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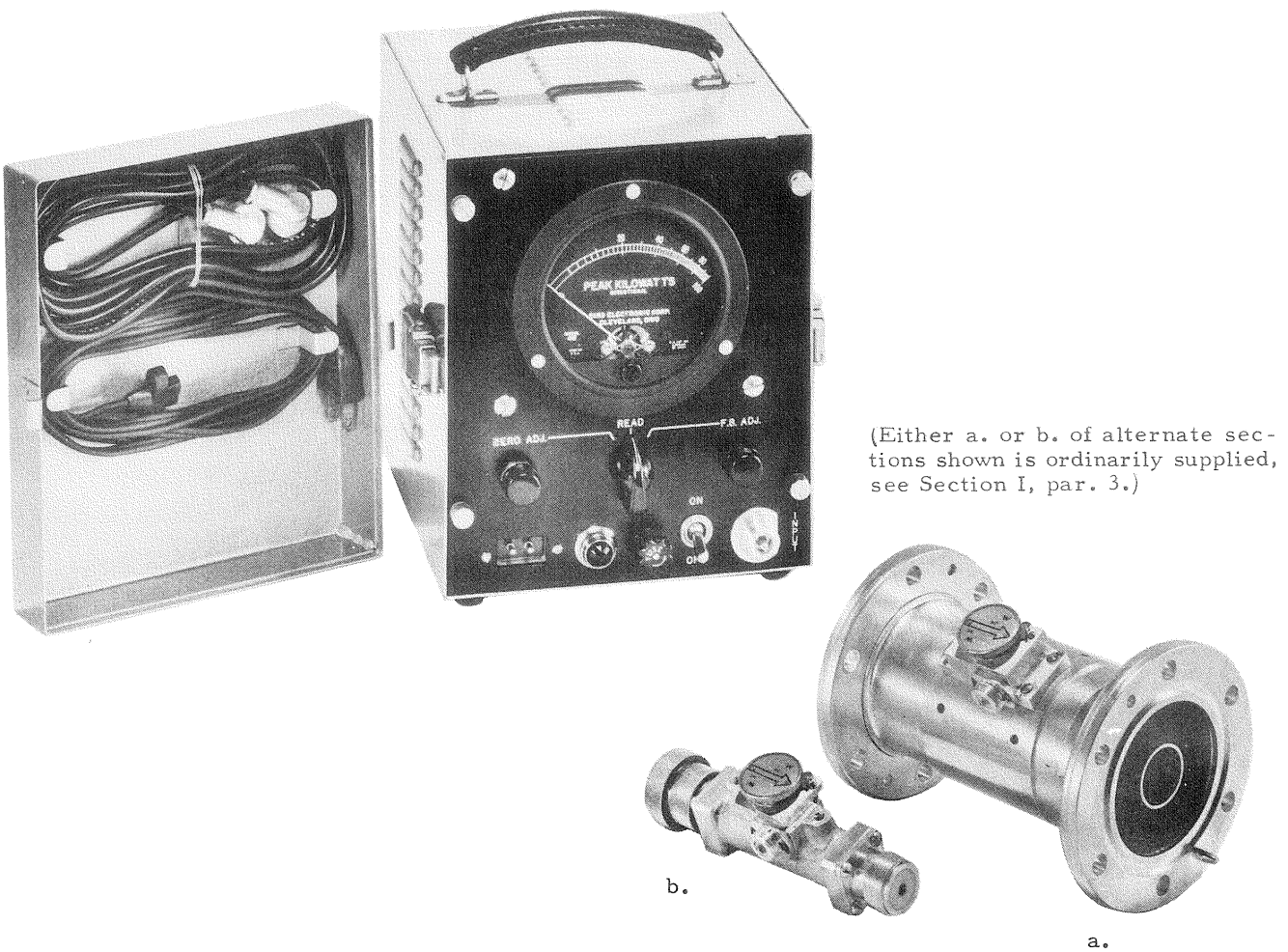
LIST OF ILLUSTRATIONS



(Either a. or b. of alternate sections shown is ordinarily supplied, see Section I, par. 3.)

Fig. 1-1. Model 640 Peak Wattmeter Equipment.

PEAK WATTMETER
MODEL 640

Section I

GENERAL DESCRIPTION

1. Scope of Manual

This instruction book covers the description, theory, operation and maintenance of the Bird Peak Wattmeter (Model 640).

2. Purpose of Equipment

The Model 640 Wattmeter is intended for the measurement of peak power of pulsed CW, the Peak Wattmeter responding accurately to narrow peaks of energy. The equipment has the following characteristics and is designed to operate within these limits:

CW Frequency	25 to 1000 mcs (Determined by Element Selected).
Accuracy	±10%
Pulse Modulation	1% minimum duty factor - 2.5 microsecond minimum pulse width.
Power Range	10 watts to 5 megawatts full scale - determined by Element selected.
Measuring Circuit	Coaxial, 51.5 or 50.0 ohms Nominal (See equipment supplied for actual type of connections and standard impedance).
Power Supply	117 volts, 60 cycle, 40 watts

3. Description

Equipment Supplied: Item a. or b. see Fig. 1-1.

a.

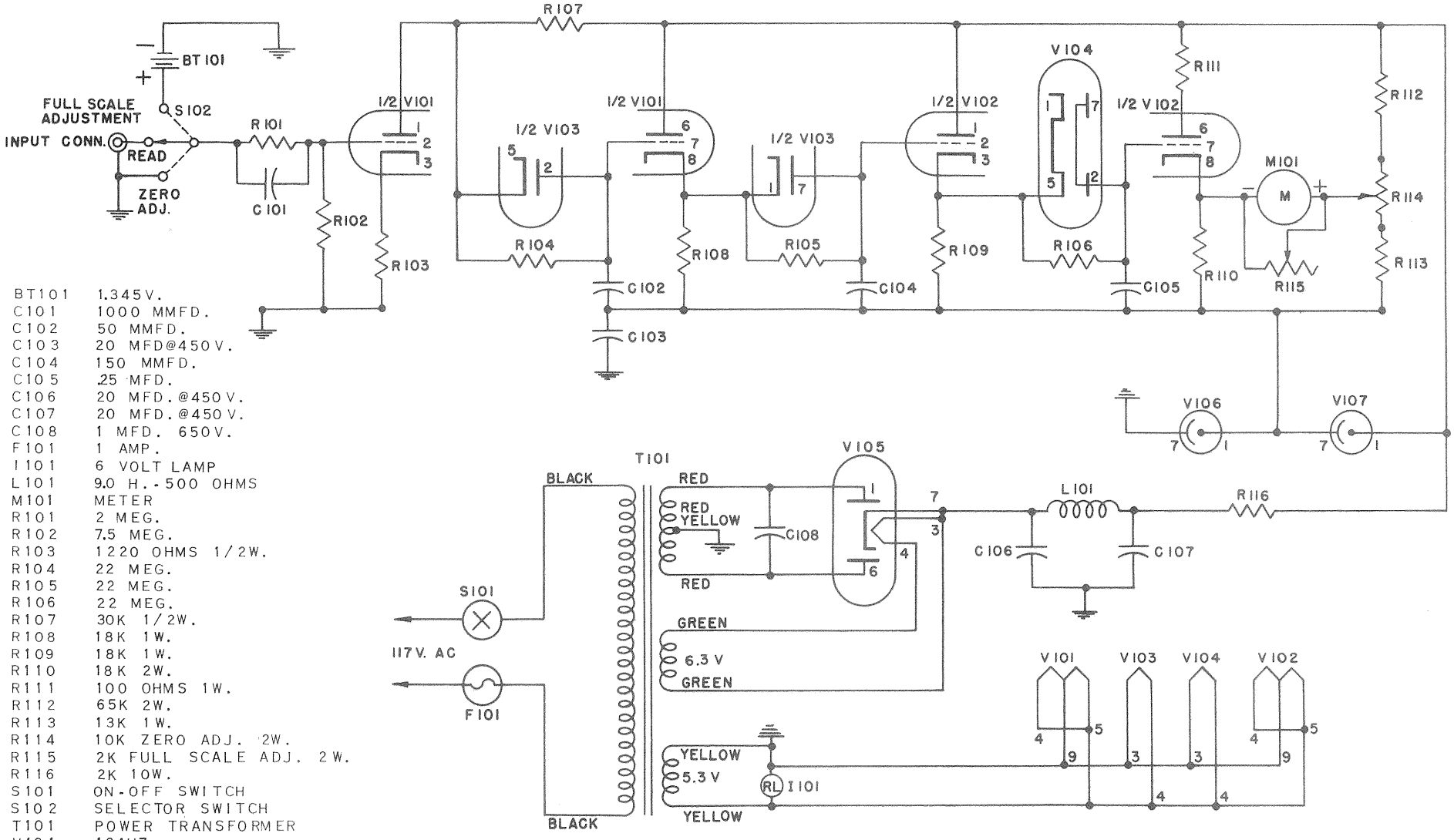
Bird THRULINE Coaxial Line Section for 3-1/8 inch air line with swivel flange and calibrated coupling Element. 12 ft. coaxial instrument cable (RG-58/U cable with special sealed connector plugs).
Peak Power Meter Unit reading 100 KW Full Scale. Special 6 ft. power cord.

b.

Bird THRULINE Coaxial Line Section for RG-19/U cable, or equivalent, with mating coplanar connectors and calibrated coupling Element. 12 ft. coaxial instrument cable (RG-58/U cable with special sealed connector plugs).
Peak Power Meter Unit reading 10 KW Full Scale. Special 6 ft. power cord.

The pulsed energy is fed through a short length of transmission line into the mounted THRULINE Section. The Section transmits the energy into an appropriate non-reflective load resistor unit, such as Bird Model 502-H or Model 824, shown in Installation Drawings Fig. 3-1 and Fig. 3-2. A rotatable directionally sensitive coupling Element operates in the socket of the THRULINE Section. The output of the coupling Element is carried by the RG-58/U cable to the meter unit, where the detected signal is properly amplified and altered, and is read on the meter scale.

The amplifier-meter unit is housed in a ventilated enamelled steel carrying case with handle. It is fully protected for handling by the removable face cover. The equipment nameplate is located on the bottom of the case.



BT101	1.345V.
C101	1000 MMFD.
C102	50 MMFD.
C103	20 MFD@450V.
C104	150 MMFD.
C105	.25 MFD.
C106	20 MFD.@450V.
C107	20 MFD.@450V.
C108	1 MFD. 650V.
F101	1 AMP.
I101	6 VOLT LAMP
L101	9.0 H.-500 OHMS
M101	METER
R101	2 MEG.
R102	7.5 MEG.
R103	1220 OHMS 1/2W.
R104	22 MEG.
R105	22 MEG.
R106	22 MEG.
R107	30K 1/2W.
R108	18K 1W.
R109	18K 1W.
R110	18K 2W.
R111	100 OHMS 1W.
R112	65K 2W.
R113	13K 1W.
R114	10K ZERO ADJ. 2W.
R115	2K FULL SCALE ADJ. 2W.
R116	2K 10W.
S101	ON-OFF SWITCH
S102	SELECTOR SWITCH
T101	POWER TRANSFORMER
V101	12AU7
V102	12AU7
V103	6AL5
V104	6AL5
V105	6X4
V106	0B2
V107	0B2

Fig. 2-1. Circuit Diagram of Meter - Amplifier Unit.

Section II
THEORY OF OPERATION

1. General

There is an increasing demand for instruments yielding peak power indication of repetitive waveforms. This is true especially where the average value over one cycle is small, as in the case of television synchronizing pulses or in radar equipment. Here the maximum energy level of the wave is more important than the average value.

In the design of electronic equipment, such as transmitters, it is the peak value of signals that extend beyond the linear range and cause undesirable transients and distortion. If the transients are of short duration, they cannot be measured by average indicating power meters, but require an instrument such as the Bird Peak Wattmeter, Model 640.

2. Circuit Description

When the transmission line is properly connected, with a matching resistive load of suitably low VSWR, the power in the transmission line circuit will be almost non-reflective, ie; the power will flow entirely in one direction. Element is positioned to sample this flow only in the exact forward or reverse direction of the transmission line. The directional coupling Element is precisely and accurately mounted in its THRULINE Section to give stable and repeatable measurements. The position of the Element in relation to center conductor is uniformly maintained in all the THRULINE Sections of the same type. The Element seat and socket are machined for smooth, steady contact.

The circuit of the Element consists of a coupling loop, a crystal detector, and a filter network. When in operation, the Element is coupled both inductively and capacitively to the inner conductor of the transmission line. It is readily apparent that the phase of the voltage resultant in the Element due to capacitive coupling is independent of direction of flow. However, the voltage induced in the Element from inductive coupling depends accordingly upon the loop position, ie; forward or reverse with relation to current direction in the power transmission line. Hence, by proper design and balance of the components therein, an Element may be produced such that the inductive and capacitive voltages are equal, and will be additive in the forward direction and will cancel in the reverse direction. Such an Element, as we have in the Model 640 Peak Power Wattmeter, is therefore very directionally sensitive, and will produce readings for power only in the direction indicated by the arrow on the cap. The Elements have a very flat response over a frequency range of more than 2-1/2 to one.

By means of the crystal rectifier and filter network, the Element delivers a D C voltage proportional to the peak voltage on CW, or a pulse of magnitude proportional to the peak voltage on pulsed CW.

This voltage is now impressed on the initial stage, first 1/2V101 which consists of a D C voltage amplifier, of the amplifier-meter unit. Fig. 2-1 shows the circuit diagram for the amplifier-meter unit. The signal then passes through two diode pulse stretcher V103. The third diode rectifier V104, with a relatively long time constant, charges an output load capacitor C105 to accurately represent peak voltages of the signal. Triode repeater amplifiers, last 1/2V101 and first 1/2V102, are used between these diode stages.

A final triode, last 1/2V102, again repeats this D C voltage into a 100 microampere meter having a square law scale to indicate power. Viz; Based on the fundamental relationship $W=E^2/R$, which relationship is illustrated in the scale drawing, Fig. 2-2.

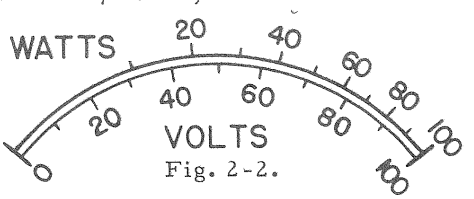


Fig. 2-2.
Square Law Scale, Watts vs Volts

The meter is adjusted for zero scale position by grounding the input grid and balancing the meter output against a bridge circuit of the output triode. For full scale adjustment, the 1.345 dc voltage from a mercury standard cell is fed through the system and the meter accordingly adjusted by altering the external shunt resistance.

The high voltage power supply is rendered especially stable by several means. The secondary of the constant voltage power transformer is loaded with a high voltage capacitor, somewhat dampening the AC wave. The cathode output of the rectifier is well filtered with a high resistance 9.0 henry choke and two large capacity by-pass capacitors. The voltage is again divided and stabilized by two OB2 tubes in series, tapped and by-passed to ground with a large capacitance for cathodes of all later diode and triode stages. The stability of the instrument is well protected against sudden minor fluctuations; an ultimate change of ± 15% in supply voltage causes a corresponding change of about 2% in full scale power indication.

Section III
INSTALLATION & OPERATION

1. Installation

Setting up this equipment is relatively simple, and respective installations for the two types of THRULINE Coaxial Sections are shown in Fig. 3-1 and Fig. 3-2.

Release the pull-down clasps at either side of the meter case, and remove the face cover. This will disclose the panel of unit, with all controls and connections. Insert the THRULINE Section as close as construction will permit to the point where measurement is desired. The figures are self-explanatory as to the arrangement of the pieces of equipment. Connect DC Cable to connector on THRULINE Element socket block and the other end to the input connector on wattmeter. Joints of all electrical connections should be clean and dust-free before attachment, and all joints should be screwed tight and true. The power transmission line should not have discontinuities and the d-c connections must be sound. Position the meter, if possible, so that it is easily read while the operator is using the measuring Elements. The meter case has bumper feet on both the back end and on the bottom, and may be operated while standing in either position.

2. Adjustment

Plug in the power cord to the receptacle on lower left front of meter panel and into a normal 115 volt AC power outlet. (A line not subject to heavy power load variations is desirable). Push up the power switch marked "ON-OFF" (next to input connector) to "ON", turn selector pointer to "zero adjust", and check that the pilot light goes on. The meter needle will quickly run up past the full scale position and then settle back down. Allow the unit to warm up to stability for about five minutes while remaining in the "zero adjust" position.

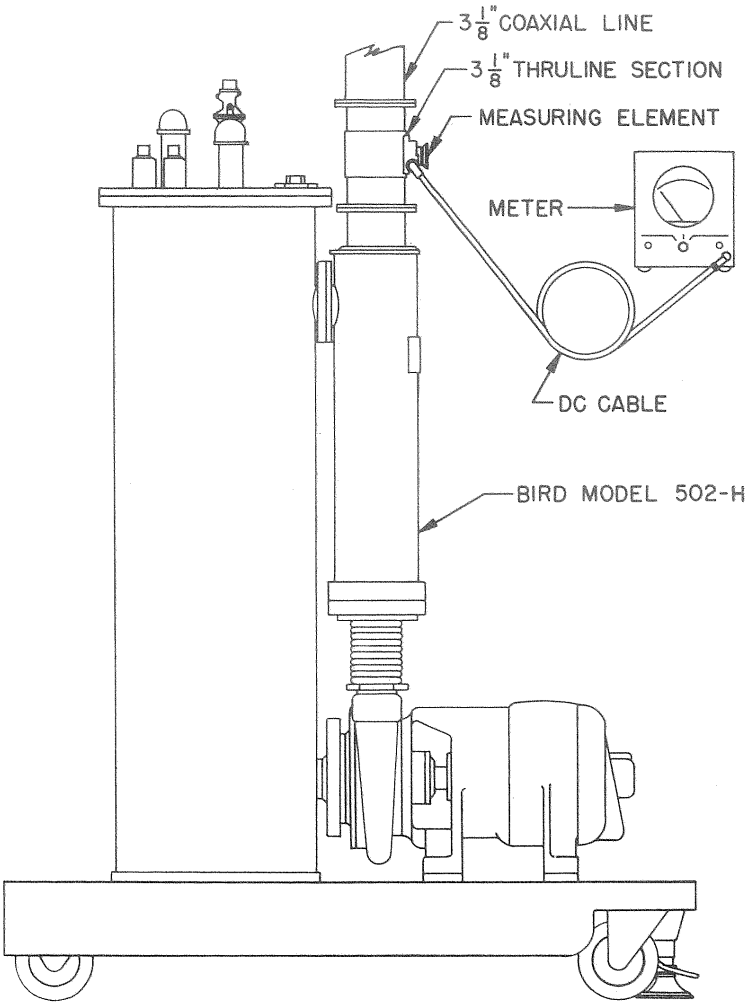


Fig. 3-1. Installation with Model 502-H

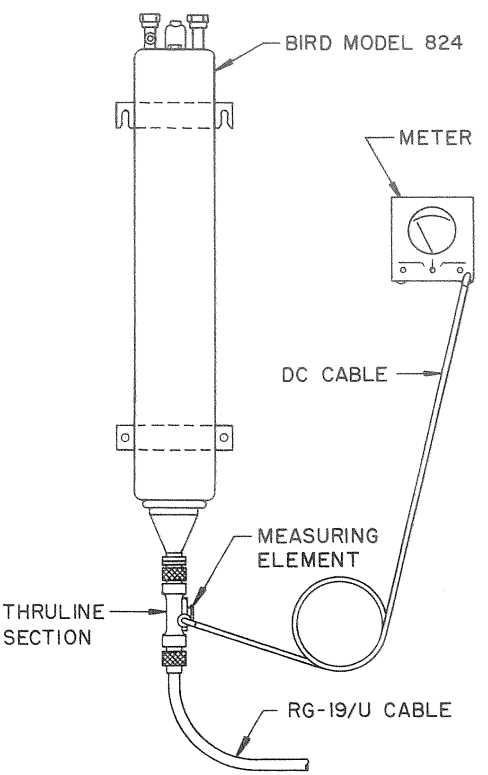


Fig. 3-2. Installation with Model 824

Before making measurements, the meter must be calibrated for accurate reading. Errors which might result from extremes of tube aging or tube replacements, etc. can be quickly compensated for. The front panel controls for zero and full scale adjustment lie just below the meter face as labeled. Calibrate merely by turning the round control knobs to bring the meter pointer into described position while the center selector switch is directed to the respective side. The process of zero and full scale adjustment should be repeated two or three times to get exact results because of small interdependent effects between the two controls.

3. Measurement

Turn selector pointer to "read" position and insert the THRULINE Element in the measuring socket. Be sure that the pivoted hold-down tab is fully seated on the shoulder of the Element. The Elements read power in the direction of the arrow on the top. Be sure that the stop pin is against the end stops of the block; DC contact with the Elements occurs only when the Element is in one of these two positions. Rotate the Element full 180° for reverse power. The wattmeter will now indicate directly the peak power flowing thru the THRULINE Section.

Meter reads full scale watts for the value stamped on the nameplate of the Element. Use the Element only in the frequency band stamped on the nameplate on the cap. On lower power value Elements, particularly, use of Element materially outside of stated frequencies will result in a substantial loss in power response.

WARNING: Do not expose Elements to forward power considerably greater than that stamped on the nameplate, as permanent damage to the Element may result.

Section IV

MAINTENANCE

1. General Prevention

The simplicity and rugged construction of this equipment should make its maintenance a relatively simple matter. Keep sockets of THRULINE Sections plugged when not in use. The socket portion of the THRULINE Section and the Elements should be kept clean, especially around the mating contact surfaces. Use a small quantity of carbon tetrachloride on a cotton swab stick for cleaning these surfaces.

CAUTION: AVOID BREATHING FUMES.

DC connections can be restored by attaching the plug to a connector without fully tightening the nut, then rotate the shank of the plug about a quarter turn back and forth and retighten. The meter-amplifier unit should be kept free of dust as much as possible, and routine checks of the tubes and standard cell should be made at the end of long periods of time. The internal structure and components of the measuring Elements are critical, and we do not suggest that the operator attempt adjustments or repairs. Do not at any time expose Elements to line power substantially exceeding their rating.

The circuit of the amplifier is shown in Fig. 2-1. The voltage to ground at terminal 1 of V107 should be 210 and 105 volts at terminal 7.

2. TROUBLE SHOOTING

Symptom	Probable Causes
1. Pilot light does not light.	1. a. Power cord not connected. b. ON-OFF switch S101 faulty or not turned "ON". c. Fuse burned out or not in place. d. Faulty Power Transformer T101.
2. Meter does not show charge and discharge cycle when turned on.	2. a. Check causes on Step No. 1 b. Check all vacuum tubes. c. Check circuit components (resistors, capacitors, etc.). d. Defective Meter M101. e. Faulty Power Transformer T101.
3. Meter will not Zero adjust.	3. a. Faulty Tubes V101, V102, V103, V104. b. Faulty switch S102 (not making ground contact).
4. Meter will not full scale adjust.	4. a. Faulty Tubes V101, V102, V103, V104. b. Faulty switch S102.
5. Adjusts full scale, no meter movement at "read" position.	5. a. No power on transmission line. b. Faulty Element. c. Faulty dc cord or improper connections on dc line.
6. Meter Indication is unstable.	6. a. Faulty Tubes V101, V102, V103, V104. b. Faulty Element. c. Power being measured is unstable. d. Line voltage unstable - check with full scale calibration reading.

A convenient way to secure access to the meter unit chassis is to set the case on its back with the panel facing upwards. Unscrew the four knurled finger screws at the edges of the panel and remove. By gently tilting the case and chassis back to horizontal, the panel will jog out of position by itself and can be readily removed for service. Before touching the wiring of the chassis, or making any measurements, the operator should short out each of the three by-pass capacitors C103, C106 and C107 to avoid the possibility of shock from their retained charges. The Figures 4-1 and 4-2 indicate the location of components in the wiring diagram to assist the operator or repairman in circuit tracing and part identification.

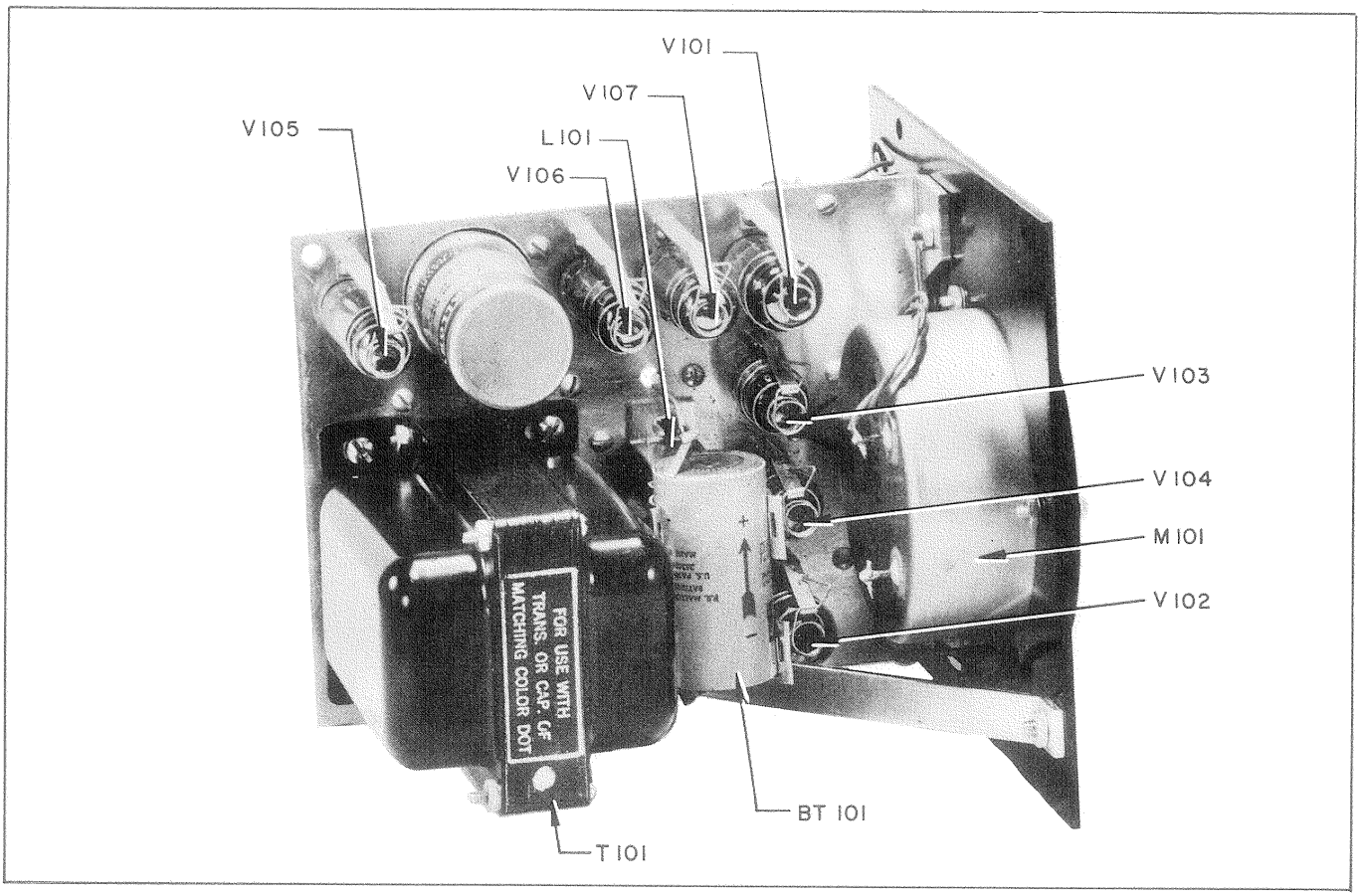


Fig. 4-1. Component Locations - Topside

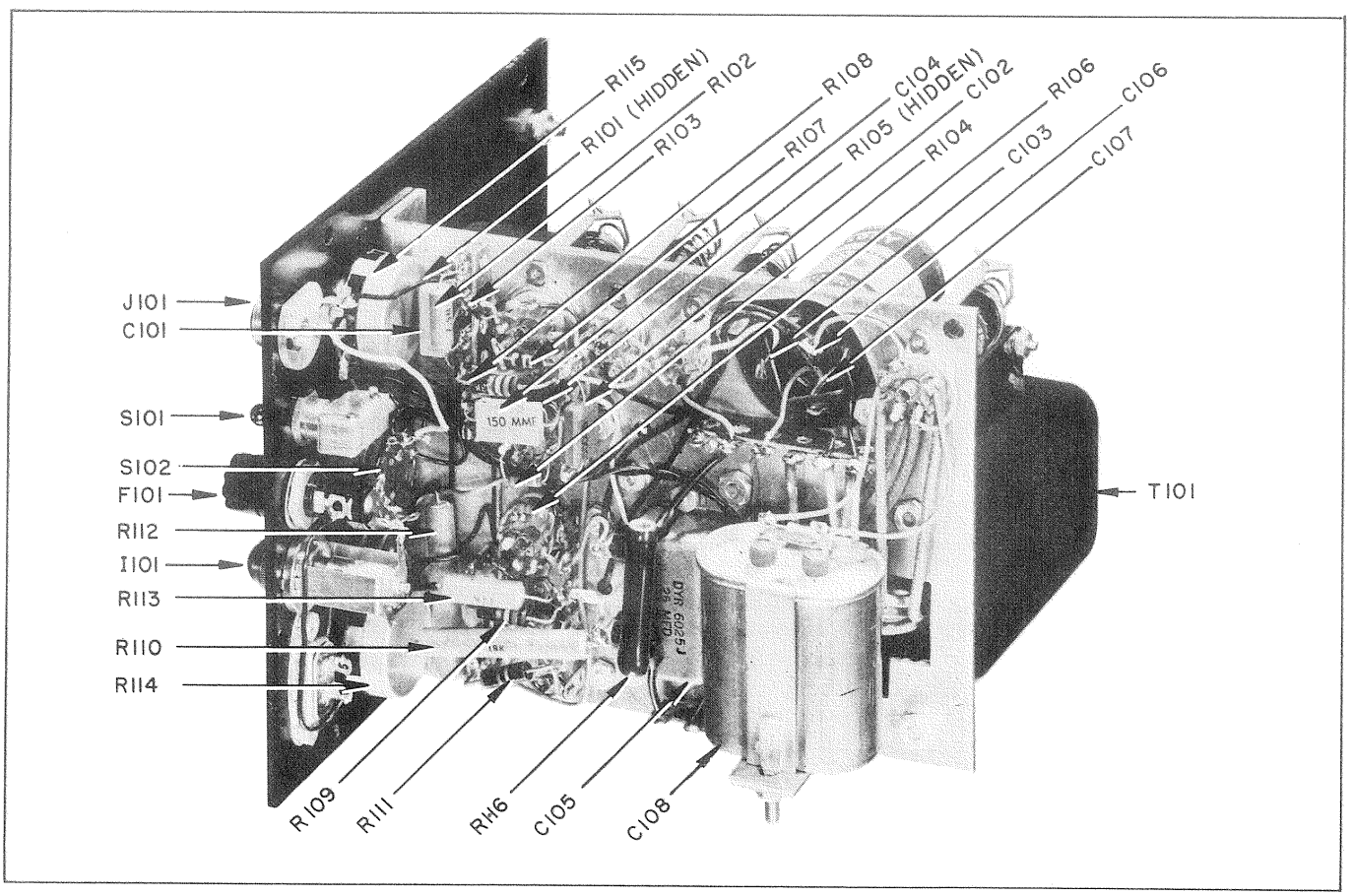


Fig. 4-2. Component Locations - Underside