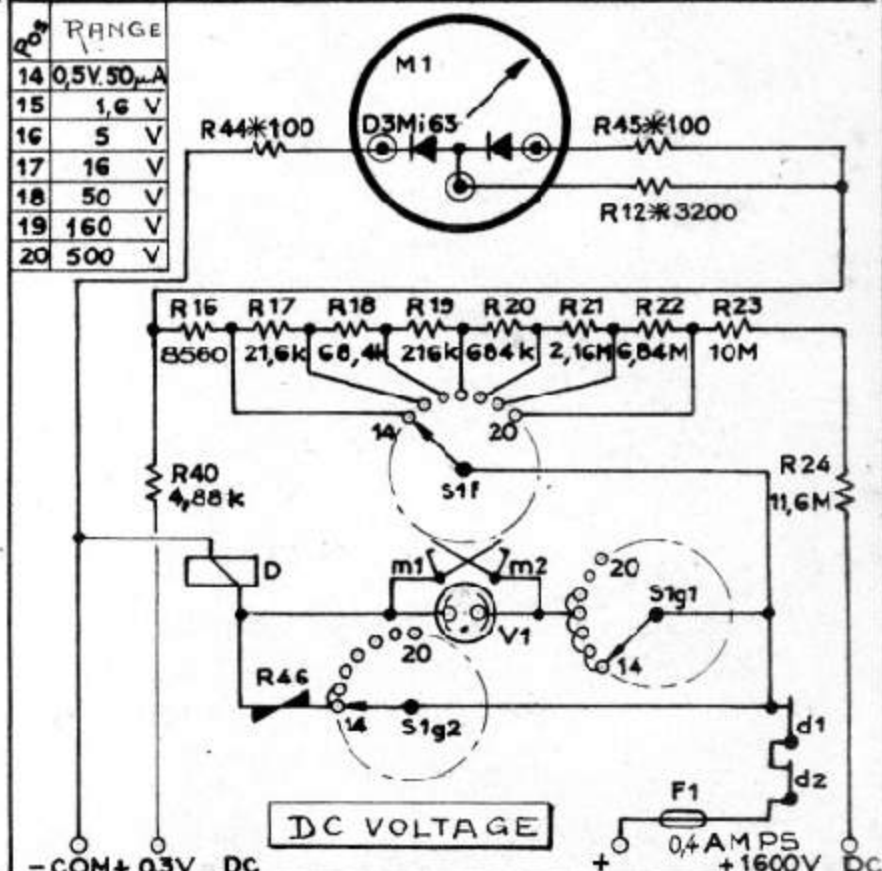
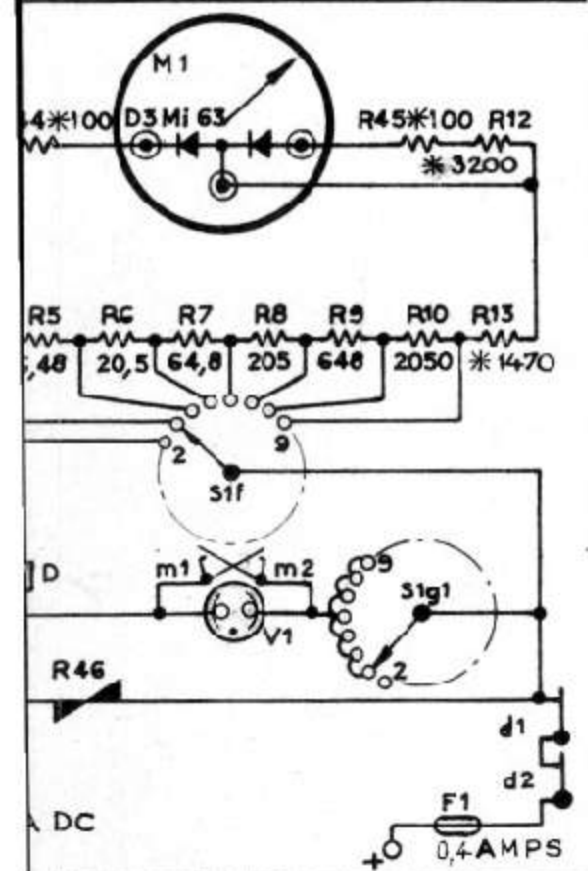
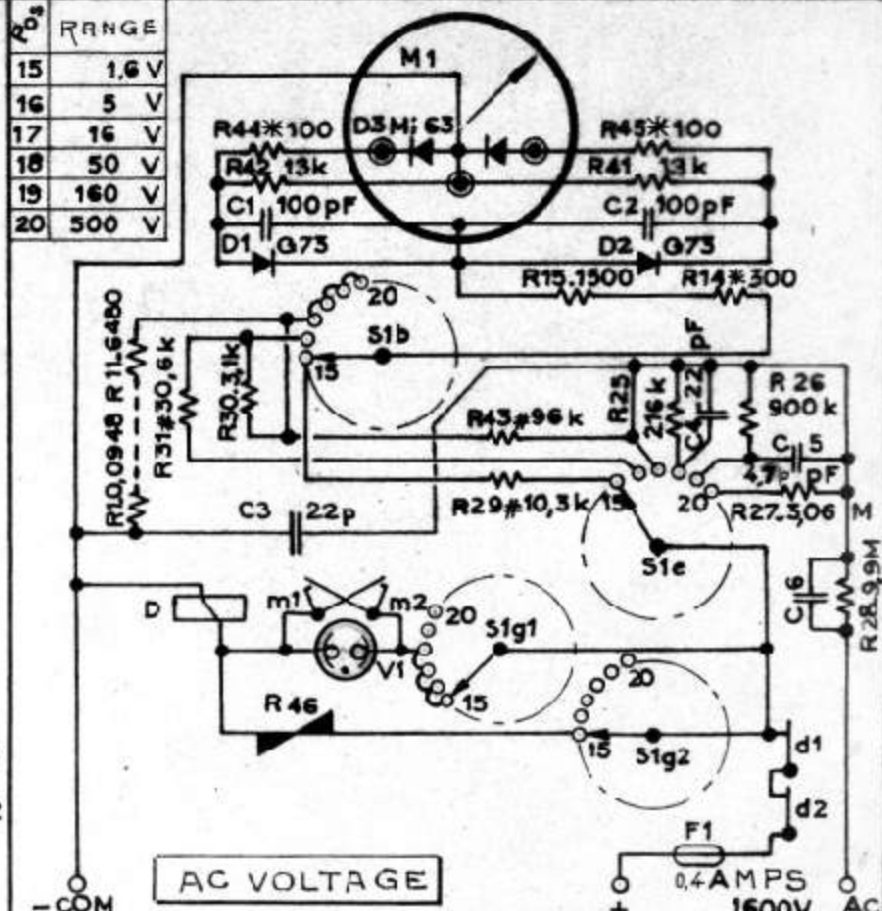
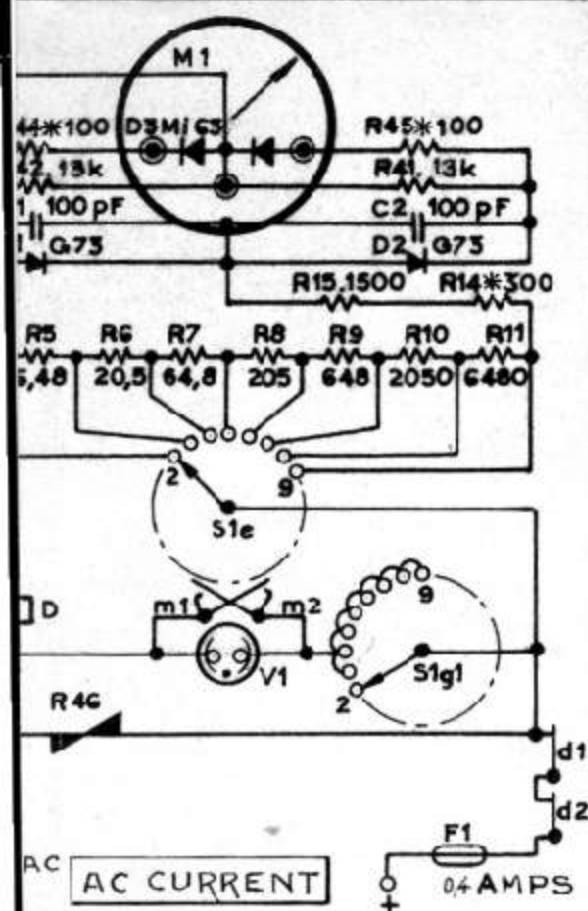


| RANGE         |
|---------------|
| 2 500 mA      |
| 3 160 mA      |
| 4 50 mA       |
| 5 16 mA       |
| 6 5 mA        |
| 7 1.6 mA      |
| 8 500 $\mu A$ |
| 9 160 $\mu A$ |



DC CURRENT





MULTIMETER TYPE 477 - METRIX  
BASIC CIRCUITS