# INSTRUCTION MANUAL

## FOR THE

## STARK

## MASTER CIRCUIT ANALYZER

### IMPORTANT NOTE PERTAINING TO STARK MODEL RP.

The War Departments of both Canada and the U.S.A. have just passed an order prohibiting the use of small 45 volt Batteries for other than hearing aids.

In order, therefore, to permit release of RP instruments now completed, we were forced to substitute with a standard 4½ volt Battery. We have, however, equipped the RP case with 2 pin jacks and a special set of connecting leads to permit instant connection of any 45 volts Battery supply whenever it is necessary to employ the R X 100 ohmmeter range, the only range on the instrument which will require the use of the external Battery hook-up.

When Batteries of various types are once more made available, we will of course revert immediately to our previous completely enclosed 45 volt Battery. We ask your indulgence in the meantime.

Nov. 1-1944

STARK ELECTRONIC INSTRUMENTS LIMITED

STARK

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TORONTO, CANADA

11901

1M-6-45

STARK ELECTRONIC INSTRUMENTS LIMITED manufacture a complete line of Electrical Indicating Meters, Tube Testers and Circuit Analyzers, in sizes and ranges to suit every purpose.

TUBE TESTERS are modern and up-to-date, accurate, and easily operated.

CIRCUIT ANALYZERS can be had in many designs from the handy pocket size to large de-luxe models. They cover an extremely wide range of all electrical measurements.

ELECTRICAL INDICATING METERS incorporated in Stark Tube Testers and Circuit Analyzers are completely manufactured in our own plants.

All meter needs for AC or DC voltage and current measurements, both Panel Mounting and Portable, can be supplied in five distinctive styles, in round or rectangular, from 2" to 9" sizes.

See inside back cover for further details.

## 1. GENERAL

The Stark Model RP Circuit Analyzer is a multi-range voltmeter, milliammeter and ohmmeter, covering a range of measurements proven most useful for the servicing and maintenance of radio and other electronic equipment.

## 2. GENERAL DESCRIPTION

2.1 CIRCUITS: The instrument provides a total of 17 ranges of measurement, which are as follows:

0 - 10 - 50 - 100 - 500 - 1000 Volts DC.
0 - 10 - 50 - 100 - 500 - 1000 Volts AC.
0 - 10 - 100 - 500 Milliamperes DC.
0 - 2000 ohms—30,000 ohms—300,000 ohms—3 megohms.

A desired range is chosen by the insertion of test leads in appropriate pin-jacks, and by the proper positioning of two switches on the panel. An additional adjustment is provided to compensate for changes in the voltage of the battery used in the ohmmeter circuits.

The circuit components are arranged in a manner which minimizes the possibility of breakdown or of errors due to wear or changes in the characteristics of components.

2.2 METER: The meter used in this instrument is completely manufactured in our own plant, and is especially designed for this service. It has a D'Arsonval type of movement, requiring one milliampere of current for full scale deflection. The accuracy of the meter is guaranteed to be within 2% of full scale deflection at any point on the scale.

2.3 RESISTORS: All critical resistors of 50,000 ohms or less are wire wound in our own plant, and are impregnated and annealed to assure stability against the effects of humidity and time. They are calibrated to a value within 1% of their designated value, and will maintain their accuracy indefinitely.

Where wire wound resistors are impractical, metallized resistors are used. They are completely sealed against the effects of humidity, and are only slightly affected by age or temperature.

2.4 RECTIFIER: This component is a high quality copper oxide unit, of the full wave type. It is capable of measuring voltage at frequencies as high as 1000 cycles per second with negligible error, and may be used as an indicator of voltage at any audio frequency. It can withstand current overloads of 500% for short periods without harmful effect.

2.5 OTHER COMPONENTS: The switches employed are the best obtainable for use in test instruments of this type. The contact resistance is extremely low, and the contacts themselves are well insulated and mounted on a thoroughly impregnated bakelite punching.

The potentiometer and other components are standard units with well-known characteristics, and have been proven well suited for use in test instruments.

## 3. CIRCUIT DESCRIPTION

3.1 D.C. VOLTAGE MEASUREMENT

3.11 CIRCUIT: Referring to Fig. 1, it will be seen that this circuit consists of Resistors R1 to R5, and the meter, and that connection is made to the meter and pinjacks through the AC - DC switch and the top deck of the selector switch, in the conventional series arrangement.

3.22 APPLICATION: The voltmeter circuit has a sensitivity of 1000 ohms per volt, which is ample for the majority of measurements, including measurements of grid bias and plate voltage, power supply voltage and battery voltage. In high resistance circuits, however, the loading effect of the voltmeter may result in an indicated voltage which is somewhat lower than the actual voltage after removal of the voltmeter from the circuit. This error can be neglected in many cases, or correction can be made when necessary by reference to Fig. 2 and the following formula:—

$$V1 = KV2.$$

where $V1$ = actual voltage across R2.

$V2$ = indicated voltage across R2.

$$K = 1 + \frac{R1 \quad R2}{R3\ (R1+R2)}$$

R1 + R2 = total resistance in series with voltage source.

R2 = portion of total resistance across which the measurement is to be taken.

R3 = resistance of voltmeter. Since the voltmeter sensitivity is 1000 ohms per volt, the voltmeter resistance on the 50 volt range, for instance, would be 50 x 1000 = 50,000 ohms.

## 3.2 AC VOLTAGE MEASUREMENT

3.21 CIRCUIT: Reference to Fig. 1 shows that this circuit is comprised of Resistors R12 to R17, the full wave rectifier, and the meter. Connections are made to the pinjacks and meter by means of the bottom deck of the selector switch, and the AC - DC switch. Resistor R17 across the output of the rectifier has a value which reduces the sensitivity of the circuit to a uniform level of 800 ohms per volt. R17 varies in value with the efficiency of the rectifier and in general is calibrated to each individual rectifier. Resistor R12 must also be individually calibrated, since its value depends on the effective resistance of the rectifier.

3.22 APPLICATION: The relatively high sensitivity of this circuit enables the operator to make accurate measurements of audio frequency amplifier gain, transformer turns ratio, etc., at any frequency in the range 25 - 1000 cycles per second, and to make comparative measurements at higher audio frequencies. The actual signal voltage can be traced step by step through the equipment under test, thus decreasing the time required for trouble shooting. The usual power transformer and line voltage measurements can also be made effectively with this circuit.

3.23 LIMITATIONS: The use of any rectifier of this type in voltage measurements introduces possible sources of error, which can be compensated for if they are understood and recognized.

All copper oxide rectifiers exhibit a change in effective resistance due to a change in temperature. This is equivalent to changing the total series resistance of the voltmeter circuit, and has its greatest effect where this series resistance is a minimum, since the variable resistance of the rectifier is then a considerable proportion of the total series resistance. For this reason the possible error on the 10 volt range, due to temperature change alone, is several times as great as the error on the remaining ranges.

This type of rectifier is also subject to errors if the wave form of the voltage under test is not sinusoidal. As examples of the error to be expected for serious distortion of the waveform, the following may be cited. If the voltage wave contains a 50% second harmonic, the error may be in the range 0 to 10 percent, and if it contains a 50% third harmonic the error may be — 10 to + 16 percent, the actual error depending on the relative phase of the harmonic and fundamental waves. In general, such acute distortion is not experienced and the error will thus be proportionately less.

## 3.3 DIRECT CURRENT MEASUREMENT

3.31 CIRCUIT: For current measurements, a ring type shunt is used. This is shown as Resistors R9 to R11, Fig. 1. Connections are completed to the meter and pinjacks through the AC - DC switch and both decks of the selector switch. In this type of shunt the resistors are permanently soldered together and connections are made in such a manner that variations in switch contact resistance, or poor connections at the pinjacks, do not materially affect the accuracy of the circuit.

3.32 APPLICATION: This circuit provides sufficient range for the majority of current measurements required in radio and allied equipment. Determination of plate and screen currents, filament current, and others which will suggest themselves to the operator, can readily be made.

## 3.4 RESISTANCE MEASUREMENTS

3.41 CIRCUIT: As may be seen from Fig. 1, the circuit used for this function is comprised of Resistors R6 to R8, the potentiometer R18, the battery B, and the meter. Connections are made to the meter and pinjacks through the AC - DC switch and the top deck of the selector switch.

A typical circuit, the "R x 10" range for example, includes the meter, the potentiometer R18, the battery B, and the resistor R7, connected in series with the pinjacks. When the pinjacks are short circuited, the current flowing through this circuit is limited by Resistor R7 to approximately one milliampere, and is adjusted by rotation of R18 to exactly one milliampere as indicated by full scale deflection of the meter. If, then, the short circuit is removed and replaced by a resistance, the meter deflection will be somewhat less than full scale due to the added resistance in the circuit. The scale of the meter is calibrated in terms of this added resistance.

To obtain a lower resistance range (The "R" range) the meter sensitivity is reduced to 10 milliamperes full scale by connecting across it the 10 milliampere shunt used in current measurements. This reduces the range of measurement by a factor of 10. For an increased range of measurement (The "R x 100" range) the meter sensitivity of one milliampere full scale is retained, but the battery voltage is increased from 4.5 to 45 volts, thus increasing the range by a factor of 10.

For the measurement of resistances lower than provided for in the "R", "R x 10" and "R x 100" ranges, the "R x 10" circuit is arranged in a slightly different manner. The short circuit, formerly performed manually, is provided automatically in the instrument by setting the selector switch in the "LOW OHMS" position, and the pinjacks are then connected to the two meter terminals. The unkown resistance connected to the pinjacks is thus in parallel with the meter, and the current flowing in the circuit is divided between the meter and the unknown resistor in inverse proportion to their resistances, causing a reduction in the deflection of the meter. A separate scale is provided for this range, calibrated in terms of the unknown resistance.

3.42 APPLICATION: The lowest resistance which can be conveniently measured with this instrument is 2 ohms, while the highest resistance marked on the scale is 3 megohms. This range permits the operator to determine the resistance of many communication equipment components, including the majority of resistors commonly encountered, radio and audio frequency coils, transformers, and loudspeaker voice and field coils. In addition this circuit may be used for conventional continuity testing.

The circuit depends for its accuracy upon the battery voltage, and upon the accuracy of the meter. However, the accuracy of measurement is also affected by the care with which the preliminary adjustment to full scale deflection is made, and by the accuracy with which the meter is first set at its zero deflection position.

## 4. BATTERY REPLACEMENT

4.1 BATTERIES: The battery required for the Model RP Analyzer is a General Dry Battery Co. Type V-30-AAA, which is specially constructed

for this instrument. It may be replaced by a General Dry Battery Co. Type V-30-AA, or any two batteries, one of which will provide 4.5 volts and the other 45 volts. In the latter case the negative terminals of the two batteries must be connected together.

4.2 REPLACEMENT: The battery should be replaced only when it is no longer possible to obtain a proper adjustment of the "ZERO OHMS" knob as described in paragraph 5.41(d) and 5.42(c).

To replace the battery, remove the four corner screws in the panel, and lift the instrument out of the cabinet. The battery can then be removed from its bracket without difficulty. In replacing with a new battery, correct polarity must be observed.

If it is required to mount the battery externally, a small hole may be drilled in one side of the cabinet and the three battery leads passed through this hole before connecting to the instrument.

## 5. OPERATING INSTRUCTIONS

### 5.1 DC VOLTAGE MEASUREMENT

See paragraphs 3.11 and 3.12.

Range 0 - 10 - 50 - 100 - 500 - 1000 volts.

Sensitivity 1000 ohms per volt.

(a) Set AC - DC switch in "DC" position.

(b) Set selector switch on suitable voltage range. If in doubt as to magnitude of voltage to be measured, set in "1000 V" position.

(c) Insert test leads in pair of pinjacks marked "DC VOLTS - OHMS - MA" with red lead in "+" pinjack.

(d) Connect test prods to voltage source under test, with red prod on positive terminal.

(e) Read voltage on meter scale marked "VOLTS AND D.C. MA."

## 5.2 AC VOLTAGE MEASUREMENT

See paragraphs 3.21, 3.22 and 3.23.
Range 0 - 10 - 50 - 100 - 500 - 1000 volts.
Sensitivity 800 ohms per volt.

(a) Set AC - DC Switch in "AC" position.

(b) Set Selector Switch on suitable voltage range. If in doubt as to magnitude of voltage to be measured, set in "1000 V" position.

(c) Insert test leads in pair of pinjacks marked "AC VOLTS ONLY".

(d) Connect test prods to voltage source under test.

(e) Read voltage on meter scale marked "10 A.C.V. ONLY", if Selector Switch is in "10 V" position, or on scale marked "VOLTS AND D.C. MA." if Selector Switch is in any other voltage position.

## 5.3 DIRECT CURRENT MEASUREMENT

See paragraphs 3.31 and 3.32.
Range 0 - 10 - 100 - 500 Milliamperes.

(a) Set AC - DC Switch in "DC" position.

(b) Set Selector Switch on suitable current range. If in doubt as to magnitude of current to be measured, set in "500 MA" position.

(c) Insert test leads in pair of pinjacks marked "DC VOLTS - OHMS - MA", with red lead in "+" pinjack.

(d) Connect test prods in series with circuit in which current is to be measured, with red prod on positive terminal.

(e) Read current in milliamperes on meter scale marked "VOLTS AND D.C. MA."

## 5.4 RESISTANCE MEASUREMENT

### 5.41 HIGH RESISTANCE MEASUREMENT

See paragraphs 3.41, 3.42 and 4.2.
Range 0 - 30,000 ohms - 300,000 ohms - 3 megohms, designated "R", "R x 10" and "R x 100" respectively.

(a) Set AC - DC Switch in "DC" position.

(b) Set Selector Switch on suitable "R" range.

(c) Insert test leads in pair of pinjacks marked "D.C. VOLTS - OHMS - MA."

(d) Connect free ends of test prods together, causing meter needle to deflect, then adjust knob marked "ZERO OHMS" until meter reads exactly full scale (zero ohms on scale marked "HI OHMS"). If another range is used the "ZERO OHMS" knob must be re-adjusted.

(e) Connect test prods to resistance to be measured.

(f) Read value of resistance on meter scale marked "HI OHMS", and multiply this reading by the factor indicated at the Selector Switch to obtain the actual resistance value in ohms. For example, if the meter indication is 300 ohms, and the Selector Switch is in the "R x 10" position, the actual resistance is 300 x 10 = 3000 ohms.

## 5.42 LOW RESISTANCE MEASUREMENT

See paragraphs 3.41, 3.42, and 4.2.

Range 0 - 2000 ohms.

(a) Set AC - DC Switch in "DC" position.

(b) Set Selector Switch in "LOW OHMS" position. This automatically causes meter needle to deflect.

(c) Adjust knob marked "ZERO OHMS" until meter reads exactly full scale.

(d) Insert test leads in pinjacks marked "D.C. VOLTS - OHMS - MA".

(e) Connect test prods to resistance under test.

(f) Read resistance value directly on meter scale marked "LO OHMS". No multiplication is required, as this scale is direct reading.

CAUTION: Do not leave Selector Switch in "LOW OHMS" position when instrument is not in use.

## MAJOR PARTS LIST

| Description | Part No. |
|---|---|
| Battery, General Dry Battery Co. No. V-30-AAA or equivalent | 101B7 |
| Battery bracket, mounting | 104A8 |
| Battery plug, for connections | 133A1 |
| Cabinet | 107A11 |
| Knob, 1¼" pointer | 121B1 |
| Knob, ¾" round | 121B2 |
| Manual, instruction | 119O1 |
| Meter, complete | M3571 |
| Panel | 128A12 |
| Pinjack, black | 132A2 |
| Pinjack, red | 132B2 |
| Potentiometer | 134A12 |
| Rectifier | 138A8 |
| Resistor, .222 ohm, spool | R11 |
| Resistor, .888 ohm, spool | R10 |
| Resistor, 10 ohms, spool | R9 |
| Resistor, 200 ohms, spool | R6 |
| Resistor, 4200 ohms, spool | R7 |
| Resistor, 9900 ohms, spool | R1 |
| Resistor, 32,000 ohms, spool | R13 |
| Resistor, 40,000 ohms, spool | R2 or R 14 |
| Resistor, 45,000 ohms, spool | R8 |
| Resistor, 50,000 ohms, spool | R3 |
| Resistor, 320,000 ohms, metallized | R15 |
| Resistor, 400,000 ohms, metallized | R4 or R16 |
| Resistor, 500,000 ohms, metallized | R5 |

| | |
|---|---|
| Resistor, calibration, spool | R12 |
| Resistor, calibration, spool | R17 |
| Sub-panel, for resistors | 115P2 |
| Switch, 2 position, single deck | 144C3 |
| Switch, 12 position, 2 deck | 144A4 |
| Test lead set, complete | 151B1 |

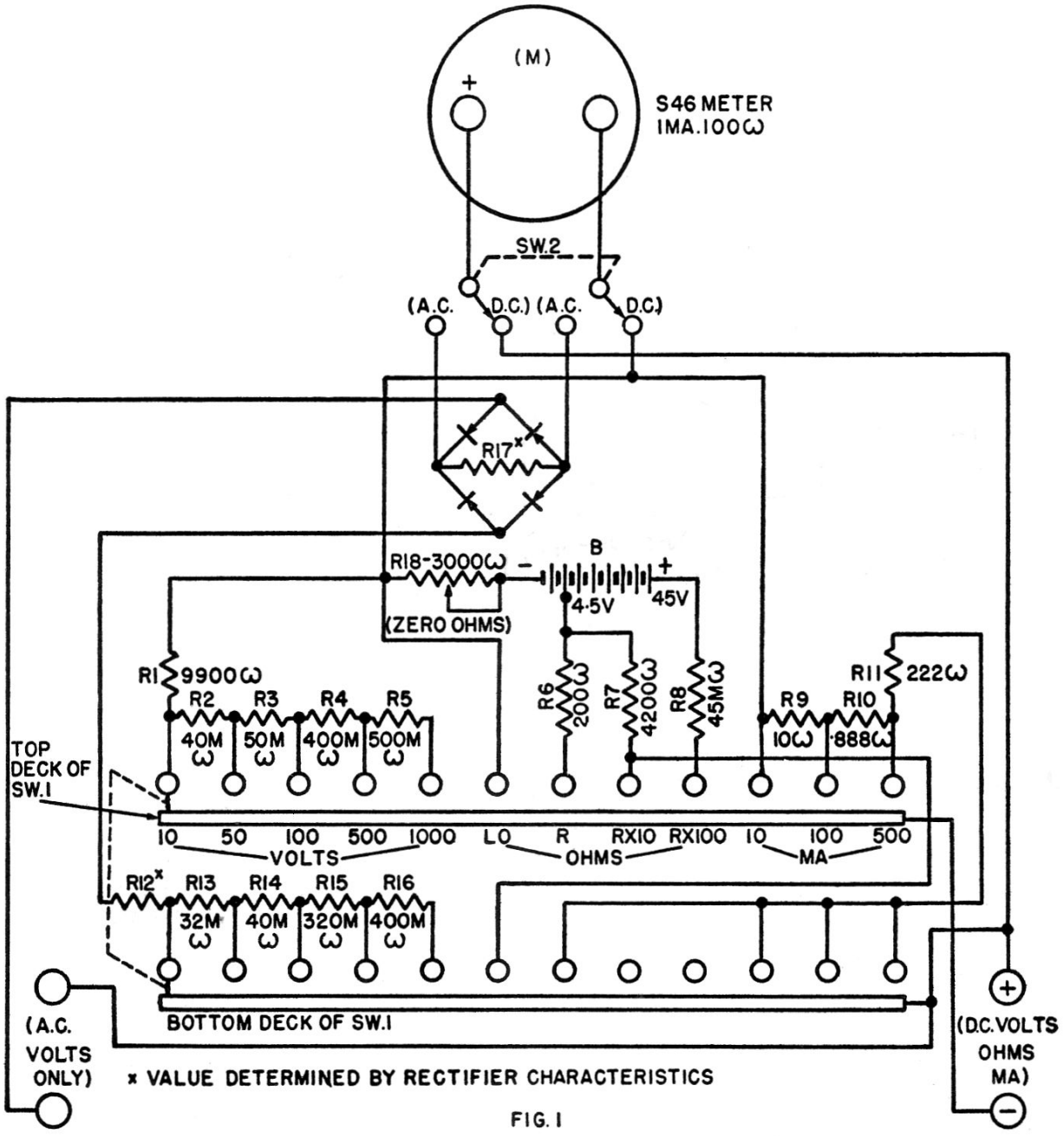
(M)
+
S46 METER
1MA.100Ω
SW.2
(A.C.
D.C.) (A.C.
D.C.)
R17*
R18-3000Ω
B
4.5V
45V
(ZERO OHMS)
R1 9900Ω
R2
R3
R4
R5
40MΩ
50MΩ
400MΩ
500MΩ
R6 200Ω
R7 4200Ω
R8 45MΩ
R9 10Ω
R10 .888Ω
R11 222Ω
TOP DECK OF SW.1
10 50 100 500 1000 VOLTS
LO R RX10 RX100 OHMS
10 100 500 MA
R12*
R13
R14
R15
R16
32MΩ
40MΩ
320MΩ
400MΩ
BOTTOM DECK OF SW.1
(A.C. VOLTS ONLY)
(D.C. VOLTS OHMS MA)
* VALUE DETERMINED BY RECTIFIER CHARACTERISTICS

FIG. 1

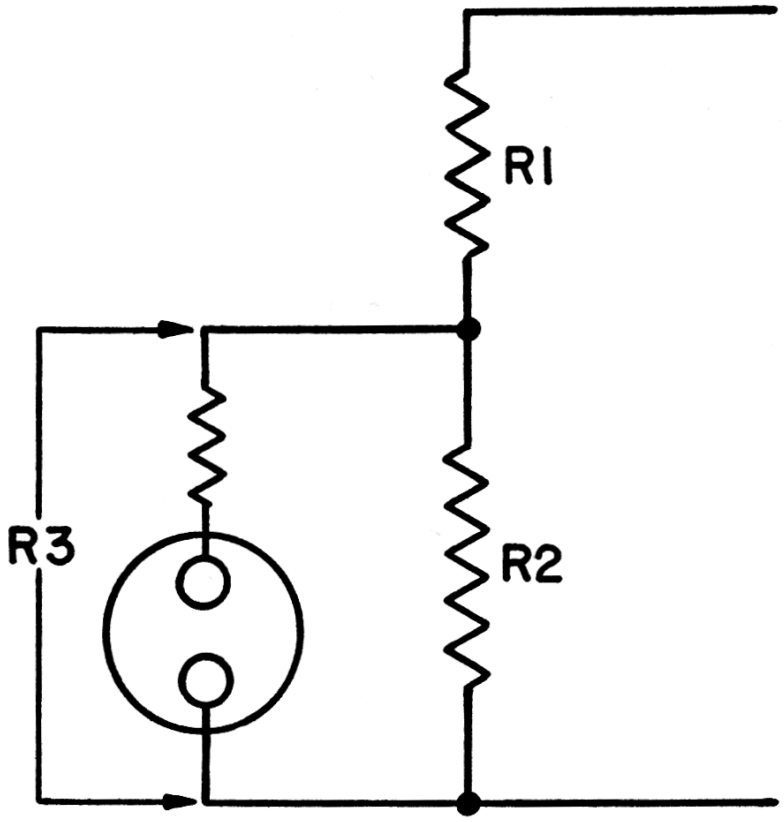


FIG.2

## STARK TUBE TESTERS:

(PACKED)

Model 9-11—Approx. 10½"x 9"x5"— 9 lbs.
Model 9-55—Approx. 13½"x12"x5"—11 lbs.
*Model 9-44—Approx. 10½"x 9"x5"— 9 lbs.
*Model SY —Approx. 10½"x 9"x5"— 9 lbs.

*SELF POWERED - INDEPENDENT OF EXTERNAL POWER SUPPLY.

Model SY also provides DC Voltage Range 0-10-300 and Ohms 0-100,000-1 Meg.

## STARK ANALYZERS:

(PACKED)

DC 1,000 Ohms per Volt.
Model AF-2 —Approx. 6½"x3¼"x3½"—1½ lbs.

AC & DC 1,000 Ohms per Volt.
Model RP —Approx. 8¾"x3¼"x5¾"—3½ lbs.

AC & DC 20,000 Ohms per Volt.
Model KM —Approx. 15"x 10"x 5"—10 lbs.

AC & DC 400 or 1,000 Ohms per Volt.
Model ND-3—Approx. 5"x5½"x5½"—3½ lbs.