OPERATING INSTRUCTIONS

FOR

PRECISION

VACUUM TUBE VOLTMETER
AND
MULTI-RANGE TEST SET

SERIES EV-20

PRECISION TEST EQUIPMENT
Standard of Accuracy

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GENERAL SPECIFICATIONS

The PRECISION Series EV-20 Vacuum Tube Voltmeter and Multi-Range Test Set is a modern sensitive high impedance measuring instrument specifically engineered to meet the rapidly expanding requirements of present and future electrical, electronic and communications fields, --- A.M., F.M. and TV.

Although compact, in terms of physical dimensions, Series EV-20 affords the full functions of EIGHT distinctly individual instruments, stressing the utmost in performance, ease of manipulation, stability and accuracy (not usually associated with electronic test meters). It provides true ZERO-CENTER OPERATION ON ALL D.C. V.T.V.M. RANGES!

The EIGHTH facility is available thru use of the optional SERIES RF-10-A Vacuum Tube Probe which is directly attachable (plug-in cable) at the front of the EV-20 panel. Incorporating a miniature type 9002 tube, this latter accessory provides for direct measurements of audio super-sonic, R.F. and U.H.F. voltages as required for special service and laboratory applications. (Series RF-10-A Probe may be obtained from the same source of supply from which EV-20 is purchased).

All instrument functions have been engineered to afford a maximum of operational simplicity by reducing the number of switching and connecting operations to an absolute minimum. For example it will be noted that the 1000 ohms per volt functions are available to the operator without necessitating connection of the instrument to the power line: In addition the H.F. accessory Probe and D.C. V.T.V.M. isolating Probe are both provided with their individual Instrument Panel Connectors, eliminating repetitive insertions and disconnections.

Before proceeding into the actual use and operation of the Series EV-20's eight functions, it will be found desirable to examine the following condensation of the outstanding features and overall coverage of this most complete instrument:-

1. VOLTAGE REGULATED BRIDGE CIRCUIT:- Stabilized bridge circuit provides a high degree of direct reading V.T.V.M. accuracy with complete freedom from minor tube variations. Incorporates 1 - 6C4, 1 - 6X4, and 1 - 0A2 Voltage Regulator. Regulated plate voltage power supply minimizes undesirable meter shift due to A.C. line voltage variations.

2. TRUE, ALL-ZERO CENTER V.T.V.M.:- Provides in ONE OPERATION, BOTH magnitude and polarity of voltage at any test point, WITHOUT reversal of test prods. Common terminal grounded for maximum safety, stability, and simplicity of operation. A zero-center V.T.V.M. is ideal for F.M. discriminator adjustments, bias measurements, etc., as well as the only simple solution to "blind" tests wherein test polarity is an unknown factor.

3. DIRECT READING HIGH FREQUENCY VOLTAGE SCALES:- Includes special low range compensated scale for maximum low voltage reading accuracy in addition to direct reading scales to 120 V. Peak. A built-in bridge balancing network minimizes zero-shift effects of Probe tube contact potential.

4. SHIELDED COAXIAL TEST PROBE:- A universal, circuit-isolating, coaxial probe is furnished as original equipment. This permits direct D.C. voltage measurements in signal carrying circuits, without materially disrupting operating conditions.

5. DUO-BALANCED ELECTRONIC-BRIDGE OHMMETER:- Effectively eliminates the gross inaccuracies oftentimes associated with vacuum-tube-ohmmeter readings. BOTH ends of the ohmmeter scales are individually electrically adjusted, providing unusually high accuracy throughout entire scale length. A single "OHMS" scale serves for ALL SIX resistance ranges. V.T.V.M. and OHMMETER zero settings remain essentially unchanged for any series of voltage or resistance range selections.

6. OHMMETER BATTERIES QUICKLY AND CONVENIENTLY REPLACEABLE FROM REAR OF INSTRUMENT.

7. FULL VISION 4-5/8" RECTANGULAR METER:- Employs large, wide faced, easy reading scales. 200 microampere D'Arsonval type movement. Rugged, double-sapphire bearing construction.

8. EACH INSTRUMENT INDIVIDUALLY CALIBRATED at multiple points with four internal calibrating controls, sealed against laboratory standards. Assures strict adherence to specified tolerances and duplicate performance of each and every unit.

9. 48 INDIVIDUAL RANGE PROVISIONS. More than adequately cover normal and special sensitivity measurement needs.

(a) SIX ALL-ZERO-CENTER D.C. V.T.V.M. RANGES WITH DIRECT CIRCUIT-ISOLATING PROBE:- ±3, ±12, ±30, ±120, ±300, ±1200 volts.
Direct reading ±12,000 and ±30,000 Volts D.C. ranges available thru use of optional PRECISION Series TV Super High Voltage Safety-type Multiplier Probe.

INPUT RESISTANCE: 13.3 Megohms constant up to 1200 volts D.C.
133.3 Megohms at 12,000 volts D.C.
333.3 Megohms at 30,000 volts D.C.

(b) SIX WIDE RANGE, OHMMETER-MEGOHMMETER RANGES: Only two standard type 1½ volt flashlight cells power all resistance ranges!

NOTE: Batteries are replaceable from the rear of the instrument WITHOUT REMOVING THE INSTRUMENT FROM ITS CARRYING CASE.

0-2000 ohms (20 ohms center scale reading)
0-200K ohms (2000 ohms center scale reading)
0-2 Megohms (20K ohms center scale reading)
0-20 Megohms (200K ohms center scale reading)
0-200 Megohms (2 Megohms center scale reading)
0-2000 Megohms (20 Megohms center scale reading)

Ideal selection of overlapping ranges provide for all normal resistance measurement requirements, as well as for insulation resistance tests, condenser tests, etc.

(c) SIX A.C., SIX D.C AND SIX OUTPUT VOLTAGE RANGES at standard 1000 ohms per volt sensitivity. Does not require any connection to power line.

0-3-12-30-120-300-1200 volts.

A necessary feature for standard (1000 ohms per volt) sensitivity measurements in conformance with the point to point voltage reading tables furnished by receiver manufacturers and in service manuals; equally valuable and desirable for tests not requiring the extreme sensitivity of the V.T.V.M. section, as well as for audio frequency signal measurements.

(d) EIGHT D.C. CURRENT RANGES:

0-300 Microamperes; 0-1.2-3-12-120 Milliamperes; 0-1.2 and 0-12 Amperes

(e) SIX DECIBEL RANGES:- From -20 to +63DB. A valuable adjunct for transmission and output level tests and comparisions. Uses 1 MW, 600 ohms ODB reference level.

(f) FOUR DIRECT READING, HIGH FREQUENCY, HIGH IMPEDANCE RANGES:- 0-3-12-30-120 volts. Response to 300 Mc. Use optional Precision RF-10-A H.F. Probe.

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From the foregoing, the reader can readily comprehend the very wide scope of application which Series EV-20 affords. It eliminates the annoyance caused by frequent shifting from one instrument to another when performing various types of circuit tests. The inherent economy of a device such as Series EV-20 is readily apparent and where this factor is not of major importance, operative efficiency plus single-unit portability of a multiplicity of instruments, becomes a matter worthy of recognition.

FUNCTIONS AND DESCRIPTIONS OF PANEL COMPONENTS

Examination of the Series EV-20 Panel reveals surprisingly few components for manipulation of an instrument which provides eight distinctly separate functions with 48 individual ranges.

1. "ZERO ADJUST" Control: This control adjusts the meter pointer to the zero calibration on all "D.C. V.T.V.M.", "Resistance" and "H.F. Probe" Ranges. The control functions as a Bridge balancing element and as such has no effect on the mechanical zero set of the Meter when the instrument is set to the "A.C.V.-DB" or "D.C.V.-MA" positions.

2. FUNCTION SELECTOR SWITCH: This switch provides for simple and distinct selection of the desired instrument function.

3. "OHMS INF. ADJ." CONTROL: As the title implies, this control adjusts the right hand "Infinity" (INF.) setting of meter on all resistance ranges.

4. MASTER RANGE SELECTOR SWITCH: All instrument ranges are selected thru use of this Master switch. Each position of the switch serves a dual purpose dependent upon the setting of the Function Selector Switch.

5. The "Fuse" Extractor Post employs a 1/2 ampere type 3AG fuse. In case of fuse burn-out, the cause of burnout should be determined before another fuse is inserted. Never use a fuse rated higher than 1/2 ampere.

6. Connectors and Jacks at the bottom of the instrument panel.

   a. "HF Probe" Connector. This connector provides complete circuit and filament power facilities for use of the optional Precision Series RF-10-A High Frequency Vacuum Tube probe.

   b. "Megohmmeter" Jacks: All resistance measurements from 0 to 2000 Megohms are made thru use of these jacks in conjunction with the shielded "MEGOMMETER CABLE" provided with Series EV-20 and illustrated in Fig. 2 .

   c. "D.C. VTVM" Connector. All D.C. Vacuum Tube Voltmeter readings are made with the "VTVM Cable" (illustrated in Fig. 3) connected to this panel connector. The "VTVM Cable" incorporates a 1-1/3 Megohm resistor in its prod end thereby insuring highly desired circuit probing isolation for all D.C. V.T.V.M. measurements.

   d. "A.C. - D.C.V.--MA--DB" Pin Jacks: In accordance with the title all standard 1000 ohm per volt multi-range meter functions are available thru use of these jacks in conjunction with the set of universal test leads provided with each Series EV-20

   e. "1200 Ma." and "12 Amps" JACKS: For measurement of these high current values, the negative general purpose test lead connects to the negative jack under "A.C. - D.C.V.--MA--DB", and the positive (red) test lead connects to either one of the "1200 Ma." or "12 Amps" jack.

   f. "Output" Jack: All output measurement facilities (which oftentimes require provisions for D.C. isolation) are provided thru use of the jack marked "output" and the negative jack under "A.C. - D.C.V.--MA--DB". The Output jack imcorporates a .1 mfd., 600 W V, blocking condenser.

      IMPORTANT NOTE: The 1000 ohms per volt functions (A.C. Volts, DB, D.C. Volts) and the D.C. Current measuring facilities of Series EV-20 can be used with the power to the EV-20 switched off. It is not necessary to connect the EV-20 to the power line when using these functions. Conversely it is not necessary to switch the power off when using the aforementioned functions. These ranges are completely isolated from the power energized circuits of EV-20.

THE METER SCALEPLATE

The operator should become immediately familiar with the physical layout of the meter scaleplate in order to take advantage of the reading simplicity it affords.

a. The Two uppermost scales are for Resistance (Ohms) and D.C. V.T.V.M. functions only.

b. The next two lower scales are labelled for their respective standard multi-range meter purposes and have their OWN set of numerals (1000 ohms per volt A.C./D.C., and D.C. current ranges). They are COMPLETELY INDEPENDENT of the UPPER two scales, just as if the EV-20 had incorporated two individual meters, one for D.C. V.T.V.M. and Resistance Measuring purposes, and the other for standard multi-range meter functions.

c. The scales marked "H.F. Volts" are for use only when optional PRECISION Series RF-10-A H.F. Probe is used with the Series EV-20 for High Frequency Voltage Measurements.

d. The bottom scale marked "Db" is associated with the 1000 ohms per volt A.C.V. function of the instrument and is based upon a 0-Db reference level of 1 milliwatt at 600 ohms.

DETAILED OPERATING INSTRUCTIONS

To employ the V.T.V.M., functions of this instrument, the line plug must be connected to a 110-120 volt 50-60 cycle A.C. source. Other voltage and frequency requirements are accommodated only on special order. Unless otherwise specified, this instrument should be employed ONLY within the line voltage and frequency range listed above.

1. Standard Zero-Center D.C. V.T.V.M. Ranges

Set Circuit Selector Switch to "D.C. V.T.V.M." position

Set the Master Range Selector Switch to any one of the desired voltage ranges.

The "D.C. V.T.V.M." cable (illustrated in Fig. 3) is then connected to the "D.C. V.T.V.M." panel connector.

Throw the power toggle switch to "ON" position with the instrument connected to the A.C. Power Line. Allow the EV-20 to warm up for a period of about 3 to 5 minutes.

NOTE: During the warm-up period, the meter may first deflect slightly to the left and then swing over towards the center-zero position of the V.T.V.M. scale (second from top). With the prod tip of the D.C. V.T.V.M. cable shorted to the alligator clip of the cable, rotate the meter pointer to exact zero-center position. After the zero-center setting is obtained, disconnect the alligator clip from the prod tip (removing the temporary short). It may sometimes be noted that when the alligator clip is disconnected from the prod tip, the meter pointer may deflect a bit from the true Zero-center setting. This shift from true Zero-center (if it occurs at all) is generally attributable to extremely minute grid current flowing in the high input resistance and does not affect the accuracy of the voltage readings to be taken.

The instrument is now prepared for D.C. voltage tests with a constant input impedance of 13-1/3 Megohms, throughout the ranges of 0-3, 12, 30, 120, 300 and 1200 volts full scale.

It is always good practice to set the MASTER RANGE SELECTOR to the highest range first when voltage of unknown value is to be measured, and then change setting to the appropriate lower range as dictated by the initial reading.

Connect the ALLIGATOR CLIP to a GROUND TERMINAL or CHASSIS of the device under test and the Prod Tip directly to the point at which the voltage measurement is to be made. The meter will instantly indicate BOTH the magnitude and polarity of the voltage with respect to neutral or ground. As marked on the meter scale plate, readings to the LEFT of center zero are NEGATIVE (-) and to the RIGHT, POSITIVE (+). This important Zero Center feature of Series EV-20 completely eliminates both the need for inconvenient polarity-reversal switches, and minimizes possibilities of meter overloading when measuring in circuits of unknown polarity.

READ METER AS FOLLOWS on second scale from top:

3 volt range, read on 30 scale, and divide readings by 10.
12 volt range, read directly on 12 scale.
30 volt range, read directly on 30 scale.
120 volt range, read on 12 scale and multiply by 10.
300 volt range, read on 30 scale and multiply by 10.
1200 volt range, read on 12 scale and multiply by 100.

For D.C. V.T.V.M. voltage measurements above 1200 volts and up to 30,000 volts D.C., use the Precision Series TVP/A High Voltage Safety-type multiplier Probe, with the Probe connected to the "D.C. V.T.V.M." panel connector.

The proper "TVM" Multiplier cartridge for use with the desired high voltage range is listed as follows:

a. For 12,000 Volts D.C. range, use TVPA Probe with TVM-121.3 cartridge.

b. For 30,000 volts D.C. range, use TVPA Probe with TVM-320-1.3 cartridge.

The Procedure for High Voltage Measurements is listed as follows:

1. Set up the instrument for D.C. V.T.V.M. Measurements.
2. Rotate the Master Selector Switch to the "1200 V. Position".
3. Attach the connector of the Series TVP/A Multiplier Probe to the "D.C. V.T.V.M." panel connector of Series EV-20.

a. If the 12,000 volts multiplier is being used, read the 12-0-12 D.C. V.T.V.M. scale and multiply the readings by 1000.

b. If the 30,000 volts multiplier is being used, read the 30-0-30 D.C. V.T.V.M. scale and multiply the readings by 1000.

CAUTION!!! Observe all High Voltage precautions detailed in the Instruction book accompanying Series TV-High Voltage Multiplier Probe!

2. OHMMETER-MEGOHMMETER RANGES

Series EV-20 provides for an unusually wide range of DIRECT resistance measurements in six overlapping ranges. All ohmmeter ranges are selected directly on the six inner right-hand positions of the Master Range Selector and are read on the uppermost scale as follows:

0-2000 ohms range (20 ohms at center scale) read directly.
0-200,000 ohms range (2000 ohms center) read on 2000 scale and multiply by 100.
0-2 Megohms range (20,000 ohms center) read on 2000 scale and multiply by 1000.
0-20 Megohms range (200,000 ohms center) read on 2000 scale and multiply by 10,000.
0-200 Megohms range (2 Megohms center) read on 2000 scale and multiply by 100,000.
0-2000 Megohms range (20 Megohms center) read on 2000 scale and multiply by 1,000,000.

To employ the Ohmmeter-Megohmmeter function of Series EV-20 the "MEGOHMMETER CABLE" (Fig. 2) is connected as follows:

BLACK tip plug to "GND" "Megohmmeter" jack.
RED (probe) tip plug to "High" "Megohmmeter" jack.

With the Circuit Selector Switch set to "RESISTANCE" position and the Master Range Selector switch set to the desired ohmmeter range, turn the instrument "ON" and allow 3 to 5 minutes warm-up, if the instrument has not been already previously used and hence in heated condition.

The Meter pointer may (if heating, first deflect slightly to left, then) swing toward the Infinity ("INF.") end of the "OHMS" scale.

NOTE: Zero adjustment on a vacuum-tube operated ohmmeter differs a bit from the more conventional types and requires separate adjustment or setting of each end of the scale--one with test leads OPEN CIRCUITED and the other test leads SHORTED.

We are now ready to make our Zero Adjustments (the procedure is very simple, once performed a few times):

1. Short the "MEGOHMMETER CABLE" alligator clip to the test prod tip. (Meter will swing to left, possibly off-scale).
2. With leads still shorted rotate the "Zero Adj." control until the meter pointer coincides with the Zero ("0") of the OHMS scale.
3. Separate the MEGOHMMETER cable alligator clip from the test tip, thereby removing the temporary short. (The meter pointer will swing to right, possibly off-scale).
4. Rotate the "OHMS INF. ADJ." control until the Meter pointer coincides with the "INF." mark (extreme right hand end of "OHMS" scale).

Inasmuch as there may be some reaction between the settings of these controls, the aforementioned process should be repeated until BOTH ends of the "OHMS" scale are properly adjusted. Once set, these adjustments will remain essentially unchanged for the last five ohmmeter ranges. The first (2000 ohms) range may require slightly different settings because of the variation of internal battery resistance, which affects a low ohms range such as this.

Ohmmeter zero-adjustment of Series EV-20 will be found even simpler, if the approximate final positions of the controls are noted for future reference. Of course, the settings will slowly change, as the batteries grow older, and in this connection, Series EV-20 has been designed, (as have all Precision ohmmeter circuits) to accommodate widest possible variation in battery potential without affecting ohmmeter accuracy. In addition, the dual zero-adjust system, provided in Series EV-20, offers unusually high direct reading "OHMS" scale accuracy, not generally associated with electronic apparatus.

CAUTION: Always first disengage AT LEAST ONE END of resistance from the circuit before making resistance measurements. Otherwise an indication of the true resistance value may not be obtained due to the possibility of the circuit therein involved effectively shunting the resistance to be measured, thus reducing the true reading by an amount proportionate to the resistance of the included shunt network. Also be sure that ABSOLUTELY NO VOLTAGE IS PRESENT at the resistance under test. In this connection, the surest method is to completely disconnect the device under test, from any and all source of power, including grounds.

The "MEGOHMMETER CABLE" leads are applied across the two points whereat resistance measurements are to be taken; the alligator clip to the "low" side of the resistor, (if one end is still connected to some circuit), and the probe tip to the other.

IMPORTANT NOTE!! When the two 1½ volt ohmmeter batteries have become exhausted to the point where adjustment of both ends of the ohmmeter scales cannot be accomplished, the batteries can be replaced from the rear of the instrument without removing the instrument from its wrinkle-finished carrying case.

BATTERY REPLACEMENT procedure is detailed as follows:

1. Remove the four outermost self tapping screws which fasten the rectangular battery plate to the rear surface of the Wrinkle-finish carrying case.
2. Remove the battery plate assembly from the back of the carrying case as far as the two connecting leads will allow.
3. Unsolder the Red Lead from the positive contact of the 1½ volt flashlight cell.
4. Remove the rubber retaining bumper from the battery plate and remove the "exhausted" batteries.
5. Replace with fresh cells, and reassemble in reverse order as detailed above.

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3. STANDARD 1000 OHMS PER VOLT MULTI-RANGE METER FUNCTIONS

Unlike the "D.C. V.T.V.M.", "RESISTANCE" and "H.F. PROBE" functions of the Series EV-20, the 1000 ohms per volt multi Range functions DO NOT require connection of EV-20 to a power source AND IS NOT ZERO-CENTER, but rather conventional left hand zero. Particular note should be made of the fact that the lower RIGHT hand set of pin jacks, under the label "AC-DCV-MA-DB", is employed for these regular tests. The operation is as simple as when employing a fully individual, standard sensitivity instrument. The unshielded, flexible (Red and Black rubber) test leads are used for these functions.

a. A.C. VOLTAGE MEASUREMENTS: 1000 ohms per volt

The high sensitivity of this circuit suitably adapts it to both power and audio frequency measurements, limited by the fact that the copper-oxide rectifier response decreases rapidly as frequency increases materially above 7000 to 8000 cycles. For normal routine applications, the circuit impedance may be considered to be 1000 ohms multiplied by the voltage range being employed, or 300,000 ohms at 300 volts, etc.

Set the Circuit Selector switch to the "A.C.V.-DB" position for all A.C. voltage measurements. Select suitable voltage range on the Master Range Selector. Read A.C. voltage on the RED.A.C. CORRECTION SCALE (third scale from top) as follows:

0-3 volts read on 30 scale, divide by 10.
0-12 volts read directly on 12 scale.
0-30 volts read directly on 30 scale.
0-120 volts read on 12 scale, multiply by 10.
0-300 volts read on 30 scale, multiply by 10.
0-1200 volts read on 12 scale, multiply by 100.

NOTE: When using the A.C. (1000 ohms per volt scale), a slight vibration of the meter pointer tip may be noticeable. This should be no cause for concern: it is merely attributable to the fact that Series EV-20 meter employs a long pointer in order to provide wide-spread easy reading scales; this pointer length therefore greatly magnifies the very minute pulsations which A.C. rectifiers transmit to the meter movement. It will be found, however, that this vibration is not discernable at the portion of the pointer which intersects the A.C. correction scale, and therefore in no way whatsoever affects accuracy or readability.

b. D.C. VOLTAGE MEASUREMENTS: 1000 OHMS PER VOLT

The standard "1000 ohms per volt" sensitivity ranges will be found highly invaluable for routine voltage tests as well as for point to point voltage readings, in accordance with tables furnished in service manuals and in radio receiver manufacturers' service notes. When higher sensitivity is required, Series EV-20 can be automatically switched to V.T.V.M. functions; ONE INSTRUMENT thereby serves all requirements. The circuit switching is so arranged that there is NO INTERCONNECTION between V.T.V.M. and STANDARD functions, so that the instrument can, at all times, be left connected to the power line and even turned "ON". In this manner, the operator can switch back and forth between the various test facilites, and thereby avoid delay in pre-heating, whenever V.T.V.M. or OHMS tests are desired.

For all STANDARD D.C. voltage measurements, set Circuit Selector to the "D.C.V.-MA" position and select suitable voltage ranges on Master Range Selector. Read D.C. voltage on "D.C." scale (fourth scale from top) as follows:

0-3 volts read on 30 scale, divide by 10.
0-12 volts read directly on 12 scale.
0-30 volts read directly on 30 scale.
0-120 volts read on 12 scale, multiply by 10.
0-300 volts read on 30 scale, multiply by 10.
0-1200 volts read on 12 scale, multiply by 100.

c. D.C. CURRENT MEASUREMENTS

Set "CIRCUIT SELECTOR" switch to the "D.C.V.-MA" position for all D.C. current ranges on the "MASTER RANGE SELECTOR". Read D.C. current measurements on "D.C." meter scale as follows:

0-.3 Ma. (300 Microamperes) read on 30 scale, divide by 100.
0-1.2 Ma. read on 12 scale, divide by 10.
0-3 Ma. read on 30 scale, divide by 10.
0-12 Ma. read directly on 12 scale.
0-30 Ma. read directly on 30 scale.
0-120 Ma. read on 12 scale, multiply by 10.
*0-1200 Ma. (1.2 AMPERES) read on 12 scale multiply by 100.
*0-12 AMPERES, read directly on 12 scale.

*It is important to note that both the 1200 Ma (1.2 AMPERES) and 12 AMPERES ranges are ONLY available thru use of the indicated special pin jacks located to the left of the "A.C.-D.C.V.-MA-DB" jacks along the lower edge of the panel.

Whenever either one of these two high current ranges are used, the negative test lead inserts into the Minus (-) jack under "A.C.-D.C.V.-MA.-DB" and the Positive test lead inserts into either the "1200 Ma." or "12 Amps" jack as desired. The Master Selector Switch is set to "120 Ma.Position" when these high current jacks are to be employed.

NOTE: When using the "12 AMPS" D.C. range, never remove pin jacks while current is flowing through the circuit. Failure to observe this would result in arcing at the pin when being removed, and though it would not injure the meter, the jack would gradually char.

CAUTION: **When voltage or current of unknown value is to be measured, it is advisable to employ the highest range first. If the meter indication is slight, then select next lower range, etc. Adhere closely to the above instructions in order to prevent slamming of meter pointer and meter overloading.**

d. OUTPUT METER INDICATIONS

The A.C. voltage measuring facilities of Series EV-20 at a high sensitivity of 1000 ohms per volt render this instrument ideally suitable for use as an output meter.

There are two methods that can be used for obtaining output meter indications, as listed below:

IN THE FIRST METHOD, make connections from the voice coil of speaker or secondary of output transformer to "A.C.-D.C.V.-MA-DB" tip jacks. In the event that easy access to the voice coil or secondary of transformer cannot be had, then refer to method outlined on the next page.

IN THE SECOND METHOD, make connections from plate of output tube, and ground or chassis of radio receiver to "OUTPUT" and the minus (-) "A.C.-D.C.V.-MA-DB" tip jack. A .1 mfd 600 w.v. condenser is already included in series with the "OUTPUT" lead in order to block the D.C. component. The voltage appearing at the points across which the output measurements are taken should never be in excess of 600 volts peak, otherwise an additional condenser of equal capacity and of equal or higher voltage rating should be included externally in series with "OUTPUT" jack.

PROCEDURE:

With the use of either method noted above, set Circuit Selector Switch to the "A.C.V.-DB" position and rotate the Master Range Selector to the highest voltage range. An output meter indication will be had when signal generator and radio receiver is put into operation. If the meter indication is slight, then use the next lower A.C. voltage range, etc.

Any gain or loss by reason of balancing or trimming will be accordingly noted by corresponding meter pointer deflection.

NOTE: The output meter can also be used to great advantage for obtaining comparisons in tube performance by noting the difference in meter indications when any or all of the tubes are substituted in the radio receiver under test. Also note that 300 volts is the highest range on which the "OUTPUT" jack can be employed directly. For higher output voltage tests the 1200 volt position should be employed with an external series condenser of appropriate voltage rating.

e. DECIBEL METER

The Series EV-20 incorporates a direct reading and calibrated decibel scale providing readings from -20 to +63Db in six ranges.

The initial scale reading -20 to +11Db is based upon a zero level of 1 milliwatt across a 600 ohm line. The most common use of a decibel meter is that of a power level indicator across known impedances. Because of calibration at one definite impedance, conversions must be made to the new impedance when used at other than 600 ohms. Such tables may be found in a multiplicity of textbooks and technical magazines.

NOTE: Refer to Decibel Chart, (last page of this Instruction book), for interpretation of decibel readings in terms of power and voltage ratios. Caution must be observed in the use of the Db ranges that the circuit across which the meter is placed is isolated from all D.C., else the meter and/or rectifier unit may be damaged.

f. HIGH FREQUENCY PROBE FACILITIES

In addition to the Standard D.C. V.T.V.M. and rectifier type low frequency A.C. scales on the meter of Series EV-20, two special scales for high frequency measurements marked "H.F. Volts" are included as an integral part of the instrument.

These scales are specifically calibrated for use with Precision Series RF-10A High Frequency Vacuum-Tube Test Probe. Probes of other manufacture must not be used with Series EV-20.

The procedure for High Frequency Voltage measurement is detailed as follows:

1. Connect Series RF-10A H.F. Probe to the "H.F. Probe" connector of Series EV-20.
2. Set the EV-20 Circuit selector to the "H.F. Probe" position, and the Range selector Switch to the desired voltage range.
3. Throw the toggle switch to the "ON" position with the EV-20 connected to the A.C. power line. Allow a warm-up period of from 3 to 5 minutes.
4. Set the "Zero Adj." control of the EV-20 for zero reading on the "H.F. Volts" scale. (The "High" prod tip of the Probe must be completely in the clear while making the Zero adjustment).
5. The "GND" stud of the RF-10A Probe connects to the Ground of the circuit under test; the "High" prod tip of the Probe connects to the "hot" point to be measured.

NOTE: Always connect the "GND" terminal of RF-10A to the circuit ground before making contact with the "High" prod tip in order to avoid a momentary off-scale EV-20 reading.

6. Whenever possible, use the "GND" stud of the RF-10A Probe for securing the ground connection to the circuit under test, using an absolute minimum of lead length between the stud and the circuit ground. Use the alligator clip ground lead of the Probe only in relatively low frequency measuring applications.

All voltage measurements using Series RF-10A "HF Probe" with Series EV-20 are read directly on the two scales marked "HF Volts".

THESE "HF VOLTS" SCALES ARE DIRECTLY CALIBRATED IN TERMS OF POSITIVE PEAK VOLTAGE. TO OBTAIN RMS READINGS, MULTIPLY THE VOLTAGE READING BY .707

IMPORTANT NOTE: The Instruction Book for Series RF-10A may include voltage correction curves for use with Precision Series EV-10 Vacuum Tube Multi-Master. These curves are to be disregarded when using the Probe with Series EV-20.

4. CURRENT MEASUREMENTS OF LEAKAGE IN ELECTROLYTIC CONDENSERS.

The leakage in an electrolytic is measured in terms of D.C. current (per microfarad) flowing through the condenser, when rated D.C. voltage is applied.

All electrolytic condensers contain an inherent current leakage. However, if leakage above an allowable amount is present, it can then be termed as poor. Allowable current leakage is dependent upon such factors as age and manufacturers' specifications of a condenser, design of power unit, filter system and rectifier tube of the radio receiver in which the condenser is incorporated. In general, considering an 8 mfd. condenser THAT HAS BEEN IN USE (rated at 450 volts) the maximum allowable leakage is approximately .5 MA per microfarad or 4 MA total.

The following will serve as a basis for computing approximate allowable leakages:

a) For condensers rated at 300 volts or more, leakage of approximately .5 MA per microfarad is permissable.

b) For condensers rated between 100 to 275 volts, permissible leakage is approximately .2 MA per microfarad.

c) For condensers rated below 100 volts, permissible leakage is approximately .1 MA per microfarad.

CAUTION: WHEN OBTAINING ELECTROLYTIC LEAKAGE MEASUREMENTS, HIGH VOLTAGE IS EMPLOYED. IT IS THEREFORE EXTREMELY IMPORTANT THAT THE FOLLOWING INSTRUCTIONS BE ADHERED TO IMPLICITLY TO PREVENT DAMAGE TO METER.

PROCEDURE:

With condenser disconnected from radio receiver circuit, CHECK CONDENSER FOR SHORT with ohmmeter using the 0-200,000 OHMS RANGE. POLARITIES MUST BE OBSERVED. The "GND" tip jack is connected to outside can or negative terminal of condenser and the "HIGH" tip jack is connected to the anode (positive) terminal of condenser. A decided low resistance reading or constant full scale deflection of ohmmeter pointer indicates that the condenser is shorted and SHOULD BE REJECTED WITHOUT FURTHER TESTING.

When an electrolytic INCORPORATED IN A RADIO RECEIVER is to be tested, the necessary rated voltage is automatically applied and the following connections are made for "forming" and measuring the current leakage, after being (ohmmeter) tested for short.

1. Set "CIRCUIT SELECTOR" switch to the "D.C.V.-MA" position and rotate MASTER RANGE SELECTOR to the 120 MA position.

2. Remove lead from (positive) anode terminal of condenser and connect this lead to the positive (+) "A.C.-D.C.V.-M.A.-DB" tip jack with a PROPER LIMITING RESISTOR IN SERIES. (Where voltage applied to condenser is above 100 volts the limiting resistor should be approximately 3000 ohms. When the applied voltage is below 100 volts, the value of the limiting resistor should be approximately 1000 ohms. This limiting resistor is very important and should not be omitted.

3. Connect the negative (-) "EXTERNAL TESTS" pin jack to the (positive) anode terminal of condenser. (From the above connections, it can be seen that the "EXTERNAL TEST" tip jacks limiting resistor, condenser terminals and the voltage source are in series connection.)

4. After series connections are made, turn on switch of radio set. The meter pointer will now deflect to near full scale and then gradually recede to the zero mark or near zero, after the expiration of about three minutes. THIS PROCEDURE IS KNOWN AS "FORMING" THE CONDENSER.

NOTE: A steady meter pointer indication without receding to or near zero (after forming process) indicates a shorted or leaky electrolytic and should be rejected WITHOUT FURTHER TESTING.

5. After "forming", short out the limiting resistor and read current leakage of condenser under test directly on the 120 MA scale. If meter reading is under 30 Ma, set "Range Selector" to the 30 MA position for a better meter indication and read on 30 MA scale, etc. (For computation of permissible condenser leakage, refer to basis noted previously.)

CAUTION: After this test is completed, always first disconnect the negative test lead from circuit before turning off power supply to prevent slamming of meter pointer due to discharge of condenser under test.

To test electrolytic condensers NOT INCORPORATED IN A RADIO SET, an external D.C. power supply is necessary, preferably one that employs various voltage taps suitable to application for the various D.C. voltage condenser ratings. In this case, adhere to the same testing procedure as noted above, in paragraphs 1, 4 and 5, but making the following series connections:

a) Select voltage tap of D.C. power supply approximating rated voltage of condenser to be tested.

b) Connect positive potential of power supply to the positive (+) "EXTERNAL TESTS" tip jack with a 3000 ohm limiting resistor in series if applied potential is above 100 volts. If potential is 100 volts or under, use a 1000 ohm limiting resistor.

c) Connect negative potential of power supply to outside can or negative terminal of condenser.

d) Connect negative (-) "EXTERNAL TESTS" tip jack to the (positive) anode terminal of condenser.

e) Refer to paragraphs 1, 4 and 5, for obtaining current leakage measurements.

* * * * *

5. QUALITATIVE PAPER CONDENSER TESTS: Using D.C. V.T.V.M. voltage ranges, Resistance ranges, or 1000 Ohms Per Volt Scales.

The insulation resistance or permissible leakage of paper and mica condensers is expressed in megohm microfarads. A good 1 mfd. condenser will have an insulation of approximately 450 megohms. Furthermore, insulation resistance of paper and mica condensers of similar voltage ratings is inversely proportional to its capacity, so that a good .1 mfd. condenser will have ten times the insulation resistance of a similar 1 mfd. condenser, or 4500 megohms. It therefore can be readily seen that it would not be entirely accurate to use even the Series EV-20 high range ohmmeter for measuring leakages in paper or mica condensers when the capacity is smaller than .1 mfd.

In the method to be described, a high D.C. potential is applied to the condenser in series with the proper D.C. VOLTS range (V.T.V.M. or 1000 ohms per volt) to determine whether or not it has low insulation resistance or abnormal leakage.

The necessary D.C. potential can be obtained from an external high voltage D.C. power supply or from the power output tube socket of a radio receiver. In the latter instance, the plate prong position of that socket will be the positive high voltage lead, and the negative return or ground will be the negative lead. Voltage to be applied to the condenser should not be greater than its rated voltage.

PROCEDURE:

1. Measure and adjust the D.C. voltage obtainable from D.C. power supply. Then select the proper meter range that would indicate full scale deflection for the voltage there available and in keeping with the condenser rating.

2. With the power supply OFF, insert the condenser to be tested in series with one of the test leads.

3. Turn ON power supply. An instantaneous deflection due to the charge of the condenser will be indicated on the D.C. meter.

a) In the case of a good condenser, the needle pointer will recede to (or VERY close to) the zero voltage mark.

b) If the meter pointer remains noticeably above the zero mark, then this indicates that the condenser has abnormal leakage.

c) If the meter pointer remains at the indicated value of the voltage measurement obtained primarily, then the condenser is "shorted".

d) If no meter deflection is obtained, then this indicates that the condenser is "open" or that the capacity is too low in value to indicate an instantaneous noticeable meter deflection when charged.

NOTE: After this test is completed, always FIRST disengage the negative test lead from circuit BEFORE turning off power supply to prevent slamming of needle pointer due to discharge of condenser under test.

This method of using a relatively high D.C. potential in series with a D.C. V.T.V.M. to qualitatively check paper condensers is superior to a simple high range ohmmeter check due to the fact that the high potential tends to "search out" condenser defects which could cause breakdown at operating potentials. The low battery voltage of the Megohmmeter circuit (3 volts) is insufficient to perform the "searching" function.

GENERAL INFORMATION

In an instrument manual of this nature, it is inadvisable to attempt to cover too much ground, other than the basic operation of the facilities available. In practice, there is hardly a limit to the number of applications to which an instrument such as Series EV-20 may be applied, bounded only by the operator's technical training and necessities. Accordingly, it is suggested that reference be made to one or more of many texts and technical magazine articles on the application and use of vacuum-tube-voltmeter, vacuum-tube-Ohmmeters, standard multi-range meters, etc. Such articles provide detailed data and calculations (when necessary) for such useful measurement simplifications as "Guard" terminals for insulation leakage tests; application of D.C.-V.T.V.M.'s to peak and R.M.S. radio frequency measurements, microammeter measurements, etc.

NOTE: A slight overload will damage or change characteristics of the meter rectifier. Rectifiers are checked before instruments leave the factory. It is important to note this fact inasmuch as rectifiers are not guaranteed when overloaded.

Instructions and guarantee card are enclosed with this instrument. Mail the guarantee card at once for future information to be mailed from this record. Always give Model Number and Serial Number when writing for information relative to this instrument.

SERIES EV-20 ACCESSORIES INCLUDED:

2 - #950 Eveready Batteries or #2 Burgess Batteries or equivalent.
1 - Set #227 Standard Super-Flex Test Leads for use with A.C.-D.C.V.-MA-DB pin jacks.
1 - Megohmmeter Cable.
1 - Circuit-Isolating D.C. V.T.V.M. cable.
1 - Set of tubes consisting of 6C4, 6X4 and OA2.
1 - Series EV-20 Instruction Manual.

PRECISION APPARATUS COMPANY, INC.
92-27 Horace Harding Blvd.,
Elmhurst, L.I., N.Y.

* * * * * *

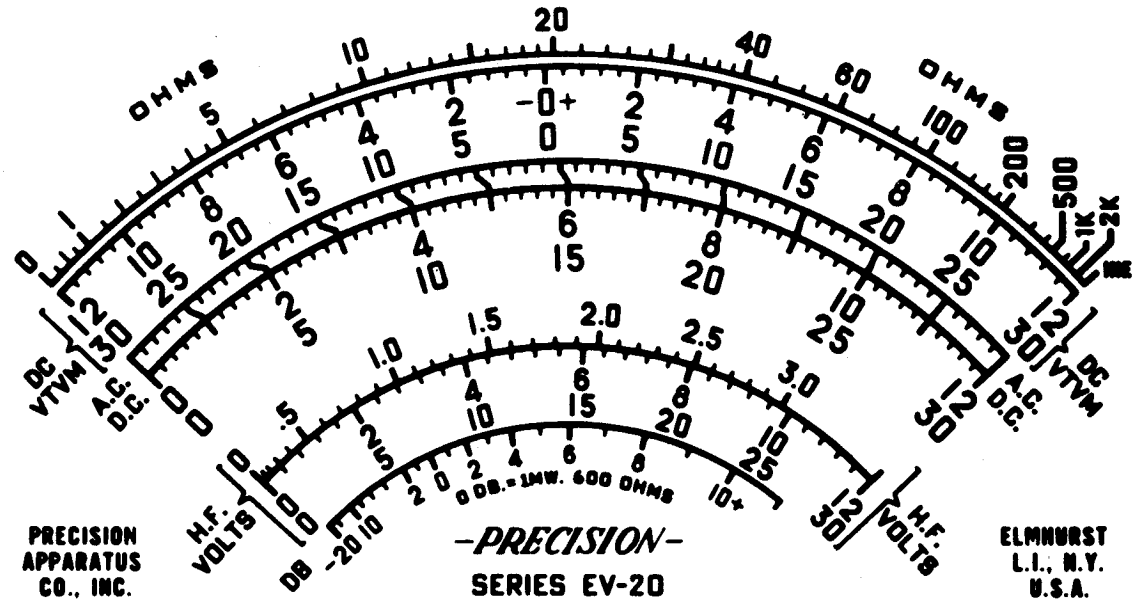


FIG. 1

EV-20 MEGOHMMETER CABLE

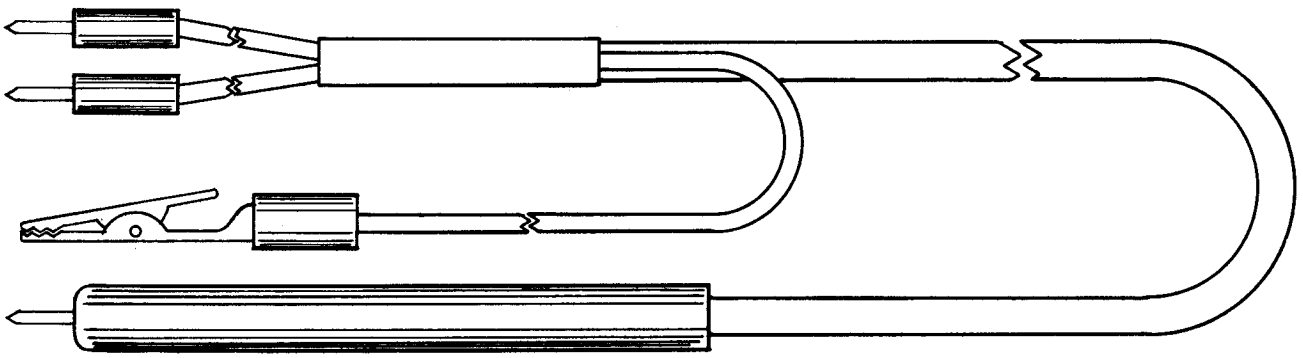


FIG. 2

EV-20 CIRCUIT ISOLATING D.C. V.T.V.M. CABLE

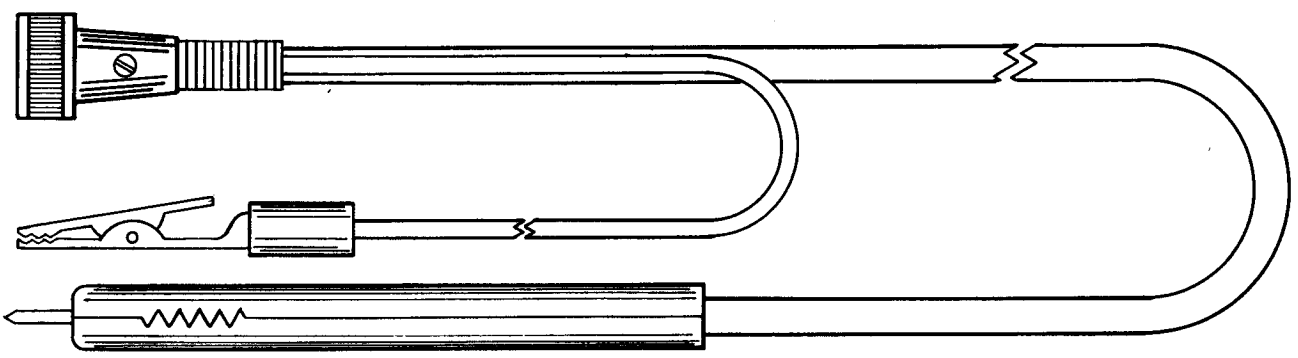
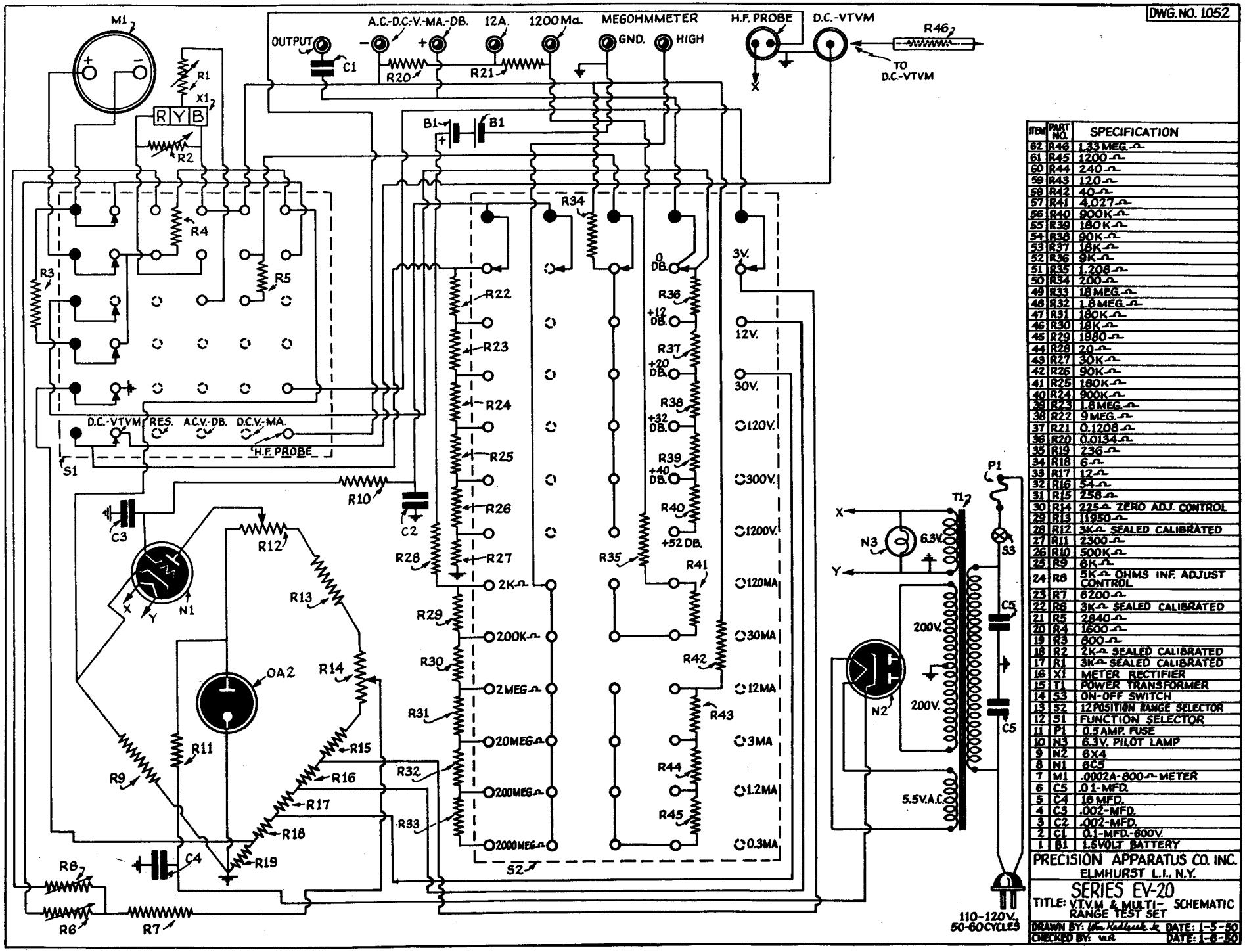


FIG. 3



ITEM	PART NO.	SPECIFICATION
62	R46	1.33 MEG.
61	R45	1200
60	R44	240
59	R43	120
58	R42	40
57	R41	4.027
56	R40	900K
55	R39	180K
54	R38	90K
53	R37	18K
52	R36	9K
51	R35	1.208
50	R34	200
49	R33	18 MEG.
48	R32	1.8 MEG.
47	R31	180K
46	R30	18K
45	R29	1980
44	R28	20
43	R27	30K
42	R26	90K
41	R25	180K
40	R24	900K
39	R23	1.8 MEG.
38	R22	9 MEG.
37	R21	0.1208
36	R20	0.0134
35	R19	236
34	R18	6
33	R17	12
32	R16	54
31	R15	258
30	R14	225 ZERO ADJ. CONTROL
29	R13	11950
28	R12	3K SEALED CALIBRATED
27	R11	2300
26	R10	500K
25	R9	6K
24	R8	5K OHMS INF. ADJUST CONTROL
23	R7	6200
22	R6	3K SEALED CALIBRATED
21	R5	2840
20	R4	1600
19	R3	600
18	R2	2K SEALED CALIBRATED
17	R1	3K SEALED CALIBRATED
16	X1	METER RECTIFIER
15	T1	POWER TRANSFORMER
14	S3	ON-OFF SWITCH
13	S2	12 POSITION RANGE SELECTOR
12	S1	FUNCTION SELECTOR
11	P1	0.5 AMP. FUSE
10	N3	6.3V. PILOT LAMP
9	N2	6X4
8	N1	6C5
7	M1	.0002A-600 METER
6	C5	.01-MFD.
5	C4	16 MFD.
4	C3	.002-MFD.
3	C2	.002-MFD.
2	C1	.01-MFD-600V.
1	B1	1.5VOLT BATTERY

PRECISION APPARATUS CO. INC.
ELMHURST L.I., N.Y.

SERIES EV-20
TITLE: V.T.V.M & MULTI-RANGE TEST SET SCHEMATIC

DRAWN BY: [illegible] DATE: 1-5-50
CHECKED BY: [illegible] DATE: 1-6-50

FORM DBC-1

DECIBEL CHART

NEG. Voltage Ratio	NEG. Power Ratio	-Db+	POS. Voltage Ratio	POS. Power Ratio
1.0000	1.0000	0	1.000	1.000
.9772	.9550	.2	1.023	1.047
.9550	.9120	.4	1.047	1.096
.9333	.8710	.6	1.072	1.148
.9120	.8318	.8	1.096	1.202
.8913	.7943	1.0	1.122	1.259
.8710	.7586	1.2	1.148	1.318
.8511	.7244	1.4	1.175	1.380
.8318	.6918	1.6	1.202	1.445
.8128	.6607	1.8	1.230	1.514
.7943	.6310	2.0	1.259	1.585
.7762	.6026	2.2	1.288	1.660
.7586	.5754	2.4	1.318	1.738
.7413	.5495	2.6	1.349	1.820
.7244	.5248	2.8	1.380	1.905
.7079	.5012	3.0	1.413	1.995
.6918	.4786	3.2	1.445	2.089
.6761	.4571	3.4	1.479	2.188
.6607	.4365	3.6	1.514	2.291
.6457	.4169	3.8	1.549	2.399
.6310	.3981	4.0	1.585	2.512
.6166	.3802	4.2	1.622	2.630
.6026	.3631	4.4	1.660	2.754
.5888	.3467	4.6	1.698	2.884
.5754	.3311	4.8	1.738	3.020
.5623	.3162	5.0	1.778	3.162
.5495	.3020	5.2	1.820	3.311
.5370	.2884	5.4	1.862	3.467
.5248	.2754	5.6	1.905	3.631
.5129	.2630	5.8	1.950	3.802
.5012	.2512	6.0	1.995	3.981
.4898	.2399	6.2	2.042	4.169
.4786	.2291	6.4	2.089	4.365
.4677	.2188	6.6	2.138	4.571
.4571	.2089	6.8	2.188	4.786
.4467	.1995	7.0	2.239	5.012
.4365	.1905	7.2	2.291	5.248
.4266	.1820	7.4	2.344	5.495
.4169	.1738	7.6	2.399	5.754
.4074	.1660	7.8	2.455	6.026
.3981	.1585	8.0	2.512	6.310
.3890	.1514	8.2	2.570	6.607
.3802	.1445	8.4	2.630	6.918
.3715	.1380	8.6	2.692	7.244
.3631	.1318	8.8	2.754	7.586
.3548	.1259	9.0	2.818	7.943
.3467	.1202	9.2	2.884	8.318
.3388	.1148	9.4	2.951	8.710
.3311	.1096	9.6	3.020	9.120
.3236	.1047	9.8	3.090	9.550
.3162	.1000	10.0	3.162	10.000
.3090	.09550	10.2	3.236	10.47
.3020	.09120	10.4	3.311	10.96
.2951	.08710	10.6	3.388	11.48
.2884	.08318	10.8	3.467	12.02
.2818	.07943	11.0	3.548	12.59
.2754	.07586	11.2	3.631	13.18
.2692	.07244	11.4	3.715	13.80
.2630	.06918	11.6	3.802	14.45
.2570	.06607	11.8	3.890	15.14
.2512	.06310	12.0	3.981	15.85
.2455	.06026	12.2	4.074	16.60
.2399	.05754	12.4	4.169	17.38
.2344	.05495	12.6	4.266	18.20
.2291	.05248	12.8	4.365	19.05
.2239	.05012	13.0	4.467	19.95
.2188	.04786	13.2	4.571	20.89
.2138	.04571	13.4	4.677	21.88
.2089	.04365	13.6	4.786	22.91
.2042	.04169	13.8	4.898	23.99
.1995	.03981	14.0	5.012	25.12
.1950	.03802	14.2	5.129	26.30
.1905	.03631	14.4	5.248	27.54
.1862	.03467	14.6	5.370	28.84
.1820	.03311	14.8	5.495	30.20
.1778	.03162	15.0	5.623	31.62
.1738	.0320	15.2	5.754	33.11
.1698	.02884	15.4	5.888	34.67
.1660	.02754	15.6	6.026	36.31
.1622	.02630	15.8	6.166	38.02
.1585	.02512	16.0	6.310	39.81
.1549	.02399	16.2	6.457	41.69
.1514	.02291	16.4	6.607	43.65
.1479	.02188	16.6	6.761	45.71
.1445	.02089	16.8	6.918	47.86
.1413	.01995	17.0	7.079	50.12
.1380	.01905	17.2	7.244	52.48
.1349	.01820	17.4	7.413	54.95
.1318	.01738	17.6	7.586	57.54
.1288	.01660	17.8	7.762	60.26
.1259	.01585	18.0	7.943	63.10
.1230	.01514	18.2	8.128	66.07
.1202	.01445	18.4	8.318	69.18
.1175	.01380	18.6	8.511	72.44
.1148	.01318	18.8	8.710	75.86
.1122	.01259	19.0	8.913	79.43
.1096	.01202	19.2	9.120	83.18
.1072	.01148	19.4	9.333	87.10
.1047	.01096	19.6	9.550	91.20
.1023	.01047	19.8	9.772	95.50
.1000	.01000	20.0	10.000	100.00

VOLTAGE RATIOS BEYOND THE RANGE OF THE TABLES.

A. Ratios less than those in tables: Multiply ratio by 10 successively until the result can be found in the tables. From the decibel value found from the table subtract +20Db for each time the multiple of 10 was used.

Example:- Voltage Ratio of 0.02042 - find Db value:-
.02042 x 10 x 10 = 2.042 from the table:- Voltage ratio of 2.042 = 6.2 Db
6.2 Db - 20 Db - 20 Db = -33.8 Db.

B. Ratios greater than those in tables: Divide ratio by 10 successively until the result can be found in the tables. To the Db value found from the table add +20Db for each time the divisor of 10 was used.

Example:- Voltage Ratio of 407.4 - find Db value:-
407.4 ÷ 10 ÷ 10 = 4.074 from the table:- Voltage ratio of 4.074 = 12.2 Db
12.2 Db + 20 Db + 20 Db = 52.2 Db.

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