Westinghouse

TYPE IW TRANSMITTER FOR HIGH IMPULSE TELEMETERING

INSTRUCTIONS

CAUTION

Before putting transmitters 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 is 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-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 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 receiving point where they are used to operate receiving devices which initiate indicating and recording meters as well as automatic load control equipment. A typical system showing the schematic connections between the various elements 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.

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 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 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 means of indicating the magnitude and direction of power flow.

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 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.

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 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.

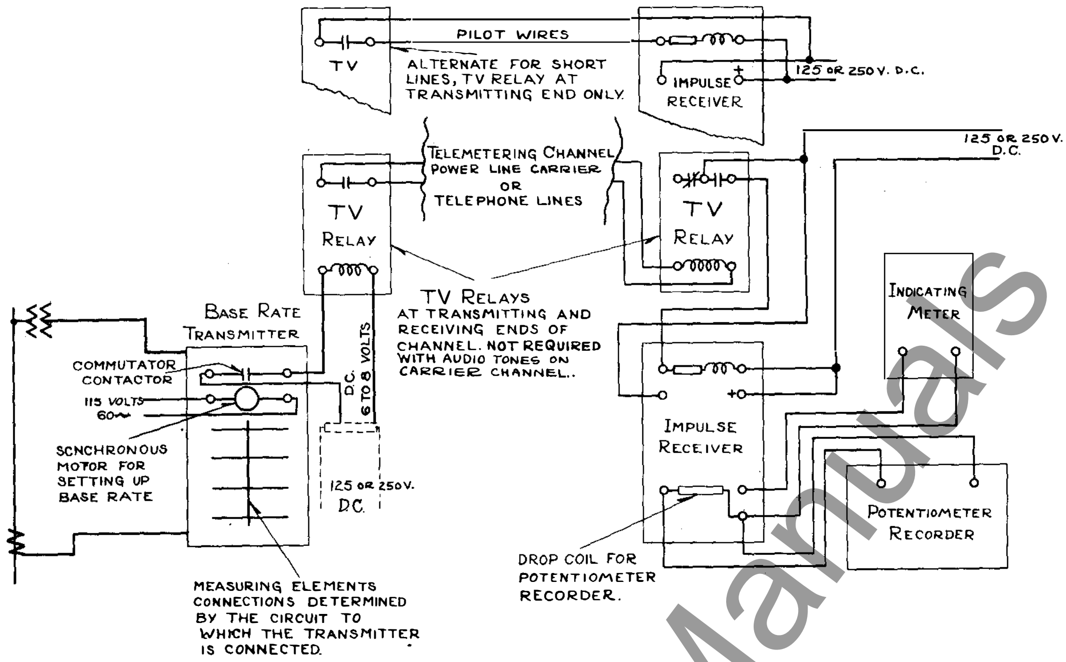


Figure 1
Schematic Connections of a Typical High Rate Impulse Telemetering System.

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 and impulse rates, for the several scales.

ZERO AT CENTER OF SCALE

Scale Deflection	Left End	Center	Right End
Disc RPM	-25	0	+25
Imp. per min.	40	120	200

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

ZERO AT LEFT END OF SCALE

Scale Deflection	Left End	Right End
Disc RPM	0	+25
Imp. per min.	80	220

RELAYS IN TYPE FT CASES

The type **FT** Cases are dust-proof enclosures combining relay elements 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 three main units of the type **FT** case: the case, cover and chassis. The case is an all welded steel housing containing the hinge half of the knife-blade test switches and the terminals for external connections. The cover is a drawn steel frame with a clear window which fits over the front of the case with the switches closed. The chassis is a frame that supports the transmitter elements and the contact jaw half of the test switches. This slides in and out of the case. The electrical connections between the base and chassis are completed through the closed knife-blades.

Removing Chassis

To remove the chassis, first remove the cover by unscrewing the captive nuts at the corners. There are two cover nuts on the S size case and four on the L and M size cases. This exposes the transmitter elements and all the test switches for inspection and testing. The next step is to open the test switches. In opening the test switches they should be moved all the way back against the stops. With all the switches fully opened, grasp the two cam action latch arms and pull outward. This releases the chassis from the case. 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. The chassis operated shorting switch located behind the current test switch prevents open circuiting the current transformers when the current type test switches are closed.

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

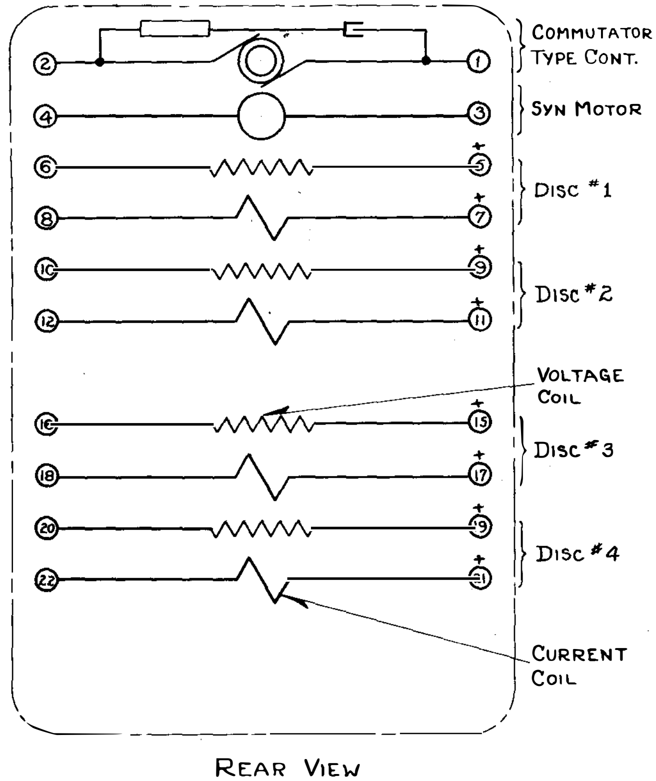


Figure 2
Internal Schematic of the Type IW Transmitter With Four Single Phase Elements in the Standard Case.

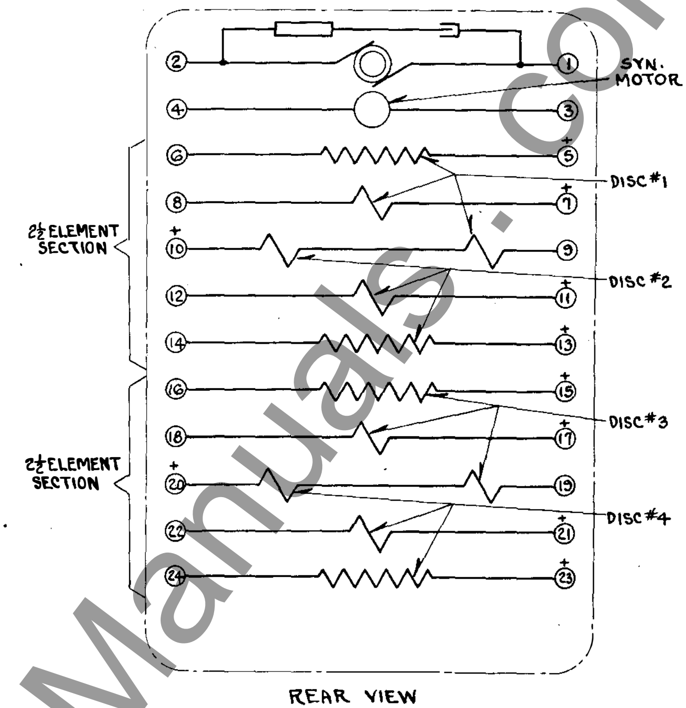


Figure 3
Internal Schematic of the Type IW Transmitter With Two 2-1/2 Elements in the Standard Case.

Electrical Circuits

Each terminal in the base connects thru a test switch to the transmitter elements 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 transmitter are disconnected from the external circuit by opening the associated test switches. Opening the current test switch short-circuits the current transformer secondary and disconnects one side of the transmitter coil but leaves the other side of the coil connected to the external circuit thru the current test jack jaws. This circuit can be isolated by inserting the current test plug (without external connections), by inserting the ten circuit test plug, or by inserting a piece of insulating material approximately 1/32" thick into the current test jack jaws. Both switches of the current test switch pair must be open when using the current test plug or insulating material in this manner to short-circuit the current transformer secondary.

A cover operated switch can be supplied with its contacts wired in series with the control circuit. This switch opens the circuit when the cover is removed. This switch can be added to the existing type FT cases at any time.

Testing:-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:-The ammeter test plug can be inserted in the current test jaws after opening

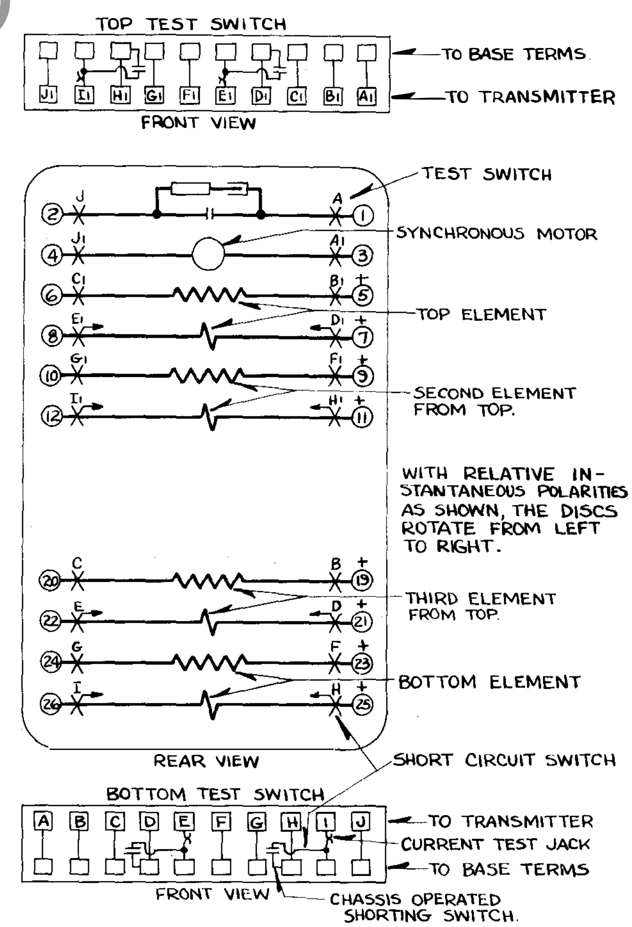


Figure 4
Internal Schematic of the Type IW Transmitter With Four Single Phase Elements in the Type FT Case.

the knife-blade switch to check the current thru the transmitter. This plug consists of two conducting strips separated by an insulating strip. The ammeter is connected to these strips by terminal screws and the leads are carried out thru holes in the back of the insulated handle.

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:-With all blades in the full open position, the ten circuit test plug can be inserted in the contact jaws. This connects the transmitter elements 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 external test circuits are connected to these binding posts. 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 elements by #2 test clip leads instead of the test plug. When connecting an external test circuit to the current elements using clip leads, care should be taken to see that the current test jack jaws are open so that the transmitter is completely isolated from the external circuits. Suggested means for isolating this circuit are outlined above, under "Electrical Circuits".

Testing Out of Case:-With the chassis removed from the base relay elements 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 by a small percentage. It is recommended that the transmitter 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 terminal 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.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of these transmitters 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 taken apart for repairs, or if it is desired to check the adjustments at regular maintenance periods, the instructions below should be followed.

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.

Transmitters which measure power in generating stations 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.

Tie line 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.

Calibration for both directions of rotation must be considered in tie line transmitters, and because of this it will not be possible to set the light load points up to 100% accuracy. However, the light load error is insignificant when read on the scales of the indicating and recording receivers. To illustrate what is meant by this statement, assume a transmitter and receiver have been arranged for a scale range of 30......0......30 Megawatts. (Total span of 60 MW). Also assume that the transmitter is operating at a light load of 3 Megawatts with an error of .18 Megawatts slow. In terms of actual load this would be 6% but the accuracy of indicating and recording meters is defined as a percentage of the full scale span, hence the error is

$$\frac{.18}{60} \times 100 = .3 \text{ of one per cent.}$$

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.

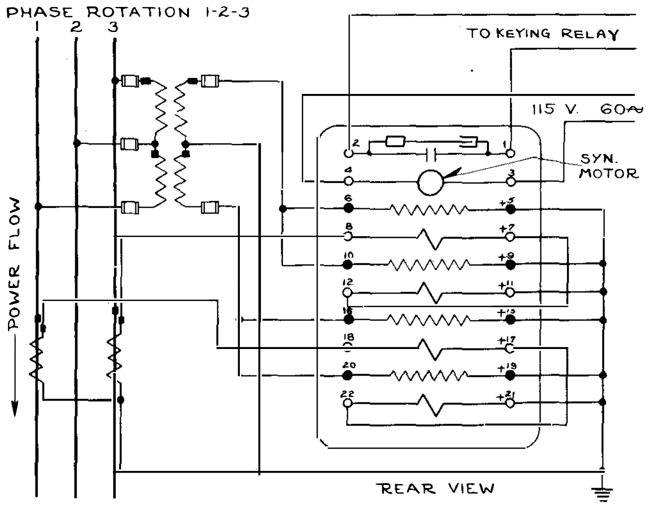


Figure 5
External Connections of the Four Element Type IW Transmitter in the Standard Case for Totalizing a 3 Phase 3 Wire Circuit With 2 Potential and 2 Current Transformers.

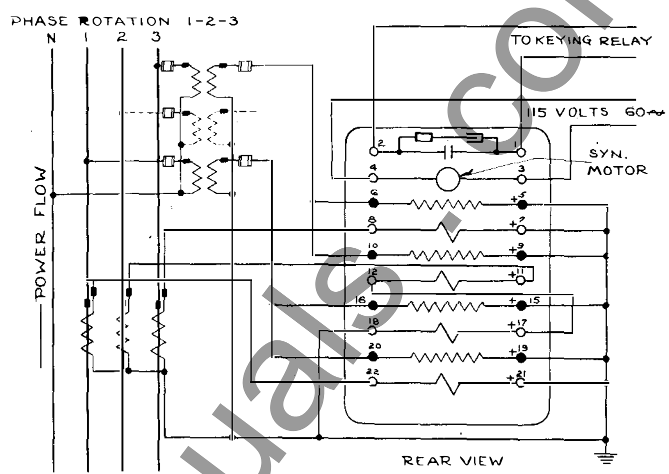


Figure 6
External Connections of the Four Element Type IW Transmitter in the Standard Case for Totalizing a 3 Phase 4 Wire Circuit With 2 Potential and 3 Current Transformers.

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 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 Type 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. 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.

If a commutator is smooth, it is only necessary to clean out the dust with an air 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.

Care of Motor and Motor Gearing

The motor should be oiled every two years. Use Westinghouse oil S#1275575 which may be obtained in 1 oz. bottles.

At the lower end of the motor shaft is an oil cap filled with oil saturated wool. A small wick carries the oil from the cap to the bearing which is inside the motor core. The lower end of the shaft rests on a jewel in the bottom of the cap. When oiling is necessary, unscrew the cap, fill it about two-thirds full of oil and replace.

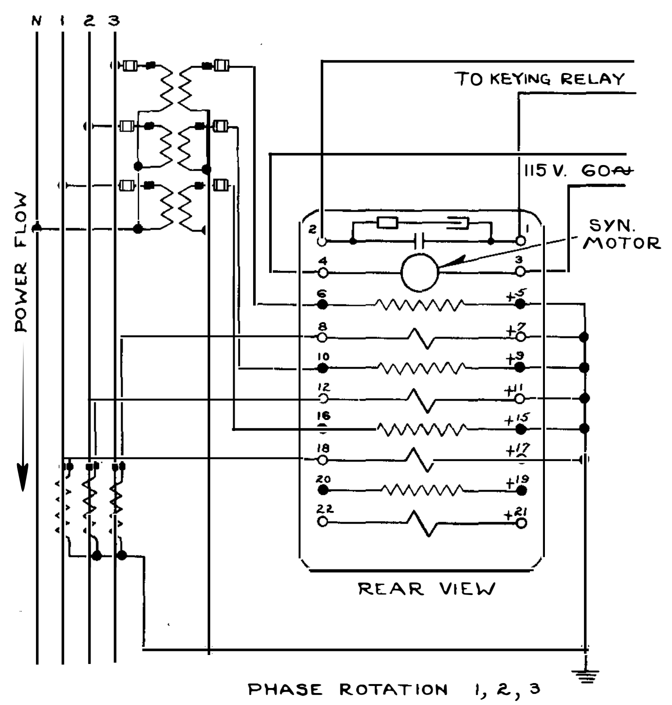


Figure 7
External Connections of the Four Element Type IW Transmitter in the Standard Case for Totalizing a 3 Phase 4 Wire Circuit With 3 Potential and 3 Current Transformers.

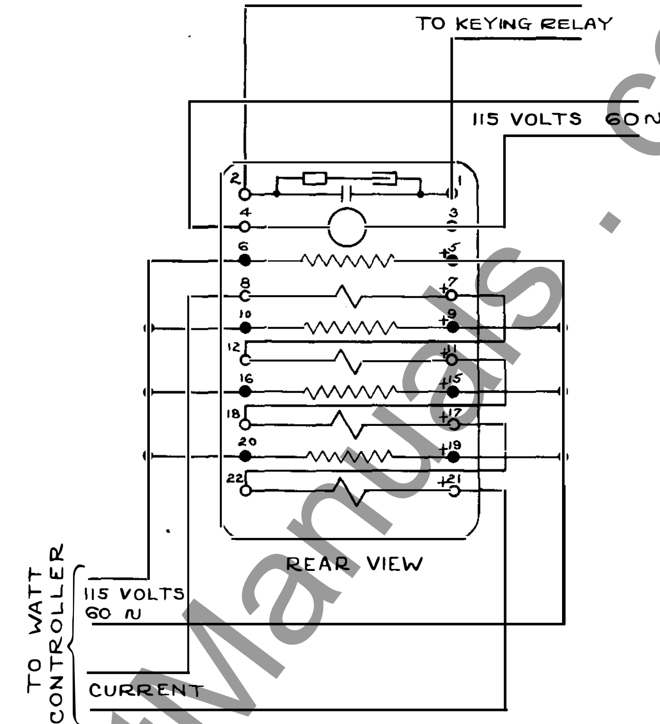
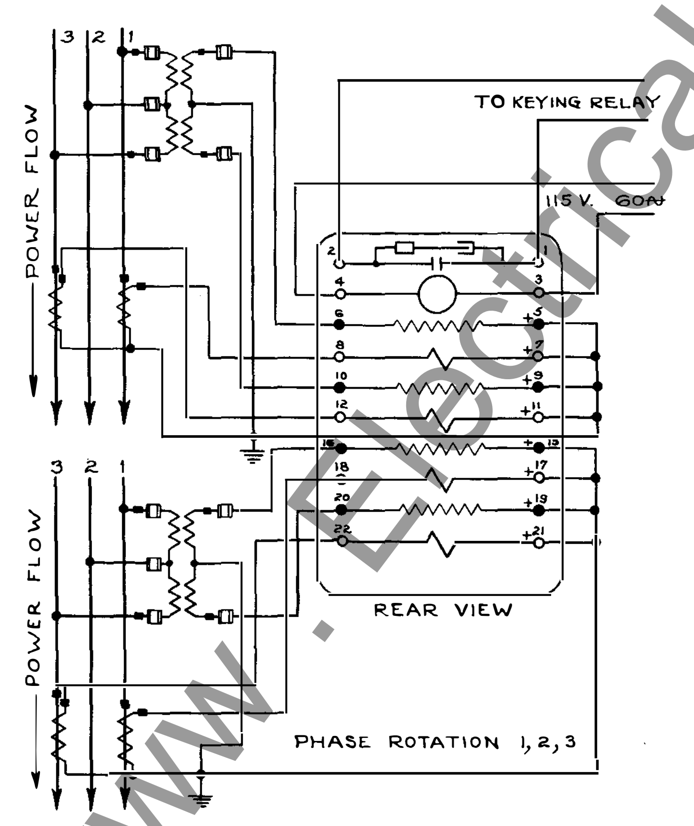


Figure 8
External Connections of the Four Element Type IW Transmitter in the Standard Case When Used With an Equivalent Watt Controller.



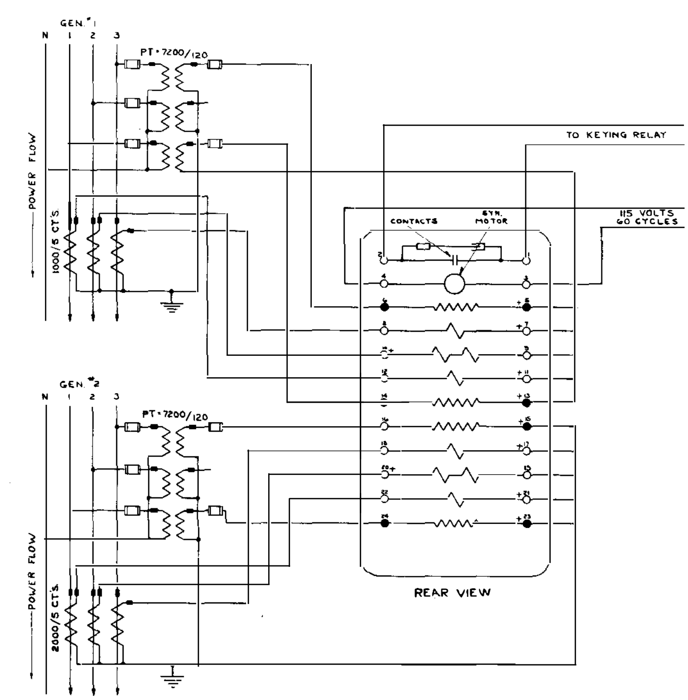


Figure 9
External Connections of the Four Element Type IW Transmitter in the Standard Case for Totalizing Two 3 Phase 3 Wire Circuits Each With 2 Potential and 2 Current Transformers.

Figure 10
External Connections of the Two 2-1/2 Element Type IW Transmitter in the Standard Case for Totalizing Two 3 Phase 3 Wire Circuits Each With 2 Potential and 3 Current Transformers.

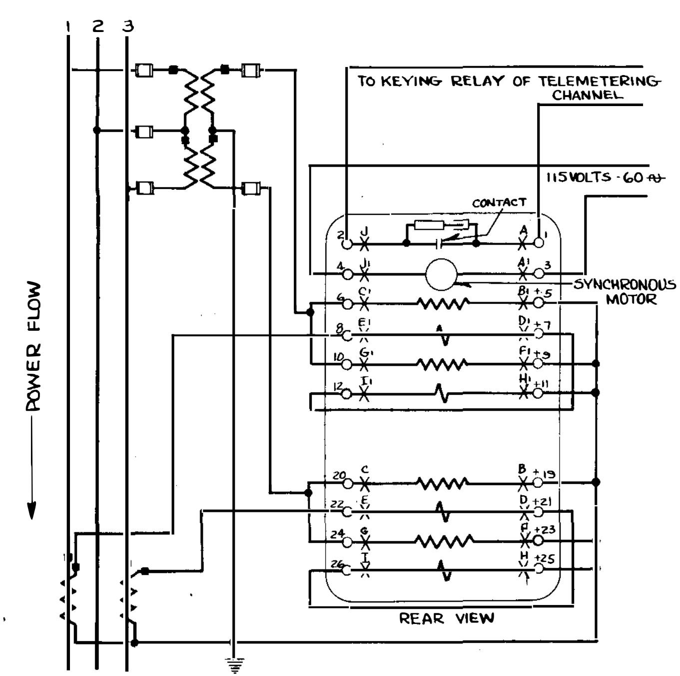


Figure 11
External Connections of the Four Element Type IW Transmitter in the Type FT Case for Totalizing a 3 Phase 3 Wire Circuit With 2 Potential and 2 Current Transformers.

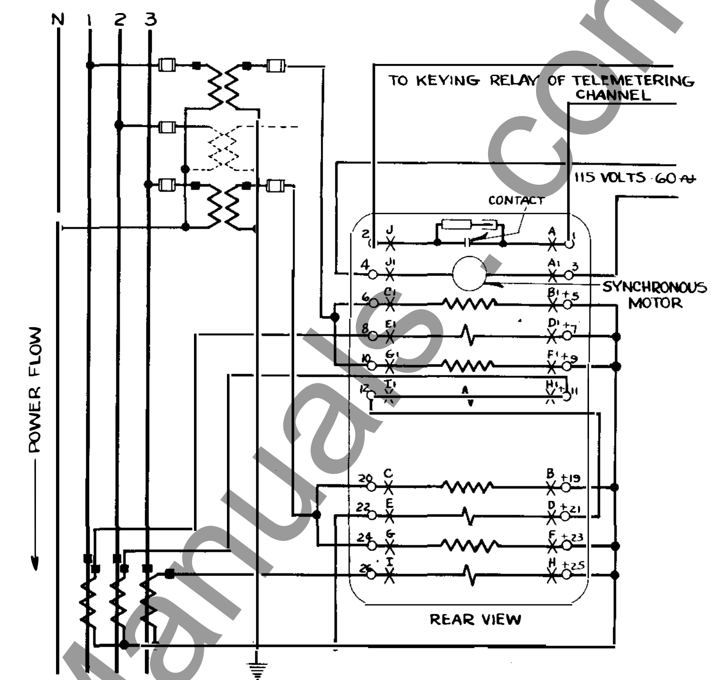


Figure 12
External Connections of the Four Element Type IW Transmitter in the Type FT Case for Totalizing a 3 Phase 4 Wire Circuit With 2 Potential and 3 Current Transformers.

The intermediate gear shaft is between the motor and the shaft assembly of the rotating brush. It has a bearing similar to that of the motor and the same oiling procedure should be followed.

The sleeve bearing and the hub bearing of the shaft of the rotating brush should be inspected and oiled slightly every three months. Inspect by turning the gears by hand. If the gearing does not spin freely and seems tight or rough in its action, it is probable that an excessive amount of sludge has formed in the bearing. This may cause enough friction to prevent the motor from starting. If this is the case, the shaft should be removed and the bearing cleaned. Use the same oil as for motor.

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:

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.

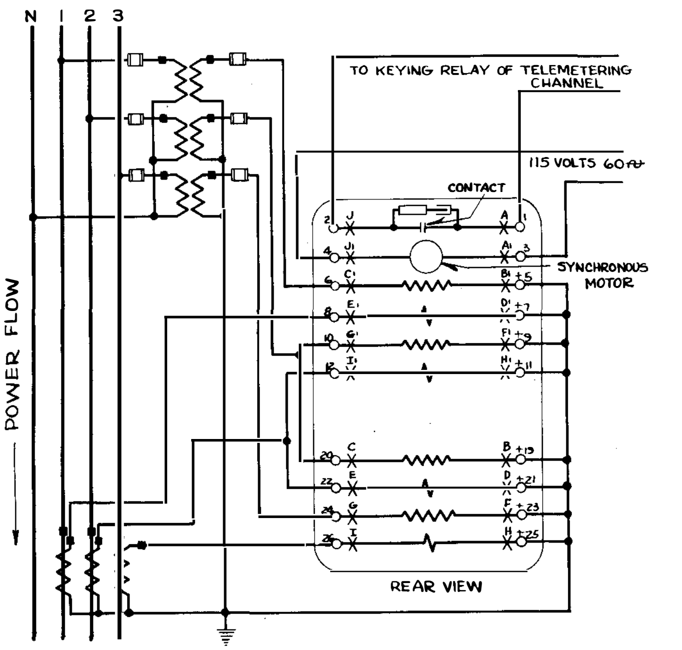


Figure 13
External Connections of the Four Element Type IW Transmitter in the Type FT Case for Totalizing a 3 Phase 4 Wire Circuit With 3 Potential and 3 Current Transformers.

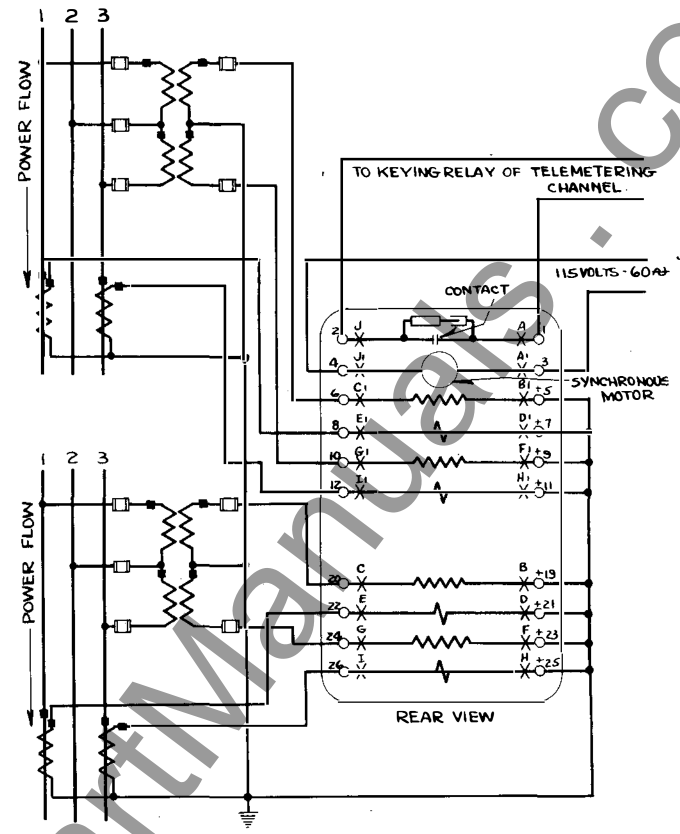


Figure 14
External Connections of the Four Element Type IW Transmitter in the Type FT Case for Totalizing Two 3 Phase 3 Wire Circuits Each With 2 Potential and 2 Current Transformers.

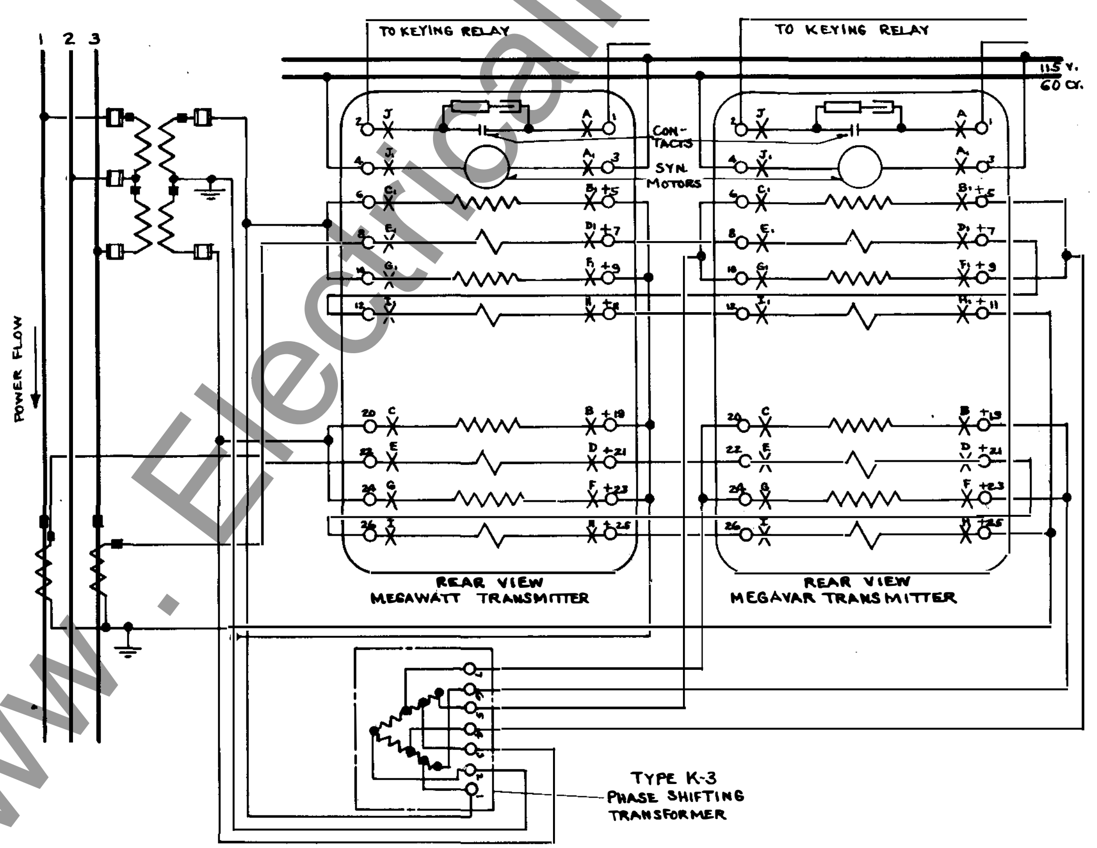


Figure 15
External Connections of Two Four Element Type IW Transmitters in the Type FT Case and the Type K3 Phase Shifting Transformer for Totalizing Megawatts and Megavars on a 3 Phase 3 Wire Circuit With 2 Potential and 2 Current Transformers.

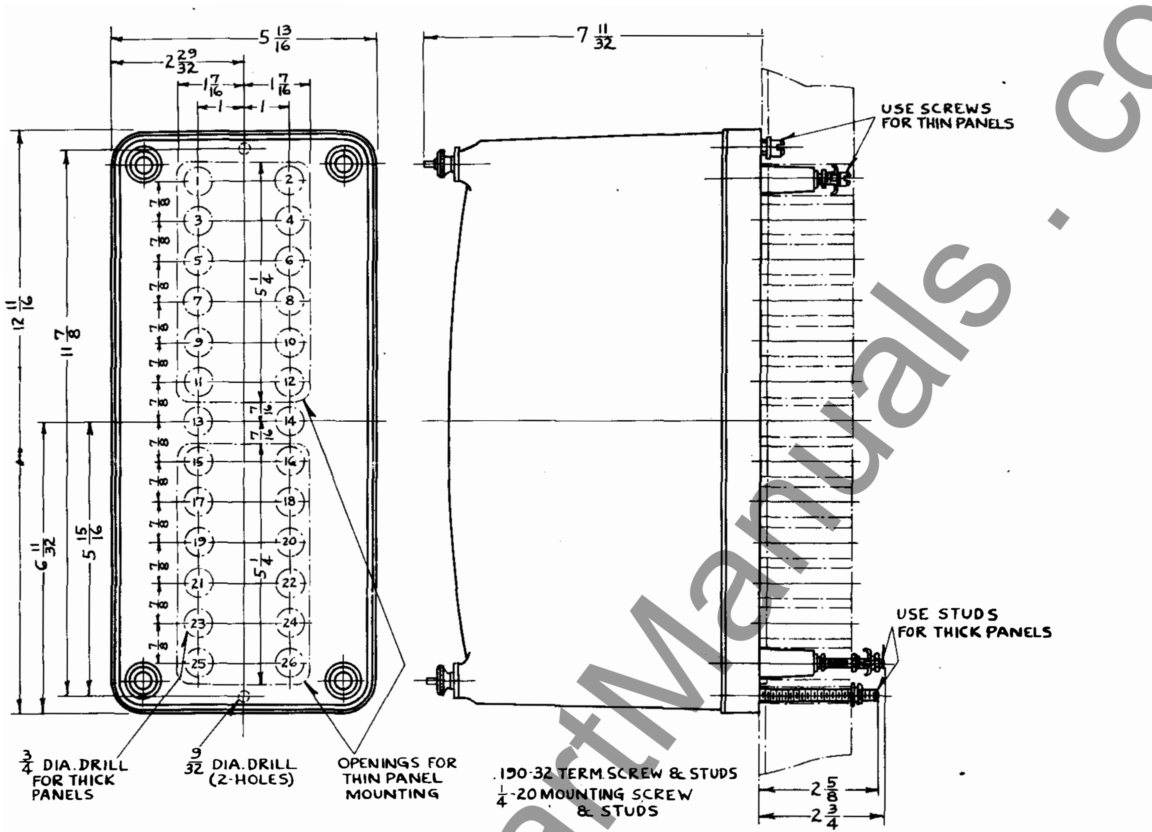


Figure 16
Outline and Drilling Plan for the Standard Projection Type Case. See the Other Internal Schematics for the Terminals Supplied. (For Reference Only.)

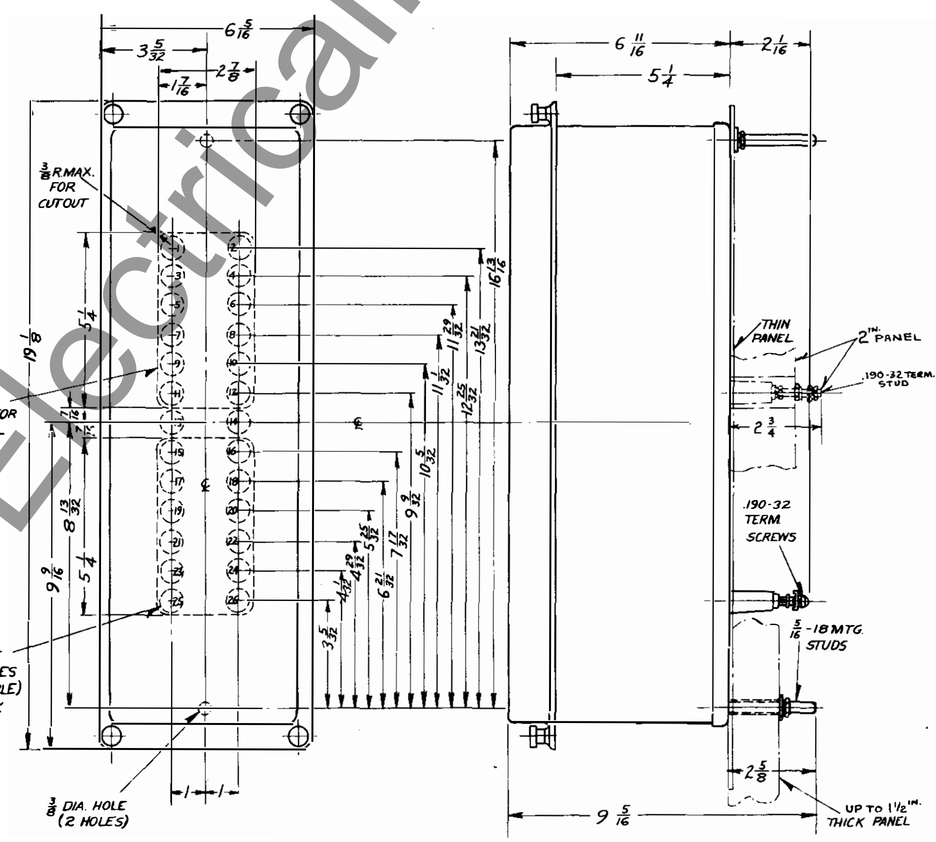


Figure 17
Outline and Drilling Plan for the M20 Projection Type FT Case. See the Internal Schematics for the Terminals Supplied. (For Reference Only.)

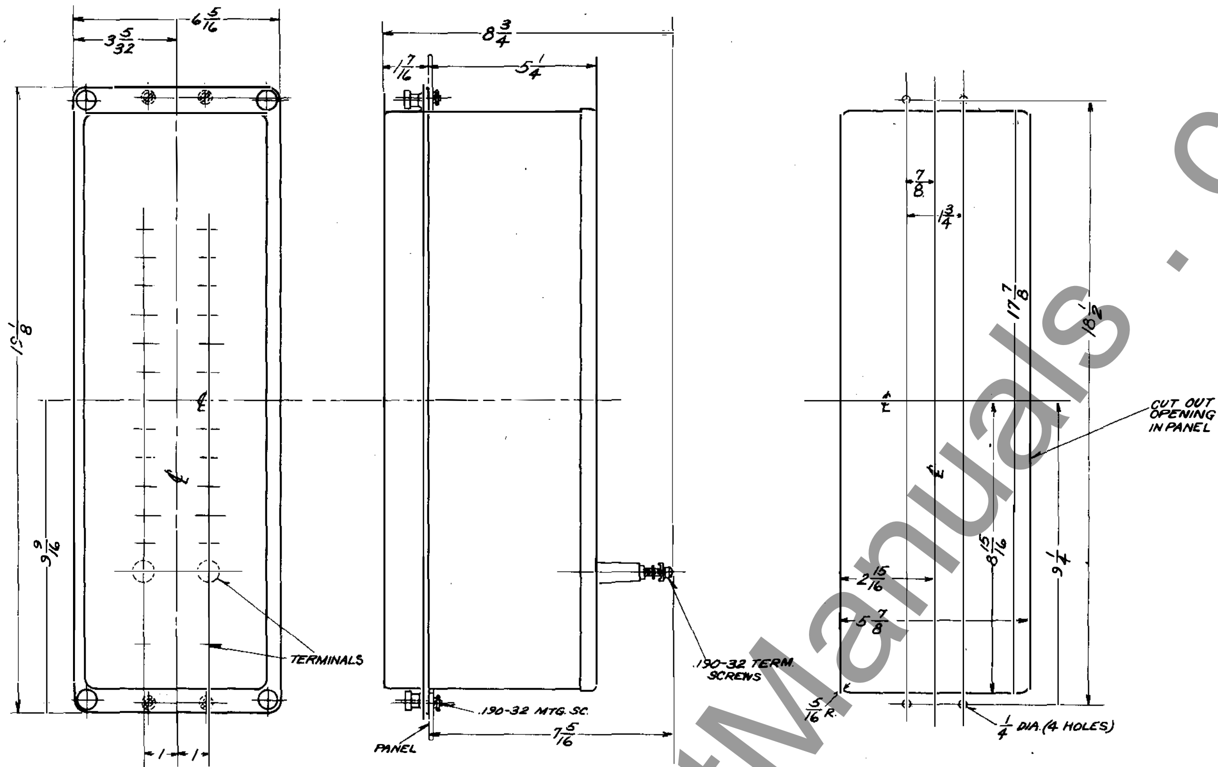


Figure 18
Outline and Drilling Plan for the M20 Semi-Flush Type FT Case. (For Reference Only.)

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE IW TRANSMITTER FOR HIGH RATE IMPULSE TELEMETERING

CAUTION Before putting transmitters 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 is used on 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-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.

CONSTRUCTION AND OPERATION

Type IW Transmitter

The transmitter consists of four watt measuring elements, and a photo tube device for generating impulses.

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 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. Positive power applied to the measuring elements should cause the main discs to turn from left to right viewed from the front of the transmitter. Negative power should cause them to turn in the reverse direction.

At zero load the transmitter generates a constant base impulse rate, but under load conditions the rate is either increased or decreased from this base value, depending on the direction of power flow and by an amount proportional to the load. See Figures 2 and 3.

These impulses are generated by means of a phototube and light source with two shutter discs having suitable holes for pulsing the light. One shutter is driven continuously at constant speed, always in the same direction by a synchronous motor. The other is driven by the measuring elements at a speed proportional to the load, and in either direction depending on the direction of power flow. The dimensions and spacing of the holes of the two shutters are identical. One shutter is mounted directly above the other, and the light must pass through the holes of both in order to strike the window of the phototube, hence the rate of pulsing the light depends on the relative speed of the two shutters. At zero load only the constant-speed shutter turns, giving the base rate, but at other loads the second also turns, superimposing the load impulses on the base value.

The cathode of the photo tube is connected to the control grid of a 2-D-21 thyratron, causing the thyratron to fire at the same rate

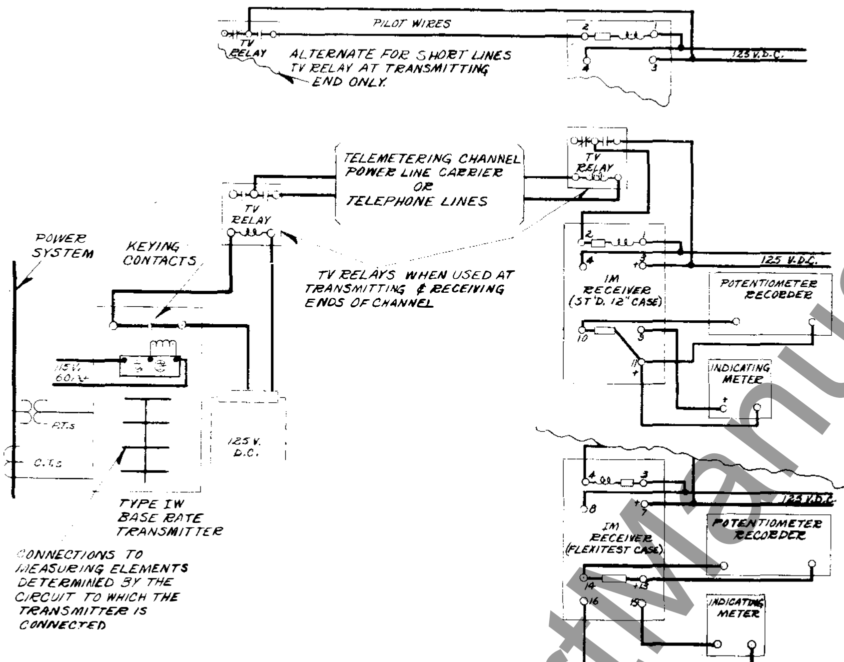


Fig. 1—Schematic Connections of a Typical High Rate Impulse Telemetering System.

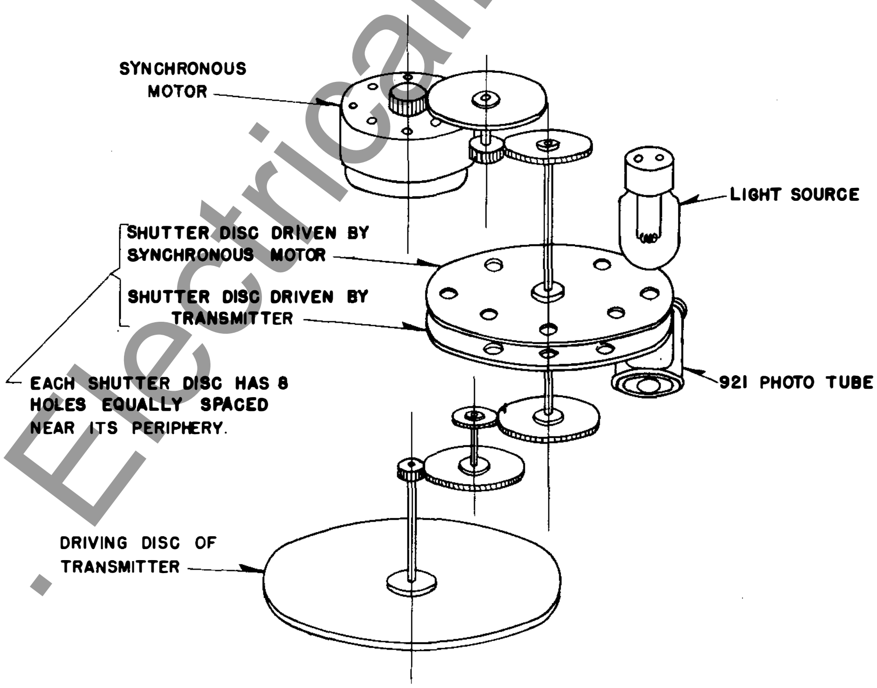


Fig. 2—Schematic Diagram of the Phototube Unit Showing the Operating Principles.

that the light is pulsed. The thyratron in turn operates a relay which is connected in its plate circuit. As this plate current is rectified half wave, a filter condenser is used across the relay coil to prevent chatter.

Control Circuit

A 115-volt 60-cycle control circuit is required for operating the synchronous motor, and for energizing the circuits of the photo tube, the thyratron, and the filament transformer. Case terminals 3 and 4 are for the control circuit.

The grounded line of the control circuit should be connected to terminal #3. If this cannot be done, then an isolating transformer of 1 to 1 ratio should be connected between the control circuit and terminals 3 and 4, so that #3 may be grounded.

As soon as the control circuit is energized, the lamps of the light source should burn and the synchronous motor start running. The relay should start operating as soon as the heater of the thyratron is warmed up, which will require only several seconds.

Satisfactory operation will be obtained with voltage variations between 105 and 125 volts, but it is recommended that 115 volts be maintained as closely as practical. Below 105 volts the operation of the relay becomes less positive and may fail at about 90 volts. Voltages above 115 volts will shorten the tube life.

The two lamps of the light source and the heater of the thyratron are energized from the 6-volt secondary of the filament transformer. This transformer is mounted in the top of the transmitter.

Keying Relay

A small relay is mounted on a panel inside the transmitter near the top of the case, and is normally operated by the firing of the thyratron, but if so desired it can be disconnected and instead an external relay operated. Disconnect links are provided on the panel for changing the connections, as illustrated in Fig. 4.

The link positions are as follows:

When the internal relay is to be used both links must point left. This link arrangement places the coil of the internal relay in the plate circuit of the 2-D-21 thyratron and connects the keying contacts to case terminals 1 and 2. No spark suppressor is provided across these contacts.

If an external relay is to be operated by the thyratron, both links must point right. This arrangement opens the circuits of the internal relay coil and its contacts, and connects the plate circuit of the 2-D-21 thryatron directly to case terminals 1 and 2. An external relay may now be operated from the thyratron without any other source of excitation by connecting its operating coil to terminals 1 and 2. A condenser must be used across the coil to prevent chatter.

The operating characteristics of this relay need not be critical. Any d-c telephone type relay may be used which has a resistance of not less than 1000 ohms and which will operate positively up to 220 impulses per minute on 20 milliamperes or less. If the resistance is too low it should be padded to limit the operating current to the desired value. Usually a condenser of 1 to 4 mfd across the coil will prevent chatter.

Type 921 Gas-Filled Photo Tube

The photo tube is in a shielded insulated housing directly beneath the shutters, and a shielded lead runs from the cathode end of the tube to the control grid of the 2-D-21 thyratron. The shields are connected to one side of the 115-volt 60-cycle control circuit.

The tube is held firmly in the housing by spring pressure on the plunger-shaped anode contact at the right, and the housing is hinged at the left end to facilitate removal and replacement of the tube. To remove, push the plunger to the right, free from the tube, and swing the housing forward about the hinge. The tube now is loose in the housing and may be readily removed.

To replace, slide the tube into the housing, concave surface of the cathode up toward the window, and rectangular end toward the rear. This rectangular part fits loosely in a slot

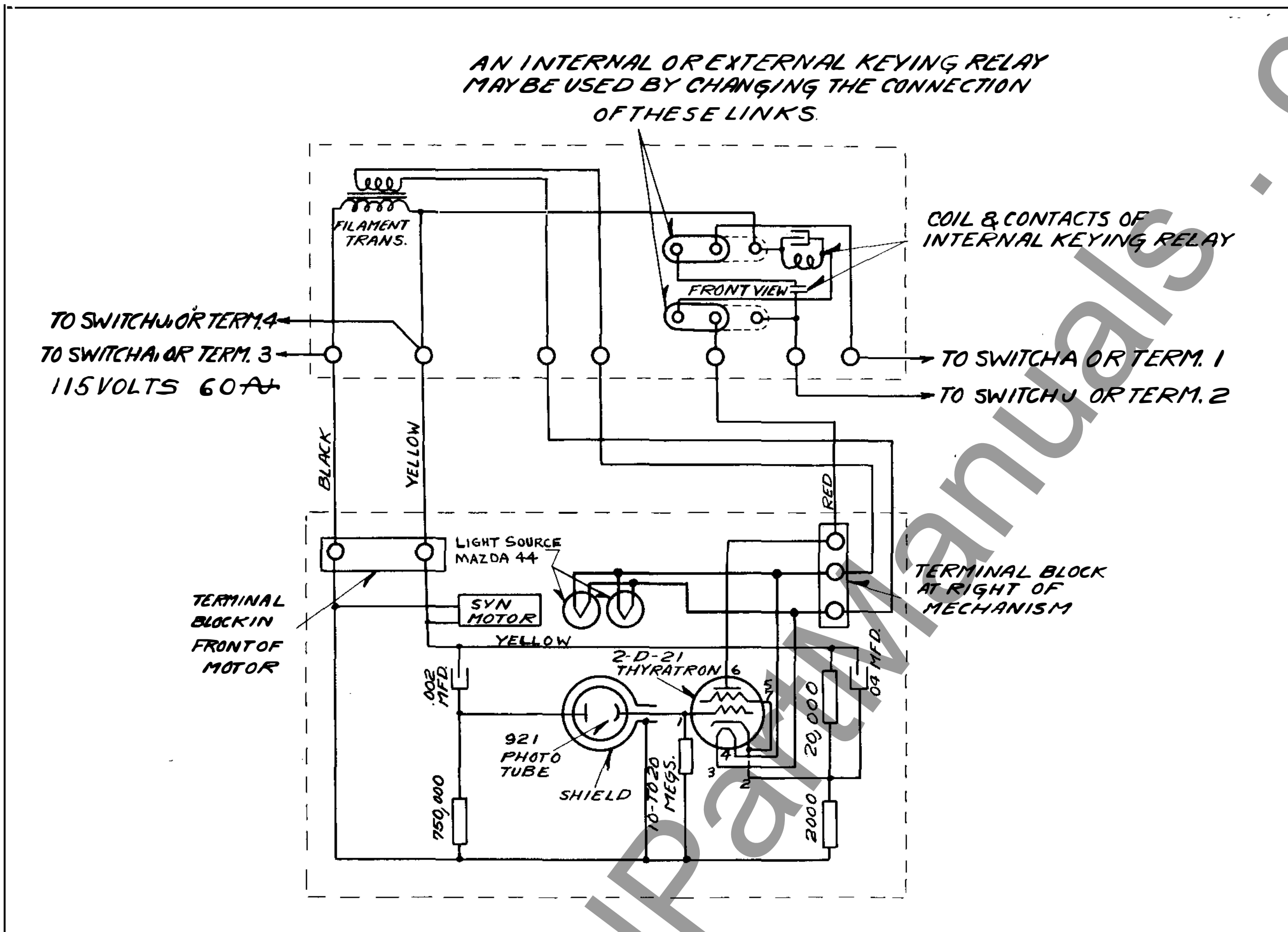


Fig. 3—Internal Schematic Connections of the Phototube Keying Unit.

at the end of the housing which prevents the tube from turning an excessive amount. Do not jam the rectangular part cornerwise into the slot. If jammed, the cathode end may not make contact. Next swing the housing back into place and snap the anode contact back into the hollow in the right end of the tube.

Light Source

Two lamps, type MAZDA 44, 6-8 volts are used in the light source. They are mounted on a bracket just above the shutters. To remove and replace the lamps, loosen the two screws which hold the bracket to the upper plate of the mechanism. The right-hand screw hole is slotted permitting the bracket to be swung forward about the left-hand screw giving access to the lamps. Hold the bracket firmly when removing and replacing lamps in order not to bend it. Next swing the bracket back into place and tighten the screws.

The Type 2-D-21 miniature thyratron is located at the right side of the light source. Its socket grips the prongs very tightly making the tube a little difficult to remove and replace unless it is slightly rocked back and forth. The tube can be inserted only in the correct position as the socket has only 7 holes corresponding to the 7 prongs in the base.

Mounting of Mechanism to Meter Frame

The electronic unit and mechanism is held to the meter frame with three screws. Access to these screws may be had by swinging the photo tube housing forward as was outlined in paragraphs above. The screws can then be reached with a slender screw driver.

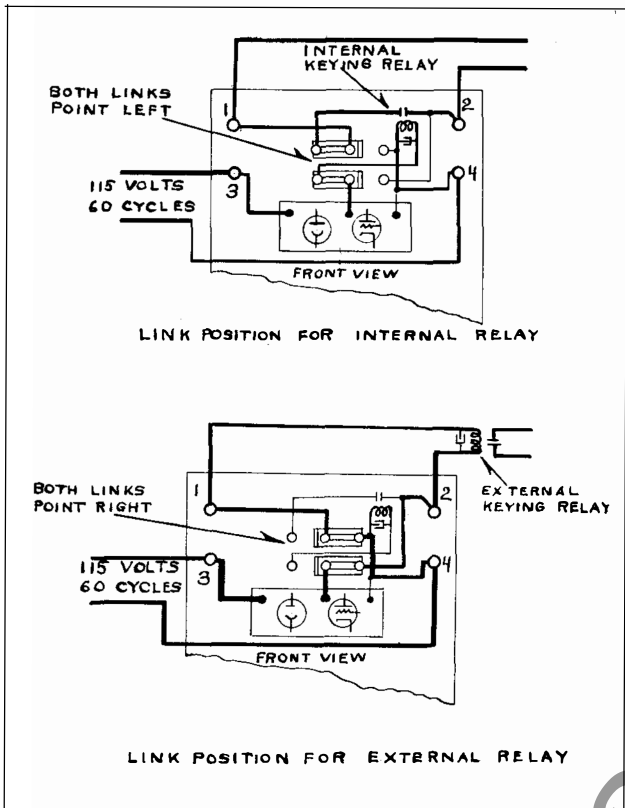


Fig. 4—Link Positions and Schematic Connections for the Keying Relay.

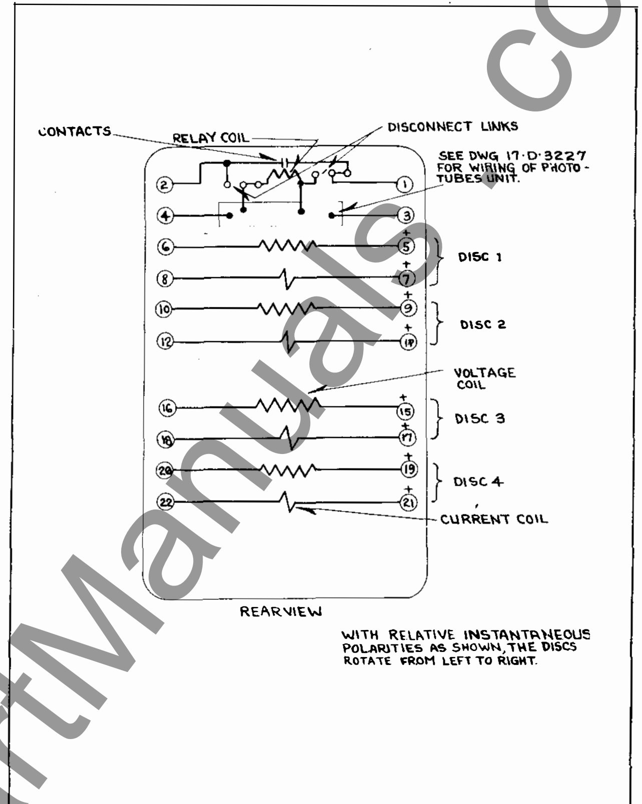


Fig. 5—Intermal Schematic of the Type IW Transmitter With Four Single Phase Elements in the Standard Case.

Gear Mesh

The following provision has been made should it be found necessary to adjust the mesh between the pinion of the main disc shaft and the first gear of the mechanism. The lower left mounting point rests on a short hex post of adjustable height. The height of this post determines the mesh. The two upper mounting points rest directly on the meter frame with provision for a slight amount of rocking. By loosening the three screws and lock nut on the hex post, the mesh can be adjusted. Retighten the lock nut and screws.

Care of Motor and Motor Gearing

The motor and shafts of the motor gearing should be oiled every two years. Use Westinghouse oil S#1275575 which may be obtained in 1-oz. bottles.

At the lower end of the motor shaft is an oil cap filled with oil-saturated wool. A small wick carries the oil from the cap to the bearing which is inside the motor core. The lower end of the shaft rests on a jewel in the bottom of the cap. When oiling is necessary, unscrew the cap, fill it about two thirds full of oil and replace.

The intermediate shaft has a bearing similar to that of the motor but does not have the removable oil cap. This bearing can be oiled by lifting out the shaft and placing a few drops of oil in the hole at the top.

The sleeve bearing and hub bearing of the shaft at the shutter disc may be oiled slightly where the hub rests on the bearing post. Sufficient oil will creep down into the sleeve for proper lubrication. The bearing and shaft are made of materials which will not cause objectionable sludging of the oil.

Spark Suppressors for Keying Contacts

The inductive kick of the relays in the keyed circuit may generate voltages sufficiently high to cause objectionable arcing at

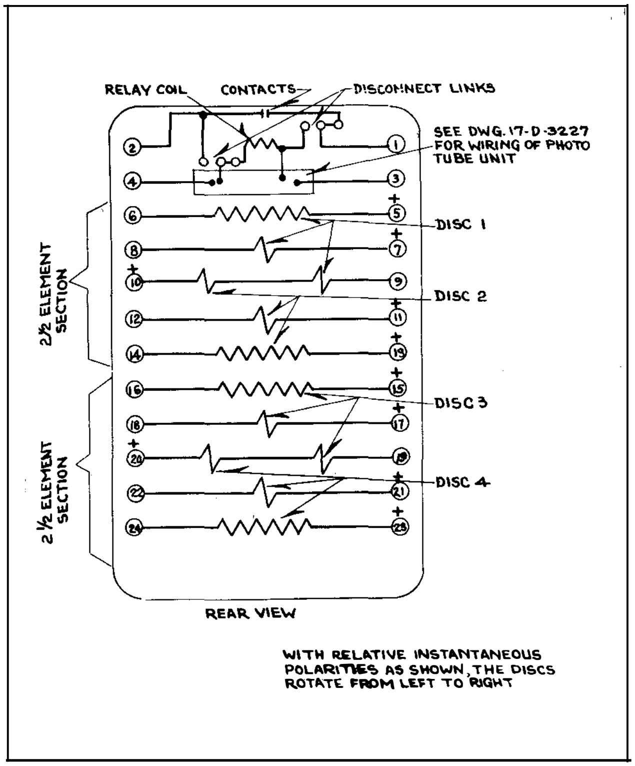


Fig. 6—Internal Schematic of the Type IW Transmitter With Two 2½ Elements in the Standard Case.

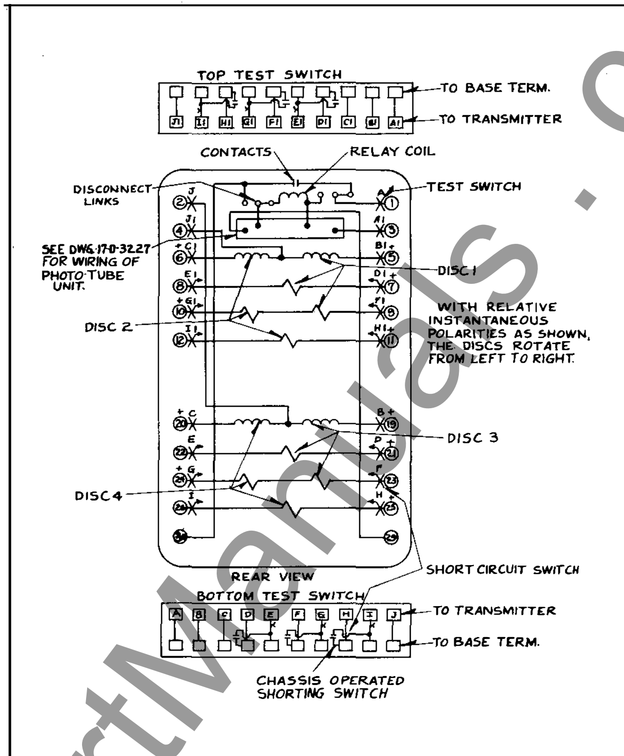


Fig. 7—Internal Schematic of the Type IW Transmitter With Two 2½ Elements in the Type FT Case.

the keying contacts even though the control voltage is too low to cause arcing: hence spark suppressors are frequently used to diminish or kill the arc and prolong contact life.

One common form of suppressor is a condenser and resistor in series connected directly across the contacts. Another form is a shunting resistor connected directly across the coil. The values of the capacity and resistance are best determined by experiment to suit the characteristics of the keyed circuit.

The following applications are here given as a guide:

(a) When keying the relay of a type IM receiver, a suppressor should be used. The IM receiver has a 1500-ohm telephone type relay with 2240-ohm series resistor and requires a 125-volt d-c control circuit. A bright spark is produced at the keying contacts. A suppressor consisting of a 1/2 mfd condenser and 1000-ohm series resistor connected directly across the contacts will kill the spark.

(b) When keying a TV relay no suppressor need be used other than that which is already installed in the relay. There is a shunting resistor connected directly across the coils which absorbs the induced voltage.

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 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.

CHARACTERISTICS

Transmitters must measure the power in a large variety of circuits such as tie lines,

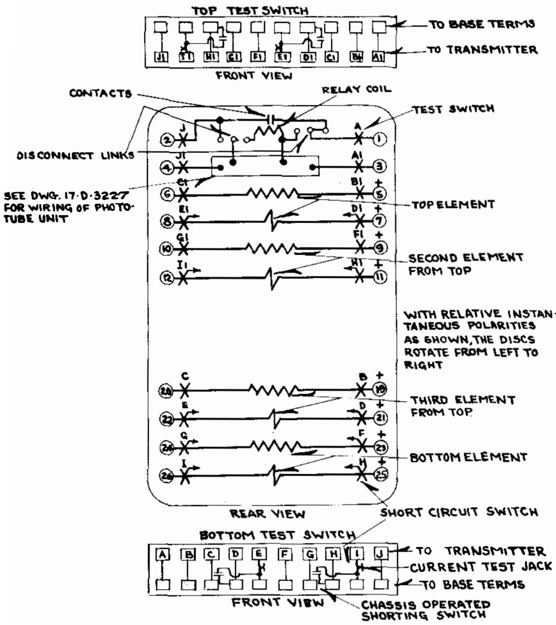


Fig. 8—Internal Schematic of the Type IW Transmitter With Four Single Phase Elements in the Type FT Case.

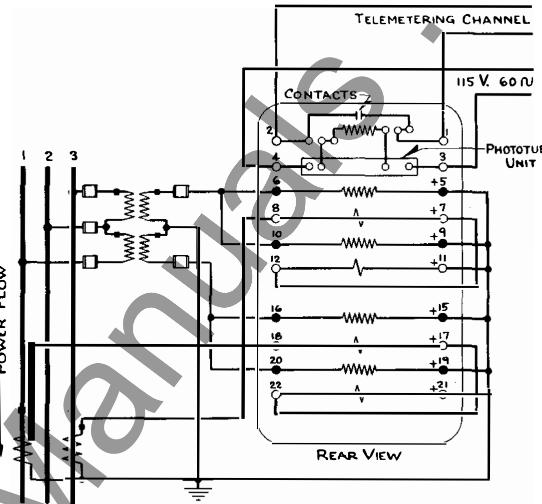


Fig. 9—External Connections of the Four Element Type IW Transmitter in the Standard Case for Totalizing a 3 Phase 3 Wire Circuit with 2 Potential and 2 Current Transformers.

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 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 and impulse rates, for the several scales.

ZERO AT CENTER OF SCALE

Scale Deflection	Left End	Center	Right-End
Disc RPM	-25	0	+25
Imp. per min.	40	120	200

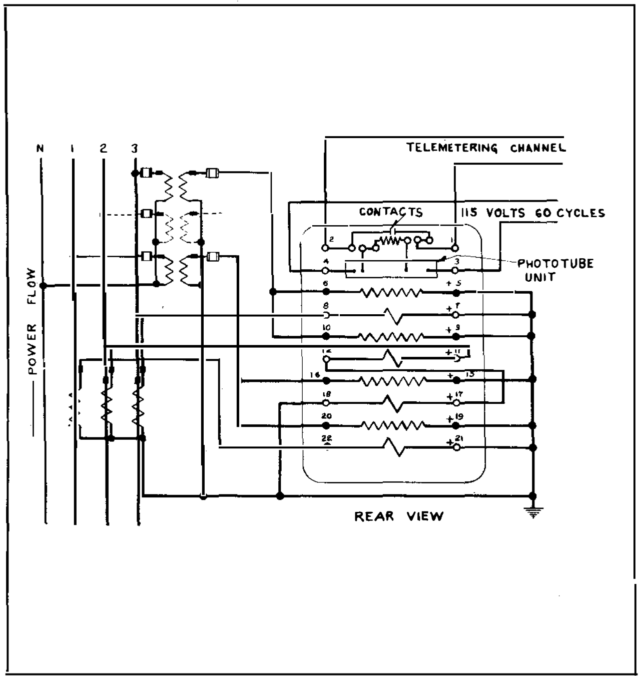


Fig. 10—External Connections of the Four Element Type IW Transmitter in the Standard Case for Totalizing a 3 Phase 4 Wire Circuit With 2 Potential and 3 Current Transformers.

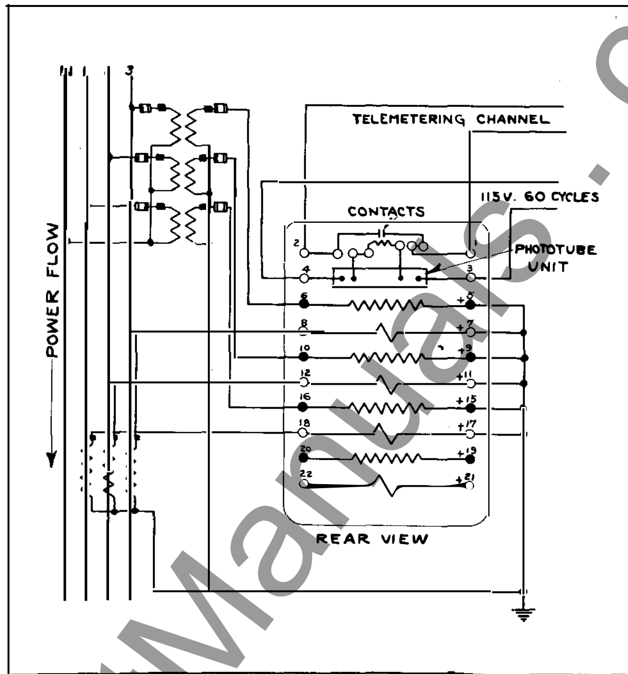


Fig. 11—External Connections of the Four Element Type IW Transmitter in the Standard Case for Totalizing a 3 Phase 4 Wire Circuit With 3 Potential and 3 Current Transformers.

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

ZERO AT LEFT END OF SCALE

Scale Deflection	Left End	Right-End
Disc RPM	0	+25
Imp. per min.	80	220

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of these transmitters 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 taken apart for repairs, or if it is desired to check the adjustments at regular maintenance periods, the instructions below should be followed.

The measuring elements are similar to those used in watthour meter 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 shutter friction has some effect on the light load calibration.

Transmitters which measure power in generating stations 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.

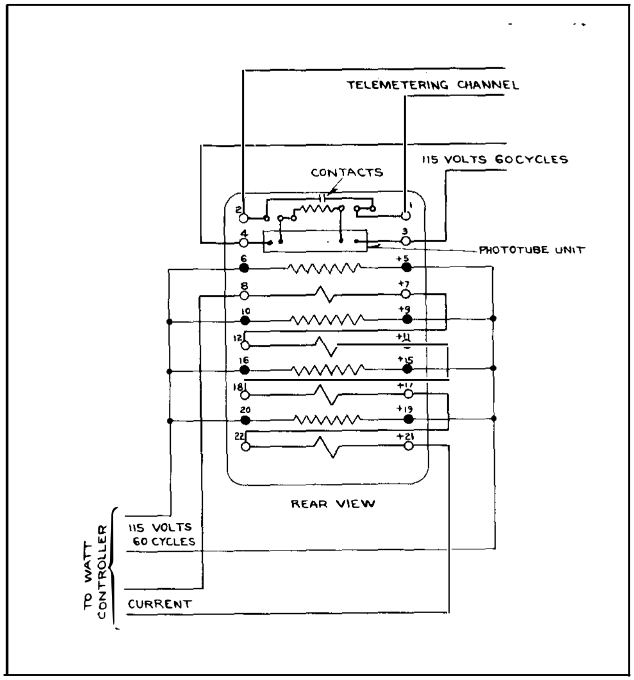


Fig. 12—External Connections of the Four Element Type IW Transmitter in the Standard Case When Used With an Equivalent Watt Controller.

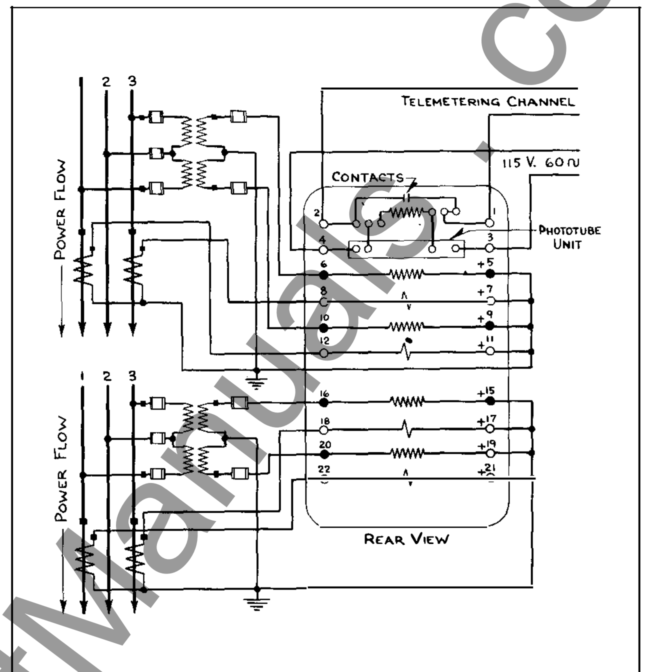


Fig. 13—External Connections of the Four Element Type IW Transmitter in the Standard Case for Totalizing Two 3 Phase 3 Wire Circuits Each With 2 Potential and 2 Current Transformers.

Tie line 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.

Calibration for both directions of rotation must be considered in tie line transmitters, and because of this it will not be possible to set the light load points up to 100% accuracy. However, the light load error is insignificant when read on the scales of the indicating and recording receivers. To illustrate what is meant by this statement, assume a transmitter and receiver have been arranged for a scale range of 30.....0.....30 Megawatts. (Total span of 60 MW). Also assume that the transmitter is operating at a light load of 3 Megawatts with an error of .18 Megawatts slow. In terms of actual load this would be 6% but the accuracy of indicating and recording meters is defined as a percentage of the full scale span, hence the error is $\frac{.18}{60} \times 100 = .3$ of one percent.

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

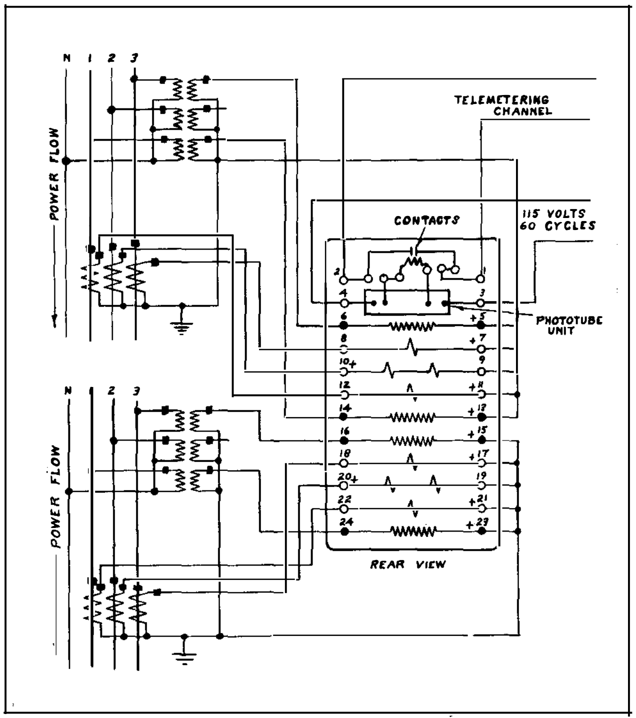


Fig. 14—External Connections of the Two 2½ Element Type IW Transmitter in the Standard Case for Totalizing Two 3 Phase 3 Wire Circuits Each With 2 Potential and 3 Current Transformers.

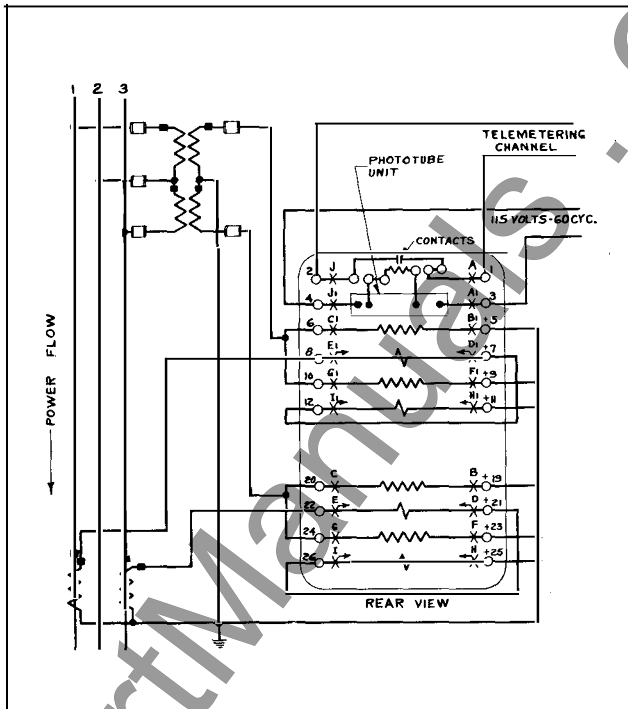


Fig. 15—External Connections of the Four Element Type IW Transmitter in the Type FT Case for Totalizing a 3 Phase 3 Wire Circuit with 2 Potential and 2 Current Transformers.

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 over-all 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:

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 wire watts cause disc to run 25 RPM. 1250 watts for one hour consumed 1250 watthours and cause the disc to make 1500 revolutions. The value of one revolution $= \frac{1250}{1500} = \frac{5}{6} = .833$ watthours = secondary K_h

In a similar manner the

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

TRANSMITTERS IN TYPE FT CASE

The type FT cases are dust-proof enclosures combining relay elements 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 three main units of the type FT case: the case, cover and chassis. The case is an all welded steel housing containing the hinge half of the knife-blade test switches and the terminals for external connections. The cover is a drawn steel frame with a clear window which fits over the front of the case with the switches closed. The chassis is a frame that supports the transmitter elements and the contact jaw half of the test switches. This slides in and out of the case. The electrical connections between the base and chassis are completed through the closed knife-blade.

Removing Chassis

To remove the chassis, first remove the cover by unscrewing the captive nuts at the corners. There are two cover nuts on the S size case and four on the L and M size cases. This exposes the transmitter elements and all the test switches for inspection and testing. The next step is to open the test switches. In opening the test switches they should be moved all the away back against the stops With all the switches fully opened, grasp the two cam action latch arms and pull outward. This releases the chassis from the case. Using 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 for the blade portion of the switches can be closed and the cover put in place without the chassis. The chassis operated shorting switch located behind the current test switch prevents open circuiting the current transformers when the current type test switches are closed.

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

Electrical Circuits

Each terminal in the base connects thru a test switch to the transmitter elements 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 transmitter are disconnected from the external circuit by opening the associated test switches Opening the current test switch short-circuits the current transformer secondary and disconnects one side of the transmitter coil but leaves the other side of the coil connected to the external circuit thru the current test jack jaws. This circuit can be isolated by inserting the current test plug (without external connections), by inserting the ten circuit test plug, or by inserting a piece of insulating material approximately 1/32" thick into the current test jack jaws. Both switches of the current test switch pair must be open when using the current test plug or insulating material in this manner to short-circuit the current transformer secondary.

Testing

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

The ammeter test plug can be inserted in the current test jaws after opening the knife-blade switch to check the current thru the transmitter. This plug consists of two conducting strips separated by an insulating strip. The ammeter is connected to these strips by terminal screws and the leads are carried out thru holes in the back of the insulated handle.

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

With all blades in the full open position, the ten circuit test plug can be inserted in the contact jaws. This connects the transmitter elements 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 external test circuits are connected to these binding posts. The plug is inserted in the bottom test jaws with the binding posts up and in the top test switch jaws with binding posts down.

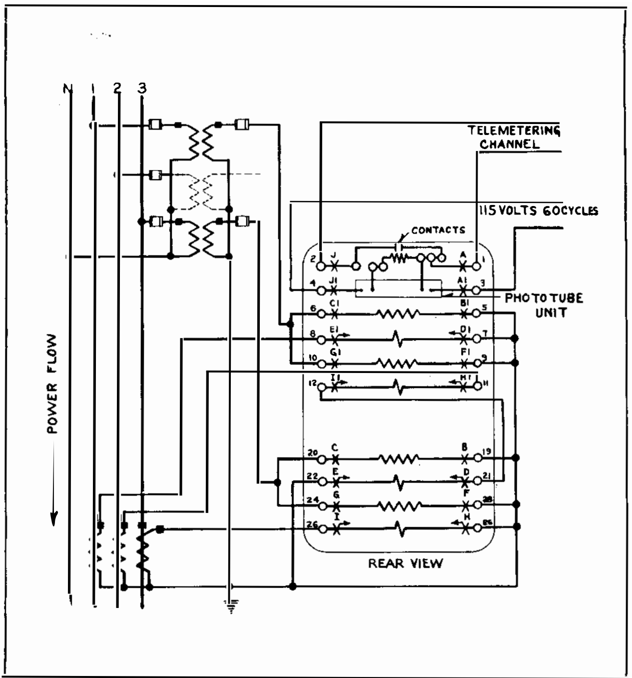


Fig. 16—External Connections of the Four Element Type IW Transmitter in the Type FT Case for Totalizing a 3 Phase 4 Wire Circuit With 2 Potential and 3 Current Transformers.

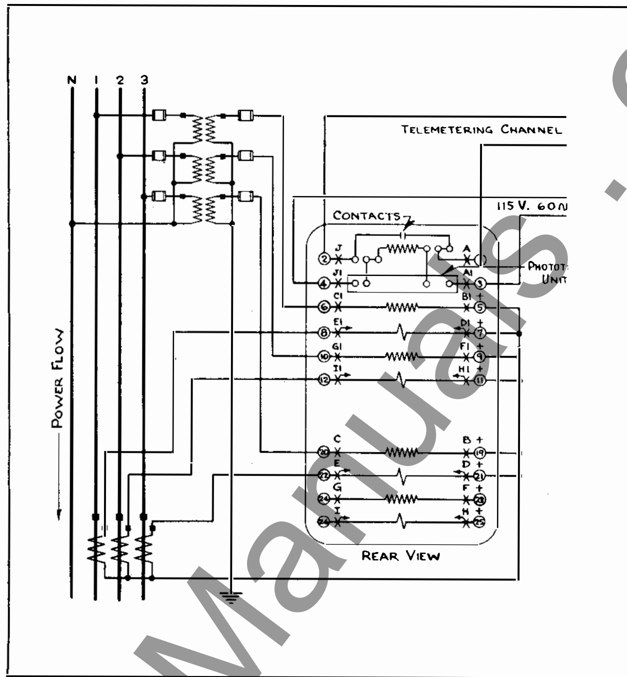


Fig. 17—External Connections of the Four Element Type IW Transmitter in the Type FT Case for Totalizing a 3 Phase 4 Wire Circuit With 3 Potential and 3 Current Transformers.

The external test circuits may be made to the transmitter elements by #2 test clip leads instead of the test plug. When connecting an external test circuit to the current elements that the current test jack jaws are open so that the transmitter is completely isolated from the external circuits. Suggested means for isolating this circuit are outlined above, under "Electrical Circuits".

Testing Out of Case

With the chassis removed from the case relay elements 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 by a small percentage. It is recommended that the transmitter 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 terminal studs furnished with the transmitter for ebony-asbestos or slate apanel 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.

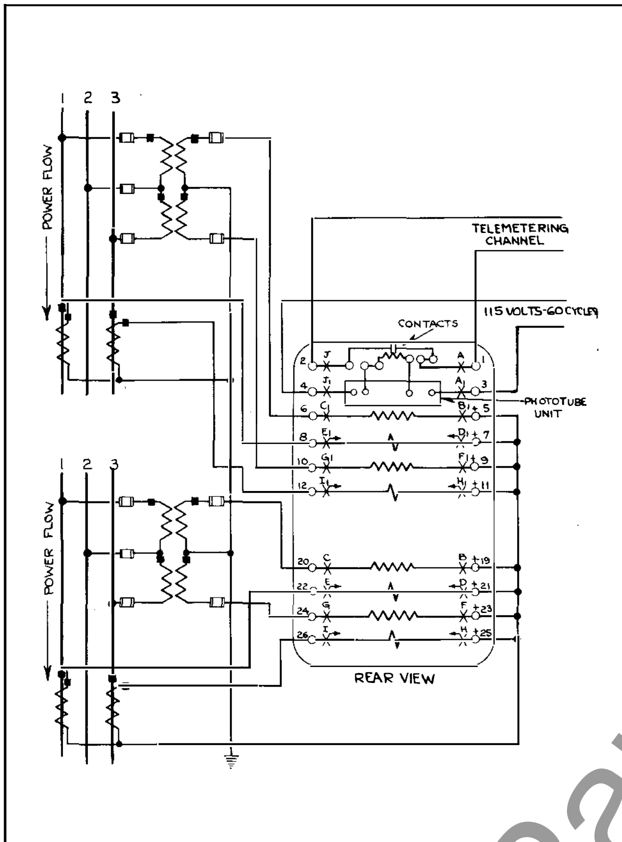


Fig. 18—External Connections of the Four Element Type IW Transmitter in the Type FT Case for Totalizing Two 3 Phase 3 Wire Circuits Each With 2 Potential and 2 Current Transformers.

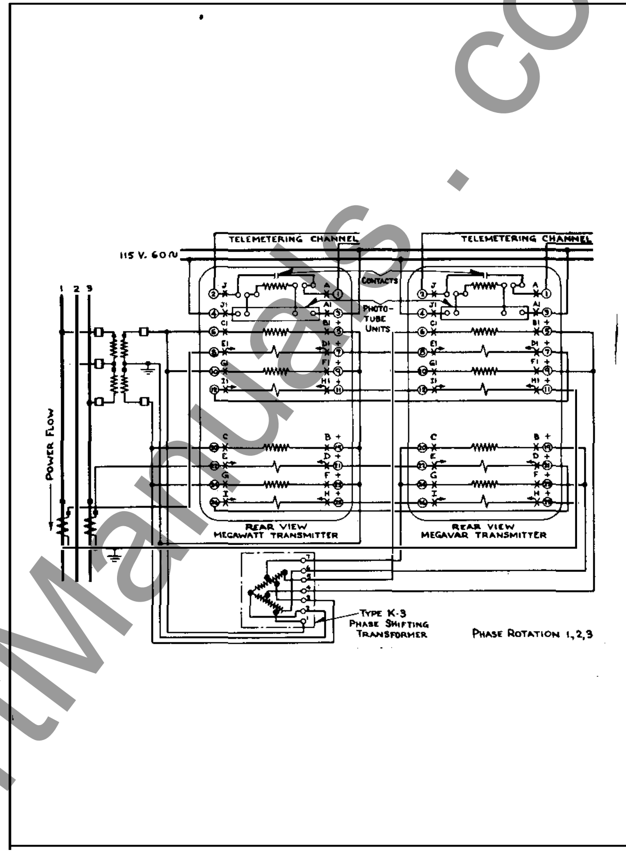


Fig. 19—External Connections of Two Four Element Type IW Transmitters in the Type FT Case and the Type K3 Phase Shifting Transformer for Totalizing Megawatts and Megavars on a 3 Phase 3 Wire Circuit with 2 Potential and 2 Current Transformers.

ENERGY REQUIREMENTS

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

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 photo tube circuit, including the synchronous motor requires 115 volts 60 cycles and draws 105 milliamp., 11 watts.

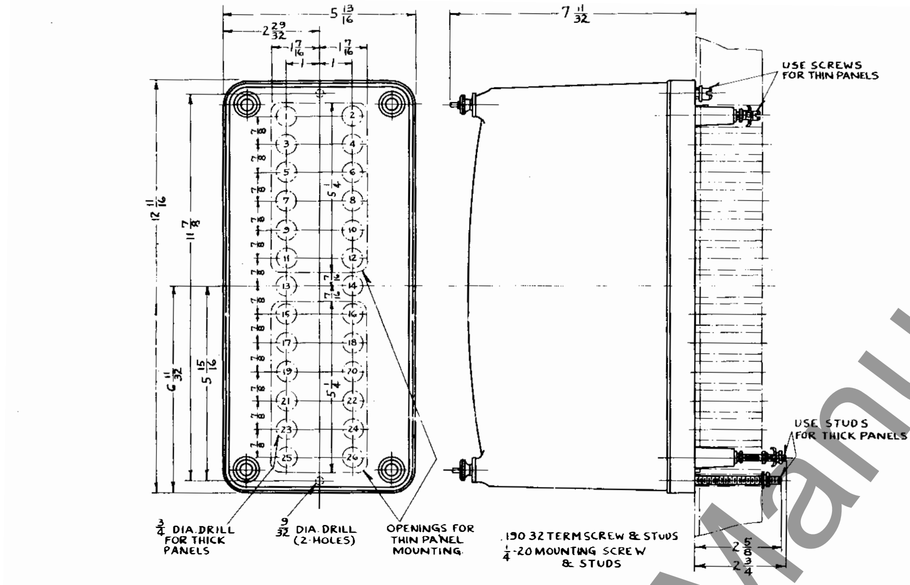


Fig. 20—Outline and Drilling Plan for the Standard Projection Type Case. See the Other Internal Schematic for the Terminals Supplied.

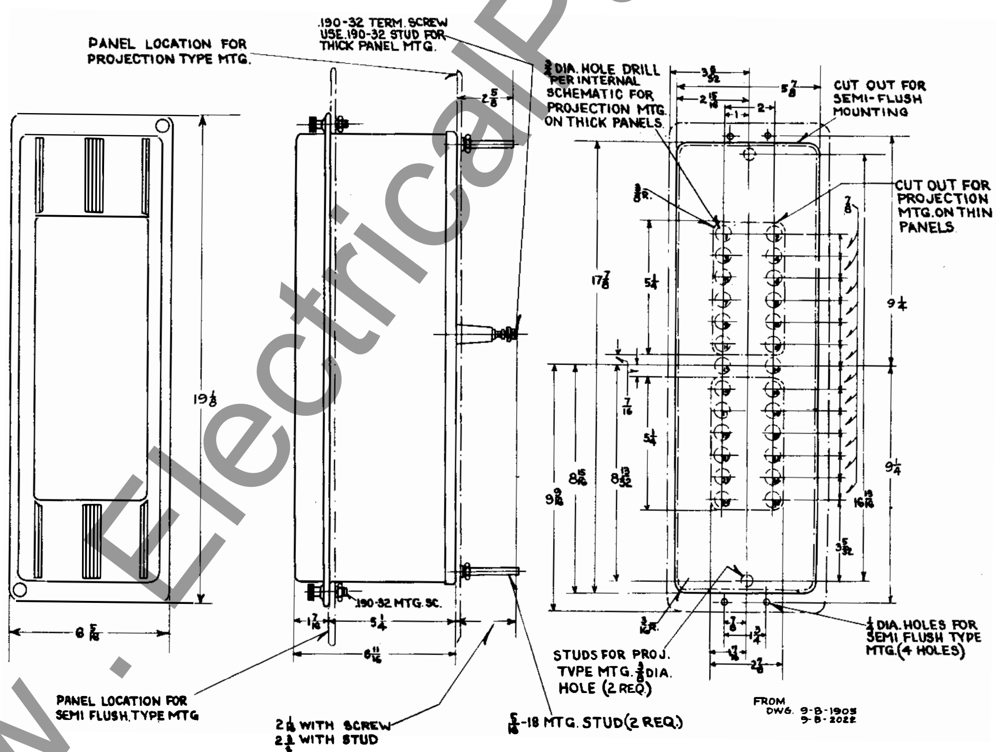


Fig. 21—Outline and Drilling Plan for the M20 Projection or Semi-Flush Type FT Case. See the Internal Schematics for the Terminals Supplied.

WESTINGHOUSE ELECTRIC CORPORATION

METER DIVISION • **NEWARK, N.J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE
INSTRUCTIONS

TYPE IW TRANSMITTER FOR HIGH RATE IMPULSE TELEMETERING

CAUTION Before putting transmitters 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 is used on 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-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.

CONSTRUCTION AND OPERATION

Type IW Transmitter

The transmitter consists of four watt measuring elements, and a photo tube device for generating impulses.

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 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. Positive power applied to the measuring elements should cause the main discs to turn from left to right viewed from the front of the transmitter. Negative power should cause them to turn in the reverse direction.

At zero load the transmitter generates a constant base impulse rate, but under load conditions the rate is either increased or decreased from this base value, depending on the direction of power flow and by an amount proportional to the load. See Figures 2 and 3.

These impulses are generated by means of a phototube and light source with two shutter discs having suitable holes for pulsing the light. One shutter is driven continuously at constant speed, always in the same direction by a synchronous motor. The other is driven by the measuring elements at a speed proportional to the load, and in either direction depending on the direction of power flow. The dimensions and spacing of the holes of the two shutters are identical. One shutter is mounted directly above the other, and the light must pass through the holes of both in order to strike the window of the phototube, hence the rate of pulsing the light depends on the relative speed of the two shutters. At zero load only the constant-speed shutter turns, giving the base rate, but at other loads the second also turns, superimposing the load impulses on the base value.

The cathode of the photo tube is connected to the control grid of a 2-D-21 thyratron, causing the thyratron to fire at the same rate

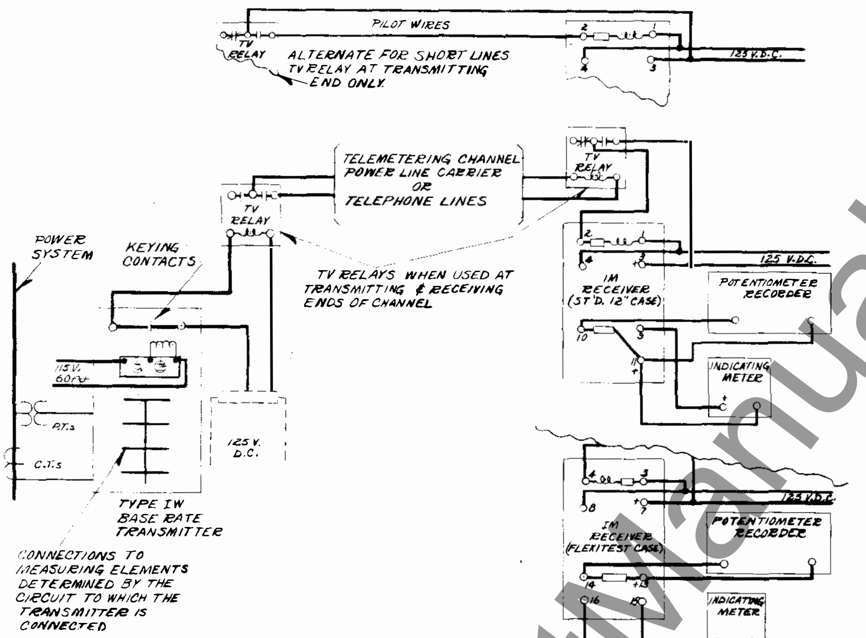


Fig. 1—Schematic Connections of a Typical High Rate Impulse Telemetering System.

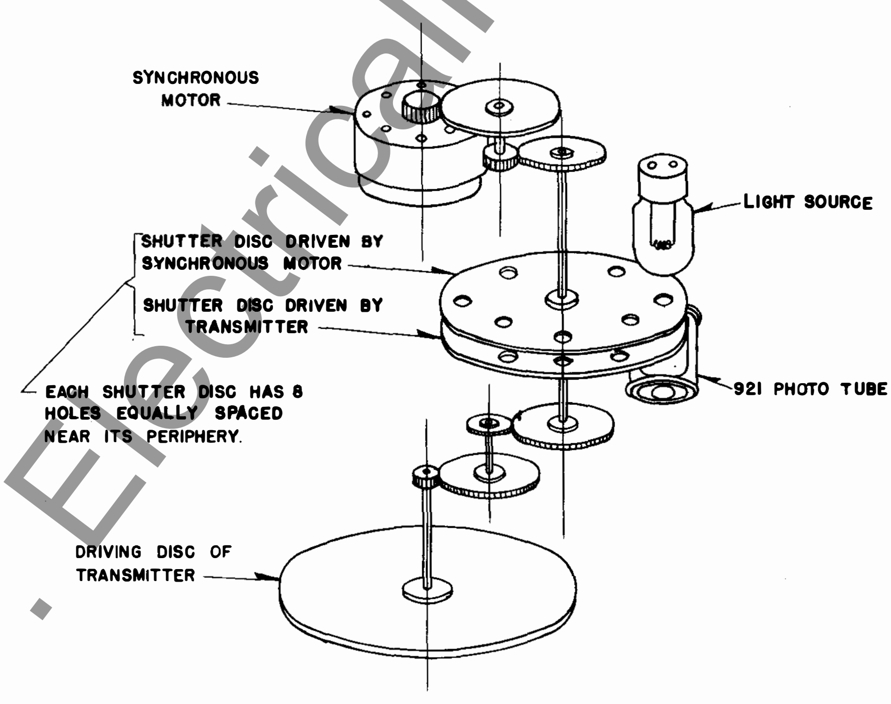


Fig. 2—Schematic Diagram of the Phototube Unit Showing the Operating Principles.

that the light is pulsed. The thyratron in turn operates a relay which is connected in its plate circuit. As this plate current is rectified half wave, a filter condenser is used across the relay coil to prevent chatter.

Control Circuit

A 115-volt 60-cycle control circuit is required for operating the synchronous motor, and for energizing the circuits of the photo tube, the thyratron, and the filament transformer. Case terminals 3 and 4 are for the control circuit.

The grounded line of the control circuit should be connected to terminal #3. If this cannot be done, then an isolating transformer of 1 to 1 ratio should be connected between the control circuit and terminals 3 and 4, so that #3 may be grounded.

As soon as the control circuit is energized, the lamps of the light source should burn and the synchronous motor start running. The relay should start operating as soon as the heater of the thyratron is warmed up, which will require only several seconds.

Satisfactory operation will be obtained with voltage variations between 105 and 125 volts, but it is recommended that 115 volts be maintained as closely as practical. Below 105 volts the operation of the relay becomes less positive and may fail at about 90 volts. Voltages above 115 volts will shorten the tube life.

The two lamps of the light source and the heater of the thyratron are energized from the 6-volt secondary of the filament transformer. This transformer is mounted in the top of the transmitter.

Keying Relay

A small relay is mounted on a panel inside the transmitter near the top of the case, and is normally operated by the firing of the thyratron, but if so desired it can be disconnected and instead an external relay operated. Disconnect links are provided on the panel for changing the connections, as illustrated in Fig. 4.

The link positions are as follows:

When the internal relay is to be used both links must point left. This link arrangement places the coil of the internal relay in the plate circuit of the 2-D-21 thyratron and connects the keying contacts to case terminals 1 and 2. No spark suppressor is provided across these contacts.

If an external relay is to be operated by the thyratron, both links must point right. This arrangement opens the circuits of the internal relay coil and its contacts, and connects the plate circuit of the 2-D-21 thryatron directly to case terminals 1 and 2. An external relay may now be operated from the thyratron without any other source of excitation by connecting its operating coil to terminals 1 and 2. A condenser must be used across the coil to prevent chatter.

The operating characteristics of this relay need not be critical. Any d-c telephone type relay may be used which has a resistance of not less than 1000 ohms and which will operate positively up to 220 impulses per minute on 20 milliamperes or less. If the resistance is too low it should be padded to limit the operating current to the desired value. Usually a condenser of 1 to 4 mfd across the coil will prevent chatter.

Type 921 Gas-Filled Photo Tube

The photo tube is in a shielded insulated housing directly beneath the shutters, and a shielded lead runs from the cathode end of the tube to the control grid of the 2-D-21 thyratron. The shields are connected to one side of the 115-volt 60-cycle control circuit.

The tube is held firmly in the housing by spring pressure on the plunger-shaped anode contact at the right, and the housing is hinged at the left end to facilitate removal and replacement of the tube. To remove, push the plunger to the right, free from the tube, and swing the housing forward about the hinge. The tube now is loose in the housing and may be readily removed.

To replace, slide the tube into the housing, concave surface of the cathode up toward the window, and rectangular end toward the rear. This rectangular part fits loosely in a slot

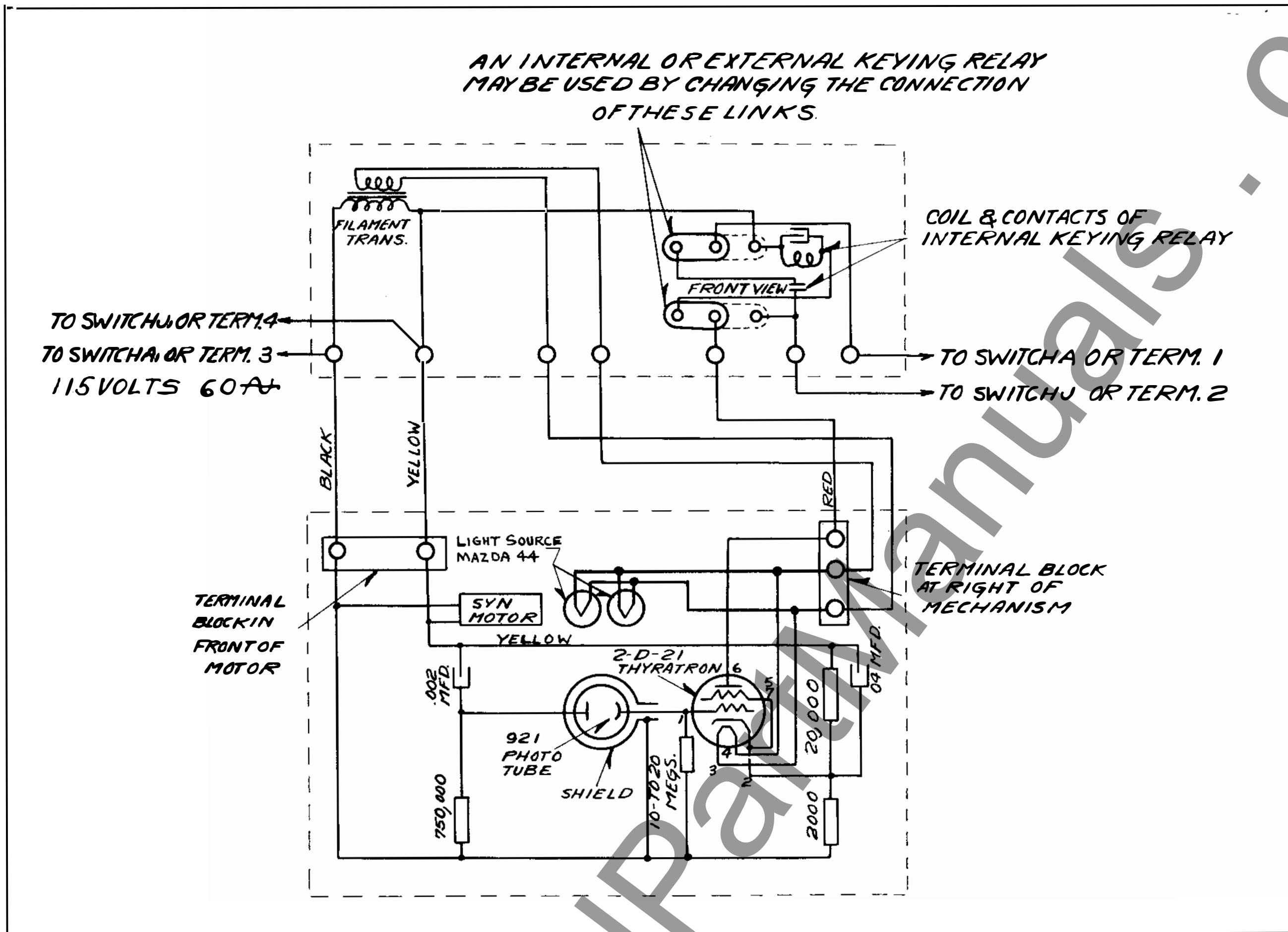


Fig. 3—Internal Schematic Connections of the Phototube Keying Unit.

at the end of the housing which prevents the tube from turning an excessive amount. Do not jam the rectangular part cornerwise into the slot. If jammed, the cathode end may not make contact. Next swing the housing back into place and snap the anode contact back into the hollow in the right end of the tube.

Light Source

Two lamps, type MAZDA 44, 6-8 volts are used in the light source. They are mounted on a bracket just above the shutters. To remove and replace the lamps, loosen the two screws which hold the bracket to the upper plate of the mechanism. The right-hand screw hole is slotted permitting the bracket to be swung forward about the left-hand screw giving access to the lamps. Hold the bracket firmly when removing and replacing lamps in order not to bend it. Next swing the bracket back into place and tighten the screws.

The Type 2-D-21 miniature thyratron is located at the right side of the light source. Its socket grips the prongs very tightly making the tube a little difficult to remove and replace unless it is slightly rocked back and forth. The tube can be inserted only in the correct position as the socket has only 7 holes corresponding to the 7 prongs in the base.

Mounting of Mechanism to Meter Frame

The electronic unit and mechanism is held to the meter frame with three screws. Access to these screws may be had by swinging the photo tube housing forward as was outlined in paragraphs above. The screws can then be reached with a slender screw driver.

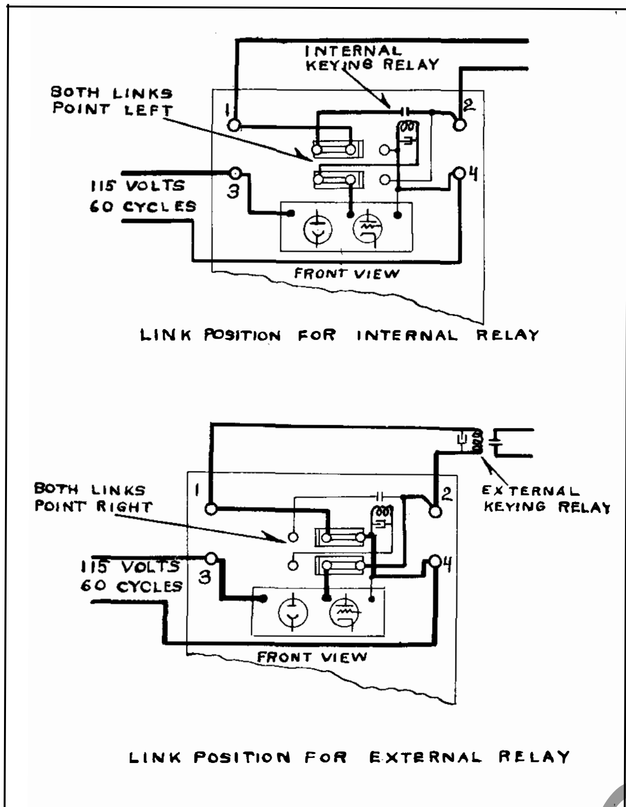


Fig. 4—Link Positions and Schematic Connections for the Keying Relay.

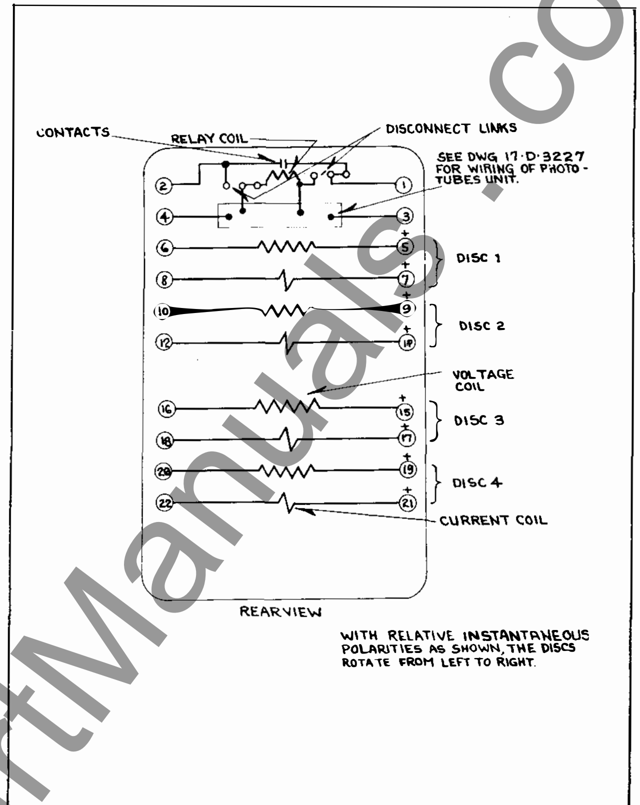


Fig. 5—Internal Schematic of the Type IW Transmitter With Four Single Phase Elements in the Standard Case.

Gear Mesh

The following provision has been made should it be found necessary to adjust the mesh between the pinion of the main disc shaft and the first gear of the mechanism. The lower left mounting point rests on a short hex post of adjustable height. The height of this post determines the mesh. The two upper mounting points rest directly on the meter frame with provision for a slight amount of rocking. By loosening the three screws and lock nut on the hex post, the mesh can be adjusted. Retighten the lock nut and screws.

Care of Motor and Motor Gearing

The motor and shafts of the motor gearing should be oiled every two years. Use Westinghouse oil S#1275575 which may be obtained in 1-oz. bottles.

At the lower end of the motor shaft is an oil cap filled with oil-saturated wool. A small wick carries the oil from the cap to the bearing which is inside the motor core. The lower end of the shaft rests on a jewel in the bottom of the cap. When oiling is necessary, unscrew the cap, fill it about two thirds full of oil and replace.

The intermediate shaft has a bearing similar to that of the motor but does not have the removable oil cap. This bearing can be oiled by lifting out the shaft and placing a few drops of oil in the hole at the top.

The sleeve bearing and hub bearing of the shaft at the shutter disc may be oiled slightly where the hub rests on the bearing post. Sufficient oil will creep down into the sleeve for proper lubrication. The bearing and shaft are made of materials which will not cause objectionable sludging of the oil.

Spark Suppressors for Keying Contacts

The inductive kick of the relays in the keyed circuit may generate voltages sufficiently high to cause objectionable arcing at

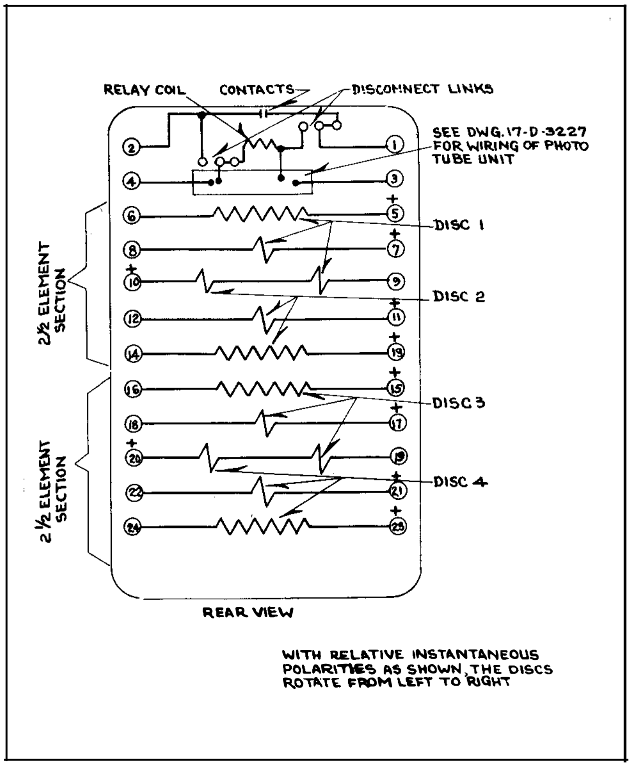


Fig. 6—Internal Schematic of the Type IW Transmitter With Two 2½ Elements in the Standard Case.

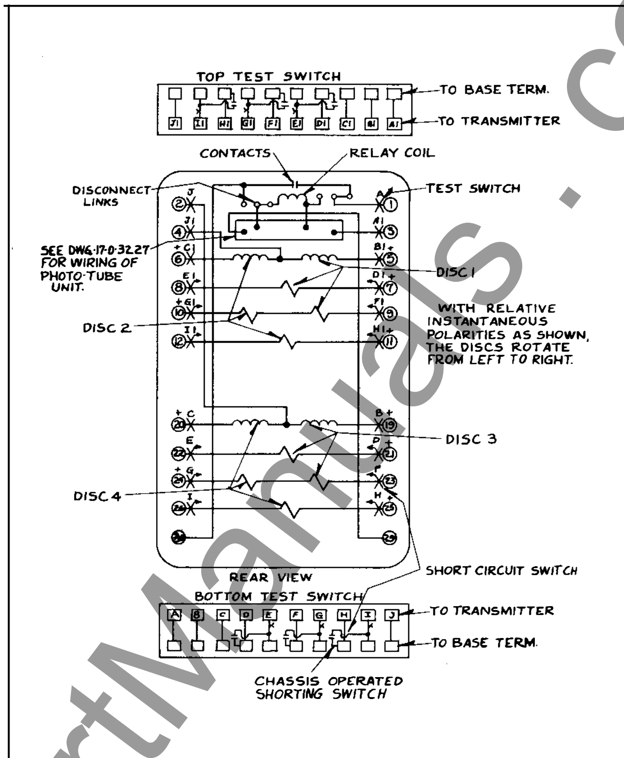


Fig. 7—Internal Schematic of the Type IW Transmitter With Two 2½ Elements in the Type FT Case.

the keying contacts even though the control voltage is too low to cause arcing: hence spark suppressors are frequently used to diminish or kill the arc and prolong contact life.

One common form of suppressor is a condenser and resistor in series connected directly across the contacts. Another form is a shunting resistor connected directly across the coil. The values of the capacity and resistance are best determined by experiment to suit the characteristics of the keyed circuit.

The following applications are here given as a guide:

(a) When keying the relay of a type IM receiver, a suppressor should be used. The IM receiver has a 1500-ohm telephone type relay with 2240-ohm series resistor and requires a 125-volt d-c control circuit. A bright spark is produced at the keying contacts. A suppressor consisting of a 1/2 mfd condenser and 1000-ohm series resistor connected directly across the contacts will kill the spark.

(b) When keying a TV relay no suppressor need be used other than that which is already installed in the relay. There is a shunting resistor connected directly across the coils which absorbs the induced voltage.

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 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.

CHARACTERISTICS

Transmitters must measure the power in a large variety of circuits such as tie lines,

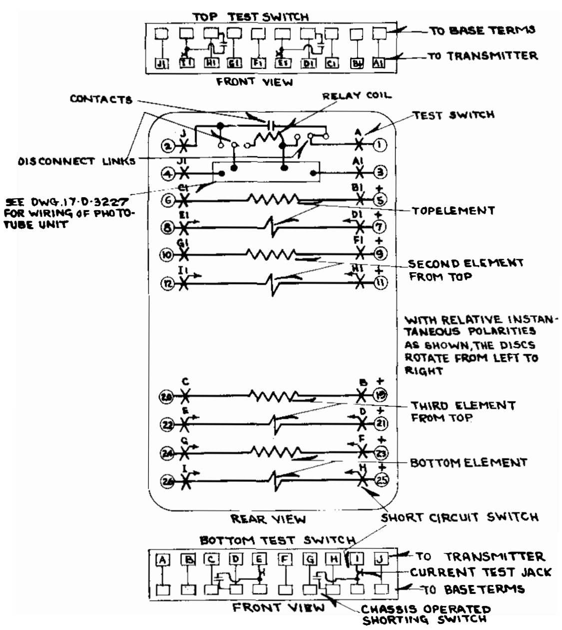


Fig. 8—Internal Schematic of the Type IW Transmitter With Four Single Phase Elements in the Type FT Case.

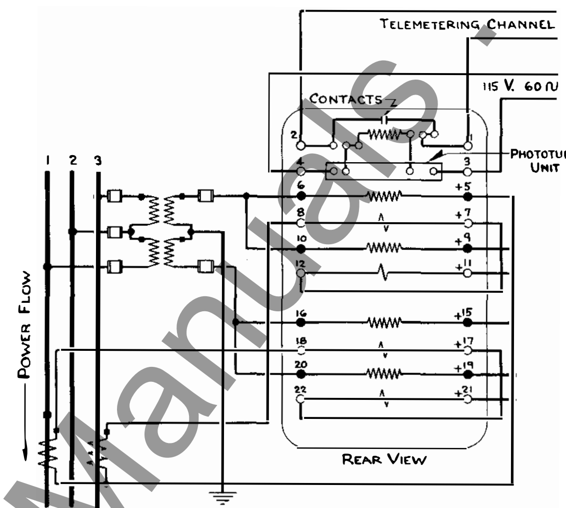


Fig. 9—External Connections of the Four Element Type IW Transmitter in the Standard Case for Totalizing a 3 Phase 3 Wire Circuit with 2 Potential and 2 Current Transformers.

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 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 and impulse rates, for the several scales.

ZERO AT CENTER OF SCALE

Scale Deflection	Left End	Center	Right-End
Disc RPM	-25	0	+25
Imp. per min.	40	120	200

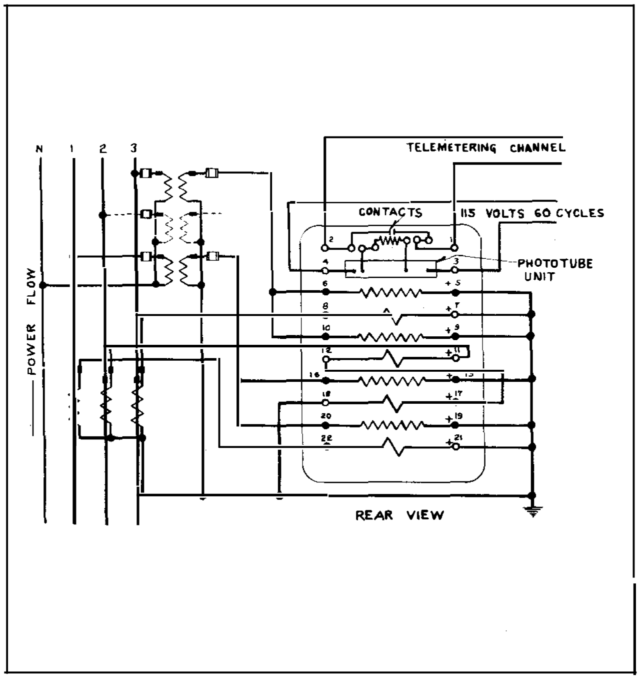


Fig. 10—External Connections of the Four Element Type IW Transmitter in the Standard Case for Totalizing a 3 Phase 4 Wire Circuit With 2 Potential and 3 Current Transformers.

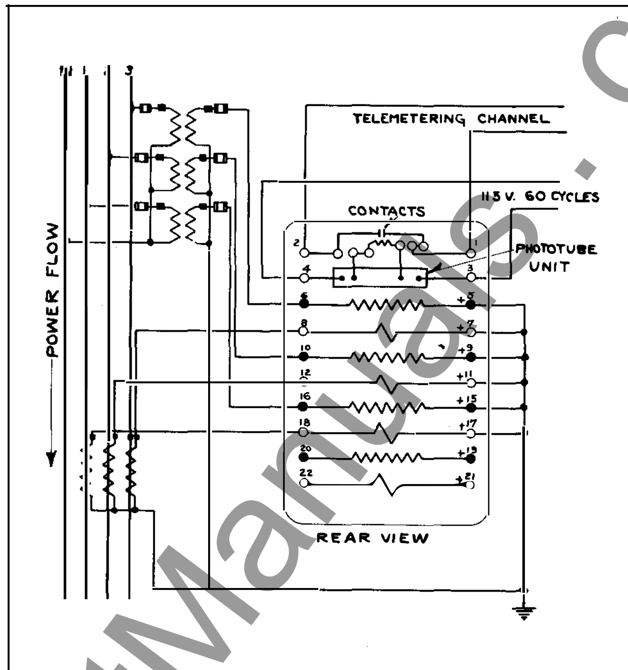


Fig. 11—External Connections of the Four Element Type IW Transmitter in the Standard Case for Totalizing a 3 Phase 4 Wire Circuit With 3 Potential and 3 Current Transformers.

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

ZERO AT LEFT END OF SCALE

Scale Deflection	Left End	Right-End
Disc RPM	0	+25
Imp. per min.	80	220

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of these transmitters 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 taken apart for repairs, or if it is desired to check the adjustments at regular maintenance periods, the instructions below should be followed.

The measuring elements are similar to those used in watthour meter 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 shutter friction has some effect on the light load calibration.

Transmitters which measure power in generating stations 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.

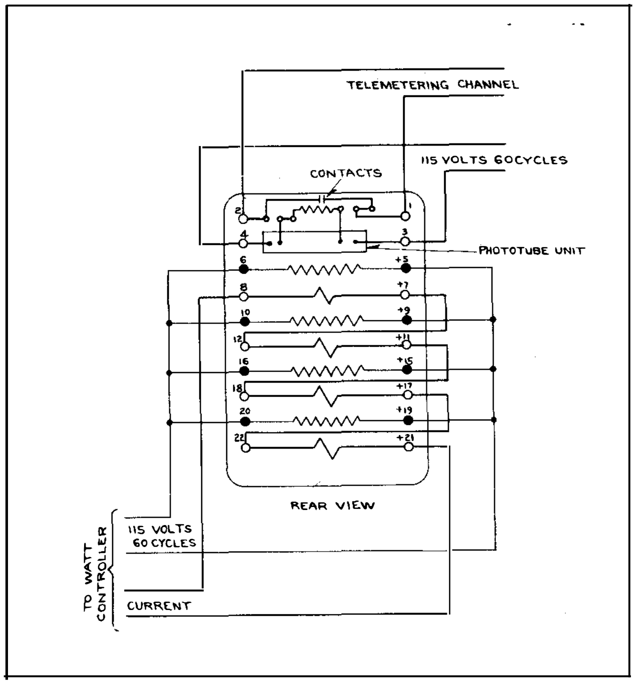


Fig. 12—External Connections of the Four Element Type IW Transmitter in the Standard Case When Used With an Equivalent Watt Controller.

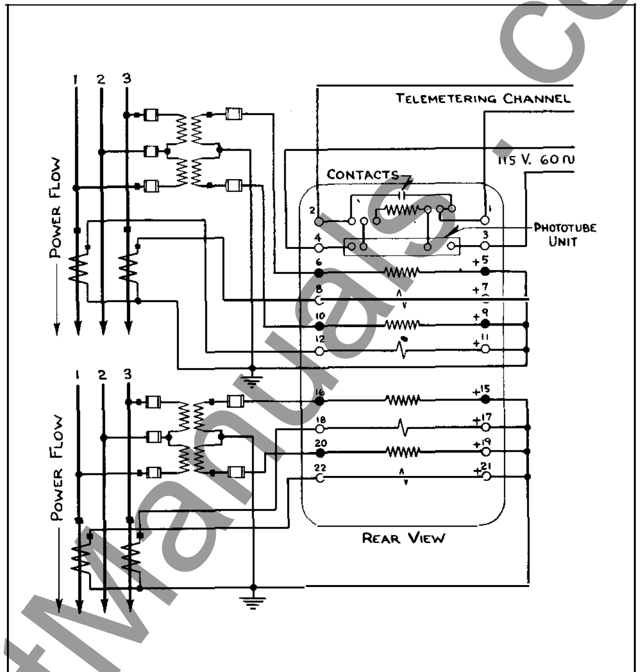


Fig. 13—External Connections of the Four Element Type IW Transmitter in the Standard Case for Totalizing Two 3 Phase 3 Wire Circuits Each With 2 Potential and 2 Current Transformers.

Tie line 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.

Calibration for both directions of rotation must be considered in tie line transmitters, and because of this it will not be possible to set the light load points up to 100% accuracy. However, the light load error is insignificant when read on the scales of the indicating and recording receivers. To illustrate what is meant by this statement, assume a transmitter and receiver have been arranged for a scale range of 30.....0.....30 Megawatts. (Total span of 60 MW). Also assume that the transmitter is operating at a light load of 3 Megawatts with an error of .18 Megawatts slow. In terms of actual load this would be 6% but the accuracy of indicating and recording meters is defined as a percentage of the full scale span, hence the error is $\frac{.18}{60} \times 100 = .3$ of one percent.

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

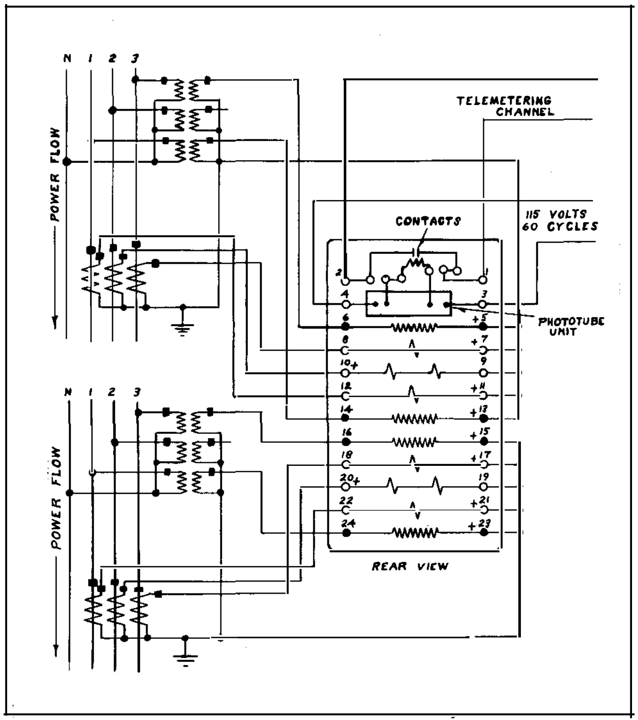


Fig. 14—External Connections of the Two 2½ Element Type IW Transmitter in the Standard Case for Totalizing Two 3 Phase 3 Wire Circuits Each With 2 Potential and 3 Current Transformers.

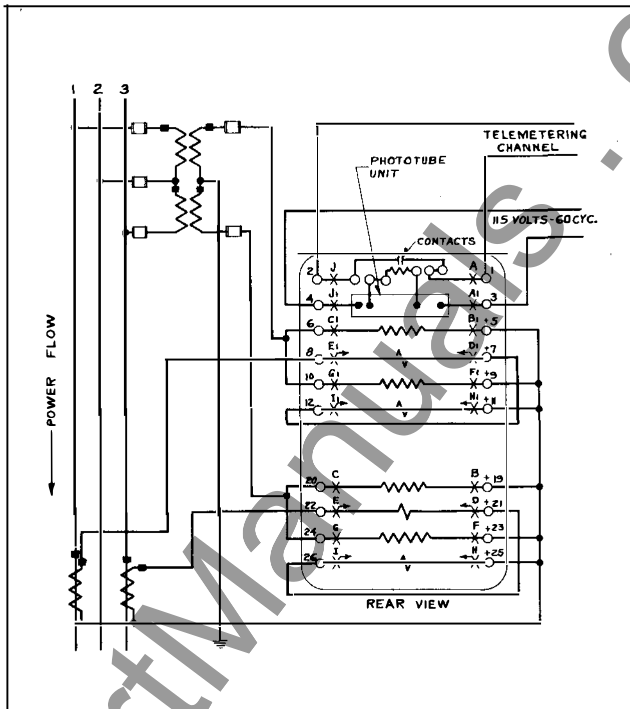


Fig. 15—External Connections of the Four Element Type IW Transmitter in the Type FT Case for Totalizing a 3 Phase 3 Wire Circuit with 2 Potential and 2 Current Transformers.

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:

Overall Transformer ratio =

$$\frac{110,000}{110} \times \frac{200}{5} = 40000$$

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

Hence 1250 three phase wire watts cause disc to run 25 RPM. 1250 watts for one hour consumed 1250 watthours and cause the disc to make 1500 revolutions. The value of one revolution $= \frac{1250}{1500} = \frac{5}{6} = .833$ watthours = secondary K_h

In a similar manner the

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

TRANSMITTERS IN TYPE FT CASE

The type FT cases are dust-proof enclosures combining relay elements 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 three main units of the type FT case: the case, cover and chassis. The case is an all welded steel housing containing the hinge half of the knife-blade test switches and the terminals for external connections. The cover is a drawn steel frame with a clear window which fits over the front of the case with the switches closed. The chassis is a frame that supports the transmitter elements and the contact jaw half of the test switches. This slides in and out of the case. The electrical connections between the base and chassis are completed through the closed knife-blade.

Removing Chassis

To remove the chassis, first remove the cover by unscrewing the captive nuts at the corners. There are two cover nuts on the S size case and four on the L and M size cases. This exposes the transmitter elements and all the test switches for inspection and testing. The next step is to open the test switches. In opening the test switches they should be moved all the away back against the stops With all the switches fully opened, grasp the two cam action latch arms and pull outward. This releases the chassis from the case. Using 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 for the blade portion of the switches can be closed and the cover put in place without the chassis. The chassis operated shorting switch located behind the current test switch prevents open circuiting the current transformers when the current type test switches are closed.

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

Electrical Circuits

Each terminal in the base connects thru a test switch to the transmitter elements 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 transmitter are disconnected from the external circuit by opening the associated test switches Opening the current test switch short-circuits the current transformer secondary and disconnects one side of the transmitter coil but leaves the other side of the coil connected to the external circuit thru the current test jack jaws. This circuit can be isolated by inserting the current test plug (without external connections), by inserting the ten circuit test plug, or by inserting a piece of insulating material approximately 1/32" thick into the current test jack jaws. Both switches of the current test switch pair must be open when using the current test plug or insulating material in this manner to short-circuit the current transformer secondary.

Testing

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

The ammeter test plug can be inserted in the current test jaws after opening the knife-blade switch to check the current thru the transmitter. This plug consists of two conducting strips separated by an insulating strip. The ammeter is connected to these strips by terminal screws and the leads are carried out thru holes in the back of the insulated handle.

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

With all blades in the full open position, the ten circuit test plug can be inserted in the contact jaws. This connects the transmitter elements 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 external test circuits are connected to these binding posts. The plug is inserted in the bottom test jaws with the binding posts up and in the top test switch jaws with binding posts down.

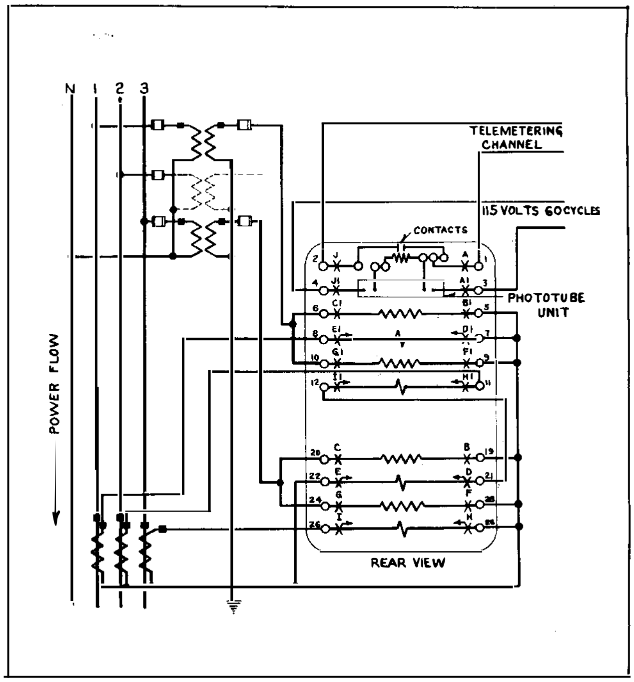


Fig. 16—External Connections of the Four Element Type IW Transmitter in the Type FT Case for Totalizing a 3 Phase 4 Wire Circuit With 2 Potential and 3 Current Transformers.

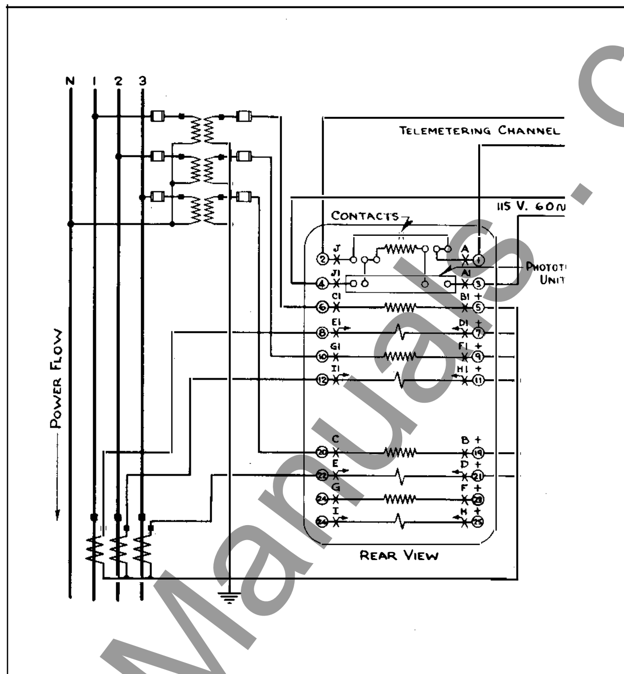


Fig. 17—External Connections of the Four Element Type IW Transmitter in the Type FT Case for Totalizing a 3 Phase 4 Wire Circuit With 3 Potential and 3 Current Transformers.

The external test circuits may be made to the transmitter elements by #2 test clip leads instead of the test plug. When connecting an external test circuit to the current elements that the current test jack jaws are open so that the transmitter is completely isolated from the external circuits. Suggested means for isolating this circuit are outlined above, under "Electrical Circuits".

Testing Out of Case

With the chassis removed from the case relay elements 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 by a small percentage. It is recommended that the transmitter 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 terminal studs furnished with the transmitter for ebony-asbestos or slate apanel 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.

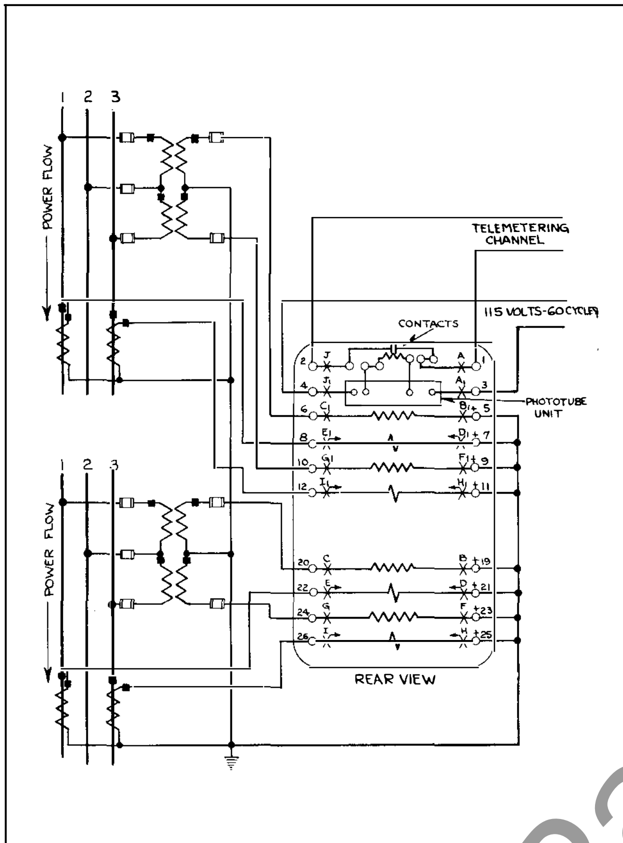


Fig. 18—External Connections of the Four Element Type IW Transmitter in the Type FT Case for Totalizing Two 3 Phase 3 Wire Circuits Each With 2 Potential and 2 Current Transformers.

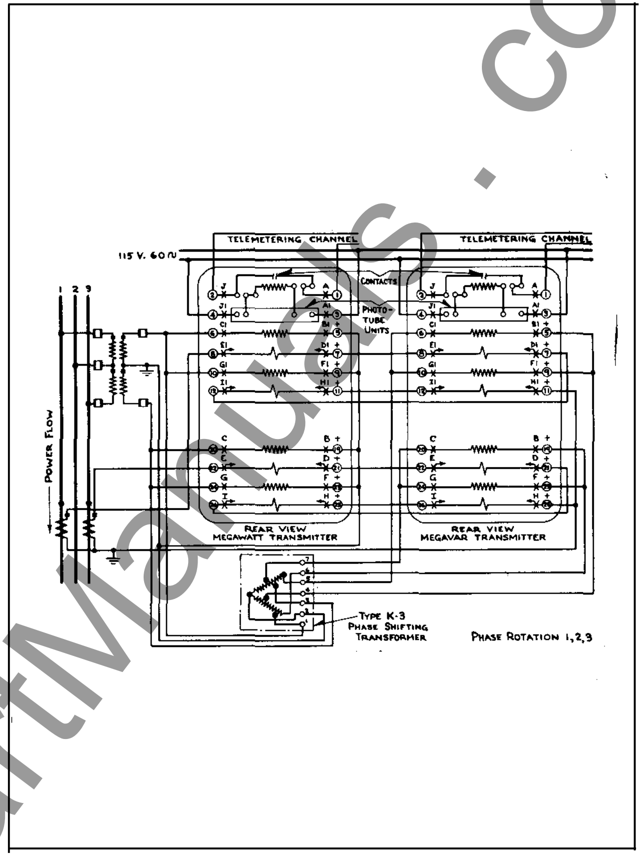


Fig. 19—External Connections of Two Four Element Type IW Transmitters in the Type FT Case and the Type K3 Phase Shifting Transformer for Totalizing Megawatts and Megavars on a 3 Phase 3 Wire Circuit with 2 Potential and 2 Current Transformers.

ENERGY REQUIREMENTS

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

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 photo tube circuit, including the synchronous motor requires 115 volts 60 cycles and draws 105 milliamp., 11 watts.

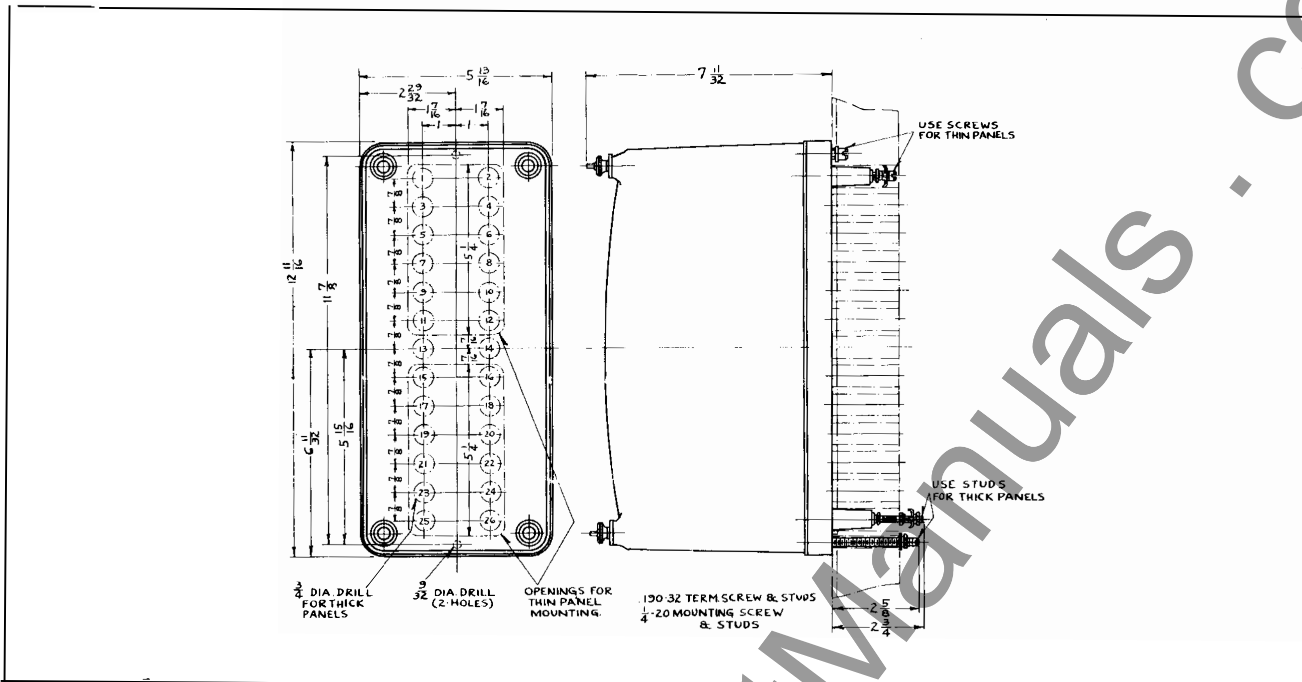


Fig. 20—Outline and Drilling Plan for the Standard Projection Type Case. See the Other Internal Schematic for the Terminals Supplied.

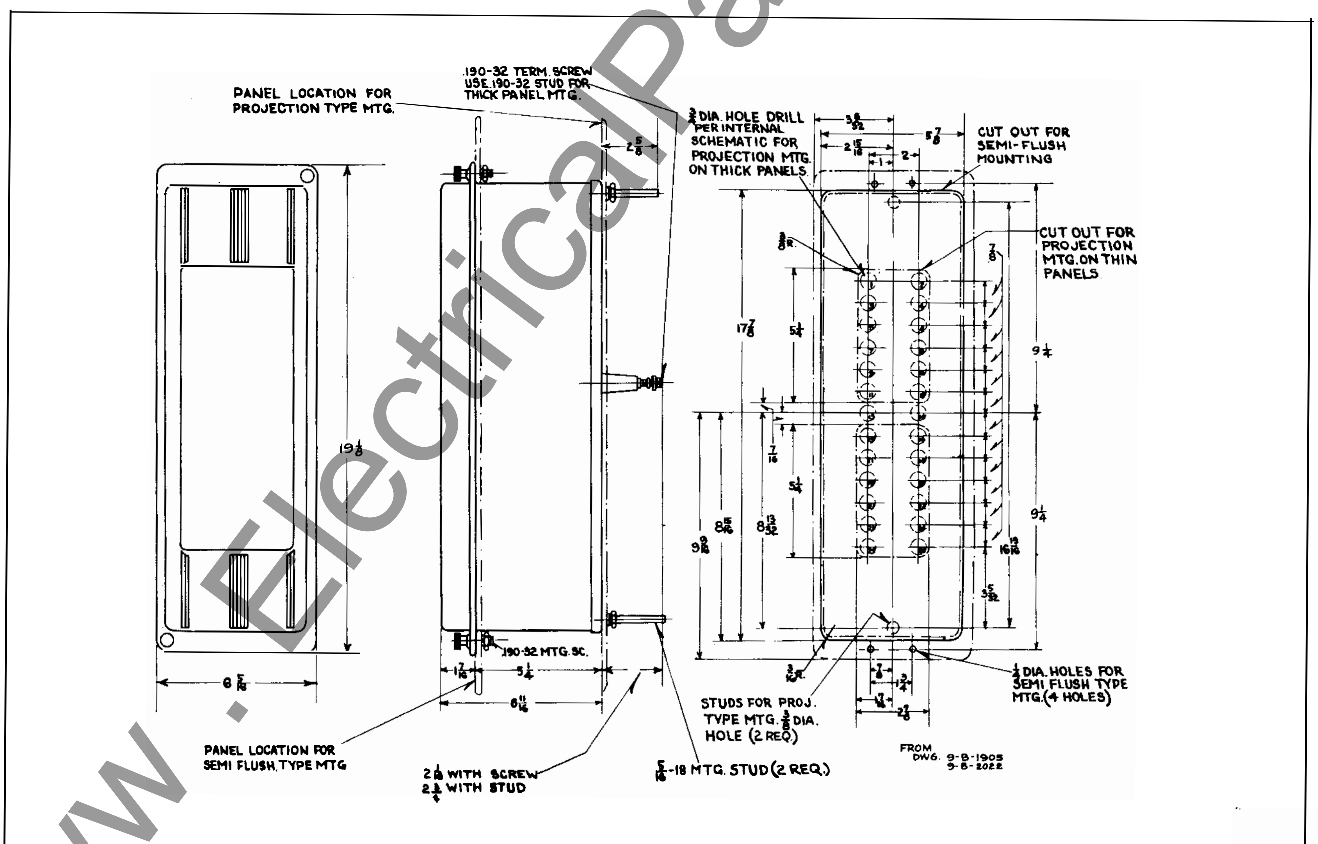


Fig. 21—Outline and Drilling Plan for the M20 Projection or Semi-Flush Type FT Case. See the Internal Schematics for the Terminals Supplied.

WESTINGHOUSE ELECTRIC CORPORATION

METER DIVISION • **NEWARK, N.J.**

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