GEH-764AB
Supersedes GEH-764AA

INSTRUCTIONS

Polyphase Switchboard Watthour Meters

TYPES DS-19, DSW-19, DSM-19, DS-20, DSW-20
DSM-20, DS-34, DSW-34, DSM-34, DS-35
DSW-35, DSM-35, DS-38, DSW-38, DSM-38
DS-39, DSW-39, DSM-39, DS-40, DSM-40
DSW-40, DS-41, DSW-41, DSM-41, DS-43
DSW-43, DSM-43, DS-44, DSW-44, DSM-44

GENERAL ELECTRIC

TYPES COVERED

TWO-ELEMENT CONSTRUCTION

- DS-19, DSW-19, DSM-19 (Surface Mounting)
- DS-34, DSW-34, DSM-34 (Semiflush Mounting)
- DS-38, DSW-38, DSM-38 (Drawout, Semiflush Mounting)
- DS-40, DSW-40, DSM-40 (Drawout, Surface Mounting)
- DS-43, DSW-43, DSM-43 (Drawout, Semiflush or Surface Mounting)

THREE-ELEMENT CONSTRUCTION

- DS-20, DSW-20, DSM-20 (Surface Mounting)
- DS-35, DSW-35, DSM-35 (Semiflush Mounting)
- DS-39, DSW-39, DSM-39 (Drawout, Semiflush Mounting)
- DS-41, DSW-41, DSM-41 (Drawout, Surface Mounting)
- DS-44, DSW-44, DSM-44 (Drawout, Semiflush or Surface Mounting)

POLYPHASE

SWITCHBOARD WATTHOUR METERS

The Types DS-19, DS-34, DS-38, DS-40, and DS-43 meters are back-connected, switchboard, two-stator, polyphase meters. The DS-20, DS-35, DS-39, DS-41, and DS-44 are the corresponding three-stator meters.

The above meters can be furnished self-contained in current capacities of 5 and 10 amperes and for voltages up to 600 volts. Transformer-rated meters can be furnished for use with both current and potential transformers or with current transformers only.

The meters are called Types DSW-19, DSW-34, DSW-38, DSW-40, DSW-43, and DSW-20, DSW-35, DSW-39, DSW-41, and DSW-44 when they are equipped with contact device terminals and 2-wire or 3-wire contact devices. Separate instructions covering the contact devices accompany such meters.

The meters are known as Types DSM-19, DSM-34, DSM-38, DSM-40, DSM-43, and DSM-20, DSM-35, DSM-39, DSM-41, and DSM-44 watthour demand meters when they are equipped with demand meter registers. Separate instructions covering the register and containing supplementary diagrams and dimensions accompany these watthour demand meters.

INSTALLATION

The DS-19 and DS-20 polyphase watthour meters are designed for surface mounting and are equipped with two studs for this purpose at the top center and bottom center of the case.

The DS-34 and DS-35 meters are the corresponding polyphase watthour meters available for semiflush mounting. The meter is mounted through the panel with the flange against the front of the panel. Holes in the flange will accomodate mounting bolts or screws $\frac{3}{16}$ in. in diameter. No other support is necessary.

The DS-38, DS-39, DS-40, and DS-41 meters are similar to the DS-34, DS-35, DS-19, and DS-20 respectively, but provide the additional advantage of a drawout construction. The case for these meters may be mounted and wired permanently before the meter unit is placed in the case. The meter unit is then installed by aligning it with the guides in the case and sliding into place. The connecting plug is next inserted completing the electric circuits through the meter and locking the latch on the cradle. The cover is drawn to the case by four thumb-screws, holding the connecting plug in place.

The DS-43 meter is the latest model drawout switchboard two-stator, polyphase meter. It supersedes the DS-38 and DS-40 meters, and is so designed that it may be used either for surface or semi-flush mounting. The DS-44 meter is the corresponding three-stator meter replacing the DS-39 and DS-41 meters and is also designed for use either for surface or semiflush mounting. Screws for semiflush mounting are inserted from the back of the panel into threaded bosses on the mounting flange. Screws and bosses are hidden by the cover. An assortment of hardware providing for any type of mounting (semiflush, surface, metal or insulating panel), and either type of connection (threaded stud with nuts and flat washers or washer head screw with prong washer) accompanies each meter.

The proper dimension sketch given in this book should be followed for switchboard drilling. The meters have jewel bearings which may be injured by rough handling; consequently all wiring and hammering should be done on the switchboard before the meters are installed.

The meters have removable studs and are shipped with the studs removed.

Before placing the meter in service, remove the shipping device and make sure that the meter is perfectly clean and in good operating condition.

The meters are tested before shipment and only require connecting and sealing before being placed in operation.

SEALING

The cover is held in position by sealing screws, four on the drawout cases and two on all other meters. The screws have knurled heads to permit tightening with the fingers and are slotted to take all standard types of sealing devices. When assembling the cover on the meter, make sure that the edges enter the recess in the meter base properly. The sealing screws should not be tightened any more than necessary to produce a slight compression of the felt gasket in the recess in the meter base.

CONNECTIONS

The connection diagrams in this book show approved methods of wiring the apparatus. Other methods are possible which are electrically equivalent and which for particular installations may result in more convenient or economical wiring. If properly connected in the circuit, the disk will rotate counterclockwise, viewed from above.

Connections for the DSM and DSW type meters are identical to those for the DS type meters except for the register motor connections for the DSM and the contact device terminal connections for the DSW line of meters.

The current terminals are identified by the letter C, the potential terminals by the letter P and the contact device terminals by the letters K, Y, and Z. These three terminals and studs are furnished whether the meter has 2-wire or 3-wire contact devices. For 2-wire contact devices only K and Z are connected, while for 3-wire contact devices all three are used. Letters identifying the terminals are stamped on the base.

It is frequently desirable to use transformers in circuits of over 150 volts. The cases of meters which are used with current and potential transformers should be connected to the grounded side of the secondary circuit of such transformers. For this purpose No. 12 Awg copper wire is suitable.

At the earth end of the wire the usual precautions employed in connection with lightning arresters should be followed.

POLARITY MARKINGS

Instrument transformers have polarity markings of white paint or markers, H_1 for primary and X_1 for secondary, on or near one primary and one secondary terminal. These markings denote the relative polarity and facilitate making proper connections for correct direction of rotation of watthour meters. The relation of the marked leads is such that the instantaneous direction of the current in them is the same; namely, toward the transformer in the marked primary lead and from the transformer in the marked secondary lead, or vice versa. These polarity markings are indicated in the connection diagrams and should be followed irrespective of their physical location on the transformers.

POTENTIAL INDICATING LAMPS

Meters are furnished with potential circuit indicating lamps and have special potential coils with an auxiliary winding connected to these lamps as illustrated in Fig. 14.

METERS FOR USE WITH CURRENT TRANSFORMERS

In order to utilize effectively the accuracy of these meters, 2.5-ampere meters are used with instrument current transformers. The current coils have double the normal turns of the standard 5-ampere meter. The torque is therefore double, and affords the advantages inherent in such high-torque characteristics and with practically no sacrifice in accuracy throughout the working range.

Under no conditions should the current circuits of a transformer-rated meter be opened without first short-circuiting the secondary winding of the current transformer. This may be done either at the transformer terminals or the meter current terminals. Removal of the connection plug in drawout type meters automatically short-circuits the current terminals so that the meter unit can safely be removed from the case.

CALIBRATING ADJUSTMENTS

The letters S and F and the arrows on the retarding magnets denote the proper direction to turn all adjusting screws for calibrating the meter.

Full Load

Full-load adjustment is accomplished by movable permanent magnets.

The two magnets in the two-stator meter and the three magnets of the three-stator meter may be placed in an approximately correct position and clamped.

A change in the position of any magnet affects all stators alike. Moving the magnet in will increase the speed of the meter, while conversely, moving the magnet out will decrease the speed of the meter. When the proper adjustment has been obtained, the magnet should be clamped securely to its support by means of the clamping screw.

To facilitate the clamping of the magnets, hexagonal head screws are provided which are easily turned with a wrench. *Do not use special open-end wrenches for this purpose. They are not strong enough.*

Light Load

The brackets supporting the lag and light load plates are attached to the frame. The one for the upper stator is located just under the disk and the one for the lower stator, and the middle and lower in three-stator meters, is just over the disk.

The light-load adjustment is made by turning the adjusting screw located at the extreme right of the bracket. Turning the screw counterclockwise increases the speed of the meter and clockwise decreases it. The screw at the extreme left of the bracket should not be disturbed.

The effect of light-load adjustment varies inversely with the load. For example, a 5 per cent change at 1/10 full-load current changes the calibration at full-load current approximately 0.5 per cent.

INDUCTIVE LOAD (WATTHOUR STATORS)

The inductive-load adjustment is made by turning the screw located to the left of the light load adjusting screw. Turning the screw counterclockwise increases the speed of the meter and clockwise decreases it.

If the lag plate is moved, full and light load should be checked.

Meters furnished for 25- and 30-cycle service sometimes are provided with an adjustable compensating coil. The purpose of this coil is to give additional range of adjustment for calibrating the meter at inductive loads.

The two ends of the figure-eight compensating coil are extended beyond the meter stator and are connected by an adjustable slider soldered in position. The wires are covered with insulation tubing and both slider and wires are protected by an outer sleeving. These adjustable ends of the coils are located along the edge of the back side of the meter frame.

These meters are adjusted in the factory so that the front screw adjustment for inductive loads provides a range sufficient for most conditions of operation. Should it be necessary to change this range, its limits can be raised or lowered by means of the adjustable compensating coil. The procedure is outlined below:

1. Remove the outer sleeving and inner insulation tubing, unsolder the sliding connector and move it to the desired position.

Move the connector away from the stator to increase the speed of the meter and toward the stator to decrease it.

2. Resolder the connector carefully in its new position.

Allow the connector and wires to cool to room temperature before checking the meter, so its calibration will not be affected by the increased resistance of the coil due to heating.

3. When the connector has been set in its final position, reinsulate the wires with the proper tubing and replace the outer protective sleeving. Care should be taken to locate the butt joints in the tubing so they are not opposite each other or a section of bare wire.

Adjustments Between Stators

Equalizing the torque of the stators may be accomplished from the front of the meters and without disturbing any of the parts.

The meter stators are balanced at the factory, but if it is necessary to make any change loosen the lock nut, turn the adjusting screws an equal amount in the same direction, then tighten the lock nut. Turning clockwise decreases and counterclockwise increases the torque of the stator.

READING THE METER REGISTER

The meter register is of the dial type and is normally furnished with a register ratio so that it reads in primary kilowatt-hours.

On meters measuring a large amount of power and equipped with a "primary-reading" register a dial-face multiplier is printed below the dials.

For a "secondary-reading" register the actual reading must be multiplied by a constant which is the ratio of primary energy to secondary energy, that is, usually the product of the current and potential transformer ratios of the instrument transformers used with the meter.

Facing the meter, one revolution of the extreme right pointer equals 10 kilowatt-hours; one revolution of the second, 100 kilowatt-hours, etc., except in the case of meters which have a dial-face multiplier.

One division of a circle, it will be seen, corresponds to one tenth of the total amount indicated by one complete revolution of the pointer.

In deciding upon the reading of a pointer, the pointer before it (to the right) must be consulted. Unless the pointer has reached or passed the "0" or, in other words, completed a revolution, the other has not completed the division on which it may appear to rest. For this reason ease and rapidity are gained by read-

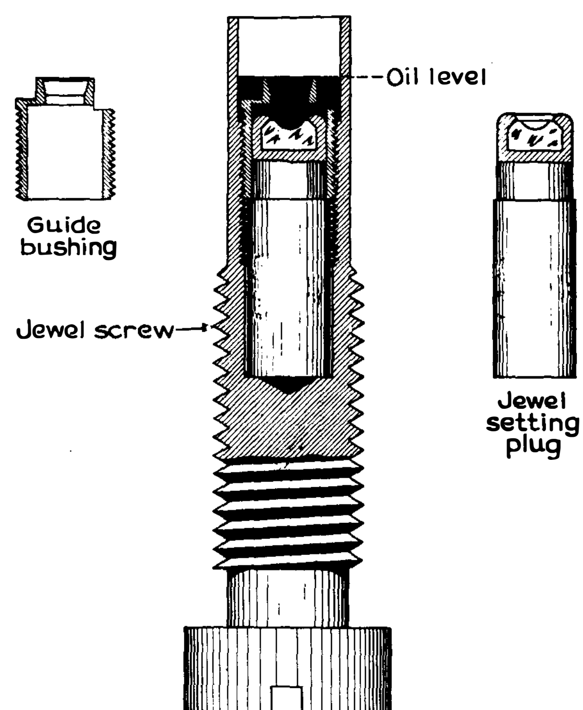


Fig. 1. Oiltight jewel screw

ing the meter register from right to left.

The test constant marked on the nameplate or disk is for use only in calibrating and checking the meter and must not be used in connection with the register reading.

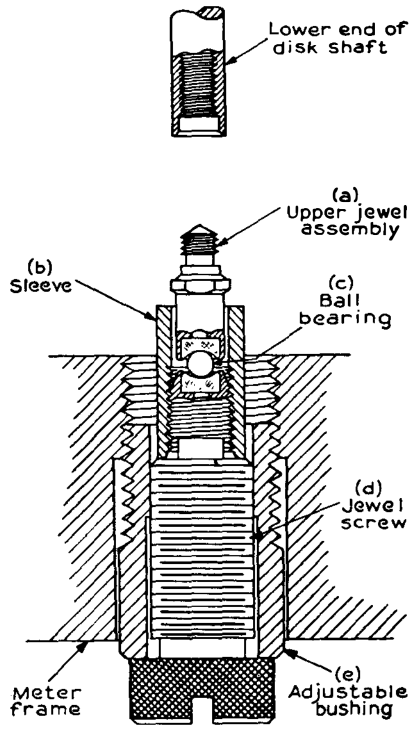


Fig. 2. Open-type ball bearing

MAINTENANCE

Bearings

The lower bearing may be one of two forms as follows:

a. The oiltight jewel-pivot bearing.
b. The open-type ball bearing.

The oiltight jewel-pivot bearing, Fig. 1, consists of a jewel assembled within an adjustable bushing at the bottom of the meter frame, and a pivot which is screwed into the lower end of the disk shaft.

The open-type ball bearing consists of a ball held between an upper and lower jewel and protected with a sleeve as shown in Fig. 2.

The upper bearing consists of a guide pin mounted in an adjustable top-bearing plug and a guide bushing set into the tip of the disk shaft.

1. Lubrication of Oiltight Jewel-pivot Bearing

All jewels shipped from the factory in meters are properly lubricated. Since meters may be stored for indefinite periods before use and since the length of time between tests is increasing, it is recommended that all jewels be examined for proper oil level before the meter is placed in service and that General Electric Watthour Meter Jewel Oil be added, if required, to raise it to the level indicated in Fig. 1. It is not always necessary to disassemble the jewel screw for a second oiling, as there is little chance for the oil in the reservoir to be lost.

Jewels shipped separately as supplies are not oiled at the factory and must therefore be oiled before they are installed in meters.

The following directions for initial oiling of the Oiltight Jewel Screw are given with reference to Fig. 1:

a. Remove the guide bushing by means of the combination jewel-and-pivot wrench.
b. Invert the screw and allow the jewel-setting plug to drop out. If the plug does not drop out readily, gently tap the head of the screw.
c. By means of a wire-loop oil applicator, put two drops of G-E Watthour Meter Jewel Oil in the reservoir of the jewel screw. Allow a short time for the oil to run to the bottom of the reservoir. It is necessary that this reservoir under the jewel plug be filled.
d. Drop the jewel plug in the screw.
e. Replace the guide bushing and screw it down tightly.
f. Put in another drop of oil which will run down through the oil slot of the guide bushing into the jewel cup.
g. Inspect the oil level, which should be as shown in Fig. 1. Because of minor variations in mechanical dimensions of the reservoir or variation in size of the drops obtained from the wire loop, three drops of oil cannot always be taken as the correct amount. If more is needed to fill to the right level, it should be added.

The pivots require no lubrication other than that obtained from properly oiled jewel screws.

The top-bearing assembly should require no attention during the normal life of the meter.

2. Replacement of Oiltight Jewel-pivot Bearing

At each test period the jewel screw should be removed, inspected for oil level, and re-oiled with G-E Wattthour Meter Jewel Oil if necessary.

If a meter requires a new lower bearing, both the pivot and jewel should be changed. Pivots are injured by operation in badly worn or damaged jewels.

The following procedure is recommended for replacement of a pivot and jewel:

a. Loosen the top-bearing clamping screw so that the bearing plug is free to move.
b. Remove the jewel screw from its adjustable bushing. Do not disturb the setting of this

bushing since it is adjusted at the factory to provide proper clearance of the meter disk in the magnet GAP when the jewel screw is screwed completely into it.

c. Insert the pivot-wrench end of a combination jewel-and-pivot wrench through the jewel-screw hole. Engage the pivot and unscrew.

d. Replace with a new pivot.

e. Disassemble the jewel screw, replace the jewel-setting plug with a new one, reassemble and re-oil according to instructions given previously.

f. Assemble the repaired jewel screw, or a new one, screwing it into the adjustable bushing as far as it will go.

g. Should the disk need adjusting for proper clearance in the retarding magnet gap, this may be accomplished by loosening the clamping screw of the guide bushing and moving the guide bushing and jewel-screw assembly up or down as desired.

h. Reset the top bearing by pushing the disk of the moving element up against the top of the retarding magnet gap and the electrical stator gap, and then tightening the top bearing clamping screw. This gives the proper setting for the top bearing, and it is recommended that this be followed.

3. Lubrication of Open-type Ball Bearing

It is recommended that no lubrication be used with this type of meter bearing.

4. Replacement of Open-type Ball Bearing

If the meter requires a new jewel, the following procedure, with reference to Fig. 2, is recommended for replacement of an open-type ball bearing.

a. Loosen the top bearing clamping screw so that the bearing plug is free to move.

b. Remove the jewel screw from its adjustable bushing. Do not disturb the setting of this bushing since it is adjusted at the factory to provide proper clearance of the meter disk in the magnet gap when the jewel screw is screwed completely into it.

c. Insert the special jewel-assembly wrench, Cat. No. 4131823, through the jewel-screw hole. Engage the upper jewel assembly and unscrew.

d. Replace upper jewel assembly.

e. Replace lower jewel assembly with a new assembly and ball. Check to insure that sleeve (b) is tight on the jewel screw (d).

f. Carefully screw the lower jewel screw into the adjustable guide bushing (e) in the watthour meter frame, as far as it will go.

g. Should the disk need adjusting for proper clearance in the retarding magnet gap, this may be accomplished by loosening the clamping screw of the guide bushing and moving the guide bushing and jewel-screw assembly up or down as desired.

h. The top bearing should then be reset by pushing the disk of the moving element up against the top of the retarding magnet gap and the electrical driving stator gap, and tightening the top bearing clamping screw. This gives the proper setting for the top bearing, and it is recommended that this be followed.

Register

The register dial face may be cleaned by the use of a cloth moistened slightly in water.

When replacing a register, carefully inspect the mesh of its wormwheel with the worm on the disk shaft to see that it is approvimately 1/3 to 1/2 the length of tooth of the register wormwheel. If not, a means for its adjustment is provided in the eccentric adjusting screw in the bracket on the back of the register. Avoid meshing too deeply, which might cause friction and effect the accuracy of the meter.

The use of oil on the bearings of watthour meter registers is not recommended.

Refer to separate Instructions for proper care of the demand registers used on Types DSM-19, -20, -34, -35, -38 to -41 incl., -43, and -44 meters.

Stators

In case a potential or current coil is damaged the entire stator should be replaced.

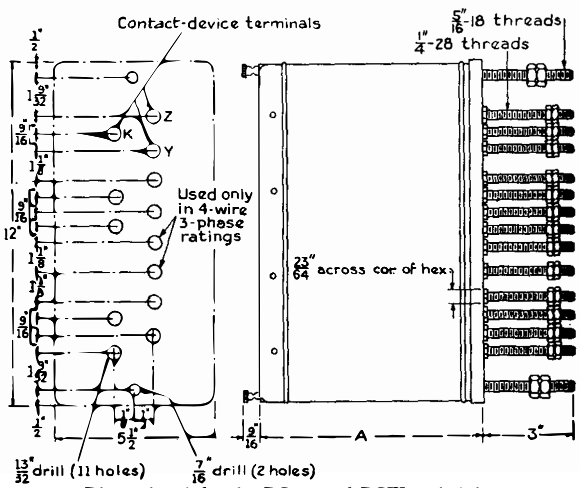
TEST CONSTANT

The watthour constant, or the watthours per revolution of the meter disk, is marked on the nameplate or disk. In the case of transformer-rated meters, the K_h is the over-all constant for the meter with its transformers. The "Test K" on the nameplate, however, is the watthour constant to be used when testing the meter without its transformers.

TESTING

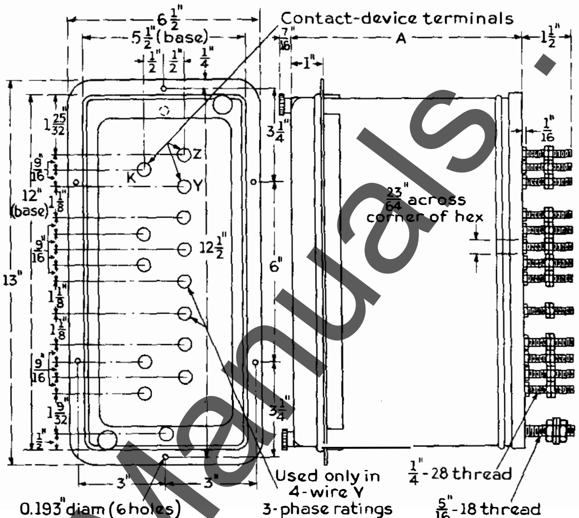
All electric central station companies should be equipped for periodic meter calibration. One method of making such tests is by the use of a reliable timing device and indicating instruments. Although there is no question regarding the accuracy of this method, the portable watthour-meter standards manufactured by the General Electric Company provide a means for testing more quickly, yet accurately and independently of load variations. Instructions for testing watthour meters accompany each portable standard. Copies may also be obtained on application to the General Electric Company.

OUTLINE AND MOUNTING DIMENSIONS



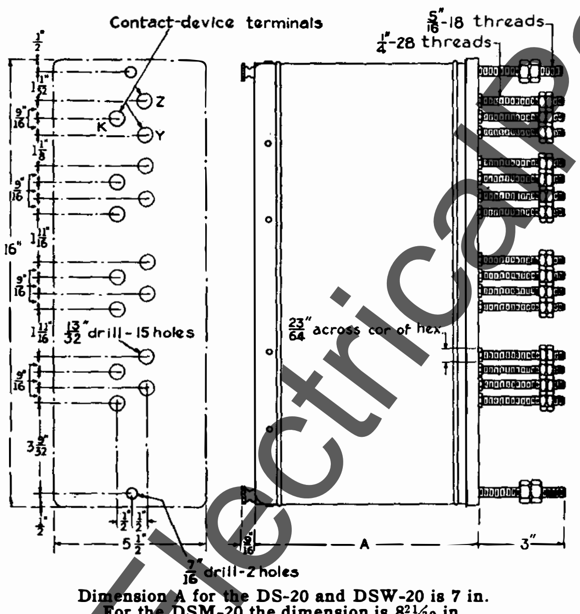
Dimension A for the DS-19 and DSW-19 is 7 in.
For the DSM-19 the dimension is $8^{21}/_{32}$ in.

Fig. 3. Dimensions and front-view drilling plan for Types DS-19, DSW-19, and DSM-19
See notes 1, 2 and 3 below



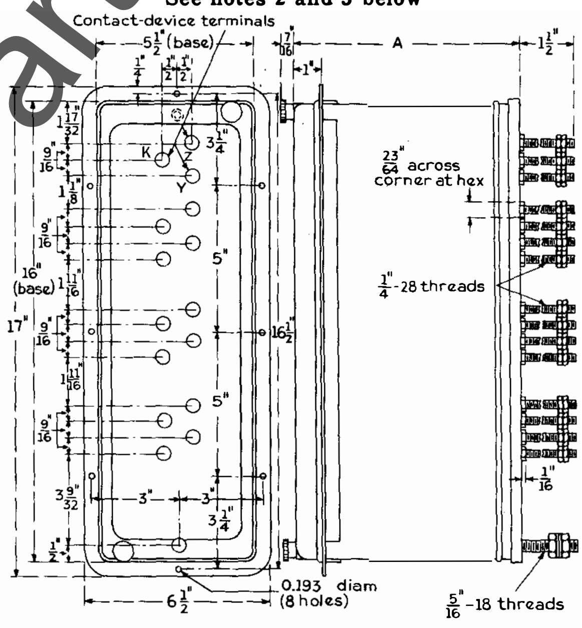
Dimension A for the DS-34 and DSW-34 is 7 1/8 in.
For the DSM-34 the dimension is $8^{11}/_{16}$ in.

Fig. 4. Dimensions for Types DS-34, DSW-34, and DSM-34
See notes 2 and 3 below



Dimension A for the DS-20 and DSW-20 is 7 in.
For the DSM-20 the dimension is $8^{21}/_{32}$ in.

Fig. 5. Dimensions and front-view drilling plan for Types DS-20, DSW-20, and DSM-20
See notes 1, 2 and 3 below



Dimension A for the DS-35 and DSW-35 is 7 1/8 in.
For the DSM-35 the dimension is $8^{11}/_{16}$ in.

Fig. 6. Dimensions for Types DS-35, DSW-35, and DSM-35
See notes 2 and 3 below

NOTES: 1. When Types DS-19, DS-20, etc. meters are mounted on steel panels, using insulating bushings and washers, drill 5/8 in. clearance holes for all studs, except the two mounting studs.

2. Contact-device terminals K, Y, and Z are furnished for Types DSW-19, -20, -34, and -35 only. For 25-cycle ratings of Types DSM-19, -20, -34, and -35 above 280 volts (Y voltage for DSM-20 and -35) two extra terminals K and Z are furnished.

3. For Types DSM-19, -20, -34, and -35 the dimensions do not show the reset device on the front of the cover, which protrudes out 1/2 in. or 3/4 in., depending on the type of demand register.

OUTLINE AND MOUNTING DIMENSIONS

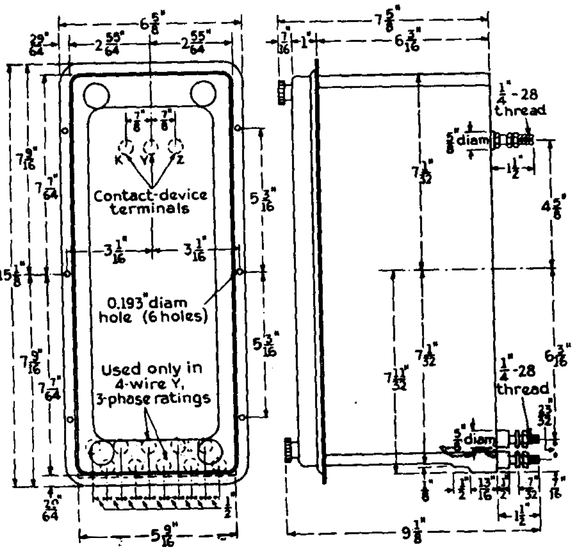


Fig. 7. Dimensions for Types DS-38, DSW-38, and DSM-38
See notes 2 and 3 below

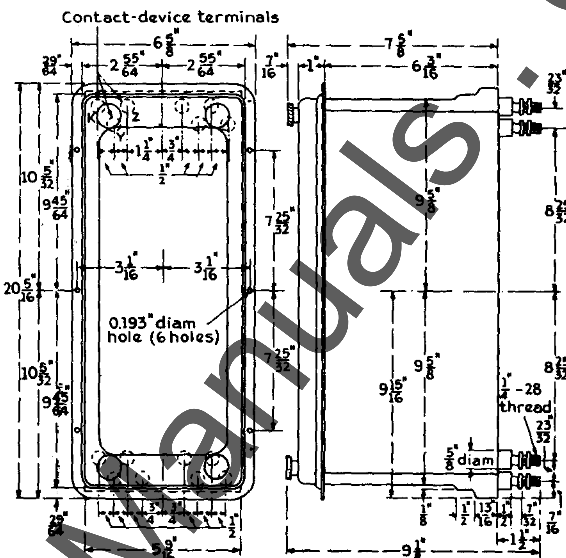


Fig. 8. Dimensions for Types DS-39, DSW-39, and DSM-39
See notes 2 and 3 below

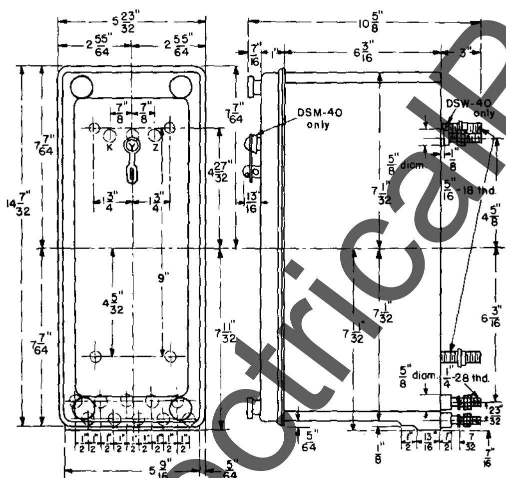


Fig. 9. Dimensions for Types DS-40, DSW-40, and DSM-40
See notes 1, 2 and 3 below

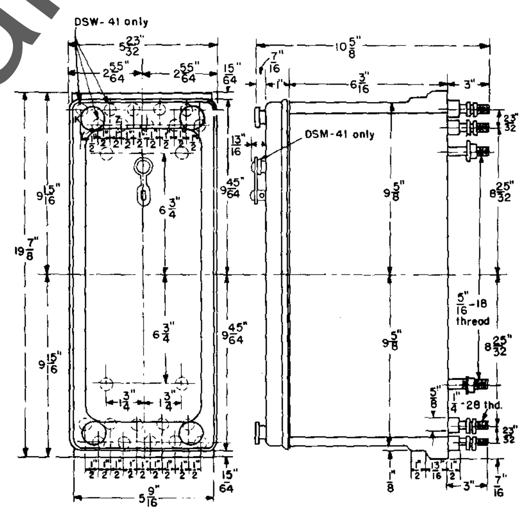


Fig. 10. Dimensions for Types DS-41, DSW-41, and DSM-41
See notes 1, 2 and 3 below

NOTES:
1. When Types DS-40, DS-41, etc., meters are mounted on steel panels, using insulating bushings and washers, drill $\frac{11}{16}$ in. clearance holes for all stud *Textolite projection whether or not studs are used at that location. Drill $\frac{21}{64}$ in. clearance holes for the four mounting studs.
2. Contact-device terminals K, Y, and Z are turnished for Types DSW-38, -39, -40, and -41 only. For 25-cycle ratings of Types DSM-38, -39, -40, and -41 above 280 volts (Y voltage for DSM-39 and -41) two extra terminals K and Z are furnished.
3. For Types DSM-38, and -39, the dimensions do not show the reset device on the front of the cover, which protrudes out ½ in. or ¾ in., depending on the type of demand register.

* Reg. U.S. Pat. Off.

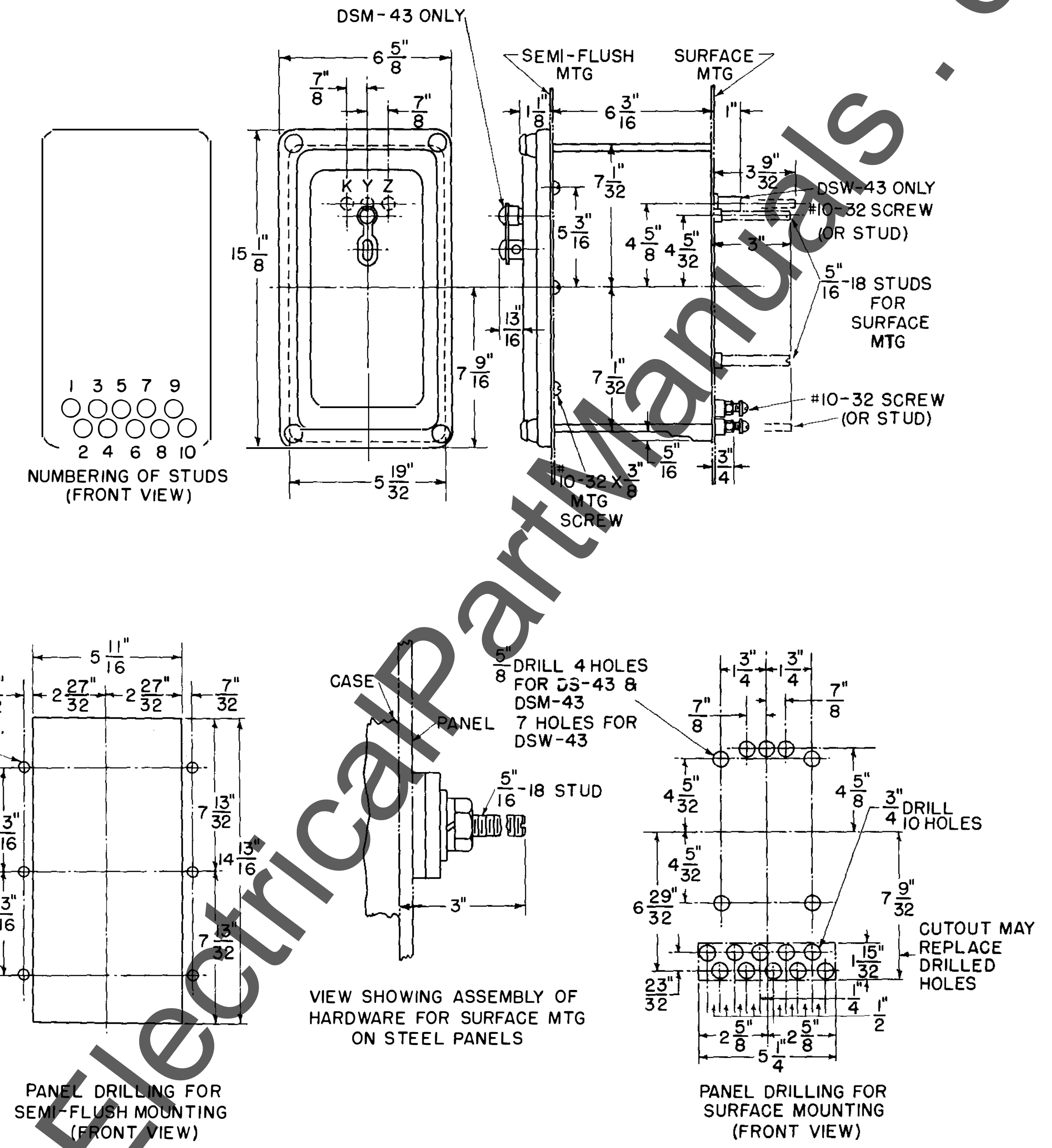


Fig. 11. Dimensions for Types DS-43, DSW-43, and DSM-43

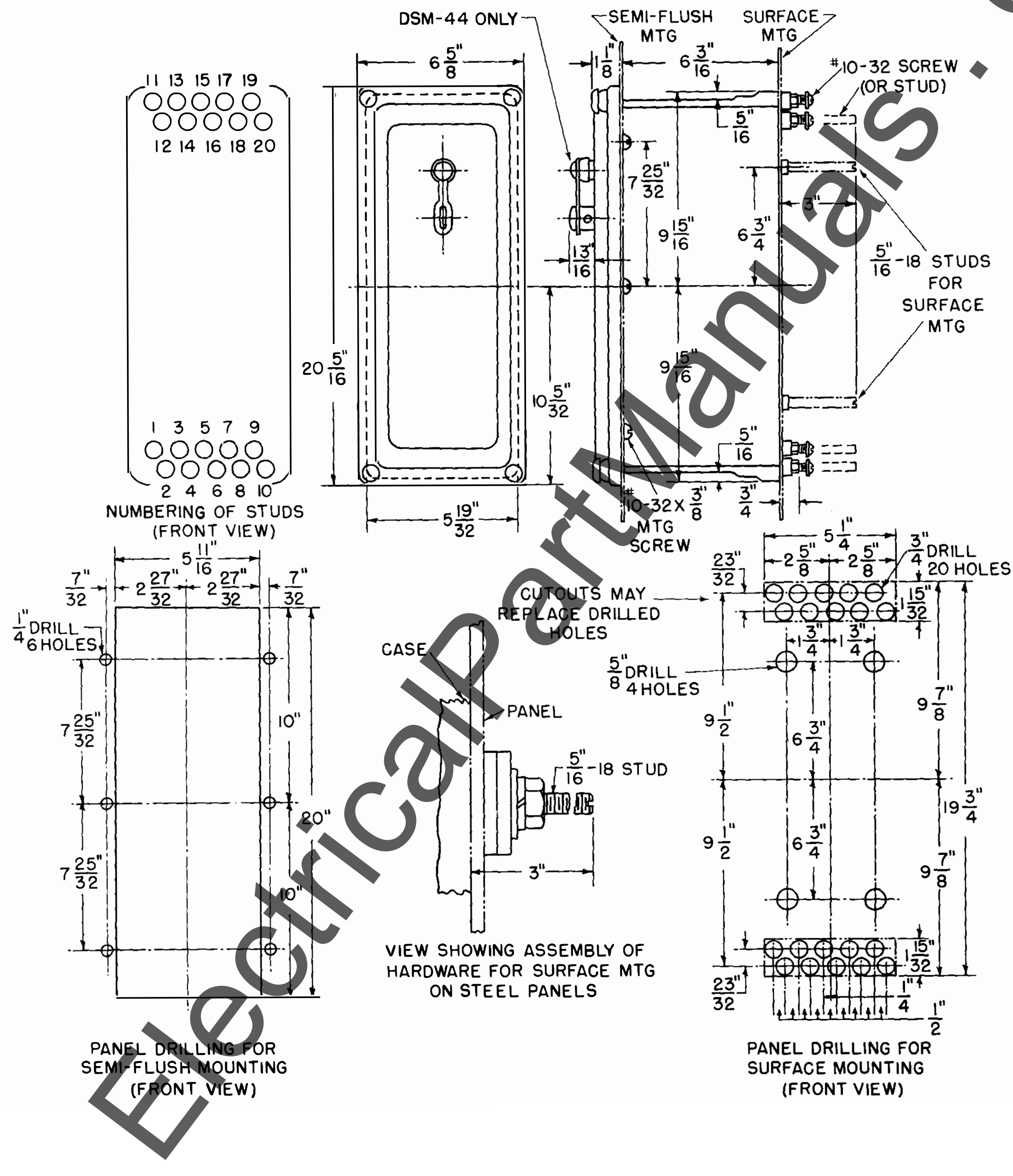
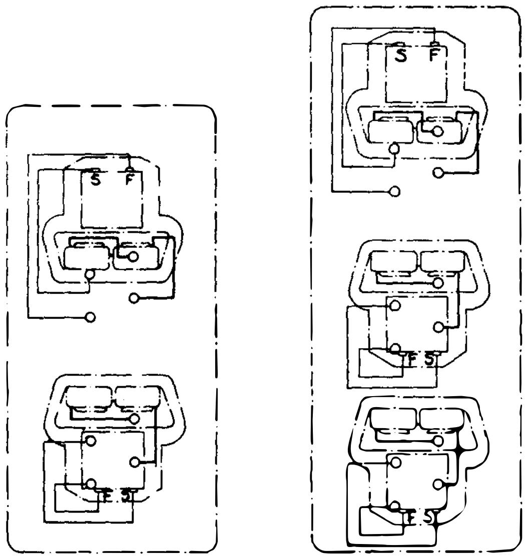


Fig. 12. Dimensions for Types DS-44, DSW-44, and DSM-44

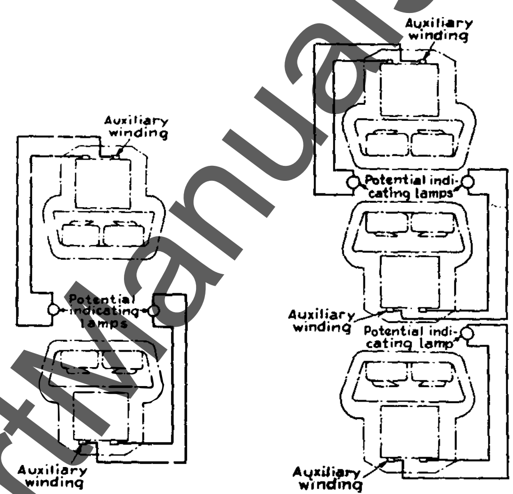
SCHEMATIC CONNECTION DIAGRAMS



(a) Types DS-19 and DS-34, 3-wire, 2- and 3-phase, and 4-wire, 2-phase

(b) Types DS-20 and DS-35, 4-wire, 3-phase

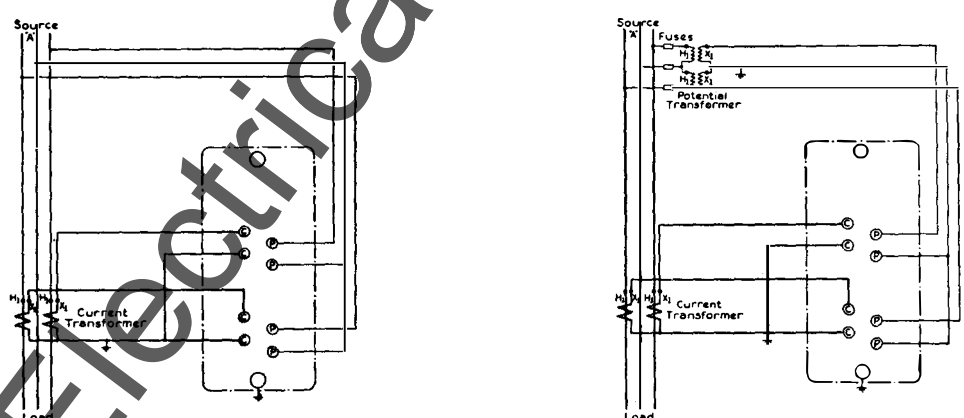
Fig. 13. Internal connections (front views)



(a) Types DS-19, DS-34, DS-38, and DS-40

(b) Types DS-20, DS-35, DS-39, and DS-41

Fig. 14. Showing connections of open potential circuit indicating lamps to auxiliary potential windings (front views)



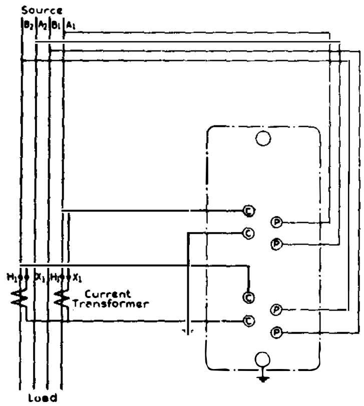
With Current Transformers

With Current and Potential Transformers

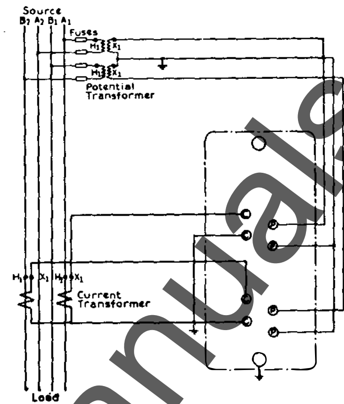
NOTE: For 3-wire, 2-phase circuits, wire "A" should be the common return.
For 3-wire single-phase circuits, wire "A" should be the neutral.

Fig. 15. Connections for Types DS-19 and DS-34, 3-wire, single-, 2-, or 3-phase (back views)

SCHEMATIC CONNECTION DIAGRAMS

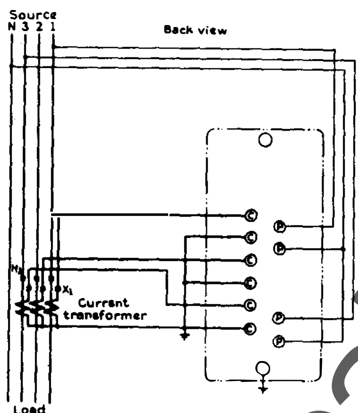


With Current Transformers

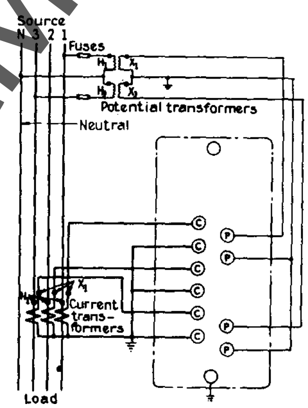


With Current and Potential Transformers

Fig. 16. Connections for Types DS-19 and DS-34, 4-wire, 2-phase (back views)

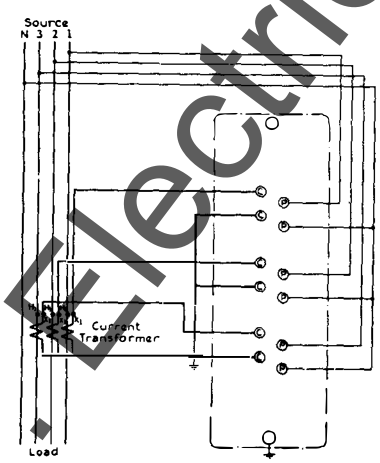


With Current Transformers

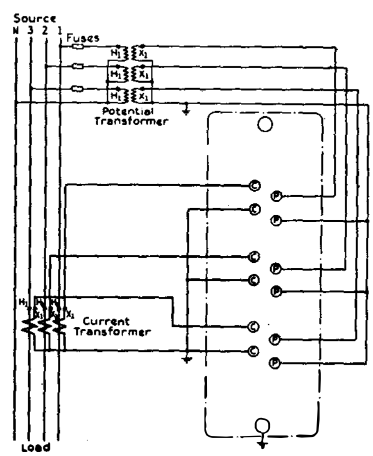


With Current and Potential Transformers

Fig. 17. Connections for Types DS-19 and DS-34 for 4-wire Y, 3-phase circuits (back views)



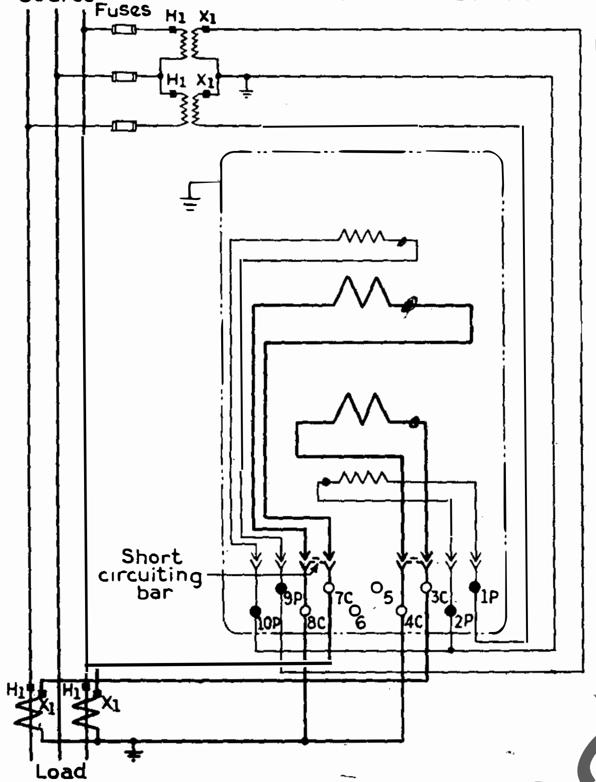
With Current Transformers



With Current and Potential Transformers

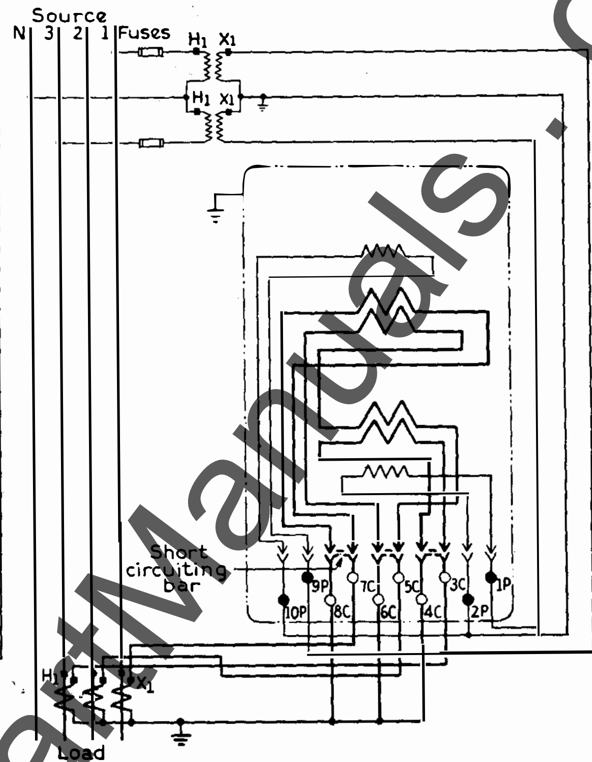
Fig. 18. Connections for Types DS-20 and DS-35, 4-wire Y, 3-phase (back views)

SCHEMATIC CONNECTION DIAGRAMS



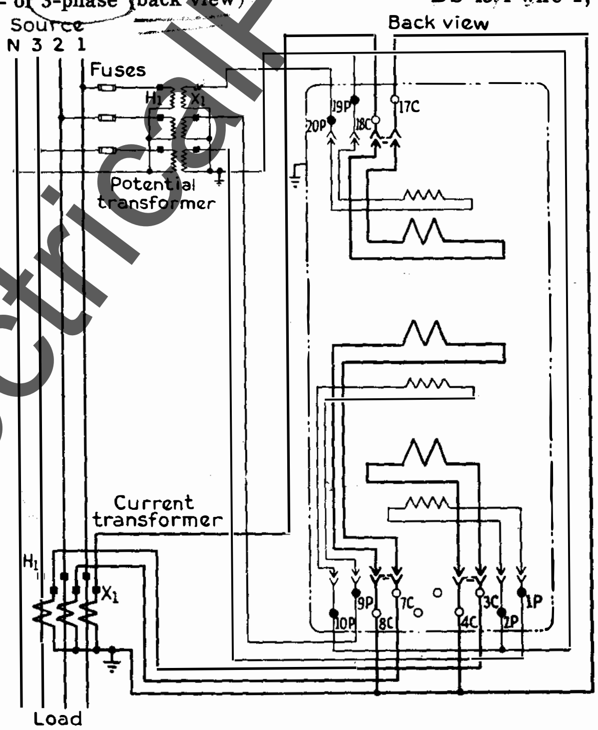
With Current and Potential Transformers

Fig. 19. Connections for Types DS-38, DS-40, and DS-43 3-wire, single-, 2- or 3-phase (back view)



With Current and Potential Transformers

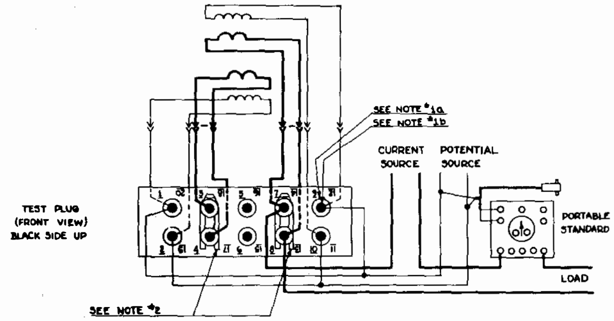
Fig. 20. Connections for Types DS-38, DS-40, and DS-43 4-wire Y, 3-phase (back view)



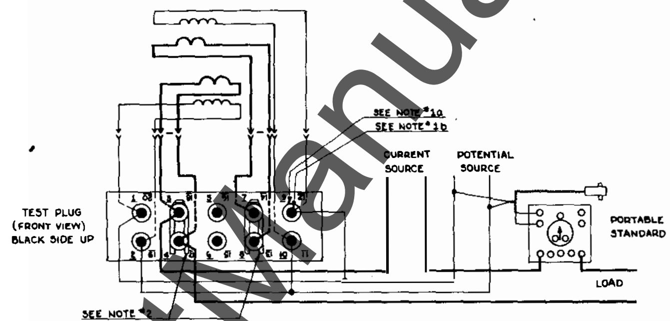
With Current and Potential Transformers

Fig. 21. Connections for Types DS-39, DS-41, and DS-44 4-wire Y, 3-phase (back view)

FIELD TESTING CONNECTION DIAGRAMS

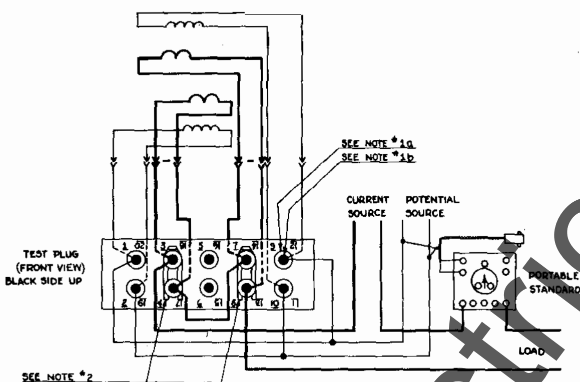


CONNECTIONS FOR TESTING TOP ELEMENT



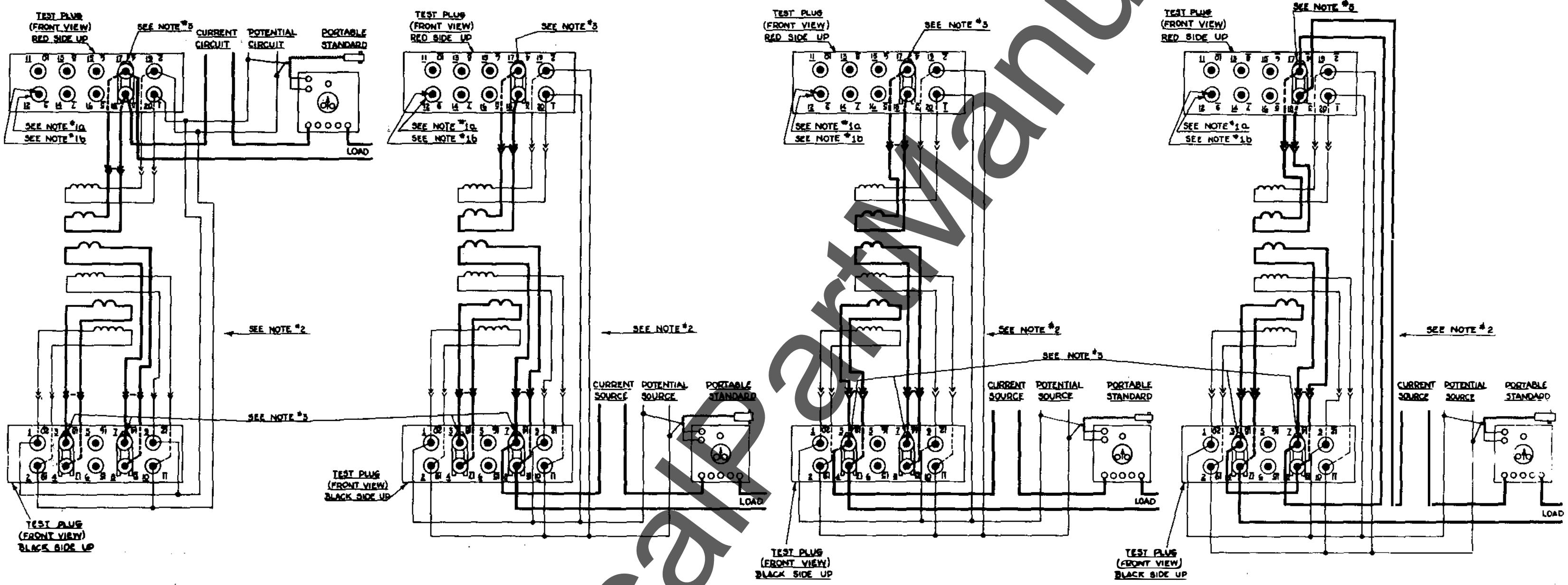
CONNECTIONS FOR TESTING BOTTOM ELEMENT

	NOTES
1	CONCENTRIC BINDING POSTS
	a - RED THUMB NUTS CONNECT TO STUDS
	b - BLACK THUMB NUTS ENGAGE METER INTERNAL CONNECTIONS
2	REMOVABLE LINKS MUST BE LOCATED AS SHOWN BEFORE INSERTING PLUG



CONNECTIONS FOR TESTING BOTH ELEMENTS WITH POTENTIAL COILS IN MULTIPLE AND CURRENT COILS IN SERIES

Fig. 22 Field testing connections for Types DS-38, DS-40, and DS-43 using test plug model 12XLA12A1



CONNECTIONS FOR TESTING TOP ELEMENT (FRONT VIEW)

CONNECTIONS FOR TESTING MIDDLE ELEMENT (FRONT VIEW)

CONNECTIONS FOR TESTING BOTTOM ELEMENT (FRONT VIEW)

CONNECTIONS FOR TESTING THREE ELEMENTS WITH POTENTIAL COILS IN MULTIPLE AND CURRENT COILS IN SERIES (FRONT VIEW)

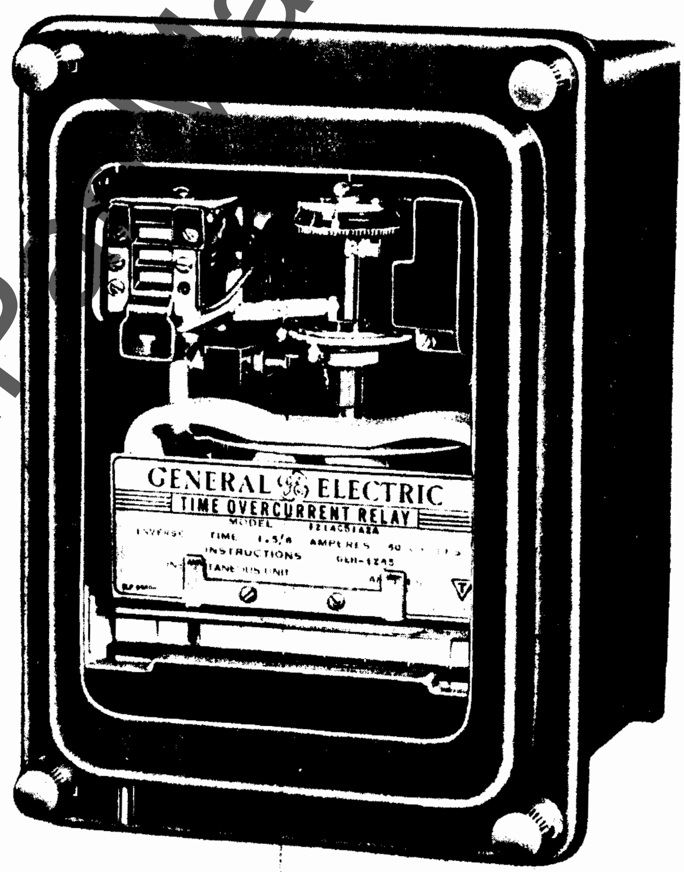
	NOTES
1	CONCENTRIC BINDING POSTS
	a - RED THUMB NUTS CONNECT TO STUDS
	b - BLACK THUMB NUTS ENGAGE METER INTERNAL CONNECTIONS
2	TWO TEST PLUGS MUST BE USED FOR TESTING THE THREE ELEMENT METER TO ISOLATE METER ELEMENTS
3	SHORT CIRCUITING LINK MUST BE LOCATED AS SHOWN BEFORE INSERTING PLUG.

Fig. 23 Field testing connections for Types DS-39, DS-41, and DS-44 using test plug model 12XLA12A1

GEH-1753C

INSTRUCTIONS *Switchgear*

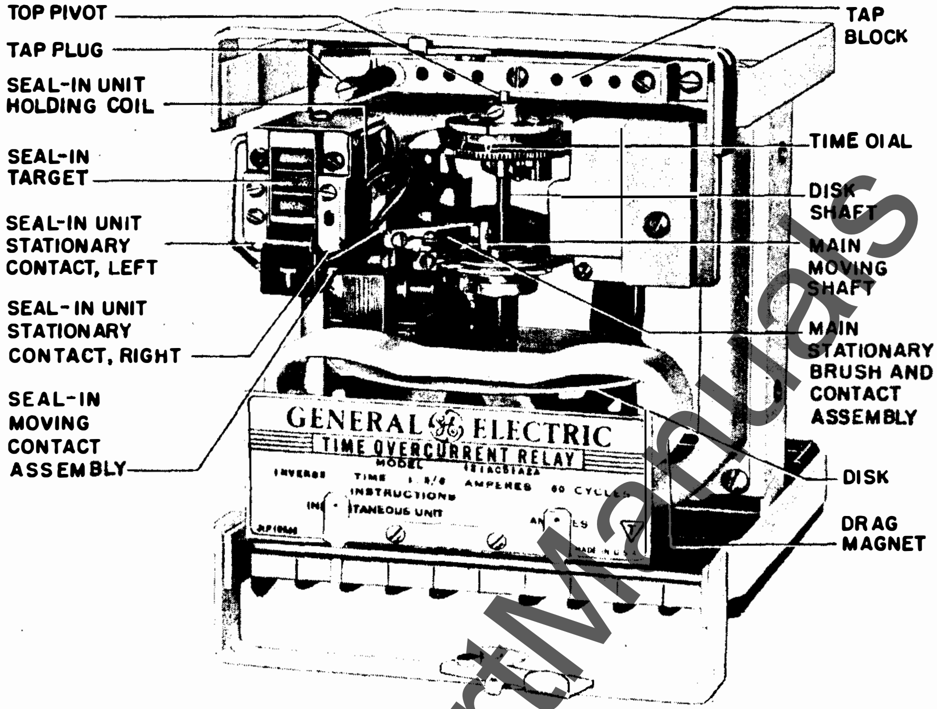
TIME OVERCURRENT RELAYS



Types

IAC51A IAC51B IAC51C
IAC51D IAC51R IAC52A
IAC52B

GENERAL ELECTRIC



A - (Front View)

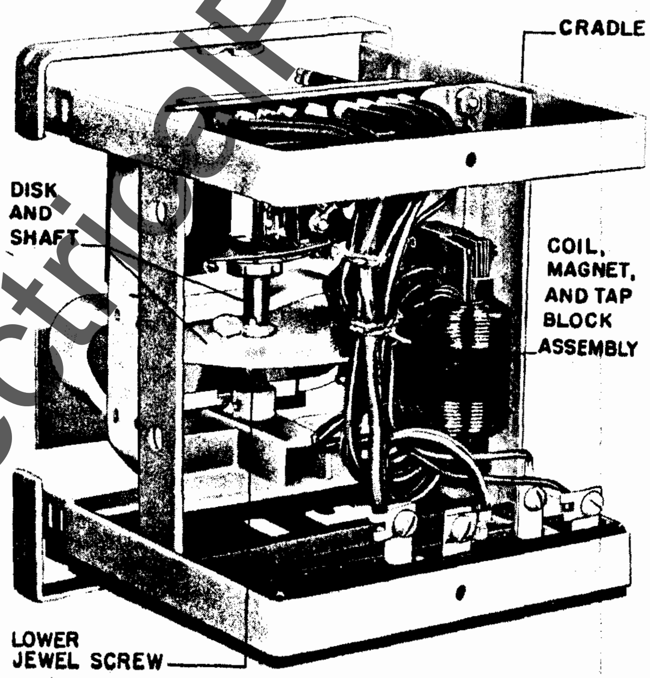


Fig. 1 The Induction Unit for Type IAC Relays B - (Rear View)

TIME OVERCURRENT RELAYS
TYPE IAC

INTRODUCTION

Type	Contact Circuits	Instantaneous Unit	AC Trip Unit	Induction Unit	Outline and Panel Drilling	Internal Connection
IAC51A(-)A	One	No	No	One	Fig. 19	Fig. 11
IAC51B(-)A	One	Yes	No	One	Fig. 19	Fig. 12
IAC51C(-)A	One	No	Yes	One	Fig. 19	Fig. 13
IAC51D(-)A	One	No	No	Three	Fig. 20	Fig. 14
IAC51R(-)A	One	Yes	Yes	One	Fig. 19	Fig. 15
IAC52A(-)A	Two	No	No	One	Fig. 19	Fig. 16
IAC52B(-)A	Two	Yes	No	One	Fig. 19	Fig. 17

The Type IAC relays comprise a group of relays that are employed to protect against overcurrent on single-phase and polyphase circuits. The various relays in this IAC group are identified by model numbers, and the relays differ in the number of circuits they close, the length of time delay and features that are determined by the characteristics of the protected circuit.

These relays consist of an induction unit or an induction unit with an instantaneous element which permits instantaneous tripping for extremely high currents, or an induction unit with an a-c tripping element for use where d-c power is unavailable or a-c tripping is preferred. Since practically all IAC relays are composed of various combinations of the above - that is, the induction unit, the instantaneous element and the a-c tripping element - they are for convenience, described separately in the following text. The above table indicates the units comprising each type and also lists the internal connections and outline and panel drilling diagrams.

The case is suitable for either surface or semi-flush panel mounting and an assortment of hardware is provided for either mounting. The cover attaches to the case and also carries the reset mechanism when one is required. Each cover screw has provision for a sealing wire.

The case has studs or screw connections at both ends or at the bottom only for the external connections. The electrical connections between the relay units and the case studs are made through spring backed contact fingers mounted in stationary molded inner and outer blocks between which nests a removable connecting plug which completes the circuits. The outer blocks, attached to the case, have the studs for the external connections, and the inner blocks have the terminals for the internal connections.

The relay mechanism is mounted in a steel framework called the cradle and is a complete unit with all leads being terminated at the inner block. This cradle is held firmly in the case with a latch at the top and the bottom and by a guide pin at the back of the case. The cases and cradles are so constructed that the relay cannot be inserted in the case upside down. The connecting plug, besides making the electrical connections between the respective blocks of the cradle and case, also locks the latch in place. The cover, which is fastened to the case by thumbscrews, holds the connecting plug in place.

To draw out the relay unit the cover is first removed, and the plug drawn out. Shorting bars are provided in the case to short the current transformer cirucits. The latches are then released, and the relay unit can be easily drawn out. To replace the relay unit, the reverse order is followed.

A separate testing plug can be inserted in place of the connecting plug to test the relay in place on the panel either from its own source of current and voltage, or from other sources. Or, the relay unit can be drawn out and replaced by another which has been tested in the laboratory.

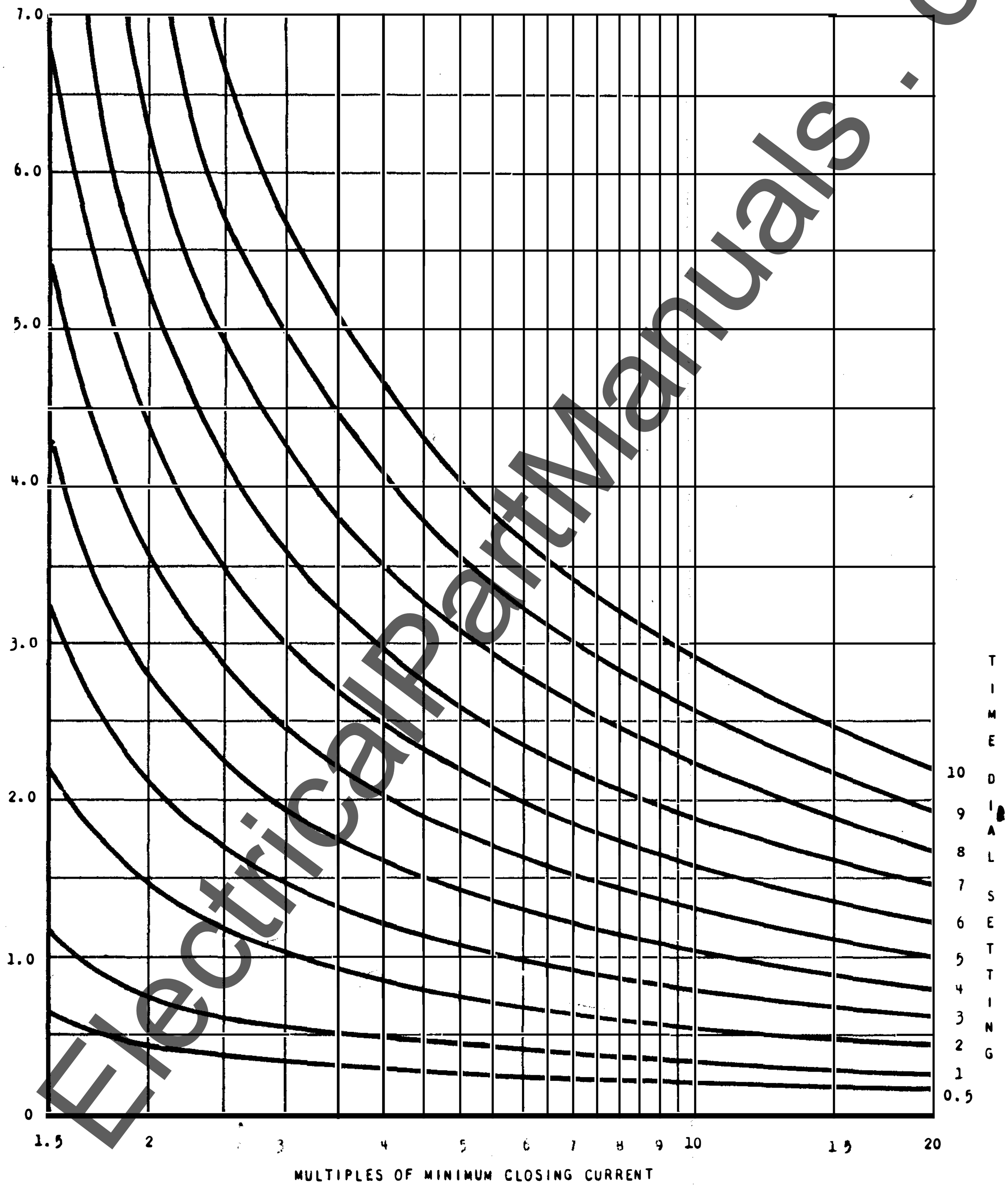


Fig. 2 Time-current Curves of Type IAC Relays With Inverse-time Characteristics

INDUCTION UNIT

INTRODUCTION

The induction unit is the basic unit in all IAC relays. Fig. 1 shows the induction unit mounted in the cradle. These units are of the induction-disk construction type. The disk is actuated by a current operating coil on a laminated U-magnet. The disk shaft carries the moving contact which completes the alarm or trip circuit when it touches the stationary contact or contacts. The disk shaft is restrained by a spiral spring to give the proper contact-closing current and its motion is retarded by permanent magnets acting on the disk to give the correct time delay.

There is a seal-in element mounted on the front to the left of the shaft. This element has its coil in series and its contacts in parallel with the main contacts such that when the main contacts close the seal-in element picks up and seals in. When the seal-in element picks up, it raises a target into view which latches up and remains exposed until released by pressing a button beneath the lower left corner of the cover.

APPLICATION

The induction unit is the main unit in all IAC relays, supplying the inverse time delay characteristics of the relay and sounding an alarm or tripping the breakers for overload currents which cause it to close its contacts.

OPERATING CHARACTERISTICS

The induction unit may have one or two circuit-closing contacts which close as the current increases to the pick-up value as set on the tap block. The time delay in closing the contacts is determined by the setting of the time dial (Fig. 1). The time-current characteristics are shown in Fig. 2.

RATINGS

The induction element is designed to use any one of three operating coils, each having a different combination of taps as follows: 4.5, 6, 8, 10, 12, and 16 amperes; 1.5, 2.0, 2.5, 3.0, 4.0, 5.0 and 6.0 amperes; 0.5, 0.6, 0.8, 1.0, 1.2, 1.5, and 2.0 amperes.

The current-closing rating of the contacts is 30 amperes for voltages not exceeding 250 volts. The current-carrying ratings are affected by the selection of the tap on the target and seal-in coil as indicated in the following table:

Function	Amperes, AC or DC	
	2-Amp Tap	0.2 Amp Tap
Tripping Duty	30	5
Carry Continuously	4	0.8

The 2-ampere tap has a d-c resistance of 0.13 ohms and a 60 cycle impedance of 0.53 ohms while the 0.2-ampere tap has a 7 ohm d-c resistance and a 52 ohm 60 cycle impedance. The tap setting used on the seal-in element is determined by the current drawn by the trip coil.

The 0.2-ampere tap is for use with trip coils that operate on currents ranging from 0.2 up to 2.0 amperes at the minimum control voltage. If this tap is used with trip coils requiring more than 2 amperes, there is a possibility that the the 7-ohm resistance will reduce the current to so low a value that the breaker will not be tripped.

The 2-ampere tap should be used with trip coils that take 2 amperes or more at minimum control voltage, provided the tripping current does not exceed 30 amperes at the maximum control voltage. If the tripping current exceeds 30 amperes an auxiliary relay should be used, the connections being such that the tripping current does not pass through the contacts or the target and seal-in coils of the protective relay.

BURDENS

Burdens for the standard coils are given in the following table. These are calculated burdens at five amperes based on burden of minimum tap.

Volt-ampere burdens for the lowest tap on any of the three coils can be determined for any value of current, up to 20 times tap setting, from Fig. 3.

Coil Amperes	Freq.	Tap	Volt-Amps	Imp. Ohms	PF
4-16	60	4.0	8.8	0.35	0.29
	50	4.0	8.0	0.32	0.31
	25	4.0	7.5	0.30	0.36
1.5-6.0	60	1.5	59.0	2.36	0.26
	50	1.5	52.0	2.08	0.28
	25	1.5	48.0	1.92	0.34
0.5-2.0	60	0.5	530.0	21.2	0.26
	50	0.5	470.0	18.8	0.28
	25	0.5	430.0	17.2	0.34

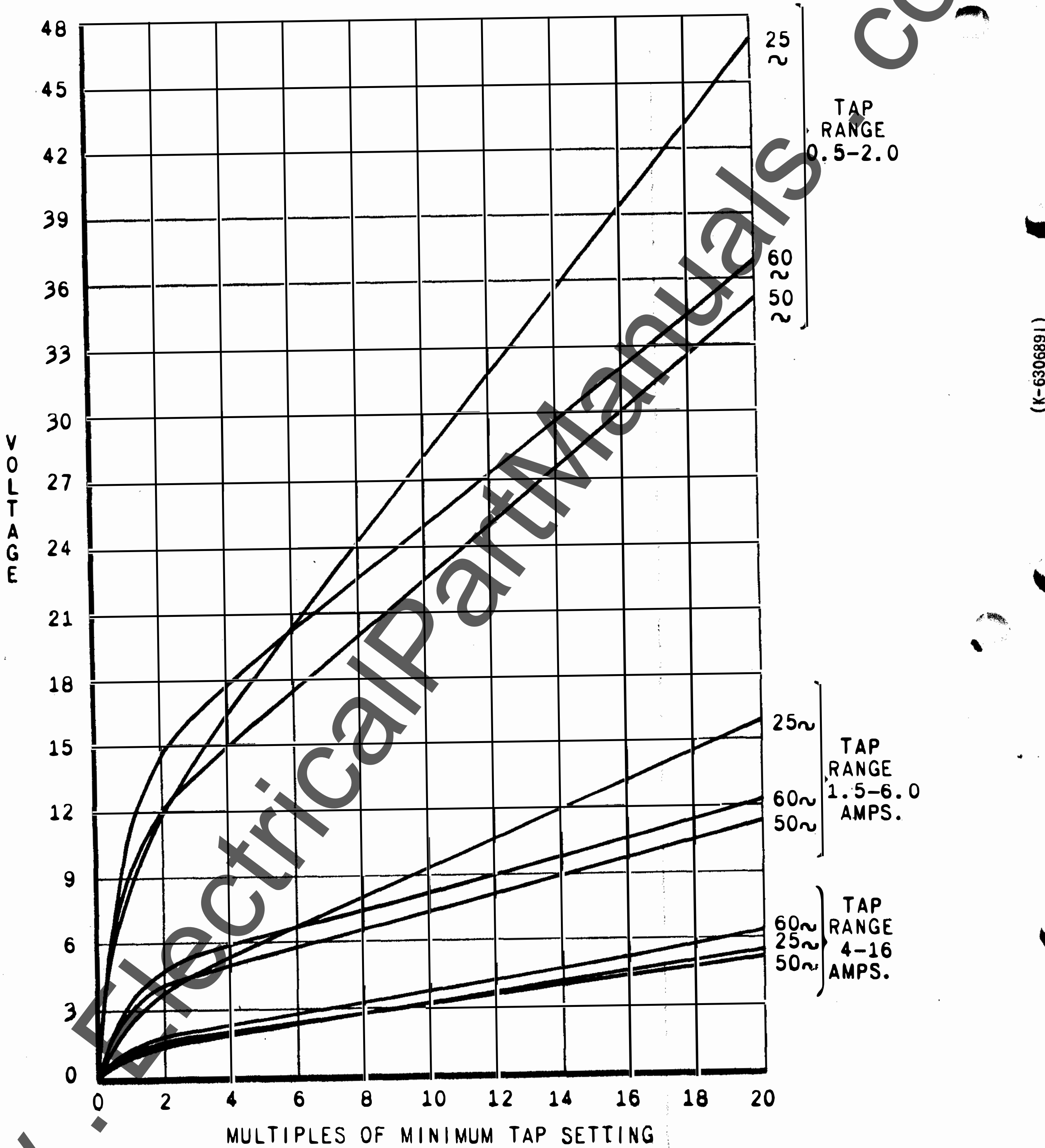


Fig. 3 Saturation Curves for Lowest Taps of the Induction Unit of Type IAC Relays with Inverse-time Characteristics

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DEVICE FUNCTION NUMBERS FOR USE WITH ALL EXTERNAL DIAGRAMS

50 - Instantaneous Element

51 - Overcurrent, Relay, Type IAC

51N- Ground Overcurrent Relay, Type IAC

52 - Power Circuit Breaker

SI - Seal-in Unit, with Target

TC - Trip Coil

A - Auxiliary contact, closed when breaker closes.

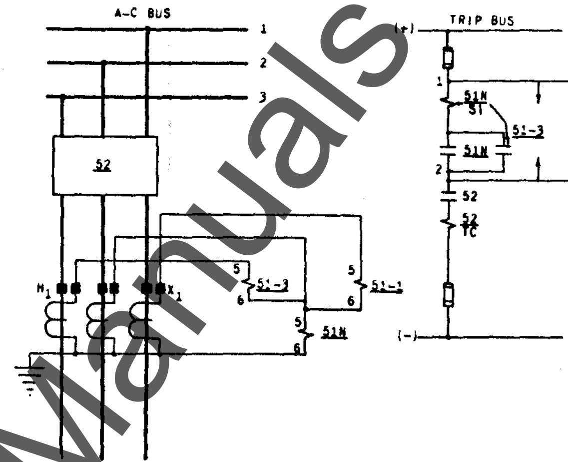

Fig. 4 External Connections of Three Type IAC51A Relays Used For Phase-to-Phase and Ground Overcurrent Protection of a 3-Phase Circuit

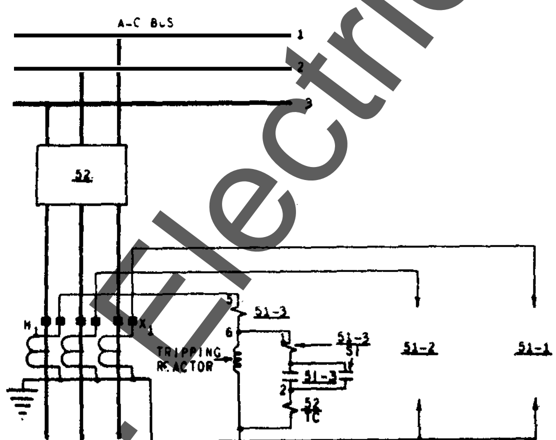

Fig. 5 External Connections of Three Type IAC51A Relays Used in Conjunction With Tripping Reactors For Protection of a Three-Phase Circuit

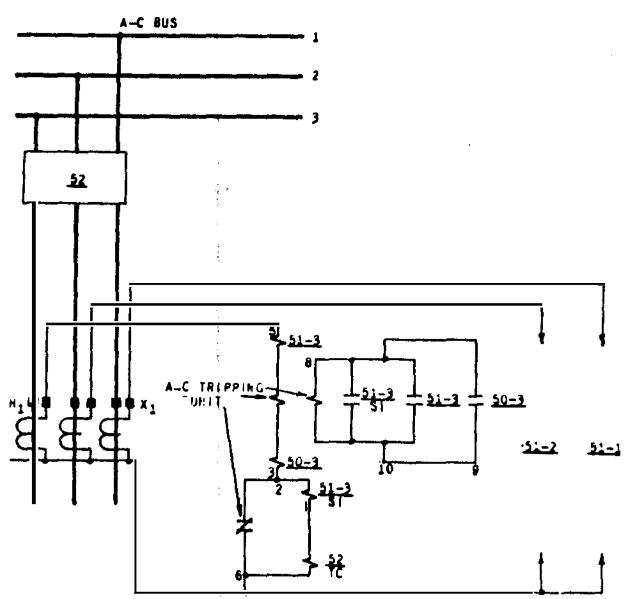

Fig. 6 External Connections of Three Type IAC51R Relays Used for 3-Phase Circuit Protection

Fig. 4 (K-6375667)

Fig. 5 (K-6375668)

Fig. 6 (K-6375669)

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INSTANTANEOUS ELEMENT

INTRODUCTION

The instantaneous element is a small instantaneous hinge-type element which may be mounted on the right front side of the induction unit (See Fig. 7). Its contacts are normally connected in parallel with the contacts of the main unit. Its coil is connected in series with the operating coil of the main unit.

When the current reaches a predetermined value, the instantaneous element operates, closing the contact circuit and raising its target into view. The target latches in the exposed position until released by pressing the button beneath the lower left-hand corner of the relay cover.

APPLICATION

The instantaneous element is used on certain IAC relay models to provide instantaneous tripping for current exceeding a predetermined value.

OPERATING CHARACTERISTICS

The instantaneous element operates over a 4 to 1 range and has its calibration stamped on a scale mounted beside the adjustable pole piece. Time-current characteristics are shown in Fig. 10.

RATINGS

The instantaneous element is designed to use either of two coils having pickup ranges of 10 to 40, and 20 to 80 amperes respectively. The current-closing rating of the contacts is 30 amperes for voltages not exceeding 250 volts.

BURDENS

Burden data on the instantaneous element coils are given in the following table:

Coil	Freq	Amp	Volt Amp	Imp. Ohms	PF
10-40	60	5	0.83	0.033	0.95
	50	5	0.80	0.032	0.95
	25	5	0.65	0.027	0.98
20-80	60	5	0.21	0.008	0.95
	50	5	0.20	0.008	0.95
	25	5	0.15	0.007	0.98

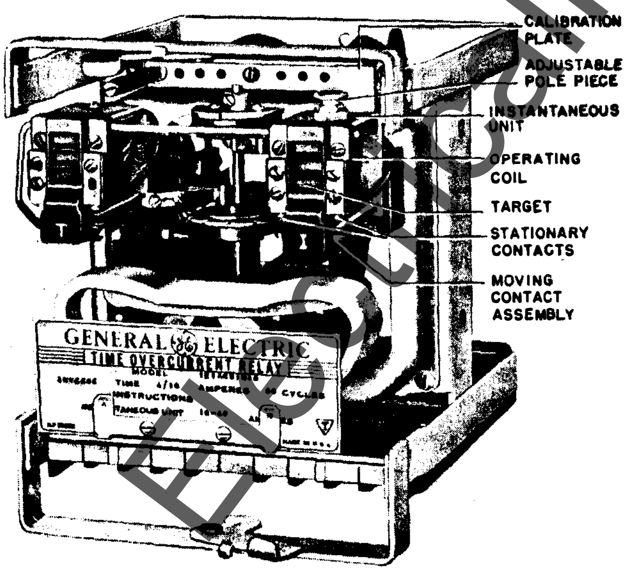

Fig. 7 Type IAC Relay With An Instantaneous Unit

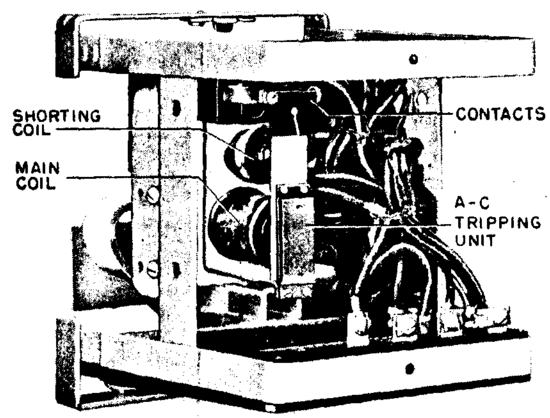

Fig. 8 Type IAC Relay With An A-C Tripping Unit

A-C TRIPPING ELEMENT

INTRODUCTION

The a-c tripping element is a Type REA relay element designed to energize a circuit breaker trip coil from its associated current transformer upon the operation of the main unit of the IAC relay. It transfers the current from the secondary of the current transformer into the trip coil and removes the current from the trip coil when the breaker trips.

The tripping element is mounted on the rear of the frame opposite the tapped operating coil of the induction unit (see Fig. 8). The operation of this element is illustrated in Fig. 9. The secondary current circulates through the induction unit current coil and the main coil of the REA auxiliary tripping element, returning through the REA contacts to the current transformer. Normally, most of the flux generated by the main REA coil passes through the upper limb of the magnetic structure and holds the armature firmly against this limb. When the contacts of the induction unit close, the shorting coil of the REA is short-circuited and current flows in this coil by transformer action, causing a redistribution of flux which actuates the armature and the REA contacts. The opening of the REA contacts causes the secondary current to flow through the trip coil which trips the breaker.

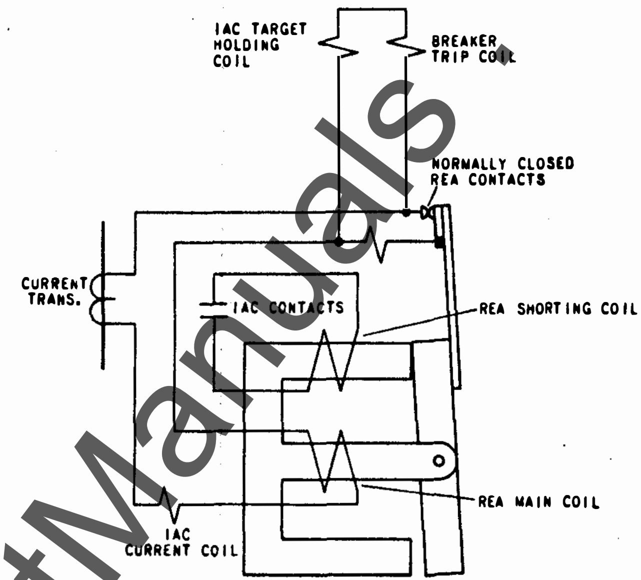

Fig. 9 Diagram Illustrating Operation of Type IAC Relays Having An A-C Tripping Unit

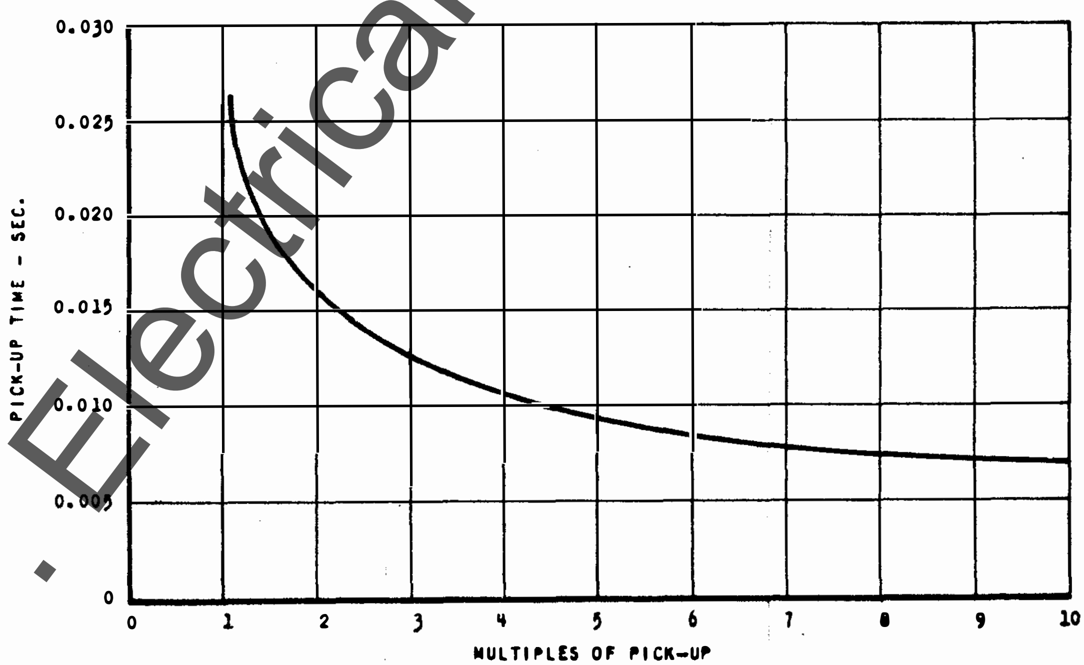

Fig. 10 Time-current Characteristic of Instantaneous Unit

APPLICATION

The a-c tripping element is used in Type IAC relays where a reliable direct-current tripping source is not available and it is necessary to trip the breaker from the current-transformer secondary.

RATING

The a-c tripping element has a continuous rating of five amperes but will operate on a minimum current of 3.5 amperes. They should be used with three-ampere trip coils. The contacts of these elements will transfer current transformer secondary current up to 100 amperes. For applications where the secondary current exceeds 100 amperes, the REA11B relay, which has contacts rated 200 amperes, can be used in conjunction with IAC overcurrent relays. The REA11B is not mounted inside the IAC case.

BURDENS

Burdens of the REA element are given in the following table:

Frequency	Amp	Impedance in Ohms	PF	Volt-Amperes
60	5	0.49	0.80	12.2
50	5	0.33	0.85	8.4
25	5	0.23	0.62	5.8

RECEIVING, HANDLING AND STORAGE

These relays, when not included as a part of a control panel, will be shipped in cartons designed to protect them against damage. Immediately upon receipt of the relay, an examination should be made for any damage sustained during shipment. If injury or damage resulting from rough handling is evident, a claim should be filed at once with the transportation company and the nearest Sales Office of the General Electric Company notified promptly.

Reasonable care should be exercised in unpacking the relay in order that none of the parts are injured or the adjustments disturbed.

If the relays are not to be installed immediately, they should be stored in their original cartons in a place that is free from moisture, dust, and metallic chips. Foreign matter collected on the outside of the case may find its way inside when the cover is removed and cause trouble in the operation of the relay.

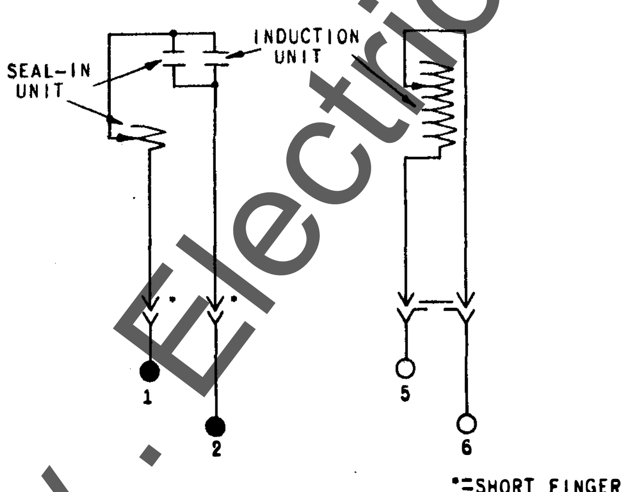

Fig. 11 Internal Connections for the Type IAC51A Relay Front View

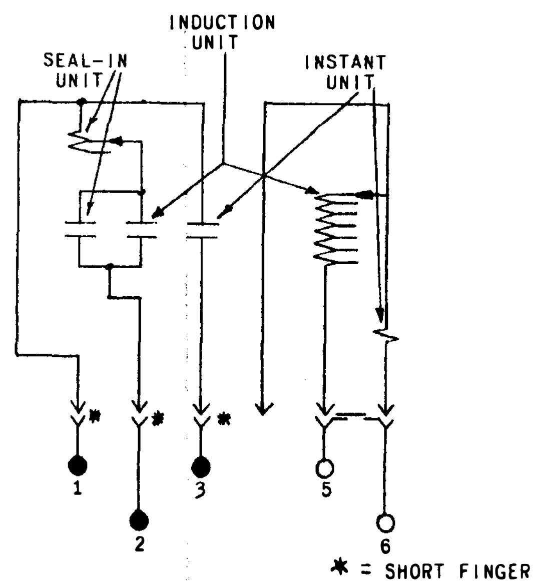

Fig. 12 Internal Connections for the Type IAC51B Relay Front View

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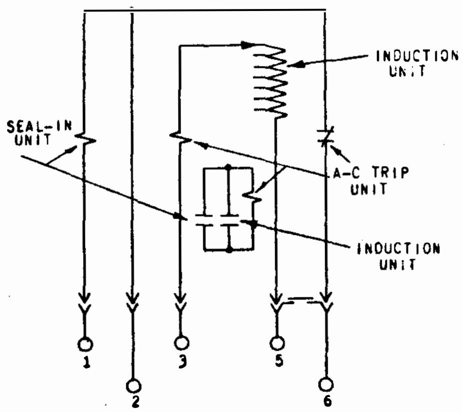

Fig. 13 Internal Connections for the Type IAC51C Relay Front View

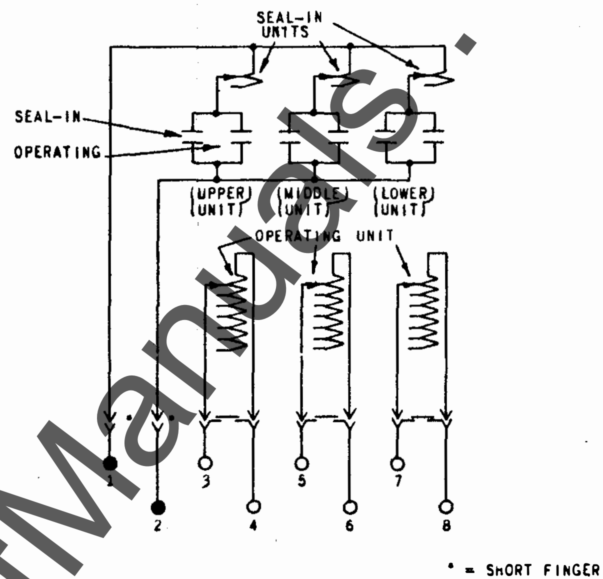

Fig. 14 Internal Connections for the Type IAC51D Relay Front View

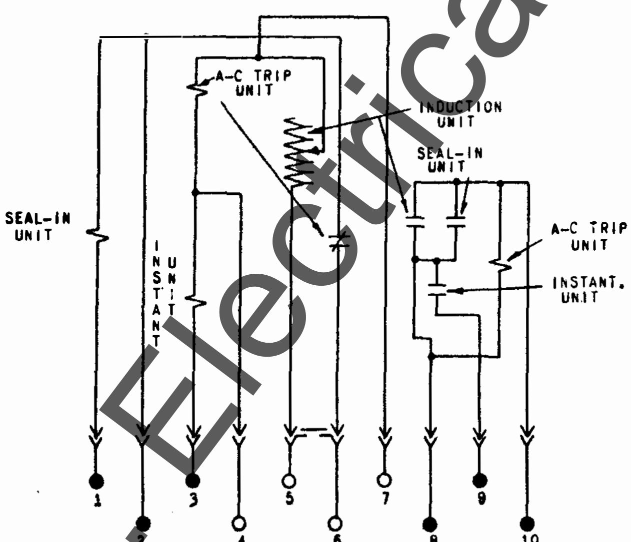

Fig. 15 Internal Connections for the Type IAC51R Relay Front View

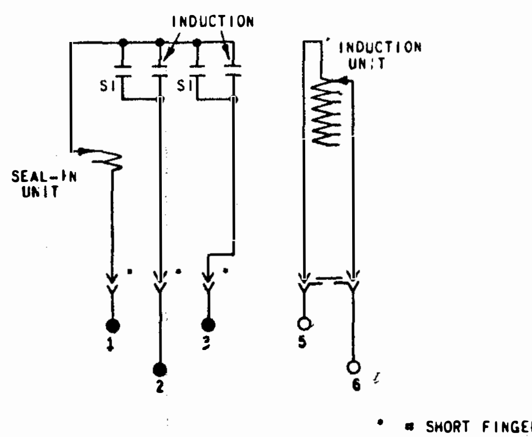

Fig. 16 Internal Connections for the Type IAC52A Relay Front View

Fig. 13 (K-6209660)
Fig. 14 (K-6209659)
Fig. 15 (K-6209294)
Fig. 16 (K-6209662)

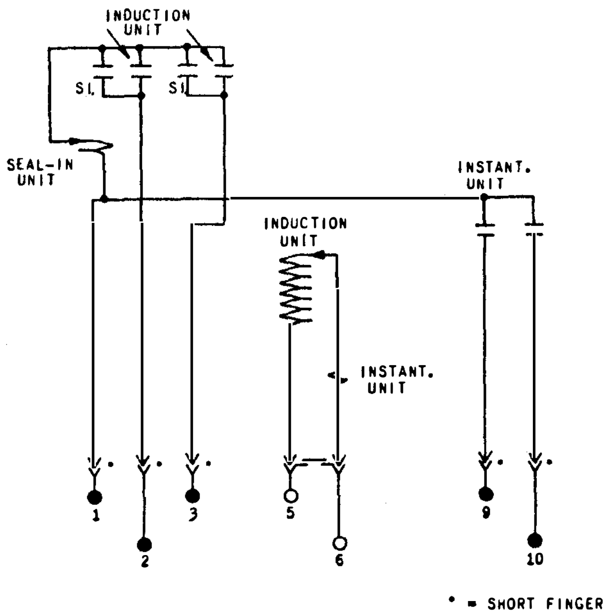

Fig. 17 Internal Connections for the Type IAC52B Relay Front View

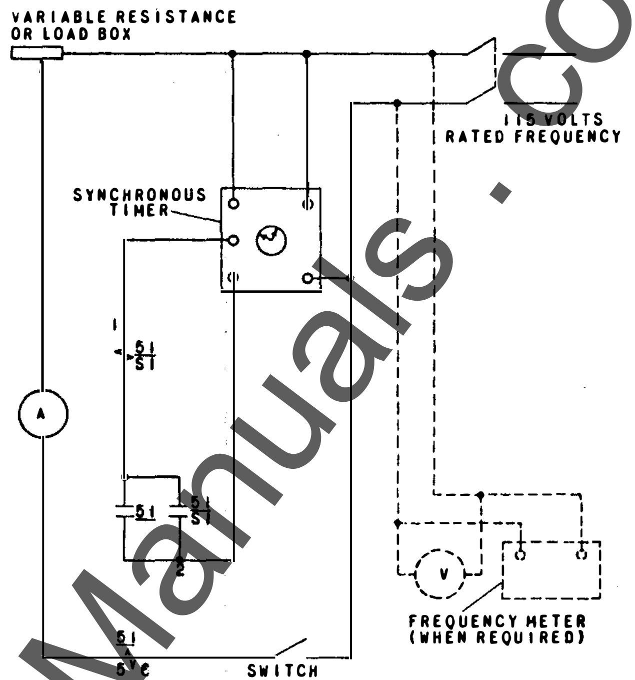

Fig. 18 Testing Connections for Type IAC Relays such as Type IAC51A

INSTALLATION

LOCATION

The location should be clean and dry, free from dust and excessive vibration, and well lighted to facilitate inspection and testing

MOUNTING

The relay should be mounted on a vertical surface. The outline and panel diagrams are shown in Figures 19 and 20.

CONNECTIONS

Internal connection diagrams for the various relay types are shown in Fig. 11 to 17 inclusive. Typical wiring diagrams are given in Fig. 4 to 6 inclusive.

One of the mounting studs or screws should be permanently grounded by a conductor not less than No. 12 B&S gage copper wire or its equivalent.

INSPECTION

At the time of installation, the relay should be inspected for tarnished contacts, loose screws, or other imperfections. If any trouble is found, it should be corrected in the manner described under "Maintenance".

ADJUSTMENTS

TARGET & SEAL-IN ELEMENT

For trip coils operating on currents ranging from 0.2 up to 2.0 amperes at the minimum control voltage, set the target and seal-in tap plug in the 0.2-ampere tap.

For trip coils operating on currents ranging from 2 to 30 amperes at the minimum control voltage, place the tap plug in the 2-ampere tap.

The tap plug is the screw holding the right-hand stationary contact of the seal-in element. To change the tap setting, first remove the connecting plug. Then, take a screw from the left-hand stationary contact and place it in the desired tap. Next remove the screw from the other tap, and place it in the left-hand contact. This procedure is necessary to prevent the right-hand stationary contact from getting out of adjustment. Screws should not be in both taps at the same time as pickup for d-c will be the higher tap value and a-c pickup will be increased.

MAIN ELEMENT

CURRENT SETTING

The current at which the contacts operate may be changed by changing the position of the tap plug in the tap block at the top of the relay. Screw the

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tap plug firmly into the tap marked for the desired current (below which the unit is not to operate).

When changing the current setting of the unit, remove the connecting plug to short circuit the current transformer secondary circuit. Next, screw the tap plug into tap marked for the desired current and then replace the connecting plug.

The pickup of the unit for any current tap is adjusted by means of a spring-adjusting ring. The ring may be turned by inserting a screw driver in the notches around the edge. By turning the ring, the operating current of the unit may be brought into agreement with the tap setting employed, if for some reason, this adjustment has been disturbed. This adjustment also permits any desired setting intermediate between the various tap settings to be obtained. The unit is adjusted at the factory to close its contacts from any time-dial position at a minimum current within five percent of the tap-plug setting. The unit resets at 90 per cent of the minimum closing value.

TIME SETTING

The setting of the time dial determines the length of time the unit requires to close its contacts when the current reaches a predetermined value. The contacts are just closed when the dial is set on 0. When the dial is set on 10, the disk must travel the maximum amount to close the contacts and therefore this setting gives the maximum time setting.

The primary adjustment for the time of operation of the unit is made by means of the time dial. However, further adjustment is obtained by moving the permanent magnet along its supporting shelf; moving the magnet in toward the back of the unit decreases the time, while moving it out increases the time.

If selective action of two or more relays is required, determine the maximum possible short-circuit current of the line and then choose a time value for each relay that differs sufficiently to insure the proper sequence in the operation of the several circuit breakers. Allowance must be made for the time involved in opening each breaker after the relay contacts close. For this reason, unless the circuit time of operation is known with accuracy, there should be a difference of about 0.5 second (at the maximum current) between relays whose operation is to be selective.

EXAMPLE OF SETTING

The time and current settings of the overcurrent unit can be made easily and quickly. Each time value shown in Fig. 2 indicates the time required for the contacts to close with a particular time-dial setting when the current is a prescribed number of times the current-tap setting. In order to secure any of the particular time-current settings shown in Fig. 2, insert the removable plug in the proper tap receptacle and adjust the time-dial to the proper position. The following example illustrates the procedure in making a relay setting.

Assume a Type IAC relay is used in a circuit where the circuit breaker should trip on a sustained current of approximately 450 amperes; also, the breaker should trip in 1.9 seconds on a short-circuit current of 3750 amperes. Assume further that current transformers of 60/1 ratio are used.

The current tap setting is found by dividing the minimum primary tripping current by the current transformer ratio. In this case, 450 divided by 60 equals 7.5 amps. Since there is no 7.5-amp tap, the 8-amp. tap is used. To find the proper time-dial setting to give 1.9 seconds time delay at 3750 amperes, divide 3750 by the transformer ratio. This gives 62.5 amperes secondary current which is 7.8 times the 8-ampere setting. By referring to the time current curves (Fig. 2), it will be seen that 7.8 times the minimum operating current gives 1.9 seconds time delay when the relay is set slightly above the No. 6 time-dial setting.

The above results should be checked by means of an accurate timing device. Slight readjustment of the dial can be made until the desired time is obtained.

Aid in making the proper selection of relay settings may be obtained on application to the nearest Sales Office of the General Electric Company.

CONTACT ADJUSTMENT

The contacts should have approximately 1/32 inch wipe. That is, the stationary contact should be deflected about 1/32 inch when the disk completes its travel. The contact wipe is adjusted by turning the screws in the contact brush which regulates the position of the brush, in relation to the brush stop. For relays with two circuit-closing contacts, the tips should be in the same vertical plane.

When the time dial is moved to a position where the contacts just close, the time-dial scale should indicate zero. If this is found incorrect, and the brushes are correctly adjusted, regulate the dial to read zero. This is done by changing the position of the arm attached to the shaft which is located below the time dial. Loosen the screw which clamps the arm to the shaft and turn the arm, relative to the shaft, until the contacts just make at the zero time-dial setting.

INSTANTANEOUS ELEMENT

Select the current above which is desired to have the instantaneous element operate and set the adjustable pole piece so that its hexagon head is even with the desired calibration on the scale. To raise or lower the pole piece loosen the locknut and turn it up or down and then tighten in position.

The contacts should be adjusted to make at about the same time and to have approximately 1/8" wipe. This adjustment can be made by loosening the screws holding the stationary contacts and moving the contacts up or down as required.

A-C TRIPPING ELEMENT

The a-c tripping element should not require any attention other than occasional cleaning of the contacts. However, if the adjustment should be lost, it may be restored as follows:

1. CONTACT ADJUSTMENT

With the element de-energized, the movable contact should lie against the stationary contact with enough tension to always insure a good closed circuit. The movable contact brush should be free of any kinks. Also this contact brush should not touch the compound bushing supported from the top of the armature. The brass backing strip should be adjusted to allow a 1/16-inch contact gap with the contacts open. The compound bushing support should be adjusted to allow the back of the movable contact to just touch the brass backing strip when the armature operates to open the contacts. The outer edge of the compound bushing should be approximately 1/32 - inch from the inner edge of the stationary contact supporting post.

2. ARMATURE ADJUSTMENT

Loosen the two screws which hold the armature-assembly bracket to the bottom of the frame. Slide the bracket in or out, whichever is necessary, until the armature just touches the pole face of the upper core. In this position, the armature should be about 1/32 inch from the pole face of the lower core. Next, slide the bracket in until the armature leaf spring assumes a vertical position and is spaced clear of both armature and the vertical tip of the bracket. With this setting, the armature should be flush against the pole face of both cores, and should put enough pressure on the armature to always return it flush against the pole face of the lower core after each operation of the unit. This alignment is important as a slight gap between armature and pole face of the lower core after the unit operates may cause contacts to open momentarily, dropping the relay target when the circuit breaker is reclosed. Under these conditions, the momentary opening of the contacts is due to the shock of the armature being pulled in against the pole face when the lower coil is energized. Excessive pressure on the armature, caused by the bracket being pushed in too far, will result in too high a pickup or chattering of the movable contact during operation of the element. Tighten the bracket screws securely after the proper adjustment has been obtained.

OPERATION

Before the relay is put into service it should be given a partial check to determine that factory adjustments have not been disturbed. The time-dial will be set at zero before the relay leaves the factory. It is necessary to change this setting in order to open the relay contacts.

The pickup current should be checked on one or more of the taps and the time should be checked for one or more dial settings.

Recommended test connections for the above test are shown in Fig. 18.

MAINTENANCE

The relays are adjusted at the factory and it is advisable not to disturb the adjustments. If, for any reason, they have been disturbed, the following points should be observed in restoring them:

DISK AND BEARINGS

The lower jewel may be tested for cracks by exploring its surface with the point of a fine needle. If it is necessary to replace the jewel a new pivot should be screwed into the bottom of the shaft at the shaft at the same time. A very small drop of General Electric meter-jewel oil, or fine watch oil, should be placed on the new jewel before it is inserted. The jewel should be turned up until the disk is centered in the air gaps, after which it should be locked in this position by the set screw provided for this purpose.

CONTACT CLEANING

For cleaning fine silver contacts, a flexible burnishing tool should be used. This consists of a flexible strip of metal with an etched roughened surface, resembling in effect a superfine file. The polishing action is so delicate that no scratches are left, yet corroded material will be removed rapidly and thoroughly. The flexibility of the tool insures the cleaning of the actual points of contact. Sometimes an ordinary file cannot reach the actual points of contact because of some obstruction from some other part of the relay.

Fine silver contacts should not be cleaned with knives, files, or abrasive paper or cloth. Knives or files may leave scratches which increase arcing and deterioration of the contacts. Abrasive paper or cloth may leave minute particles of insulating abrasive material in the contacts and thus prevent closing.

The burnishing tool described above can be obtained from the factory.

PERIODIC TESTING

An operation test and inspection of the relay at least once every six months are recommended. Test connections are shown in Fig. 18.

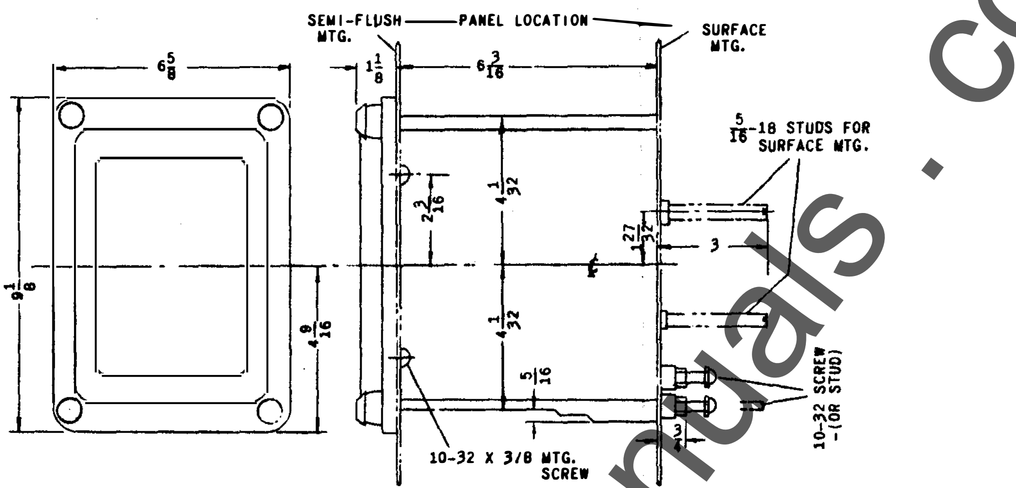
RENEWAL PARTS

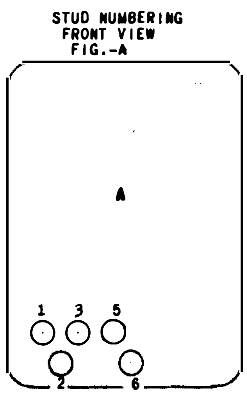
It is recommended that sufficient quantities of renewal parts be carried in stock to enable the prompt replacement of any that are worn, broken, or damaged.

When ordering renewal parts, address the nearest Sales Office of the General Electric Company, specify quantity required, name of part wanted, and give complete nameplate data, including serial number. If possible, give the General Electric Company requisition number on which the relay was furnished.

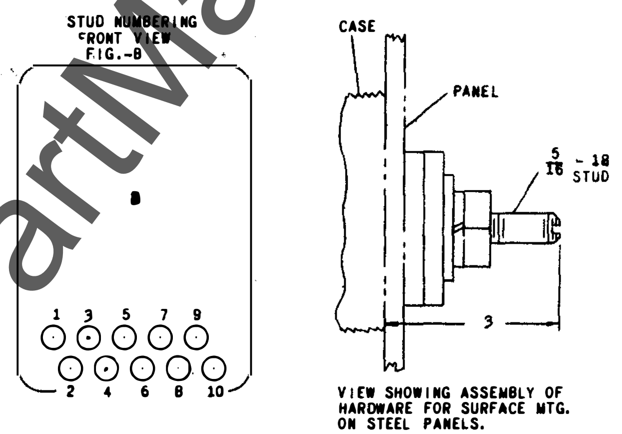
For a recommended parts list refer to Parts Bulletin number GEF2149.

AFZ





STUD NUMBERING FIG.	RELAY TYPE
A	IAC51A
A	IAC51B
A	IAC51C
A	IAC52A
B	IAC51R
B	IAC52B



OUTLINE

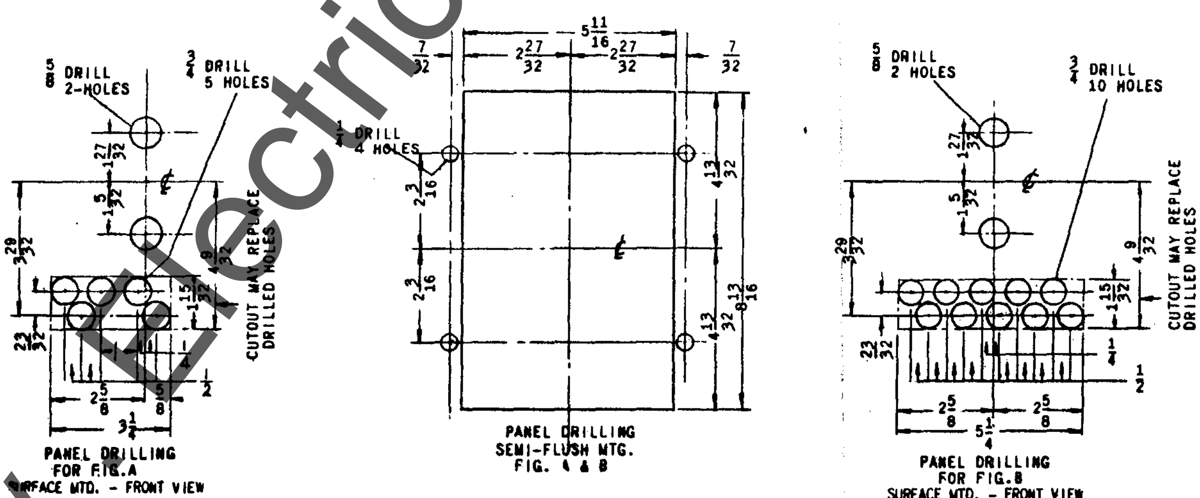


Fig. 19 Outline and Panel Drilling for the Type IAC51A, IAC51B, IAC51C. IAC51R, IAC52A, and IAC52B Relays

Fig. 19 (237C707)

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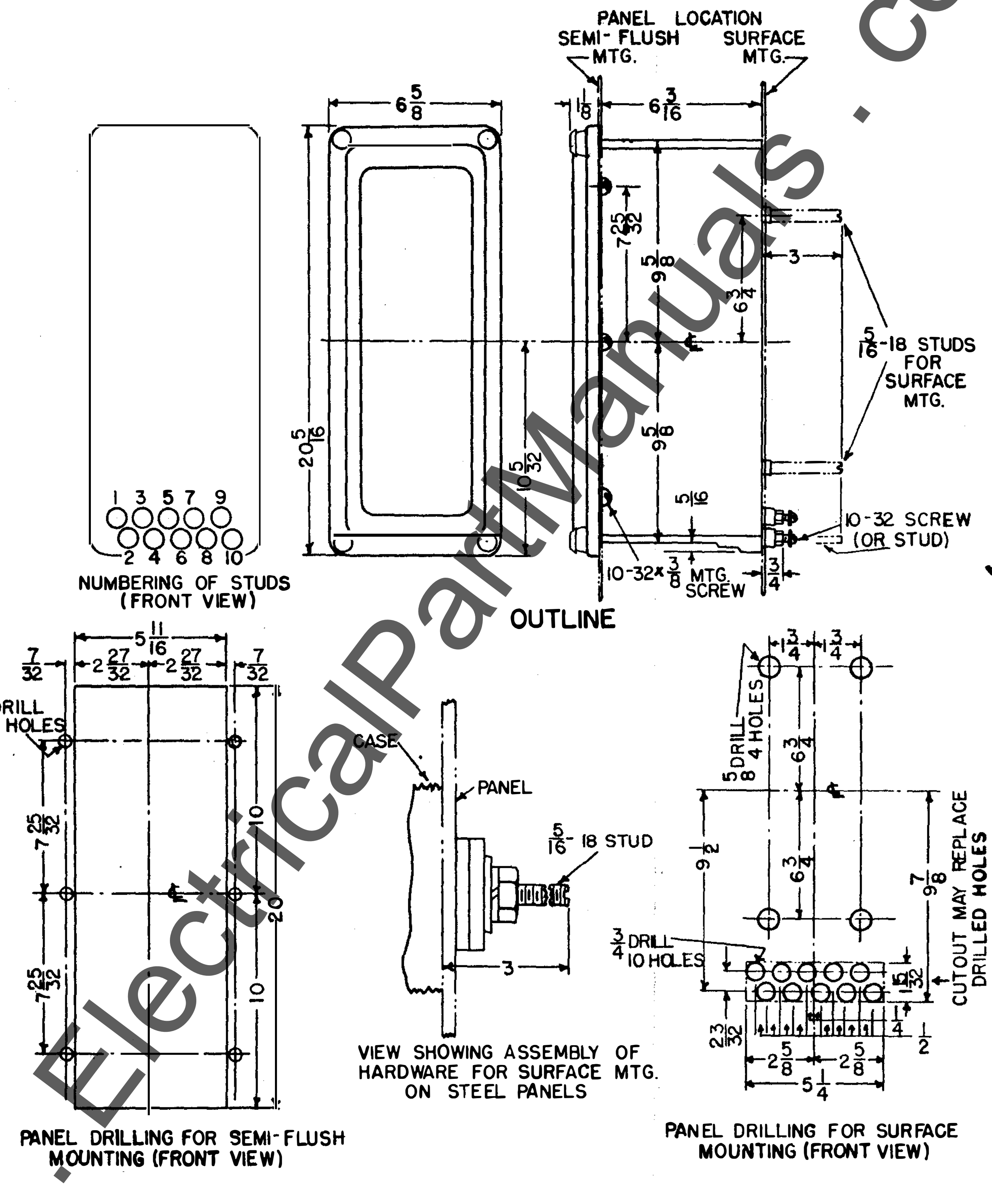

Fig. 20 (K-6209275)

Fig. 20 Outline and Panel Drilling for the Type IAC51D Relay