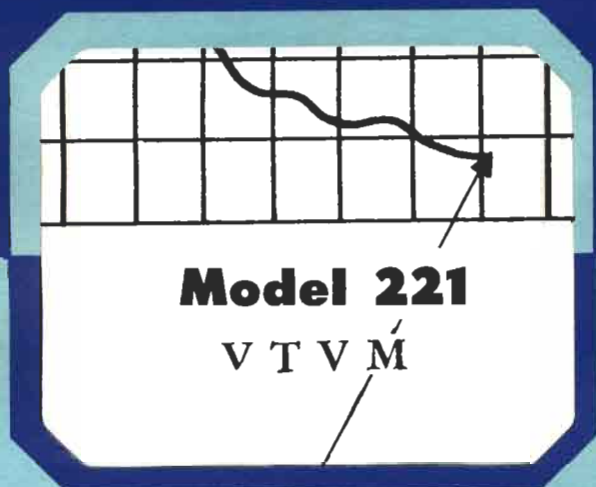


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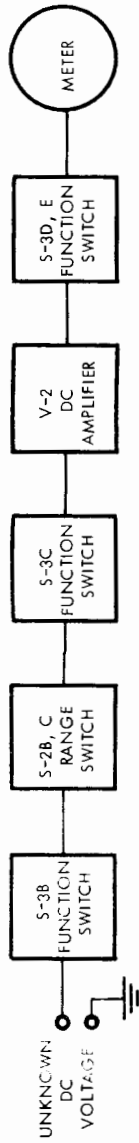


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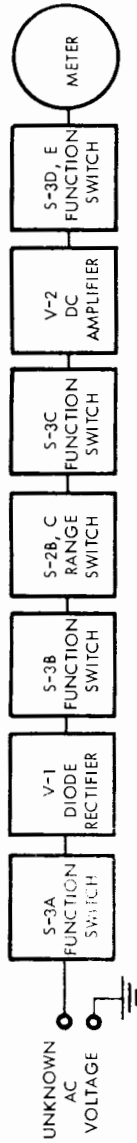
**EICO ELECTRONIC
INSTRUMENT CO., Inc.**

131-01 39th AVENUE, FLUSHING 54, N. Y.

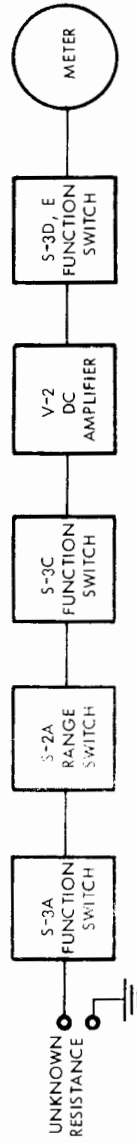
DC VOLTMETER -



AC VOLTMETER -



OHMMETER -



221-235-552A

GENERAL DESCRIPTION

The EICO Model 221 Electronic Volt-Ohm Meter is a high quality VTVM that is especially suited for use in television, f-m, and a-m radio servicing. Featuring a rugged and easy reading 4 1/2" meter, this instrument provides entirely electronic measurement of a-c voltage, d-c voltage, decibels and resistance.

Complete overload protection is provided electronically on all a-c voltage, d-c voltage, and ohmmeter ranges. To eliminate the need for reversing the test leads on d-c voltage measurement (when a negative d-c voltage is to be measured), positive and negative d-c positions have been provided on the function switch. A zero centering position on the meter facilitates discriminator alignment in f-m and a-f-c circuits.

This instrument allows measurement of d-c and a-c voltages up to 1000 volts in five ranges. The d-c voltage range can be extended to 30,000 volts with the EICO Model HVP-1 High Voltage Probe. Another accessory, the EICO Model P-75 RF Probe extends the frequency range of the instrument (20 - 200,000 cps) to 200 Mc.

The readings on the d-c voltage ranges are accurate within 3% and on the a-c ranges within 5% of full-scale (the multiplier resistors used are accurate within 1%). As the input impedance is 25 megohms on d-c and 3 megohms on a-c voltage ranges, the current drawn by the instrument is negligible, so there is no problem of error due to circuit loading. A balanced bridge circuit maintains constant accuracy despite variations in line voltage.

On the ohmmeter ranges, advantage is taken of the high sensitivity of the d-c amplifier to provide resistance measurements up to 1000 megohms using only the 1 1/2 volt battery. This feature avoids any danger to delicate apparatus that may be tested with the instrument, since it eliminates the high voltage normally encountered in high resistance measuring circuits.

The user of the instrument will benefit from direct reading scales, simple operation, and the dependable quality that results from high grade components, and careful engineering and testing in the field. It will prove to be an extremely valuable tool for signal tracing, alignment, for voltage and resistance measurements in television and radio receivers, and for testing many types of electrical equipment.

SPECIFICATIONS

D-C Voltage Ranges:

0 to 5, 10, 100, 500, 1000 volts
(to 30 KV with HVP-1 probe)

Input impedance: 25 Meg.

Accuracy: d-c volts, ohms -- $\pm 3\%$
a-c volts -- $\pm 5\%$

Power Supply: 115 v, 50-60 cps, 10 w

A-C Voltage Ranges:

0 to 5, 10, 100, 500, 1000 volts
(Special scale for 0 to 5 volts)

Input impedance: 3 Meg.

Ohmmeter Battery: 1 1/2 v dry cell

Tubes: 6X5, 6H6, 6SN7

Electronic Ohmmeter Ranges:

0 to 1000 ohms, 10,000 ohms,
1 Meg., 10 Meg., 1000 Meg.

(Measures from 0.2 ohm to 1000 Meg.)

Overall Dimensions: width - 6 in.,
height - 9 7/16 in., depth - 5 in.

Weight: 10 pounds

Decibel Ranges: -20 to + 55 db

Cabinet: Blue grey wrinkle
lacquer on steel

Frequency Range: 20 - 200,000 cps
(Up to 200 Mc with P-75 probe)

Panel: 3 color, deep etched

OPERATING INSTRUCTIONS

INITIAL STEPS: Check the mechanical zero adjustment of the meter pointer when the power is off. If the pointer is off zero, turn the slotted screw directly beneath the meter face until the pointer is brought to zero.

Plug the line cord into the 60 cycle, 115 volt a-c supply, turn the power on with the "ON-OFF" switch, and allow a normal warm-up time (about one minute).

Insert the phone plug, P1 (on the DC test lead), in the DC jack, J1, on the panel. Insert the pin plug, P2 (on the AC-OHMS test lead), in the AC-OHMS jack, J2, on the panel. Insert the banana plug, P3 (on the COMMON test lead), into the COMMON (ground) jack, J3, on the panel. This is the COMMON lead for all functions.

CAUTION: Never connect the COMMON lead to a high voltage point as this will place the meter chassis and case at a high voltage above ground.

When working with high voltages, avoid contact with or close proximity to high voltage points. If possible, attach the test leads with the power off in the circuit to be measured. After the leads are attached, turn the power on and take the reading.

D-C VOLTAGE MEASUREMENT: Set the FUNCTION switch to "+DC" or "-DC VOLTS", the RANGE switch to desired voltage range, and then use the ZERO ADJ. potentiometer to bring the meter pointer to zero*. Clip the COMMON lead to ground or the low side and touch the DC probe to the high side of the

source to be measured. On the 5V and 500V ranges, read the 0-5 AC-DC scale (black); on the 10V, 100V, and 1000V ranges, read the 0-10 AC-DC scale.

A-C VOLTAGE MEASUREMENT: Set the FUNCTION switch to "AC VOLTS", the RANGE switch to the desired voltage range, and then use the ZERO ADJ. potentiometer to bring the meter pointer to zero*. Clip the COMMON lead to ground or the low side and touch the AC-OHMS probe to the high side of the source to be measured. On the 5V range, read the special 5VAC scale (red); on the 500V range, read the 0-5 AC-DC scale (black); on the 10V, 100V, and 1000V ranges, read the 0-10 AC-DC scale.

RESISTANCE MEASUREMENT: Set the FUNCTION switch to "OHMS" and the RANGE switch to the desired ohms range; connect the COMMON lead to the AC-OHMS lead and then use the ZERO ADJ. to bring the meter pointer to zero; separate the COMMON lead from the AC-OHMS lead and then use the OHMS ADJ. potentiometer to set the meter pointer so that it reads exactly full-scale. Clip the COMMON lead to one terminal of the unknown resistance and touch or connect the AC-OHMS probe to the other terminal. Read the OHMS scale on the meter. On the RX1 range, read the OHMS scale directly in ohms; on RX10, RX1000, and RX10,000 ranges, multiply the scale reading by 10, 1000, and 10,000 respectively and read in ohms; on the RX1MEG range, read the scale directly in megohms. Note: The small reading noted on the lowest range is the resistance of the leads.

CAUTION: Never leave the FUNCTION switch set at the "OHMS" position as this will greatly shorten the life of the ohmmeter battery.

DECIBEL MEASUREMENT: The instructions for decibel measurement are the same as for a-c voltage measurement except that the DB scale is read. To the reading on the DB scale, add the number of db shown on the meter as corresponding to the a-c voltage range used. Correction for measuring across different impedances is included in the APPLICATIONS section under "OUTPUT METER".

ZERO-CENTER INDICATION: See APPLICATIONS section.

APPLICATIONS

OUTPUT METER: When the RANGE switch is set at 10V and the FUNCTION switch is set at AC VOLTS, the power level in a 500 ohm circuit can be read directly in decibels on the DB scale, which is calibrated from - 20 to + 15 DB, based on a reference level of 6.0 milliwatts and 500 ohms. This reference level is marked "0" decibels, and corresponds to 1.73 vac on the 0-10 volt scale. To measure higher levels, proceed as instructed in the OPERATING INSTRUCTIONS section under "DECIBEL MEASUREMENT".

The DB scale on the meter is calibrated across a 500 ohm line. If the DB measurement is being made across an impedance other than 500 ohms, use

*See note on electrostatic pickup in the MAINTENANCE section, page 9.

the correction table below to obtain the number of DB (corresponding to the actual impedance) that has to be added to or subtracted from the measured value. This correction is separate from the correction made for the a-c volts range used.

ACTUAL IMPEDANCE	CORRECTION FACTOR	ACTUAL IMPEDANCE	CORRECTION FACTOR
4 ohms	+ 21 db	200 ohms	+ 4 db
8 ohms	+ 18 db	300 ohms	+ 2.2 db
16 ohms	+ 15 db	500 ohms	0 db
50 ohms	+ 10 db	600 ohms	- 0.8 db
75 ohms	+ 8.2 db	1000 ohms	- 3 db
150 ohms	+ 5.2 db	2000 ohms	- 6 db

RECEIVER ALIGNMENT: To use the DB scale for receiver alignment: 1) connect the AC-OHMS probe and the COMMON lead across the voice coil; 2) set the FUNCTION switch at AC VOLTS and the RANGE switch at 10V; 3) feed a 400 cycle modulated r-f or i-f signal into the receiver. Keep the receiver volume control at maximum, and adjust the signal generator output to produce a small deflection on the DB scale. As alignment adjustments are made, thus increasing the sensitivity, the DB scale will show the improvement directly in decibels. The effective attenuation of wave traps, in decibels, can be determined by noting the decrease in decibels as the trap is tuned through resonance.

ZERO-CENTER APPLICATIONS: In some applications, for example in aligning the discriminator in f-m or a-f-c circuits, it is convenient to use a zero-center d-c voltmeter, because the d-c output of the discriminator changes from + to - to + as the secondary of the discriminator transformer is tuned or as the input frequency is varied above and below resonance.

Zero-center indication can be obtained as follows: 1) set the FUNCTION switch at either "+DC" or "-DC VOLTS", 2) set the RANGE switch at "5V" (higher if necessary); 3) turn the ZERO ADJ. knob to bring the meter pointer to the special zero mark (-0+) beneath the center of the DB scale; 4) connect the COMMON lead to the low side of the discriminator load; 5) connect the DC probe to the high side of the discriminator load; 6) refer to the special center scale zero mark; when the secondary of a conventional discriminator is correctly tuned, the DC output is zero and the meter will indicate zero.

POWER OUTPUT IN WATTS: Use formula: $\text{Watts} = \frac{\text{Output Voltage Squared}}{\text{Load Impedance}}$

EXAMPLE: The maximum undistorted output voltage across a 2 ohm load is 5 volts.

$$\text{Power Output} = \frac{5 \times 5}{2} = \frac{25}{2} = 12.5 \text{ Watts}$$

OSCILLATOR STRENGTH: The negative d-c voltage developed on the oscillator grid is always directly proportional to the strength of oscillation. This voltage can be measured very readily at the oscillator grid while the band switch is turned to the various bands, and in each of its positions the main tuning condenser is rotated from minimum capacity. This will give an indication of the strength of oscillation at all frequencies within the oscillator's range.

A-V-C VOLTAGE: The automatic volume control voltage developed by the incoming signal can be measured at a number of places in the receiver. This negative voltage first appears across the diode load resistor. It may also be measured along the a-v-c bus and at the grids of the r-f tubes being controlled. The d-c voltage measured at the diode load resistor is a very convenient output indication during receiver alignment.

Owing to the high input resistance of this instrument, it is possible to measure bias (a-v-c) voltage on the grid of r-f and i-f amplifier tubes without disrupting the signal.

D-C SUPPLY VOLTAGES: Power supply d-c voltages can be measured at the rectifier filaments and in the filter circuits. Plate, screen, and cathode d-c voltages can be measured at the corresponding pins of the tube sockets.

BIAS CELL VOLTAGE: This instrument will accurately measure the voltage of a bias cell. Current drawing voltmeters are not capable of making this measurement and in many cases will damage the cell.

TELEVISION RECEIVER ADJUSTMENTS: This instrument will measure the d-c voltage developed across the second-detector load resistor in the picture channel of a television receiver. This measurement is most useful when adjusting antenna orientation as well as when adjusting antenna matching sections.

GASSY TUBES: One effect of a gassy tube is to reduce the normal negative grid bias, or even make the grid positive. This instrument is ideal for measuring the voltage directly at the control grid of any tube in order to determine whether or not this effect is present. Excessive gas will cause the tube to cease operating normally, and in an audio amplifier will usually cause the volume control to become noisy. This amount of gas will not always produce a noticeable change in the operation of the radio receiver. Consequently if repeated difficulty is experienced with volume controls becoming noisy, in this type of circuit, this instrument should be used to check for incorrect bias.

A-C VOLTAGES: The a-c voltmeter within the instrument is extremely useful in measuring all a-c voltages encountered in the average radio receiver. The measurements that can be made include all voltages from power transformer secondaries, audio signal voltages at grids and plates of amplifiers, and audio voltages developed across the output transformer or voice coil (as an indication of output during receiver alignment).

ACCESSORIES

R-F PROBE P-75 (K): An EICO R-F probe (P-75K - kit form, P-75 - factory wired) for use in measuring voltages up to 50 volts and to 200 Mc is available to extend the uses of the instrument. This probe is simply plugged into the D-C jack of the instrument and the r-f voltages are read on the regular D-C scales.

HIGH VOLTAGE PROBE HVP-1: An EICO High Voltage Probe HVP-1 (factory wired only) for measuring d-c voltages up to 30KV is available to extend the uses of the instrument. The probe may be supplied with a multiplier resistor of 240 Megohms to give a high voltage range of 10,000 volts or with a multiplier resistor of 740 Megohms to give a high voltage range of 30,000 volts.

CIRCUIT DESCRIPTION

GENERAL: The meter measures either d-c or a-c voltages by making use of the rectifying and amplifying characteristics of vacuum tubes. The input impedances are very high (d-c - 25 megohms, a-c - 3 megohms), and the current used to actuate the indicating meter is not taken from the circuit being measured. A bridge circuit, used to stabilize the operating voltages of the tubes, provides constant accuracy despite line variations. When used as an ohmmeter, the instrument will measure resistances between zero and 1000 megohms. Decibel measurements between - 20 and + 55 db can be made using the DB scale.

D-C AMPLIFIER CIRCUIT: (See Figures 1 and 3) A balanced bridge circuit is used in the d-c amplifier, comprising the twin triode V-2, a common plate load resistor R-3, and the balanced cathode load resistors R-10, R-11, and R-12. The meter M-1 is connected across the two cathodes of V-2. In the normal condition, a reference current flows through V-2B, which has a grounded grid. Current flow through V-2A is adjusted by means of the ZERO ADJ. control R-12 to equal the current flow in V-2B. The meter then reads zero.

OPERATION AS A D-C VOLTMETER: (See Figures 1 and 3) The circuit for operation as a d-c voltmeter is as follows: The unknown voltage is applied across the connectors J-1 and J-3 (ground). The FUNCTION switch S-3 connects the range voltage divider across J-1 and ground. A voltage, depending on the RANGE switch setting, is then applied to the grid of d-c amplifier V-2A. This grid voltage unbalances the bridge circuit, and the meter is deflected in direct proportion to the unbalanced current.

OPERATION AS AN A-C VOLTMETER: (See Figures 1 and 3) The circuit for operation as an a-c voltmeter is as follows: The unknown a-c voltage is applied across the connectors at J-2 and J-3 (ground). The FUNCTION switch applies the voltage to the diode rectifier V-1. The d-c output voltage of V1

is then applied to the voltage divider. A d-c voltage, depending on the RANGE switch setting, is then applied to the grid of d-c amplifier V-2A. The remaining portion of a-c voltmeter operation is the same as the d-c voltmeter operations. The a-c circuit is also used for decibel measurements but the readings are made on the DB scale.

OPERATION AS AN OHMMETER: (See Figures 1 and 3) The circuit for operation as an ohmmeter is as follows: The unknown resistance is connected across connectors J-2 and J-3. The FUNCTION switch connects the range voltage divider and battery B-1 across J-2 and ground. A voltage, depending on the RANGE switch setting, is then applied to the grid of the d-c amplifier V-2A. The remaining portion of the ohmmeter circuit follows the same pattern as the d-c voltmeter circuit.

POWER SUPPLY: (See Figures 1 and 3) The operating potential for the d-c amplifier V-2A is obtained from the full wave rectifier V-3. The B+ output of the rectifier is suitably filtered by R-1, R-2, and C-2. Filament voltages for all tubes are obtained from the 6.3 volt winding of the power transformer T-1.

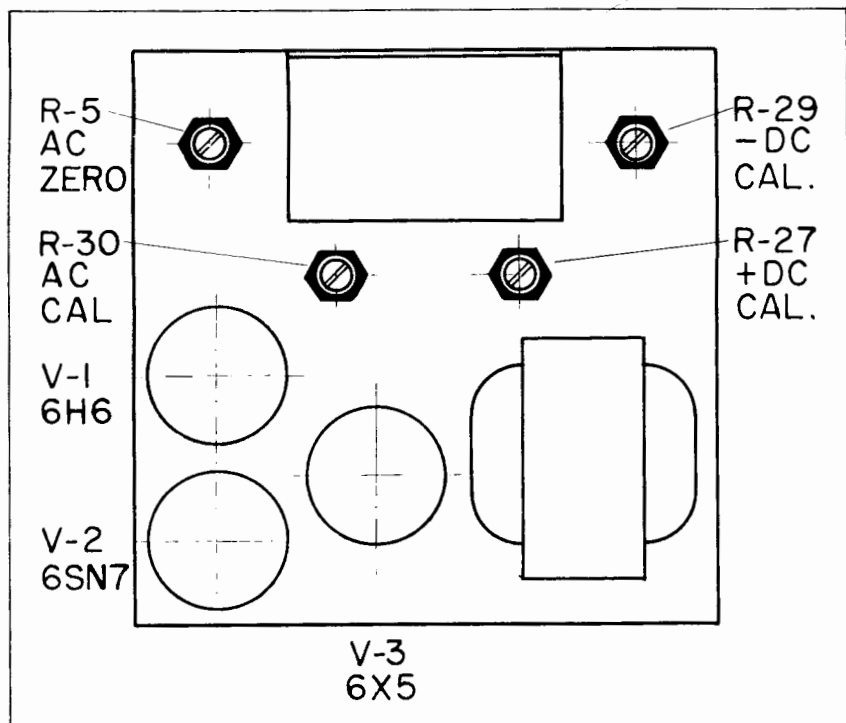


Fig. 2 - Top View of Chassis - Location of calibrating pots.

MAINTENANCE

1. CALIBRATION: After construction of the instrument is completed, it is necessary to carry out the calibration procedure described below.

If a change occurs in the accuracy of the instrument after a long period of use, it is probably due to aging of the components. The accuracy of the instrument may readily be restored by repeating this calibration procedure. Recalibration will also be necessary, whenever parts (tubes, etc.) are replaced.

A. INITIAL STEPS: Follow the procedure described in "INITIAL STEPS" in the OPERATING INSTRUCTIONS section. In addition, check to see that the isolation resistor, R-31, is properly connected within the D-C test probe.

B. D-C VOLTMETER CALIBRATION: (See Fig. 2) To calibrate the d-c voltage ranges, use two flashlight batteries connected in series. The terminal voltage will be 3.10 volts when fresh batteries are used. Set the FUNCTION switch to "-DC" and the RANGE switch to "5V". Short the D-C (red) probe to the COMMON lead (ground) and turn the ZERO ADJ. control until the meter pointer is at zero (ignore any change after the test leads are disconnected). Connect the batteries between the D-C test leads with the COMMON (ground) lead touching the positive side of the batteries. Adjust the "-DC" calibration potentiometer R-29 until a 3.10 volt reading is obtained on the meter (3.10 on the 0 to 5 D-C scale). To calibrate the "+DC" voltage ranges, repeat the above steps with the FUNCTION switch set at "+DC" and the positive end of the cells connected to the D-C probe. Adjust the "+DC" calibration potentiometer R-27.

NOTE: The electrostatic pickup which appears on the low a-c and d-c voltage ranges, when either the AC-OHMS or DC probe is held or touched is normal in a sensitive vacuum tube voltmeter, due to the extreme sensitivity of the instrument. However, if the AC-OHMS or DC probe (depending upon the function) is shorted to the COMMON (ground) lead when the zero adjustment is made, the zero obtained will result in correct meter readings and no error will be introduced because of electrostatic pickup.

C. A-C VOLTMETER CALIBRATION: (See Fig. 2) To calibrate the a-c voltage ranges, set the FUNCTION switch at "AC" and the RANGE switch at "1000V". Short the AC-OHMS (black) test lead to the COMMON lead (ground) and turn the ZERO ADJ. control until the meter pointer is at zero. Turn the RANGE switch to the "5V" position and adjust the A-C shift balance potentiometer, R-5, until the meter pointer returns to zero. Then turn the RANGE switch to the "500V" position; the meter pointer should move very little, usually not at all. Connect the COMMON and AC-OHMS test leads to the 115 volt A-C supply and adjust the A-C calibration potentiometer, R30, until the meter reads 115 volts. Calibration with the 115 volt A-C supply will result in the instrument being accurate within 5%. If greater accuracy is desired, the instrument should be calibrated against a known, standard A-C voltage.

D. OHMMETER CALIBRATION: No separate calibration required.

2. BATTERY REPLACEMENT: When it is no longer possible to adjust the meter pointer to full-scale deflection with the OHMS ADJ. potentiometer, the battery is probably at fault. This battery is a standard 1.5 volt flashlight cell and so may be readily replaced.

NOTE: When replacing the battery, make certain that polarity is observed as shown in the schematic diagram. Recalibration is not required when the battery is replaced.

EICO REPAIR SERVICE

If your instrument fails to function properly and the cause of the trouble is not apparent, you may return it to the EICO repair department where it will be repaired for a nominal charge.

REFERENCES

- Carlisle, J. H., "Universal Voltmeter", Radio News, June, '47
Krueger, R. H., "Vacuum-Tube Voltmeter", Radio News, June, '48
Mayo, G., "Vacuum-Tube Voltmeter for A.C. and D.C.", Nov., '43
Parket, A. T., "Get The Most From Your VTVM", Radio Maint., Apr., '48
Rider, J.F., "Vacuum Tube Voltmeters", J.F. Rider Publisher, N.Y., N.Y., '51
Terman, F. E., "Measurements in Radio Engineering", 1st ed., McGraw-Hill Book Co., N. Y., N. Y., '35. p. 18.



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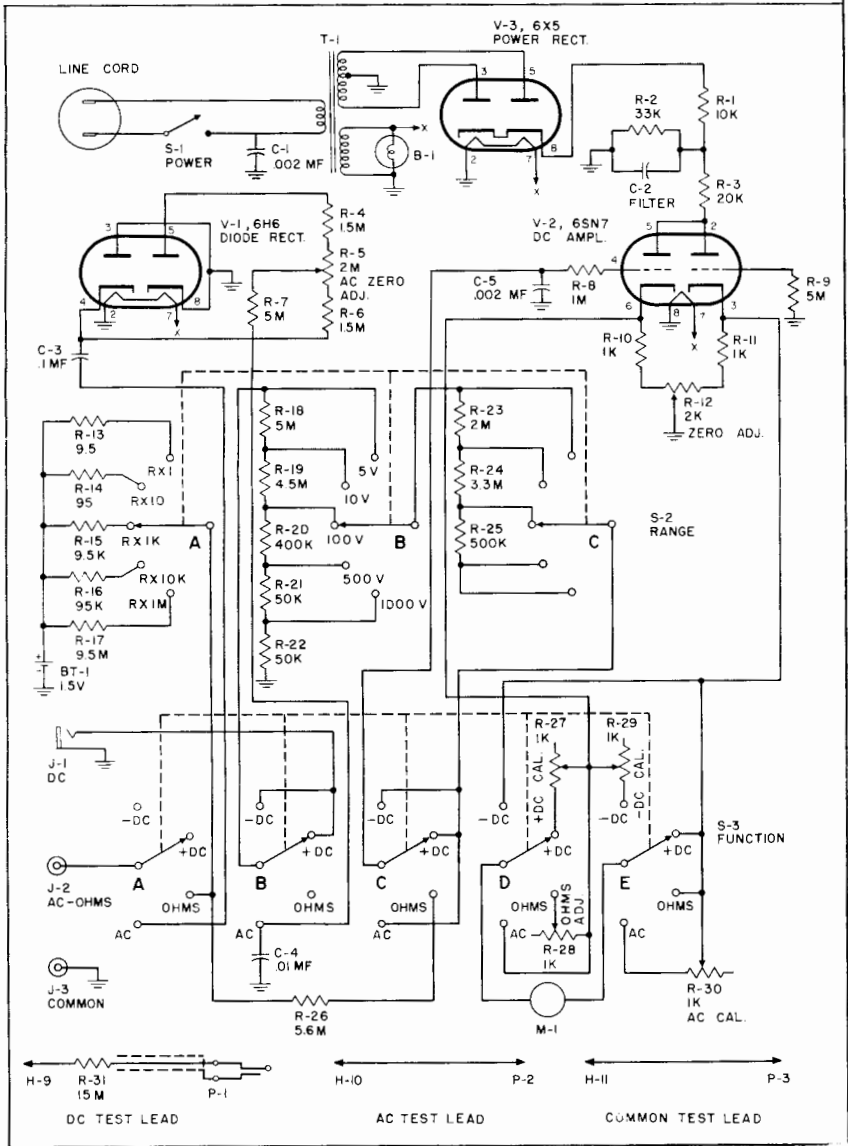


Fig. 3 - Schematic Diagram

PARTS LIST FOR MODEL 221

St. #	Sym.	Description	Amt.	St. #	Sym.	Description	Amt.	St. #	Sym.	Description	Amt.
100	B1	pilot light.....	1	130	H25	meter washer.....	4	158	R9	5M ohm res.....	1
101	BT1	1.5 v battery.....	1	131	H26	ground lug.....	5	159	R10	1K ohm res.....	1
102	C1	.002 mfd cond.....	1	132	H27	pot ground lug.....	1	159	R11	1K ohm res.....	1
103	C2	filter cond.....	1/4	133	H28	1/4" standoff.....	2	160	R12	2K ohm pot adj.....	1
104	C3	.1 mfd cond.....	1	134	H29	#10-24 nut.....	2	161	R13	9.5 ohm 1% res....	1
105	C4	.01 mfd cond.....	1	135	H30	3/8" lock washer..	10	162	R14	95 ohm 1% res....	1
102	C5	.002 mfd cond.....	1	136	H31	3/8" flat washer..	4	163	R15	9.5K ohm 1% res....	1
106	H1	panel.....	1	137	H32	3/8" hex nut.....	9	164	R16	95K ohm 1% res....	1
107	H2	chassis.....	1	138	H33	wire.....	roll	165	R17	9.5M ohm 1% res....	1
108	H3	cabinet.....	1	139	H34	test lead wire....	2	166	R18	5M ohm 1% res....	1
109	H4	handle.....	1	140	H35	shielded wire....	pc.	167	R19	4.5M ohm 1% res..	1
110	H5	pilot light ass'y...	1	141	H36	#6 lock washer....	7	168	R20	400K ohm 1% res..	1
111	H6	line cord.....	1	142	H37	bare wire.....	pc.	169	R21	50K ohm 1% res....	1
112	H7	wafer socket.....	3	143	H38	nut, shldr. washer...	1	169	R22	50K ohm 1% res....	1
113	H8	battery bracket....	1	144	H39	nut, washer.....	1	170	R23	2M ohm res.....	1
114	H9	red test prod.....	1	145	H40	#6 fibre washer....	2	171	R24	3.3M ohm res.....	1
115	H10	black test prod....	1	146	J1	phone jack.....	1	172	R25	500K ohm res.....	1
116	H11	alligator clip....	1	147	J2	pin jack.....	1	173	R26	5.6M ohm res.....	1
117	H12	bar knob.....	2	148	J3	banana jack.....	1	174	R27	1K ohm pot cal....	1
118	H13	round knob.....	2	149	M1	meter.....	1	175	R28	1K ohm pot adj....	1
119	H14	3/8" grammet....	1	150	P1	phone plug.....	1	174	R29	1K ohm pot cal....	1
120	H15	1 lug term. strip...	1	151	P2	pin plug.....	1	174	R30	1K ohm pot cal....	1
121	H16	3 lug term. strip...	1	152	P3	banana plug.....	1	176	R31	15M ohm res.....	1
122	H17	7/16" nut (S1)....	2	153	R1	10K ohm res. 2W...	1	177	S1	SPST switch.....	1
123	H18	#6-32 screw.....	4	154	R2	33K ohm res. 2W...	1	178	S2	3 pole, 5 pos. sw...	1
124	H19	#6-32 nut.....	8	155	R3	20K ohm res.....	1	179	S3	6 pole, 4 pos. sw...	1
125	H20	#10-24 screw.....	2	156	R4	1.5M ohm res.....	1	180	T1	transformer.....	1
126	H21	spaghetti.....	pc.	157	R5	2M ohm pot.....	1	181	V1	6H6 tube.....	1
127	H22	#6 P.K. screw....	7	156	R6	1.5M ohm res.....	1	182	V2	6SN7 tube.....	1
128	H23	meter lug.....	2	158	R7	5M ohm res.....	1	183	V3	6X5 tube.....	1
129	H24	meter nut.....	2	159	R8	1M ohm res.....	1	184		instruction book...	1

Notes: 1) All resistors 1/2 watt unless noted differently. 2) WHEN ORDERING A PART FOR REPLACEMENT, please include the stock number of the part and the serial number of your instrument.

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