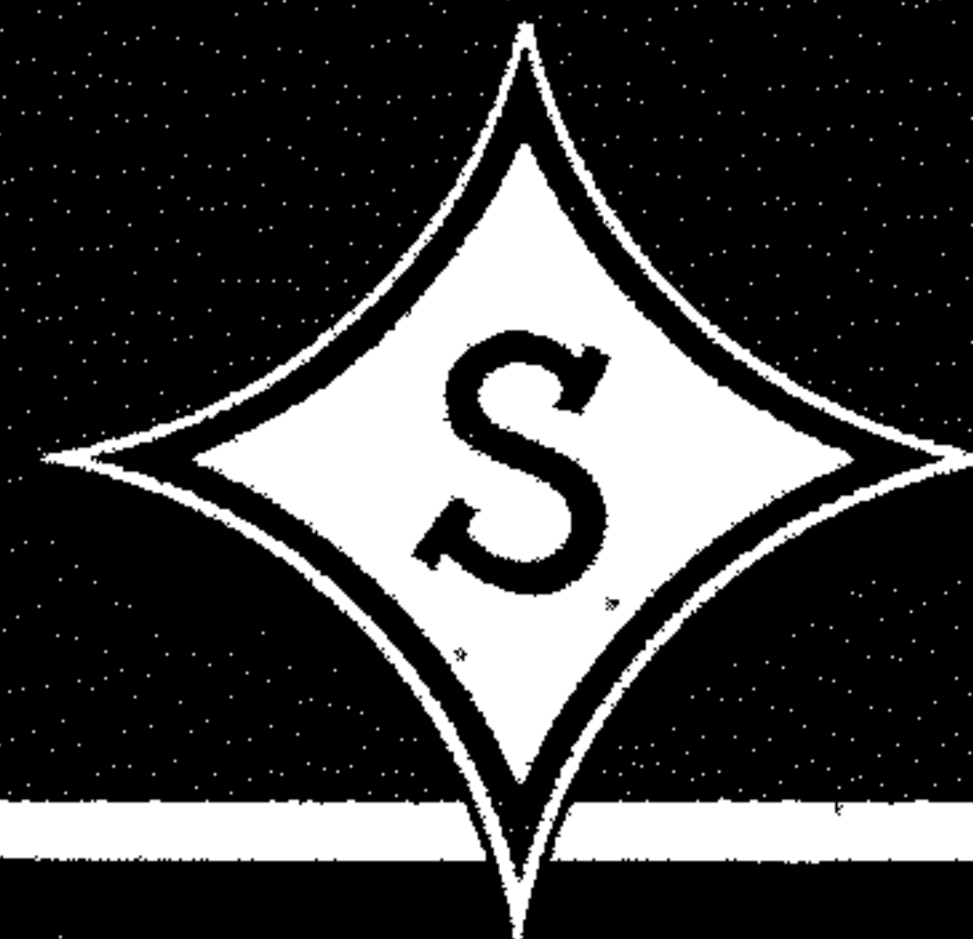


# *Sensitive Research*



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**ELECTRICAL  
INSTRUMENT  
SERVICE**

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# Sensitive Research\*

INSTRUMENTS

## ELECTRICAL MEASURING STANDARDS

CATALOG 76

Since 1927, *Sensitive Research* engineers have established and maintained a tradition for designing and producing dependable high accuracy electrical measuring instruments. The product line today, ranges from portable and panel type indicating instruments to the most sophisticated laboratory standards. Calibration of all *Sensitive Research* instruments is traceable to the National Bureau of Standards where applicable.



### Panel Meters/Portable Instruments

- AC/DC PANEL INSTRUMENTS . . . . . 2  
MODELS: EW5A-EW7A-JW4A-NP-UPP
- AC/DC POLYRANGERS . . . . . 2-3  
MODELS: U88- USP- U-SP  
A-UVA-WVA
- AC/DC THERMOCOUPLE INSTRUMENTS . . . . . 4  
MODELS: A-AU-RF-UNIVERSITY
- AC/DC WATTMETERS . . . . . 4-5  
MODELS: PDW-PDLW-VAW-DW  
DLW-UNIVERSITY
- AC/DC VOLTMETERS & AMMETERS . . . . . 5  
MODELS: C-S-HS-N-UNIVERSITY  
D-MI-UNIVERSITY
- MAGNETIC TESTING INSTRUMENTS . . . . . 6  
MODELS: MAT-EPS-MU-COL-FM  
FS-FC-FCM-FLV-FLVC
- HIGH VOLTAGE MEASUREMENT . . . . . 7  
MODELS: ESD- UNIVERSITY-ESH  
CRV-VPA-DCHI-PARK
- INSTRUMENT ACCESSORIES . . . . . 8  
MODELS: T-MUL-TR-SH-STC



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**ELECTRICAL INSTRUMENT SERVICE, INC.**

25 Dock Street, Mount Vernon, N.Y. 10550

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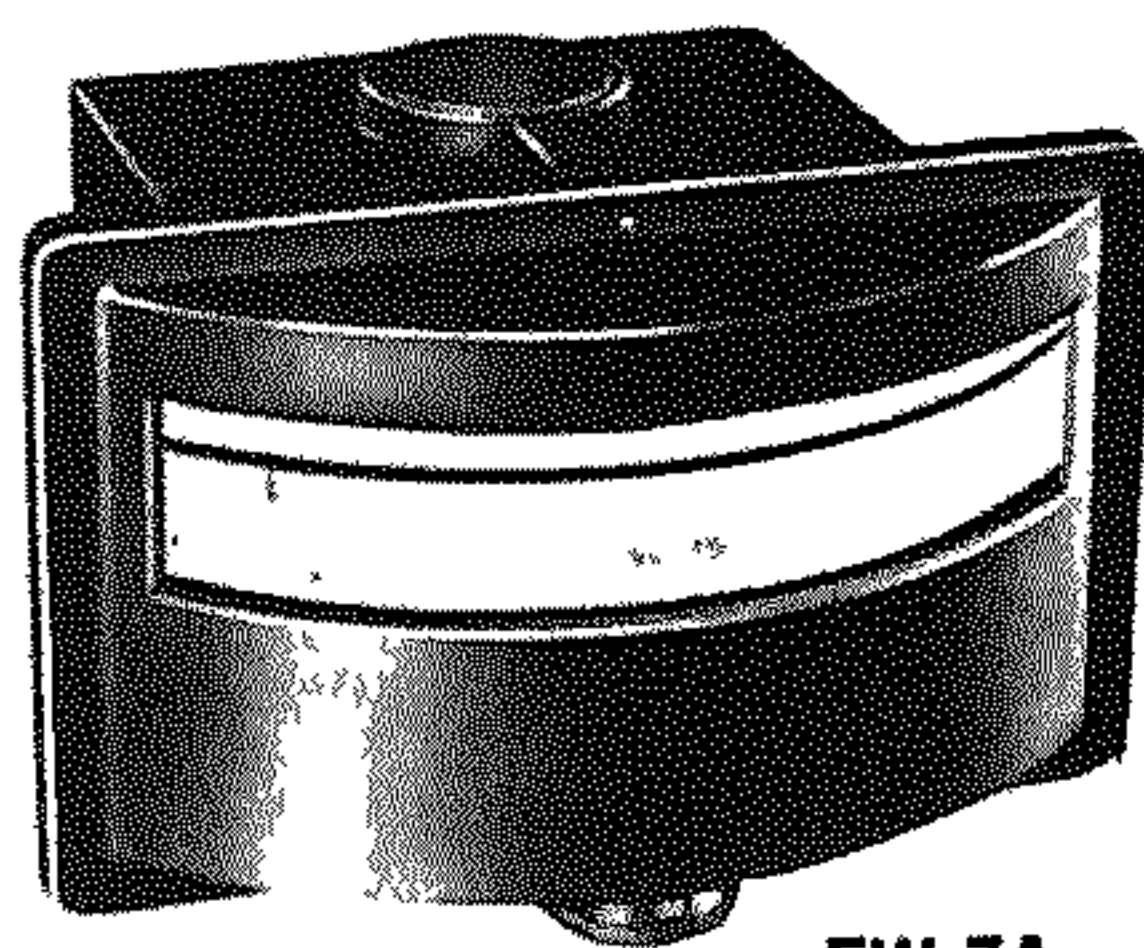




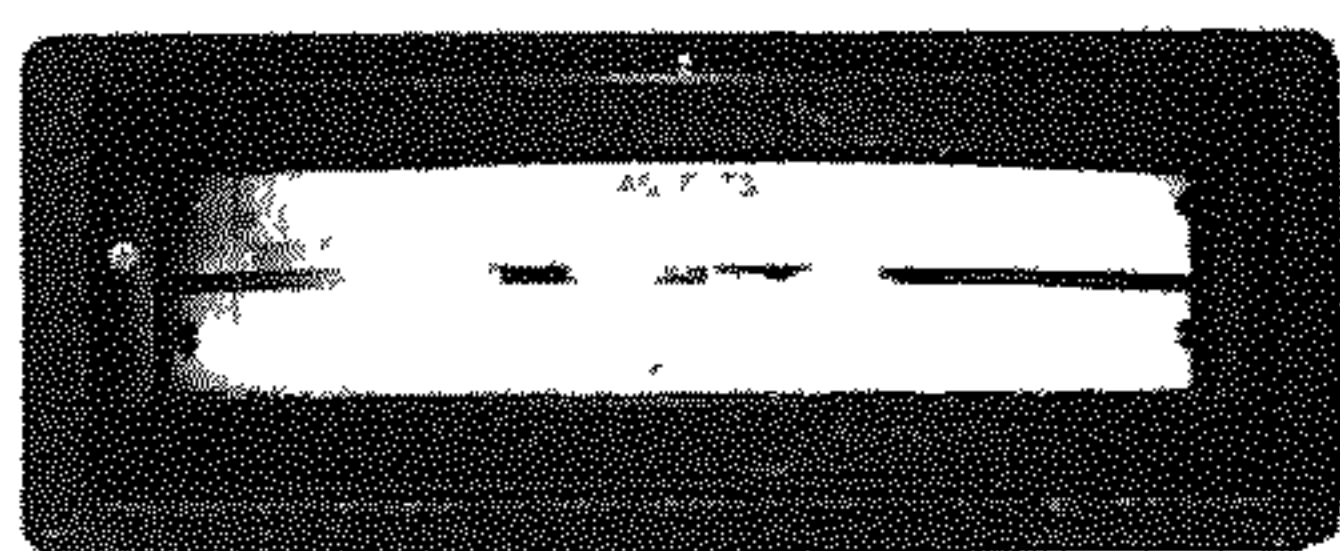
# Sensitive Research\*

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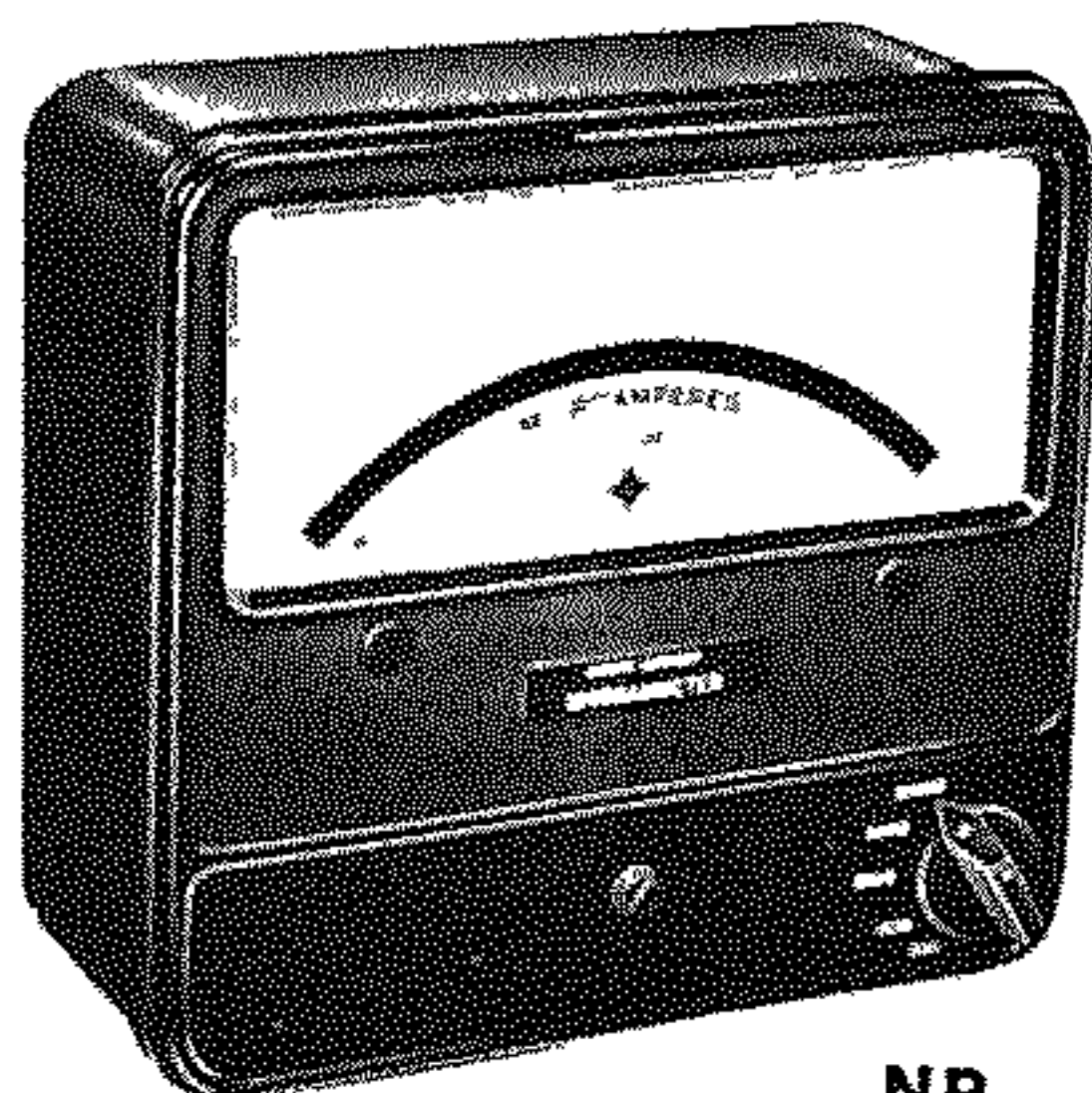
## PANEL METERS AND AC-DC POLYRANGER\* INSTRUMENTS



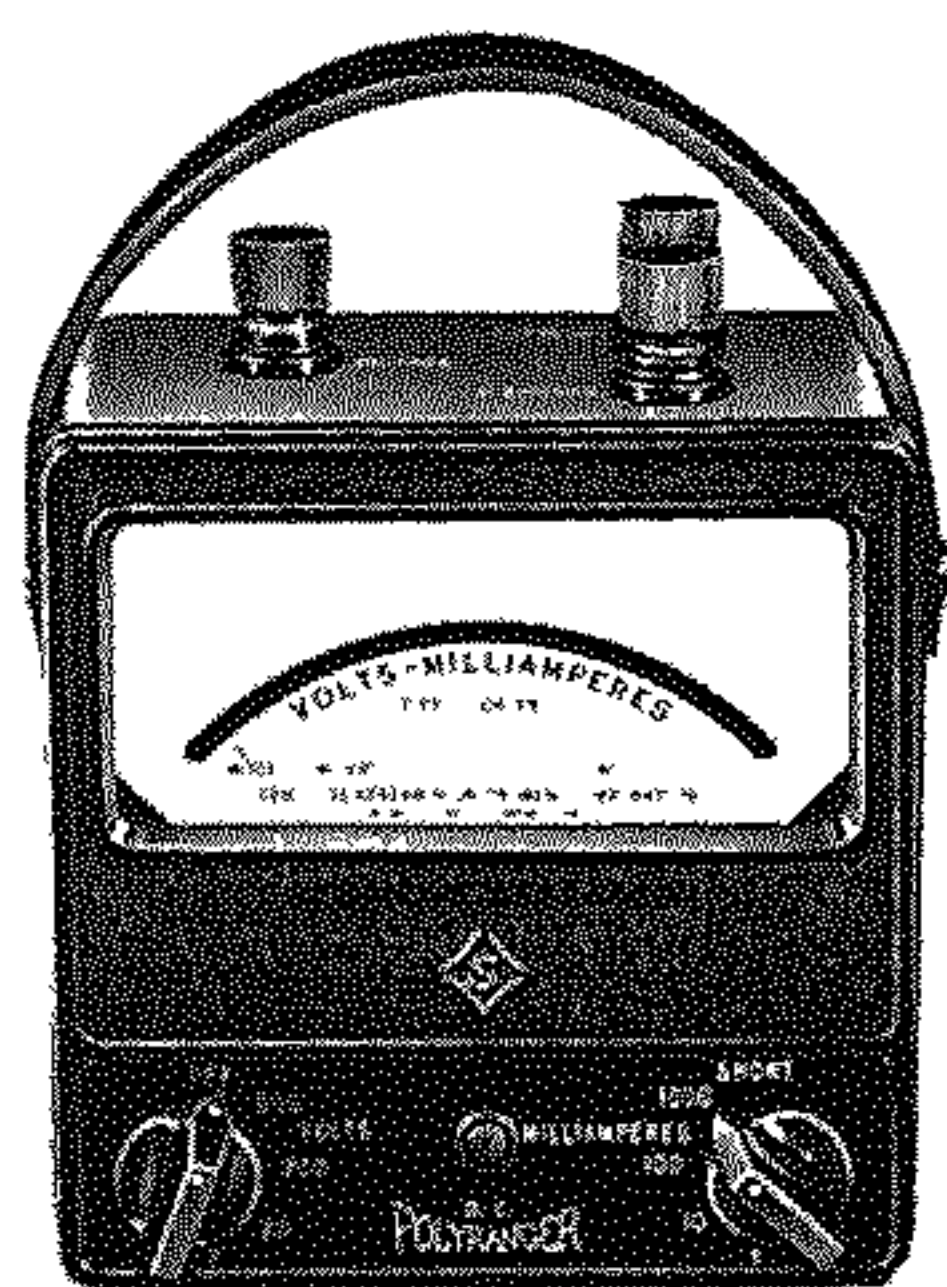
EW-7A



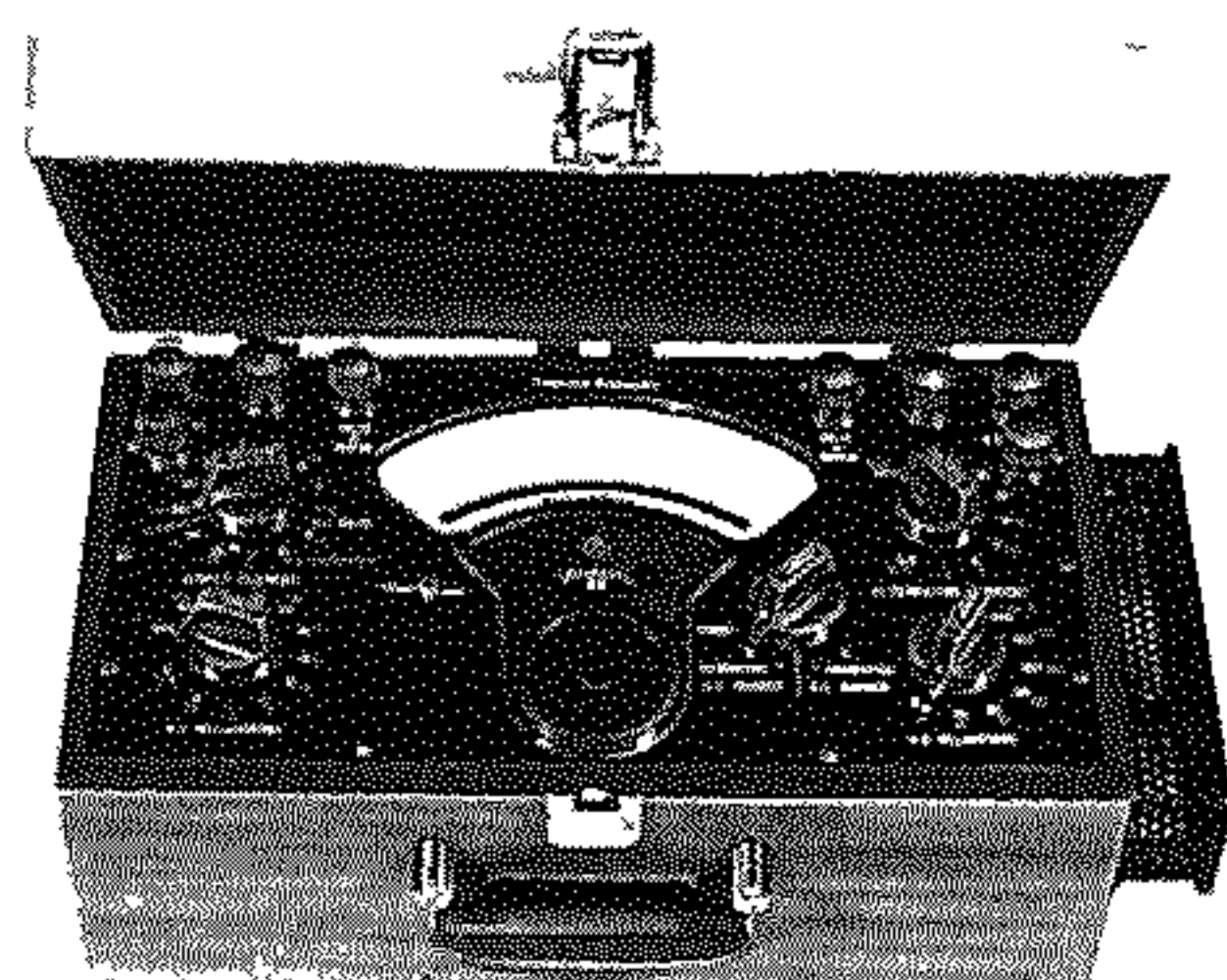
JW-4A



NP



University



U88

### Precision Electrical Measurements

This catalog digest outlines only part of the Sensitive Research measurement capability. A capability that includes AC and DC instruments with ranges from 1 microvolt to 100,000 volts, a wide range of current measuring and calibrating equipment at frequencies up to 1 GC/s.

Detailed specifications on all of these instruments are available from our Sales Representatives whose address is shown on the rear page; they will be happy to assist you in any of your measurement application problems.

Sensitive Research AC and DC panel instruments are precision portables adapted for panel mounting. They are available as flat faced rectangular and curved scale edgewise types. With minor variations, construction is identical to their counterpart bench models, and in the case of edgewise panel instruments this also applies to critical performance characteristics. In general all panel instruments conform to ASAC-39.1 and MIL-M-16034B, where applicable. Special scales, pointers and calibrations are available.

### AC - DC Edgewise Panel Instruments

All Sensitive Research precision portable instruments (with the exception of Models N and University) can be furnished in the Type EW-5A (5" scale length) and EW-7A (7" scale length) edgewise aluminum cases for vertical panel mounting. Poly Ranger models and other instruments, where the number of ranges or design demand more space, are furnished on a standard 19" rack panel with the basic indicator in an EW case.

EW cases for the mounting of electro-dynamometers differ from the schematic in that they are 4 $\frac{1}{16}$ " deep. Any portable installed in an edgewise case derives its nomenclature by adding the case type number to the model letter (example: Model C in an EW-7A case becomes Model CEW-7A).

Model JW-4A is a  $\pm 0.5\%$  accurate, low cost, compact edgewise panel instrument available with up to 3 self contained ranges from 2  $\mu$ a and 2 mv. DC fs. (5000 ohms/v). 4" scale length. Model JDJW-4A is a differential instrument in a JW-4A case.

### DC Rectangular Panel Instruments

Model NP is a  $\pm 0.5\%$  accurate rectangular panel instrument with a 6.1" scale length and up to 5 switch controlled ranges in various combs. from 200  $\mu$ a and 50 mv fs. Sensitivities to 5000 ohms/v. Model UPP is a  $\pm 0.5\%$  compact, lower cost panel instrument similar in performance to the Model NP. 4" scale length.

Poly Ranger instruments are offered as permanent magnet, moving coil instruments for use on DC, transformer-coupled moving irons and electro-dynamometers for measuring AC at standard power frequencies, and thermocouple instruments for AC/DC applications necessitating a relatively flat frequency response up to 15 Kc/s. Thermocouple instruments use a permanent magnet, double pivoted moving coil as their basic indicator.

Poly Ranger instrument designs combine reliable electromechanical indicators and newer electronic components that enable such features as self checking, automatic temperature compensation, overload protection and scale expansion. Accuracies are as high as  $\pm 0.25\%$  fs. All Poly Ranger instruments have diamond pivots and sapphire spring mounted jewels to give a virtually friction-free moving element that will withstand the severest operating conditions. Vertically mounted models can be supplied in a 19" x 7" x  $\frac{5}{16}$ " rack panel to the same performance specifications as portable models. The basic indicator is housed in an edgewise panel case.

### Thermocouple Poly Ranger\* Instruments

Sensitive Research thermocouples have excellent AC/DC transfer characteristics (low reversal). Consequently, the accuracy specification of the thermal side of a Poly Ranger instrument is the same for both AC and DC. They can be calibrated directly on DC and only their AC/DC difference, or frequency influence, has to be checked by AC transfer methods.

Models UX, U88, USP, and U-SP have two measuring circuits; one, for AC/DC use, includes the thermocouple, the other, for DC use only, bypasses the thermocouple. Because the primary application of a thermocouple is for AC measurements, the AC/DC circuit is referred to herein as the "AC side."

A thermocouple replacement feature (TRF), Type 357 or 362, allows for the field replacement of overloaded thermocouples with the retention of full instrument accuracy. Type 357 replacement thermocouples are furnished with two calibrated fixed resistors which must be soldered into place by the user; Type 362 thermocouples are furnished with a variable sensitivity resistor (to adjust full scale deflection of the instrument for maximum scale linearity) and replacement is by "plug-in."

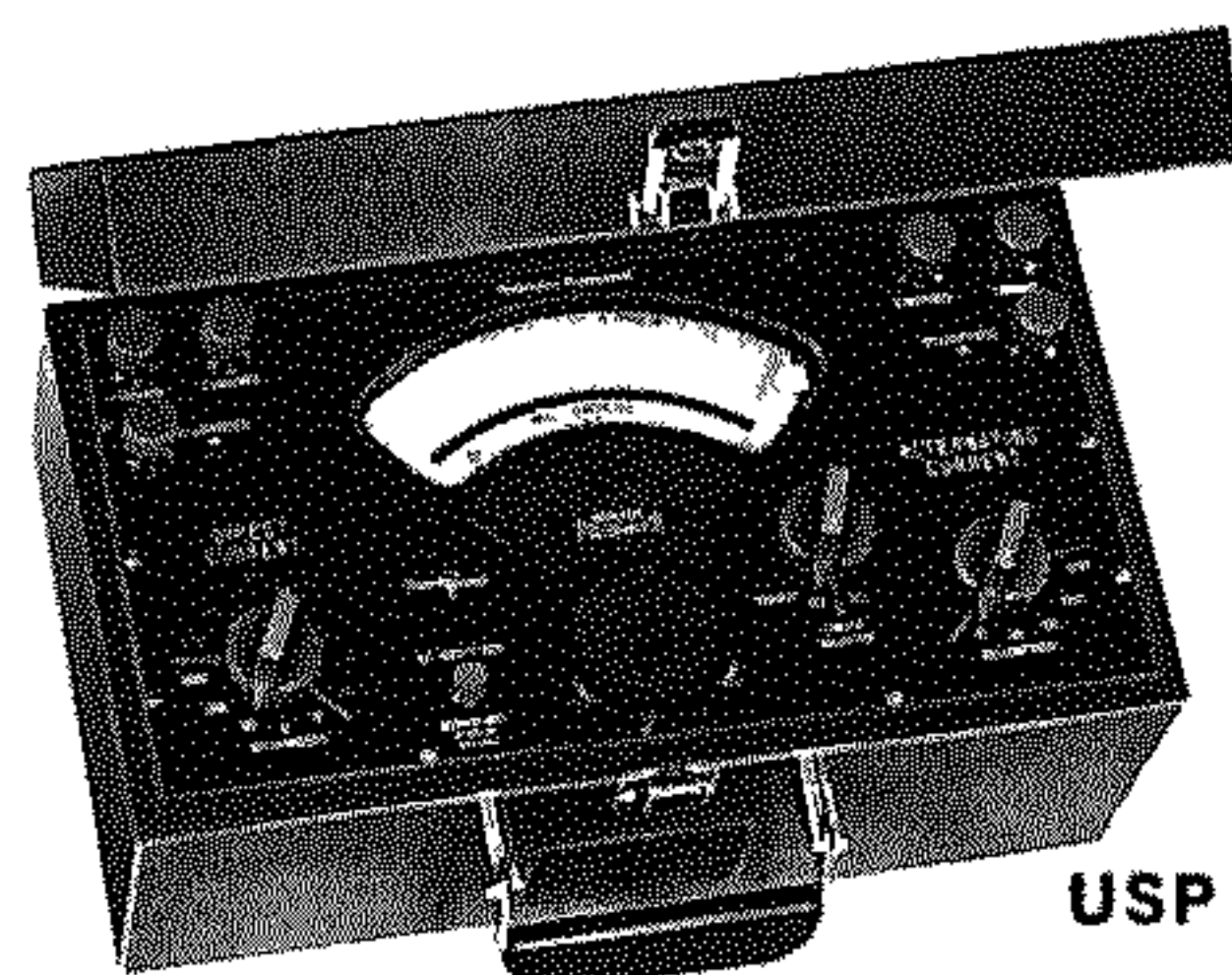
**SENSITIVE RESEARCH PRODUCTS — Mfd. by ELECTRICAL INSTRUMENT SERVICE, INC.**



# AC-DC POLYRANGER\* INSTRUMENTS

## Sensitive Research\*

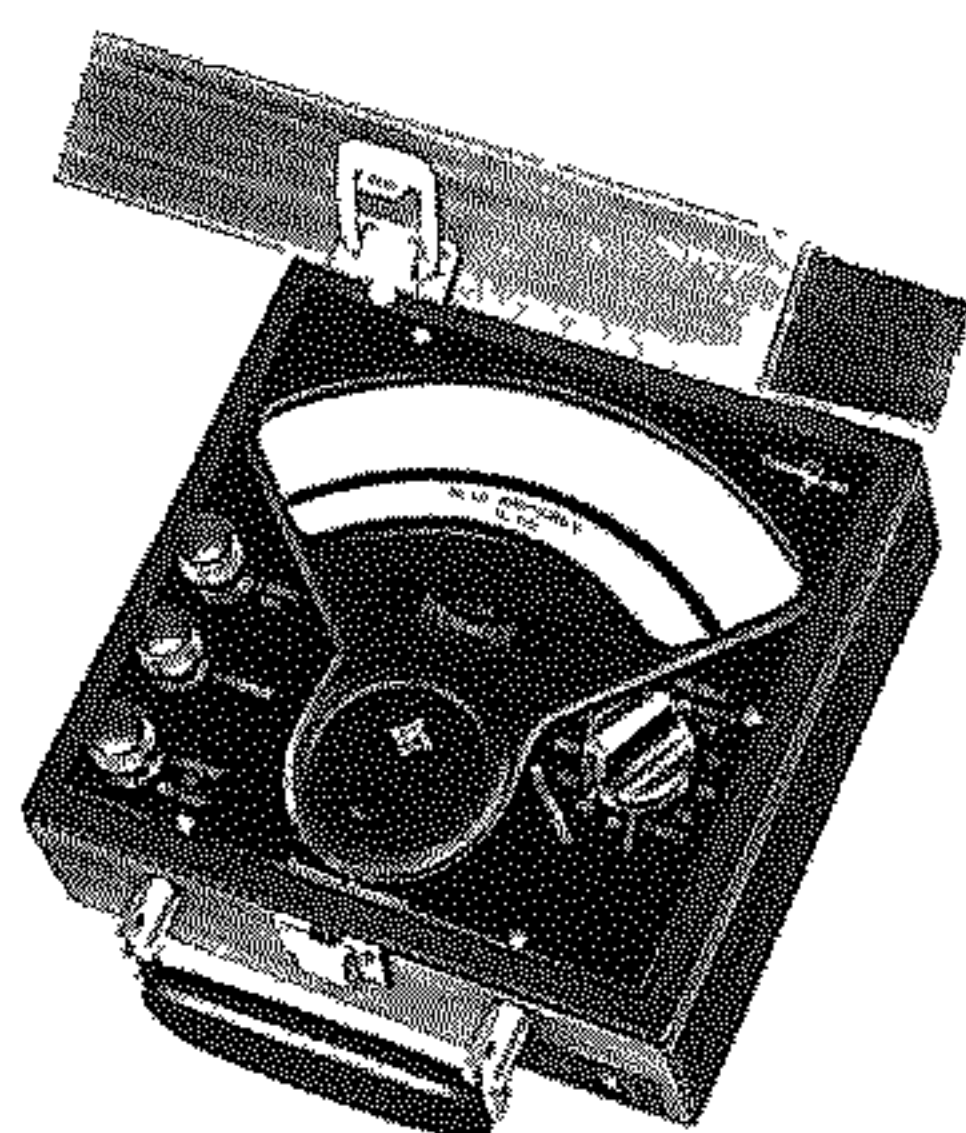
\* A TRADEMARK OF EIS



USP

### 88 Range AC and DC Volt-Ammeter

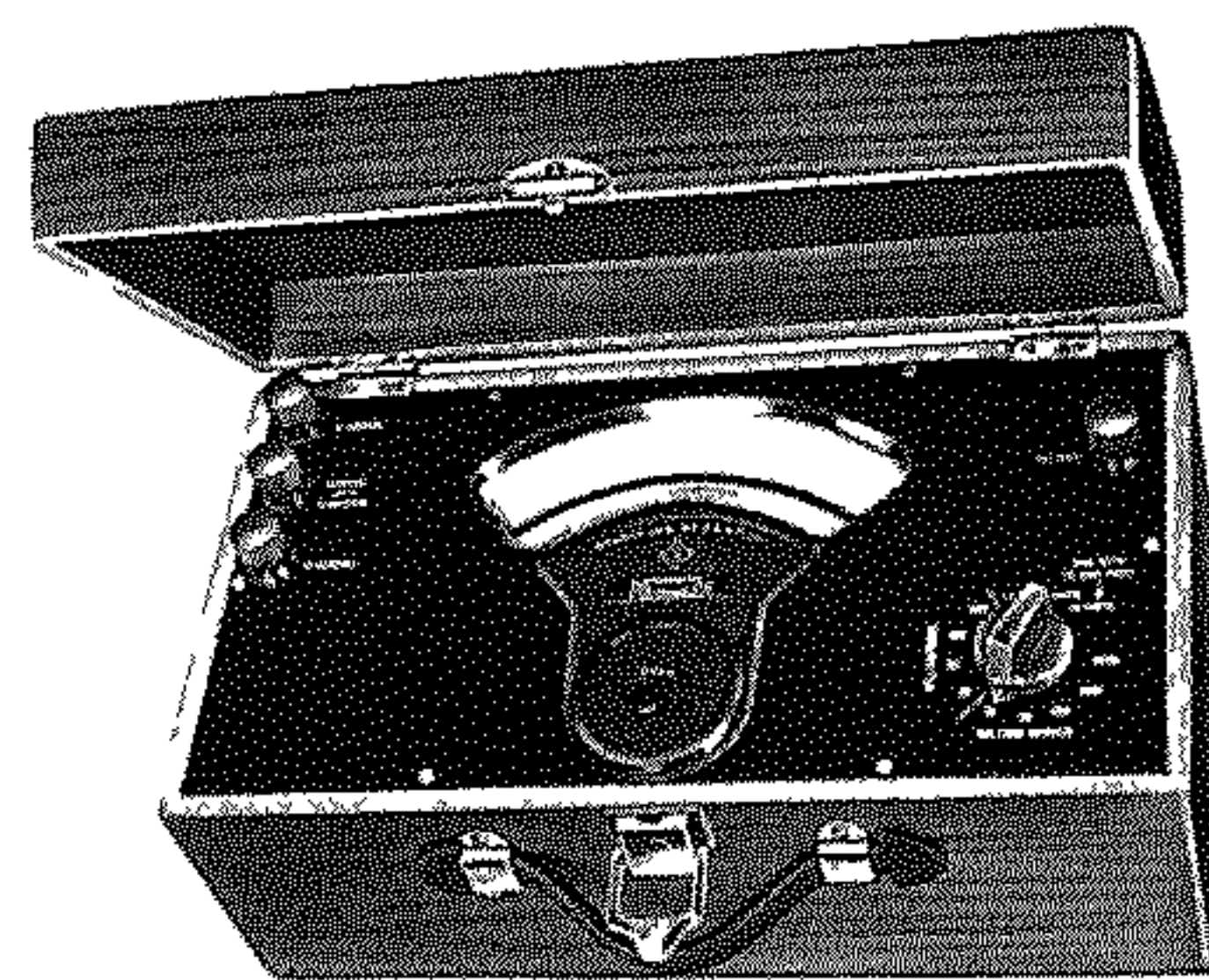
Model U88 is an AC/DC electrical indicating instrument with 88 switch controlled ranges, each overlapping so that all readings can be taken on the upper third of the scale. Accuracy is  $\pm 0.5\%$  fs on DC and  $\pm 0.75\%$  full scale on AC. Ranges fs from 200  $\mu$ a to 1.5 amps and 20 mv to 750 v DC (3333 or 5000 ohms/v according to range); 10 ma to 3 amps and 0.5 to 750 v AC (66.6 or 100 ohms/v according to range). Frequency span is 7 cps to 5 Kc/s on voltage and 7 cps to 15 Kc/s on current. 5.2" scale length.



A

### Universal AC and DC Volt-Ammeter

Model USP is an AC/DC electrical indicating instrument with 28 overlapping ranges. It has the advantage of being more economically priced than the Models UX and U88 while still maintaining the versatility of these instruments by covering the same broad measuring range and incorporating some of their most desirable features. Switch controlled full scale ranges from 200  $\mu$ a to 2 amps and 5 mv to 1000 v DC (5000 ohms/v on 5 and 50 mv, all other ranges 1000 ohms/v); 15 ma to 3 amps and 0.3 to 750 v (100 ohms/v). 5.2" scale length. Model U-SP is similar to USP but has added DC ranges of 2/20 amps and 4/40 v; AC ranges from 10 ma to 3 amps and 0.3 to 1000 v. Accuracy  $\pm 0.75\%$  AC and  $\pm 0.5\%$  DC of full scale.



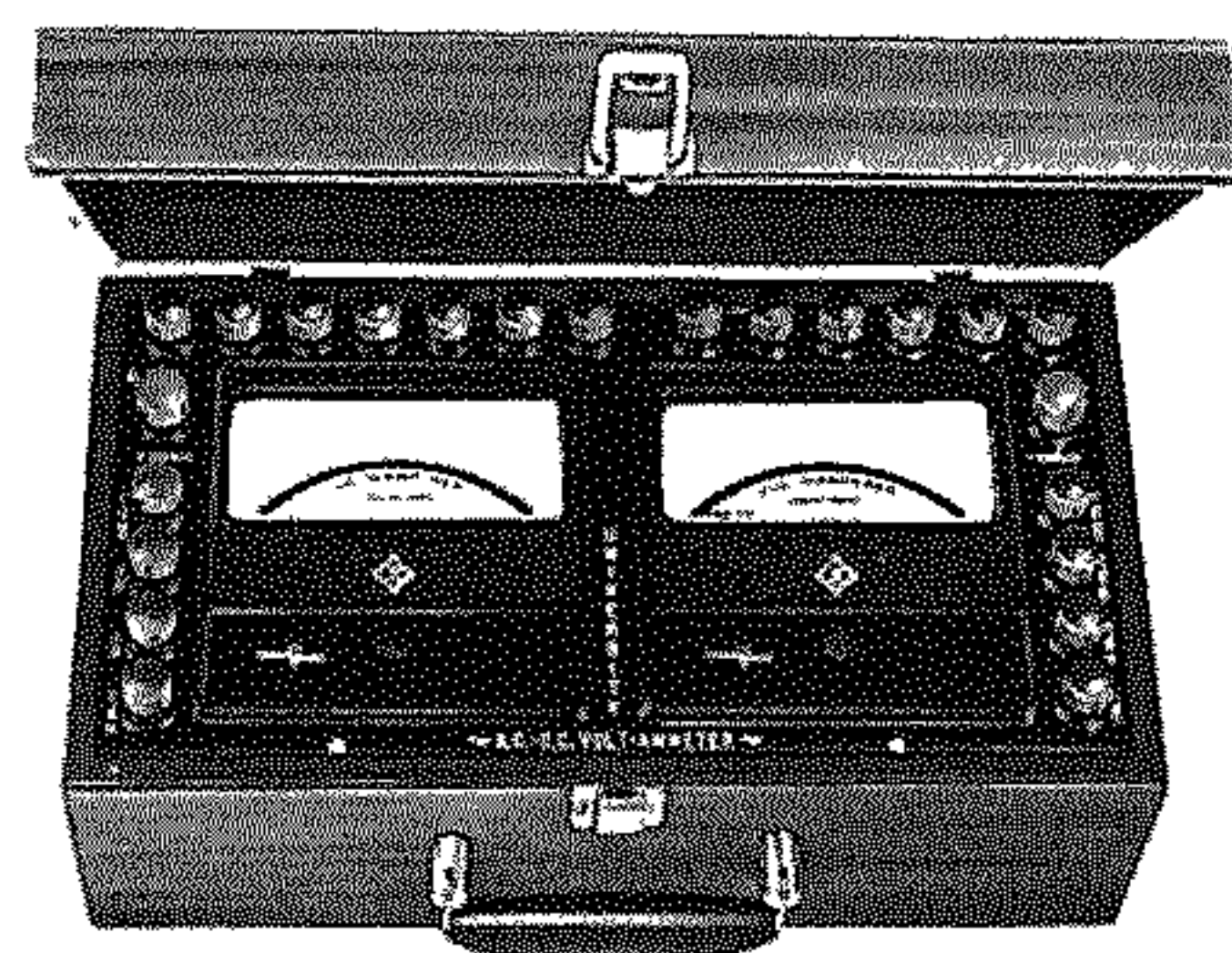
DYP

### AC/DC Volt-Ammeters

Model A Polyranger instruments are  $\pm 0.75\%$  accurate, switch controlled AC/DC electrical indicating instruments designed primarily for the measurement of AC over a wide range of audio frequencies. They differ from other AC/DC Polyranger models in that they are smaller sized (but have a longer scale, 6.3") and have one pair of input terminals and a single circuit for both AC and DC measurements. Available in six fs range combs. as follows: 1-AA, 10 ma to 1 amp and 0.5 to 500 v (12 ranges); 1-AB, same as 1-AA except add 5 amps range; 1-AC, same as 1-AA except add 1000 v range; same as 1-AC except add 5 amps and 1000 v range (all combs. 100 ohms/v); 2-A, 2 ma to 1 amp and 2 to 500 v (11 ranges; only Polyranger instrument with a sensitivity of 500 ohms/v); 3-A, 15 ma to 5 amp and 0.5 to 1500 v (14 ranges; 100 ohm/v).

### AC Dynamometer Volt-Ammeter

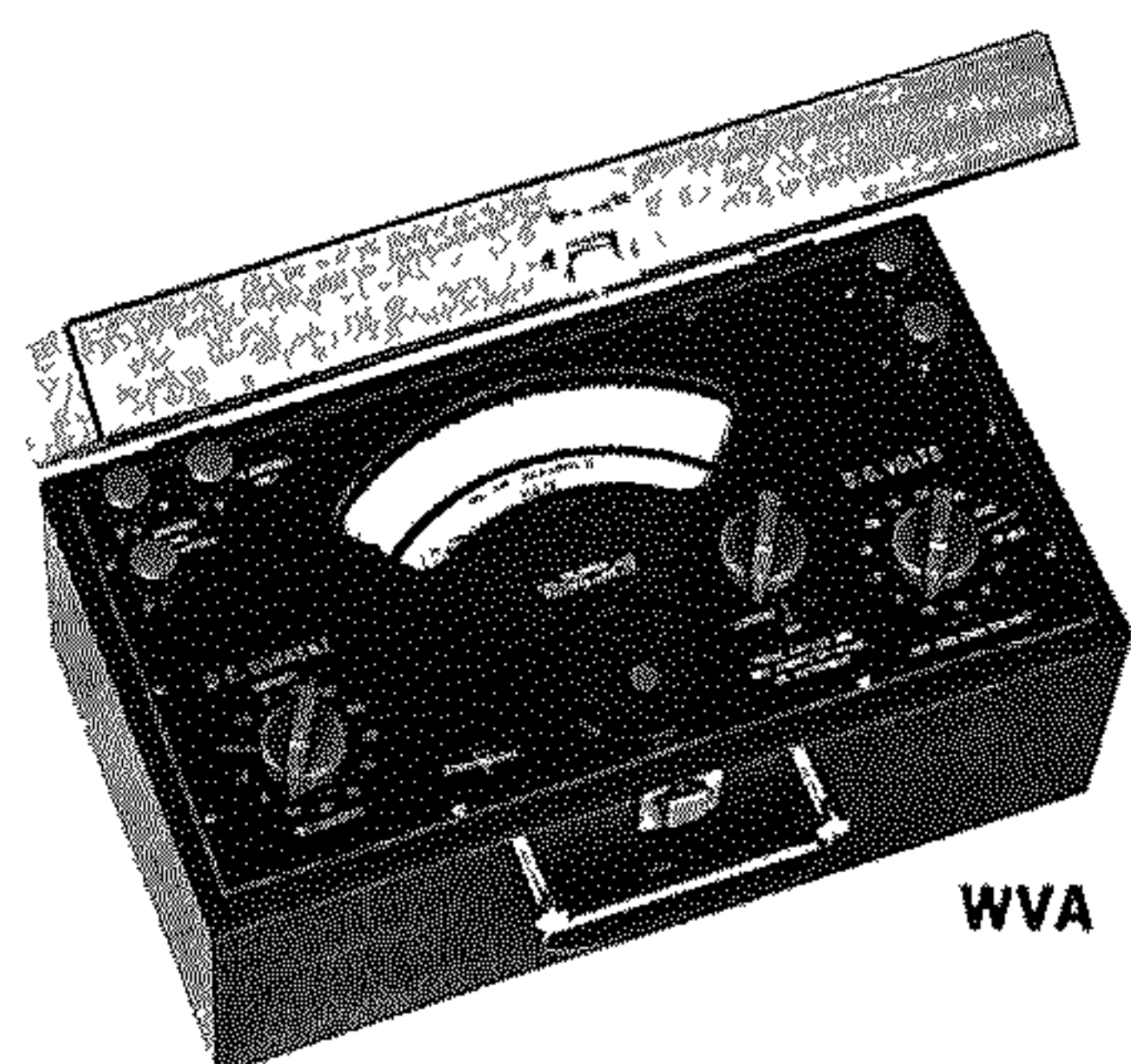
Model DYP is a  $\pm 0.3\%$  accurate, switch controlled, transformer coupled dynamometer for 60 cps measurements only (50 cps on special order). Comb. #1 has 12 fs ranges, 10 ma to 10 amps and 10 to 1000 v; Comb. #2 has 20 fs ranges, 5 ma to 10 amps and 5 to 1000 v (2000 optional). 6.3" scale length.



UVA

### AC and DC University Volt-Ammeter

Model UVA is a 22 range AC and DC Polyranger instrument consisting of two separate University Model electrical indicating instruments mounted in a single case. Offered as a versatile, low cost, rugged indicator that has wide application in educational institutions and industrial field testing. Designed for use by relatively inexperienced personnel. All ranges engraved on separate binding posts, minimizing the danger of connecting incorrectly into a circuit or of inadvertently selecting the wrong range by a switch. Both indicators withstand overloads of 500% without additional protection (100% on 1000 v range). AC instrument is  $\pm 0.75\%$  accurate transformer coupled moving iron; DC is  $\pm 0.5\%$  accurate permanent magnet moving coil. Ranges from 1 ma to 10 amps and 50 mv to 1000 v DC (1000 ohms/v); 10 ma to 10 amps and 10 to 500 v (1 to 5 va burden). 4" scale lengths.



WVA

### DC Reference Standard Volt-Ammeters

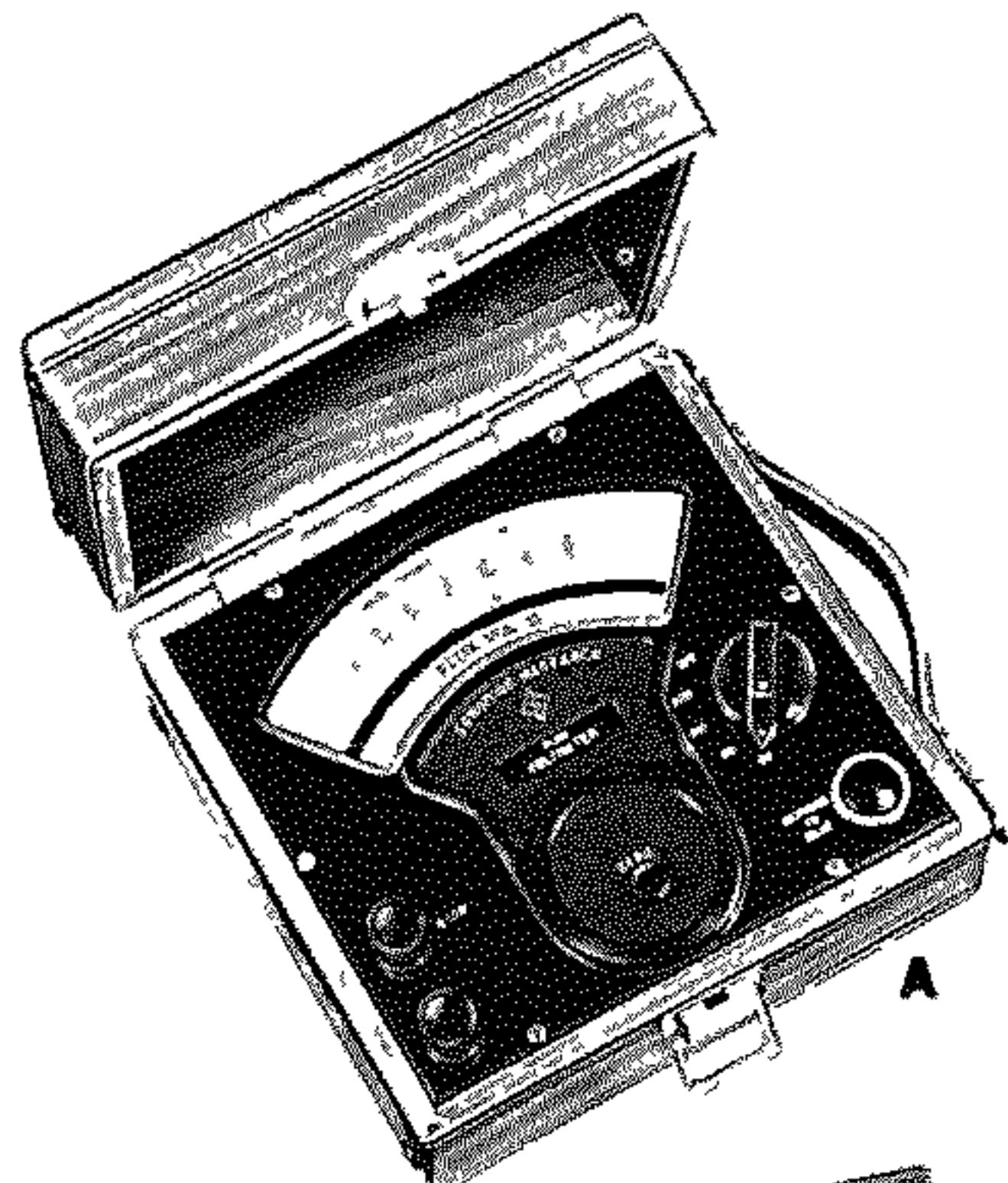
Model WVA offers the widest measuring capability available in a self-contained  $\pm 0.25\%$  accurate DC reference standard indicating instrument. Its 27 overlapping ranges from 1 ma to 15 amps and 100 mv to 1000 v (1000  $\Omega$ /v), enable readings to be taken at, or near full scale. Voltage and current circuits are independent of each other and "dummy loaded." When current and voltage are supplied at the same time, by reversing the circuit selector switch, almost simultaneous readings can be taken without unbalancing either input, and values of DC resistance and power can be calculated. Instrument contains a 0-1 scale which indicates current being drawn during voltage measurements. 6.3" scale length. Switch controlled. Excellent stability and ruggedness. 1 second response time.



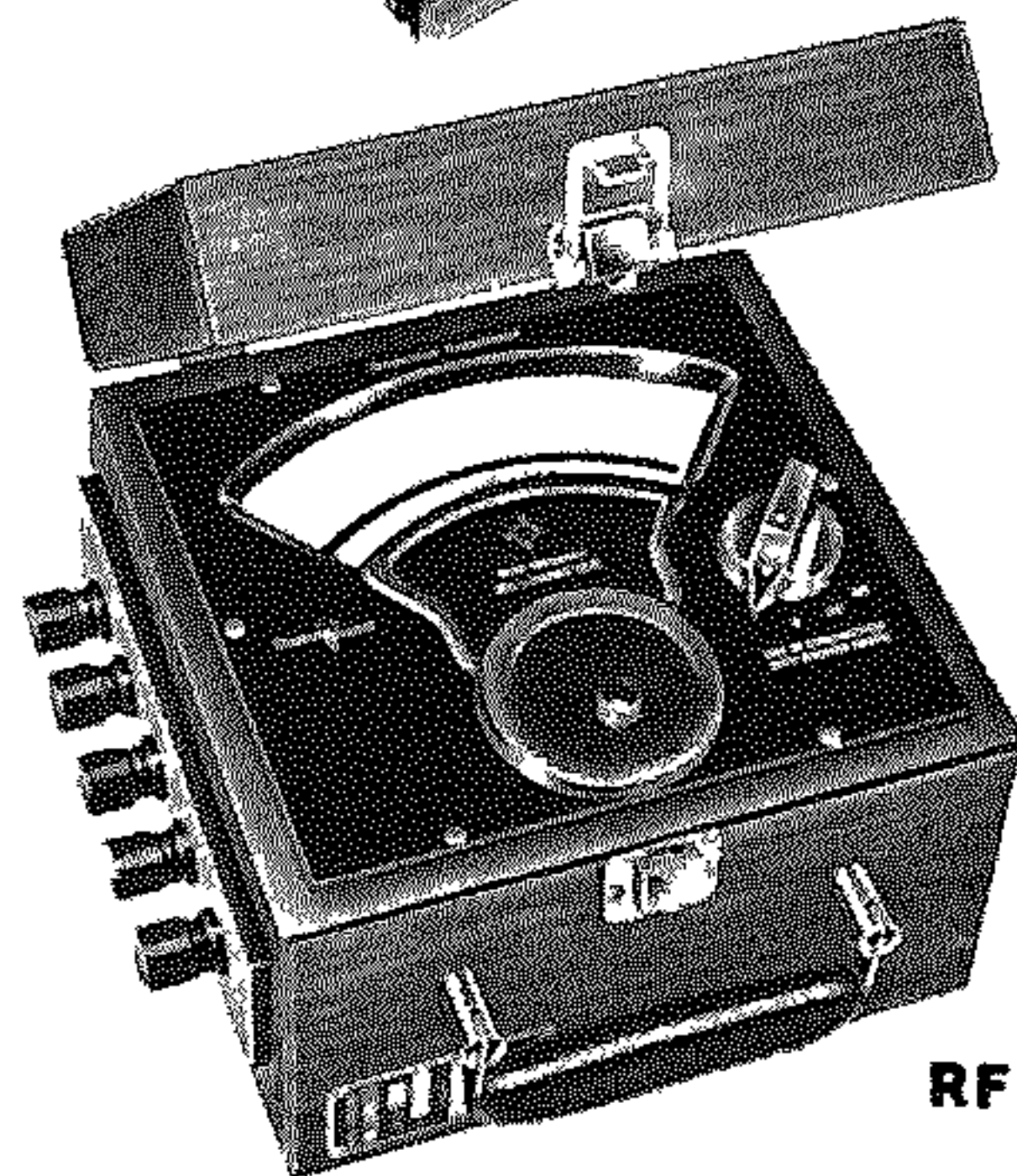
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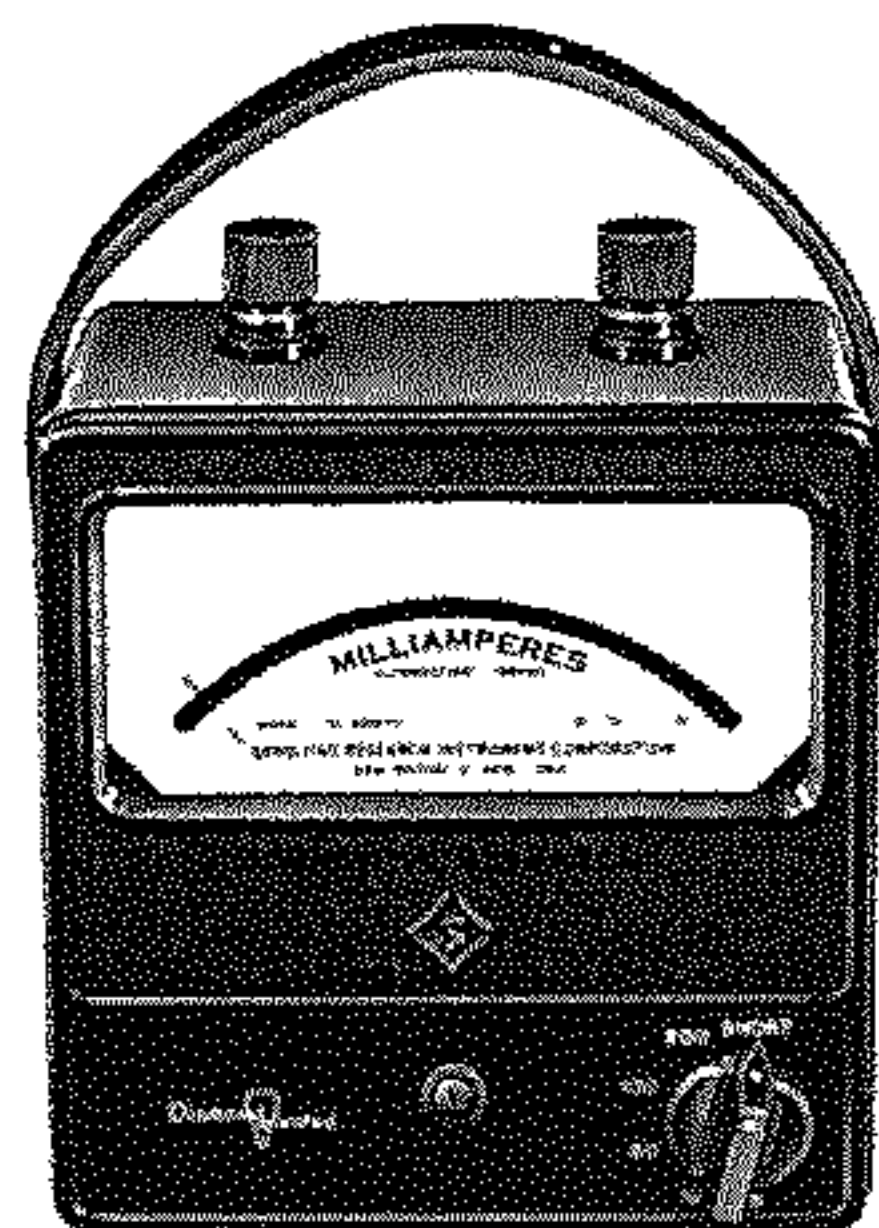
## THERMOCOUPLE METERS AC-DC WATTMETERS



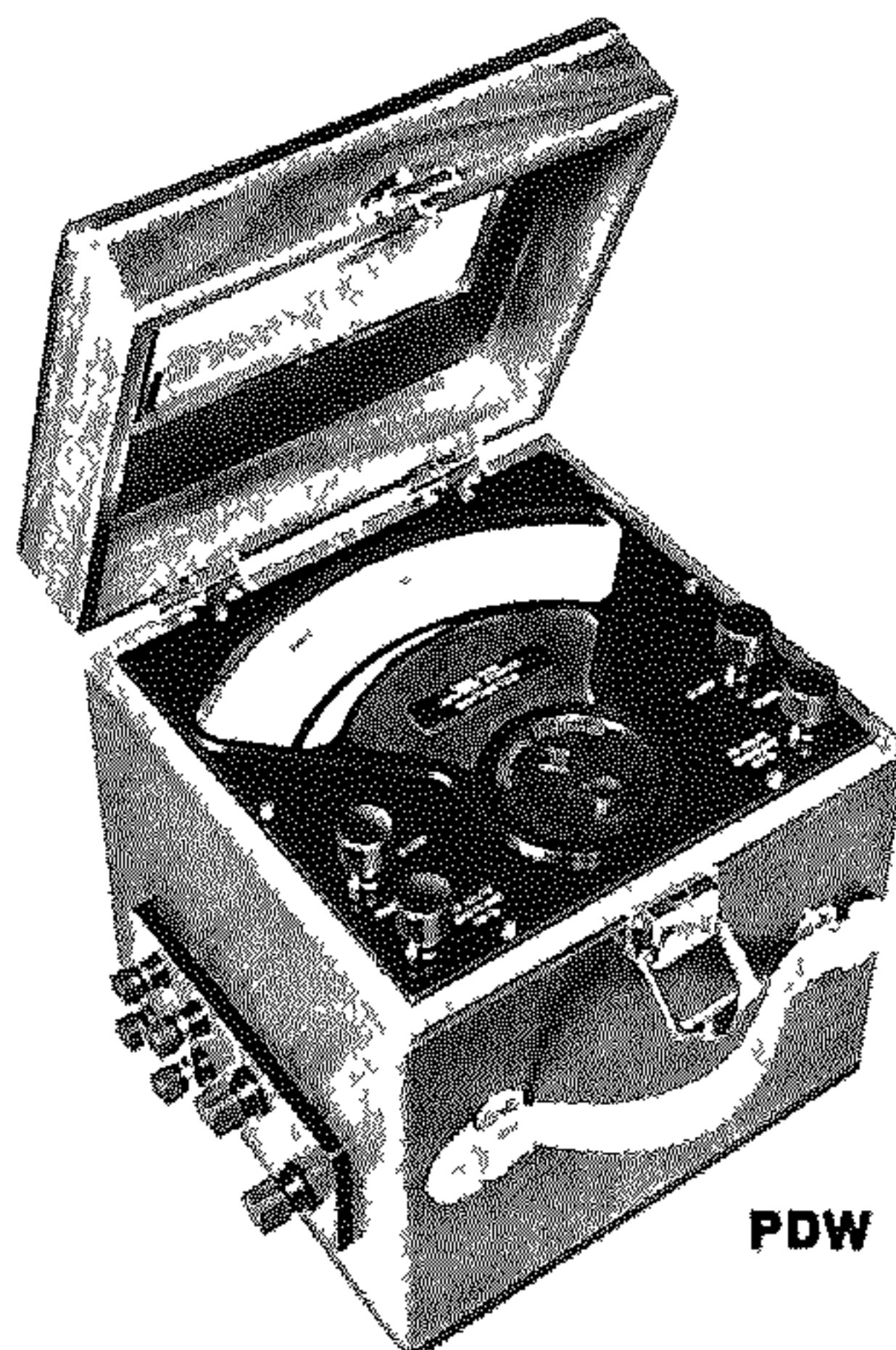
A



RF

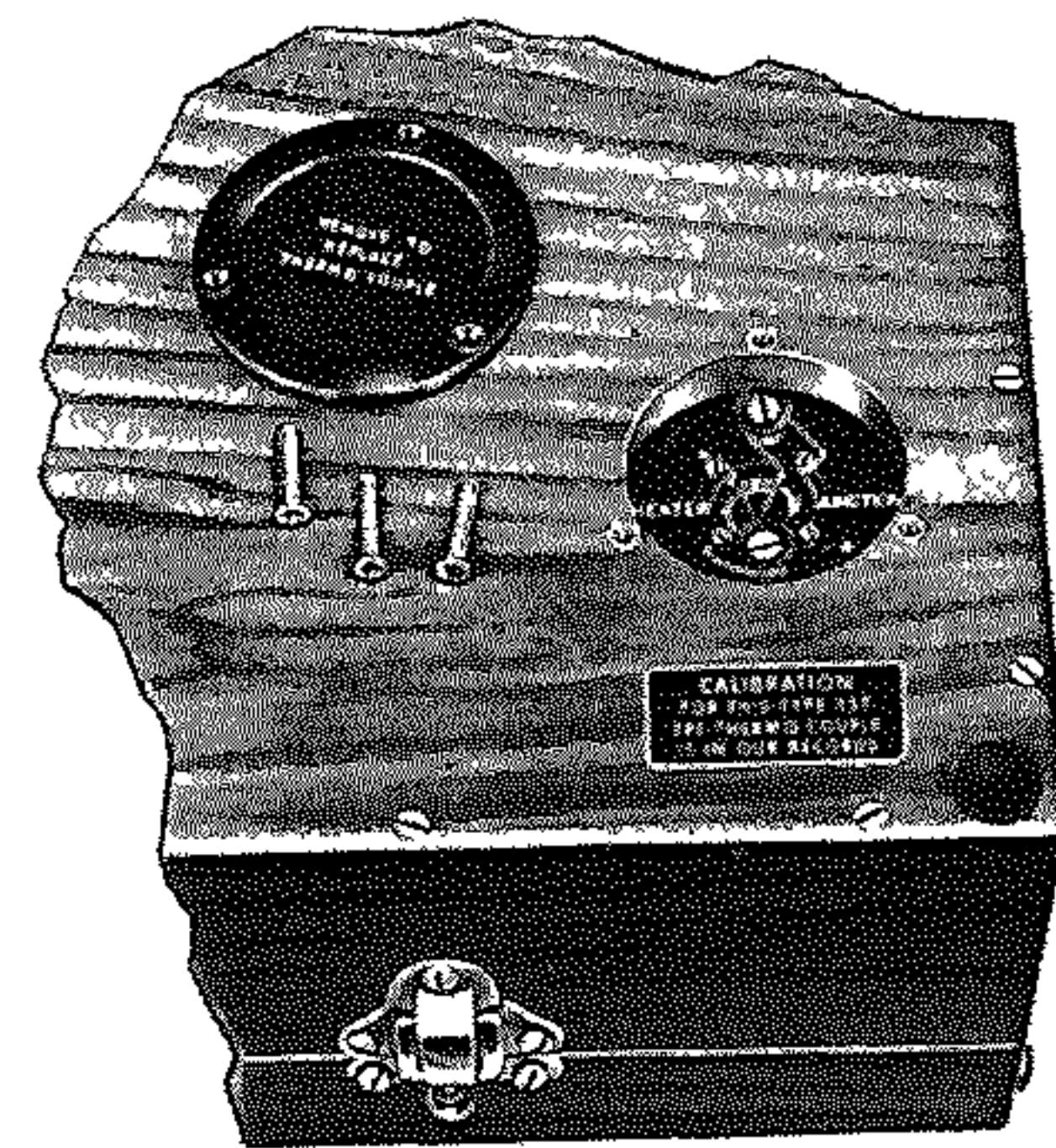


University



PDW

Thermocouple instruments offer the user significant advantages in frequency response and sensitivity over other AC types with true rms response. They can be used on DC and AC from 7 cps to 20 Mc/s, and in instances where UHF thermal converters are employed, this frequency range can be extended to over 100 Mc/s. Sensitive Research thermoelements have excellent AC/DC transfer characteristics (low reversal). Thermocouple instruments can be calibrated directly on DC and only their AC/DC difference, or frequency influence, has to be checked by AC transfer methods. A thermocouple field replacement feature (TRF) is supplied in the Models A and AU. Automatic or manual "Push to Read" overload protection is available. Automatic temperature compensation from 20° to 30° C is standard (except University Model).



TRF

(Thermocouple Replacement Feature)

### Audio Frequency Volt and Milliammeters

Model A series consists of AC/DC multirange milliammeters and single or multirange voltmeters. Accuracy is  $\pm 0.5\%$  fs ( $\pm 0.75\%$  for instruments with fs ranges of 3 ma or less or a sensitivity of 500 ohms/v). Multirange combinations are offered from 1 ma to 1.5 amps; 0.2 v to 1.5 kv. Frequency range is 7 cps to 7 Kc/s on voltage and 7 cps to 15 Kc/s on current. Sensitivity is 100, 200 or 500 ohms/v. 6.3" scale length. (Single range milliammeters have a frequency response up to 1 Mc/s and are listed under Model RF.) Model AU is identical to the Model A, except frequency range is extended to 35 Kc/s on voltage and 20 Kc/s on current.

### Radio Frequency Volt, Amp and Milliammeters

Model RF series consists of AC/DC single range and multirange instruments for use up to 20 Mc/s. Model RF multirange voltmeters utilize special switching to increase frequency range considerably beyond normal limits of other instruments containing this operational feature. Frequency influence is negligible over the first 20% of their frequency span. Accuracy is  $\pm 0.5\%$  fs + ( $\pm 0.5\%$  max. frequency influence) on multirange units from 1 v (5 Mc/s) to 300 v (150 Kc/s). Instruments with a single range of 1 v or 3 v have a  $\pm 0.5\%$  frequency response to 10 Mc/s. RF ammeters and milliammeters are available with accuracies of  $\pm 1\%$  fs from 1 ma to 100 amps. 6.3" scale length.

### Compact Thermocouple Instruments

University Model comprises a series of  $\pm 0.75\%$  accurate, low cost, small sized milliammeters and voltmeters for AC/DC measurements up to 7.5 Kc/s (single range milliammeters up to 500 Kc/s). Multirange instruments are switch controlled. Up to 7 fs ranges available from 2 ma to 1 amp or 200 mv to 300 v (100 or 500 ohms/v). 4" scale length. University Model is comparable in general construction quality to Model A, but has certain limitations in range, frequency response, resolution and the accessory features it can contain (temperature compensation, TRF, etc.), because of relatively small size.

### Polyphase Wattmeters

Model PDW is a multirange 2 element AC/DC electrodynamic wattmeter for the measurement of single and 3 phase power down to 50% PF and up to 800 cps. Can be used in 3 phase 3 wire circuits, single phase 3 wire circuits and 3 phase 4 wire circuits. Indicates 3 phase power for any combination of balanced or unbalanced loads. Accuracy  $\pm 0.5\%$  fs. 6.3" scale length. Model PDLW is a  $\pm 0.75\%$  accurate wattmeter for use down to 20% PF and up to 500 cps. 5.2" scale length. Compensating inductor available for third leg of 3 phase circuits to balance load imposed by wattmeter insertion.

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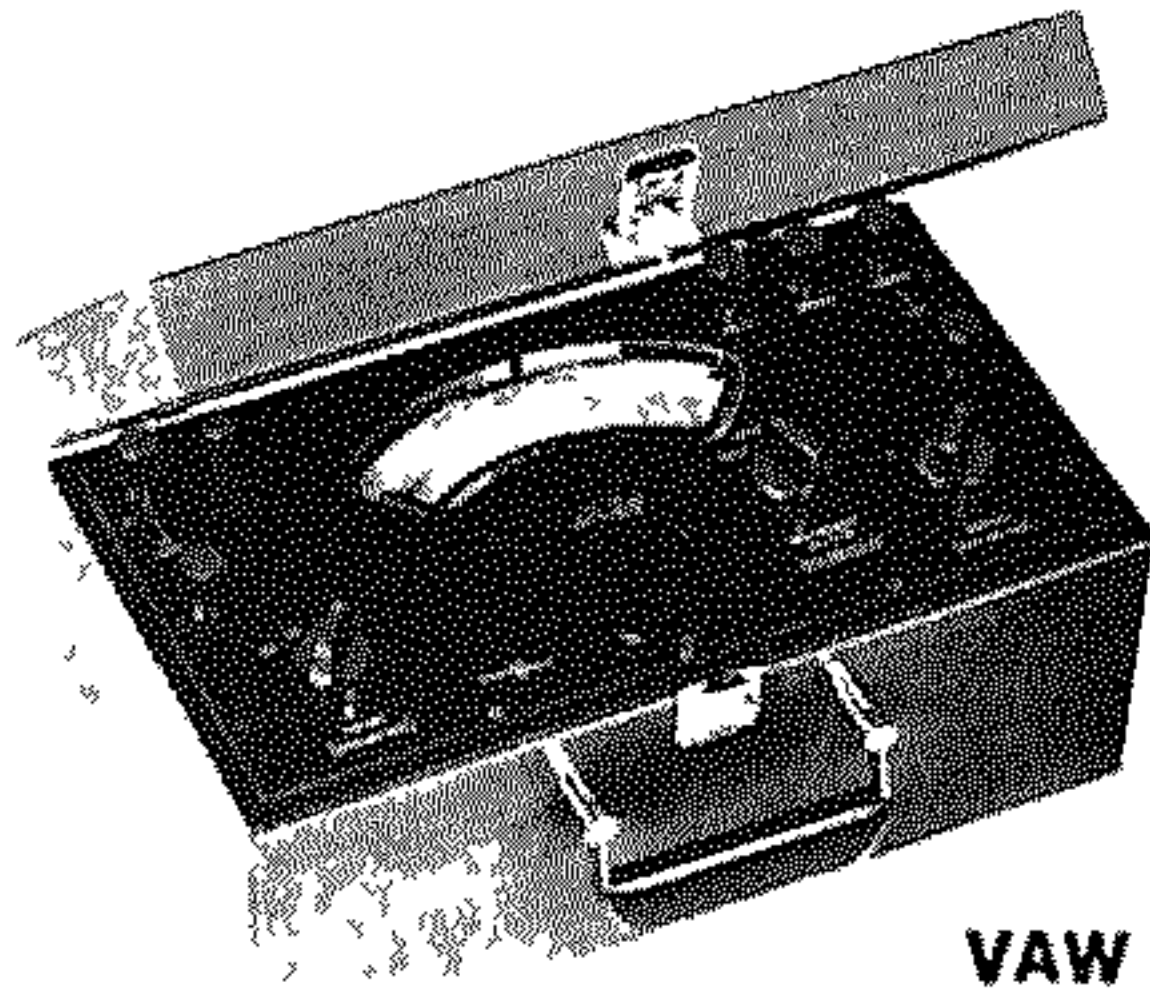


# AC-DC WATTMETERS GENERAL PURPOSE INSTRUMENTS

## Sensitive Research\*

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### Volt-Amp-Wattmeter

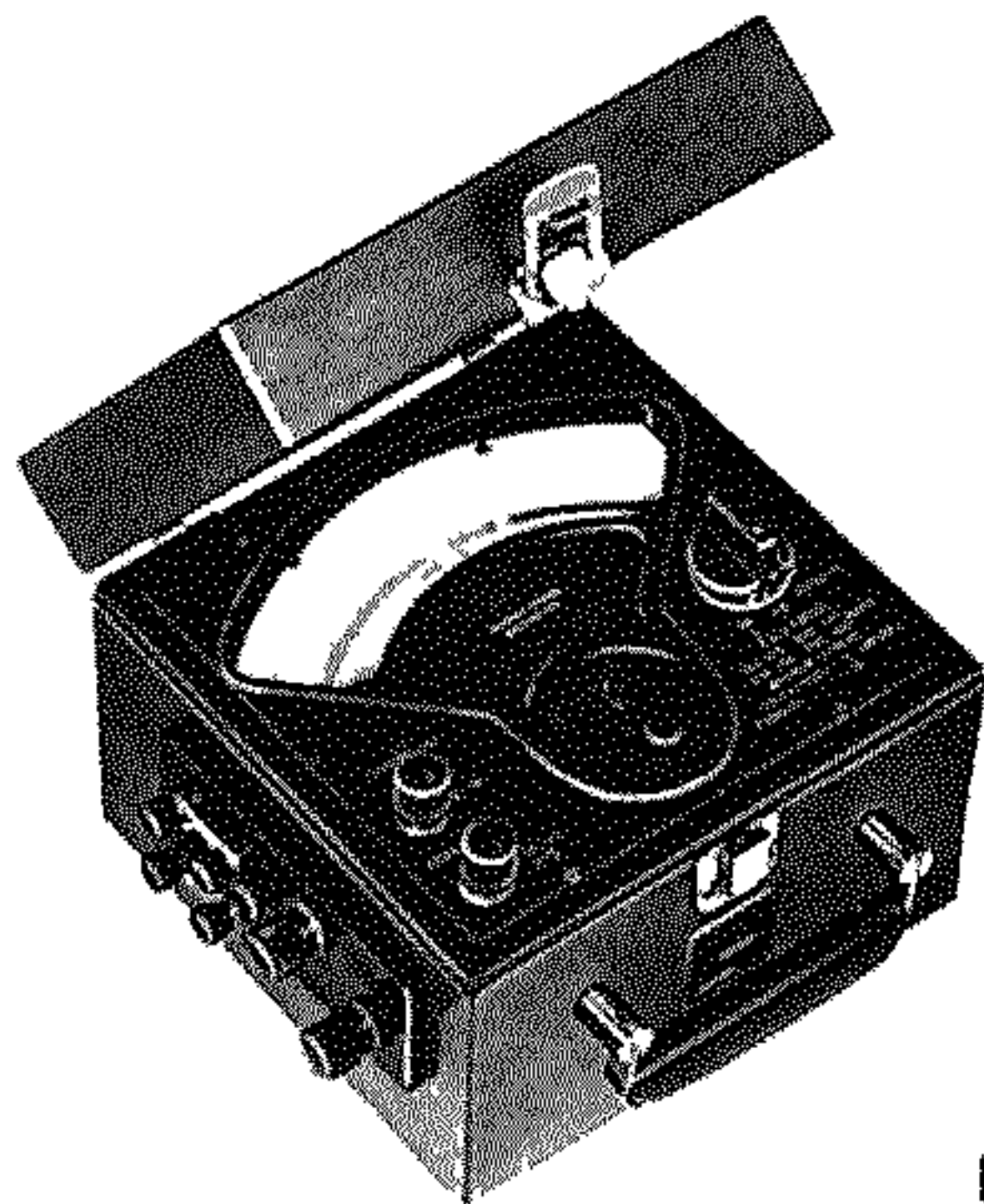


VAW

Model VAW, volt-amp-wattmeters, are transformer-coupled electrodynamicometers that make 50 to 125 cps or 50 to 800 cps tare-free compensated measurements of AC power down to 50% PF in 12 ranges from 12.5 w to 5 kw fs. Has potential drop ranges of 25/50/100/200/500 v fs; current ranges of 0.5/15/10 amps fs (12.5/25 w and 25/50 v included in 50 to 125 cps model only). Accuracy on current and voltage ranges  $\pm 0.5\%$  fs; on watts  $\pm 0.75\%$  fs. Switch controlled ranges. Measures all circuit parameters without necessity of changing external connections. Special 10 ma range for current measurements only. 5.2" scale length. Self-contained in portable case.

### Single Phase Wattmeters

Model DW is a  $\pm 0.25\%$  accurate single phase AC/DC electrodynamicometer wattmeter for use down to 50% PF and frequencies of 25 to 800 cps (2500 cps on special order). Overall accuracy, ruggedness and stability make it ideally suited for use as either a calibration standard or general purpose testing instrument. 6.3" scale length. Y Boxes available for measurements of balanced 3 phase power. Model DLW is a single phase  $\pm 0.5\%$  accurate wattmeter for use down to 20% PF and up to 500 cps. University Model, having accuracies of  $\pm 0.5\%$  fs down to 50% PF and  $\pm 0.75\%$  down to 20% PF, is a compact version of the Models DW and DLW. Has the advantage of being more economically priced than these instruments while covering essentially the same wide measuring range. Molded bakelite case. 4" scale length.



DW

### Differential Instruments

Model SD measures the difference between two DC currents or voltages. Inputs are isolated. Accuracy is  $\pm 0.5\%$  fs for most ranges between 2  $\mu$ a and 500 ma. Normally furnished zero center. Uniqueness is ability to withstand sustained overloads of 1000% which results in a 10X increase in comparison accuracy and scale resolution. 5.2" scale length. Model JD is a differential galvanometer with a 3.25" scale length that permits higher sensitivity. Suitable for horizontal bench mounting. Model JDJW-4 is an edgewise panel instrument with a 4" scale length.

### DC Reference Standards

Model C is a rugged  $\pm 0.25\%$  fs accurate permanent magnet moving coil electrical indicating instrument. Moving element features an exceptionally high torque to weight ratio. 6.3" scale length. Up to 9 self contained ranges available in switch controlled multirange combs. from 50  $\mu$ v and 50 mv DC fs. Millivoltmeter available calibrated for use with external heavy current shunts. Sensitivities to 20,000 ohms/v. Design emphasis is on stability and sturdiness for long term accuracy and reliability.

Model S is a deluxe high sensitivity  $\pm 0.5\%$  fs accurate instrument of the same superb quality and physical dimensions as the Model C. Up to 9 switch controlled ranges in various combs. available from 1.5  $\mu$ a to 1 mv fs. Sensitivities to 500,000 ohms/v (1,000,000 ohms/v when zero center). Constant resistance multirange microammeters available for special applications. Low range millivoltmeters are particularly suited for use with thermal converters for ultra high frequency AC measurements. Model HS is an ultra high sensitivity multirange millivoltmeter designed mainly for use in corrosion and electrolysis measurements. Model J is a  $\pm 0.5\%$  accurate instrument made primarily to use as a bench mounted, pointer type, high sensitivity galvanometer.

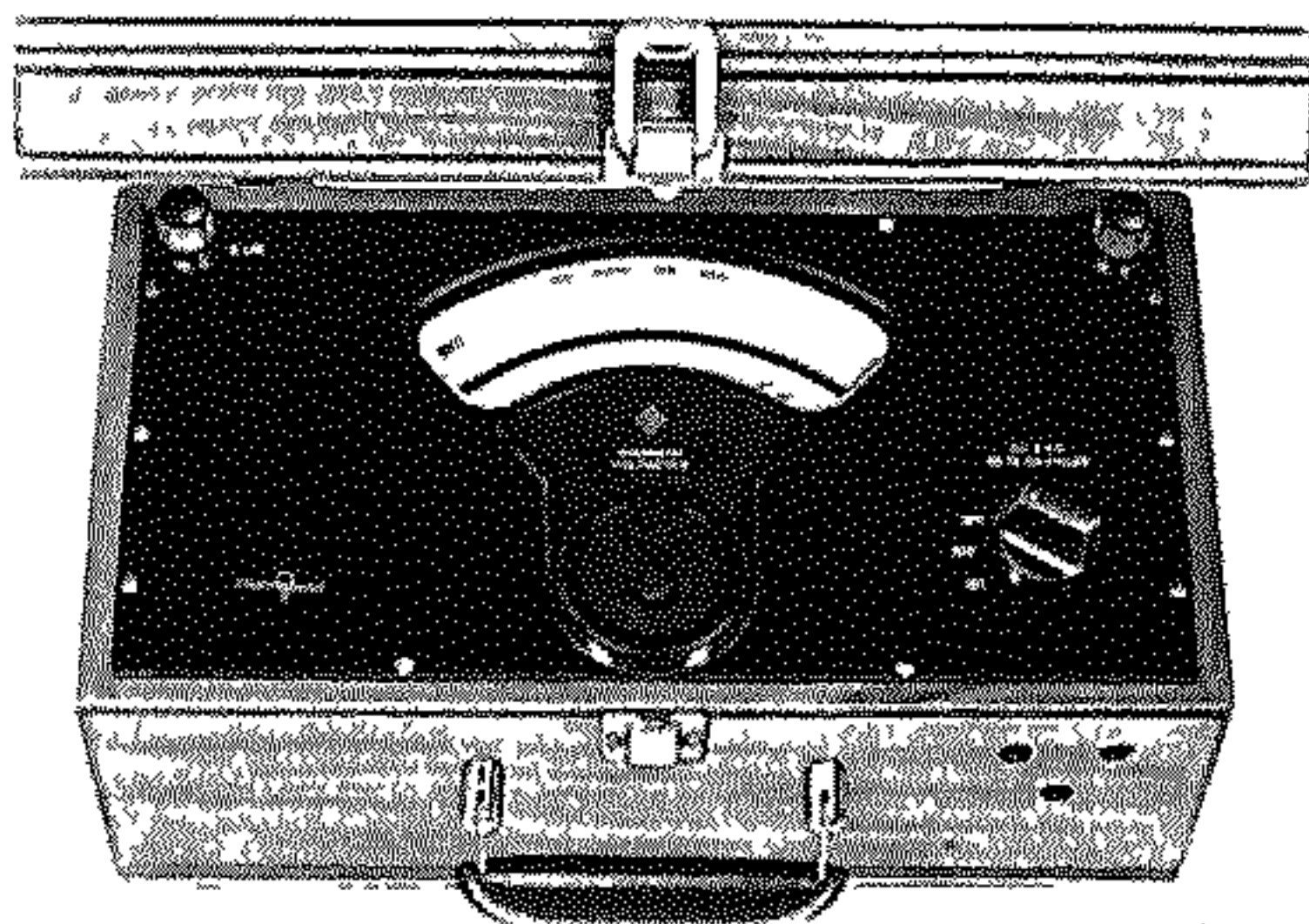
Model N is a low cost permanent magnet moving coil instrument with many features of higher priced indicators. Accuracy is  $\pm 0.5\%$  or  $\pm 0.25\%$  fs as required. Housed in a rugged plastic case for field use. Up to 5 switch controlled ranges available from 50  $\mu$ a and 50  $\mu$ v (up to 50 amps self contained). Sensitivities to 5000 ohms/v. 6.1" scale length.

University Model is a low cost, compact,  $\pm 0.5\%$  accurate version of the Model S, having slightly less sensitivity and resolution. Up to 5 switch controlled, self contained ranges from 2  $\mu$ a and 2 mv fs. Sensitivities to 5000 ohms/v. 4" scale length. Model UTS is a portable DC test set with 4 University Model indicating instruments to measure from 50  $\mu$ a to 60 amps and 20 mv to 1200 v. Contains a Wheatstone Bridge, a decade resistance box and all necessary switching and facilities to make potentiometer voltmeter, zero resistance, DC power and high resistance voltmeter measurements.

### AC and AC/DC Reference Standards

Model D is a rugged AC/DC  $\pm 0.25\%$  fs accurate dynamometer electrical indicating instrument. 6.3" scale length. Up to 4 self contained ranges available in switch controlled multirange combs. from 1.5 to 1000 v and 5 ma to 20 amps. Frequency response DC, 25 to 2500 cps.

Model MI is a rugged  $\pm 0.5\%$  fs accurate moving iron electrical indicating instrument. Up to 3 self contained ranges available from 10 ma to 20 amps and 7.5 to 750 v. Frequency response 25 to 500 cps. 6.3" scale length. Special transformer coupled voltmeter has 8 switch controlled ranges from 3 to 750 v fs. Model NSI is a low cost  $\pm 0.5\%$  fs accurate version of the Model MI. Housed in a molded plastic field case. 6" scale length. University Model is a compact low cost  $\pm 0.5\%$  fs accurate version of the Model D. Up to 4 ranges available from 10 ma to 1 amps and 30 to 750 v. Frequency response DC, 25 to 125 cps (500 cps on special order). 4" scale length.



D

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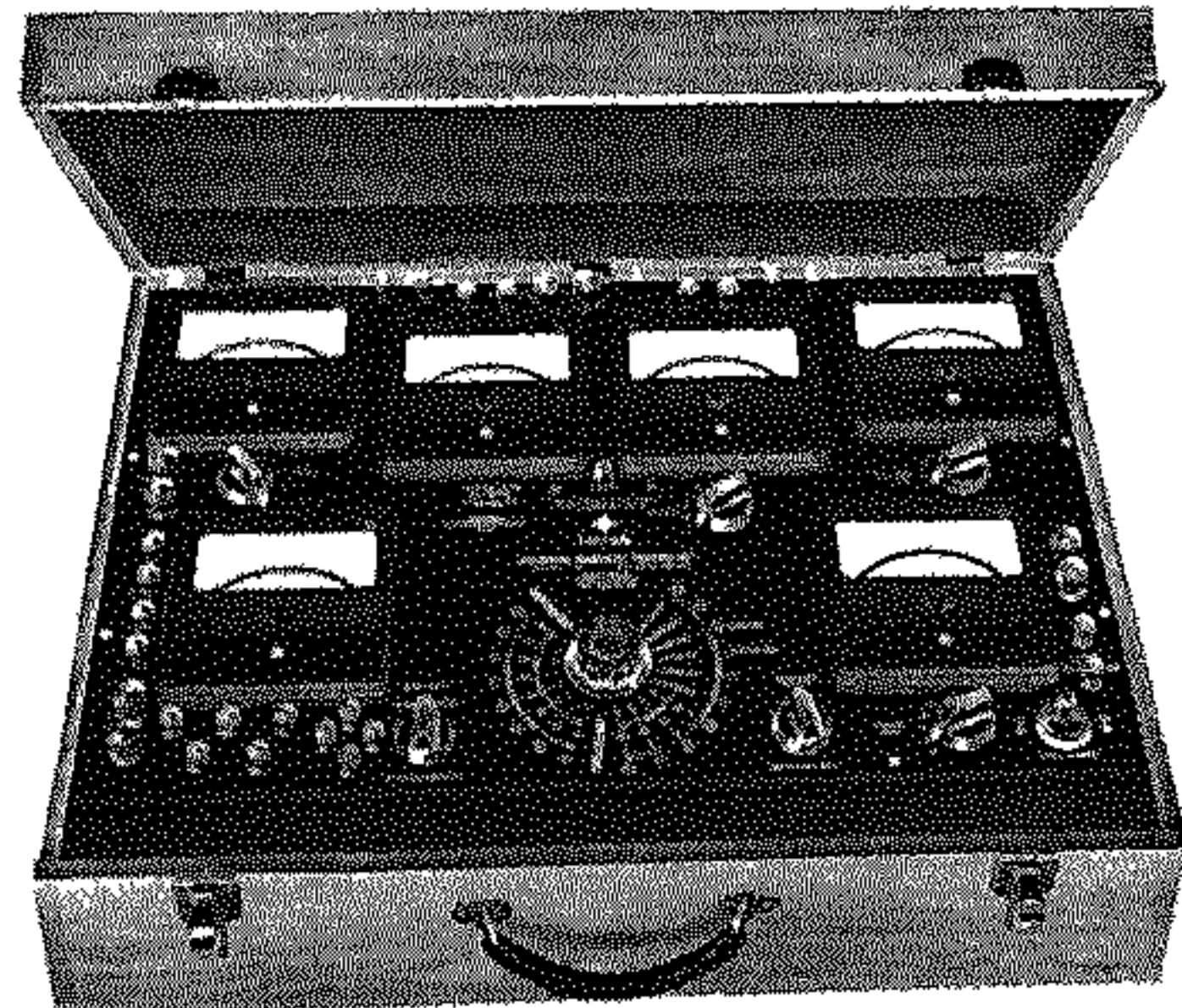


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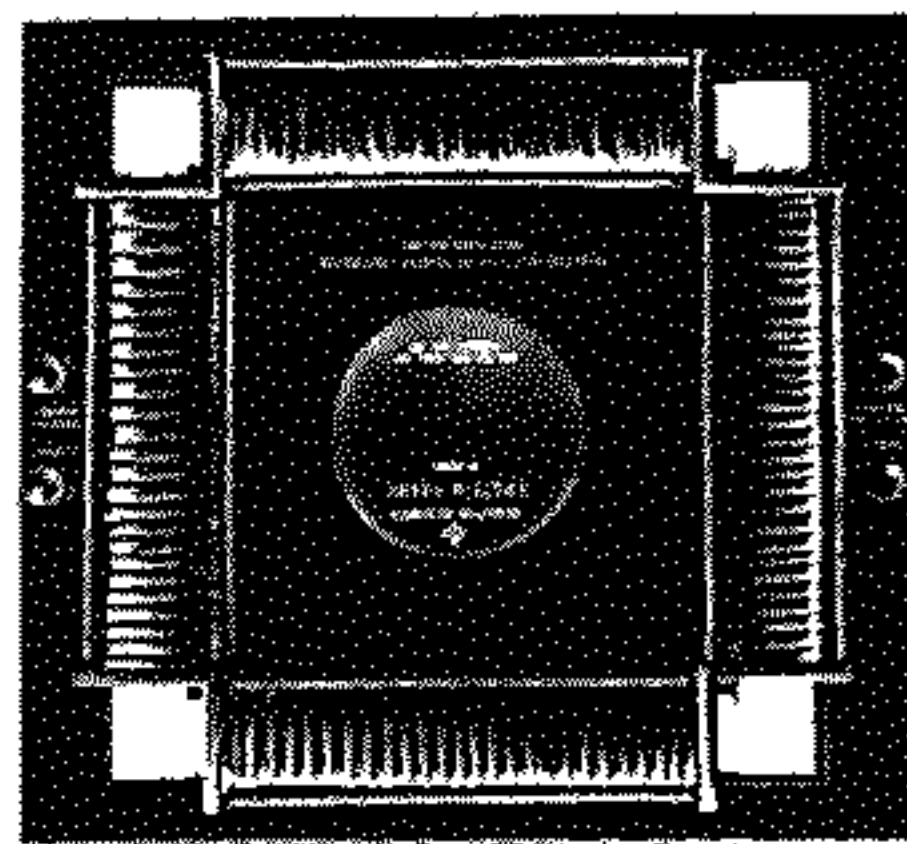
\* A TRADEMARK OF EIS

## MAGNETIC TESTING INSTRUMENTS

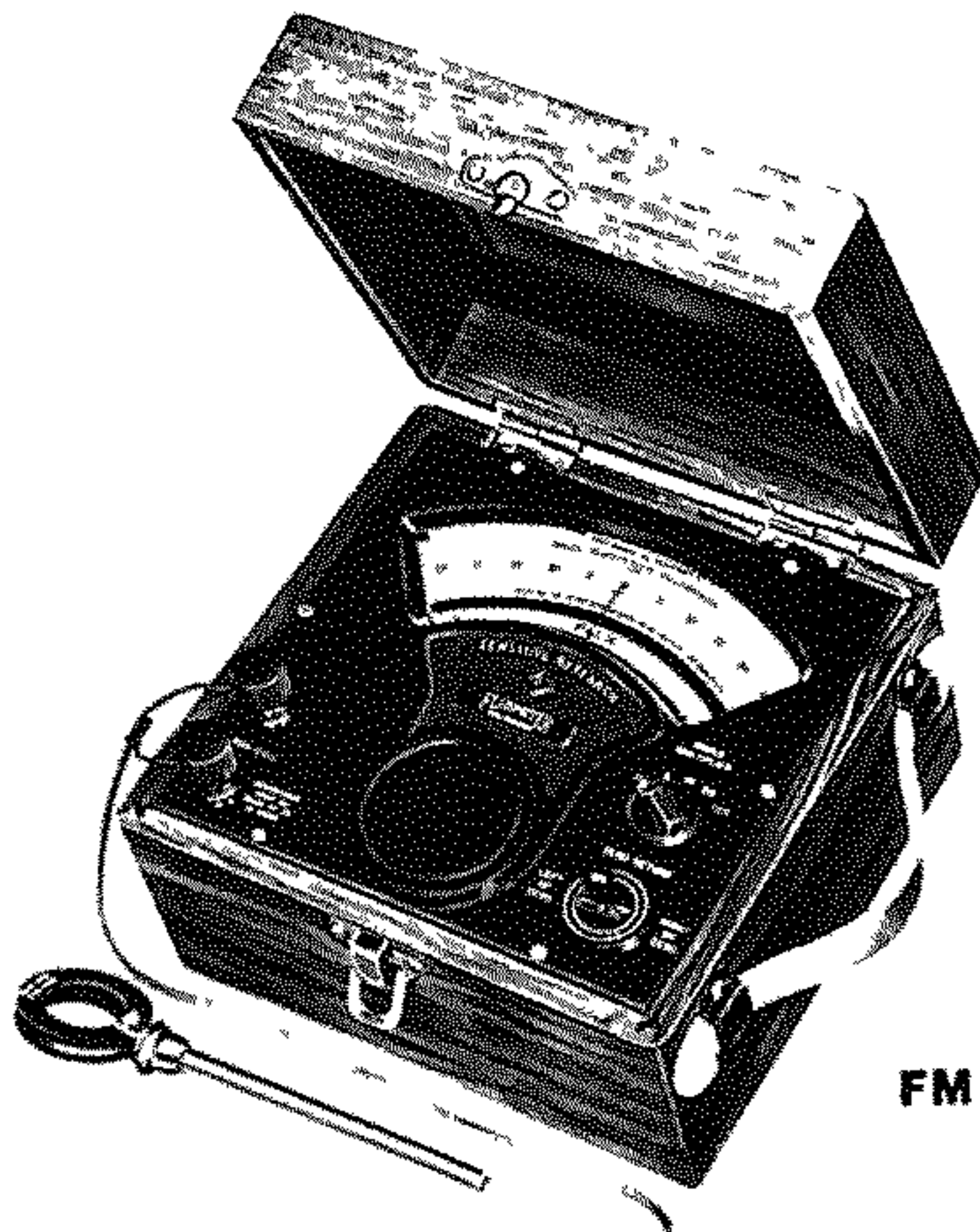
### Universal Magnetic Testing Set



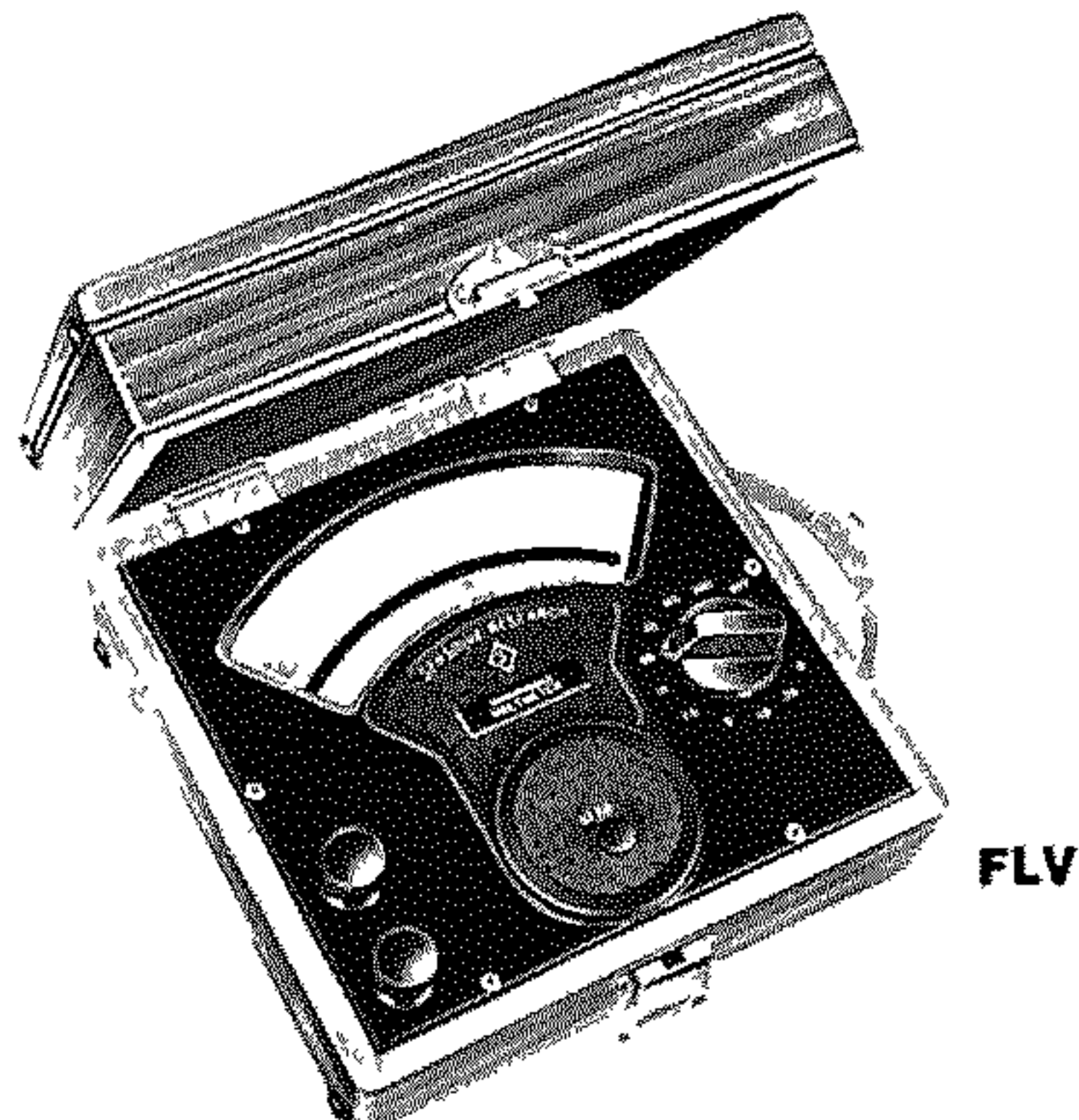
MAT



EPSTEIN FRAME



FM



FLV

Model MAT performs magnetic measurements in accordance with ASTM specifications listed in A343. Applications are for core loss measurements (utilizing Model EPS 25 cms Epstein Frame or E and I cores), determination of DC hysteresis loops, measurements of total flux of hard magnets and magnet field strength, and AC permeability testing (with accessory Model MU mutual inductors). Test set compensated for internal power losses and core loss is read directly in watts without correction. Switch controlled instrumentation consists of a  $\pm 0.5\%$  accurate DC ammeter with 10 fs ranges from 30 ma to 30 amps, a  $\pm 0.75\%$  accurate overload protected AC/DC rms ammeter and voltmeter with 7 fs ranges from 50 ma to 5 amps and 5 fs ranges from 15 to 300 v (500 ohms/v) respectively; a  $\pm 0.5\%$  accurate AC average reading flux voltmeter with 5 fs ranges from 15 to 300 v (333 ohms/v); a  $\pm 0.75\%$  accurate AC/DC single phase (20% PF) wattmeter with ranges of 12.5/25/50/100 200 v and 0.2/0.4 amps (normal), 2/4 amps (max.); a  $\pm 1\%$  accurate DC fluxmeter with 5 ranges from 500,000 to 50,000,000 maxwells (sensitivity 10,000 lines/div. using a 1 turn search coil). 4" scale lengths. Compensated up to 500 cps.

Model COL is a production type magnetic test set designed specifically for AC measurements of core loss, excitation currents and permeability. It has the same AC measuring ranges but differs from the Model MAT in that it provides faster, easier operation at higher accuracy in these areas.

### DC Fluxmeters

Models FM (multirange) and FS (single range) are  $\pm 1\%$  accurate direct reading DC fluxmeters for the measurement of total magnetic flux in cgs lines, and use in related applications such as obtaining B-H curves and DC permeability testing. If area of search coil is known, readings can be converted to gauss. Model FM has 5 switch controlled ranges from 500,000 to 50,000,000 lines fs. Sensitivity is 1000 lines/div. using Model GPS, a 15 ohm 10 turn search coil with a 15 cms mean area and 1 1/4" center hole. Operation is independent of probe insertion speed. 5.2" scale length.

### Fluxmeter Calibrator

Model FC is a fluxmeter calibrator that provides  $\pm 0.2\%$  accurate calibration points from 100,000 to 50,000,000 flux linkages, for checking Model FM and FS fluxmeters, or any other fluxmeter or ballistic galvanometer designed for use with a 15 ohm external circuit. Model FCM is a 0.5% accurate standard 50,000 line magnet and special search coil for one point calibrations.

### Average Reading Flux Voltmeters

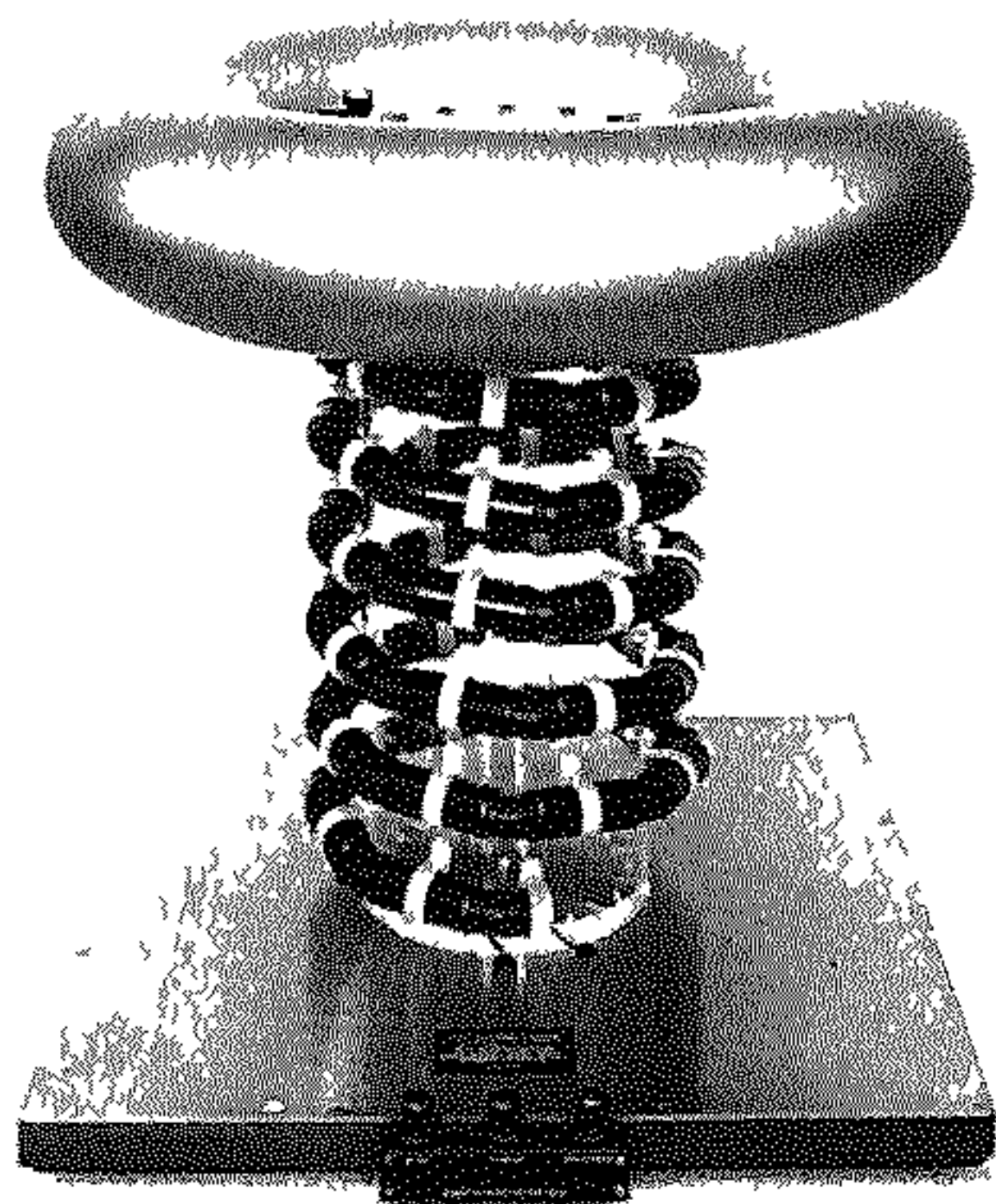
Models FLV ( $\pm 0.5\%$  accurate) and FLVC ( $\pm 0.25\%$  accurate) are full wave rectified average reading AC voltmeters calibrated in terms of the rms values of a sine wave. Designation as "flux voltmeters" arises from applications in magnetic measurements to determine the max. flux density (Beta) of transformer windings. Flux density in a magnetic core is proportional to the average value of the positive and negative half values of voltage. Near saturation flux density reading errors result in still larger core loss and exciting va errors. As many as 4 fs ranges available in various combs. from 5 to 300 v at 3333 or 1000 ohms/v, compensated from 25 to 1000 cps. 6.3" scale length.



# HIGH VOLTAGE MEASUREMENT

## *Sensitive Research\**

\*A TRADEMARK OF EIS



PARK

### High Voltage Divider

Model PARK Voltage Divider is constructed to a design by J. H. Park. (Ref: "Journal of Research" of National Bureau of Standards, Engineering and Instrumentation Vol. 66C, No. 1, Jan.—Mar., 1962. Reprints available upon request.) It is similar to the NBS standard employed in their calibration of high voltage instruments. Each 100 kv divider consists of 100 individually shielded one-megohm resistors, matched to each other to achieve an approximate temperature coefficient of less than 1 ppm/°C, and connected in series to form a vertical helix between a ground plate and a high voltage electrode. Uniquely shielded, testing indicates that corona, heating and leakage errors are less than 10 ppm at less than 10 ppm at 50 kv and 50 ppm at 100 kv.

The divider's special "hat" is designed to give uniform gradients from the high voltage electrode to ground and allows stacking of additional 100 kv units for higher voltage measurements. Each unit is only 22¼" high! DC Ratio Accuracy: ±.05%, 100 kv to 1 v; ±.5%, 100 kv to 1 kv. AC Ratio Accuracy: ±.5%, 50 kv (max.) to 500 v. (60 cps only). Recommended readout instrument at 1 v output tap is a precision DC potentiometer, at 1 kv tap (.5 kv on AC) recommended instrument is a ±.5% accurate electrostatic voltmeter (Sensitive Research Model ESD described below).



DCHI

### Special High Voltage Dividers

Based on experience with the many Park Dividers already manufactured and their proved reliability, special designs have been constructed and proposed. These special dividers are essentially the same as the Park except for such criteria as sensitivity and size. Designs up to 600 KV DC at ±1% accuracy have been constructed and successfully used by our customers. Dividers for use up to 1,000,000 volts are under consideration. Although most designs considered so far have been for single ranges, there is no particular objection to building a divider with several ranges. Present certification by NBS is limited to 100 KV but higher ranges can be calibrated by "bootstrapping" methods.

### DC Kilovoltmeter (multirange)

Model DCHI is a multirange permanent magnet moving coil, DC kilovoltmeter. Available at 50,000 ohms/v, ±1% fs accuracy, ranges of 1.5/3/7.5/15 kv or 3/7.5/15/30 kv, and at 75,000 ohms/v, ±.5% fs accuracy, ranges of 2/5/10/20 kv. The indicator is a University Model ±.5% accurate microammeter with a 4" scale length. It is self-contained in a moulded bakelite case and internally bracketed to the instrument panel. Size: 13¾" x 7½" x 8" h.



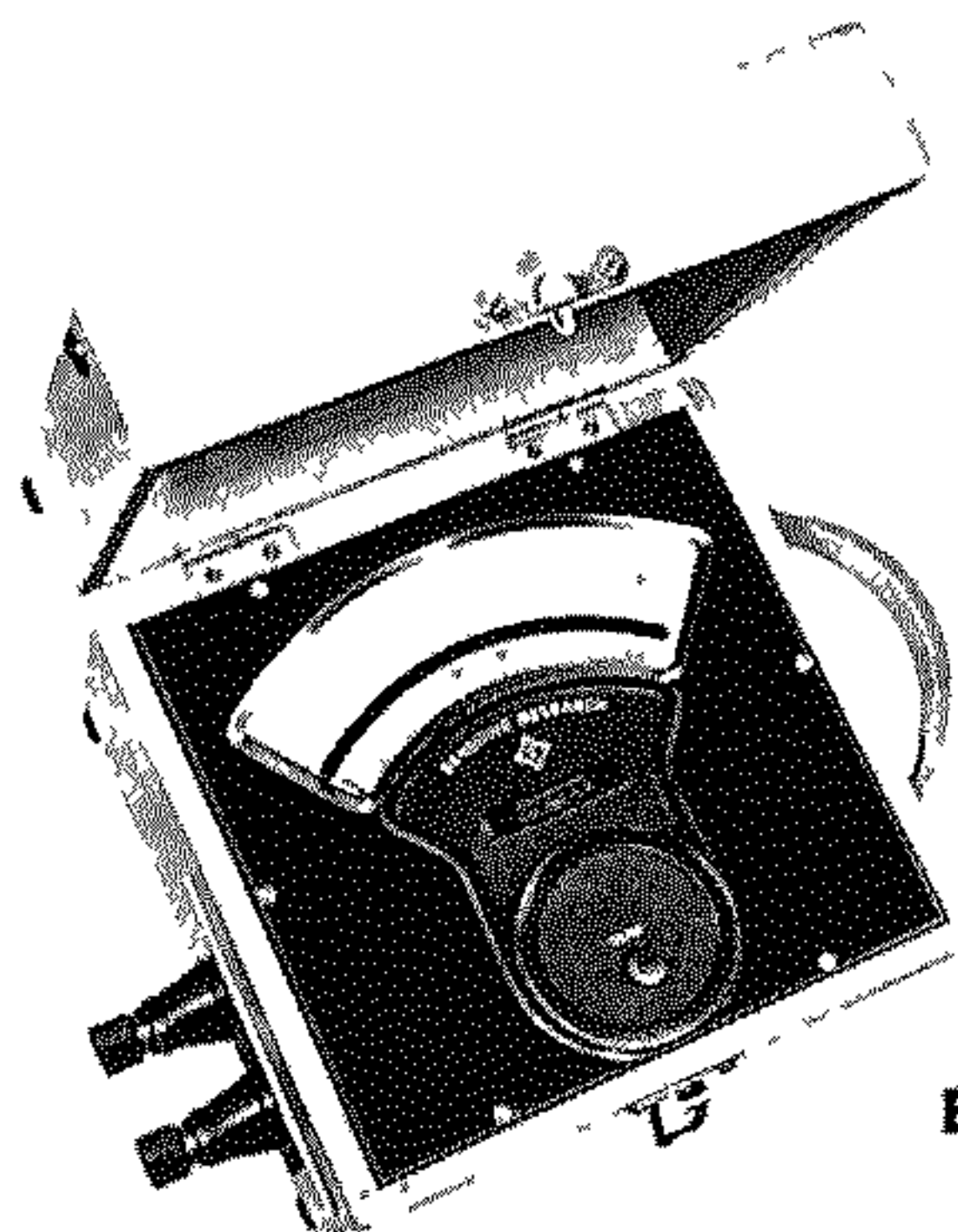
ESH

### Electrostatic Voltmeter (high voltage)

Model ESH AC/DC electrostatic voltmeter is available as a single range instrument up to 100 kv fs (140 kv DC only), or with as many as 4 switch-controlled ranges from 5 to 50 kv fs. DC input resistances to  $5 \times 10^{15}$  ohms. Capacitance varies from approx. 30 mmfd on 5 kv range to 10 mmfd on 50-100 kv ranges. Reads true RMS. Accuracy is ±1% fs (±.5% up to 30 kv on special order). 6" scale length. Transit lock and brackets for panel mounting available. Maximum frequency usage is expressed as follows:  $f = 2 \sqrt{CE}$ , where  $f = \text{max. allowable operating frequency}$ ,  $C = \text{capacitance of instrument in farads}$ ,  $E = \text{voltage in volts}$ .

### Electrostatic Voltmeter (portable)

Model ESD portable AC/DC electrostatic voltmeter is available as a single or multirange instrument to measure from 120 to 6 kv fs. Insulation resistance is  $1 \times 10^{15}$  ohms. Capacitance varies from approx. 225 mmfd for a 120 v range to 20 mmfd for a 6 kv range. Multirange instruments are designed for AC/DC measurements on first range, AC only on higher ranges. ±.5% to 1% fs accuracy (±1.5% for ranges of 150 v and less). 5.2" scale length. Size: 7¾" x 7½" x 6¼". Available as edgewise panel instrument with the same performance characteristics except insulation resistance approx.  $1 \times 10^{13}$  ohms.



ESD

### Electrostatic Voltmeter (small portable)

University Model is a smaller, more economical version of the portable Model ESD. Single and multirange instruments available from 300 v to 5 kv fs. ±1% fs accuracy. 4" scale length. Moulded bakelite case. Size 5¼" x 5" x 4¾".

**SENSITIVE RESEARCH PRODUCTS — Mfd. by ELECTRICAL INSTRUMENT SERVICE, INC.**



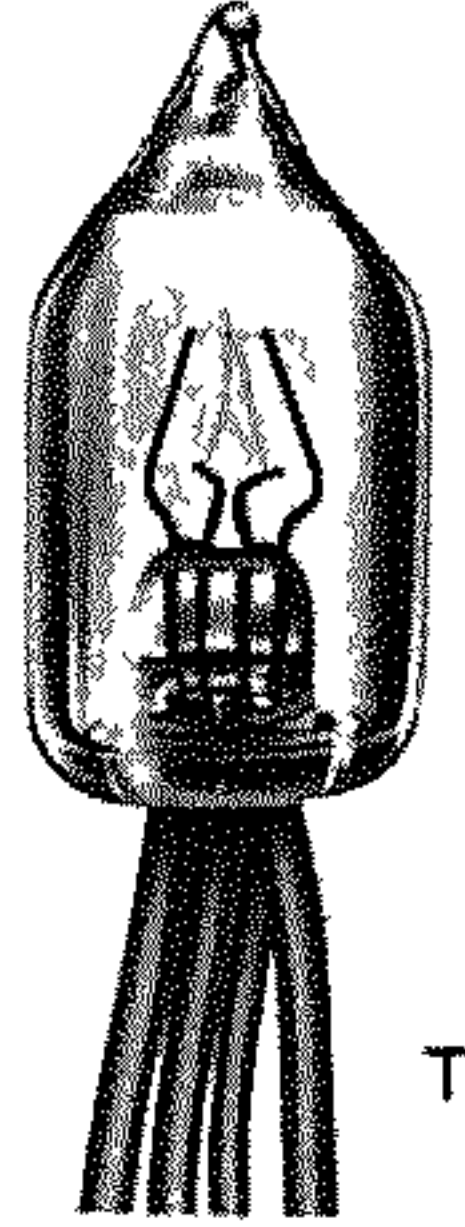
# Sensitive Research\*

\* A TRADEMARK OF EIS

## INSTRUMENT ACCESSORIES

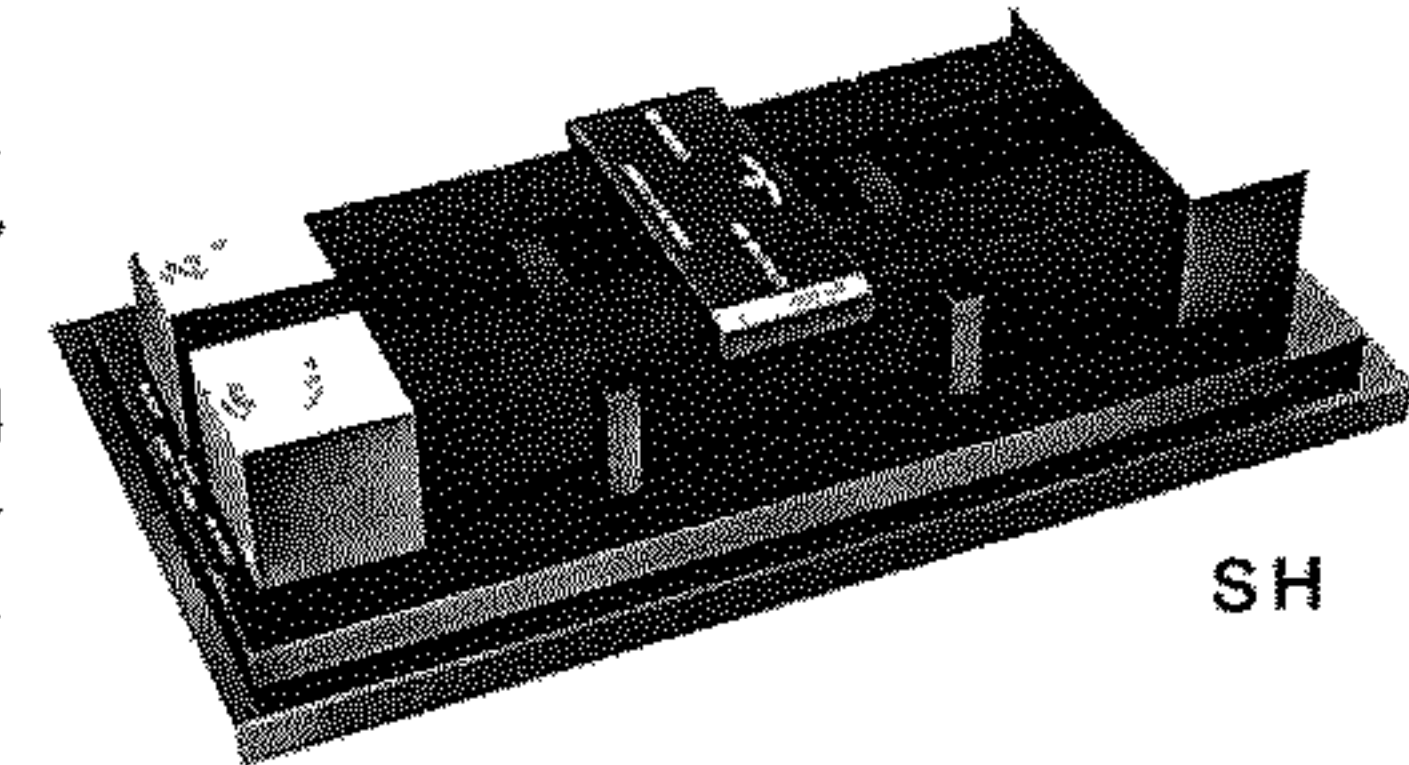
### Thermoelements

Model T are vacuum thermoelements with normal current ratings from 1 ma to 500 ma. For use up to 100 Mc/s. Can be supplied case mounted and/or with isolated heaters. DC reversal as low as  $\pm 0.01\%$ . Accuracy is dependent on frequency range and type. Model TX contact type thermoelements are mounted in air for heavy current measurements from 1 to 100 amps.



### Current Transformers

Model TR, current transformers, (25 to 500 cps) extend the ranges of AC indicating instruments. Type 1 has a ratio accuracy of  $\pm 0.25\%$  and is mainly for use with ammeters having a burden lower than 5 va. Type 2 has a ratio accuracy of  $\pm 15\%$ , lower phase angle errors, 15 va allowable loading, and is suitable for use with wattmeters or ammeters having a relatively high burden. Primary ranges are 10/20/50/100/200/400/800 to a 5 amp secondary.



### Heavy Current Shunts

Model SH is a  $\pm 0.1\%$  accurate (0.05% on special order), 4 terminal, 50, 100 or 300 mv drop, laboratory standard, manganin shunt designed for continuous duty. Ratings available up to 1000 amps.

### Voltage Multiplier

Model MUL is  $\pm 0.1\%$  accurate (0.05% on special order) voltage multiplier to extend the range of a voltmeter or be placed in series with a microammeter or milliammeter to create voltage ranges. Multirange combinations available up to 10 kv at 10,000 ohms/v (up to 1 megohm/v on special order).

### Unsaturated Miniature Standard Cell

Model STC is a  $\pm 0.025\%$  accurate unsaturated standard cell. Temperature coefficient is  $-0.0001\text{v}/^\circ\text{C}$ . Internal resistance is below 1200 ohms. Available mounted ( $3\frac{1}{4}$ " dia. x 3" high) or unmounted (1" W x 3" L).

## WORLD-WIDE REPRESENTATION

#### • ARIZONA

Williams-Associates, Inc.  
7520 E. 2nd Street  
Suite #5  
Scottsdale, Az. 85251  
(602) 947-4287  
TWX: 910-950-1187

#### • COLORADO NEBRASKA & WYOMING

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Denver, Co. 80239  
(303) 373-4730  
TWX: 910-932-0121

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Measurement Consultants Corp.  
523 Main Street  
New Canaan, Ct. 06840  
(203) 966-4630

#### • ILLINOIS & INDIANA

Saffro & Associates, Inc.  
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Evanston, Il. 60201  
(312) 328-0140

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Shawnee Mission, Ks 66202  
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TWX: 910-743-4172

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Measurement Consultants Corp  
181 West Street  
Waltham, Ma. 02154  
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Comtel Instruments Co.  
17500 W. McNichols Road  
Detroit, Mi. 48235  
(313) 255-1970

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420 Washington Avenue S.E.  
Albuquerque, N.M. 87108  
(505) 255-1638  
TWX: 910-989-0622

#### • NEW YORK (Metropolitan Area) NEW JERSEY

Electrical Instrument Service, Inc.  
25 Dock Street  
Mount Vernon, N.Y. 10550  
(914) 699-9717

#### • NEW YORK (Upstate)

The Robert F. Lamb Co., Inc.  
P.O. Box 5083  
Albany, N.Y. 12205  
(518) 869-3355

The Robert F. Lamb Co., Inc.  
1865 Kenmore Avenue  
Buffalo, N.Y. 14217  
(716) 874-4900  
TWX: 710-522-1808

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The Robert F. Lamb Co., Inc.  
4515 Culver Road  
Rochester, N.Y. 14622  
(716) 544-5580

The Robert F. Lamb Co., Inc.  
160 Pickard Bldg., East Molloy Road  
Syracuse, N.Y. 13211  
(315) 454-2469

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Comtel Instruments Co  
5827 Mayfield Road  
Cleveland, Oh. 44124  
(216) 442-8080  
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Comtel Instruments Co.  
Kettering P.O. Box 2036  
1717 Big Hill Road  
Dayton, Oh. 45439  
(513) 298-7573  
Telex: 28-8249

#### • OKLAHOMA & ARKANSAS

Data Marketing Associates, Inc.  
2401 N.W. 39 Expressway  
Suite 103  
Oklahoma City, Ok. 73112  
(405) 528-6071

#### • PENNSYLVANIA (Western) & W. VIRGINIA

Comtel Instruments Co  
No. 2 Parkway Center  
Pittsburgh, Pa. 15220  
(412) 922-5720

#### • TEXAS

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300 E. Huntland Drive, Suite 210  
Austin, Tx. 78752  
(512) 451-5174

Data Marketing Association, Inc.  
14235 Proton Road  
Dallas, Tx. 75240  
(214) 661-0300

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Data Marketing Association, Inc.  
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#### • WISCONSIN (Eastern)

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P.O. Box 79  
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268081  
Telex: 011-2369

#### • ITALY

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Piazza De Angeli 7  
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49.82.451  
Telex: 332033 Nucleo I

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Telex: 053380

Matsushita Electric Trading Co., Inc.  
30th Floor World Trade Center Bldg. 4-1  
Hamamatsu-cho, Minato-ku  
Tokyo 105, Japan  
(435) 4501  
Telex: J24647

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Ex-Im Mexicana, S.A.  
Apartado / P.O. Box 32-1003  
Reforma 95-704  
Mexico 4, D.F.  
566-8226  
Telex: 017 77223

#### • TAIWAN

Industrial Electronics  
P.O. Box 22423  
Taipei, Taiwan  
(02) 771-4257  
Telex: 23612 LEOTRONX



# ELECTRICAL INSTRUMENT SERVICE, INC.

25 Dock Street, Mt. Vernon, N. Y. 10550 • Phone 914 OW 9-9717

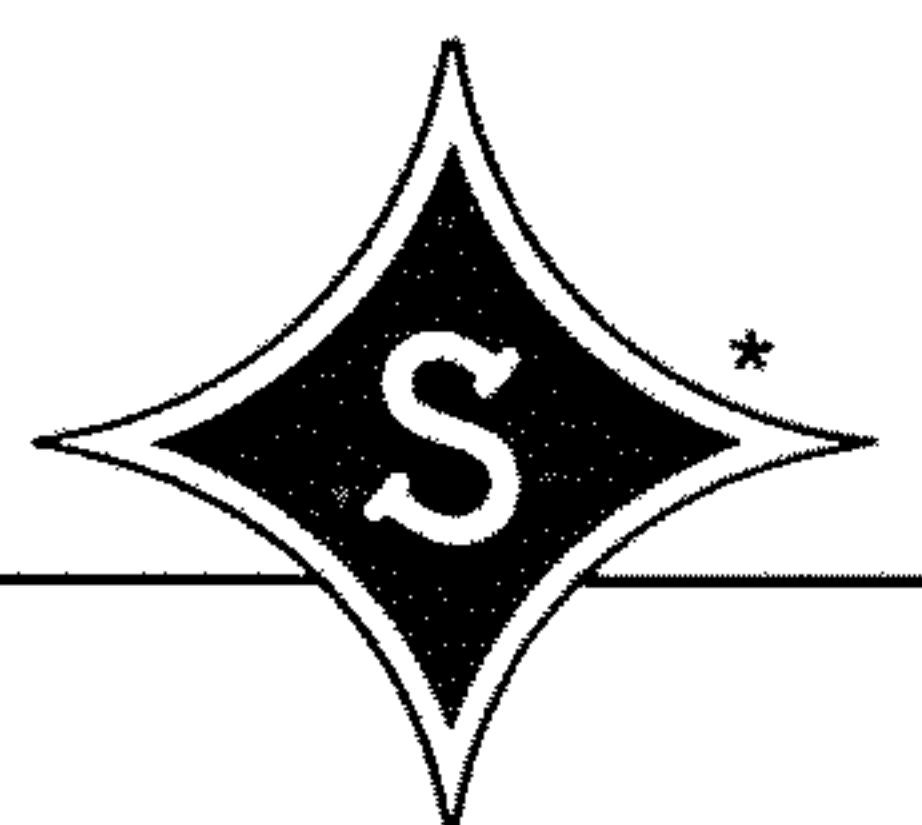


# AC, DC and AC/DC LABORATORY STANDARDS



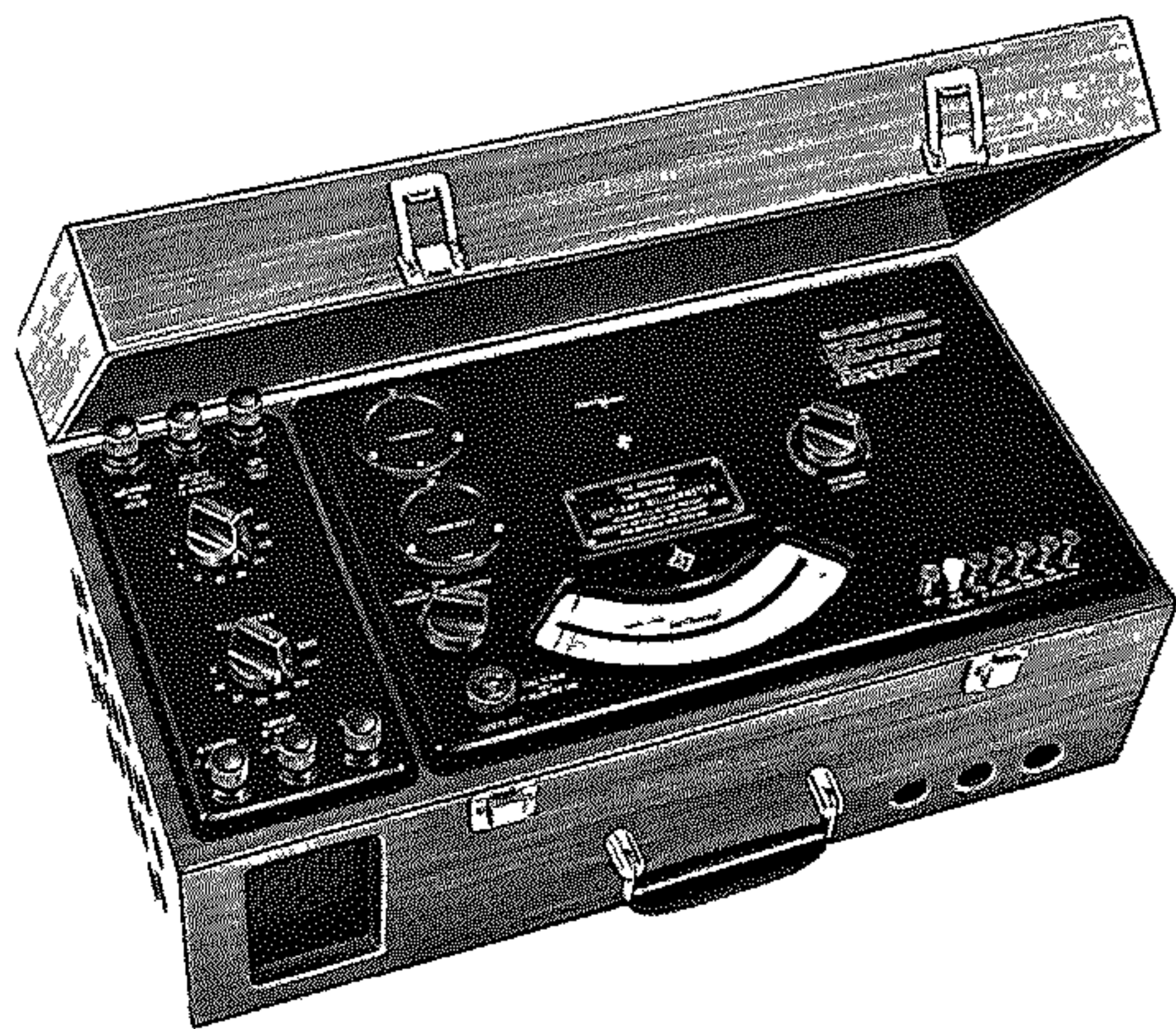
Model	Description	Page
THACH	0.2% AC/DC "Self Checking" Volt-Amp-Milliammeter. 6.3" scale length	2
DYL	0.15% AC Laboratory Standard Volt-Amp-Milliammeter. 12" scale length	2
L	0.1% AC/DC Laboratory Standard Ammeters, Milliammeters and Voltmeters. 12" scale length	3
LW	0.1% AC/DC Laboratory Standard Wattmeter. 12" scale length	3
B	0.1% DC Laboratory Standard Millivoltmeters, Voltmeters, Milliammeters and Ammeters	4
STV	0.01% Electronic Voltage Source	4

*Prices and specifications subject to change without notice.*





**AC/DC "SELF CHECKING  
VOLT—AMP—MILLIAMMETER  
MODEL THACH**



**CAPABILITIES**

The Model THACH measures both voltage and current, AC or DC, at an accuracy of  $\pm 0.1\%$  of fs at "self check" points and  $\pm 0.2\%$  elsewhere on the scale. This model is available in three styles known as combinations which describe their self checking system. The Combination 1X references an unsaturated cell and only the full scale point can be self checked. The combination 3X is identical to the 1X except that it gives self check points at 100%, 90%, 80%, 70% and 60% of fs. The Combination 5X has the same self check points as the Combination 3X but it references an electronic voltage standard instead of an unsaturated cell. All combinations include a manually operated "Push-to-read" thermocouple overload protection system which permits safe overloads up to 1,000%. Each instrument is equipped with 2 thermoelements. Separate scales are drawn for each and are selected by switch.

**SPECIFICATIONS AND PRICES**

**Scale Length:** 6.3"

**Case:** Formica; 20<sup>1</sup>/<sub>4</sub>" x 10<sup>1</sup>/<sub>2</sub>" x 8" h for comb. 5X.

**Weight:** 33 lbs. net; 90 lbs. shipping for comb. 5X.

**Frequency:** DC and 7 cps to 4 kc (no frequency error except ranges of 2 amps, 5 amps and 1000 v have an upper limit of 2.5 kc)

**RANGES**

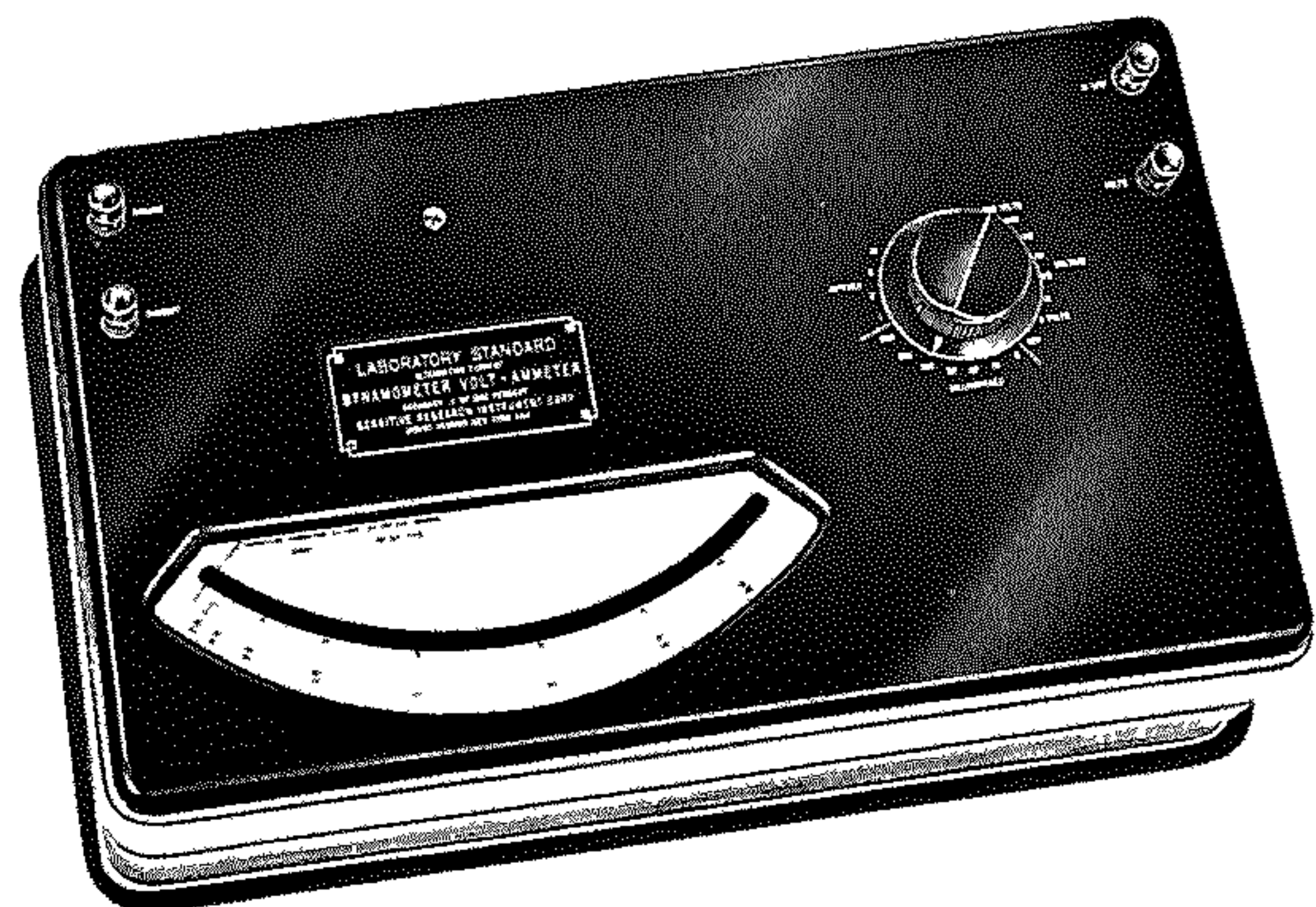
<b>Voltage:</b>	1	2	5	10	20	50	100	200	500	1000v AC/DC
<b>Sensitivity:</b>	100 $\Omega$ /v									
<b>Current:</b>	10	20	50	100	200	500 ma	1	2	5 amps AC/DC	
<b>Approx. Resist.:</b>	30	37.5	20.4	11.1	5.8	2.4	1.2	.5		.24 $\Omega$

Comb.	Code	Description
1X	DELABACHEK	Self Checking at full scale. Internal standard cell and galvanometer
3X	DEMULTILAB	Self Checking at 60%, 70%, 80%, 90% and 100% of full scale. Internal standard cell and galvanometer
5X	DEMULTISTV	Self Checking at 60%, 70%, 80%, 90% and 100% of full scale. Internal Zener diode reference source

**ACCESSORIES**

1. Replacement or spare thermocouples.
  - a. Calibrated type can only be supplied when the particular Model THACH is on hand at our factory for matching...  
... Specify: Model TH-10M....
  - b. Uncalibrated type is supplied with preadjusted "makeup" resistors and its characteristic output might vary enough from the particular THACH to require redrawing of the scale... Specify: Uncalibrated Model THACH replacement thermocouple and give THACH serial number...  
If two or more uncalibrated thermocouples are required which are matched to each other an additional matching charge of \$25.00 applies to the second and subsequent thermocouples.
2. Replacement unsaturated standard cells with standard resistors for field installation in the THACH combination 1X or 3X... Specify: Model STC, Code: ACSTEL...
3. Voltage multipliers are available. Specify range extension required and operating frequency if for AC.

**AC VOLT—AMP—MILLIAMMETER  
MODEL DYL**



**CAPABILITIES**

The Model DYL offers best possible measuring accuracy for common AC voltages and currents. It is particularly useful as an AC standard when calibrating 0.25% (or worse) instruments because no AC/DC transfers are necessary.

**SPECIFICATIONS AND PRICES**

**Ranges:** 20/50/100/200/500 Volts  
10/20/50/100/200/500 MA  
1/2/5/10 AMPS

**Scale Length:** 12"

**Accuracy:**  $\pm 0.15\%$  of fs

**Frequency:** 50 cps to 70 cps

**Type:** Transformer coupled Electrodynamometer

**Sensitivity:** Approx. 0.3 watts all current ranges. 10 watts all voltage ranges.

**Case:** Walnut; 24" x 14" x 8" h

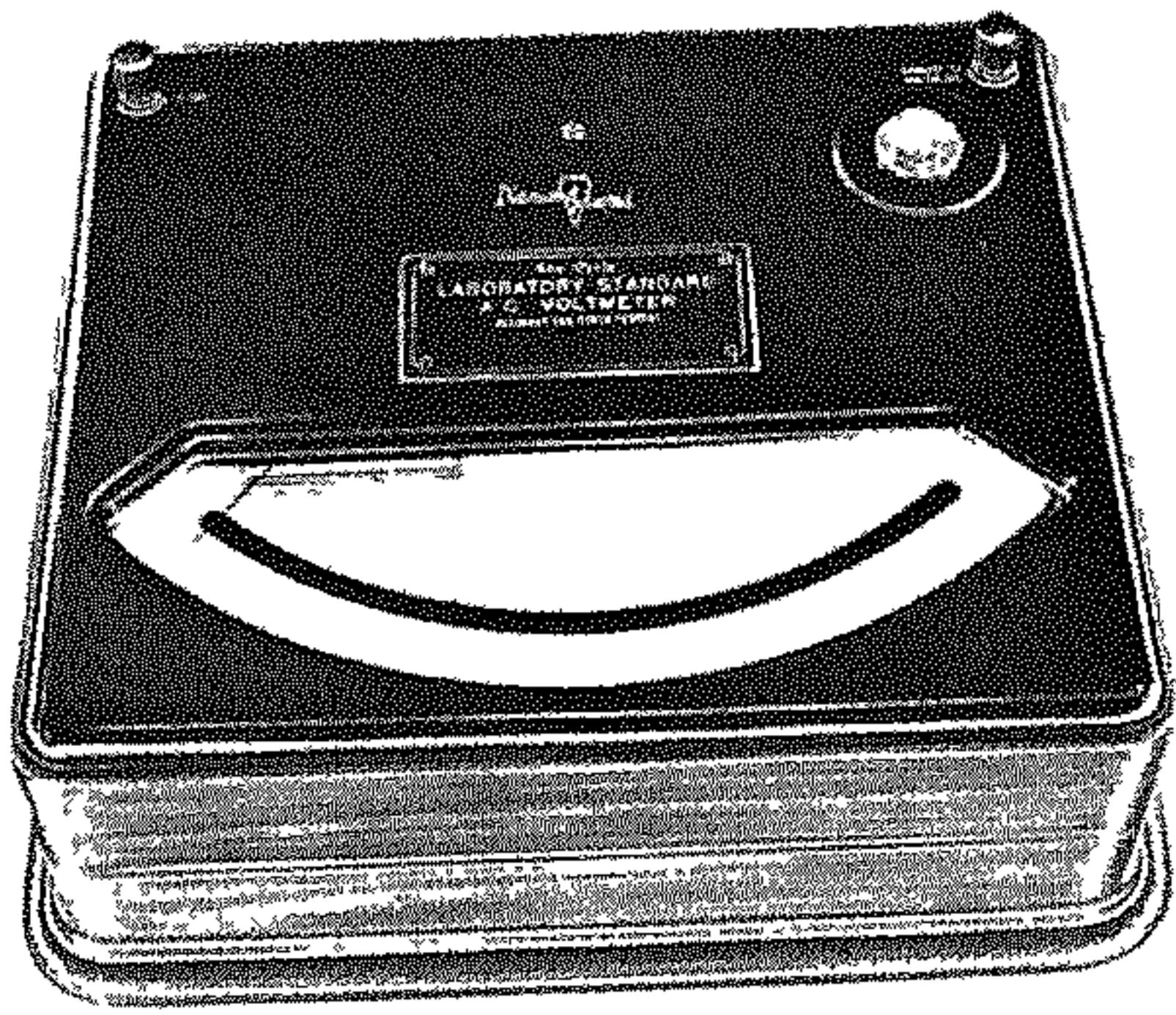
**Weight:** Approx. 30 lbs. net; 50 lbs. shipping

.. Specify: Model DYL... Code:

DYNLAB-S



## AC/DC LABORATORY AMMETERS MILLIAMMETERS AND VOLTMETERS MODEL L



### CAPABILITIES

The Model L is an electro-dynamometer type indicating standard which can be supplied to measure either current or voltage at an accuracy of  $\pm 0.1\%$  of full scale. All voltmeters, ammeters, and those milliammeters above 300 milliamperes are supplied with separate boxes to mount multipliers or shunts.

### SPECIFICATIONS AND PRICES

Scale Length: 12"

Case: Formica 16 1/2" x 14 1/2" x 5" h (Ext. boxes 12" x 9" x 5" h).

Weight: 17 lbs. net; 50 lbs. shipping (Ext. boxes when supplied add up to 25 lbs. shipping).

#### MILLIAMMETERS

DC and 25 cps to 125 cps				DC and 50 cps to 400 cps	
Range	Approx. Burden in VA at 60 Cycles	Scale Div.	Code	Code	Approx. Burden in VA at 60 Cycles
50 100	2	100	LABMIL	LABMIL-X	50
75 150	3	150	LABNOT	LABNOT-X	50
100 200	4	100	LABNAK	LABNAK-X	40
150 300	3	150	LABMOR	LABMOR-X	40
500 1000	3	100	LABMUD	LABMUD-X	40
750 1500	6	150	LABMEX	LABMEX-X	40

#### AMMETERS

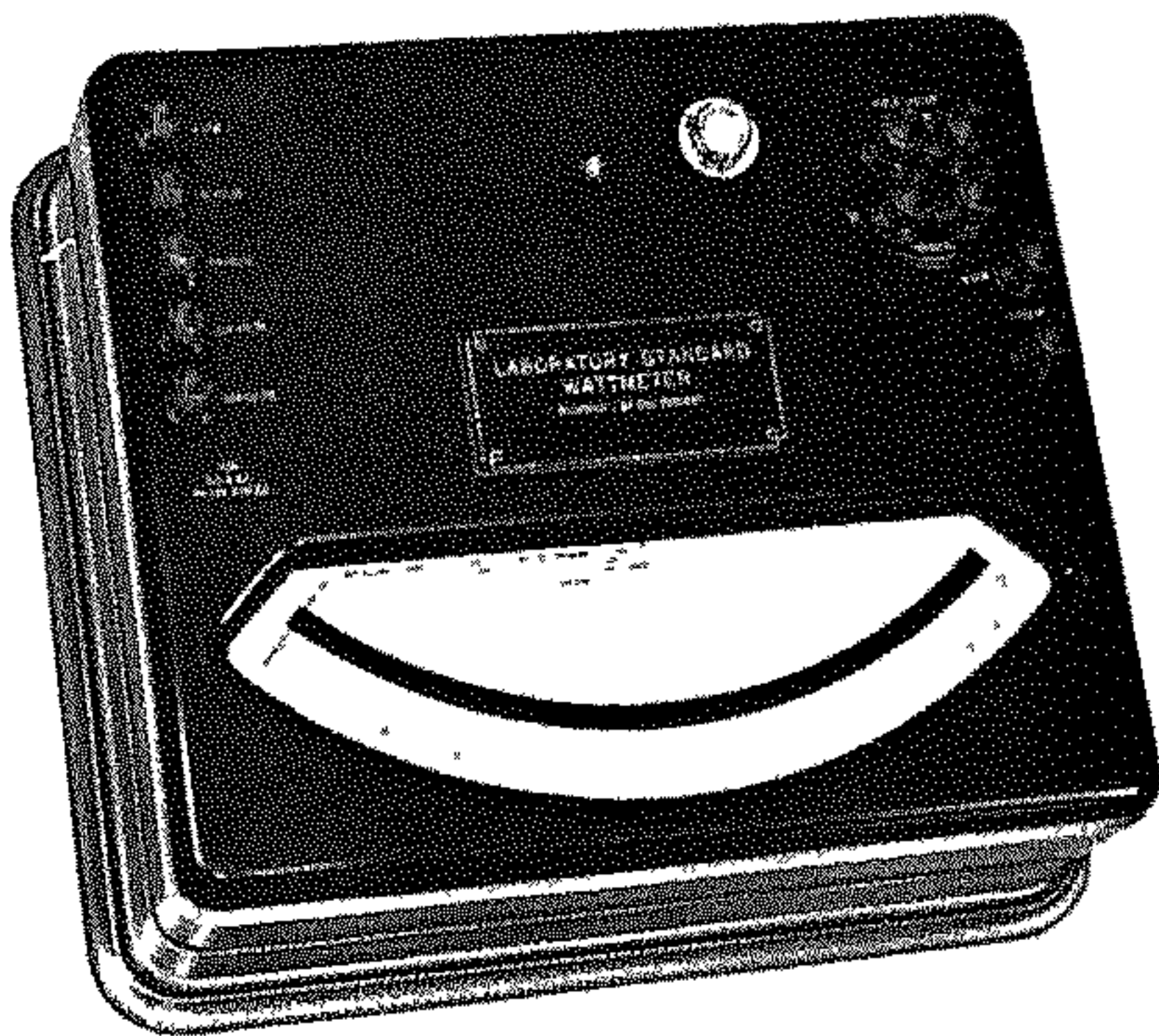
Range	Approx. Burden in VA at 60 Cycles	Scale Div.	Code	Code	Approx. Burden in VA at 60 Cycles
1 2	6	100	LABAST	LABAST-X	40
1.5 3	9	150	LABAMP	LABAMP-X	40
2.5 5	10	125 100	LABAMK	LABAMK-X	40
5 10	15	100	LABAMI		
7.5 15	26	150	LABAMU		
10 20	24	100	LABAMO		

DC and 25 cps to 125 cps			
Range	Approx. $\Omega/v$	Scale Div.	Code
75/150/300	22	150	LABVOI
30/75/150/300	20	150	LABVOL
50/100/200/500	24	100	LABVOM
75/150/300/750	22	150	LABVOS
100/200/500/1000	44	100	LABVOX

#### VOLTMETERS

DC and 50 cps to 400 cps			
Range	Approx. $\Omega/v$	Scale Div.	Code
30 75 150	6	150	LABVOP-X
50 100 200	10	100	LABVOK-X
75 150 300	10	150	LABVOI-X
100 200 500	18	100	LABVOA-X
150 300 750	20	150	LABVOB-X
200 500 1000	30	100	LABVOC-X

## AC/DC LABORATORY STANDARD WATTMETER MODEL LW



### CAPABILITIES

The Model LW is a  $\pm 0.1\%$  of full scale, single phase, AC/DC Laboratory Standard, Electro-dynamometer Wattmeter that is used primarily in the calibration of other wattmeters. It is also very useful in the precision measurement of power, when the power factor is no lower than 80%, from 25 watts to 6,000 watts.

### SPECIFICATIONS AND PRICES

Scale Length: 12"

Case: Formica 16 1/2" x 14 1/2" x 5" h (Ext. boxes 12" x 9" x 5" h).

Weight: 17 lbs. net; 50 lbs. shipping (Ext. boxes when supplied add up to 25 lbs. shipping).

Frequency: DC and 25 to 125 cps

Overload Rating: Normal current ranges 20%  
Potential ranges 25%

#### RANGES

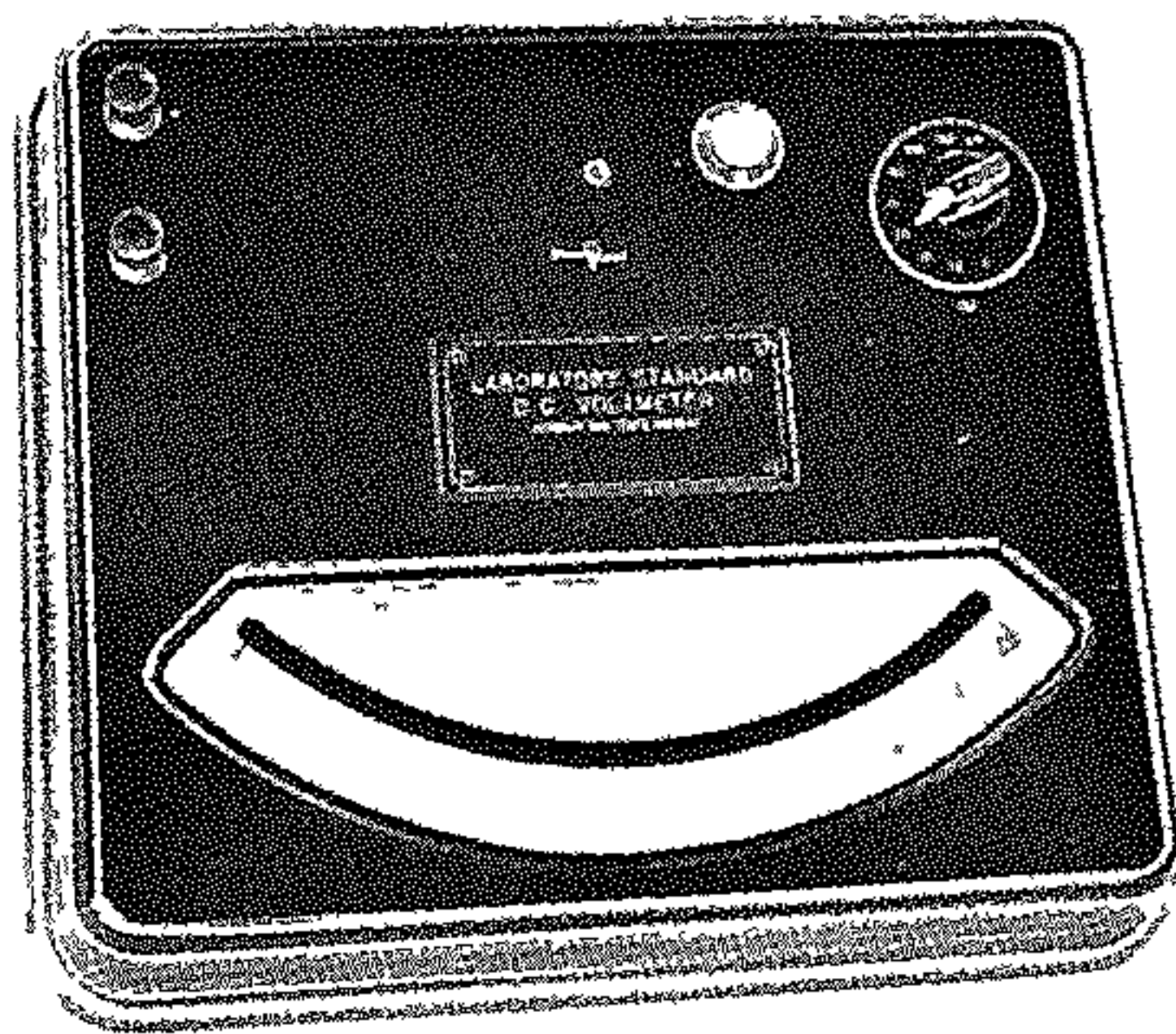
Note: Watt ranges are obtained by cross multiplying potential ranges and normal current ranges. To assist the reader, the instruments below have their watt ranges listed in separate columns headed by the potential ranges which provide them.

WATT RANGES			CURRENT RANGES				Scale Div.	Range Printed*	CODE
75 Volts	150 Volts	300 Volts	Normal		Maximum				
			Series	Parallel	Series	Parallel			
25 50	50 100	100 200	.33	.66	.4125	.825	100	100	LWATTO
37.5 75	75 150	150 300	.5	1.0	.625	1.25	150	75	LWATAM
75 150	150 300	300 600	1	2	1.25	2.50	150	150	LWATER
187.5 375	375 750	750 1500	2.5	5	3.125	6.25	150	750	LWATHY
250 500	500 1000	1000 2000	3.33	6.66	4.1625	8.325	100	1000	LWATIS
375 750	750 1500	1500 3000	5	10	6.25	12.50	150	750	LWATJA
500 1000	1000 2000	2000 4000	6.66	13.33	8.325	16.6625	100	1000	LWATKO
750 1500	1500 3000	3000 6000	10	20	12.50	25.00	150	1500	LWATLU

\*An additional scale can be drawn and printed at a surcharge of \$125.00



**DC LABORATORY STANDARD  
MODEL B**



**SPECIFICATIONS AND PRICES**

**Accuracy:**  $\pm 0.1\%$  of full scale

**Scale Length:** 12" vernier

**Some Commonly Used Ranges Are:**

**MICROAMMETERS**

Range	Scale Div.	Code
*30	150	BAMICO
50	100	BAMICH
100	100	BAMICY

*Any single range microammeter from 150  $\mu$ a full scale.*

**MULTIRANGE MILLIAMMETERS**

Range	Scale Div.	Code
*.03/.15/.3/1.5/3/15/30/150/300	150	BAMILXO
.05/.1/.5/1/5/10/50/100	100	BAMILJI
.1/5/1/5/10/50/100/500	100	BAMILEK
.5/1/5/10/50/100/500/1000	100	BAMILUK
.3/.75/1.5/3/7.5/15/30/75/150	150	BAMILOP
1/2/5/10/20/50/100/200/500/1000	100	BAMILOO
1.5/3/7.5/15/30/75/150/300/750/1500	150	BAMILEE

\* Accuracy for these ranges is  $\pm 0.15\%$  of fs.

**SINGLE RANGE MILLIAMMETERS**

Any single range milliammeter from 1 ma full scale,

**AMMETERS**

Range	Scale Div.	Code
.3 1.5 3.15 30	150	BAANKET
5 10 20 50	100	BAAMEX

**MILLIVOLTMETERS**

Range*	Scale Div.	Code
50	100	BAMVLT
100	100	BAMVOK
50 100	100	BAMVPS

**VOLTMETERS**

Range	Scale Div.	Code
3/7.5/15/30/75/150/300	150	BAVOST
3/7.5/15/30/75/150/300/750	150	BAVOKI
5/10/20/50/100/200/500/1000	100	BAVOMO

*Sensitivity of voltmeters is approximately 1000  $\Omega$ /1.*

All ammeters are supplied with external matching shunt boxes, 12" x 9" x 5" h. Approximate maximum weight: 12 lbs. net; 16 lbs. shipping.

**Case:** Formica 16 $\frac{1}{2}$ " x 14 $\frac{1}{2}$ " x 3"

**Weight:** Approx. 17 lbs. net; 42 lbs. shipping.

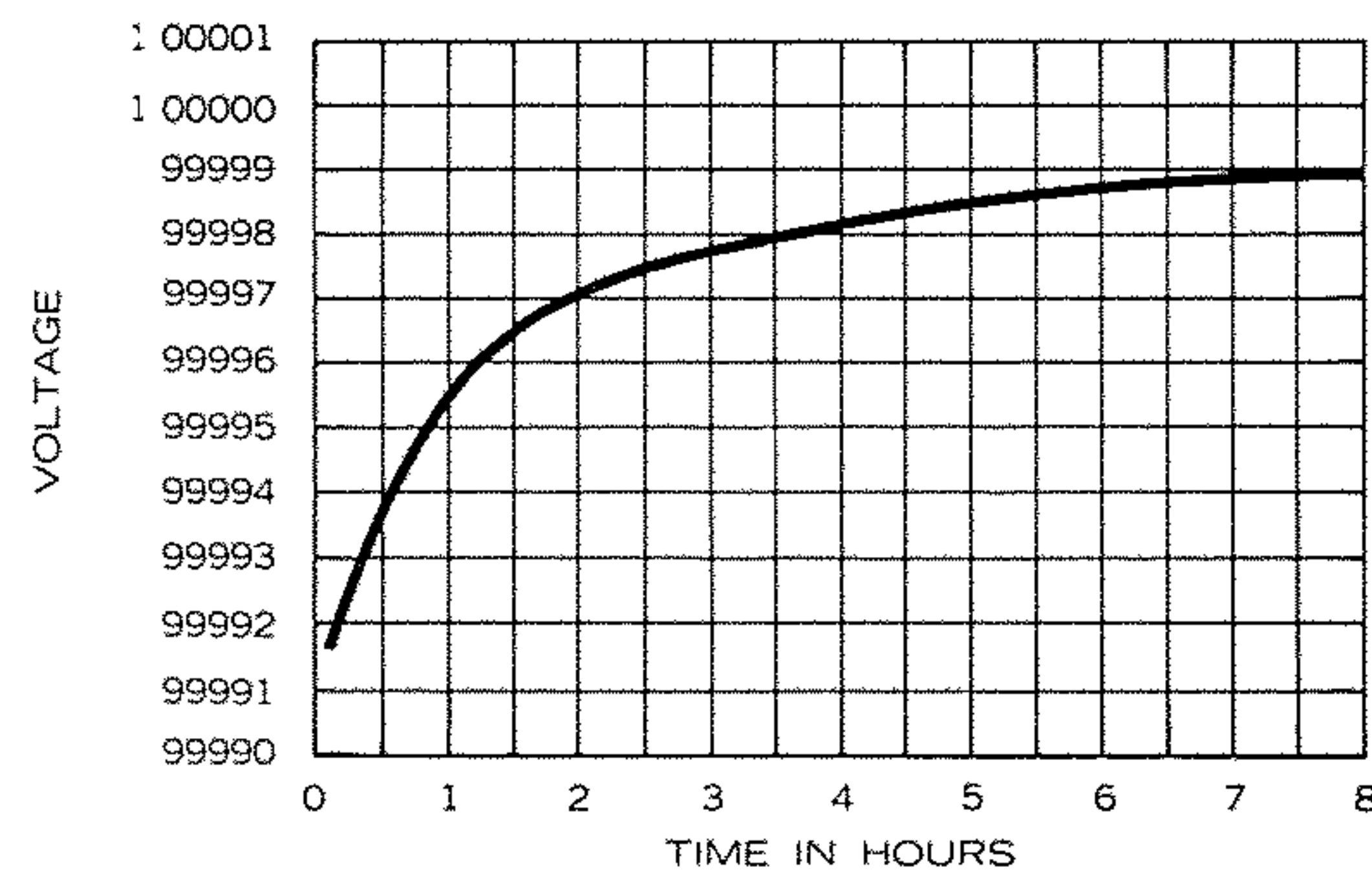
**ELECTRONIC VOLTAGE SOURCE  
MODEL STV**



**CAPABILITIES**

The Model STV is a zener diode stabilized source of standardizing voltage and is primarily intended for use with potentiometers and other infinite impedance devices. Although this instrument can be adjusted for use as a standard current source, its prime intention is to replace the standard cell for relatively short term use. By means of a screwdriver adjustment, the output can be adjusted to within 10 microvolts of the rated output. It is recommended that this adjustment be made every 30 days or less for greatest assurance.

TYPICAL WARM-UP CURVE SHOWING VOLTAGE VARIATION WITH TIME



**SPECIFICATIONS AND PRICES**

**Nominal Output:** 1.0000 V & 1.0185 V DC

**Output Accuracy:**  $\pm 0.01\%$  of nominal output

**Output Stability:**  $\pm 0.01\%$  of actual output for 30 days

**Input:** 100 to 130 V AC, 60 cps, (25VA)

**Line Voltage Stability:** 0.002% of actual output for 100-130 volt input

**Temperature Coefficient:**  $\pm 0.001\%$  per  $^{\circ}$ C from 20 $^{\circ}$ C to 30 $^{\circ}$ C

**Operational Life:** 25,000 hrs. minimum

**Case:** Formica; 9 $\frac{3}{8}$ " x 7 $\frac{5}{8}$ " x 5" h

**Weight:** 10 lbs. net; 24 lbs. shipping



# AC, DC and AC/DC LABORATORY STANDARDS

PRICE LIST NOVEMBER 1, 1980

**AC/DC VOLT AMMETER — MODEL THACH**

Voltage:	1	2	5	10	20	50	100	200	500	*1000v AC/DC
Sensitivity:	100 Ω/v									
Current:	10	20	50	100	200	500ma	1	*2		
Approx. Resist.:	30	37.5	20.4	11.1	5.8	2.4	1.2	.5Ω		
	*5 amps AC/DC .24Ω									

\*Frequency on these ranges is limited to 2.5 kHz for full accuracy.

COMB.	CODE	DESCRIPTION	PRICE
1X	DELABACHEK	Self Checking at full scale. Internal standard cell and galvanometer	\$1656
3X	DEMULITLAB	Self Checking at 60%, 70%, 80%, 90% and 100% of full scale. Internal standard cell and galvanometer	2118
5X	DEMULISTV	Self Checking at 60%, 70%, 80%, 90% and 100% of full scale. Internal Zener diode reference source	2460

**AC VOLT-AMMETER — MODEL DYL**

RANGE	CODE	PRICE
20/50/100/200/500 volts 10/20/50/100/200/500 MA 1/2/5/10 Amps	DYNLAB-S	\$2850

**AC/DC MILLIAMMETER — MODEL L**

CODE	PRICE
LABMIL	\$1225
LABNOT	1225
LABNAK	1225
LABMOR	1225
LABMUD	1225
LABMEX	1240

**AC/DC VOLTMETER — MODEL L**

CODE	PRICE
DC & 25-125 Hz	
LABVOI	\$1290
LABVOL	1430
LABVOM	1455
LABVOS	1455
LABVOX	1520

**AC/DC MILLIAMMETER — MODEL L**

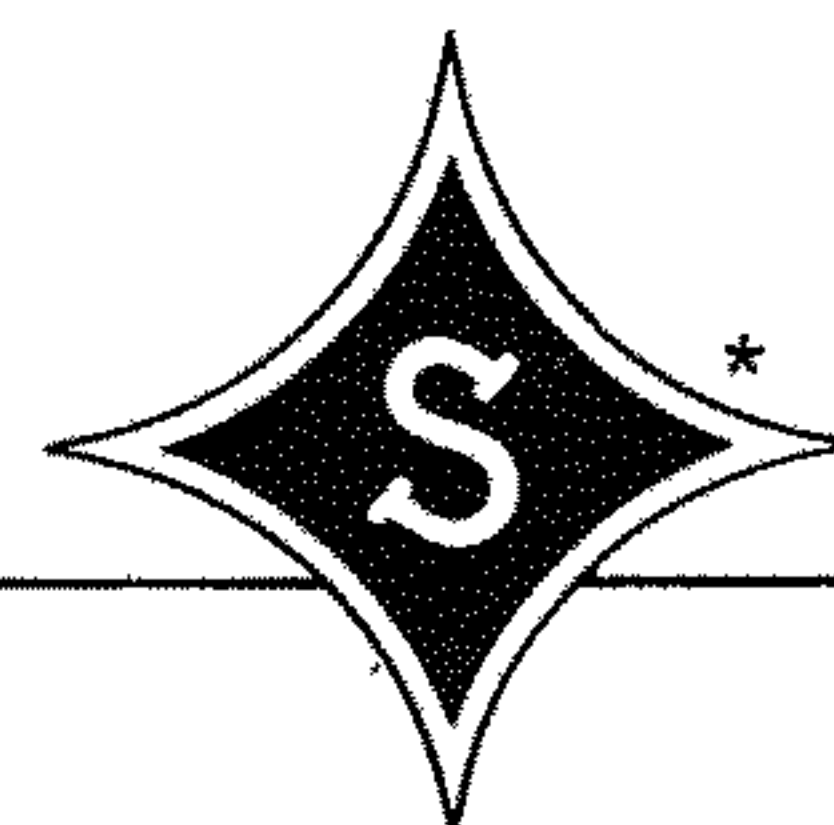
CODE	PRICE
LABMIL-X	\$1530
LABNOT-X	1530
LABNAK-X	1530
LABMOR-X	1530
LABMUD-X	1530
LABMEX-X	1545

**AC/DC VOLTMETER — MODEL L**

CODE	PRICE
LABVOP-X	\$1480
LABVOK-X	1595
LABVOI-X	1630
LABVOA-X	1700
LABVOB-X	1760
LABVOC-X	1820

**AC/DC AMMETER — MODEL L**

CODE	PRICE
LABAST	\$1247
LABAMP	1247
LABAMK	1247
LABAMI	1305
LABAMU	1305
LABAMO	1305
LABAST-X	\$1550
LABAMP-X	1550
LABAMK-X	1625





## AC/DC LABORATORY STANDARD WATTMETER

### MODEL LW

#### CAPABILITIES

The Model LW is a  $\pm 0.1\%$  of full scale, single phase, AC/DC Laboratory Standard, Electrodynamometer Wattmeter that is used primarily in the calibration of other wattmeters. It is also very useful in the precision measurement of power, when the power factor is no lower than 80%, from 25 watts to 6,000 watts.

#### SPECIFICATIONS AND PRICES

**Scale Length:** 12"

**Case:** Formica 16 1/2" x 14 1/2" x 5" h

**Weight:** 17 lbs. net; 50 lbs. shipping (Ext. boxes when supplied add up to 25 lbs. shipping).

**Frequency:** DC and 25 to 125 cps

**Overload Rating:** Normal current ranges 20%  
Potential ranges 25%

WATT RANGES			CURRENT RANGES				Scale Div.	Range Printed*	CODE	Price
75 Volts	150 Volts	300 Volts	Normal		Maximum					
			Series	Parallel	Series	Parallel				
25/50	50/100	100/200	.33	.66	.66	1.33	100	100	LWATTO	\$1830
37.5/75	75/150	150/300	.5	1.0	1.0	2.0	150	75	LWATAM	1760
75/150	150/300	300/600	1	2	2	4	150	150	LWATER	1760
187.5/375	375/750	750/1500	2.5	5	5	10	150	750	LWATHY	1760
250/500	500/1000	1000/2000	3.33	6.66	6.66	13.33	100	1000	LWATIS	1760
375/750	750/1500	1500/3000	5	10	10	20	150	750	LWATJA	1760
500/1000	1000/2000	2000/4000	6.66	13.33	13.33	26.66	100	1000	LWATKO	1830
750/1500	1500/3000	3000/6000	10	20	20	40	150	1500	LWATLU	1990

\*An additional scale can be drawn and printed at a surcharge of \$125.00.

#### MODEL B

##### DC Milliammeters, Ammeters and Voltmeters

CODE	Portable PRICE
BAMICO	\$1120
BAMICH	1020
BAMICY	985
ANY SINGLE RANGE MICROAMMETER FROM 150 UA	960
BAMILXO	\$1595
BAMILJI	1395
BAMILEK	1330
ANY SINGLE RANGE MILLIAMMETER FROM 1 MA	940

##### ELECTRONIC VOLTAGE SOURCE

	PRICE
MODEL STV-1A (Portable)	\$390

#### MODEL B

##### DC Milliammeters, Ammeters and Voltmeters

CODE	Portable PRICE
DC MILLIAMMETERS	
BAMILUK	1180
BAMILOP	1215
BAMILOO	1265
BAMILEE	1265
DC AMMETERS	
BAANKET	1485
BAAMEX	1510
DC VOLTMETERS	
BAMVLT	990
BAMVOK	990
BAMVPS	1140
BAVOST	1215
BAVOKI	1290
BAVOMO	1326



**Sensitive Research\*****AC, DC AND AC/DC POLYRANGER INSTRUMENTS**

MULTIRANGE INSTRUMENTS TO MEASURE CURRENT AND VOLTAGE



**PORTABLE  
AND  
RACK PANEL  
MOUNTED**

MODEL	DESCRIPTION	PAGE
	"About Polyranger Instruments" . . . Thermocouple Replacement . . . Temperature Compensation	152
C	.25% DC Reference Standards. 14 ranges. 6.3" scale length	153
UX	.5% DC, .5% AC Self Checking Thermocouple Instrument. 51 ranges. 5.2" scale length	154-155
U88	.5% DC, .75% AC Thermocouple Instrument. 88 ranges. 5.2" scale length	156-157
USP	.5% DC, .75% AC Thermocouple Instrument. 28 ranges. 5.2" scale length	158-159
U-SP	.5% DC, .75% AC Thermocouple Instrument. 31 ranges. 5.2" scale length	159
A	.75% AC/DC Thermocouple Instruments. 11 to 14 ranges. 6.3" scale length	160
UVA	.5% DC and .75% AC University Instruments mounted in a single case. 22 ranges .4" scale lengths	161
WVA	.25% DC Reference Standard. 27 ranges. 6.3" scale length	162

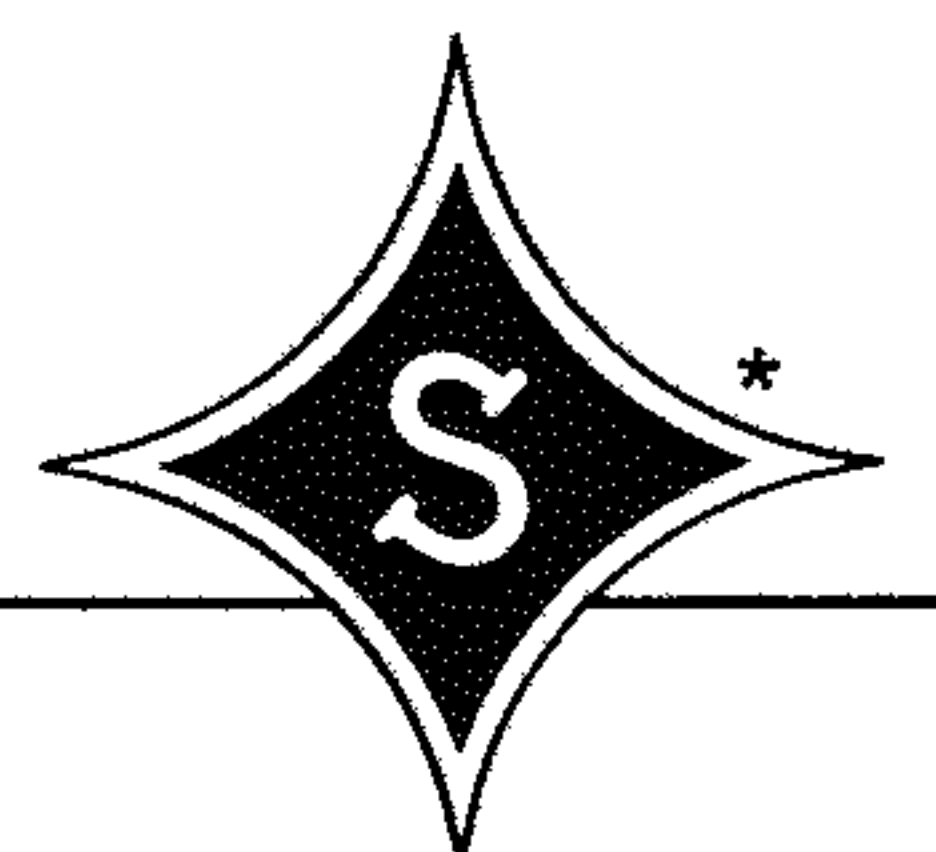
*Prices and specifications subject to change without notice.*

**Sensitive Research\*** INSTRUMENTS

\*A Trademark of EIS

ELECTRICAL INSTRUMENT SERVICE, INC.

25 Dock Street, Mount Vernon, N. Y. 10550 - (914) 699-9717





## THERMOCOUPLE TYPE POLYRANGER

Sensitive Research thermal elements have excellent AC/DC transfer characteristics. They are selected for their low reversal effect. Consequently the accuracy specification of the thermal side of a Polyranger is the same for both AC and DC. Polyrangers that incorporate thermocouples can, therefore, be calibrated directly on DC and only their AC/DC difference, or frequency influence has to be checked by AC transfer methods.

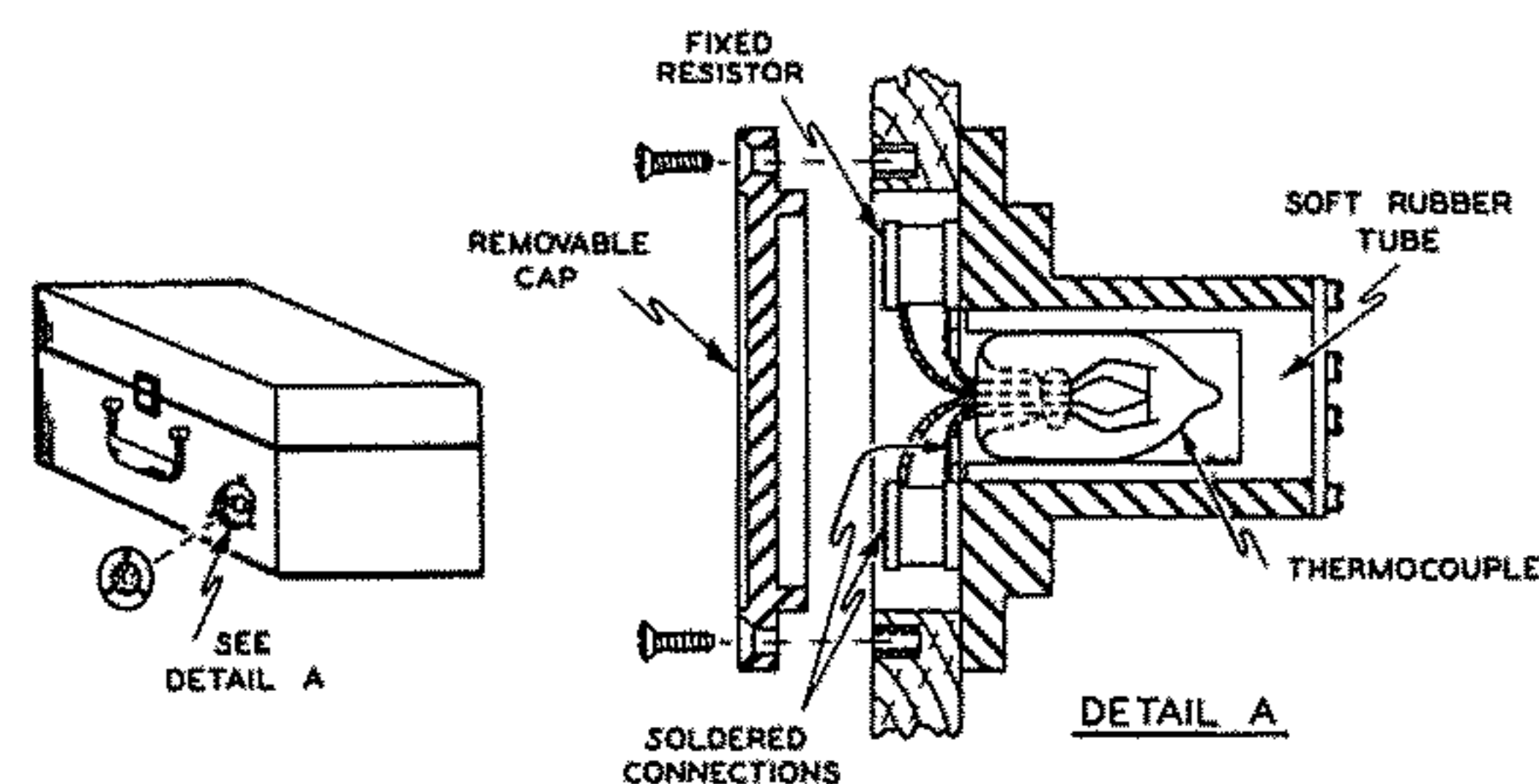


Figure 1. Type 357 TRF

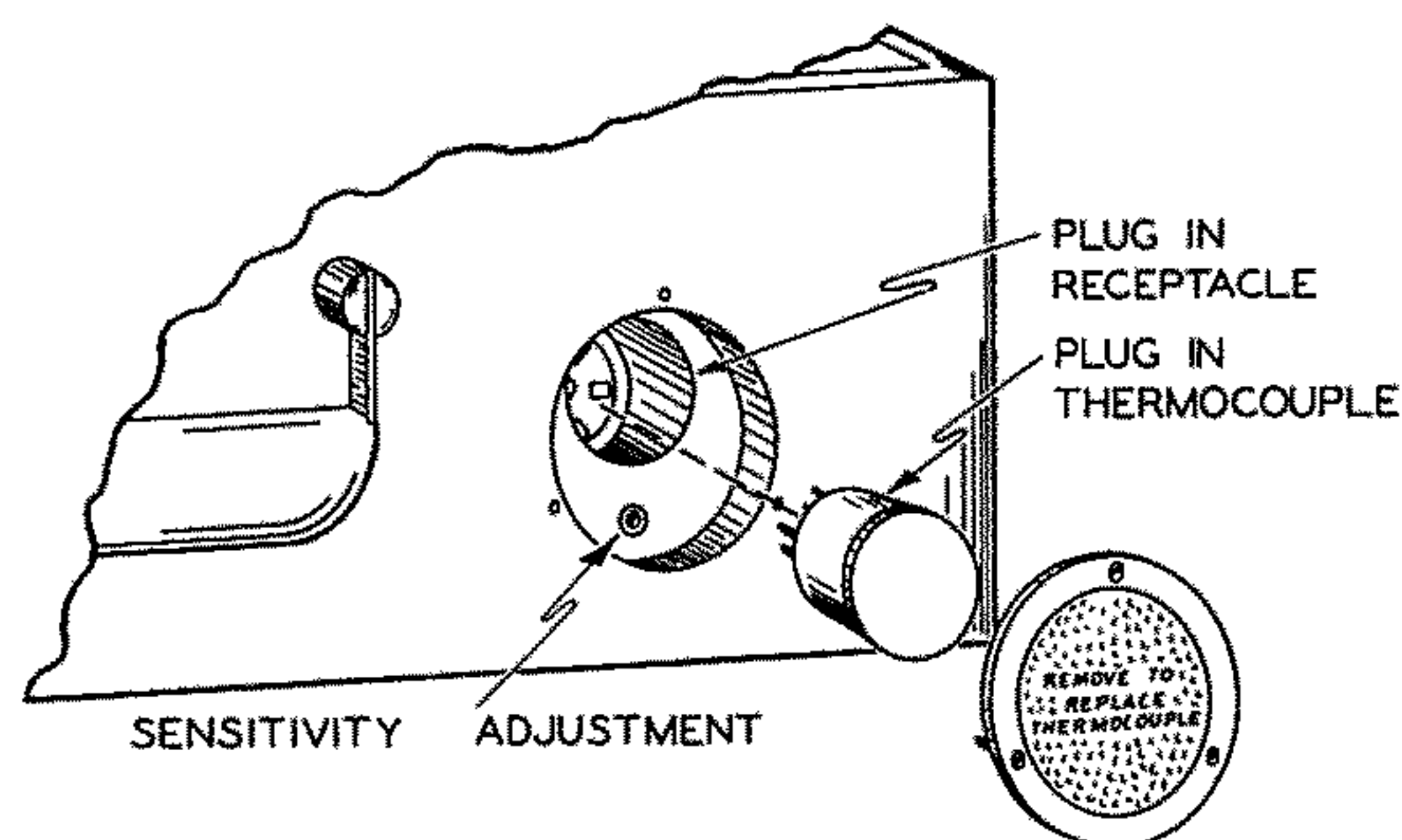


Figure 2. Type 362 TRF

A Thermocouple Replacement Feature (TRF), Type 357, is normally supplied and included in the price of all Polyrangers. Its installation allows for the field replacement of overloaded or burned out thermocouples with the retention of full instrument accuracy. Type 357 replacement thermocouples are furnished with two calibrated fixed resistors which must be soldered into place by the user. (See Figure 1.) The Type 362 is a new optional thermocouple replacement feature that can be substituted for the Type 357. Replacement can be made by "plug-in" instead of soldering. A variable sensitivity resistor is provided to enable the user to adjust full scale deflection of the instrument for maximum scale linearity. (See Figure 2.) The Type 362 is available for all thermocouple Polyrangers excepting the Model A, Comb. 2A.



## MODEL USP

AC/DC POLYRANGER . . . a modern laboratory standby

Replacement thermocouples can be ordered by specifying Replacement Thermocouple Type 357 or 362, and when designed for use with existing instruments in the field, the instrument serial number. Instrument thermocouple types are identified for users in the field by a black and silver metallic label mounted adjacent to the thermocouple feature. Delivery of spare thermocouples is from stock.

A manually operated "Push-to-Read" thermocouple overload protection system is normally contained in most thermoelement type instruments when range and frequency performance permits. The instrument has a red "Safety" line drawn and labeled at the 20% point on its scale. When the push button is left in an upright position, 80% of the input current is shunted around the heater of the thermoelement. If the instrument's indication is below the "Safety" line, it is being used on the correct full scale range; if above the line an overload is being applied and change to a higher range value is indicated. The button can be turned to lock in place in the "Read" position. This removes the safety shunt for normal operation while making measurements. The overload system is compensated so loading of the circuit being measured remains at the same level whether the button is depressed or not. The thermocouple is protected for overloads of 1000%. Overall instrument protection (including range resistors) is 1000%.



# REFERENCE STANDARD DC POLYRANGER INSTRUMENTS

## SPECIFICATIONS

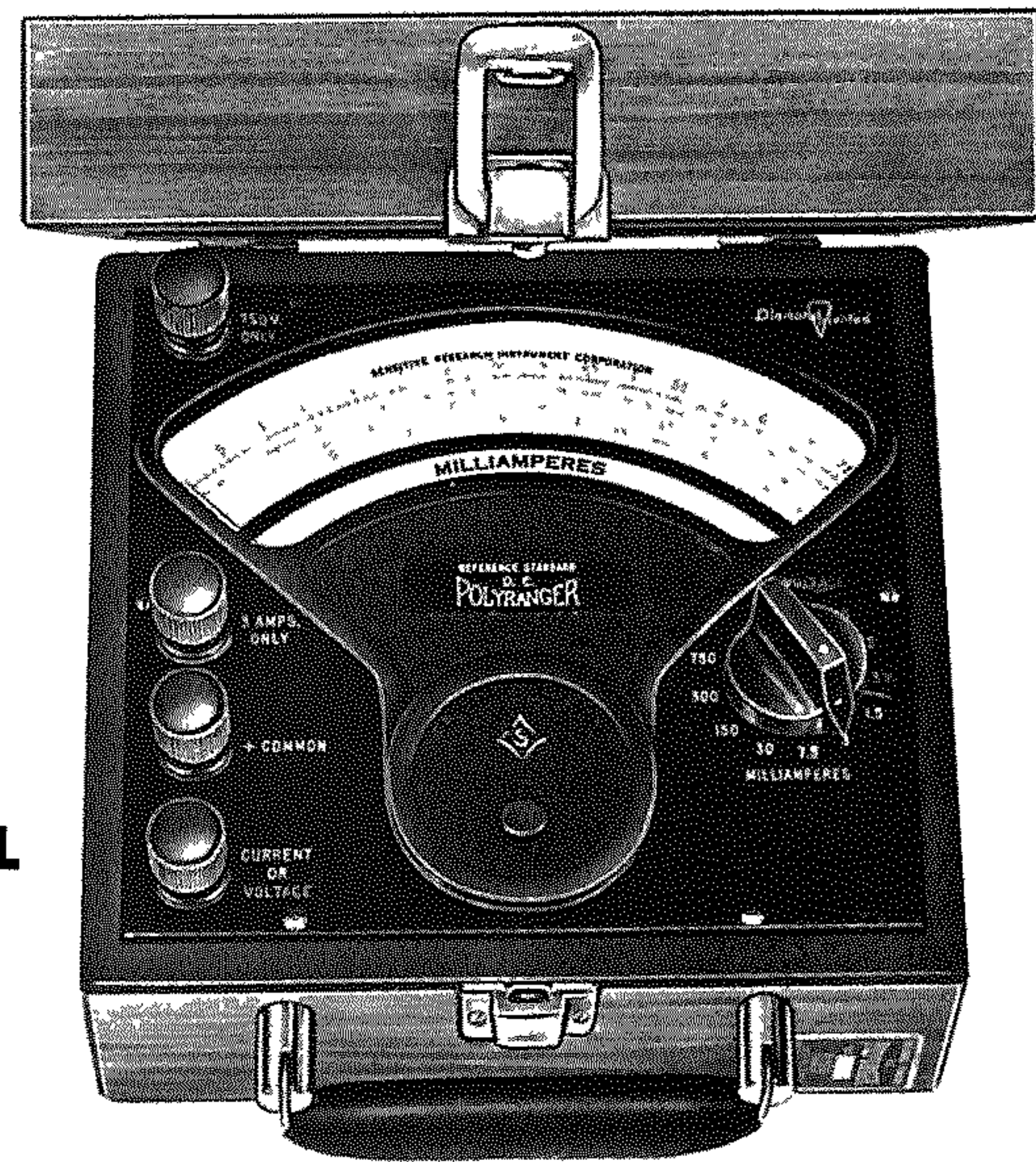
DC PORTABLE—HORIZONTAL USE

ACCURACY	.25% of full scale
TYPE	Permanent magnet, double pivoted moving coil
SENSITIVITY	1000 $\Omega/v$ ; all current range resistances listed below.
SCALE	Hand-drawn; 6.3"; anti-parallax mirror
SCALE DIVISIONS	Comb. 1-C: 150/100 divisions printed 0-30/100 Comb. 3-C: 150 divisions printed 0-15/30/75 Comb. 4-C: 100 divisions printed 0-50/100
POINTER	Knife edge
PERIOD	1 second
DAMPING	Induced emf
PIVOTS	Diamond pivoted
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
RANGE CHANGING	Switch controlled excepting ranges of 3 amps or higher and 1000 v on separate binding posts
MAGNETIC SHUNT	Internal; 3% max. adjustment
MECHANICAL ZERO	External zero shifter
CASE	Formica; 7 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 4 $\frac{5}{16}$ " h.; black bakelite panel; hinged cover; carrying handle
APPROX. WEIGHT	8 lbs. net; 11 lbs. shipping

All instruments are provided with data cards listing temperature corrections and maximum overload ratings.

### OPTIONAL ACCESSORIES

1. Voltage ranges can be extended by the addition of multipliers. (See Section 10.) If multipliers are ordered with the instrument, they can be calibrated together for an overall accuracy of .25% of full scale.



**MODEL C**

### GENERAL DESCRIPTION

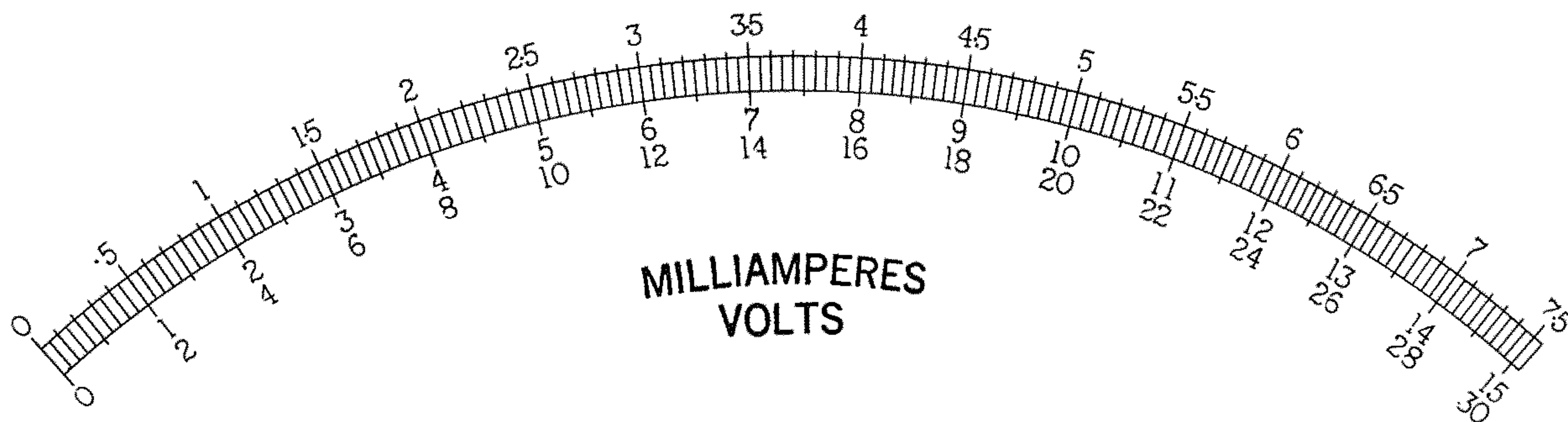
The Model C is a 14 range DC reference standard indicating instrument similar in concept to the Model WVA (see page 162), but smaller in size and more economically priced. All .25% accurate instruments of this type, because of their stability and ruggedness, make excellent transfer devices between laboratory standards and small factory portables.

### RANGES

COMBINATION 1-C	Code RANGER							
Current Ranges:	1	3	10	30	100	300 ma	1	3 amps
Approx. Resist:	54.5	72.8	27.6	9.8	3	1	.34	.1 $\Omega$
*Voltage Ranges:	3	10	30	100	300	1000 v		

COMBINATION 3-C	Code RANGOK							
Current Ranges:	1.5	3	7.5	30	150	300	750 ma	3 amps
Approx. Resist:	43	86	50	14.3	3	1.5	.6	.15 $\Omega$
*Voltage Ranges:	3	15	30	150	300	750 v		

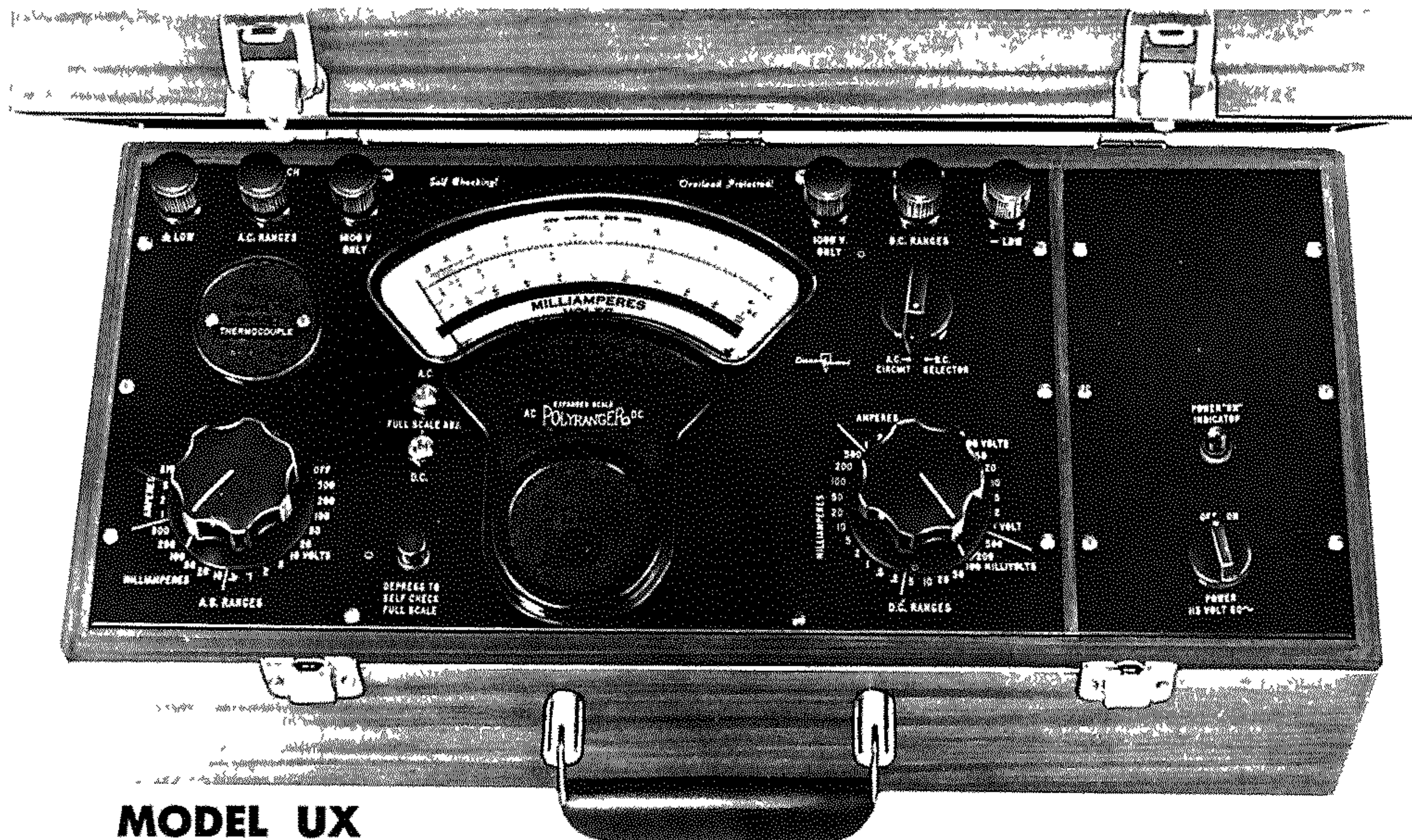
COMBINATION 4-C	Code RANGIS							
Current Ranges:	10	50	100	500 ma	1	5	10 amps	
Approx. Resist:	27.5	6	3	.6	.3	.06	.03 $\Omega$	
*Voltage Ranges:	1	5	10	50	100	500	1000 v	
* Sensitivity of all Combinations 1000 $\Omega/v$								



Facsimile Model C Polyranger Scale (Comb. 3C)



# SELF CHECKING EXPANDED SCALE AC-DC POLYRANGER



**MODEL UX**

## SPECIFICATIONS

AC/DC PORTABLE—HORIZONTAL USE

ACCURACY	.5% of full scale
FREQUENCY	DC and 7 cps to 15 kc all ranges excepting ampere ranges to 5 kc. (May be used over a wider frequency span at reduced accuracy.)
TYPE	DC: Permanent magnet, double pivoted moving coil AC: Thermocouple
SENSITIVITY	DC Voltage: 5000 $\Omega/v$ AC Voltage: 100 $\Omega/v$ All current range resistances, see pg. 155.
SCALE	Hand-drawn; 5.2"; anti-parallax mirror. (AC scale is expanded. Effective scale length is 7.28".)
SCALE DIVISIONS	AC, DC: 100 divisions printed 0-10/20/50
POINTER	Knife edge
PERIOD	DC: 3 seconds; AC: 6 seconds
DAMPING	Induced emf
PIVOTS	Diamond pivoted
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
TEMPERATURE COEFFICIENT	Automatic temperature compensation from 20°C to 30°C.
THERMOCOUPLE REPLACEMENT FEATURE	Type 357 (Type 362 optional, see right)
RANGE CHANGING	Switch controlled excepting 1000 v ranges on separate binding posts
MAGNETIC SHUNT	Internal; 3% max. adjustment
MECHANICAL ZERO	External zero shifter
CASE	Formica; 17 $\frac{5}{8}$ " x 7 $\frac{1}{2}$ " x 6 $\frac{3}{8}$ " h.; black bakelite panel; hinged cover; carrying handle
APPROX. WEIGHT	18 lbs. net; 30 lbs. shipping

All instruments are provided with data cards listing temperature corrections and maximum overload ratings.

## OPTIONAL SPECIFICATIONS

1. A "Plug-in" Thermocouple Replacement Feature (TRF), Type 362, is available. (In the Type 357 normally furnished, replacement thermocouples are soldered into place.) The Type 362 is particularly valuable when installed in the Model UX since its system includes a variable resistance which allows for the adjustment of the sensitivity of the thermocouple. By employing the instrument's Self Checking facility, the output of the thermocouple at full scale deflection can be set for maximum direct reading accuracy without the necessity of using either an external source or standard. Both types of replacement features are described more fully on page 152.

Additional adjustments are required when field replacing the UX thermo elements because the AC scale is expanded. For details request additional information.

If the Type 362 "Plug-in" Thermocouple Replacement Feature is desired, specify and add \$25.00 to the price of the Model UX or UXEW-5A.

## OPTIONAL ACCESSORIES

1. Spare thermocouples for replacement in the field can be ordered with the Model UX. If ordered after the instrument is in service, the type number of the feature and the serial number of the instrument in which it is to be installed must be specified. For details request further information.

<u>Replacement Thermocouple</u>	<u>Price</u>
TYPE 357	
TYPE 362	

2. AC and DC voltage ranges and DC current ranges can be extended by the addition of multipliers and shunts. If ordered with the Model UX, they can be supplied so that the direct reading accuracies of the ranges they create are within the accuracy of the instrument. If ordered at a future date, overall accuracy is the sum of the accuracies of both units. When ordering multipliers to extend AC voltage ranges, specify frequency at which measurements are to be made.



# SELF CHECKING EXPANDED SCALE AC-DC POLYRANGER

Shunts cannot be provided for the extension of AC current ranges since their addition causes variations in scale linearity. Higher AC current ranges can be achieved by employing the Model TR Type 1 Transformer in conjunction with instrument ranges of 2 to 5 amps. Radio frequency measurements can be made by taking the output of an external vacuum thermocouple and plotting it on the scale of the 5 or 10 mv DC ranges of the instrument. Vacuum thermocouples with isolated heater junctions can be supplied separately mounted.

## PANEL MOUNTED INSTRUMENTS

The Model UX is also available for vertical rack panel mounting. The indicator is housed in a Type EW-5A edge-wise panel case with a 5" scale length and installed in a 19" x 8 $\frac{3}{4}$ " x 5/16" black bakelite panel. Performance characteristics are the same as listed for the portable model.

Specify: Model UXEW-5A

## GENERAL DESCRIPTION

The Model UX is a 51 range portable AC/DC electrical indicating instrument featuring increased scale resolution, automatic overload protection and auto-calibration capability. It is designed for those applications demanding a versatile self-contained instrument where good accuracy from DC to 15 kc, operational safeguards and long term reliability are important factors.

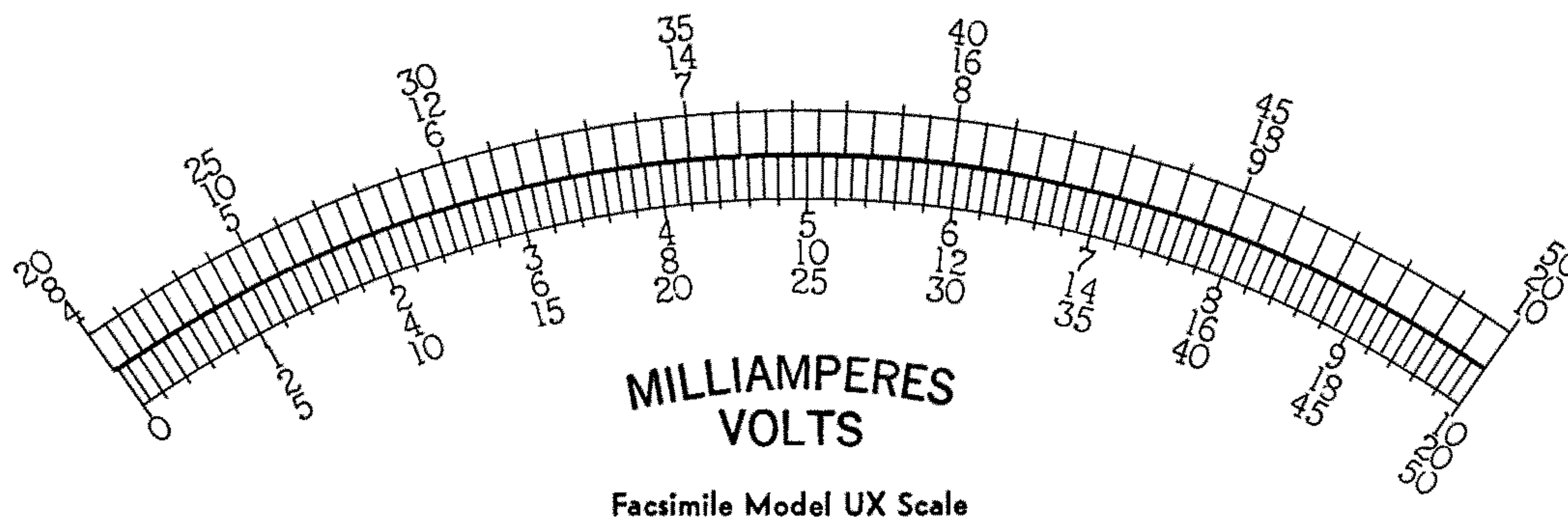
AC resolution is increased by electrically suppressing the first 40% of the full scale range. The ability to make measurements at lower scale values is not affected since all ranges are overlapping and suppression occurs in that area over which accurate readings cannot normally be obtained.

A "Self Checking" system allows for full scale sensitivity calibration (and simple adjustment, if necessary) against a  $\pm 0.1\%$  accurate, internal Zener diode reference source. The stability of the reference source is guaranteed to  $\pm 0.05\%$  for a period of one year. Operating power required is 60 cycles, 95 to 135 v. (50 cps and/or 220 v operation available at an additional charge of \$25.00.)

The automatic overload protection feature enables the thermocouple to withstand overloads of 500% or 10 amps and 500 v above rated voltage, whichever is the lesser figure, without affecting operation or calibration.

The DC and AC circuits of the Model UX are not connected to the moving coil at the same time and, therefore, excessive overloading of the thermocouple circuit does not affect the DC side.

Operation is fast and relatively simple. The instrument is "Self Checked" by depressing a push button on the panel and adjusting for full scale deflection if necessary. Overload protection and temperature compensation are automatic. Ranges are switch controlled (excepting the 1000 v ranges) and all values are clearly engraved. The instrument is direct reading, and because ranges are overlapping, most measurements may be made at, or near, full scale for maximum accuracy.



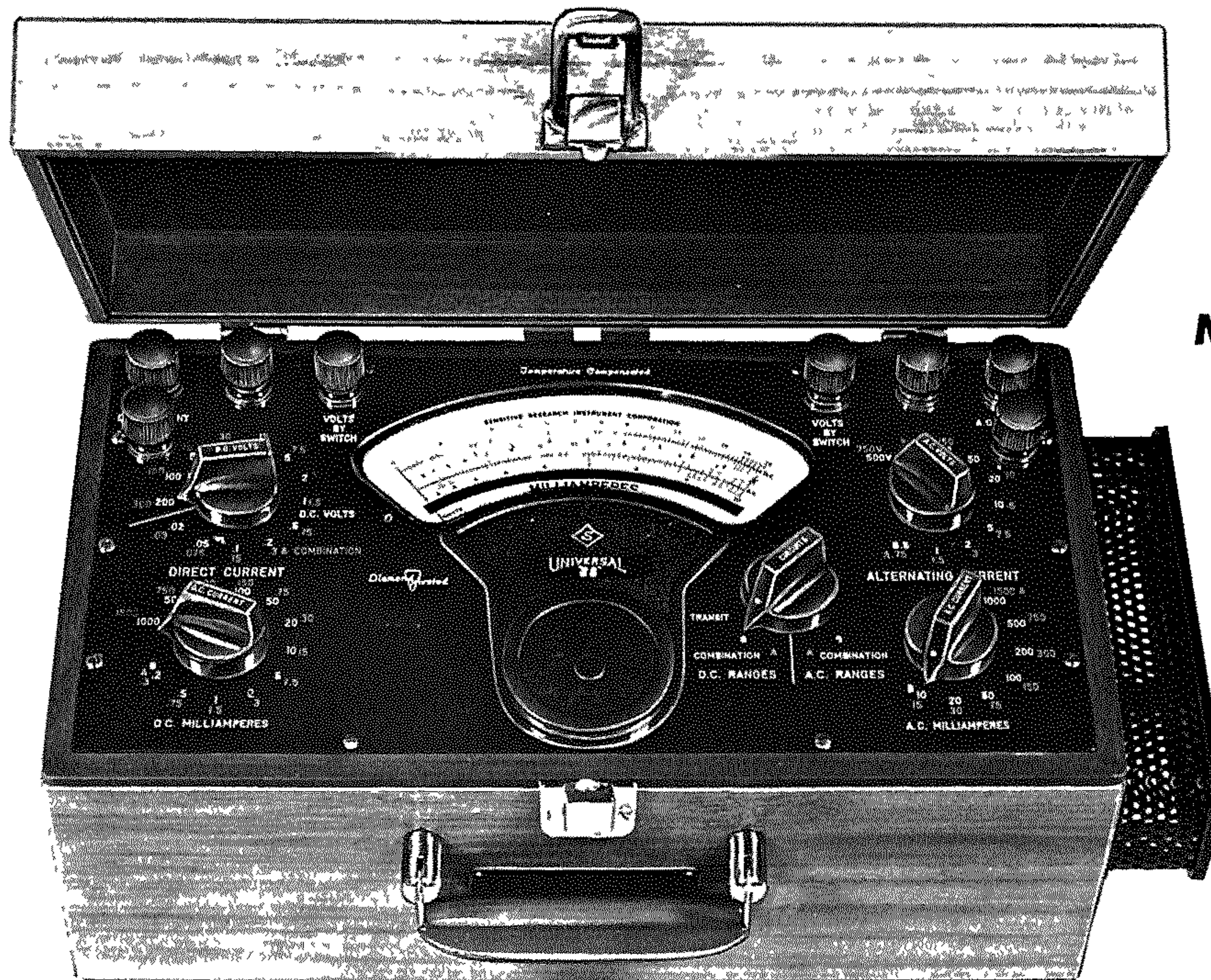
## RANGES

<b>DC Voltage:</b>	5	10	20	50	100	200	500 mv	1	2	5	10	20	50	100	200	500	1000 v	
<b>Sensitivity:</b>	All ranges 5000 $\Omega/v$																	
<b>DC Current:</b>	200	500 $\mu a$	1	2	5	10	20	50	100	200	500 ma	1	2	5 amps				
<b>Approx. Resistance:</b>	203	92.5	48	24.6	9.96	5.01	2.53	1.03	.507	.255	.105	.055	.030	.015 $\Omega$				
<b>AC Voltage:</b>	.2-.5	1	2	5	10	20	50	100	200	500	1000 v							
<b>Sensitivity:</b>	All ranges 100 $\Omega/v$																	
<b>AC Current:</b>	4-10	20	50	100	200	500 ma	1	2	5 amps									
<b>Approx. Resistance:</b>	29.84	37.47	20.43	11.13	5.81	2.4	1.22	.601	.244 $\Omega$									

Model UX Code UXSAL



# UNIVERSAL 88 POLYRANGER INSTRUMENTS



**MODEL U88**

## SPECIFICATIONS

AC/DC PORTABLE—HORIZONTAL USE

ACCURACY	DC: .5% of full scale AC: .75% of full scale
FREQUENCY	DC and 7 cps to 15 kc for current ranges up to 1 amp; to 5 kc for current ranges above 1 amp and all voltage ranges. (May be used over a wider frequency span at reduced accuracy.)
TYPE	DC: Permanent magnet, double pivoted moving coil AC: Thermocouple
SENSITIVITY	DC voltage: 3333 $\Omega/v$ or 5000 $\Omega/v$ according to range. AC voltage: 66.6 $\Omega/v$ or 100 $\Omega/v$ according to range. All current range resistances, see pg. 157.
SCALE	Hand-drawn; 5.2"; anti-parallax mirror
SCALE DIVISIONS	AC, DC: 75/100 divisions printed 0-15/10
POINTER	Knife edge
PERIOD	DC: 3 seconds; AC: 6 seconds
DAMPING	Induced emf
PIVOTS	Diamond pivoted
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
TEMPERATURE COEFFICIENT	Automatic temperature compensation from 20°C to 30°C
THERMOCOUPLE REPLACEMENT FEATURE	Type 357 (Type 362 optional)
RANGE CHANGING	Switch controlled, excepting 500 and 750 v ranges DC, and 2 and 3 amp ranges AC, on separate binding posts
MAGNETIC SHUNT	Internal; 3% max. adjustment
MECHANICAL ZERO	External zero shifter
CASE	Formica; 13 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 6 $\frac{3}{8}$ " h.; black bakelite panel; hinged cover; carrying handle
APPROX. WEIGHT	10 lbs. net; 19 lbs. shipping

All instruments are provided with data cards listing temperature corrections and maximum overload ratings.

## OPTIONAL SPECIFICATIONS

1. A "Plug-in" Thermocouple Replacement Feature (TRF), Type 362 is available. (In the Type 357 normally furnished, replacement thermocouples are soldered into place.) The Type 362 system includes a variable resistance and, therefore, the output of the thermocouple can be adjusted for optimum full scale deflection and maximum scale linearity when it is checked against an external reference standard. Both types of replacement features are described more fully on pages 152 and 153. If the Type 362 "Plug-in" Thermocouple Replacement Feature is desired, specify and add \$25.00 to the price of the Model U88 or U88EW-5A.

## OPTIONAL ACCESSORIES

1. Spare thermocouples for replacement in the field can be ordered with the Models U88 and U88EW-5A. If ordered after the instrument is in service, the type number of the feature and the serial number of the instrument in which it is to be installed must be specified.

Replacement Thermocouple	Price
TYPE 357	
TYPE 362	

2. AC and DC voltage ranges and DC current ranges can be extended by the addition of multipliers and shunts. If ordered with the Model U88, they can be supplied so that the direct reading accuracies of the ranges they create are within the accuracy of the instrument. If ordered at a future date, overall accuracy is the sum of the accuracies of both units. When ordering multipliers to extend AC voltage ranges, specify frequency at which measurements are to be made.



# UNIVERSAL 88 POLYRANGER INSTRUMENTS

Shunts cannot be provided for the extension of AC current ranges since their addition causes variations in scale linearity. Higher AC current ranges with maximum accuracy can be achieved by employing the Model TR Type 1 Transformer in conjunction with instrument ranges of 2 to 5 amps.

## PANEL MOUNTED INSTRUMENTS

The Model U88 is also available for vertical rack panel mounting. The indicator is housed in a Type EW-5A edge-wise panel case with a 5" scale length and installed in a 19" x 7" x 5/16" black bakelite panel. Performance characteristics are the same as listed for the portable model.

Specify: Model U88EW-5A

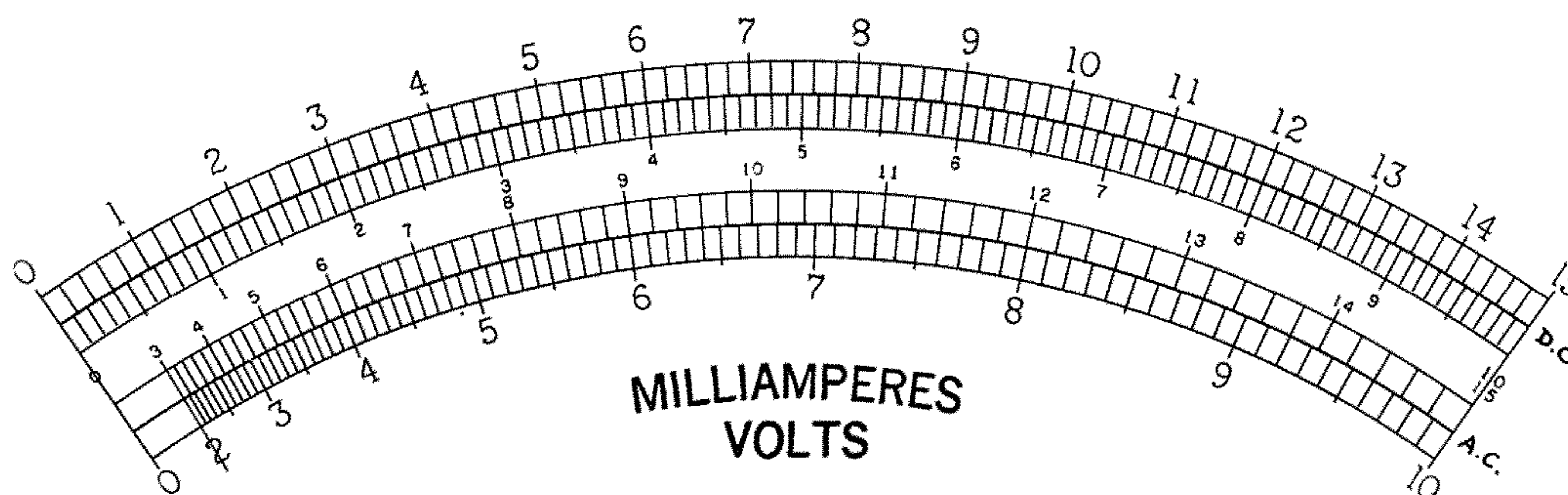
## GENERAL DESCRIPTION

The Model U88 is a portable AC/DC electrical indicating instrument with 88 ranges, each overlapping so that all readings can be taken on the upper third of the scale. Since accuracy is in terms of full scale, and the AC scale divisions are greatly expanded in this area, the Model U88 can be employed more advantageously than most instruments for maximum accuracy and resolution.

A manually operated overload protection system provides the thermocouple with 1000% safeguarding (see page 152). Since the DC and AC circuits of the instrument are not connected to the moving coil at the same time, excessive overloading of the thermocouple circuit does not affect the DC side.

Operation of the Model U88 is facilitated by a simplified method of switching. All ranges are switch controlled (except as noted) and each position designates 2 full scale ranges, one from Combination A, engraved in red, and the other from Combination B, engraved in white. A separate switch is used to select the combination desired. The function of each range switch is specific; i.e., DC volts, DC current, AC volts, AC current, and is engraved on the switch knobs. Separate input terminals are provided for use with each function switch.

The Model U88 is diamond pivoted with shock mounted sapphire jewels to give a virtually friction-free moving element that will withstand abnormal handling. Its portable case made of tough, durable formica is gasketed to provide an effective dust and humidity barrier.



Facsimile Model U88 Scale

## RANGES

<b>DC Current:</b>	.2	.3	.5	.75	1	1.5	2	3	5	7.5	10	15	20	30	50	75	100	150	200	300	500	750	1000	1500	ma
<b>Approx. Resistance:</b>	10	60	61.5	70	40	42.3	23.6	23.1	9.6	9.7	4.9	4.9	2.5	2.5	1.0	1.0	0.5	0.5	0.25	0.25	0.1	0.1	.05	.05	Ω
<b>DC Voltage:</b>	.02	.03	.05	.075	.1	.15	.2	.3	.5	.75	1	1.5	2	3	5	7.5	v								
<b>Sensitivity:</b>	5000	3333	5000	3333	5000	3333	5000	3333	5000	3333	5000	3333	5000	3333	5000	3333	Ω/v								
<b>DC Voltage:</b>	10	15	20	30	50	75	100	150	200	300	500	750	v												
<b>Sensitivity:</b>	5000	3333	5000	3333	5000	3333	5000	3333	5000	3333	5000	3333	Ω/v												
<b>AC Current:</b>	10	15	20	30	50	75	100	150	200	300	500	750	1000	1500	ma	2	3	amps							
<b>Approx. Resistance:</b>	30	20	37.4	34.9	20.1	19.7	10.8	10.6	5.5	5.4	2.4	2.3	1.2	1.1	.6	.6	Ω								
<b>AC Voltage:</b>	.5	.75	1	1.5	2	3	5	7.5	10	15	20	30	50	75	100	150	200	300	500	750	v				
<b>Sensitivity:</b>	100	66.6	100	66.6	100	66.6	100	66.6	100	66.6	100	66.6	100	66.6	100	66.6	100	66.6	100	66.6	Ω/v				

Model U88

Code EXCEL



# UNIVERSAL POLYRANGER INSTRUMENTS



**MODEL USP**

## SPECIFICATIONS

AC/DC PORTABLE—HORIZONTAL USE

ACCURACY	DC: .5% of full scale AC: .75% of full scale
FREQUENCY	DC and 7 cps to 15 kc for current ranges up to 1 amp; to 5 kc for current ranges above 1 amp and all voltage ranges. (May be used over a wider frequency span at reduced accuracy.)
TYPE	DC: Permanent magnet, double pivoted moving coil AC: Thermocouple
SENSITIVITY	DC voltage: 5000 $\Omega/v$ on 5 and 50 mv ranges; 1000 $\Omega/v$ all other ranges AC voltage: 100 $\Omega/v$ All current range resistances, see pg. 159.
SCALE DIVISIONS	Hand-drawn; 5.2"; anti-parallax mirror DC: 100 divisions printed 0-5/200 AC: 75 divisions printed 0-15/30/750
POINTER	Knife edge
PERIOD	DC: 3 seconds; AC: 6 seconds
DAMPING	Induced emf
PIVOTS	Diamond pivoted
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
TEMPERATURE COEFFICIENT	Automatic temperature compensation from 20°C to 30°C
THERMOCOUPLE REPLACEMENT FEATURE	Type 357 (Type 362 optional)
RANGE CHANGING	Switch controlled, excepting 2 amp DC and 3 amp AC ranges on separate binding posts
MAGNETIC SHUNT	Internal; 3% max. adjustment
MECHANICAL ZERO	External zero shifter
CASE	Formica; 13 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 6 $\frac{3}{8}$ " h.; black bakelite panel; hinged cover; carrying handle
APPROX. WEIGHT	10 lbs. net; 19 lbs. shipping

All instruments are provided with data cards listing temperature corrections and maximum overload ratings.

## OPTIONAL SPECIFICATIONS

1. A "Plug-in" Thermocouple Replacement Feature (TRF), Type 362 is available. (In the Type 357 normally furnished, replacement thermocouples are soldered into place). The Type 362 system includes a variable resistance and, therefore, the output of the thermocouple can be adjusted for optimum full scale deflection and maximum scale linearity when it is checked against an external reference standard. Both types of replacement features are described more fully on page 152.

If the Type 362 "Plug-in" Thermocouple Replacement Feature is desired, specify and add \$25.00 to the price of the Model USP or USPEW-5A.

## OPTIONAL ACCESSORIES

1. Spare thermocouples for replacement in the field can be ordered with the Models USP and USPEW-5A. If ordered after the instrument is in service, the type number of the feature and the serial number of the instrument in which it is to be installed must be specified.

Replacement Thermocouple	Price
TYPE 357	
TYPE 362	

2. AC and DC voltage ranges and DC current ranges can be extended by the addition of multipliers and shunts. If ordered with the Model USP, they can be supplied so that the direct reading accuracies of the ranges they create are within the accuracy of the instrument. If ordered at a future date, overall accuracy is the sum of the accuracies of both units. When ordering multipliers to extend AC voltage ranges, specify frequency at which measurements are to be made.



# UNIVERSAL POLYRANGER INSTRUMENTS

Shunts cannot be provided for the extension of AC current ranges since their addition causes variations in scale linearity. Higher AC current ranges with maximum accuracy can be achieved by employing the Model TR Type 1 Transformer in conjunction with instrument ranges of 2 to 5 amps. Radio frequency measurements can be made by taking the output of an external vacuum thermocouple and plotting it on the scale of the 5 mv DC range of the instrument. Vacuum thermocouples with isolated heater junctions can be supplied separately mounted.

## PANEL MOUNTED INSTRUMENTS

The Model USP is also available for vertical rack panel mounting. The indicator is housed in a Type EW-5A edge-wise panel case with a 5" scale length and installed in a 19" x 7" x 5/16" black bakelite panel. Performance characteristics are the same as listed for the portable model.

Specify: Model USPEW-5A

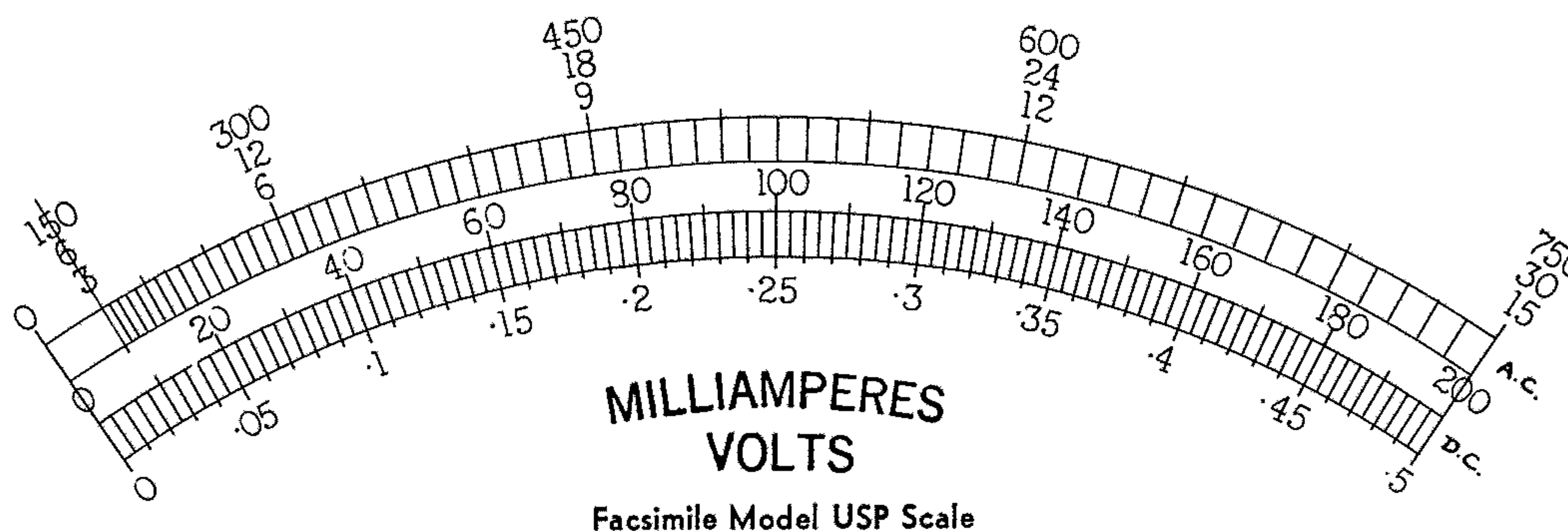
## GENERAL DESCRIPTION

The Model USP is a portable AC/DC electrical indicating instrument with 28 overlapping ranges. It has the advantage of being more economically priced than the models UX and U88 (see pages 154 to 157) while still maintaining the versatility of these Polyrangers by covering the same broad measuring range and incorporating some of their most desirable features. The full scale ranges available make it possible to take readings on the upper two thirds of the scale the great majority of the time.

A manually operated overload protection system provides the thermocouple with 1000% safeguarding (see page 152). Since the DC and AC circuits of the instrument are not connected to the moving coil at the same time, excessive overloading of the thermocouple circuit does not affect the DC side.

Operation of the Model USP is relatively simple for an instrument with so many ranges. All ranges are switch controlled (except as noted) and separate input terminals for current and voltage are provided for measuring AC or DC. A function switch connects either the AC or DC side to the indicator. The instrument is read directly on an easily interpolated double scale. The AC and DC range combinations, scale markings and scale divisions are different, making it impossible for the user to read the wrong scale.

The Model USP is diamond pivoted with shock mounted sapphire jewels to give a virtually friction-free moving element that will withstand abnormal handling. Its portable case made of tough, durable formica is gasketed to provide an effective dust and humidity barrier.



## RANGES

<b>DC Current:</b>	.2	2	20	200	1000 ma	2 amps		
<b>Approx. Resist:</b>	10	22.7	2.53	.275	.077	.026 Ω		
<b>DC Voltage:</b>	5	50	100	500 mv	2	20	200	1000 v
<b>Sensitivity:</b>	5000 Ω/v on 5 and 50 mv ranges; all other ranges 1000 Ω/v							

<b>AC Current:</b>	15	30	150	300	1500 ma	3 amps		
<b>Approx. Resist:</b>	40	30	7.65	3.95	.813	.398 Ω		
<b>AC Voltage:</b>	.3	1.5	3	15	30	150	300	750 v
<b>Sensitivity:</b>	All ranges 100 Ω/v							

Model USP

Code VERSALY

## MODEL U-SP

The Model U-SP having similar specifications to the Model USP described above, except as indicated below, was originally developed for use by the United States Air Force. Switch controlled, excepting 2/20 amps and 40/400 v DC, 3 amps AC, on binding posts. DC voltage sensitivity 5000 Ω/v on 2 and 20 mv ranges; 1000 Ω/v on all others. Includes 10,000% automatic overload protection with negligible frequency influence.

## RANGES

<b>DC current:</b>	.2	2	20	200	1000 ma	2	20	amps			
<b>DC voltage:</b>	.002	.02	.1	.2	2	20	40	200	400	1000	volts
<b>AC current:</b>	10	30	100	300	1000	3000	ma				
<b>AC voltage:</b>	.3	1	3	10	30	100	300	1000	volts		

Model U-SP

Code USAFUSP



# MODEL A POLYRANGER INSTRUMENTS

## SPECIFICATIONS

AC/DC PORTABLE—HORIZONTAL USE

ACCURACY	.75% of full scale
FREQUENCY	DC and 7 cps to 15 kc for current ranges up to 1 amp; to 5 kc for current ranges above 1 amp and all voltage ranges, except 500 v range of Comb. 2A to 3kc. (May be used over a wider frequency span at reduced accuracy.)
TYPE	Thermocouple
SENSITIVITY	All Combs. 100 $\Omega/v$ excepting Comb. 2A, 500 $\Omega/v$ . All current range resistances listed below
SCALE	Hand-drawn; 6.3"; anti-parallax mirror
SCALE DIVISIONS	Combs. 1-AA, 1-AB, 1-AC, 1-AD: 100 divisions printed 0-10/50 Comb. 2-A: 100/100 divisions printed 0-10/50/200 and 0-2 Comb. 3-A: 100/150 divisions printed 0-50/15
POINTER	Knife edge
PERIOD	6 seconds
DAMPING	Induced emf
PIVOTS	Diamond pivoted
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
TEMPERATURE COEFFICIENT	Automatic temperature compensation from 20°C to 30°C
THERMOCOUPLE REPLACEMENT	Type 357 (Type 362 optional on all but Comb. 2-A)
RANGE CHANGING	Switch controlled excepting as noted in descriptions of individual range combinations below
MAGNETIC SHUNT	Internal; 3% max. adjustment
MECHANICAL ZERO	External zero shifter
CASE	Formica; 7 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 6 $\frac{1}{8}$ " h.; black bakelite panel; hinged cover; carrying handle
APPROX. WEIGHT	8 lbs. net; 11 lbs. shipping

All instruments are provided with data cards listing temperature corrections and maximum overload ratings.

## OPTIONAL SPECIFICATIONS

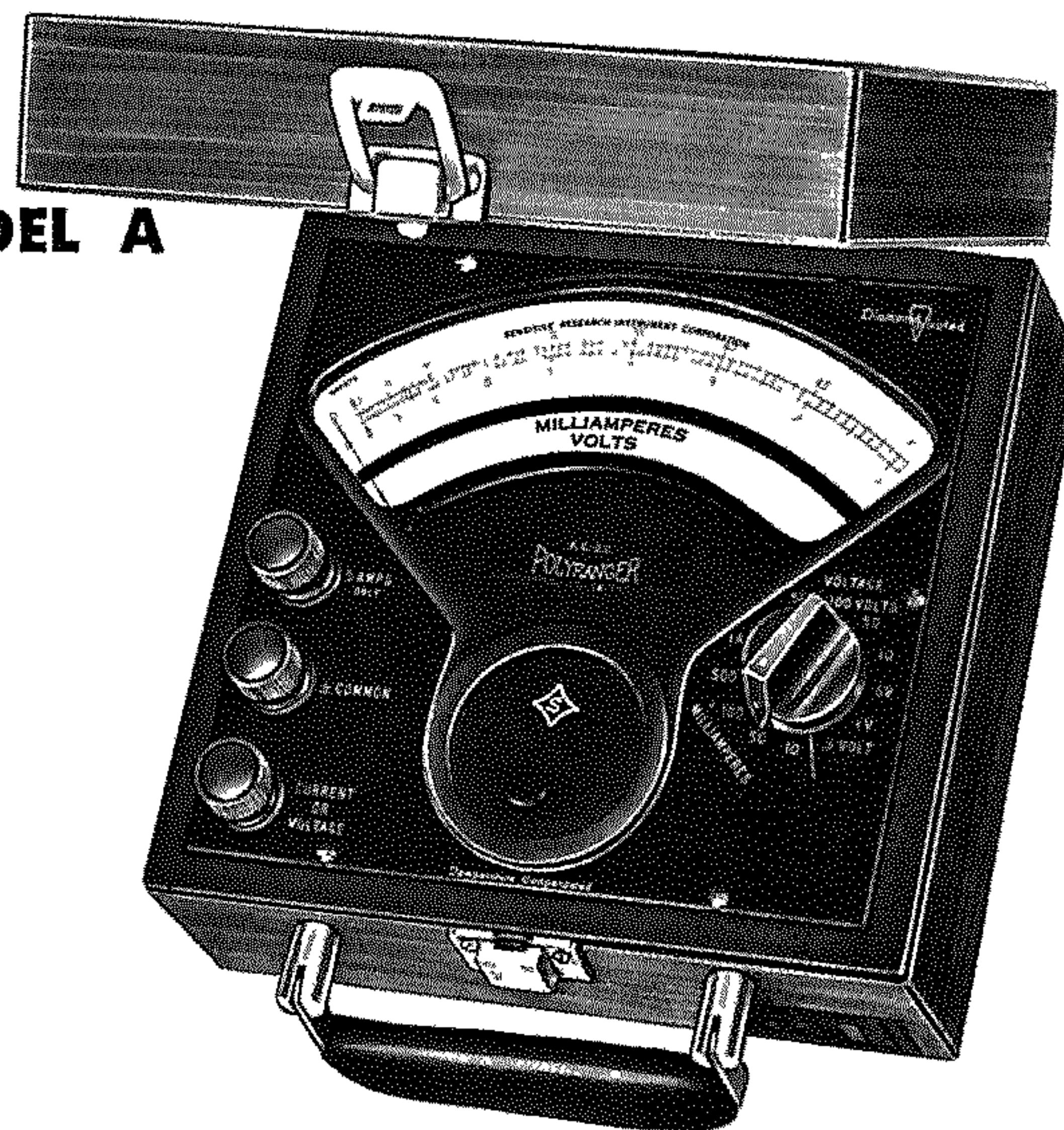
1. A "Plug-in" Thermocouple Replacement Feature (TRF), Type 362, is available for all Model A Polyrangers (excepting the Comb. 2-A). (In the Type 357 normally furnished, replacement thermocouples are soldered into place.) The Type 362 system includes a variable resistor to adjust the full scale output of the thermocouple for optimum scale linearity. (Reference pages 152 and 153.) If the Type 362 "Plug-in" Thermocouple Replacement Feature is desired, specify and add \$25.00 to the price of the portable

## OPTIONAL ACCESSORIES

1. Spare thermocouples for replacement in the field can be ordered with the Model A portable or panel Polyrangers. If ordered after the instrument is in service, the type number of the feature and the serial number of the instrument in which it is to be installed must be specified.

2. Voltage ranges can be extended by the addition of external multipliers. If ordered with the Model A, they can be supplied so that the direct reading accuracies of the ranges they create are within the accuracy of the instrument. When ordering multipliers to extend voltage ranges, specify frequency at which measurements are to be made. Higher AC current ranges can be achieved by employing the Model TR Type 1 Transformer in conjunction with instrument ranges of 2 to 5 amps.

MODEL A



## GENERAL DESCRIPTION

The Model A Polyrangers are portable AC/DC electrical indicating instruments whose basic application is the measurement of AC over a wide area of audio frequencies. They differ from the AC/DC Polyrangers previously described in that they are smaller in size, and have one set of input terminals with a single circuit for both AC and DC measurements. The Model A Polyrangers have the advantage of being economically priced while still covering the same broad measuring ranges as other models. The effectiveness of their overlapping ranges is increased because of the exceptional resolution provided by their 6.3" scale length. Operation is simplified by having ranges selected by a single switch.

A manually operated overload protection system provides the thermocouple with 1000% safeguarding (see page 152). The Comb. 2-A utilizing a 500  $\Omega/v$  thermocouple can withstand overloads of 5000% or 1500 v and 2 amps, whichever is the lesser.

COMBINATION 1-AA		Code AMULTI				
Current Ranges:	10   50   100	500 ma	1 amp			
Approx. Resist:	30   20   11	2.4	1.2 $\Omega$			
Voltage Ranges:	.5   1   5   10   50   100	500 v				
Sensitivity:	All ranges 100 $\Omega/v$					

Variations of Code AMULTI have the same ranges plus the following:

COMBINATION:	1-AB	1-AC	1-AD
Additional Ranges:	5 amps*	1000 v	5 amps* & 1000 v

COMBINATION 2-A		Code AMULTA				
Current Ranges:	2   10   50   200	500 ma	1 amp			
Approx. Resist:	640   538   124   32	12.8	6.4 $\Omega$			
Voltage Ranges:	2   10   50   200   500 v					
Sensitivity:	All ranges 500 $\Omega/v$					

COMBINATION 3-A		Code AMULTO				
Current Ranges:	15   50   150 ma	.5   1.5   5 amps*				
Approx. Resist:	40   20.4   7.6	2.4   .8   .24 $\Omega$				
Voltage Ranges:	.5   1.5   5   15   50   150   500   1500 v*					
Sensitivity:	All ranges 100 $\Omega/v$					

\* Range on separate binding posts



## SPECIFICATIONS

AC/DC PORTABLE—HORIZONTAL USE

ACCURACY	DC: .5% of full scale AC: .75% of full scale
FREQUENCY	60 cps only (50 cps can be substituted. See "Optional Specifications" below.)
TYPE	DC: Permanent magnet, double pivoted moving coil AC: Transformer-coupled moving iron
SENSITIVITY	See listings below.
SCALES	Hand-drawn; 4"; anti-parallax mirror
SCALE DIVISIONS	DC: 75/100 divisions printed 0-150 and 0-50/100 AC: 75/100 divisions printed 0-150 and 0-50/100
POINTER	Knife edge
PERIOD	DC: 2 seconds AC: 3-4 seconds
DAMPING	DC: Induced emf AC: Air vane
PIVOTS	Diamond pivoted
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
RANGE CHANGING	Binding posts
MAGNETIC SHUNT	DC only; internal; 3% max. adjustment
MECHANICAL ZERO	External zero shifter
CASE	Formica; 13 <sup>3</sup> / <sub>4</sub> " x 7 <sup>1</sup> / <sub>2</sub> " x 6 <sup>3</sup> / <sub>8</sub> " h.; black bakelite panel; hinged cover; carrying handle.
APPROX. WEIGHT	10 lbs. net; 19 lbs. shipping

All instruments are provided with data cards listing temperature corrections and maximum overload ratings.

### OPTIONAL SPECIFICATIONS

1. The Model UVA can be supplied for use on 50 cps only. Specify at time of ordering and add \$25.00 to price. Correspondence is invited regarding usage at other single frequencies in the low audio range.

### OPTIONAL ACCESSORIES

1. AC and DC voltage and DC current ranges can be extended by the addition of multipliers and shunts. If ordered with the Model UVA they can be supplied so that the direct reading accuracies of the ranges they create are within the accuracy of the instrument. If ordered at a future date, overall accuracy is the sum of the accuracies of both units.

It is impractical to provide shunts for the extension of AC current ranges because of problems involving excessive heat dissipation and temperature coefficient. Higher AC current ranges can be effectively added by employing the Model TR Type 1 Transformer in conjunction with the 5 ampere range of the instrument.

## MODEL UVA



### GENERAL DESCRIPTION

The Model UVA is a 22 range AC/DC Polyrange consisting of two separate University Model (see Section 3) electrical indicating instruments mounted in a single case. It is offered as a versatile, low cost, rugged indicator that will find wide application in educational institutions and industrial field testing. The instrument is designed for use by relatively inexperienced personnel. All ranges are plainly engraved on separate binding posts, minimizing the danger of connecting incorrectly into a circuit, or of inadvertently selecting the wrong range such as might occur with a switch controlled instrument. Both indicators will easily withstand overloads of 500% without additional protection (100% on 1000 v range). The design of the AC moving iron indicator makes it virtually impossible to mechanically distort the pointer from an electrical overload.

The Model UVA is diamond pivoted with shock mounted sapphire jewels to give a virtually friction-free moving element that will withstand abnormal handling. Its portable case made of tough, durable formica is gasketed to provide an effective dust and humidity barrier.

### RANGES

DC Current:	1	10	100 ma	1	10 amps	
Approx. Resist:	100	45	5	.5	.05 Ω	
DC Voltage:	50	100 mv	1	10	150	1000 v
Sensitivity:	All ranges 1000 Ω/v					

AC Current:	10	50	100	500 ma	1	5	10 amps
Approx. Burden:	.52	.68	.73	.75	.93	1.1	1.4 va
AC Voltage:	10	50	150	500 v			
Approx. Burden:	1	2.5	1.5	5 va			

Model UVA Code UNIVOAMP



# WILLIAMSON VOLT-AMMETER

## SPECIFICATIONS

DC PORTABLE—HORIZONTAL USE

ACCURACY	.25% of full scale
TYPE	Permanent magnet, double pivoted moving coil
SENSITIVITY	1000 $\Omega/v$ ; all current range resistances listed below
SCALE	Hand-drawn; 6.3"; anti-parallax mirror
SCALE DIVISIONS	100/150 divisions printed 0-1 and 0-1.5/3/7.5
POINTER	Knife edge
PERIOD	1 second
DAMPING	Induced emf
PIVOTS	Diamond pivoted
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
RANGE CHANGING	Switch controlled excepting 15 amp range on separate binding posts
MAGNETIC SHUNT	Internal; 3% max. adjustment
MECHANICAL ZERO	External zero shifter
CASE	Formica; 13 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 6 $\frac{3}{8}$ " h.; black bakelite panel; hinged cover; carrying handle
APPROX. WEIGHT	10 lbs. net; 19 lbs. shipping

All instruments are provided with data cards listing temperature corrections and maximum overload ratings.

### GENERAL DESCRIPTION

The Model WVA offers the widest measuring capability available in a self-contained DC reference standard indicating instrument. Its 27 overlapping ranges enable readings to be taken at, or near full scale for maximum accuracy. The voltage and current circuits are independent of each other. They are "dummy loaded" so that when current and voltage are supplied at the same time, by reversing the circuit selector switch, almost simultaneous readings can be taken without unbalancing either input. Via this method, values of DC resistance and power can be calculated. The instrument also contains a 0-1 scale which gives a direct reading indication of the current being drawn when making voltage measurements. (0-1 ma full scale = 1000  $\Omega/v$ )



**MODEL WVA**

The Model WVA is diamond pivoted with shock mounted sapphire jewels to give a virtually friction-free moving element that will withstand abnormal handling. Its portable case made of tough, durable formica is gasketed to provide an effective dust and humidity barrier.

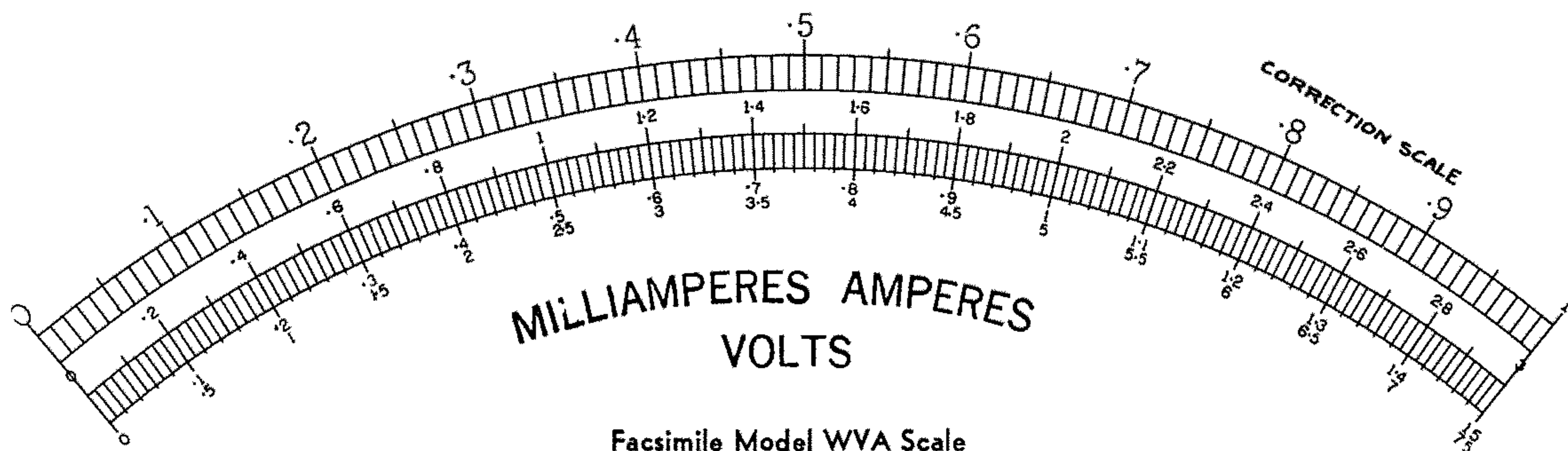
### OPTIONAL ACCESSORIES

1. Ranges can be extended by the addition of shunts and multipliers (see Section 10). If ordered with the Model WVA, they can be supplied so that the accuracies of the ranges they create are within the accuracy of the instrument.

### PANEL MOUNTED INSTRUMENTS

The Model WVA is also available for vertical rack panel mounting. The indicator is housed in a Type EW-7A edge-wise panel case with a 7" scale length, and installed in a 19" x 7" x 5/16" black bakelite panel. Performance characteristics are the same as listed for the portable model.

Specify: Model WVAEW-7A



Facsimile Model WVA Scale

### RANGES

Current:	1	1.5	3	7.5	15	30	75	150	300	750 ma	1.5	3	7.5	15 amps
Approx. Resist:	100	66.5	66.5	34.5	18.6	9.62	3.95	1.98	.97	.36	.18	.08	.03	.02 $\Omega$
Voltage:	100	150	300	750 mv	1.5	3	7.5	15	30	75	150	300	1000 v	
Sensitivity:	All ranges 1000 $\Omega/v$										Model WVA		Code WILAM	



**Sensitive Research****AC, DC AND AC/DC POLYRANGER INSTRUMENTS**

MULTIRANGE INSTRUMENTS TO MEASURE CURRENT AND VOLTAGE

PRICE LIST - JANUARY 1, 1981AC-DC POLYRANGERS

<u>MODEL</u>	<u>CODE</u>	<u>PRICE</u>
UXEW5A	-	1345.00
UX	UXSAL	1245.00
U88EW-5A	-	955.00
U88	EXCEL	860.00
USPEW-5A	-	920.00
USP	VERSALY	785.00
U-SP	USAFUSP	885.00

MODEL A POLYRANGERS

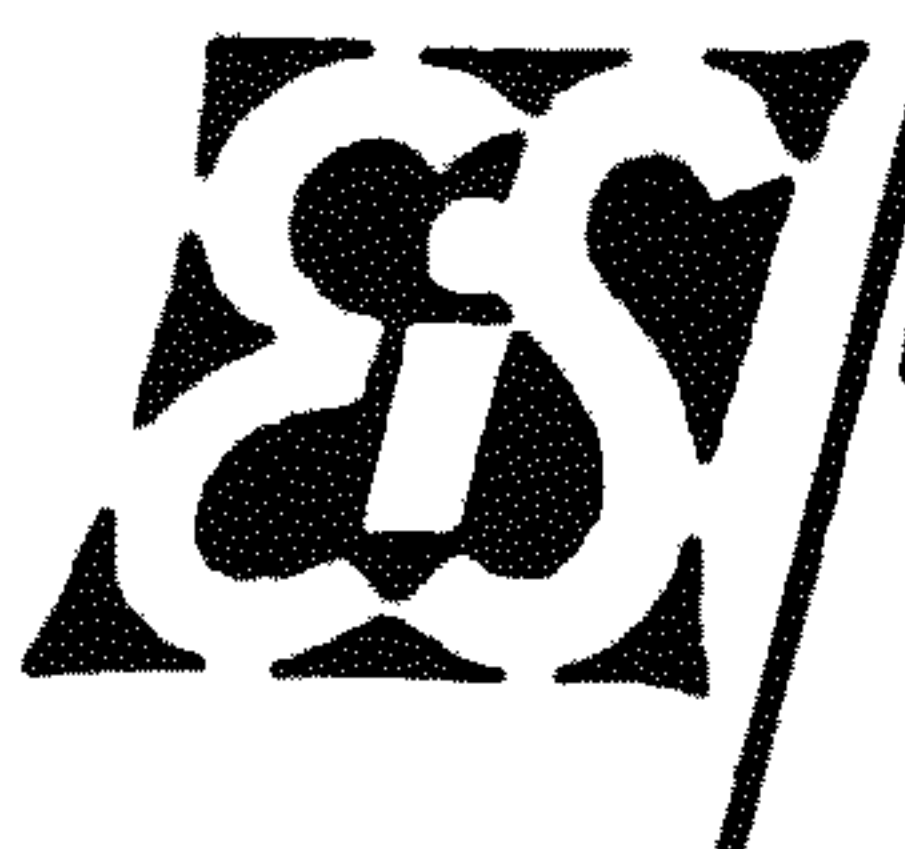
<u>COMBINATION</u>	<u>CODE</u>	<u>PRICE</u>
1-AA	AMULTI	675.00
1-AB	AMULTI	712.00
1-AC	AMULTI	712.00
1-AD	AMULTI	748.00
2-A	AMULTA	780.00
3-A	AMULTO	780.00

AC, DC, AC/DC VOLT AMMETER & POLYRANGERS

<u>MODEL</u>	<u>CODE</u>	<u>PRICE</u>
UVA	UNIVOAMP	655.00
WVA	WILAM	760.00
WVAEW-7A	-	875.00
1-C	RANGER	585.00
3-C	RANGOK	560.00
4-C	RANGIS	560.00

REPLACEMENT THERMOCOUPLES

<u>TYPE</u>	<u>PRICE</u>
TRF 357	100.00
TRF 362	110.00



\* A TRADEMARK OF EIS

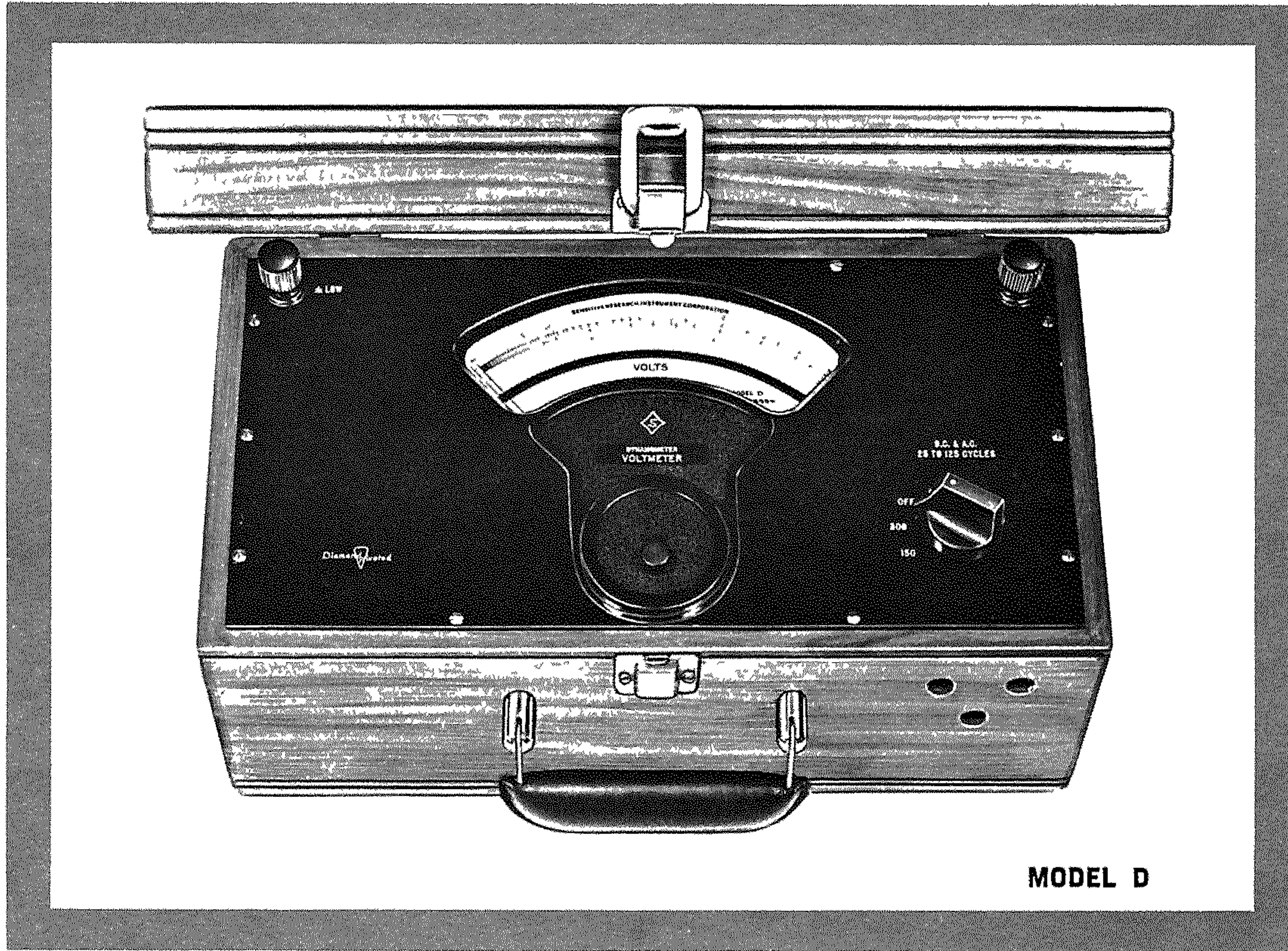
**ELECTRICAL INSTRUMENT SERVICE, INC.**

25 Dock Street, Mount Vernon, N.Y. 10550 914-699-9717





**AC/DC AND AC REFERENCE STANDARD  
DYNAMOMETER and MOVING IRON INSTRUMENTS**



**PORTABLE  
AND  
PANEL**

**MODEL D**

**AMMETERS, MILLIAMMETERS AND VOLTMETERS**

MODEL	DESCRIPTION	PAGE
D	.25% AC/DC Dynamometer Ammeters, Milliammeters and Voltmeters. 6.3" Scale length	252-254
University	.5% AC/DC Dynamometer Ammeters, Milliammeters and Voltmeters. 4" Scale length	255
MI	.5% AC Moving Iron Ammeters, Milliammeters and Voltmeters. 6.3" Scale length	256
NSI	.5% AC Moving Iron Ammeters, Milliammeters and Voltmeters. 6" Scale length	257

Refer to model descriptions for availability of portable instruments in edgewise cases (Types EW-5A and EW-7A) for panel mounting.

*Prices and specifications subject to change without notice.*



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**ELECTRICAL INSTRUMENT SERVICE, INC.**  
25 Dock Street, Mount Vernon, N.Y. 10550 914-699-9717





# DYNAMOMETER REFERENCE STANDARDS

## SPECIFICATIONS

AC/DC PORTABLE—HORIZONTAL USE

ACCURACY	.25% of full scale
FREQUENCY	See individual ranges
TYPE	Electrodynamometer
SCALE	Hand-drawn; 6.3"; anti-parallax mirror
POINTER	Knife edge
PERIOD	3-4 seconds
DAMPING	Air vane
PIVOTS	Diamond pivoted
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
RANGE CHANGING	Single and double range binding posts only; three or more ranges switch controlled
MECHANICAL ZERO	External zero shifter
CASE	Formica; Size 11 case 7 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 6 $\frac{1}{8}$ " h.; Size 12 case 13 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 6 $\frac{1}{2}$ " h.; black bakelite panel; hinged cover; carrying handle
APPROX. WEIGHT	8 lbs. net; 12 lbs. shipping (Size 11 case) 12 lbs. net; 16 lbs. shipping (Size 12 case)

All instruments are provided with data cards listing temperature corrections and maximum overload ratings.

The Model D conforms to the following specifications: ASA C-39.1; and on request Mil-M-16034B

All instruments are diamond pivoted with shock mounted sapphire jewels to give a virtually friction-free moving element that will withstand abnormal handling. Portable cases are made of tough, durable formica and are gasketed to provide an effective dust and humidity barrier.



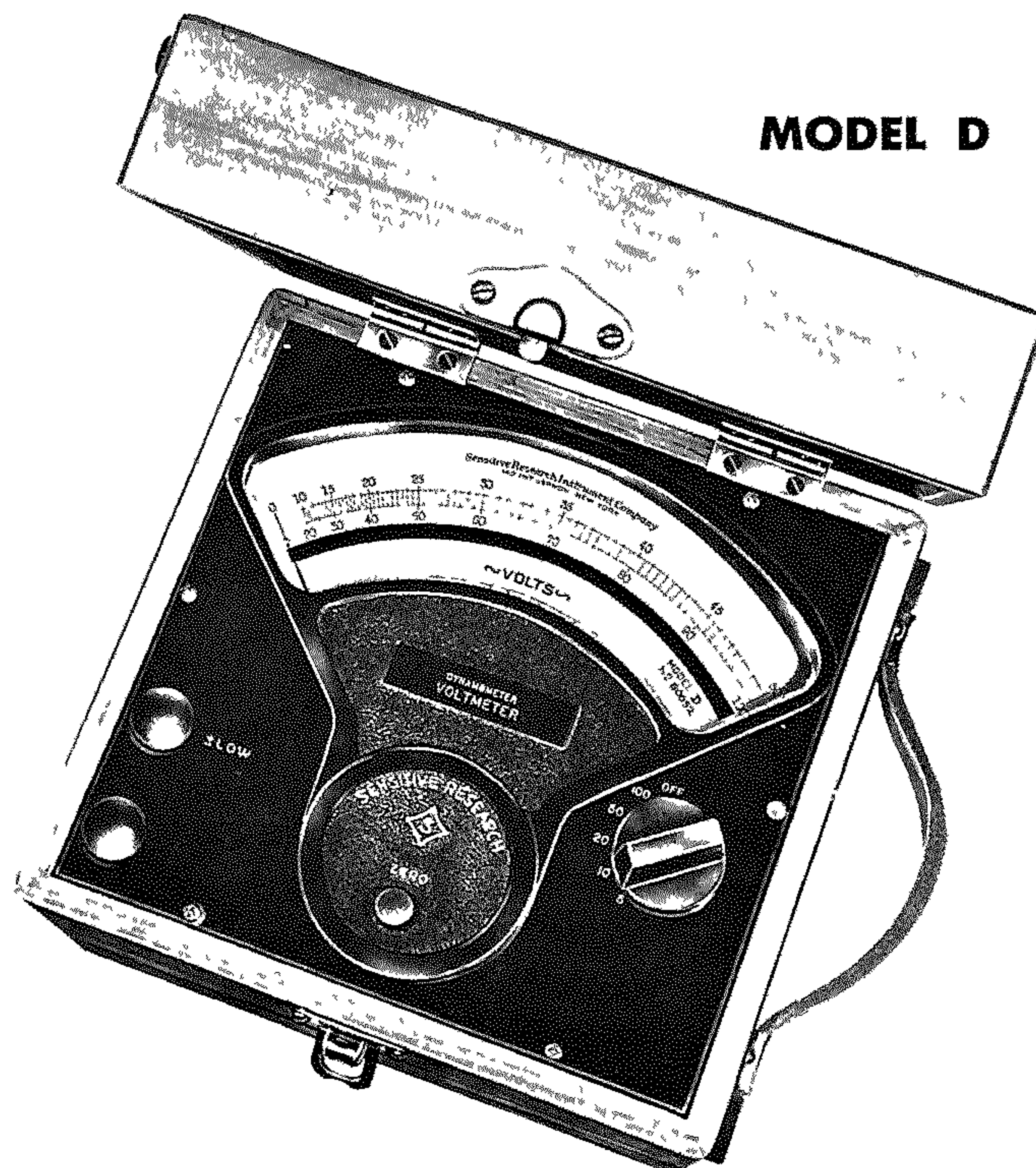
MODEL DEW-7A

### PANEL INSTRUMENTS

The Model D is also available for vertical panel mounting in the deep EW-5A (5" scale length) or EW-7A (7" scale length) edgewise panel case. For dimensions see page 258.

Performance characteristics are the same as listed for the portable type.

**Specify:** Model DEW-5A or DEW-7A and code word of portable instrument having ranges desired.



MODEL D

The electro-dynamometer type of instrument is inherently a rugged, fast acting indicator capable of maintaining highly accurate calibration over the years. Since it is a true RMS measuring instrument, it has great value as a portable laboratory standard. Within its frequency range it is completely unaffected by wave form distortion.

The deflection torque of the electro-dynamometer instrument is the average torque produced by the mutual action of the electromagnetic fields created by currents in the fixed and moving coils. The instantaneous torque is proportional to the product of the instantaneous magnitudes of the currents in the fixed field coils and the moving coil. When measuring alternating current, the moving coil torque occurs in surges, two for each cycle of the current. Because the moving element has a time constant that is very long compared to the period of the alternating current, these surges of torque are mechanically averaged.

If the same current flows in the moving coil and fields, or there is a fixed ratio of one to the other, the deflection of the instrument is proportional to the mean square value of current in the coils. The scale contains a root factor and so scale readings are in RMS values. See page 254 for typical dynamometer scale.

With direct current in the coils, the torque is still proportional to the RMS (steady DC) value. Thus the electro-dynamometer is an accurate transfer instrument which may be calibrated on direct current and used to measure alternating current. When measuring direct current, maximum accuracy is obtained by reversing polarities and using the average value of the two readings.

All frequency ranges specified are based on sinusoidal waveforms. Harmonic components outside the stated frequency range of the instrument often do not cause appreciable errors in reading, since the response of the instrument does not fall off rapidly with increasing frequency. It is not recommended for frequencies below 15 cycles.



# DYNAMOMETER MILLIAMMETERS AND AMMETERS

## DYNAMOMETER MILLIAMMETERS

Full Scale Milliamperes	*Approx. Resist. ohms	*Approx. Induct. in Henrys	Scale Div.	D.C. & 25-125 cps		D.C. & 25-500 cps		D.C. & 25-1000 cps		D.C. & 25-2500 cps	
				Code	Price	Code	Price	Code	Price	Code	Price
5/10	3500/2500	3/3	100	DYMISA							
10/20	2000/1000	.63/.16	100	DYMIFF		DYMIFF-5					
15/30	1375/600	.55/.14	150	DYMILL		DYMILL-5					
30/60	300/175	.18/.045	120/150	DYMIPP		DYMIPP-5					
50/100	100/85	.07/.018	100	DYMITT		DYMITT-5		DYMITT-10		DYMITT-25	
75/150	60/30	.08/.02	150	DYMIJE		DYMIJE-5		DYMIJE-10		DYMIJE-25	
150/300	15/9	.017/.004	150	DYMIKS		DYMIKS-5		DYMIKS-10		DYMIKS-25	
250/500	9.8/4.9	.006/.0017	125/100	DYMILE		DYMILE-5		DYMILE-10		DYMILE-25	
300/600	6.4/2.5	.006/.0017	150/120	DYMIST		DYMIST-5		DYMIST-10		DYMIST-25	
500/1000	3.5/1.9	.0028/.00007	100	DYMIXE		DYMIXE-5		DYMIXE-10		DYMIXE-25	

All dynamometer MILLIAMMETERS compensated up to 500 cycles, and the codes DYMITT-10, DYMIJE-10, DYMIKS-10, DYMILE-10 are contained in the Size 11 case (7 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 6 $\frac{1}{8}$ ").

All other dynamometer MILLIAMMETERS compensated above 500 cycles are contained in the Size 12 case (13 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 6 $\frac{1}{2}$ ").

## DYNAMOMETER AMMETERS

Full Scale Amperes	*Approx. Resist. ohms	*Approx. Induct. in Henrys	Scale Div.	D.C. & 25-125 cps		D.C. & 25-500 cps		D.C. & 25-1000 cps		D.C. & 25-2500 cps	
				Code	Price	Code	Price	Code	Price	Code	Price
1/2	2.1/.7	2.8/.7 mh	100	DYAMAL		DYAMAL-5		DYAMAL-10		DYAMAL-25	
2.5/5	1.1/.48	.6/.15 mh	125/100	DYAMER		DYAMER-5		DYAMER-10		DYAMER-25	
5/10	.125/.06	.04/.01 mh	100	DYAMIK		DYAMIK-5		DYAMIK-10		DYAMIK-25	
10/20	.066/.03	.02/.005 mh	100	DYAMOO		DYAMOO-5		DYAMOO-10		DYAMOO-25	

\* Values for 25-125 cps instruments

All dynamometer AMMETERS are contained in the Size 12 case excepting the codes DYAMAL and DYAMAL-5.

## SINGLE RANGE INSTRUMENT PRICING

Single range instruments available from 5 milliamperes to 20 amperes.

**MILLIAMMETERS**—Use price of multirange milliammeter whose *lowest* range is the required range and deduct \$25 for 25-125 cps instruments. For frequency compensated instruments deduct additionally as follows: 500 cps, \$5; 1000 cps, \$7; 2500 cps, \$15.

**AMMETERS**—Use price of multirange ammeter whose *highest* range is the required range and follow same procedure as for milliammeters.

## FREQUENCY COMPENSATION FOR AMMETERS AND VOLTMETERS

Dynamometer instruments normally furnished for use on DC and 25-125 cycles, can usually be compensated over a greater frequency span depending on the range, sensitivity and accuracy required. The practical limitations are ones of power consumption and increased size and cost. Instruments designed for use over a range of 25-2500 cycles draw considerably more power than those manufactured for use at lower frequencies and/or a narrower span. In some instances, the compensated instrument must be installed in a larger case, or furnished with an external multiplier or shunt box. In a multirange instrument, the ratio of highest to lowest range is of significance inasmuch as the power consumed in the lowest range is multiplied by the ratio factors of the higher ranges (i.e. a voltmeter with a range of 0-15 volts draws about 350 ma, or dissipates 5.25 watts, if compensated from 25-2500 cycles. If ranges of 30/75/150/300 volts are added, the power consumption for each extra range is multiplied by factors of 2/5/10/20 for a dissipation of 10.5/26.5/52.5/105 watts. While such an instrument can be manufactured, it is obviously not practical from the standpoint of efficiency, size and cost).

When compensated, no frequency correction factor need be applied to achieve rated accuracy. The compensation is accomplished by introducing a capacitive time constant into the circuit to balance the inductive time constant of the dynamometer and its multiplier resistances. In this way, the impedance of the instrument is substantially constant over the complete range of frequencies for which it is compensated.

Listed above and on page 254 are single and multirange Dynamometer Milliammeters, Ammeters and Voltmeters with their maximum practical frequency span. It is possible to supply special single range instruments for use "at" a particular frequency (i.e. 400 cycles with a span of 380-420 cycles) with less power consumption than if designed for operation over a wider frequency span. Maximum frequency can exceed 2500 cycles in some cases if calibration is "at" a particular frequency. In addition, special instruments with different ranges than listed can be supplied provided their ratios of ranges and sensitivity do not exceed the practical considerations just detailed. Correspondence concerning special instruments is invited.



# DYNAMOMETER VOLTMETERS

## SPECIFICATIONS

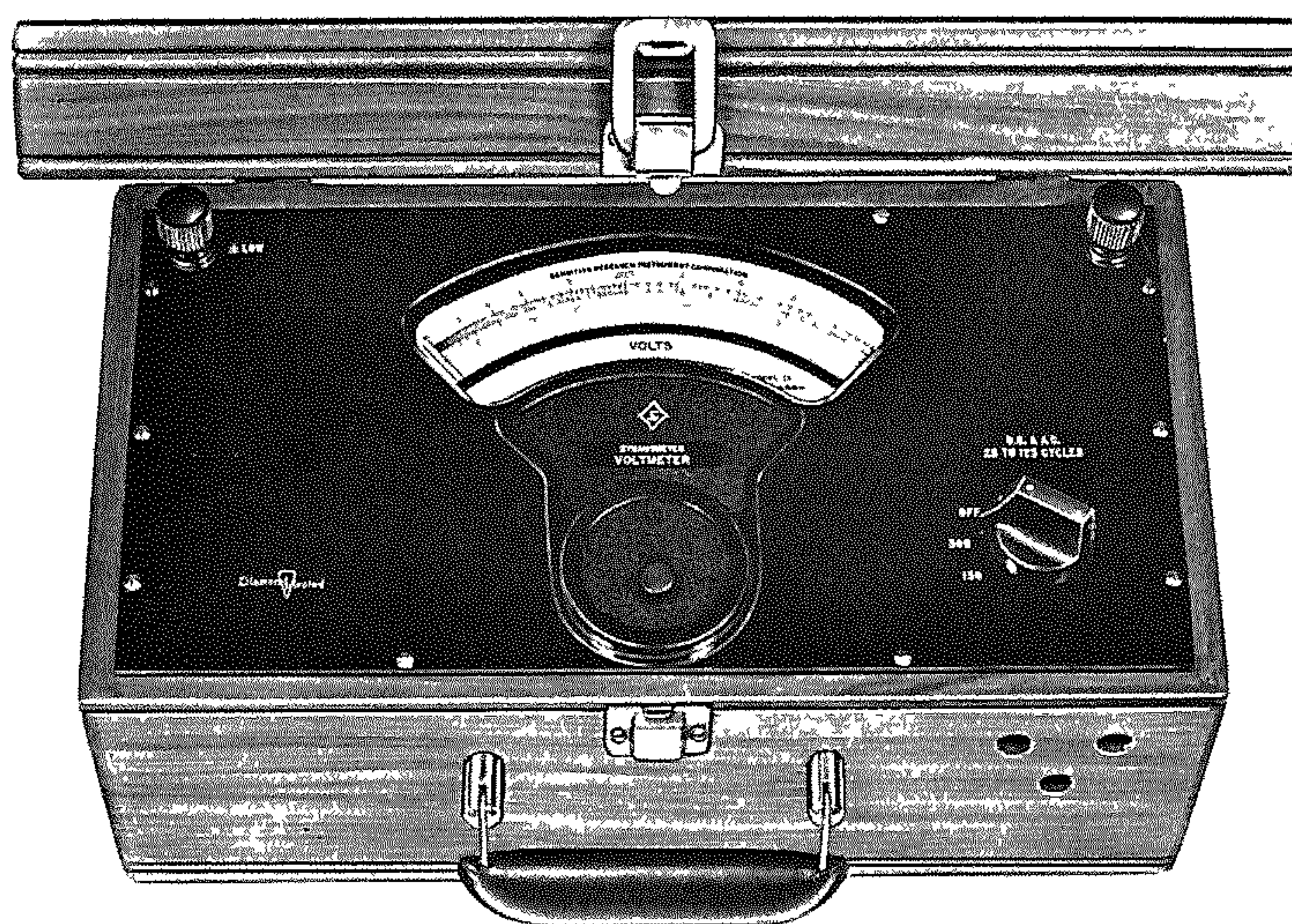
VOLTMETER specifications are as listed on page 252.

**SPECIAL RANGES** are available within the minimum and maximum ranges listed. External multipliers may be used for extension of ranges beyond 1000 volts. Correspondence is invited.

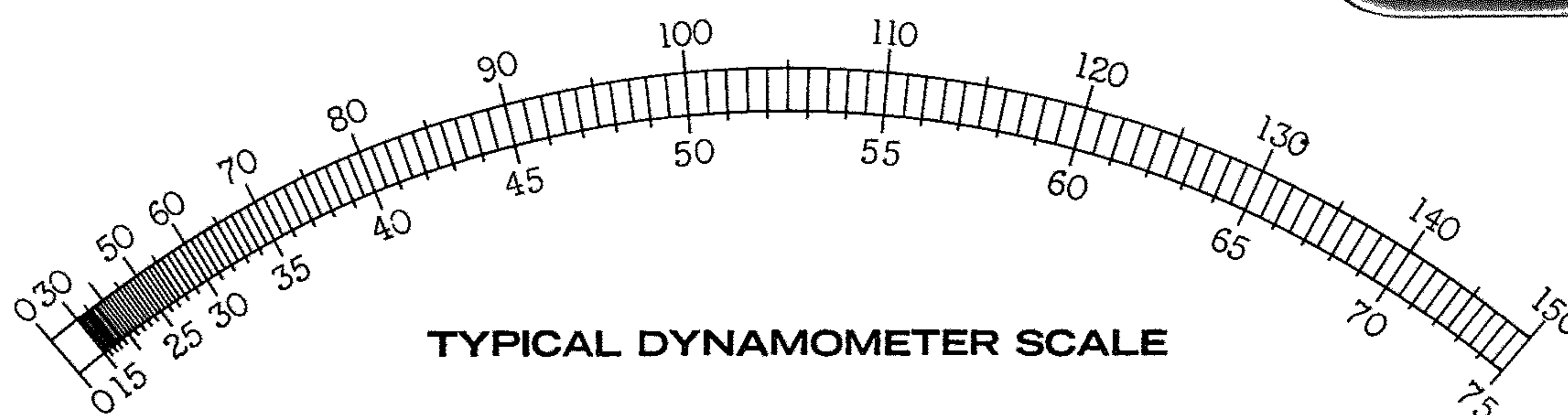
**LEADS** supplied for all voltmeters with ranges below 7.5 volts.

**RESISTANCES** listed below are for 25-125 cycle meters. Higher frequency voltmeters have lower resistances, e.g., at 1000 cycles, resistances decrease by approx. 60%.

**PANEL INSTRUMENTS** available. See page 252.



**MODEL D**



**TYPICAL DYNAMOMETER SCALE**

### SINGLE RANGE VOLTMETERS

Full Scale Volts	Approx. Total Resist. Ohms	Scale Div.	D.C. & 25-125 cps		D.C. & 25-500 cps		D.C. & 25-1000 cps		D.C. & 25-2500 cps	
			Code	Price	Code	Price	Code	Price	Code	Price
*1.5	3.5	150	*DYVOSH							
*3	7	150	*DYVOLT							
7.5	65	150	DYVOMO		DYVOMO-5		DYVOMO-10			
15	200	150	DYVONI		DYVONI-5		DYVONI-10		DYVONI-25	
30	400	150	DYVOOK		DYVOOK-5		DYVOOK-10		DYVOOK-25	
50	1300	100	DYVOPA		DYVOPA-5		DYVOPA-10		DYVOPA-25	
75	2500	150	DYVORI		DYVORI-5		DYVORI-10		DYVORI-25	
100	5000	100	DYVOST		DYVOST-5		DYVOST-10		DYVOST-25	
150	15000	150	DYVOTO		DYVOTO-5		DYVOTO-10		DYVOTO-25	
300	30000	150	DYVOWI		DYVOWI-5		DYVOWI-10		DYVOWI-25	
500	50000	100	DYVOBA		DYVOBA-5		DYVOBA-10		DYVOBA-25	
750	75000	150	DYVOCO		DYVOCO-5		DYVOCO-10		DYVOCO-25	
1000	90000	100	DYVODI		DYVODI-5		DYVODI-10		DYVODI-25	

All single range dynamometer voltmeters compensated for 2500 cps, and all single range instruments over 100 volts compensated for 1000 cps are contained in the Size 12 case (13 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 6 $\frac{1}{2}$ "). Other single range instruments are in the Size 11 case (7 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 6 $\frac{1}{8}$ ").

### MULTIRANGE VOLTMETERS

Full Scale Volts	Scale Div.	D.C. & 25-125 cps		D.C. & 25-500 cps		D.C. & 25-1000 cps		D.C. & 25-2500 cps	
		Code	Price	Code	Price	Code	Price	Code	Price
*1.5/3	150	*DYVOSP							
7.5/15	150	DYVOTI		DYVOTI-5					
30/75	150	DYVOLL		DYVOLL-5		DYVOLL-10			
75/150	150	DYVOBY		DYVOBY-5		DYVOBY-10		DYVOBY-25	
150/300	150	DYVOCA		DYVOCA-5		DYVOCA-10		DYVOCA-25	
300/600	150/120	DYVOXY		DYVOXY-5		DYVOXY-10		DYVOXY-25	
300/750	150	DYVOPX		DYVOPX-5		DYVOPX-10		DYVOPX-25	
75/150/300	150	DYVOKA		DYVOKA-5		DYVOKA-10			
150/300/600	150/120	DYVOLP		DYVOLP-5		DYVOLP-10			
150/300/750	150	DYVOUT		DYVOUT-5		DYVOUT-10			
7.5/15/30/75	150	DYVOOM		DYVOOM-5		All multirange dynamometer voltmeters are contained in the Size 12 case. Multirange instruments have a constant ohms per volt on all ranges which is the same as their lowest range.			
10/20/50/100	100	DYVDOM		DYVDOM-5					
15/30/75/150	150	DYVOOT		DYVOOT-5					
30/75/150/300	150	DYVOOS		DYVOOS-5					
75/150/300/750	150	DYVOOZ		DYVOOZ-5					

\*Codes DYVOSH, DYVOLT and DYVOSP, accuracy .25% at 60 cps and .5% from 25 to 70 cps.



# COMPACT DYNAMOMETER MILLIAMMETERS – AMMETERS – VOLTMETERS

## SPECIFICATIONS

AC/DC PORTABLE—HORIZONTAL USE

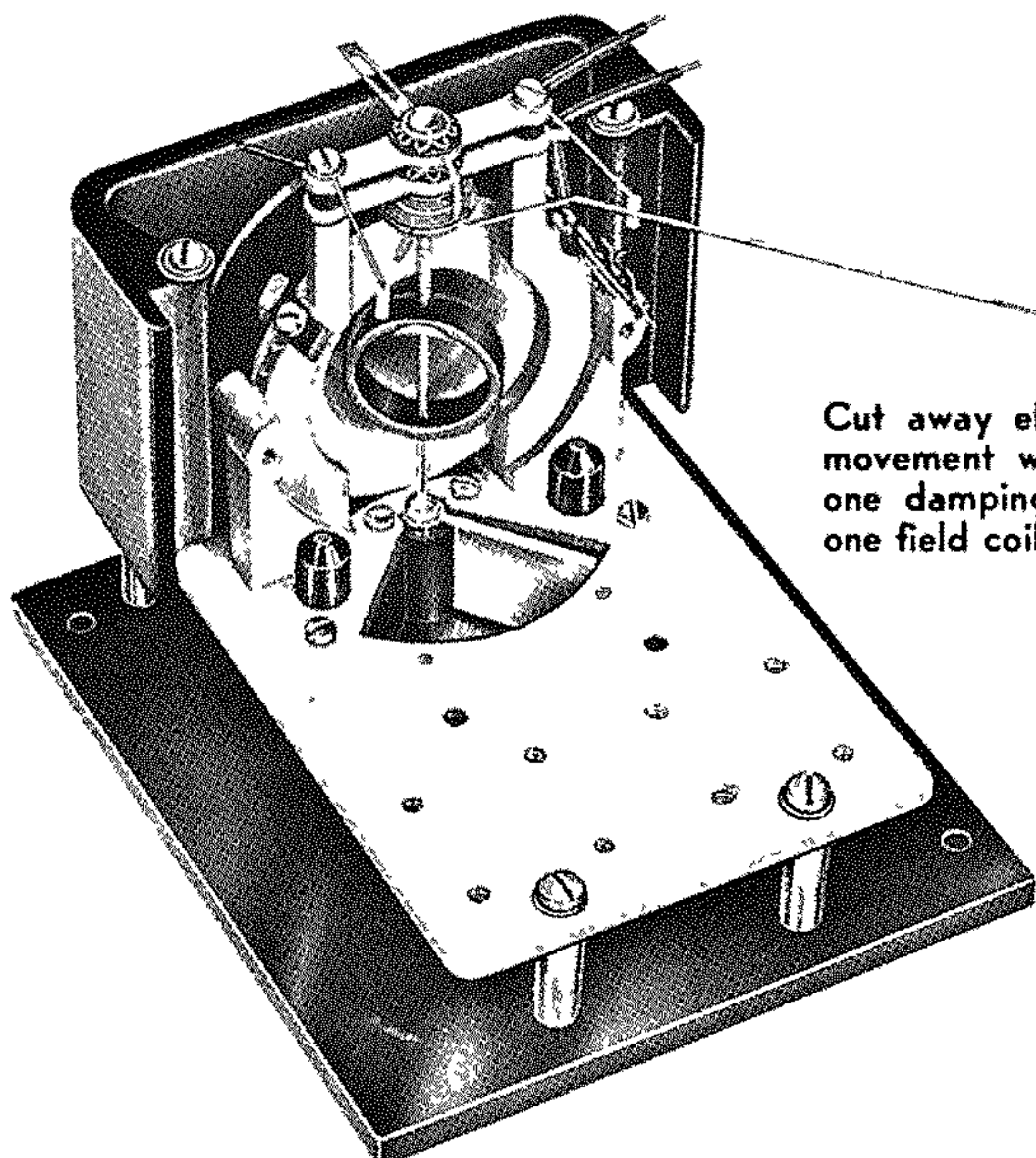
ACCURACY	.5% of full scale
FREQUENCY	DC & 25-125 cps
TYPE	Electrodynamometer
SCALE	Hand-drawn; 4"; anti-parallax mirror
POINTER	Knife edge
PERIOD	2-3 seconds
DAMPING	Air vane
PIVOTS	Diamond pivoted
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
RANGE CHANGING	Single & double range binding posts only; three ranges and above switch controlled
MECHANICAL ZERO	External zero shifter
CASE	Moulded black bakelite: 5-5/16" x 5-1/8" x 4-1/2" deep; carrying handle
APPROX. WEIGHT	5 lbs net; 8 lbs shipping

All instruments are provided with data cards listing temperature corrections and maximum overload ratings.

The University Model Dynamometer is a moderately priced AC/DC electrical indicating instrument employing the same operating principles as the Model D described on pages 252-254. It makes available in a small portable general purpose case the principal features of the dynamometer type construction.

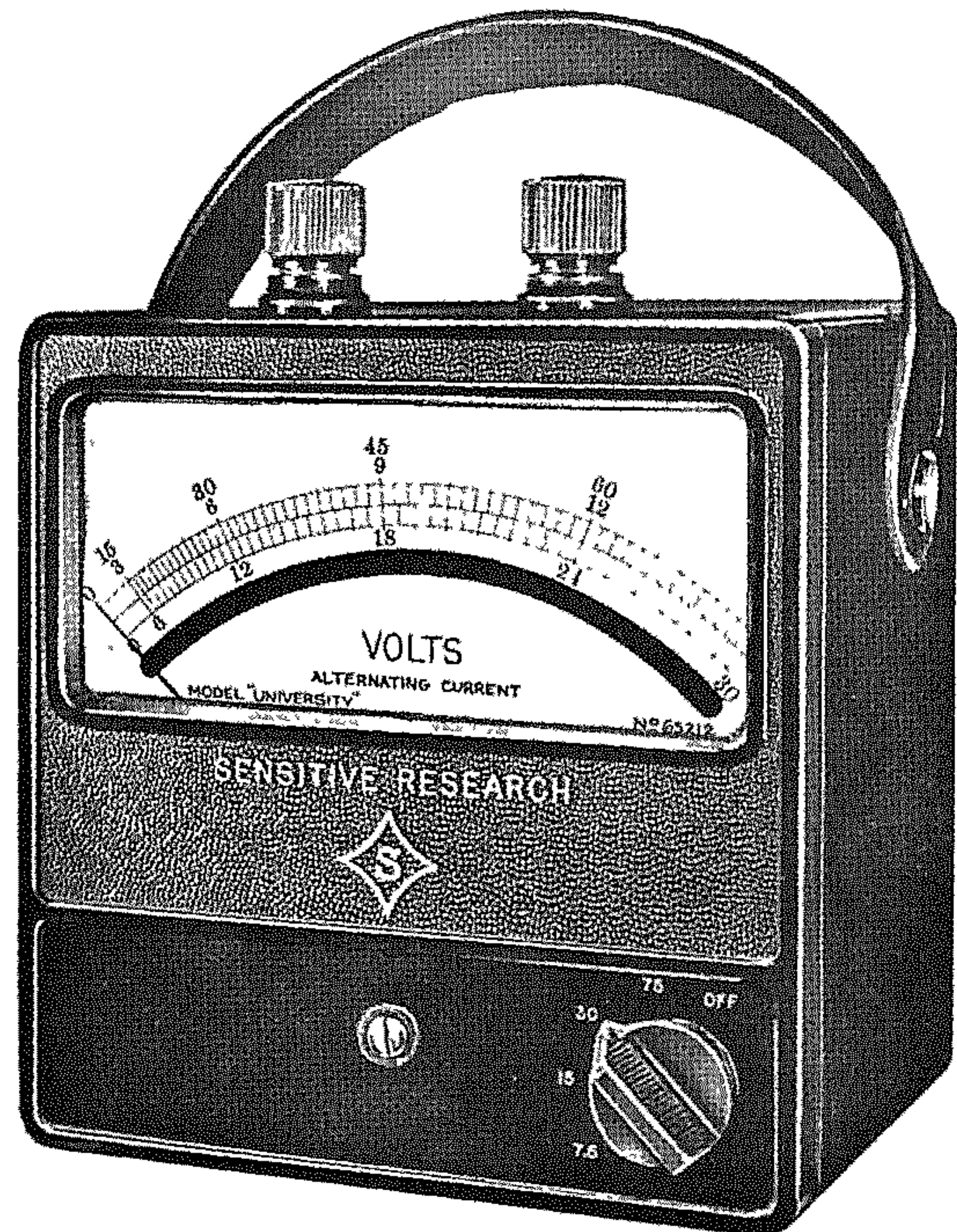
The moving element is located in a compartment that is isolated from the main network of wiring and resistors. This section of the instrument can therefore be serviced without exposing the moving element to contamination in the atmosphere. In addition it is relatively free from the effects of self-heating by its multipliers and can be used for continuous duty on higher volt ranges without a circuit interrupter.

Although the scale length is 4 inches, because the scale characteristics are approximately square law, the upper 60% is greatly expanded. Therefore the scale divisions are wider, or resolution is markedly increased, in the area where readings are most meaningful. The scale is compressed at the lower end where it is not good instrumentation practice (even with a linear scale) to attempt high accuracy measurements.



Cut away electrodynamic movement with part of shield, one damping vane cover, and one field coil removed.

## UNIVERSITY MODEL



### AMMETERS

Full Scale Amperes	Scale Div.	Code	Price
1.5/3	75/60	UDAYBO	
2.5/5	125/100	UDYADI	
5/10	100	UDYAFO	

For single range instruments deduct \$10.00.

### MILLIAMMETERS

Full Scale Milliamperes	Approx. Resistance $\Omega$	Scale Div.	Code	Price
10/20	2000/1000	100	UDYMAE	
15/30	1375/600	75/60	UDYMET	
30/60	300/175	60	UDYMOO	
50/100	100/85	100	UDYMUS	
75/150	60/30	75	UDYMIP	
150/300	15/9	75/60	UDYMAT	
250/500	9.8/4.9	125/100	UDYMEQ	
300/600	6.4/2.5	60	UDYMIX	
500/1000	3.5/1.9	100	UDYMOY	

For single range instruments deduct \$10.00.

### VOLTMETERS

Full Scale Volts	Approx. Ohms per volt	Scale Div.	Code	Price
75/150	100	75	UDYVUR	
150/300	100	75/60	UDYVOX	
300/750	100	60/75	UDYVAP	
30/75/150	13.3	60/75	UDYVAX	
75/150/300	100.	60/75	UDYVIS	
150/300/600	100.	60/75	UDYVUL	
7.5/15/30/75	3.3	60/75	UDYOKI	
10/20/50/100	10.	100	UDYOPA	
15/30/75/150	13.3	60/75	UDYOBI	
30/75/150/300	13.3	60/75	UDYOCK	



# MOVING IRON AMMETERS – MILLIAMMETERS – VOLTMETERS

## SPECIFICATIONS

AC PORTABLE—HORIZONTAL USE

ACCURACY	.5% of full scale
FREQUENCY	See note A below.
TYPE	Moving iron
SCALE	Hand drawn; 6.3"; anti-parallax mirror
POINTER	Knife edge
PERIOD	2—3 seconds
DAMPING	Air vane
PIVOTS	Diamond pivoted
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
RANGE CHANGING	Single & double range binding posts only; three ranges or more switch controlled.
MECHANICAL ZERO	External zero shifter
CASE	Formica; 7 $\frac{3}{4}$ " x 7 $\frac{3}{4}$ " x 4 $\frac{3}{4}$ " h.; black bakelite panel; hinged cover; carrying handle.
APPROX. WEIGHT	7 lbs. net; 11 lbs. shipping.

All instruments are provided with data cards listing temperature corrections and maximum overload ratings.

### PANEL INSTRUMENTS

The Model MI is also available for vertical panel mounting in the shallow EW-5A (5" scale length) or EW-7A (7" scale length) edgewise panel case. For dimensions see page 258.

Performance characteristics are the same as listed for the portable type, except frequency compensation cannot be provided above 800 cycles.

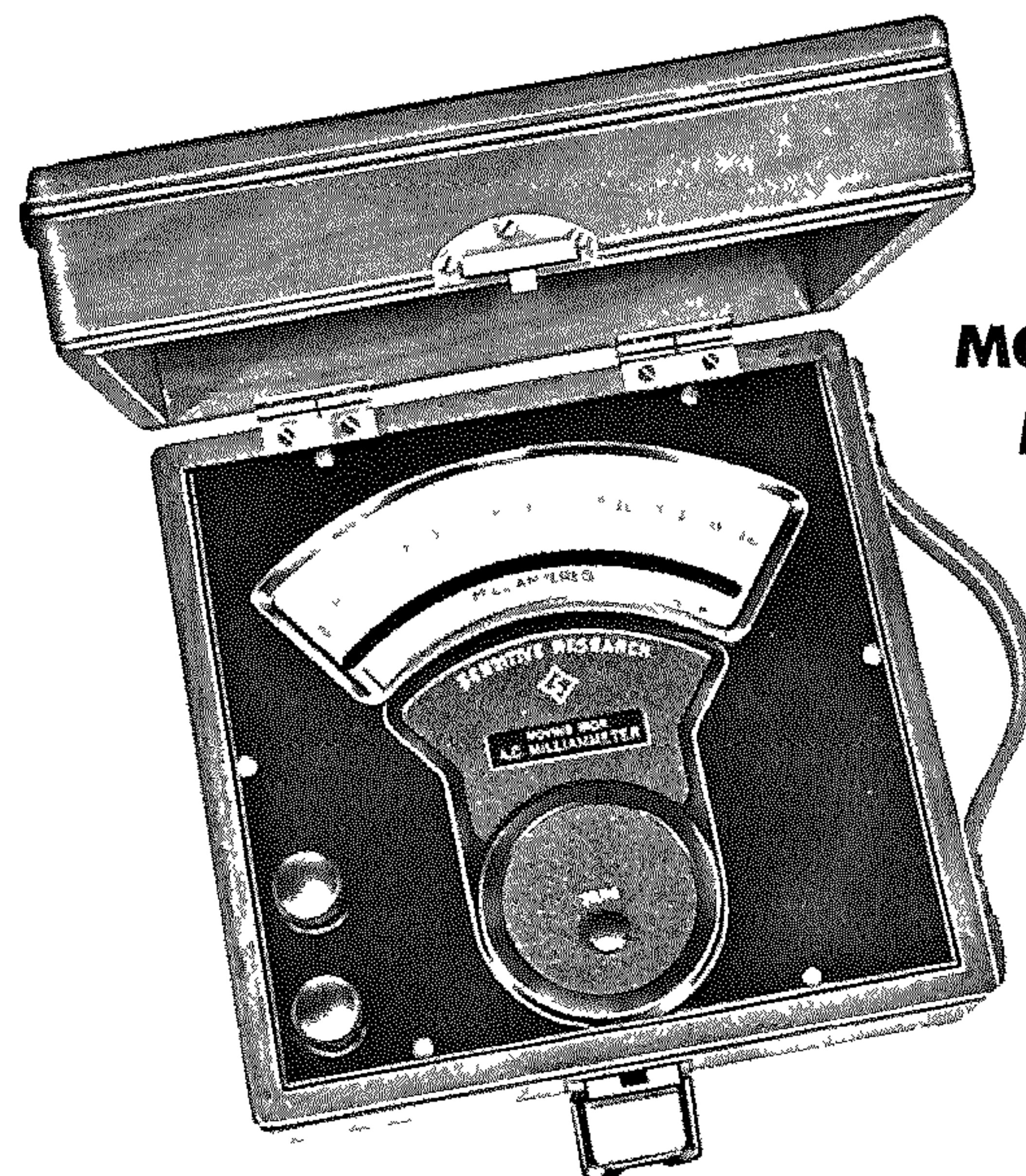
Specify: Model MIEW-5A or MIEW-7A and code word of portable instrument having ranges desired.

### MILLIAMMETERS (See Note A)

Milliamps.	Approx. Res. $\Omega$	Scale Div.	Code	Price
10	1800	100	MIMAAH	
15	1050	150	MIMILZ	
30	300	150	MIMILO	
50	90	100	MIMILK	
75	40	150	MIMILI	
100	24	100	MIMIST	
150	12	150	MIMIKO	
300	3.5	150	MIMIBU	
500	1.0	100	MIMICK	
750	.38	150	MIMIFA	
75/150	40/20	150	MIMIOK	
150/300	12/6	150	MIMIRT	
250/500	4/2	125/100	MIMIKY	
500/1000	1/.5	100	MIMIOT	

### AMMETERS (See Note A)

Amperes	Scale Div.	Code	Price
1	100	MIAMAB	
2	100	MIAMEC	
3	150	MIAMID	
5	100	MIAMOF	
10	100	MIAMUJ	
15	150	MIAMO	
20	100	MIAMFA	
25	125	MIAMJY	
30	150	MIAMKS	
50	100	MIAMLY	
1.5/3	150	MIAMOO	
2.5/5	125/100	MIAMAS	
5/10	100	MIAMII	
10/20	100	MIAMAU	



MODEL  
MI

The Model MI is an excellent selection for use as an AC electrical indicating instrument when price, ruggedness and good accuracy over a low frequency range are primary considerations. The indicating mechanism employed is a moving iron movement which can withstand unusual physical abuse and relatively large electrical overloads. In fact, it is virtually impossible to distort the pointer by an electrical overload. All moving iron types have scales that are almost linear over their upper 85%.

### VOLTMETERS Frequency, 25-125 cycles (See Note A)

Volts	Approx. Res. $\Omega$	Scale Div.	Code	Price
** 7.5	50	150	MIVOHO	
** 10.0	90	100	MIVODA	
** 15.0	170	150	MIVOFY	
30	425	150	MIVOLT	
50	1150	100	MIVOMO	
75	2700	150	MIVOPI	
150	5500	150	MIVOSY	
250	19000	125	MIVOTE	
300	22500	150	MIVOVA	
500	38000	100	MIV OBS	
** 7.5/15		150	MIVOJI	
** 10/50		100	MIVONA	
30/75	<i>Multirange instruments have a constant ohms per volt on all ranges which is the same as their lowest range.</i>	150	MIVOZR	
50/100		100	MIVOEP	
* 125/250		125	MIVOIN	
* 150/300		150	MIVOOM	
* 300/750		150	MIVOUT	
* 30/75/150		150	MIVOYA	
* 50/100/250		100/125	MIVOYO	
* 75/150/300		150	MIVOYI	
* 100/200/500		100	MIVOYU	
* 150/300/750		150	MIVOYE	

NOTE A — FREQUENCY: Current instruments are normally calibrated at 60 cycles. However, if specified by the customer, calibration may be done at 400 cycles. The following accuracies apply:

MILLIAMMETERS calibrated at:

60 cps. — 1/2% 25-125 cps.; 3/4% 125-500 cps.  
400 cps. — 1/2% 300-500 cps.; 3/4% 25-300 cps.

AMMETERS calibrated at:

60 cps. — 1/2% 25-125 cps.; 1% 125-500 cps.  
400 cps. — 1/2% 300-500 cps.; 1% 25-300 cps.

VOLTMETERS: Above 15 volts, voltmeters can be supplied compensated for use from 25 to 1000 cycles, at additional cost. Voltmeters compensated for 25-1000 cycles, will be supplied at a lower resistance than shown above.

\*Edgewise panel instruments supplied with external multipliers mounted on rear.

\*\* .5% accuracy for 50-70 cycles only.



# MOVING IRON AMMETERS – MILLIAMMETERS – VOLTMETERS

## SPECIFICATIONS

AC PORTABLE—HORIZONTAL USE

ACCURACY	.5% of full scale
FREQUENCY	Voltmeters 25-125 cps.; ammeters and milliammeters refer to note A below.
TYPE	Moving iron
SCALE	Hand drawn; 6"; almost linear; anti-parallax mirror
POINTER	Knife edge
PERIOD	2-3 seconds
DAMPING	Air vane
PIVOTS	Polished steel
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
RANGE CHANGING	Binding posts only
MECHANICAL ZERO	External zero shifter
CASE	Moulded black bakelite; 7½" x 6½" x 3⅜" deep; black bakelite panel; carrying handle
APPROX. WEIGHT	4½ lbs. net; 8 lbs. shipping

All instruments are provided with data cards listing temperature corrections and maximum overload ratings.

If diamond pivots are desired add \$30.00 to list price.

THE MODEL NSI moving iron type instrument is a low cost AC electrical indicating instrument based on the same operating principles as the Model MI described on page 256. It makes available the principal features of the moving iron design in a portable general purpose case.

The moving element is located in a compartment that is isolated from the main network of wiring and resistors. The resistors and/or shunts can therefore be serviced without danger of accidentally damaging the moving element, or exposing it to dust particles. In addition the Model NSI is relatively free from the effects of self heating by its multipliers and can be used for continuous duty up to \*500 volts without requiring a press to read switch.

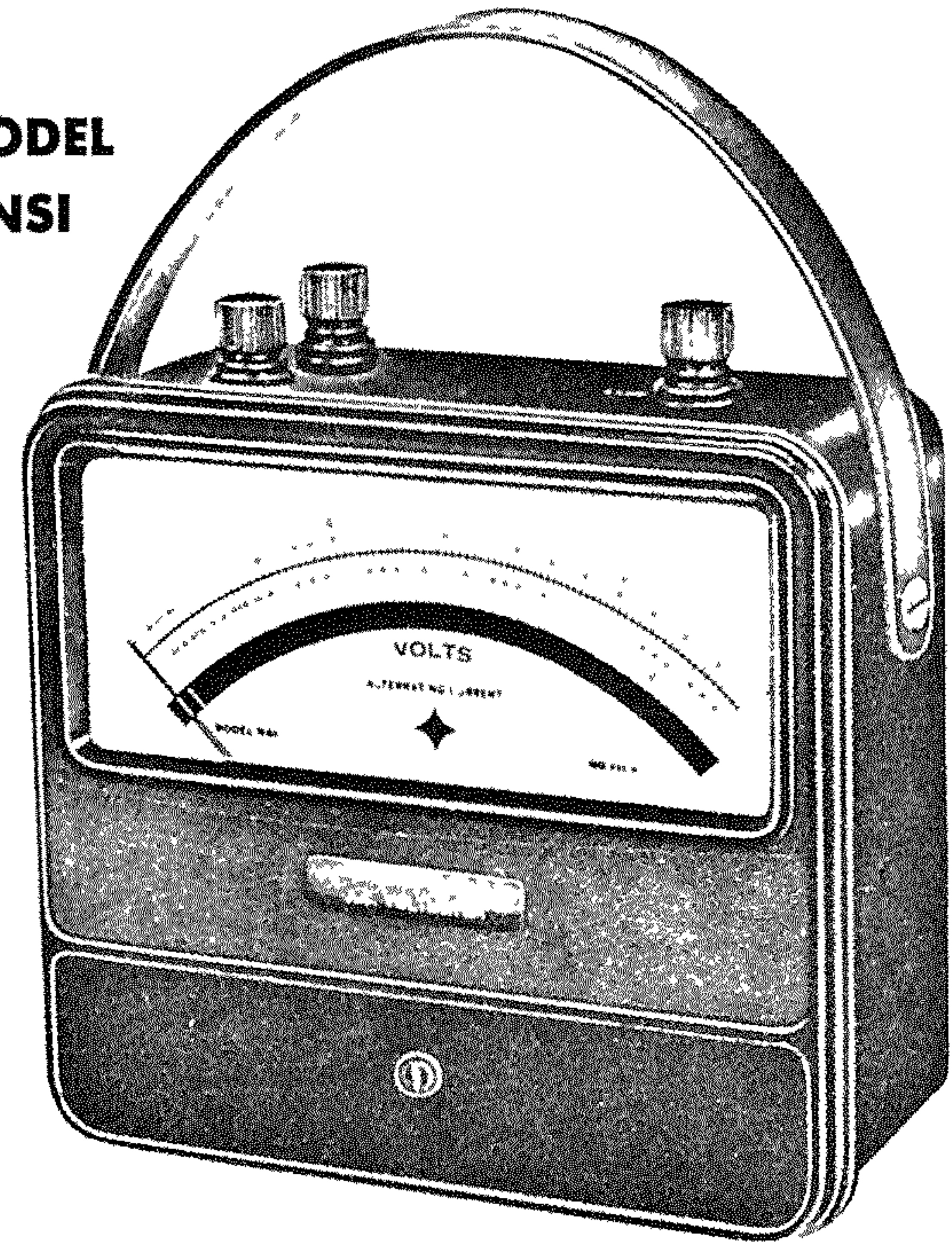
### VOLTMETERS (25-125 cycles)

Volts	Approx. Resistance Ohms	Scale Div.	Code	Price
** 7.5	25	150	NSIVOB	
** 10	40	100	NSIVOC	
** 15	75	150	NSIVOD	
30	120	150	NSIVOE	
120	5500	120	NSIVOF	
150	7500	150	NSIVOG	
300	22,000	150	NSIVOK	
*500	35,000	100	NSIVOK	
*750	52,500	150	NSIVOL	
7.5/15	25/50	150	NSIVOM	
15/30	75/150	150	NSIVOO	
75/150	2700/5400	150	NSIVOP	
150/300	7500/15,000	150	NSIVOR	
*300/600	22,000/44,000	150/120	NSIVOT	
30/75/150	120/300/600	150	NSIVOV	
75/150/300	2700/5400/10,800	150	NSIVOW	
*100/200/500	6600/13,200/33,300	100	NSIVOX	
*150/300/600	7500/15,000/30,000	150/120	NSIVOY	
*150/300/750	7500/15,000/37,500	150	NSIVOZ	

\* Press to read switch provided for ranges of 500 volts and above. These ranges not for continuous operation.

\*\* .5% accuracy for 50-70 cycles only.

## MODEL NSI



### SPECIAL MULTIRANGE VOLTMETER

Full Scale Volts	Scale Div.	Code	Price
3/7.5/15/30/75/150/300/750	50	NSIVOMUL	\$225.00

This is a transformer coupled instrument for 50-125 cycle use only. Switch controlled.

### AMMETERS (See Note A)

Amperes	Scale Div.	Code	Price
1	100	NSIAMP	
2	100	NSIAMB	
3	150	NSIAMI	
5	100	NSIAMO	
10	100	NSIAMU	
1.5/3	150	NSIAMA	
2.5/5	125/100	NSIAME	
5/10	100	NSIAMY	

### MILLIAMMETERS (See Note A)

Milliams.	Approx. Res. Ohms	Approx. Inductance mh	Scale Div.	Code	Price
10	1800	3130	100	NSIMIL	
15	1050	900	150	NSIMIM	
30	307	235	150	NSIMIN	
50	90	140	100	NSIMIO	
75	40	90	150	NSIMIP	
100	24	50	100	NSIMIR	
150	10	26	150	NSIMIS	
300	2.6	5.5	150	NSIMIT	
500	.94	1.8	100	NSIMIV	
750	.4	9	150	NSIMIZ	
50/100	90/45	140/35	100	NSIMAA	
75/150	40/20	90/24	150	NSIMEE	
150/300	10/5	26/6.5	150	NSIMII	
250/500	3.6/1.8	7/1.8	125/100	NSIMOV	
500/1000	2/1	1.8/.45	100	NSIMOY	

NOTE A—FREQUENCY: AC Milliammeters and Ammeters are frequency compensated. Rated accuracy is maintained 25-125 cps. Frequency influence will not exceed .2% additional for 125-500 cps.



# EDGEWISE PANEL CASE DIMENSIONS

## DYNAMOMETER AND MOVING IRON INSTRUMENTS

### GENERAL INFORMATION

The Model D (Pages 252-254) and Model MI (Page 256) are available for flush, vertical panel mounting in the EW-5A and EW-7A cases as per mounting dimensions and specifications listed below. The principal feature of an edgewise panel design is that any portable horizontal type can be converted for panel mounting without sacrificing accuracy or sensitivity for an equivalent scale length. Pivots ride in a normal upright position and hence pivot roll or instability is virtually eliminated.

The case is of cast aluminum with a black wrinkle finish. Electrical specifications detailed on above referenced pages apply to the edgewise panel types. Instruments that are mounted in the EW-7A case have increased burdens by approximately 20% because of this model's longer scale

length. The UNIVERSITY model dynamometer is not available as an edgewise panel instrument.

**NOTE 1:** Edgewise panel cases are NORMALLY furnished with terminal strips. However, some instruments, such as high current types, demand binding posts and are furnished that way.

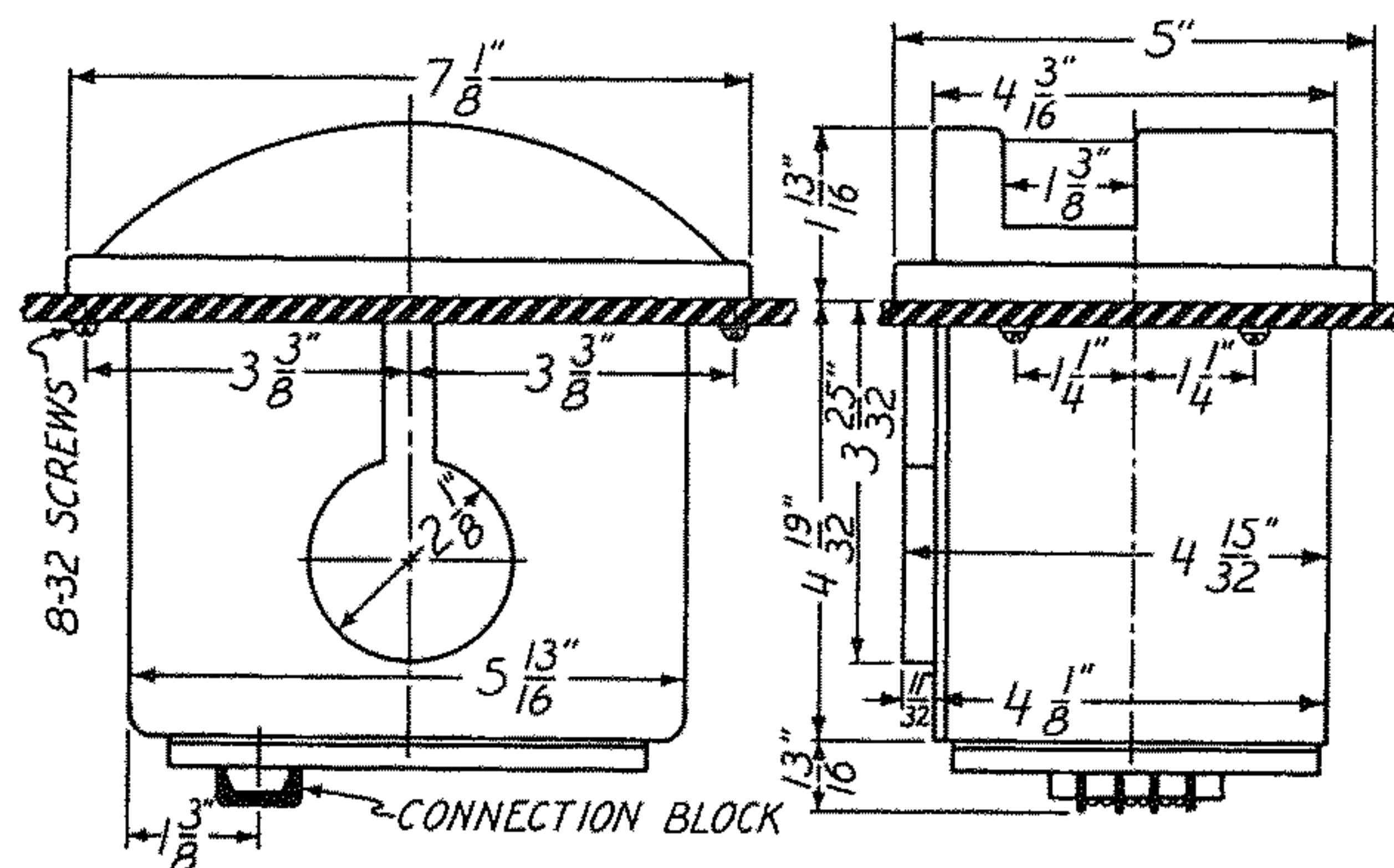
**NOTE 2:** Front zero adjusters are standard on the deep and shallow EW-5A and EW-7A cases.

**NOTE 3:** Where switch control is available in the EW-5A & EW-7A deep cases the same type of switch is utilized as is illustrated in the dimensional drawings of the shallow cases.

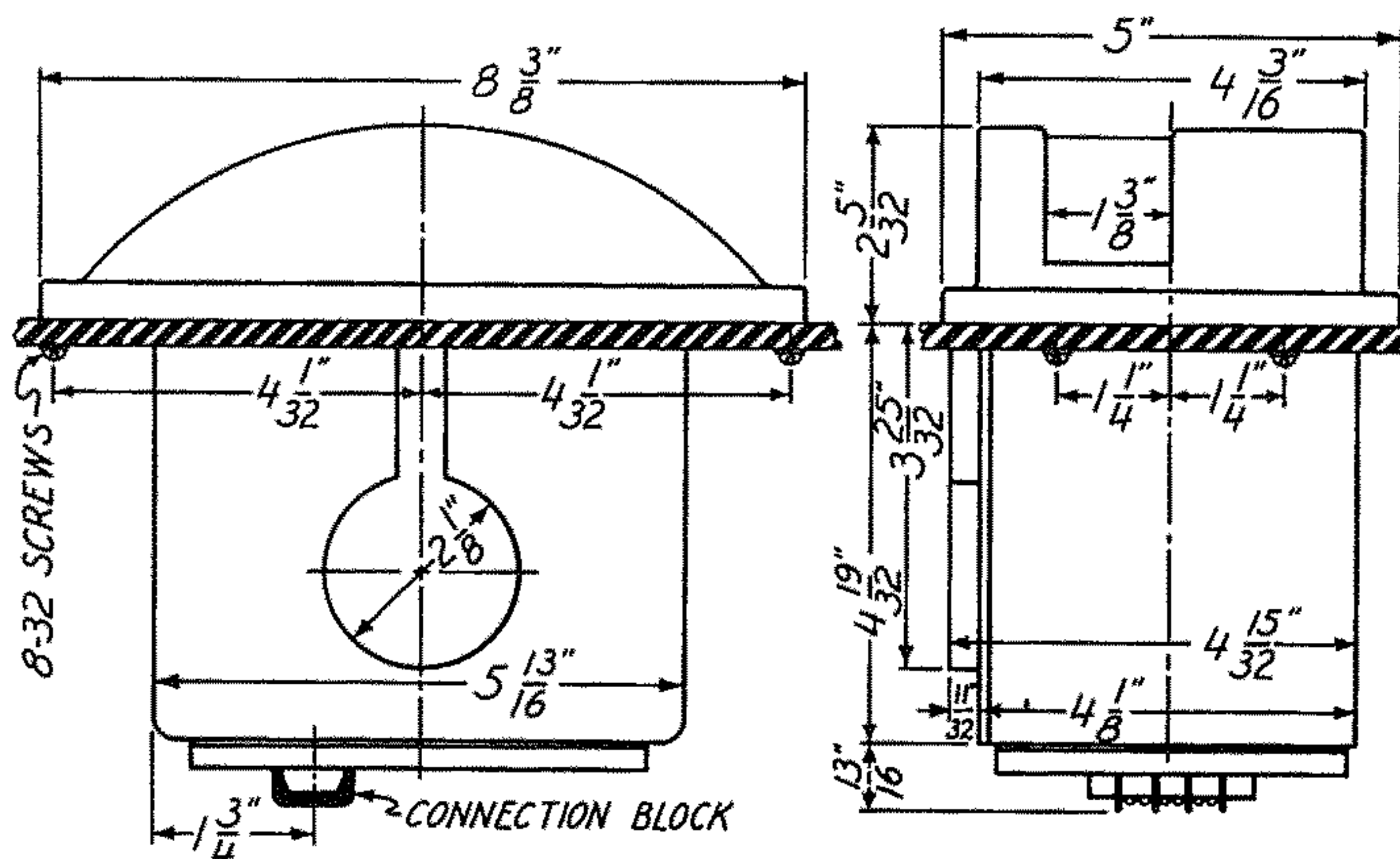
### MODEL D, DYNAMOMETER INSTRUMENTS

Current instruments are supplied with binding posts or terminal strips on the rear of the case. Voltmeters with 3 ranges or more are supplied with range switch in front of case. For most multi-range instruments of 3 ranges or more, external multipliers (not

more than 2½" deep) are supplied mounted on the back of the instrument because of limited space in the edgewise case.



DEW-5A DEEP CASE, Scale Length 5"

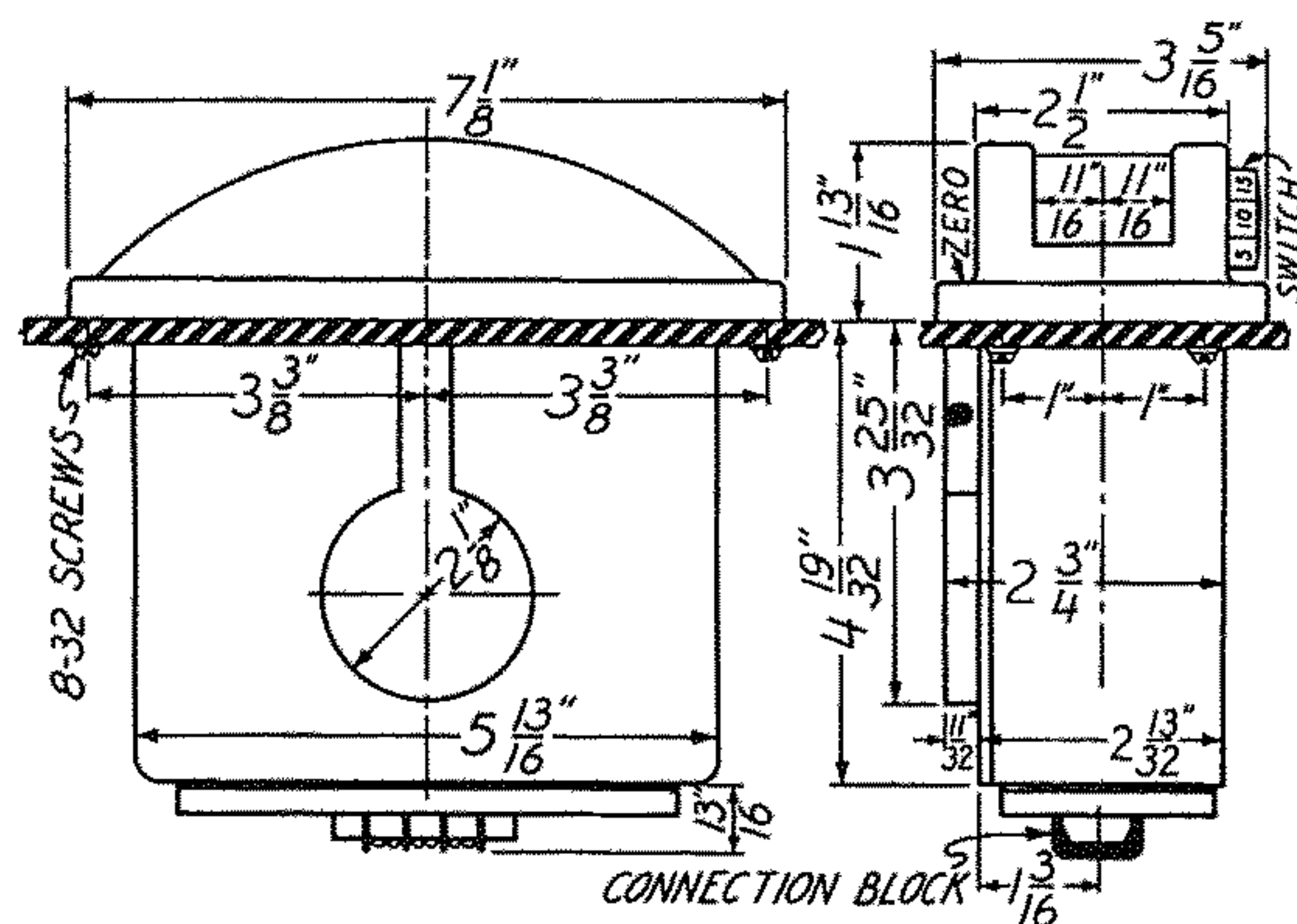


DEW-7A DEEP CASE, Scale Length 7"

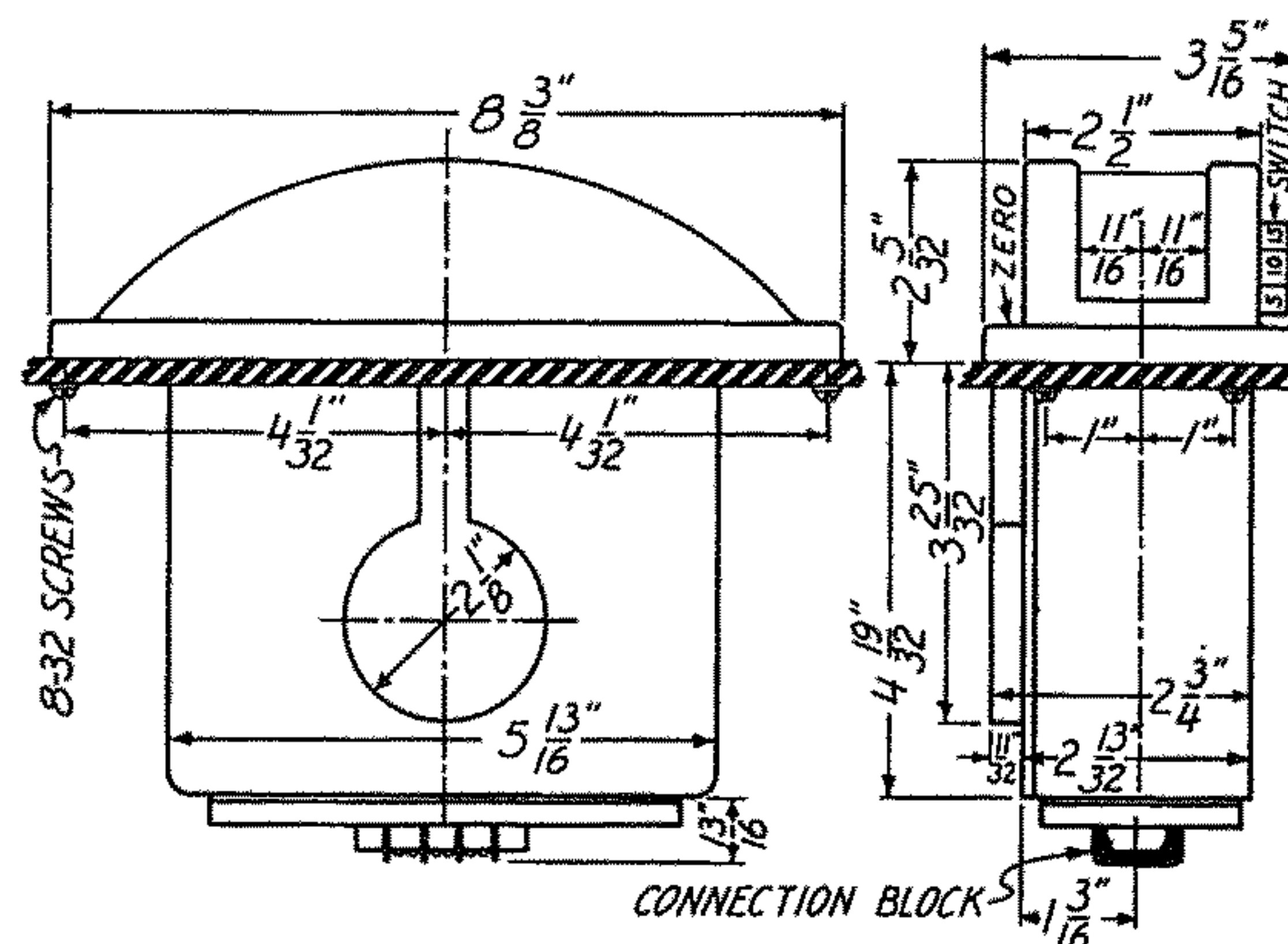
### MODEL MI, MOVING IRON INSTRUMENTS

For complete specifications on moving iron voltmeters, milliammeters, and ammeters see page 256. All instruments are supplied with binding posts or terminal strips only. Voltmeters with a range of 250 volts or higher are furnished with external multipliers mounted on the back of the instrument because of limited space in

the panel mounting case. Prices include these multipliers. Where external multipliers are supplied the instrument may be used for continuous duty and no push-button or "Press to Read" is necessary.



MIEW-5A SHALLOW CASE, Scale Length 5"



MIEW-7A SHALLOW CASE, Scale Length 7"

Prices and specifications subject to change without notice

Printed in U.S.A. 75-4



# AC/DC AND AC REFERENCE STANDARD DYNAMOMETER and MOVING IRON INSTRUMENTS

MODEL D  
DYNAMOMETER MILLIAMMETERS

JANUARY 1, 1981

D.C. & 25-125 HZ		D.C. & 25-500 HZ		D.C. & 25-1000 HZ		D.C. & 25-2500 HZ	
CODE	PRICE	CODE	PRICE	CODE	PRICE	CODE	PRICE
DYMISA	730.00						
DYMIFF	705.00	DYMIFF-5	735.00				
DYMILL	650.00	DYMILL-5	675.00				
DYMIPP	650.00	DYMIPP-5	675.00				
DYMITT	650.00	DYMITT-5	695.00	DYMITT-10	720.00	DYMITT-25	750.00
DYMIJE	650.00	DYMIJE-5	695.00	DYMIJE-10	720.00	DYMIJE-25	750.00
DYMIKS	650.00	DYMIKS-5	695.00	DYMIKS-10	720.00	DYMIKS-25	750.00
DYMILE	650.00	DYMILE-5	695.00	DYMILE-10	720.00	DYMILE-25	750.00
DYMIST	650.00	DYMIST-5	695.00	DYMIST-10	720.00	DYMIST-25	750.00
DYMIXE	650.00	DYMIXE-5	695.00	DYMIXE-10	720.00	DYMIXE-25	750.00

DYNAMOMETER AMMETERS

DYAMAL	650.00	DYAMAL-5	695.00	DYAMAL-10	720.00	DYAMAL-25	750.00
DYAMER	670.00	DYAMER-5	720.00	DYAMER-10	740.00	DYAMER-25	775.00
DYAMIK	670.00	DYAMIK-5	720.00	DYAMIK-10	740.00	DYAMIK-25	775.00
DYAMOO	670.00	DYAMOO-5	720.00	DYAMOO-10	740.00	DYAMOO-25	775.00

SINGLE RANGE VOLTMETERS

DYVOSH	565.00						
DYVOLT	565.00						
DYVOMO	565.00	DYVOMO-5	610.00	DYVOMO-10	635.00		
DYVONI	565.00	DYVONI-5	610.00	DYVONI-10	635.00	DYVONI-25	655.00
DYVOOK	565.00	DYVOOK-5	610.00	DYVOOK-10	635.00	DYVOOK-25	655.00
DYVOPA	565.00	DYVOPA-5	610.00	DYVOPA-10	635.00	DYVOPA-25	655.00
DYVORI	565.00	DYVORI-5	610.00	DYVORI-10	635.00	DYVORI-25	655.00
DYVOST	565.00	DYVOST-5	610.00	DYVOST-10	635.00	DYVOST-25	655.00
DYVOTO	565.00	DYVOTO-5	610.00	DYVOTO-10	635.00	DYVOTO-25	655.00
DYVOWI	575.00	DYVOWI-5	620.00	DYVOWI-10	640.00	DYVOWI-25	665.00
DYVOBA	605.00	DYVOBA-5	650.00	DYVOBA-10	660.00	DYVOBA-25	685.00
DYVOCO	615.00	DYVOCO-5	660.00	DYVOCO-10	670.00	DYVOCO-25	700.00
DYVODI	620.00	DYVODI-5	670.00	DYVODI-10	680.00	DYVODI-25	705.00



\* A TRADEMARK OF EIS

**ELECTRICAL INSTRUMENT SERVICE, INC.**

25 Dock Street, Mount Vernon, N.Y. 10550 914-699-9717





MODEL D

MULTIRANGE VOLTMETERS

<u>D.C. &amp; 25-125 HZ</u>		<u>D.C. &amp; 25-500 HZ</u>		<u>D.C. &amp; 25-1000 HZ</u>		<u>D.C. &amp; 25-2500 HZ</u>	
<u>CODE</u>	<u>PRICE</u>	<u>CODE</u>	<u>PRICE</u>	<u>CODE</u>	<u>PRICE</u>	<u>CODE</u>	<u>PRICE</u>
DYVOSP	625.00						
DYVOTI	605.00	DYVOTI-5	680.00				
DYVOLL	625.00	DYVOLL-5	680.00	DYVOLL-10	730.00		
DYVOBY	630.00	DYVOBY-5	705.00	DYVOBY-10	730.00	DYVOBY-25	760.00
DYVOCA	630.00	DYVOCA-5	710.00	DYVOCA-10	730.00	DYVOCA-25	765.00
DYVOXY	655.00	DYVOXY-5	730.00	DYVOXY-10	760.00	DYVOXY-25	785.00
DYVOPX	665.00	DYVOPX-5	735.00	DYVOPX-10	770.00	DYVOPX-25	790.00
DYVOKA	675.00	DYVOKA-5	775.00	DYVOKA-10	850.00		
DYVOLP	690.00	DYVOLP-5	790.00	DYVOLP-10	825.00		
DYVOUT	705.00	DYVOUT-5	800.00	DYVOUT-10	830.00		
DYVOOM	720.00	DYVOOM-5	845.00				
DYVDOM	720.00	DYVDOM-5	845.00				
DYVOOT	740.00	DYVOOT-5	870.00				
DYVOOS	745.00	DYVOOS-5	875.00				
DYVOOZ	780.00	DYVOOZ-5	900.00				

MODEL UNIVERSITY  
AMMETERS

UDAYBO	450.00
UDYADI	450.00
UDYAFO	450.00

MILLIAMMETERS

UDYMAE	465.00
UDYMET	395.00
UDYMOO	425.00
UDYMUS	425.00
UDYMIP	425.00

UDYMAT	425.00
UDYMEO	425.00
UDYMIX	425.00
UDYMOY	425.00

VOLTMETERS

UDYVUR	430.00
UDYVOX	435.00
UDYVAP	440.00
UDYVAX	495.00
UDYVIS	500.00

UDYVUL	500.00
UDYOKI	540.00
UDYOPA	540.00
UDYOBI	540.00
UDYOCK	555.00

MODEL MI  
VOLTMETERS

MIVOHO	375.00
MIVODA	375.00
MIVOFY	375.00
MOVOLT	375.00
MIVOMO	375.00

MIVOPI	375.00
MIVOSY	375.00
MIVOTE	380.00
MOVOVA	385.00
MIVOBS	390.00

MIVOJI	395.00
MIVONA	395.00
MIVOZR	395.00
MIVOEP	395.00

MIVOIN	405.00
MIVOOM	410.00
MIVOUT	420.00
MIVOYA	425.00

MIVOYO	430.00
MIVOYI	435.00
MIVOYU	440.00
MIVOYE	450.00



MODEL MI

AMMETERS

<u>CODE</u>	<u>PRICE</u>
MIAMAB	340.00
MIAMEC	340.00
MIAMID	340.00
MIAMOF	340.00
MIAMUJ	340.00

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MIAMO	340.00
MIAMFA	340.00
MIAMJY	340.00
MIAMKS	340.00
MIAMLY	385.00

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MIAMCO	420.00
MIAMAS	420.00
MIAMII	420.00
MIAMAU	420.00

MILLIAMMETERS

<u>CODE</u>	<u>PRICE</u>
MIMAAH	340.00
MIMILZ	340.00
MIMILO	340.00
MIMILK	340.00
MIMILI	340.00

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MIMIST	340.00
MIMIKO	340.00
MIMIBU	340.00
MIMICK	340.00
MIMIFA	340.00

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MIMIOK	415.00
MIMIRT	415.00
MIMIKY	415.00
MIMIOT	415.00

MODEL NSI

SPECIAL MULTIRANGE  
VOLTMETER

NSIVOMUL	630.00
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VOLTMETERS

NSIVOB	310.00
NSIVOC	310.00
NSIVOD	310.00
NSIVOE	310.00

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NSIVOF	310.00
NSIVOG	310.00
NSIVOJ	310.00
NSIVOK	310.00
NSIVOL	325.00

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NSIVOM	335.00
NSIVOO	335.00
NSIVOP	335.00
NSIVOR	335.00
NSIVOT	335.00

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NSIVOV	370.00
NSIVOW	370.00
NSIVOX	370.00
NSIVOY	370.00
NSIVOZ	370.00

AMMETERS

NSIAMP	300.00
NSIAMB	300.00
NSIAMI	300.00
NSIAMO	300.00

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NSIAMU	300.00
NSIAMA	345.00
NSIAME	345.00
NSIAMY	345.00

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NSIMIL	300.00
NSIMIM	300.00
NSIMIN	300.00
NSIMIO	300.00
NSIMIP	300.00

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NSIMIR	300.00
NSIMIS	300.00
NSIMIT	300.00
NSIMIV	300.00
NSIMIZ	300.00

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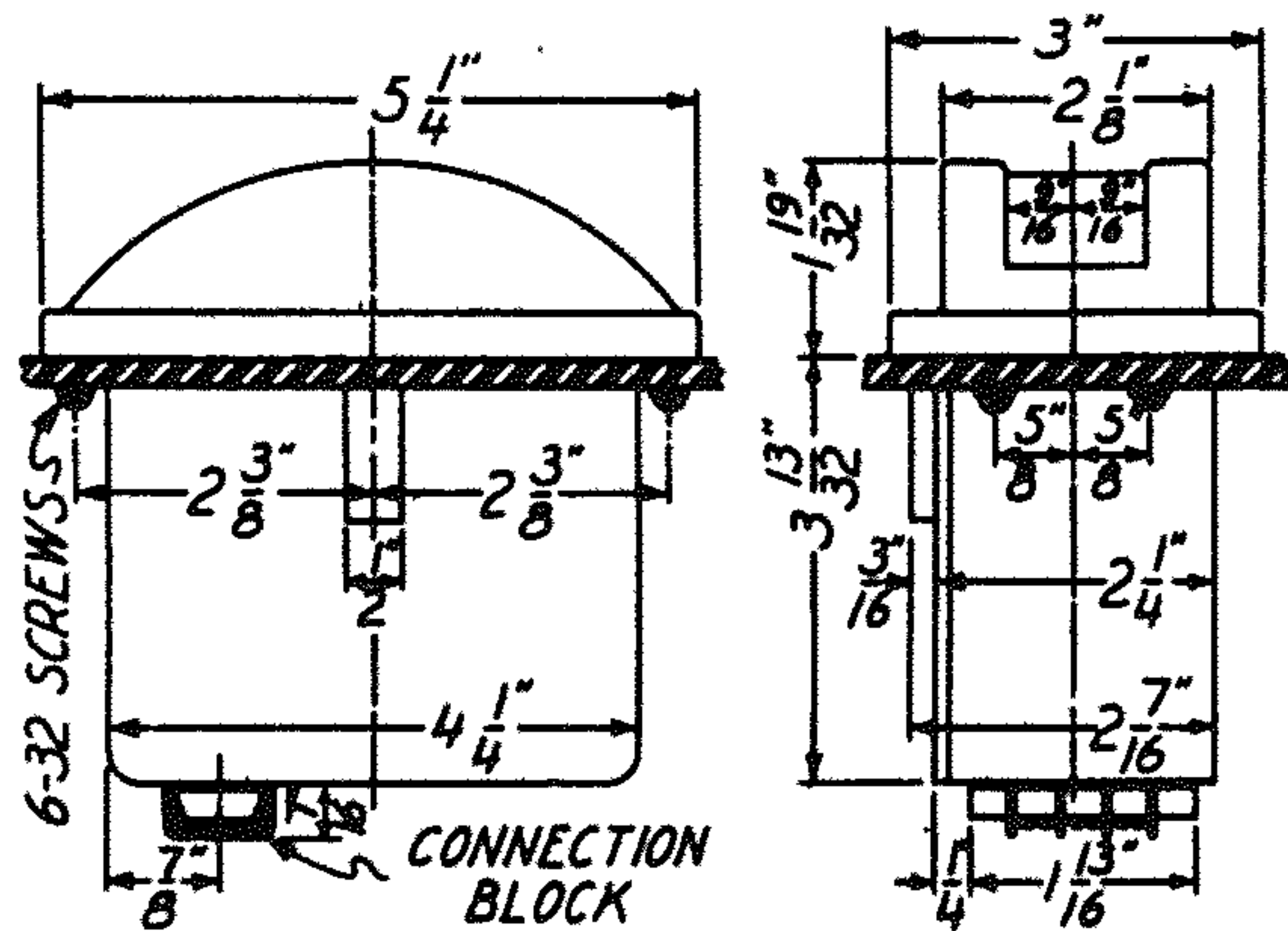
NSIMAA	345.00
NSIMEE	345.00
NSIMII	345.00
NSIMOV	345.00
NSIMOY	345.00



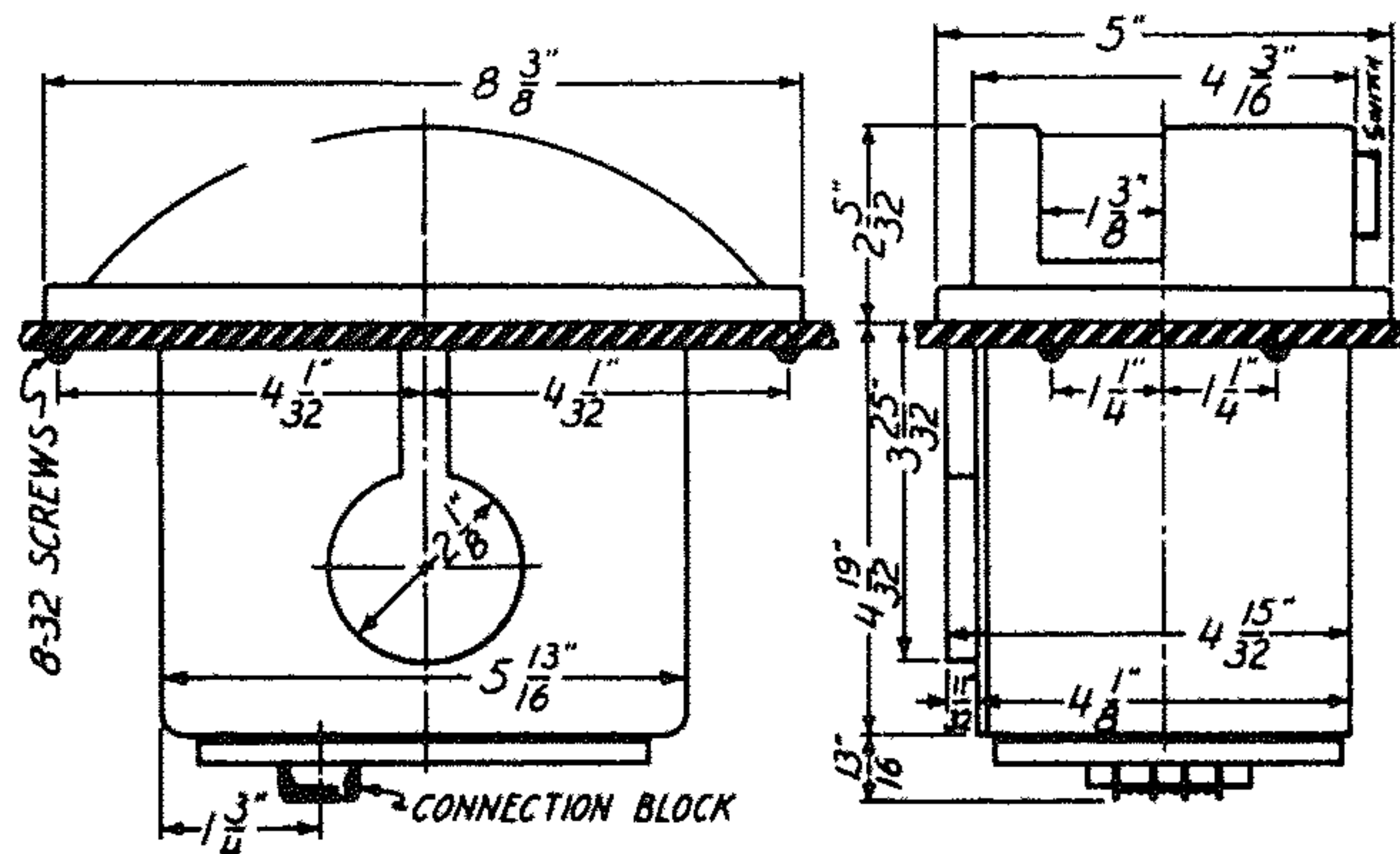
# Sensitive Research

INSTRUMENTS

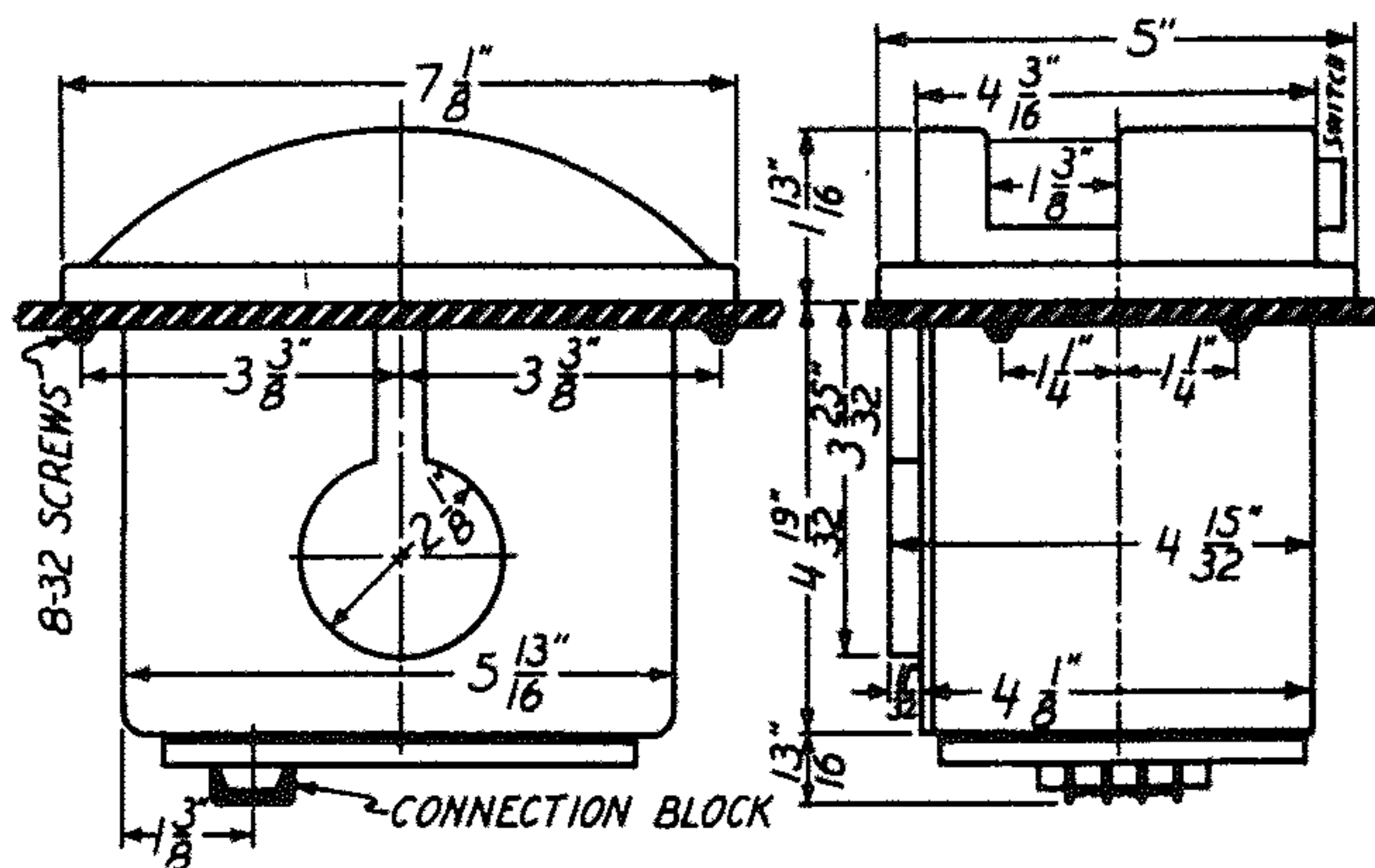
## MOUNTING DIMENSIONS FOR PANEL INSTRUMENTS



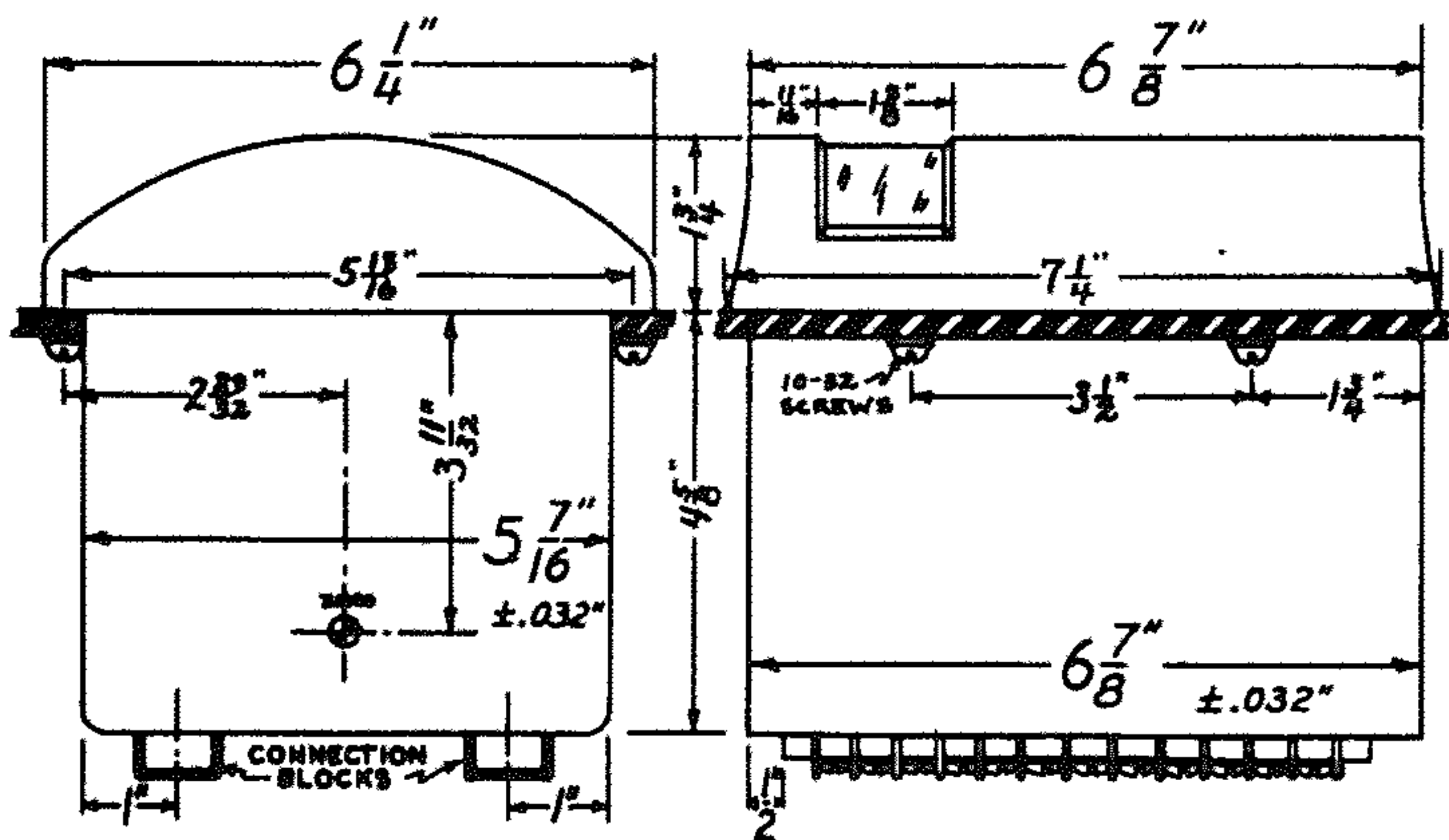
MODEL JDJW-4A CASE, Scale Length 4"  
FOR MODELS JW, JDJW, JWG



Type EW-7A DEEP CASE, Scale Length 7"  
FOR MODELS DW, D, DYSP, ESD, FRE, PF AND PPF



Type EW-5A DEEP CASE, Scale Length 5"  
FOR MODELS D, DLW, DW, ESD, GM, DYSP,  
FRE, PF AND PPF



PDWEW-5 and PDLWEW-5 CASE, Scale Length 5"  
for Models PDW and PDLW



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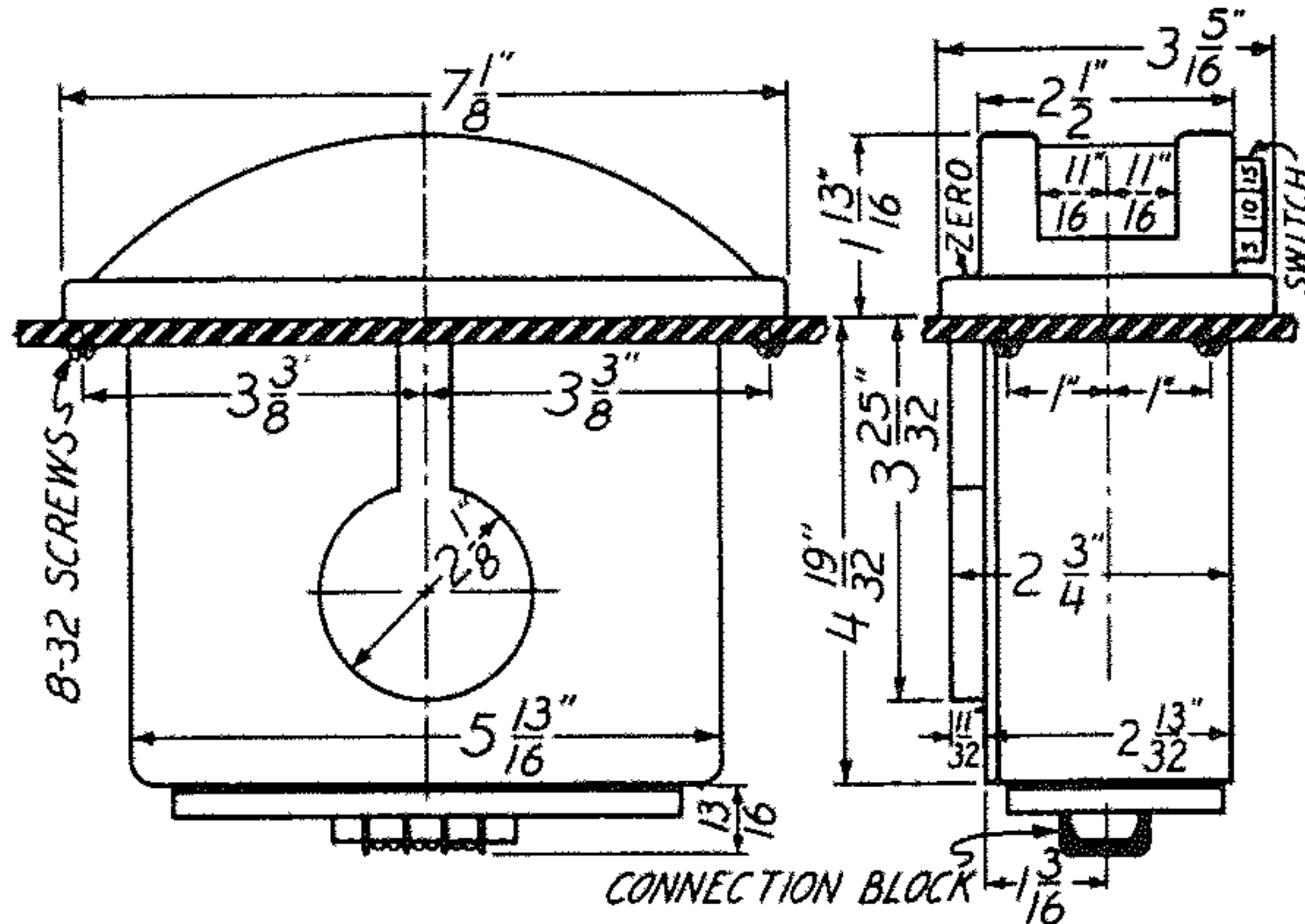
# MOUNTING DIMENSIONS FOR PANEL INSTRUMENTS



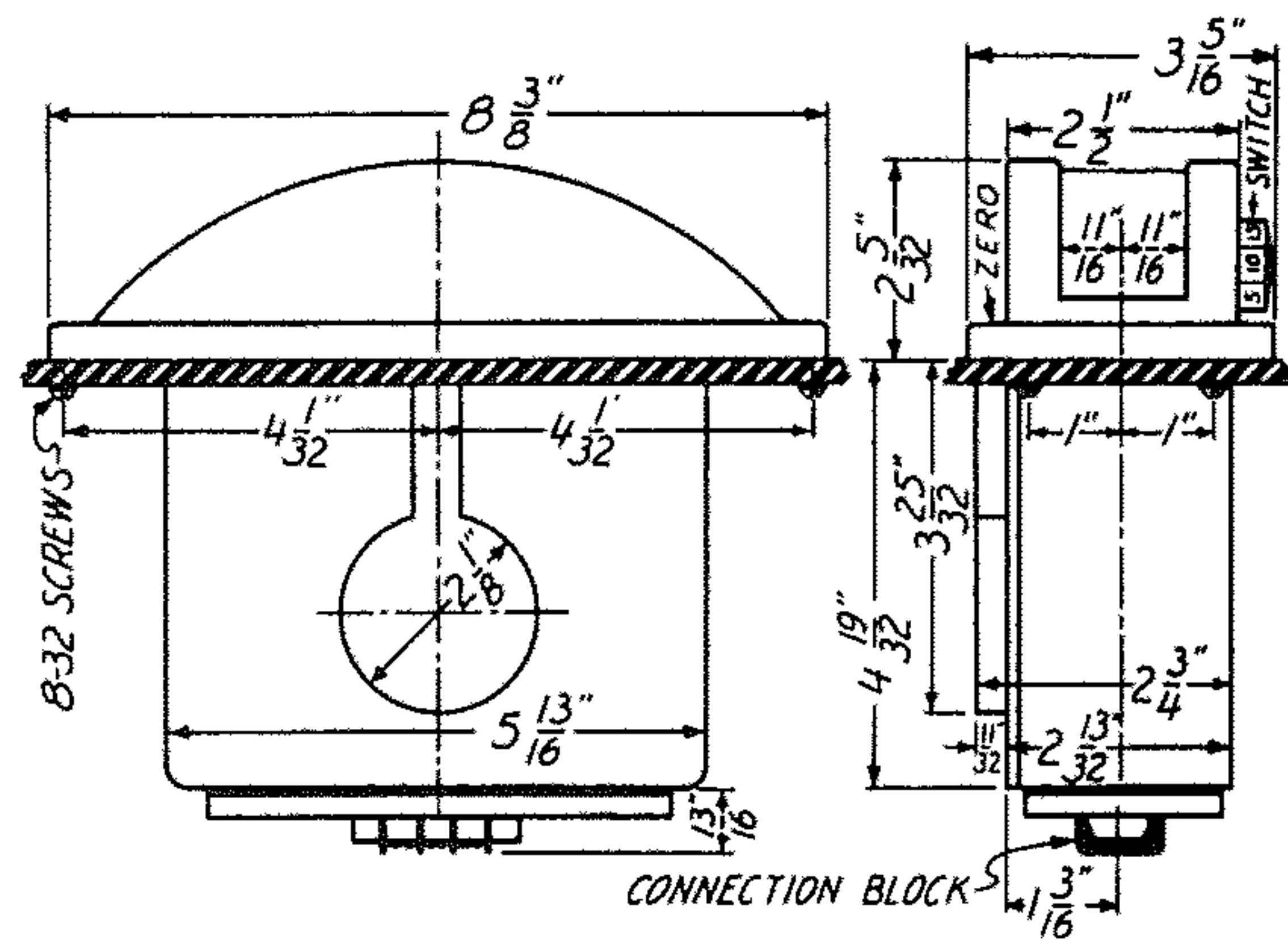
Edgewise panel cases are supplied for flush mounting in a vertical panel. Binding posts or connection lugs are furnished in the rear. Cases are of die cast aluminum with a black wrinkle finish. Switches, when supplied, are as indicated in the drawings. (See individual portable model specifications for specific information on instruments that are to be installed in EW-5A and EW-7A cases.) External zero shifters are supplied on the front of all cases.

## NOTE

The Types EW-5A, EW-7A and JW-4A replaced the Types EW-5, EW-7 and JW-4 in May 1961. There are minor dimensional differences between the types. For purposes of exact replacement, the Types EW-5, EW-7 or JW-4 can be supplied at no additional charge, but must be specified at time of ordering.

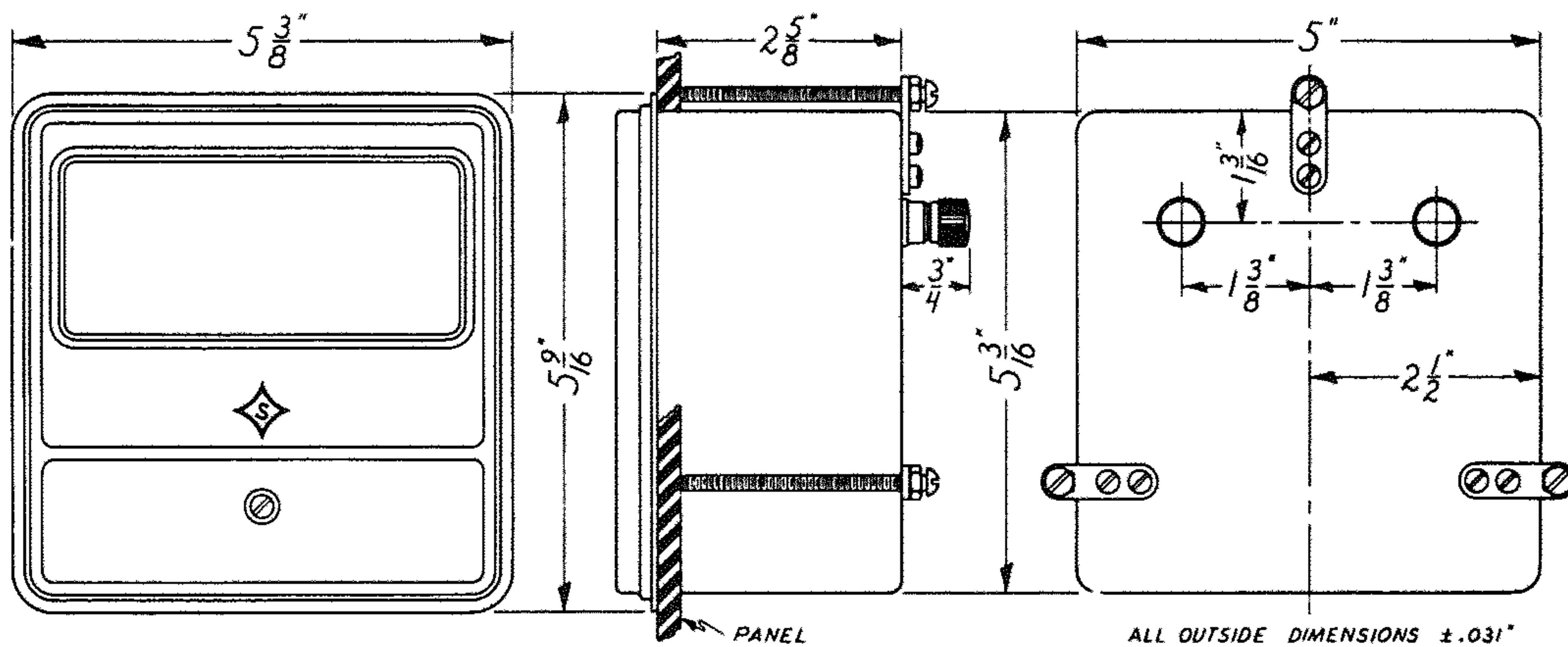


**Type EW-5A Shallow Case, Scale Length 5"**  
FOR MODELS S, C, A, HS, MI, FS, FM, SD, RA,  
AU, XT, RF AND FLV

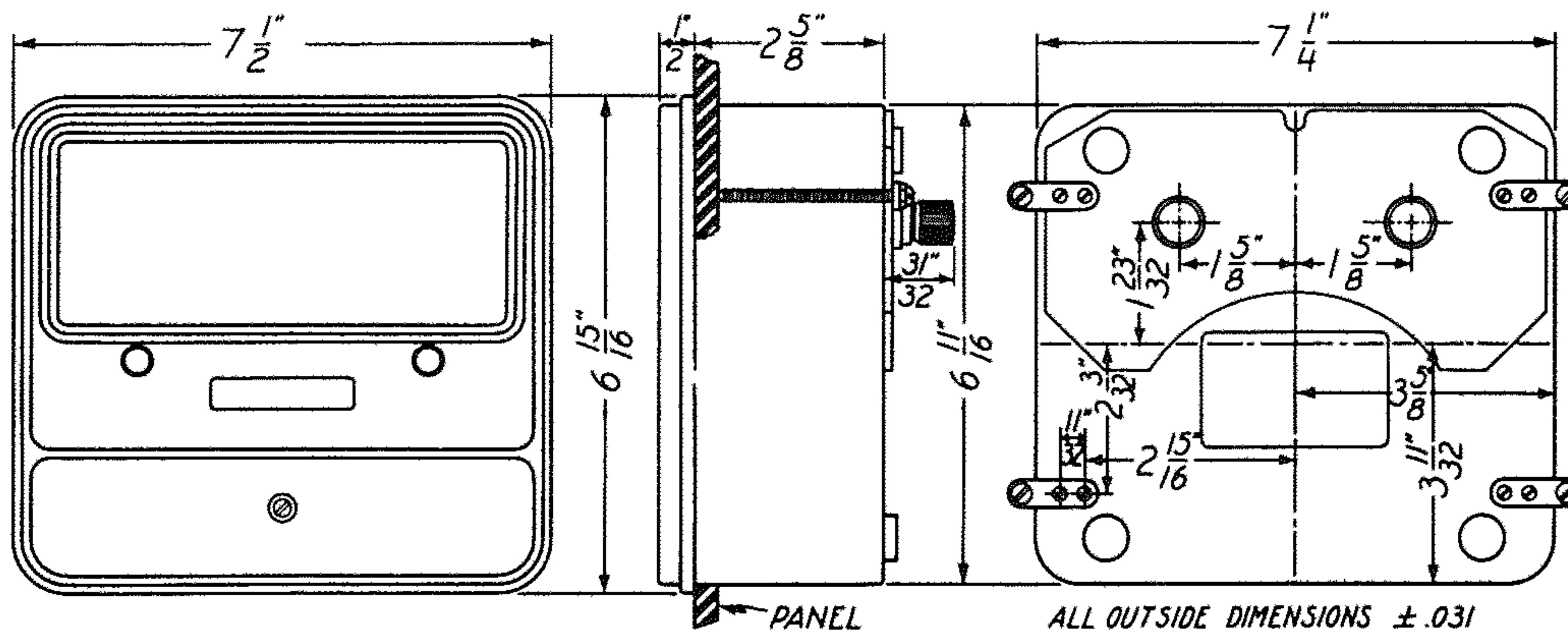


**Type EW-7A Shallow Case, Scale Length 7"**  
FOR MODELS S, C, FLV, MI, FS, FM, A AND RA

## MODEL UPP



NOTE: The Model UPP can be furnished for projection mounting at no extra charge, but must be specified.



**Model NP (flush mounting), NSI**



**Sensitive Research\***

**AC/DC ELECTRODYNAMOMETER WATTMETERS**



**Power Measurement**

Reference Standard Wattmeters  
 Low Power Factor Wattmeters  
 Volt-Amp Wattmeters

- SINGLE PHASE
- POLYPHASE

**PORTABLE and PANEL**

**POWER FACTOR INSTRUMENTS, VOLT-AMP-WATTMETERS**

MODEL	DESCRIPTION	MIN. PF
VAW	.5% and .75% AC Single Phase Volt-Amp-Wattmeters. 5.2" scale length	50%
DW	.25% AC/DC Single Phase Wattmeters. 6.3" scale length	50%
DLW	.5% AC/DC Single Phase Wattmeters. 5.2" scale length	20%
PDW	.5% AC/DC 2 Element (or Polyphase) Wattmeters. 6.3" scale length	50%
PDLW	.75% AC/DC 2 Element (or Polyphase) Wattmeters. 5.2" scale length	20%
University	.5% and .75% AC/DC Single Phase Wattmeters. 4" scale length	20%
PF	Single Phase Power Factor Instrument. 6.3" scale length	
PPF	Polyphase Power Factor Instrument. 6.3" scale length	

Refer to model descriptions for availability of portable instruments in edgewise cases (Types EW-5A and EW-7A) for panel mounting.

Prices and specifications subject to change without notice.



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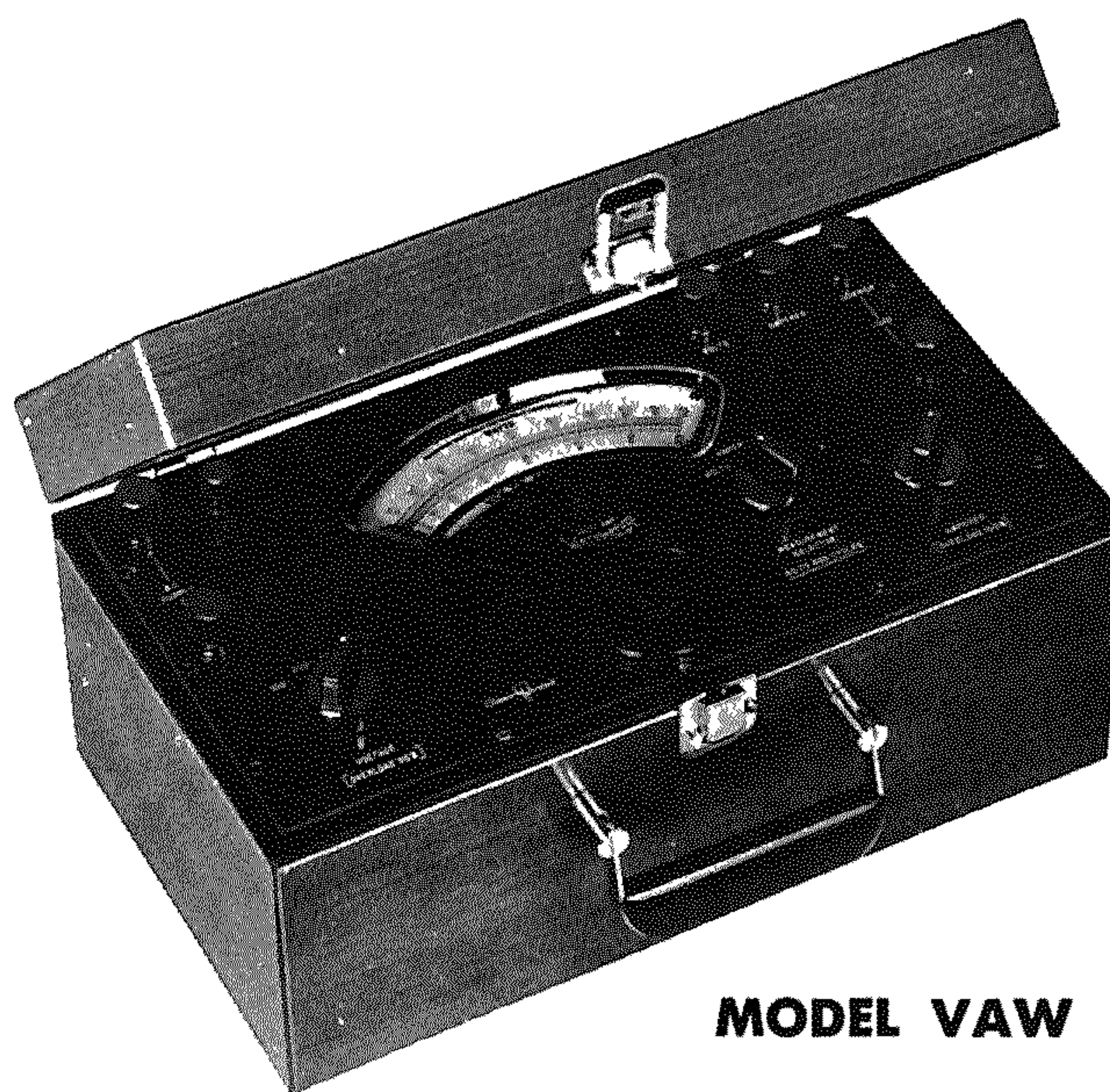


# VOLT-AMP-WATTMETER

## SPECIFICATIONS

AC PORTABLE—HORIZONTAL USE

ACCURACY	Current and voltage: .5% of full scale Watts: .75% of full scale
POWER FACTOR	50% to 100%
FREQUENCY	Code VOLTAWATT: 50 to 125 cps Code VOLTOWATT: 50 to 800 cps
TYPE	Transformer-coupled electro-dynamometer
SENSITIVITY	Potential circuit 100 $\Omega/v$
SCALE	Hand drawn; 5.2"; anti-parallax mirror
SCALE DIVISIONS	Two 100 div. scales. Watt scale printed 0-500/100 Volt and ampere scale printed 0-10/50
POINTER	Knife edge
PERIOD	2-3 seconds
DAMPING	Air vane
PIVOTS	Diamond pivoted
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
RANGE CHANGING	Switch controlled excepting 10 ma range on separate binding post
MECHANICAL ZERO	External zero shifter
CASE	Formica; 13 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 6 $\frac{3}{8}$ " h.; black bakelite panel; hinged cover; carrying handle
APPROX. WEIGHT	12 lbs. net; 20 lbs. shipping



**MODEL VAW**

plished by incorporating a special winding on the internal current transformer. By connecting the potential circuit directly across the load, tare-free compensated measurements can be made.

The Model VAW is particularly valuable as a portable measuring instrument for field use. Operation is simplified by making all ranges switch controlled. Both range combinations are diamond pivoted with shock mounted sapphire jewels to give a virtually friction-free moving element that will withstand abnormal handling. Portable cases made of tough, durable formica, are gasketed to provide an effective dust and humidity barrier.

All instruments are provided with data cards listing temperature corrections and maximum overload ratings. Potential circuits can be operated at 60% overload.

### GENERAL DESCRIPTION

The Model VAW, Volt-Amp-Wattmeter, is a multirange transformer-coupled indicating instrument that (1) makes tare-free measurements of AC power, voltage and current, (2) measures all circuit parameters without the necessity of changing circuit connections, (3) has a field current rating for use down to 50% PF or 100% overload and (4) is completely self-contained in a standard portable case.

All uncompensated wattmeters read high by the power consumed in their potential circuit, and in those cases where voltage sensitivity is low, or low values of wattage are to be measured, this can be a considerable factor in overall accuracy. Compensation is accom-

These instruments accomplish all measurements without changing connections. All necessary switching is internally controlled by positive detent selector switches. It is extremely simple to make external connections to measure the VOLTS applied to the load, the load AMPERES and the WATTS. (See Figure 2.)

Connections for use as a separate ammeter or voltmeter

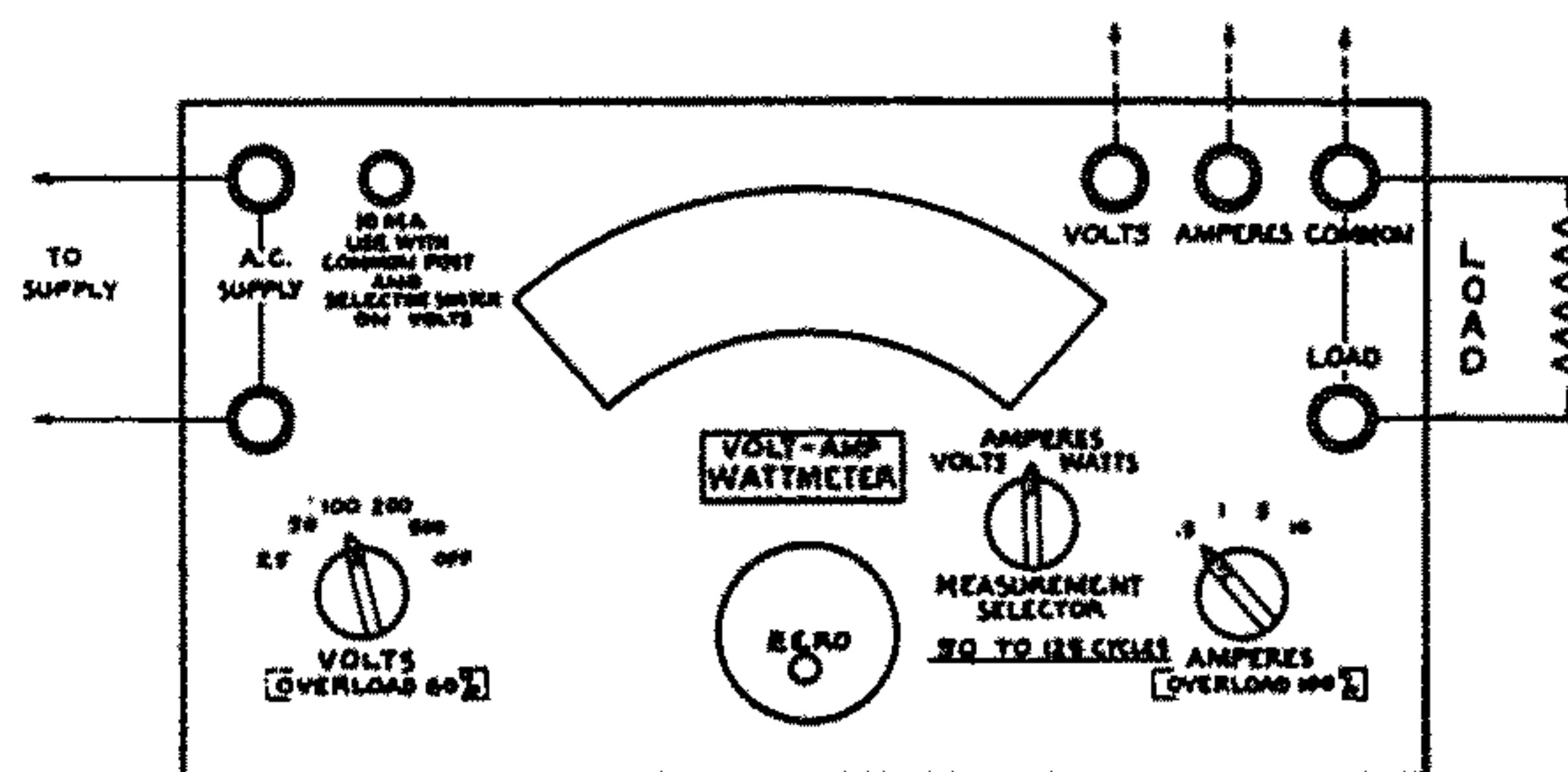
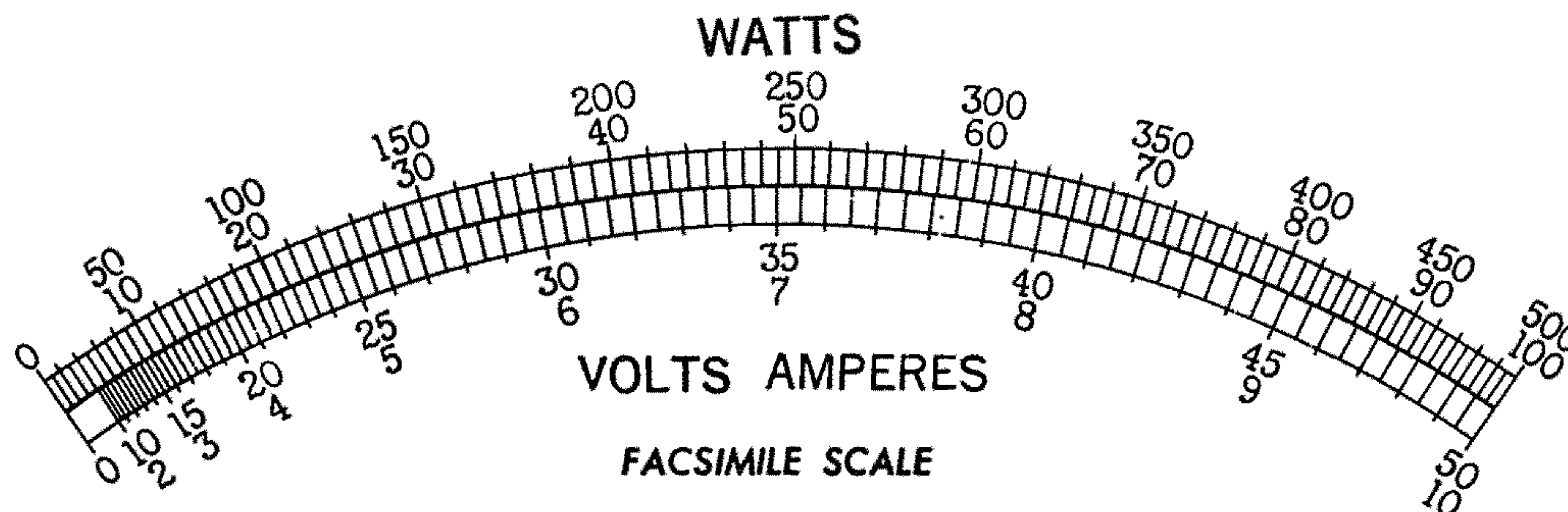


Figure 2

Note 1: Each instrument contains a 10 ma current range on a separate binding post. This range cannot be used for watt measurements.

\*The Code VOLTOWATT is guaranteed to make watt measure-

ments within rated accuracy when used at (1) 50 to 125 cps and 50% to 100% PF and (2) 50 to 800 cps and 100% PF. At 400 cps, 50% PF, accuracy is 1.5% and at 300 cps, 50% PF, accuracy is 3%.





# ABOUT WATTMETERS

The measurement of AC power is a far more complex problem than indicated by the simple DC relationship  $P = EI$ . This formula holds true for AC measurements on an instantaneous basis only, and depending on the relative phase angle between current and voltage, may not be correct for the rms values of each. The actual power becomes  $EI \cos\theta$ , with  $\theta$  being the phase angle between voltage and current for sinusoidal wave forms.

The design of an electro-dynamometer type of instrument (see photo on page 304) is well suited for the measurement of AC and DC power. In this design a magnetic field is established by a load current flowing through 2 fixed coils called the current or field coils. Rotating in that field is a moving coil with restoring springs and pointer. The torque of the moving coil is proportional to the current in the moving coil multiplied by the current in the field coils, multiplied again by the cosine of the phase angle of the two currents. If sufficient resistance is added to the moving coil circuit so that its current is proportional to an applied voltage, the operating principle of the instrument is in conformance with the  $EI \cos\theta$  formula.

The basic circuit of a dynamometer wattmeter is shown in Fig. 2. Several points about this circuit must be considered when ordering a wattmeter. As an example, assume that the angle  $\theta$  advances to 90 degrees.  $\cos\theta$  then becomes 0 and there can be either an infinite current through the field coils or an infinite voltage impressed across the potential circuit, and still no power is consumed. Obviously under these conditions the instrument could be burned out without the pointer moving at all. It is this fact, that the value of  $\cos\theta$  can assume any value from 1 to 0, that makes it necessary to assign limiting values to the current capacity of a wattmeter. This is dependent, not on the watt rating of an instrument, but upon the current ratings of the field coils. Instruments in which the current capacity of the field coils is much greater than the normal current rating for 0 degrees phase angle (100% power factor) are listed as "Low Power Factor" types. This brochure lists portable wattmeters whose field coils have a current rating sufficient for use at power factors down to 10%.

The load imposed by a wattmeter in a circuit can be a factor in overall accuracy. Fig. 3 shows the two possible ways a wattmeter can be connected. The diagram illustrates that with the potential circuit (moving coil and series resistances) connected to the load side of the field coils (B-C), the current being drawn to actuate the moving coil is added to the load current and is being measured by the instrument. On the other hand, with the potential circuit connected ahead of the field coils (A-C), the potential being used is greater than that actually applied to the load by the amount of the voltage drop in the field coils. In either case the instrument reads high by the power lost in its own potential or current circuits. Each wattmeter has its potential circuit resistance printed on its scale, so that the power it dissipates internally may be easily calculated. The circuit connection which gives the least power lost in the instrument is, of course, preferable.

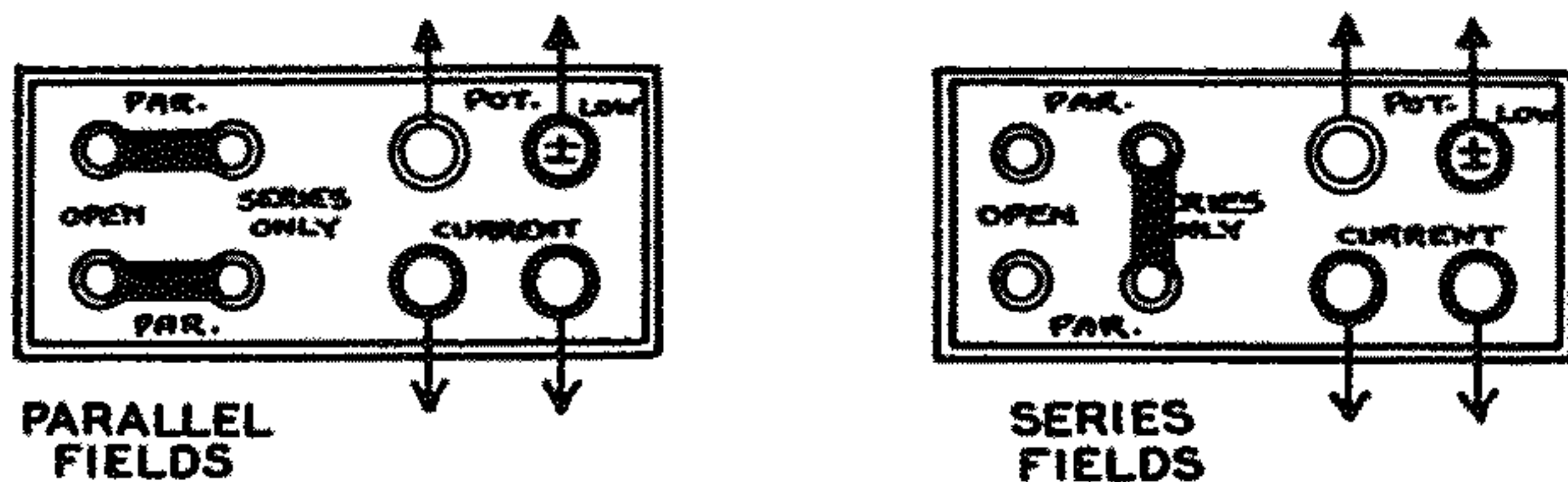


Fig. 1. Series-Parallel Fields Range Changing Connections

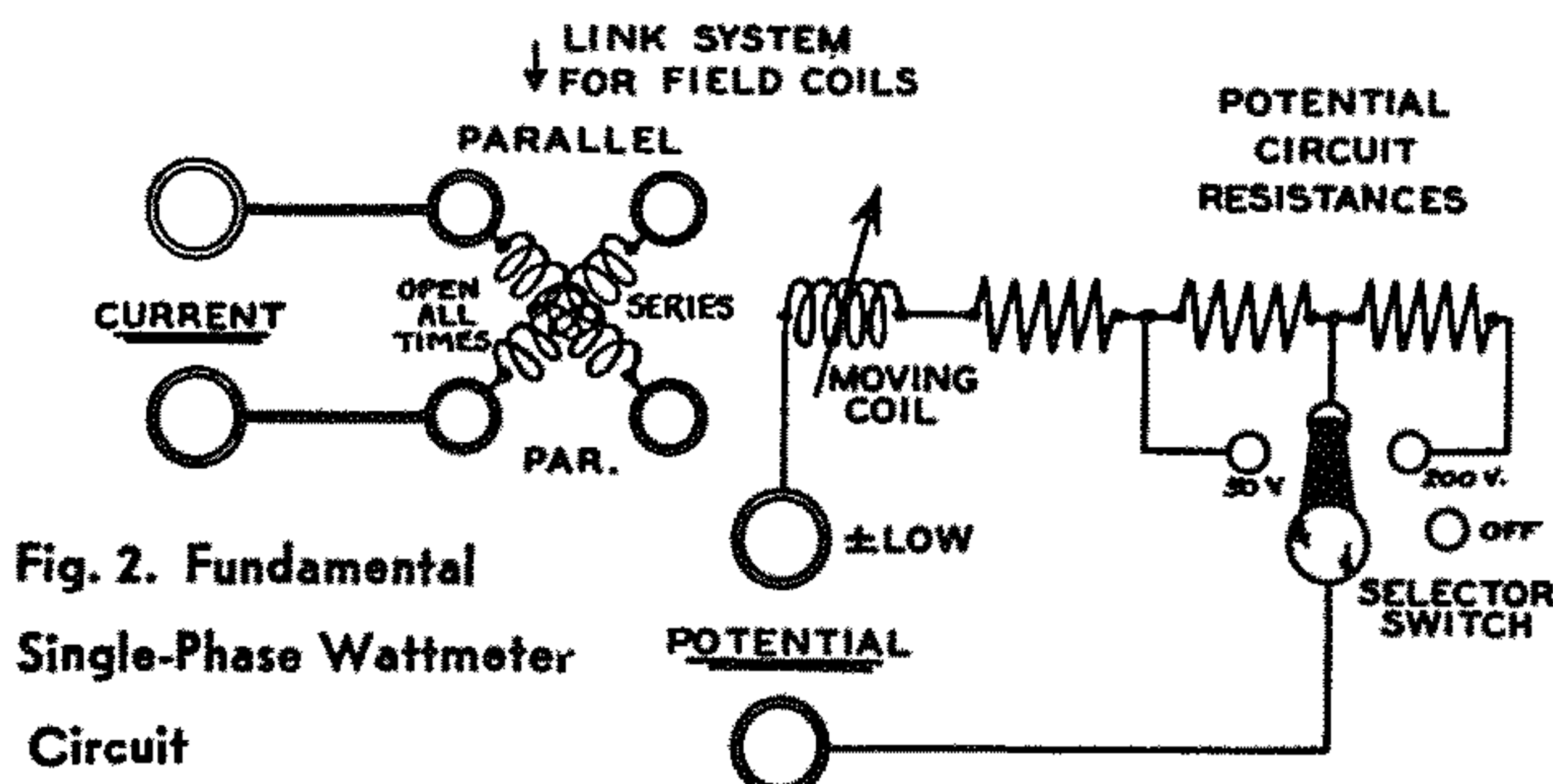


Fig. 2. Fundamental Single-Phase Wattmeter Circuit

As seen in Fig. 2 it is possible to have appreciable inductance in the potential circuit (moving coil) and, therefore, a phase angle error which would increase with frequency. This is responsible for the frequency limitation given in the instrument listings. At rated frequencies the phase angle error will ordinarily be less than one or two minutes, a negligible amount. Special instruments can be furnished compensated for a range of frequencies extending higher than catalog listings. In certain instances, even still higher frequency compensation can be furnished on a "single frequency only" basis. Correspondence on such instruments is required.

On special order most wattmeters can be furnished with compensation for the power consumed in their potential circuit. This is accomplished by a second winding on the field coils of the instrument. In general, compensation of wattmeters is not recommended since it affects their performance. Operation is complicated by the need of a special switch for series and parallel connections. It is better to use compensation external to a standard instrument than to build it into the instrument. A simple circuit for accomplishing this is shown in the Sensitive Research engineering bulletin Electrical Measurements, Volume 27, Number 12, December, 1959, available on request.

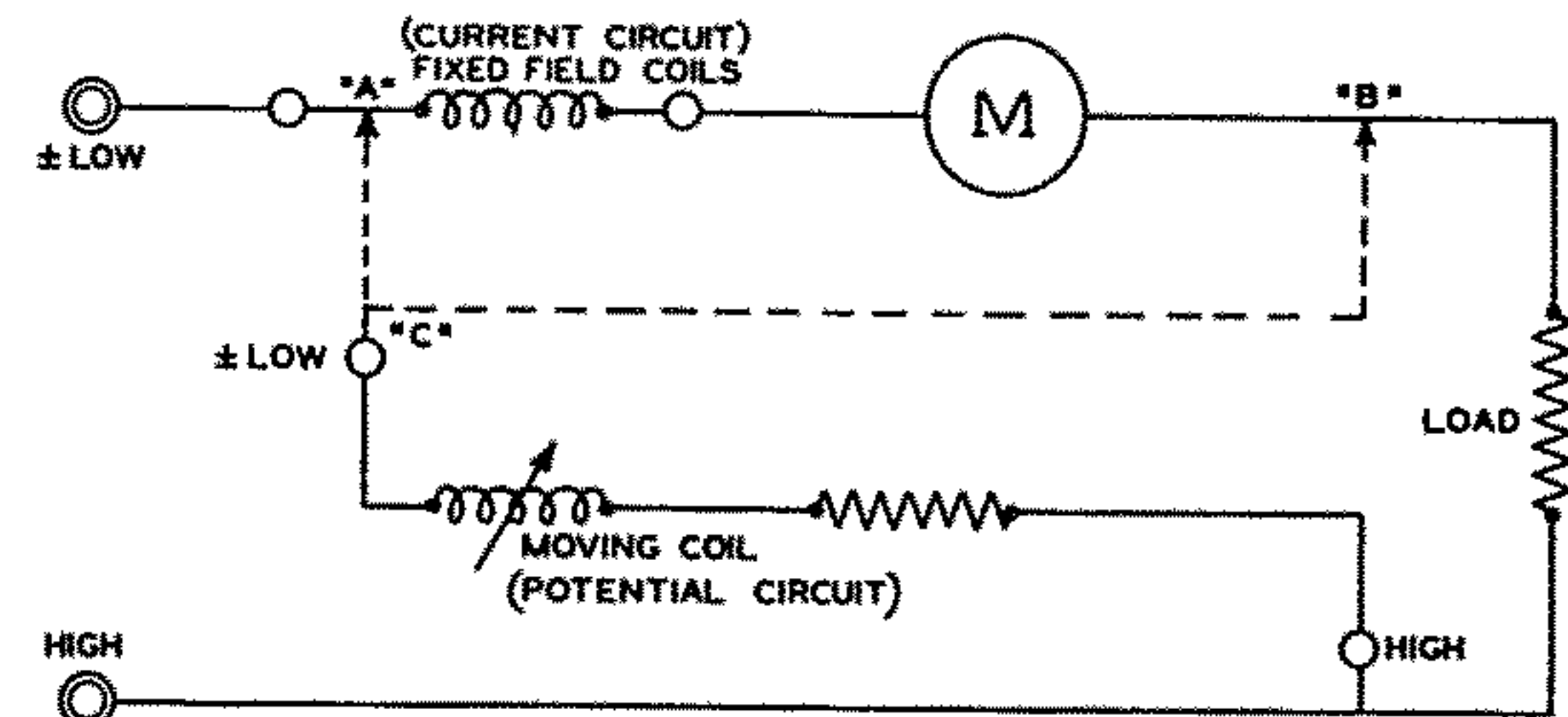


Fig. 3. Circuit Connections for a Single Phase Wattmeter

## TWO ELEMENT WATTMETERS

The measurement of polyphase power is somewhat more difficult than the measurement of single phase power. In the following discussion polyphase power is referred to as total power delivered to a given polyphase load by all 3, 4 or more number of lines used to feed the load. Inasmuch as the voltages and currents transmitted by the various lines could have widely varying phase characteristics, a standard definition of the power involved should be in agreement with, for instance, a calorimetric measurement of this power. The commonly accepted definition of polyphase power is that "if energy is supplied to a network through 'N' number of wires, the total power of the system is given by the algebraic sum of the readings of 'N' number of wattmeters so arranged that each one of the 'N' wires contains one current coil; the corresponding wattmeter potential coil is connected between that wire and some point common to all of the potential circuits."

This being a general definition, a further assumption can be made that this common point from which all potentials are measured can be upon one of the 'N' number of wires. This means that the potential between the common point and this wire is zero and that, therefore, one of the aforementioned 'N' number of wattmeters would read zero. Therefore, for any polyphase system of 'N' number of wires, the total power in the system can be read by 'N' minus 1 wattmeters. This is known as Blondell's Theorem.

Mathematical proof of this is as follows:

Let the supply conductors be denoted by the subscripts 1, 2, 3, . . . N; let the instantaneous voltages of the load be denoted by  $V_1, V_2, V_3, \dots V_N$  and the instantaneous currents at these same points be  $i_1, i_2, i_3, \dots i_N$ .



The current through wire 1 is then  $I_1$  and the instantaneous power delivered through conductor 1 is  $I_1 V_1$ , and similarly for all the other conductors. Therefore:

$$P = I_1 V_1 + I_2 V_2 + I_3 V_3 + \dots + I_N V_N \quad (1)$$

Now let  $V_0$  be the potential of any designated point on the system.

According to Kirchoff's Law:  

$$I_1 + I_2 + I_3 + \dots + I_N = 0 \quad (2)$$

Hence:  

$$I_1 V_0 + I_2 V_0 + I_3 V_0 + \dots + I_N V_0 = 0 \quad (3)$$

Subtracting (3) from (1):  

$$P = I_1 (V_1 - V_0) + I_2 (V_2 - V_0) + \dots + I_N (V_N - V_0)$$

From this the average power will be:  

$$P = \frac{1}{T} \int_0^T I_1 (V_1 - V_0) dt + \frac{1}{T} \int_0^T I_2 (V_2 - V_0) dt + \dots + \frac{1}{T} \int_0^T I_N (V_N - V_0) dt \quad (4)$$

However:  

$$\frac{1}{T} \int_0^T I_1 (V_1 - V_0) dt$$
 is the reading of wattmeter in

conductor 1 and similarly for the other terms of the expression and (4) is the summation of the  $N$  wattmeter readings.

If now the common potential  $V$  is taken to be on one of the  $N$  wires then one of the power quantities in parenthesis will be zero, the corresponding wattmeter reads zero and 'N' minus 1 wattmeters are required.

The commonest commercial polyphase power with which one has to work is 3 phase. Having shown by Blondell's Theorem that power in any polyphase circuit can be measured with  $N-1$  number of wattmeters, it follows that in a 3 phase 3 wire circuit, the power can be measured by 2 wattmeters.

Figure 4 shows the connection diagram for 2 wattmeters to measure total power in the load fed by the 3 phase line A.B.C. The sum of the readings of 2 wattmeters is equal to total power being delivered to this load. As most loads are either balanced or nearly balanced, the 2 wattmeters used are likely to be on the same range. If moving coils of the wattmeters are mounted on a single shaft, their torques add mechanically and a single scale can be calibrated to give a direct addition of the quantity being measured by each instrument. This is shown by the dotted line in Figure 4, which represents a mechanical coupling between the moving coils of the 2 instruments. This assembly is commonly called a 3 phase wattmeter, but is more properly called a 2 element wattmeter, because it has many uses besides that of measuring 3 phase power.

Actual production of a 3 phase wattmeter demands mechanical skills of the highest order, because it is necessary to have 2 instruments whose characteristics are identical so that they can use a common scale throughout their entire range. To do this, the two moving coils must be accurately aligned on a common shaft. The overall construction is complicated by the requirement that neither instrument have the slightest reaction upon the other's movement, even though

they are physically located adjacent to each other on a common shaft. The SENSITIVE RESEARCH 3 Phase Wattmeter is designed to meet these rigid requirements.

The 3 phase or 2 element wattmeter has usages other than the measurement of 3 phase power. It can be applied in single phase work where 3 wire lines are used and the load may not be completely balanced. Figure 5 shows how the instrument indicates the entire load on the line regardless of whether it is on one of the low voltage circuits or is bridged across the 2 outside or high voltage pairs.

The 2 element wattmeter can be used where the sum of the power in any 2 lines is required, such as 2 single phase lines. The two portions of the movement are completely isolated and can be used in entirely different circuits, in which case the instrument measures the sum of the power being consumed in the 2 circuits. In addition, it can be used as a simple single phase wattmeter by either two methods. Half of the movement can serve as a single phase wattmeter, and scale reads directly correct power in the circuit. If, however, the two current sections of the wattmeter are connected in series and 2 potential coils are connected in parallel, scale readings have to be divided by 2 to arrive at an actual single phase watt reading.

When voltages and currents of each of the 3 phases are identical, the load is said to be balanced. Under this condition there are several methods by which the entire load power can be measured with a single phase wattmeter, by employing current transformers or (Easiest and most acceptable) use of a "Y" box as shown in Figure 6. A "Y" box can be furnished with any standard wattmeter. It consists of a pair of resistors accurately matched to each other and to the total resistance of the potential circuit in the wattmeter used. The two resistors have their extremes attached to 2 of 3 wires feeding the load. Center tap is connected to the normal potential circuit of instrument with the low side grounded on the third leg (which contains the current circuit of wattmeter). Under these conditions wattmeter reading, multiplied by 3, is identical to total load in the 3 phase circuit.

Specialized use of the 2 element, 3 phase wattmeter is measurement of total power in a 4 wire, 3 phase circuit. Connections to accomplish this type of measurement are shown in Figure 7. From Blondell's Theorem, it seems necessary to have 3 wattmeters for measurements of total power in 4 wire, 3 phase lines. If all possible combinations of unbalanced lines were considered, this would, of necessity, be true. However, pre-supposing that the voltages only for the 3 phases will be balanced (a condition which is normally encountered in practice), reasonable measurements can ordinarily be made as diagrammed in Figure 7. Connections shown allow for unbalanced current but are in error if voltages are seriously unbalanced. This ordinarily occurs at the end of very long 3 phase lines or where the power supply is inadequate. These conditions are not frequently encountered and usage of the instrument in this fashion is very widespread.

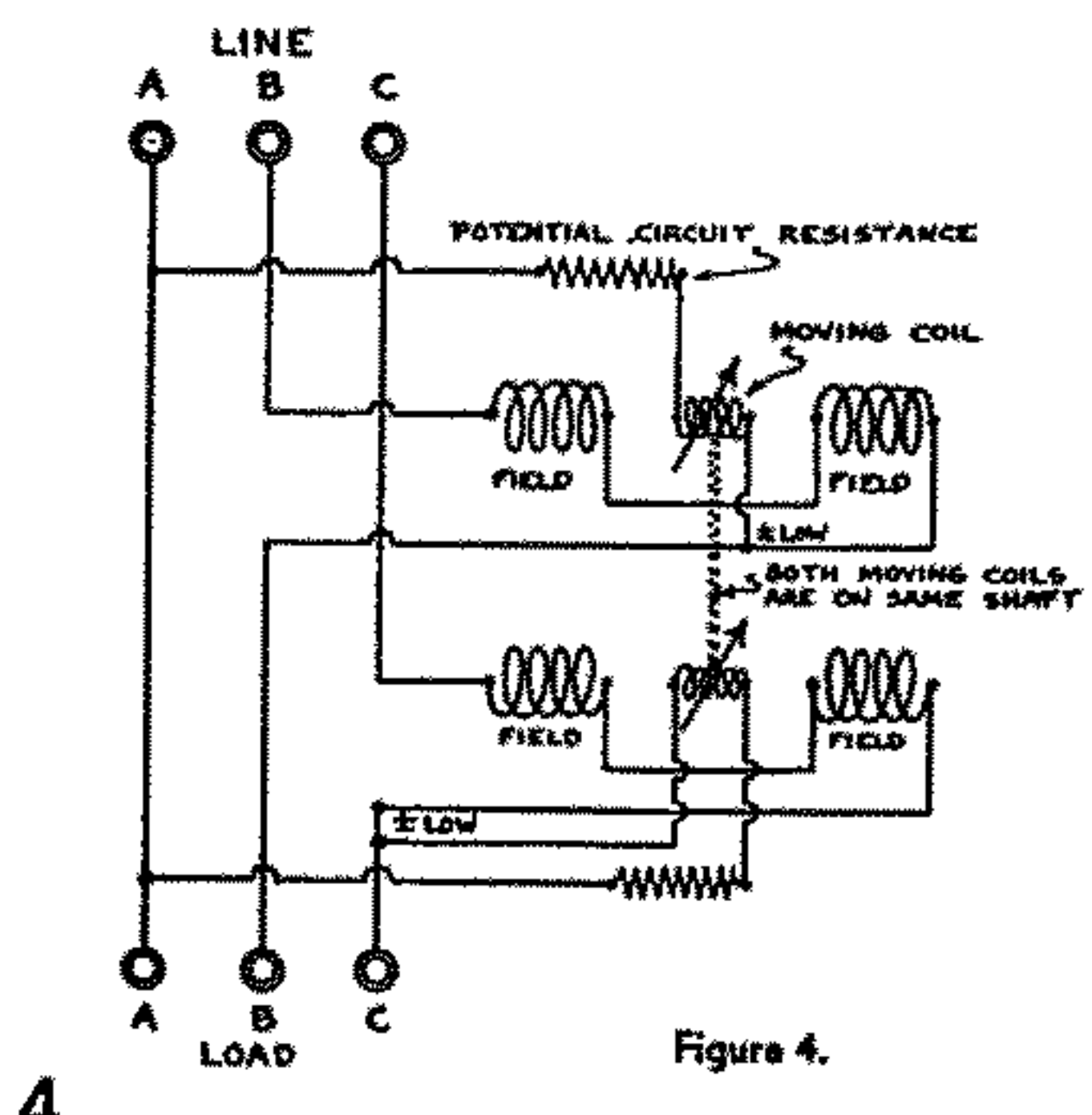


Figure 4.

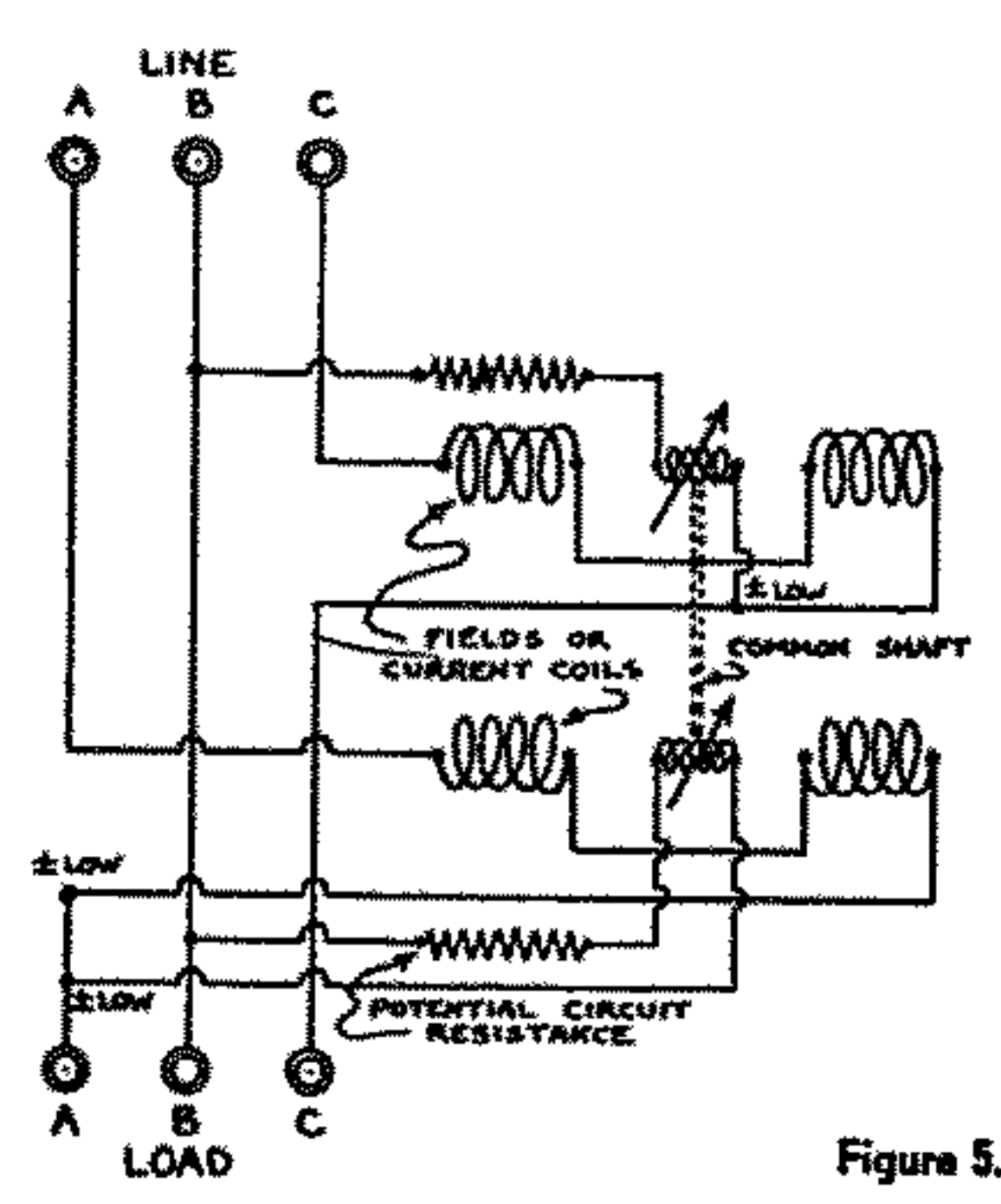


Figure 5.

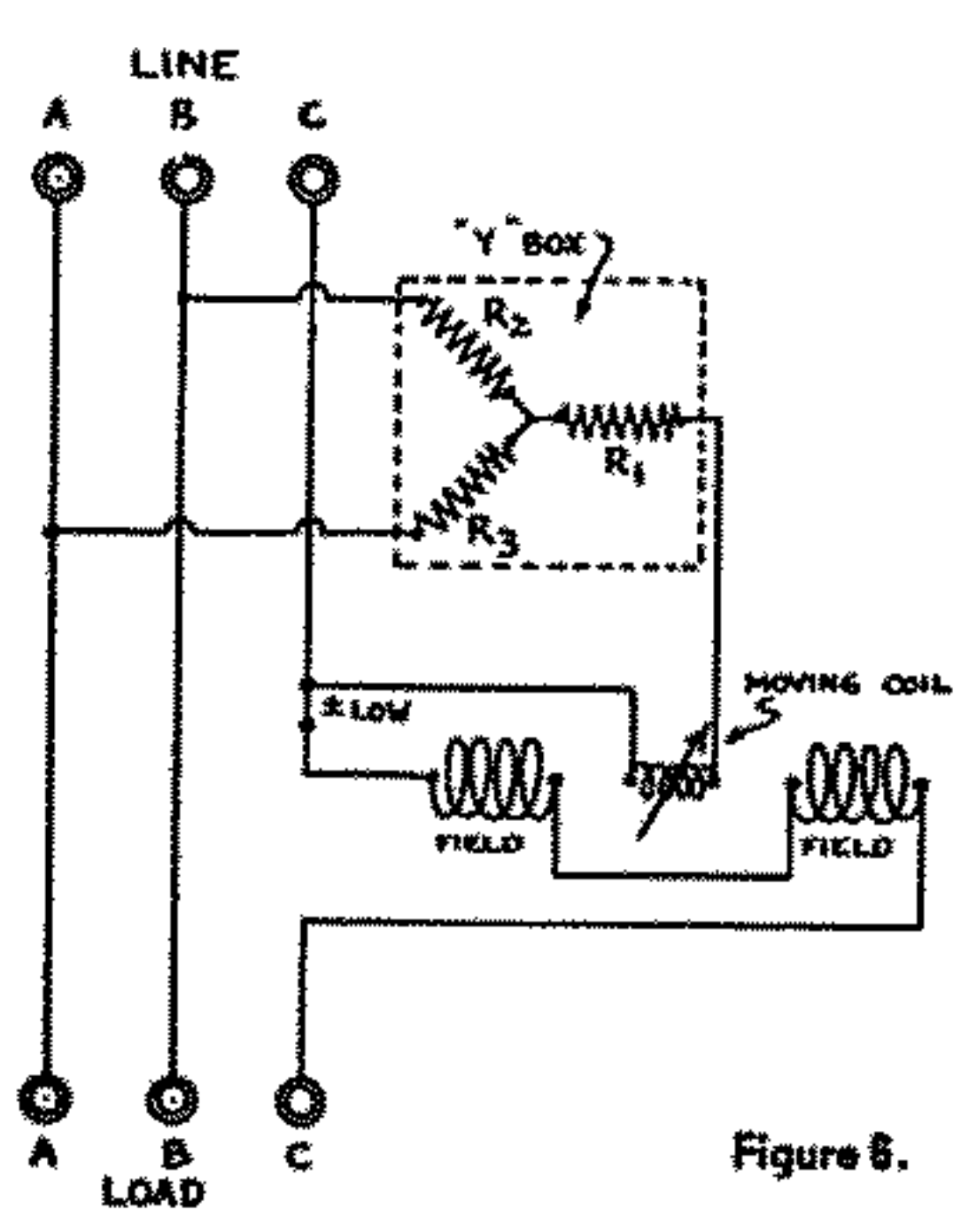


Figure 6.

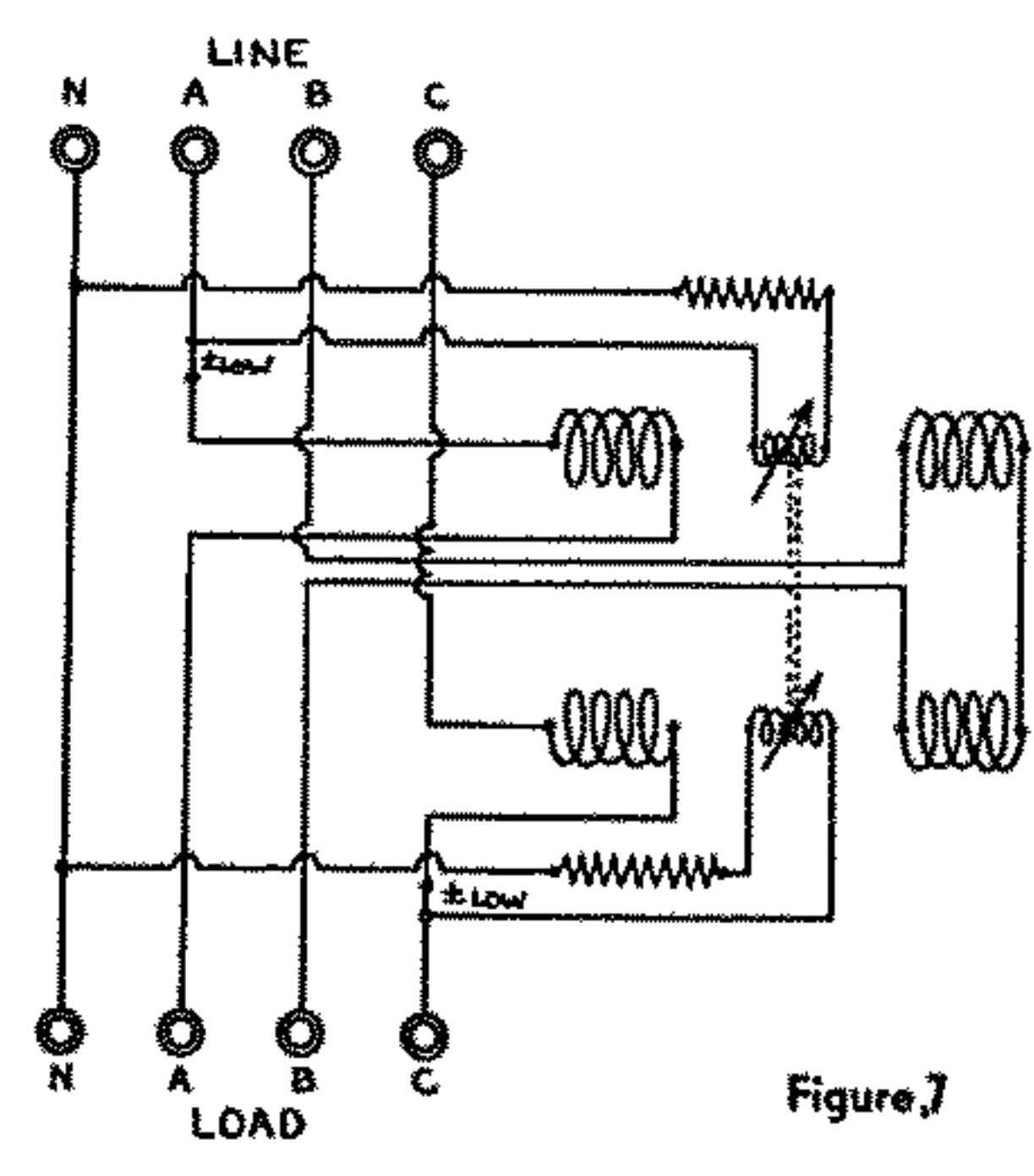


Figure 7.

**TWO ELEMENT WATTMETER CIRCUIT CONNECTIONS**



# AC/DC PORTABLE WATTMETERS

## WATTMETER SPECIFICATIONS

MODEL	DW	DLW	VAW	UNIVERSITY	PDW	PDLW
ACCURACY (% of Full Scale)	.25	.5	.75	(a) .5 (b) .75	.5	.75
POWER FACTOR	50%	20%	50%	(a) 50% (b) 20%	50%	20%
PHASE MEASUREMENT	Single	Single	Single	Single	Polyphase	Polyphase
FREQUENCY	DC & 25-800 Hz	DC & 25-500 Hz	(a) 50-800 Hz (b) 50-125 Hz	DC & 25-800 Hz (50% PF) 25-500 Hz (20% PF)	DC & 25-800 Hz.	DC & 25-500 Hz
SCALE LENGTH	6.3"	5.2"	5.2"	4"	6.3"	5.2"
PERIOD	2-3 Sec.	2-3 Sec.	2-3 Sec.	2-3 Sec.	2-3 Sec.	2-3 Sec.
APPROX. SHIPPING WT.	11 lbs.	11 lbs.	20 lbs.	10 lbs.	20 lbs.	20 lbs.

### PANEL MOUNTED WATTMETERS

Edgewise Panel Mounted designs are available at specifications comparable to Portable Instruments as follows. To order specify Model EW-5A or Model EW-7A as required and add the Code for the Portable design.

EDGEWISE PANEL MODEL	PORTABLE COMPARABLE SPECIFICATIONS	PRICE ADDITIONAL TO PORTABLE
DWEW-5A or 7A	DW	\$ 30
DLWEW-5A or 7A	DLW	30
VAWEW-5A or 7A	VAW	80
PDWEW-5	PDW	50
PDLWEW-5	PDLW	50

## MODEL DW SINGLE PHASE REFERENCE STANDARD WATTMETERS

Note: Watt ranges are calculated by cross multiplying potential ranges and normal current ranges. To assist the reader, the instruments below have their watt ranges listed in separate columns headed by the potential ranges which provide them.

WATT RANGE		NORMAL (Unity PF) FIELD CURRENT AMPS		MAXIMUM (50% PF) FIELD CURRENT AMPS		Approx. 60 cps	Potential Circuit	Scale	Code	
100 Volts	200 Volts	Series	Parallel	Series	Parallel	va	Approx. Ω/v	Div.		
5/10	10/20	.05	.1	.1	.2	.8	180	100	WALER	
7.5/15	15/30	.075	.15	.15	.3	.5	160	150	WABCL	
15/30	30/60	.15	.30	.3	.6	.4	160	150/120	WAMIS	
25/50	50/100	.25	.50	.5	1.0	.4	150	125/100	WANOT	
37.5/75	75/150	.375	.75	.75	1.5	.8	180	150	WYFAT	
75/150	150/300	.75	1.5	1.5	3.0	.6	160	150	WASUL	
125/250	250/500	1.25	2.5	2.5	5.0	.9	160	125/100	WARAB	
150/300	300/600	1.5	3	3	6	.6	160	150/120	WHACK	
250/500	500/1000	2.5	5	5	10	.75	160	125/100	WASED	
300/600	600/1200	3	6	6	12	1	160	150/120	WAHLN	
500/1000	1000/2000	5	10	10	20	1.3	180	100	WARAC	
50 Volts	100 Volts	200 Volts								
15/30	30/60	60/120	.3	.6	.6	1.2	1	270	150/120	WEAPA
25/50	50/100	100/200	.5	1.0	1.0	2.0	.7	200	125/100	WEALM
50/100	100/200	200/400	1	2	2	4	1	200	100/80	WEAZO
75/150	150/300	300/600	1.5	3	3	6	.6	160	150/120	WEAEN
125/250	250/500	500/1000	2.5	5	5	10	.75	220	125/100	WEAFE
250/500	500/1000	1000/2000	5	10	10	20	1.3	180	125/100	WEAGZ

### OPTIONAL ACCESSORIES

1. Voltage ranges can be increased by the addition of external multipliers. Correspondence required. Current ranges can be increased by the use of transformers. The Model TR Type 2 Transformer is recommended for use with wattmeters.

2. "Y" boxes can be supplied with single phase wattmeters for the measurement of balanced 3 phase power. The use of a "Y" box is restricted to an individual wattmeter.

Price \$125.00 2 Volt Ranges; \$156.00 3 Volt Ranges.

### OPTIONAL SPECIFICATIONS

1. Voltage ranges can be increased to 110, 220 and 440 v at no extra charge. Watt ranges remain the same but normal and maximum current ratings decrease in direct proportion. Specify by adding the letter "S" to the code word of the instrument ordered and state the potential ranges required. A wattmeter with two volt ranges can be increased to either 110/220 v or 220/440 v. (Specify ranges desired.) Wattmeters with special ranges and/or scales can be supplied in certain instances. Correspondence necessary.



# MODEL DLW SINGLE PHASE LOW POWER FACTOR WATTMETERS

## RANGES

Note: Watt ranges are calculated by cross multiplying potential ranges and normal current ranges. To assist the reader the standard instruments below have their watt ranges listed in separate columns headed by the potential ranges which provide them.

WATT RANGE			NORMAL (Unity PF) FIELD CURRENT AMPS		MAXIMUM (20% PF) FIELD CURRENT AMPS		Approx. 60 cps va	Potential Circuit Approx. Ω/v	Scale Div.	Code
75 Volts	150 Volts		Series	Parallel	Series	Parallel				
*.2/.4	.4/.8		.00266	.00532	.0133	.0266	.12	200	100/80	WARIK
**3/.6	.6/1.2		.004	.008	.02	.04	.12	110	60	WASOL
.5/1.0	1/2		.0066	.0132	.033	.066	.24	100	100	WAKUP
1.5/3	3/6		.02	.04	.10	.20	1	140	75/60	WAMOS
5/10	10/20		.066	.132	.33	.66	1.7	200	100	WAKOH
7.5/15	15/30		.1	.2	.5	1.0	1.7	180	75/60	WACOT
10/20	20/40		.133	.266	.666	1.333	1.7	200	100/80	WAROT
15/30	30/60		.2	.4	1.0	2.0	1.4	160	75/60	WACUM
20/40	40/80		.266	.532	1.33	2.66	1.2	150	100/80	WAPOT
37.5/75	75/150		.5	1.0	2.5	5.0	1.5	160	75	WAKER
75/150	150/300		1.0	2.0	5	10	1.5	200	75/60	WAKIT
150/300	300/600		2	4	10	20	1.3	160	75/60	WARUS
300/600	600/1200		4	8	20	40	5.2	210	60	WAAST
750/1500	1500/3000		10	20	50	100	13	125	75/60	WAOFT
75 Volts	150 Volts	300 Volts								
*.2/.4	.4/.8	.8/1.6	.00266	.00532	.0133	.0266	.12	200	100/80	WATAK
**3/.6	.6/1.2	1.2/2.4	.004	.008	.02	.04	.12	110	60	WATER
.5/1.0	1.0/2.0	2.0/4.0	.0066	.013	.0333	.0666	.24	100	100/80	WATIL
1.5/3	3/6	6/12	.02	.04	.1	.2	1	140	75/60	WATOS
5/10	10/20	20/40	.0666	.133	.333	.666	1.7	200	100/80	WATUF
15/30	30/60	60/120	.2	.4	1	2	1.4	160	75/60	WATYI
†20/40	40/80	80/160	.266	.532	1.33	2.66	1.2	150	100/80	WATKO
37.5/75	75/150	150/300	.5	1	2.5	5.0	1.5	160	75/60	WATSA
75/150	150/300	300/600	1	2	5	10	1.5	200	75/60	WATTI
150/300	300/600	600/1200	2	4	10	20	1.3	160	75/60	WATBA
300/600	600/1200	1200/2400	4	8	20	40	5.2	210	60	WATFO

\*DC and 25 - 125 cycle use only

\*\*DC and 25 - 250 cycle use only

†Recommended for fluorescent lamp measurements

## SPECIAL LOW VOLTAGE MODEL DLW WATTMETERS

WATT RANGE	POTENTIAL RANGE	Potential Circuit Approx. Ω/v	NORMAL (Unity PF) FIELD CURRENT AMPS		MAXIMUM (20% PF) FIELD CURRENT AMPS		Approx. 60 cps va	Scale Div.	Code
			Series	Parallel	Series	Parallel			
.05/.1	20	140	.0025	.0050	.0125	.025	.6	100	WALAM
.2/.4/.8/1.6	7.5/15/30	66	.026	.0533	.133	.266	1.6	100/80	WALEK
.2/.4/.8/1.6	5/10/20	90	.040	.080	.200	.400	4	100/80	WALIS
.3/.6/1.2	4/8	11	.075	.150	.375	.750	.5	60	WALOB
1/2	2	15	.500	1.00	2.5	5.0	1	100	WALUT
2.5/5/10	25/50	70	.100	.200	.50	1.00	1.4	125/100	WALLO
5/10	10	50	.50	1.00	2.5	5.00	1	100	WALLY
7.5/15	15	50	.50	1.00	2.5	5.00	1	75	WALLA
10/20	25	90	.40	.80	2	4.00	1.6	100	WALOO
10 Watts only	5/10/20	25	(.5 to 2 Amps)		(4 Amps)		2.3	100	WALEA

## VOLT-AMP-WATTMETER

### MODEL VAW

	CURRENT	VOLTAGE	WATTS
Accuracy:	.5%	.5%	.75%

Measures AC Current, AC Voltage and Single Phase tare-free power. Power Factor is, therefore, easily calculated. Can also be used for balanced 3 phase power with a "Y" Box.

### RANGES

Watts	Volts	Normal Amps (Unity PF)	Max. Amps (50% PF)	Frequency Range	Code
12.5/25/50/100/125/ 200/250/500/1000/ 2000/2500/5000	25/50/100/200/500 (100 ohms per v)	.5/1/5/10	1/2/10/20	50-125 cps	VOLTAWATT
50/100/200/250/ 500/1000/2000/ 2500/5000	100/200/500 (100 ohms per v)	.5/1/5/10	1/2/10/20	50-800 cps	VOLTOWATT*
100/200/400/500/1000 watts 2/2.5/4/5/10 kilowatts	100/200/500 (100 ohms per volt)	1/2/5/10/20	2/4/10/20/40	50-800 cps	VAW-20

Note 1: Each instrument contains a 10 ma current range on a separate binding post. This range cannot be used for watt measurements.

\*The Codes VOLTOWATT and VAW-20 are guaranteed to make watt measurements within rated accuracy when used at (1) 50 to 125 cps and 50% to 100% PF and (2) 50 to 800 cps and 100% PF. At 400 cps, 50% PF, accuracy is 1.5% and at 300 cps, 50% PF, accuracy is 3%.



# SINGLE PHASE COMPACT PORTABLE WATTMETERS POWER FACTOR INSTRUMENTS

## UNIVERSITY MODEL RANGES

WATT RANGE		NORMAL (Unity PF) FIELD CURRENT AMPS		MAXIMUM (50% PF) FIELD CURRENT AMPS		Approx. 60 cps va	Potential Circuit Approx. Ω/v	Scale Div.	Code
100 Volts	200 Volts	Series	Parallel	Series	Parallel				
5/10	10/20	.05	.1	.1	.2	.7	180	100	UWANAB
7.5/15	15/30	.075	.15	.15	.3	.4	160	75/60	UWALOP
15/30	30/60	.15	.3	.3	.6	.4	150	75/60	UWARIC
25/50	50/100	.25	.5	.5	1.0	.4	150	125/100	UWAPEB
37.5/75	75/150	.375	.75	.75	1.5	.8	180	75	UWASOD
75/150	150/300	.75	1.5	1.5	3.0	.6	160	75/60	UWATUF
125/250	250/500	1.25	2.5	2.5	5.0	.9	160	125/100	UWAVAG
150/300	300/600	1.5	3.0	3.0	6.0	.6	160	75/60	UWAVEG
250/500	500/1000	2.5	5.0	5.0	10.0	.75	160	125/100	UWABIK
300/600	600/1200	3.0	6.0	6.0	12.0	1	160	60	UWACOL
500/1000	1000/2000	5.0	10.0	10.0	20.0	1.3	180	100	UWADUM

50 Volts	100 Volts	200 Volts	NORMAL (Unity PF) FIELD CURRENT AMPS		MAXIMUM (50% PF) FIELD CURRENT AMPS		Approx. 60 cps va	Potential Circuit Approx. Ω/v	Scale Div.	Code
			Series	Parallel	Series	Parallel				
15/30	30/60	60/120	.3	.6	.6	1.2	1	270	75/60	UWAKAY
25/50	50/100	100/200	.5	1.0	1.0	2.0	.7	200	125/100	UWABAT
50/100	100/200	200/400	1.0	2.0	2.0	4.0	1	200	100/80	UWACES
75/150	150/300	300/600	1.5	3.0	3.0	6.0	.6	160	75/60	UWADIR
125/250	250/500	500/1000	2.5	5.0	5.0	10.0	.6	210	125/100	UWAFOV
250/500	500/1000	1000/2000	5.0	10.0	10.0	20.0	1.3	230	125/100	UWAGUX

### OPTIONAL SPECIFICATIONS

1. Voltage ranges can be increased to 110, 220 and 440 v at no extra charge, excepting for the codes UWAMOS, and UWAPOT listed under 20% PF instruments. Watt ranges remain the same but normal and maximum current ratings decrease in direct proportion. Specify by adding the letter "S" to the code word of the instrument ordered and state the potential ranges required. A wattmeter with two volt ranges can be increased to either 110/220 v or 220/440 v. (Specify ranges desired.)

### RANGES

SERIES FIELDS Max.			PARALLEL FIELDS Max.		
Volts	Amps	Watts	Volts	Amps	Watts
12.5	2	2.5	12.5	4	5
25	2	5	25	4	10
50	2	10	50	4	20
100	2	20	100	4	40
200	2	40	200	4	80

The instrument may be used down to power factors of 10% with reproducible results. Accuracy is 3% or better at 10% PF.

Code UWAMAT

### RANGES

Note: Watt ranges are calculated by cross multiplying potential ranges and normal current ranges. To assist the reader, the instruments below have their watt ranges listed in separate columns headed by the potential ranges which provide them.

WATT RANGE		NORMAL (Unity PF) FIELD CURRENT AMPS		MAXIMUM (20% PF) FIELD CURRENT AMPS		Approx. 60 cps va	Potential Circuit Approx. Ω/v	Scale Div.	Code
75 Volts	150 Volts	Series	Parallel	Series	Parallel				
†.2/.4	.4/.8	.00266	.00532	.0133	.0266	.12	200	100/80	UWAMOS
††.3/.6	.6/1.2	.004	.008	.02	.04	.12	100	60	UWAPOT
.5/1	1/2	.0066	.0132	.033	.066	.24	100	100	UWARUV
1.5/3	3/6	.02	.04	.10	.20	1	140	75/60	UWATEX
5/10	10/20	.066	.132	.33	.66	1.7	200	100	UWAVIH
7.5/15	15/30	.1	.2	.5	1.0	1.75	160	75/60	UWAWOB
10/20	20/40	.133	.266	.666	1.333	1.7	160	100/80	UWAXUD
15/30	30/60	.2	.4	1.0	2.0	1.4	140	75/60	UWABAF
37.5/75	75/150	.5	1.0	2.5	5.0	1.5	140	75	UWACEG
75/150	150/300	1.0	2.0	5	10	1.5	160	75/60	UWADIK
150/300	300/600	2	4	10	20	1.3	140	75/60	UWAFOJ
300/600	600/1200	4	8	20	40	5.2	180	60	UWAGUK

† DC and 25 to 125 cps only

†† DC and 25 to 250 cps only

## AC/DC PORTABLE POWER FACTOR METERS

	SINGLE PHASE MODEL PF	POLYPHASE MODEL PPF
ACCURACY:	±.005 PF	±.005 PF
RANGE:	.5-1-.5 PF	.5-1-.5 RF
VOLTAGE & FREQUENCY:	Either 115/230 V and 60 Hz or 115 Volts and 60/400 Hz Other combinations available Voltage Limits 100-130 Volts on 115 Volt Range 200-260 Volts on 230 Volt Range	115 or 230 Volts 50-500 Hz Voltage Limits 100-130 Volts on 115 Volt Range 200-260 Volts on 230 Volt Range
CURRENT:	2.5/5 amps or 5/10 amps Current limits 20 to 150% on each range	2.5/5 amps or 5/10 amps Current limits 20 to 150% on each range
SCALE LENGTH:	6.3"	6.3"
CASE:	Formica	Formica
CODE:	PFISP	PFIPP
APPROX. SHIPPING WT.:	11 lbs.	11 lbs.



# MODEL PDW POLYPHASE WATTMETERS

## RANGES

Note: Watt ranges are calculated by cross multiplying potential ranges and normal current ranges and multiplying by 2. To assist the reader, the instruments below have their watt ranges listed in separate columns headed by the potential ranges which provide them.

WATT RANGE			FIELD CURRENT PER PHASE (AMPS)				Approx. 60 cps va	Potential Circuit Approx. $\Omega/v$	Scale Div.	Code
100 Volts	200 Volts		Normal I (Unity PF)		Max. I (50% PF)					
			Series	Parallel	Series	Parallel				
15/30	30/60		.075	.15	.15	.3	.4	160	150/120	PDWAMIS
25/50	50/100		.125	.25	.25	.5	.3	150	125/100	PDWANOT
37.5/75	75/150		.1875	.375	.375	.75	.3	170	150	PDWYFAT
75/150	150/300		.375	.75	.75	1.5	.4	160	150	PDWASUL
125/250	250/500		.625	1.25	1.25	2.5	.4	160	125/100	PDWARAB
150/300	300/600		.75	1.5	1.5	3.0	.35	160	150/120	PDWHACK
250/500	500/1000		1.25	2.5	2.5	5.0	.4	170	125/100	PDWASED
300/600	600/1200		1.5	3.0	3.0	6.0	.3	130	150/120	PDWAHLN
500/1000	1000/2000		2.5	5.0	5.0	10.0	.3	150	100	PDWARAC
50 Volts	100 Volts	200 Volts								
15/30	30/60	60/120	.15	.3	.3	.6	.6	200	150/120	PDWEAPA
25/50	50/100	100/200	.25	.5	.5	1.0	.4	150	125/100	PDWEALM
50/100	100/200	200/400	.5	1.0	1.0	2.0	.4	160	100/80	PDWEAZO
75/150	150/300	300/600	.75	1.5	1.5	3.0	.3	160	150/120	PDWEAEN
125/250	250/500	500/1000	1.25	2.5	2.5	5.0	.4	170	125/100	PDWEAFE
250/500	500/1000	1000/2000	2.5	5.0	5.0	10.0	.3	150	125/100	PDWEAGZ

# MODEL PDLW LOW POWER FACTOR POLYPHASE WATTMETERS

## RANGES

Note: Watt ranges are calculated by cross multiplying potential ranges and normal current ranges and multiplying by 2. To assist the reader, the instruments below have their watt ranges listed in separate columns headed by the potential ranges which provide them.

WATT RANGE			FIELD CURRENT PER PHASE (AMPS)				Approx. 60 cps va	Potential Circuit Approx. $\Omega/v$	Scale Div.	Code
75 Volts	150 Volts		Normal I (Unity PF)		Max. I (20% PF)					
			Series	Parallel	Series	Parallel				
1.5/3	3/6		.01	.02	.05	.1	1	150	75/60	PDLWAMOS
5/10	10/20		.033	.066	.166	.33	1.2	150	100	PDLWAKOR
7.5/15	15/30		.05	.1	.25	.5	1.2	150	75/60	PDLWACOT
10/20	20/40		.066	.133	.333	.666	1.2	160	100/80	PDLWAROT
15/30	30/60		.1	.2	.5	1.	1.1	150	75/60	PDLWACUM
20/40	40/80		.133	.266	.66	1.33	.6	120	100/80	PDLWAPOT
37.5/75	75/150		.25	.5	1.25	2.5	.9	150	75	PDLWAKER
75/150	150/300		.5	1.0	2.5	5.	1.5	160	75/60	PDLWAKIT
150/300	300/600		1.	2.	5.	10.	1	150	75/60	PDLWARUS
300/600	600/1200		2.	4.	10.	20.	1.3	170	60	PDLWAAST
375/750	750/1500		2.5	5.0	12.5	25.	.9	120	75	PDLWAKOD
75 Volts	150 Volts	300 Volts								
1.5/3	3/6	6/12	.01	.02	.05	.1	1	150	75/60	PDLWATOS
5/10	10/20	20/40	.033	.066	.166	.333	1.2	150	100/80	PDLWATUF
15/30	30/60	60/120	.1	.2	.5	1.	1.1	150	75/60	PDLWATYI
20/40	40/80	80/160	.133	.266	.666	1.33	.6	120	100/80	PDLWATKO
37.5/75	75/150	150/300	.25	.5	1.25	2.5	.9	150	75/60	PDLWATSA
75/150	150/300	300/600	.5	1.	2.5	5.	1.5	160	75/60	PDLWATTI
150/300	300/600	600/1.2 kw	1.	2.	5.	10.	1	150	75/60	PDLWATBA
300/600	600/1200	1.2/2.4 kw	2.	4.	10.	20.	1.3	170	60/120	PDLWATFO
375/750	750/1500	1.5/3 kw	2.5	5.	12.5	25.	.9	120	75/60	PDLWATRI

### OPTIONAL ACCESSORIES

1. Voltage ranges can be increased by the addition of external multipliers. Correspondence required. Current ranges can be increased by the use of transformers. The Model TR Type 2 Transformer, with a 5 amp secondary, is recommended for use with wattmeters.

2. Compensating inductors are available for the third leg of 3 phase circuits in those applications where the insertion of a measuring instrument appreciably unbalances the load voltages. The resistance and inductance of an inductor is matched to the field circuit of the wattmeter with which it is to be operated, and its use is restricted to that instrument. The serial number of the wattmeter must be furnished if compensating inductors are ordered separately. Both units should be purchased together.

8 Price: \$150.00 2 Volt Ranges; \$175.00 3 Volt Ranges.

### OPTIONAL SPECIFICATIONS

1. Voltage ranges can be increased to 110, 220 and 440 v at no extra charge. Watt ranges remain the same but normal and maximum current ratings decrease in direct proportion. Specify by adding the letter "S" to the code word of the instrument ordered and state the potential ranges required. A wattmeter with two volt ranges can be increased to 110/220 v or 220/440 v. (Specify.)

2. Wattmeters with special ranges and/or scales can be supplied on special order in certain instances. Wattmeters can be compensated for frequencies above 800 cps and down to 15 cps. A detailed description of how to order special wattmeters is given on pages 302 & 304. Correspondence is required when ordering special instruments.







MODEL VAW

<u>CODE</u>	<u>PRICE</u>
VOLTAWATT	995.00
VOLTOWATT	1045.00
VAW-20	1250.00

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MODEL PF & PPF

PFISP	1370.00
PFIPP	1300.00

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MODEL UNIVERSITY

UWANAB	475.00
UWALOP	475.00
UWARIC	475.00
UWAPEB	475.00
UWASOD	475.00

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UWATUF	475.00
UWAVAG	475.00
UWAVEG	475.00
UWABIK	475.00
UWACOL	475.00
UWADUM	495.00

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UWAKAY	540.00
UWABAT	540.00
UWACES	540.00

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UWADIR	540.00
UWAFOV	540.00
UWAGUX	550.00

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UWAMAT	1480.00
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UWAMOS	500.00
UWAPOT	500.00
UWARUV	500.00
UWATEX	500.00

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UWAVIH	500.00
UWAWOB	500.00
UWAXUD	500.00
UWABAF	500.00
UWACEG	500.00
UWADIK	500.00
UWAFOJ	570.00
UWAGUK	605.00

MODEL PDW

<u>CODE</u>	<u>PRICE</u>
PDWAMIS	1305.00
PDWANOT	1305.00
PDWYFAT	1305.00
PDWASUL	1305.00
PDWARAB	1305.00

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PDWHACK	1345.00
PDWASED	1350.00
PDWAHLN	1350.00
PDWARAC	1395.00

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PDWEAPA	1350.00
PDWEALM	1350.00
PDWEAZO	1350.00

---

PDWEAEN	1375.00
PDWEAFE	1375.00
PDWEAGZ	1395.00

---

MODEL PDLW

PDLWAMOS	1565.00
PDLWAKOR	1490.00
PDLWACOT	1490.00
PDLWAROT	1490.00

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PDLWACUM	1490.00
PDLWAPOT	1490.00
PDLWAKER	1505.00
PDLWAKIT	1530.00

---

PDLWARUS	1560.00
PDLWAAST	1610.00
PDLWAKOD	1665.00

---

PDLWATOS	1560.00
PDLWATUF	1530.00
PDLWATYI	1530.00
PDLWATKO	1530.00
PDLWATSA	1550.00

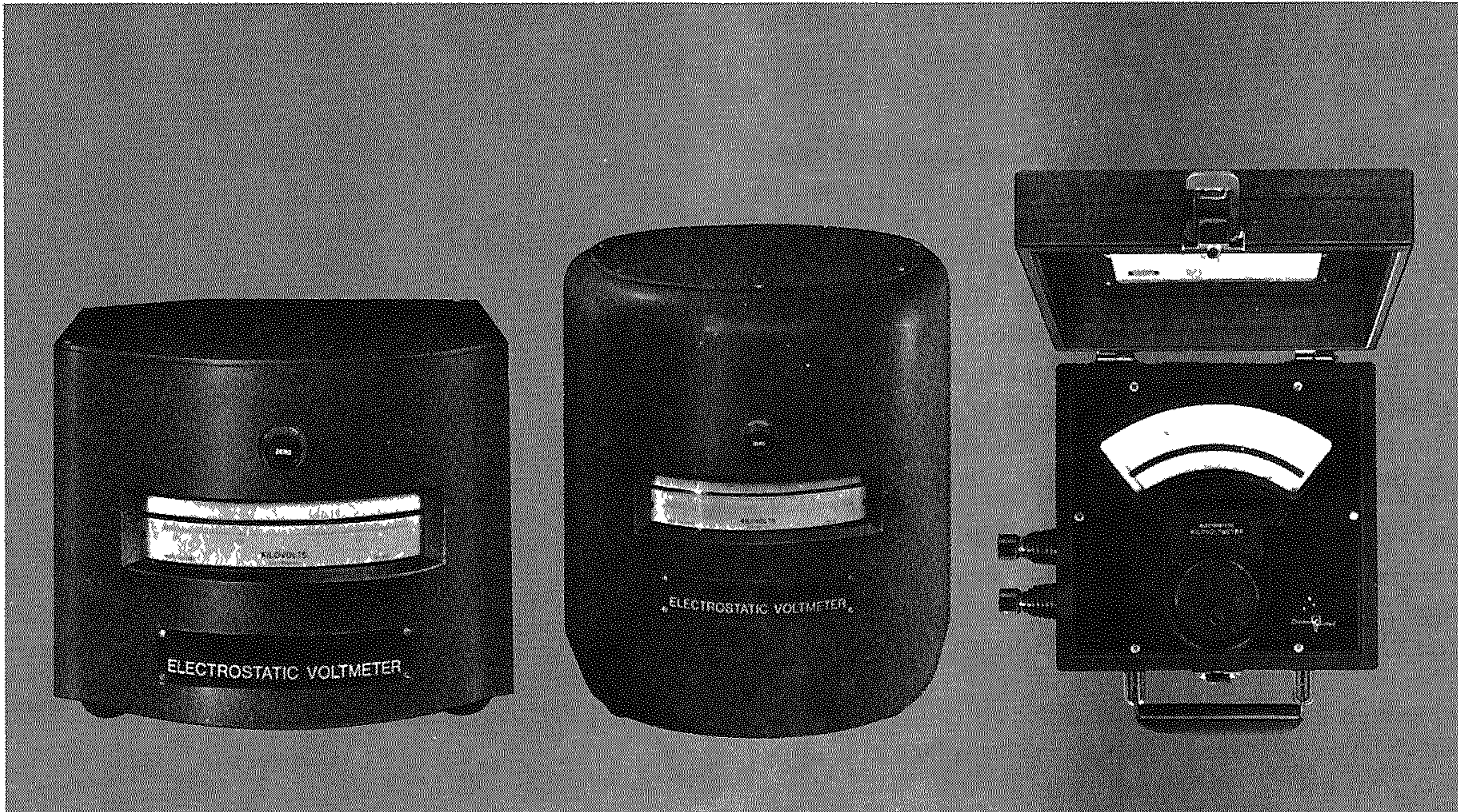
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PDLWATTI	1570.00
PDLWATBA	1600.00
PDLWATFO	1655.00
PDLWATRI	1720.00



# AC/DC Electrostatic Voltmeters

## Models ESH and ESD



Model ESH

Model ESH

Model ESD

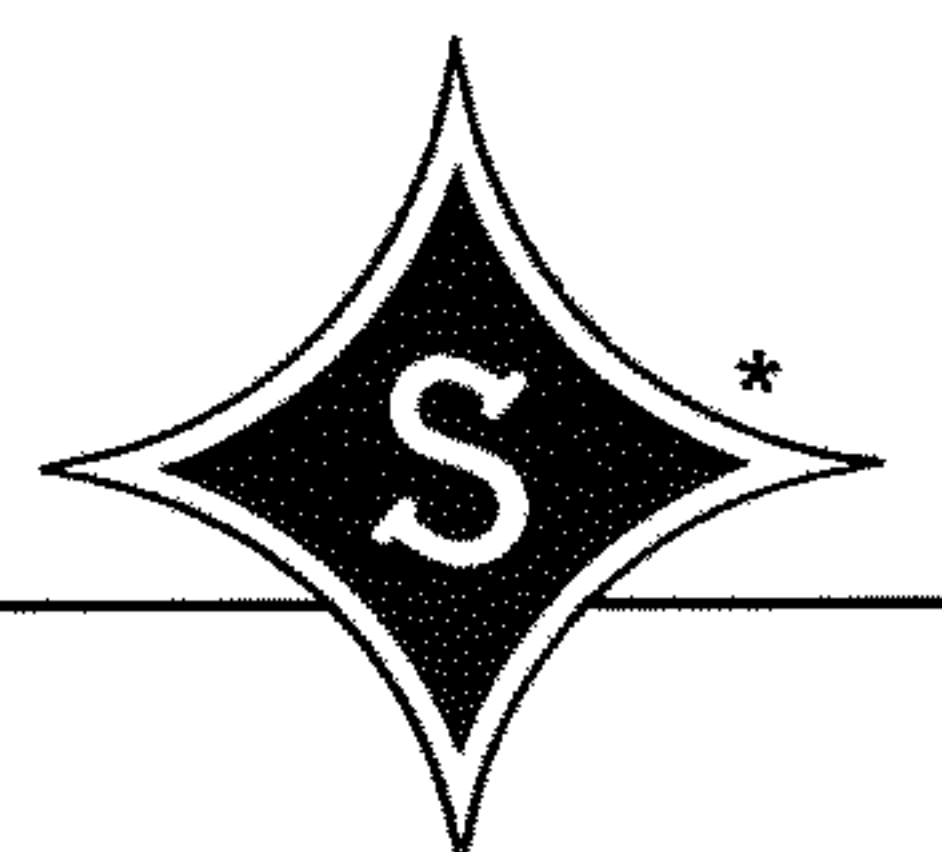
### RMS AND PEAK VOLTAGE MEASURING INSTRUMENTS

MODEL	DESCRIPTION	PAGE
	About Electrostatic Voltmeters .....	2 - 4
University	1% AC/DC Electrostatic Voltmeters. 150 V to 5 KV. 4" Scale Length .....	5
ESH	.5% and 1% AC/DC Electrostatic Voltmeters. 3 KV to 100 KV. 6" Scale Length .....	6 - 7
ESD	.5% and 1% AC/DC Electrostatic Voltmeters. 120 V to 6 KV. 5.2" Scale Length .....	8 - 9
CRV	1% Electrostatic RMS or Peak Voltage Measuring Instrument (5.2" Scale Length); Model CRV Multipliers .....	10
VPA	Peak Adaptors for Electrostatic Voltmeters .....	11
PARK	High Voltage Park Divider - .05% .....	12

Prices and specifications subject to change without notice.

**Sensitive Research\*** INSTRUMENTS

\*A Trademark of EIS



ELECTRICAL INSTRUMENT SERVICE, INC.

25 Dock Street, Mount Vernon, N. Y. 10550 - (914) 699-9717



# CHARACTERISTICS OF THE ELECTROSTATIC VOLTMETER

## Measures True Voltage Directly

The outstanding feature of electrostatic voltmeters is that they represent the only true method of measuring voltage directly. Conventional voltmeters universally measure voltage as a function of current. The electrostatic voltmeter operates directly from the impressed voltage and draws virtually no current. Any current that does flow is incidental to the measurement and is not the cause of the deflection. The deflection is directly proportional only to the rms value of the voltage appearing between the plates.

On DC the instrument draws a momentary charging current which instantly drops to a negligible value determined by the insulation resistance of the instrument. The insulation resistance is always several terohms and varies with the type of instrument, temperature, humidity and other factors. However, under the worst conditions, charging current from this cause is several hundred times smaller than the current drawn by any other type of voltmeter. In the great majority of steady DC circuits, the electrostatic voltmeter can be considered a "zero current" device.

## Operates Over Wide Frequency Range

The frequency range of the electrostatic voltmeter is almost unlimited. There are three factors which place the upper frequency limit on the use of the instrument.

The first is the effect of loading on the circuit being measured. The voltmeter as a circuit element is a very low loss capacitor. Its capacitance lies between the limits of 225 pf for the 120 volt instruments to about 10 pf for the 100 kilovolt type. In the radio frequency range, the reactance of the instrument is a quantity to be considered.

The second limitation is that the instrument and its leads behave as a resonant or partially resonant transmission line. The leads and the capacitive termination formed by the voltmeter movement may result in a voltage distribution along the line which is not constant. Thus the instrument may indicate a voltage which is not the same as that to which the leads are connected.

The third limitation is the current-carrying capacity of the instrument. For any given combination of voltage and frequency, such capacity will allow a current to flow. This current must not exceed 200 mA (for all models) or a permanent change in calibration may occur. This poses an upper frequency limit which is dependent on the voltage level used with the instrument.

For example: a 30 kilovolt instrument (capacity about 10 pf) at 20 kilovolt, could be used up to approximately 160 kHz.

## Measures RMS Voltage of all Waveforms

The electrostatic voltmeter measures rms voltage whether the voltage is DC, sinusoidal AC, or pulsed. The pulse or high-peaked type of voltage wave usually has an rms value which is small compared to the peak value. This sometimes misleads the user into thinking that the instrument is not functioning properly.

The instantaneous torque developed by the electrostatic voltmeter is equal to a constant (for a given deflection) multiplied by the square of the instantaneous terminal voltage. If the instantaneous terminal voltage is steady DC, then the average torque which produces the deflection is the same as the instantaneous torque and the instrument reads DC voltage. When alternating voltages are applied, the instantaneous torque of the electrostatic voltmeter is proportional to the square of the instantaneous terminal voltage. This results in the alternating voltage producing surges of torque which are mechanically averaged by the instrument movement.

The instrument movement can do an accurate averaging job because it has a mechanical time constant which is very long, compared to the period of the alternating voltage being measured. Consequently, the instrument responds to the theoretical concept of root mean square voltage, regardless of wave shape.

Since the electrostatic voltmeter as a circuit element is a high quality capacitor, the power taken by the instrument is negligible.

## Multirange Instruments

Sensitivity of an electrostatic voltmeter depends upon the spacing of the electrodes and can therefore be altered by varying the electrode spacing. The **SENSITIVE RESEARCH** Model ESH High Voltage Electrostatic Voltmeter uses this principle in a very refined mechanism for positioning the stationary electrode in as many as four positions to obtain an equivalent number of voltage measurements with one instrument. The ranges available are shown on page 6. The Model ESH also has the advantage of the voltmeter capacity decreasing as the voltage range increases.

The Model ESD electrostatic voltmeters obtain their multiranges by different means. It is not convenient to vary the spacing of the electrodes in the more sensitive instruments and so capacity type voltage multipliers are used. From the circuit shown in Figure 1, the condensers form a voltage divider for AC components which provide fixed accurate multiplying factors. The dotted resistances shown represent leakage resistances of the individual condensers used in the divider when DC is applied. Due to normal



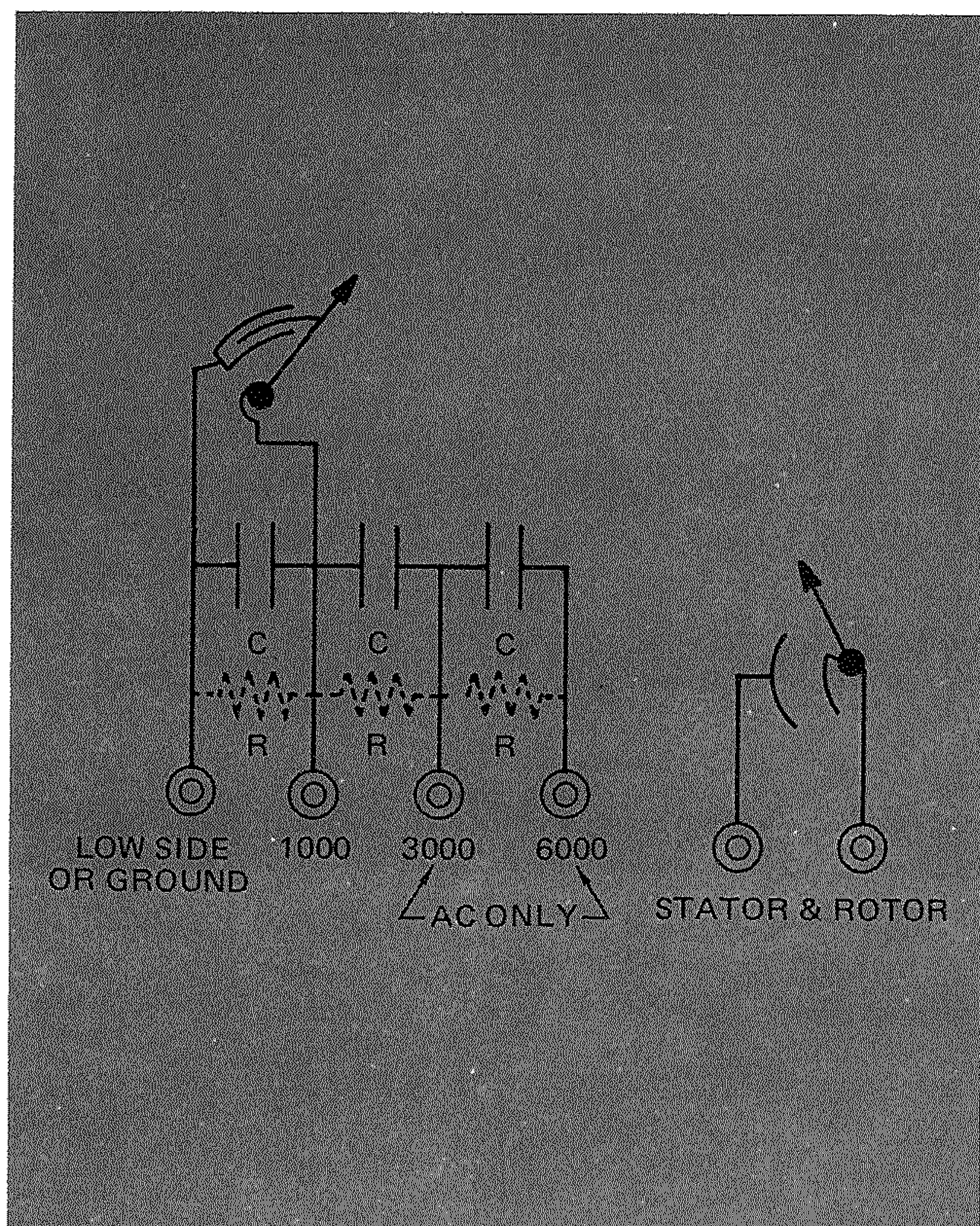


Figure 1

manufacturing tolerances, this leakage resistance can only be held within a range above some given high value, but not to a definite value of resistance. The DC path is through the leakage resistances, with the voltage appearing across the movement being proportional. Since the leakage resistances are of undetermined values, the voltages appearing across them are unreliable. For this reason, multirange Model ESD instruments should be used for DC readings only on the lowest range.

### Special Uses for the Electrostatic Voltmeter:

#### As a High Impedance AC Voltmeter:

At commercial power frequencies, the electrostatic voltmeter provides a very high impedance instrument for many types of measurement. For instance, the Model ESH 30 kilovolt instrument at 60 hertz has an input impedance of about 266 megohms, due to its capacitance, and draws a current of only 120 microamperes. It compares favorably with any type of electronic instrument in impedance, and is much superior in long term stability.

At lower voltages such as 1000 volts, 60 hertz, the Model ESD instrument with a capacitance of about 55 pf draws a current of 20.6 microamperes. This represents an equivalent input impedance of 48.5 megohms.

High voltage measurements on high reactance transformers, such as those used for cathode ray tube supplies and low current, high voltage supplies for breakdown testing, are examples requiring high voltage measurements at low current drain.

It should also be noted that this is a completely reactive current and there is no power consumption even at low levels. This is usually a theoretical advantage, however, rather than of practical importance.

The inclusion of an electrostatic voltmeter for AC measurements at power frequencies may in many cases eliminate the necessity of electronic circuitry with the attendant difficulties of tube replacements, recalibrations, etc.

#### As an Extremely High Resistance DC Meter:

When used as a DC voltmeter, the electrostatic voltmeter has no equal in having high input resistance at high voltage. The electrometer tube voltmeter for measuring a few volts has a comparable input resistance, but when the range of 100 volts and up is reached, the electrostatic instrument is in a class by itself.

An electrostatic voltmeter on DC draws only a momentary charging current due to its capacitance and draws a very low current thereafter. The value of this current is very small. For instance, a 10,000 volt instrument has a leakage resistance of at least  $3 \times 10^{15}$  ohms. After the initial charging current, such an instrument draws a current of only  $3 \times 10^{-11}$  amperes, a completely negligible value.

This low current is extremely useful for many applications such as Geiger counters, condenser microphones, ionization chambers, etc. These devices employ a polarizing voltage from a very limited current source. It is difficult to measure these voltages with ordinary instruments because of the current drain error. With the electrostatic voltmeter, true readings are easily obtained. In fact, the current drain is so low that it can be neglected entirely and the meter left connected for monitoring during any operation.

"Atomic" batteries using a radioactive source for providing power in place of chemical action can be readily checked with an electrostatic voltmeter. Any other type instrument will give incorrect low readings because of the limited current capabilities of this type of battery.

Any requirement for measuring voltage in the DC ranges, from 30 to 40 volts up to 100 kilovolts, in which very limited power is available for operation of an instrument, becomes the natural field of measurement using the electrostatic voltmeter.



# CHARACTERISTICS OF THE ELECTROSTATIC VOLTMETER (Continued)

## Other Uses

At all times an electrostatic instrument reads the rms value of the impressed voltage. This fact makes the instrument very useful as an AC-DC transfer standard, particularly in the high voltage ranges where its low power consumption makes it an attractive transfer device. The practically infinite impedance of the instrument makes it a very successful tool for the investigation of electrostatic fields. Its use in the printing, textile and paper industries is widespread. In a place where quantities of any insulating material are moved, troublesome static charges build up. This is particularly true where long continuous sheets are handled. Static fields cause sticking, misfeeding, sparking and other difficulties.

With an appropriate probe or collector, the electrostatic instrument will provide measurement of wide fields with an accuracy limited primarily by the sensing device rather

than the instrument. The measurement and plotting of such fields is the first step in being able to eliminate them to the extent required for satisfactory performance of the equipment.

The general principle to be observed in setting up such a measurement system is to provide a well insulated conductor from the field to a "field-free" position where it is connected to the high side of the electrostatic voltmeter. Under these conditions, the voltmeter reading will then be directly proportional to the field intercepted by the conductor. If such measurements have to be made at a distance, shielded cable can be used to eliminate pickup on the leads. However, the cable must be of exceptionally high insulation value or it will provide an attenuation of reading too great to tolerate.

## Scale Ranges

The ESD instruments up to 1,000 volts have a nearly square law scale giving very satisfactory readings down to about 1/3 of the full scale voltage with lowest calibrated point at 1/5 of full scale. Instruments above 1,000 volts have scales which tend to close down at the upper end.

The Model ESH has neither a true square law or linear scale. Its actual configuration is based on the full scale range of the instrument, and the combination of ranges with which it is included. Its lowest calibrated point is about 1/5 full scale.

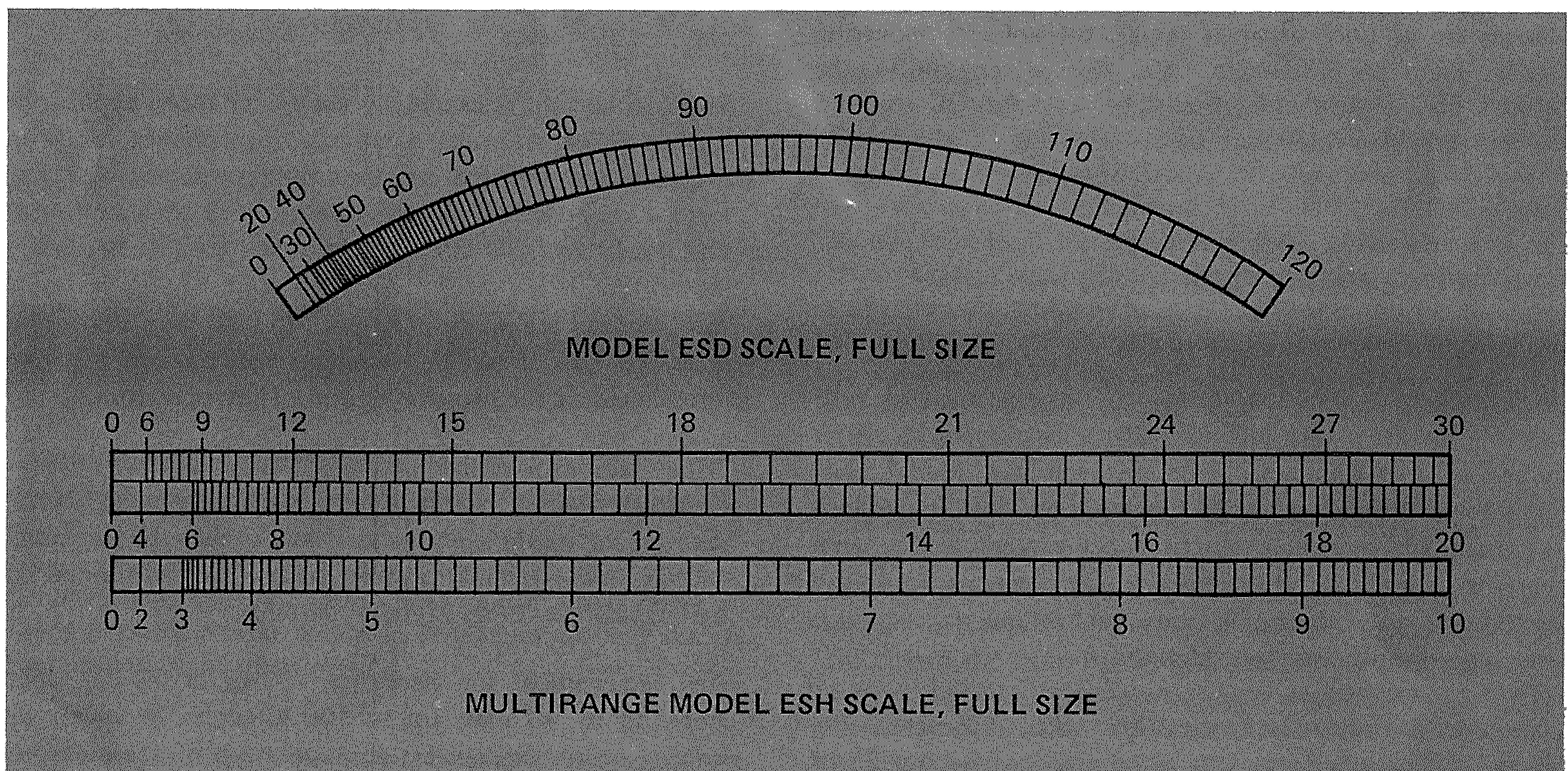
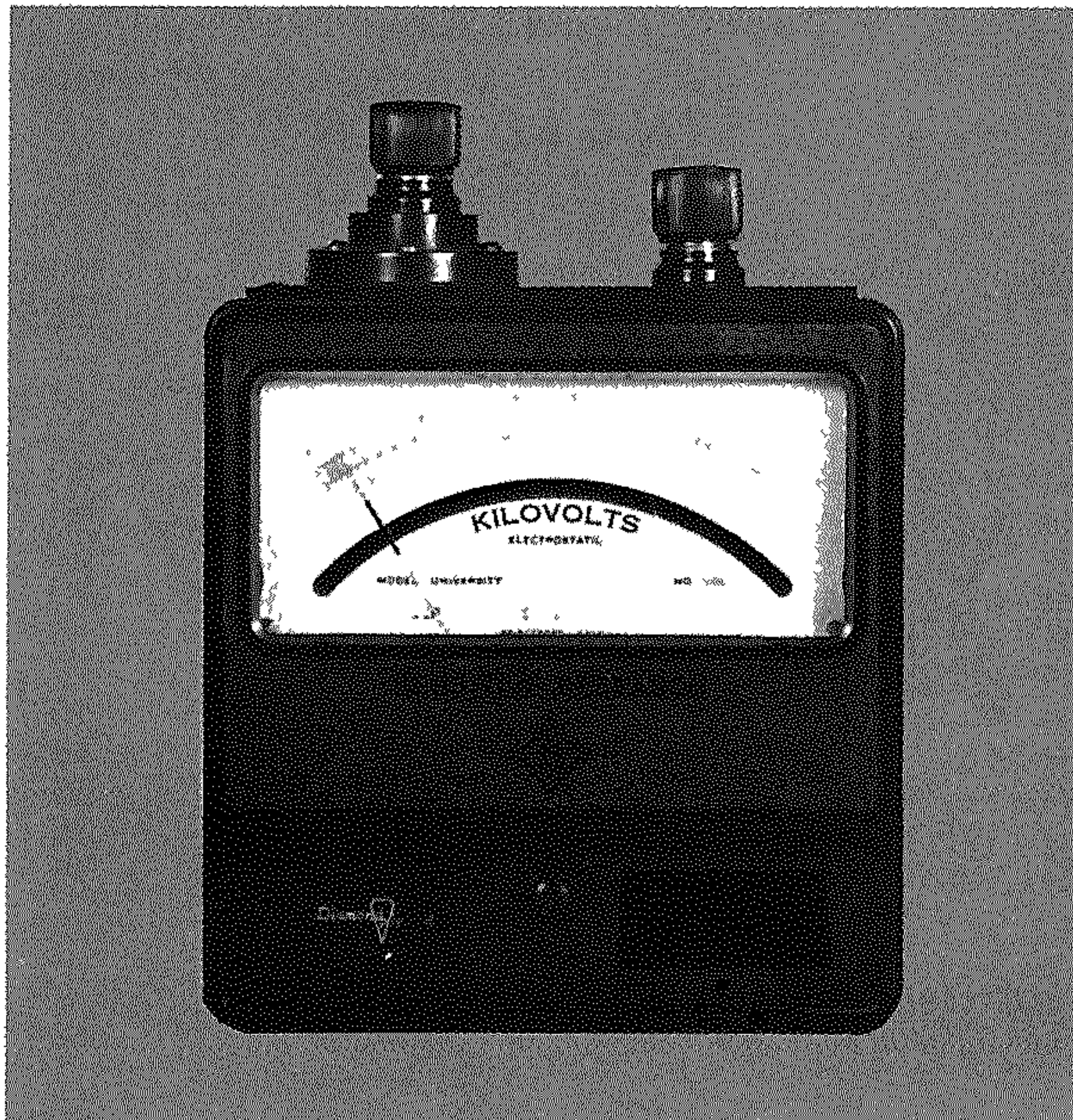


Figure 2



## UNIVERSITY MODEL



## SPECIFICATIONS

AC/DC PORTABLE — HORIZONTAL USE

ACCURACY	1%
SCALE LENGTH	4 inches
SCALE DIVISIONS	75 or 100
PERIOD	3 - 5 seconds
TYPE	Electrostatic
PIVOTS	Diamond Pivoted
CAPACITY	See below
JEWELS	Sapphire Spring Mounted
SHIELDING	Electrostatic
RANGE CHANGING	Binding Posts only
CASE	Moulded bakelite
SIZE	5 1/4" x 5" x 4 3/8"
INST. WEIGHT	4 1/2 pounds
SHIP. WEIGHT	10 pounds

### SINGLE RANGE AC-DC

Full Scale Volts	Code
†150	UELORO
300	UELENI
500	UELPRT
1000	UELFERT
1500	UELAMP
2000	UELELI
3000	UELEJO
5000	UELEMI

### \* DOUBLE RANGE CONDENSER MULTIPLIER TYPE

Full Scale Volts	Code
300/1000	UELOAK
300/1500	UELOJO
500/1500	UELOBI
500/2000	UELOKS
750/3000	UELOFI
1000/5000	UELOLK
2500/5000	UELOJY

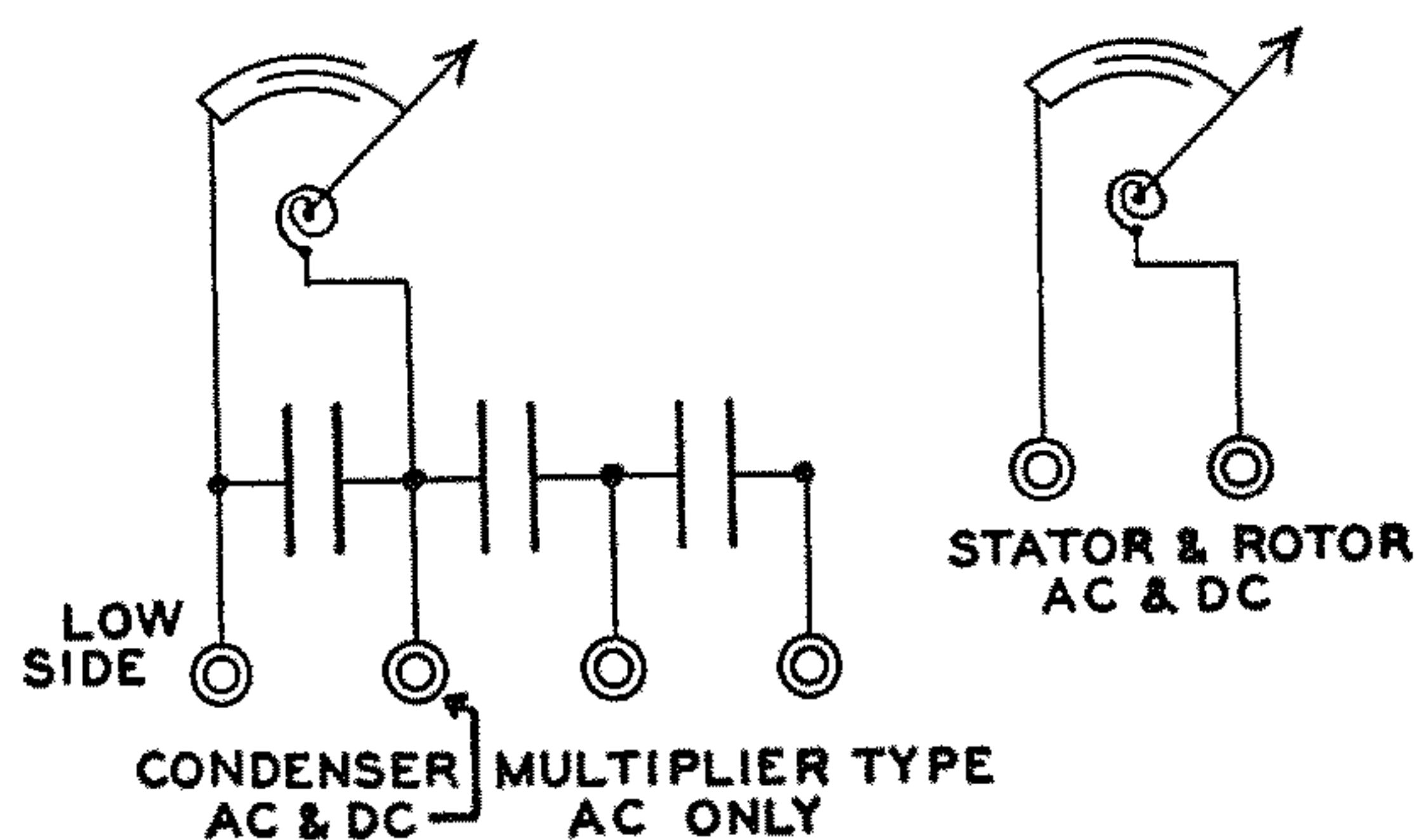
Lowest reading is 1/5 of full scale. † Accuracy 1 1/2%

\*DC measurements can be made on the lowest range only. Additional ranges are for use on AC only.

There is a slight reversal effect on all electrostatic instruments when used on D.C. This effect is not more than 1 volt.

### CONDENSER MULTIPLIER RANGES

Additional ranges are obtained by the use of condenser multipliers in an internal circuit such as shown below.



This University model electrostatic voltmeter has been particularly designed to measure both high and low D.C. and A.C. voltages in circuits where any appreciable current taken by the measuring instrument would introduce considerable error in the true reading. The insulation resistance is  $1 \times 10^{15}$  ohms. It is particularly desirable for use where small size and moderate cost is important.

The case is of molded black bakelite with brass chrome plated hardware. The high side binding post is excellently insulated with polystyrene.

The current consumption on Direct Current is zero and is very minute on alternating current. The instrument is quick reading and the movement is very effectively damped by double vane dampers in almost air tight vane chambers.

The pointer deflects over the customary anti-parallax scale and mirror for precise readings. The instrument is electrostatically shielded.

These electrostatic voltmeters use the rugged two pivot type of construction. This rigid method of assembly enables small clearances and strong springs to be used without the necessity of precisely leveling the instrument before using.

To avoid contact potentials, all of the electrical and working parts must be of the same metal, with a very minimum number of joints, since their resistance would be detrimental in radio frequency measurements. The instrument capacity varies from 220 MMFD on the 150 volt range, to 18 MMFD on the 5000 volt range.



## SPECIFICATIONS

AC/DC PORTABLE — HORIZONTAL USE

ACCURACY	1% or .5%
SCALE LENGTH	6 inches
SCALE DIVISIONS	Up to 100 as required
PERIOD	3 - 5 seconds
TYPE	Electrostatic
PIVOTS	Diamond Pivoted
JEWELS	Sapphire Spring Mounted
CAPACITY	See below
SHIELDING	Electrostatic
RANGE CHANGING	Multirange, switch controlled
CASE	Cast Aluminum
SIZE	Table on right
INST. WEIGHT	Table on right

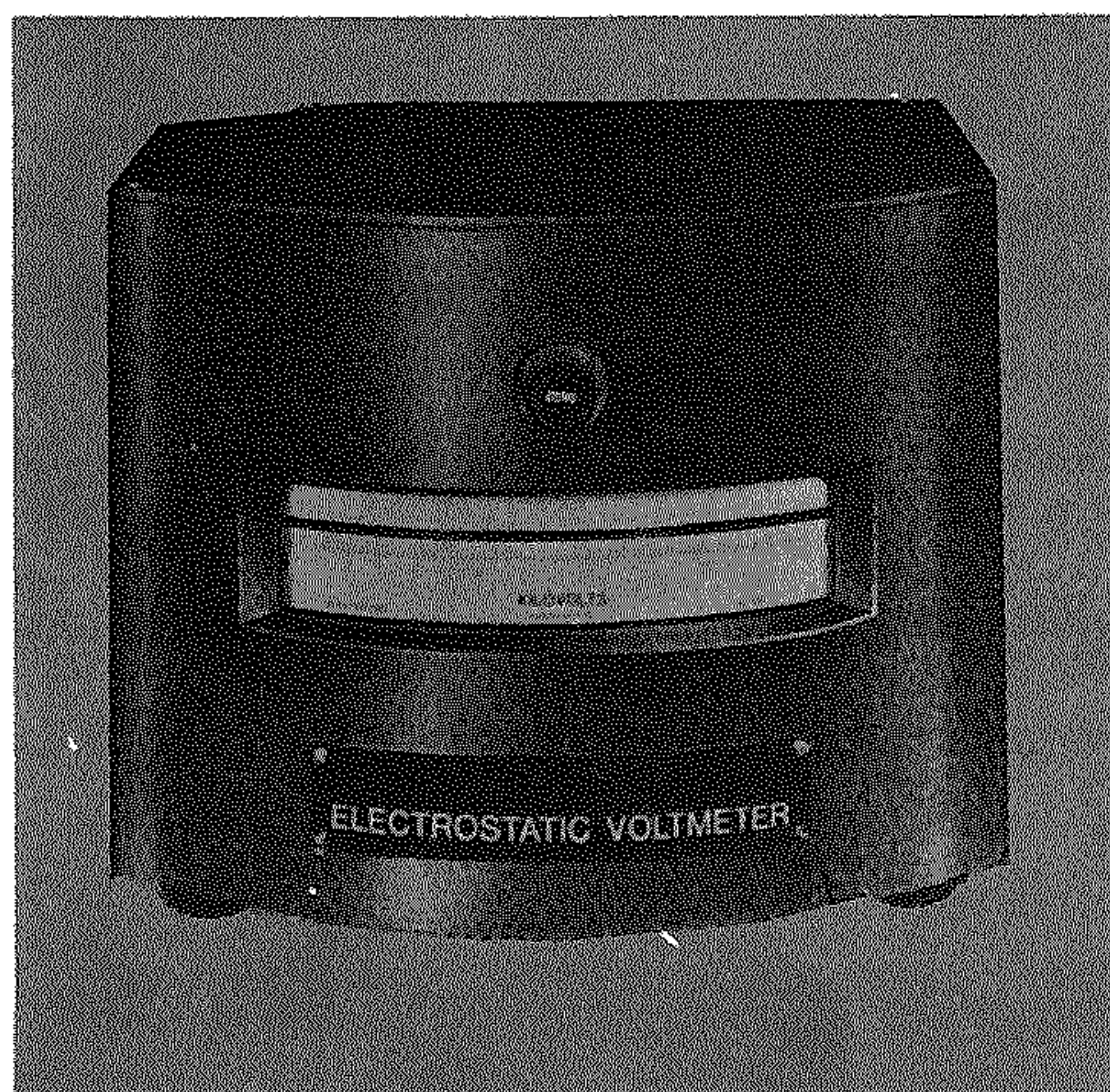
## MODEL ESH

Double Pivoted Movement

### SINGLE RANGE

Model	Range (KV)	Code Word	Case Style	Lowest Reading
ESH-1	7.5	ESHOLM	A	1.5 KV
ESH-2	10	ESHILT	A	2
ESH-3	15	ESHAIM	A	3
ESH-4	20	ESHUNS	A	4
ESH-5	25	ESHULK	A	5
ESH-6	30	ESHORE	A	6
ESH-7	40	ESHPOT	B	10
ESH-8	50	ESHIGH	B	10
ESH-9	60	ESHPEC	C	10
ESH-10	75	ESHHIY	C	15
†ESH-11	100	ESHOOP	D	20
*†ESH-12	140	ESHXL	D	30
*†ESH-12M	150	ESHIBM	D	30

\*- FOR USE ON DC ONLY  
†- ACCURACY DC 2%



30 KV INSTRUMENT

The insulation resistance of these instruments is very high—for instance on the 75 K.V. and 100 K.V. design it is more than  $5 \times 10^{15}$  ohms.

## HIGH VOLTAGE ELECTROSTATIC DESIGN MULTIRANGE VOLTMETERS FOR A.C. AND D.C.

By using a uniquely designed internal high voltage switch, multiranges of voltages from 3000 full scale volts up to 50,000 volts are obtained. This system has a distinct advantage because the capacity of the instrument decreases as the ranges increase. Briefly explained, the switch operating in successive "click" positions, moves the stator electrode away from the rotor in predetermined positions. The voltmeter is not limited to AC but can be used over all its ranges on DC. The capacity of its lowest range (3000 volts) is approximately 11 mmfd, and is about 10 mmfd at 50 to 100 kilovolts.

## SWITCH CONTROLLED MULTIRANGE VOLTMETERS

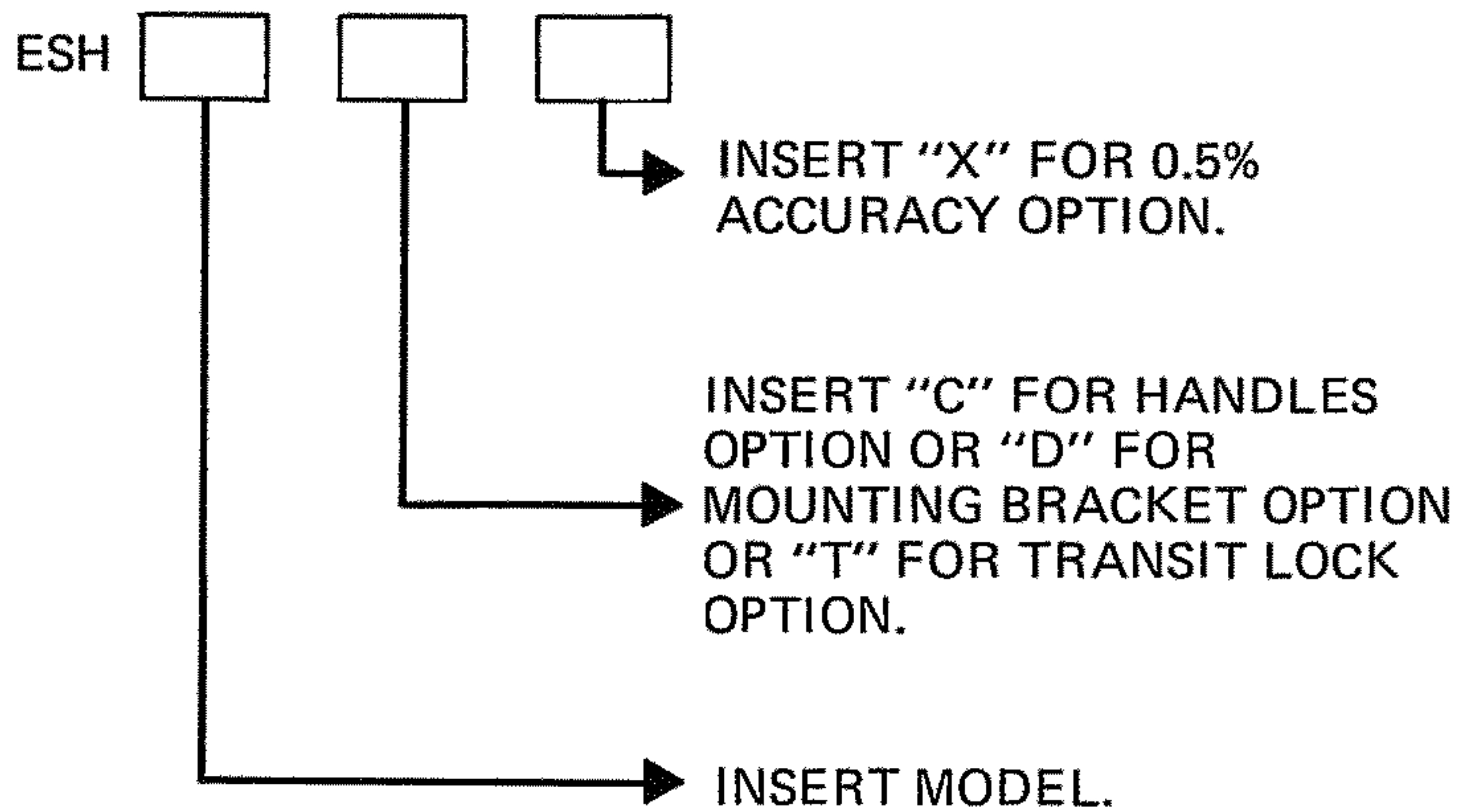
Model	Code	Range	Case Type	Lowest Reading
ESH-13	ESHAKE	5/10 KV	A	1000 V
ESH-14	ESHEEP	5/15	A	1000
ESH-15	ESHICK	10/15	A	2000
ESH-16	ESHOTS	10/20	A	2000
ESH-17	ESHAMP	10/30	A	2000
ESH-18	ESHULE	15/30	A	3000
ESH-19	ESHUL	5/7.5/10	A	1000
ESH-20	ESHMIP	5/10/15	A	1000
ESH-21	ESHMOT	5/15/30	A	1000
ESH-22	ESHMUS	10/20/30	A	2000
ESH-23	ESHMIX	10/25/50	B	2000
ESH-24	ESHUTE	5/7.5/15/30	A	1000
ESH-25	ESHMOO	5/10/15/20	A	1000
ESH-26	ESHMEE	5/10/20/30	A	1000
ESH-27	ESHMAY	10/20/30/40	B	2000
ESH-28	ESHMAX	5/10/25/50	B	1000
ESH-29	ESHDCH	3/7.5/15/30	A	600
ESH-30	ESHMIL	3/10/30	A	600
ESH-31	ESHALL	3/7.5/15	A	600
ESH-32	ESHALE	20/40	B	4000
ESH-33	ESHAME	25/50	B	5000

NOTE: All Models except ESH - 9, 10, 11, 12, 12M, available at 0.5% Accuracy



# ELECTROSTATIC VOLTMETERS

## HOW TO ORDER A MODEL ESH



EXAMPLE: ESH 7 DX = A 40 KILOVOLT INSTRUMENT WITH MOUNTING BRACKET AND 0.5% ACCURACY.

## NON-CATALOG INSTRUMENTS

ANY COMBINATION OF UP TO 4 RANGES CAN BE SUPPLIED PROVIDING:

- (A) RANGES ARE BETWEEN 3 AND 50 KV.
- (B) RANGES ARE SPACED AT LEAST 5 KV APART.
- (C) RATIO BETWEEN HIGHEST AND LOWEST RANGE IS NOT GREATER THAN 10:1.

COST WILL BE THE SAME PRICE AS AN INSTRUMENT HAVING THE SAME NUMBER OF RANGES AND THE SAME HIGHEST FULL SCALE RANGE. IF THE SAME HIGHEST RANGE IS NOT LISTED, USE PRICE FOR THE NEXT HIGHER RANGE.

Case Style	Size	Weight	Shipping Weight
A	16" x 13" x 9	21 lbs.	29 lbs.
B	23-1/2" x 13" x 14-1/2"	29 lbs.	39 lbs.
C	42-1/2" x 21-1/4" x 22"	101 lbs.	217 lbs.
D	52" x 27" x 26"	145 lbs.	358 lbs.

# Outline Dimensions

STYLE	DIMENSION		
	A	B	C
B	13in	23 1/2 in	14 1/2 in
C	21 1/4 in	42 1/2 in	22 in
D	27in	54 in	26 in



# ELECTROSTATIC VOLTMETERS

## SPECIFICATIONS

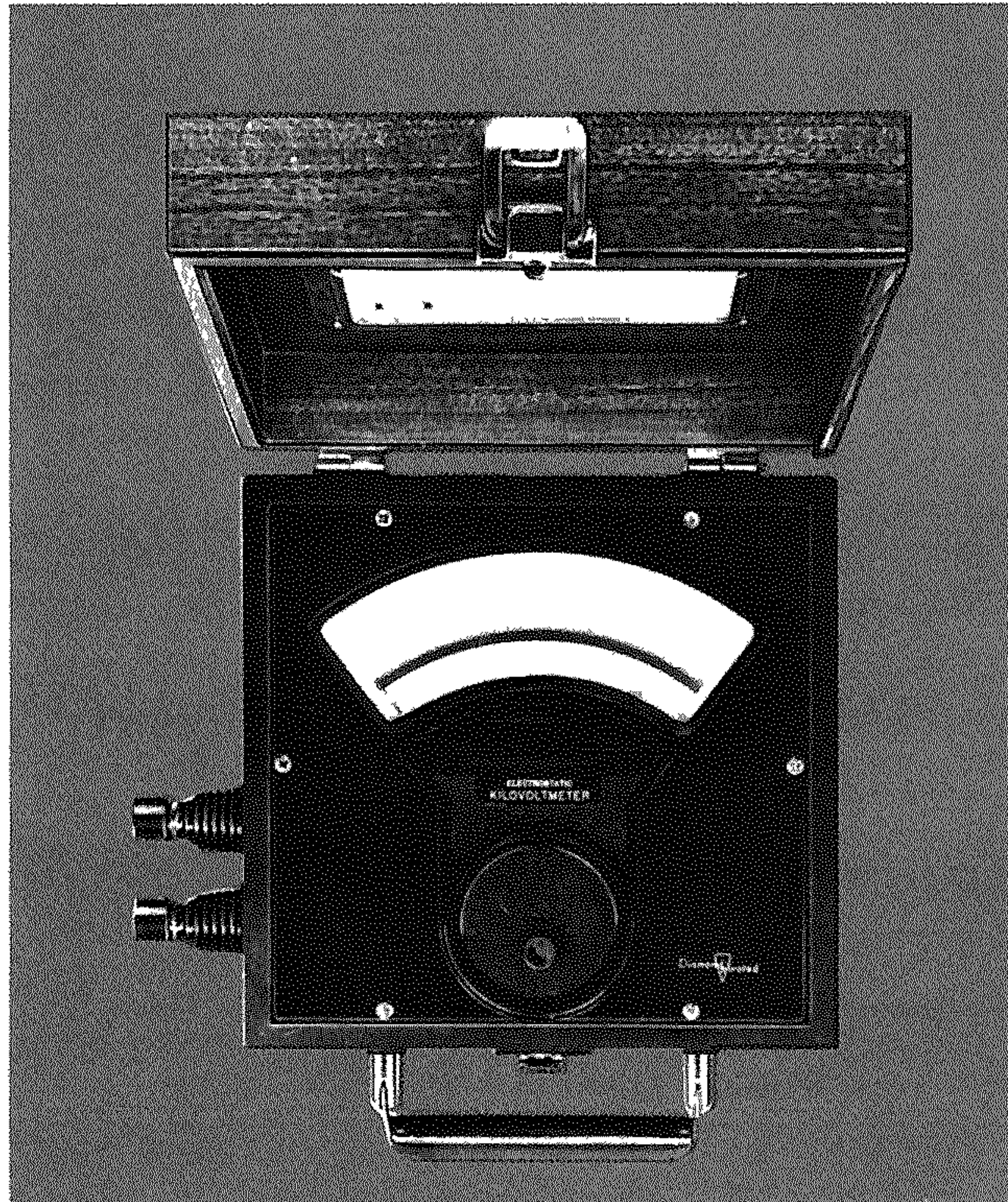
AC/DC PORTABLE — HORIZONTAL USE

ACCURACY	1% or .5%
SCALE LENGTH	5.2 inches
SCALE DIVISIONS	75 or 100
PERIOD	3 - 5 seconds
TYPE	Electrostatic
PIVOTS	Diamond Pivoted
JEWELS	Sapphire Spring Mounted
SHIELDING	Electrostatic
CAPACITY	See below
RANGE CHANGING	Binding Posts only
CASE	Formica
SIZE	7 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 6 $\frac{1}{16}$ "
INST. WEIGHT	8 lbs.
SHIP. WEIGHT	11 lbs.

FOR PANEL MOUNTING

See page 9

MODEL ESD



The Formica case has many advantages over wood; it is structurally stronger, relatively scratch proof, a good moisture barrier, relatively dust proof, and in general better able to withstand adverse field and laboratory conditions. These instruments are all supplied in Formica cases and with diamond pivots.

### A MODERN PORTABLE ELECTROSTATIC VOLTMETER

It is well known that electrostatic instruments are essentially voltage measuring devices and the deflection is due to the attraction or repulsion between two electrified surfaces. Such instruments have the advantage that they take no power from the circuit and are free from errors due to magnetic hysteresis, or frequency. They have no self-heating error and the loss of energy in the instrument is negligibly small. They read equally well on alternating or direct current circuits.

While it requires careful workmanship to construct a precise electrostatic voltmeter reading from 1000 volts or higher, the problems of low voltage design are more difficult. The working forces are very low and extreme care must be taken to select even the diamond pivots

and shock mounted jewels that must be perfect in all respects, at magnification of 100 diameters.

The rotor is made of duralumin for lightness and strength. The insulation is of selected polystyrene and has an insulation resistance of over  $1 \times 10^{15}$  ohms. The hand drawn scale is 5.2 inches in length, on our standard white enamel finish, with a knife edge pointer moving over a flat mirror to avoid parallax errors in reading. Full scale capacity of the instrument is approximately 18 MMFD on the 5000 volt instrument, to 220 MMFD on the 120 volt instrument. They are normally supplied in portable formica cases with brass chrome plated hardware and a heavy carrying strap.



# ELECTROSTATIC VOLTMETERS

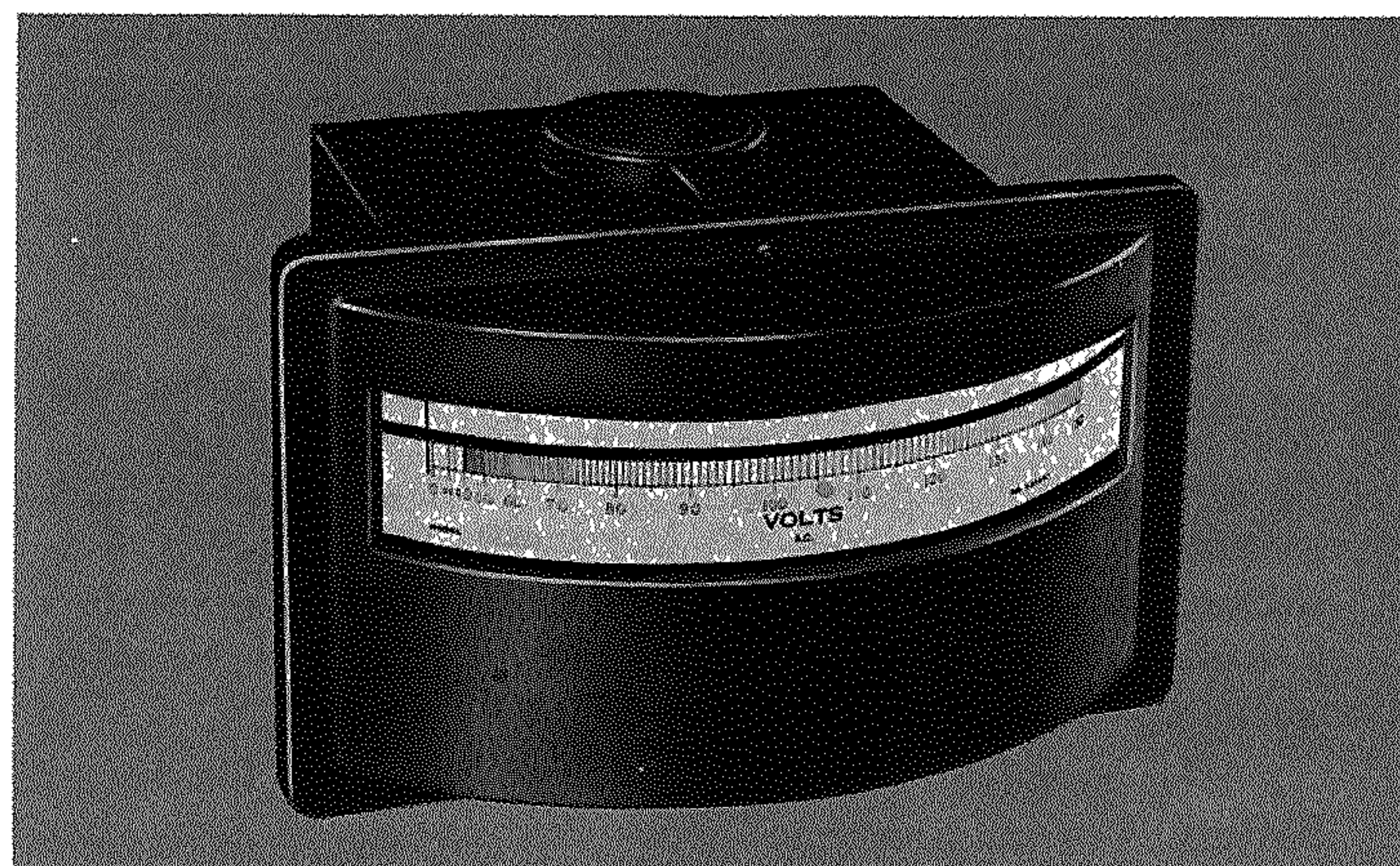
## MODEL ESD

Our Electrostatic Voltmeters all use the rugged two pivot method of construction. This rigid method of assembly enables small clearances and strong springs to be used.

### SINGLE RANGE (AC-DC)

Full Scale Volts	Model	Code
†120	ESD-1	ELECNA
†150	ESD-2	ELECMI
200	ESD-3	ELECPU
300	ESD-4	ELECBA
500	ESD-5	ELECFO
1000	ESD-6	ELECJY
1500	ESD-7	ELECTA
2000	ESD-8	ELECCI
3000	ESD-9	ELECKO
5000	ESD-10	ELECLI
6000	ESD-11	ELECHU

All single range Model ESD Voltmeters 500 volts and above can be calibrated to an accuracy of .5% for an additional charge



ESDEW-5A

There is a slight reversal effect on all electrostatic instruments when used on D.C. This effect is not more than 1 volt.

### \*\* Multirange (Condenser Type)

Full Scale Volts	Code
†120/240	ELEDA
†150/300	ELIFOR
†150/750	ELOHIT
250/500	ELUJAK
300/1500	ELAKIS
500/2000	ELEFTI
1000/5000	ELILIK

Lowest reading is 1/5 of full scale.  
†Accuracy 1½%

Full Scale Volts	Code
†125/500/750	ELUNIK
200/500/1000	ELAPIS
300/750/1500	ELERTI
500/1500/3000	ELISPO
750/1500/5000	ELOTKA
1000/3000/6000	ELUVIN

\*\*The lowest range can be used on direct or alternating current; upper ranges on alternating only.

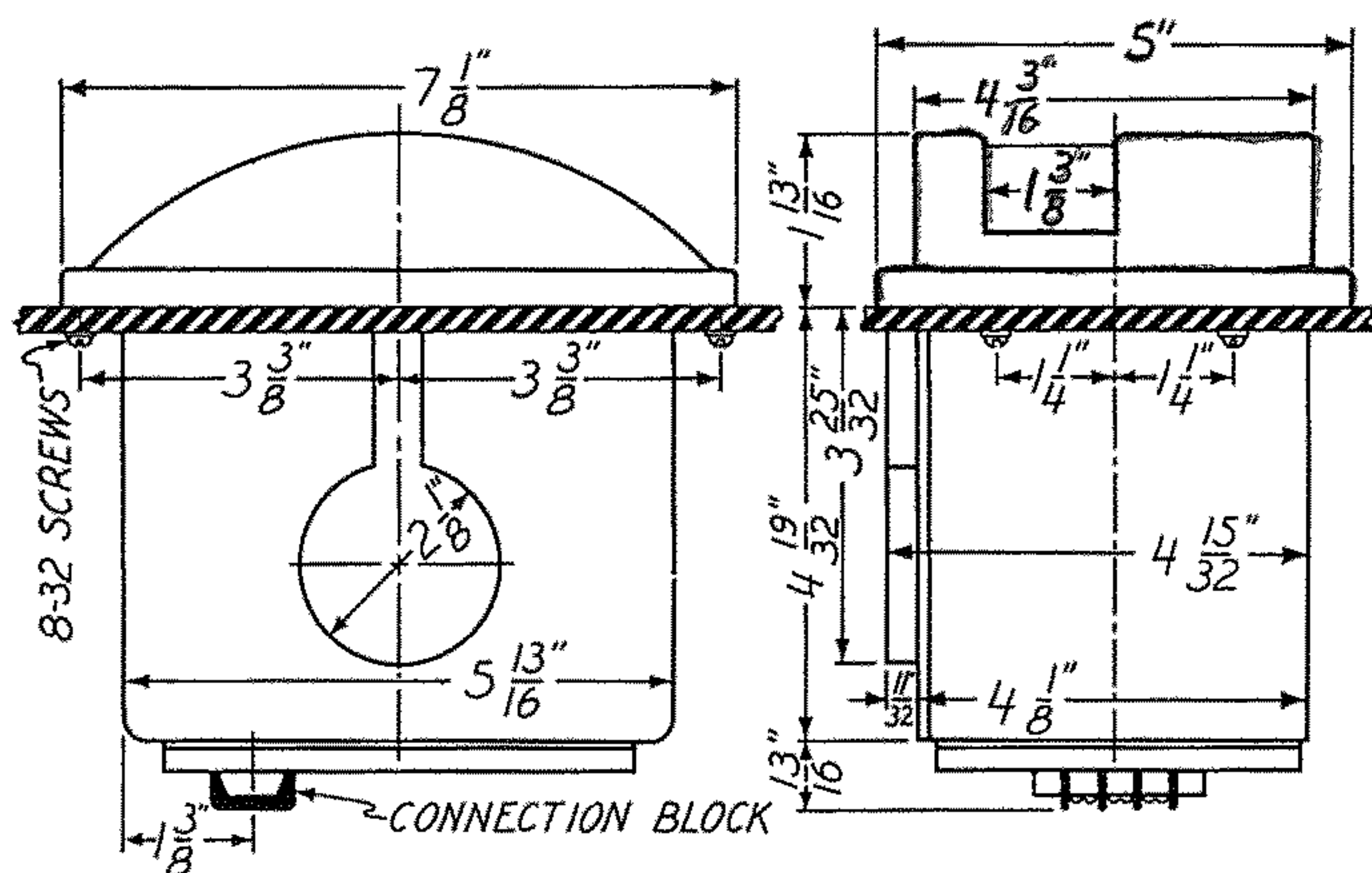
## Panel Instruments

The Model ESD is also available for vertical panel mounting. Single range instruments are supplied in the deep EW-5A (5" scale length) edgewise panel case. Multirange instruments are supplied in the deep EW-7A case with a 5" scale length.

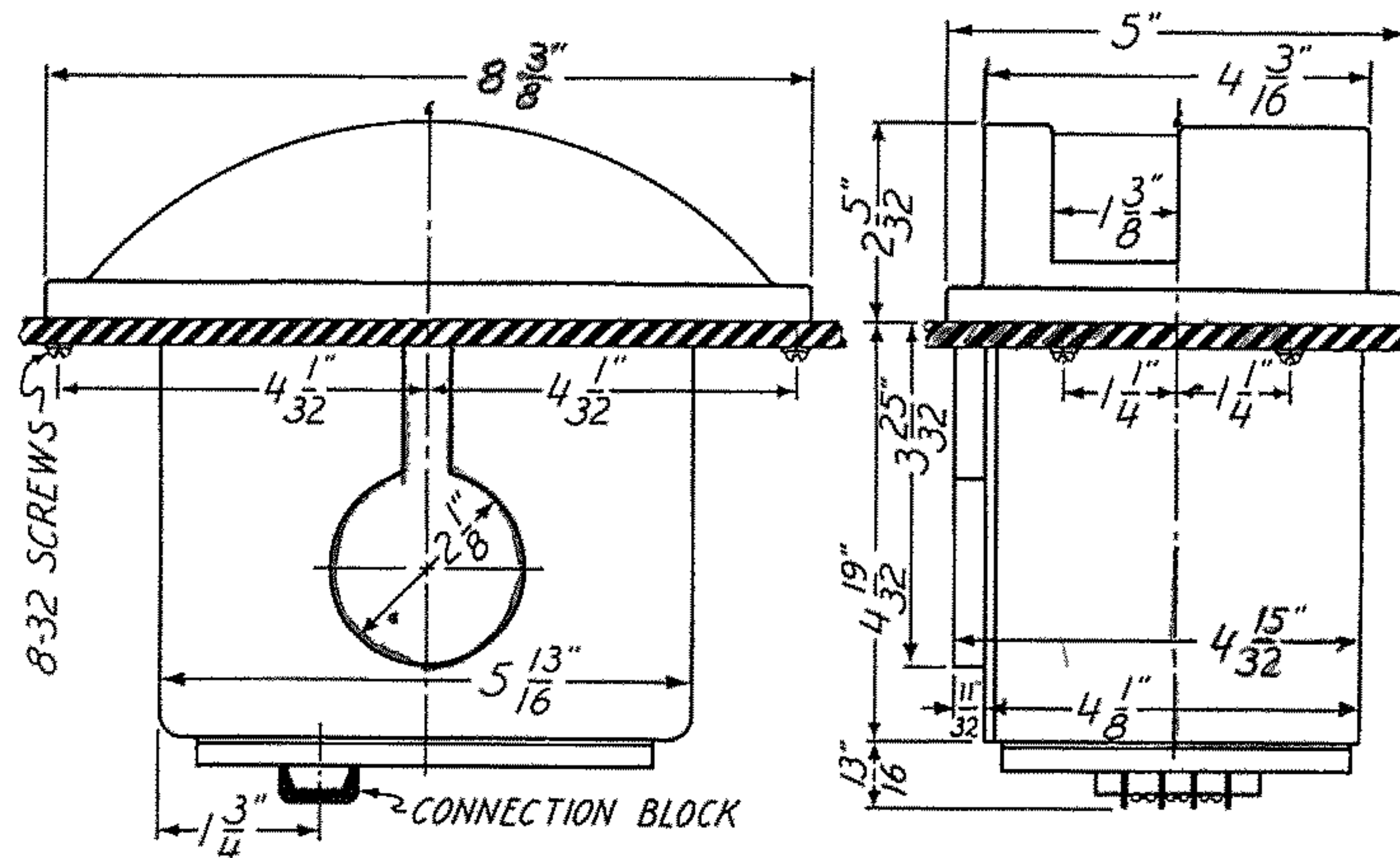
Performance characteristics are the same as listed for the portable type, except as follows:

- (a) Insulation resistance is lower than in portable instruments ( $.5 \times 10^{13}$  ohms minimum for single range units).
- (b) The metal case and the low side of the instrument connections must be used connected and grounded together.

**Specify:** Model ESDEW-5A or ESDEW-7A and code word of portable instrument having ranges desired.



ESDEW-5A (DEEP CASE) — 5" scale length  
For single range instruments



ESDEW-7A (DEEP CASE) — 5" scale length  
For multirange instruments

Furnished with binding posts only.



# CREST VOLTMETERS

## MODEL CRV

The Model CRV is an instrument for the measurement of CREST voltages (also called peak voltages) of either AC or pulsed DC sources. It consists of an electrostatic voltmeter combined in one case with a peak voltage rectifier circuit and switching to allow measurement of either positive or negative peaks, or RMS values. The basic circuit is shown in Fig. 3 at the right.

The range of the instrument is 0-1000 volts, the accuracy 1% for recurrent peaks repeating at rates of 20 or more times per second on the "slow" position and at 100 or more times per second on the "fast" range. For full accuracy the duty cycle (width of peak to space between peaks) must not be less than 1 to 2000 and the peak width more than 2 microseconds.

The peak rectifier has a battery supplied filament allowing use of the instrument without power line limitations. Battery is readily replaced from the outside of case. The long life peak rectifier has at least an expected life of 1000 hours and can be replaced without affecting calibration.

Multipliers are available for operation up to 100 kilovolts as listed below. These are a combined resistance-capacity type for use on AC and pulsed DC at an accuracy of 1%. These multipliers are also usable for intermittent operation on pure DC with an accuracy of 3%. Multipliers are individually calibrated with each instrument. If they are not ordered with the instrument, but at some later date to increase its range, the instrument must be returned to the factory for calibration with the multiplier. Calibration curves are normally supplied. *Separate scales may be drawn on the instrument for additional ranges at a cost of \$50.00 per scale.*

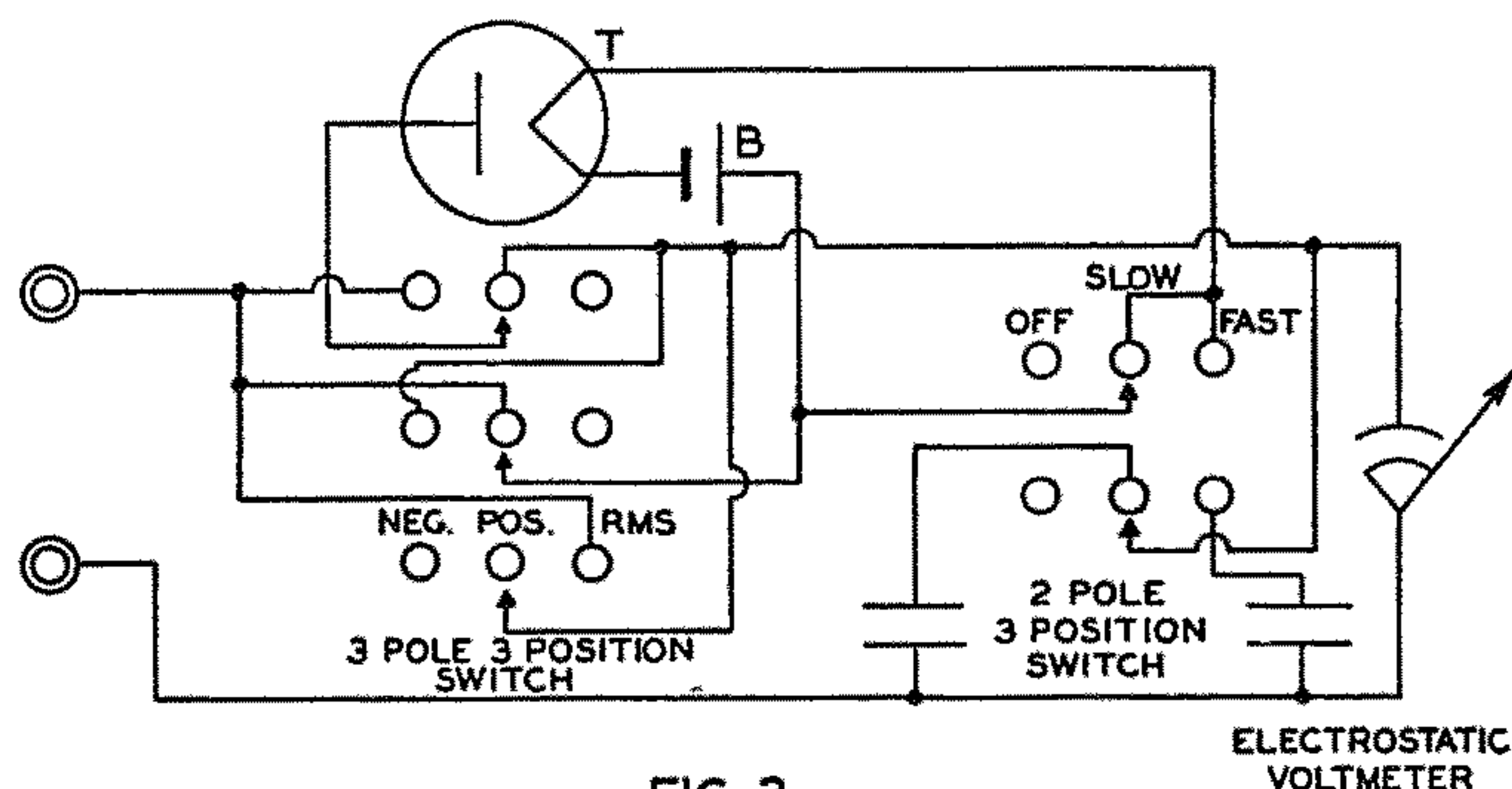


FIG. 3  
RMS-CREST VOLTMETER CIRCUIT

## CREST VOLTMETER

FOR

### READING TRUE RMS, NEGATIVE PEAKS AND POSITIVE PEAKS

<b>RANGES</b>	Basic instrument 0-1 Kilovolt. External multipliers available up to 100 Kilovolts. A maximum of 4 scales, including the basic 1 KV range, may be provided.
<b>ACCURACY</b>	1% of full scale for RMS and for peaks of 100 per second and faster on "Fast" position or, 20 or more per second on "Slow" position.
<b>SCALE LENGTH</b>	5.2 inches
<b>PIVOTS</b>	Diamond Pivoted
<b>ELECTROSTATIC SHIELDING</b>	is standard.
<b>INPUT IMPEDANCE</b>	RMS = 10,000 megohms and 25 micro microfarads. Positive Peak = 10,000 megohms and 15 micro microfarads. Negative Peak = 10,000 megohms and 15 micro microfarads.
<b>CASE</b>	Formica
<b>PHYSICAL DIMENSIONS</b>	Basic instrument 13 <sup>3</sup> / <sub>4</sub> " x 7 <sup>1</sup> / <sub>2</sub> " x 8" 50 KV range multipliers 12" x 9" x 27 <sup>1</sup> / <sub>2</sub> " Other ranges proportionate in height with range of multipliers.

Basic instrument — Code CREST —

#### MULTIPLIERS

RANGE	CODE	RANGE	CODE
100 KV	CRABE	30 KV	CRUGI
75 KV	CRECT	20 KV	CRYJU
50 KV	CROFA	10 KV	CRAAK
40 KV	CRFAO	5 KV	CREEL

#### MULTIPLIERS

Resistance-capacitor divider type for AC or pulsed DC at 1% and 3% on DC. Input impedance — Varies with the full scale range used.

- EXAMPLE (1) 2 KV = .001 mfd. & 50 megohms.  
(2) 100 KV = .000025 mfd. & 500 megohms



## PEAK VOLTAGE MEASUREMENTS

The need for a peak reading electrostatic voltmeter has been growing for many years. During the 2nd world war we, as pioneers in the electrical measurements field, experimented with peak voltage measuring circuits using the components which were then available. In the ensuing years there has been an increasing need for an accurate, simple, direct method for making peak voltage measurements *without* loading the circuit being measured. "SENSITIVE RESEARCH" ELECTROSTATIC VOLTMETERS have, for over two decades, been the leading method for making both A.C. and D.C. high voltage measurements with virtually no power drawn from the circuit under measurement. These electrostatic voltmeters have provided very reliable service in the measurement of true RMS voltage. In recent years the need for peak voltmeters in radar, corona, ignition, and hipot measurements has become increasingly more pressing. To meet this need we have developed the "SENSITIVE RESEARCH" PEAK VOLTMETER UNITS. These units or accessories provide a very convenient means of converting most "SENSITIVE RESEARCH" electrostatic voltmeters to an accurate peak reading voltmeter which

takes a negligible amount of power from the circuit under measurement.

Multirange ESD and University instruments used on other than the lowest range are not suitable for this use. All other instruments including multirange ESH types are satisfactory.

The peak voltmeter stores positive peaks and during the negative swing of the voltage, the peak unit is subjected to the inverse peak voltage of the wave. In the case of the usual pulse voltages, the peak value is the same as the inverse peak, but for sinusoidal or repetitive symmetrical waves, the inverse peak voltage is twice the peak value. For this reason, SENSITIVE RESEARCH PEAK VOLTMETER UNITS are rated in inverse peak volts.

When properly connected to our electrostatic voltmeters the instrument reading will be the peak voltage of the particular circuit being measured.

These units are normally supplied for use on "positive" peaks but can be furnished for "negative" peaks. See ordering information below.

### MODEL VPA LOW VOLTAGE PEAK UNIT

#### ELECTRICAL CHARACTERISTICS

Maximum Inverse Peak Voltage.....3000 Volts  
 Charging Time Constant.....5 microseconds  
 Discharging Time Constant.....5 seconds  
 Frequency Range .....60 cps to 1 mc

MECHANICAL DIMENSIONS 4" Dia. 5" High Weight 4 pounds

#### Code

LOW Voltage Positive Peak Unit.....LOPEEK  
 LOW Voltage Negative Peak Unit.....NEGLO

### MODEL VPA HIGH VOLTAGE PEAK UNIT

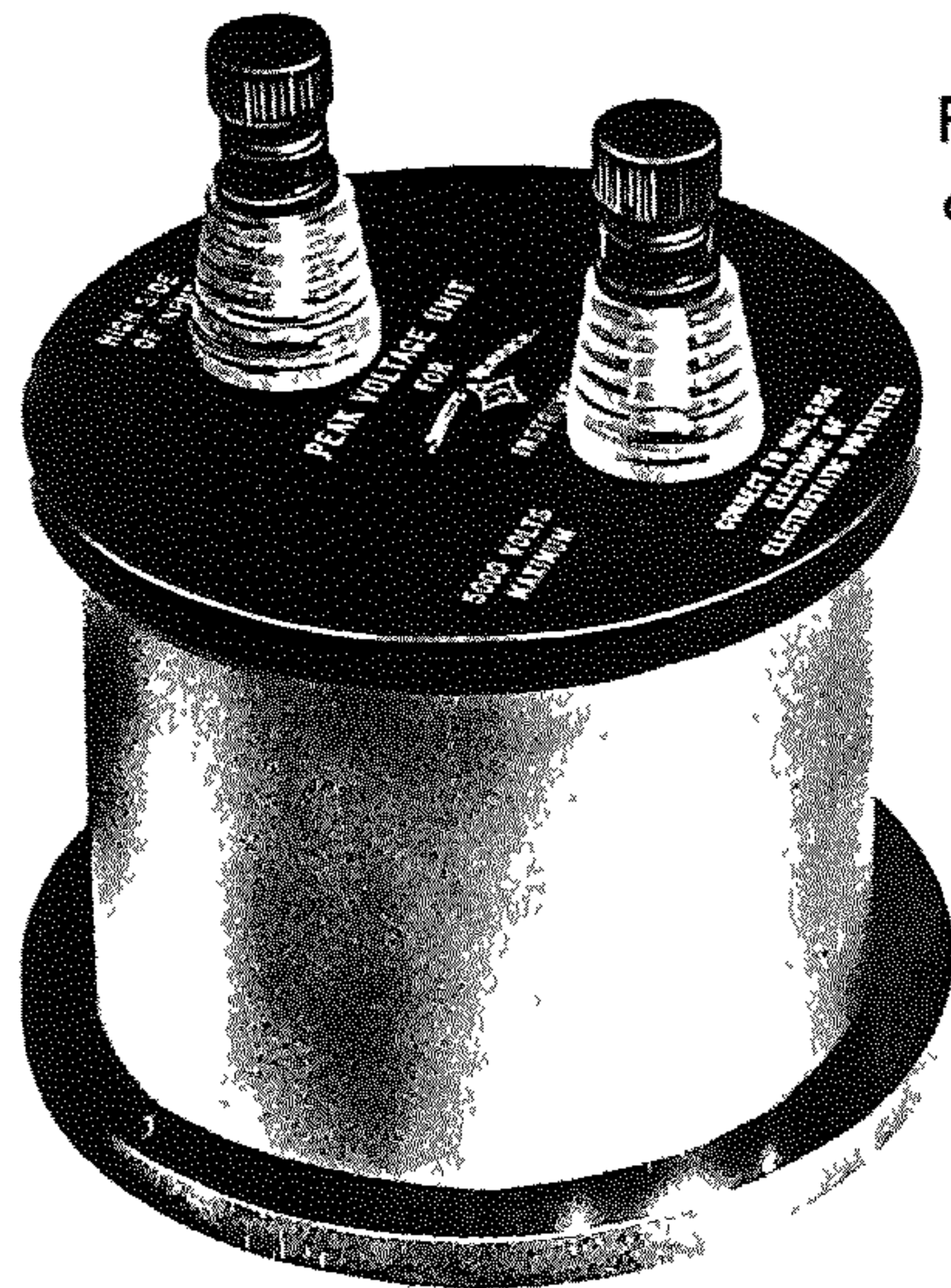
#### ELECTRICAL CHARACTERISTICS

Maximum Inverse Peak Voltage.....30,000 Volts  
 Charging Time Constant.....10 microseconds  
 Discharging Time Constant.....5 seconds  
 Frequency Range .....60 cps to 1 mc

MECHANICAL DIMENSIONS 6" Dia. 8" High Weight 5 pounds

#### Code

HIGH Voltage Positive Peak Unit .....HIPEAK  
 HIGH Voltage Negative Peak Unit .....NEGHI



For use on "POSITIVE"  
 or "NEGATIVE" Peaks

Mounted in  
 Shielded Containers  
 with Insulated Covers  
 and ground binding post

## ELECTROSTATIC VOLTMETERS

### MAXIMUM FREQUENCY AND CAPACITANCE VALUES

#### MODEL ESD and UNIVERSITY (Single Range)

Insulation greater than  $1 \times 10^{15}$  ohms (ESD)

Voltage Range	Full Scale Capacitance	Maximum Frequency
120	220 MMF	1.5 MHZ
150	220 MMF	1.2 MHZ
200	220 MMF	.75 MHZ
300	220 MMF	.5 MHZ
500	115 MMF	.60 MHZ
1000	59 MMF	.55 MHZ
1500	25 MMF	.7 MHZ
2000	25 MMF	.5 MHZ
3000	18 MMF	.5 MHZ
4000	18 MMF	.3 MHZ
5000	18 MMF	.3 MHZ
6000	18 MMF	.25 MHZ

#### MODEL ESH (Single and Multi Range)

Insulation greater than  $3.6 \times 10^{14}$  ohms

Voltage Range	Full Scale Capacitance	Maximum Frequency
5 KV	8-10 MMF	600 KHZ
10 KV	8-10 MMF	300 KHZ
20 KV	8-10 MMF	180 KHZ
30 KV	8-10 MMF	140 KHZ
40 KV	8-10 MMF	100 KHZ
50 KV	8-10 MMF	90 KHZ
60 KV	8-10 MMF	85 KHZ
75 KV	8-10 MMF	70 KHZ
100 KV	8-10 MMF	50 KHZ



**Sensitive Research\***

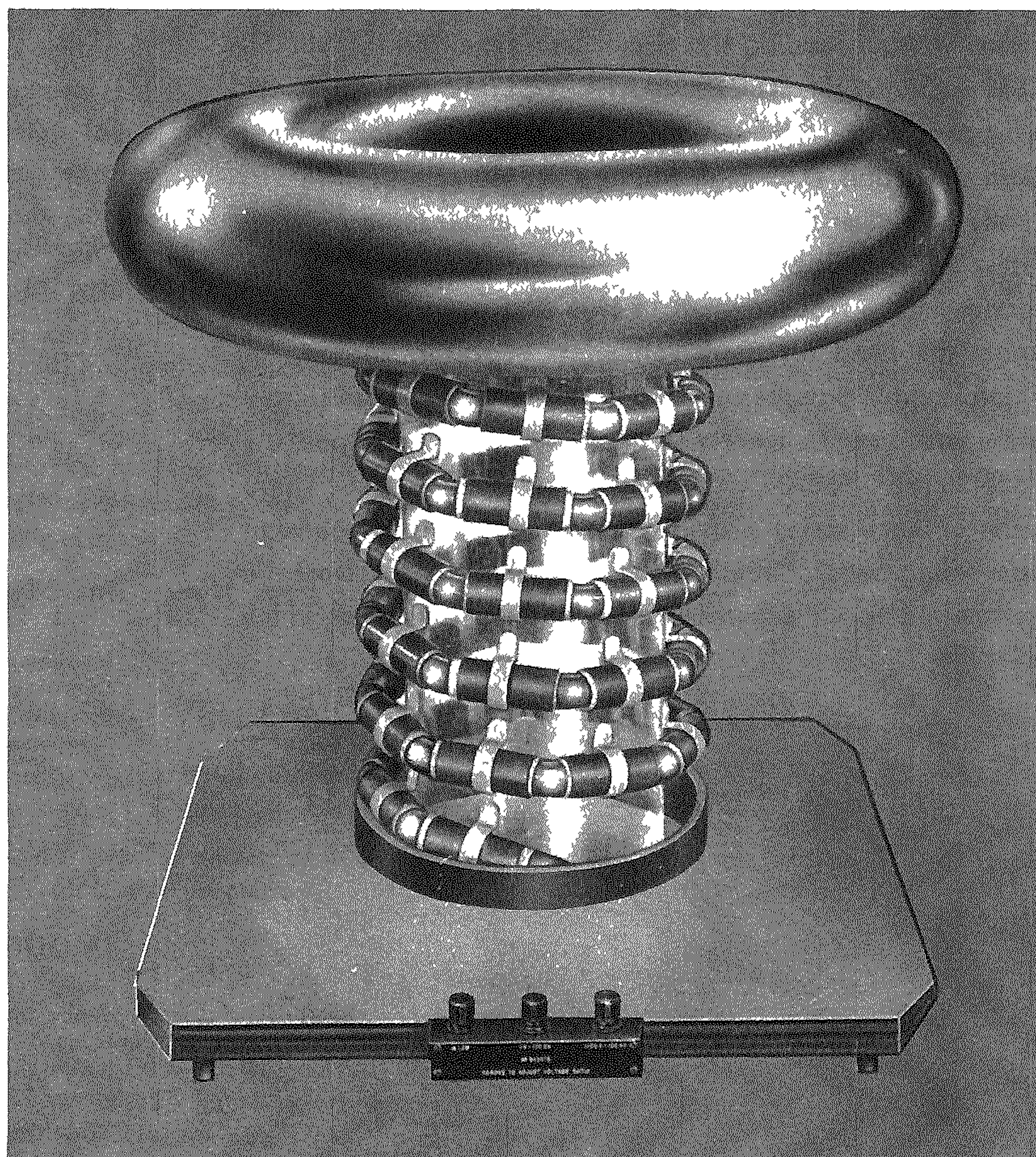
# **.05% ACCURATE HIGH VOLTAGE DIVIDER**

## **Model Park**

### **SPECIFICATIONS**

<b>RANGE:</b>	100 kv (max.)
<b>DC RATIO ACCURACY:</b>	100 kv to 1 v $\pm$ .05% 100 kv to 1 kv $\pm$ .5%
<b>AC RATIO ACCURACY:</b>	50 kv (max.) to 500 v $\pm$ .5%
<b>DUTY CYCLE:</b>	50 kv (max.), continu- ous; 100 kv (max.), 15 min./hour
<b>TOTAL RESISTANCE:</b>	100 megohms (nominal)
<b>SIZE:</b>	22 $\frac{1}{4}$ " h x 22" diameter
<b>APPROX. WEIGHT:</b>	50 lbs. net; 115 lbs. shipping
<b>SPECIFY:</b>	Model PARK

**Note:** Ratio accuracy of  $\pm$  .05% at 100,000 to 1 is conservatively set pending additional stability testing with time. Current data indicates stability better than  $\pm$  .02% and initial adjustment within  $\pm$  .01% of the National Standard.



**A NEW VOLTAGE DIVIDER** constructed to a design by J. H. Park. (Ref.: "Journal of Research" of National Bureau of Standards, Engineering and Instrumentation Vol. 66C, No. 1, Jan.-Mar., 1962. Reprints available upon request.) Each 100 kv unit consists of 100 individually shielded one-megohm resistors, matched to each other to achieve an approximate temperature coefficient of less than 1 ppm/ $^{\circ}$ C, and connected in series to form a vertical helix between a ground plate and a high voltage electrode. Uniquely shielded, testing indicates that corona, heating and leakage errors are less than 10 ppm at 50 kv and 50 ppm at 100

kv. The divider's special "hat" or high voltage electrode is designed to give uniform gradients from it to ground, and allows stacking of additional 100 kv units for higher voltage measurements. Each unit is only 22 $\frac{1}{4}$ " high!

**The Park Divider**, while mainly designed for DC, can also be used for AC (60 cps only) measurements to 1% overall accuracy or better. AC accuracy is based on the use of an SRI 0.5% Model ESD electrostatic voltmeter. Specifications can be supplied on high accuracy, precision DC potentiometers for readout of 1 v or less.

**Sensitive Research** INSTRUMENTS





# *Sensitive Research*<sup>\*</sup>

## AC/DC ELECTROSTATIC VOLTMETERS

PRICE LIST - JANUARY 1, 1981

MODEL ESH

SINGLE RANGE (AC-DC)

<u>MODEL</u>	<u>RANGE</u>	<u>CODE WORD</u>	<u>PRICE</u>
ESH-1*	7.5 KV	ESHOLM	\$ 675
ESH-2*	10	ESHILT	675
ESH-3*	15	ESHAIM	675
ESH-4*	20	ESHUNS	675
ESH-5*	25	ESHULK	675
ESH-6*	30	ESHORE	695
ESH-7*	40	ESH POT	880
ESH-8*	50	ESHIGH	895
ESH-9	60	ESHPEC	1685
ESH-10	75	ESH HIY	2050
ESH-11	100	ESH OOP	2430
ESH-12□	140	ESH CXL	2525
ESH-12M□	150	ESH IBM	2670

□-FOR USE ON DC ONLY

OPTIONS AND ACCESSORIES

\* MODEL ESH - 0.5% ACCURACY - ADD X TO MODEL AND \$25.00 PER RANGE TO PRICE.

MODEL ESH - TRANSIT LOCK ADD T TO MODEL AND \$80.00 TO PRICE.

MODEL ESH - MOUNTING BRACKETS ADD D TO MODEL AND \$40.00 TO PRICE.

MODEL ESH - CARRYING HANDLES - ADD C TO MODEL AND \$20.00 TO PRICE.

MODEL HVP - HIGH VOLTAGE PROBE - \$70

VOLTAGE DIVIDER

MODEL PARK                      100 KV                      \$3380

MODEL ESH

MULTIRANGE (AC-DC)

<u>MODEL</u>	<u>RANGE</u>	<u>CODE WORD</u>	<u>PRICE</u>
ESH-13*	5/10 KV	ESHAKE	\$ 765
ESH-14*	5/15	ESHEEP	765
ESH-15*	10/15	ESHICK	765
ESH-16*	10/20	ESHOTS	765
ESH-17*	10/30	ESHAMP	810
ESH-18*	15/30	ESHULE	810
ESH-19*	5/7.5/10	ESHUL	845
ESH-20*	5/10/15	ESHMIP	845
ESH-21*	5/15/30	ESHMOT	855
ESH-22*	10/20/30	ESHMUS	855
ESH-23*	10/25/50	ESHMIX	1025
ESH-24*	5/7.5/15/30	ESHUTE	900
ESH-25*	5/10/15/20	ESHMOO	900
ESH-26*	5/10/20/30	ESHMEE	900
ESH-27*	10/20/30/40	ESHMAY	1000
ESH-28*	5/10/25/50	ESHMAX	1075
ESH-29*	3/7.5/15/30	ESH DCH	900
ESH-30*	3/10/30	ESHMIL	855
ESH-31*	3/7.5/15	ESHALL	855
ESH-32*	20/40	ESHALE	920
ESH-33*	25/50	ESHAME	990
ESH-34*	7.5/15/30/50	ESHMET	1075
ESH-35*	10/20/30/50	ESHFDA	1075

NON-CATALOG INSTRUMENTS

ANY COMBINATION OF UP TO 4 RANGES CAN BE SUPPLIED PROVIDING:

- (A) RANGES ARE BETWEEN 3 AND 50 KV
- (B) RANGES ARE SPACED AT LEAST 5 KV APART.
- (C) RATIO BETWEEN HIGHEST AND LOWEST RANGE IS NOT GREATER THAN 10:1.

COST WILL BE THE SAME PRICE AS AN INSTRUMENT HAVING THE SAME NUMBER OF RANGES AND THE SAME HIGHEST FULL SCALE RANGE. IF THE SAME HIGHEST RANGE IS NOT LISTED, USE PRICE FOR THE NEXT HIGHER RANGE.



\* A TRADEMARK OF EIS

**ELECTRICAL INSTRUMENT SERVICE, INC.**

25 DOCK STREET, MOUNT VERNON, N.Y. 10550 (914) 699-9717

**Sensitive  
Research**



# AC/DC ELECTROSTATIC VOLTMETERS

For supplementary information see CATALOG SECTION 6

## MODEL ESD ELECTROSTATIC VOLTMETER SINGLE RANGE (AC-DC)

FULL SCALE VOLTS	MODEL	CODE	PRICE
†120	ESD-1	ELECNA	\$ 790
†150	ESD-2	ELECMI	750
200	ESD-3	ELECPU	700
300	ESD-4	ELECBA	700
500	ESD-5	ELECFO	700
1000	ESD-6	ELECJY	635
1500	ESD-7	ELECTA	635
2000	ESD-8	ELECCI	635
3000	ESD-9	ELECKO	635
5000	ESD-10	ELECLI	665
6000	ESD-11	ELECHU	665

### SURCHARGES ADD "X" TO MODEL PRICE

All single range Model ESD Voltmeters 500 volts and above can be calibrated to an accuracy of .5%

Lowest reading is 1/5 of full scale  
† Accuracy 1 1/2%

## MODEL UNIVERSITY ELECTROSTATIC VOLTMETER SINGLE RANGE (AC-DC)

FULL SCALE VOLTS	CODE	PRICE
† 150	UELORO	635
300	UELENI	600
500	UELPRT	525
1000	UELFERT	495
1500	UELAMP	495
2000	UELELI	495
3000	UELEJO	495
5000	UELEMI	500

### NOTES

Lowest reading is 1/5 of full scale  
† Accuracy 1 1/2%

## MODEL CRV — CREST VOLTMETER

Used with CRV-M Multipliers for Positive or Negative Peak and RMS Voltages.

Rep. Rate: 20 per second or faster

Min. Peak Width:  $2 \times 10^{-6}$  Sec

Min. Duty Cycle: 1 to 2000 (Width of peak to space between peaks)

RANGE	CODE	PRICE
1 KV	CREST	900

## LOW VOLTAGE PEAK UNIT

Maximum Inverse Peak Voltage.....	3000 Volts
Charging Time Constant.....	5 microseconds
Discharging Time Constant.....	5 seconds
Frequency Range.....	60 Hz to 1 MHz
CODE PRICE	
LOW Voltage Positive Peak Unit.....	LOPEEK 370
LOW Voltage Negative Peak Unit.....	NEGLO 400
Used with Model ESD of suitable range for measurement of Peak Voltages	

## MODEL ESD

### \* MULTIRANGE ELECTROSTATIC VOLTMETER (AC only) (Condenser Multiplier Type)

\* Multirange instruments are designed for AC/DC measurements on first range, AC only on higher ranges.

FULL SCALE VOLTS	CODE	PRICE
†120/240	ELEDA	\$ 870
†150/300	ELIFOR	835
†150/750	ELOHIT	785
250/500	ELUJAK	785
300/1500	ELAKIS	745
500/2000	ELEFTI	715
1000/5000	ELILIK	715
†125/500/750	ELUNIK	930
200/500/1000	ELAPIS	900
300/750/1500	ELERTI	860
500/1500/3000	ELISPO	810
750/1500/5000	ELOTKA	810
1000/3000/6000	ELUVIN	830

### NOTES

Lowest reading is 1/5 of full scale  
† Accuracy 1 1/2%

## PANEL MOUNTED INSTRUMENTS MODEL ESDEW-5A or ESDEW-7A

Edgewise Panel Instruments PRICE—\$35 00 additional to Portable Model ESD Price. To order specify Model ESDEW-5A or Model ESDEW-7A as required and add the Code for the Portable design

## MODEL UNIVERSITY \* DOUBLE RANGE (AC only) ELECTROSTATIC VOLTMETER (Condenser Multiplier Type)

\* Multirange instruments are designed for AC/DC measurements on first range, AC only on higher ranges.

FULL SCALE VOLTS	CODE	PRICE
300/1000	UELOAK	635
300/1500	UELOJO	635
500/1500	UELOBI	600
500/2000	UELOKS	600
750/3000	UELOFI	600
1000/5000	UELOLK	600
2500/5000	UELOJY	600

## MULTIPLIERS MODEL CRV-M

RANGE	CODE	PRICE
100 KV	CRABE	995
75 KV	CRECT	725
50 KV	CROFA	610
40 KV	CRFAO	580
30 KV	CRUGI	525
20 KV	CRYJU	500
10 KV	CRAAK	435
5 KV	CREEL	425

## MODEL VPA

### HIGH VOLTAGE PEAK UNIT

Maximum Inverse Peak Voltage.....	30 000 Volts
Charging Time Constant.....	10 microseconds
Discharging Time Constant.....	5 seconds
Frequency Range.....	60 Hz to 1 MHz
CODE PRICE	
HIGH Voltage Positive Peak Unit.....	HIPEAK 420
HIGH Voltage Negative Peak Unit.....	NEGHI 495
Used with Model ESH of suitable range for measurement of Peak Voltages	



# Sensitive Research\*

## MODEL DCHI HIGH RESISTANCE KILOVOLTMETERS

### SPECIFICATIONS

DC PORTABLE—HORIZONTAL USE

ACCURACY	.5% and 1% of full scale according to ranges. (See below)
TYPE	Permanent magnet, double pivoted moving coil
SCALE	Hand-drawn; 4"; anti-parallax mirror
POINTER	Knife edge
PERIOD	2 seconds
DAMPING	Induced emf
PIVOTS	Diamond pivoted
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
RANGE CHANGING	Plug-in connections
MAGNETIC SHUNT	Internal; 3% max. adjustment
MECHANICAL ZERO	External zero shifter
CASE	Formica; 13 <sup>3</sup> / <sub>4</sub> " x 7 <sup>1</sup> / <sub>2</sub> " x 8" h.; black bakelite panel; hinged cover; carrying handle
APPROX. WEIGHT	13 lbs. net; 23 lbs. shipping

### MODEL DCHI



All instruments are provided with data cards listing temperature corrections and maximum overload ratings.

The Model DCHI conforms to the following specifications: ASA C-39.1; and on request MIL-M-16034B.

### GENERAL DESCRIPTION

The Model DCHI is a multirange DC kilovoltmeter that provides a safe and accurate means of making high voltage measurements up to 30 kv. The indicator is a University Model .5% accurate microammeter with a basic sensitivity of either 13.3 or 20 microamperes full scale. It is self-contained in a moulded bakelite case and internally bracketed to the instrument panel.

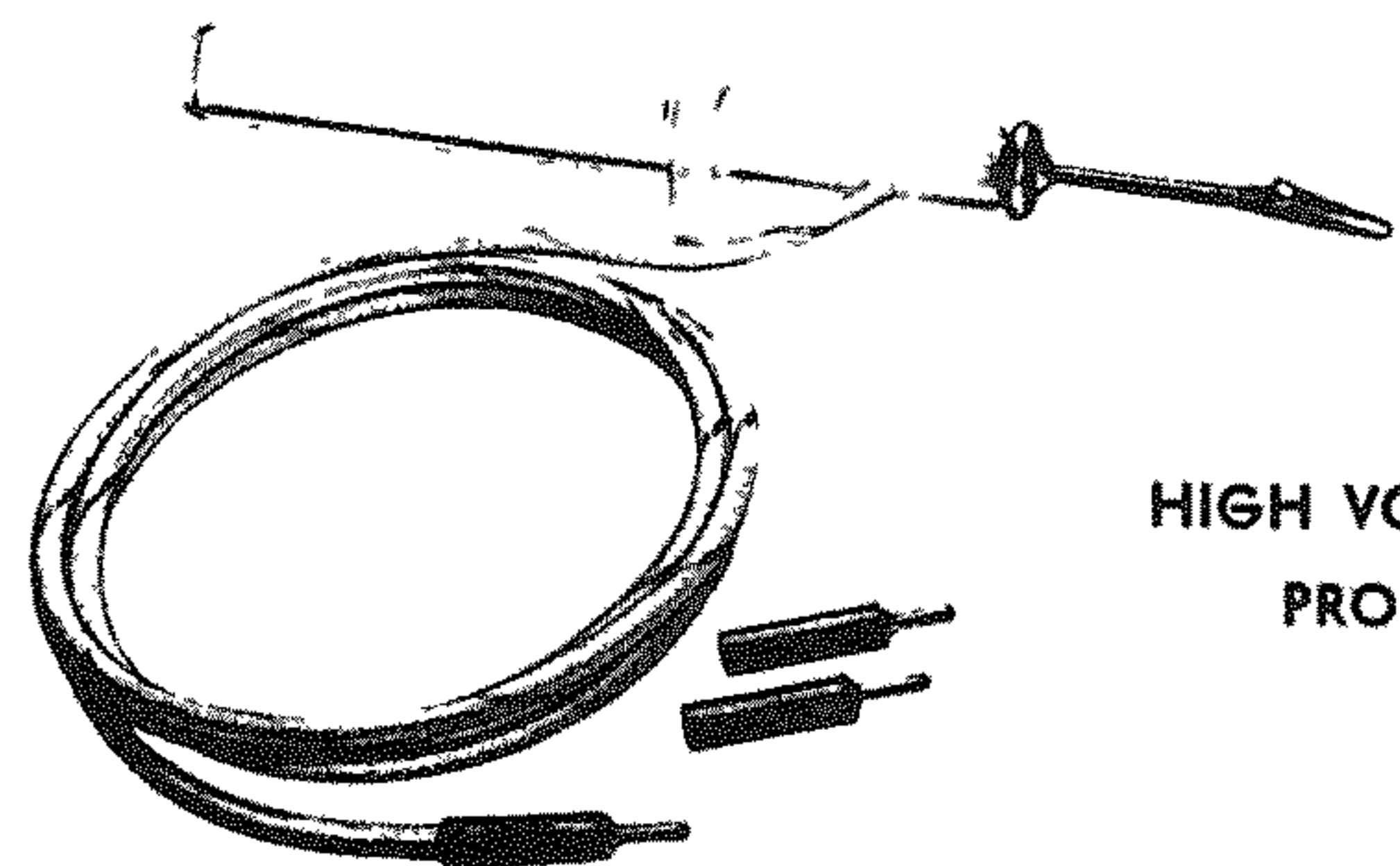
The indicator is connected to the low side, and is in series with a high voltage multiplier which is encapsulated to keep corona to a minimum. A polarity reversing switch is located on the panel. The range connection sockets are made of polyethylene to increase the effective leakage resistance path between the high and low sides. Two extra plugs are supplied for the making up of test leads.

Because of space limitations in the instrument case, continuous operation at voltages of 25 kv or higher is not recommended. At such levels a maximum duty cycle of not more than 15 minutes in an hour is advisable.

Additional kilovolts are available. Electrostatic voltmeters with an insulation resistance of  $1 \times 10^{15} \Omega$  can be supplied for AC/DC measurements up to 100 kv.

### OPTIONAL ACCESSORIES

Operator safety is an important consideration when making high voltage measurements and therefore an insulated probe is available and recommended for use with the Model DCHI. The probe (pictured right) has a polystyrene handle with a special hand guard, and an anti-corona ring at its tip. Its flexible test lead is a shielded high voltage cable. A convenient clip attachment is provided for those instances when such a circuit connection is desirable. Specify "High Voltage Probe."



HIGH VOLTAGE PROBE

### KILOVOLTMETERS

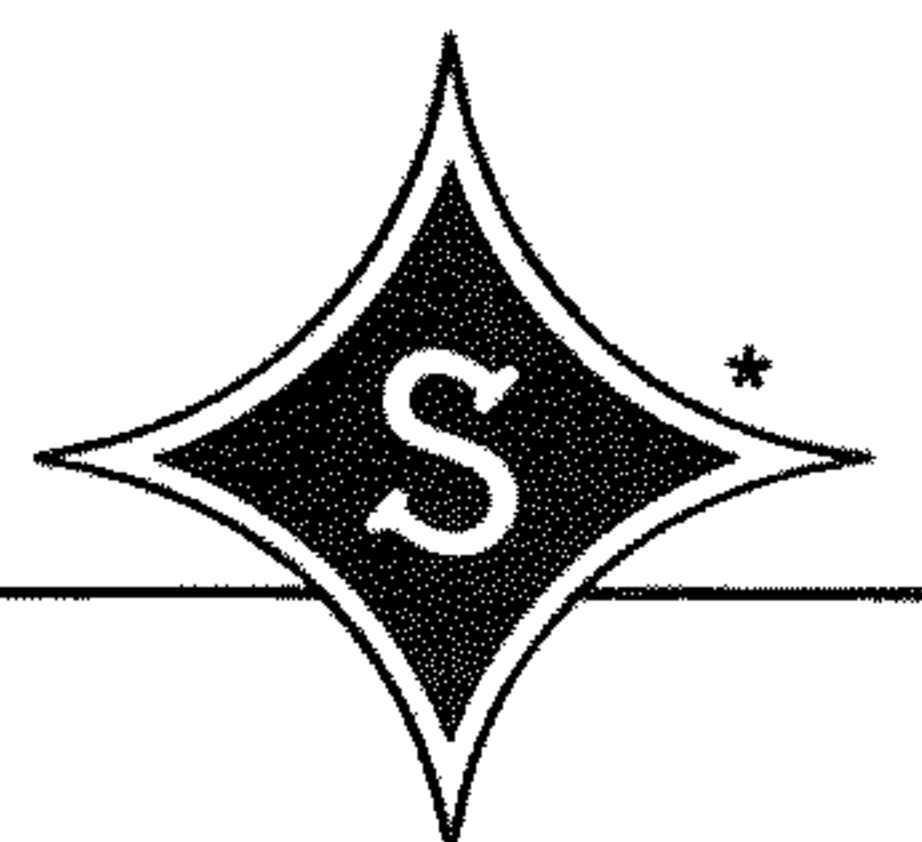
RANGE	ACCURACY	SENSITIVITY	SCALE DIV.	CODE
1.5/3/7.5/15	1%	50,000 $\Omega/V$	75/60	VOLTHO
1.5/3/7.5/15	.5%	50,000 $\Omega/V$	75/60	VOLTHOX
3/7.5/15/30	1%	50,000 $\Omega/V$	60/75	VOLTHI
3/7.5/15/30	.5%	50,000 $\Omega/V$	60/75	VOLTHIX
2/5/10/20	.5%	75,000 $\Omega/V$	100	VOLTHUX

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# ***Sensitive Research***\*

## **MODEL DCHI HIGH RESISTANCE KILOVOLTMETERS**

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PRICE LIST - JANUARY 1, 1981

### KILOVOLTMETERS

<u>RANGE</u>	<u>ACCURACY</u>	<u>SENSITIVITY</u>	<u>SCALE DIV.</u>	<u>CODE</u>	<u>PRICE</u>
1.5/3/7.5/15	1%	50,000 $\Omega/V$	75/60	VOLTHO	\$575
1.5/3/7.5/15	.5%	50,000 $\Omega/V$	75/60	VOLTHOX	620
3/7.5/15/30	1%	50,000 $\Omega/V$	60/75	VOLTHI	590
3/7.5/15/30	.5%	50,000 $\Omega/V$	60/75	VOLTHIX	645
2/5/10/20	.5%	75,000 $\Omega/V$	100	VOLTHUX	670

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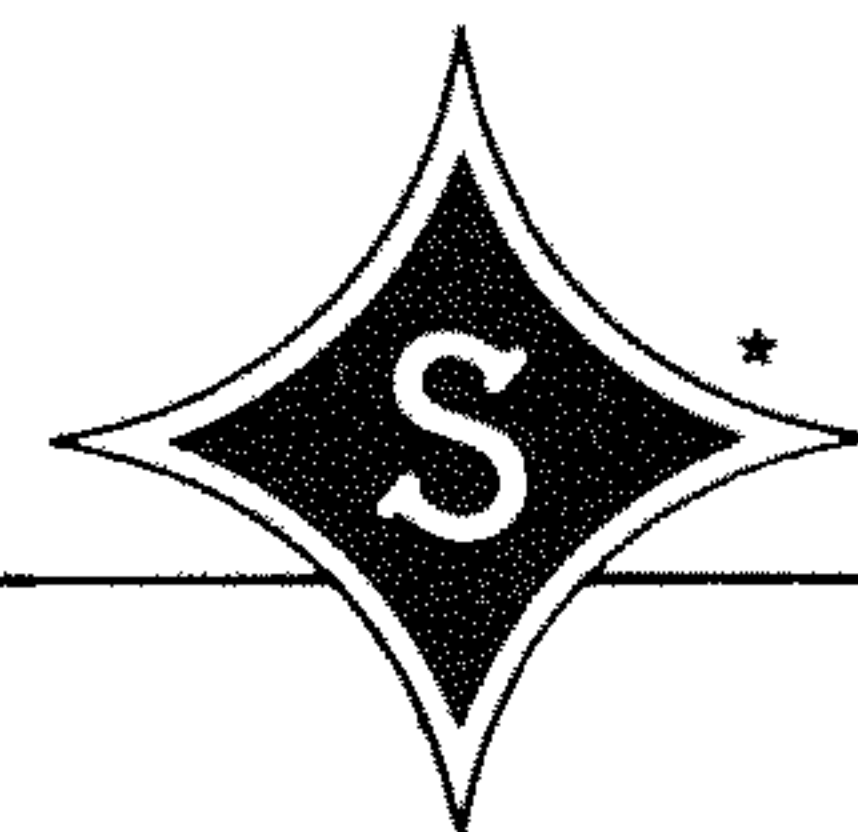
### OPTIONAL ACCESSORY

<u>DESCRIPTION</u>	<u>MODEL</u>	<u>PRICE</u>
HIGH VOLTAGE PROBE	HVP-1	\$72

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# Sensitive Research\*

## AC/DC AUDIO AND RADIO FREQUENCY THERMOCOUPLE INSTRUMENTS



### PORTABLE and PANEL

- VOLTMETERS
- MILLIAMMETERS
- AMMETERS

MODEL	DESCRIPTION	MAXIMUM FREQUENCY	PAGE
	"About Thermocouple Instruments" .....		402
University	.75% Compact Milliammeters and Voltmeters. 4" scale length .....	7.5 kc .....	403
A	.5% and .75% Milliammeters and Voltmeters. 6.3" scale length .....	15 kc .....	404-405
AU	.5% and .75% Milliammeters and Voltmeters. 6.3" scale length .....	35 kc .....	406
RF	.5% and .75% Milliammeters and Voltmeters, 1% Ammeters, 6.3" scale length .....	20 mc.....	407-410
	Radio Frequency Measurements Using a DC Millivoltmeter and External Thermocouples.....	10 mc.....	410-411
T	Mounted Insulated Vacuum Thermocouples. (Also see Section 10) .....	10 mc.....	411
TX	Heavy Current Air Thermocouples .....	20 mc.....	411
TM	Multirange Vacuum Thermocouple Unit .....	100 kc .....	411
	Mounting Dimensions for Edgewise Panel Cases .....		412

Refer to model descriptions for availability of portable instruments in edgewise cases (Types EW-5A and EW-7A) for panel mounting.

Prices and specifications subject to change without notice.



\* A TRADEMARK OF EIS

**ELECTRICAL INSTRUMENT SERVICE, INC.**

25 Dock Street, Mount Vernon, N.Y. 10550 914-699-9717





# ABOUT THERMOCOUPLE INSTRUMENTS

## GENERAL CHARACTERISTICS

Electrical indicating instruments that employ a thermoelement as a converter offer the user significant advantages in frequency response and sensitivity over other AC types with true rms response. They can be used with equal facility and accuracy on DC and AC from 7 cps to 20 mc, and in instances where UHF thermal converters are employed, this frequency range can be extended to over 100 mc. Thermocouple instruments have long served as a standard in the indication of frequency influence. They have true rms response regardless of waveform. Relatively high sensitivity makes it convenient to offer multirange instruments starting with full scale values as low as 200 mv and 1 ma and going on up to 1500 v and 100 amps. (Instruments can be supplied with external multipliers to extend voltage ranges.)

*Sensitive Research* thermoelements have excellent AC/DC transfer characteristics. They are selected for their low reversal effect. Consequently, guarantee of accuracy is the same for both AC and DC. Instruments that incorporate thermocouples can be calibrated directly on DC and only their AC/DC difference, or frequency influence, has to be checked by AC transfer methods.

---

## OVERLOAD PROTECTION

A manually operated "Push-to-Read" thermocouple overload protection system is normally self contained in most thermoelement type instruments where range and frequency performance permits. The instrument has a red "Safety" line drawn and labeled at the 20% point on its scale. When the push button is in an upright position, 80% of the input current is shunted around the heater of the thermoelement. If the instrument's indication is below the "Safety" line, it is being used on the correct full scale range; if above the line an overload is being applied and change to a higher range value is indicated. The button can be turned to lock in place in the "Read" position. This removes the safety shunt for normal operation while making measurements. The overload system is compensated so loading of the circuit being measured remains at the same level whether the button is depressed or not. The thermocouple is protected for overloads of 1000% during initial operation.

---

## THERMOCOUPLE REPLACEMENT

A Thermocouple Replacement Feature (TRF) Type 357, (see photo) is normally supplied and included in the price of all Model A and AU instruments. Its installation allows for the field replacement of overloaded or burned out thermocouples with the retention of full instrument accuracy. Type 357 replacement thermocouples are furnished with two calibrated fixed resistors which must be soldered into place by the user.

The Type 362 (Fig. 1, pg. 403) is a new optional thermocouple replacement feature presently only available for Model A instruments with a sensitivity of 100  $\Omega/v$  or a lowest range of 10 ma. Replacement can be made by "plug-in" instead of soldering. A variable sensitivity resistor is provided to enable the user to adjust full scale deflection of the instrument for maximum accuracy.

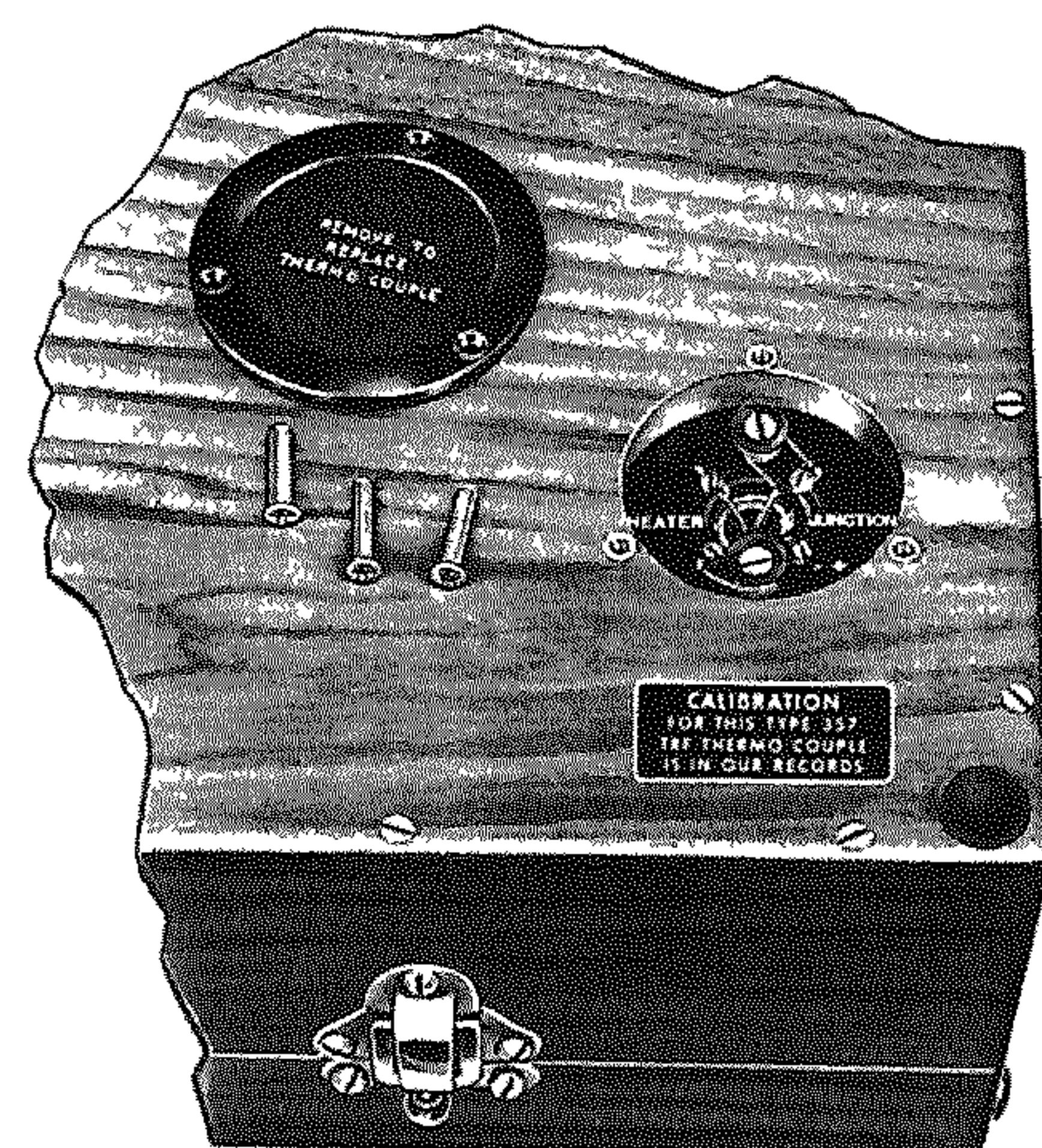
Replacement thermocouples are supplied with a correction chart (Fig. 2, pg. 403) for proper scale linearity. Most corrections are within the accuracy tolerance of the instrument in which they are to be replaced. If spare thermocouples are ordered at the time of purchasing an instrument, they can be matched for maximum replacement accuracy. Type 362 replacement thermocouples seldom require correction charts.

Replacement thermocouples can be ordered by specifying the Replacement Thermocouple type number, and when designed for use with existing instruments in the field, the instrument serial number. Replacement thermocouple types, either 357 or 362, are identified for users in the field by a black and silver metallic label mounted adjacent to the thermocouple feature. In older instruments the replacement feature may exist but be unidentified. Such an instrument should be returned for conversion to the present design. Delivery of spare thermocouples is from stock.



UNMOUNTED  
VACUUM THERMOCOUPLE

Vacuum Thermocouples of all types are listed separately in Section 10.



TYPE 357 THERMOCOUPLE REPLACEMENT FEATURE

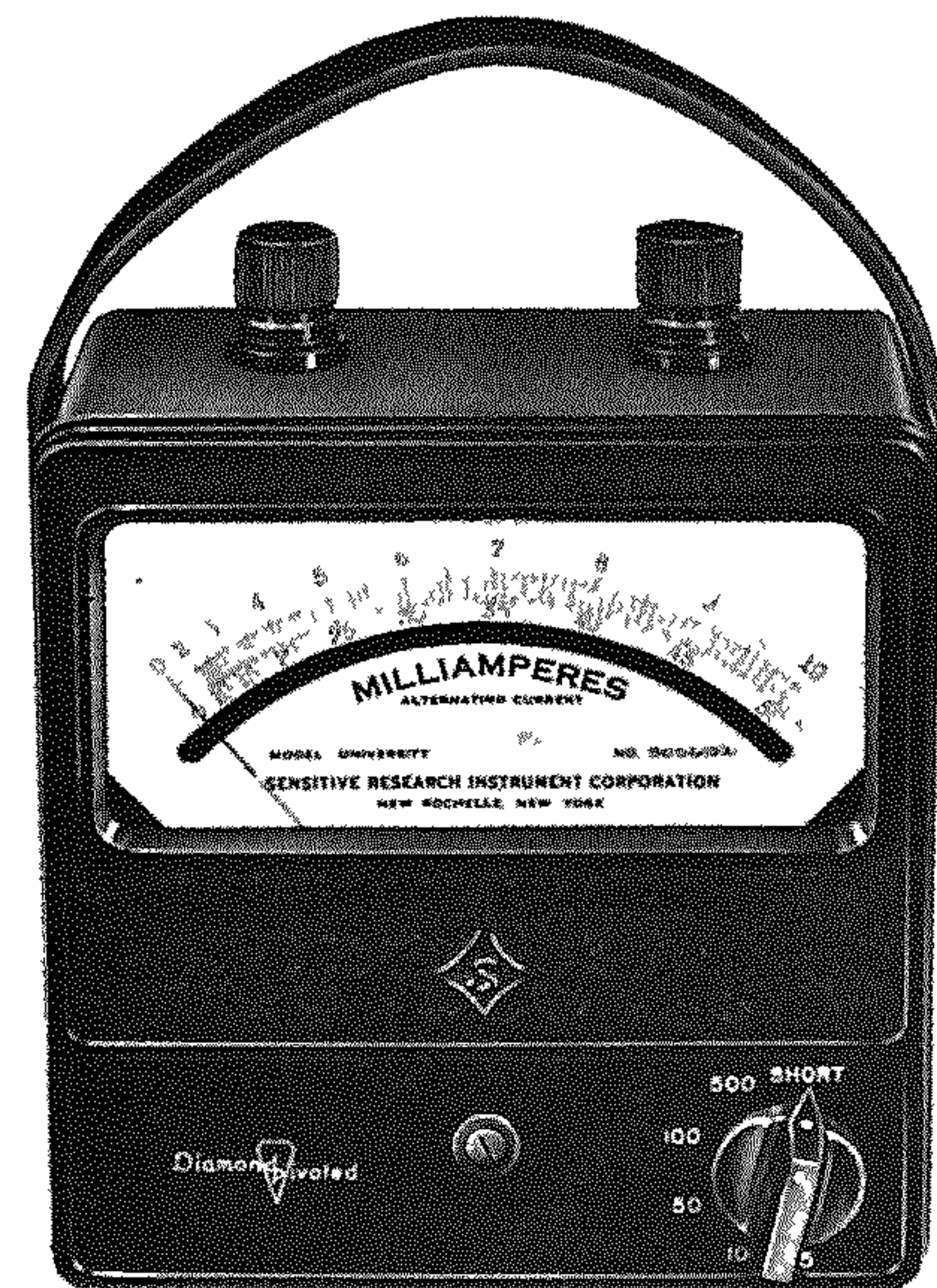


# COMPACT UNIVERSITY MODELS THERMOCOUPLE MILLIAMMETERS & VOLTMETERS

## SPECIFICATIONS

AC/DC PORTABLE—HORIZONTAL USE

ACCURACY	.75% of full scale
FREQUENCY	DC and 7 Hz to 7.5 kHz max. (single range milliammeters for use up to .5 MHz; Frequency specifications for individual instruments listed below.)
TYPE	Thermocouple; permanent magnet, double pivoted moving coil; true rms response
SCALE	Hand-drawn; 4"; anti-parallax mirror
POINTER	Knife edge
PERIOD	6 seconds
DAMPING	Induced emf
PIVOTS	Diamond pivoted
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
TEMPERATURE COEFFICIENT	Approximately .2%/C°
RANGE CHANGING	Switch controlled
MAGNETIC SHUNT	Internal; 3% max. adjustment
MECHANICAL ZERO	External zero shifter
CASE	Moulded black bakelite; 5 <sup>5</sup> / <sub>16</sub> " x 5 <sup>1</sup> / <sub>8</sub> " x 3 <sup>1</sup> / <sub>8</sub> " deep; carrying handle
APPROX. WEIGHT	4 lbs. net; 8 lbs. shipping



## MILLIAMMETERS

**Frequency:** a) Single range instruments; DC and 7 Hz to 500 kHz. at .75% accuracy.  
b) Multirange instruments; DC and 7 Hz to 7.5 kHz at .75% accuracy.

Single range instruments can be supplied from 2 ma to 500 ma full scale. Ranges and resistances same as for the Model RF listed on page 408. Order by specifying the University Model and the range required. Deduct \$85.00 from the price of the single range Model RF for the price of the University Model.

Range	Approx. Resist. Ω	Scale Div.	Code	Price
2/10/20/100/200	640/538/295/63/32	100	UTHEMO	\$
5/10/50/100/500	70/205/74/37/7.5	100	UTHENY	
10/20/100/200/1000	30/37.5/12/5.8/1.2	100	UTHEOS	
10/50/100/500/1000	30/21/12/2.4/1.2	100	UTHEPO	
20/100/200/500/1000	10/3.6/2/8/4	100	UTHEIK	

## VOLTMETERS

**Frequency:** a) Instruments with a sensitivity of 500 Ω/v; DC and 7 Hz to 4 kHz at .75% accuracy. In multirange instruments, ranges of 300 v or higher, rated accuracy to 2 kHz; 1.5% accuracy above 2 kHz to 4 kHz (single instruments 1% accuracy).  
b) Instruments with a sensitivity of 100 Ω/v; DC and 7 Hz to 6 kHz at .75% accuracy. In multirange instruments, ranges of 300 v or higher, rated accuracy to 4 kHz; 1.5% accuracy above 4 kHz to 6 kHz (single range instruments 1% accuracy).

Any single range instrument with a sensitivity of 100 Ω/v, from .2 v to 300 v full scale, price \$ ; over 300 v to 1000 v, price \$  
When sensitivity is 500 Ω/v, ranges from 1.5 to 300 v, price \$ ; over 300 v to 1000 v, price \$

When ordering, specify model, range and ohms per volt required.

Range	Scale Div.	Code	100 Ω/v Price	500 Ω/v Price
.2/1/5/10/20	100	UTHOCI	\$	—
3/15/30/75/150	60/75	UTHOXI		\$
7.5/15/30/75/150	75/60	UTHOPP		
15/30/75/150/300	75/60	UTHONS		
1.5/3/7.5/15/30/75/150	75/60	UTHODO		
7.5/15/30/75/150/300	75/60	UTHORA		

## OPTIONAL SPECIFICATIONS

Instruments with special scales and/or ranges available. Correspondence is required.

## GENERAL DESCRIPTION

The University Model of the thermocouple type is an economically priced, compact, AC/DC indicating instrument for measurements in the medium audio frequency range. (Single range milliammeters have a relatively flat frequency response up to .5 MHz) It utilizes standard vacuum thermocouples. All instruments are diamond pivoted with shock mounted sapphire jewels to give a virtually friction-free moving element. Ranges are switch controlled for operating convenience.

Space limitations do not permit the installation of automatic temperature compensation, a thermocouple overload protection system, or a thermocouple replacement feature. However, uncalibrated thermocouples can be supplied for replacement in the field if desired. (See Section 10.) The user in such cases should have a facility for either re-drawing the original instrument scale to the characteristics of the new thermocouple or calibrating the thermocouple against the original scale and using the instrument with correction curves. (A precision instrument scale drawing machine is described in Section 9.)

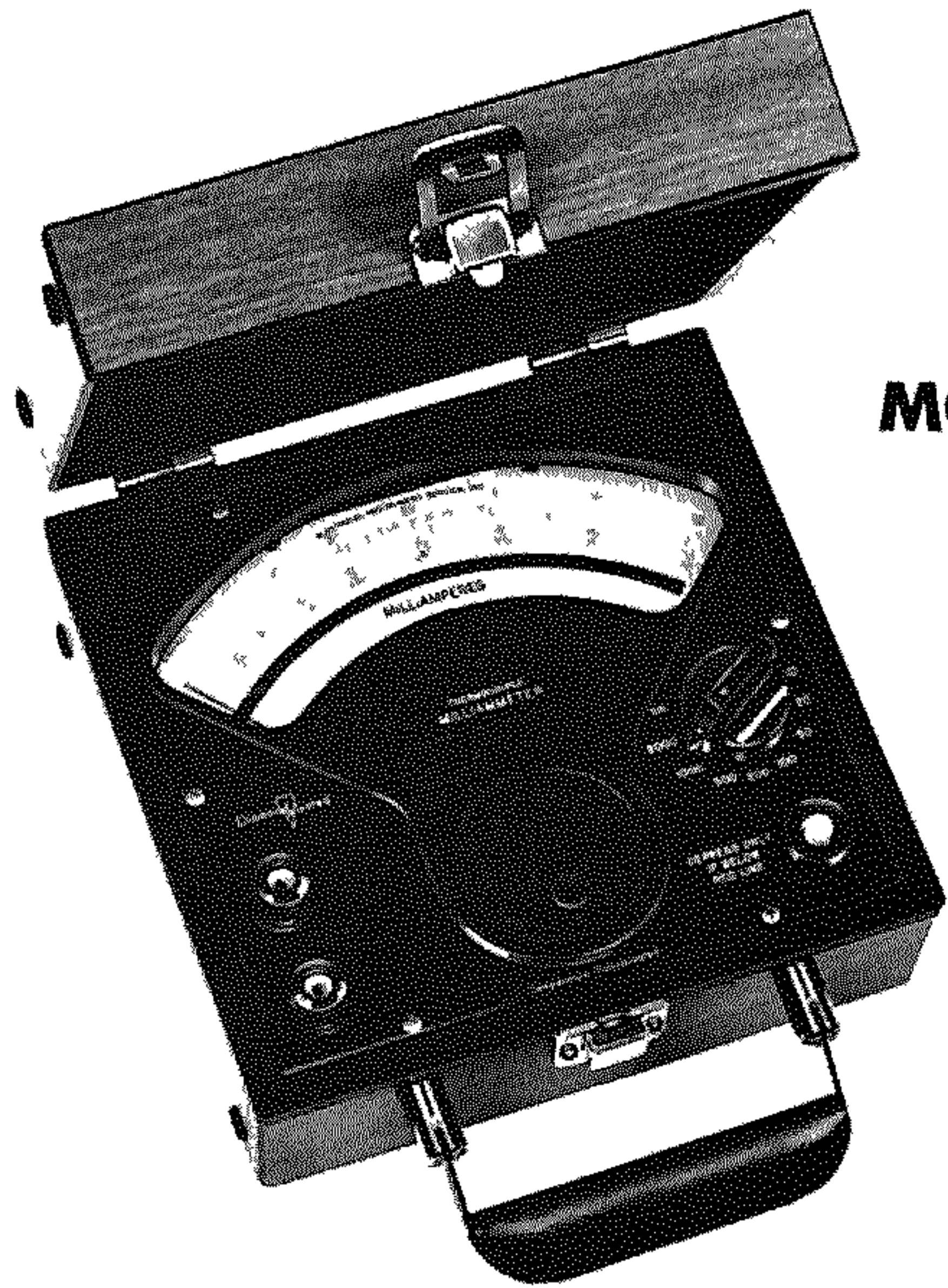
The University Model is also offered as a (1) AC/DC dynamometer instrument (see section 4), (2) AC/DC wattmeter (see section 5), (3) DC permanent magnet moving coil instrument (see section 3), and (4) AC/DC electrostatic voltmeter (see section 6).

## OPTIONAL ACCESSORIES

Voltage ranges can be extended by the addition of external multipliers. Frequency range must be specified. If multipliers are ordered with the instrument, both units can be calibrated together and overall accuracy is within the accuracy of the instrument. (Multipliers are described in Section 10.)



# MODEL A THERMOCOUPLE MILLIAMMETERS & VOLTMETERS



**MODEL  
A**

## SPECIFICATIONS

AC/DC PORTABLE—HORIZONTAL USE

ACCURACY	.5% of full scale; .75% for instruments with a basic sensitivity of 3 ma or 500 $\Omega/v$ , or higher
FREQUENCY	DC and 7 Hz to 15 kHz max. Frequency specifications for individual instruments listed with ranges.
TYPE	Thermocouple; permanent magnet, double pivoted moving coil; true rms response
SENSITIVITY	Voltmeters: 100 $\Omega/v$ or 500 $\Omega/v$ as specified. Approx. resistances of milliammeter ranges listed below.
SCALE	Hand-drawn; 6.3"; anti-parallax mirror
POINTER	Knife edge
PERIOD	6 seconds
DAMPING	Induced emf
PIVOTS	Diamond pivoted
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
TEMPERATURE COEFFICIENT	Automatic temperature compensation from 20°C to 30°C
THERMOCOUPLE REPLACEMENT FEATURE	Type 357 (Type 362 optional.)
RANGE CHANGING	Switch controlled
MAGNETIC SHUNT	Internal; 3% max. adjustment
MECHANICAL ZERO	External zero shifter
CASE	Formica; 7 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 4 $\frac{3}{16}$ " h.; black bakelite panel; hinged cover; carrying handle
APPROX. WEIGHT	7 lbs. net; 10 lbs. shipping

All instruments are provided with data cards listing temperature corrections and maximum overload ratings.

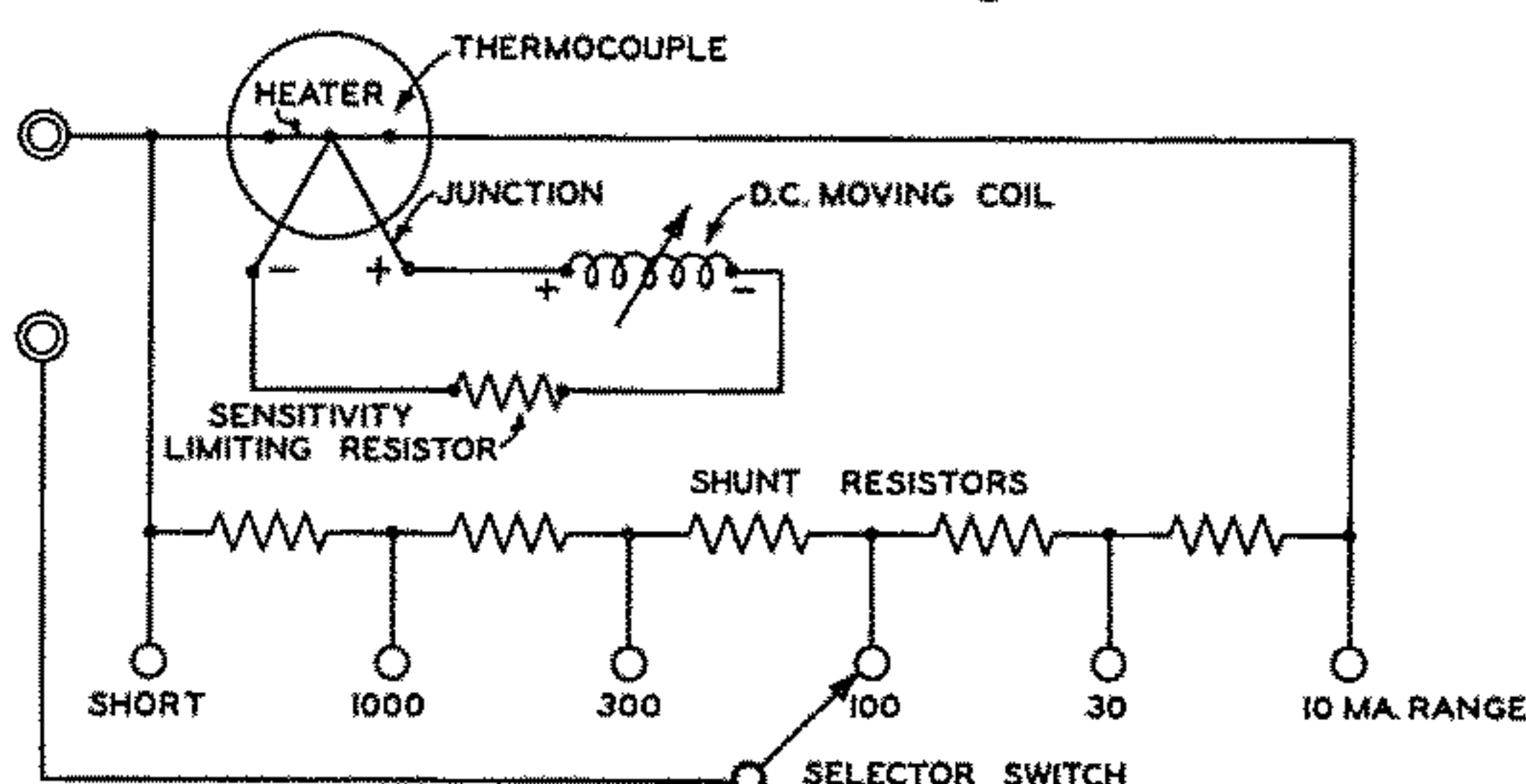


FIGURE 1. MULTIRANGE MILLIAMMETER CIRCUIT

## OPTIONAL SPECIFICATIONS

1. A "Plug-in" Thermocouple Replacement Feature (TRF), Type 362, can be furnished instead of the Type 357. (In the Type 357, thermocouples are soldered into place.) It can be supplied in all milliammeters with a lowest range of 7.5, 10, 15 or 20 ma, and all voltmeters with a sensitivity of 100  $\Omega/v$ . The Type 362 system includes a variable resistor to adjust the full scale output of the thermocouple for optimum scale linearity. Both types of replacement features are described more fully on pages 402-403.

If the Type 362 "Plug-in" Thermocouple Replacement Feature is desired, specify and add \$75.00 to the price of the portable or edgewise panel instrument selected.

2. Instruments with special scales and/or ranges are available. Multirange instruments are normally switch controlled to 3 amps and 1000 v (500 v maximum between switch positions). Voltmeters are normally offered with a highest sensitivity of 500  $\Omega/v$  but can be supplied in special instances with sensitivities of 750 or 1000  $\Omega/v$  depending on the lowest volt range, frequency response and accuracy required. Correspondence is necessary on all special instruments.

3. Instruments with a lowest range of 3 ma or less or a sensitivity of 500  $\Omega/v$  on special order can be supplied with a fundamental accuracy of .5%. Correspondence required.

## OPTIONAL ACCESSORIES

1. Spare thermocouples for installation in the field can be ordered with the Model A. If ordered after the instrument is in service, the type number of the feature and the serial number of the Model A must be specified. (Reference page 402.)

Replacement Thermocouple	Price
Type 357	
Type 362	

2. Voltage ranges can be extended by the addition of external multipliers. If multipliers are ordered with the Model A, they can be calibrated together, and overall accuracy is guaranteed within the accuracy of the instrument. When ordering multipliers to extend voltage ranges, specify frequency at which measurements are to be made. Shunts cannot be provided for the extension of current ranges because their addition creates variations in scale linearity. Higher current ranges can be obtained by using the Model TR, Type 1 Transformer in conjunction with any instrument range from 2 to 5 amps. Accessory measuring units such as multipliers and transformers are described in Section 10.

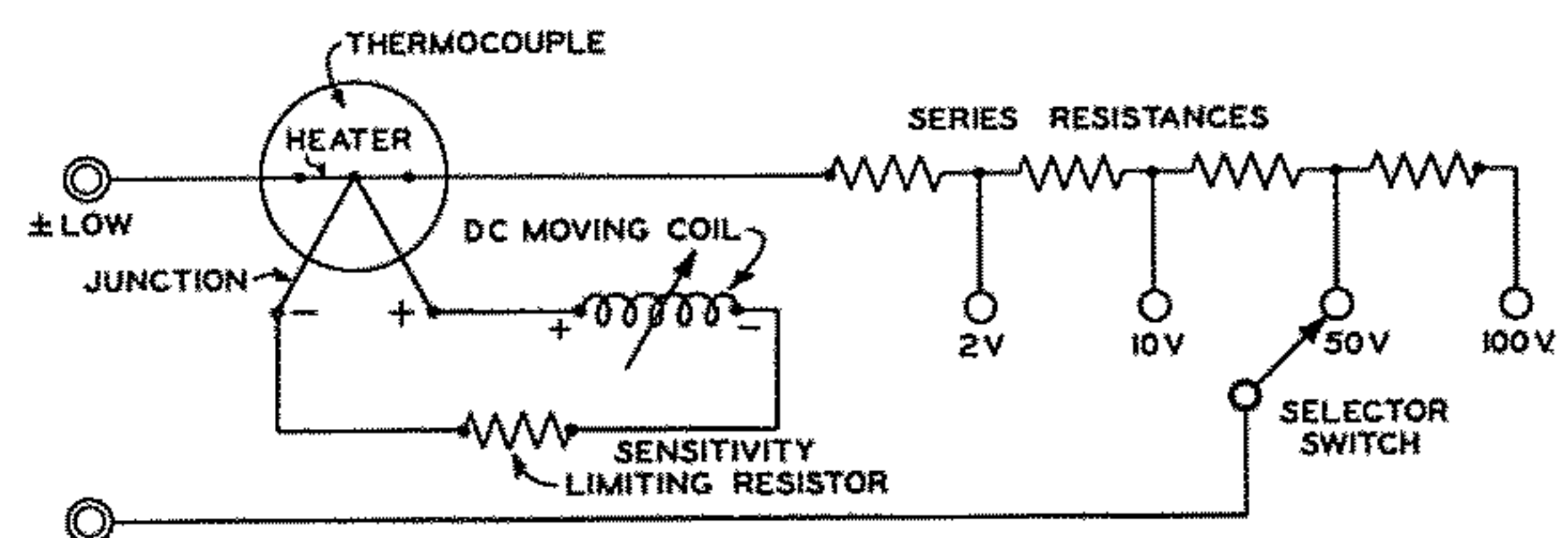


FIGURE 2. MULTIRANGE VOLTMETER CIRCUIT



# MODEL A THERMOCOUPLE MILLIAMMETERS & VOLTMETERS

## GENERAL DESCRIPTION

The Model A series consists of AC/DC multirange milliammeters and single range or multirange voltmeters. They are designed primarily for AC applications in the medium audio range. (Single range milliammeters have a relatively flat frequency response up to 1 MHz and are listed under the Model RF on page 408.) If desired, they can be used at reduced accuracy with repeatable results over a wider frequency span than listed. (See figures 1 and 2.)

A manually operated thermocouple overload protection system is incorporated in all milliammeters with a lowest range of 200 ma or less and in all voltmeters. The instrument has a red "Safety" line drawn and labeled at the 20% point on its scale. When the push button is in an upright position, 80% of the input current is shunted around the heater of the thermoelement. If the instrument's indication is below the "Safety" line, it is being used on the correct full scale range; if above the line an overload is being applied and change to a higher range value is indicated. The button can be turned to lock in place in the "Read" position. This removes the safety shunt for normal operation while making measurements. The overload system is compensated so loading of the circuit being measured remains at the same level whether the button is depressed or not. The thermocouple is protected for overloads of 1000% during initial operation.

Instruments without thermocouple protection can withstand overloads of 100%. On ranges of 500 v or more, the limitation is 500 v above rated voltage.

All instruments are diamond pivoted with shock mounted sapphire jewels to give a virtually friction-free moving element that will withstand abnormal handling. Portable cases made of tough, durable formica are gasketed to provide an effective dust and humidity barrier.

## PANEL MOUNTED INSTRUMENTS

The Model A is also available for vertical panel mounting in the shallow EW-7A (7" scale length) or EW-5A (5" scale length) edgewise panel case. Case dimensions are diagramed on page 403.

Performance characteristics are the same as listed for the portable type except as follows:

1. The possible introduction of stray capacitance from grounding the case necessitates reducing frequency limits in some instances. Ranges of 20 v and above have a frequency span of 50% of normal. Correspondence is recommended if the instrument is to be used at higher frequencies.
2. The Thermocouple Replacement Feature (TRF) is mounted on the rear of the case.
3. Multirange instruments can have a maximum of 8 ranges switch controlled (only 7 ranges if either a "Short" or "Open" position is desired); the remainder must be supplied on terminals.
4. Type EW-5A cased instruments are limited to a maximum of 100 scale divisions.
5. Manually operated overload protection is not available. Specify: Model AEW-5A or AEW-7A and code word of portable instrument having ranges desired.  
Price: Add \$ to price of code word selected.

## THERMO MILLIAMMETERS

Frequency: a) Instruments with lowest range of 3 ma and below; DC and 7 Hz to 7.5 kHz at .75% accuracy.

b) Instruments with lowest range of 5 ma or more; DC and 7 Hz to 15 kHz at .5% accuracy. (Ranges of 1 amp and higher limited to 4 kHz. Accuracy above 4 kHz to 10 kHz is .75%.)

Range	Approx. Resist. $\Omega$	Scale Div.	Code	Price
2/10/50/100/500	640/538/124/63/13	100	AMILKO	\$
5/10/50/100/500	242/148/34/17/3.5	100	AMILSA	
10/50/100/500/1000/2000	30/21/12/2.4/1.2/.6	100	AMILUR	
20/100/200/500/1000	10/3.6/2/.8/.4	100	AMILTI	
50/100/200/500/1000/2000	5/3.8/2.5/1/.5/.25	100	AMILKU	
2/5/10/20/50/100/200/500/1000	640/870/538/295/124/63/32/13/6.4	100	AMILWA	
3/7.5/15/30/75/150/300/750/1500	500/440/260/140/60/30/15/6/3	150	AMILTY	
5/10/20/50/100/200/500/1000	242/148/81/34/17/8.8/3.5/1.8	100	AMILBO	
10/20/50/100/200/500/1000/2000	30/38/21/12/5.8/2.4/1.2/.6	100	AMILAC	
15/30/75/150/300/750/1500	20/20/10/5.8/3/1.2/.6	150	AMILDA	

## VOLTMETERS

Frequency: a) Instruments with sensitivities of 100  $\Omega/v$ ; DC and 7 Hz to 7 kHz at .5% accuracy, except ranges of 300 v or higher limited to 5 kHz.

b) Instruments with sensitivities of 500  $\Omega/v$ ; DC and 7 Hz to 5 kHz at .75% accuracy, except ranges of 300 v or higher limited to 3 kHz.

Any single range instrument with a sensitivity of 100  $\Omega/v$ , from .2 v to 300 v full scale, price \$ ; over 300 v to 1000 v, price \$

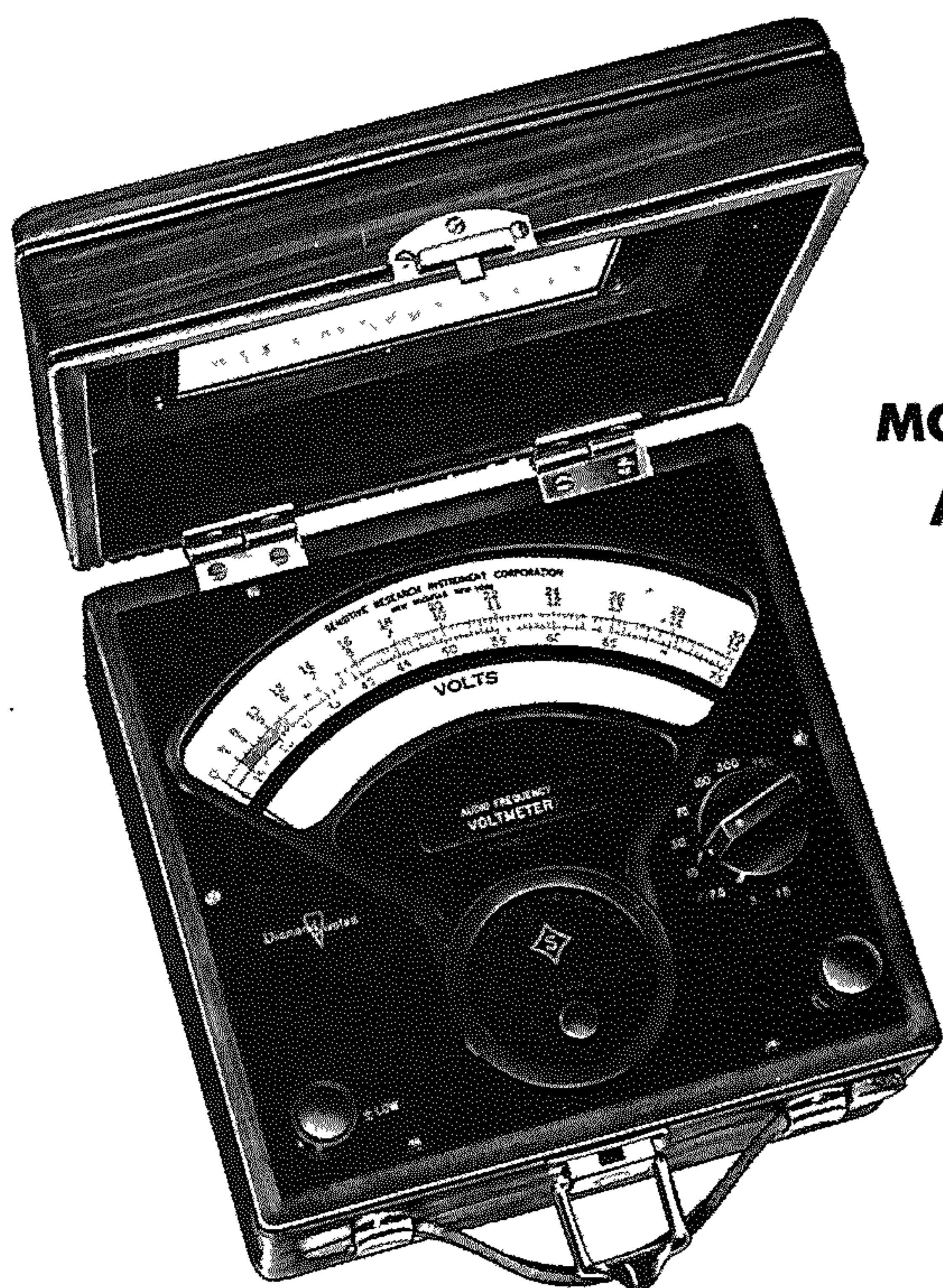
When sensitivity is 500  $\Omega/v$ , ranges from 1.5 v to 300 v, price \$ , over 300 v to 1000 v, price \$

Range	Code	Scale Div.	Price 100 $\Omega/v$	Price 500 $\Omega/v$
.2/1/5/20	AVALMA	100	\$	---
.5/2/10/50	AVOLNO	100		---
1.5/7.5/30/75	AVOLOP	150		\$
5/20/50/100	AVOLPY	100		
10/50/200/500	AVOLSY	100		
15/75/300/750	AVOLTO	150		
1.5/3/7.5/15/30/75/150	AVOLKA	150		
2/5/10/20/50/100/200	AVOLBI	100		
7.5/15/30/75/150/300/750/1500	AVOLCU	150		
.3/75/1.5/3/7.5/15/30/75/150/300	AVOLUM	150		---
1.5/3/7.5/15/30/75/150/300/750	AVOLVO	150		
2/5/10/20/50/100/200/500/1000	AVOLWY	100		

When ordering voltmeters, specify  $\Omega/v$  desired.



# MODEL AU-AUDIO FREQUENCY THERMOCOUPLE MILLIAMMETERS & VOLTMETERS



**MODEL  
AU**

## OPTIONAL ACCESSORIES

1. Spare thermocouples available for field replacement. **Specify:** Replacement Thermocouple Type 357. **Price:** \$ (See pages 402-403.)

2. Voltage ranges can be extended by the addition of external multipliers. If multipliers are ordered with the Model AU they can be calibrated together, and, depending on the frequency range required, overall accuracy is within the accuracy of the instrument. Correspondence necessary.

## GENERAL DESCRIPTION

The Model AU consists of AC/DC multirange milliammeters or voltmeters for measurements over the entire audio frequency range and up to 35 kHz. If desired they can be used at reduced accuracy, with repeatable results, over a wider frequency span than listed.

## PANEL MOUNTED INSTRUMENTS

Model AU milliammeters only are also available for vertical panel mounting in the shallow EW-7A (7" scale length) or EW-5A (5" scale length) edgewise panel case. Case dimensions are diagrammed on page 412.

Performance characteristics are the same as listed for the portable type except as follows:

1. The Thermocouple Replacement Feature (TRF) is mounted on the rear of case.

2. Multirange instruments can have a maximum of 8 ranges switch controlled (only 7 ranges if either a "Short" or "Open" position is desired); the remainder must be supplied on terminals.

3. Type EW-5A cased instruments are limited to a maximum of 100 scale divisions.

**Specify:** Model AUEW-5A or AUEW-7A and code word of portable instrument having ranges desired.

**Price:** Add \$ to price of code word selected.

**Note:** Panel mounted thermocouple voltmeters are offered only in the Model A (pages 404-405). They cannot be supplied in the Model AU because of the possible introduction of stray capacitance when grounding the edgewise panel case.

## SPECIFICATIONS

AC/DC PORTABLE—HORIZONTAL USE

ACCURACY	.5% of full scale; .75% for instruments with a basic sensitivity of 2 ma or 500 $\Omega/v$ or higher
FREQUENCY	DC and 7 Hz to 35 kHz max. Frequency specifications listed with ranges
TYPE	Thermocouple; permanent magnet, double pivoted moving coil; true rms response
SENSITIVITY	Voltmeters: 200 $\Omega/v$ , 500 $\Omega/v$ or 750 $\Omega/v$ as specified. Approx. resistances of milliammeters listed with ranges
SCALE	Hand-drawn; 6.3"; anti-parallax mirror
POINTER	Knife edge
PERIOD	6 seconds
DAMPING	Induced emf
PIVOTS	Diamond pivoted
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
TEMPERATURE COEFFICIENT	Automatic temperature compensation from 20°C to 30°C
THERMOCOUPLE REPLACEMENT	Type 357
RANGE CHANGING	Switch controlled
MAGNETIC SHUNT	Internal; 3% max. adjustment
MECHANICAL ZERO	External zero shifter
CASE	Formica; 7 $\frac{3}{4}$ " l x 7 $\frac{1}{2}$ " w (Milliammeters 4 $\frac{5}{16}$ " h; voltmeters 6 $\frac{1}{8}$ " h); bakelite panel; hinged cover; handle
APPROX. WEIGHT	7 lbs. net; 12 lbs. shipping

All instruments are provided with data cards listing temperature corrections and maximum overload ratings.

## OPTIONAL SPECIFICATIONS

1. Special scales and/or ranges available.

## THERMO MILLIAMMETERS

**Frequency:** a) Milliammeters with lowest range of 1.5 ma or 2 ma; DC and 7 Hz to 15 kHz at .75% accuracy. b) Instruments with lowest range of 5 ma or 10 ma; DC and 7 Hz to 20 kHz at .5% accuracy. (1 amp range of multirange instruments limited to 10 kHz. Between 10 kHz and 20 kHz accuracy .75%.)

Range	Approx. Resist. $\Omega$	Scale Div.	Code	Price
1.5/5/15/50/150	1000/320/136/44/15	150/100	AULYB	\$
2/10/50/100/500	800/200/48/25/5	100	AUDOM	
5/10/50/100/500	65/270/90/50/10	100	AUDIT	
10/20/100/200/500	139/37.5/12/5.8/2.4	100	AUTIM	
10/50/200/500/1000	30/21/5.8/2.4/1.2	100	AUGOM	

## VOLTMETERS

**Frequency:** a) Voltmeters with a sensitivity of 500  $\Omega/v$  or 750  $\Omega/v$ ; DC and 7 Hz to 35 kHz at .75% accuracy. b) Instruments with a sensitivity of 200  $\Omega/v$ ; DC and 7 Hz to 35 kHz at .5%

Range	$\Omega/v$	Scale Div.	Code	Price
1.5/3/7.5/15/30/75/150/300/750	200	150	AUVOLT	\$
2/5/10/20/50/100/200/500	200	100	AUVOMO	
1.5/7.5/15/30/75/150	500	150	AUVONI	
2/5/10/20/50/100/200	500	100	AUVOOP	
3/7.5/15/30/75/150	750	150	AUVOPF	
5/10/20/50/100	750	100	AUVORP	



# MODEL RF RADIO FREQUENCY THERMOCOUPLE INSTRUMENTS

## SPECIFICATIONS

AC/DC PORTABLE—HORIZONTAL USE

ACCURACY	.5% of full scale excepting .75% for ranges of 2 ma or less and all multirange milliammeters. 1% for ammeters
FREQUENCY	DC and 7 Hz to 20 MHz max.
TYPE	Thermocouple; permanent magnet, double pivoted moving coil; true rms response
SENSITIVITY	Voltmeters: Approx. 200 $\Omega/v$ Approx. resistances of milliammeter ranges listed below
SCALE	Hand-drawn; 6.3"; anti-parallax mirror
POINTER	Knife edge
PERIOD	6 seconds
DAMPING	Induced emf
PIVOTS	Diamond pivoted
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
TEMPERATURE COEFFICIENT	Automatic temperature compensation from 20°C to 30°C
RANGE CHANGING	Switch controlled
MAGNETIC SHUNT	Internal; 3% max. adjustment
MECHANICAL ZERO	External zero shifter
CASE	Formica; black bakelite panel; carrying handle
SIZE & APPROX. WEIGHT	Single range milliammeters: 7 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 4 $\frac{5}{16}$ " h.; 7 lbs. net; 10 lbs. shipping Multirange milliammeters: 7 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 6 $\frac{1}{8}$ " h.; 8 lbs. net; 11 lbs. shipping Single range voltmeters: 7 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 4 $\frac{5}{16}$ " h.; 7 lbs. net; 10 lbs. shipping Multirange voltmeters: 13 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 8" h.; 10 lbs. net; 19 lbs. shipping Ammeters: 7 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 4 $\frac{5}{16}$ " h.; 7 lbs. net; 10 lbs. shipping

All instruments are provided with data cards listing temperature corrections and maximum overload ratings.

## OPTIONAL SPECIFICATIONS

Instruments with special ranges and/or scales can be supplied. In some instances instruments can be guaranteed for higher accuracy than rated, if for use over a narrower frequency span. Conversely, instruments can be employed over a wider frequency span at reduced accuracy. Correspondence required.

## PANEL MOUNTED INSTRUMENTS

Model RF single and multirange milliammeters are also available for vertical panel mounting in the deep EW-5A (5" scale length) or EW-7A (7" scale length) edgewise panel case. For dimensions see page 412.

Performance characteristics are the same as listed for the portable type excepting as follows:

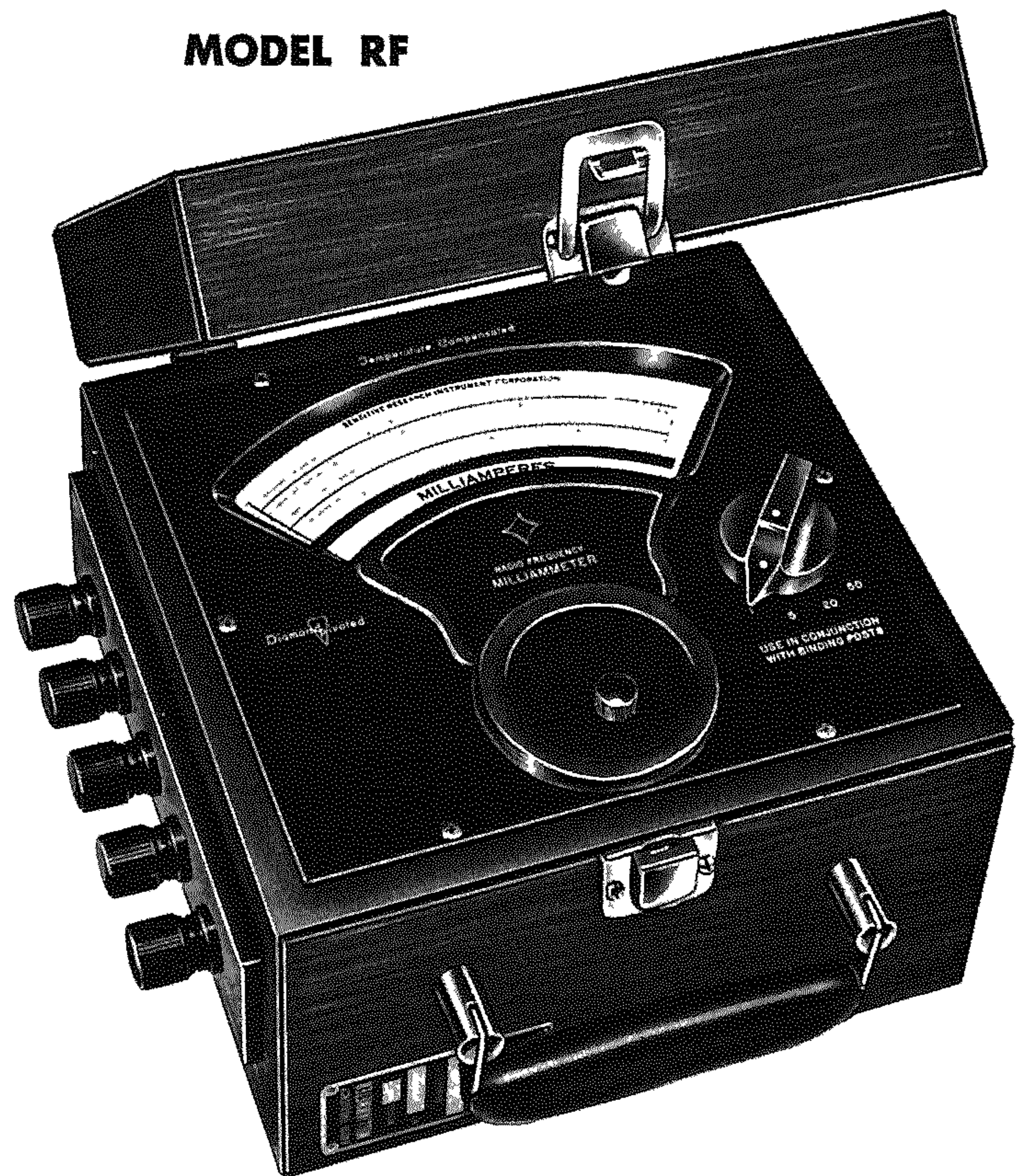
1. Frequency range limited to 500 kHz for single range instruments and 100 kHz for multirange instruments.
2. Type EW-5A cased instruments are limited to a maximum of 100 scale divisions.

**Specify:** Model RFEW-5A or RFEW-7A and code word of portable instrument having ranges desired.

**Price:** Add \$ to price of code word selected.

**Note:** Panel mounted thermocouple voltmeters are offered only in the Model A. (See pages 404-405.)

## MODEL RF



## GENERAL DESCRIPTION

The Model RF, consisting of AC/DC milliammeters, ammeters and voltmeters, is designed for applications demanding accurate true rms measurements over a wide range of radio frequencies. Typical applications are the checking of oscillators, signal generators and electronic voltmeters, and making frequency response tests on thermocouples and thermocouple instruments.

There are some basic variations in construction between the Model RF instruments listed depending on what they are to measure, and this results in their having dissimilar case sizes, and in certain instances, specifications. As an example, multirange milliammeters employ 4 individual thermocouples with the junction circuits completely switch controlled (Fig. 1, pg. 408). This circuit is more complex than single range milliammeters or multirange milliammeters for use over a narrower frequency span that are constructed with a single thermal element shunted to obtain additional ranges. Ammeters utilize air thermocouples rather than vacuum types. Their heavy wattage dissipation makes it advisable to furnish their thermal element attached externally to the instrument case as shown. (Note that circuit connections are made directly to the heater of the air couple.) Dual range ammeters are supplied with an additional thermocouple of the same type attached to the opposite side of the case. Multirange voltmeters are furnished in a larger case than current measuring instruments in order to accommodate a circuit configuration that allows all ranges to be switch controlled with a minimum frequency influence (Fig. 4, pg. 410). In switching ranges, all resistances and wiring other than that associated with the range in use, are isolated from the circuit.



# MODEL RF RADIO FREQUENCY MILLIAMMETERS

A manually operated "Push-to-Read" thermocouple overload protection system is normally self contained in most thermoelement type instruments where range and frequency performance permits. The instrument has a red "Safety" line drawn and labeled at the 20% point on its scale. When the push button is in an upright position, 80% of the input current is shunted around the heater of the thermoelement. If the instrument's indication is below the "Safety" line, it is being used on the correct full scale range; if above the line an overload is being applied and change to a higher range value is indicated. The button can be turned to lock in place in the "Read" position. This removes the safety shunt for normal operation while making measurements. The overload system is compensated so loading of the circuit being measured remains at the same level whether the button is depressed or not. The thermocouple is protected for overloads of 1000%.

Single range milliammeters with a lowest range of 200 ma or less can be provided with the 1000% overload protection circuit described above, for use during initial operation. Frequency span is reduced to 100 kHz. Installation is optional and must be specified at time of ordering. Instruments without overload protection can withstand overloads of 100%, excepting ammeters which are rated for 50%.

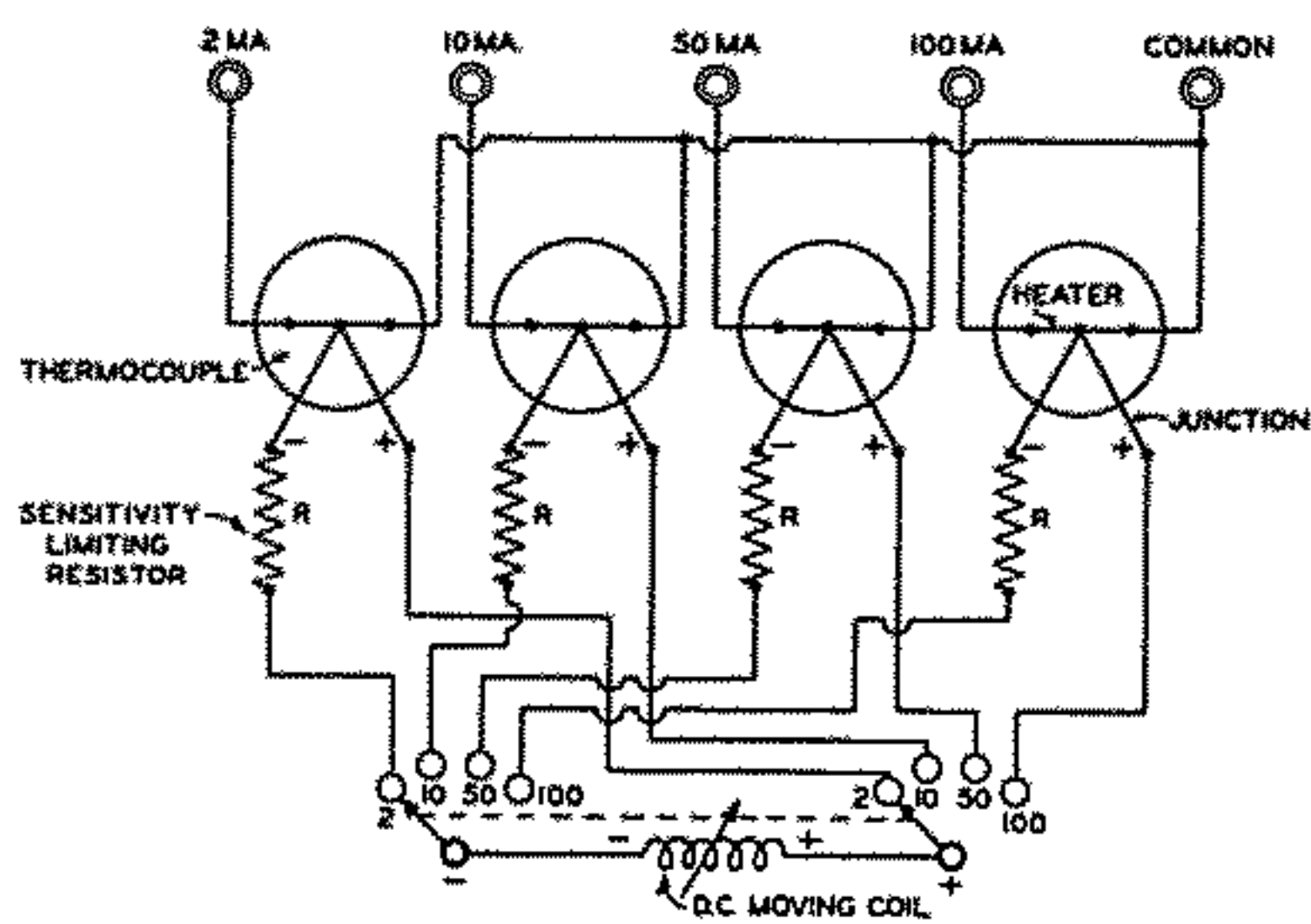


Fig. 1. MODEL RF MULTIRANGE MILLIAMMETER CIRCUIT  
MILLIAMMETERS

**Single Range**  
Frequency: a) Instruments with a range of 2 ma or lower; DC and 7 Hz to 1 MHz at .75% accuracy. b) Instruments with a range of 5 ma to 500 ma; DC and 7 Hz to 1 MHz at .5% accuracy.

Range	Approx. Heater Resist. $\Omega$	Scale Div.	Code	Price
1.0	2000	100	RAMIL	\$.
1.5	1000	150	RABIT	
2	800	100	RADAN	
5	80	100	RACER	
7.5	40	150	RAMON	
10	20	100	RANOR	
20	10	100	RAVIN	
50	5	100	RACON	
100	2	100	RADIT	
200	.5	100	RACUM	
300	.4	150	RADUM	
500	.3	100	RAFUS	

While all thermocouple instruments make excellent AC/DC transfer standards, the Model RF is particularly valuable in such usage because of its flat response from DC through a wide range of radio frequencies. It can be used to determine AC/DC differences (or the influence of frequency when referenced to DC) by standardizing a single point on DC by means of a potentiometer and then applying an equivalent AC of the same value. The short term stability in such applications is well above rated accuracy, and with good technique the instrument can be relied on to repeat its readings within its resolution.

Possible capacitance effects from grounding prohibit supplying Model RF voltmeters in an edgewise panel case. A thermocouple replacement feature is not available in any instrument. However, uncalibrated spare thermocouples can be provided if the user's facilities permit installation and recalibration in the field. This calibration can be done on direct current. When ordering spare thermocouples, specify the serial number of the instrument in which they are to be installed. Prices are listed in Section 10.

All instruments are diamond pivoted with shock mounted sapphire jewels to give a virtually friction-free moving element that will withstand abnormal handling. Cases, made of tough, durable formica, are gasketed to provide an effective dust and humidity barrier.

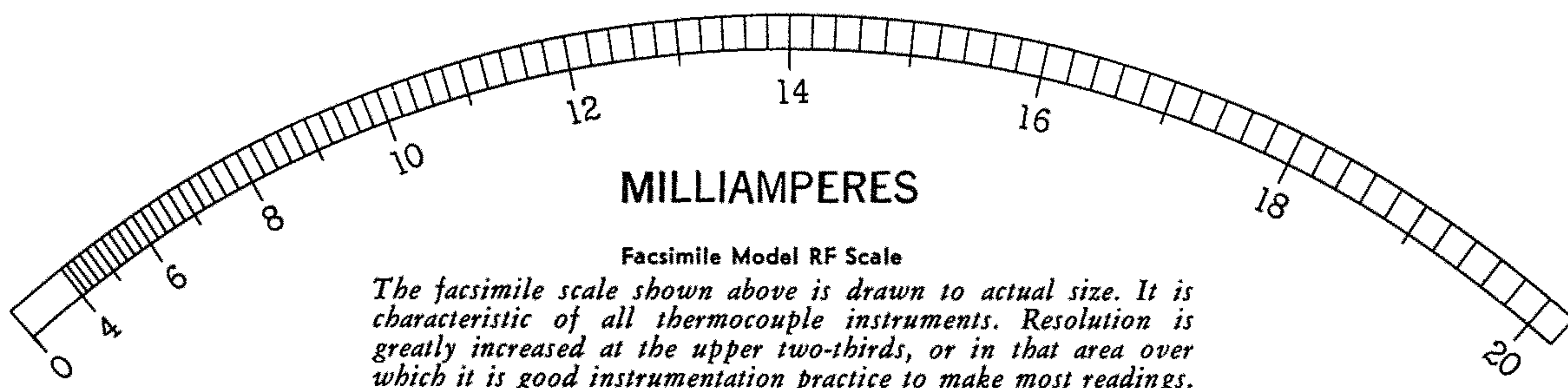
## MULTIRANGE MILLIAMMETERS

**Note 1.** Each thermocouple is in an isolated circuit and has an individually calibrated scale. Ranges out of service because of thermocouple burnout do not affect usage of remaining ranges. Instruments with a 1 amp range use a contact type air thermocouple.

**Multi Range**  
Frequency: a) Ranges of 2 ma or less; DC and 7 Hz to 250 kHz at .75% accuracy. b) Ranges of 5 ma or higher; DC and 7 Hz to 250 kHz at .5% accuracy.

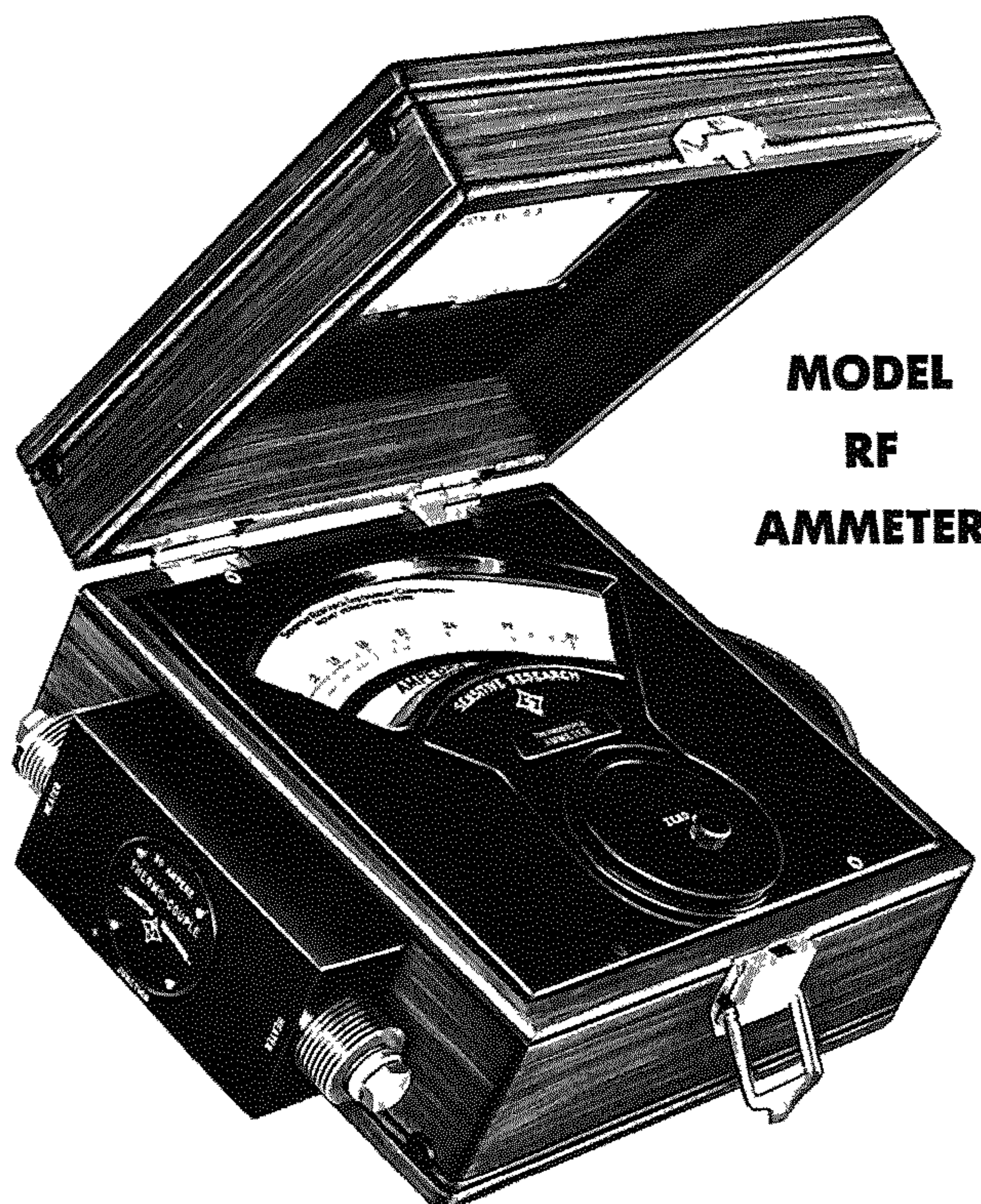
Range	Approx. Heater Resist. $\Omega$	Scale Div.	Code	Price
1/5/20/50	2000/80/10/5	100	RIJKO	\$
2/10/50/100	800/20/5/2	100	RIKLA	
2/10/25/100	800/20/8/2	100/125	RILMI	
2/5/25/50	800/80/8/5	100/125	RIMNU	
2/10/100/200	800/20/2/.5	100	RIMOS	
10/25/50/100	20/8/5/2	100/125	RIOPO	
10/50/100/1000	2/5/2/.1	100	RIPRY	
25/50/100/500	8/5/2/.3	125/100	RIRSU	
50/200/500/1000	10/.5/.3/.1	100	RISTY	
*10/10/10/10	20/20/20/20	100	RISTO	
*2/2/10/10	800/800/20/20	100	RITUK	

\*2 or 4 identical ranges are offered for applications where the instrument must be kept in continuous service and cannot always be returned immediately for a replacement thermocouple.





# MODEL RF RADIO FREQUENCY THERMOCOUPLE AMMETERS AND VOLTMETERS



**MODEL  
RF  
AMMETER**

## AMMETERS

Frequency: DC and 7 Hz to 20 MHz at 1% accuracy.

Note 1. Double range instruments can be supplied. A second range can be selected from any of the heavy current air thermocouples listed on page 411. Order by specifying the Model RF and add the letter "-D" to the code word of the single range instrument desired. Specify the code word of the air thermocouple and its range in amps. Add the price of the air thermocouple plus \$75.00 to the price of the single range instrument selected. Double range Model RF ammeters are provided with an individually calibrated scale for each thermocouple. Input to the instrument is via either set of thermocouple heater wire terminals and a switch is provided to connect either of the junction leads to the moving element.

Range	Scale Div.	Code	Price
1	100	TARIK	
2	100	TALEM	
5	100	TASIS	
10	100	TAMOR	
20	100	TAKIM	
30	150	TAFOR	
50	100	TABEL	
100	100	TACZX	

## MODEL RF VOLTMETERS

The Model RF voltmeter utilizes specially designed switching to increase its operating frequency range considerably beyond the limits listed for other multirange self-contained thermocouple models. Figure 2 shows the effective circuit of a multirange voltmeter made for measurements in the low to medium audio range. Part of the effective stray capacitances are shown as  $C_1$  to  $C_6$ .  $C_1$ ,  $C_2$ ,  $C_3$ , and  $C_4$  (the switch and lead capacities) are directly across the individual series resistance sections and hence seriously affect frequency response. The errors from these stray capacitances are significant to the point that without changes in circuit layout any improvement in the frequency response of the multiplying resistors themselves is of little value.

In the Model RF voltmeters the series resistors in the multiplier chain are a deposited metal film type with a relatively flat frequency response well beyond 10 megacycles and excellent long term stability. In order to make the most of this characteristic the effective circuit shown in Figure 3 is employed. (Figure 4 shows the complete circuit.) In this configuration the capacity  $C_1$  is no longer shunting  $R_1$ .  $C_1$  and  $C_4$  are in series with  $R_2$  and the series capacitor chain is shunting  $R_1$ . This reduces stray capacitance errors by a factor of more than two to one. Special attention given in assembly to placement of the wiring, low capacity switches, resistors with excellent frequency response characteristics and a circuit design with low effective stray capacitance, all add up to an AC/DC voltmeter for precision operation in the radio frequency range.

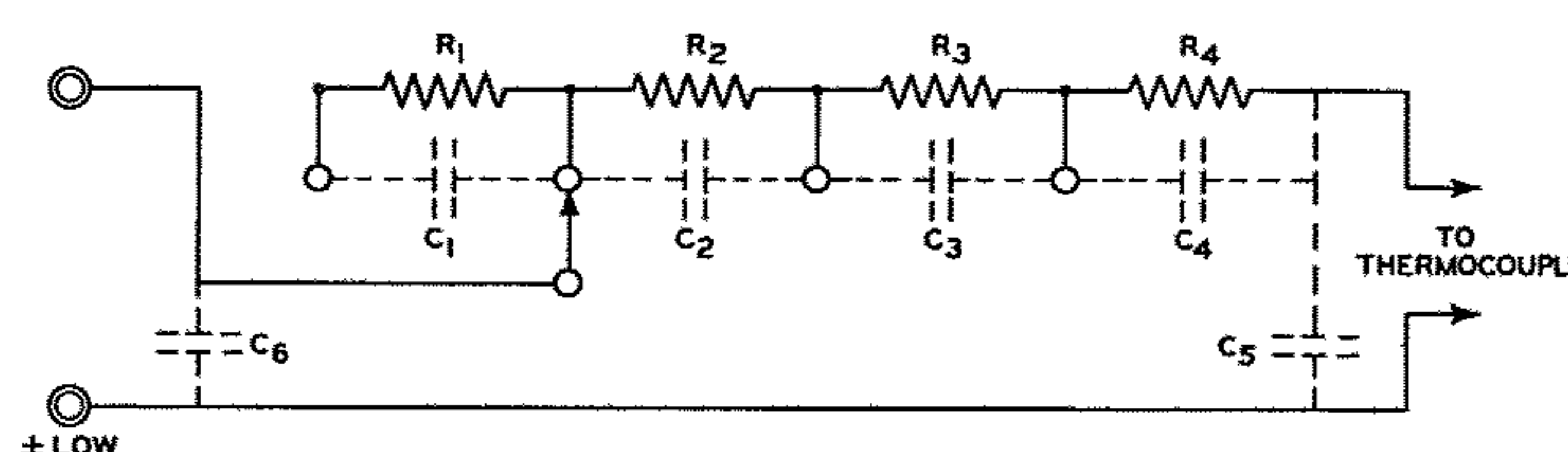


Figure 2.

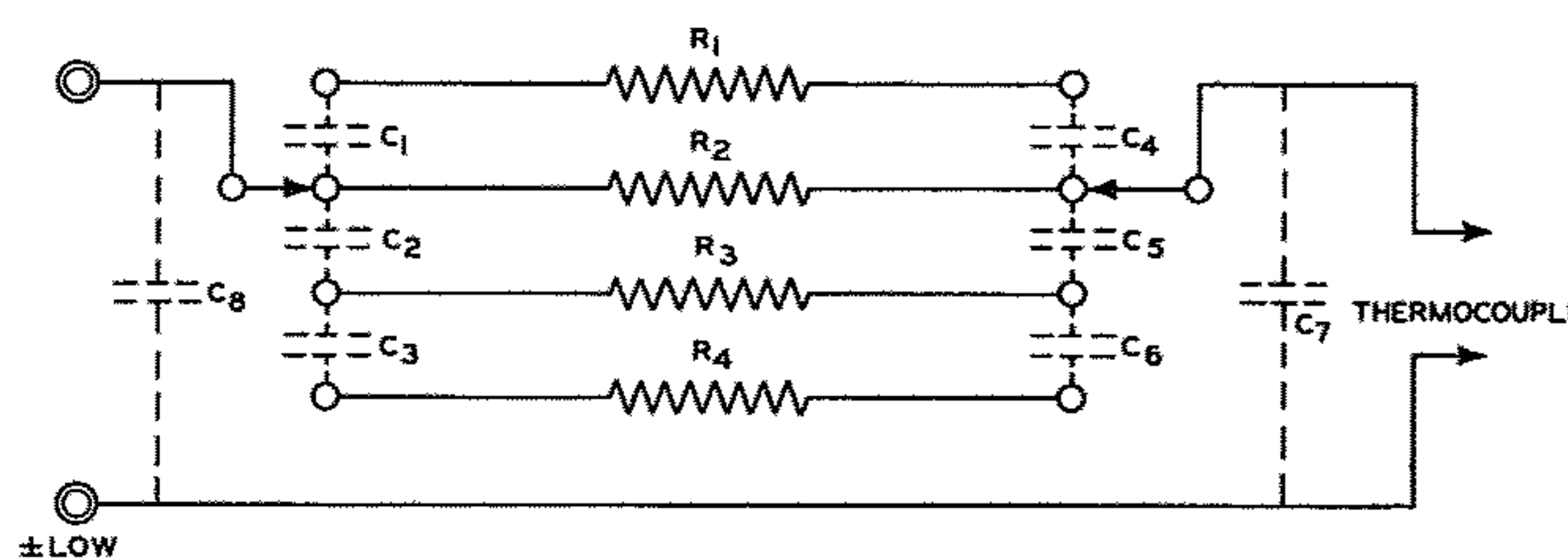


Figure 3.



# RADIO FREQUENCY VOLTMETERS

## DC MILLIVOLTMETERS & EXTERNAL THERMOCOUPLES

### VOLTMETERS

**Frequency:** All Model RF voltmeters have a rated accuracy of .5% when used on DC and AC from 7 Hz. Frequency influence is negligible over the first 20% of the entire frequency span for each range, and, therefore, no correction in direct reading accuracy need be made in that area. There is a frequency influence of no greater than .5% when usage is over the upper 80% of the frequency span. The maximum frequency at which each voltage range can be employed without exceeding .5% frequency influence is as follows:

RANGE (Volts)	MAX. FREQ. (Megahertz)	RANGE (Volts)	MAX. FREQ. (Megahertz)
1	5	20 & 30	.6
1.5-3	2	50 & 75	.4
5	1.5	100	.2
7.5 & 10	1	150-300	.15
15	.75		

### RANGES

Range	$\Omega/v$	Scale Div.	Code
1/3/10/30/100/300	200	100/150	RFVOLT
1/2/5/10/20/50	200	100	RFVATS
1.5/3/7.5/15/30/75	200	150	RFVEEK
5/10/20/50/100/200	200	100	RFVIOZ
7.5/15/30/75/150/300	200	150	RFVYOX

### MODEL RF MULTIRANGE VOLTMETER

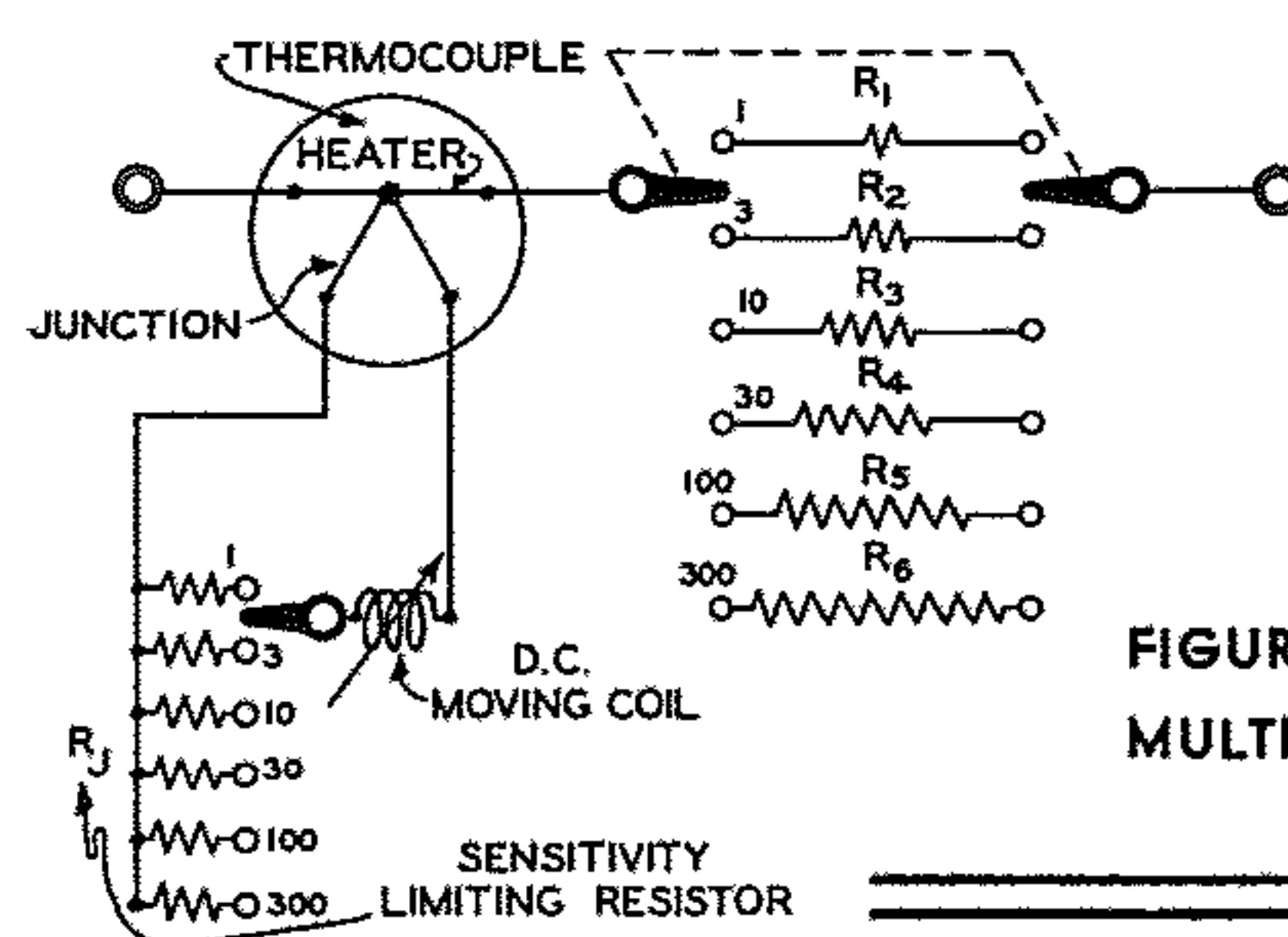
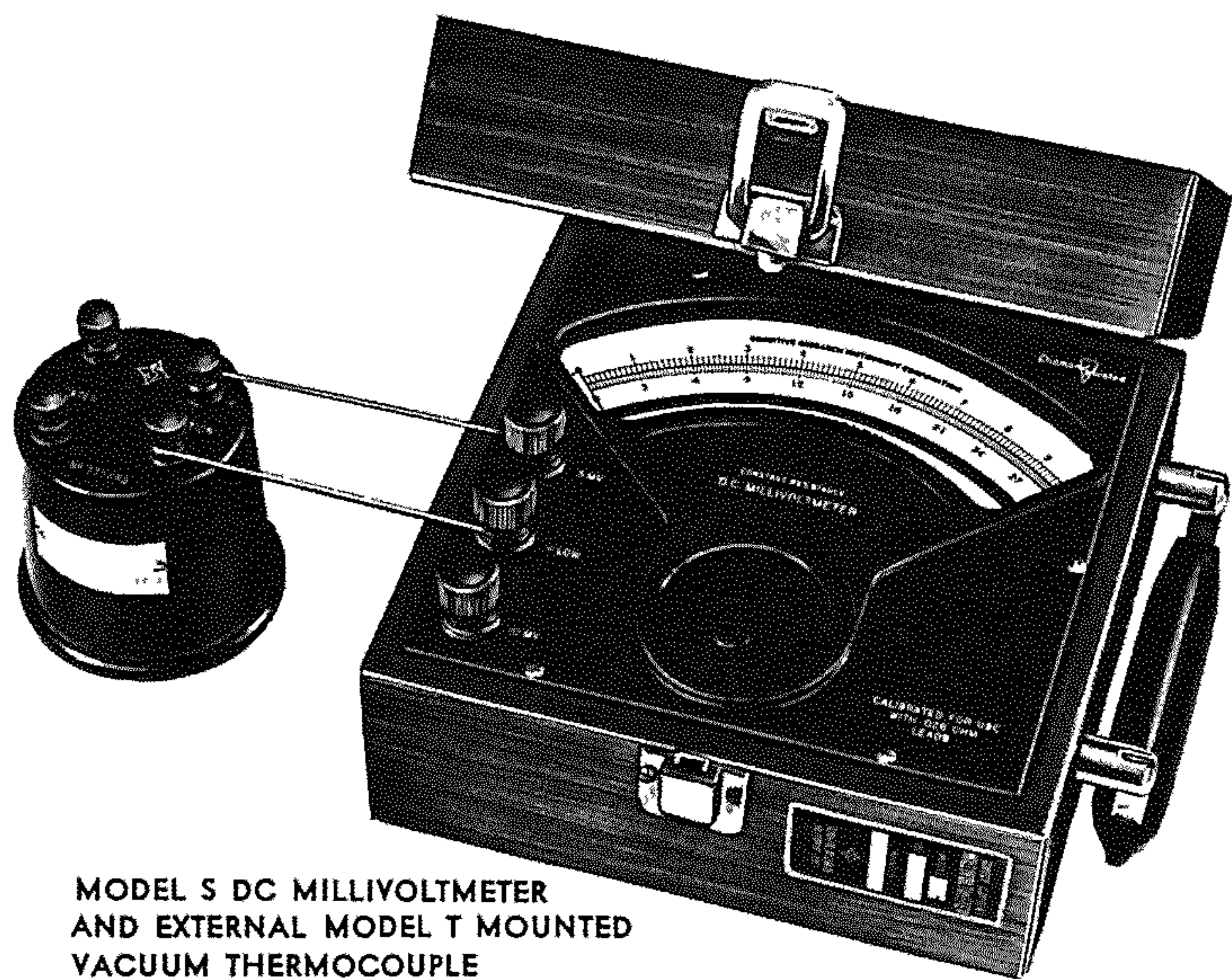


FIGURE 4. MODEL RF MULTIRANGE VOLTMETER CIRCUIT

# RADIO FREQUENCY MEASUREMENTS

## WITH DC MILLIVOLTMETERS & EXTERNAL THERMOCOUPLES



MODEL S DC MILLIVOLTMETER AND EXTERNAL MODEL T MOUNTED VACUUM THERMOCOUPLE

A DC millivoltmeter, with ranges from 2 to 10 mv full scale and a nominal sensitivity of 5  $\Omega/v$ , can be used in conjunction with external instrument thermocouples to measure RF voltages and currents with true rms response.

The scale of the indicating instrument is drawn directly in DC millivolts and the characteristics of individual thermal elements are plotted against it to obtain a calibration curve in AC voltage or current. (See pg. 411, "Thermocouple Cali-

bration Data.") The overall combination has a temperature coefficient of approximately .2%/C°. Current measurements are made by connecting the junction terminals of the thermocouple to the millivoltmeter and applying an input directly to the heater terminals. Voltage measurements are made by placing a resistance in series with one heater terminal and following the same procedure.

When selecting a millivoltmeter for use with thermocouples, the "open circuit" rating listed can often be misleading since this figure does not take into account the loading introduced by the instrument and the junction circuit of the thermocouple. This figure is valid only when recording by potentiometric methods or the equivalent. It can be proven mathematically that the most efficient operation occurs when the resistance of the millivoltmeter equals the resistance of the thermocouple junction circuit. Since the junction resistance of thermocouples varies from 5 to 15 $\Omega$ , a 2 mv, 200  $\mu a$  instrument having an internal resistance of 10 $\Omega$  is generally considered to have optimum sensitivity. Rated current into such loading produces an output of approximately 3.5 mv. By operating the thermocouple at an overload of 50%, an output in the range of 7 to 8 mv can be generated. The user can either (1) apply series resistance to the junction circuit to limit the output of the thermocouple to match full scale on the millivoltmeter, or (2) obtain an instrument with ranges that can indicate the maximum emf generated from 0 to 150% of rated input to the thermocouple.



# RADIO FREQUENCY MEASUREMENTS DC MILLIVOLTMETERS & EXTERNAL THERMOCOUPLES

Listed below are recommended millivoltmeters, mounted vacuum thermocouples with insulated heater and junction circuits (see Figure 5) and, at right, heavy current air couples. For additional details on Model S millivoltmeters see Section 3.

## MODEL S MILLIVOLTMETERS

**Specifications:** Accuracy .5% of full scale; 100 division, 6.3" hand-drawn mirrored scale; sensitivity 5  $\Omega$ /mv; shielded; diamond pivoted; formica case.

Range	Code	Price
2 mv	SMVPU	\$
5 mv	SMVSI	
2/5 mv	SMVZO	
*3/10 mv	SMVLA	

\*Constant resistance of 10  $\Omega$  (both ranges)

## MODEL T INSULATED HEATER MOUNTED VACUUM THERMOCOUPLES

Frequency influence less than .5% from DC and 7 Hz to 10 MHz. Maximum allowable current is 200% of normal rating.

Normal Milliamps	Approx. Open Cir. Millivolts	Insulated Type Max. Heater Resistance	CASE MOUNTED Code	Price
1.0	7	2000	TEBPAP-S	
1.5	7	1000	TEBONY-S	
2	7	800	TEMPIR-S	
5	7	80	TELAMG-S	
7	7	45	TEVERT-S	
7.5	7	40	TEZZIN-S	
10	7	20	TENORT-S	
15	7	14	TELERT-S	
20	7	10	TEKEST-S	
25	7	7	TELFRO-S	
50	7.5	5	TEBALT-S	
100	7.5	2	TESOFT-S	
150	7.5	1.5	TEMAID-S	
250	7.5	.6	TECANT-S	
500	7.5	.4	TESACT-S	

Vacuum thermocouples of all types are listed separately in Section 10.

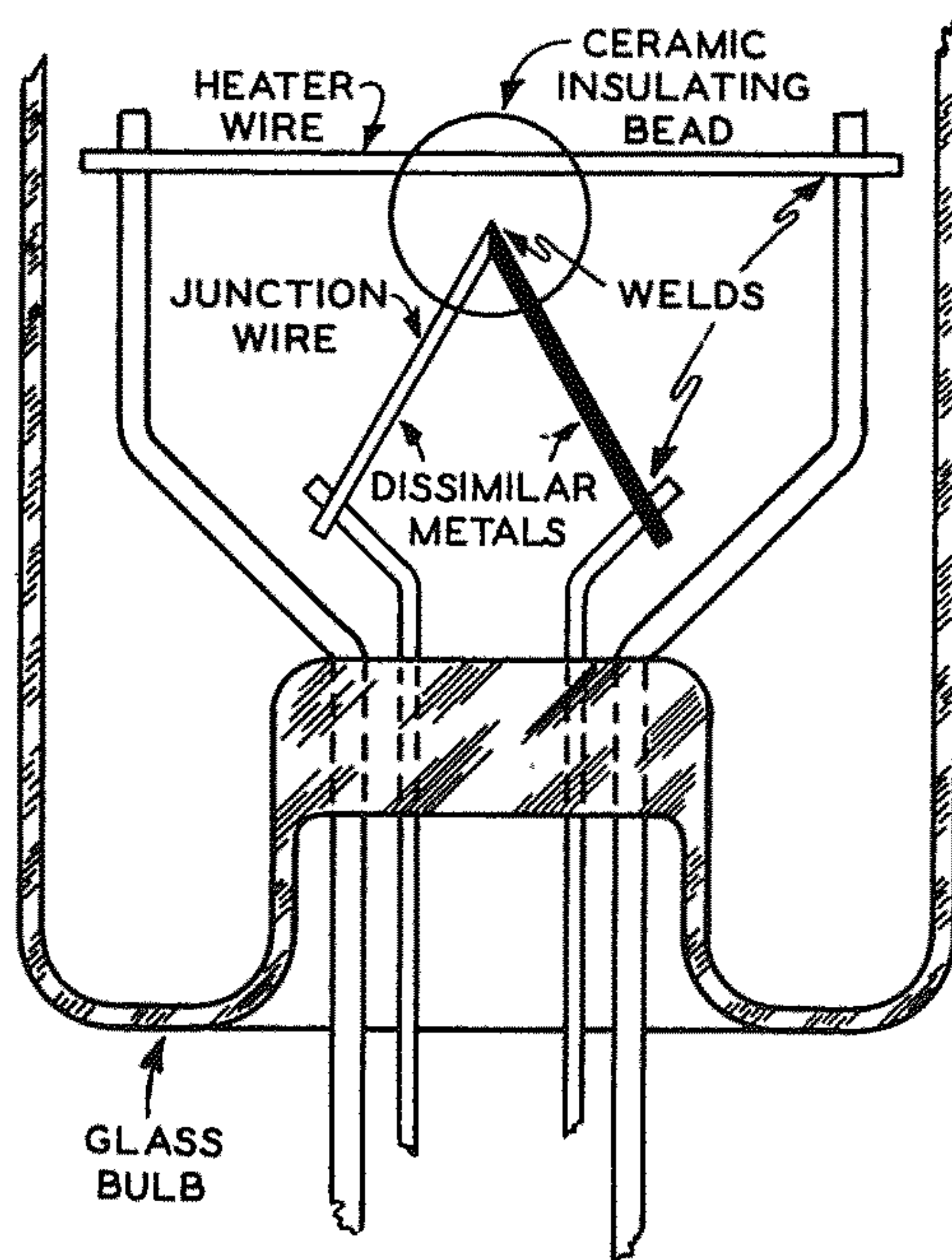


Figure 5. Insulated Heater Type Thermoelement

## MODEL TX AIR THERMOCOUPLES

Frequency influence less than .5% from DC and 7 Hz to 20 MHz. Contact type junction circuit is used. Maximum allowable current is 150% of normal rating.

Normal Amps	Code	Price	Normal Amps	Code	Price
1	TXARO	\$	20	TXUBY	
2	TXEAM		30	TXOOG	
5	TXILE		50	TXOHR	
10	TXEZI		100	TXAMP	

## MODEL TM

A multirange thermocouple unit for use with millivoltmeters. Frequency influence is less than .5% from DC and 7 Hz to 100 kHz. Unit consists of 5 individual vacuum thermocouples of the insulated junction type. The junction leads are switch controlled and connect to a single set of output terminals. Ranges listed below can be varied, if required, to suit the user's application.

Range	Code	Price
2/10/50/100/500 ma	THERUN	

Note: Calibration figures for each thermocouple range can be supplied as listed below.

## THERMOCOUPLE CALIBRATION DATA

The output of any thermocouple can be plotted against the scale of a millivoltmeter. While it is advantageous to calibrate both units together, it is not necessary to return the millivoltmeter if additional thermocouples are ordered at a later date. Simply specify the serial number of the instrument and data can be supplied from a standard millivoltmeter of the same type.

Thermocouples can be supplied with 4 types of calibration data as follows:

**Calibration No. 1:** Adjusted with rated heater current for full scale on a particular single range millivoltmeter. (Includes junction resistance.) Customer must supply an instrument or exact specifications as to loading of the indicator with which the thermocouple is to be used.

Price 30.00 per thermocouple

**Calibration No. 2:** Calibrated for use with a particular double range millivoltmeter. If the output of the thermocouple at rated current exceeds the highest range of the millivoltmeter, a resistance is inserted in the junction circuit to limit the output to full scale deflection. Calibration data is furnished for both ranges.

Price 35.00 per thermocouple

**Calibration No. 3:** Calibrated by potentiometric methods. The "open circuit" emf of the thermocouple is measured when zero to rated current is applied.

Price 30.00 per thermocouple

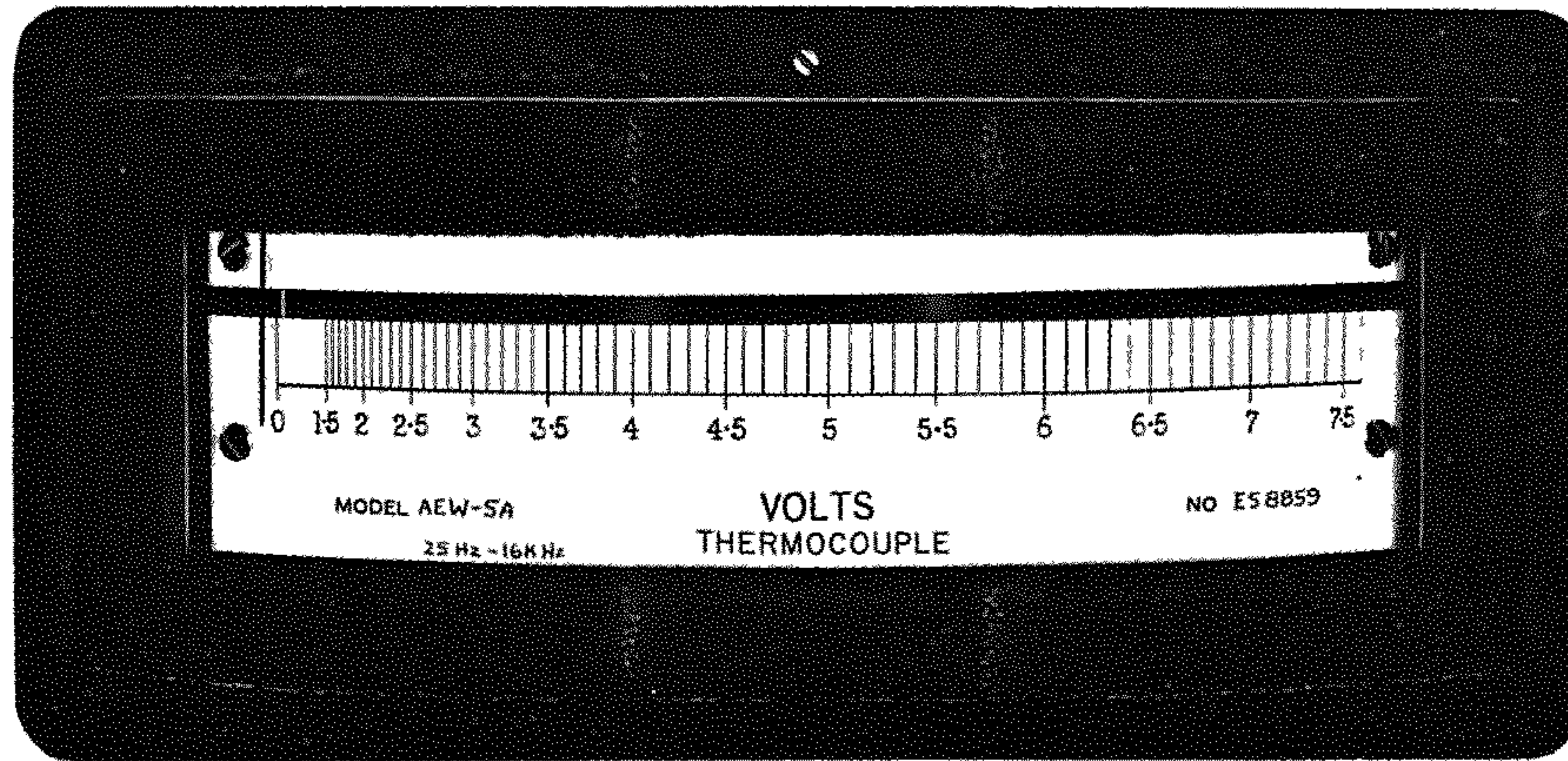
**Calibration No. 4:** Same as No. 3 but thermocouple output is measured from zero to maximum allowable current.

Price 35.00 per thermocouple



# PANEL INSTRUMENTS

## MODEL AEW-7A AC and DC MILLIAMMETER

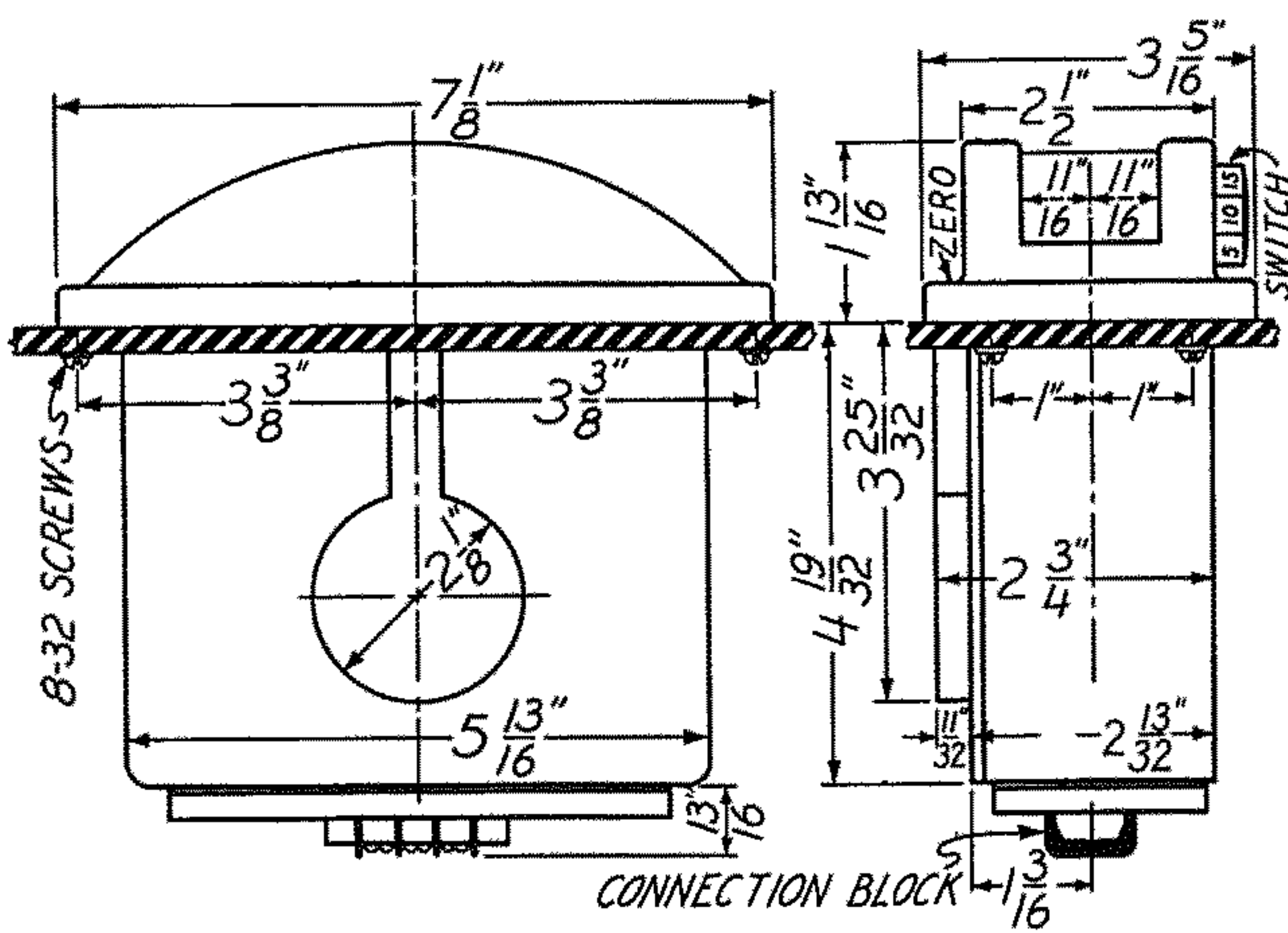


## MOUNTING DIMENSIONS FOR EDGEWISE PANEL INSTRUMENTS

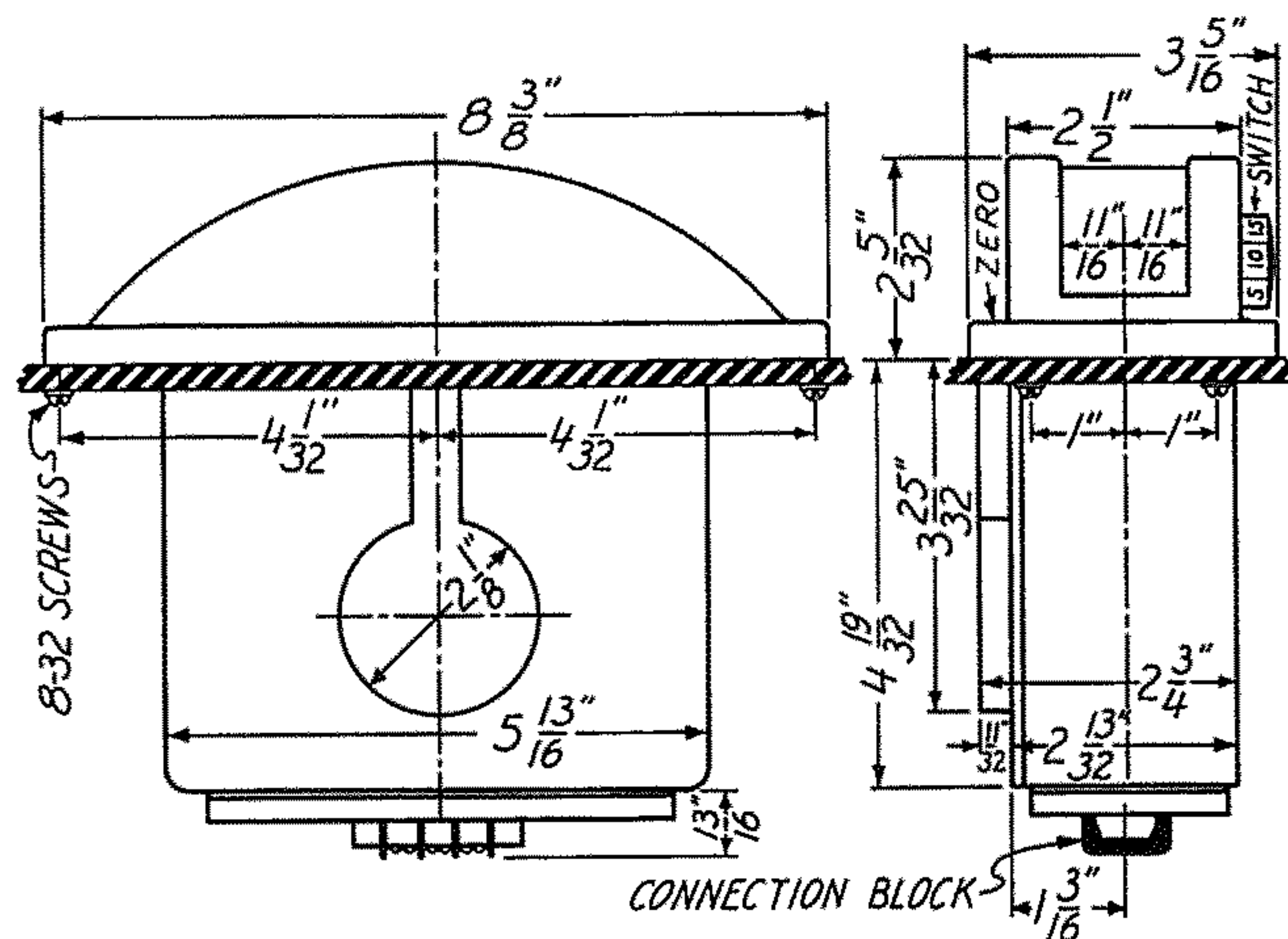
All Model A instruments, Model AU milliammeters and Model RF milliammeters can be supplied in Type EW-5A or EW-7A cases for flush vertical panel mounting. Binding posts or connection lugs are furnished in the rear. Cases are of die cast aluminum with a black wrinkle finish. Switches, when supplied, are as indicated in the drawings. (See individual portable model specifications.) External zero shifters are supplied on the front of all cases.

### NOTE

The Types EW-5A and EW-7A replaced the Types EW-5 and EW-7 in May, 1961. There are minor dimensional differences between the two types. For purposes of exact replacement, the Types EW-5 or EW-7 can be supplied at no additional charge, *but must be specified at time of ordering.*



TYPE EW-5A SHALLOW CASE, Scale Length 5"  
for Model A, and AU and RF Milliammeters



TYPE EW-7A SHALLOW CASE, Scale Length 7"  
for Model A, and AU and RF Milliammeters



# Sensitive Research\*

## AC/DC AUDIO AND RADIO FREQUENCY THERMOCOUPLE INSTRUMENTS

PRICE LIST - JANUARY 1, 1981

### MODEL UNIVERSITY THERMO MILLIAMMETERS

<b>Single Range</b> Accuracy: .75% DC & 7 Hz to 500 kHz.
<b>RANGES</b>
Single range instruments can be supplied from 2 ma to 500 ma full scale. Ranges and resistances same as for the Model RF listed on page 408. Order by specifying the University Model and the range required. Deduct \$85.00 from the price of the single range Model RF for the price of the University Model.

Multi Range	APPROX. RESIST. $\Omega$	SCALE DIV.	CODE	PRICE
2/10/20/100/200	640/538/295/63 32	100	UTHEMO	\$445
5/10/50/100/500	70/205/74/37 7.5	100	UTHENY	415
10/20/100/200 1000	30/37.5/12/5.8 1.2	100	UTHEOS	415
10/50/100/500 1000	30/21/12/2.4/1.2	100	UTHEPO	415
20/100/200/500 1000	10/3.6/2/.8/.4	100	UTHEIK	415

### MODEL UNIVERSITY THERMO VOLTMETERS

**Frequency:** a) Instruments with a sensitivity of 500  $\Omega/v$ ; DC and 7 Hz to 4 kHz at .75% accuracy. In multirange instruments, ranges of 300 v or higher, rated accuracy to 2 kHz; 1.5% accuracy above 2 kHz to 4 kHz (single instruments 1% accuracy).  
b) Instruments with a sensitivity of 100  $\Omega/v$ ; DC and 7 Hz to 6 kHz at .75% accuracy. In multirange instruments, ranges of 300 v or higher, rated accuracy to 4 kHz; 1.5% accuracy above 4 kHz to 6 kHz (single range instruments 1% accuracy).

<b>Single Range</b> Any single range instrument with a sensitivity of 100 $\Omega/v$ , from .2 v to 300 v full scale, price \$346 over 300 v to 1000 v, price \$305. When sensitivity is 500 $\Omega/v$ , ranges from 1.5 to 300 v, price \$410 over 300 v to 1000 v, price \$444. When ordering, specify model, range and ohms per volt required.
--

Multi Range	SCALE DIV.	CODE	PRICE	
RANGE			100 $\Omega/v$	500 $\Omega/v$
.2/1/5/10/20	100	UTHOCI	\$430	-
3/15/30/75/150	60/75	UTHOXI	430	\$495
7.5/15/30/75/150	75/60	UTHOPP	430	495
15/30/75/150/300	75/60	UTHONS	440	505
1.5/3/7.5/15/30/75 150	75/60	UTHODO	470	540
7.5/15/30/75/150/300	75/60	UTHORA	460	530

### MODEL A THERMO MILLIAMMETERS

**Frequency:** a) Instruments with lowest range of 3 ma and below; DC and 7 Hz to 7.5 kHz at .75% accuracy.  
b) Instruments with lowest range of 5 ma or more; DC and 7 Hz to 15 kHz at .5% accuracy. (Ranges of 1 amp and higher limited to 4 kHz. Accuracy above 4 kHz to 10 kHz is .75%.)

RANGE	APPROX. RESIST. $\Omega$	SCALE DIV.	CODE	PRICE
2/10/50/100/500	640/538/124/63/13	100	AMILKO	\$625
5/10/50/100/500	242/148/34/17/3.5	100	AMILSA	600
10/50/100/500/1000/2000	30/21/12/2.4/1.2/.6	100	AMILUR	625
20/100/200/500/1000	10/3.6/2/.8/.4	100	AMILTI	600
50/100/200/500/1000/2000	5/3.8/2.5/1/.5/.25	100	AMILKU	655
2/5/10/20/50/100/200/500/1000	640/870/538/295/124/63/32/13/6.4	100	AMILWA	655
3/7.5/15/30/75/150/300/750/1500	500/440/260/140/60/30/15/6/3	150	AMILTY	655
5/10/20/50/100/200/500/1000	242/148/81/34/17/8.8/3.5/1.8	100	AMILBO	640
10/20/50/100/200/500/1000/2000	30/38/21/12/5.8/2.4/1.2/.6	100	AMILAC	640
15/30/75/150/300/750/1500	20/20/10/5.8/3/1.2/.6	150	AMILDA	625

For Single Range Milliammeters see Model RF.



\* A TRADEMARK OF EIS  
**ELECTRICAL INSTRUMENT SERVICE, INC.**  
25 Dock Street, Mount Vernon, N.Y. 10550 914-699-9717





**MODEL A  
THERMO VOLTMETERS**

<b>Frequency:</b> a) Instruments with sensitivities of 100 $\Omega/v$ ; DC and 7 Hz to 7 kHz at .5% accuracy, except ranges of 300 v or higher limited to 5 kHz. b) Instruments with sensitivities of 500 $\Omega/v$ ; DC and 7 Hz to 5 kHz at .75% accuracy, except ranges of 300 v or higher limited to 3 kHz.		
<b>SINGLE RANGE</b>	<b>PRICE</b>	
	100 $\Omega/v$	500 $\Omega/v$
.2 Volt to 300 Volts	\$495	—
1.5 Volts to 300 Volts	—	\$545
301 Volts to 1000 Volts	530	575

**MODEL A THERMO VOLTMETERS — (continued)**

RANGE	CODE	SCALE DIV.	PRICE	
			100 $\Omega/v$	500 $\Omega/v$
.2/1/5/20	AVALMA	100	\$580	—
.5/2/10/50	AVOLNO	100	580	—
1.5/7.5/30/75	AVOLOP	150	580	\$620
5/20/50/100	AVOLPY	100	580	620
10/50/200/500	AVOLSY	100	615	635
15/75/300/750	AVOLTO	150	625	655
1.5/3/7.5/15/30/75/150	AVOLKA	150	645	670
2/5/10/20/50/100/200	AVOLBI	100	645	670
7.5/15/30/75/150/300/750/1500	AVOLCU	150	680	755
.3/.75/1.5/3/7.5/15/30/75/150/300	AVOLUM	150	650	—
1.5/3/7.5/15/30/75/150/300/750	AVOLVO	150	650	735
2/5/10/20/50/100/200/500/1000	AVOLWY	100	655	745

**MODEL AU**

**THERMO MILLIAMMETERS**

<b>Frequency:</b> a) Milliammeters with lowest range of 1.5 ma or 2 ma; DC and 7 Hz to 15 kHz at .75% accuracy. b) Instruments with lowest range of 5 ma or 10 ma; DC and 7 Hz to 20 kHz at .5% accuracy. (1 amp range of multirange instruments limited to 10 kHz. Between 10 kHz and 20 kHz accuracy .75%.)				
RANGE	APPROX. RESIST. $\Omega$	SCALE DIV.	CODE	PRICE
1.5/5/15/50/150	1000/320/136/44	150/100	AULYB	\$690
2/10/50/100/500	15			
5/10/50/100/500	800/200/48/25/5	100	AUDOM	685
10/20/100/200	65/270/90/50/10	100	AUDIT	665
500	139/37.5/12/5.8	100	AUTIM	665
10/50/200/500	2.4			
1000	30/21/5.8/2.4/1.2	100	AUGOM	665

**THERMO VOLTMETERS**

<b>Frequency:</b> a) Voltmeters with a sensitivity of 500 $\Omega/v$ or 750 $\Omega/v$ ; DC and 7 Hz to 35 kHz at .75% accuracy. b) Instruments with a sensitivity of 200 $\Omega/v$ ; DC and 7 Hz to 35 kHz at .5% accuracy.					
RANGE	$\Omega/v$	SCALE DIV.	CODE	PRICE	
1.5/3/7.5/15/30/75/150	200	150	AUVOLT	\$690	
300/750					
2/5/10/20/50/100/200/500	200	100	AUVOMO	705	
1.5/7.5/15/30/75/150	500	150	AUVONI	695	
2/5/10/20/50/100/200	500	100	AUVOOP	710	
3/7.5/15/30/75/150	750	150	AUVOFF	765	
5/10/20/50/100	750	100	AUVORP	735	

**MODEL RF**

**THERMO MILLIAMMETERS**

Single Range				
<b>Frequency:</b> a) Instruments with a range of 2 ma or lower; DC and 7 Hz to 1 MHz at .75% accuracy. b) Instruments with a range of 5 ma to 500 ma; DC and 7 Hz to 1 MHz at .5% accuracy.				

Range	Approx. Heater Resist. $\Omega$	Scale Div.	Code	Price
1.0	2000	100	RAMIL	\$560
1.5	1000	150	RABIT	530
2	800	100	RADAN	530
5	80	100	RACER	510
7.5	40	150	RAMON	510
10	20	100	RANOR	510
20	10	100	RAVIN	510
50	5	100	RACON	510
100	2	100	RADIT	510
200	.5	100	RACUM	510
300	.4	150	RADUM	510
500	.3	100	RAFUS	510

**THERMO MILLIAMMETERS**

Multi Range				
<b>Frequency:</b> a) Ranges of 2 ma or less; DC and 7 Hz to 250 kHz at .75% accuracy. b) Ranges of 5 ma or higher; DC and 7 Hz to 250 kHz at .5% accuracy.				

Range	Approx. Heater Resist. $\Omega$	Scale Div.	Code	Price
1/5/20/50	2000/80/10/5	100	RIJKO	\$700
2/10/50/100	800/20/5/2	100	RIKLA	670
2/10/25/100	800/20/8/2	100/125	RILMI	670
2/5/25/50	800/80/8/5	100/125	RIMNU	670
2/10/100/200	800/20/2/.5	100	RIMOS	670
10/25/50/100	20/8/5/2	100/125	RIPOO	665
10/50/100/1000	2/5/2/.1	100	RIPRY	665
25/50/100/500	8/5/2/.3	125/100	RIRSU	665
50/200/500/1000	10/.5/.3/.1	100	RISTY	660
*10/10/10/10	20/20/20/20	100	RISTO	660
*2/2/10/10	800/800/20/20	100	RITUK	675

\*2 or 4 identical ranges are offered for applications where the instrument must be kept in continuous service and cannot always be returned immediately for a replacement thermocouple.



### MODEL RF THERMO AMMETERS

Frequency: DC and 7 Hz to 20 MHz at 1% accuracy.

RANGE	SCALE DIV.	CODE	PRICE
1	100	TARIK	\$545
2	100	TALEM	545
5	100	TASIS	545
10	100	TAMOR	560
20	100	TAKIM	585
30	150	TAFOR	595
50	100	TABEL	635
100	100	TACZX	850

### MODEL T

#### INSULATED HEATER

#### MOUNTED VACUUM THERMOCOUPLES

Frequency influence less than .5% from DC and 7 Hz to 10 MHz. Maximum allowable current is 200% of normal rating.

NORMAL MILLIAMPS	APPROX. OPEN CIR. MILLIVOLTS	INSULATED TYPE MAX. HEATER RESISTANCE	CASE MOUNTED CODE	PRICE
1.0	7	2000	TEBPAP-S	\$99
1.5	7	1000	TEBONY-S	85
2	7	800	TEMPIR-S	85
5	7	80	TELAMG-S	75
7	7	45	TEVERT-S	75
7.5	7	40	TEZZIN-S	75
10	7	20	TENORT-S	75
15	7	14	TELERT-S	75
20	7	10	TEKEST-S	75
25	7	7	TEFRQ-S	75
50	7.5	5	TEBALT-S	75
100	7.5	2	TESOFT-S	75
150	7.5	1.5	TEMAID-S	75
250	7.5	.6	TECANT-S	75
500	7.5	.4	TESACT-S	75

Price DOES NOT include Calibration Data.

### MODEL S MILLIVOLTMETERS

Specifications: Accuracy .5% of full scale; 100 division, 6.3" hand-drawn mirrored scale; sensitivity 5  $\Omega$ /mv; shielded; diamond pivoted; formica case.

Range	Code	Price
2 mv	SMVPU	\$355
5 mv	SMVSI	355
2/5 mv	SMVZO	375
*3/10 mv	SMVLA	425

\*Constant resistance of 10  $\Omega$  (both ranges)

### OPTIONAL SPECIFICATIONS

#### MODELS A & AU

A "Plug-in" Thermocouple Replacement Feature (TRF), Type 362, can be furnished instead of the Type 357. (In the Type 357, thermocouples are soldered into place.) It can be supplied in all milliammeters with a lowest range of 7.5, 10, 15 or 20 ma, and all voltmeters with a sensitivity of 100  $\Omega$ /v. The Type 362 system includes a variable resistor to adjust the full scale output of the thermocouple for optimum scale linearity. Both types of replacement features are described more fully on pages 402-403.

If the Type 362 "Plug-in" Thermocouple Replacement Feature is desired, specify and add \$75.00 to the price of the portable or edgewise panel instrument selected.

### THERMO VOLTMETERS

Accuracy .5% with Frequency Influence .5% max. up to following frequencies:

RANGE (Volts)	MAX. FREQ. (Megahertz)	RANGE (Volts)	MAX. FREQ. (Megahertz)
1	5	20 & 30	.6
1.5-3	2	50 & 75	.4
5	1.5	100	.2
7.5 & 10	1	150-300	.15
15	.75		

RANGE	$\Omega$ /v	SCALE DIV.	CODE	PRICE
1/3/10/30/100/300	200	100/150	RFVOLT	\$995
1/2/5/10/20/50	200	100	RFVATS	935
1.5/3/7.5/15/30/75	200	150	RFVEEK	935
5/10/20/50/100/200	200	100	RFVIOZ	950
7.5/15/30/75/150/300	200	150	RFVYOX	960

### MODEL TX

#### AIR THERMOCOUPLES

Frequency influence less than .5% from DC and 7 Hz to 20 MHz. Contact type junction circuit is used. Maximum allowable current is 150% of normal rating.

NORMAL AMPS	CODE	PRICE
1	TXARO	\$ 90
2	TXEAM	90
5	TXILE	90
10	TXEZI	90
20	TXUBY	100
30	TXOOG	100
50	TXOHR	135
100	TXAMP	295

Price DOES NOT include Calibration Data.

### MODEL TM

RANGE	CODE	PRICE
2/10/50/100/500 ma	THERUN	\$395

Price DOES NOT include Calibration Data.

CALIBRATION DATA FOR MODELS T, TM and TX CAN BE SUPPLIED — REFER TO FACTORY.

### PANEL MOUNTED INSTRUMENTS

MODEL AEW5A OR 7A & MODEL AUEW5A OR 7A
Edgewise Panel Instruments PRICE—\$30.00 additional to Portable Price.
To order, specify Model AEW5A (or AEW7A, etc.) as required and add the Code for the Portable Design.

### OPTIONAL ACCESSORIES

Spare thermocouples for installation in the field can be ordered with the A and AU. If ordered after the instrument is in service, the type number of the feature and the serial number of the instrument must be specified. (Reference page 402.)

Replacement Thermocouple	Price
Type 357	\$ 100
Type 362	110



**Sensitive Research\***

# MAGNETIC TESTING INSTRUMENTS



## PORTABLE and PANEL

- FLUXMETERS
- FLUXMETER CALIBRATORS
- FLUX VOLTMETERS
- UNIVERSAL MAGNETIC TESTING SETS
- AC CORE LOSS TEST SETS

Model	Description	Page
FS	1% Single Range DC Fluxmeters. 5.2" scale length	452-454
FM	1% Multirange DC Fluxmeter. 5.2" scale length	452-454
GPS	General Purpose Search Coil	452
STM	Standard Magnet	452
FCM	Special Magnet and Search Coil to calibrate fluxmeters	452
FC	Fluxmeter Calibrator for use as a fast, precision laboratory standard	455
FLV	.5% AC Flux Voltmeters. 6.3" scale length	456
FLVC	.25% AC Flux Voltmeters. 6.3" scale length	456
	A Discussion of Commercial Magnetic Measurements	457-458
MAT	Universal Magnetic Testing Set	459-461
EPS	Standard 25 cm Epstein Frame for core loss testing	461
MU	Mutual Inductors for AC permeability testing	461
COL	AC Core Loss Test Set	462

Refer to model descriptions for availability of portable instruments in edgewise cases (Types EW-5A and EW-7A) for panel mounting.

Prices and specifications subject to change without notice.



\* A TRADEMARK OF EIS

**ELECTRICAL INSTRUMENT SERVICE, INC.**

25 Dock Street, Mount Vernon, N.Y. 10550 914-699-9717





# MODELS FS and FM DC FLUXMETERS

## SPECIFICATIONS

DC PORTABLE — HORIZONTAL USE

ACCURACY	1% of full scale* except 1.5% on X100 range
SENSITIVITY	10,000 lines per division using a 1 turn search coil
TYPE	Permanent magnet, double pivoted moving coil
SCALE	Hand-drawn; 5.2"; anti-parallax mirror
SCALE DIVISIONS	100 divisions printed 50-0-50 (Zero Center)
POINTER	Knife edge
DAMPING	Induced emf
PIVOTS	Polished osmium alloy point, non-magnetic shaft
JEWELS	Sapphire
SHIELDING	Electrostatic
RANGE CHANGING	Model FM switch controlled
MECHANICAL ZERO	Lever switch and internal battery
CASE	Formica; 7¼" x 7½" x 6⅛" h.; black bakelite panel; hinged cover; carrying handle
APPROX. WEIGHT	6 lbs. net; 22 lbs. shipping

All instruments are provided with data cards listing temperature corrections and maximum overload ratings.

\*Full scale in a "Zero Center" instrument is defined as the sum of the full scale deflections to either side of zero.

### OPTIONAL SPECIFICATIONS

1. Instruments can be supplied at no extra charge with "Zero Left" rather than "Zero Center" scales. Other special scales can be furnished if required but correspondence is necessary.

### OPTIONAL ACCESSORIES

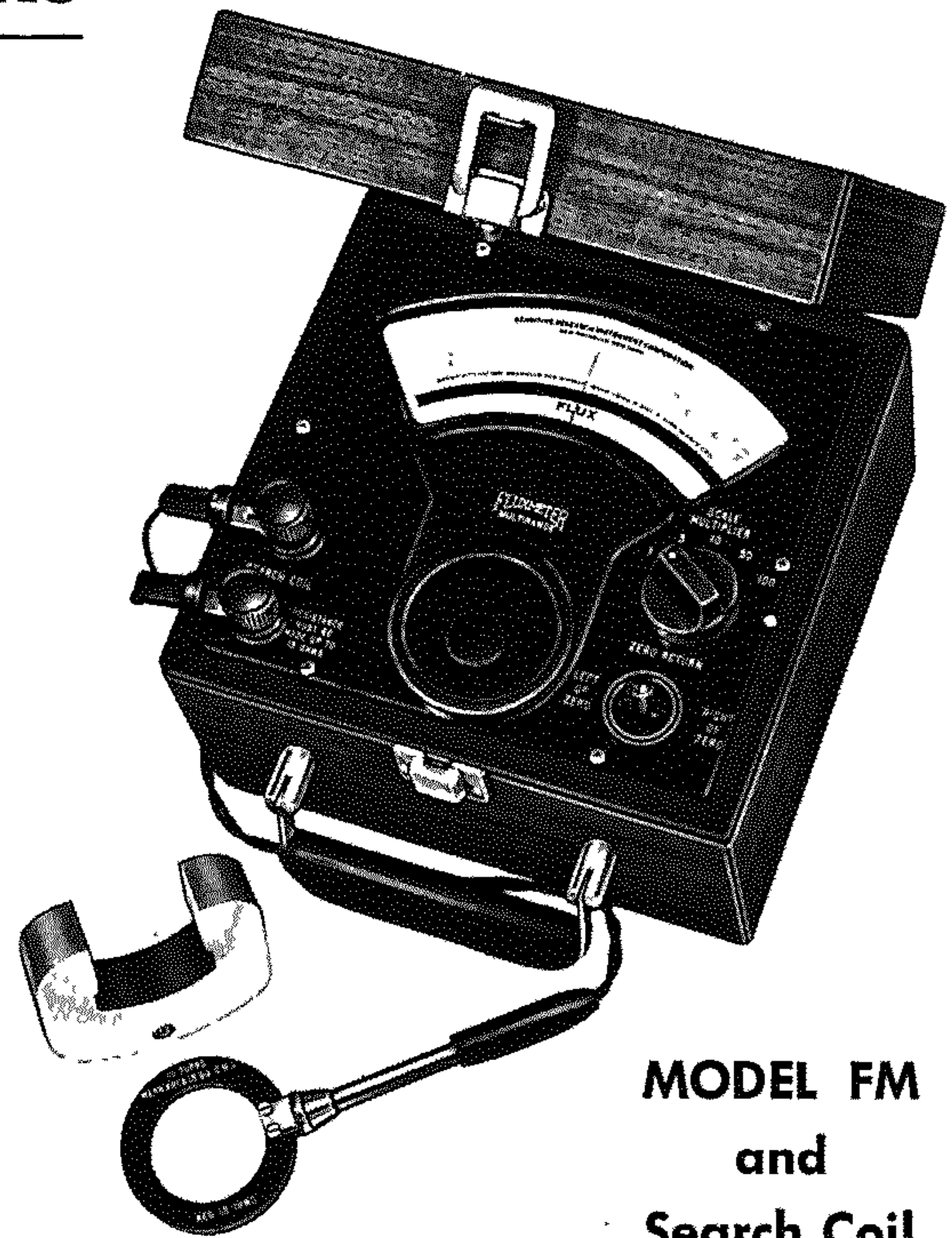
1. A 10 turn, 15 ohm general purpose search coil with a mean area of 15 square cms and a 1¼" center hole is available and recommended for use with the models FS and FM. It has a 5" metal handle and 3' flexible test leads.

**Specify: Model GPS. Price**

Information is available on the design of special search coils. Because of the wide variety of requirements encountered in various applications only a standard search coil can be supplied by Sensitive Research.

To achieve maximum absolute accuracy, special search coils must always be made up to 15 ohms. Where extreme sensitivities are required purely on a comparative basis, such as checking residual magnetism on small samples of soft steel, search coil resistances of much more than 15 ohms can be used on the X1 range of the Model FM or with the most sensitive Model FS. Under these conditions, multiplier values and calibrations are incorrect, but accurate comparisons can be made. (See Fig. 1.)

2. Standard "U" shaped magnets adjusted to an accuracy of 1% are available with any fixed value of total flux from 10,000 to 50,000 lines (maxwells). **Specify: Model STM** and give value of total flux desired. **Price**



**MODEL FM  
and  
Search Coil**

3. A general purpose 10 turn search coil and a 50,000 line standard magnet can be supplied as an inexpensive .5% accurate system for calibrating fluxmeters. This combination can check full scale deflection (on either side of zero) for the Model FM multirange fluxmeter, on its X1 range; and for a Model FS single range fluxmeter, with a range of 500,000 lines. Additional magnets are available with any value from 10,000 lines to 50,000 lines and can be calibrated with the search coil to provide .5% accurate checks at intermediate scale points. For the search coil and 50,000 line magnet, specify the **Model FCM. Price** If additional magnets calibrated with the search coil are desired, specify the values required in lines or maxwells. **Price** each additional calibrated magnet.

The attention of the user is directed also to the Model FC, a fluxmeter calibrator developed for production testing of the models FM and FS at Sensitive Research. See Pg. 455.

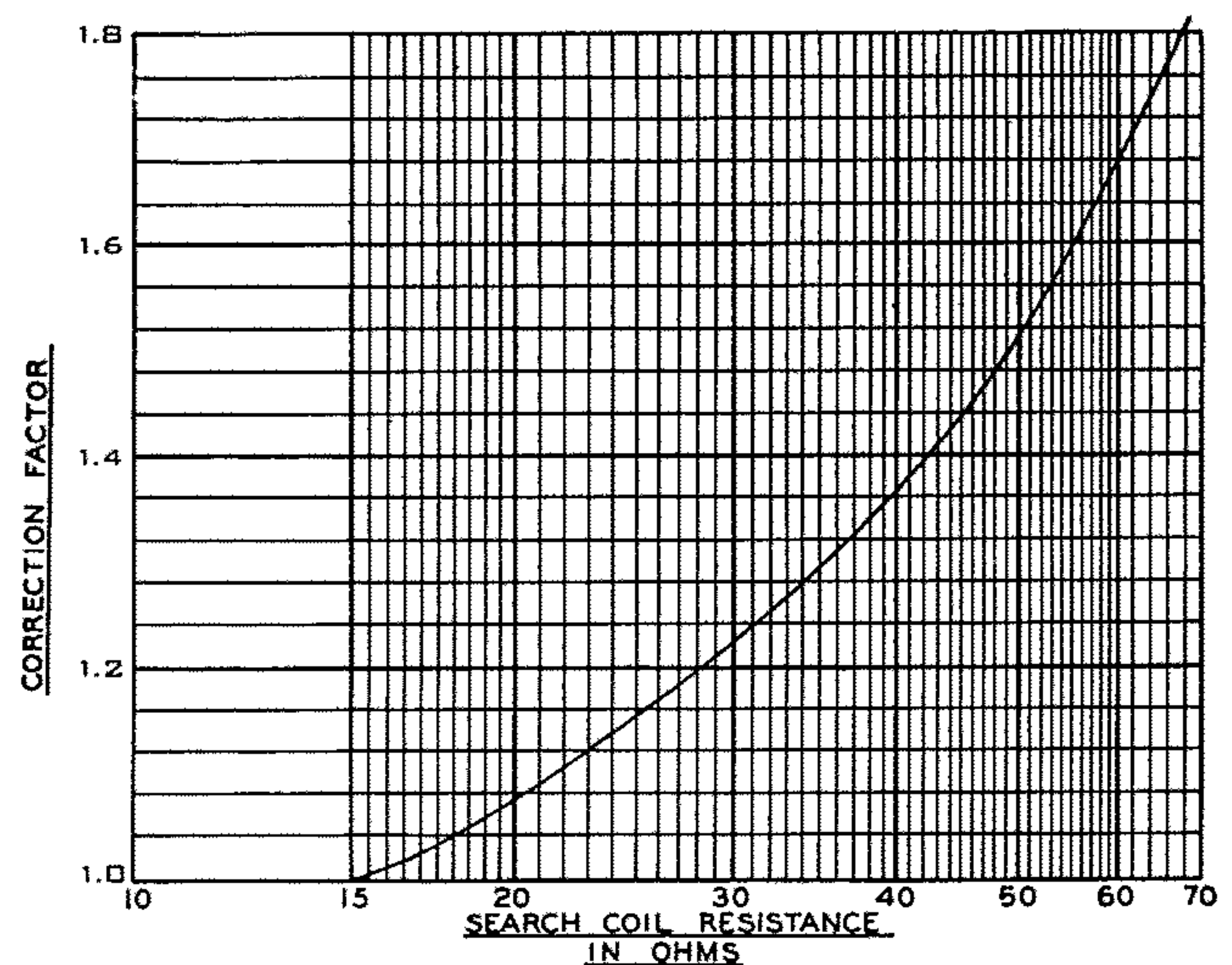


Figure 1.

Approximate correction curve for use with search coils over 15 ohms. (Applies to fluxmeters manufactured after Nov. 1958.)



## GENERAL DESCRIPTION

The Models FS (single range) and FM (multirange) are direct reading fluxmeters for the measurement of total magnetic flux in maxwells (or cgs lines) and use in related applications such as (1) *obtaining B-H curves*, (2) *DC permeability testing*, (3) *determining the number of turns wound on an iron core or that can be placed on an iron core* and (4) *measurements of electrical discharge*. By calculation, if the area of the search coil is known, readings in lines (or cgs lines or maxwells) can be converted to indicate flux density in lines per square cm, or gaussses. The only difference between the two models offered is that the Model FM is supplied with 5 switch controlled ranges while the Model FS is a single range instrument only.

The fluxmeter is actually a galvanometer movement without restraining springs. Deflection of the pointer is opposed only by a counter emf set up by the rotation of the moving coil in a magnetic field. The pointer remains at its maximum deflection unless manually actuated by the user to return to zero. A lever switch is mounted on the panel for this purpose. Power is supplied by an internal mercury battery. If desired, at slightly reduced accuracy, the range of the instrument can be increased twofold by zeroing the pointer at full scale instead of center scale.

The fluxmeter has many advantages over the ballistic galvanometer method of making magnetic measurements. When using the latter instrument, it is essential that the discharge from the search coil be completed before the galvanometer coil begins to move and the deflection of the galvanometer must be quickly observed "on the run" before it returns to zero. In the fluxmeter, because it lacks an appreciable restoring torque, deflection is virtually independent of the insertion speed of the search coil, and the pointer remains with little drift for short periods of time at its maximum deflection.

The fundamental sensitivity of the fluxmeter is 10,000 lines per division using a 1 turn 15Ω search coil. Sensitivity can be increased on a pro rata basis by using a search coil with more turns. As an example, a search coil of 100 turns enables a sensitivity of 100 lines per division; 1000 turns, 10 lines per division, and so on in similar sequence. To achieve maximum accuracy, however, the search coil must be made up to 15Ω as accurately as possible. Search coils can be used with resistances that exceed 15Ω, but at reduced accuracy. This applies only to the X1 range of the Model FM or a 500,000 line Model FS. (See Fig. 1.)

The relatively complex theory of operation of the models FM and FS fluxmeters can be rather simply explained. An external search coil encloses a definite number of flux lines with a definite number of turns. An internal coil of a number of turns encloses a definite number of lines created by an internal permanent magnet. From the conservation of energy theory, it requires energy to change the flux linkages

of this complete circuit, but because of the absence of springs or friction, no latent energy is present. Therefore, when the external flux changes the number of lines linking the search coil, the internal coil, if it is not to have energy expended, takes up a position such that it cuts more or fewer lines (as the case may be). The final position of the pointer is achieved when the total lines being enclosed by the whole circuit, internal and external, is the same as originally existed.

While the fluxmeter design presupposes a theoretically torqueless moving system, actually some small restraining forces do exist. These do not appreciably affect accuracy or operation. When the fluxmeter is used with a 15Ω search coil, mechanical positioning is guaranteed to a stability of ±1 division for 15 seconds.

## Applications of the Models FS and FM

Fluxmeters of this design can be employed in innumerable applications requiring general DC magnetic measurements or integration. A brief résumé of some of the most common usages is given in the following discussion.

### (1) Measurements of Magnetic Flux in Maxwells and Gaussses

A search coil of known number of turns and mean area in square cms is inserted into a magnetic field to be measured. It is removed from the field to a position of zero flux. The fluxmeter scale reads directly in cgs lines as follows:

$$A. \text{ Total flux in cgs lines} = \frac{KD}{T}$$

K = cgs lines per division for a specific fluxmeter and range used

where D = divisions deflection

T = number of turns in search coil

If the reading equals 20 divisions when used on the X1 range of a Model FM fluxmeter with a 10 turn 15Ω search coil, then:

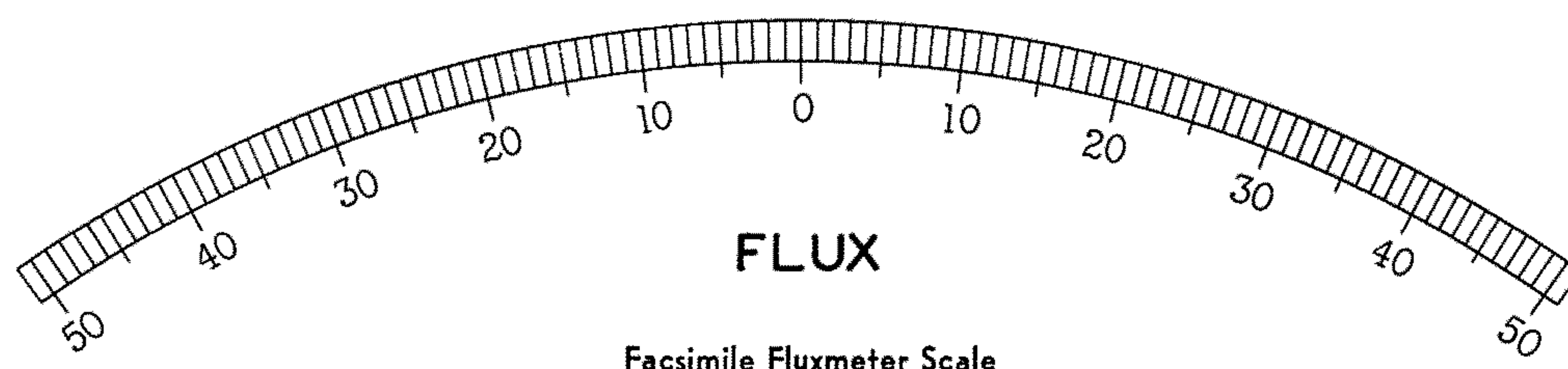
$$\text{Total flux} = \frac{KD}{T} = \frac{10,000 \times 20}{10} = 20,000 \text{ cgs lines}$$

B. To find the strength of a magnetic field in cgs lines per square cm, or gaussses

$$\frac{\text{cgs lines}}{\text{area}} = \frac{KD}{TA} = \text{gaussses where } A = \text{mean area of search coil in square cms}$$

### (2) Obtaining β-H Curves

The sample to be tested should preferably be in a toroidal core form having a primary and a secondary winding. Its radial thickness should be made small as compared with its mean radius. By connecting (1), the primary winding (through a reversing switch) and an ammeter to a DC supply, and (2), the secondary winding to a fluxmeter, points for a β-H curve can be obtained by quickly reversing the current and reading the fluxmeter deflection.





# MODELS FS and FM DC FLUXMETERS

The magnetizing field is easily determined from the current in the magnetizing winding and the magnetic path length.

Magnetizing force in oersteds (gilberts per cm) =  $H = \frac{.4 \pi NI}{L}$  where

N = Number of turns in primary winding; I = Primary current in amperes; L = Mean length of magnetic path in cm =  $2\pi r$  where r is the mean radius of the ring in cm:

Flux density in maxwells per square cm or gaussses =  $\beta = \frac{DK}{2AN_s}$  where

D = Fluxmeter deflection; K = Maxwells per division (fluxmeter sensitivity); A = Cross sectional area of magnetic path is sq. cm; N<sub>s</sub> = Number of turns in secondary winding; 2 = Constant because current is reversed and flux density changes from +  $\beta$  to -  $\beta$ .

### (3) DC Permeability Testing

Such measurements are made by using data obtained from B-H curves.

Permeability =  $\frac{\beta}{H} = \frac{\text{gausses}}{\text{oersteds (gilberts per cm)}}$

### (4) Determining the Number of Turns in an Unknown Coil Wound on an Iron Core or That Can Be Placed on an Iron Core

This is accomplished by winding a few turns along the length of an unknown coil and connecting to a fluxmeter. A measured current is reversed through the unknown coil and the deflection on the fluxmeter noted. An exact number of turns is wound over both the unknown coil and the search coil, and a current is reversed through this coil to produce the same fluxmeter deflection. (See Fig. 2.) Then:

Unknown turns =  $\frac{\text{ampere turns in substitute winding}}{\text{amperes in unknown winding}}$

**NOTE:** If the coil to be checked is not on a ferromagnetic core, it must be placed temporarily on some form of closed magnetic path.

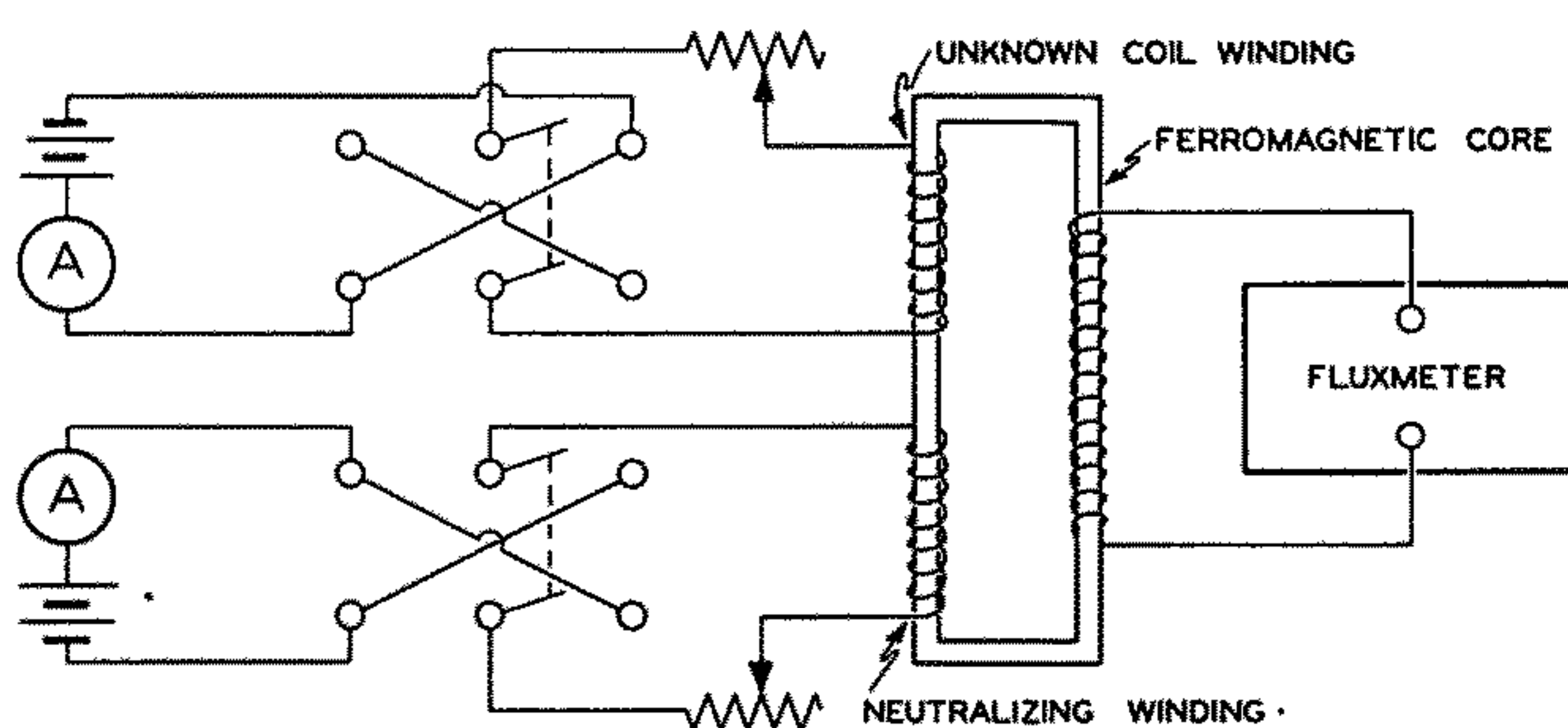


Figure 2

### (5) Measurement of Electrical Discharges

In this application the fluxmeter can be considered a calibrated coulomb meter. The discharge must take place through a low resistance, non-inductive shunt. Then:

Coulombs discharged = (Q) =  $\frac{DK}{R \times 10^8}$  where D =

Fluxmeter deflection; K = Maxwells per division of fluxmeter; R = Resistance of shunt in ohms.

Milliamperes seconds discharged =  $\frac{DK}{R \times 10^5}$

## PANEL MOUNTED INSTRUMENTS

The models FS and FM are also available for vertical panel mounting in the shallow EW-5A (5" scale length) or EW-7A (7" scale length) edgewise panel case. (For dimensions see page 220, Section 3.)

Performance characteristics are the same as listed for the portable type except that the lever switch and battery employed to zero the movement are furnished separately for installation in the user's panel.

**Specify:** A. *Single Range:* Model FSEW-5A or FSEW-7A and code word of single range fluxmeter having range desired. Price

B. *Multirange:* Model FMEW-5A or FMEW-7A, Code FLUXO. Price

**NOTE:** For production testing, an edgewise panel mounted fluxmeter can be furnished with a "zero left" scale and arranged so that the user can provide continuous automatic return of the pointer to zero. This requires an external battery and a switch that is either foot operated or incorporated into a test jig. Such operation allows for high speed semi-automatic testing of magnets. Correspondence is suggested.

If the application makes it desirable, fluxmeters can be supplied in a flanged case for recessed mounting in a horizontal bench. Terminals can be placed either on the top panel or on the underside of the case. Specify "Flanged case for bench mounting" and add \$15.00 to the price of the portable model.

## RANGES

Ranges and sensitivities listed below are based on using the fluxmeter with a 1 turn search coil. If a standard *Sensitive Research* general purpose 10 turn search coil is used, sensitivity is increased by a factor of 10. Full scale range is on the basis of a "zero center" scale. By zeroing at full scale, twice the normal full scale deflection can be obtained.

### MODEL FS (Single Range)

Full Scale Range in Lines	Sensitivity in Lines/Div.	Code	Price
500,000	10,000	FLUXA	
1,500,000	30,000	FLUXE	
5,000,000	100,000	FLUXI	
15,000,000	300,000	FLUXU	
50,000,000	1,000,000	FLUXY	

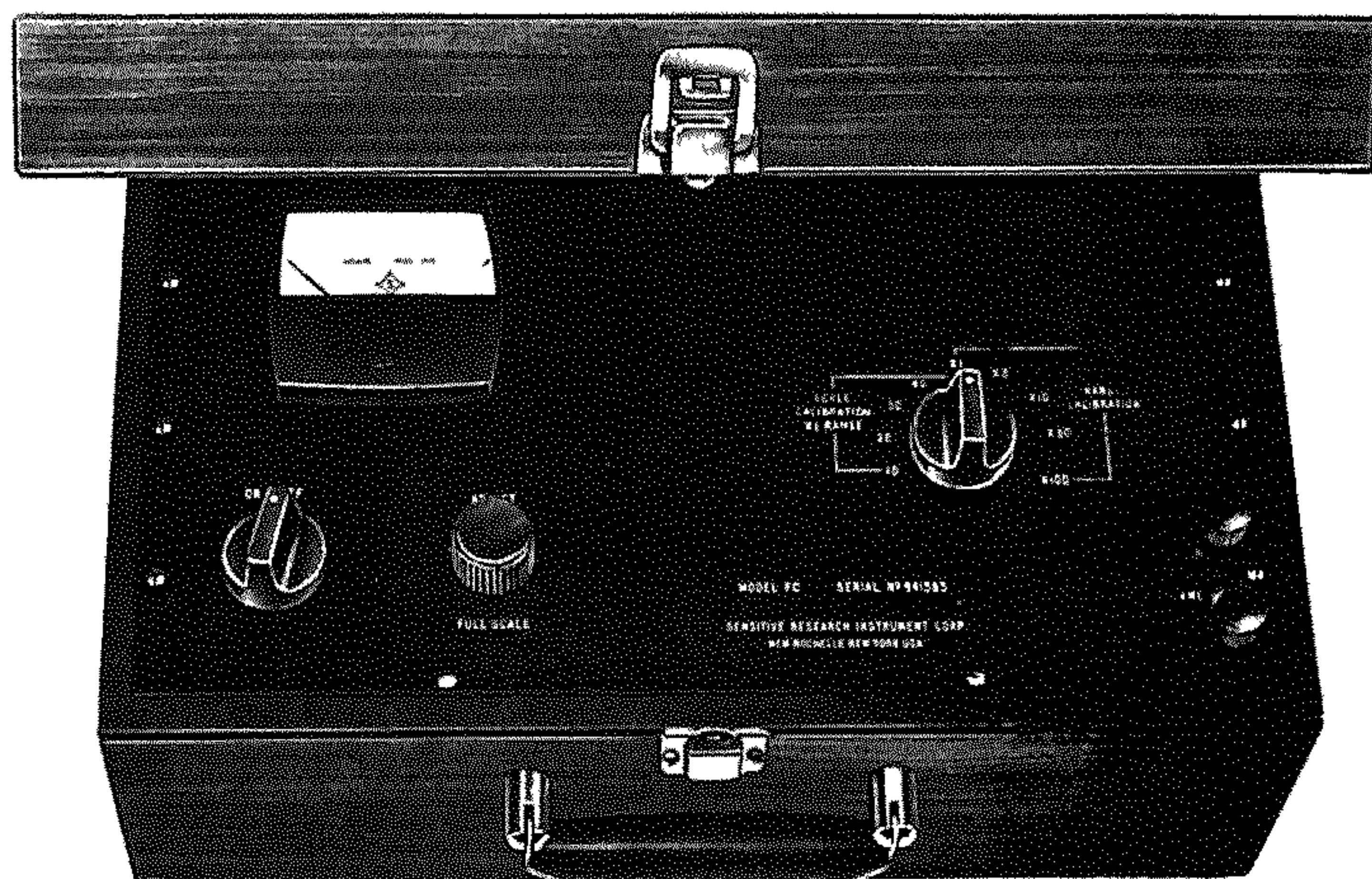
### MODEL FM (Multirange)

Full Scale Range in Lines	Switch Position	Sensitivity in Lines/Div.	Code	Price
500,000	X1	10,000	FLUXO	
1,500,000	X3	30,000		
5,000,000	X10	100,000		
15,000,000	X30	300,000		
50,000,000	X100	1,000,000		



# MODEL FC FLUXMETER CALIBRATOR

## MODEL FC



## SPECIFICATIONS

### PORTABLE DC FLUXMETER CALIBRATOR

ACCURACY	.2% of output
OUTPUT RANGES	Specific calibration points as follows: 100,000 / 200,000 / 300,000 / 400,000 / 500,000/1.5 million/5 million/15 million/50 million flux linkages. (Output ranges correspond to cardinal points on the Model FM multirange fluxmeter scale as follows: 10/20/30/40/50 on either side of zero on the XI range and full scale for all other ranges.)
RANGE CHANGING	Switch controlled
OUTPUT RESISTANCE	15Ω
TEMPERATURE COEFFICIENT	.04%/°C for a deviation of ±5°C from a reference temperature of 25°C
POWER REQUIREMENTS	2 # RM-42R Mallory batteries (or equal) mounted internally and replaceable from the back of the case.
CASE	Formica; 13¾" x 7½" x 6½"; black bakelite panel; hinged cover; carrying handle
APPROX. WEIGHT	12 lbs. net; 26 lbs. shipping

## OPTIONAL SPECIFICATIONS

1. Special output ranges having a value of any multiple of 100,000 flux linkages and not exceeding 50 million flux linkages can be supplied. Standard output ranges (as listed above) up to and including 5 million flux linkages can be furnished for use with instruments requiring an external circuit resistance of 1Ω or less in addition to the normal 15Ω specified. Correspondence is invited.

## PANEL MOUNTING

The Model FC can be supplied on a standard 19" x 7" x 1/8" grey aluminum panel for rack mounting.

Specify: Model FC-P Code FLUCAL Price:

## GENERAL DESCRIPTION

The Model FC provides .2% accurate calibration points for checking the *Sensitive Research* Models FM and FS fluxmeters (see pages 452-454), or any other fluxmeter or ballistic galvanometer designed for use with a 15Ω external circuit. It is a simple to operate, easy to maintain, rapid calibrator, with higher accuracy than it has hitherto been possible to furnish in a low cost instrument. When calibrating the multirange Model FM, it provides a check for basic scale linearity at 10 points (5 points on either side of "0") as well as for all ranges at full scale. Consequently it is ideally suited for the calibration of this instrument and the Model FS with a range of 500,000 lines full scale.

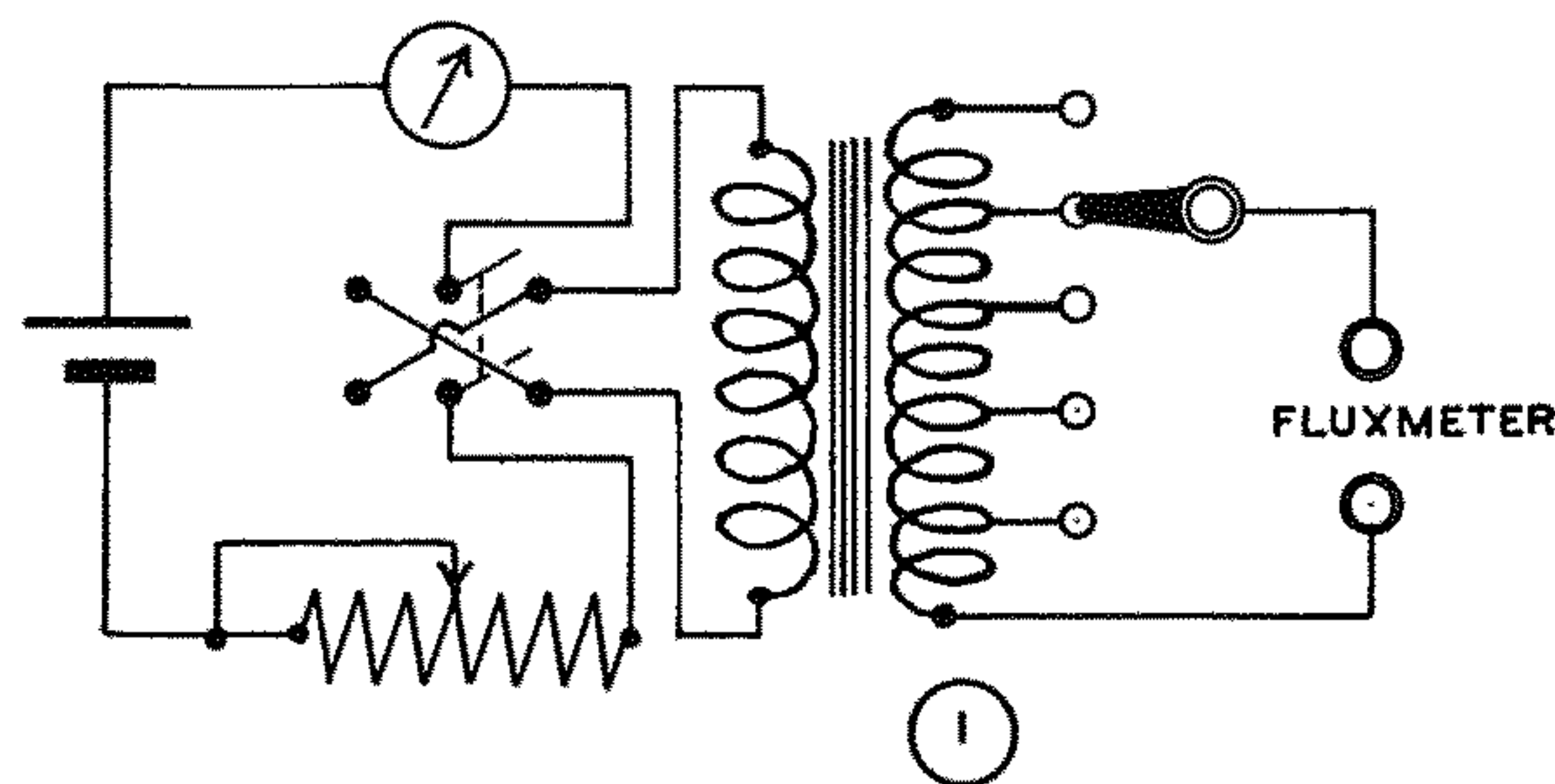


Fig. 1. Basic circuit of fluxmeter calibrator.

The calibrator is furnished complete and requires no accessory equipment or standards. Operation of the instrument is based on the complete flux reversal of a "square loop" core material driven well into saturation. (See Fig. 1.) The core has two windings—a primary for the exciting current, and a secondary with taps to adjust to an appropriate number of turns to sense the flux reversals in the core. These flux reversals constitute the calibration energy for the fluxmeter. In such usage saturation density is an extremely stable characteristic and repeatability and long term stability are readily achieved. The exciting current, which only slightly affects total flux density and hence does not have to be accurately controlled, is set by adjusting a rheostat to give full scale deflection on a 2½" scale panel meter.

Recommended batteries are the Mallory RM-42R or equivalent. They can be expected to have a 100 hour life when in continuous usage and at least twice this figure when the calibrator is used intermittently.

Model FC

Code FLUCAL

Price:



Calibrating a Model FM Fluxmeter



# MODELS FLV and FLVC FLUX VOLTMETERS

## SPECIFICATIONS

AC PORTABLES—HORIZONTAL USE

ACCURACY	A. Model FLV: .5% of full scale B. Model FLVC: .25% of full scale
FREQUENCY	A. Model FLV: 25 cps to 1000 cps B. Model FLVC: 25 cps to 500 cps
TYPE	Full wave rectified, permanent magnet, double pivoted moving coil. Responds to the average value of a voltage.
SENSITIVITY	A. Model FLV: 1000 $\Omega/v$ or 3333 $\Omega/v$ as indicated B. Model FLVC: 1000 $\Omega/v$
SCALE	Hand-drawn; 6.3"; anti-parallax mirror
POINTER	Knife edge
PERIOD	1-2 seconds
DAMPING	Induced emf
PIVOTS	Diamond pivoted
JEWELS	Sapphire; spring mounted
SHIELDING	Magnetic; electrostatic
RANGE CHANGING	Switch controlled
MAGNETIC SHUNT	Internal; $\pm 3\%$ max. adjustment
MECHANICAL ZERO	External zero shifter
CASE	Formica; 7 $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " x 4 $\frac{5}{16}$ "; black bakelite panel; hinged cover; carrying handle
APPROX. WEIGHT	7 lbs. net; 10 lbs. shipping

All instruments are provided with data cards listing temperature corrections and maximum overload ratings.

## OPTIONAL SPECIFICATIONS

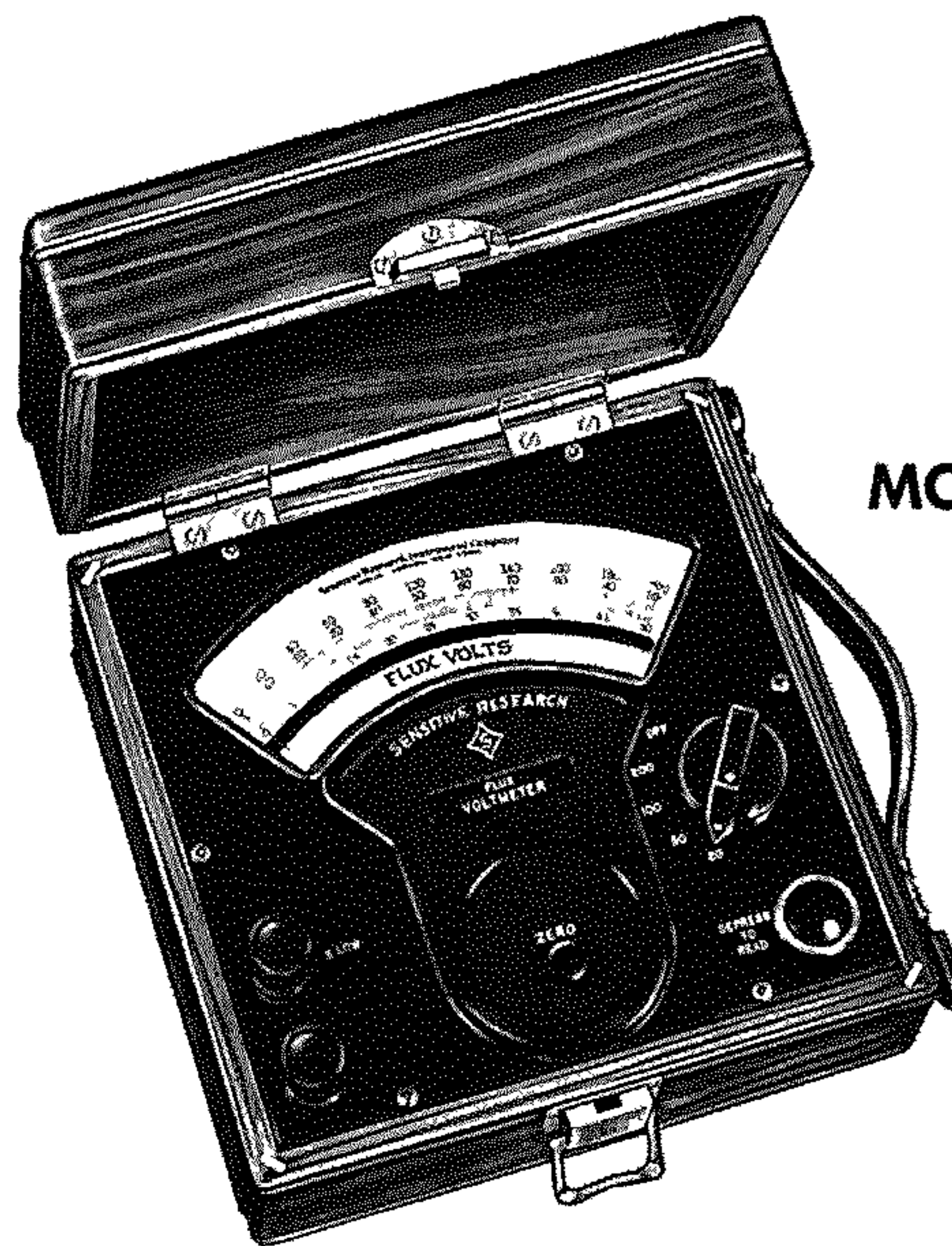
1. Special ranges and/or scales are available. Ranges starting from 5 v full scale can be supplied in the Model FLV, and from 15 v full scale in the Model FLVC. Lower range instruments down to 1 v full scale are available in the Model FLV but they have large and non-linear temperature coefficients, varying in the area of 0.3%/C°, and therefore are practical only for usage in a closely controlled laboratory environment. The number of ranges that can be supplied in a multirange instrument depends on the accuracy required and their full scale values. In general, separate scales must be drawn in the Model FLV for all ranges of 50 v or less, and in the Model FLVC, for all ranges of 100 v or less. Correspondence is required.

## PANEL MOUNTED INSTRUMENTS

The Models FLV and FLVC are available for vertical panel mounting in the shallow EW-5A (5" scale length) and EW-7A (7" scale length) edgewise panel cases. (For dimensions see page 220 of Section 3.) Performance characteristics are the same as listed for the portable types excepting the EW-5A case can accommodate a maximum of 100 scale divisions.

**Ordering Information:** Designate the portable model desired and add the suffix EW-5A or EW-7A. (Example: Model FLVEW-5A.) Specify the code word for the ranges desired, and when ordering the Model FLV, whether sensitivity is to be 1000  $\Omega/v$  or 3333  $\Omega/v$ .

**Price:** Add \$25.00 to price listed for the code word of the instrument selected.



MODEL FLV

## GENERAL DESCRIPTION

The Models FLV and FLVC are full wave rectified, average reading AC voltmeters calibrated in terms of the rms values of a sine wave (average volts  $\times 1.111$ ). Their designation as "flux voltmeters" arises from the fact that instruments of this type have been widely employed in magnetic measurements to ascertain the maximum flux density ( $\beta$ ) of transformer windings. They are extremely useful in this application because the flux density induced in a magnetic core is proportional to the average value of both the positive and negative half cycles of the voltage. Since the flux voltmeter only responds to average values, variations in waveform do not cause errors in the instruments' response to flux density. In flux density measurements near saturation, the accuracy of the flux voltmeter is of importance because errors of setting flux density are reflected as much larger errors in core loss and exciting va readings. It is for this reason that accuracies of both .5% and .25% are offered. The reader is referred to the American Society for Testing Materials' publication "Standard Methods of Test for Alternating Current Core Loss and Permeability of Magnetic Materials" (ASTM Designation: A343) for a complete description of the application of flux voltmeters in magnetic measurements.

The Models FLV and FLVC can also be employed as general purpose AC voltmeters when usage is on a sinusoidal waveform. In only this instance do the scales read true rms values. They make excellent indicators that are somewhat preferable to other AC types because of a combination of qualities which include fast response time, high sensitivity, wide frequency range and overall general ruggedness.

Range	Scale Div.*	Code	MODEL FLV†		MODEL FLVC	
			1000 $\Omega/v$	3333 $\Omega/v$	Code	1000 $\Omega/v$
30/75	150	FVABO			FVABOC	
60/120	120	FVDEF			FVDEFC	
75/150	150	FVGOI			FVGOIC	
5/10/20	100	FVVUL			—	—
7.5/15/30	150	FVVEE			—	—
7.5/15/150	150	FVVAK			—	—
30/75/150	150	FVJOL			FVJOLC	
50/100/200	100	FVANO			FVANOC	
75/150/300	150	FVPOR			FVPORC	
30/75/150/300	150	FVVOX			FVVOXC	

\* According to number of ranges and model, individual instruments have up to 4 sets of scale divisions.

† Specify  $\Omega/v$  required when ordering.



Organizations performing magnetic measurements are consistently plagued by test results that exhibit less than satisfactory overall accuracy and precision. There often exists not only a lack of agreement between producers and users of magnetic materials employing the same test procedures on the same materials, but also significant discrepancies within an organization trying to repeat its own results. The basis of this discussion is to examine carefully some of the major problems encountered in magnetic measurements and to relate their solution to the extensive line of *Sensitive Research* test equipment designed specifically for this application. In particular this analysis is meant to serve as a preface to the specifications for the **Model MAT, Universal Magnetic Testing Set** (see pages 459-461) and the **Model COL, Core Loss Test Set** (see page 462).

The greatest volume and hence the greatest measurement needs occur in the "soft" magnetic steel industry. "Soft" in this case refers to low retentivity materials such as low carbon and silicon steels, usually used in laminated form, primarily for transformers and motors. These materials can be classified as to whether they are high density or low density types and as to their use.

**High density materials** are those used for power transformers and motors. Such material is commonly sold on the basis of a  $v_a$  and/or watts per pound specification. Usual test densities are 10 kilogausses and 15 kilogausses. Tests are made using the circuit shown in Fig. 1.

In choosing the instruments for these tests, care must be exercised. The current instrument and the wattmeter field circuit are in series with the exciting winding of the test sample. These instruments must be of relatively low impedance or they have a major effect on the accuracy of the measurement being performed. The core material at these densities is extremely non-linear in response and it is impossible to maintain a sinusoidal waveform for both current and voltage. Therefore, it is desirable to keep the flux (induced voltage) sinusoidal, as high frequency components of a distorted wave have high loss factors and contribute more to high core loss readings than does a sinusoidal test. If series resistance is added in the exciting winding it tends to cause the current to be sinusoidal and the induced voltage becomes non-sinusoidal. Series resistance to adjust the excitation current cannot be used satisfactorily. This measurement requires not only low impedance instruments but a low impedance power source.

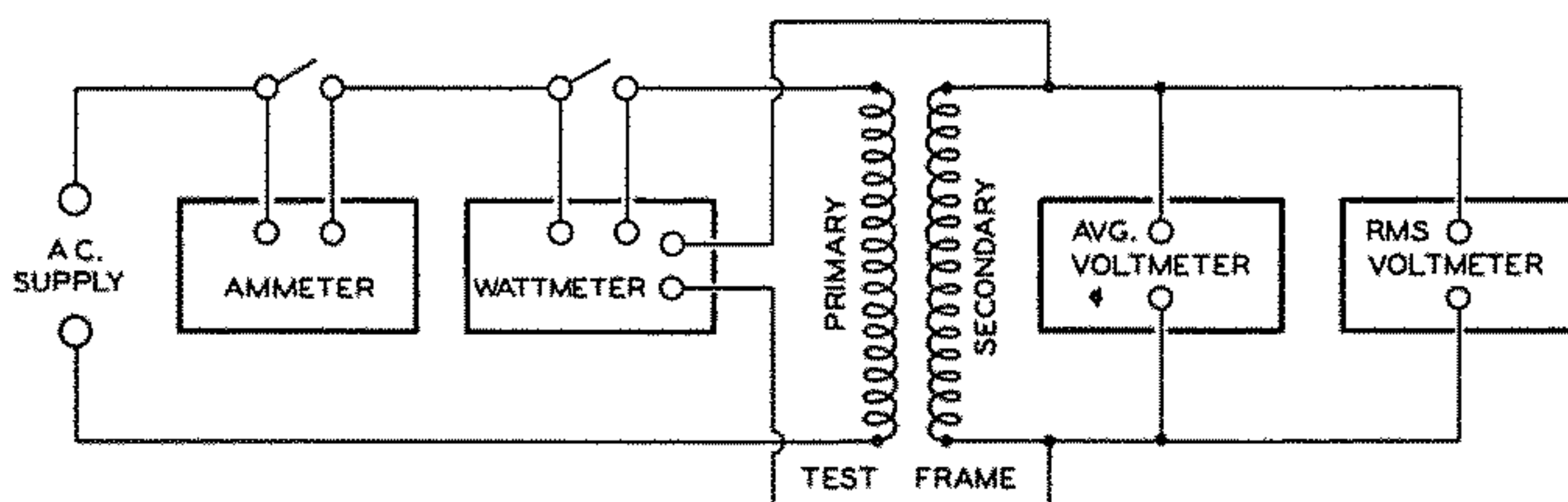


Figure 1.

The induced voltage is read on an average responding instrument whose scale is marked in terms of  $1.11 \times E$  average. Such an instrument is commonly called a "flux voltmeter" and it gives readings proportional to  $B_{max}$ , regardless of waveform distortion. In addition, an rms responding instrument, as shown in Fig. 1, is in parallel with the flux voltmeter. These two instruments agree exactly (within their accuracies) for induced sinusoidal voltages, and when differences occur, these differences are indicative of the distortion present. This arrangement allows for a correct measurement of exciting  $v_a$  and core loss. The test sample can be in the form of a stack of 3 cm x 28 cm strips in an Epstein Frame. With care to keep copper losses negligible, it can also be two windings on a suitable stack of EI laminations. In some cases the sample material can even be used with a single coil and the potential circuits of the instruments connected directly across the exciting winding. *Great care must be used to minimize copper loss errors in single coil tests.*

The Circuit of Fig. 1 can be modified as shown in Fig. 2. Here an air core mutual inductor has its primary inserted in the exciting winding and provision for connecting the flux voltmeter to the secondary. The average voltage on the secondary is proportional to the peak of the exciting current. Using a calibration factor supplied with each mutual inductor, the peak exciting current can be determined. This peak exciting current is used to calculate an  $H_{max}$  value, and combined with the  $B_{max}$  value set by means of the flux voltmeter on the induced voltage winding on the test sample, it is used to determine permeability as being  $\frac{B_{max}}{H_{max}}$ . This is the value of permeability most often used for high and medium density materials. There are many other values of AC permeability which can be defined. This  $\frac{B_{max}}{H_{max}}$  value is the value specified in ASTM Specification A343, and in lieu of any statement to the contrary is usually meant when discussing permeability in medium to high density tests.

A precaution must be observed in high density measurements to carefully define what is meant by path length and cross section of the sample material. ASTM specifications base all cross section values on sample weights and on assumed density for the material rather than on measured cross sections. Path length assumptions on EI samples can cause major discrepancies between different laboratories making similar tests.

Another factor that must be taken into consideration is the lack of reproducibility of the average sample of laminated materials. With samples .014" and thinner, in most commercial materials a test can be made, the material removed from the test fixture, shuffled and restacked in the same fixture, and a different set of readings obtained. Reasonable variations are in the order of 1/2% to 1 1/2% for 10 kilogausses tests on Epstein samples and 1% to 2% for EI samples. For 15 kilogausses tests, these vary appreciably, approximating 1% to 2% for Epstein Frame samples and 1 1/2% to 3% for EI samples. Correlation of results can not in general be relied upon to better than these values except on a statistical basis. These values are the variations due to the samples alone and do not include instrument errors.



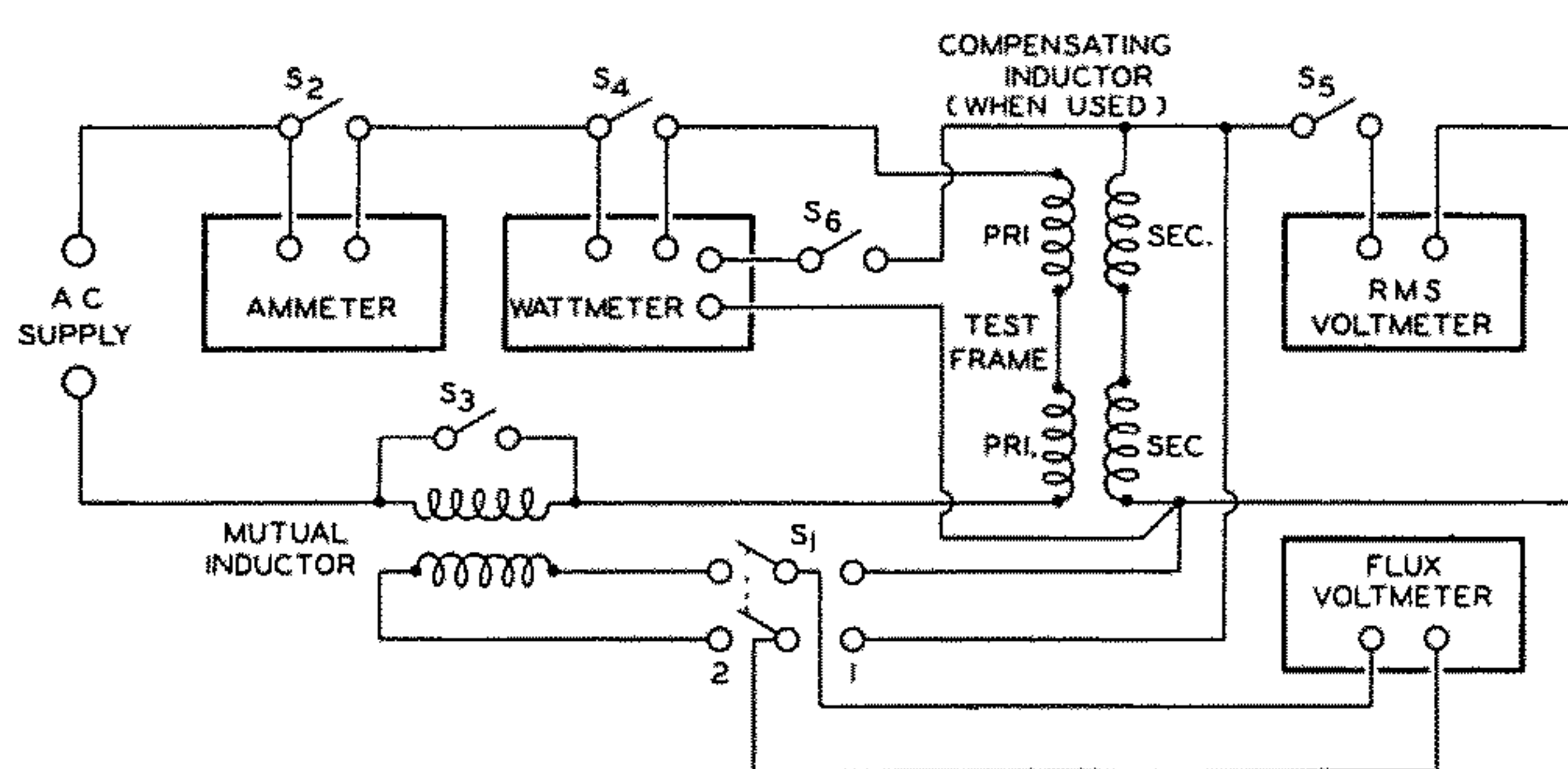


Figure 2.

In addition to high density core loss characteristics, many "soft" materials are also purchased on the basis of a low density specification. These materials are generally classed as audio grades. Common test densities are 40, 200 and 2000 gauss. At these densities the quality criterion is ordinarily permeability, which in this instance is usually defined as that value which when inserted into the formula 
$$L = \frac{.4\pi N^2 \mu A}{10^8 l}$$
 gives the parallel inductance in henries. This value is obtained from either a bridge measurement or by impedance matching in some other comparison circuit. At the densities involved no particular problems with wave form are usually encountered. The ASTM method can be employed at medium densities and gives nearly comparable values of AC permeability. It is not suitable for very low density measurements, and at high density it does not give permeability values that agree with results obtained by bridge tests, nor do either of them agree exactly with values calculated from  $v_a$  measurements.

The second largest group of magnetic measurements are concerned with the "hard" magnetic materials used as permanent magnets. Various permeameter methods are used for research and design work with such materials. However, commercial users of hard materials are nearly always concerned with either total flux or "flux density in a gap" measurements. Total flux measurements are ordinarily made by insertion of a magnet into a coil and measurement of the change of flux linkages when it is removed. A fluxmeter or a ballistic galvanometer is most commonly used as the measuring instrument. Of the two, the fluxmeter is the more convenient and stable device. It eliminates the nuisance of taking readings "on the run" (see Model FM pages 452-454). For readings of gap density one can use either a suitably shaped search coil and a fluxmeter (or a ballistic galvanometer), or one of the Hall effect probes in small areas too tight to allow insertion of a satisfactory search coil. In some special cases a rotating coil can be inserted into a field as a pick up device and its output read as either an AC voltage or synchronously rectified and read as a DC voltage.

Many other types of magnetic materials are of course used commercially. Common are the ferrites and powdered iron materials for high frequency uses. Ferrites and tape wound core materials for "square loop" applications, and a whole field of special materials used for shielding purposes, require special tests related to their normal uses and do not

readily fit into a general purpose measurements program employing standard procedures and instruments.

The entire previous discussion has been based on performing AC measurements on "soft" materials and DC flux measurements on hard materials. It should be noted that DC tests can be made also on all soft materials by merely using an excitation winding with DC flowing, and a sensing winding with a fluxmeter. Point by point measurements can then be made to trace out complete hysteresis loops. These DC tests are valuable as an investigative tool because they show the characteristics of a material without modification by other factors as is sometimes a problem in AC testing. In AC measurements the characteristics of a material are affected by gauge, insulation, burr and other similar frequency sensitive factors.

The Model MAT is the equivalent, with its available accessory equipment, of a complete magnetic testing laboratory. It is capable of all of the core loss, permeability and  $v_a$  measurements called for by ASTM, plus the DC measurements on both "soft" and "hard" materials. In addition it has built-in compensation circuits which eliminate errors from instrument losses and allow completely "tare free" readings of all values. (See pages 459-461.)

The Model COL makes the core loss and  $v_a$  measurements described in ASTM procedures and has a long scale flux voltmeter for extra resolution in setting flux density. This is of importance inasmuch as inaccuracies in setting density (the test voltage) produce errors that are much larger in core loss. The error in the exciting current at 15 kilogausses caused by the voltage error may be 10 to 20 times as large as the voltage error. The Model COL also has internal tare compensation. Primarily, it is a production type test set, whose specific purpose is to speed up and simplify core loss measurements, while providing more accuracy and resolution than available in the Model MAT in this one application. (See page 462.)

The exact range of sample size and measurements which can be made are so interlocked that they are hard to define separately. One must use a sufficiently large sample in order to read on the wattmeter the expected loss at the test density desired. In designing coils for tests on other than Epstein samples the same sensitivity limitations apply. There must be sufficient turns to allow the induced voltage to be within the range of the flux and rms voltmeters. Similarly, the exciting winding must operate within the range of the current meter for the turns used. In the case where the exciting winding and the induced voltage winding are not identical in turns, the measurement requires correction by an appropriate factor.

The purpose of the preceding discussion has been to describe briefly the most common procedures and problems associated with commercial magnetic testing. The subject is complex enough to prohibit complete coverage of the topic in this catalog. However, in most instances, the procedures detailed represent the area of total interest to industrial users and producers of commercial magnetic materials. For further information the reader is referred to the "Book of ASTM Standards" and the bibliographies listed therein.

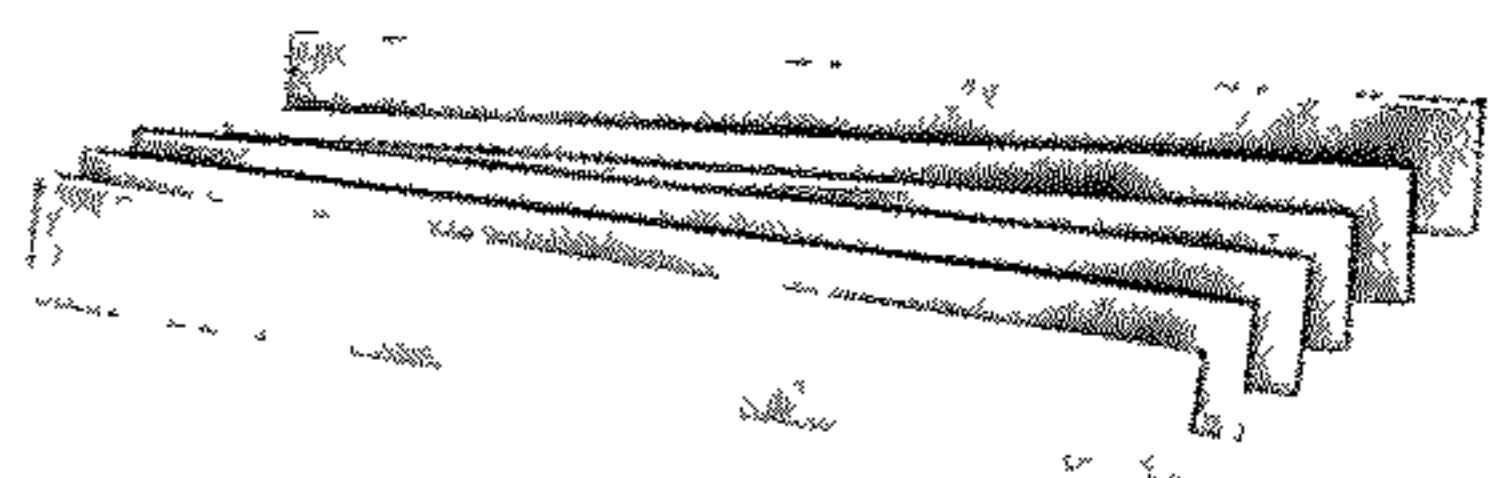
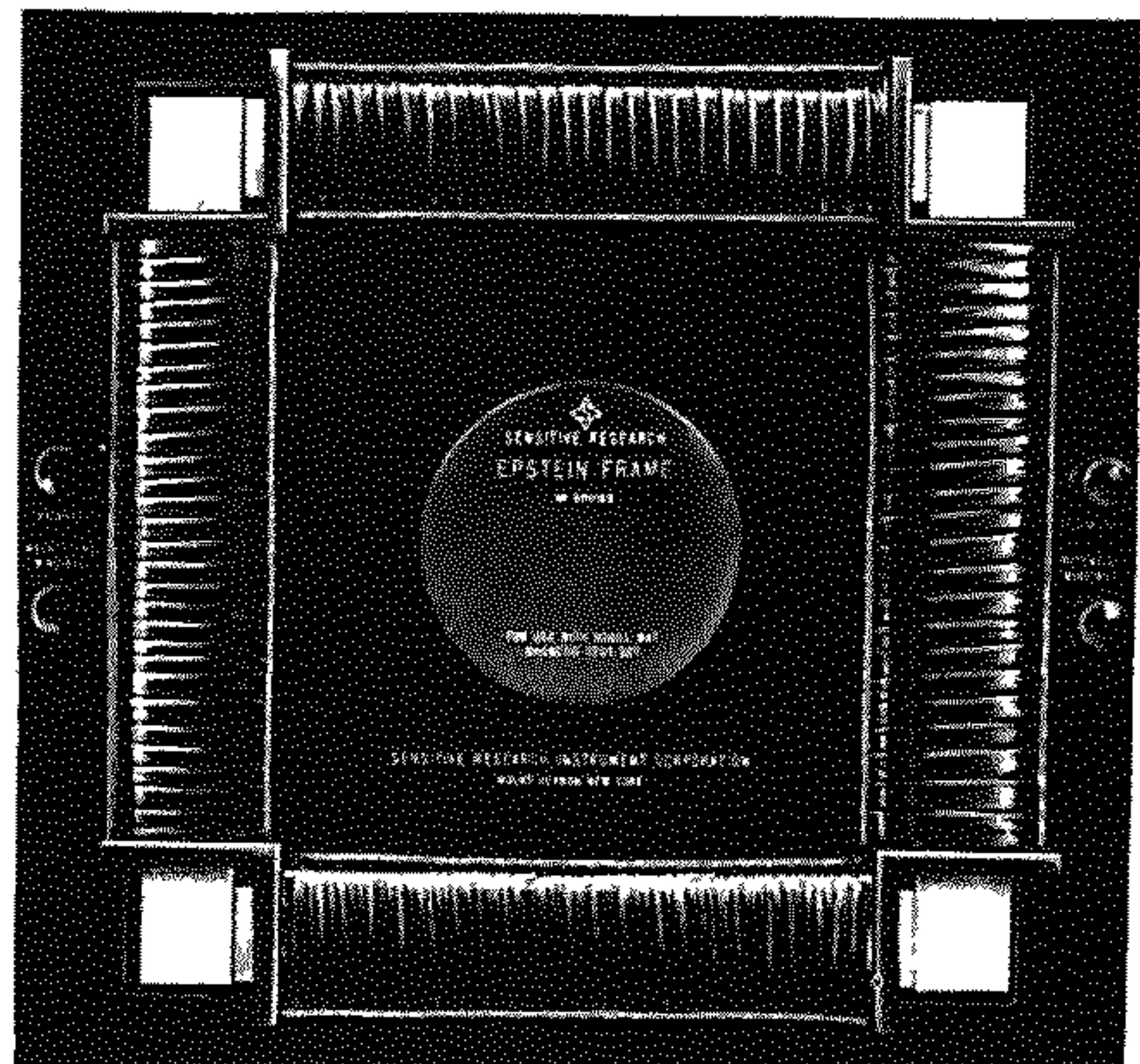


# MODEL MAT MAGNETIC TESTING SET

## MODEL EPS EPSTEIN FRAME

### MODEL MAT

### MODEL EPS



### GENERAL DESCRIPTION

The Model MAT is a portable, multipurpose, magnetic testing set, designed for the following applications:

A. Measurements of core loss,  $v_a$  and permeability in accordance with the procedures of the American Society for Testing Materials (ASTM) as detailed in their publication "Standard Methods of Test for Alternating Current Core Loss and Permeability of Magnetic Materials" (ASTM Designation: A343).

B. A comprehensive DC analysis of hard and soft magnetic materials.

The test set was first introduced in 1954, and since that time it has been universally accepted by both producers and users of soft magnetic materials and hard magnets as the industry standard for core loss measurements and the investigation of related magnetic phenomena. Basically it consists of 6 multirange precision indicating instruments. Each is electrically isolated from the other and, therefore, can be used separately or in as many different combinations as may be necessary. They are mounted in the panel of a suitcase style portable case together with all necessary switching and binding posts for easy interconnection and operation. Such optional equipment as an Epstein Frame for core loss measurements, mutual inductors for permeability testing and a general purpose search coil to assist in measuring total flux, are offered as accessories. Excepting for power supplies, the Model MAT and its accessory items require no other equipment for the following specific tests:

1. Measurements of core loss in watts by using Epstein Frame specimens, EI cores or specimens of other configurations.

2. Measurements of AC permeability by using two mutual inductors, one for magnetizing currents up to approximately 1 amp and the other for currents above 1 amp.

3. The point by point determination of DC hysteresis loops (B-H curves).

4. Measurements of total flux of hard magnets.

5. Measurements of magnetic field strength.

6. General laboratory and production measurements of AC/DC voltage, current and power. The fluxmeter, in addition to its other functions, can be employed as a calibrated coulomb meter for the measurement of electrical discharges, and for determining the number of turns in an unknown coil (see pages 452-454).

In summation, the Model MAT is an extremely versatile magnetic testing set that can also be employed for a variety of other measurements. It is relatively low in price and easy to use for the capability which it provides. Measurements of cores loss are facilitated by including a tare compensation system so that readings in watts can be taken directly without the necessity of calculating and applying correction factors caused by the loading of other measuring instruments in the circuit and the potential circuit of the wattmeter itself. The user has only to divide through by the weight of his sample to obtain an answer in watts per pound.

Other economic and technical considerations are of importance. The test set is now the predominant standard employed in the magnetic materials industry, and where usage is common to quality control and incoming inspection departments, there is a provable, significantly better correlation of test results between the two. Since core loss testing is expensive as regards both the sample material that must be provided and the actual performance of measurements, any duplication of testing that can be avoided is an important saving.



# MODEL MAT UNIVERSAL MAGNETIC TESTING SET

## SPECIFICATIONS

### ELECTRICAL INDICATING INSTRUMENTS

**General:** All instruments unless otherwise noted, have the same specifications as the University Model of the same type described in detail in other sections of this catalog. (DC permanent magnet, moving coil types are listed in Section 3; AC/DC thermocouple types in Section 7; AC/DC dynamometer type wattmeters in Section 5.) The exceptions are the fluxmeter and the flux voltmeter which have no exact University Model counterparts. Excepting for scale length and case size the fluxmeter conforms to the specifications of the Model FM listed on pages 452-454, and the flux voltmeter to the specifications of the Model FLV listed on page 456.

All indicating instruments have 4" hand-drawn mirrored scales. They have diamond pivots and spring mounted jewels to provide virtually friction-free moving elements that can withstand abnormally severe operating conditions (excluding the fluxmeter whose design does not lend itself to their inclusion). All instruments are meticulously constructed in conformance with ASA specifications C-39 (where applicable). Accuracies listed are in terms of percent of full scale.

**DC Ammeter:** Accuracy .5%; 60/75 scale divisions printed 0-30/75/150. Range changing is by binding posts.

Range:	.03	.075	.15	.3	.75	1.5	3	7.5	15	30 amps
Approx. Resist.:	4	1.7	1	.5	.2	.1	.05	.02	.01	.005 Ω

**AC/DC Ammeter:** Accuracy .75%; thermocouple type, true rms response irrespective of waveform; frequency range DC and 7 cps to 5000 cps; 100 scale divisions printed 0-50/100/200; range changing is switch controlled. Automatic overload protection safeguards the thermocouple for overloads of 500% or 10 amps, whichever is the lesser figure.

Range:	.05	.1	.2	.5	1	2	5 amps
Approx. Resist.:	5	3.75	2.2	.95	.5	.25	.1 Ω

**NOTE A:** A Type 357 Thermocouple Replacement Feature is included for the user's convenience in the event the thermoelement is inadvertently overloaded beyond the rating of its protection system. Thermocouples can be replaced in the field without the necessity of returning the test set for recalibration. Replacements are supplied with correction curves. A complete description of the Type 357 Thermocouple Replacement Feature is given on page 153 of Section 2. If spare thermocouples are ordered at the same time as the test set they can be supplied in most cases within the accuracy of the thermocouple ammeter without the necessity of applying correction factors. When ordering, specify "Type 357 Replacement Thermocouple." If additional thermocouples are ordered at a later date than the test set specify the serial number of the indicating instrument in which a replacement is to be made. Price: per thermocouple.

**AC/DC Voltmeter.** Accuracy .75%; thermocouple type, true rms response irrespective of waveform; frequency range DC and 7 cps to 4000 cps; 60/75 scale divisions printed 0-30/75/150. Range changing is switch controlled. \*Automatic overload protection safeguards the thermocouple for overloads of 5000% or 600 v whichever is the lesser figure.

Range:	15	30	75	150	300 v
Sensitivity:	All ranges 500 Ω/v				

**NOTE A:** A Type 357 Thermocouple Replacement Feature is included as described in Note A of the specifications for the AC/DC thermal ammeter. Price: per replacement thermocouple.

**\*NOTE B:** The automatic overload protection system starts to clip when peak to rms ratios greater than 4 to 1 are encountered. If the instrument is used with excitation in the saturation region of square loop type materials it tends to read lower than the actual applied voltage. *This does not occur in normal core loss or permeability testing.* However, provision is made for the simple disconnection of the overload protection system by the user in the event it is found desirable to do so in a particular measurement.

**AC Flux Voltmeter:** Accuracy .5%; full wave rectified, average reading instrument (average volts  $\times$  1.111); scale reads true rms only on a sinusoidal waveform; frequency range DC and 25 cps to 1000 cps; 60/75 scale divisions printed 0-15/30/75/150/300; range changing is switch controlled.

Range:	15	30	75	150	300 v
Sensitivity:	All ranges 3333 Ω/v				

**AC/DC Single Phase Wattmeter:** Accuracy .75% when used from 100% PF down to 50% PF, 1% when used below 50% PF down to 20% PF; frequency range DC & 25 cps to 500 cps, excepting the 12.5 v range DC & 50 cps to 70 cps and the 25 v range DC & 25 cps to 125 cps; approx. 60 cps burden 1.5 va; approximate sensitivity of potential circuit 80 Ω/v; 100/80 scale divisions printed 0-5/10/20/40; selection of all watt ranges is switch controlled.

### RANGES

Volts	Normal Amps at 100% PF	Maximum Amps	Watts
12.5	.2	2	2.5
12.5	.4	4	5
25	.2	2	5
25	.4	4	10
50	.2	2	10
50	.4	4	20
100	.2	2	20
100	.4	4	40
200	.2	2	40
200	.4	4	80



# MODEL MAT UNIVERSAL MAGNETIC TESTING SET

**NOTE A:** Volt ranges may be used at 160% of nominal rating without loss of accuracy. Maximum current ratings enable the wattmeter to be employed at power factors down to 10% without overloading its current circuit. Accuracy in this area of PF varies to 3% depending on the range and frequency being measured, but results are reproducible within the normal precision of the instrument.

**NOTE B:** Current ranges can be increased by the use of the Model TR Type 2 Transformer. (See Section 10.)

**DC Fluxmeter:** Accuracy 1% except 1.5% on X100 range; basic sensitivity 10,000 lines (maxwells) per division using a 15Ω, 1 turn search coil; 100 division scale printed 50-0-50; range changing is switch controlled.

Switch Position	Full Scale Range in Lines	Sensitivity in Lines/Div.
X1	500,000	10,000
X3	1,500,000	30,000
X10	5,000,000	100,000
X30	15,000,000	300,000
X100	50,000,000	1,000,000

**NOTE A:** Sensitivity of the fluxmeter is stated in terms of its being used with a 15Ω 1 turn search coil. Sensitivity increases on a pro rata basis when a greater number of turns are wound on the search coil (provided the 15Ω limitation is observed). A general purpose 10 turn search coil is offered as an "Optional Accessory." When it is used with the fluxmeter, sensitivity is increased by a factor of 10 to become 1000 lines per division.

## OPTIONAL ACCESSORIES

**1. Model EPS:** An Epstein Frame having replaceable tube liners and constructed in accordance with ASTM specifications as listed in A343-60T.

The Epstein Frame is essentially a transformer whose core is the specimen to be tested. It consists of four solenoids, each having a primary and secondary winding surrounding 4 sides of a square magnetic circuit and a mutual inductor to compensate for air flux within the solenoids. A total of 700 turns, equally divided over the 4 solenoids, is wound on non-magnetic, non-conducting forms and mounted on a 14½" x 14½" x 3¾" bakelite base. The center line of the solenoids on opposite sides of the square are 25 cm apart. The frame is for use with a test specimen made of strips of sheet material 28 cm long x 3 cm wide. The air flux compensating inductor is mounted in the center of the frame and internally connected to it. The compensator eliminates the effects of air flux so that only the intrinsic flux of the specimen itself is measured. Weight 21 lbs.; shipping weight 43 lbs.

It is recommended that spare replaceable liners be obtained at the time of purchasing the frame.

**2. Model GPS:** A 10 turn, 15Ω general purpose *Search Coil* for use with the fluxmeter for the measurement of flux density. Special search coils are not available from *Sensitive Research* but information can be supplied as to their construction. A more complete description of the Model GPS standard search coil and its application is given on page 452.

## MODEL MU



**3. Model MU:** Two *Mutual Inductors* are available to be employed with the Model MAT to make permeability measurements. The inductors are a direct ASTM design. The Code MULO, for low current use up to approximately 1 amp, has a greater number of turns for a high value of mutual inductance. The Code MUHI for use at currents higher than 1 amp to approximately 5 amps has a fewer number of turns and therefore is smaller in size and less sensitive.

In operation the primary winding of the mutual inductor is inserted in series with the exciting winding on the test sample, and a flux voltmeter reading is taken across the secondary. The secondary reading multiplied by the calibration factor supplied with each unit is the crest ampere value of the exciting current. This current value is used in the

formula  $H = \frac{.4\pi NI \text{ crest}}{l}$  and the value of H can be com-

puted.  $\beta$  is determined from the flux voltmeter reading across the secondary by formula

$$\beta \text{ max} = \frac{E}{4.44 fN \& A \times 10^{-8}} \text{ Permeability is then } \frac{\beta \text{ max}}{H \text{ max}}$$

The Model MAT is supplied in a sturdy 25" x 18¼" x 9" deep oak case with removable hinged cover and carrying handle. There is a compartment for test leads, clips and other accessories. Approximate weight is 75 lbs. net; 170 lbs. shipping. Operating instructions as well as publication "ASTM Standards Relating to Magnetic Properties" are furnished.

Model	Description	Code	Price
MAT	Universal Magnetic Testing Set	MATSET	
EPS	Epstein Frame (Replaceable Liners for Epstein Frame \$15.00/set of 4)	EPSMAT	
MU	Mutual Inductor (up to 1 amp) Mutual Inductor (over 1 amp to 5 amps)	MULO MUHI	
GPS	General Purpose 10 Turn Search Coil for Fluxmeter		



# MODEL COL AC CORE LOSS TEST SET

## GENERAL DESCRIPTION

The Model COL is a production type test set designed specifically for measuring AC core loss and excitation currents as described in the American Society for Testing Materials, publication A 343-54, sections 5 to 7, pages 385 to 391. It differs from the Model MAT, a multipurpose magnetic testing set previously described on pages 459 to 461 in that it provides faster, easier operation at higher accuracy in a limited area of measurement. Whereas each indicating instrument in the Model MAT can be used separately if desired, thereby preserving the utmost in versatility, the instruments in the Model COL are completely connected internally and can only be employed as a fixed combination for measurements as specified in certain ASTM procedures.

The Model COL can be used either with an Epstein Frame or with suitable test coils wound on stacks of EI laminations. It is intended for measurements of power transformer materials at relatively high densities, such as the measurement of  $v_a$  and core loss at 10 kilogausses and/or 15 kilogausses, and at 60 cps and/or 400 cps. An internal tare compensation system enables direct reading of both watts and current, without correction, and results in a significant saving of time during production testing.

The flux voltmeter in the test set has excellent resolution as provided by a 6.3" scale length. This is an important advantage because any errors in setting the test voltage are magnified in the watt readings at high densities. The error in the exciting current at 15 kilogausses caused by the voltage error may be 10 to 20 times as large as the voltage error.

## SPECIFICATIONS

**General:** All instruments in the Model COL have hand-drawn mirrored scales, diamond pivots and spring mounted sapphire jewels, and automatic temperature compensation. They are constructed to conform to ASA specifications C-39 (where applicable). *Range changing is completely switch controlled.* The individual instruments comprising the test set are listed below. For a more complete description of each type, the reader is referred to the listings for portables in other parts of this catalog section and Sections 7 (thermocouple instruments) and 5 (wattmeters). Accuracies listed are in terms of percent of full scale.

**AC/DC Ammeter:** Accuracy .5%; thermocouple type, true rms response regardless of wave form; frequency range DC and 7 cps to 2000 cps; 100 division 4" scale printed 0-1/2/5; automatic overload protection safeguards the thermocouple for overloads of 500% or 10 amps, whichever is the lesser figure.

Range: .05/.1/.2/.5/1/2/5 amps

**NOTE A:** A Type 357 Thermocouple Replacement Feature is included as described on page 460 in Note A of the specifications for the AC/DC thermal ammeter in the Model MAT. Price per thermocouple.

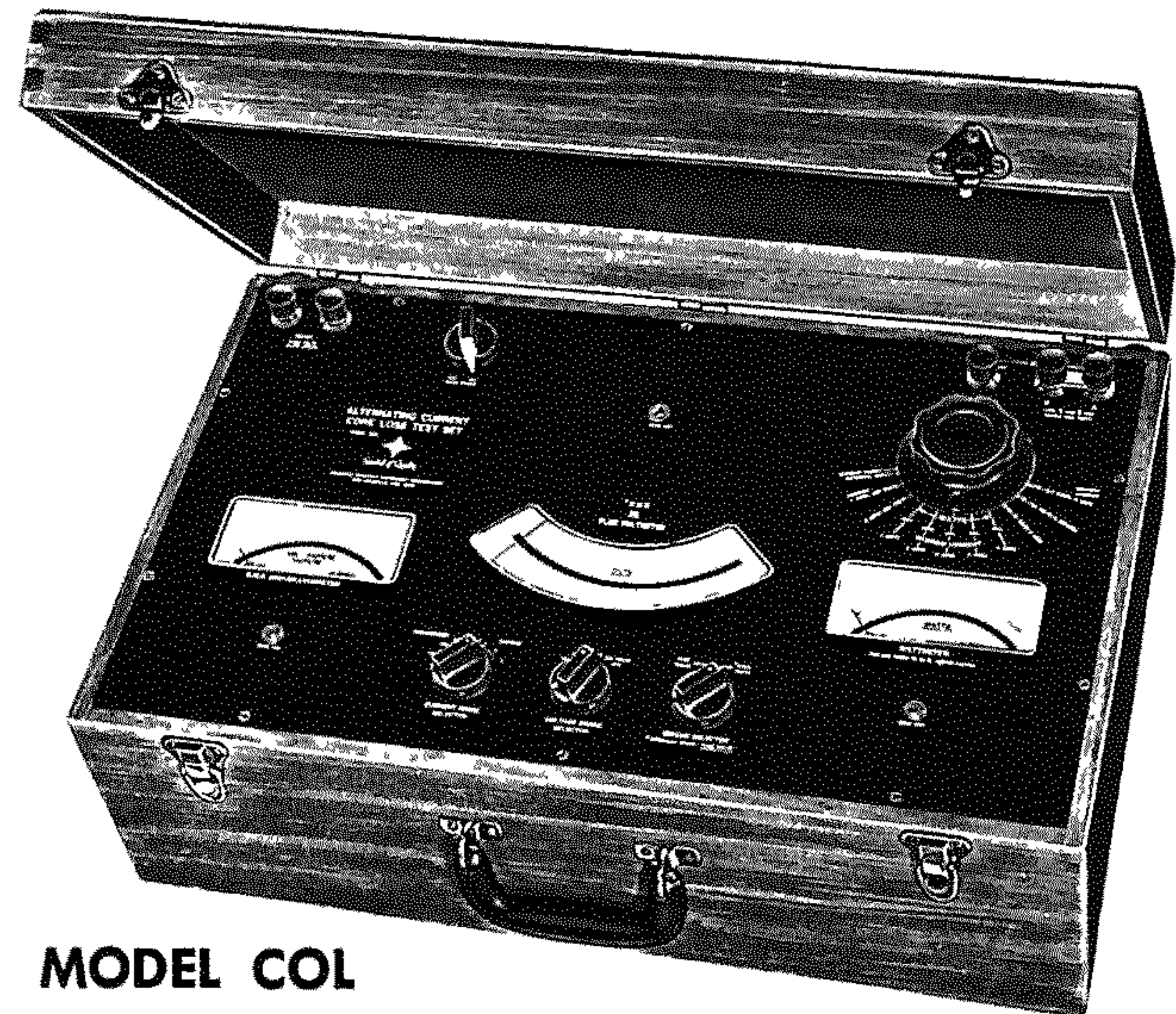
The AC voltmeter with true rms response and the AC flux voltmeter that reads average volts x 1.111 are combined in a single dual purpose instrument numbered 1 and 2 below. Readout is on separate scales drawn on a single scale plate. In operation, when a wave form check is required the readings of the rms instrument can be quickly compared to that of the average reading instrument by merely flicking a switch.

1. **AC/DC Voltmeter:** Accuracy .5%; thermocouple type, true rms response regardless of wave form; frequency response DC and 7 cps to 2000 cps; 150 division 6.3" scale printed 0-30/75/150; automatic overload protection safeguards the thermocouple for overloads of 500% or 600 v, whichever is the lesser figure.

Range: 15/30/75/150/300 v

**NOTE A:** A Type 357 Thermocouple Replacement Feature is included as described on page 460 in Note A of the specifications for the AC/DC thermal ammeter in the Model MAT. Price per thermocouple.

**NOTE B:** The automatic overload protection system starts to clip when peak to rms ratios greater than 4 to 1 are encountered. This is not a factor in normal core loss or permeability testing. However, provision is made for the simple disconnection of the overload protection system by the user if desirable.



MODEL COL

2. **AC Flux Voltmeter:** Accuracy .5%; full wave rectified average reading instrument (average volts x 1.111); scale reads true rms only on a sinusoidal wave form; frequency range 25 to 1000 cps; 150 scale divisions printed 0-15/30/75/150/300.

Range: 15/30/75/150/300 v

**AC/DC Single Phase Wattmeter:** Accuracy .75% when used from 100% PF down to 50% PF, 1% when used below 50% PF down to 20% PF; frequency range DC & 25 cps to 500 cps, excepting the 12.5 v range DC & 50 cps to 70 cps and the 25 v range DC & 25 cps to 125 cps; 100/80 scale divisions printed 0-5/10/20/40. Ranges as follows:

Volts	Normal Amps at 100% PF	Maximum Amps at Minimum PF	Watts
12.5	.2	2	2.5
12.5	.4	4	5
25	.2	2	5
25	.4	4	10
50	.2	2	10
50	.4	4	20
100	.2	2	20
100	.4	4	40
200	.2	2	40
200	.4	4	80

**Note A:** Additional specifications as per notes "A" and "B" on page 461 in the description of the wattmeter in the Model MAT.

## OPTIONAL ACCESSORIES

Model EPS is an Epstein frame having replaceable tube liners and constructed in accordance with ASTM specifications as listed in A343-54. See description on page 461.

The Model COL is supplied in a 22" x 13 1/2" x 9" formica case, with removable hinged cover and carrying handle. Approximate weight is 35 lbs. net, 150 lbs. shipping. Operating instructions as well as ASTM publication A343 are supplied.

Model	Description	Code	Price
COL	Core Loss Test Set	CORLOS	
EPS	Epstein Frame	EPSMAT	
	(Replaceable Liners for Epstein Frame /set of 4)		

Prices and Specifications Subject to Change Without Notice.

Printed in U.S.A.

75-2



# Sensitive Research\*

## MAGNETIC TESTING INSTRUMENTS

PRICE LIST - JANUARY 1, 1981

### DC FLUXMETERS

#### MODEL FS (Single Range)

FULL SCALE RANGE IN LINES	SENSITIVITY LINES/DIV. (With 1 Turn Search Coil)	CODE	PRICE
500,000	10,000	FLUXA	480

#### MODEL FM (Multirange)

FULL SCALE RANGE IN LINES	SWITCH POSITION	SENSITIVITY LINES/DIV. (With 1 Turn Search Coil)	CODE	PRICE
500,000	X1	10,000	FLUXO	650
1,500,000	X3	30,000		
5,000,000	X10	100,000		
15,000,000	X30	300,000		
50,000,000	X100	1,000,000		

#### MODEL GPS (General Purpose Search Coil)

10 Turn	15 ohm 15 sq cm	Price	75
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#### MODEL STM (Standard Magnet)

1% Accurate	Total flux — 50,000 lines	Price	65
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#### MODEL FCM (Special 0.5% Standard Magnet and Search Coil)

Magnet (50,000 line) and Search Coil	Price	160
Additional Magnets 0.5%	Price	85

Approx. Shipping Weight: 150 lbs.

### AVERAGE READING AC VOLTMETERS (AC FLUX VOLTMETERS)

#### MODEL FLV

Accuracy 5%	25 Hz to 1000 Hz
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#### MODEL FLVC

Accuracy .25%	25 Hz to 500 Hz
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#### MODEL FLV

RANGE	SCALE DIV.	CODE	PRICE		CODE	PRICE
			1000 $\Omega/v$	3333 $\Omega/v$		1000 $\Omega/v$
30/75	150	FVABO	440	475	FVABOC	580
60/120	120	FVDEF	450	490	FVDEFC	585
75/150	150	FVGOI	450	490	FVGOIC	585
5/10/20	100	FVVUL	620	640	—	—
7.5/15/30	150	FVVEE	590	625	—	—
7.5/15/150	150	FVVAK	590	625	—	—
30/75/150	150	FVJOL	495	530	FVJOLC	625
50/100/200	100	FVANO	510	540	FVANOC	635
75/150/300	150	FVPOR	510	540	FVPORC	635
30/75/150/300	150	FVVOX	560	590	FVVOXC	655

#### MODEL FLVC

### FLUXMETER CALIBRATOR

Model FC      Code FLUCAL      Price: \$1170.00



\* A TRADEMARK OF EIS  
**ELECTRICAL INSTRUMENT SERVICE, INC.**  
 25 Dock Street, Mount Vernon, N.Y. 10550 914-699-9717





**MODEL MAT  
UNIVERSAL MAGNETIC TESTING SET**

Includes the following instruments:

**DC AMMETER**

<b>DC Ammeter:</b> Accuracy .5%; 60/75 scale divisions printed 0-30 75/150 Range changing is by binding posts.									
Range:	.03	.075	.15	.3	.75	1.5	3	7.5	15
Approx. Resist.:	4	1.7	1	.5	.2	.1	.05	.02	.01
<u>30 amps</u>									
.005 Ω									

**AC/DC AMMETER**

<b>AC/DC Ammeter:</b> Accuracy .75%; thermocouple type, true rms response irrespective of waveform; frequency range DC & 7 Hz to 5 kHz							
Range:	.05	.1	.2	.5	1	2	5 amps
Approx. Resist.:	5	3.75	2.2	.95	.5	.25	.1 Ω

**AC/DC VOLTMETER**

<b>AC/DC Voltmeter.</b> Accuracy 75%; thermocouple type, true rms response irrespective of waveform, frequency range DC and 7 Hz to 4 Hz					
Range	15	30	75	150	300 v
Sensitivity	All ranges 500 Ω/v				

**AC FLUX VOLTMETER**

<b>AC Flux Voltmeter:</b> Accuracy .5%; full wave rectified, average reading instrument (average volts X 1.111); Calibrated in RMS Volts DC & 25-1000 Hz.					
Range.	15	30	75	150	300 v
Sensitivity	All ranges 3333 Ω/v				

**ACCESSORIES**

**MODEL MU- MUTUAL INDUCTORS** — For Permeability Measurements

**MODEL EPS — Epstein Frame** — For Test Specimens .28 cm long x 3 cm wide. Satisfactory for specimen weights of 2 kg, 1 kg and 0.5 kg

**MODEL GPS** — For use with DC Fluxmeter — 10 Turn — 15 ohm — 15 sq. cm mean area — 1/4" Center Hole

**AC/DC SINGLE PHASE WATTMETER**

<b>AC/DC Single Phase Wattmeter:</b> Accuracy 75% when used from 100% FP down to 50% PF (can be used down to 10% PF at reduced accuracy) Frequency Range DC & 25 to 125 Hz			
RANGES			
VOLTS	NORMAL AMPS AT 100% PF	MAXIMUM AMPS	WATTS
12.5	2	2	2.5
12.5	.4	4	5
25	2	2	5
25	.4	4	10
50	2	2	10
50	.4	4	20
100	.2	2	20
100	.4	4	40
200	.2	2	40
200	.4	4	80

**DC FLUXMETER**

<b>DC Fluxmeter:</b> Accuracy 1% except 1.5% on X100 range; basic sensitivity 10,000 lines (maxwells) per division using a 15 Ω, 1 turn search coil; 100 division scale printed 50-0-50, range changing is switch controlled
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**PRICES**

MODEL	DESCRIPTION	CODE	PRICE
MAT	Universal Magnetic Testing Set	MATSET	5330
EPS	Epstein Frame (Replaceable Liners for Epstein Frame \$40/set of 4)	EPSMAT	715
MU	Mutual Inductor (up to 1 amp)	MULO	580
	Mutual Inductor (over 1 amp to 5 amps)	MUHI	480
GPS	General Purpose 10 Turn Search Coil for Fluxmeter		75

**MODEL COL  
AC CORE LOSS TEST SET**

Includes the following instruments:

**AC/DC AMMETER**

<b>AC/DC Ammeter:</b> Accuracy .5%; thermocouple type, true rms response regardless of wave form; frequency range DC and 7 Hz to 2000 Hz	
Range:	.05/.1/ 2/.5/1/2/5 amps

**AC FLUX VOLTMETER**

<b>AC Flux Voltmeter:</b> Accuracy .5%; full wave rectified average reading instrument (average volts x 1.111); scale reads true rms only on a sinusoidal wave form; frequency range 25 to 1000 Hz.	
Range.	15/30/75/150/300 v

**AC/DC VOLTMETER**

<b>AC/DC Voltmeter:</b> Accuracy 5% thermocouple type, true rms response regardless of wave form; frequency response DC and 7 Hz to 2000 Hz.	
Range:	15/30/75/150/300 v

**AC/DC SINGLE PHASE WATTMETER**

<b>AC/DC Single Phase Wattmeter:</b> Accuracy 75% when used from 100% PF down to 50% PF Can be used down to 10% PF at reduced accuracies. Specifications identical to Wattmeter in Model MAT.	
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**PRICES**

MODEL	DESCRIPTION	CODE	PRICE
COL	Core Loss Test Set	CORLOS	3460
EPS	Epstein Frame (Replaceable Liners for Epstein Frame \$40/set of 4)	EPSMAT	715