Superseded by 41-825.1 (11/44) & 41-825.2A 3/49

Westinghouse

TYPE IW TRANSMITTER & TYPE IM RECEIVER FOR HIGH RATE IMPULSE TELEMETERING

INSTRUCTIONS

see 41-384A for TV Relay

CAUTION

Before putting transmitters and receivers into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the transmitters and receivers to check the calibration and electrical connections.

APPLICATION

The Type IW Transmitter and Type IM Receiver are used in Load Dispatching Systems where important load indications are to be transmitted between stations. The electrical quantities measured and transmitted are megawatts or megavars. The measurements are made at the tie tie - lines, substations or generating stations and transmitted to the dispatchers office for the purpose of dispatching and load control. Impulses are transmitted over carrier current channels, pilot wires, or telephone lines at a rate proportional to the measured quantity plus or minus a base rate.

The fundamentals of this high rate impulse telemetering scheme are shown in Figure 1.

The Type IW Transmitter measures the megawatts or megavars to be transmitted and closes commutator type contacts at a rate proportional to the load. These impulses are transmitted over a suitable channel to the type IM Receiver which converts the impulses into d-c microamperes directly proportional to the impulse rate. This direct current is used to operate indicating meters and recorders having their scales marked corresponding to the load measured by the transmitter. A typical system showing the schematic connections between the various elements is shown in Figure 2.

CONSTRUCTION AND OPERATION

Type IW Transmitter

The transmitter consists of four watt measuring elements, a synchronous motor, and a contact mechanism. These elements are mounted in the standard cases, Figures 12 and 13. The schematic internal connections are shown in Figures 3 and 4.

The measuring elements are similar to those used in polyphase watthour meters. Four separate electromagnets are mounted one above the other, each acting on a disc mounted on a common shaft. The voltage and current coils of each electromagnet are brought out to separate terminals in the standard transmitter (Figure 3) thereby making it applicable to many special as well as standard circuits.

By proper connection to the power circuits, the disc shaft is driven at a speed proportional to the load and in either direction depending on the direction of power flow.

The contact mechanism consists of a double brush type contact assembled so that it can rotate around a small commutator geared to the disc shaft. Every other segment on the commutator is fastened to a slip ring while the remaining segments are left disconnected. A fixed double brush type contact makes contact with this slip ring. The moving contact is driven around the commutator at a fixed rate of speed by a synchronous motor thru a gear train. Current is introduced into the rotating brush by

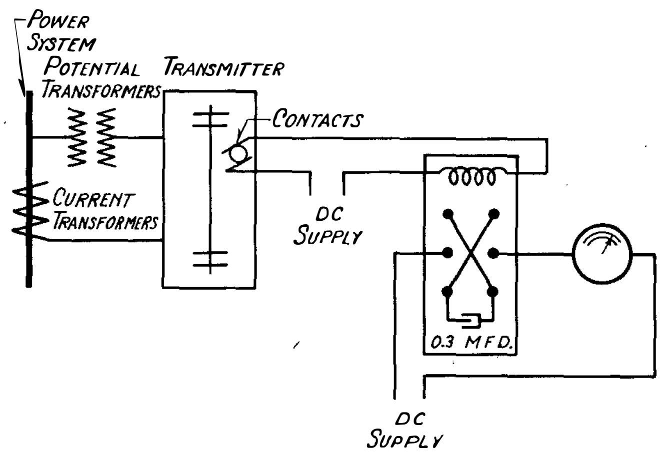


Figure 1
Elementary Schematic of the High Rate Impulse Telemetering System.

another fixed, double brush and slip ring assembly. Each time the rotating brush makes contact with a segment of the commutator, connected to the slip ring, an impulse of current can flow thru the circuit. The base impulse rate is determined by the constant rate of speed of the synchronous motor.

At zero load the commutator does not rotate, so that the base impulse rate is transmitted. At the receiving terminal, this rate gives a zero reading on the indicating or recording instruments. When power is flowing thru the watt elements, the commutator revolves in the same direction as the contacts to decrease the impulse rate; or in the opposite direction, to increase the impulse rate. This change in the base impulse rate provides the

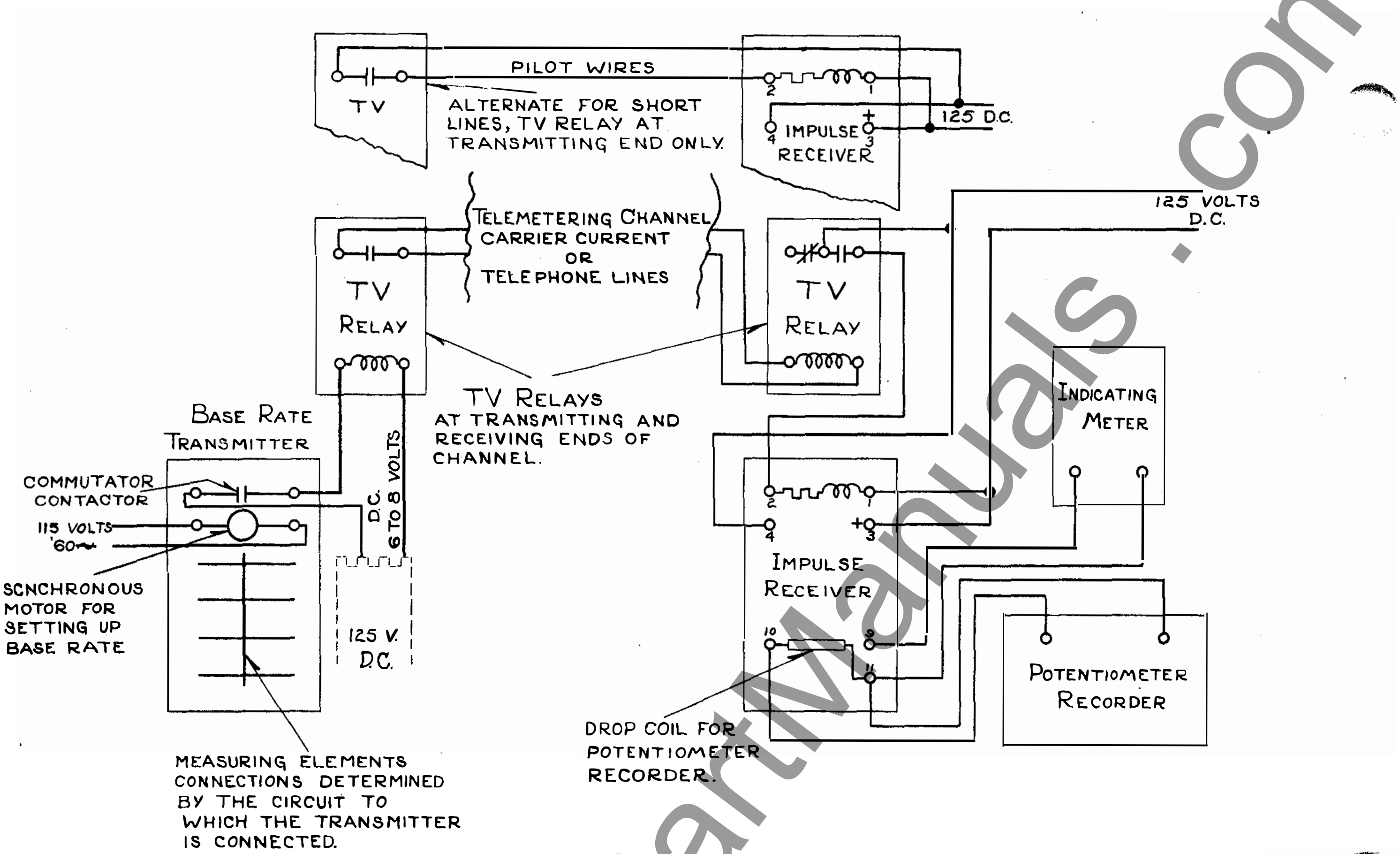


Figure 2
Schematic Connections of a Typical High Rate Impulse Telemetering System.

means of indicating the magnitude and direction of power flow.

Type IM Receiver

The receiver consists of a reversing relay, a capacitor unit, a regulator tube, a filter, and drop coil all mounted in the standard cases, Figures 12 and 13. The schematic internal connections are shown in Figure 5.

The receiver converts the impulse rate from the transmitter into direct current microamperes. This current is used to operate direct current indicating instruments or is passed thru a resistance coil to give a suitable millivolt drop for operating a potentiometer type of recorder. The scales of these instruments are marked in terms of the quantity measured by the transmitter.

The reversing relay operates on each received impulse to alternately charge and discharge a 0.3 mfd. capacitor from a constant direct current supply. Every operation of the relay provides an impulse of current flowing thru the direct current supply and the indicating instrument circuit in the same direction. See Figure 1. The total quantity of current sent thru the instrument in a second is proportional to the impulse rate and is independent of the circuit resistance, provided this resistance is low enough so that the condenser can completely charge during the time the reversing relay contacts are closed. The direct current type of instruments used operates on the average value of current flowing.

The accuracy of this arrangement depends upon the fact that a condenser when charged from a direct voltage of constant value will hold a definite quantity of electricity. To maintain a constant d-c voltage from a station battery whose voltage may vary appreciably, a type 874 regulator tube is incorporated in the receiver circuit. The voltage across the tube remains constant at approximately 90 volts even though the battery voltage varies.

The current which flows through the .3 mfd. condenser is a pulsating quantity but its peak value is reduced by placing resistance directly in series with the reversing contacts. An additional smoothing action is obtained by passing the pulsations through a two stage condenser reservoir. The first stage has a 24 mfd. condenser with a rectox valve in series with it to delay its discharge. The second stage has a large electrolytic condenser. This reservoir reduces the peak of the pulsations to such a value that for any given impulse rate, within the operating range of the receiver, the d-c output is a steady current that follows an essential straight line characteristic over the operating range.

One complete cycle of the reversing relay is considered an impulse. During the cycle the charge in the condenser is changed from +90 volts to -90 volts and back again to +90 volts. This is equivalent to four charges at 90 volts. At an impulse rate of 200 impulses per minute, 360 microamperes pass through the 0.3 mfd. condenser and into the filter. A part of this current is used to operate the receiving meters and the remainder is shunted around them for calibration purposes.

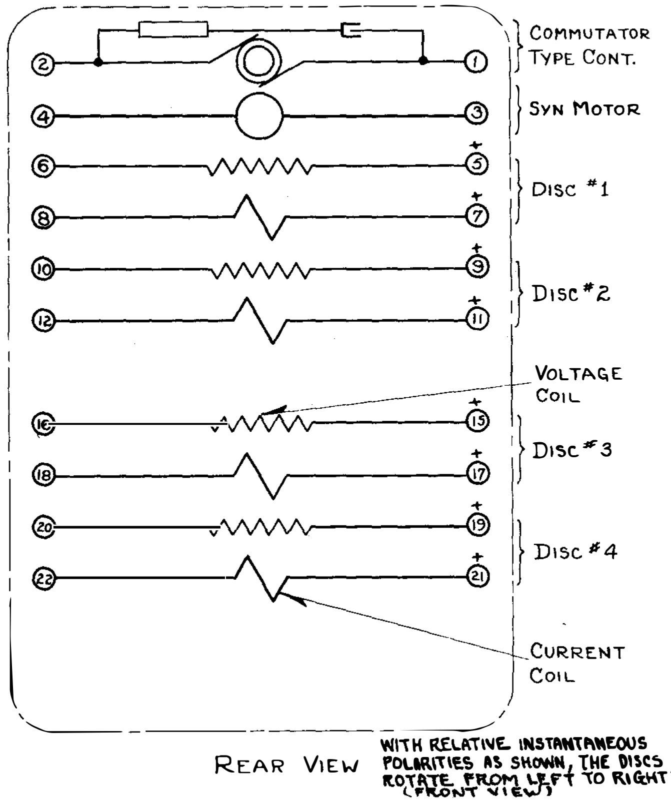


Figure 3
Schematic Internal Connections of the Type IW Transmitter With Four Single Phase Elements.

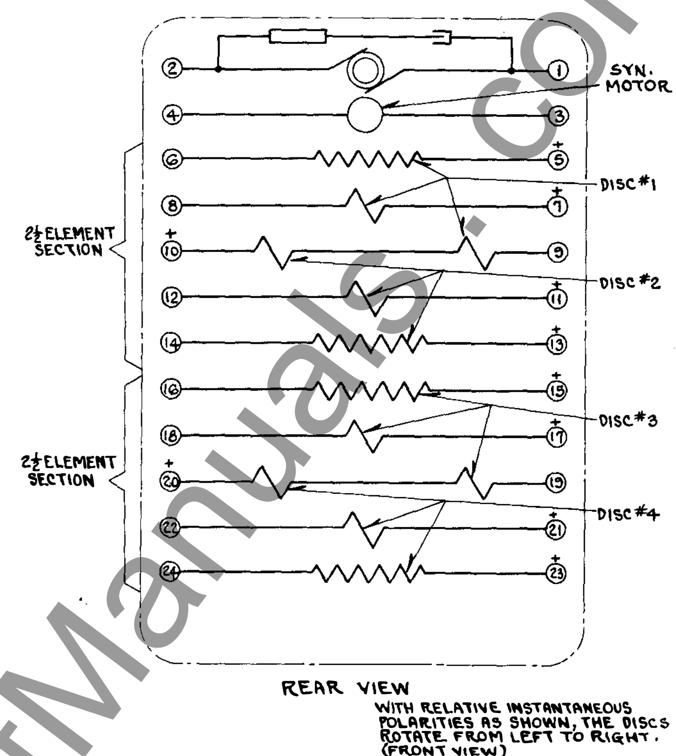


Figure 4
Schematic Internal Connections of the Type IW Transmitter. Special For Totalizing Two-Three-Phase Four Wire Circuits.

COORDINATION OF THE TRANSMITTER AND RECEIVER WITH THE CIRCUIT

The scale of the receiving meter must satisfactorily cover the range of the load being telemetered. This scale is marked in terms of the megawatts or megavars being metered and not in terms of microamperes, millivolts, or impulses. The transmitter measures megawatts or megavars but transmits impulses, hence the calibration of the transmitter must be coordinated with the scale of the receiver.

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 transformers. 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 in the calibration of the transmitter by selecting a disc constant K_h suitable to meet the circuit conditions. Although watthour meter electromagnets are used, usually it is not practical to use the conventional watthour disc constants. Full load on the transmitter is assumed to give full scale deflection on the receiver for positive power flow, and calibration is made accordingly.

The following three classes of receiver scales have been selected to cover practically all circuit conditions. They are:

Zero at the center of the scale using a base rate of 120 impulses per minute.

Zero at 1/4 scale using a base rate of 80 impulses per minute.

Zero at left end of the scale using a base rate of 80 impulses per minute.

The following tabulation gives the transmitter disc speeds, impulse rates, and the outputs of the receiving filters.

ZERO AT CENTER OF SCALE

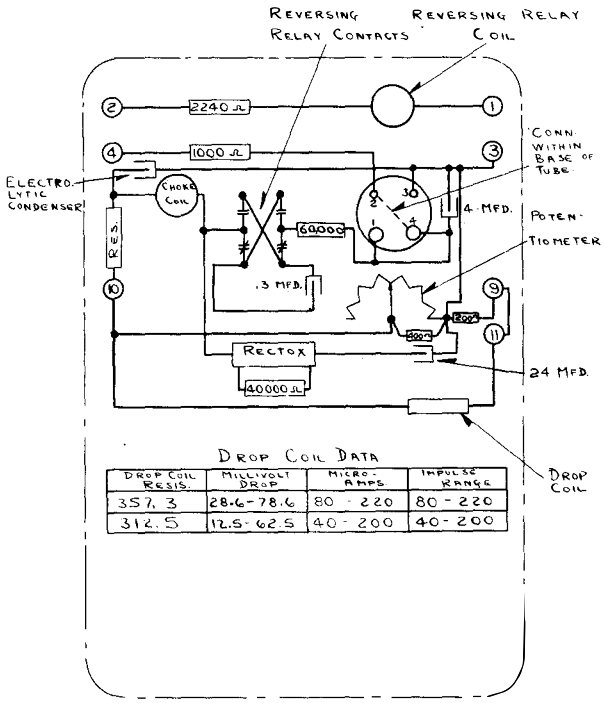
Scale Deflection	Left End	Center	Right End
Disc RPM	-25	0	+25
Imp. per min.	40	120	200
Microamp. output	40	120	200
Millivolt drop	12.5	37.5	62.5

ZERO AT 1/4 SCALE

Scale Deflection	Left End	1/4 Scale	Right End
Disc RPM	-8-1/3	0	+25
Imp. per min.	40	80	200
Microamp. output	40	80	200
Millivolt drop	12.5	25	62.5

ZERO AT LEFT END OF SCALE

Scale Deflection	Left End	Right End
Disc RPM	0	+25
Imp. per min.	80	220
Microamp. output	80	220
Millivolt drop	28.6	78.6



Drop Coil Resis.	Millivolt Drop	Micro-Amps	Impulse Range
357.3	28.6-78.6	80 - 220	80 - 220
312.5	12.5-62.5	40 - 200	40 - 200

Rear View

Figure 5
Schematic Internal Connections of the Type IM Receivers.

INSTALLATION

The transmitters and receivers should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the transmitters and receivers vertically by means of the two mounting studs. Either of these studs may be utilized for grounding the transmitter or receiver base. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the transmitter or receiver 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 nuts with a wrench.

External connections for the Type IW transmitter are shown in Figures 6 to 11. External connections for the Type IM receiver are shown in Figure 2.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of these transmitters and receivers in the telemetering circuit have been made at the factory and should not be disturbed after receipt by the customer. If the adjustments have been changed, the transmitter or receiver taken apart for repairs, or if it is desired to check the adjustments at regular maintenance periods, the instructions below should be followed.

All contacts should be periodically cleaned with a fine file. S#1002110 file is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

Type IW Transmitter

The measuring elements are similar to those used in watthour meters and require only the care common to watthour meter practice. Only the special adjustments and special maintenance are covered in the following paragraphs:

Calibration: The transmitter may be calibrated in the same manner as a watthour meter using the disc constant K_h which is marked on the nameplate, and comparing disc rotations with the rotations of a portable watthour standard. The base rate synchronous motor should be kept running during the test as the brush friction has some effect on the light load calibration.

For transmitters which are to run in only one direction, the full load and light load are adjusted in the same manner as is a watthour meter; the full load adjustment being obtained by varying the damping of the permanent magnet and the light load compensation by shifting the light load loops.

Transmitters which must measure power flow in either direction must likewise rotate in either direction, hence calibration must be checked for both directions of rotation. Full load calibration is obtained by the permanent magnets as before, but light load should be set for an average calibration when the discs are rotated in both directions.

Disc Constant K_h: The value of the disc constant K_h is marked on the name plate and may be used in checking the calibration of the transmitter. Its value is the number of watthours consumed per revolution of the disc. As transmitters are usually connected to the circuits through voltage and current transformers, the constant is given for both, the primary and secondary sides of the transformers and is designated Primary K_h and Secondary K_h. When connections are made to the circuits in the standard methods for power measurements, the secondary K_h = the primary K_h divided by the overall instrument transformer ratios. The disc runs 25 RPM at a load corresponding to the right end of the receiver scale. The value of the constant depends on the instrument transformer ratios and on the disc speed.

To further illustrate the constant K_h, the following example of a specific transmitter is given:

A transmitter is connected to a three phase three wire circuit through two 110,000/110 PT's and two 200/5 CT's. The scale of the receiving meter is to be center zero with a range of 50......0......50 Megawatts.

The instrument transformers reduce the magnitude of the voltages and currents without changing their phase relations, and apply to the transmitter the equivalent to a watt load equal to the primary load divided by the overall instrument transformer ratio.

The disc of the transmitter must run 25 RPM at a load of 50 Megawatts giving the results in the following calculations:

$$\text{Overall Transformer ratio} = \frac{110,000}{110} \times \frac{200}{5} = 40000$$

$$\text{Secondary load} = \frac{50,000,000}{40,000} = 1250 \text{ watts}$$

Hence 1250 three phase three wire watts cause the disc to run 25 RPM. 1250 watts for one hour consumes 1250 watthours and cause the disc to make 1500 revolutions. The value of one revolution =

$$\frac{1250}{1500} = \frac{5}{6} = .833 \text{ watthours} = \text{secondary } K_h$$

In a similar manner the

$$\text{Primary } K_h = \frac{50,000,000}{1500} = 33333 \text{ watthours}$$

Care of Commutator: An auxiliary relay or an equivalent device should be interposed between the commutator and the telemetering channel to relieve the commutator of excessive duty. The TV relay generally used for this purpose requires 6 to 8 volts d-c and draws approximately 20 milliamperes. Two such relays may be operated in parallel from one commutator.

With brushes carefully adjusted, and with a low voltage, low current relay load similar to that just mentioned, the rate of wear is very small.

The contact surfaces are made of silver and will gradually tarnish. However, this tarnish is a coat of silver sulphide and is a good conductor. The commutator and brushes should be disturbed as little as possible.

Sparking is the chief source of wear and is caused by vibration, insufficient brush tension, dirt or dust on the contact surfaces.

When a commutator is roughened by sparking, it should be polished by means of a narrow strip of worn crocus cloth about one-fourth of an inch wide. New crocus cloth should not be used until it is worn smooth on some hard metal object, to remove all loose particles of grit which might work into the surface of the commutator and care should be taken not to lay the crocus cloth down in locations where it may collect dust.

The worst roughness is usually found at the edges of the commutator bars and the polishing should go on until the entire surface is smooth. After using the crocus cloth, the commutator should be given a final polish with a linen tape. In using the crocus cloth and tape, care must be taken to avoid the use of sufficient force to bend the shaft. Crossing the tape so that it clings to the commutator and a light quick stroke, gives the armature a spinning motion, that produces the best results.

If a commutator is smooth, it is only necessary to clean out the dust with an air syringe or a camel's hair brush.

The tension on all of the brushes should be sufficient to eliminate any tendency of the brushes to bounce due to vibration from outside sources being transmitted through the meter mounting. The brushes are of the gravity type and the tension, which is obtained by means of a weight, is very uniform. The average adjustment is with the weights approximately 3/32" from the end of their mounting screw. The brush tension can be varied by moving the weight in or out on this screw. Care should be taken to see that the weights are securely locked after adjusting.

Type IM Receiver

The 125 volts d-c control circuit for the filter is connected across terminals 3 and 4. Number 3 terminal is positive. See figure 5. If a 250 volt control circuit is used an external resistor must be used to absorb the excess voltage. A 4000 ohm resistor capable of handling 50 milliamps, 125 volts, is suitable. Separate control circuits must be used if two or more filters are connected in series to obtain a totalized output.

Type 874 Regulator Tube: The battery voltage may vary between 120 and 140 volts. The purpose of the 874 tube is to hold a constant voltage of approximately 90 volts on the receiver so that its calibration will not be disturbed by the variations of battery voltage.

Tube Characteristics

Starting supply voltage	125 d-c volts
Operating voltage	90 d-c "
Current (operating)	10 to 50milliamperes
Current continuous	50 milliamperes

Pin 1 Cathode (Cylinder of electrode)
Pin 3 Anode (Center of electrode)
Pins 2 and 4 are connected together by a jumper within the base.

The applied voltage must be high enough to fire the tube. When properly operating it will show a slight purple glow and the voltage across its terminals will be nearly the same as the battery voltage. A convenient place to measure this voltage is across the two terminals of the 4 mfd. section of the condenser which is just below the tube socket.

Drop Coil: The "drop coil" provides a millivolt drop for the potentiometer recorder. It is a small resistance spool mounted in the right side of the case just above the 24 mfd. condenser. It is connected between terminals 10 and 11. A millivoltmeter cannot be used across this coil as the meter will shunt a portion of the current. A potentiometer must be used to measure the drop. An extra terminal #9 is brought out to provide a means for inserting a microammeter in series with the drop coil, this meter to be connected to terminals 9 and 11. When the meter is not used, terminals 9 and 11 must be shorted.

The value of the current and the resistance of the drop coil have been selected so as to give a 50 millivolt span from the left end to the right end of the recorder scale.

Receiving filters having an impulse range of 40 to 200 impulses per minute have a corresponding current output of 40 to 200 microamperes and use a drop coil of 312.5 ohms.

Receiving filters having an impulse range at 80 to 220 impulses per minute have a current output of 80 to 220 microamperes and use a drop coil of 357.3 ohms.

A small adjustable rheostat is mounted inside the filter case and is to be used for setting the millivolt drop at its correct value. Turning the knob to the right increases the drop and causes the recorder pen to be driven up scale.

A switchboard microammeter and the potentiometer recorder may both be operated from the same filter if local conditions make such a combination necessary. However, the very wide variation in the resistance values of the various types of commercial forms of microammeters make necessary that each such application be handled as a special case. In general, when a number of indicators are to be used with a recorder, a re-transmitting attachment should be built into the recorder for operating the indicators.

Reversing Relay: The reversing relay coil with its series resistor is connected between terminals 1 and 2. The coil has a resist-

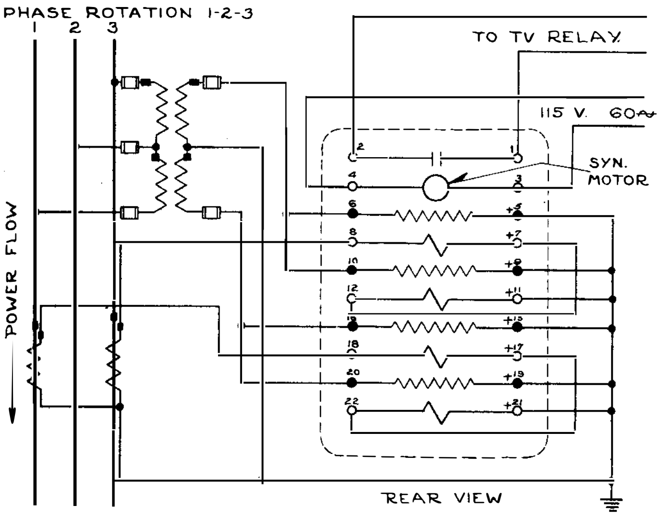


Figure 6
External Connections of the Type IW Transmitter When Used On a Three-Phase Three-Wire Circuit.

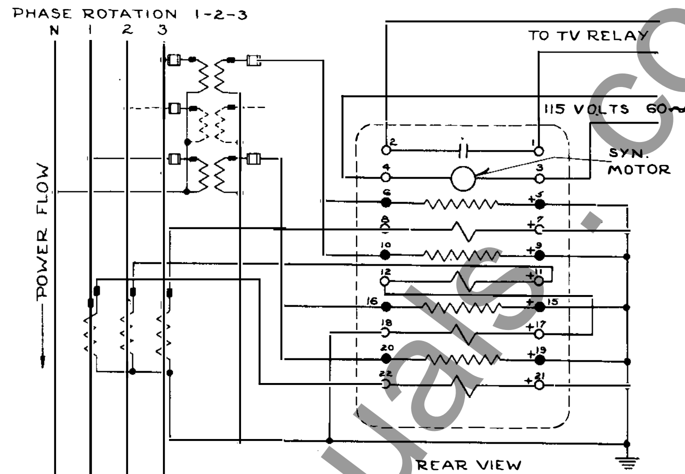


Figure 7
External Connections of the Type IW Transmitter When Used On a Three-Phase Four-Wire Circuit Using Two Potential and Three Current Transformer.

ance of 1500 ohms and the resistor a value of 2240 ohms. The control circuit is 125 volts d-c.

It is necessary that the relay positively operate its contacts when the coil is energized or de-energized within the wide limits of control voltage, line resistance, and impulse rates. It has a large factor of safety, but the line resistance should not be so high or the voltage so low as to permit the operating current to drop below 20 milliamperes.

For any given impulse rate the energized and de-energized periods are nearly equal. Unequal operating periods generally indicate trouble in the timing of auxiliary and repeating relays which may be in the telemetering channel. All relays should be set so that their "on" and "off" periods are approximately equally spaced.

If field adjustments of the contacts are necessary the following may be used as a guide:

The contact pile up is equivalent to a double pole, double throw switch and wired into the filter as a reversing switch.

There must be no bridging of contacts. Bridging is encountered when a moving contact touches both of its stationary contacts at the same time. It shorts the .3 mfd. condenser and causes erratic readings, and "spikes" on the recorder chart.

Both moving contacts must operate simultaneously so that they both break or both make at the same instant. If they do not, there is a possibility of encountering a condition similar to that of bridging and shorting the condenser. The moving contact springs should have a definite downward pressure on their insulating bushings when the relay is in the de-energized position. These adjustments are by no means critical but reasonable care should be taken in bending the springs.

Total travel of the moving contacts is .028 inch. The follow, that is the amount the stationary contact follows before breaking, or if making the amount it follows after contact is made is .008 inch.

Due to the lever ratio of the armature, the armature travel is approximately one half of the contact travel. Adjustments can be checked with a thickness gage between the relay core and the residual pin of the armature. With the relay in the de-energized position the gap between the core and the pin is .014 inch. When the lower contacts start to break, the gap is .010 inch and when the upper contacts make the gap is .004 inch.

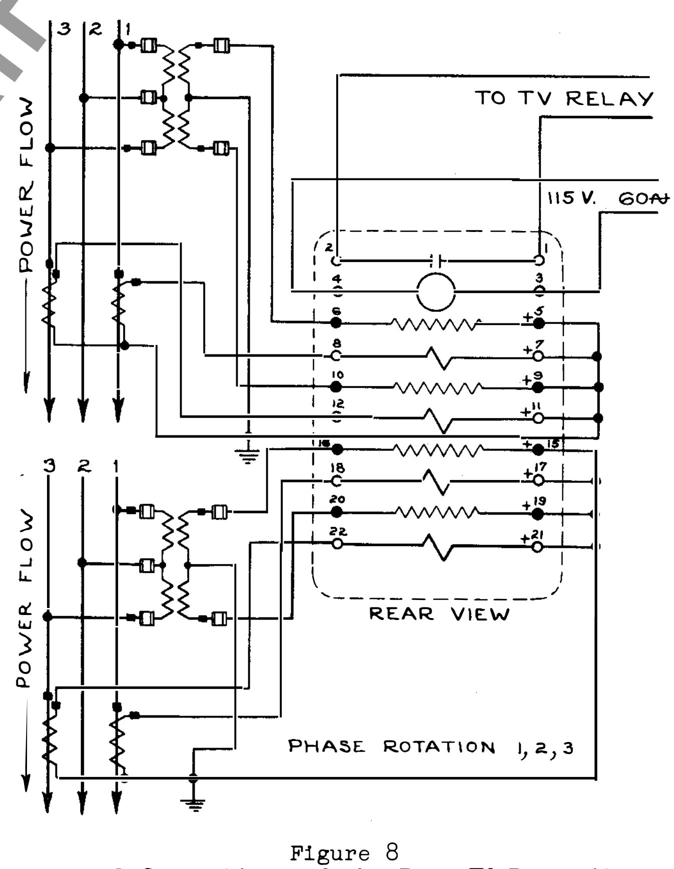


Figure 8
External Connections of the Type IW Transmitter When Used to Totalize Two Three-Phase Three-Wire Circuits.

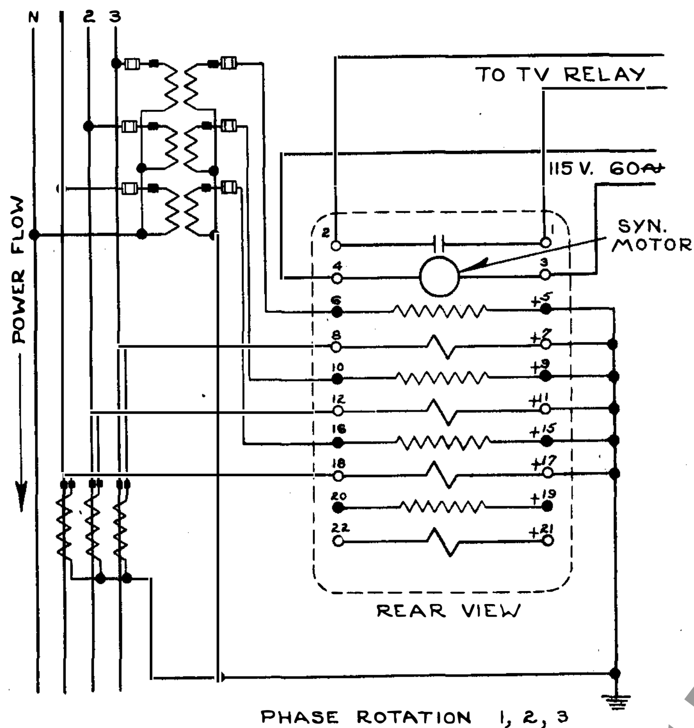


Figure 9
External Connections of the Type IW Transmitter When Used on a Three-Phase Four-Wire Circuit Using Three Potential and Three Current Transformers.

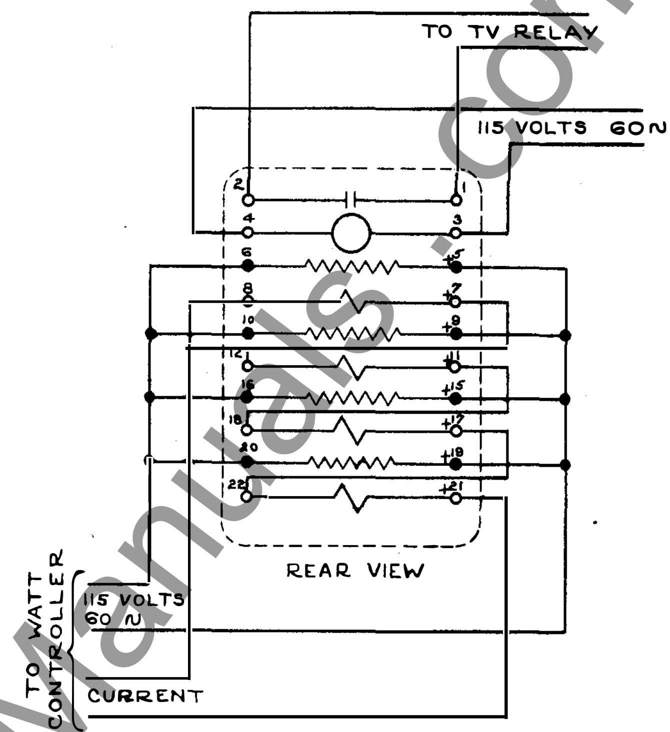


Figure 10
External Connections of the Type IW Transmitter When Used With a Watt Controller.

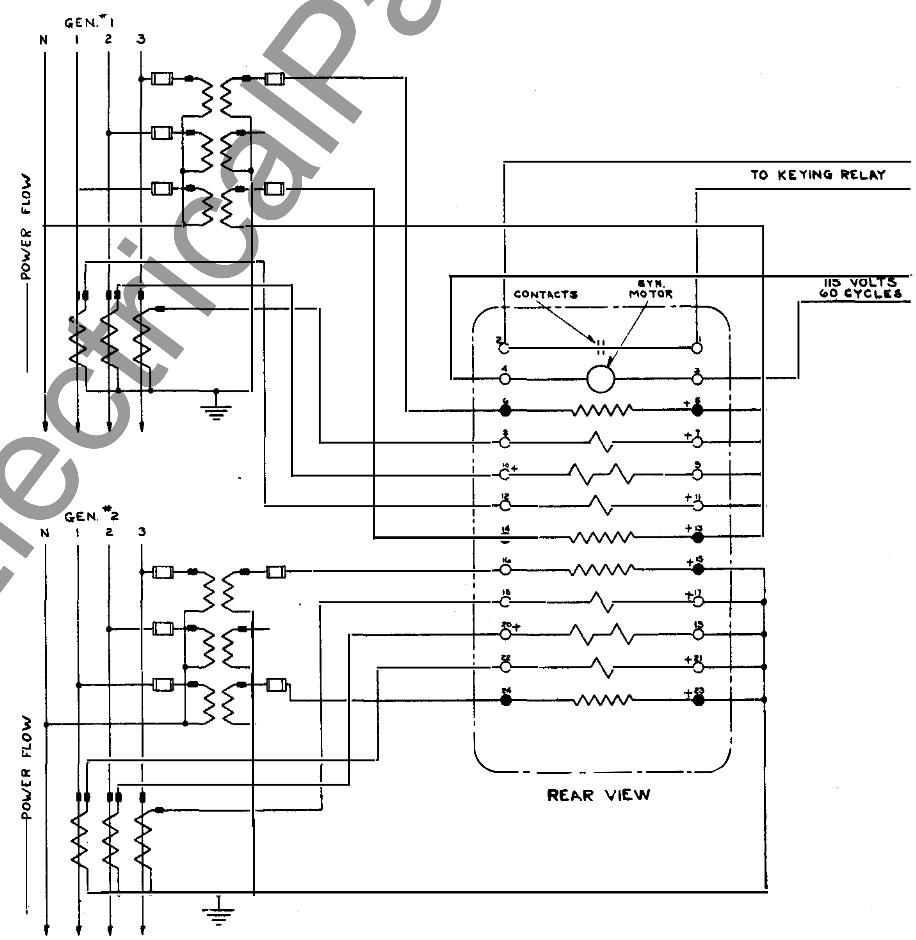


Figure 11
External Connections for the Special Type IW Transmitter of Figure 4 When Used to Totalize Two Three Phase Four Wire Circuits.

The residual pin is fixed and cannot be adjusted. The armature stroke which is the gap between the core and the residual pin can be adjusted by loosening the screw which holds the armature bearing, and shifting until the desired stroke is obtained. When tightening the screw, align the armature so that it seats squarely on the core.

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

The following gives the energy requirements of the various coils and circuits of the type IW transmitter and the type IM receiver:

Type IW Transmitter

Each voltage coil requires 8.5 volt-amperes and 1.7 watts at 115 volts 60 cycles.

Each current coil requires .31 volt-amperes and .2 watts at 5 amperes 60 cycles.

The synchronous motor requires a 115 volt 60 cycle control circuit and draws 15 milliamps., 1.2 watts.

Type IM Receiver

The reversing relay has a coil resistance of 1500 ohms and a series resistor of 2240 ohms. When operated from 125 volts d-c, the circuit draws approximately 33 milliamperes. The operating current should not be permitted to drop below 20 milliamperes when additional line resistance is inserted into the circuit.

The control voltage for the 874 tube circuit is 125 volts d-c. The current drawn at this voltage is 35 milliamperes.

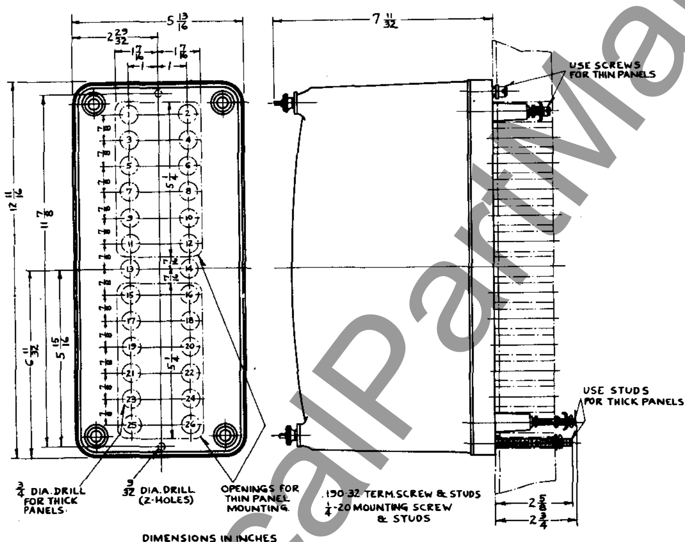


Figure 12
Outline and Drilling Plan for the Standard Projection Type Case (See Internal Schematics for Terminals Supplied).

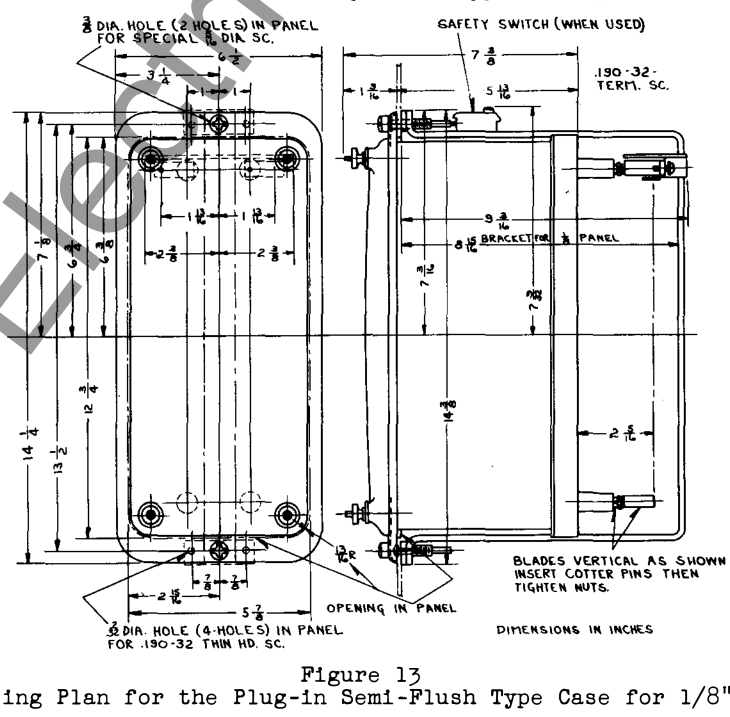


Figure 13
Outline and Drilling Plan for the Plug-in Semi-Flush Type Case for 1/8" Panel Mounting.