INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

ELECTRONIC TELEMETERING TRANSMITTER
TYPE IT-1

CAUTION Before putting transmitters into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment.

APPLICATION

IT-1 transmitters are used in conjunction with thermal wattmeters for telemetering power measurements. The function of a transmitter is to convert the dc millivolt output of a thermal wattmeter to frequency. This frequency is directly proportional to the power measured by the thermal wattmeter and is transmitted over the telemetering channel to the receiving point where it is converted back to a power indication by means of the IR-1 receiver.

The block diagram in Figure #1 shows the position of the several units of a telemetering system. The 100 millivolt values shown in the diagram have been arbitrarily chosen as full load values. However, due to varied applications particularly those involving totalization, millivolt values ranging from 30 to 500 may be expected. The span across the scale will in all cases be 15 to 35 cycles per second regardless of the millivolt range, or whether the scale is left zero or center zero.

CONSTRUCTION AND OPERATION

The transmitter consists of a vibrator which chops the d.c. millivolts into 60 cycles pulses, an amplifier, an oscillator and a bias to obtain a base frequency.

Figure 3 is a general schematic of the transmitter, and Figure 2 is a detailed schematic diagram of the transmitter circuit showing all of the electrical components.

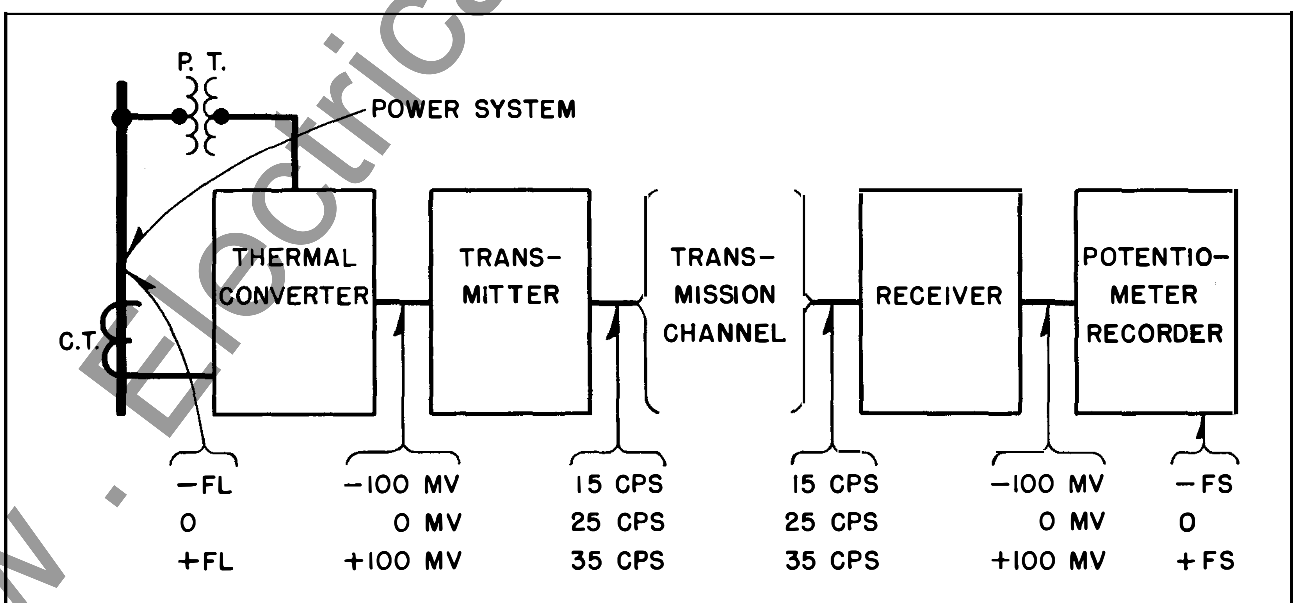

Fig. 1.—Block Diagram of Telemetering System.

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Table #1 is a tabulation of the values of the resistors, capacitors, and transformers that are used in Figure 2. All components are mounted on a sub base which is completely insulated from the frame and case of the transmitter.

The dc voltage for the plates is supplied by a small rectifier which is inside the transmitter case. The negative side of the d.c. is grounded to the sub base.

The control circuit is 120 volts, 60 cycles. It energizes the transmitter through a transformer, thus insulating the control circuit from all electrical components.

The IT-1 transmitter is a servo system; that is, a function of its output is fed back for comparison with its input and the difference between these quantities, is used to control the amplifier. The dc millivolts are "chopped" into 60-cycle pulses. These pulses are then amplified and rectified. The rectified voltage controls the oscillator. The purpose of the feed back which originates at resistor R4 of Figure 2 is to make the transmitter performance independent of the tube characteristics, the amplifier and the rectifier. Figure 3 is a general schematic of the transmitter and it is shown here only for the purpose of illustrating the operation of the transmitter.

CHARACTERISTICS

Transmitters must measure the power in a large variety of circuits such as tie lines, generating stations and transmission lines; some involving totalization and interchange. The circuits may be three phase three wire or three phase four wire or have special features. In addition to this there is a large number of possible combinations of current and voltage transformer. It is obvious that these variable factors must be considered when coordinating a transmitter with its receiver. Most of these variables can be taken care of by specifying the power input for a desired d.c. millivolt output for the thermal wattmeter. Full load on the thermal wattmeter is assumed to give the desired dc millivolt output for operating the IT-1 transmitter.

CALIBRATION

All transmitters are calibrated with an output span of 15 to 35 cycles per second but the input millivolts which is usually supplied by a thermal wattmeter, may be different for different application.

Two examples are used to illustrate the factors that appear when calibrating a transmitter.

Example #1

Assume the required calibration

- 60	0	+60	millivolts
15	25	35	cycles per second

This means that the thermal wattmeter delivers to the transmitter, -60 millivolts for full scale negative power flow, zero millivolts for zero power flow, and +60 millivolts for full scale positive power flow. The corresponding frequencies are 15, 25, and 35 cycles per second. For zero power flow the transmitter delivers 25 cycles per second, and this is called the base frequency for center zero applications.

In order that the transmitter may be able to deliver this base of 25 cps, a constant millivolt quantity is required, connected in series with the millivolt output of the thermal wattmeter. This constant base millivolt quantity is the drop across resistor R-3 and comes from a voltage supply which is regulated by the OC-3 tube, V-1. R-3 is adjustable, as the base is different for different millivolt ranges. For the range

- 60	0	+60	millivolts
15	25	35	cycles per second

a base of 150 millivolts is needed to give the 25 cps. This base is easily calculated. The

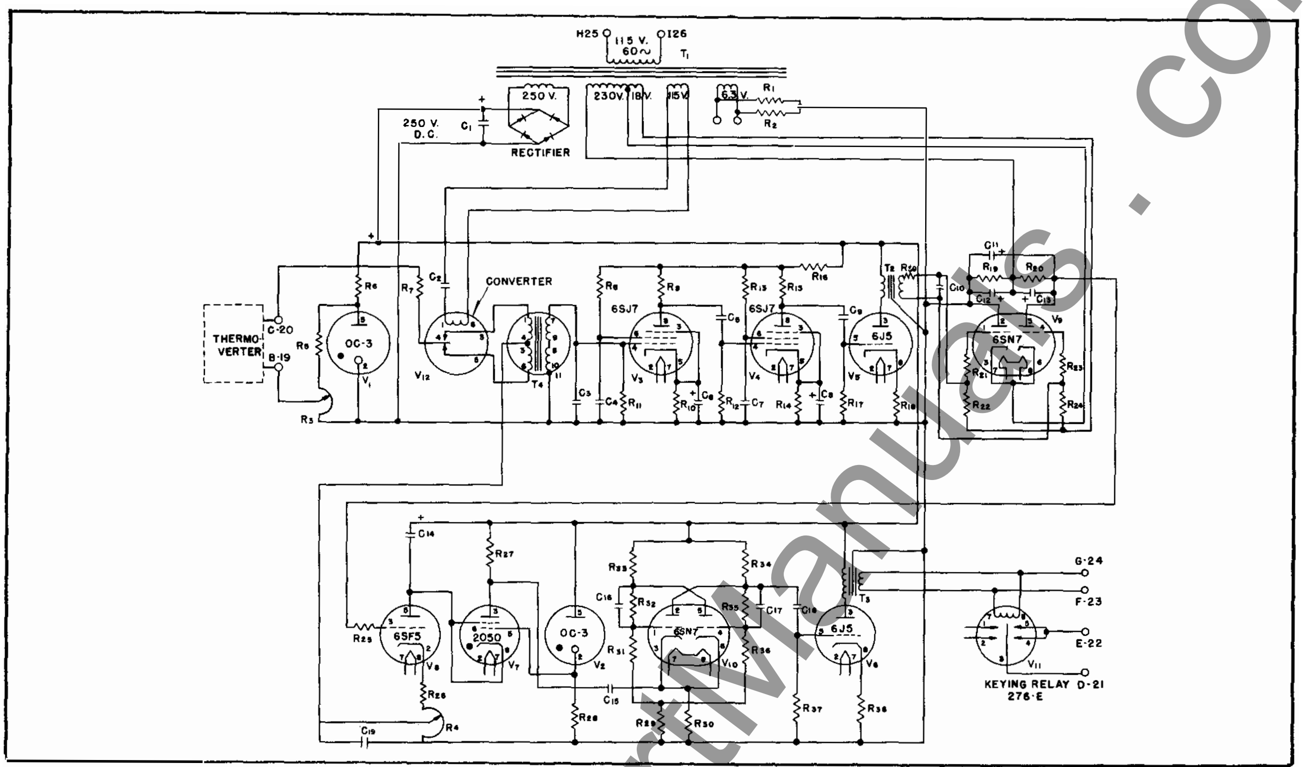

Fig. 2—Internal Schematic of the IT-1 Transmitter.

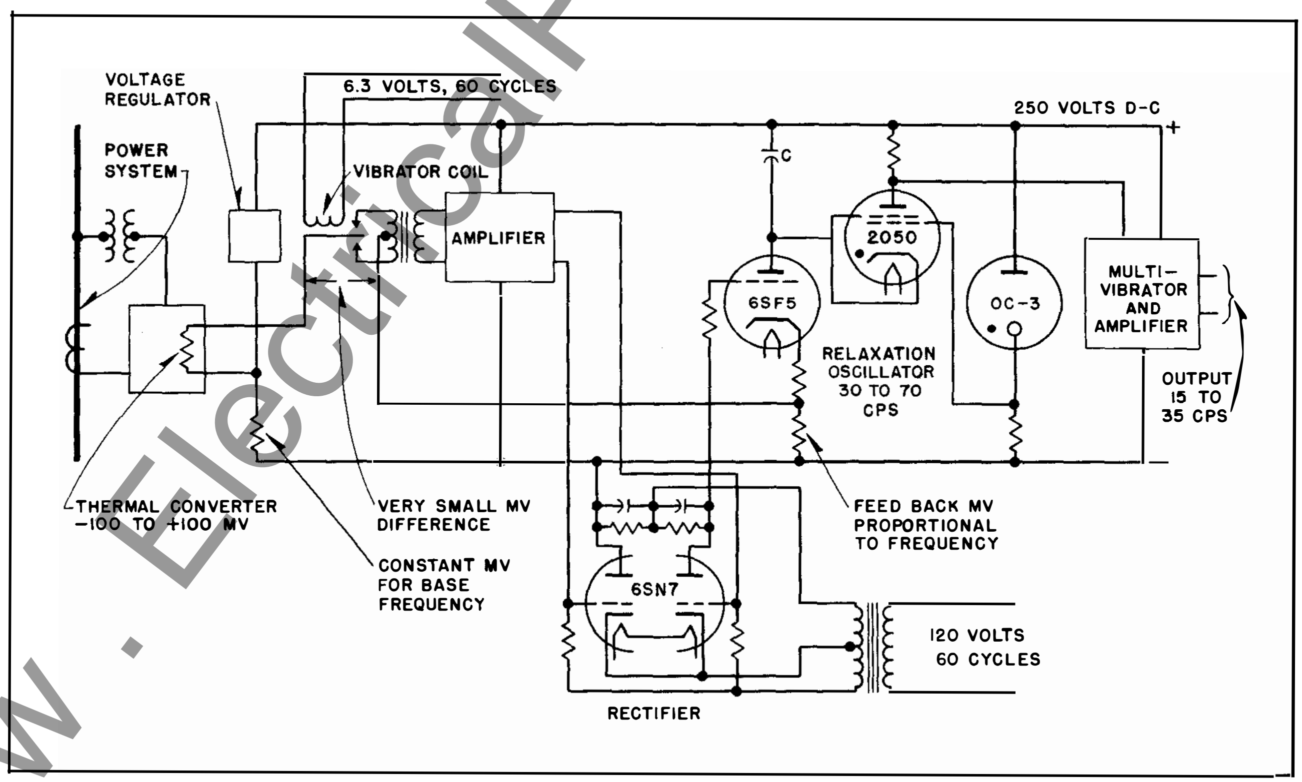

Fig. 3—Schematic Diagram of the IT-1 Transmitter.

TABLE I

LIST OF COMPONENT PARTS

FOR THE

TYPE IT-1 TRANSMITTER

DIAGRAM SYMBOL	FUNCTION	RATING
	CAPACITORS	
C_1	Power Supply Filter	80 MFD 450 V.D.C. Electrolytic
C_2	Phase Shifting	0.75 MFD 330 V.D.C. Oil Filled
C_3	Harmonic Suppression	0.10 MFD 400 V.D.C. Paper
C_4	By Pass	0.10 MFD 400 V.D.C. Paper
C_5	Coupling	0.10 MFD 400 V.D.C. Paper
C_6	By Pass	50 MFD 150 V.D.C. Electrolytic
C_7	By Pass	0.10 MFD 400 V.D.C. Paper
C_8	By Pass	50 MFD 150 V.D.C. Electrolytic
C_9	Coupling	0.10 MFD 400 V.D.C. Paper
C_{10}	Secondary Tuning	0.02 MFD 600 V.D.C. Paper
C_{11}	Filter	50 MFD 150 V.D.C. Electrolytic
C_{12}	Filter	4 MFD 450 V.D.C. Electrolytic
C_{13}	Filter	4 MFD 450 V.D.C. Electrolytic
C_{14}	Relaxation Oscillator	0.10 MFD 400 V.D.C. Paper
C_{15}	Coupling	0.005 MFD 400 V.D.C. Paper
C_{16}	Multi-Vibrator Oscillator	0.005 MFD 400 V.D.C. Paper
C_{17}	Multi-Vibrator Oscillator	0.005 MFD 400 V.D.C. Paper
C_{18}	Coupling	0.10 MFD 400 V.D.C. Paper
C_{19}	Damping	50 MFD 150 V.D.C. Electrolytic
	RESISTORS	
R_1	Heater Grounding	470 Ohms 1 Watt
R_2	Heater Grounding	470 Ohms 1 Watt
R_3	Base Millivolt Control	20 Ohms Variable 4 Watts
R_4	Feedback Control	1000 Ohm Variable 4 Watts
R_5	Voltage Dropping	4750 Ohms 25 Watts
R_6	Voltage Dropping	3000 Ohms 25 Watts
R_7	Current Limiting	1000 Ohms 1 Watt
R_8	Screen	470,000 Ohms 1 Watt
R_9	Plate	150,000 Ohms 1 Watt
R_{10}	Cathode	470 Ohms 1 Watt
R_{11}	Grid	4,700,000 Ohms 1 Watt
R_{12}	Grid	470,000 Ohms 1 Watt
R_{13}	Screen	470,000 Ohms 1 Watt
R_{14}	Cathode	470 Ohms 1 Watt
R_{15}	Plate	150,000 Ohms 1 Watt
R_{16}	Voltage Dropping	33,000 Ohms 1 Watt
R_{17}	Grid	470,000 Ohms 1 Watt
R_{18}	Cathode	1000 Ohms 1 Watt
R_{19}	Plate	39,000 Ohms 1 Watt

DIAGRAM SYMBOL	FUNCTION	RATING
	RESISTORS (CONT'D.)	
R_{20}	Plate	39,000 Ohms 1 Watt
R_{21}	Grid	470,000 Ohms 1 Watt
R_{22}	Grid	470,000 Ohms 1 Watt
R_{23}	Grid	470,000 Ohms 1 Watt
R_{24}	Grid	470,000 Ohms 1 Watt
R_{25}	Current Limiting	2,200,000 Ohms 1 Watt
R_{26}	Cathode	27,000 Ohms 1 Watt
R_{27}	Current Limiting	270 Ohms 1 Watt
R_{28}	Voltage Regulator	6300 Ohms 25 Watts
R_{29}	Grid Coupling	68,000 Ohms 1 Watt
R_{30}	Cathode	15,000 Ohms 1 Watt
R_{31}	Grid	220,000 Ohms 1 Watt
R_{32}	Coupling	330,000 Ohms 1 Watt
R_{33}	Plate	15,000 Ohms 1 Watt
R_{34}	Plate	15,000 Ohms 1 Watt
R_{35}	Coupling	330,000 Ohms 1 Watt
R_{36}	Grid	220,000 Ohms 1 Watt
R_{37}	Grid	470,000 Ohms 1 Watt
R_{38}	Cathode	1000 Ohms 1 Watt
R_{39}	Current Limiting	470,000 Ohms 1 Watt
	TRANSFORMERS	
T_1	Power	Iron Core
T_2	Coupling	Iron Core
T_3	Coupling	Iron Core
T_4	Input	Iron Core

total span from one end of the scale to the other is 120 millivolts, and 20 cycles, which is 6 millivolts for each cycle, hence at 25 cps the millivolt value will be 150.

Example #2

Assume a left zero application has the following calibration:

0 - 50 millivolts
15 - 35 cycles per second

Here the base frequency is 15 cps.

The span is 50 millivolts for 20 cycles making the value of each cycle 2.5 millivolts. Hence at 15 cps the base will be 37-1/2 millivolts.

The graph in Figure 4 further illustrates base frequency and base millivolts. In this illustration the thermal wattmeter is assumed to be used on a tie line application where power flow may be either forward or reverse, and its calibration is - 100 - 0 - +100 millivolts.

Calibration Adjustments

There are two rheostats for adjusting the calibration: R-3 for setting the base millivolts, and R-4 for adjusting the feed back. The dc output of the thermal wattmeter is connected to B-19 and C-20 of the transmitter, B and C referring to the switch blades and 19 and 20 to the case terminals. If a thermal wattmeter is not available to supply the dc millivolts, a slide wire energized from a constant dc supply may be used, and the slide set to give the desired millivolts. The

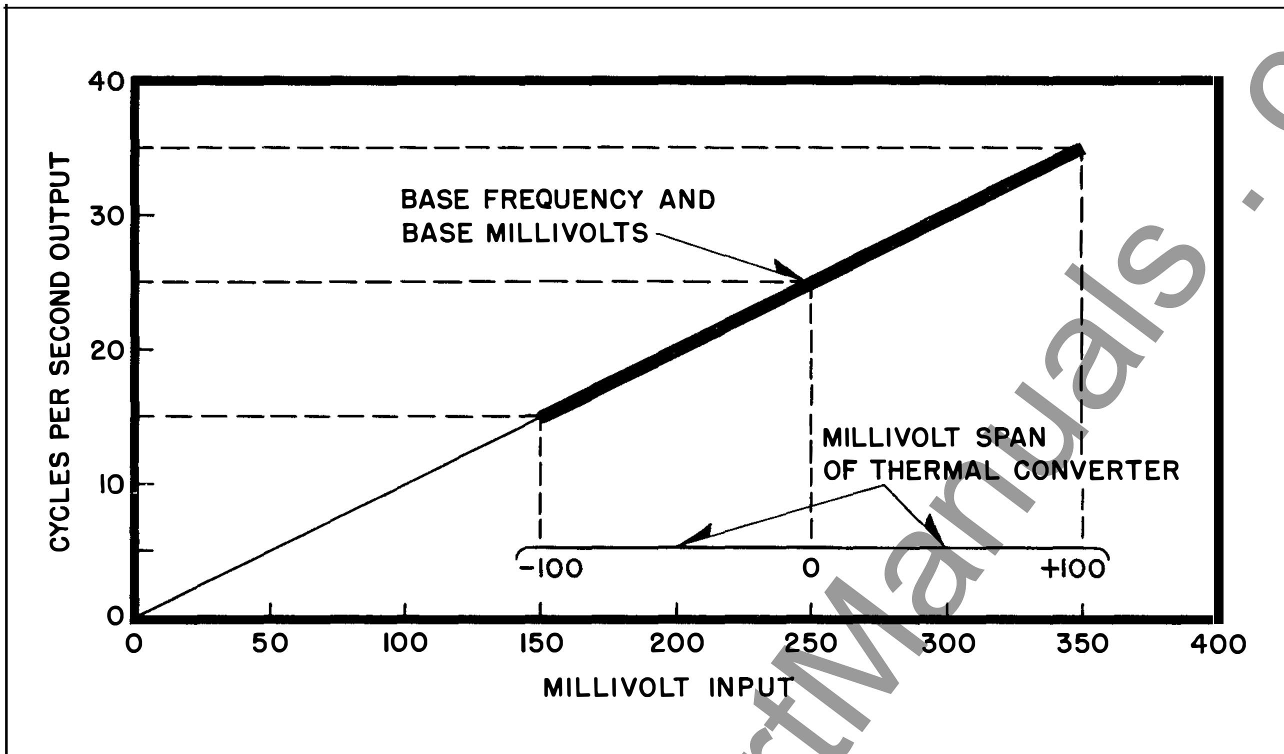

Fig. 4—Illustration of Calculation of Base Millivolts.

frequency output is measured across F-23 and G-24. First set the base millivolts with R-3. It is 150 for the -60 - 0 - +60 range. This base may be measured by connected a high resistance millivoltmeter between terminal B-19 and the negative side of the dc. Once this base is set it need not be changed again except slightly for minor calibration changes.

Next adjust the thermal wattmeter load to zero so that the dc millivolts applied to C-19 and C-20 are zero. This leaves only the base of 150 millivolts to initiate the amplifier. Next adjust the feed back rheostat R-4 until the frequency output is 25 cps. The transmitter is now in calibration. Slight re-adjustment of the rheostats may be desired for further refinement in calibration. Next increase the load being measured by the thermal wattmeter until its output is +60 millivolts. This 60 adds to the base of 150, and the frequency will be found to have risen to 35 cps. Next reverse the load until the d.c. millivolt output is -60 millivolts. This -60 subtracts from the base of 150 and the frequency drops to 15 cps.

The scale distribution has a high degree of linearity hence if any one point is accurately set the others will be correct.

Instruments Used in Calibration

To measure the d.c. millivolts use either a potentiometer suitable for measuring millivolts or a d.c. millivoltmeter. The potentiometer is preferred as it draws no current when balanced. A millivoltmeter is more convenient to use but should have a resistance of 1000 ohms per volt or higher, and should be capable of measuring up to 500 millivolts. A multi-range meter is desirable.

The frequency output can be measured with a frequency meter, but as reliable portable frequency standards may be difficult to obtain, a cathode ray oscillograph may be used and the frequency output compared with the power circuit frequency of 60 cycles. With present day practice of interconnection of power systems the 60 cycle frequency is held sufficiently close to be used as a standard.

Using the 60 cycle power circuit as a reference, the 30 cycle calibration point of the transmitter can be checked by the pattern on the screen of the scope, and as the scale is linear the calibration should be correct for other points on the scale. For the range

-60	0	+60 millivolts
15	25	35 cycles per second

the 30 cycle point will be at ± 30 millivolts. Set the base accurately at 150 millivolts. Set the thermal wattmeter output accurately at + 30 millivolts. Now compare on the scope the frequency output with the 60 cycles and adjust the feed back R-4 until the pattern approximates a Figure 8 and stands still. When the pattern stands still, the output is 30 cycles.

When making this test a capacitor of approximately 4 mfd should be connected across terminals G-24 and F-23. The only purpose of this capacitor is to load the circuit to improve the wave form so that a smoother pattern may be obtained on the scope.

TRANSMITTERS IN TYPE FT CASE

The type FT cases are dust-proof enclosures combining transmitter components and knife-blade test switches in the same case. This combination provides a compact flexible assembly easy to maintain, inspect, test and adjust. There are six case sizes, designated as S10, S20, M10, M20, L10, L20. S refers to the small; M the medium; and L, the large size chassis frame. The numbers refer to the possible number of test switch positions, 10 or 20.

Removing Chassis

To remove the chassis, first remove the cover which exposes the transmitter component and test switches for inspection and testing. Next open all switches. With all the switches fully opened, grasp the two cam action latch arms and pull outward. Using the latch arms as handles, pull the chassis out of the case. The chassis can be set on a test bench in a normal upright position as well as on its top, back or sides for easy inspection, maintenance and test.

After removing the chassis a duplicate chassis may be inserted in the case or the blade portion of the switches can be closed and the cover put in place without the chassis.

When the chassis is to be put back in the case, the above procedure is to be followed in the reversed order.

Electrical Circuits

The electrical circuits are as follows: Each terminal in the base connects thru a test switch to the transmitter components in the chassis as shown on the internal schematic diagrams. The transmitter terminal is identified by numbers marked on both the inside and outside of the base. The test switch positions are identified by letters marked on the top and bottom surface of the moulded blocks. These letters can be seen when the chassis is removed from the case.

The potential and control circuits thru the relay are disconnected from the external circuit by opening the associated test switches.

The transmitters can be tested in service, in the case but with the external circuits isolated or out of the case as follows:

Testing In Service

For testing in service, the voltages between the potential circuits can be measured conveniently by clamping #2 clip leads on the projecting clip lead lug on the contact jaw.

Testing In Case

For testing in the case the ten circuit test plug can be inserted in the contact jaws, with all blades in the full open position. This connects the transmitter components to a set of binding posts and completely isolates the transmitter circuits from the external connections by means of an insulating barrier on the plug. The plug is inserted in the bottom test jaws with the binding posts up and in the top test switch jaws with the binding posts down.

The external test circuits may be made to the transmitter components by #2 test clip leads instead of the test plug.

Testing Out of Case

For testing out of the case transmitter components may be tested by using the ten circuit test plug or by #2 test clip leads as described above. The factory calibration is made with the chassis in the case and removing the chassis from the case will change the calibration values of some transmitters by a small percentage. It is recommended that the relay be checked in position as a final check on calibration.

INSTALLATION

The transmitters should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the transmitter vertically by means of the two mounting studs for the standard cases and type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the transmitter. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminals studs furnished with the transmitter for ebony-asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

ENERGY REQUIREMENTS

Transmitter Output

15 to 35 cycles per second, 65 volts RMS open circuit across terminals F-23 and G-24. 5000 ohms internal impedance.

If necessary the telemetering channel may be contact keyed with a 276 E relay. Provision is made to mount this relay inside the transmitter case. See Figure 2.

Power Consumption

Transmitter-50 watts at 90% power factor.

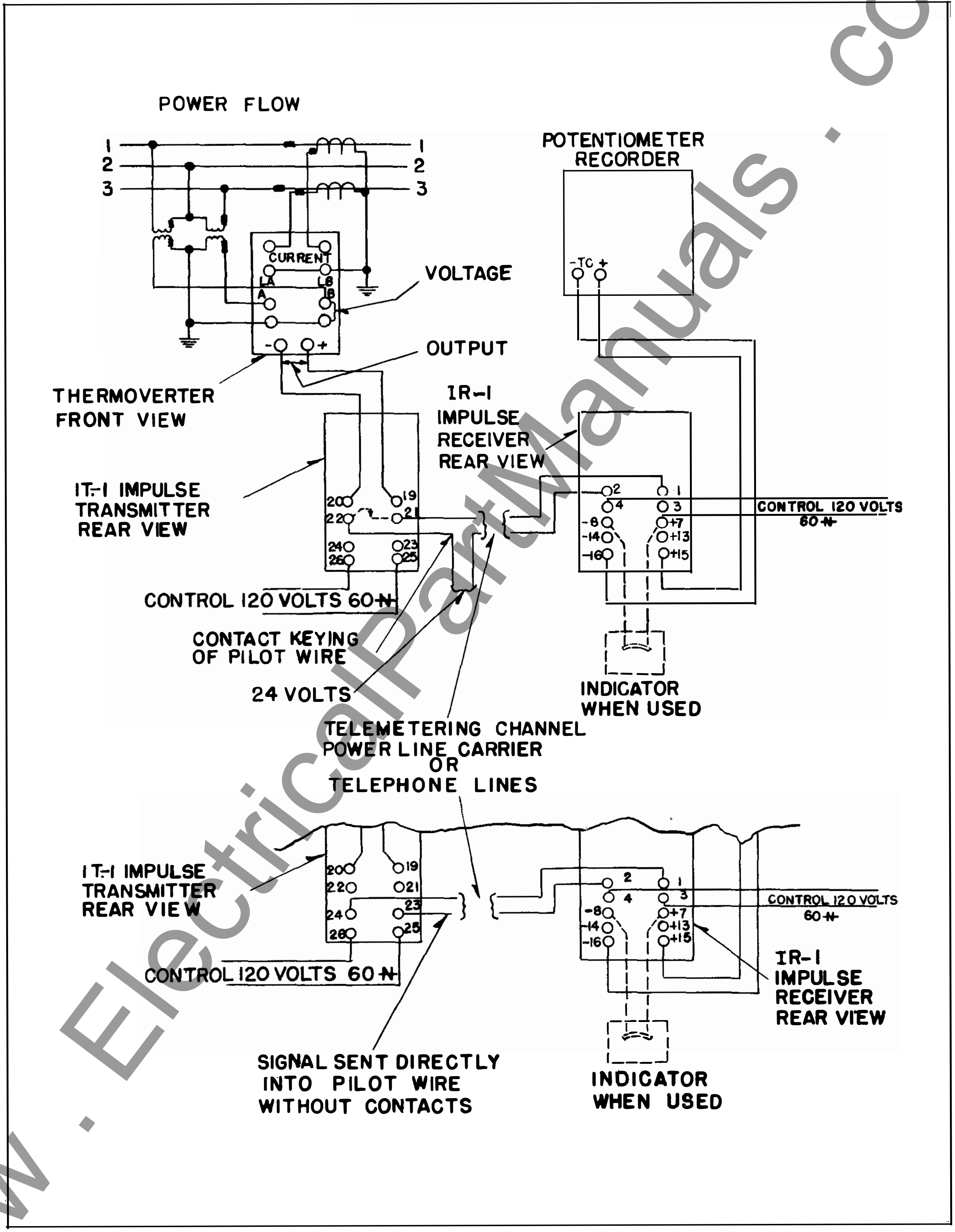

Fig. 5—Schematic of Electronic Telemetering System.

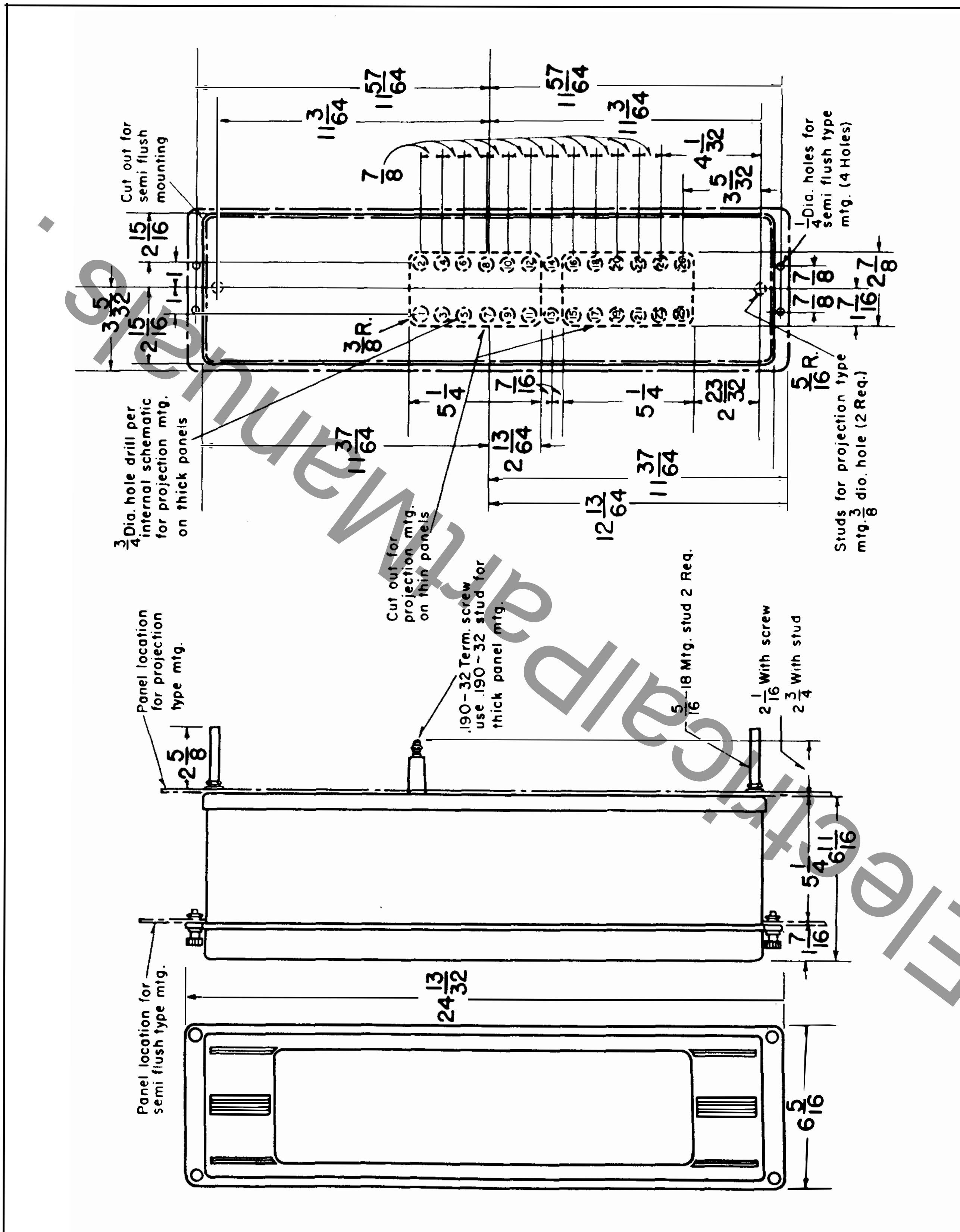

Fig. 6—Outline Dimensions and Drilling Plan for IT-1 Transmitter. For Reference Only.

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