G.E. - MAGNE-BLAST SWITCHGEAR

TAB #	CAT SECTION	DESCRIPTION	CONTENTS
1	GEI-25390C	Instructions	Type MI-6 & MI-9 Metal-Clad Switchgear
2	GEH-1802W	Instructions	Type M26 & M36 Metal-Clad Switchgear
	GEH-1802V	Instructions & Recommended Pts	for Magne-Blast Air Circuit Breaker
	GEH-1802R	Instructions & Renewal Parts	Type AM-4.16 & AM-13.8
	GEH-1802K	Instructions	
	GEH-1802H	Instructions & Renewal Parts	
3	GEF-4351B	Renewal Parts	Types M-26 & M-36 Metal-Clad Switchgear
3A	GEI-88775A	Instructions	MC-4.76 Switchgear
4	0156C9403	Instructions	Replacement of TUF-LOC Bushings
			Below for GEH-1802R M26 & M36 Swgr
5	GEH-230Z	Instructions	Instrument Transformers
	GEH-908M	Instructions	Control & Instrument Switches
	198 4555K10-006	Installation	Type AB-30 Ammeters & Voltmeters
	GEH-1788D	Instructions	Time Overcurrent Relays
	GEH-2901	Instructions	Lightning Arrestors
	GEI-10951L	Instructions	Current Limiting Fuse Units
	GEI-88760A	Instructions	Capacitor Trip Device

GEI-25390C

INSTRUCTIONS

Switchgear

Type MI-6 and MI-9
For Oil- and Air-circuit Breakers

METAL-CLAD SWITCHGEAR

GENERAL ELECTRIC

CONTENTS

METAL CLAD SWITCHGEAR

TYPE MI-6 AND TYPE MI-9

FOR

OIL AND AIR CIRCUIT BREAKERS

GENERAL INFORMATION

Metal Clad Switchgear is equipment to control and protect various types of electrical apparatus and power circuits.

The switchgear consists of one or more units which are mounted side by side and connected mechanically and electrically together to form a complete switching equipment. Typical equipments are shown in figures 1-2-3-4.

The circuit breakers are easily removable to provide maximum accessibility for maintenance with minimum interruption of service. The switchgear is designed to provide maximum safety to the operator. All equipment is enclosed in grounded metal compartments.

The equipment is available in the ratings listed in the following tables. For outdoor installation the same basic equipment is built into a weatherproof housing as in Fig. 4 and 9.

TYPE MI-9 LIGHT DUTY METAL CLAD EQUIPMENT
MAXIMUM VOLTAGE 5 KV.

CIRCUIT BREAKERS	TYPE	INTERRUPT. CAPACITY KVA	MAX. BKR. VOLTAGE	CURRENT	FIGURE
FK-1-2	Oil Blast	25,000	5000	600	1
FK-1-3		50,000	5000	600-1200	
AM-3-50	Magne Blast	50,000	5000	600-1200	1

TYPE MI-6 HEAVY DUTY METAL CLAD EQUIPMENT
MAXIMUM VOLTAGE 15 KV.

CIRCUIT BREAKER	TYPE	INTERRUPT. CAPACITY KVA	MAX. BKR. VOLTAGE	CURRENT	FIGURE
FK-25-100	Oil Blast	100,000	5000	600-1200	
150		150,000	15000	600-1200	2
250		250,000	15000	600-1200-2000	
500		500,000	15000	1200-2000	3
AM-3-100		100,000	5000	600-1200-2000	
150		150,000	5000	600-1200-2000	2
250		250,000	5000	600-1200-2000	
AM-15-250	Magne Blast		15000	1200-2000	
500			15000	1200-2000	3

DESCRIPTION

Each unit is made up of a secondary enclosure and a primary enclosure, as shown in Figures 5-6.

Secondary Enclosure

The secondary enclosure is usually located at the front or breaker withdrawal side of the unit. It consists of a compartment with a hinged door upon which are mounted the necessary instruments, control and protective devices. The terminal blocks, fuse blocks, and some control devices are mounted inside the enclosure on the side sheets and a trough is provided at the top to carry wiring between units. When a large number of devices are required a second enclosure is sometimes provided at the rear.

Primary Enclosure

The primary enclosure contains the high voltage equipment and connections arranged in compartments to confine the effects of short circuits and so minimize the damage caused.

Circuit Breaker Removable Element (Figs. 30, 31, 32, 33)

The removable element consists of a circuit breaker with trip-free operating mechanism mounted directly on the breaker frame, a tripping interlock, the removable portion of the primary and secondary disconnecting devices and necessary control wiring. Oil Circuit Breakers are inserted or withdrawn from the stationary frame by means of a transfer truck, the Magne-Blast Breakers are equipped with wheels.

The circuit breaker unit cannot be lowered from its connected position nor raised from its disconnected position, until the breaker has been tripped. This is accomplished by a mechanical interlock which trips the circuit breaker immediately upon application of the operating handle or the starting of the motor operated elevating device. This interlock also keeps the breaker in its tripped position until the connected position is reached (when elevating) or until the test position is reached (when lowering). With this arrangement, the circuit breaker must be tripped prior to any travel of the removable element. A positive stop prevents overtravel of the removable element when raised to its connected position.

The secondary disconnecting device couplers are used for connecting outside control circuits to the circuit breaker solenoid coil, trip coil and auxiliary switches. These couplers make contact automatically when the removable element is raised to the connected position. Control test jumpers are furnished which are plugged into these couplers on the stationary and removable elements when it is desired to operate the breakers in the test position.

All removable elements furnished on a particular requisition and of like design and ratings are completely interchangeable one with the other. The removable as well as the stationary elements are built with factory jigs and fixtures thus insuring interchange-ability.

FIG. 1
TYPE MI-9 METAL CLAD SWITCHGEAR (90" ENCLOSURES)

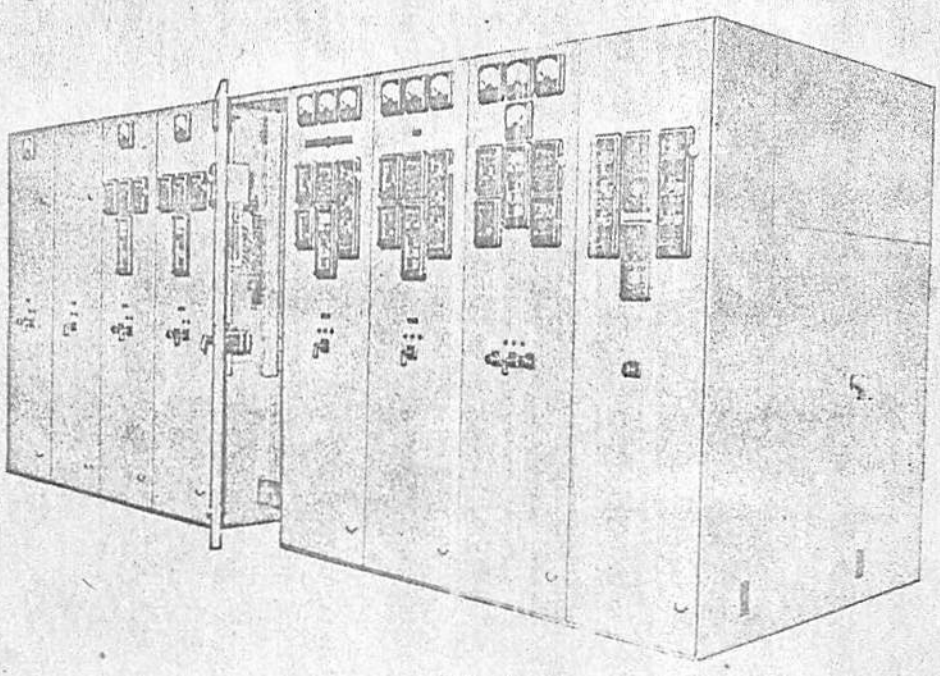


FIG. 2
TYPE MI-6 METAL CLAD SWITCHGEAR (98" ENCLOSURES)
(26" WIDE)

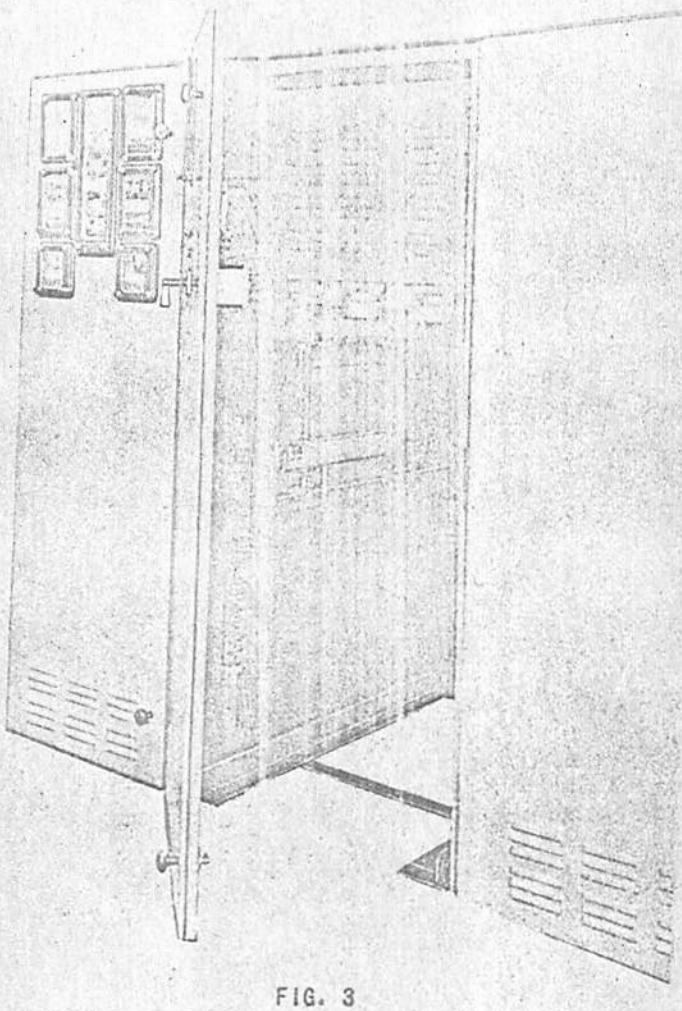


FIG. 3
TYPE MI-6 METAL CLAD SWITCHGEAR (82" ENC.)
(36" WIDE)

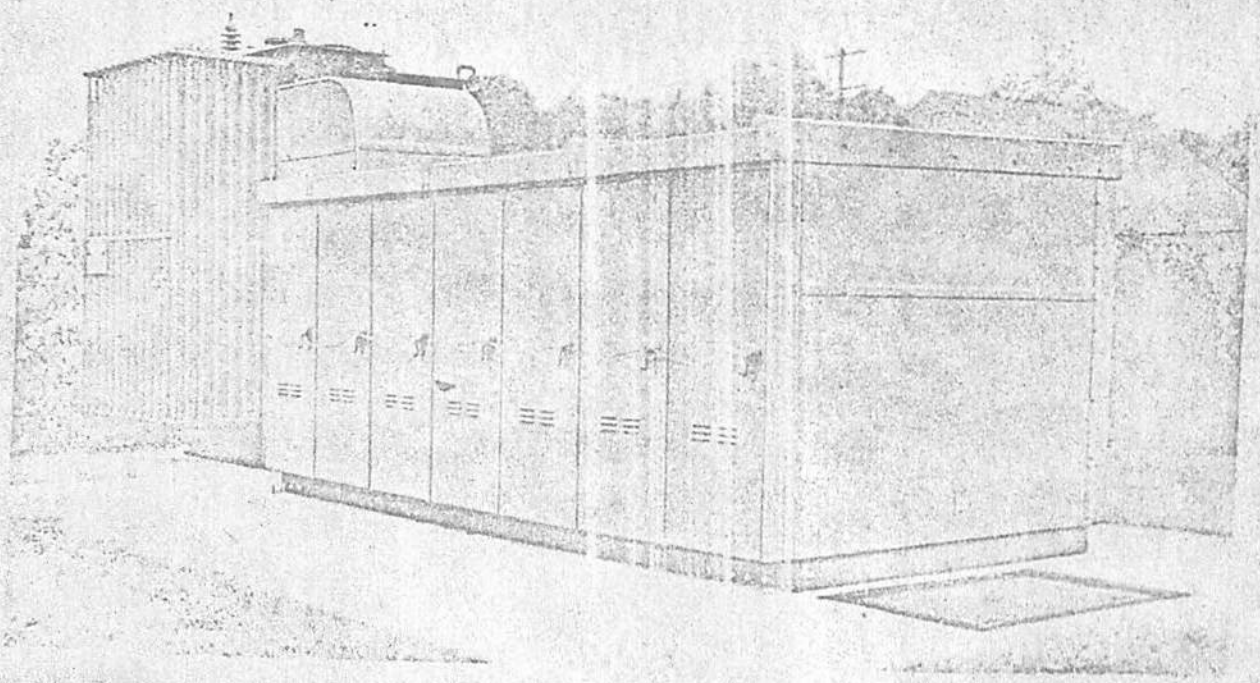


FIG. 4
TYPE MI-6 METAL CLAD SWITCHGEAR OUTDOOR UNIT SUBSTATION

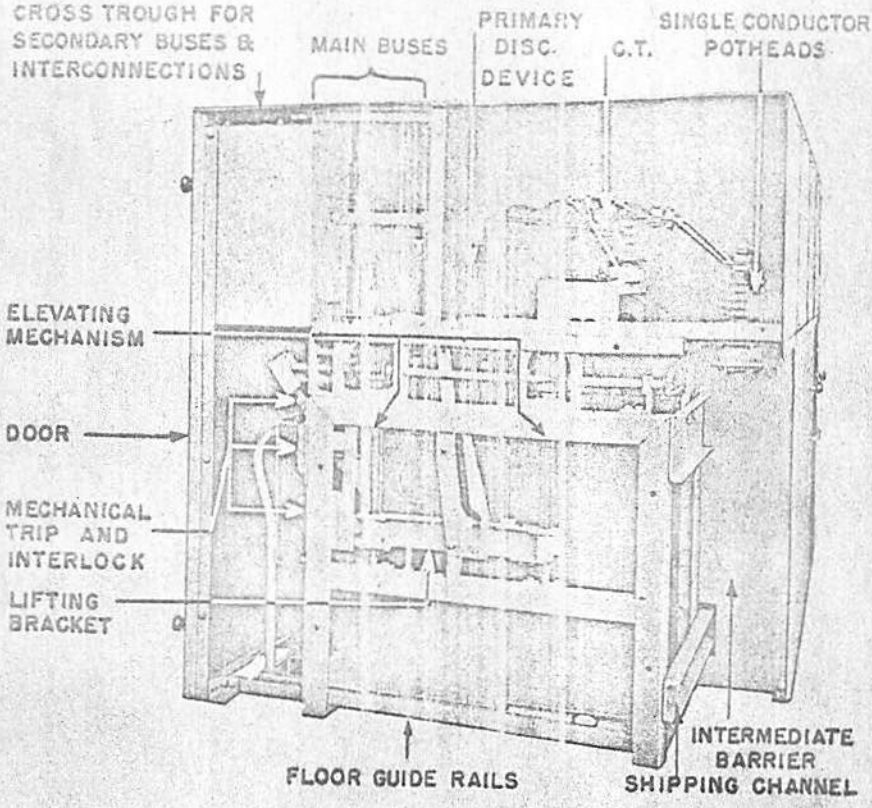


FIG. 5
TYPE MI-6 METAL CLAD SWITCHGEAR (SIDE VIEW)

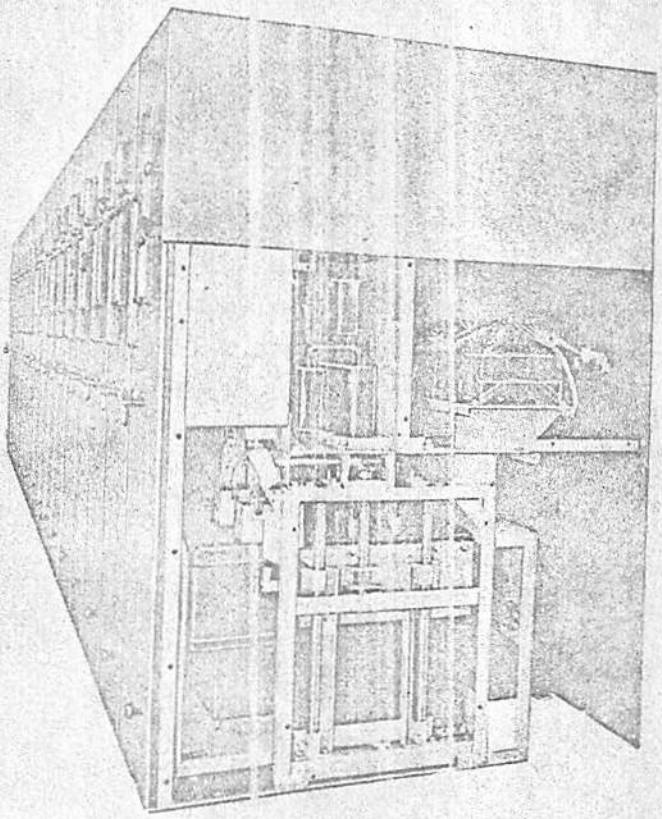
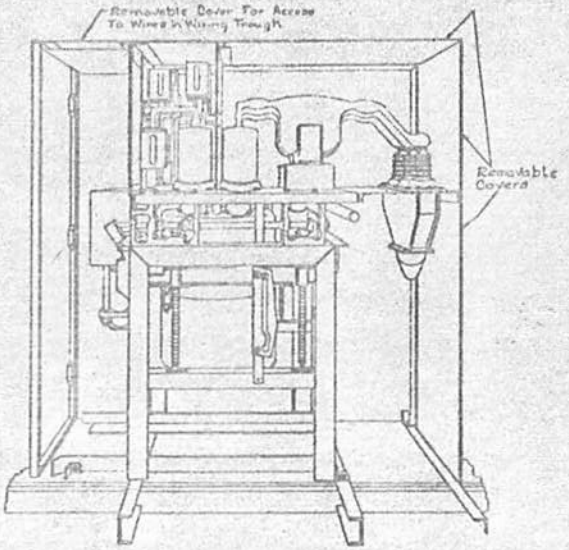
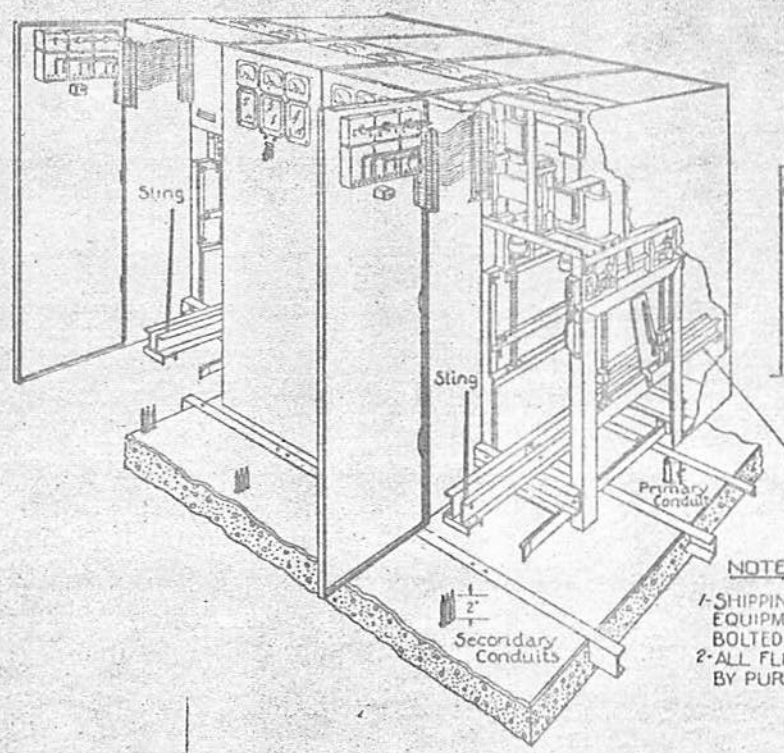
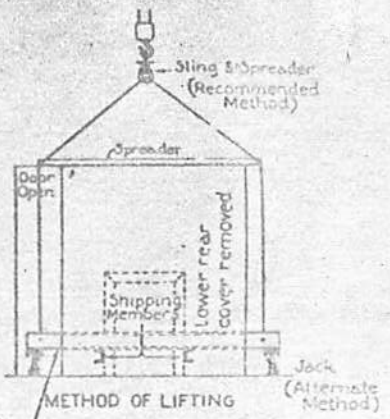


FIG. 6
TYPE MI-9 METAL CLAD SWITCHGEAR (SIDE VIEW)



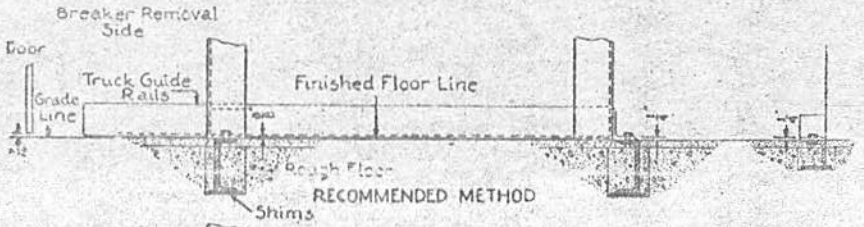




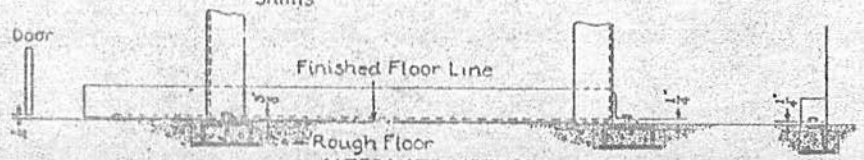
LIFTING MEMBER CHANNELS OR EQUIVALENT TO BE SUPPLIED BY PURCHASER

NOTE -

1- SHIPPING MEMBERS TO REMAIN ON EQUIPMENT UNTIL EQUIPMENT IS BOLTED TO FOUNDATION - THEN REMOVED.
2- ALL FLOOR STEEL TO BE FURNISHED BY PURCHASER



Channels should be set level with each other and should be level over their full length.



Rough floor thickness and reinforcing depends on loading and other normal factors, and should be designed in accordance with recommended practice.

NOTE: It Is Imperative That Floor Steel Be Even With Finished Floor And That Both Be Level

FIG. 7

INDOOR METAL CLAD SWITCHGEAR INSTALLATION DETAILS

Circuit Breaker Elevating Mechanism

The elevating mechanism for elevating or lowering the removable element to or from its connected position supports the removable element in either the operating or test positions. This mechanism consists of heavy-duty steel jack screws on which are carried nuts to support the elevating carriage. The carriage is so designed that the removable element can be readily inserted or withdrawn after the carriage has been lowered to the disconnected position without necessitating the removal of any bolts, nuts or screws. The mechanism causes the breaker to trip as soon as the raising or lowering operation begins and holds the tripping mechanism in this position until the breaker reaches either the connected or test positions.

Guide railsare built into the elevating mechanism frame to guide the transfer truck and (or) removal breaker element into correct position before the breaker is raised into the operating position by means of the elevating mechanism.

The elevating mechanism is operated by a hand crank. On equipments using the large breakers (36" wide) the mechanism is motor operated to increase the speed of operation.

Primary Disconnecting Device (Fig. 34)

The primary disconnecting devices utilize silver to silver contacts toinsure against reduction of current carrying capacity due to oxidation of the contact surfaces. These contacts are of the high pressure line contact tube and socket design, the tube being backed up by heavy garter springs to insure contact pressure.

Bus Compartment

The main buses are enclosed in a metal compartment with removable front and top covers to provide accessibility. The covers have louvers for ventilating the compartment.

The bus is supported by an insulating material which is practically impervious to moisture, and a excellent dielectric.

The bus insulation is molded on the bars except at the joints where the insulation is completed by means of compound filled boxes.

Current Transformer and Cable Compartment

The current transformers are mounted in a compartment isolated from the other equipment. Provision is made in this compartment for connecting the purchaser's primary cable by means of potheads or clamp type terminals.

Potential Transformers Compartment

Potential transformers are located in a compartment above the current transformers or in a separate unit adjacent to the breaker units.

The transformers are mounted on a movable support equipped with primary and secondary disconnecting devices. When the potential transformers are disconnected they are at a safe striking distance from all live parts of the switchgear. In addition a grounding device is provided which contacts the fuses when the potential transformers are disconnected, effectively discharging the transformers. In this position the transformer fuses may be safely removed and replaced.

SHIPPING - UNPACKING - STORAGE

Shipping and Unpacking

Every case or crate leaving the factory is plainly marked at convenient places with case number, requisition number, customer's order, front or rear, and when for size and other reasons it is necessary to divide the equipment for shipment, with the unit number of the portion of equipment enclosed in each shipping case.

The contents of each package of the shipments are listed in the Packing Details. This list is forwarded with the shipment, packed in one of the cases. The case is especially marked and its number can also be obtained from the Memorandum of Shipment. When unpacking, to avoid the loss of small parts, the contents of each case should be carefully checked against the Packing Details before discarding the packing material. Notify the nearest General Electric Company representative at once if any shortage of material is discovered.

All elements before leaving the factory are carefully inspected and packed by workmen experienced in the proper handling and packing of electrical equipment. Upon receipt of any apparatus an immediate inspection should be made for any damage sustained while enroute. If injury is evident or an indication of rough handling is visible, a claim for damage should be filed at once with the transportation company and the General Electric Company notified promptly. Information as to damaged parts, part number, case number requisition number, etc. should accompany the claim.

Set screws are placed in all door latches (Fig. 8) to prevent doors from accidentally opening during shipment and installation. These should be removed and discarded when the equipment is permanently located.

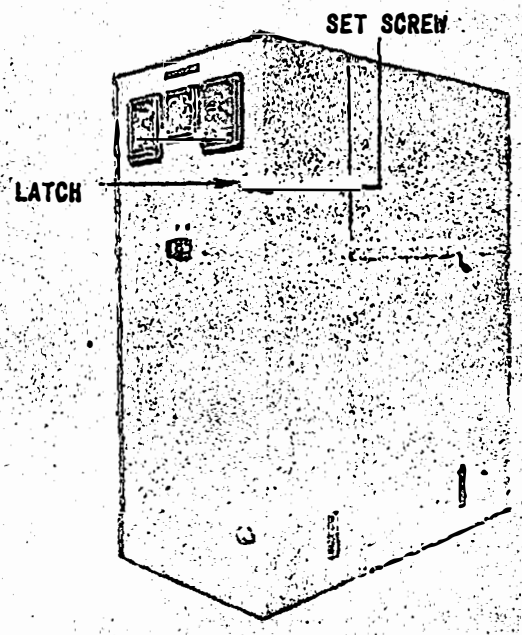


FIG. 8
DOOR LATCH LOCKING SCREW

Handling (Indoor Equipment)

Before uncrating, the equipment may be moved by a crane with slings under the skids. If crane facilities are not available rollers under the skids may be used.

After uncrating, the equipment should be handled as shown in Fig. 7. The longitudinal channels tie the group of units together to prevent distortion of the structure during shipment and handling, and therefore should not be removed until the units are permanently bolted to the station floor. The lateral or lifting channels are shipped separately and must be bolted to the longitudinal channels before attempting to lift a group of units. The door must be held open by the door stops in those units where the lifting channels are assembled. If crane facilities are not available, jacks may be applied under the lifting channels to raise or lower, and rollers used to move the equipment.

Handling (Outdoor Equipment)

Methods of handling outdoor equipment are shown in Fig. 9. After the equipment is in place, the lifting plates should be removed and reassembled, "turned in", so that passageway at the ends of the equipment will not be obstructed.

Storage

If it is necessary to store the equipment for any length of time, the following precautions should be taken to prevent corrosion:-

1. Uncrate the equipment.
2. Cover important parts such as jack screws, gears and chain of lifting mechanism, linkage and moving machine finished parts with a heavy oil or grease.
3. Store in a clean, dry place with a moderate temperature and cover with a suitable canvas to prevent deposit of dirt or other foreign substances upon movable parts and electrical contact surfaces.

INSTALLATION

Before any installation work is done consult and study all drawings furnished by the General Electric Company for the particular requisition. These drawings include arrangement drawings, wiring and elementary diagrams and a summary of the equipment.

Location

The recommended aisle space required at the front and at the rear of the equipment is shown on the floor plan drawing furnished for the particular requisition. The space at the front must be sufficient to permit the insertion and withdrawal of the circuit breakers, and their transfer to other units. The space at the rear must be sufficient for installation of cables, for inspection and maintenance, and on some equipments to draw out potential transformers.

Preparation of Floor - Anchoring (Indoor Equipment)

The station floor must be strong enough to prevent sagging due to the weight of the switchgear structure and to withstand the impact stress caused by the opening of the circuit breakers under short circuit conditions. The impact loading is approximately 1 1/2 times the static load.

Suitable means must be provided by the purchaser for anchoring the equipment to the floor. It is essential that the floor be level to avoid distortion of the switchgear structure, and the equipment be completely aligned prior to final anchoring. The recommended floor construction is shown in Figure 7. The floor channels must be level and straight with respect to each other. Steel shims should be used for final leveling of the switchgear if necessary. Care should be taken to provide a smooth, hard and level floor under and in front of the units to facilitate installation and removal of the breaker. The rear, or swivel wheels of the breaker and the transfer truck will roll on the floor rather than the unit guide rails. If the floor is not level and flush with the floor channels, it will be difficult to handle the breaker because it will not be level with respect to the stationary element.

The anchor bolts must be located according to the floor plan drawing furnished for the particular requisition.

Another method of anchoring often used is welding. A tack weld is substituted for an anchor bolt in each location.

Provision should be made in the floor for conduits for primary and secondary cables, located as shown on the floor plan drawing furnished for the particular requisition. If desired, the conduits may be installed before the switchgear. Consideration should be given to conduits which might be required for future connections.

Preparation of Foundation— Anchoring (Outdoor Equipment)

Recommendations for the foundations for outdoor equipment are given in Figure 9. Primary and secondary conduits should be installed in accordance with the requisition drawings, before the equipment is put into place.

Putting the Units in Place

After the floor has been prepared move the equipment into place by the methods described above under "Handling".

When the equipment is shipped in two or more sections, the sections must be bolted together with the spacers, which are furnished, assembled between the units. These spacers are required to maintain the required distance between the center lines of the units as indicated on the floor plan.

Holes are provided in the structure for the bolts. When several units are shipped from the factory as a group, the spacers are already installed and the bolting at installation should be done in the same manner.

The equipment should be completely aligned and securely fastened to the floor by anchor bolts or welding and the shipping channels removed.

When outdoor equipments are shipped in more than one section, the joint in the roof between sections must be weather-proofed. Apply G.E. #1201 Glyptal cement to the gaskets which are furnished and assemble the gasket between the roof flanges and bolt together. See Fig. 37, Assembly C. Joints between transformer throats and the switchgear should be weather-proofed in the same manner. (Figure 11).

Tandem Lock for Outdoor Units

Outdoor Metal Clad Equipments with more than one unit are provided with a tandem locking arrangement which makes it necessary to padlock only one door on each side. (In exceptionally long installations two or more locks may be required on each side). The unit containing the operating arm of the tandem lock is clearly marked on the drawings and also by nameplate on the equipment itself.

Before any door in the equipment can be opened it is necessary to open the padlocked door and operate the tandem locking arm to the open position. In locking the equipment the reverse procedure should be used.

Where it is desired to separately lock any particular door, the tandem lock can be disconnected in that unit by unbolting a connecting clip between the tandem bar and the locking bar, and a separate padlock used on that door.

Potential Transformer Compartment

Two 3/8" bolts are placed on the underside of the track to remove the weight of the rollout carriage from the track during shipment. These bolts should be removed after the equipment is in place.

Installation of Bus Bars

Where bus bar connections are made to join groups or separate units together, proceed as follows:

(a) Remove compartment covers.

(b) Bolt splice plates and bus bars together, see Fig. 10. Clean silvered contacts with carbon tetrachloride. Where carbon tetrachloride does not completely remove stains, use Silver polish. Do not use sand-paper.

(c) Complete the taping of the vertical riser bars using varnished cambric tape (2/3 lap) stopping the tape at the bus bar. If the riser bars connect to the bus from below, sufficient tape should be added to prevent compound leakage when filling. Apply a layer of cotton tape (1/2 lap) over the varnished cambric tape, stopping the cotton tape just inside molded splice cover.

(d) Place molded covers around the bolted splice joints. Note that compound filling space is at top of joint, and add filler pieces furnished for the purpose to the bottom of box and around bus bar laminations (Fig. 10) to prevent compound leakage while filling. Duxseal should be placed over the joints to make the box free of leaks while filling. The duxseal should be removed after the compound has set. G.E. #860 cord should be used to hold the molded parts securely in place.

(e) Heat G.E. #1347 compound (furnished) to approximately 200°C. Avoid overheating the compound for the dielectric strength may be seriously affected. Pour the compound into the molded covers intermittently, allowing an interval of cooling to prevent formation of gas or air pockets. The final pouring should be level with the top of the box and should be done only after due allowance for shrinkage is made.

(f) Paint the exposed cotton tape on vertical riser bars with G.E. #1201 varnish, for 15 KV equipments and G.E. #462 varnish for 5 KV equipments.

(g) In unit substations, the connection bars should be assembled in the Transition Compartment (Fig. 11) and the connections at the Transformer Terminals taped and painted as indicated above. The conduit for secondary circuits should also be assembled in the Transition Compartment.

Primary Cables

Before any primary cable connections are made, the cables should be identified to indicate their phase relationship with the switchgear connections. This is necessary to insure that the connections are made so that motors will rotate in the proper direction, and that the phase rotation is the same when typing two different sources of power together.

There are two common methods of making primary cable connections:

(a) Potheads, see Fig. 12, are used when it is desired to hermetically seal the end of the cable to make a moisture proof connection between the cable and the switchgear copper. A pothead also prevents seeping of oil from the end of oil impregnated varnish cambric or paper insulated cable.

(b) Clamp type terminals and wiping sleeve or cable clamp.

In all cases carefully follow the cable manufacturer's recommendations for installation of the type of cable being used, as well as the instructions contained herein.

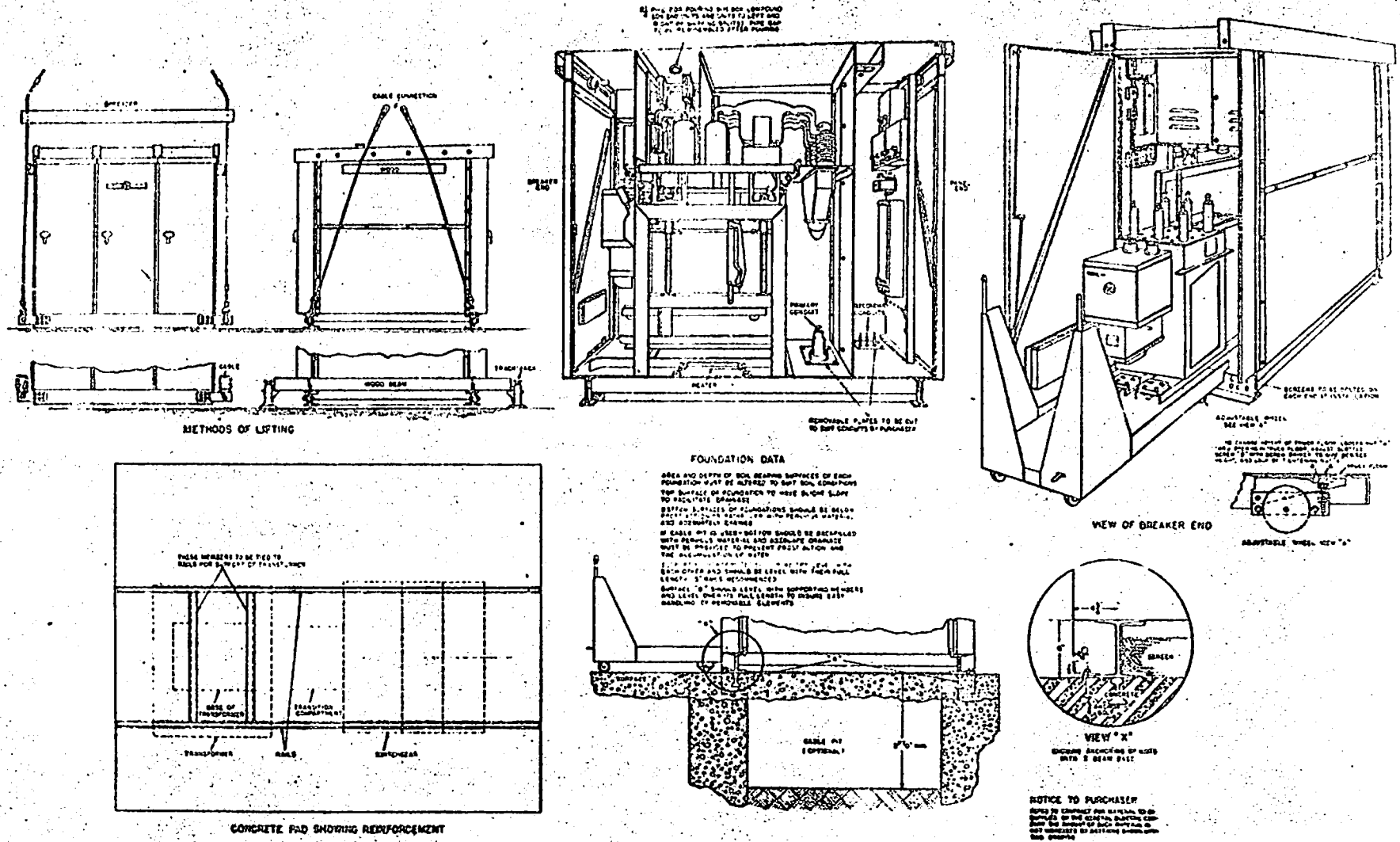


FIG. 9
OUTDOOR METAL CLAD SWITCHGEAR INSTALLATION DETAILS

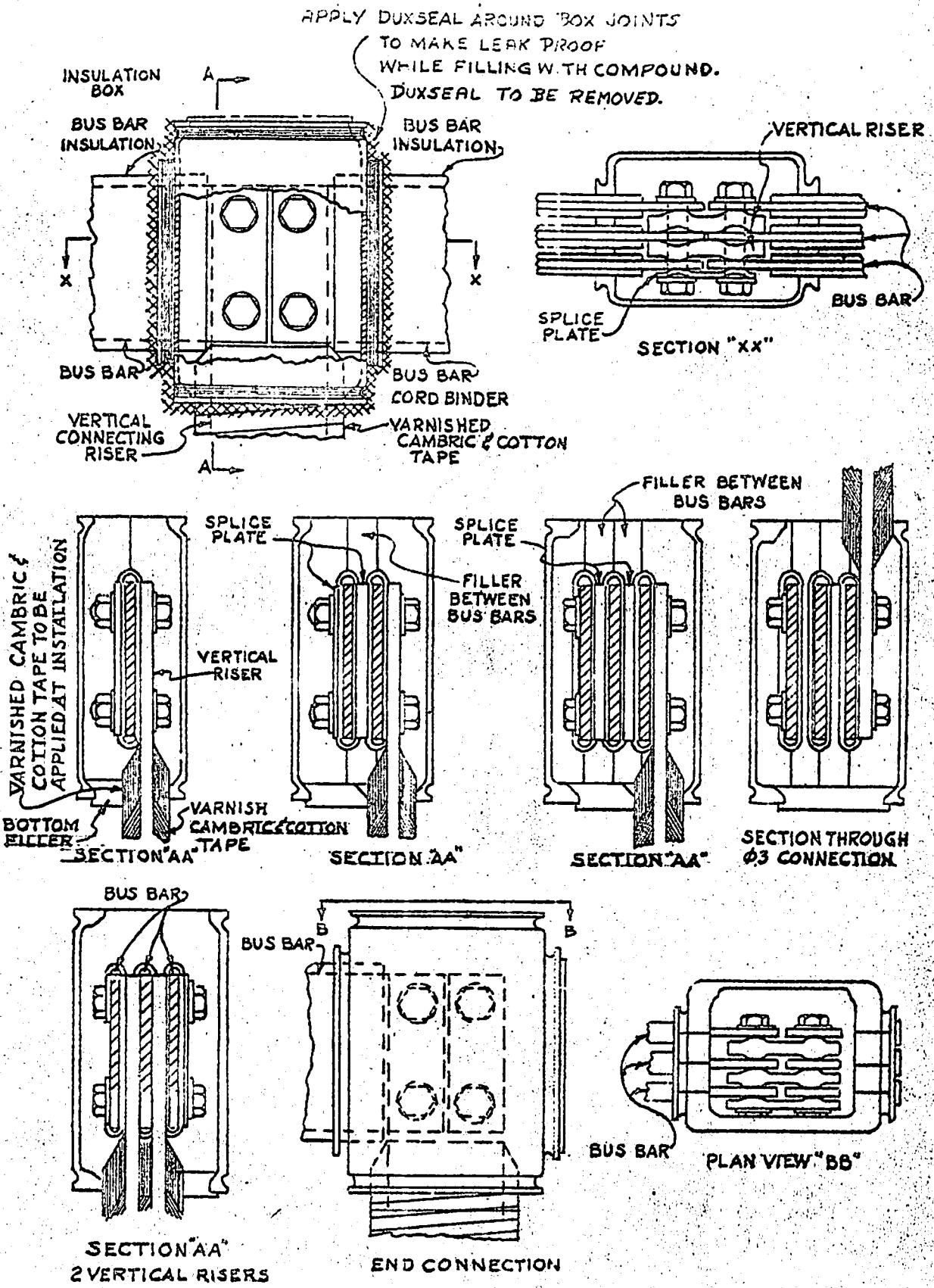


FIG. 10
METHOD OF MAKING BUS BAR CONNECTIONS

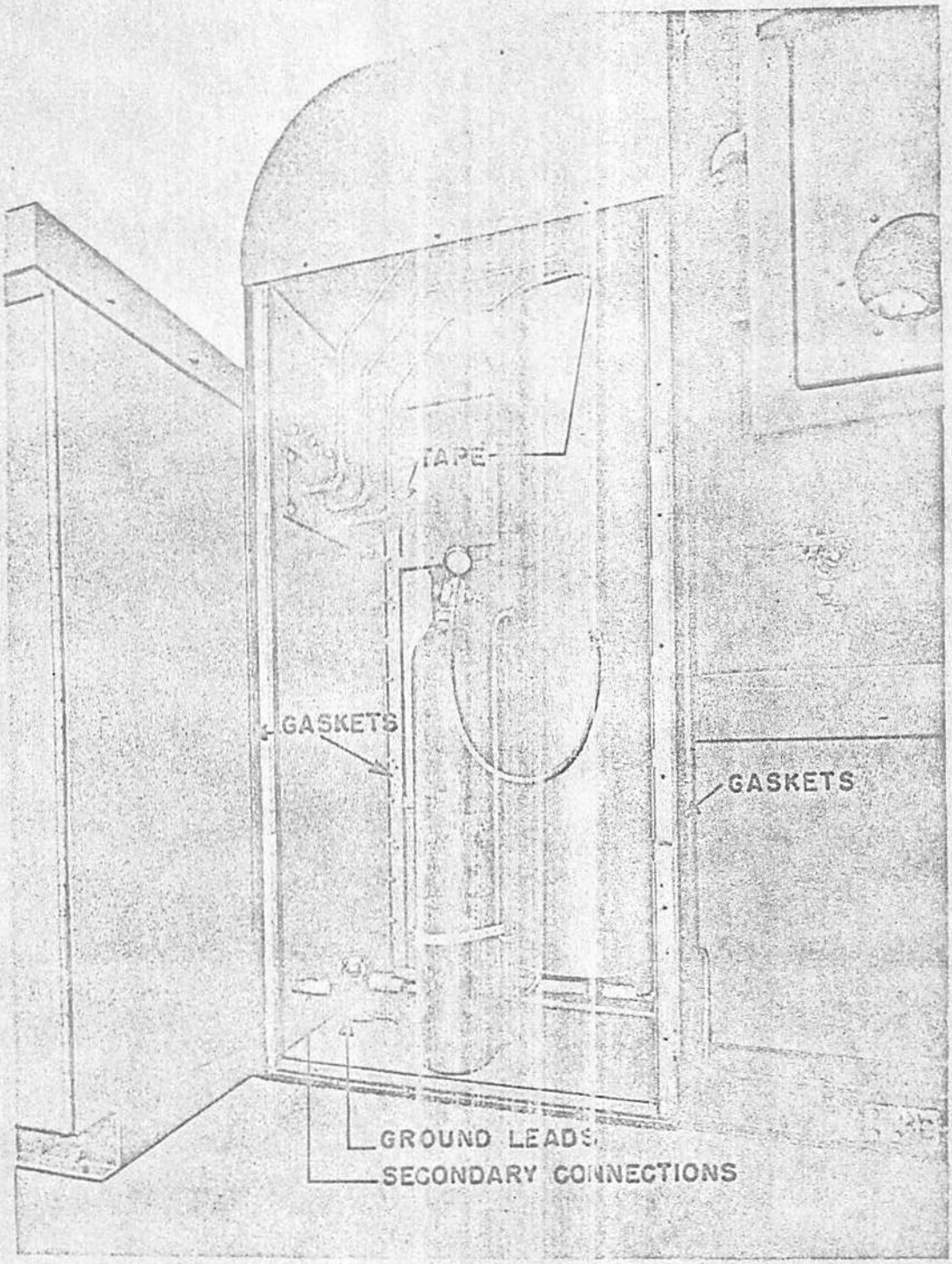


FIG. 11
UNIT SUBSTATION TRANSITION COMPARTMENT

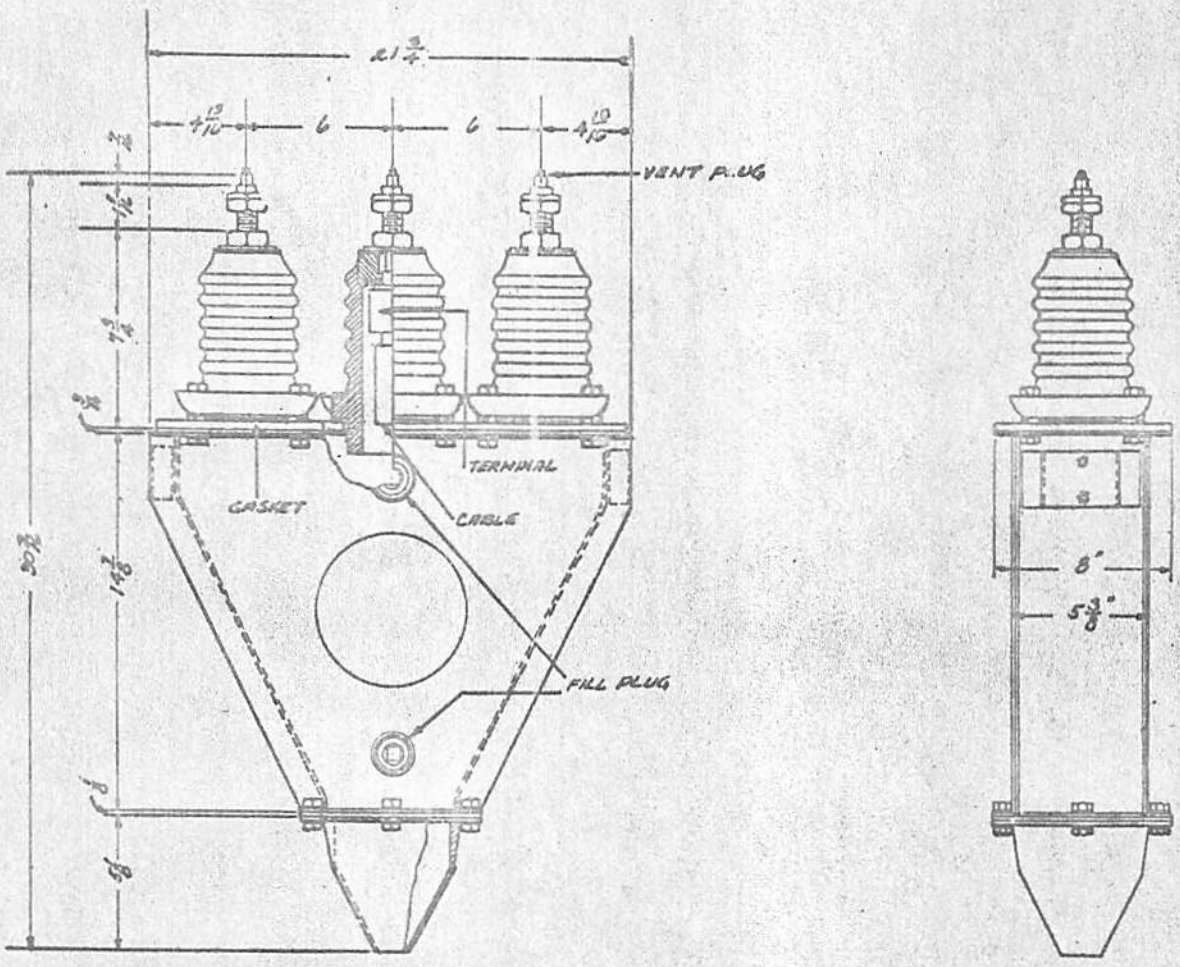


FIG. 12
G.E. POTHEAD FOR METAL CLAD SWITCHGEAR

(8903529A)

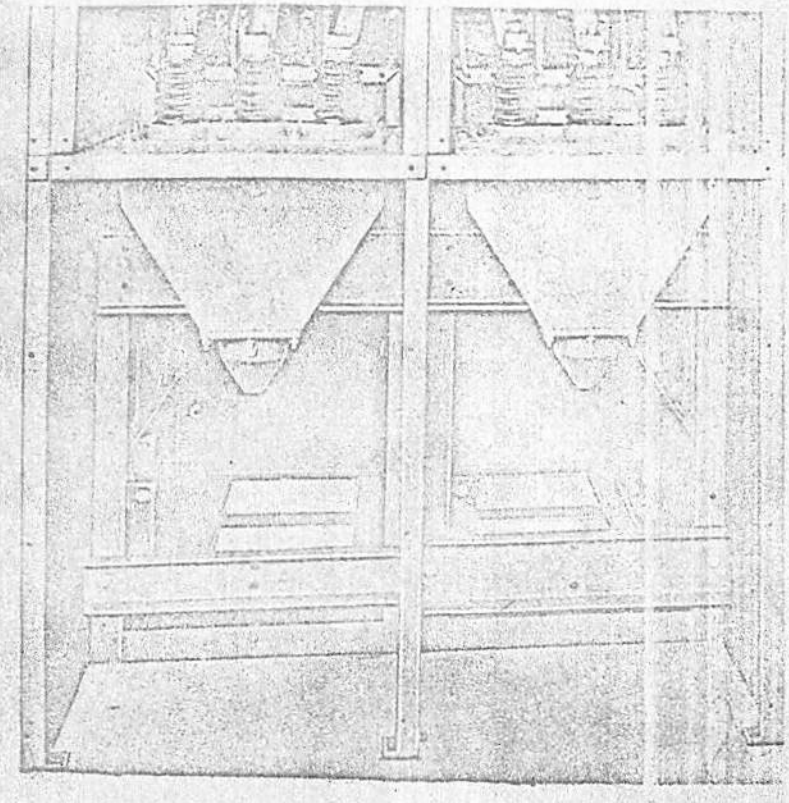


FIG. 13

FIG. 14

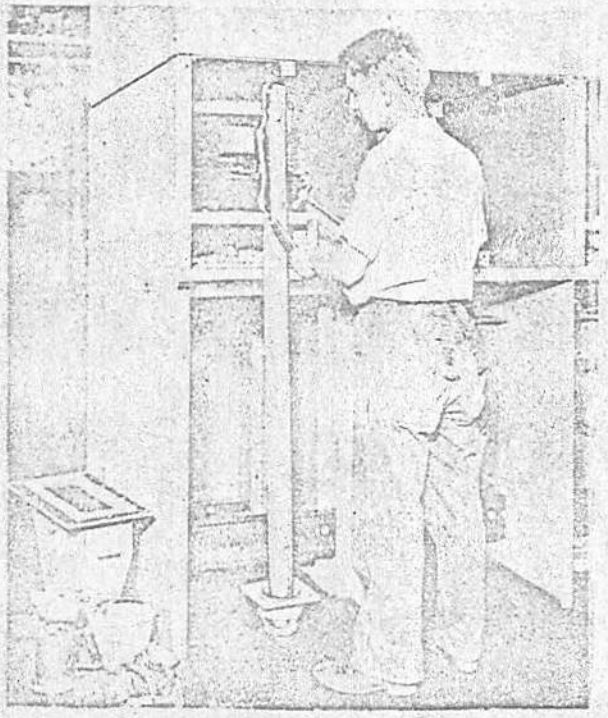


FIG. 15

FIG. 16

Installation of Potheads

Potheads are mounted on an adapter plate extending across the width of the metal clad unit as shown in Fig. 13. The adapter plate is split in two parts to facilitate the installation of the potheads.

The following description applies to the installation of a three conductor lead sheathed cable with a wiping sleeve cable entrance fitting on the pothead. This is the type most generally used. Instructions for installation of other type are included in the text following.

(a) Remove the wiping sleeve from the pothead and cut the tapered end at a point where the cable will enter it freely, and file off sharp edges. Tin the sleeve by applying flux and dipping in hot solder. Temporily assemble the wiping sleeve and gasket on the pothead.

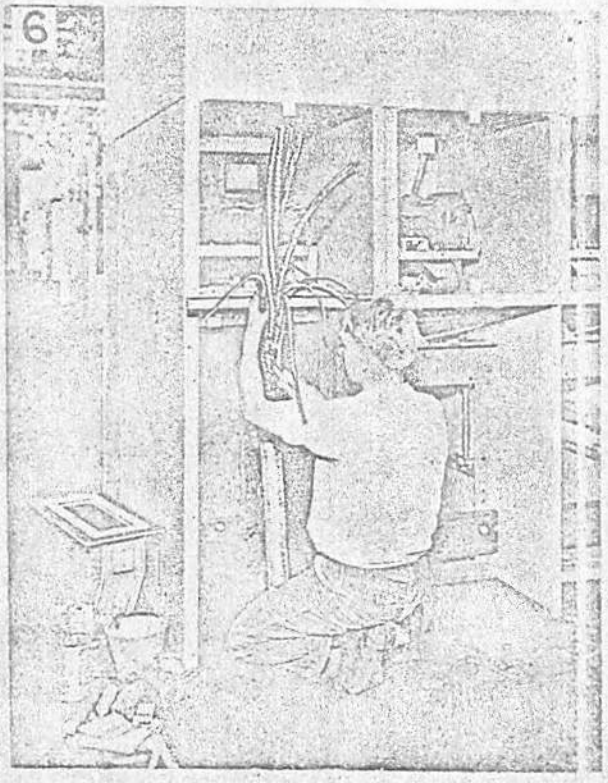


FIG. 17

(b) Train the cable in front of the pothead allowing it to extend about two inches above the top of the porcelain bushings. When training the cable handle with care and avoid sharp bending which might damage the insulation. Mark a point on the lead sheath of the cable about 1-1/2 inches above the bottom of the wiping sleeve.

(c) Remove the pothead from the unit, and slip the wiping sleeve and its gasket over the cable as shown in Figure 14.

FIG. 18

(d) Remove the lead sheath from the cable to the point marked in operation "b", as shown in Figures 15 and 16. Proceed as follows: First, make a cut around the cable half through the sheath at the reference point. Second, split the sheath lengthwise between the cut and the cable and holding the cutting tool at an angle to the cable radius to avoid damaging the insulation. Third, remove the sheath by catching the split edge with pliers and pulling directly away from the cable axis.

Clean and tin the outside of the lead sheath for about 3 inches and bell out the end of the lead sheath.

(e) Remove the belt and interphase insulation down to within 1 1/2 inches of the lead sheath as shown in Figure 17. The last few layers should be torn off to avoid damaging the individual conductor insulation. To reinforce and protect the conductor insulation, wrap two layers of half lapped varnished cambric tape over the factory insulation.

(f) Place pothead body over cable and then fan out the conductors into approximately the final position, as shown in Figure 18. The middle conductor should be bowed slightly for final adjustment of length. Avoid sharp bends and damage to the insulation, particularly at the crotch.

(g) For system voltage above 7500 volts it is recommended that stress relief cones be built up when

single conductor or three conductor shielded cable is used....Construct stress relief cones in accordance with the recommendations of the cable manufacturer. On lower voltage cables, belling out the end of the lead sheath, ordinarily provides sufficient stress relief.

(h) Bolt pothead body to metal clad adapter plate. Shape conductors into final position then cut off each conductor, distance "X", Fig. 12, above the pothead body.

(i) Remove 2" of insulation from the end of each conductor and assemble pothead terminals as shown in Figures 12 and 21. Potheads are furnished with standard round cable solderless lugs. If sector cables are used the terminals should be changed to the solder type.

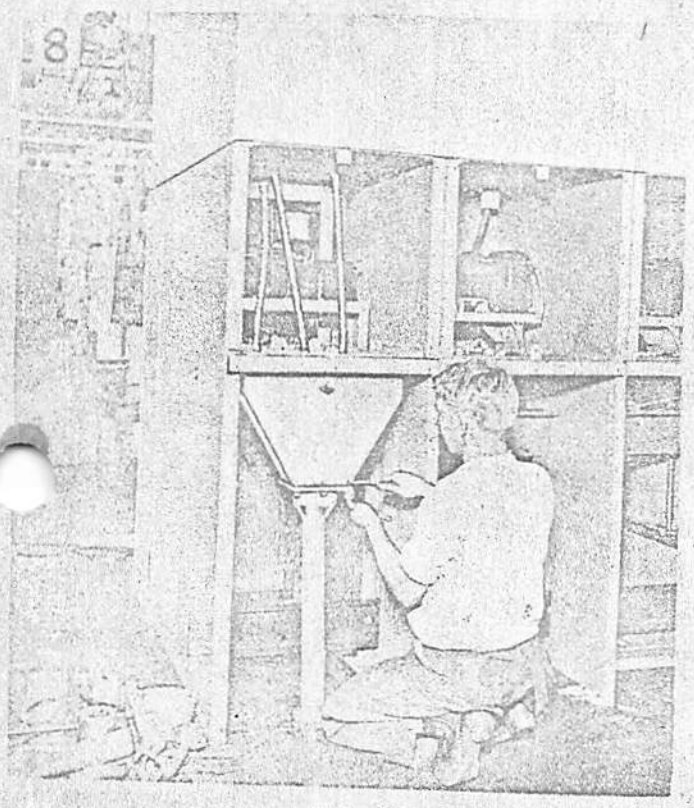


FIG. 19

(j) Bolt insulators and support and wiping sleeve to the pothead body. Thoroughly clean all gaskets and gasket surfaces. Cement all gaskets with G.E. Glyptal #1201. Compress gaskets by a partial turn on each bolt successively until the gasket is uniformly compressed forming a tight joint. Check to be sure the terminal studs are seated properly on their gaskets then screw contact nut in place. See Figures 20 and 21.

FIG. 20

(k) Make a plumber's wiped joint between the wiping sleeve and the lead sheath of the cable, as shown in Figures 22 and 23. Use a suitable flux to facilitate the wiping operation.

(l) Remove the 3/4" filling plug in the pothead body and the pipe plugs in the top of the studs. Insert a stand pipe and funnel in the filling hole, of sufficient height to extend above the top of the studs as shown in Figure 24.

Heat #227 compound to the pouring temperature, (165 Degree C). Do not overheat compound as higher temperatures may injure cable insulation and also result in excessive shrinkage of the compound while cooling. Before filling, warm pothead body to prevent sudden chilling of compound which may result in the formation of air voids. The pothead may be warmed by playing a blowtorch over the pothead body, taking care that no direct heat reaches the porcelains.

Pour compound through the filling pipe until the compound appears at the top of the pothead studs. While filling play a blowtorch on the pothead body and on the filling pipe to prevent air voids and

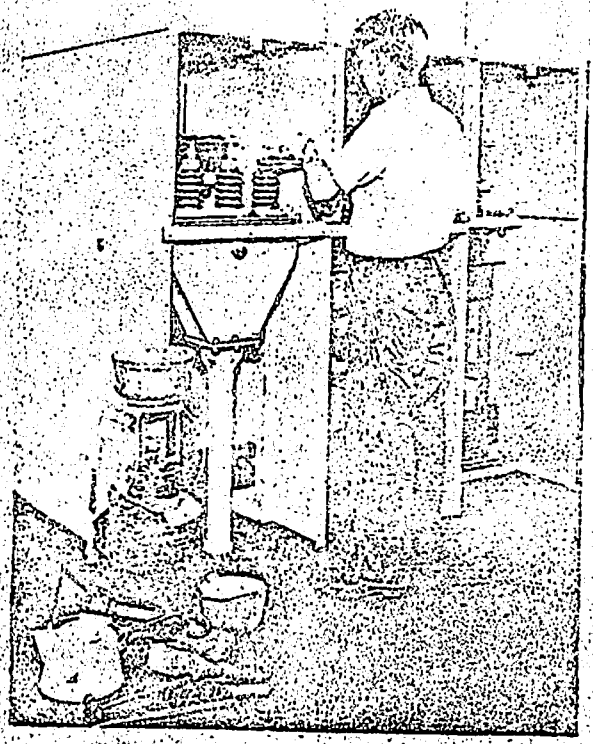


FIG. 21

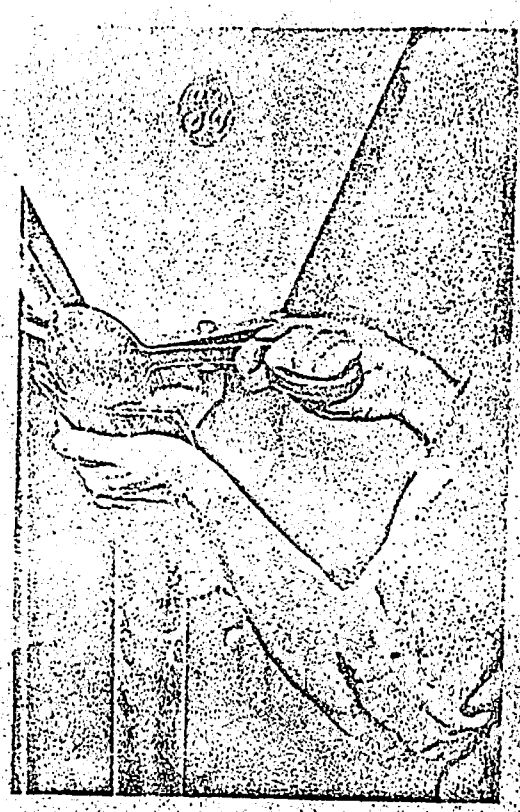


FIG. 22

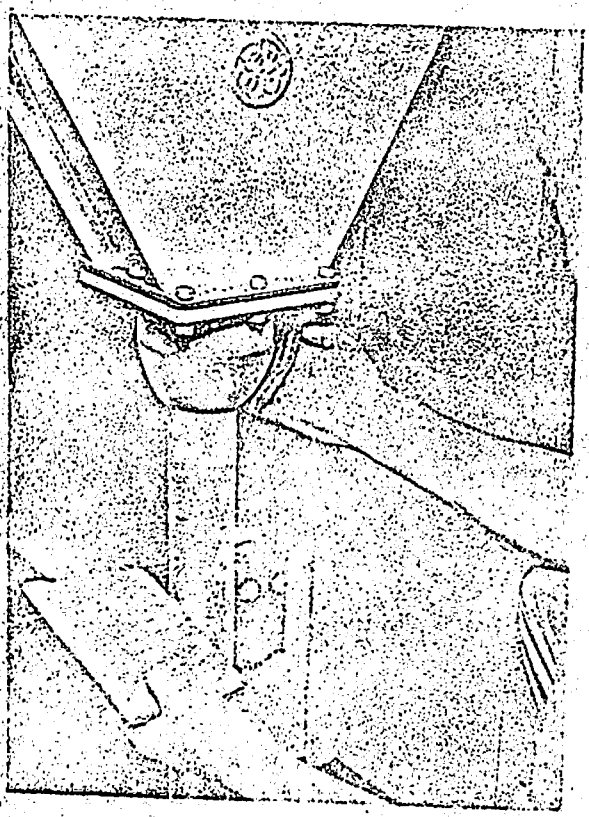


FIG. 23

FIG. 24

clogging. When full insert pipe plugs in top of studs to trap compound in the porcelain insulators. Continue pouring compound while the pothead is cooling to fill air voids which might form while the compound is cooling.

When the pothead has cooled, remove filling pipe and insert plug. Clean off compound which might have overflowed on the outside of porcelains. Retighten all bolts to be sure that all joints are tight.

(m) Assemble pothead connection bars, see Figure 25, and insulate connections as follows:

(1) Fill all cavities around bolts and nuts with "Duxseal" compound to form smooth surface for taping, thus preventing air voids. This compound is not an insulating medium and should not be used for that purpose.

(2) Wrap with varnished cambric tape, G.E. #992, as shown in Fig. 28, the number of layers depending on the voltage rating of the equipment. Where there are sharp angles apply additional layers to obtain the equivalent of the insulation of the flat surfaces.

(3) Over the varnished cambric tape apply one layer of white cotton tape, half lay, as a binder.

(4) Over the white cotton tape brush a good coat of G.E. #462 black varnish for 5KV. equipments, or G.E. #1201 red Glyptal for 15KV. equipments.

Cable Entrances other than Wiping Sleeve

Stuffing box cable entrance fittings, Fig. 26, are used for non-lead covered cable, and are installed as follows. Assemble stuffing box on pothead. Wrap graphite cord packing around the cable and compress by screwing the gland nut into the stuffing box.

A combination clamping ring and stuffing box, Figure 27, is sometimes furnished instead of a wiping sleeve for lead covered cables. This fitting is installed as follows. Wrap graphite cord packing around cable and compress by screwing gland nut into stuffing box. Bell over lead sheath and notch the edges to expose screw holes. (Note the openings in the fitting below the notches, which permit compound to reach the sheath and seal any splits which might occur while belling over and notching). Clamp lead sheath with ring and trim off sheath smoothly. Leave about 1-1/2' of belt insulation above the clamping ring.

Single Conductor Potheads

The procedure for installation of single conductor potheads is in general the same and described for three conductor potheads.

Connection of Control Cables

When control conduits enter the unit from below the conduit should not extend more than 4 inches above the floor. The control cables may be pulled through the conduits before or after the switchgear is installed whichever is more convenient.

FIG. 25

Connect the cables to the terminal blocks in accordance with the wiring diagrams furnished for the requisition.

If the control conduits enter from above, drill the top and bottom covers of the front enclosure wiring trough to suit the conduits. Fasten the conduits with locknuts to the bottom cover.

The cables from the control power source to the switchgear should be large enough to avoid excessive voltage drop when the circuit breakers are operated. See testing instructions.

Check over all screws and nuts connecting the control wiring to make sure that none have been loosened in shipment.

Installation of Ground Bus

The ground bus is shipped separate from the equipment. The bars should be bolted in place in the rear of the equipment after the shipping channels have been removed, using the same holes in the frame which are used for fastening the shipping channels.

The switchgear ground bus must be connected to the station ground bus by a conductor having a cur-

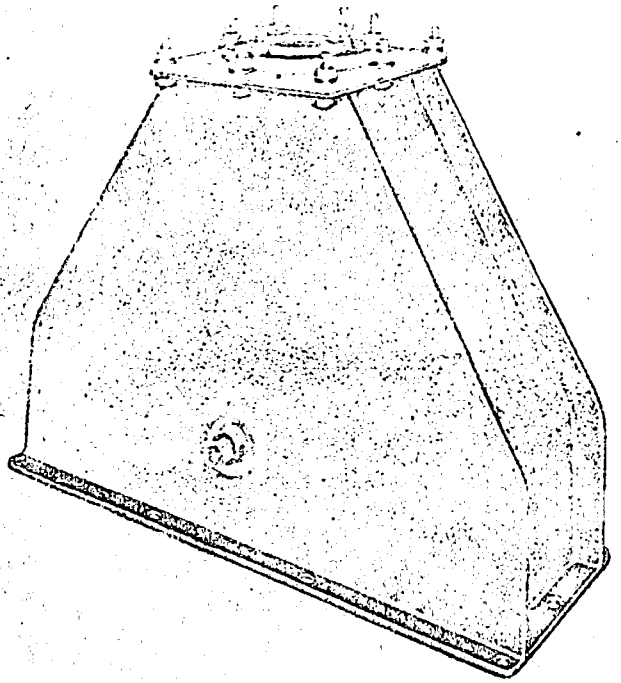


FIG. 26
STUFFING BOX

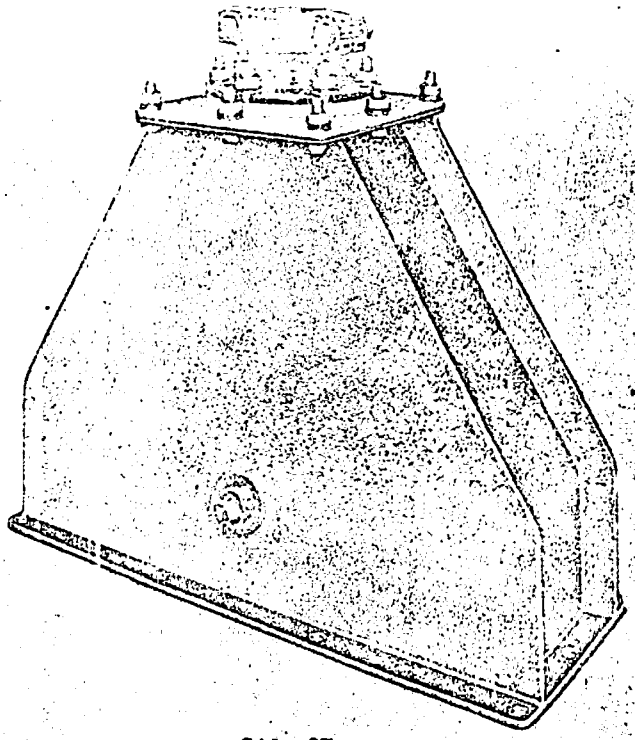


FIG. 27
CLAMPING RING AND STUFFING BOX

(800734)

(800733)

rent carrying capacity equal to that of the switchgear ground bus. It is very important that the equipment be adequately grounded, to protect the operator from injury when short circuits or other abnormal occurrences take place, and to insure that all parts of the equipment, other than live parts, are at ground potential.

Installation of Exhaust Piping

The exhaust piping for oil circuit breakers is completely assembled at the factory except where the equipment is split for shipment. To complete the piping, insert pipe between units and connect as shown in Figure 29.

Installation of Circuit Breaker Removable Element

1. Before installing or operating the removable element consult the circuit breaker instructions for directions on installation, adjustments and inspection. The operation of the trip and interlock device is given in paragraph 7 below.

   Oil circuit breakers must be filled with oil in accordance with directions in the breaker instructions. Before filling, check the contacts and moving parts to make sure that no parts have loosened or become disengaged during transit.

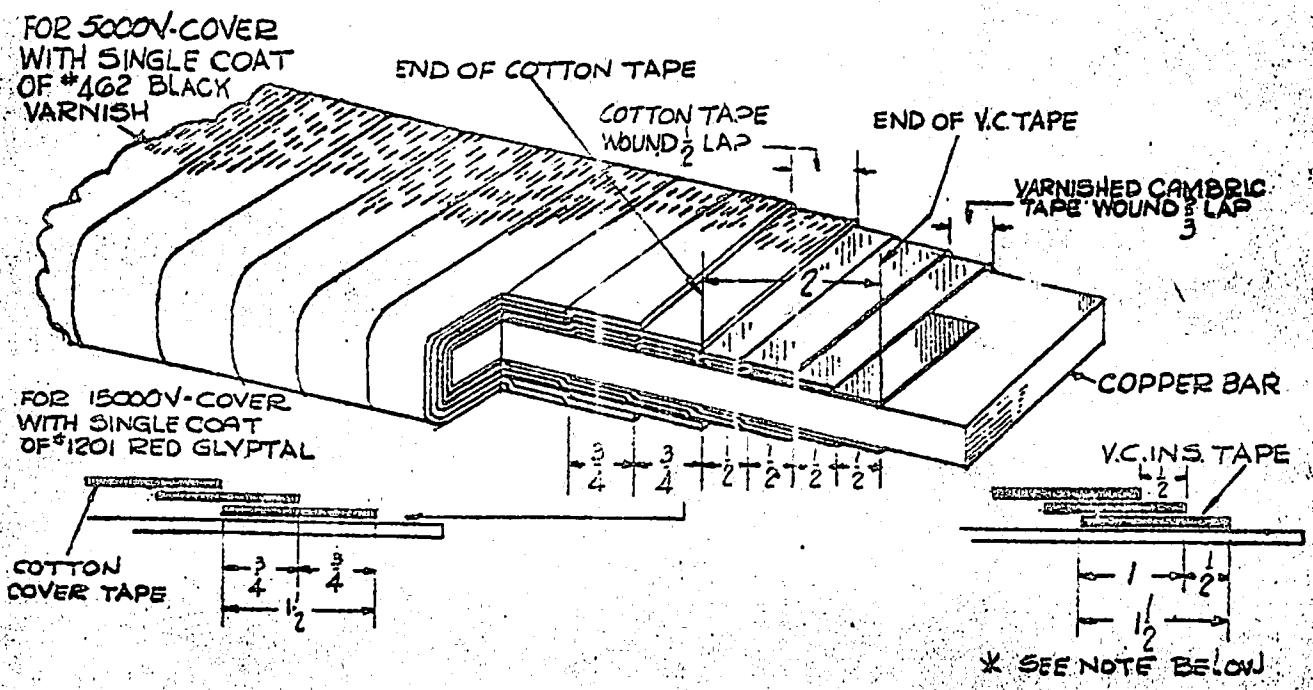
2. The elevating mechanism is accurately leveled and checked at the factory and should need no adjustment. Do not install or remove the breaker or make any adjustments unless the breaker is open.

Place the breaker on the transfer truck, except where breaker is provided with wheels, (see Figures 30, 31, 32, 33) adjusting it so that the bottom of the breaker fits into the guides provided on the truck platform for centering. Rub a small amount of Sovarex, L1 (Socony Vacuum) on the silvered portion of the breaker studs to form a thin coating for contacting purposes.

4. Lower the elevating mechanism lifting brackets, by means of the crank, until the lifting brackets are down against the lower stop bolts on the frame. The breaker should then enter the housing freely. The lower stop bolts can be adjusted if necessary to allow the breaker to enter the housing. Push the breaker into the housing until it rests against the stop at the rear of the elevating mechanism frame. This top has been adjusted at the factory so that the breaker will be in the correct position relative to the lifting brackets. Raise the lifting brackets until the breaker is lifted clear of the transfer truck. Check to see that the breaker is properly seated on the lifting brackets.

5. Carefully raise the breaker to the connected position - where the breaker plate or support solidly meets the upper stop bolts on the frame and then lower and remove it from the unit. When elevating, note that breaker studs center with respect to the stationary disconnecting device or injury to the contacts may result.

6 (a) Inspect the contact surfaces of both the breaker studs and the stationary disconnecting devices.



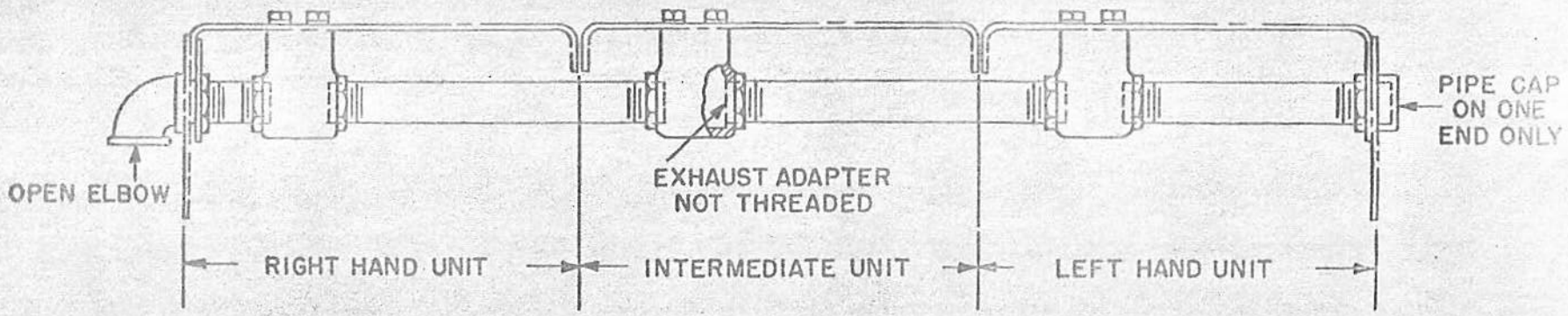
INSULATION LEVEL	INSULATION LAYERS	
	V.C.	COTTON TAPE
5000 V.	4	1
15000 V.	7	1

V.C. IS BLACK VARNISHED CLOTH (CAMBRIC) TAPE #992 WIDTH 1½" THICKNESS 0.012 COTTON TAPE IS WHITE G.E. 650-116 WIDTH 1 1/2"

*ONE LAYER (WOUND 2/3 LAP) REQUIRES 3 TURNS AROUND BAR IN ONE WIDTH OF TAPE. THE THICKNESS OF ONE LAYER IS 3 TIMES THE THICKNESS OF THE TAPE.

FIG. 28

INSULATION OF CONNECTION BARS



VIEW LOOKING FROM SIDE OPPOSITE BREAKER MECHANISM

FIG. 29

METAL CLAD EXHAUST PIPE

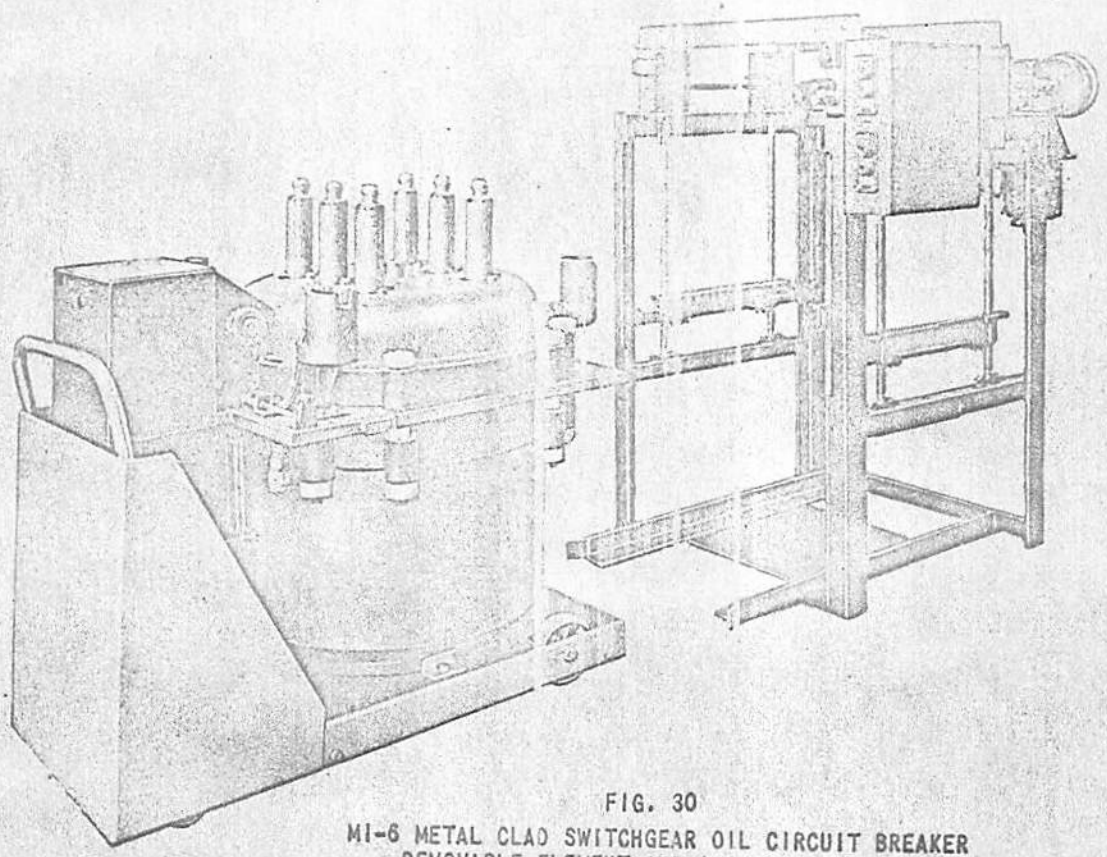


FIG. 30
MI-6 METAL CLAD SWITCHGEAR OIL CIRCUIT BREAKER
REMOVABLE ELEMENT AND INSPECTION RACK

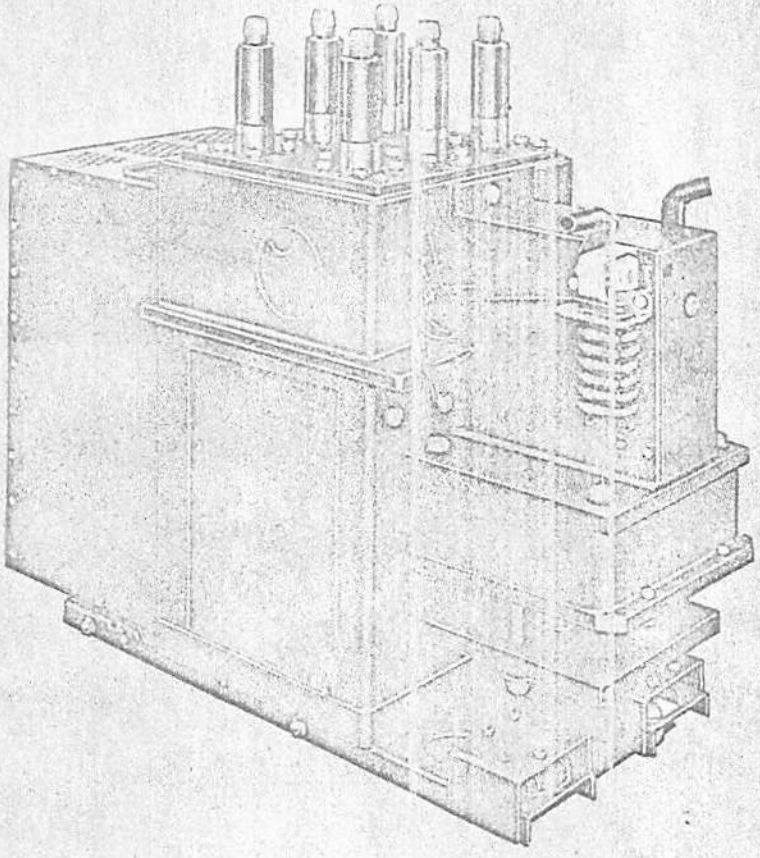


FIG. 31
MI-6 METAL CLAD SWITCHGEAR MAGNE BLAST CIRCUIT BREAKER REMOVABLE
ELEMENT

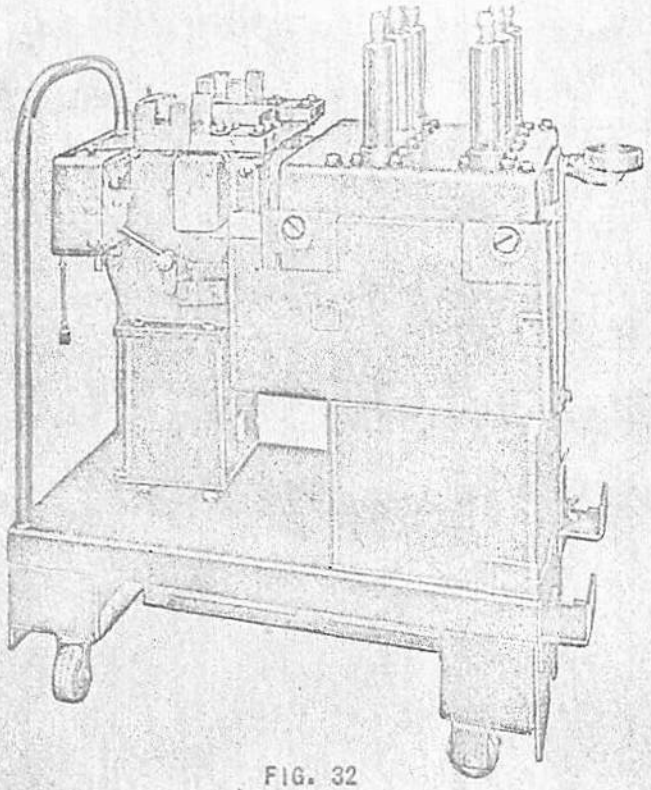


FIG. 32
OIL CIRCUIT BREAKER REMOVABLE ELEMENT

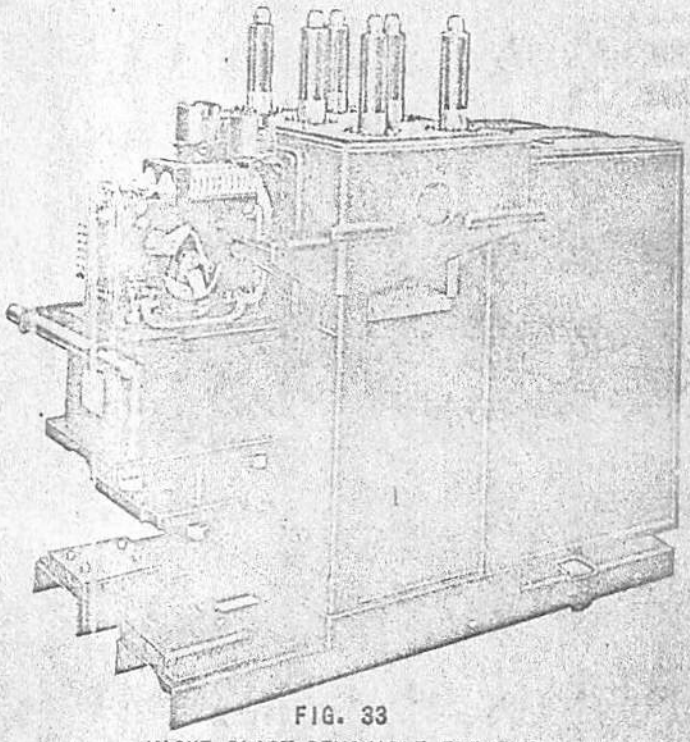


FIG. 33
MAGNE BLAST REMOVABLE ELEMENT

(b) Each segment of the stationary disconnecting device should make a heavy impression in the Sovarex L1 on the breaker studs.

(c) The wipe of the breaker stud inside the stationary disconnecting device, as indicated by the Sovarex L1, should be 7/8" (3/4" for the tube. This indicates that the breaker studs contacted at the full pressure center of the silver band on the stationary disconnecting device. The maximum permissable variation in the wipe is 3/32".

(d) Should the inspection of the contacts show that the breaker is not being raised to the proper position readjust the upper stop bolts to raise or lower the breaker to the proper location. Lock the stop bolts in the new position.

(e) If proper contacting cannot be attained by the above methods, it is necessary to adjust the stationary disconnecting device tube. DO NOT MADE ANY ADJUSTMENT. COMMUNICATE WITH THE NEAREST GENERAL ELECTRIC CO. OFFICE FOR ADDITIONAL INFORMATION.

7. The trip and interlock see Fig. 5, 6, 7, should be checked to see that the breaker cannot be raised to or lowered from the connected position unless the breaker is open. The operating crank cannot be inserted until the trip shield is moved to a vertical position, which operates the roller arm to trip the breaker. As the breaker starts to raise, the roller arm on the breaker is operated by the cam on the stationary structure to trip the breaker. The cam holds the breaker in the tripped position (circuit breaker mechanism latch in the trip free position) until the breaker is in the operating position. When lowering, the operating crank cannot be inserted until the trip shield is moved to a vertical position, which operates the roller arm to trip the breaker. Thus the breaker cannot be moved out of contact until the breaker is tripped. The cam holds the breaker in the tripped position until the breaker is lowered to the test position. When the mechanism is motor operated, the breaker is tripped electrically before the breaker can be raised or lowered.

Installation of Inspection Rack
(For Oil Circuit Breakers)

An inspection rack is furnished (See Fig. 30, 35 to provide a convenient means of inspecting, testing and maintaining the circuit breaker without interfering with the normal operation of the switchgear.

The inspection rack is a replica of the unit frame and elevating mechanism except that it has a greater travel in order to inspect the breaker contacts.

The inspection rack should be installed at a location where the breaker can be approached from all sides, providing the maximum accessibility for maintenance. Allow the same aisle space in front for manipulating the transfer truck as provided in front of the metal clad units.

The floor should be level and the rack fastened to the floor with anchor bolts. Conduit for control power cables must be installed. For electrically operated breakers, install conduits to carry cables to supply control power for testing.

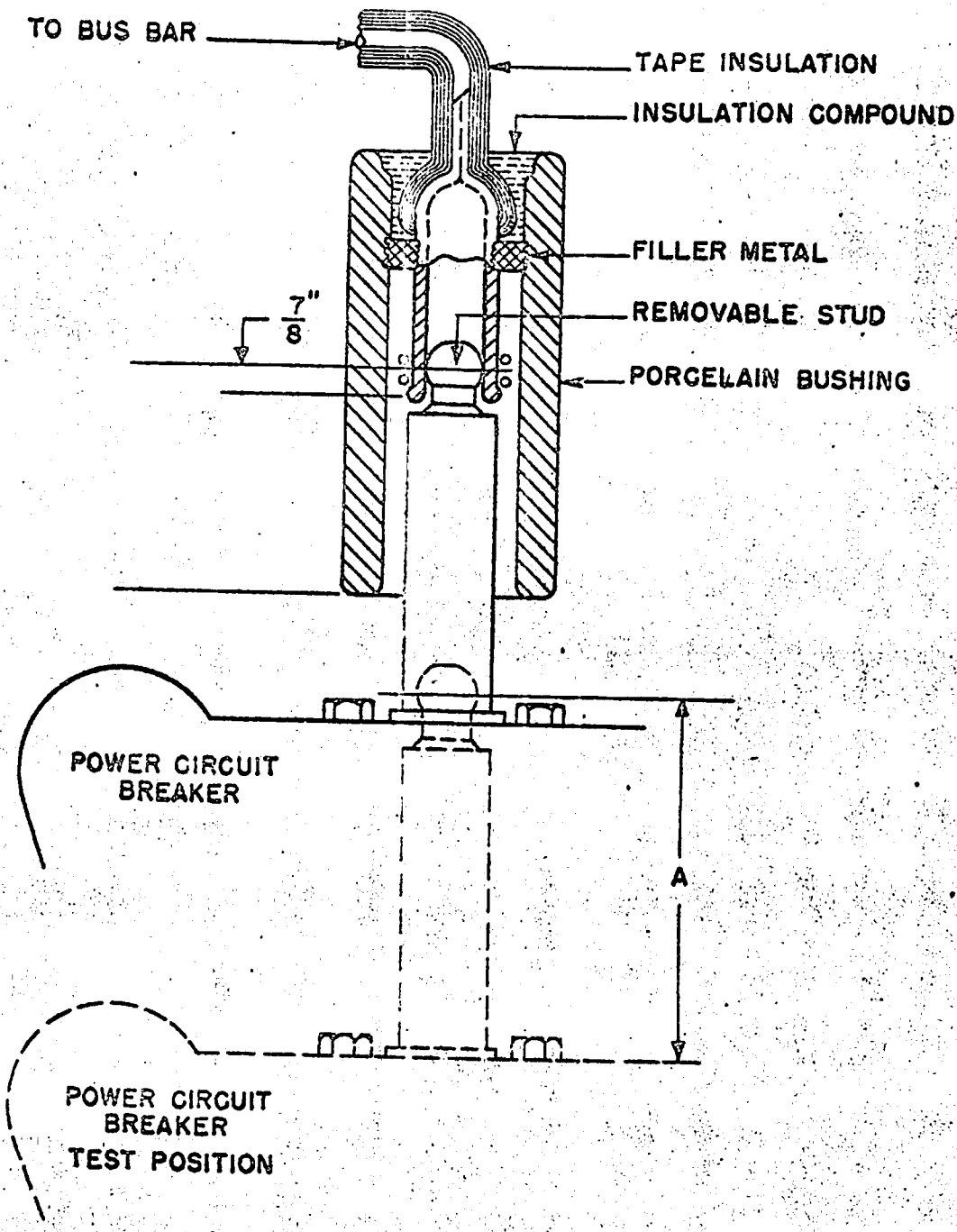


FIG. 34

MEASUREMENT OF ADJUSTMENT OF PRIMARY DISCONNECTING DEVICES

Installation of Testing Cabinet
(For Magne Blast Breakers)

The testing cabinet, Fig. 44, should be installed on the wall at a location where maintenance and testing of the breaker can be conveniently done. Conduits must be installed to carry cables to supply control power for testing.

Addition of Units to Existing Equipment

Figures 36 and 37 indicate the special procedures involved to add new metal clad units to an existing equipment. Otherwise the installation procedure is the same as described above.

TESTING AND INSPECTION

After the equipment has been installed and all connections made it should be tested and inspected before putting in service. Although the equipment and devices have been completely tested at the factory, a final field test should be made to be sure that the equipment has been properly installed and that all connections are correct and have not become loose in transportation. The primary equipment should be completely de-energized while the tests are in progress.

Directions for testing devices such as relays, instruments and meters are given in the instruction book furnished for each device. The settings of the protective relays must be coordinated with the other relays on the system and therefore these relays must be set by the purchaser. General instructions on setting the relays are given in the relay instruction books. Special instruction books are furnished for complicated automatic equipments, describing the sequence of operation of the devices required to perform the desired function. The extent of the tests on the equipment as a whole will depend on the type and function of the equipment.

When transformers are furnished to supply the control power, the primary taps should be selected so that the control voltage indicated on the wiring diagram is obtained on the secondary of the transformer.

When a battery is used to supply the control power the cables from the battery to the switchgear should be large enough to avoid excessive voltage drop. The voltage at the terminals of the breaker closing coils, when the breaker is being closed should not be less than 112.5 volts for 125 volt coils and 225 volts for 250 coils.

The operation of the breaker with its associated devices may be tested in the unit while the equipment is energized by use of the test couplers which are furnished. Lower the breaker to the test position. This is the position at which the trip mechanism roller arm disengages the cam on the structure. Attach the test couplers to connect the breaker secondary disconnecting devices to those on the structure.

High potential tests to check the integrity of the insulation are not necessary if the installation instructions in this book are carefully followed. If the purchaser wishes to make high potential tests the voltage should not exceed 75% of the AIEE factory test voltages. Potential transformers must be disconnected during high voltage testing.

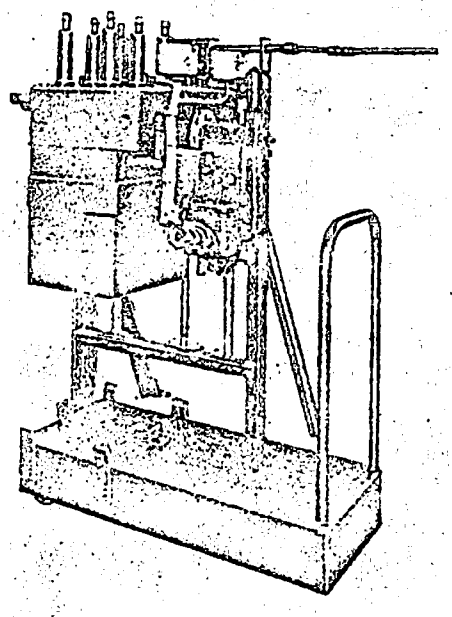


FIG. 35
MI-9 METAL CLAD SWITCHGEAR INSPECTION RACK

OPERATION

The operation of metal clad switchgear is similar to that of other types except that it provides maximum safety to the operator and the feature of easy removal and replacement of the circuit breaker.

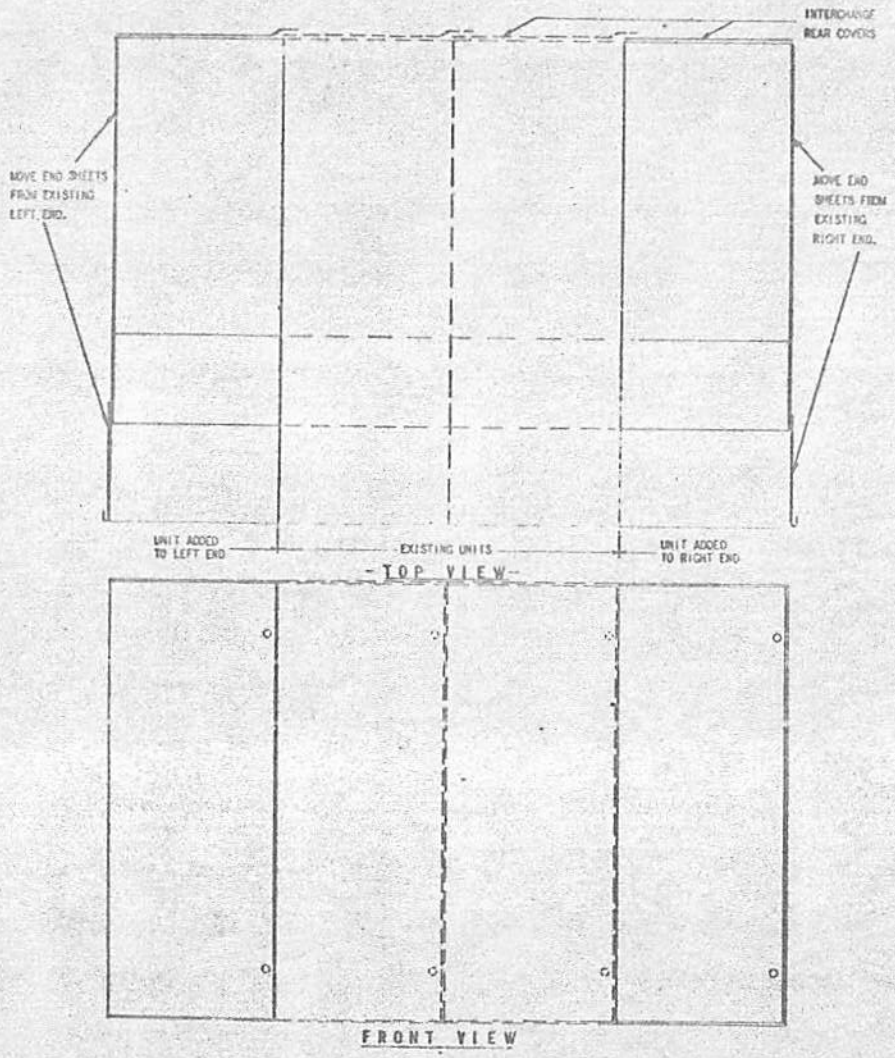
Lowering the breaker to the test position provides a means of positively isolating the cables and remote apparatus from the bus. To insure the safety of personnel working on the isolated circuit, the trip shield may be padlocked in a position to prevent insertion of the operating crank.

All circuit breaker removable elements of the same type and rating which have duplicate wiring may be interchanged.

To install the breaker in the unit proceed as follows:

(a) Clean contacts and cover with very thin coating of Sovarex L1.
(b) Place the breaker on the transfer truck, where required, adjusting it so that the bottom of the breaker fits into the guides provided on the truck platform for centering.

(65966)



PROCEDURE:

1- REMOVE END SHEETS, END EXHAUST PIPE.
2- SET NEW UNITS IN PLACE AND BOLT TO EXISTING UNITS.
3- ASSEMBLE END SHEETS AND GROUND SPLICE.
4- ASSEMBLE BUS BARS AND CONNECTION BOXES PER INSTRUCTION BOOK FIG. 10
5- ASSEMBLE EXHAUST PIPE (OIL CIRCUIT BREAKER SWITCHGEAR ONLY) PER INSTRUCTION BOOK FIG. 20

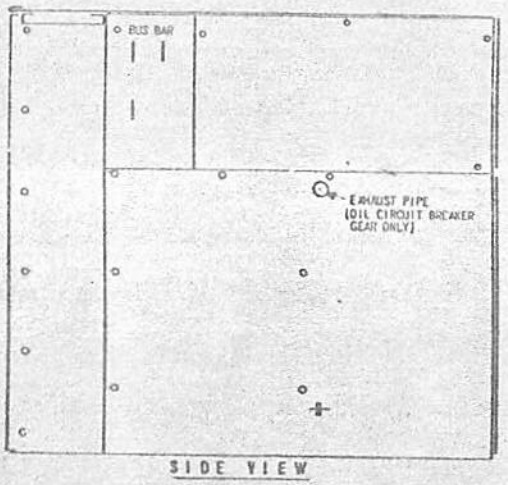
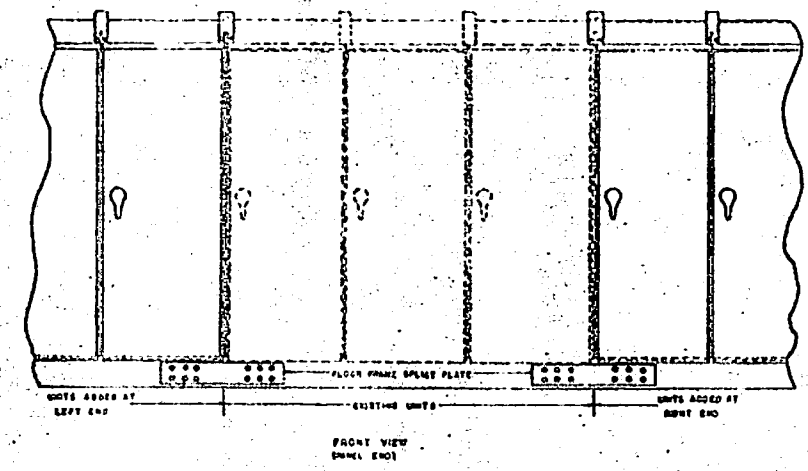
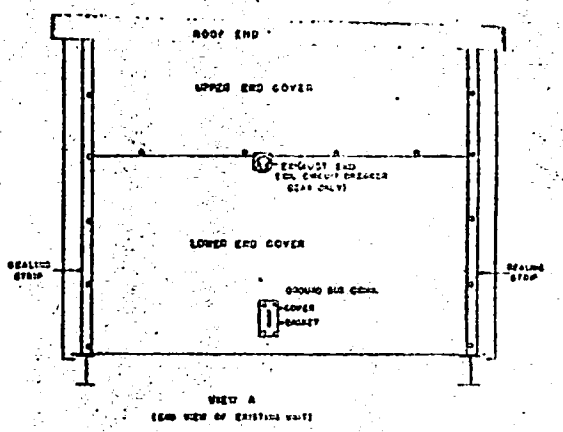
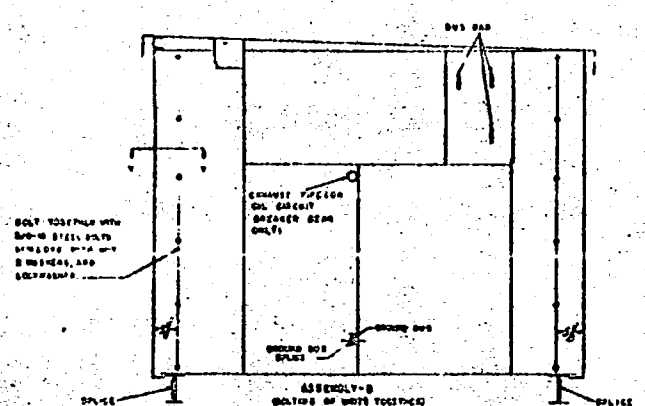
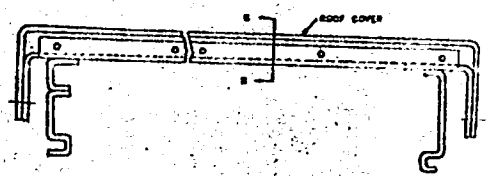


FIG. 36
ADDITION OF UNITS TO INDOOR METAL CLAD SWITCHGEAR



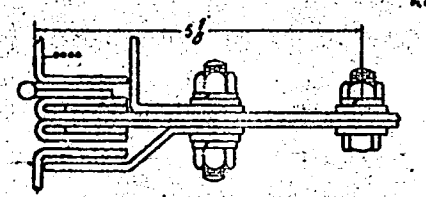






PROCEDURE:

1. REMOVE ROOF END, UPPER AND LOWER END COVERS, 2 SEALING STRIPS, EXHAUST END AND END BUS CONN. AS SHOWN ON VIEW A.
2. SET NEW UNIT IN PLACE AND BOLT TOGETHER FRONT AND BACK AS SHOWN BY ASSEMBLY B.
3. ASSEMBLE ITEMS LISTED IN PROCEDURE-1.
4. ASSEMBLE NEW ROOF COVER PER ASSEMBLY C.
5. APPLY SPLICE PLATE BETWEEN EXISTING AND NEW FLOOR FRAME AS SHOWN ON FRONT VIEW
6. ASSEMBLE BUS BARS AND CONNECTION BOXES PER INSTRUCTION BOOK FIG 10
7. ASSEMBLE GROUND BUS SPLICE BETWEEN EXISTING AND NEW GROUND BUS PER ASSEMBLY B.
8. ASSEMBLE EXHAUST PIPE (ON CIRCUIT BREAKER SWITCHGEAR ONLY) PER INSTRUCTION BOOK FIG 29



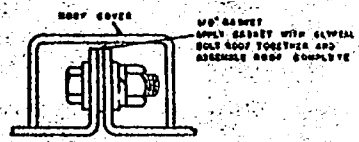


FIG. 37

ADDITION OF UNITS TO OUTDOOR METAL CLAD SWITCHGEAR

(c) Insert the operating crank and raise or lower the lifting brackets to the proper position for raising the breaker.
(d) Push the breaker into the unit until it rests against the stop.
(e) Operate crank to raise breaker until the breaker contacts the stops on the stationary element. The breaker is now in the operating position.

To remove the breaker from the unit proceed as follows:

(a) Roll the transfer truck if required into the unit until it rests against the stops.
(b) Operate the manual trip button, opening the breaker.
(c) Insert operating crank and lower the breaker. Continue lowering until lifting brackets are against lower stop bolts and free of the breaker.
(d) Roll the breaker out of the unit. Transport to another unit or to maintenance location.

Motor Operated Elevating Mechanisms

To raise the breaker operate the control switch on the door of the unit to the "Trip" position. Contacts of the switch set up the "Raise" circuit to the push button switch inside the enclosure. Operation of the "Raise" push button will now cause the breaker to raise into position. At the end of the travel, a limit switch and auxiliary relays operate to cut off the motor at the correct point.

To lower the breaker proceed the same as for raising, except operate the "Lower" push button.

The motor elevating mechanism may be disconnected by pulling out the clutch rod handle (Fig. 38) which is located just above the trip shield, to permit the use of a manual crank in raising or lowering. To disengage the clutch it is necessary to pull on the clutch rod handle and at the same time relieve the thrust of the motor against the mechanism by jogging the elevating mechanism as indicated:

(a) By using the manual crank to turn the mechanism in alternate directions.
(b) By using the motor mechanism push buttons to alternately reverse the direction. Note that when breaker is in the fully raised position against the mechanical stops the mechanism must first be lowered slightly before it is possible to jog the mechanism with the motor.

The slide plate back of the handle drops down and holds the clutch rod out, disconnecting the clutch coupler and making manual operation possible. To reconnect motor mechanism, hold clutch rod handle, push slide plate up and then let clutch rod go. The spring on the clutch mechanism will pull the clutch back so that it will connect the motor mechanism.

A portable electric motor with socket to fit the elevating mechanism shaft, maybe furnished on request to raise and lower the breakers in the stationary elements. This arrangement is equipped with and controlled from a self releasing switch. A portable weatherproof cable and plug is part of the equipment.

Space Heaters

Space Heaters are provided in all outdoor equipment in order to inhibit condensation and the resultant corrosion which might occur. The heaters should be turned on al all times. Heaters are also furnished for indoor equipments when it is known that abnormal atmospheric conditions exist at the installation.

MAINTENANCE

A regular maintenance schedule should be established to obtain the best service and reliability from the switchgear. Plant, operating and local conditions will dictate the frequency of inspection required.

For specific information regarding the maintenance of devices, such as circuit breakers, relays, meters, etc., refer to the separate instruction book furnished for each device. The inspection rack or cabinet, which is furnished, provides a convenient means for maintaining the circuit breakers. Under normal conditions the protective relays do not operate, therefore it is important to check the operation of these devices regularly.

The switchgear structure and connections should be given the following overall maintenance at least annually.

1 De-energize the equipment and thoroughly clean removing all dust and other accumulations. Wipe buses and supports clean with carbon tetrachloride. Inspect the buses and connections carefully for evidence of overheating or weakening of the insulation.

Measure the resistance to ground and between phases of the insulation of buses and connections. Since definite limits cannot be given for satisfactory insulation resistance values, a record must be kept of the readings. Weakening of the insulation from one maintenance period to the next can be recognized from the recorded readings. The readings should be taken under similar conditions each time if possible, and the record should include the temperature and humidity.

High potential tests are not required, but if it seems advisable, based on the insulation resistance tests or after repairs, the test voltage should not exceed 75% of the AIEE factory test voltage. The potential transformers must be disconnected during the high voltage testing.

2. Clean elevating mechanism and lubricate jack screws and gears with a half and half mixture of universal wheel grease and Texaco Krater #1 compound or its equivalent; and bearings, with machine oil.

3. Inspect primary disconnecting device contacts for signs of abnormal wear or overheating. Clean contacts with carbon tetrachloride. Discoloration of the silvered surfaces is not ordinarily harmful unless

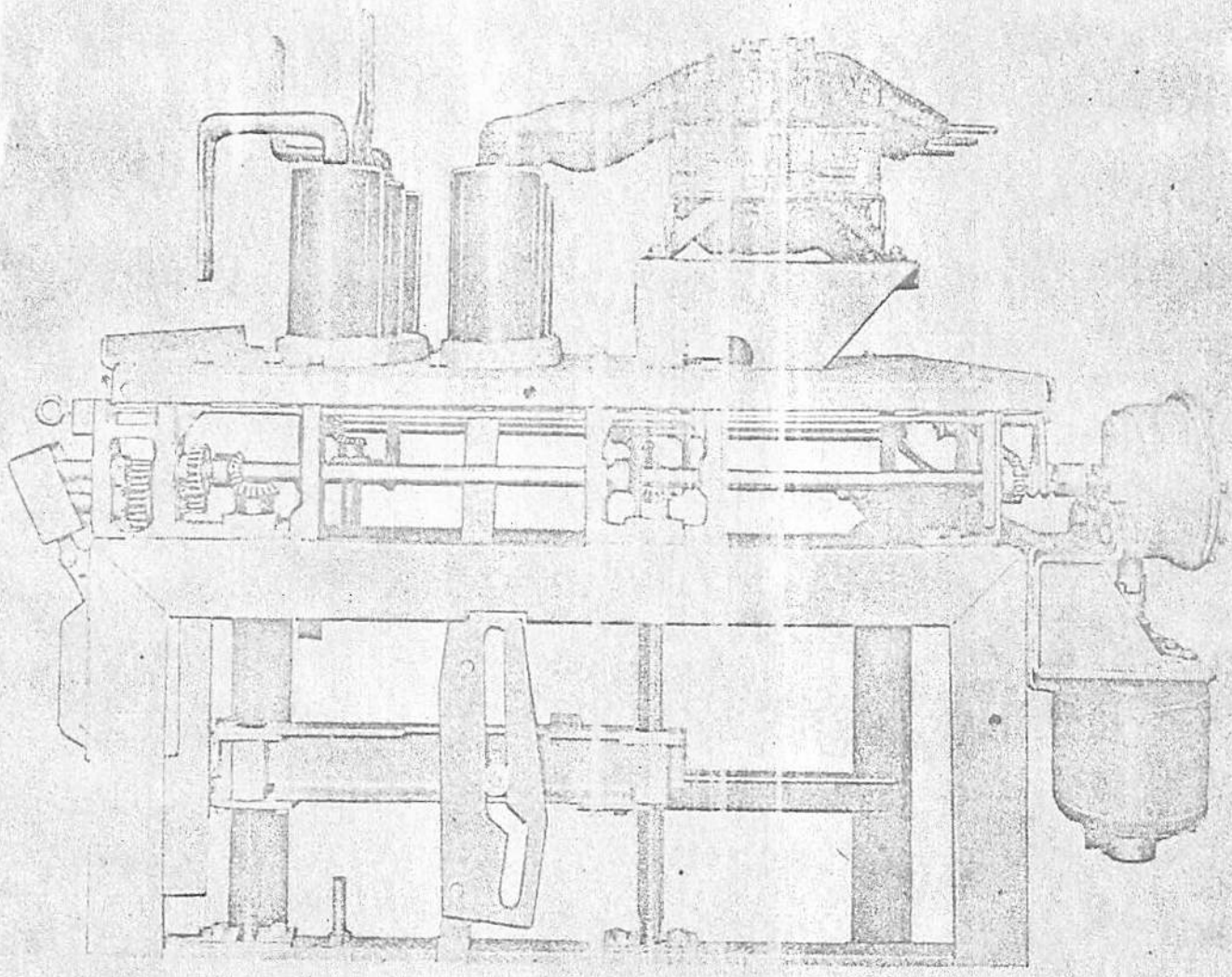


FIG. 38
TYPE MI-6 METAL CLAD SWITCHGEAR WITH MOTOR OPERATED ELEVATING MECHANISM

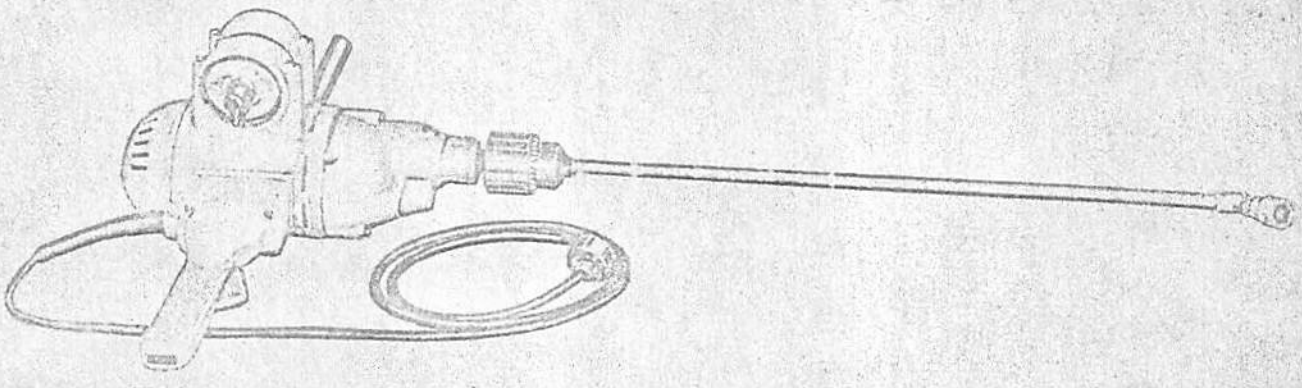


FIG. 39
PORTABLE MOTOR CRANK

atmospheric conditions cause deposits such as sulphides on the contacts. If necessary the deposits can be removed with a good grade of silver polish. Before replacing breaker, apply a thin coat of Sovarex L1.

4. Check to see that all anchor bolts and bolts in the structure are tight. Check tightness and continuity of all control connections and wiring.

A permanent record of all maintenance work should be kept, the degree of detail depending on the operating conditions. In any event it will be a valuable reference for subsequent maintenance work and for station operation. It is recommended that the record include reports of tests made, the condition of the equipment and repairs and adjustments that were made.

SPECIAL FEATURES

Key Interlocks & Interlocking

Key interlocks are applied to metal clad switchgear equipments to protect against incorrect operation of the equipment. Key interlocks are commonly used for the following purposes:

(a) To prevent the operation under load of associated disconnecting switches or dummy metal clad removable elements which have limited or no interrupting ability.

(b) To prevent the paralleling of non-synchronous sources.

(c) To prevent interconnecting systems in such a manner as to exceed the interrupting capacity of the circuit breakers.

(d) To prevent the withdrawal of fuse "Rollout" devices unless the load has been removed.

Figure 40 shows a typical application of key interlocks to a metal clad removable element and a disconnecting switch. The purpose of the interlocking is to prevent operating the switch with the breaker closed. Key interlocks A and B are the type in which the key cannot be removed unless the bolt of the interlock is extended. Under normal operating conditions, the bolt of interlock "A" is withdrawn and the key held in this lock. The bolt of interlock "B" is extended locking the disconnecting switch in the open position. It is important that only one key for the pair of locks be available to the operator otherwise the purpose of the interlocking will be defeated.

To operate the disconnecting switch the procedure is as follows: Move the trip shield to the vertical position, which operates the roller arm to trip the breaker. Turn key in interlock "A" extending the bolt. The extended bolt holds the trip shield in the vertical position and the breaker in the trip-free position. The key may now be moved from interlock "A" and used to operate interlock "B" to withdraw its bolt and release the operating mechanism of the disconnecting switch. An attachment on the shaft of the operating mechanism prevents the bolt of interlock "B" from being extended except when the switch is fully open or fully closed. Consequently the key is held in interlock "B" and the breaker cannot be released from the trip position until the switch is locked open or locked closed.

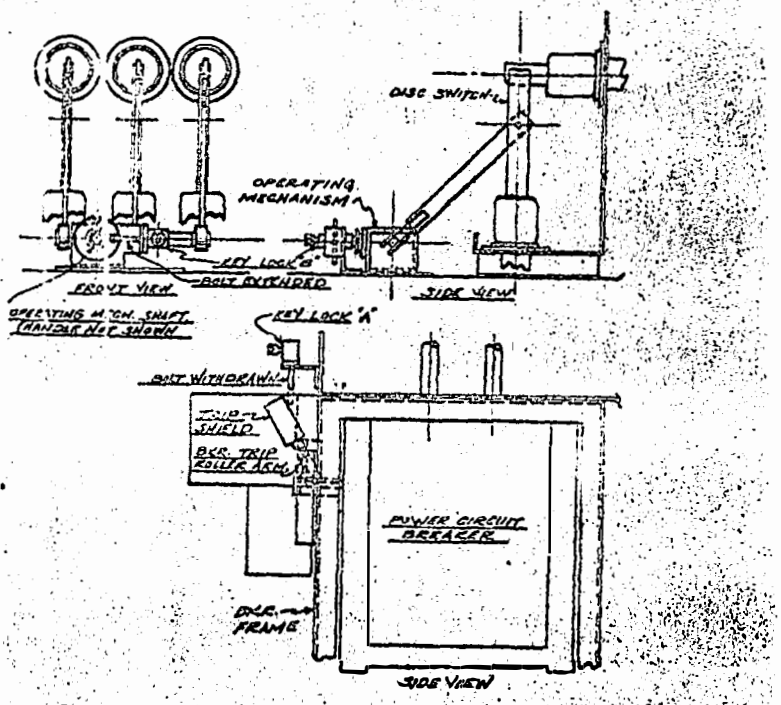


FIG. 40
KEY INTERLOCKING

Dummy Removable Element

Dummy removable elements, Fig. 41 are used as a means of isolating circuits or bus sections, where operation is infrequent and a circuit breaker cannot be economically justified. The device consists of a framework to simulate the circuit breaker removable element with a set of six studs similar to those on the metal clad breakers. The lower end of the studs are connected, front to back, by copper bars which are fully insulated and metal enclosed. The stationary structure is the same as for a circuit breaker. When the device is elevated into position it connects the front set of metal clad disconnecting devices to the rear set.

Under no conditions must the dummy element be elevated or lowered when the bus or the unit is energized. Key interlocks are applied to insure that all sources of power are disconnected before the dummy element can be operated.

Fuse Disconnecting Device

Current limiting fuses with high interrupting rating are some times used in metal clad switchgear to protect small transformers or circuits where circuit breakers cannot be economically or functionally justified.

The fuses are mounted on a movable support equipped with disconnecting devices. When the fuses are disconnected, they are at a safe striking distance from all live parts of the switchgear. In addition a grounding device is provided which contacts the fuses after they are disconnected, effectively removing any static charge from the fuses. In this position the fuses may be safely removed and replaced.

The disconnecting devices are capable of interrupting transformer magnetizing current, but should not be use to interrupt load current. For larger transformers arc quenchers are furnished to assist the disconnecting devices in interrupting the magnetizing current. Mechanical or key interlocks are applied to prevent operating the disconnecting device while the load is connected. This is generally accomplished by interlocking so that the transformer secondary breaker must be locked in the open position before the disconnecting device can be opened or closed. (Refer Fig. 42).

Grounding and Test Device

The grounding and test device, Fig. 43 provides a convenient means of grounding the cables or the bus in order to safeguard personnel who may be working on the cables or the equipment. The devices can also be used for applying power for high potential tests or for fault location, to measure insulation resistance (megger); or for phasing out cables.

The three studs of the device are similar to those of the metal clad circuit breakers. The studs are mounted on a removable plate which can be placed in either of two positions. In one position the studs will engage the front (Bus) contacts only and in the other position the studs will engage the rear (Line) contacts only of a metal clad unit.

To indicate the proper placement of the studs on the device, opposite sides of the assembly are marked "Line" and "Bus". The word corresponding to the desired position must be toward the operator.

To use, the device is rolled into the metal clad housing, in place of the circuit breaker, and raised into or lowered from the connected position by means of the circuit breaker elevating mechanism.

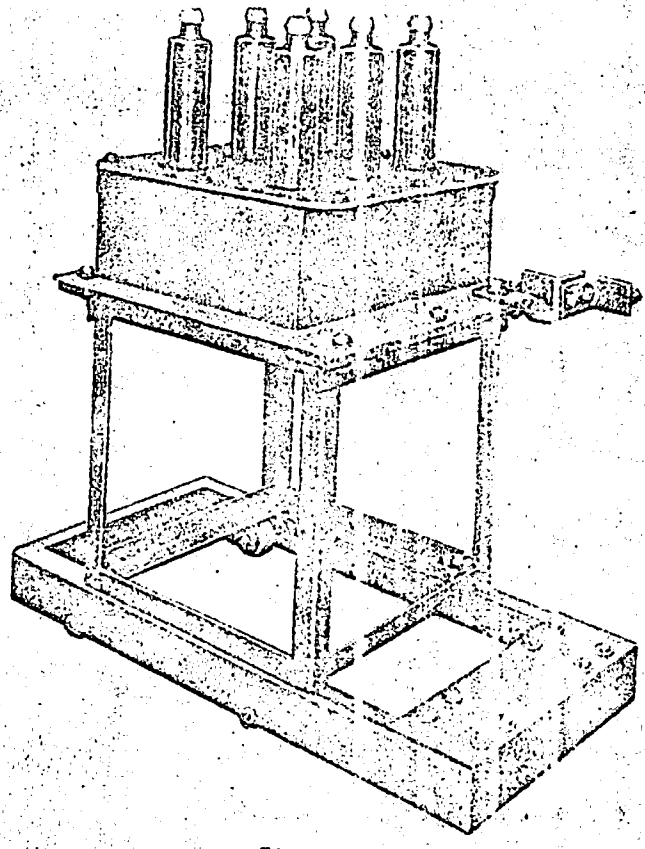


FIG. 41
DUMMY REMOVABLE ELEMENT

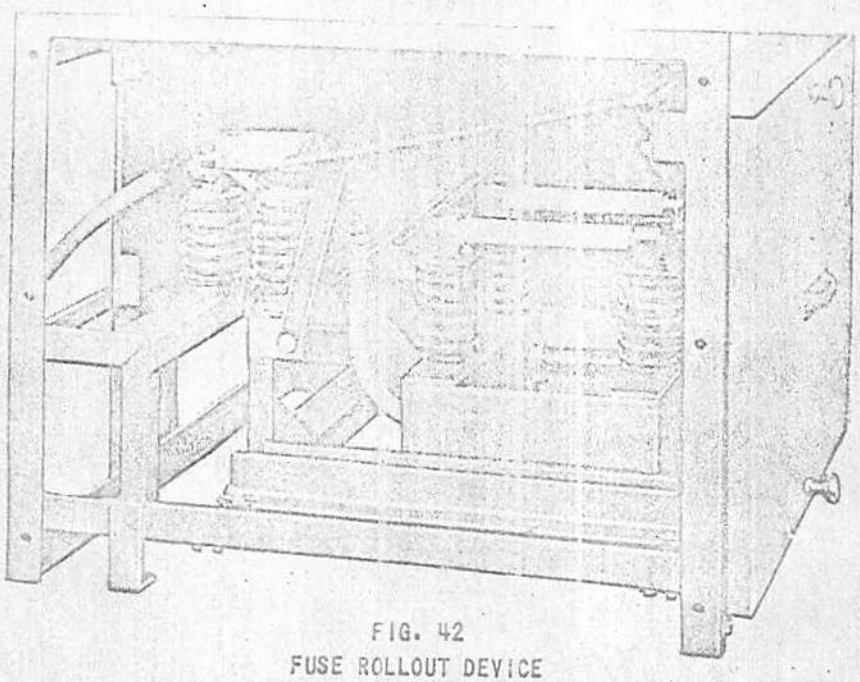


FIG. 42
FUSE ROLLOUT DEVICE

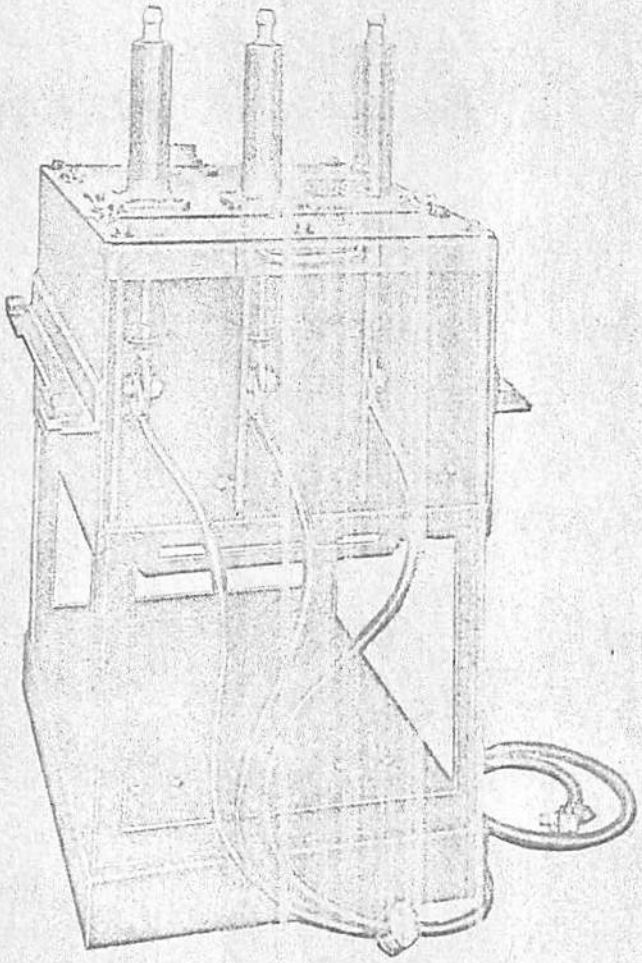
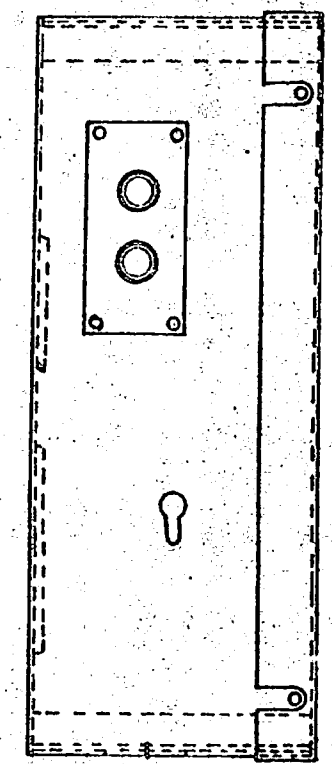
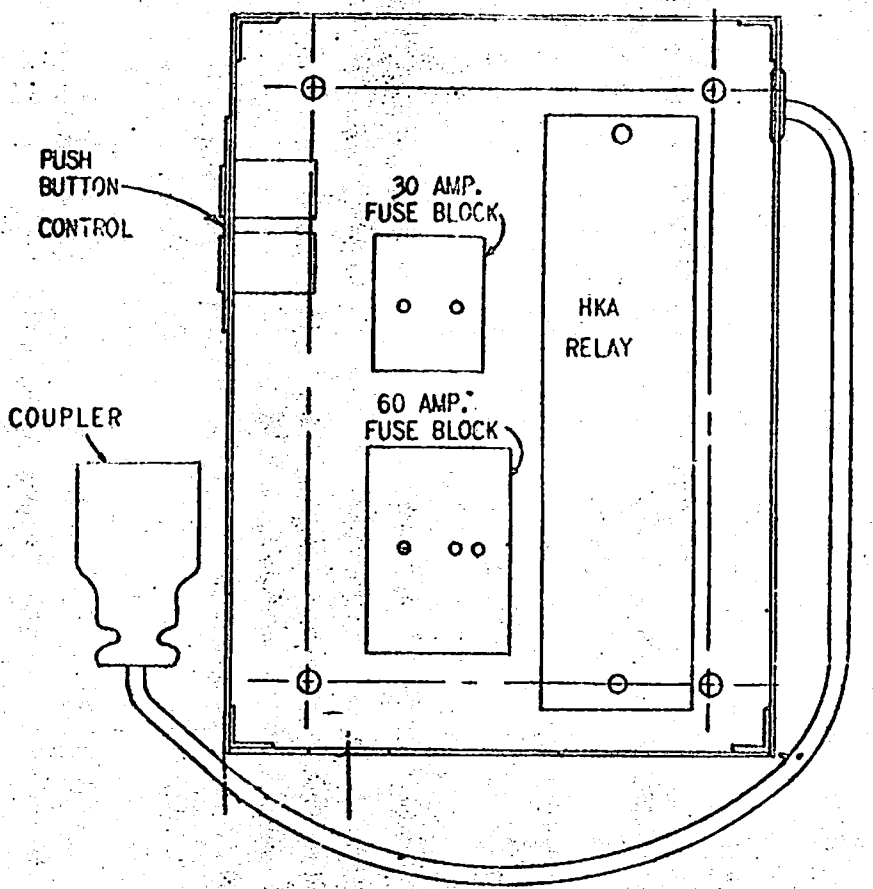


FIG. 43
GROUND AND TEST DEVICE



SIDE VIEW
WITH COVER



FRONT VIEW
COVER REMOVED

FIG.44
OUTLINE INSPECTION BOX

INSTRUCTIONS

GEH-1802W

SUPERSEDES

GEH-1802V & GEF-3837

METAL-CLAD SWITCHGEAR

Types M26 and M36

FOR MAGNE-BLAST AIR CIRCUIT BREAKER

TYPES AM-4.16 AND AM-13.8

GENERAL ELECTRIC

LIST OF ILLUSTRATIONS

Renewal Parts

NOTE: THIS INSTRUCTION BOOK HAS HAD A MAJOR REVISION. PLEASE CHECK YOUR PREVIOUS EDITION TO COMPARE MATERIAL.

CONTENTS

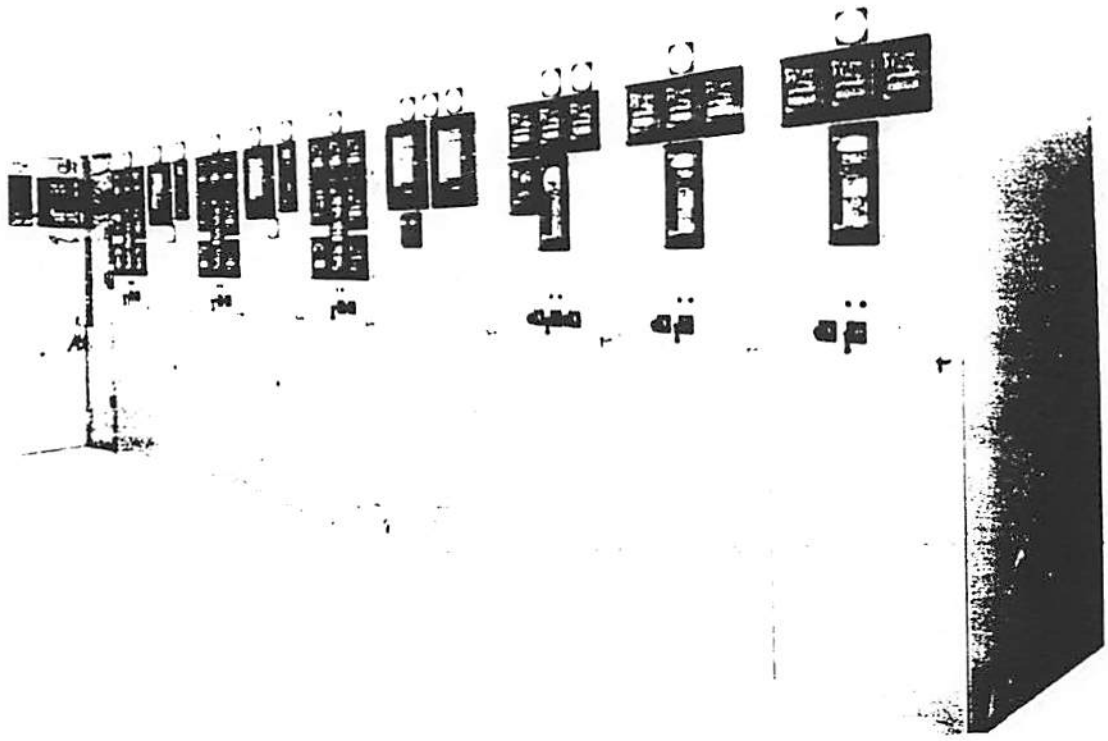


FIG. 1 (8021315) TYPICAL INDOOR METAL-CLAD SWITCHGEAR EQUIPMENT

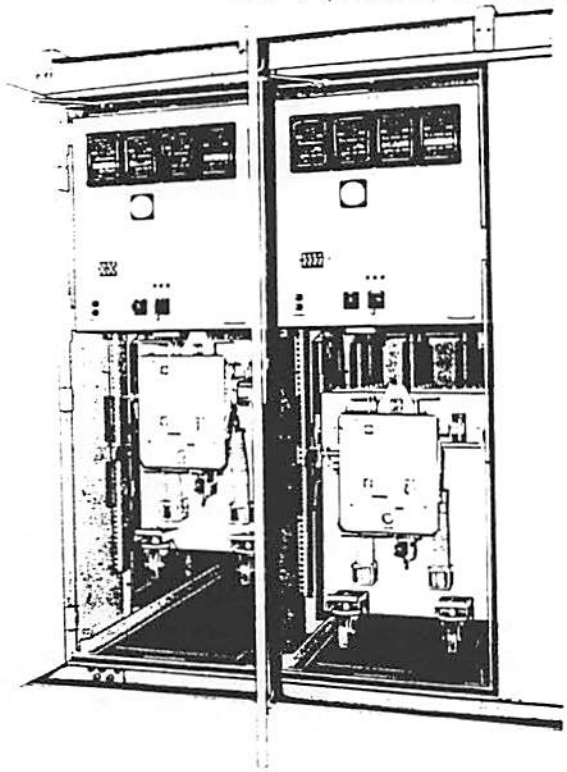


FIG. 2 (1169287) TYPICAL OUTDOOR METAL-CLAD SWITCHGEAR EQUIPMENT - FRONT VIEW

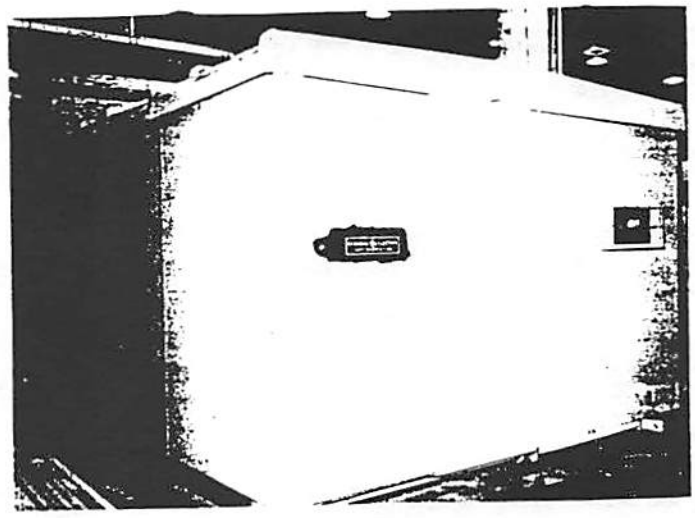


FIG. 3 (8025290) TYPICAL OUTDOOR METAL-CLAD SWITCHGEAR EQUIPMENT WITH PROTECTED AISLE-SIDE VIEW

METAL-CLAD SWITCHGEAR
TYPES M26 AND M36
FOR MAGNE-BLAST AIR CIRCUIT BREAKER
TYPES AM-4.16 AND AM-13.8

Metal-clad switchgear is equipment to control and protect various types of electrical apparatus and power circuits.

The switchgear consists of one or more units which are mounted side by side and connected mechanically and electrically together to form a complete switching equipment. Typical equipments are shown in Figures 1, 2 and 3.

The circuit breakers are easily removable to provide maximum accessibility for maintenance with minimum interruption of services. The switchgear is designed to provide maximum safety to the operator. All equipment is enclosed in grounded metal compartments.

The equipment is available in the ratings listed in the following table. The ratings of the equipment and devices are based on usual service conditions as covered in ANSI standards. Operation at currents above the equipment rating will result in temperature rises in excess of these standards, and is not recommended. For outdoor installation the same basic equipment is built into a weatherproof housing as in Figures 2 and 3.

CIRCUIT BREAKER	INTERRUPTING CAPACITY KVA	CURRENT	FIGURE
TYPE M-26			
AM-4.16-250	250,000	1200 - 2000	4
AM-4.16-350	350,000	1200 - 3000	5
TYPE M-36			
AM-13.8-500	500,000	1200 - 2000	4
AM-13.8-750	750,000	1200 - 2000	4
AM-13.8-1000	1,000,000	1200 - 3000	6
AM-7.2-500	500,000	1200 - 2000	4

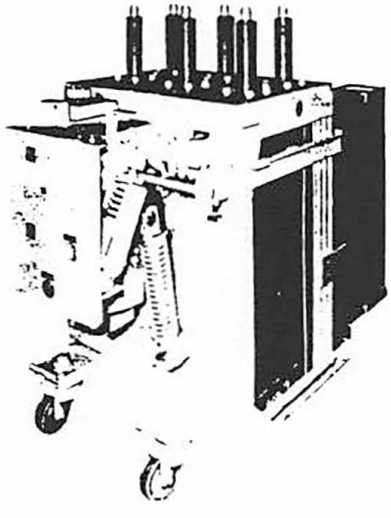


FIG. 4 (8034472)

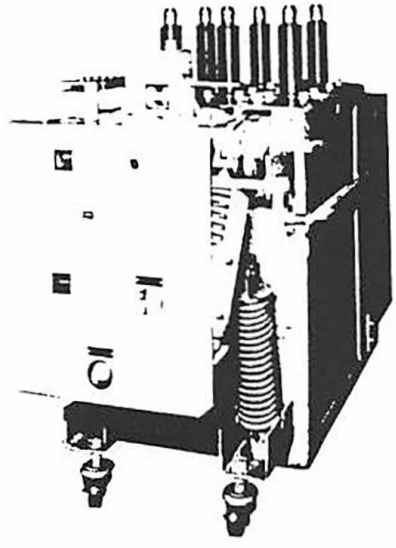


FIG. 5 (8034807)

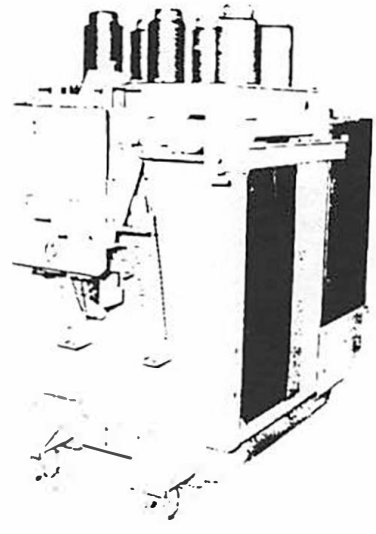


FIG. 6 (8035725)

MAGNE-BLAST BREAKERS

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

To the extent required the products described herein meet applicable ANSI, IEEE and NEMA standards; but no such assurance is given with respect to local codes and ordinances because they vary greatly.

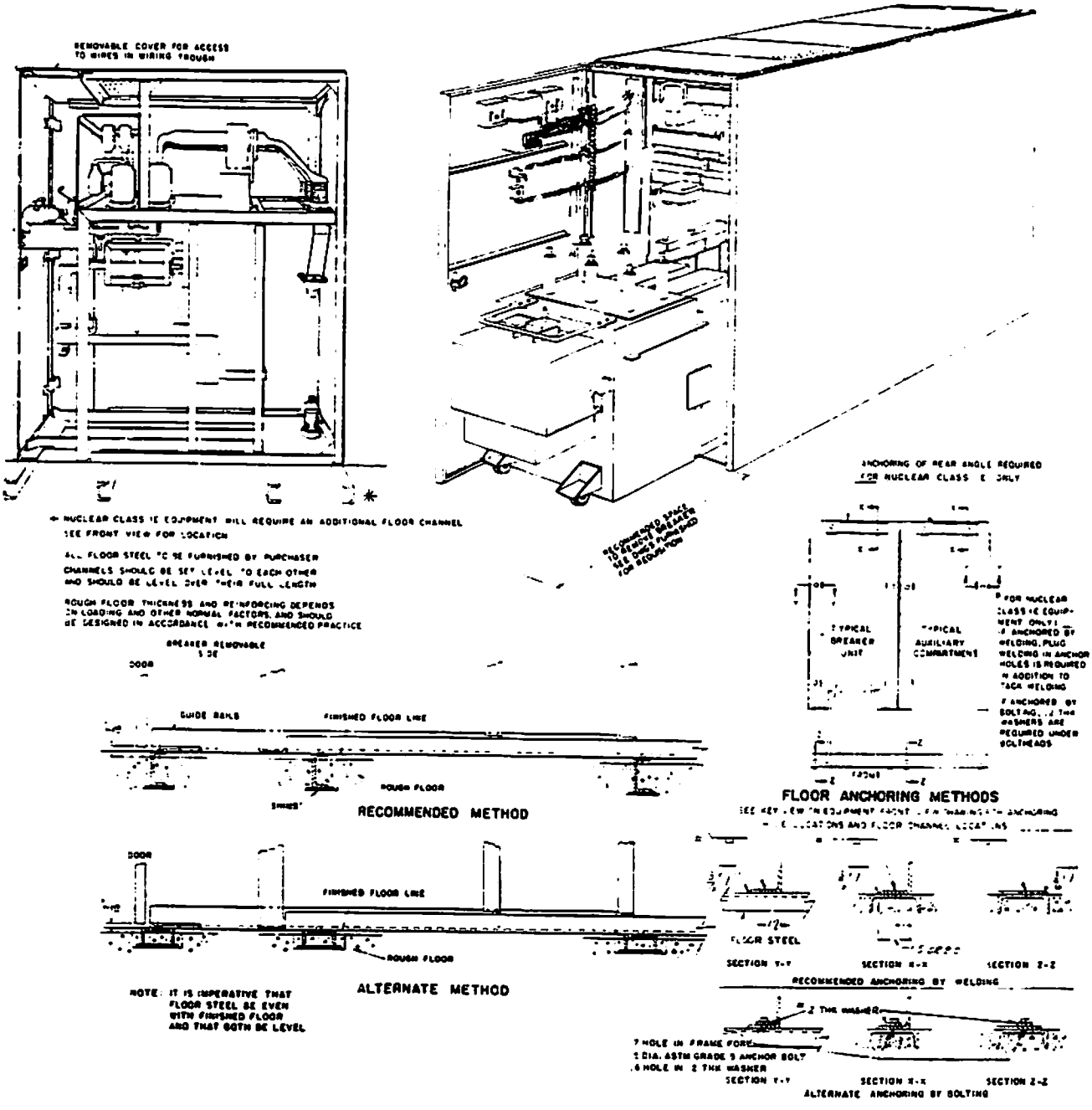
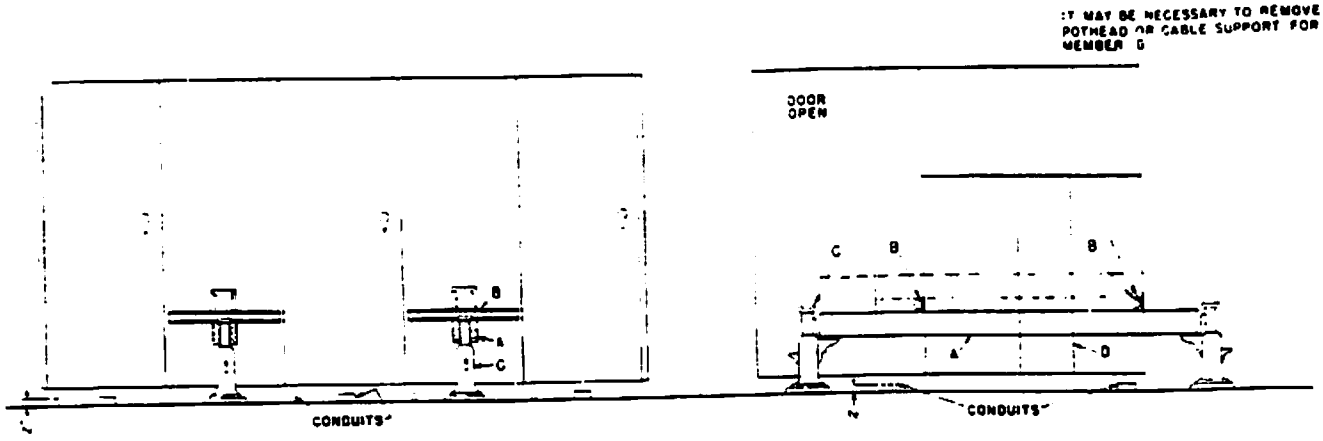


FIG. 7 (TT-6482630) INSTALLATION DETAILS FOR INDOOR METAL-CLAD SWITCHGEAR



METHOD OF LIFTING

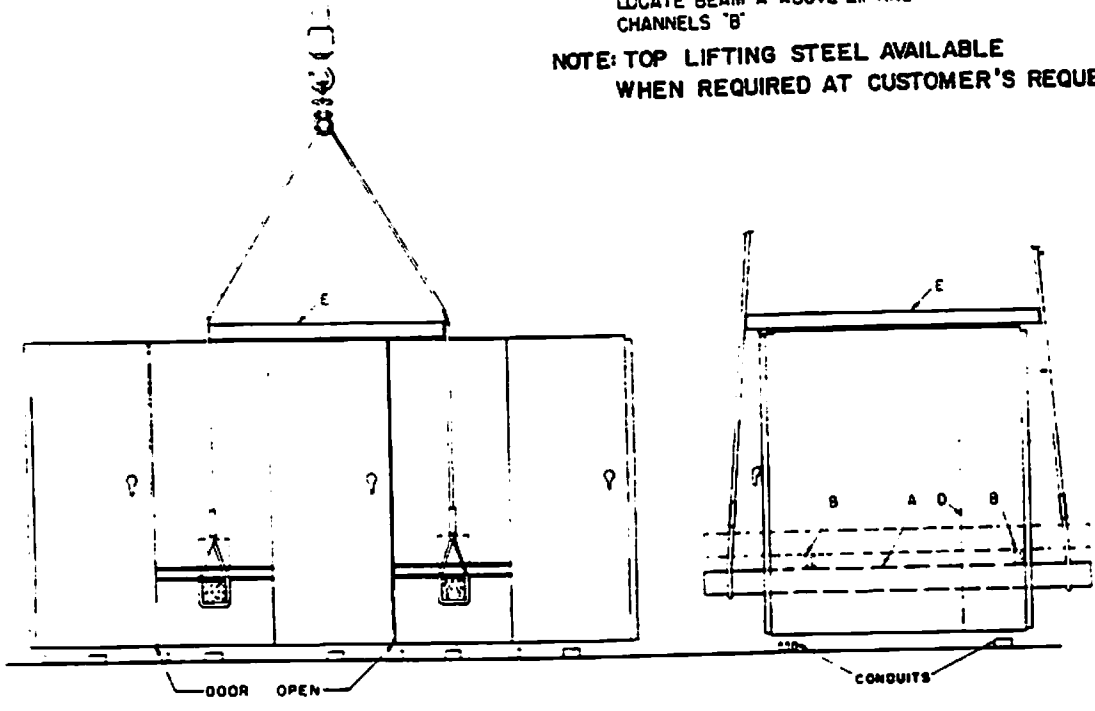
MEMBERS A-B C ——— TO BE FURNISHED BY PURCHASER
A - RAISING MEMBER - CHANNEL OR WOOD BEAM

B - 3" CHANNEL FURNISHED WITH GEAR

C - LIFTING JACKS
D - COVER TO BE REMOVED AND REASSEMBLE AFTER UNITS ARE IN PLACE

NOTE. WHEN LIFTING M-26 SWITCHGEAR LOCATE BEAM 'A' ABOVE LIFTING CHANNELS "B"

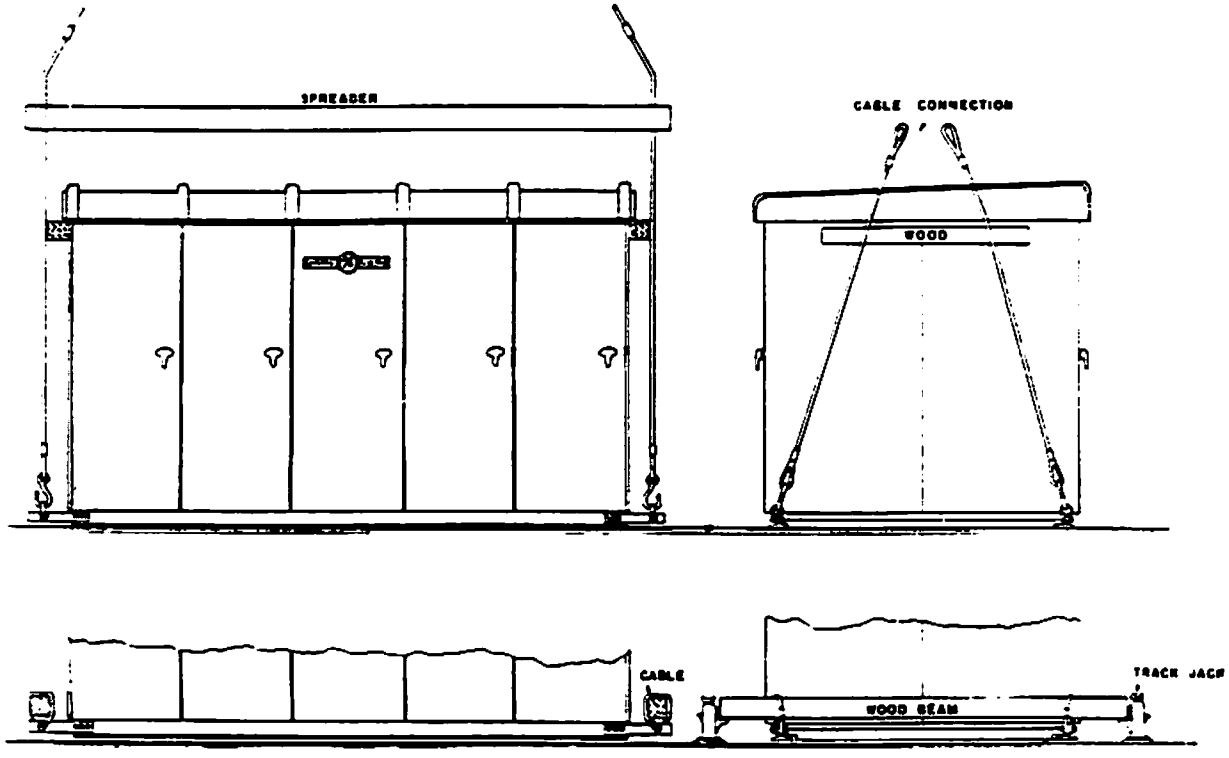
NOTE: TOP LIFTING STEEL AVAILABLE WHEN REQUIRED AT CUSTOMER'S REQUEST



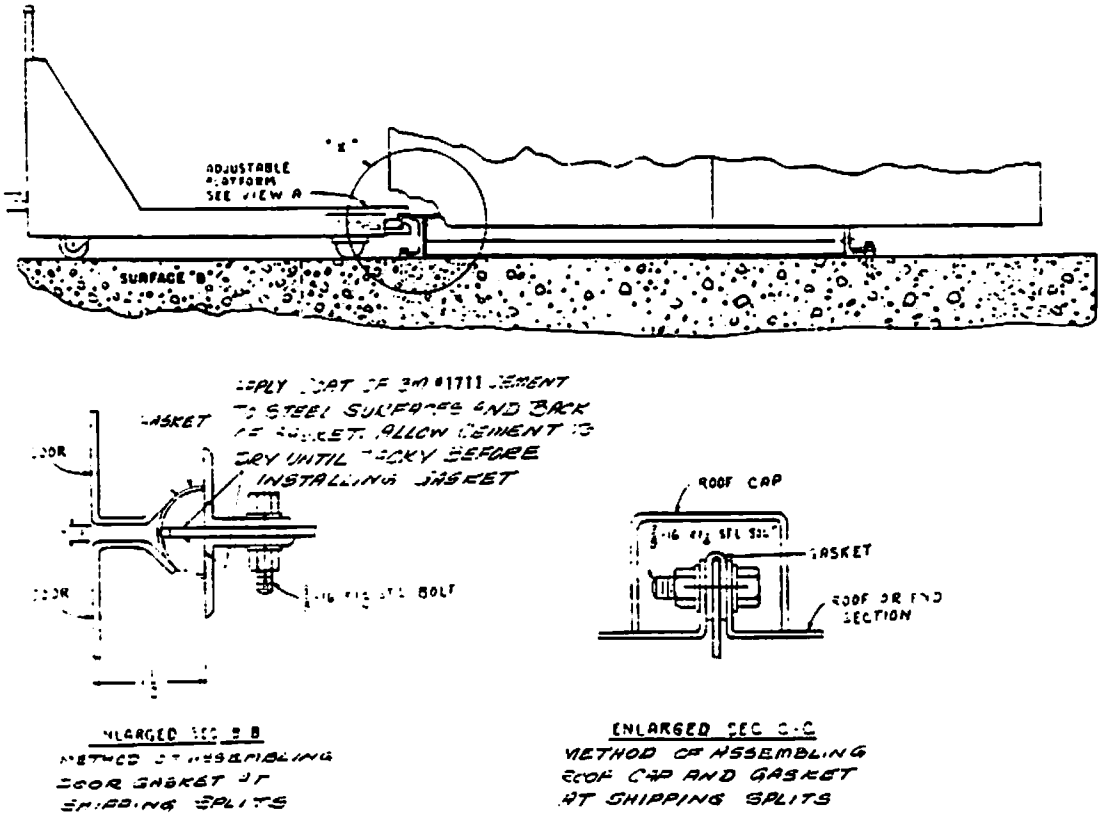
ALTERNATE METHOD OF LIFTING

MEMBERS A & E TO BE FURNISHED BY PURCHASER
B - 3" CHANNEL FURNISHED WITH GEAR
D - COVER TO BE REMOVED AND REASSEMBLED AFTER UNITS ARE IN PLACE
E - SPREADER

FIG. 7 (TT-6482630) CONTINUED



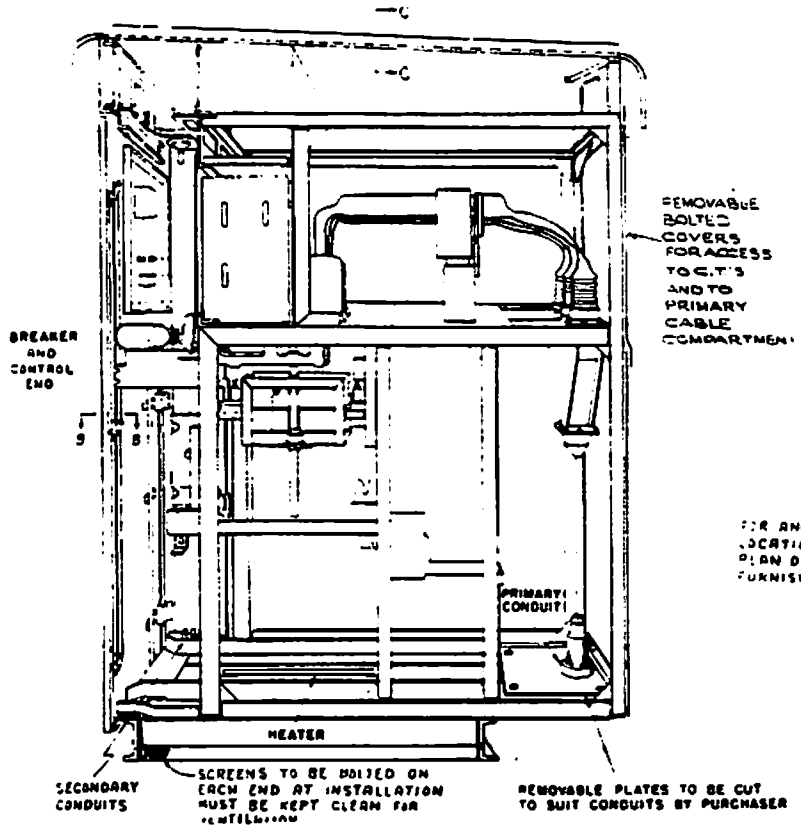
METHODS OF LIFTING



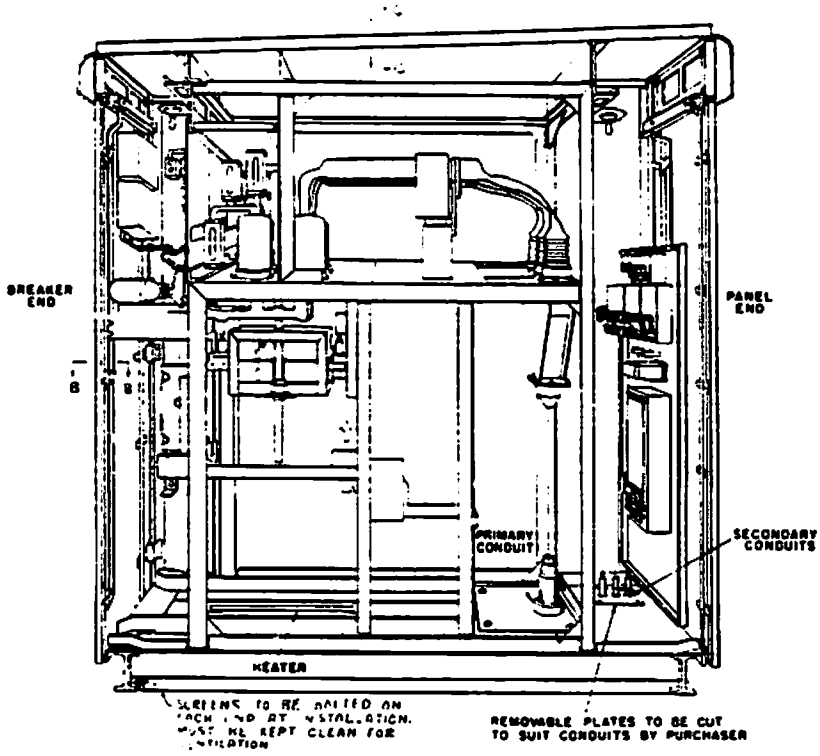
ENLARGED SEC B B
METHOD OF ASSEMBLING
DOOR GASKET AT
SHIPPING SPLITS

ENLARGED SEC C-C
METHOD OF ASSEMBLING
ROOF CAP AND GASKET
AT SHIPPING SPLITS

FIG. 8 (118RD728 & TT-6482615) INSTALLATION DETAILS FOR OUTDOOR METAL-CLAD SWITCHGEAR

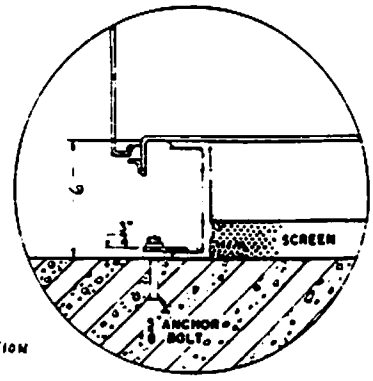


Without Rear Enclosure



With Rear Enclosure

FOR ANCHOR BOLT LOCATIONS SEE FLOOR PLAN DRAWING FURNISHED WITH REQUISITION



VIEW "X"

SHOWING ANCHORING OF UNITS WITH CHANNEL BASE

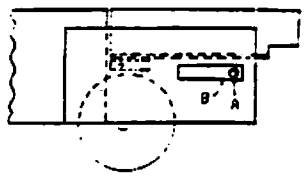
FOUNDATION DATA

AREA AND DEPTH OF SOIL BEARING SURFACES OF EACH FOUNDATION MUST BE ALTERED TO SUIT SOIL CONDITIONS.

BOTTOM SURFACES OF FOUNDATIONS SHOULD BE BELOW FROST ACTION OR BACKFILLED WITH PERVIOUS MATERIAL AND ADEQUATELY DRAINED.

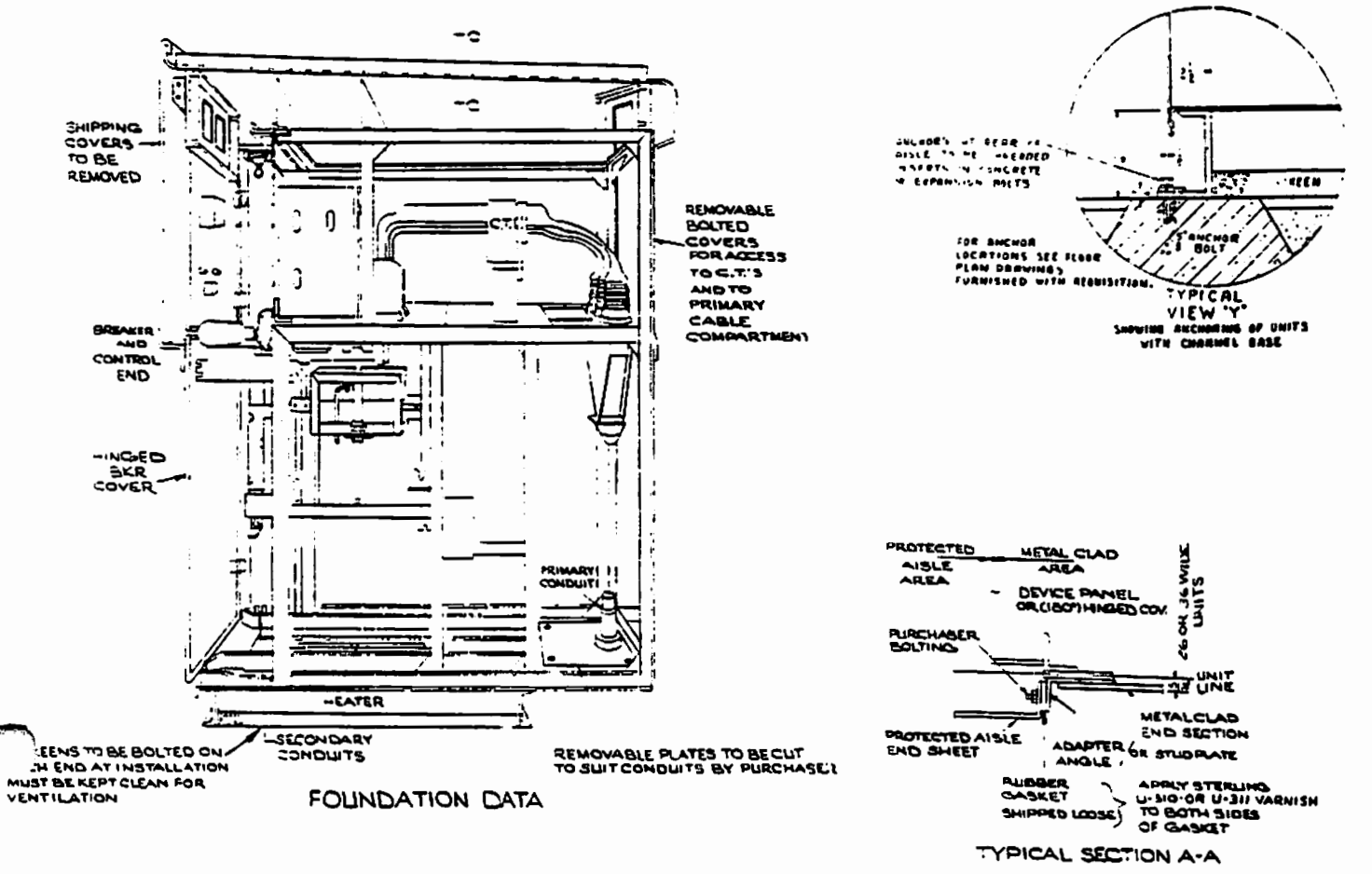
SURFACE "B" SHOULD BE LEVEL OVER ITS FULL LENGTH TO INSURE EASY HANDLING OF REMOVABLE ELEMENTS. CONCRETE PAD SHOULD BE REINFORCED IN ACCORDANCE WITH STANDARD PRACTICE.

TO CHANGE HEIGHT OF TRUCK FLOOR LOOSEN NUT "A" ADJUST LEVER "B" TO GIVE DESIRED HEIGHT AND LOCK BY TIGHTENING NUT "A".



ADJUSTABLE PLATFORM VIEW "A"

FIG. 8 (118RD728 & TT-6482615) CONTINUED



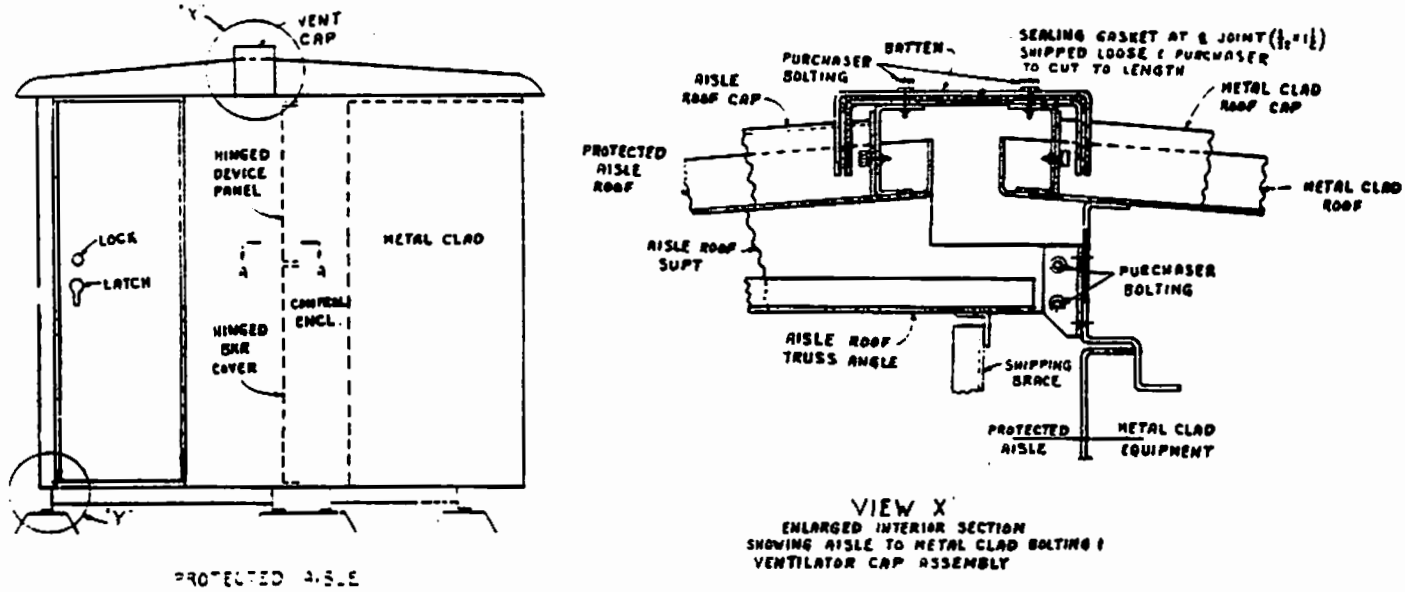


FIG. 9 (118RD727) INSTALLATION DETAILS FOR OUTDOOR METAL-CLAD SWITCHGEAR WITH PROTECTED AISLE

RECEIVING, HANDLING AND STORAGE

RECEIVING

Every case or crate leaving the factory is plainly marked at convenient places with case number, requisition number, customer's order, front or rear, and when for size and other reasons it is necessary to divide the equipment for shipment, with the unit number of the portion of equipment enclosed in each shipping case.

The contents of each package of the shipment are listed in the Packing Details. This list is forwarded with the shipment, packed in one of the cases. The case is especially marked and its number can also be obtained from the Memorandum of Shipment. To avoid the loss of small parts when unpacking, the contents of each case should be carefully checked against the Packing Details before discarding the packing material. Notify the nearest General Electric Company representative at once if any shortage of material is discovered.

All elements before leaving the factory are carefully inspected and packed by workmen experienced in the proper handling and packing of electrical equipment. Upon receipt of any apparatus an immediate inspection should be made for any damage sustained while enroute. If injury is evident or an indication of rough handling is visible, a claim for damage should be filed at once with the transportation company and the General Electric Company notified promptly. Information as to damaged parts, part number, case number, requisition number, etc., should accompany the claim.

HANDLING

Before uncrating, indoor equipment may be moved by a crane with slings under the skids. If crane facilities are not available, rollers under the skids may be used. Fig. 7 shows suggested method of handling the switchgear after it is removed from the skids.

Methods of handling outdoor equipment are show in Fig. 8. After the equipment is in place the liftin plates should be removed and reassembled, "turne in" so that passageway at the ends of the equipme will not be obstructed.

STORAGE

If it is necessary to store the equipment for ar length of time, the following precautions should b taken to prevent corrosion:

1. Uncrate the equipment.

2. Cover important parts such as jack screw gears and chain of lifting mechanism, linkage ar moving machine-finished parts with a heavy oil c grease. (D6B15 or D50H15)

3. Store in a clean, dry place with a modera temperature and cover with a suitable canvas to pre vent deposit of dirt or other foreign substances upc movable parts and electrical contact surface

4. Batteries should be uncrated and put c tricle charge immediately on receipt.

5. If dampness or condensation may be er countered in the storage location, heaters should b placed inside the units to prevent moisture damag Approximately 500 watts of heaters per unit will b required. Remove all cartons and other mis cellaneous material packed inside units befor energizing any heaters. If the equipment has bee subjected to moisture the primary insulation syste should be tested with a 1000v or 2500v megger. reading of a least 200 megohms should be obtaine

6. Breakers should be prepared for storag separately. Refer to appropriate breaker instructic book.

DESCRIPTION

Each unit is made up of a secondary enclosure and a primary enclosure, as shown in Figure 10.

SECONDARY ENCLOSURE

The secondary enclosure is usually located at the breaker withdrawal side of the unit, although in certain units it may be on the side opposite to the breaker withdrawal area. It consists of a compartment with a hinged door or panel upon which are mounted the necessary instruments, control and protective devices. The terminal blocks, fuse blocks, and some control devices are mounted inside the enclosure on the side sheets and a trough is provided at the top to carry wiring between units.

PRIMARY ENCLOSURE

The primary enclosure contains the high voltage equipment and connections arranged in compartment to limit the effects of faults and so minimize th damage.

BREAKER REMOVABLE ELEMENT

The removable element consists of a Magne Blast circuit breaker which includes its operatin mechanism, interlocks, movable primary and sec ondary disconnecting devices. The Magne-Blas breakers are equipped with wheels for easy insertic and removal. Refer to Figure 4, 5, 6.

All removable elements furnished on a particula requisition and of a like design and ratings ar completely interchangeable one with the othe

The removable as well as the stationary elemen are built with factory jigs and fixtures thus insurir interchangeability.

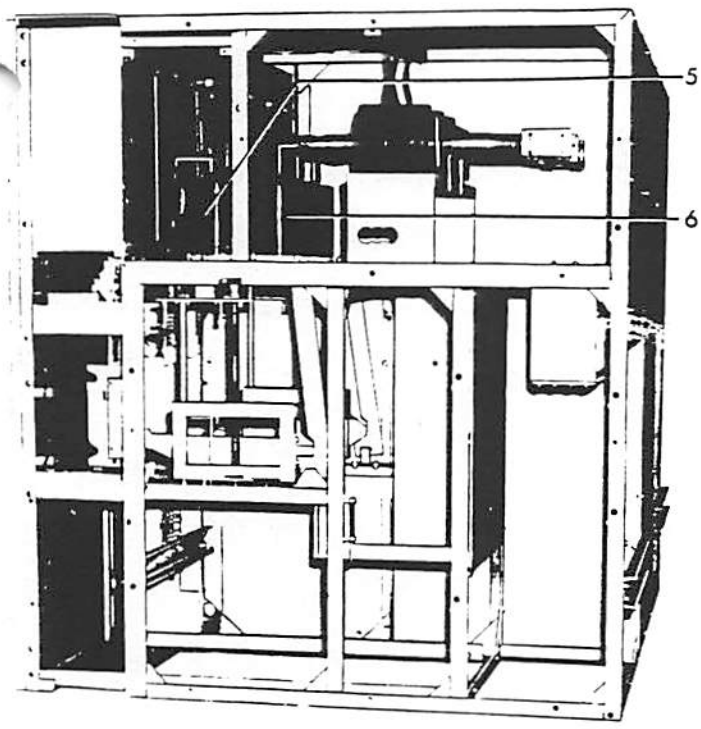


FIG. 10 (8039690) METAL-CLAD SWITCHGEAR

For a detailed description of the Magne-Blast breaker and its operation the applicable breaker instruction book should be consulted.

BREAKER ELEVATING MECHANISM

The elevating mechanism for elevating or lowering the removable element to or from its connected position supports the removable element in the operating position. In the test position the breaker is lowered to the guide rails and withdrawn from the fully inserted position 2 1/4 inches.

This mechanism consists of heavy-duty steel jack screws on which are carried nuts to support the elevating carriage. The carriage is so designed that the removable element can be readily inserted or withdrawn after the carriage has been lowered to the disconnected position without necessitating the removal of any bolts nuts or screws.

The breaker cannot be lowered or raised until it has been tripped. The breaker cannot be closed except with the breaker in either the operating or test position.

Guide rails are built into the metal-clad frame to guide the removable breaker element into correct position before the breaker is raised into the operating position by means of the elevating mechanism which is motor operated.

For a detailed explanation of the elevating mechanism refer to description under "OPERATION".

ELEVATING MOTOR

One elevating motor is furnished for each equipment. It is designed for quick interchangeability between units and is held in place by a stationary clamp under the clutch handle and a snap hasp on the front. Two dowels are located in the base to maintain alignment.

A short cable with plug is provided and must be plugged into the receptacle above the motor mounting. A selector switch is mounted on the motor for reversing the motor direction. This selector switch should not be used to start and stop the elevating gear motor.

PRIMARY DISCONNECTING DEVICE

The primary disconnecting devices utilize silver to silver contacts to insure against reduction of current carrying capacity due to oxidation of the contact surfaces. These contacts are of the high pressure line contact tube and socket design, the tube being backed up by heavy garter springs to insure contact pressure. Refer to Figure 11.

BUS COMPARTMENT

The main buses are enclosed in a metal compartment with removable front covers to provide accessibility.

The bus is supported by a flame retardent, track resistant, glass laminate insulating material which is practically impervious to moisture, and an excellent dielectric. No additional coatings should be applied.

The bus insulation is an extruded thermoplastic insulation sleeve, suitable for 105°C operating temperature. The bus bars are inserted into the sleeves leaving only the bolted joints exposed. Where standard configurations exist the joint is insulated with a Polyvinyl Chloride boot. Special conditions and non standards are taped. See page 22 item II.

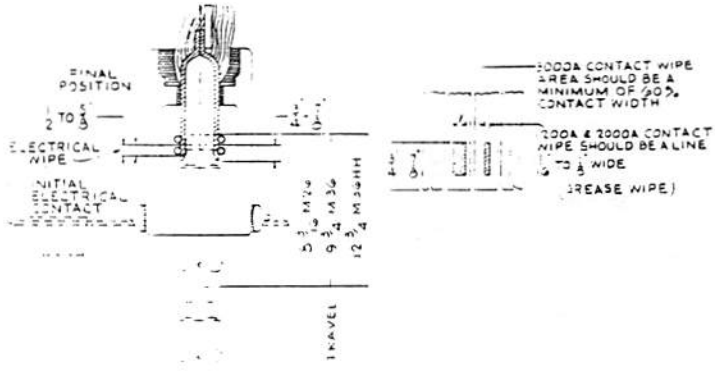


FIG. 11 BREAKER INSERTION IN PRIMARY DISCONNECTING DEVICES

CURRENT TRANSFORMER AND CABLE COMPARTMENT

The current transformers are mounted in a compartment isolated from the other equipment. Provision is made in this compartment for connecting the purchaser's primary cable by means of potheads or clamp type terminals.

POTENTIAL TRANSFORMER COMPARTMENT

Potential transformers are located in a compartment above the current transformers or in a separate unit adjacent to the breaker units.

The transformers are mounted on a movable carriage equipped with primary and secondary disconnecting devices. When the potential transformers are disconnected, they are at a safe striking distance from all live parts of the switchgear. In addition a grounding device is provided which contacts the fuses when the potential transformers are disconnected, effectively discharging the transformers. In this position the transformer fuses may be safely removed and replaced. A barrier mounted at the rear of the carriage moves with the carriage to a position in front of the stationary part of the primary disconnect device, providing a safe striking distance from all live parts. See Figure 12.

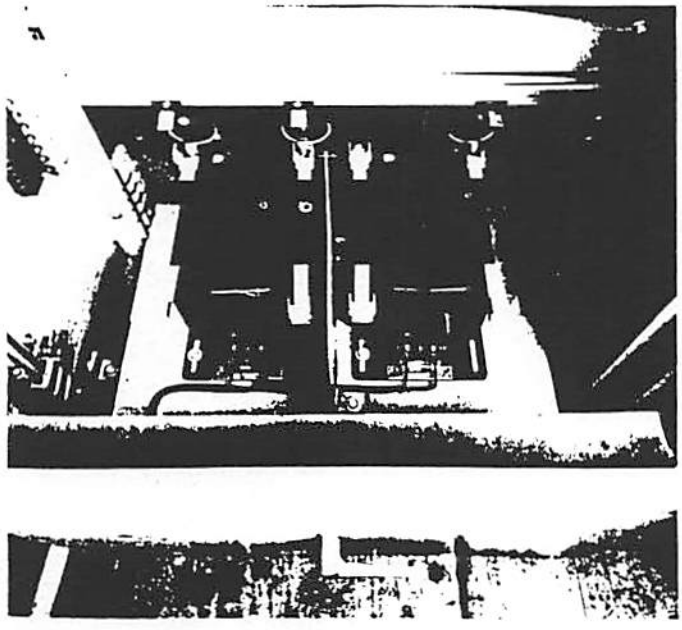


FIG. 12 POTENTIAL TRANSFORMER ROLLOUT SHOWN IN WITHDRAWN POSITION

DUMMY REMOVABLE ELEMENT

Dummy removable elements, Fig. 13, are used as a means of isolating circuits or bus sections, where operation is infrequent and a circuit breaker cannot be economically justified. The device consists of a framework to simulate the circuit breaker removable element with a set of six studs similar to those on the magneblast breakers. The lower end of the studs are connected, front to back, by copper bars which are fully insulated and metal-enclosed. The stationary structure is the same as for a circuit breaker. When the device is elevated into position it connects the front set of metal-clad disconnecting devices to the rear set.

Under no conditions must the dummy element be elevated or lowered when the bus or the unit is energized. Key interlocks are applied to insure that all source of power are disconnected before the dummy element can be operated. Refer to Figure 15

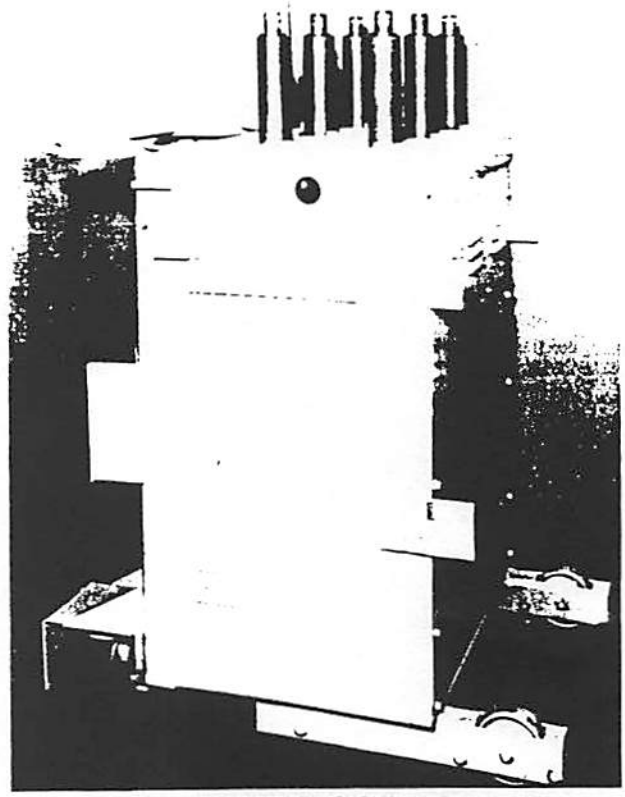


FIG. 13 DUMMY REMOVABLE ELEMENT

ROLLOUT FUSE-SWITCH UNITS

Rollout load-break disconnect switches, with or without current limiting fuses of high interrupting capacity, are sometimes used in metal-clad switchgear to protect and switch small transformers and circuits where circuit breakers cannot be economically or functionally justified.

The rollout switch is designated as type SE-10 and the units in which they are used are designated as type SEM-26 or SEM-36. For additional information on these equipments, refer to the supplementary instructions furnished.

FUSE DISCONNECTING DEVICE

Current limiting fuses with high interrupting rating are sometimes used in metal-clad switchgear to protect small transformers or circuits where circuit breakers cannot be economically or funtion-

ally justified.

The fuses are mounted on a movable support equipped with disconnecting devices. Control power transformers of 15 kva and smaller may be mounted on the rollout with the fuses. See Figure 16.

When the fuses are disconnected, they are at a safe striking distance from all live parts of the switchgear. In addition a grounding device is provided which contacts the fuses after they are disconnected, effectively removing any static charge from the fuses. In this position the fuses may be safely removed and replaced. The disconnecting devices are capable of interrupting transformer magnetizing current, but should not be used to interrupt load current. Mechanical or key interlocks are applied to prevent operating the disconnecting device while the load is connected. This is generally accomplished by interlocking so that the transformer secondary breaker must be locked in the open position before the disconnecting device can be opened or closed.

GROUNDING AND TEST DEVICE

The grounding and test device, Figure 14, provides a convenient means of grounding the cables or the bus in order to safeguard personnel who may be working on the cables or the equipment. The device can also be used for applying power for high potential tests or for fault location, to measure insulation resistance (Megger). By using potential transformers, it can also be used for phasing out cables.

The three studs of the device are similar to those of the magne-blast circuit breakers. The studs are mounted on a removable plate which can be placed in either of two positions. In one position the studs will engage the front (Bus) contacts only and in the other position the studs will engage the rear (Line) contacts only of a metal-clad unit.

To indicate the proper placement of the studs on the device, opposite sides of the assembly are marked "Line" and "Bus". The word corresponding to the desired position must be toward the operator.

To use, the device is rolled into the metal-clad housing in place of the circuit breaker, and raised into or lowered from the connected position by means of the circuit breaker elevating mechanism.

In addition to the device described above, there is available a form of grounding and testing device equipped with both bus and line side bushings, power operated grounding contacts, phasing receptacles, and a complete safety interlocking system. Refer to GEI-88768 for general design or instruction book called for on nameplate of device furnished.

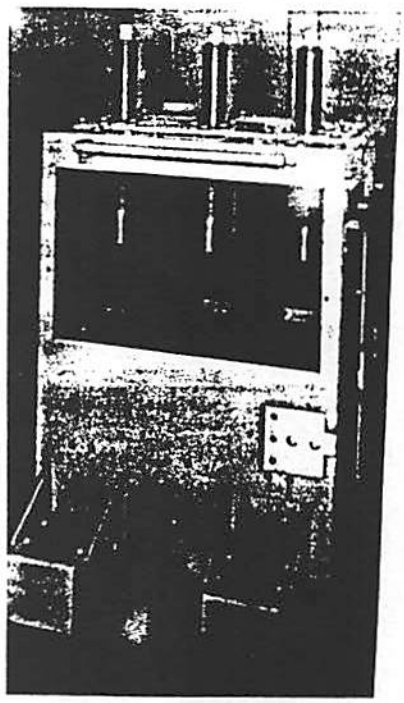


FIG. 14 (8028015) GROUND AND TEST DEVICE
(Cable shown not furnished by G. E. Co.)

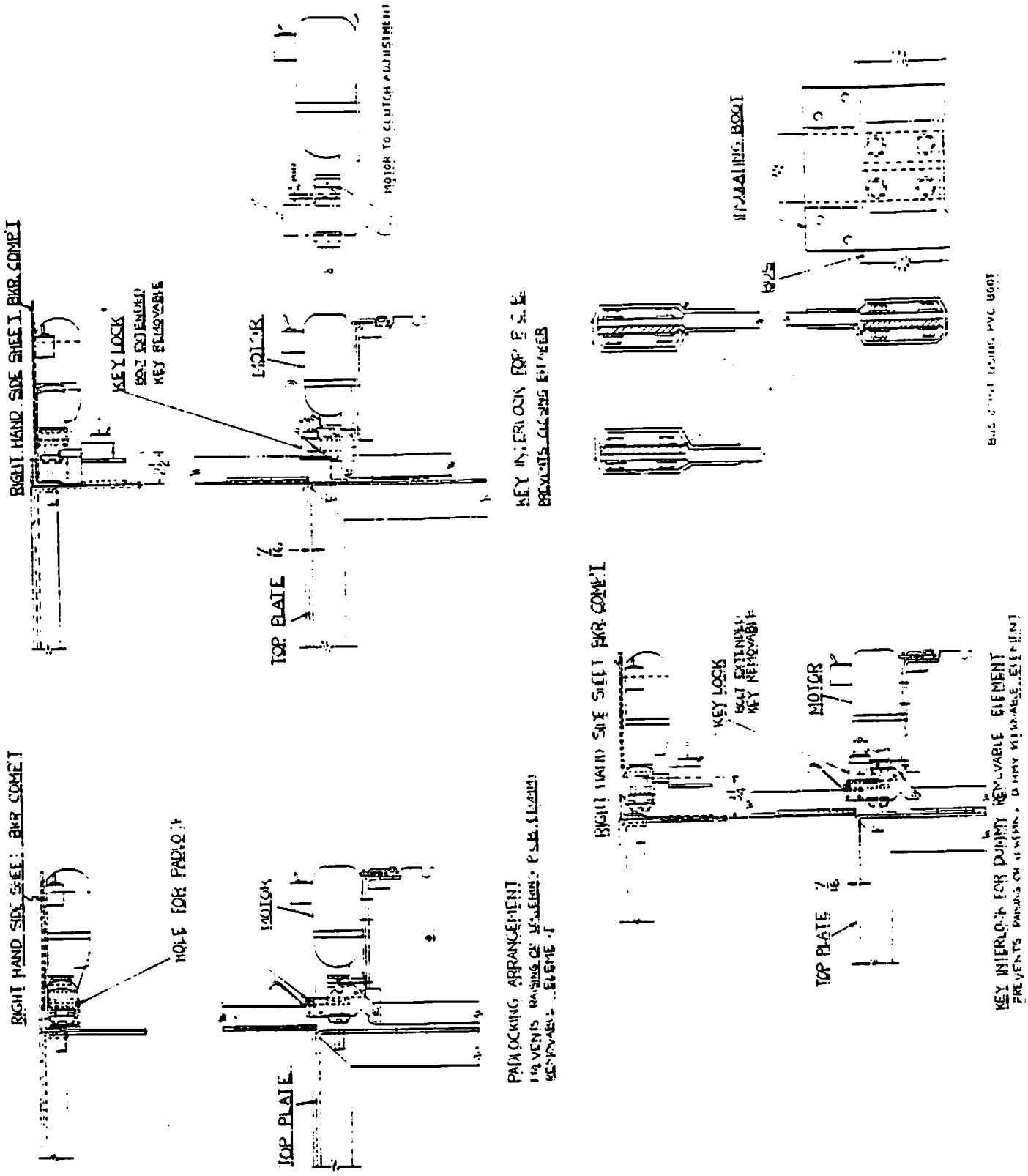


FIG. 15 PADLOCKING ARRANGEMENT, KEY INTERLOCKING AND BUS BOOT ASSEMBLY

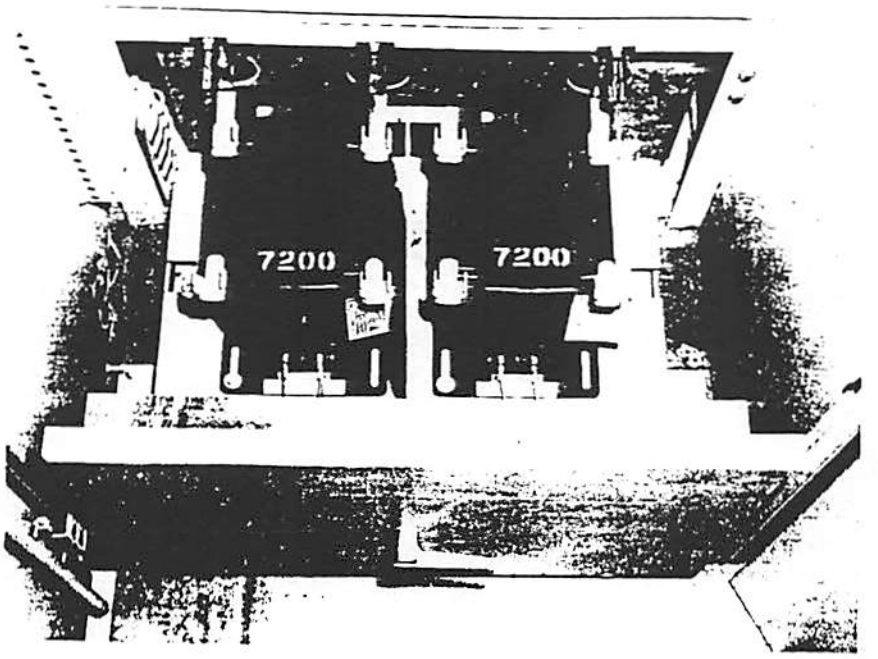


FIG. 16 (8918619B) CONTROL POWER TRANSFORMER ROLLOUT SHOWN IN OPEN POSITION

INSTALLATION

Before any installation work is done, consult and study all drawings furnished by the General Electric Company for the particular requisition. These drawings include arrangement and floor plan drawings, elementary, connection and interconnection diagrams and a device summary.

Occasionally additional shipping members are installed in the primary area to protect against shipping damage.

CAUTION - BUS SHIPPING BRACES MUST BE REMOVED PRIOR TO ENERGIZING. SHIPPING BRACES ARE PAINTED YELLOW AND MAY BE FOUND IN ANY UNIT WITH A RED "CAUTION" LABEL ON THE FRONT OF THE SHUTTER. THE BRACES ARE INDICATED ON THE ARRANGEMENT DRAWINGS. AN ADDITIONAL "CAUTION" LABEL WILL BE FOUND ATTACHED TO ONE OF THE BRACES.

After the shipping braces have been removed all joints must be properly tightened and insulated before energizing the bus.

Mats, screens, railings, etc. which are external to the switchgear, but which may be required to meet any local codes, must be furnished by the purchaser.

LOCATION

The recommended aisle space required at the front and at the rear of the equipment is shown on the floor plan drawing furnished for the particular requisition. The space at the front must be sufficient to permit the insertion and withdrawal of the circuit breakers, and their transfer to other units.

The space at the rear must be sufficient for installation of cables, for inspection and maintenance, and on some equipments to draw out potential transformers.

PREPARATION OF FLOOR - ANCHORING

Indoor Equipment

The station floor must be strong enough to prevent sagging due to weight of the switchgear structure and to withstand the impact stress caused by the opening of the circuit breakers under short circuit conditions. The impact loading is approximately 1-1/2 times the static load.

Suitable means must be provided by the purchaser for anchoring the equipment to the floor. It is essential that the floor be level to avoid distortion of the switchgear structure and the equipment be completely aligned prior to final anchoring. The recommended floor construction is shown in Figure 7. The floor channels must be level and straight with respect to each other. Steel shims should be used for final leveling of the switchgear if necessary. Care should be taken to provide a smooth, hard, and level floor under and in front of the units to facilitate installation and removal of the breaker. If the floor is not level and flush with the floor channels, it will be difficult to handle the breaker because it will not be level with respect to the stationary element.

Recommended practice is to weld the switchgear structure to the floor channels, using a tack weld at points indicated for anchoring on the drawing. If welding facilities are not available the gear should be bolted to the floor channels.

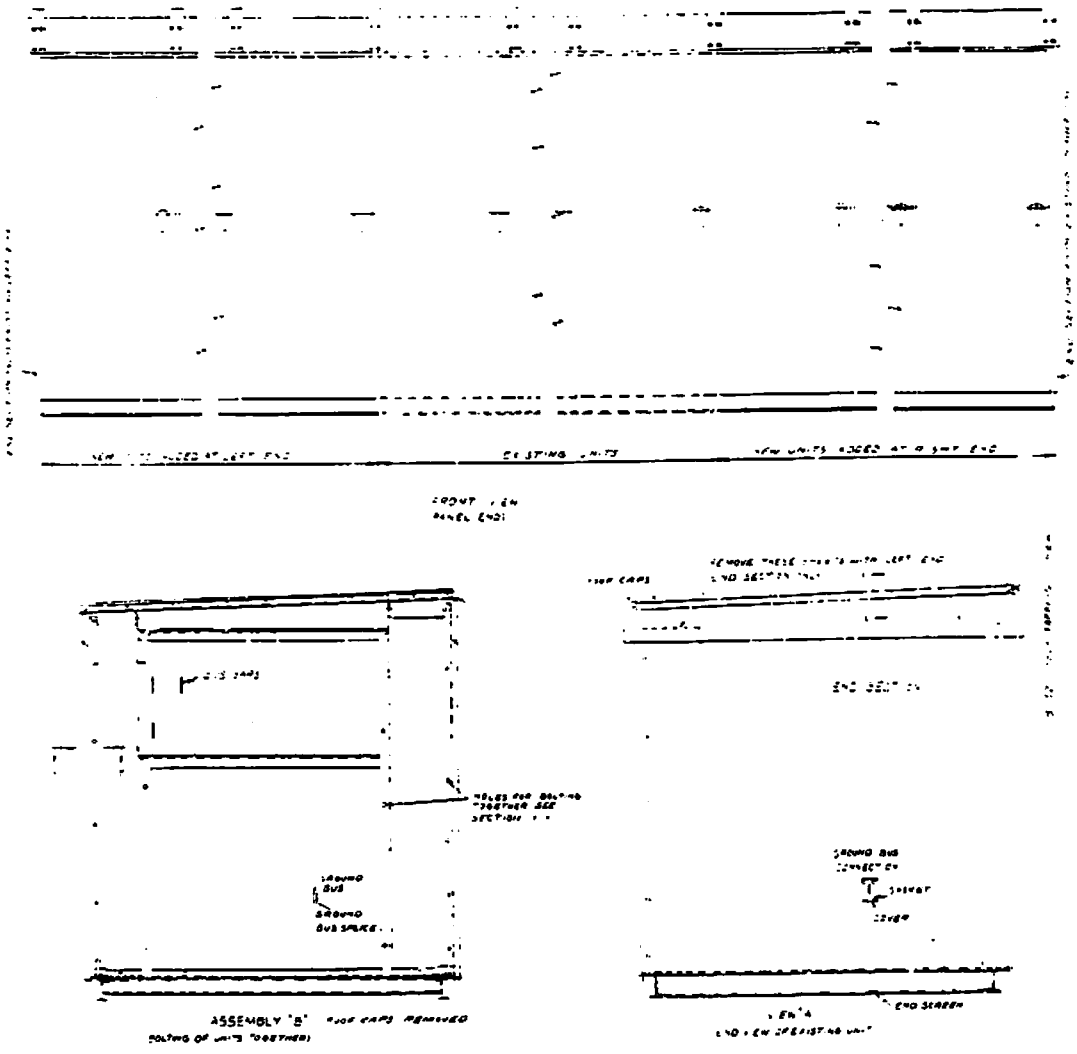
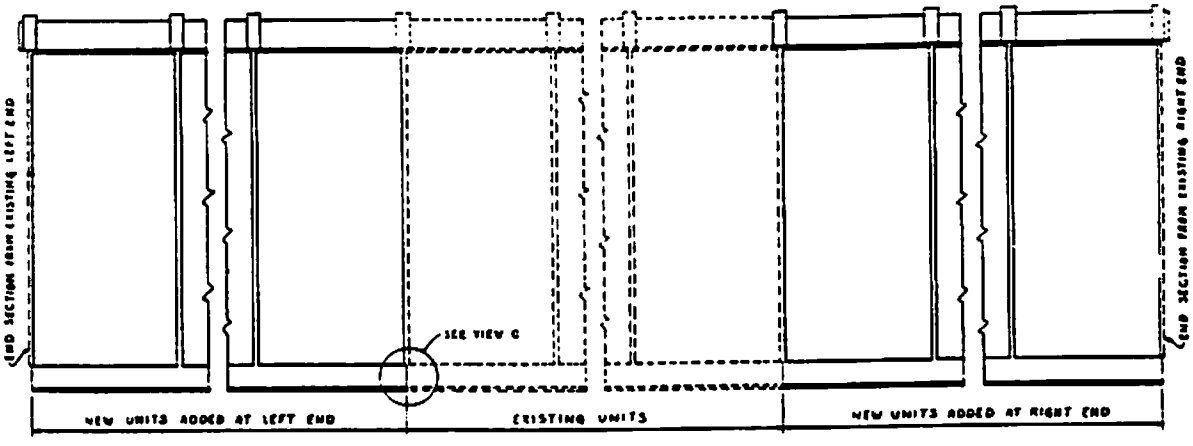
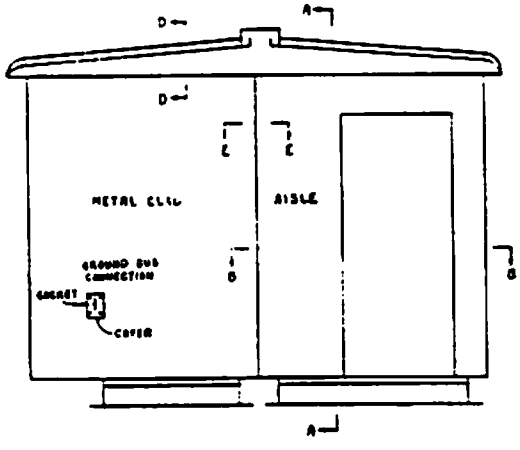
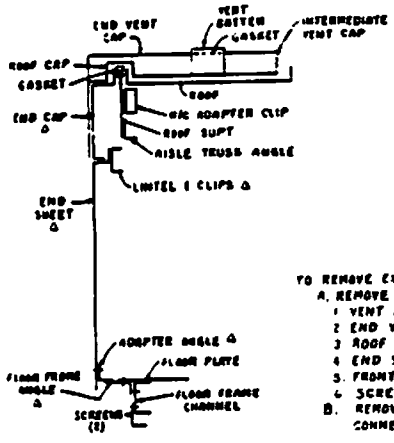


FIG. 17 (545D856) OUTDOOR METAL-CLAD SWITCHGEAR - ADDITION OF UNITS TO LINE - UP.



FRONT VIEW





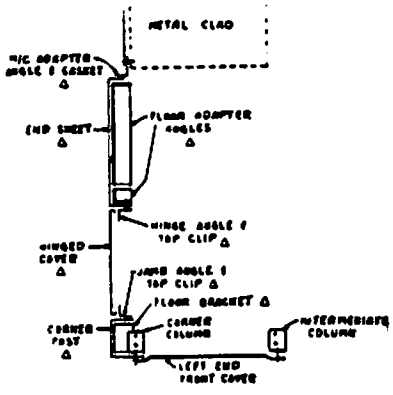
SECTION A-A

TO REMOVE EXISTING END SHEET (LEFT)
A. REMOVE THE FOLLOWING ITEMS FROM AISLE SECTION
1 VENT BATTEN
2 END VENT CAP
3 ROOF CAPS
4 END SECTION CONSISTING OF ITEMS MARKED Δ
5. FRONT COVER (MOVE TO NEW UNIT)
6 SCREENS (2)
B. REMOVE ROOF CAP, END SCREEN, GROUND BUS CONNECTION AND END SECTION FROM METAL CLAD SECTION

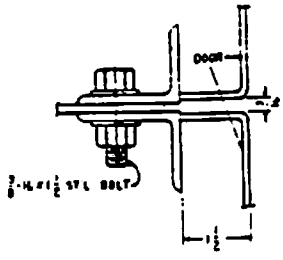
TO INSTALL NEW METAL CLAD UNITS (LEFT)
1 SET NEW UNIT(S) IN PLACE AND BOLT TOGETHER
2 ASSEMBLE ITEMS LISTED IN B
3 ASSEMBLE NEW ROOF CAPS
4 ASSEMBLE GROUND BUS SPLICE BETWEEN EXISTING AND NEW GROUND BUS
5 ASSEMBLE BUS BARS AND INSULATE PER INSTRUCTION BOOK

TO INSTALL NEW PROTECTED AISLE UNITS (LEFT)
1 INSTALL NEW FLOOR FRAMES AND FLOOR PLATE TIE DOWN ANGLE
2 REPLACE FLOOR FRAME ANGLE AT NEW END POSITION
3 INSTALL NEW FLOOR PLATES
4 ERECT NEW CORNER COLUMN (ANGLE)
5 ADD NEW AISLE TRUSS ANGLE AND METAL CLAD ADAPTER CLIP TO EXISTING END ROOF TRUSS AND SUPPORT
6 INSTALL NEW END AISLE TRUSS SUB-ASSEMBLY CONSISTING OF ROOF TRUSS ANGLE, ROOF SUPT, COLUMN CLIP, METAL CLAD ADAPTER CLIP AND ROOF SUPT CLIPS
7 REINSTALL THE ITEMS REMOVED IN A-6
NOTE - USE NEW GASKETS AND ALSO INSTALL PREVIOUS END FRONT COVER ON FRONT OF NEW END UNIT
8 INSTALL WIRING AND LIGHTING TROUGH

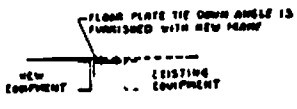
NOTE:- A SIMILAR PROCEDURE IS USED FOR RIGHT END ADDITIONS



SECTION B-B



SECTION E-E



INTERNAL VIEW C

FIG. 18 (718D393) OUTDOOR METAL-CLAD SWITCHGEAR WITH PROTECTED AISLE.

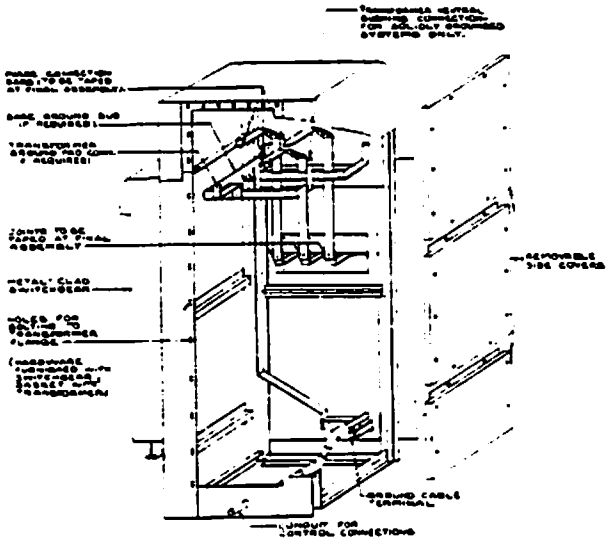


FIG. 19 (261C416)

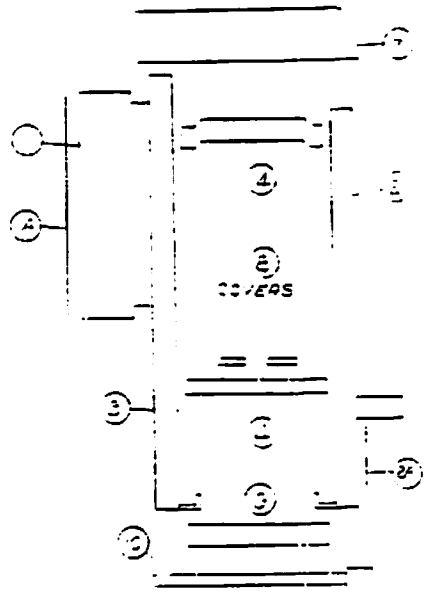


FIG. 20 (453A738)

OUTDOOR TRANSITION COMPARTMENT

Provision should be made in the floor for conduits for primary and secondary cables, located as shown on the floor plan drawing furnished for the particular requisition. If desired, the conduits may be installed before the switchgear. Consideration should be given to conduits which might be required for future connections.

Outdoor Equipment

Outdoor equipments are furnished both with and without rear enclosures. Recommendations for foundations for both types are given in Fig. 8. Primary and secondary conduits should be installed in accordance with the requisition drawings, before the equipment is put into place.

Since outdoor equipments are provided with a 6" base, a transfer truck is required to place the breaker in the housing. The level adjustment on the truck is shown in Fig. 8.

When outdoor equipments are shipped in more than one section, the joint between sections must be weatherproofed. Assemble the gasket between the doors, using cement provided. Refer to Fig. 8, Section B-B. Assemble the gasket between the roof sections, bolt together and install the roof caps. Refer to Fig. 8, Section C-C.

Outdoor Equipment with Protected Aisle

When specified by the purchaser, outdoor equipment is furnished with an enclosed, weatherproof operating aisle. See Fig. 3. The aisle enclosure is shipped separately from the switchgear.

The following procedure outlines the steps necessary to install outdoor equipment with a protected aisle:

(1) Install the switchgear in accordance with the procedure given above for outdoor equipment.

(2) Remove the shipping covers from the cont. panels. Since the relay and instrument cases are weather-proof, the control panels should be protec from inclement weather until the installation of aisle enclosure is completed.

(3) Apply Sterling U-310 or U-311 varnish both sides of the gaskets furnished for the jc between the ends of the switchgear and the ai. enclosure and to the surfaces against which gasket presses and hang the gaskets on the p: jecting studs at the ends of the switchgear line See Fig. 9, section A-A.

(4) Move the aisle enclosure into position guid the holes in the end sheets over the studs on switchgear lineup and guiding the roof sills betw the support clips bolted to the upper front of switchgear units above the control panels. T operation may be simplified by temporarily loosen the support clips.

The floor of the aisle enclosure must fit under hinged breaker cover of the metal-clad, so the a: enclosure must be moved into position on a le with the switchgear units.

(5) Bolt the aisle enclosure in place at both en and bolt the roof sills to the support clips, tighten any support clips loosened in the previous operati Replace any breaker compartment doors previou removed.

(6) If the aisle enclosure was shipped in m than one section, bolt the sections together assemble the roof caps in the manner descri above for roof joints in outdoor switchgear.

(7) Anchor the outside floor sill of the ai enclosure with anchor bolts placed in accordance v the requisition drawing. See Fig. 9, view

(8) Assemble the dome over the roof open

en the switchgear and the aisle enclosure. ig. 9, view X.

9) Remove shipping braces from aisle enclo- These braces should be left in place until the enclosure is assembled in order to maintain ment of the enclosure.

10) Connect secondary wiring to lights, con- ence outlets, etc., in accordance with the wiring rams furnished for the equipment.

Since the aisle floor is level with the floor of the chgear units, no transfer truck is required for oor equipment with a protected aisle.

The above procedure describes installation of a ected aisle enclosure with switchgear on one side ne aisle only. If the aisle is common to two line- of switchgear, the procedure will require slight ification. See the drawings furnished with the uisition for specific instructions.

nsition Compartments

Transition compartments for outdoor unit sub- tions may be one of two types (Figs. 19 and 20). ese compartments are normally shipped assem- d. The full height compartment (Fig. 19) cannot assembled for installation. The throat type artment (Fig. 20) can be installed in any of three ys, in accordance with the following instructions:

(a) Should the switchgear be positioned on its undation prior to the power transformer, the mplete transition can be mounted on the metal-clad s assembled. Remove covers =8. Apply Sterling 310 varnish to both sides of gasket 2A, and to the rfaces against which the gasket presses. Bolt ansition compartment to throat on metal-clad witchgear. Before jacking the power transformer nto its final location, apply Sterling U 310 varnish o both sides of gasket 1A and to the surfaces against which the gasket presses, and place the gasket over he mounting studs on the transformer tank wall. Slide transformer in place, guiding the transformer mounting studs through the mounting holes in #1. Center rubber seal between =1 and =3 before tightening nuts, maintaining 24" between transformer tank wall and end of metal-clad. Do not apply varnish to the rubber seal between #1 and #3. Cut secondary conduit =10 to length and assemble under the transition.

(b) Should the power transformer be positioned on its foundation prior to the switchgear, follow the procedure of paragraph (a) above, except move the switchgear up to the power transformer after assembling the transition compartment to the switchgear.

(c) If the power transformer and metal-clad switchgear are in place, disassemble transition as follows: Remove covers #8 and #9, adapter #1, dome =7, braces =4. Apply Sterling U 310 varnish to both sides of gasket =2A, and to the surfaces against which the gasket presses, before bolting #2 to metal-clad throat. Apply Sterling U 310 varnish to both sides of gasket =1A, and to the surfaces against which the gasket presses, and loosely fasten =1 and =1A to transformer tank. Slide throat of =3 into =1 and maintain approximately 4 1/2" from =3 to tank. Assemble braces =4 top and bottom to maintain size and proper alignment, then tighten =1 to transformer tank. Assemble connections, terminals, supports and complete all joints. Assemble dome =7, side covers =8 and bottom cover =9. Cut secondary conduit =10 to length and assemble under the transition.

Connect heaters located in 13.8 kv class transition compartment.

Indoor transition compartments are shipped assembled together with the adjacent metal-clad switchgear units.

BREAKER REMOVABLE ELEMENT

Before installing or operating the removable element consult the circuit breaker instructions for directions on installation and inspection.

The operation of the elevating mechanism, positive interlock and associated features are described under Operation of Equipment and should be reviewed before installing removable element.

TESTING CABINET

The testing cabinet, Fig. 22, should be installed on the wall at a location where maintenance and testing of the breaker can be conviently done. Conduits must be installed to carry cables to supply control power for testing. Test coupler springs will charge immediately.

ADDITION OF UNITS TO EXISTING EQUIPMENT

Before adding units to existing equipment, consult and study all drawings furnished with the equipment. In addition to the usual drawings furnished with new equipment special drawings may be furnished covering complicated or special assembly work. Also, check to make sure all necessary parts are on hand.

BEFORE ANY COVERS ARE REMOVED OR ANY DOORS OPENED WHICH PERMIT ACCESS TO THE PRIMARY CIRCUITS" IT IS ESSENTIAL THAT THE CIRCUIT OR CIRCUITS BE DE-ENERGIZED AND BREAKERS BE WITHDRAWN TO A DISCONNECTED POSITION AND TAGGED.

IF WORK IS TO BE DONE ON REMOTE EQUIPMENT CONNECTED TO A UNIT, THE BREAKER FOR THAT UNIT SHOULD BE PLACED IN THE DISCONNECTED POSITION AND TAGGED. ALSO THE REMOTE EQUIPMENT SHOULD BE ISOLATED FROM ANY OTHER POWER SOURCES CONNECTED TO IT.

Figure 17 indicates the special procedures required to add new metal-clad units to outdoor equipment without protected aisle, and Figure 18 indicates the special procedures required to add new metal-clad units to outdoor equipment with protected aisle. For indoor equipment, it is usually

necessary only to remove the end cover sheets and to re-assemble them on the new units after these are located and bolted to the existing units. Otherwise, the installation procedure is the same as described above.

When the units are in place and mechanical assembly is completed, assemble the main bus and other primary connections per the instructions below. (Removal of existing compound-filled connection boxes can be easily accomplished by packing the box in dry ice for 2 - 3 hours. Remove the dry ice and the cord tying the box in place, and strike the box with a hammer. The hardened box and compound will crack away from the joint.)

Secondary wiring and control bus connections should be made in accordance with the wiring diagrams furnished with the equipment.

CONNECTIONS

The main bus bars and other connection bars will be either copper or aluminum. In either case, the contact surfaces will be silver surfaced or equivalent. Do not use unplated copper or aluminum bars. All field assembled joints in primary conductors, regardless of material or method of insulation, should be made as described below:

(1) Wipe silver clean. Do not use steel wool, sandpaper or any abrasive on the silvered surface. Avoid handling of cleaned surface as much as possible.

(2) After cleaning apply D50H109 contact compound to the silvered surfaces in sufficient quantity so that the contact area will be thoroughly sealed with excess grease squeezed out of the joint when tightened. The bolts should be tightened to the torque values, shown in Table A, Fig. 23. After the bolts have been securely tightened, the joints are insulated using the molded polyvinyl-chloride boots which are furnished. These boots are placed over the bolted joints and the boot flaps are secured with nylon rivets.

(3) In some cases external connections are made to metal-clad bus by bars. The metal-clad bars are normally silver plated. Unplated bars, either copper or aluminum, should not be used to connect to silver plated bars.

(4) All field assembled Primary joints and terminations must be insulated for the operating voltage. There are two methods of insulating joints, boots where applicable and taped joints for all others. A detailed procedure for joint insulation is described under "MAIN BUS ASSEMBLY".

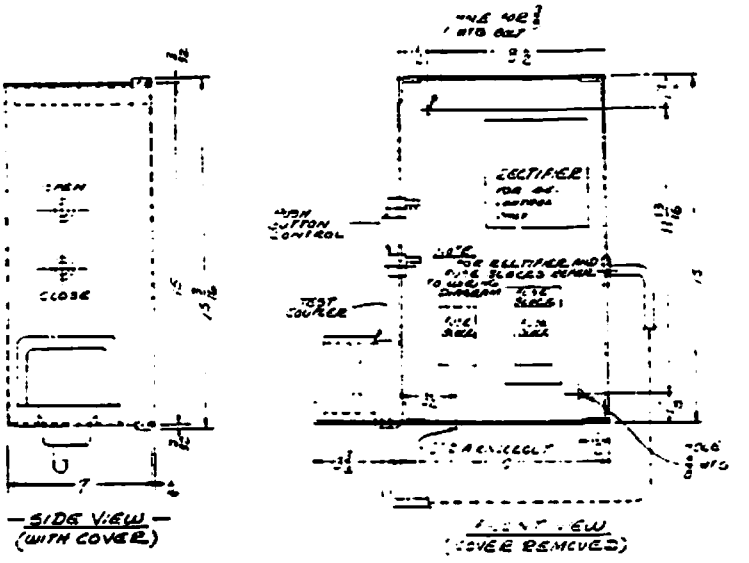


FIG. 22 (8998745) INSPECTION BOX FOR 13.8 KV METAL-CLAD SWITCHGEAR

MAIN BUS ASSEMBLY

For 4.16 kv, 7.2 kv and 13.8 kv equipment.

(a) Remove compartment covers.

(b) Bolt splice plates and bus bars together, following assembly instructions as given under CONNECTIONS. Also see Fig. 24 and Table A, Fig. 23.

Bolt Size	TIGHTENING TORQUE IN FOOT POUNDS	
	Bolted connection using standard wash, LK wash, nut with D50H109	Bolted connection using standard wash, prevailing torque lock nut with D50H109
3/8-16	20-30	15-20
1/2-13	45-55	30-35
5/8-11	60-70	45-55

FIG. 23

(c) There are two means of insulating bus joints for both 4.16 kv and 13.8 kv equipment.

1- Taped joints Fig. 26.

2- PVC(POLYVINYL CHLORIDE) boots Fig.25A.

I-TAPED JOINTS for 13.8 KV EQUIPMENT

(1) Prepare all joints as outlined under "CONNECTIONS".

(2) Fill all cavities around bolts and nuts with A50H119 compound to form a smooth surface for taping, thus preventing air voids. This compound is not an insulating medium and should not be used for that purpose.

(3) "T" Joint - Place 4" wide double thick Irrathene tape over the A50H119 compound as shown in Fig. 25. (This is not required for 4.16 joints).

(4) Wrap with insulating tape provided maintaining tension on the tape while wrapping, as shown in Fig. 26. Where there are sharp angles apply additional layers to obtain equivalent of the insulation on the flat surfaces.

(5) Over the insulating tape, apply one layer of glass tape, half lap as a protective covering as shown in Fig. 26.

(6) Over the glass tape, brush a heavy coat of U310 (brown) varnish. Varnish may be thinned, if necessary with XYLENE D5B9.

(7) Replace all covers previously removed.

II-PVC (POLYVINYL CHLORIDE) BOOT INSULATION for 13.8 KV EQUIPMENT

(1) PVC boots for 13.8 equipment can only be applied to those assemblies furnished with the molded bus barrier, Figure 36. This barrier is distinguished by the raised surface around each bus bar. Those assemblies not furnished with this barrier will have to be taped. See above.

PVC boots can be applied to 13.8 kv - 1000 MVA bus compartment or any elevated bus compartment using flat, non molded bus supports.

(2) Prepare all joints as outlined under "CONNECTIONS".

(3) Place the PVC boot over the joint as shown in Fig. 25A.

(4) Secure the PVC boot with self-locking fasteners furnished. Joint insulation is now complete.

(5) Replace all covers previously removed.

(6) Boots will be furnished for standard configurations, however special conditions must be taped.

III-PVC (POLYVINYL CHLORIDE) BOOT INSULATION for 4.16 KV EQUIPMENT

The instructions for the bolted joint and application of the PCV boot is the same as outlined for the 13.8 equipment except there are no restrictions on the bus barrier.

IV-TAPED JOINTS for 4.16 KV EQUIPMENT

(1) The instructions for the bolted joint and application of the tape insulation is the same as outlined for the 13.8 equipment except use 1/2 the amount of insulating tape and use the U-311 (black varnish). Refer to Table in Fig. 26.

(2) In unit substations, the connection bars should be assembled in the transition compartment (Figure 19 and 20) and the connections at the transformer terminals taped and painted as indicated above. The conduit for secondary circuits should also be assembled in or below the transition compartment.

CLEANING BUS INSULATION

Main bus bars are insulated with a high temperature thermoplastic material having excellent dialectric and mechanical properties. When cleaning is necessary only denatured alcohol or iso propyl alcohol should be used to remove any foreign materials from the insulation surface.

Paint on Porcelain: Use methylene chloride based paint remover. Wipe off with distilled water. Extreme care should be taken not to get any on Noryl, compound or tape.

BUS DUCT

Bus ducts connecting between groups of metal-clad switchgear, or between metal-clad switchgear and other apparatus, should be installed as shown on the arrangement drawings furnished with the ducts. Supports should be provided as indicated on the drawings.

All joints in the bus, including adjustable joints, should be assembled and insulated as described above for main buses. Adjustable joints are provided in long runs of bus duct to allow for variations in building construction, etc. These joints should be loosened before installation of the duct, then tightened after being set in the position required by the fixed points at the ends of the duct.

Outdoor bus ducts must be gasketed at the joints between shipping sections. Coat both sides of the flat gasket and the flanges of both duct sections with Sterling U310 or U311 varnish before assembly. Bolt the two duct sections together. Remove the top cover from one duct section and place 3/8" elastic compound bead along top of joint slightly overlapping the sides. Bolt top cover in place and fasten roof cap in place over the joint. See Fig. 23A. When top covers are removed after installation for inspection the 3/8" elastic compound bead must be replaced to insure a tight seal.

Removable front and rear covers of vertical sections of bus duct must also be gasketed. Coat both sides of the gasket, the flange of the duct, and the edges of the inside surface of the cover with

Sterling U310 or U311 varnish before assembly. Do not bolt these covers in place until all interior assembly work on the duct is completed and access will no longer be required.

Outdoor bus ducts of the 13.8 kv class are provided with heaters. Connect these heaters in accordance with the wiring diagrams furnished with the equipment before energizing the bus duct.

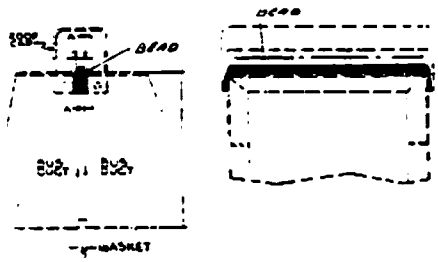


FIG. 23A BUS DUCT GASKETS

PRIMARY CABLES

The primary cable connections in indoor switchgear are reached by removing the rear bolted covers. In outdoor switchgear with rear enclosures the hinged instrument panel, if present, must be swung open and the bolted covers behind it removed.

Before any primary cable connections are made, the cables should be identified to indicate their phase relationship with the switchgear connections. This is necessary to insure that motors will rotate in the proper direction and that the phase rotation is the same when interconnecting two different sources of power.

There are two common methods of making primary cable connections:

(a) Potheads (see GEI-28838H) are used when it is desired to hermetically seal the end of the cable to make a moisture-proof connection between the cable and switchgear bus. A pothead also prevents seeping of oil from the end of oil impregnated varnish cambric or paper insulated cable.

(b) Clamp type terminals and wiping sleeve or cable clamp.

No insulation materials are furnished for cable terminations. When potheads are supplied as part of switchgear insulation materials are furnished for the bar terminations to the pothead studs.

In all cases carefully follow the cable manufacturer's recommendations for installation of the type of cable being used. A typical example of terminating a shielded cable is shown in Figures 28 and 29.

If the cable is aluminum, the conductor surface must be carefully abraided and the cable covered liberally with a joint compound recommended by the cable manufacturer.

INSULATING PRIMARY CABLE TERMINATIONS

All field assembled joints for primary cable terminations should be prepared as outlined under "CONNECTIONS". Upon completion of the cable termination, care must be exercised when taping the exposed termination.

(1) Check to see that a sufficient area of insulating tape extends beyond the painted glass tape furnished by the factory. (2" for 5KV, 3" for 15KV). It may be necessary to remove the current transformer primary conductor insulating support to obtain proper insulation joint overlap. Replace support upon completion of joint. Refer to Fig. 26

(2) All terminations should be insulated as outlined in table Fig. 26 for correct layers of insulating and glass tape.

(3) The instructions for application of the tape insulation is the same as outlined for "Taped Joints" items 1, 2, 4, 5, 6 and 7

POTHEADS

Potheads are mounted on an adapter plate extending across the width of the metal-clad unit as shown in Fig. 27. Where necessary the adapter plate is split into two parts to facilitate the installation of the potheads.

Three-Conductor Potheads

Installation procedures for a three-conductor lead-sheathed cable with a wiping sleeve cable entrance fitting on the pothead is outlined in GEI 28838H. This is the type most generally used. The factory does not furnish insulating materials for completing stress cones and cable terminations. In all cases carefully follow the cable manufacturer's recommendation for installation of the type cable being used. A suggested procedure for shielded cables is outlined below. Refer to Fig. 28 and 29 for reference.

TERMINATION WITHOUT POTHEAD

The factory does not furnish insulating material for completing the primary cable termination at the cable clamp or for stress cones. In all cases carefully follow the cable manufacturer's recommendation for installation of the type cable being used. A suggested procedure for shielded cables is outlined below. Refer to Fig. 28 and 29 for reference

Single Conductor

1. Cut cable to proper length.

2. Remove jacket and cable tape for distance of A plus B plus 3 inches, plus length to be inserted into terminal lug.

3. Unwrap shielding tape to point M, cut and solder it in place avoiding excessive heat on insu

FIG. 24 (132C7770) METHOD OF MAKING BUS BAR CONNECTIONS

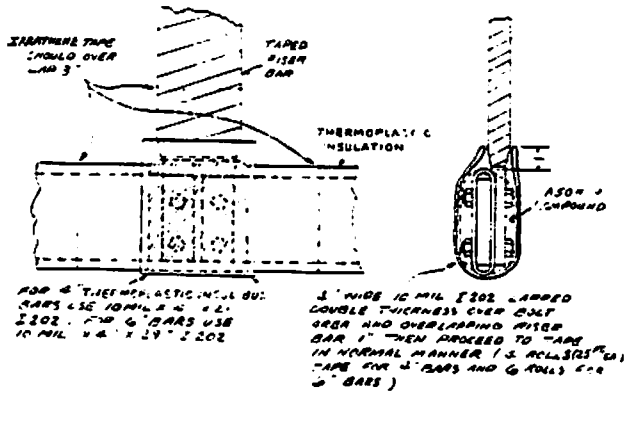


FIG. 25 (104A2714) 13.8 KV TAPED JOINTS

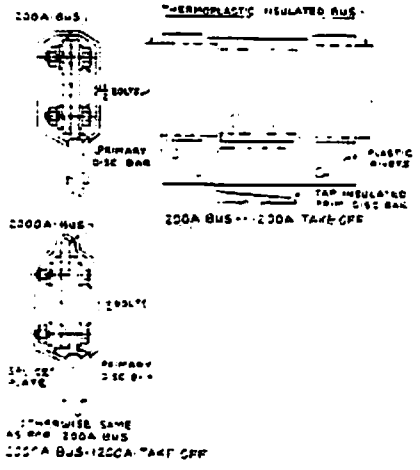


FIG. 25A (208A8953) 4.16 KV AND 13.8 KV BUS INSULATING BOOT

lation. Remove outer semi-conducting tape for same distance. Thoroughly clean surface from which the semi-conducting tape was removed.

4. Remove insulation and inner semi-conducting tape to expose conductor for distance of one inch plus length to be inserted into terminal lug.

5. Attach terminal lug to conductor. If the cable is aluminum, the conductor surface must be carefully abraided and the cable covered liberally with a joint compound recommended by the cable manufacturer.

6. Taper insulation for one inch as shown. See Fig. 28.

7. Apply end seal. Clean surface over which splicing tape is to be applied and coat with G.E. No. A50P69 adhesive cement or equivalent. When solvent evaporates, build up with splicing tape GE8380 or equivalent, as shown.

Rated kv Phase to Phase	Dimensions in Inches	
	A*	
	Indoors Dry Locations	B
2 to 5	5	2
6 to 10	9	3
11 to 15	13	4

* For ungrounded neutral use 1.33 times the dimensions in selecting distance A. See Fig. 28 and 29.

8. Build stress cone. Clean cable surface and coat with G.E. No. A50P69 adhesive cement or equivalent. When solvent evaporates, build up cone with splicing tape GE8380 or equivalent, for length B plus B. Between points M and P, tape is applied so that wrapped thickness at N is equal to 75% of the original insulation thickness - and so that the cone tapers to zero thickness at points M and P. Apply one layer No. 33 Scotch tape or equivalent, half lapped. Obtain a smooth wrapping but do not stretch tape more than necessary.

9. Pass a turn of tightly drawn braid around exposed portion of shielding tape at point M and solder in place. Then apply shielding braid in tightly drawn 1/6 inch lap wrappings to point N and spot solder. Terminate the braid by cutting 1/2 inch beyond soldering point. Turn down and solder loose ends to preceding turns. Wrap four to six turns of No. 19 AWG tinned copper wire around shielding braid and solder. Solder all turns of braid together along three lengthwise lines equally spaced around braided surface.

10. Solder ground strip over shielding tape near cable covering. Cover stress cone with one layer No. 33 Scotch tape, half lapped. Obtain a smooth wrapping but do not stretch tape more than necessary. Add two layers of splicing tape.

11. Pencil jacket for 1/2 inch as shown. Clean surface. Take particular care in cleaning outside jacket surface in order to entirely remove black wax finish. Coat with G.E. No. A50P63 adhesive cement or equivalent. When solvent evaporates, apply splicing tape GE8380 or equivalent and make sheath seal as shown on drawing. Apply one layer No. 33 Scotch tape or equivalent, half lapped. Obtain a smooth wrapping but do not stretch tape more than necessary.

12. Over entire termination, apply two layers of No. 33 Scotch tape or equivalent, half lapped, in manner to shed water. Obtain a smooth wrapping but do not stretch tape more than necessary.

TERMINATION WITHOUT POTHEAD MULTI-CONDUCTOR

The factory does not furnish insulating materials for completing the primary cable terminations at the clamp terminal or for the stress cones. Refer to Fig. 29 for reference.

Make termination as indicated for single-conductor except - substitute the following for paragraphs 10, 11 and 12;

Pencil jacket 1/2 inch. Clean surface over which sheath moisture seal is to be applied. Take particular care in cleaning outside jacket surface in order to entirely remove black wax finish. Coat with G.E. No. A50P63 adhesive cement or equivalent. Allow to dry. Apply splicing tape GE8380 or equivalent to make moisture seal as shown. This is done by starting wrapping tape near end of jacket and wrapping over ground wires for 1-1/2 inches. Bend ground wires out and back over taping just applied and continue applying lapped layers of tape to completion of moisture seal including a complete tape seal in crotch formed between the three conductors. Bond and ground the ground wires.

For a multi-conductor cable not having ground wires, the individual terminations should have grounding strips applied as for a single-conductor termination. These grounding strips are to be joined together to a common ground. This common ground must then be grounded.

GROUND FAULT CURRENT TRANSFORMERS (THROUGH-TYPE)

Through-type current transformers (See Fig. 27) are furnished where specified for sensitive protection against ground faults. These transformers are normally installed in a horizontal position directly above or below the primary cable terminals, so that the primary cable or cables can pass through them. One transformer is required for each three-phase circuit.

Where armored cable is used, the armor must be terminated and grounded before the cable passes through the transformer. Armor clamps are furnished for this purpose when specified.

When lead or other conducting sheath cable, or cable with shielding tape or braid is used, it is recommended that the sheath or shield be grounded solidly to the switchgear ground bus. The ground lead should be bonded to the sheath or shield on the side of the current transformer away from the primary terminals. In cases where the ground cannot be applied before the cable passes through the transformer, bond the lead to the sheath or shield between the transformer and the primary terminals. The ground conductor must then be passed back along the cable path through the current transformer before being connected to the ground bus.

Where potheads are used in units provided with ground fault current transformers, the pothead mountings must be insulated from ground.

CONTROL CABLES

When control conduits enter the unit from below the conduit should not extend more than 4 inches above the floor. The control cables may be pulled through the conduits before or after the switchgear is installed, whichever is more convenient.

Connect the cables to the terminal blocks in accordance with the wiring diagrams furnished for the requisition.

If the control conduits enter from above, drill the top and bottom covers of the front enclosure wiring trough to suit the conduits. Fasten the conduits to the bottom cover with locknuts.

The cables from the control power source to the switchgear should be large enough to avoid excessive voltage drop when the circuit breakers are operated. See testing instructions.

Where units have been split for shipment, any control or other secondary leads which must connect across the split will be arranged with terminal blocks in the cross trough or convenient side sheet so that the wires can be reconnected. The wires will be cut to length and formed before being folded back so that a minimum of time will be required for reconnecting them.

GROUND BUS

The ground bus is bolted to the rear of the frame near the bottom. It is arranged so that connections to the station ground can be made in any unit. When the equipment is shipped in more than one group, the sections of ground bus must be connected by using the splice plates furnished with the equipment. Assemble the ground bus joints as outlined under "CONNECTIONS" (Page 19). Ground bus connections are made in the lower portion of the cable entrance compartment. The switchgear ground bus must be connected to the station ground bus by a conductor having a current carrying capacity equal to that of the switchgear ground bus. It is very important that the equipment be adequately grounded to protect the operator from injury when short circuits or other abnormal occurrences take place and to insure that all parts of the equipment, other than live parts are at ground potential.

LIGHTNING PROTECTION

It will be the responsibility of the purchaser to provide suitable lightning arresters to protect the switchgear from damage due to lightning. The General Electric Company's recommendations as to the types of circuits requiring lightning protection, and a list of recommended lightning arresters, are contained in Bulletin GER-141 copies of which are available upon request.

When lightning arresters are furnished the primary cable terminal will be insulated at the factory unless it must be disconnected for shipment. When this connection is completed in the field it will be necessary to insulate the primary connection before the switchgear is energized.

ROOF ENTRANCE BUSHING

When assembling the connection bar end of roof entrance bushings inside of the switchgear and other terminations where porcelain insulators are used, insulation should be applied as follows:

(1) Prepare the connection bars as outlined under "CONNECTIONS".

(2) Fill all cavities around the contact nuts and connection bars with A50H119 compound. Form a smooth surface for taping, thus preventing air voids. The compound is not an insulating medium and should not be used for that purpose.

(3) Wrap joint with insulating tape provided, maintaining tension on the tape while wrapping as shown in Fig. 26 where there are sharp angles apply additional layers to obtain equivalent of the insulation on the flat surfaces.

(4) Over the insulating tape, apply one layer of glass tape, half lap as a protective covering as shown in Fig. 26.

(5) Over the glass tape, brush a heavy coat of U-310 brown (for 15kv) or U-311 black (for 5kv), varnish. See Fig. 25B.

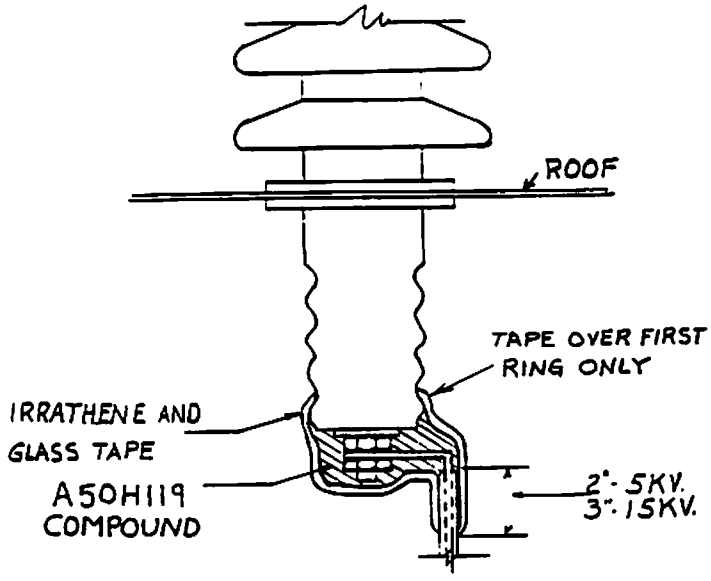
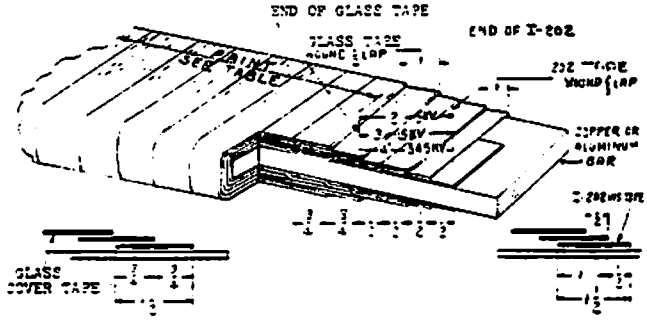


FIG. 25B TAPING OF ROOF ENTRANCE TERMINATION



INSULATION LEVEL	INSULATION LAYERS(NOTE 1) I-202 NOTE 2	GLASS NOTE 3	PAINT APPLY ONE COAT LIBERALLY
5000V	2	1	STERLING U-311 BLACK
15,000V	4	2	STERLING U-310 BROWN
34,500V	6	3	

NOTE 1:
I-202 TAPE - One layer, wound 2/3 lap requires 3 turns around bar in one width of tape. One layer thickness is 3 times tape thickness.
GLASS - One layer, wound 1/2 lap requires 2 turns around bar in one width of tape. One layer thickness is 2 times tape thickness.

NOTE 2:
Irrathene #202, width 1 1/2" thickness 0.010". Keep tension on tape at all times while applying.

NOTE 3:
Glass #2L12B width 1 1/2" thickness 0.010".

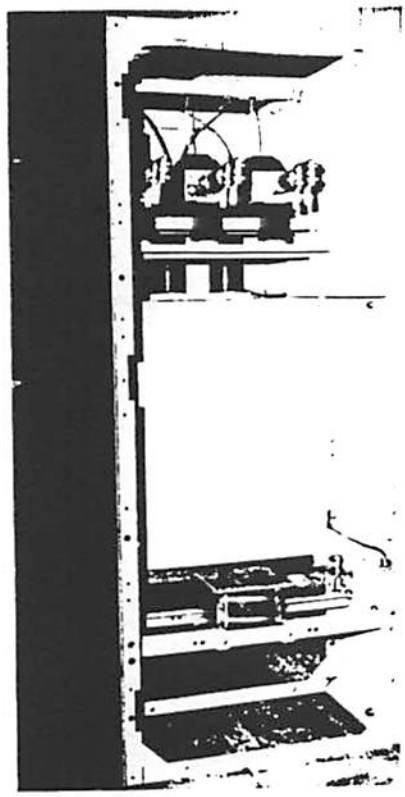


FIG. 27 (8918527-A) REAR VIEW OF UNIT SHOWING GROUND SENSOR TRANSFORMERS

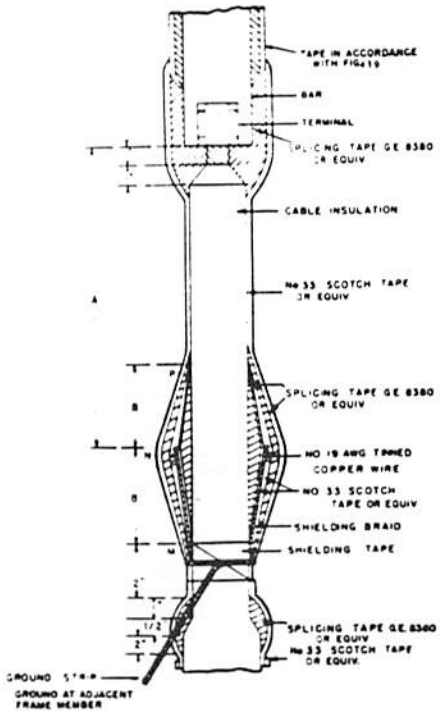


FIG. 28 (B230046C) TERMINATION WITHOUT POTHEAD SINGLE-CONDUCTOR

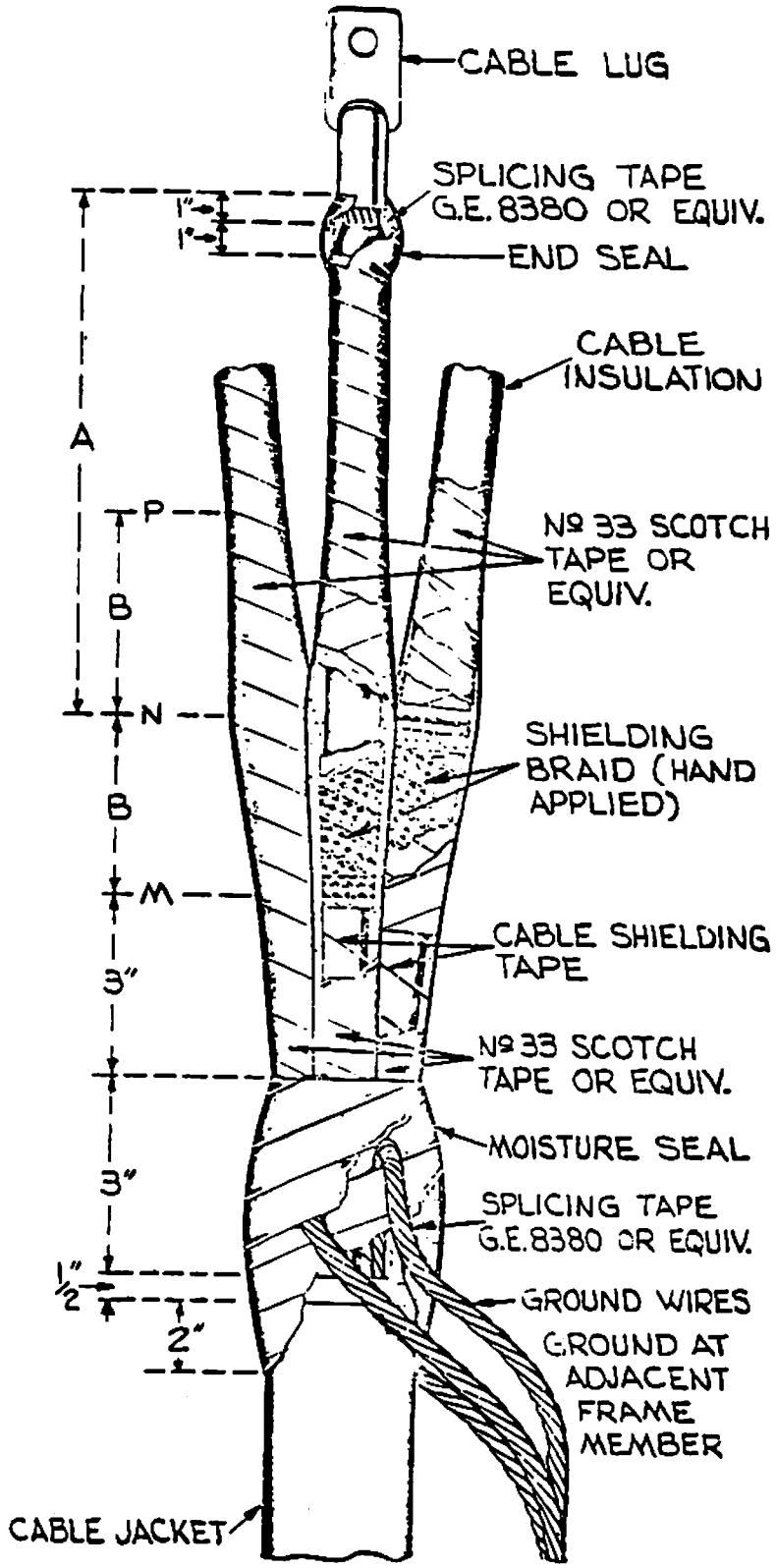


FIG. 29 (B232004C) TERMINATION WITHOUT POTHEAD MULTI-CONDUCTOR

DOOR ALIGNMENT

If for any reason it is necessary to realign the doors of metal-clad switchgear during installation the procedure given in the following paragraphs should be followed.

After checking that the switchgear is level and plumb as described above, start at either end of the switchgear lineup and realign each door individually as required.

The top of each door should be level with the adjacent doors; the sides of each door plumb; the surface of each door flush with the adjacent doors; and the space between adjacent doors equalized to permit their free swing and present a neat appearance. The door stops should be adjusted to permit a door swing of approximately 105°.

Doors may be raised or lowered vertically, or moved forward or backward horizontally, by loosening the hinge mounting nuts on the left side sheet and shifting the hinge and door assembly as allowed by the slotted holes in the hinge.

Doors may be shifted to the right or left by adding or removing washers or shims from between the hinge and side sheet.

Doors may be plumbed by slightly bending the appropriate hinges. To do this, open the door and insert a drift pin in either of the two holes in the hinge. Pulling forward on the drift pin will move the door to the right, and pushing back will move the door to the left. Adjust each hinge individually as required to plumb the door.

When properly aligned, the doors of outdoor switchgear should be tightly seated on the gasket all around. After aligning such doors, close and latch the door and check the seal by running a 3" x 5" card, shipping tag, IBM card, or some similar card around the edge of the door. If the card will pass between the door and the gasket, the door is improperly adjusted, and should be readjusted until the card will no longer pass through.

TESTING AND INSPECTION

After the equipment has been installed and all connections made, it should be tested and inspected before putting in service. Although the equipment and devices have been completely tested at the factory, a final field test should be made to be sure that the equipment has been properly installed and that all connections are correct and have not become loose in transportation. The primary equipment should be completely de-energized while the tests are in progress. See installation.

Directions for testing devices such as relays, instruments and meters are given in the instruction book furnished for each device. The settings of the protective relays must be coordinated with the other relays on the system and therefore these relays must be set by the purchaser. General instructions on setting the relays are given in the relay instruction books. Special instruction books are furnished for complicated automatic equipments, describing the sequence of operation of the devices required to perform the desired function.

When transformers are furnished to supply the control power, the primary taps should be selected so that the control voltage indicated on the wiring diagram is obtained on the secondary of the transformer. When a battery is used to supply the control power, the cables from the battery to the switchgear should be large enough to avoid excessive voltage drop. The voltage at the terminals of the breaker closing coils, when the breaker is being closed, should not be less than 112.5 volts for 125 volt coils and 225 volts for 250 volt coils.

The operation of the breaker with its associated devices may be tested in the unit while the equipment is energized by use of the test coupler which is furnished.

SOLENOID OPERATED BREAKER

Lower the breaker to the test or down position. Attach the test coupler to connect the breaker secondary disconnecting device to that on the structure.

STORED ENERGY OPERATED BREAKER

Lower the breaker to the down position and withdraw the breaker 2 1/4" until a notch in the spring discharge cam releases the breaker interlock. Attach the test coupler to connect the breaker secondary disconnecting device to that on the structure.

High potential tests to check the integrity of the insulation are not necessary if the insulation instructions in this book are carefully followed. Should the purchaser desire to make high potential tests, the test voltage should not exceed 14kv A. C. for 4.16kv and 27kv A. C. for 13.8 equipments. These voltages are 75% of factory test voltages and are in accordance with ANSI standards.

Potential transformers and control power transformers must be disconnected during high voltage testing.

OPERATION

The operation of metal-clad switchgear is similar to that of other types except that it provides maximum safety to the operator and the feature of easy removal and replacement of the circuit breaker.

All circuit breaker removable elements of the same type and rating which have duplicate wiring may be interchanged.

BREAKER POSITIONING

To place the breaker in the operating position, proceed as given below.

The elevating mechanism is accurately leveled

and checked at the factory and should need no adjustment. Do not install or remove the breaker or make adjustments unless the breaker is open.

Rub a small amount of contact lubricant D50H47 on the silvered portion of the breaker studs to form a thin coating of contact purposes.

Lower the elevating mechanism lifting brackets until the lifting brackets are in the fully lowered position. The breaker should then enter the housing freely. After first assuring that the breaker is in the open position, push the breaker into the unit until it rests against the rear of the front lifting saddle of the elevating mechanism.

The clearance between the interference block on the breaker and the interference block on the interlock lock mechanism (view X-X Figure 29) should be from 1/16" to 1/8". At this point the breaker positive interlock roller should be centered in the bottom "VEE" of the interlock cam plate.

To elevate the breaker, operate the elevating control selector switch on the elevating motor to "RAISE". A clutch handle just above the elevating motor (clutch handle is under the elevating motor in the 1000 MVA Unit) is then pulled forward until a motor limit switch closes and the motor clutch engages to raise the breaker in the unit. Carefully raise the breaker and while elevating note that the shutter slides open and the breaker studs center with respect to the openings in the stationary disconnecting devices or injury to the contacts may result.

The clutch handle is held in the forward position until a limit switch on the structure opens to stop the motor at the end of the upward travel of the breaker. The springs will charge.

The motor selector switch must not be used to energize or interrupt the motor circuit at any time.

When the breaker is fully elevated the clearance between the breaker lifting rail and the upper stop bolts should not be more than 1/8" and not less than 3/32".

The positive interlock roller should be centered in the upper "VEE" and the interlock roller should have 1/16" clearance to the stationary interference plate directly under it.

To lower the breaker, proceed the same as for raising except operate the selector switch to "LOWER". The clutch must be held in the engaged position; otherwise, a spring will return it to its normal position, opening the electrical circuit to the motor.

The breaker may be raised or lowered by an emergency hand crank which can be inserted after removing the motor. The motor is removed by unlatching the motor assembly from its support and disconnecting the motor lead plug. After removing the motor, pull the clutch forward and insert the manual crank into the end of the clutch coupling. The breaker must be open before the crank can be inserted and held in the clutch coupling.

After the breaker is lowered and withdrawn from the unit inspect the contact surfaces of both the breaker studs and the stationary disconnecting devices.

(a) Each segment of the stationary disconnecting device should make a heavy impression in the contact lubricant D50H47 on the breaker studs. Contact wipe should start not less than 1/8" from top of the contact ball although each contact need not start at the same location. See Fig. 11.

(b) The penetration of the breaker stud inside the stationary disconnecting device, as indicated by the contact lubricant D50H47, should be 3/4" to 7/8". See Fig. 11. This indicates that the breaker studs contacted at the full pressure center of the silver band on the stationary disconnecting device.

(c) Should the inspection of the contacts show that the breaker is not being raised to the proper position, readjust the upper stop bolts and limit switches to raise or lower the breaker to the proper location. Lock the stop bolts in the new position.

(d) If proper contacting cannot be attained by the above methods, additional adjustments will be necessary.

DO NOT MAKE ANY ADJUSTMENT. COMMUNICATE WITH THE NEAREST GENERAL ELECTRIC CO OFFICE FOR ADDITIONAL INFORMATION.

POSITIVE INTERLOCK
GENERAL

The positive interlock functions to prevent raising or lowering a breaker except when the primary contacts are open. It also prevents closing primary contacts when the breaker is being raised or lowered by blocking the operating mechanism mechanically and electrically.

POSITIVE INTERLOCK ASSEMBLY FOR SOLENOID OPERATE BREAKERS

To place the breaker in the operating position, proceed as given below. The elevating mechanism is accurately leveled and checked at the factory and should require no adjustment. Do not install or remove the breaker or make adjustments unless the breaker primary contacts are open.

Lower the elevating mechanism lifting brackets until the lifting brackets are in the fully lowered position. The breaker should then enter the housing freely. After first assuring that the breaker primary contacts are in the open position, insert the breaker into the unit until it rests against the rear of the front lifting saddle of the elevating mechanism.

The interlock should be checked to see that the removable element is obstructed from being raised to or lowered from the operating position when the primary contacts are closed.

BEFORE PROCEEDING WITH THIS CHECK IT IS NECESSARY THAT THE PRIMARY CIRCUITS BE DE-ENERGIZED.

Using the maintenance closing device, close the breaker and snap the selector switch to "RAISE" position and pull the clutch handle forward. Movement must be stopped by the breaker interlock roller before the contacts of the motor limit switch close and before the sliding clutch and motor connector engage. A minimum of 1/16" should be maintained between the two clutch parts when the positive interlock is blocked by the breaker interlock roller. See Fig. 15 for dimension.

Trip the breaker manually and elevate to the operating position. AGAIN IT IS EMPHASIZED THAT THE PRIMARY CIRCUITS MUST BE DE-ENERGIZED BEFORE MAKING THIS CHECK OF THE POSITIVE INTERLOCK.

Electrically close the breaker. Snap the selector switch to "LOWER" position and pull the clutch handle forward. Again, a definite stop should be encountered preventing the motor circuit limit switch from energizing the motor circuit and lowering the breaker.

If the interlock does not function as indicated above DO NOT MAKE ANY ADJUSTMENT. COMMUNICATE WITH THE NEAREST GENERAL ELECTRIC CO. OFFICE FOR ADDITIONAL INSTRUCTIONS.

POSITIVE INTERLOCK ASSEMBLY FOR STORED ENERGY

To place the breaker in the operating position, proceed as given below. The elevating mechanism is accurately leveled and checked at the factory and should require no adjustment. Do not install or remove the breaker or make adjustments unless the breaker primary contacts and or closing springs are discharged.

Lower the elevating mechanism lifting brackets until the lifting brackets are in the fully lowered position. The breaker should then enter the housing freely. After first assuring that the breaker primary contacts are in the open position, insert the breaker into the unit until it rests against the rear of the front lifting saddle of the elevating mechanism.

BEFORE PROCEEDING WITH THIS CHECK IT IS NECESSARY THAT THE PRIMARY CIRCUITS BE DE-ENERGIZED.

When entering a breaker into a unit for elevating the spring discharge cam (on the left hand side of the unit) will hold the breaker interlock trip free and the closing springs discharged until the breaker is 1/4" off the breaker floor rail. (See detailed description of Spring Discharge Cam under separate heading).

AGAIN IT IS EMPHASIZED THAT THE PRIMARY CIRCUITS MUST BE DE-ENERGIZED BEFORE MAKING THIS CHECK OF THE POSITIVE INTERLOCK.

Elevate the breaker to the raised position and electrically close the breaker. The positive interlock should be checked to see that the removable element is obstructed from being lowered from the operating position.

Snap the selector switch to "LOWER" position and pull the clutch handle forward. A definite stop should be encountered preventing the motor circuit limit switch from energizing the motor circuit and lowering the breaker.

A minimum of 1/16" must be maintained between the sliding clutch and the motor connector when the positive interlock is blocked by the breaker interlock roller. See Fig. 15 for dimension. Trip the breaker manually and lower the breaker to the fully lowered position. During the last 1/4" of travel the spring discharge cam will discharge the stored energy springs and maintain the breaker trip free as long as the breaker remains in the unit. If the interlock does not function as indicated above

DO NOT MAKE ANY ADJUSTMENT. COMMUNICATE WITH THE NEAREST GENERAL ELECTRIC CO. OFFICE FOR ADDITIONAL INFORMATION

STATIONARY AUXILIARY SWITCH

On units equipped with stationary auxiliary switches (Fig. 30A) the clearance between the end of the switch mechanism operating rod and the operating plunger on the circuit breaker should be 0 to 1/8" with the circuit breaker in the raised and open position.

Any adjustment in this dimension must be made on the auxiliary switch setting. Care should be taken to prevent destroying interchangeability of the circuit breaker by excessive adjustment.

A stationary auxiliary switch test position link is furnished as an accessory for use when the circuit breaker is in the test position.

SPRING DISCHARGE CAM

The spring discharge cam is mounted on the left hand side of the unit and operates in conjunction with a spring discharge interlock on the breaker.

When entering a breaker into a unit, to elevate to the operating position, the spring discharge cam will hold the breaker interlock trip free and the closing springs discharged until the breaker is 1/4" off the floor rails. At this point the positive interlock is blocking the spring charging and closing circuit open.

When lowering the breaker from the operating position the breaker must be open before the elevating mechanism can be operated. While the breaker is being lowered the springs are still charged but the positive interlock blocks the breaker from closing. When the breaker is about 1/4" from the floor rails the spring discharge interlock holds the breaker trip free, discharges the closing springs

and holds them discharged so long as the breaker remains in its unit.

To operate the breaker in the test position it is pulled forward, (out of the unit) about 2 1/4" until a notch in the spring discharge cam releases the breaker interlock and the breaker can be operated manually, or, by assembling the test coupler, electrically. In the test position a mechanical block prevents operating the elevating mechanism.

If after test operations the breaker is left closed and/or its closing springs charged, it will be automatically tripped and held trip free while the springs are discharged when it is reinserted in; or while being withdrawn from its unit.

KEY LOCKS

Key locks for breaker units can be furnished when requested.

The purpose of this device is to prevent a breaker from being closed in the connected position when the lock key is removed from the lock. The key lock consists of a metal support and key lock mounted on the top plate flange and adjacent to the elevating motor clutch.

To operate the key lock if the breaker is in the disconnected or test position the clutch handle is pulled forward allowing the key lock bolt to extend in back of the clutch handle. The key lock key can then be removed.

If the breaker is in the connected position the breaker must first be opened.

Snap the selector switch to the "off" position. The clutch handle can then be pulled forward allowing the key lock bolt to extend in back of the clutch handle. The key lock key can then be removed. With the clutch handle pulled forward the positive interlock cam plate has rotated the circuit breaker positive interlock shaft so as to mechanically and electrically block the breaker from closing.

To lower the breaker, snap the selector switch to "LOWER", pull the clutch forward and lower the breaker to the test position.

The key lock does not prevent operation of the breaker in the test position. However, if the breaker is elevated to the connected position the key lock will prevent its closing until the key is returned and the lock reset. See Fig. 15.

BREAKER INTERFERENCE STOPS

Stops are provided in the breaker unit to prevent the insertion of a breaker with a 1200A continuous current rating into a unit with a 2000A rating and vice-versa.

The stop plate is bolted to the left hand unit frame angle near the floor of all breaker units. A projection on the breaker frame will interfere with the unit stop plate when an attempt is made to insert an incorrect breaker into the unit.

The breaker rating should be checked against the unit rating and under no circumstances should the interference stop be removed to allow the breaker to be inserted.

TRANSFER TRUCKS

Circuit breaker transfer trucks are furnished with outdoor metal-clad switchgear to facilitate moving of circuit breakers from unit to unit or to maintenance areas. The platform at the front end of the transfer truck is adjustable in height. See Fig. 8, view A, for instructions for adjustment. The truck is equipped with two latches, one to hold the breaker on the truck and one to hold the truck to the metal-clad switchgear unit. Both latches engage automatically, and both are released by a single T-shaped foot pedal on the rear of the truck. Depressing the left side of the pedal unlatches the truck from the switchgear unit, and depressing the right side of the pedal unlatches the breaker from the truck. Trucks can be stored in breaker unit when breaker is in operating position.

SPACE HEATERS

Space heaters are provided in all outdoor equipment in order to keep the inside temperature several degrees higher than that outside. Heaters are also furnished for indoor equipment when it is known that abnormal atmospheric conditions exist at the installation, or when specified by the purchaser.

By maintaining a slight temperature differential, the heaters help facilitate drying and prevent condensation and the resulting corrosion and insulation deterioration which might occur.

Heaters are normally located at the sides of the breaker units, a few inches above the floor. In auxiliary compartments with a single rollout, the heaters will be in a space above the rollout. In auxiliary compartments with two rollouts, the heater will be in a space between the rollouts. Heaters may also be located in superstructure compartments, transition compartments, and in bus ducts if the operating conditions require them.

Before energizing the heaters, be sure the power source is of the proper voltage, frequency, and phase arrangement, and is connected in accordance with the wiring diagrams furnished with the equipment. Also, be sure to remove all cartons and miscellaneous material packed inside the units before energizing the heaters.

Heaters should be visually inspected several times a year to make sure they are operating properly.

It is recommended that the heaters be energized at all times and that thermostatic control not be used.

If thermostatic control is used, the contacts of the thermostat should be set to close between 95°F and 100°F on falling temperature, de-energizing the heaters only when strong sunlight beats on the switchgear. Under no condition should a differential thermostat be used to control the heaters because under conditions of extremely high humidity this type of thermostat will not operate at all times to keep the heaters on enough to prevent condensation in the switchgear.

MAINTENANCE

A regular maintenance schedule should be established to obtain the best service and reliability from the switchgear or bus duct. Plant operating and local conditions will dictate the frequency of inspection required. For specific information regarding the maintenance of devices, such as circuit breakers, relays, meters, etc., refer to the separate instruction book furnished for each device. The inspection cabinet, which is furnished, provides a convenient means for maintaining the circuit breakers. Under normal conditions the protective relays do not operate, therefore, it is important to check the operation of these devices regularly.

A permanent record of all maintenance work should be kept, the degree of detail depending on the operating conditions. In any event, it will be a valuable reference for subsequent maintenance work and for station operation. It is recommended that the record include reports of tests made, the condition of equipment and repairs and adjustments that were made.

BEFORE ANY COVERS ARE REMOVED OR ANY DOORS OPENED WHICH PERMIT ACCESS TO THE PRIMARY CIRCUITS, IT IS ESSENTIAL THAT THE CIRCUIT OR CIRCUITS BE DE-ENERGIZED AND BREAKERS BE WITHDRAWN TO A DISCONNECTED POSITION AND TAGGED.

IF WORK IS TO BE DONE ON REMOTE EQUIPMENT CONNECTED TO A UNIT, THE BREAKER FOR THAT UNIT SHOULD BE PLACED IN THE DISCONNECTED POSITION AND TAGGED. ALSO THE REMOTE EQUIPMENT SHOULD BE ISOLATED FROM ANY OTHER POWER SOURCES CONNECTED TO IT.

The primary circuits of metal-clad switchgear are insulated in order to reduce the size of the equipment. However, this insulation, except in one or two instances, requires a certain amount of air gap between phases and to ground to complete the insulation. Inserting any object in this air space, when equipment is energized, whether it be a tool or a part of the body, may under certain conditions, in effect, short circuit this air gap and may cause a breakdown in the primary circuit to ground and cause serious damage or injury or both.

Care should be exercised in the maintenance and checking procedures that accidental tripping or operation is not initiated.

The switchgear structure, bus duct, and connections should be given the following overall maintenance at least annually.

1. Thoroughly clean the equipment, removing all dust and other accumulations. Wipe clean the buses and supports. Inspect the buses and connections carefully for evidence of overheating or weakening of the insulation.

2. Measure the resistance to ground and between phases of the insulation of buses and connections. Since definite limits cannot be given for satisfactory insulation resistance values, a record must be kept of the reading. Weakening of the insulation from one maintenance period to the next can be recognized from the recorded readings. The readings should be taken under similar conditions each time if possible, and the record should include the temperature and humidity.

High potential tests are not required, but if it seems advisable, based on the insulation resistance tests or after repairs, the test voltage should not exceed 14kv A. C. for 4.16kv and 27kv A.C. for 13.8 equipments. These voltages are 75% of factory test voltages and are in accordance with ANSI standards.

Potential transformers and control power transformers must be disconnected during high voltage testing.

3. Clean elevating mechanism and lubricate jack screws and gears with lubricant G.E. Co. #D50H15 or equal.

4. Check primary disconnecting device contacts for signs of abnormal wear or overheating. Clean contacts with silver polish. Discoloration of the silvered surfaces is not ordinarily harmful unless atmospheric conditions cause deposits such as sulphides on the contacts. If necessary the deposits can be removed with a good grade of silver polish.

Before replacing breaker, apply a thin coat of contact lubricant D50H47 to breaker studs for lubrication.

5. Check to see that all anchor bolts and bolts in the structure are tight. Check tightness and continuity of all control connections and wiring.

6. If the switchgear is equipped with heaters, check to see that all heaters are energized and operating.

7. All filters should be inspected and cleaned or replaced once a year.

OUTDOOR ACRYLIC PAINT FINISH

The outside of standard outdoor switchgear has acrylic paint finish, blue gray ASA #24, providing improved resistance to all atmospheric conditions, longer life and less maintenance than with ordinary

paint finishes.

If it is desired to refinish acrylic painted switchgear, it is necessary to use one of the following procedures in order to secure the best adhesion of the paint to the original finish.

A. Refinishing with Acrylic Paint. It is recommended that refinishing be done with DuPont acrylic paint of the desired color. Obtain materials and instructions for application from the DuPont Company.

B. Refinishing with Alkyd or Oil Base Paints. Two methods are recommended:

1. Spray one sealer coat of DuPont 233E75300 or equivalent which has been reduced to spraying viscosity with DuPont 37692 or 37666 thinner. Air dry for one hour. Apply alkyd or oil base paint.

2. Spray one sealer coat of Arco 214-806 primer which has been reduced to spraying viscosity with Xylol. Air dry for one hour. Apply alkyd or oil base paint.

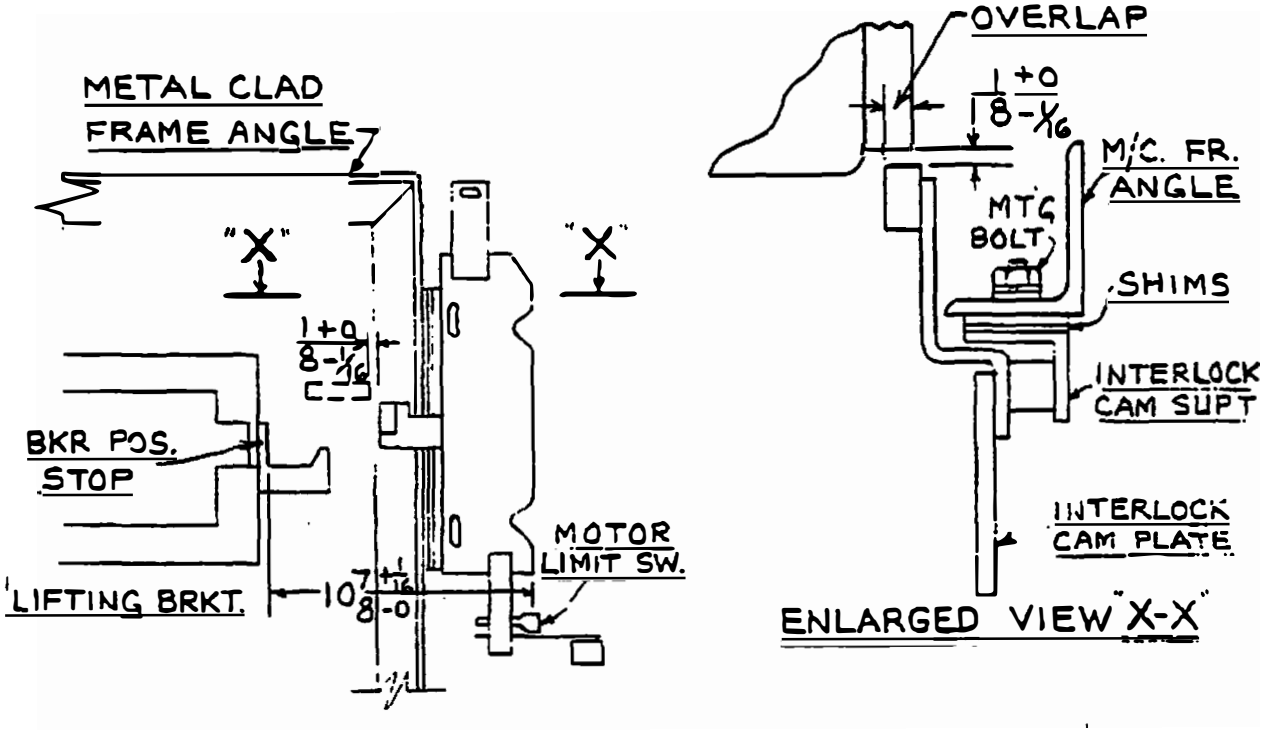
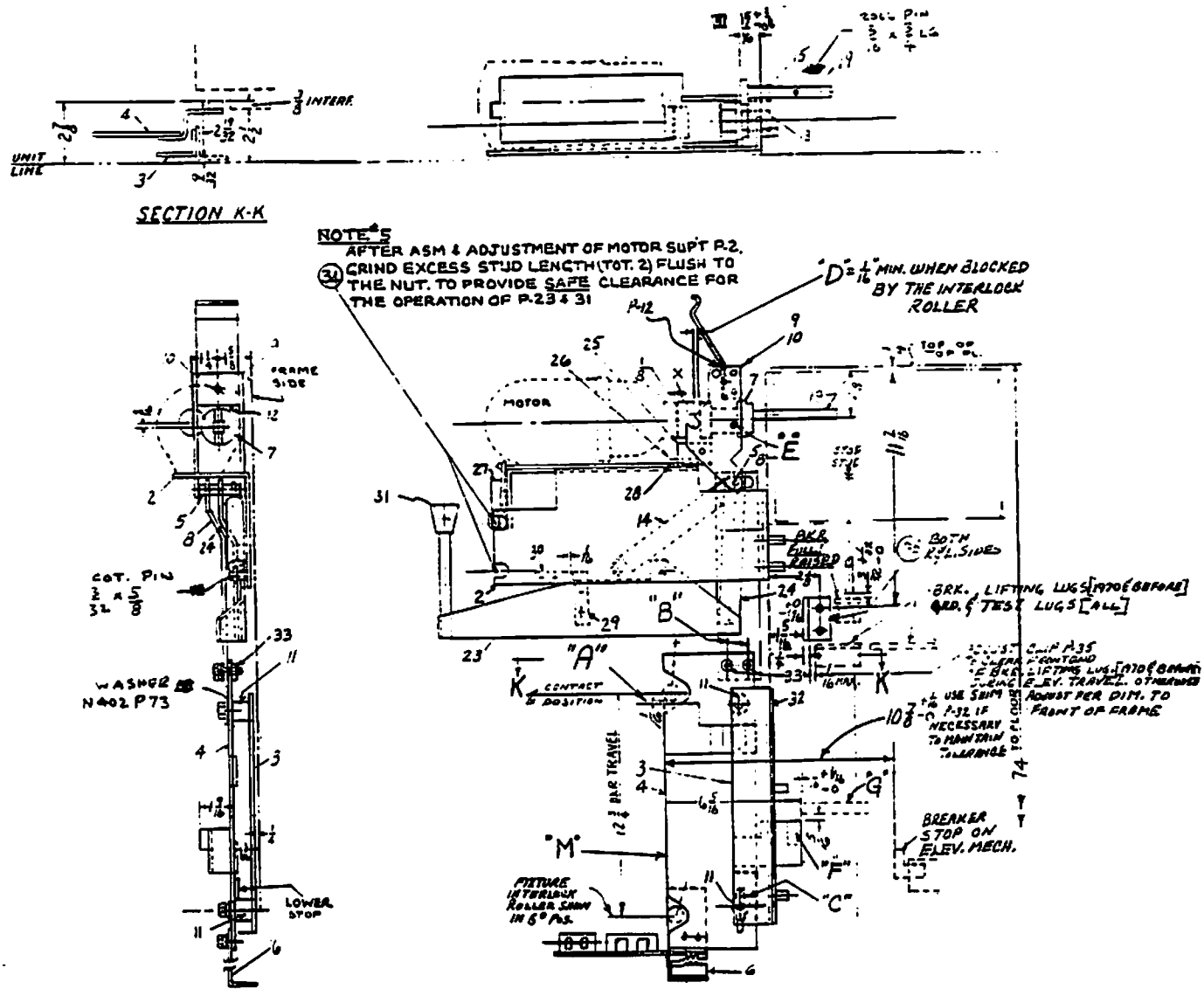


FIG. 29A (208A8952) POSITIVE INTERLOCK ADJUSTMENT



INSTRUCTIONS FOR POSITIVE INTERLOCK ADJUSTMENT

Insert breaker fixture and raise to stops as shown. The clearance between the breaker fixture supporting rail and the stop bolts should not be less than 3/32" and both sides to be equal. Set fixture interlock at 5° position. Shim cam support P-3 to maintain a 10-7/8" ± 1/16 dimension between the back of the lifting saddle and the front of the interlock cam plate indicated as "M". Also adjust for a 1/16" clearance to fixture roller at "A". With bolts at "B" loose, allow cam P-4 to rest on stop "C". Set handle P-12 so that cradle P-9 is vertical. Tighten bolts at "B". After tightening bolts, lock securely with a jamb nut. Remove fixture interlock pin. Adjust striker P-6 so that contacts of motor switch close in the last ¼" of vertical travel of cam. Fixture interlock roller must indicate between 13° and 28° when contacts in motor switch close. When handle P-12 is in forward position and clutch X & P-7 fully engaged, pins "E" must be free of clutch P-7. Set fixture interlock in 13° position, operate unit interlock: covernent must be stopped by the breaker fixture interlock roller before contacts of motor switch close and before clutch X & P-7 engage. Lower breaker fixture to rails. Set fixture interlock in 5° position, breaker interlock roller must be centered in the unit cam "V" notch. Remove fixture interlock pin and operate unit interlock: block "F" on cam must pass in front of block "G" on fixture. The clearance between the interference block on the breaker fixture and the interference block on the interlock cam assembly should be 1/16" to 1/8" maximum. Move fixture out of housing to a point that block "G" is over block "F:. Operate unit interlock: block "F"; must engage block "G" and stop movement of cam before contacts in motor switch close. For final interlock check: set breaker fixture interlock roller in 13° position, and move fixture into the housing. Operate unit interlock by pulling clutch handle forward. Movement of interlock cam must be stopped by the breaker fixture interlock roller before the contacts of the motor switch close and before the sliding clutch P-7 engages the motor clutch coupling X. A minimum of 1/16" at "D" must be maintained between the two clutch parts when the interlock is blocked by the fixture interlock roller.

FIG. 29B (829C0463) POSITIVE INTERLOCK ASSEMBLY FOR 1000 M.V.A.

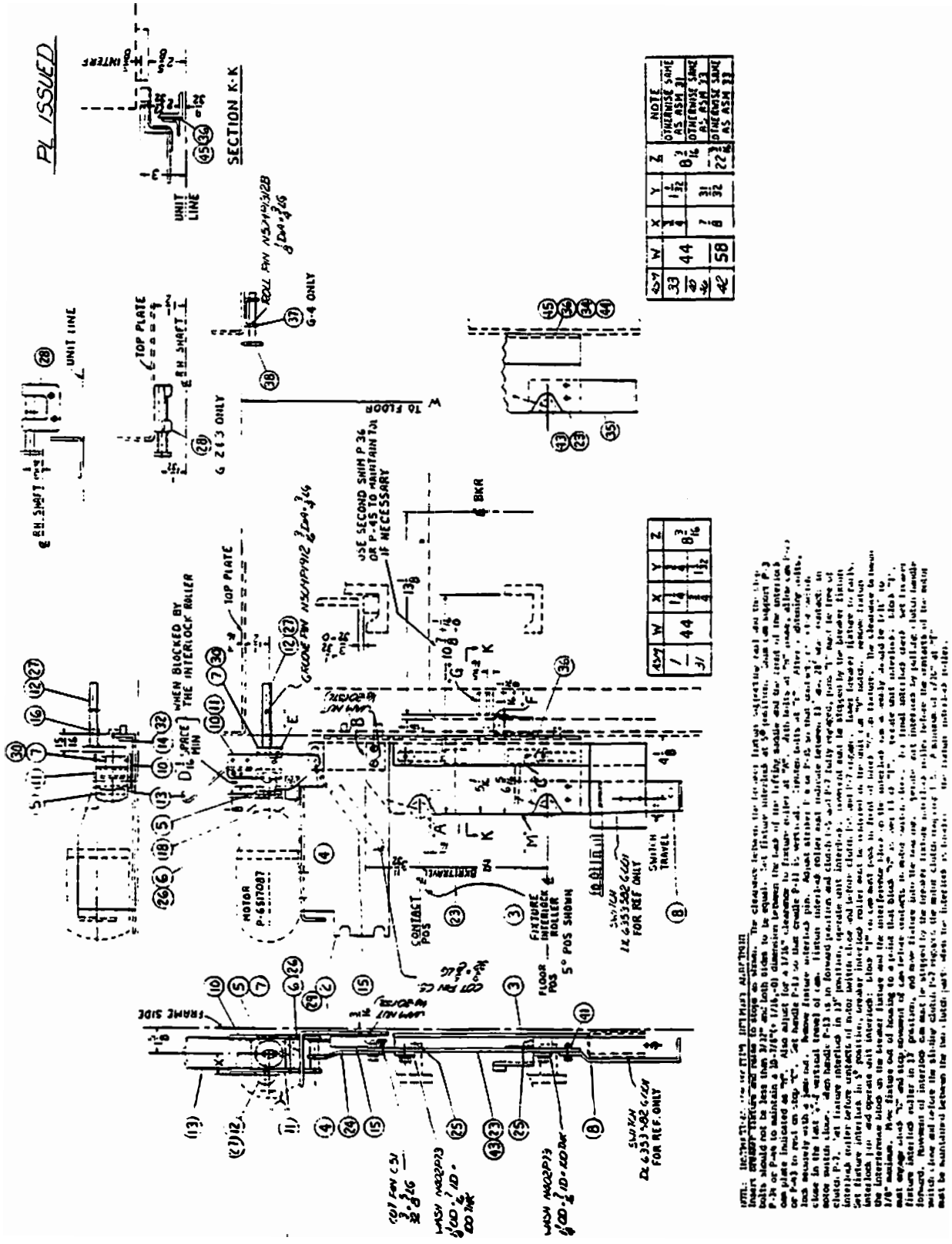


FIG. 29C (6519802) POSITIVE INTERLOCK ASSEMBLY FOR STD AM-2.4 AND 4.6

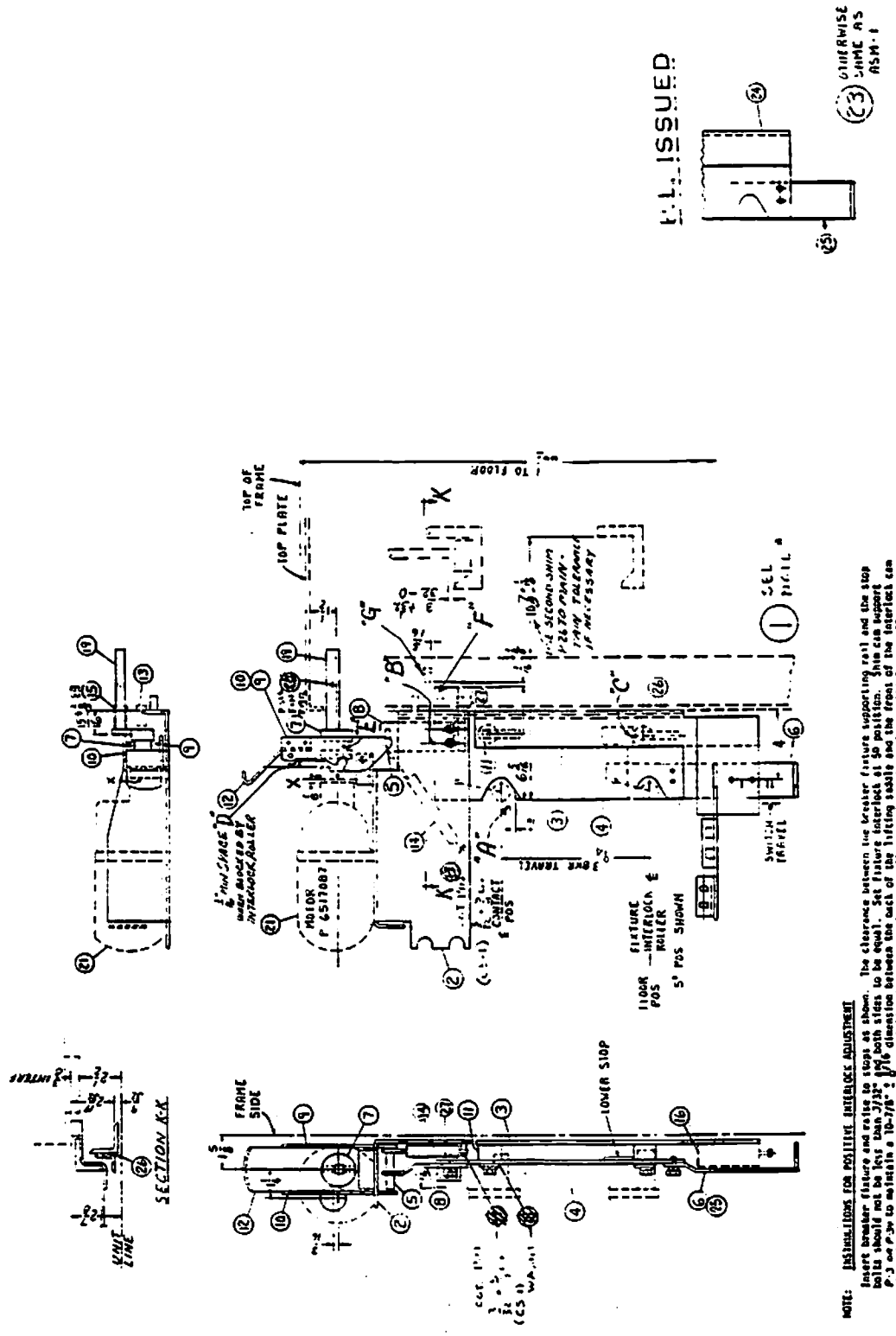


FIG. 29D (265C0235) POSITIVE INTERLOCK ASSEMBLY FOR M-36

RENEWAL PARTS

ORDERING INSTRUCTIONS

1. RENEWAL PARTS SHOULD BE ORDERED FROM THE SWITCHGEAR PRODUCTS DEPARTMENT.
2. ALWAYS SPECIFY THE REQUISITION NUMBER ON WHICH THE EQUIPMENT WAS ORIGINALLY FURNISHED.
3. SPECIFY THE QUANTITY, REFERENCE NUMBER, DESCRIPTION AND THIS BULLETIN NUMBER.
4. STANDARD HARDWARE, SUCH AS SCREWS, BOLTS, NUTS, WASHERS, ETC., IS NOT LISTED. SUCH ITEMS SHOULD BE PURCHASED LOCALLY.
5. FOR PRICES, REFER TO THE NEAREST OFFICE OF THE GENERAL ELECTRIC COMPANY.
6. IF INSULATING MATERIAL, SUCH AS TAPE, VARNISH, COMPOUND, ETC., IS REQUIRED, IT MUST BE SPECIFIED SEPARATELY.
7. IF PARTS LISTED SEPARATELY ARE TO BE ASSEMBLED AT THE FACTORY, ORDER MUST SO STATE.
8. NOT ALL PARTS LISTED HEREIN WILL BE USED ON ANY ONE EQUIPMENT. PARTS NOT USED IN ORIGINAL EQUIPMENT SHOULD NOT BE ORDERED AS RENEWAL PARTS.

PRIMARY DISCONNECT DEVICES
(SEE FIG. NO. 11)

REF. NO.	DESCRIPTION
5	Front Primary Disconnect Device Assembly, 3 Pole, Complete with Connections
6	Rear Primary Disconnect Device Assembly, 3 Pole, Complete with Connections

NOTE: Insulating material required for Ref. Nos. 5 and 6 will be furnished with order.

POSITIVE MECHANICAL INTERLOCK
(FIG. NO. 30A)

REF. NO.	DESCRIPTION
3	Complete positive mechanical interlock assembly
4	Elevating mechanism motor (115-v a-c)
4	Elevating mechanism motor (230-v d-c)
4	Elevating mechanism motor (230-v d-c)
18	Spring only

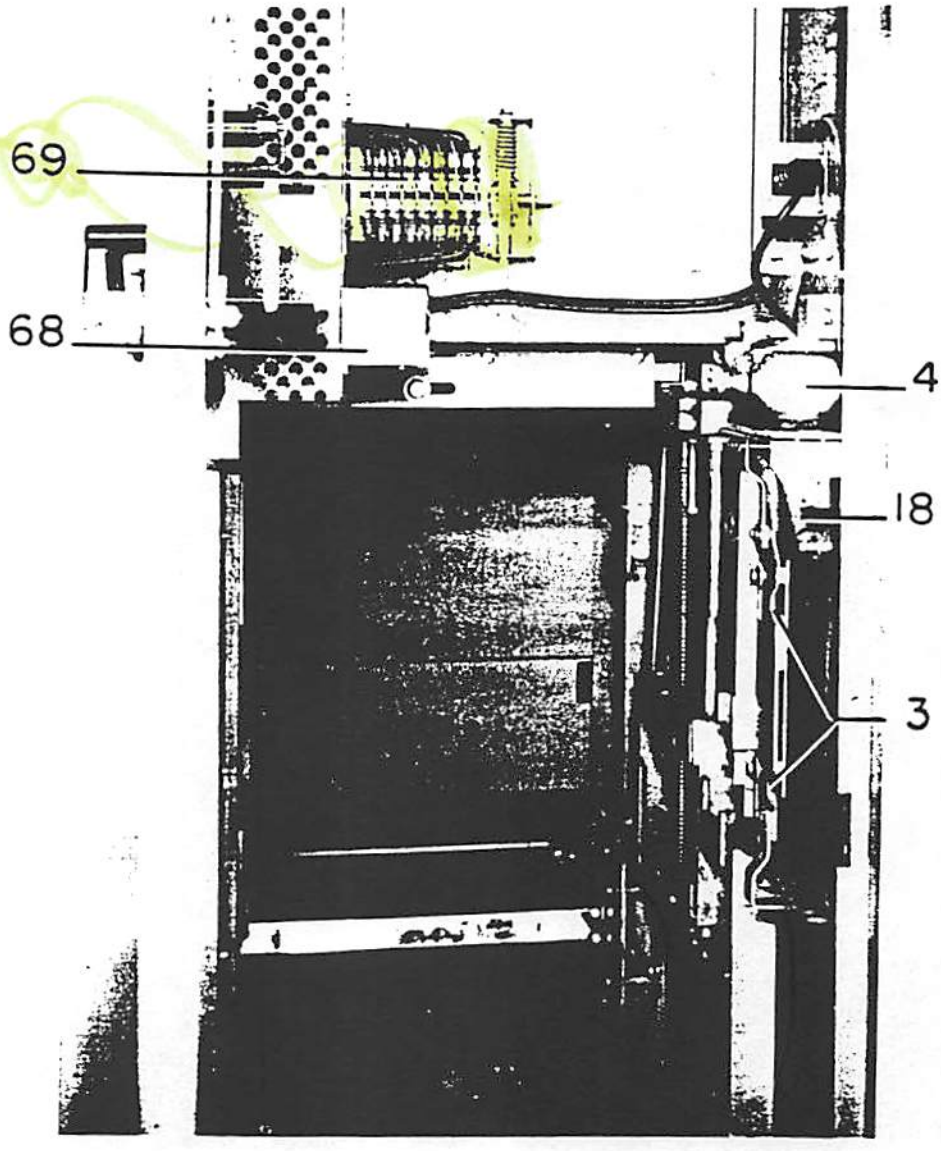


FIG. 30A VIEW SHOWING ELEVATING MECHANISM MOTOR AND CONTROL UNIT

INSTRUCTIONS AND
RECOMMENDED PARTS
FOR MAINTENANCE

GEH-1802V
Supersedes
GEH-1802U & GEF-3837

METAL-CLAD SWITCHGEAR

Types M26 and M36

FOR MAGNE-BLAST AIR CIRCUIT BREAKER

TYPES AM-4.16 AND AM-13.8

SWITCHGEAR PRODUCTS DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA, PA.

LIST OF ILLUSTRATIONS

CONTENTS

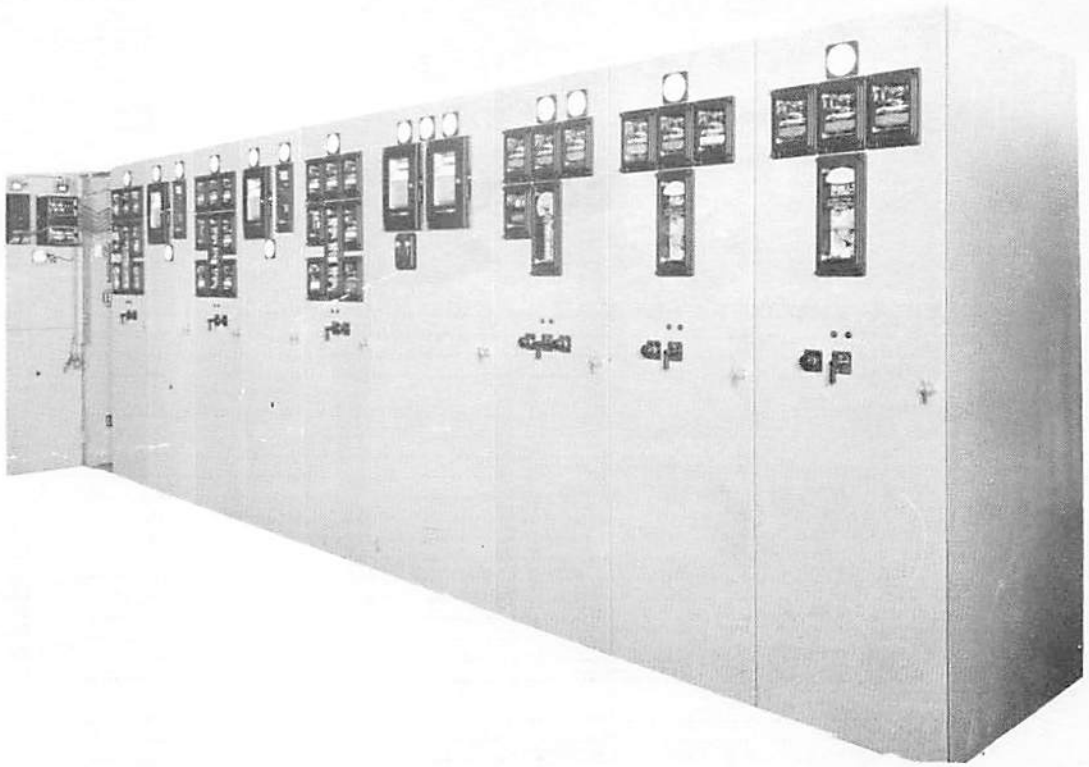


Fig. 1 (8021315)

Fig. 1 Typical Indoor Metal-clad Switchgear Equipment

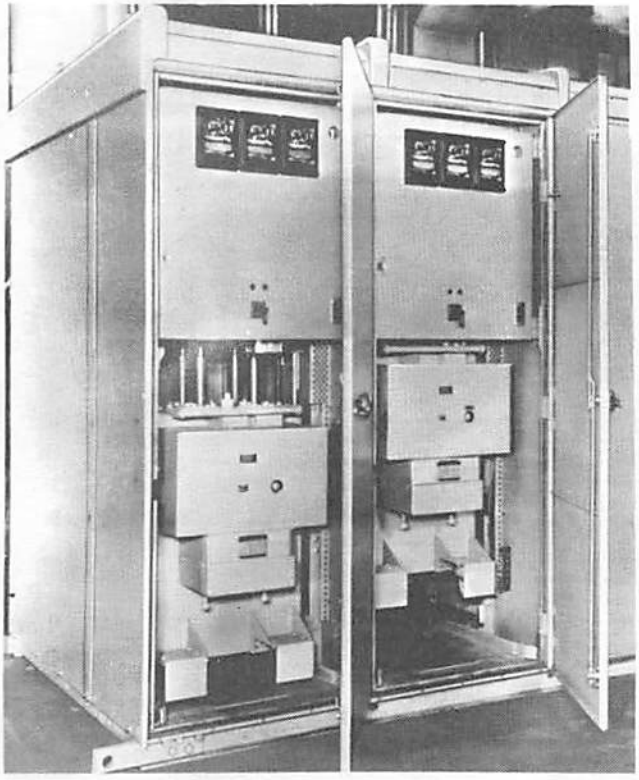


Fig. 2 (1169287)

Fig. 2 Typical Outdoor Metal-clad Switchgear Equipment - Front View

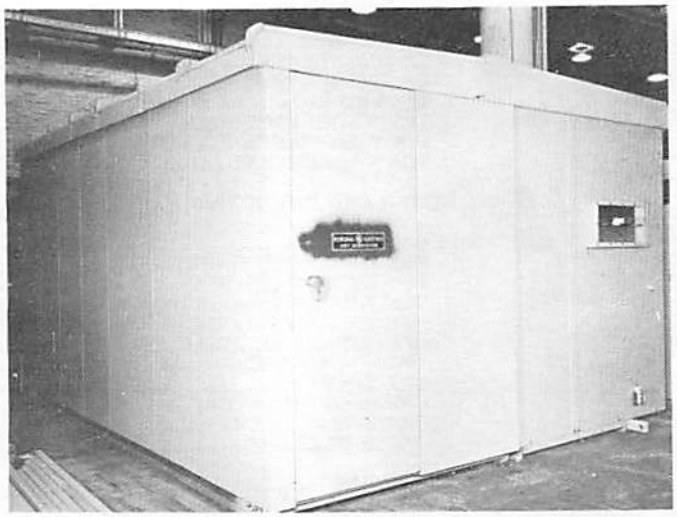


Fig. 3 (8025290)

Fig. 3 Tynical Outdoor Metal-clad Switchgear Equipment With Protected Aisle - Side View

METAL-CLAD SWITCHGEAR
TYPES M26 AND M36
FOR MAGNE-BLAST AIR CIRCUIT BREAKER TYPES AM-4.16 AND AM-13.8

Metal-clad switchgear is equipment to control and protect various types of electrical apparatus and power circuits.

The switchgear consists of one or more units which are mounted side by side and connected mechanically and electrically together to form a complete switching equipment. Typical equipments are shown in Figures 1, 2 and 3.

The circuit breakers are easily removable to provide maximum accessibility for maintenance with minimum interruption of services. The switchgear is designed to provide maximum safety to the operator. All equipment is enclosed in grounded metal compartments.

The equipment is available in the ratings listed in the following table. The ratings of the equipment and devices are based on usual service conditions as covered in ANSI standards. Operation at currents above the equipment rating will result in temperature rises in excess of these standards, and is not recommended. For outdoor installation the same basic equipment is built into a weatherproof housing as in Figures 2 and 3.

CIRCUIT BREAKER	INTERRUPTING CAPACITY KVA	CURRENT	FIGURE
TYPE M-26			
AM-4.16-250 AM-4.16-350	250,000 350,000	1200 - 2000 1200 - 3000	4 5
TYPE M-36			
AM-13.8-500 AM-13.8-750 AM-13.8-1000 AM-7.2-500	500,000 750,000 1,000,000 500,000	1200 - 2000 1200 - 2000 1200 - 3000 1200 - 2000	4 4 6 4

Fig. 4 (8034472)

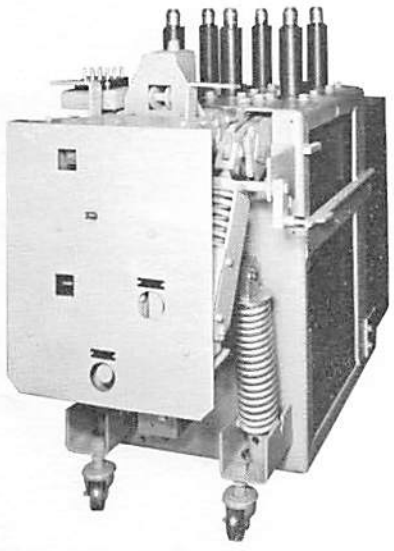


Fig. 4

Fig. 5 (8034807)

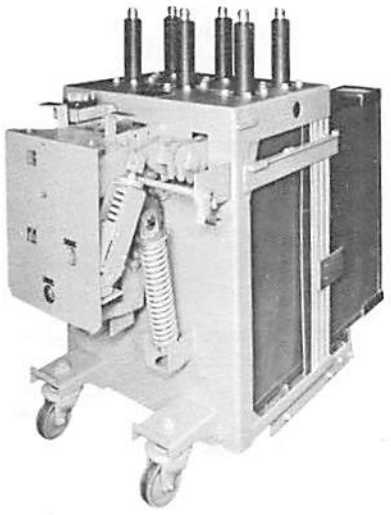


Fig. 5

Fig. 6 (8035725)

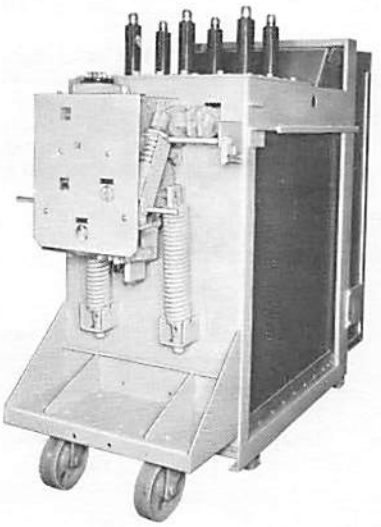
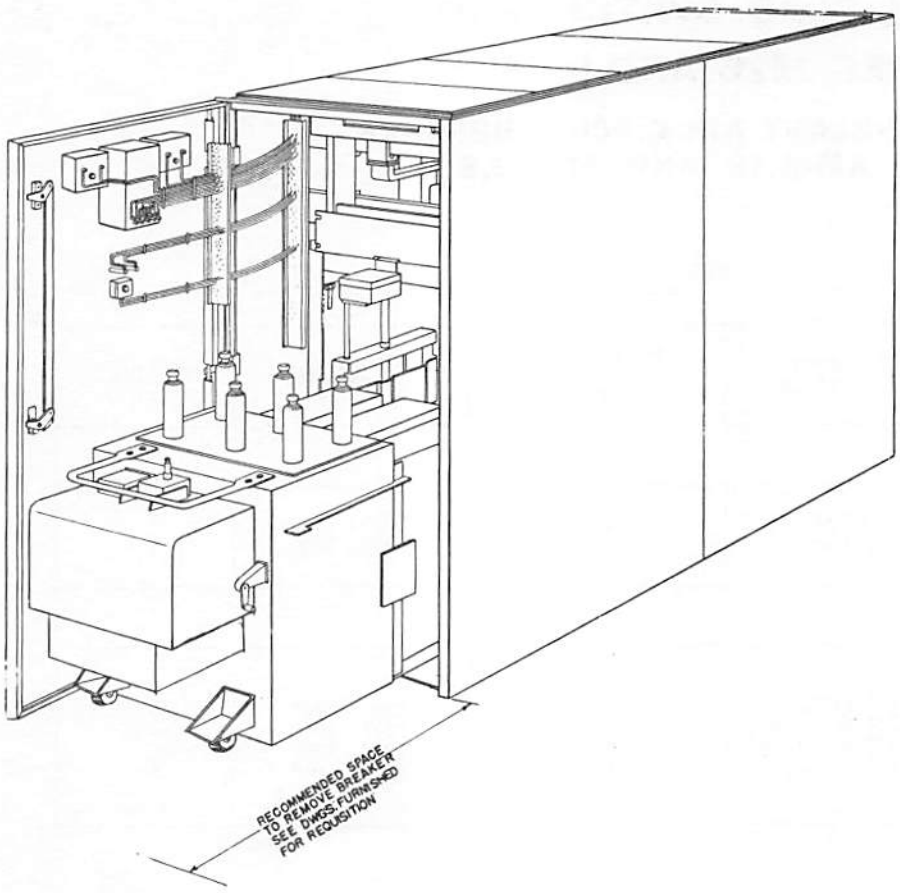


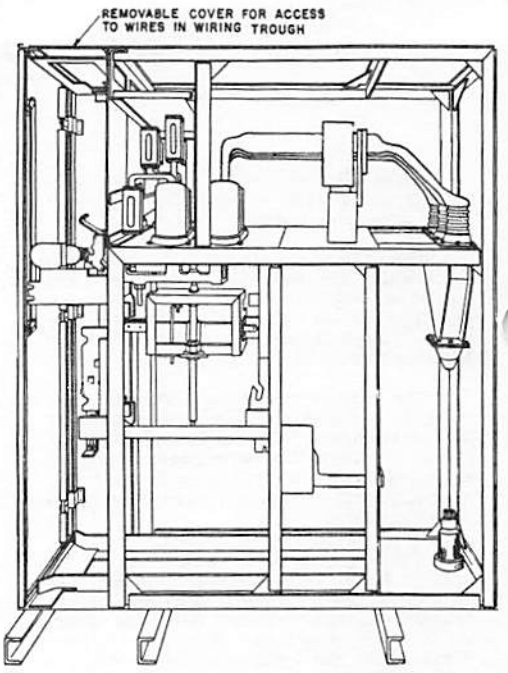
Fig. 6

Magne-blast Breakers

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

To the extent required the products described herein meet applicable ANSI, IEEE and NEMA standards; but no such assurance is given with respect to local codes and ordinances because they vary greatly.

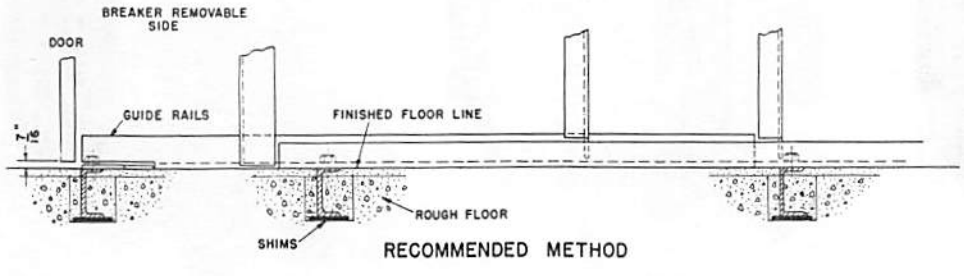




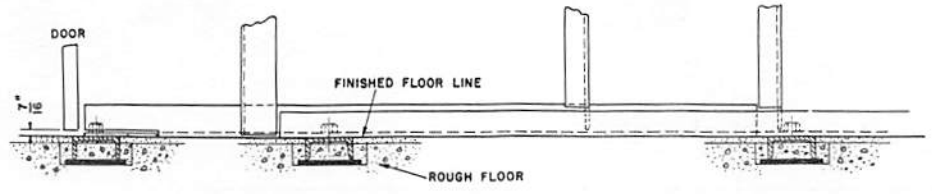
ALL FLOOR STEEL TO BE FURNISHED BY PURCHASER

CHANNELS SHOULD BE SET LEVEL WITH EACH OTHER AND SHOULD BE LEVEL OVER THEIR FULL LENGTH

ROUGH FLOOR THICKNESS AND REINFORCING DEPENDS ON LOADING AND OTHER NORMAL FACTORS, AND SHOULD BE DESIGNED IN ACCORDANCE WITH RECOMMENDED PRACTICE



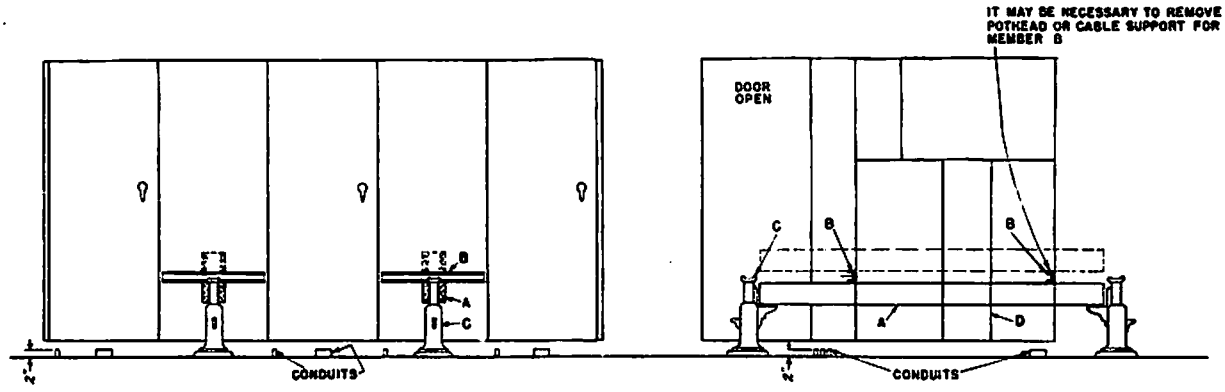
RECOMMENDED METHOD



ALTERNATE METHOD

NOTE: IT IS IMPERATIVE THAT FLOOR STEEL BE EVEN WITH FINISHED FLOOR AND THAT BOTH BE LEVEL

Fig. 7 Installation Details



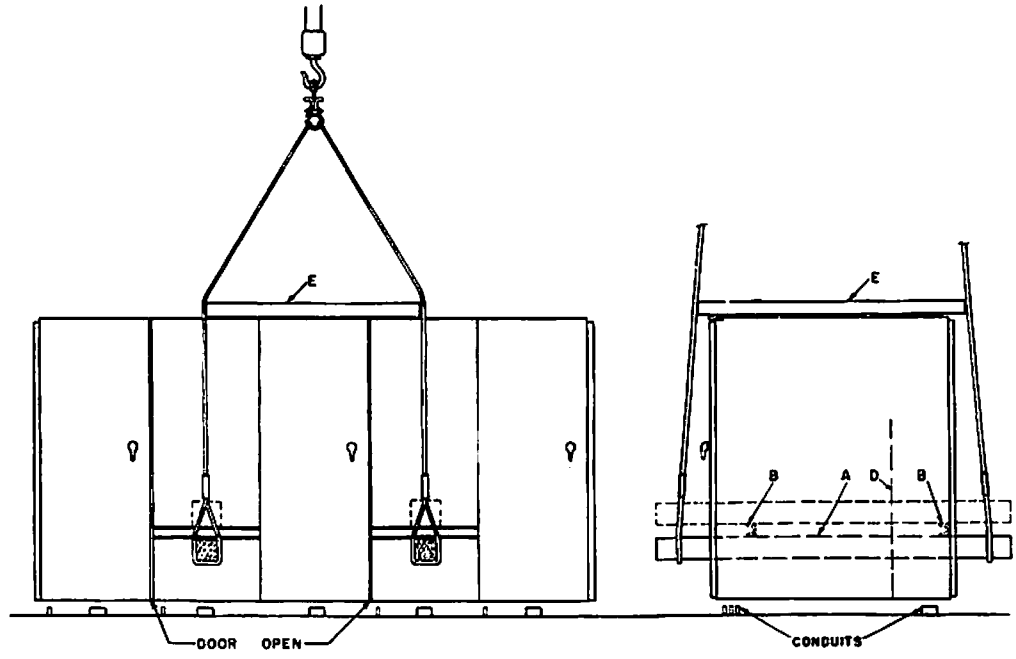
METHOD OF LIFTING

MEMBERS A-& C ——— TO BE FURNISHED BY PURCHASER
A- RAISING MEMBER - CHANNEL OR WOOD BEAM

B- 3" CHANNEL FURNISHED WITH GEAR

C- LIFTING JACKS
D- COVER TO BE REMOVED AND REASSEMBLED AFTER UNITS ARE IN PLACE

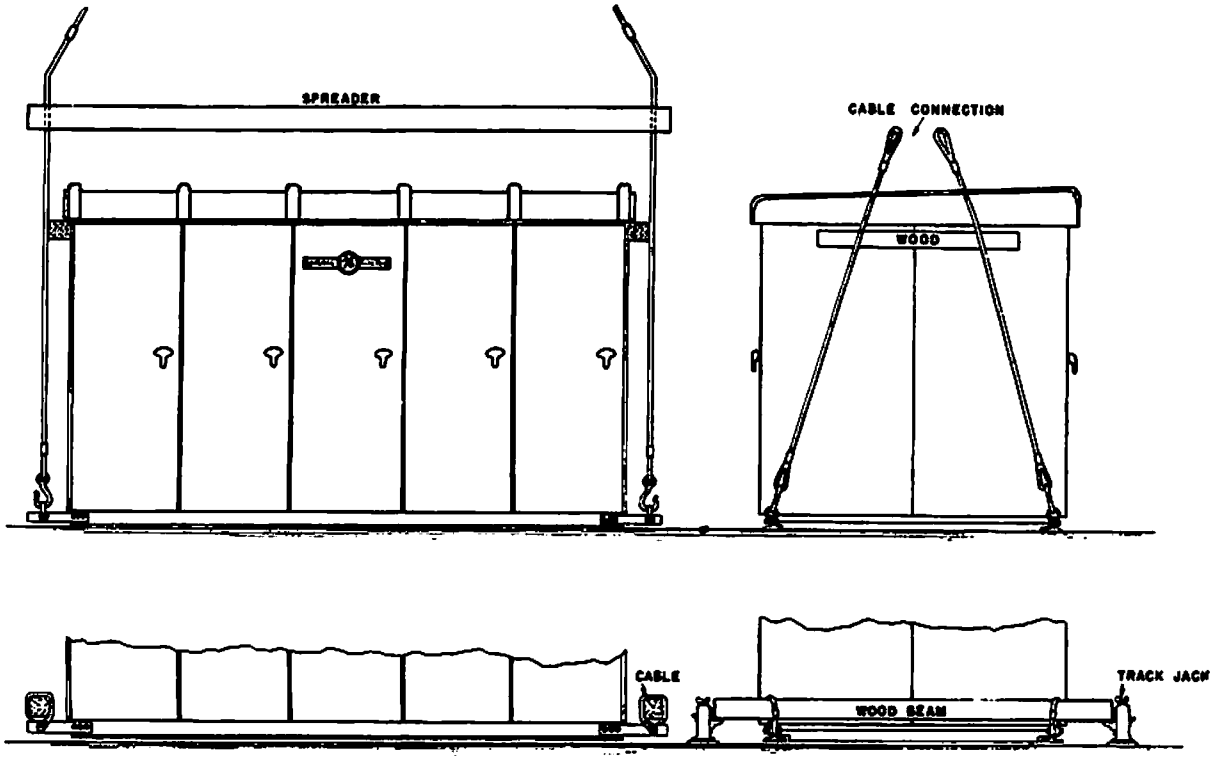
NOTE: WHEN LIFTING M-26 SWITCHGEAR LOCATE BEAM "A" ABOVE LIFTING CHANNELS "B"



ALTERNATE METHOD OF LIFTING

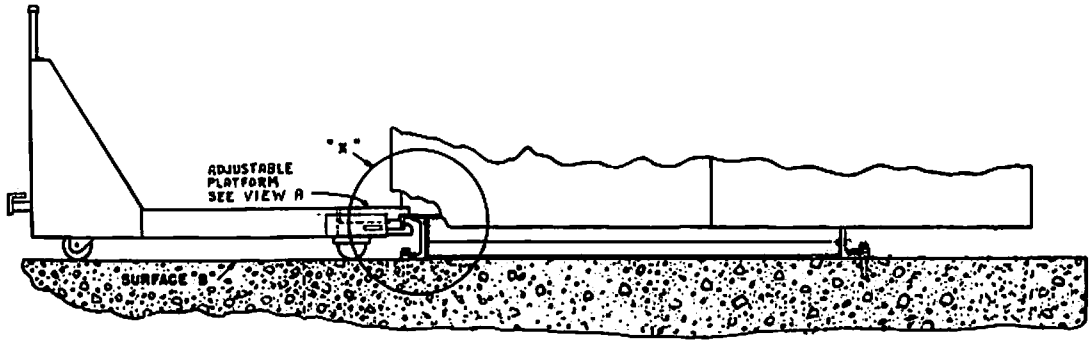
MEMBERS A & E TO BE FURNISHED BY PURCHASER
B - 3" CHANNEL FURNISHED WITH GEAR
D - COVER TO BE REMOVED AND REASSEMBLED AFTER UNITS ARE IN PLACE
E - SPREADER

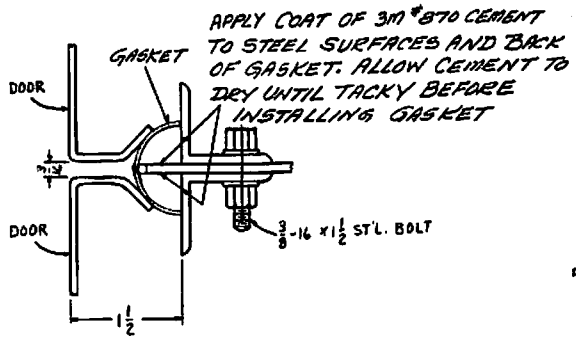
Fig. 7 (T: 3W32630)



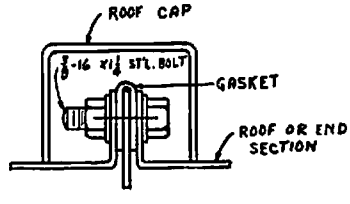
METHODS OF LIFTING

Fig. 8 (118R0728 & TT-6482615)





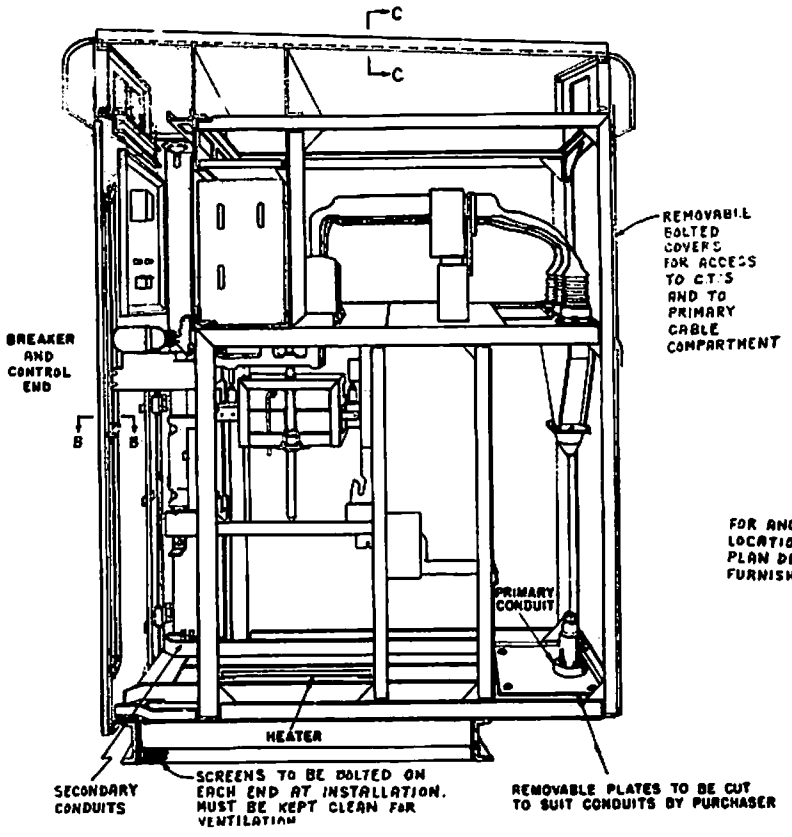
ENLARGED SEC. B-B
METHOD OF ASSEMBLING DOOR GASKET AT SHIPPING SPLITS



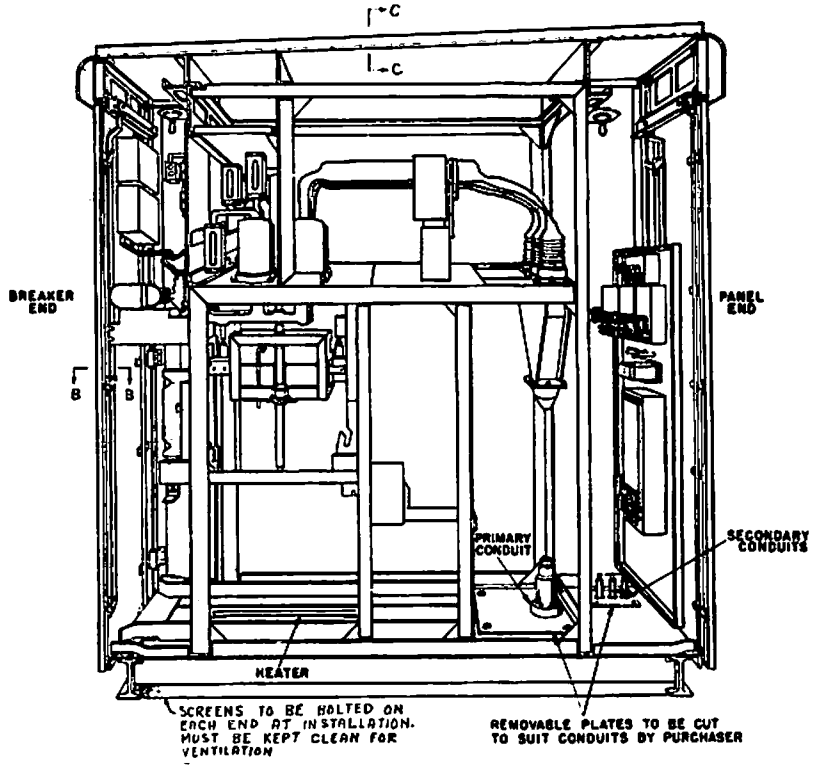
ENLARGED SEC. C-C
METHOD OF ASSEMBLING ROOF CAP AND GASKET AT SHIPPING SPLITS

Fig. 8 Installation Details

Fig. 8 (11&12D728 & TT-6482615)



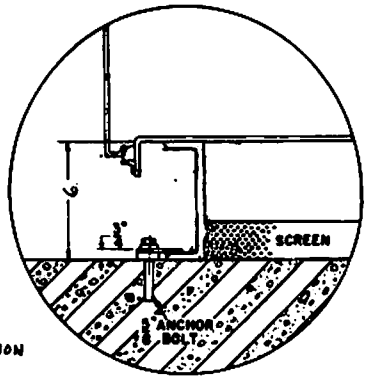
Without Rear Enclosure



With Rear Enclosure

for Outdoor Metal-clad Switchgear

FOR ANCHOR BOLT LOCATIONS SEE FLOOR PLAN DRAWINGS FURNISHED WITH REQUISITION



VIEW "X"

SHOWING ANCHORING OF UNITS WITH CHANNEL BASE

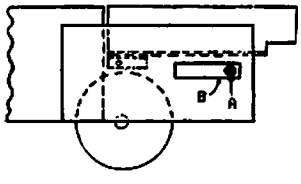
FOUNDATION DATA

AREA AND DEPTH OF SOIL BEARING SURFACES OF EACH FOUNDATION MUST BE ALTERED TO SUIT SOIL CONDITIONS.

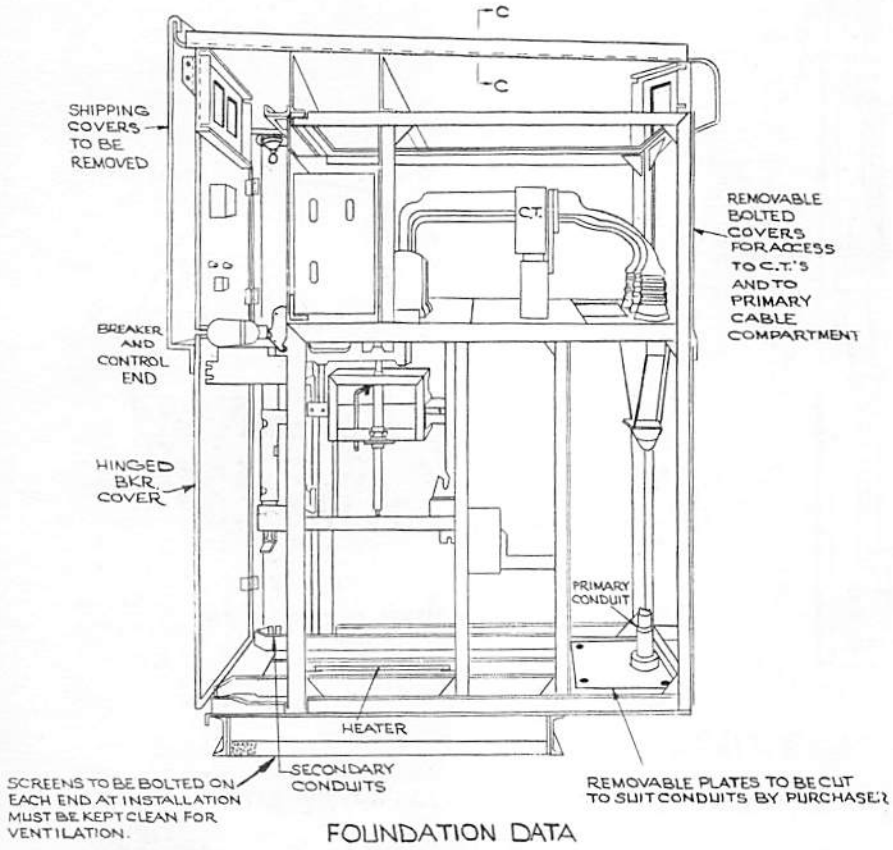
BOTTOM SURFACES OF FOUNDATIONS SHOULD BE BELOW FROST ACTION OR BACKFILLED WITH PERVIOUS MATERIAL AND ADEQUATELY DRAINED.

SURFACE "B" SHOULD BE LEVEL OVER ITS FULL LENGTH TO INSURE EASY HANDLING OF REMOVABLE ELEMENTS. CONCRETE PAD SHOULD BE REINFORCED IN ACCORDANCE WITH STANDARD PRACTICE.

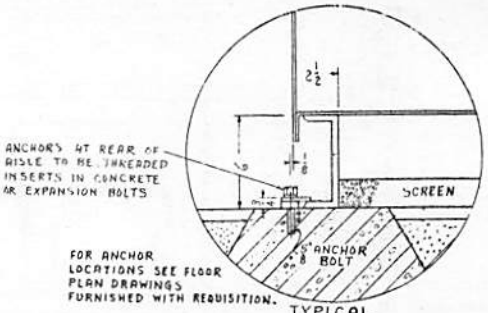
TO CHANGE HEIGHT OF TRUCK FLOOR LOOSEN NUT "A". ADJUST LEVER "B" TO GIVE DESIRED HEIGHT AND LOCK BY TIGHTENING NUT "A".



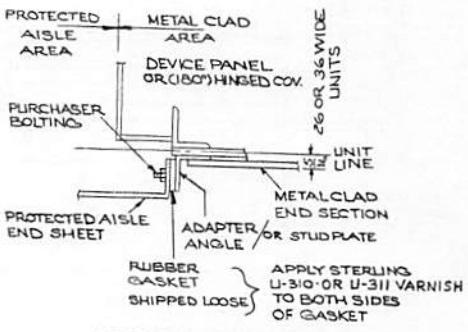
ADJUSTABLE PLATFORM VIEW "A"



FOUNDATION DATA

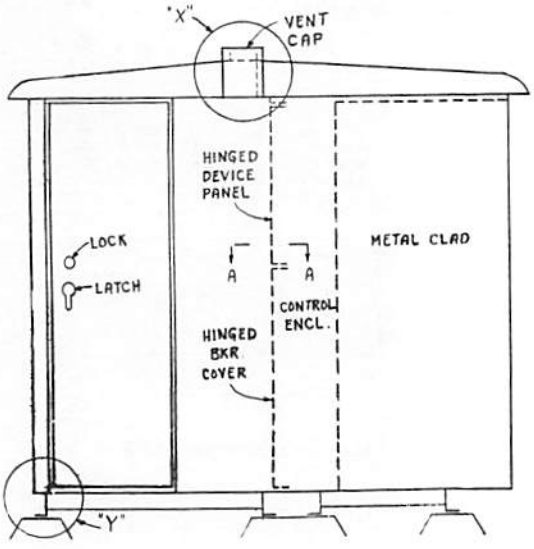


TYPICAL VIEW "Y"
SHOWING ANCHORING OF UNITS WITH CHANNEL BASE

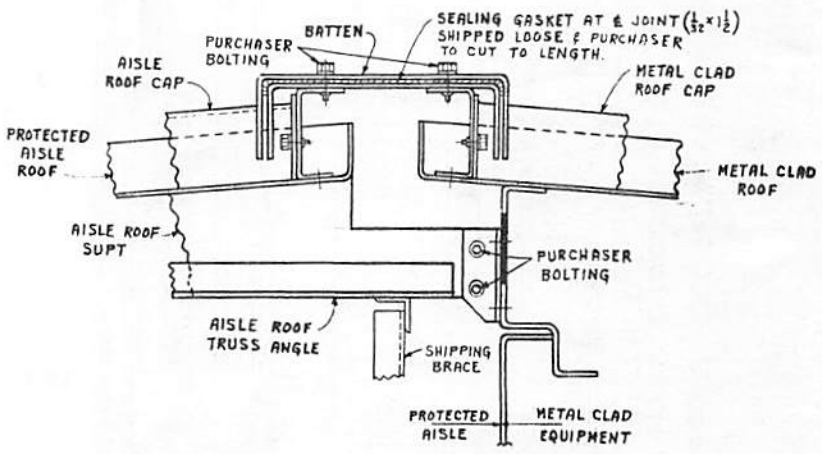


TYPICAL SECTION A-A

Fig. 9 (118RD727)



PROTECTED AISLE



VIEW "X"
ENLARGED INTERIOR SECTION SHOWING AISLE TO METAL CLAD BOLTING & VENTILATOR CAP ASSEMBLY

Fig. 9 Installation Details for Outdoor Metal-clad Switchgear with Protected Aisle

RECEIVING, HANDLING AND STORAGE

RECEIVING

Every case or crate leaving the factory is plainly marked at convenient places with case number, requisition number, customer's order, front or rear, and when for size and other reasons it is necessary to divide the equipment for shipment, with the unit number of the portion of equipment enclosed in each shipping case.

The contents of each package of the shipment are listed in the Packing Details. This list is forwarded with the shipment, packed in one of the cases. The case is especially marked and its number can also be obtained from the Memorandum of Shipment. To avoid the loss of small parts when unpacking, the contents of each case should be carefully checked against the Packing Details before discarding the packing material. Notify the nearest General Electric Company representative at once if any shortage of material is discovered.

All elements before leaving the factory are carefully inspected and packed by workmen experienced in the proper handling and packing of electrical equipment. Upon receipt of any apparatus an immediate inspection should be made for any damage sustained while enroute. If injury is evident or an indication of rough handling is visible, a claim for damage should be filed at once with the transportation company and the General Electric Company notified promptly. Information as to damaged parts, part number, case number, requisition number, etc., should accompany the claim.

HANDLING

Before uncrating, indoor equipment may be moved by a crane with slings under the skids. If crane facilities are not available, rollers under the skids may be used. Fig. 7 shows suggested method of handling the switchgear after it is removed from the skids.

Methods of handling outdoor equipment are shown in Fig. 8. After the equipment is in place the lifting plates should be removed and reassembled, "turned in" so that passageway at the ends of the equipment will not be obstructed.

STORAGE

If it is necessary to store the equipment for any length of time, the following precautions should be taken to prevent corrosion:

1. Uncrate the equipment.

2. Cover important parts such as jack screws, gears and chain of lifting mechanism, linkage and moving machine-finished parts with a heavy oil or grease.

3. Store in a clean, dry place with a moderate temperature and cover with a suitable canvas to prevent deposit of dirt or other foreign substances upon movable parts and electrical contact surfaces.

4. Batteries should be uncrated and put on trickle charge immediately on receipt.

5. If dampness or condensation may be encountered in the storage location, heaters should be placed inside the units to prevent moisture damage. Approximately 500 watts of heaters per unit will be required. Remove all cartons and other miscellaneous material packed inside units before energizing any heaters. If the equipment has been subjected to moisture it should be tested with a 1000v or 2500v megger. A reading of at least 200 megohms should be obtained.

6. Breakers should be prepared for storage separately. Refer to appropriate breaker instruction book.

DESCRIPTION

Each unit is made up of a secondary enclosure and a primary enclosure, as shown in Figure 10.

SECONDARY ENCLOSURE

The secondary enclosure is usually located at the breaker withdrawal side of the unit, although in certain units it may be on the side opposite to the breaker withdrawal area. It consists of a compartment with a hinged door or panel upon which are mounted the necessary instruments, control and protective devices. The terminal blocks, fuse blocks, and some control devices are mounted inside the enclosure on the side sheets and a trough is provided at the top to carry wiring between units.

PRIMARY ENCLOSURE

The primary enclosure contains the high voltage equipment and connections arranged in compartments to limit the effects of faults and so minimize the damage.

BREAKER REMOVABLE ELEMENT

The removable element consists of a Magne-Blast circuit breaker which includes its operating mechanism, interlocks, movable primary and secondary disconnecting devices. The Magne-Blast breakers are equpped with wheels for easy insertion and removal. Refer to Figure 4, 5, 6.

All removable elements furnished on a particular requisition and of a like design and ratings are completely interchangeable one with the other.

The removable as well as the stationary elements are built with factory jigs and fixtures thus insuring interchangeability.

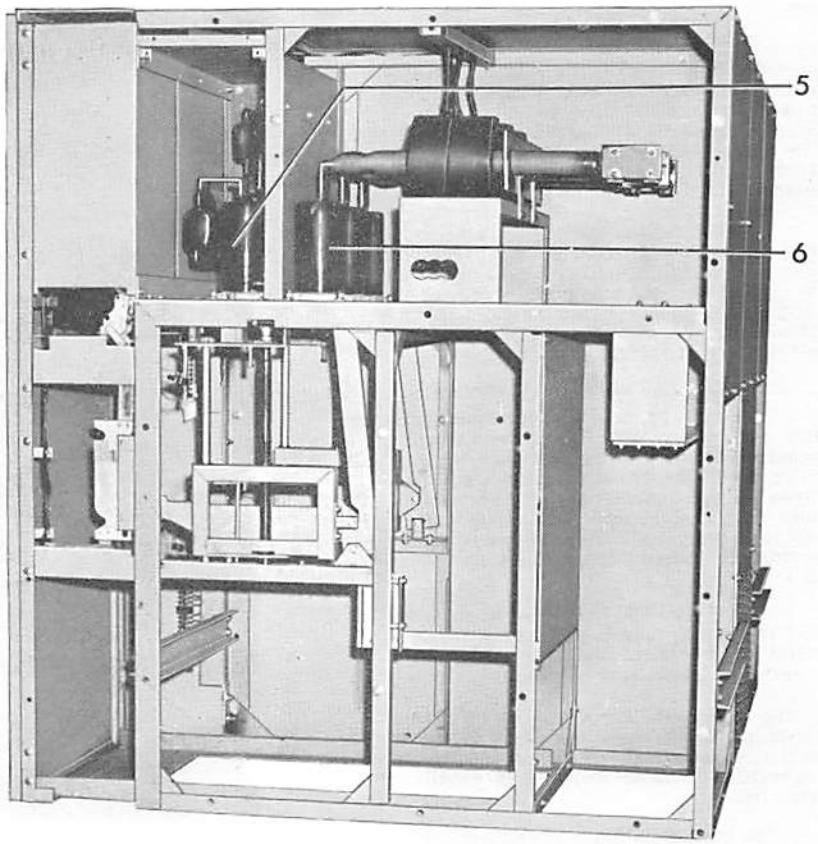


Fig. 10 (8039690) Metal-Clad Switchgear

For a detailed description of the Magne-Blast breaker and its operation the applicable breaker instruction book should be consulted.

BREAKER ELEVATING MECHANISM

The elevating mechanism for elevating or lowering the removable element to or from its connected position supports the removable element in the operating position. In the test position the breaker is lowered to the guide rails and withdrawn from the fully inserted position 2 1/4 inches.

This mechanism consists of heavy-duty steel jack screws on which are carried nuts to support the elevating carriage. The carriage is so designed that the removable element can be readily inserted or withdrawn after the carriage has been lowered to the disconnected position without necessitating the removal of any bolts nuts or screws.

The breaker cannot be lowered or raised until it has been tripped. The breaker cannot be closed except with the breaker in either the operating or test position.

Guide rails are built into the metal-clad frame to guide the removable breaker element into correct position before the breaker is raised into the operating position by means of the elevating mechanism which is motor operated.

For a detailed explanation of the elevating mechanism refer to description under "OPERATION".

ELEVATING MOTOR

One elevating motor is furnished for each equipment. It is designed for quick interchangeability between units and is held in place by a stationary clamp under the clutch handle and a snap hasp on the front. Two dowels are located in the base to maintain alignment.

A short cable with plug is provided and must be plugged into the receptacle above the motor mounting. A selector switch is mounted on the motor for reversing the motor direction. This selector switch should not be used to start and stop the elevating gear motor.

PRIMARY DISCONNECTING DEVICE

The primary disconnecting devices utilize silver to silver contacts to insure against reduction of current carrying capacity due to oxidation of the contact surfaces. These contacts are of the high pressure line contact tube and socket design, the tube being backed up by heavy garter springs to insure contact pressure. Refer to Figure 11.

BUS COMPARTMENT

The main buses are enclosed in a metal compartment with removable front covers to provide accessibility.

The bus is supported by a flame retardent, track resistant, glass laminate insulating material which is practically impervious to moisture, and an excellent dielectric.

The bus insulation is an extruded thermoplastic insulation sleeve, suitable for 105° C operating temperature. The bus bars are inserted into the sleeves leaving only the bolted joints exposed. Where standard configurations exist the joint is insulated with a Polyvinyl Chloride boot. Special conditions and non standards are taped.

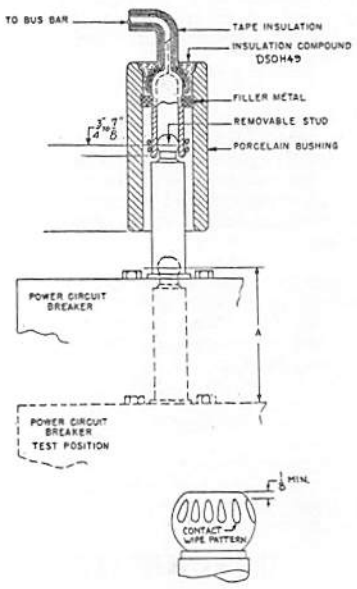


Fig. 11 Measurement of Adjustment for Primary Disconnecting Devices

CURRENT TRANSFORMER AND CABLE COMPARTMENT

The current transformers are mounted in a compartment isolated from the other equipment. Provision is made in this compartment for connecting the purchaser's primary cable by means of potheads or clamp type terminals.

POTENTIAL TRANSFORMER COMPARTMENT

Potential transformers are located in a compartment above the current transformers or in a separate unit adjacent to the breaker units.

The transformers are mounted on a movable carriage equipped with primary and secondary disconnecting devices. When the potential transformers are disconnected, they are at a safe striking distance from all live parts of the switchgear. In addition a grounding device is provided which contacts the fuses when the potential transformers are disconnected, effectively discharging the transformers. In this position the transformer fuses may be safely removed and replaced. A barrier mounted at the rear of the carriage moves with the carriage to a position in front of the stationary part of the primary disconnect device, providing a safe striking distance from all live parts. See Figure 12.

DUMMY REMOVABLE ELEMENT

Dummy removable elements, Fig. 13, are used as a means of isolating circuits or bus sections, where operation is infrequent and a circuit breaker cannot be economically justified. The device consists of a framework to simulate the circuit breaker removable element with a set

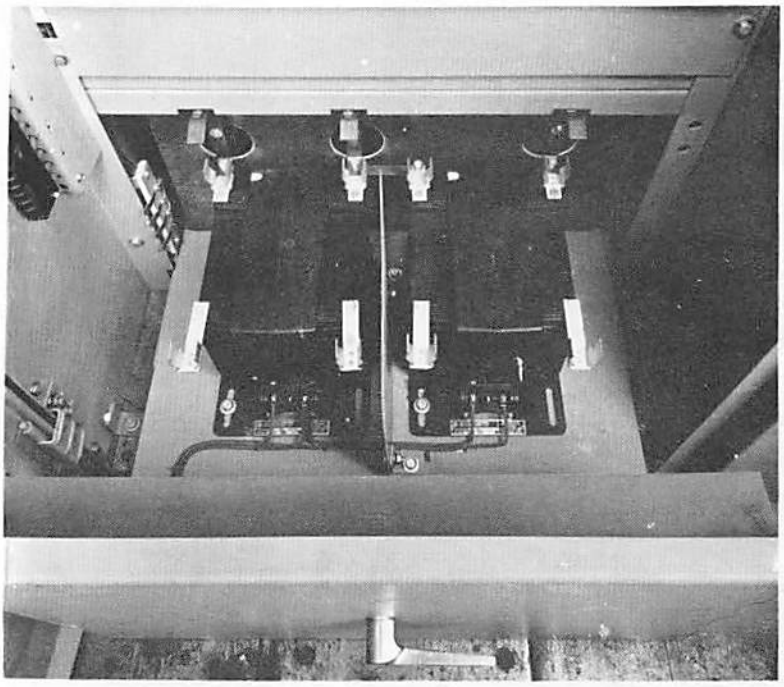


Fig. 12 Potential Transformer Rollout Shown in Withdrawn Position

Fig. 13 (8026011)

Fig. 14 (8028015)

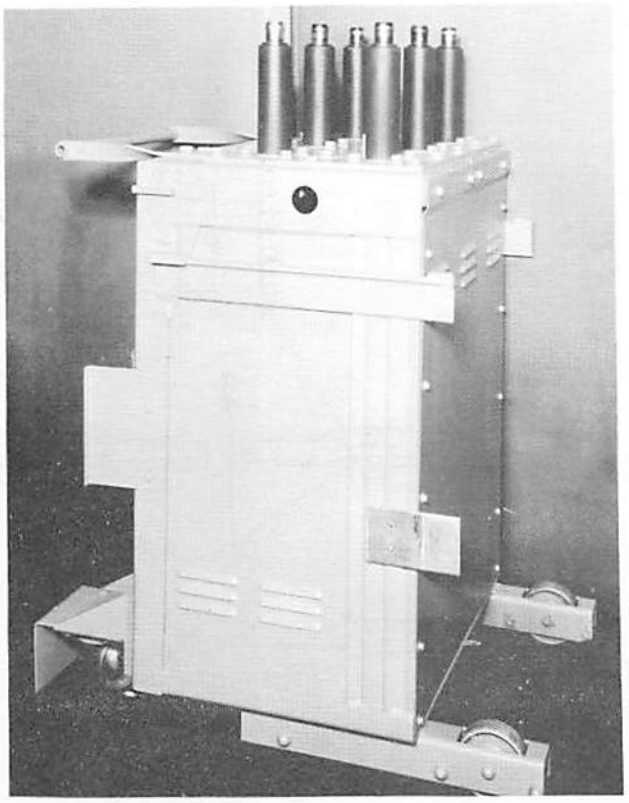


Fig. 13 Dummy Removable Element

of six studs similar to those on the magne-blast breakers. The lower end of the studs are connected, front to back, by copper bars which are fully insulated and metal-enclosed. The stationary structure is the same as for a circuit breaker. When the device is elevated into position, it connects the front set of metal-clad disconnecting devices to the rear set.

Under no conditions must the dummy element be elevated or lowered when the bus or the unit is energized. Key interlocks are applied to insure that all source of power are disconnected before the dummy element can be operated. Refer to Figure 15.

ROLLOUT FUSE-SWITCH UNITS

Rollout load-break disconnect switches, with or without current limiting fuses of high interrupting capacity, are sometimes used in metal-clad switchgear to protect and switch small transformers and circuits where circuit breakers cannot be economically or functionally justified.

The rollout switch is designated as type SE-10, and the units in which they are used are designated as type SEM-26 or SEM-36. For additional information on these equipments, refer to the supplementary instructions furnished.

FUSE DISCONNECTING DEVICE

Current limiting fuses with high interrupting rating are sometimes used in metal-clad switchgear to protect small transformers or circuits where circuit breakers cannot be economically or functionally justified.

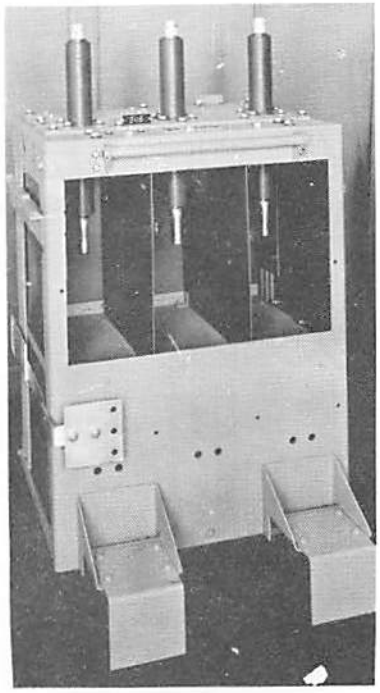


Fig. 14 (8028015) Ground and Test Device
(Cable shown not furnished by G. E. Co.

The fuses are mounted on a movable support equipped with disconnecting devices. Control power transformers of 15 kva and smaller may be mounted on the rollout with the fuses. See Figure 16.

When the fuses are disconnected, they are at a safe striking distance from all live parts of the switchgear. In addition a grounding device is provided which contacts the fuses after they are disconnected, effectively removing any static charge from the fuses. In this position the fuses may be safely removed and replaced. The disconnecting devices are capable of interrupting transformer magnetizing current, but should not be used to interrupt load current. Mechanical or key interlocks are applied to prevent operating the disconnecting device while the load is connected. This is genearally accomplished by interlocking so that the transformer secondary breaker must be locked in the open position before the disconnecting device can be opened or closed.

GROUNDING AND TEST DEVICE

The grounding and test device, Figure 14, provides a convenient means of grounding the cables or the bus in order to safeguard personnel who may be working on the cables or the equipment. The device can also be used for applying power for high potential tests or for fault location, to measure insulation resistance (Megger). By using potential transformers, it can also be used for phasing out cables.

The three studs of the device are similar to those of the magne-blast circuit breakers. The studs are mounted on a removable plate which can be placed in either of two positions. In one position the studs will engage the front (Bus) contacts only and in the other position the studs will engage the rear (Line) contacts only of a metal-clad unit.

To indicate the proper placement of the studs on the device, opposite sides of the assembly are marked "Line" and "Bus". The word corresponding to the desired position must be toward the operator.

To use, the device is rolled into the metal-clad housing in place of the circuit breaker, and raised into or lowered from the connected position by means of the circuit breaker elevating mechanism.

In addition to the device described above, there is available a form of grounding and testing device equipped with both bus and line side bushings, power operated grounding contacts, phasing receptacles, and a complete safety interlocking system. For details of construction and operation of this device, refer to GEI-38957 for 4.16 kv equipment, or GEI-50114 for 7.2 kv and 13.8 kv equipment.

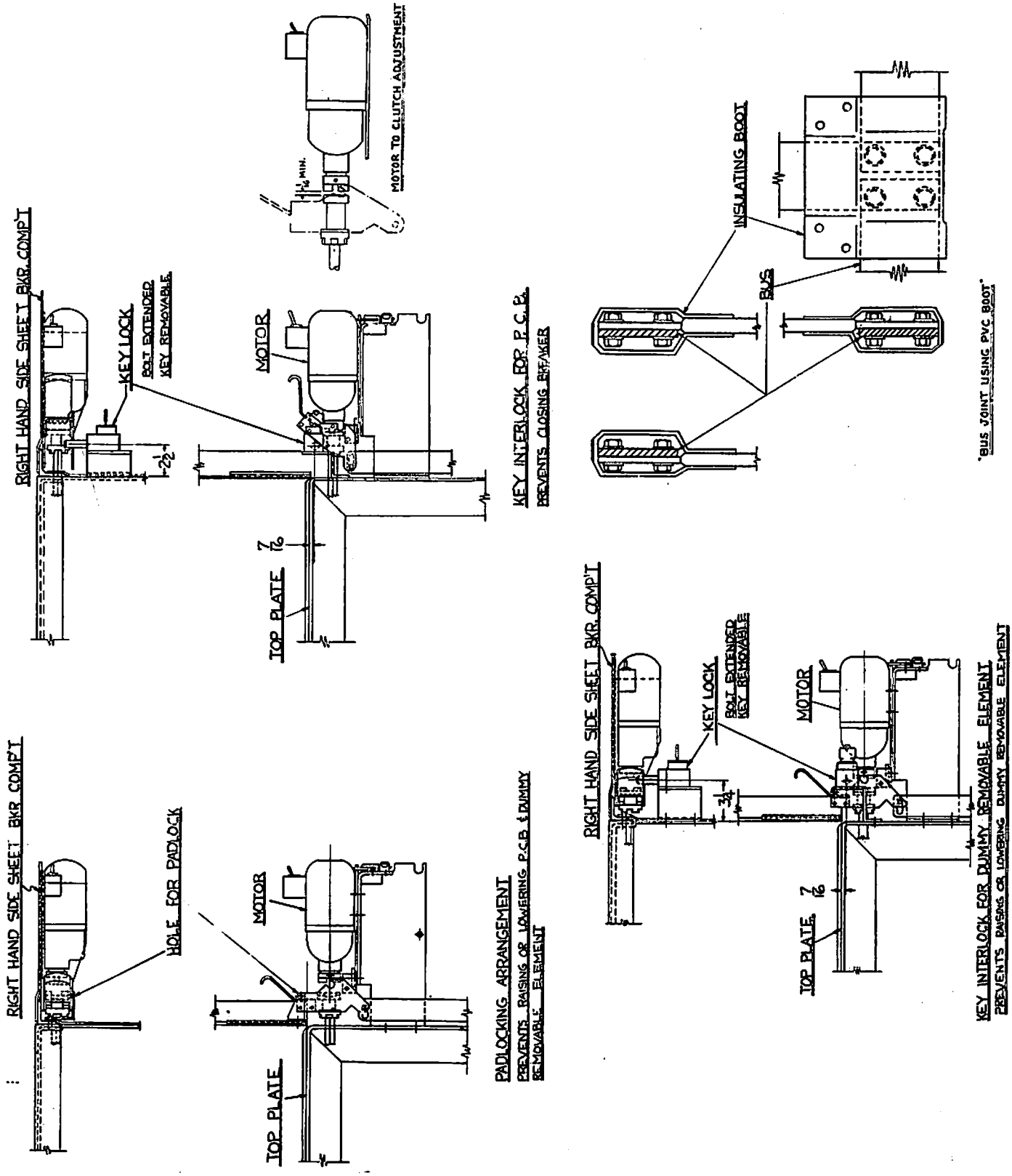


Fig. 15 Padlocking Arrangement, Key Interlocking and Bus Boot Assembly

Fig. 16 (8039444)

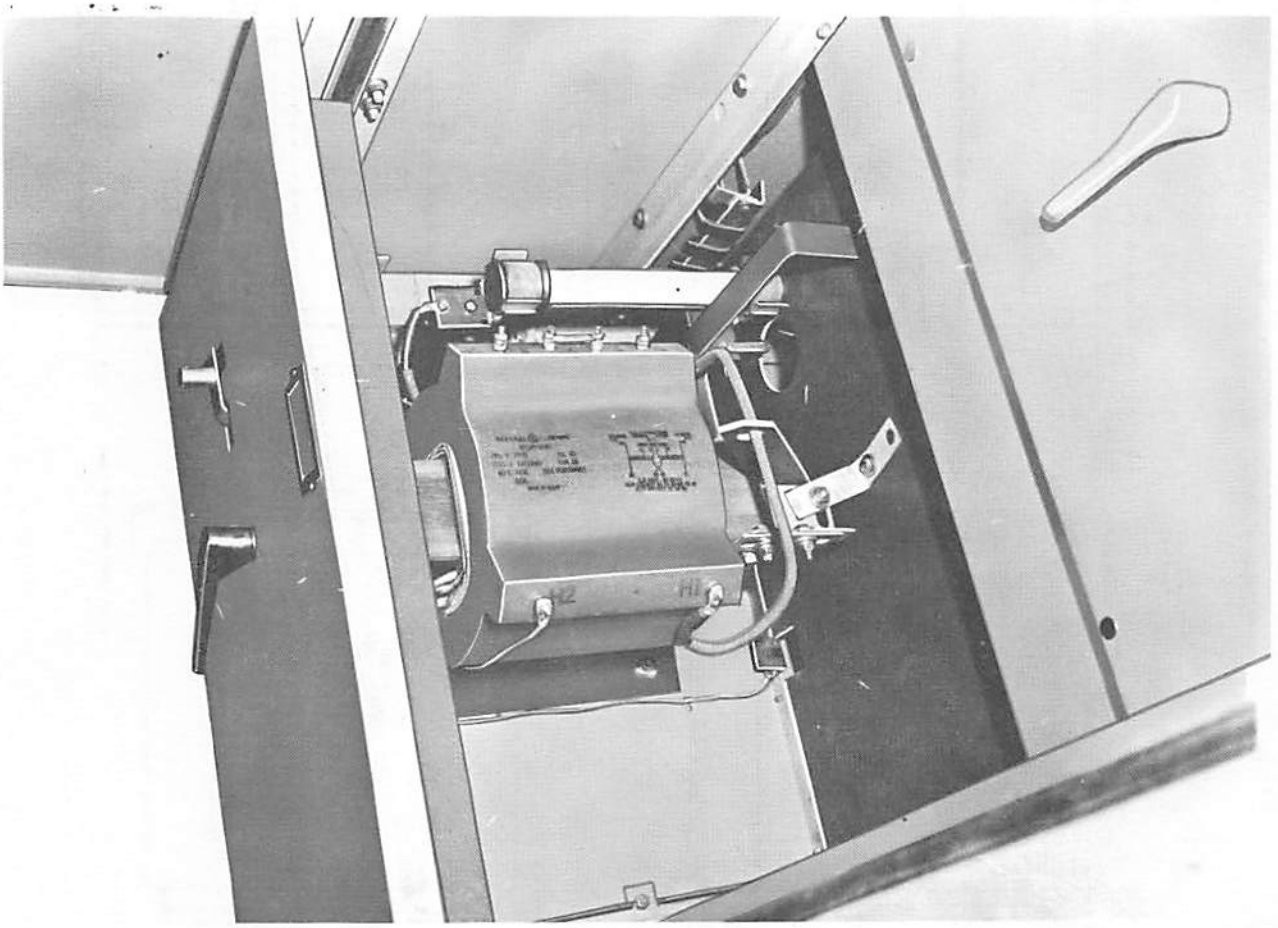


Fig. 16 Control Power Transformer Rollout Shown in Open Position

INSTALLATION

Before any installation work is done, consult and study all drawings furnished by the General Electric Company for the particular requisition. These drawings include arrangement drawings, wiring and elementary diagrams and a summary of the equipment.

Frequently additional shipping members are installed in the bus and primary area to insure against shipping damage. It is imperative that all shipping members be removed, joints properly tightened and insulated before energizing the bus. All exposed primary joints and connections must be insulated for the system rating. Shipping braces are shown on the arrangement drawings.

Mats, screens, railings, etc. which are external to the switchgear, but which may be required to meet any local codes, must be furnished by the purchaser.

LOCATION

The recommended aisle space required at the front and at the rear of the equipment is shown on the floor plan drawing furnished for the particular requisition. The space at the front must be sufficient to permit the insertion and withdrawal of the circuit breakers, and their transfer to other units.

The space at the rear must be sufficient for installation of cables, for inspection and maintenance, and on some equipments to draw out potential transformers.

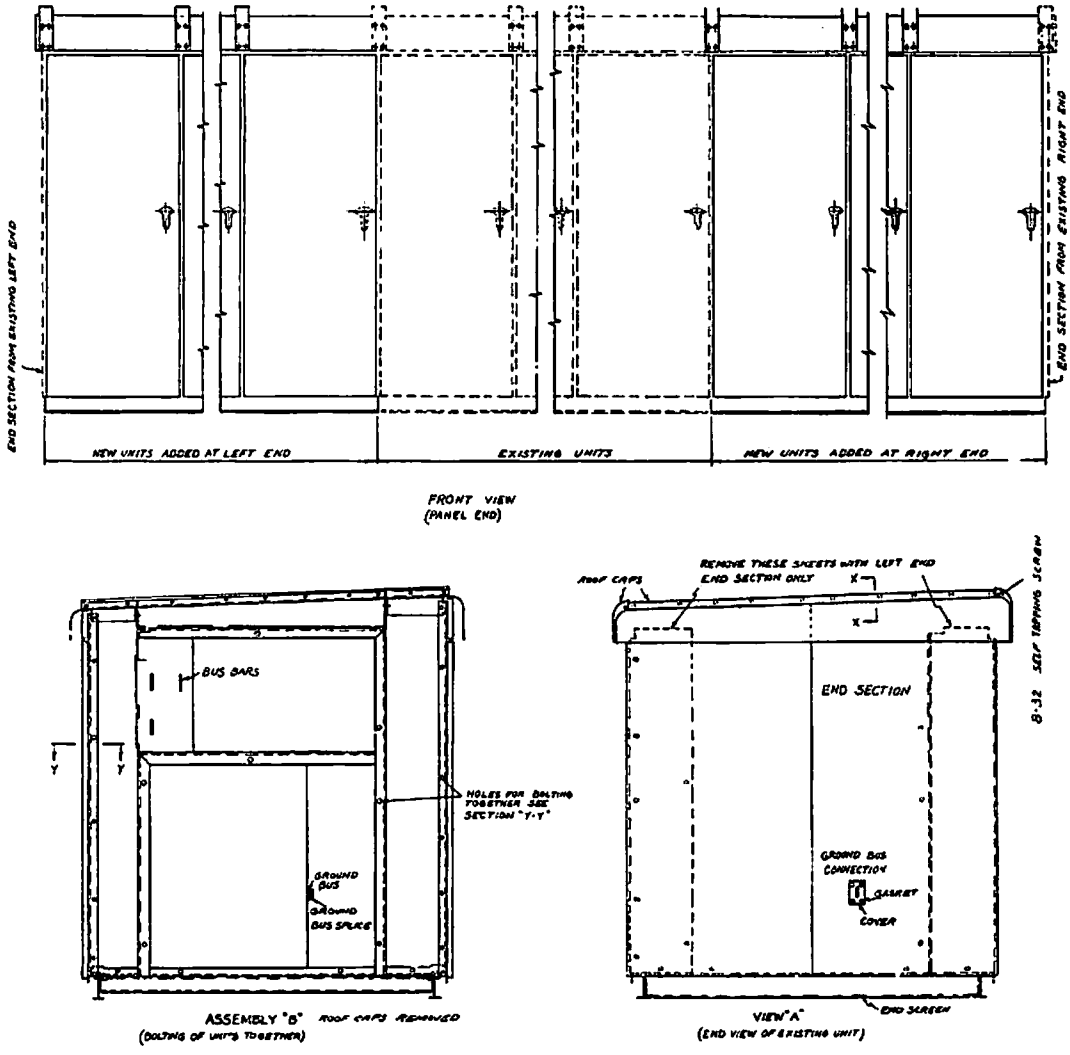
PREPARATION OF FLOOR - ANCHORING

Indoor Equipment

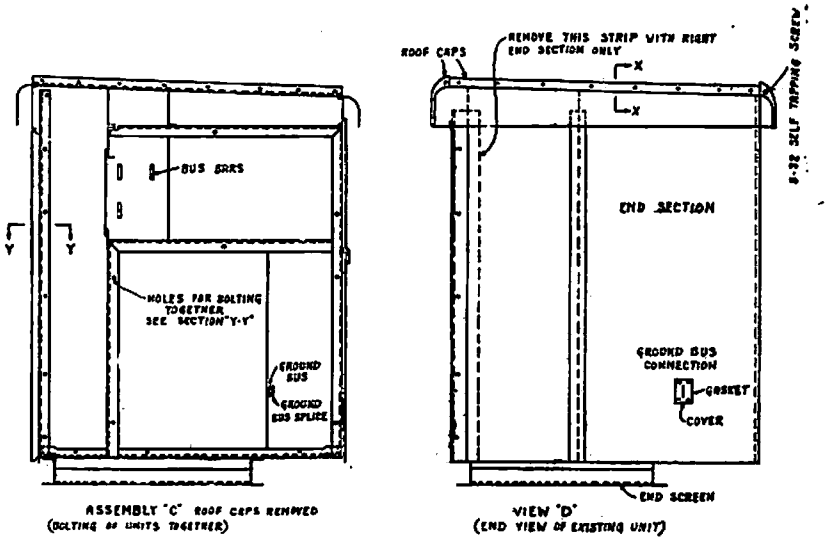
The station floor must be strong enough to prevent sagging due to weight of the switchgear structure and to withstand the impact stress caused by the opening of the circuit breakers under short circuit conditions. The impact loading is approximately 1-1/2 times the static load.

Suitable means must be provided by the purchaser for anchoring the equipment to the floor. It is essential that the floor be level to avoid distortion of the switchgear structure and the equipment be completely aligned prior to final anchoring. The recommended floor construction is shown in Figure 7. The floor channels must be level and straight with respect to each other. Steel shims should be used for final leveling of the switchgear if necessary. Care should be taken to provide a smooth, hard, and level floor under and in front of the units to facilitate installation and removal of the breaker. If the floor is not level and flush with the floor channels, it will be difficult to handle the breaker because it will not be level with respect to the stationary element.

Recommended practice is to weld the switchgear structure to the floor channels, using a tack weld at points indicated for anchoring on the drawing. If welding facilities are not available the gear should be bolted to the floor channels.



WITH REAR ENCLOSURE



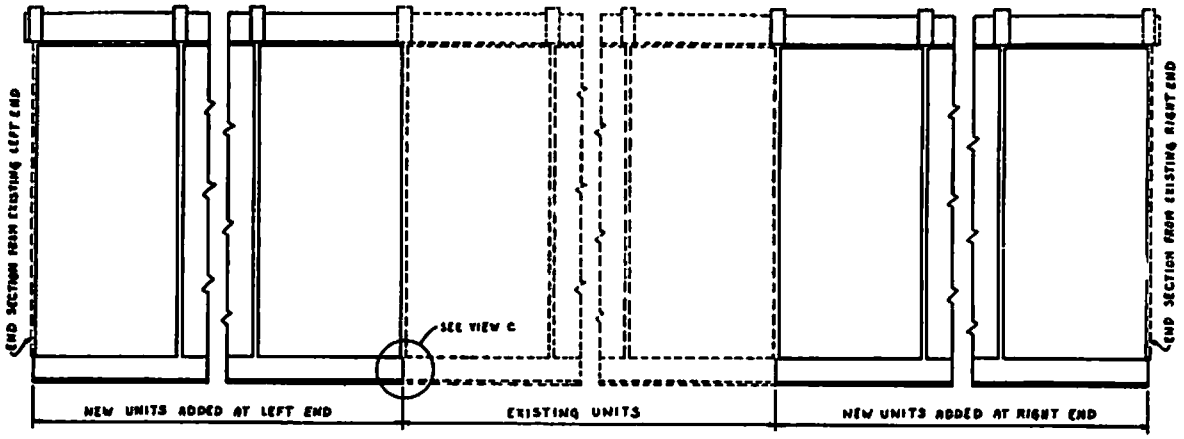
PROCEDURE

1. REMOVE ROOF CAP, END SCREEN, GASKET, BUS CONNECTION, AND END SECTION. SEE VIEW "A" & VIEW "D"
2. SET NEW UNIT(S) IN PLACE AND BOLT TOGETHER AS SHOWN IN ASSEMBLY "B." & ASSEMBLY "C"
3. ASSEMBLE ITEMS LISTED IN PROCEDURE NO.1
4. ASSEMBLE NEW ROOF CAPS AS SHOWN IN VIEW "A" & VIEW "D".
5. ASSEMBLE GROUND BUS SPLICE BETWEEN EXISTING AND NEW GROUND BUS. AS SHOWN IN ASSEMBLY "B" & ASSEMBLY "C"
6. ASSEMBLE BUS BARS AND INSULATE PER INSTRUCTION BOOK.

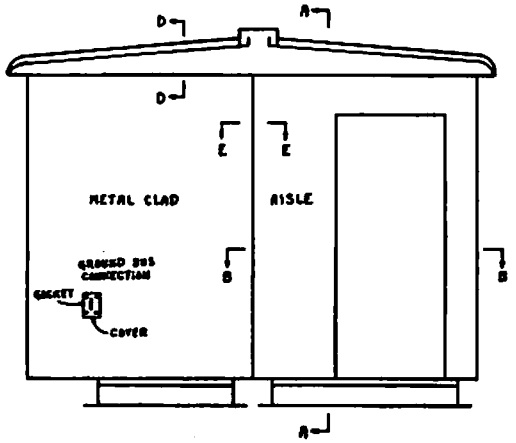
ROOF CAP

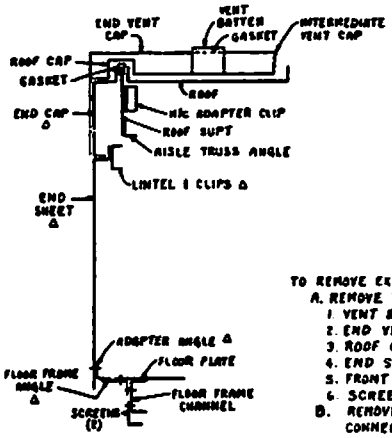
WITHOUT REAR ENCLOSURE

Fig. 17 Outdoor Metal-Clad Switchgear - Addition of Units to Line - Up.



FRONT VIEW





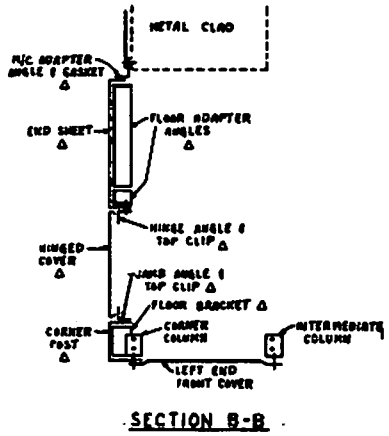
SECTION A-A

TO REMOVE EXISTING END SHEET (LEFT)
A. REMOVE THE FOLLOWING ITEMS FROM AISLE SECTION
1. VENT BATTEN
2. END VENT CAP
3. ROOF CAPS
4. END SECTION CONSISTING OF ITEMS MARKED Δ
5. FRONT COVER (MOVE TO NEW UNIT)
6. SCREENS (E)
B. REMOVE ROOF CAP, END SCREEN, GROUND BUS CONNECTION AND END SECTION FROM METAL CLAD SECTION

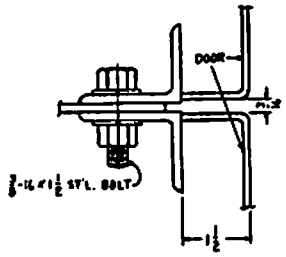
TO INSTALL NEW METAL CLAD UNITS (LEFT)
1. SET NEW UNIT(S) IN PLACE AND BOLT TOGETHER
2. ASSEMBLE ITEMS LISTED IN B
3. ASSEMBLE NEW ROOF CAPS
4. ASSEMBLE GROUND BUS SPLICE BETWEEN EXISTING AND NEW GROUND BUS
5. ASSEMBLE BUS BARS AND INSULATE PER INSTRUCTION BOOK

TO INSTALL NEW PROTECTED AISLE UNITS (LEFT)
1. INSTALL NEW FLOOR FRAMES AND FLOOR PLATE TIE DOWN ANGLE
2. REPLACE FLOOR FRAME ANGLE AT NEW END POSITION
3. INSTALL NEW FLOOR PLATES
4. ERECT NEW CORNER COLUMN (ANGLE)
5. ADD NEW AISLE TRUSS ANGLE AND METAL CLAD ADAPTER CLIP TO EXISTING END ROOF TRUSS AND SUPPORT
6. INSTALL NEW END AISLE TRUSS SUB-ASSEMBLY CONSISTING OF ROOF TRUSS ANGLE, ROOF SUPT, COLUMN CLIP, METAL CLAD ADAPTER CLIP AND ROOF SUPT CLIPS
7. REINSTALL THE ITEMS REMOVED IN A-4
NOTE:- USE NEW GASKETS AND ALSO INSTALL PREVIOUS END FRONT COVER ON FRONT OF NEW END UNIT
8. INSTALL WIRING AND LIGHTING TROUGH

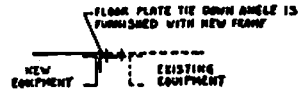
NOTE:- A SIMILAR PROCEDURE IS USED FOR RIGHT END ADDITIONS



SECTION B-B



SECTION E-E



INTERNAL VIEW C

Fig. 18 (718D393)

Fig. 18 Outdoor Metal-Clad Switchgear with Protected Aisle.

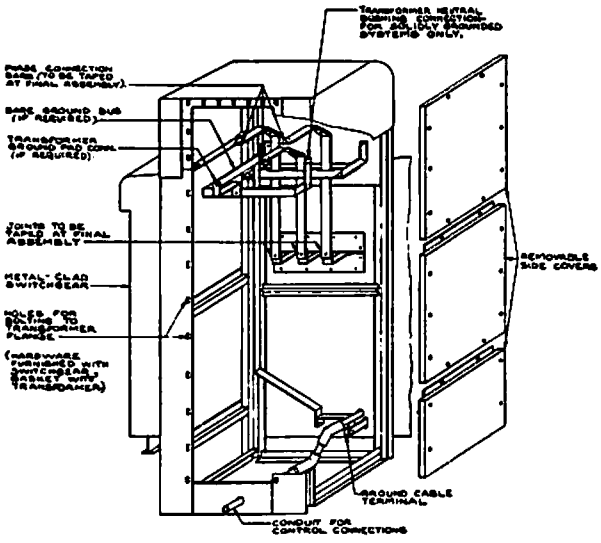


Fig. 19

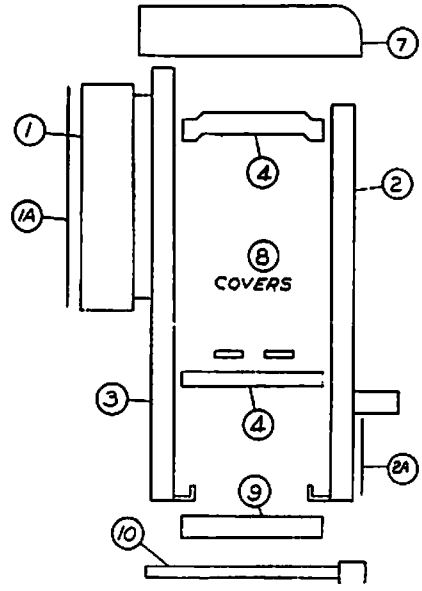


Fig. 20

Outdoor Transition Compartment

Provision should be made in the floor for conduits for primary and secondary cables, located as shown on the floor plan drawing furnished for the particular requisition. If desired, the conduits may be installed before the switchgear. Consideration should be given to conduits which might be required for future connections.

Outdoor Equipment

Outdoor equipments are furnished both with and without rear enclosures. Recommendations for foundations for both types are given in Fig. 8. Primary and secondary conduits should be installed in accordance with the requisition drawings, before the equipment is put into place.

Since outdoor equipments are provided with a 6" base, a transfer truck is required to place the breaker in the housing. The level adjustment on the truck is shown in Fig. 8.

When outdoor equipments are shipped in more than one section, the joint between sections must be weatherproofed. Assemble the gasket between the doors, using cement provided. Refer to Fig. 8, Section B-B. Assemble the gasket between the roof sections, bolt together and install the roof caps. Refer to Fig. 8, Section C-C.

Outdoor Equipment with Protected Aisle

When specified by the purchaser, outdoor equipment is furnished with an enclosed, weatherproof operating aisle. See Fig. 3. The aisle enclosure is shipped separately from the switchgear.

The following procedure outlines the steps necessary to install outdoor equipment with a protected aisle:

(1) Install the switchgear in accordance with the procedure given above for outdoor equipment.

(2) Remove the shipping covers from the control panels. Since the relay and instrument cases are not weather-proof, the control panels should be protected from inclement weather until the installation of the aisle enclosure is completed.

(3) Apply Sterling U-310 or U-311 varnish to both sides of the gaskets furnished for the joint between the ends of the switchgear and the aisle enclosure and to the surfaces against which the gasket presses and hang the gaskets on the projecting studs at the ends of the switchgear lineup. See Fig. 9, section A-A.

(4) Move the aisle enclosure into position guiding the holes in the end sheets over the studs on the switchgear lineup and guiding the roof sills between the support clips bolted to the upper front of the switchgear units above the control panels. This operation may be simplified by temporarily loosening the support clips.

The floor of the aisle enclosure must fit under the hinged breaker cover of the metal-clad, so the aisle enclosure must be moved into position on a level with the switchgear units. If desired this job may be simplified by removing the breaker enclosure doors.

(5) Bolt the aisle enclosure in place at both ends, and bolt the roof sills to the support clips, tightening any support clips loosened in the previous operation. Replace any breaker compartment doors previously removed.

(6) If the aisle enclosure was shipped in more than one section, bolt the sections together and assemble the roof caps in the manner described above for roof joints in outdoor switchgear.

(7) Anchor the outside floor sill of the aisle enclosure with anchor bolts placed in accordance with the requisition drawing. See Fig. 9, view Y.

(8) Assemble the dome over the roof opening between the switchgear and the aisle enclosure. See Fig. 9, view X.

(9) Remove shipping braces from aisle enclosure. These braces should be left in place until the aisle enclosure is assembled in order to maintain alignment of the enclosure.

(10) Connect secondary wiring to lights, convenience outlets, etc., in accordance with the wiring diagrams furnished for the equipment.

Since the aisle floor is level with the floor of the switchgear units, no transfer truck is required for outdoor equipment with a protected aisle.

The above procedure describes installation of a protected aisle enclosure with switchgear on one side of the aisle only. If the aisle is common to two lineups of switchgear, the procedure will require slight modification. See the drawings furnished with the requisition for specific instructions.

Transition Compartments

Transition compartments for outdoor unit substations may be one of two types (Figs. 19 and 20). These compartments are normally shipped assembled. The full height compartment (Fig. 19) cannot be disassembled for installation. The throat type compartment (Fig. 20) can be installed in any of three ways, in accordance with the following instructions:

(a) Should the switchgear be positioned on its foundation prior to the power transformer, the complete transition can be mounted on the metal-clad as assembled. Remove covers #8. Apply Sterling U 310 varnish to both sides of gasket 2A, and to the surfaces against which the gasket presses. Bolt transition compartment to throat on metal-clad switchgear. Before jacking the power transformer into its final location, apply Sterling U 310 varnish to both sides of gasket 1A and to the surfaces against which the gasket presses, and place the gasket over the mounting studs on the transformer tank wall. Slide transformer in place, guiding the transformer mounting studs through the mounting holes in #1. Center rubber seal between

Fig. 20 (453A738)

Fig. 19 (261C416)

#1 and #3 before tightening nuts, maintaining 24" between transformer tank wall and end of metal-clad. Do not apply varnish to the rubber seal between #1 and #3. Cut secondary conduit #10 to length and assemble under the transition.

(b) Should the power transformer be positioned on its foundation prior to the switchgear, follow the procedure of paragraph (a) above, except move the switchgear up to the power transformer after assembling the transition compartment to the switchgear.

(c) If the power transformer and metal-clad switchgear are in place, disassemble transition as follows: Remove covers #8 and #9, adapter #1, dome #7, braces #4. Apply Sterling U 310 varnish to both sides of gasket #2A, and to the surfaces against which the gasket presses, before bolting #2 to metal-clad throat. Apply Sterling U 310 varnish to both sides of gasket #1A, and to the surfaces against which the gasket presses, and loosely fasten #1 and #1A to transformer tank. Slide throat of #3 into #1 and maintain approximately 4 1/2" from #3 to tank. Assemble braces #4 top and bottom to maintain size and proper alignment, then tighten #1 to transformer tank. Assemble connections, terminals, supports and complete all joints. Assemble dome #7, side covers #8 and bottom cover #9. Cut secondary conduit #10 to length and assemble under the transition.

Connect heaters located in 13.8 kv class transition compartment.

Indoor transition compartments are shipped assembled together with the adjacent metal-clad switchgear units.

BREAKER REMOVABLE ELEMENT

Before installing or operating the removable element consult the circuit breaker instructions for directions on installation and inspection.

The operation of the elevating mechanism, positive interlock and associated features are described under Operation of Equipment and should be reviewed before installing removable element.

TESTING CABINET

The testing cabinet, Fig. 22, should be installed on the wall at a location where maintenance and testing of the breaker can be conviently done. Conduits must be installed to carry cables to supply control power for testing.

ADDITION OF UNITS TO EXISTING EQUIPMENT

Before adding units to existing equipment, consult and study all drawings furnished with the equipment. In addition to the usual drawings furnished with new equipment special drawings may be furnished covering complicated or special assembly work. Also, check to make sure all necessary parts are on hand.

BEFORE ANY COVERS ARE REMOVED OR ANY DOORS OPENED WHICH PERMIT ACCESS TO THE PRIMARY CIRCUITS, IT IS ESSENTIAL THAT THE CIRCUIT OR CIRCUITS BE DE-ENERGIZED AND BREAKERS BE WITHDRAWN TO A DISCONNECTED POSITION AND TAGGED.

IF WORK IS TO BE DONE ON REMOTE EQUIPMENT CONNECTED TO A UNIT, THE BREAKER FOR THAT UNIT SHOULD BE PLACED IN THE DISCONNECTED POSITION AND TAGGED. ALSO THE REMOTE EQUIPMENT SHOULD BE ISOLATED FROM ANY OTHER POWER SOURCES CONNECTED TO IT.

Figure 17 indicates the special procedures required to add new metal-clad units to outdoor equipment without protected aisle, and Figure 18 indicates the special procedures required to add new metal-clad units to outdoor equipment with protected aisle. For indoor equipment, it is usually necessary only to remove the end cover sheets and to re-assemble them on the new units after these are located and bolted to the existing units. Otherwise, the installation procedure is the same as described above.

When the units are in place and mechanical assembly is completed, assemble the main bus and other primary connections per the instructions below. (Removal of existing compound-filled connection boxes can be easily accomplished by packing the box in dry ice for 2 - 3 hours. Remove the dry ice and the cord tying the box in place, and strike the box with a hammer. The hardened box and compound will crack away from the joint.)

Secondary wiring and control bus connections should be made in accordance with the wiring diagrams furnished with the equipment.

CONNECTIONS

The main bus bars and other connection bars may be either copper or aluminum. In either case, the connection surfaces will be silver surfaced or equivalent. All field assembled joints in primary conductors, regardless of material or method of insulation, should be made as described below:

(1) Wipe silver clean. Do not use sandpaper or any abrasive on the silvered surface. Avoid handling of cleaned surface as much as possible.

(2) Join the clean contact surfaces by using the hardware provided as shown in Figure 24 and the torque values listed in Table A, Figure 23.

(3) In some cases external connections are made to metal-clad bus by bars. The metal-clad bars are normally silver plated. Unplated bars, either copper or aluminum, should not be used to connect to silver plated bars.

(4) All field assembled Primary joints and terminations must be insulated for the operating voltage. There are two methods of insulating joints, boots where applicable and taped joints for all others. A detailed procedure for joint insulation is described under "MAIN BUS ASSEMBLY".

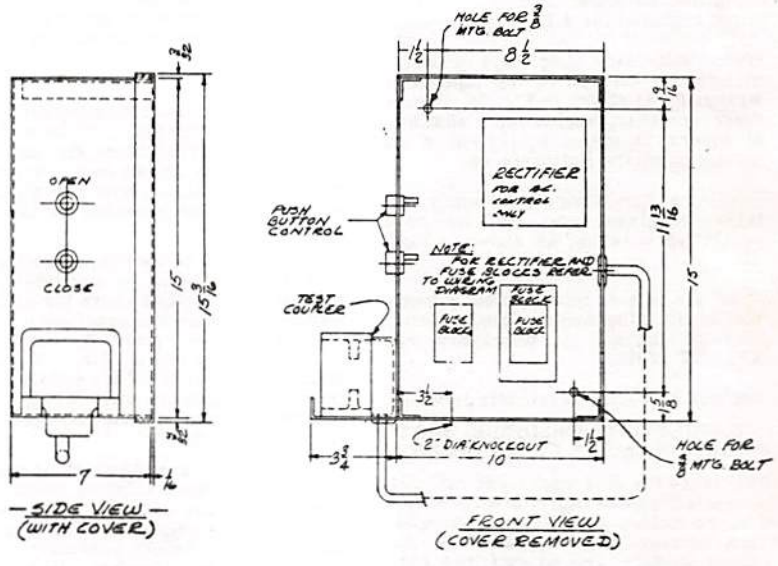


Fig. 22 Inspection Box for 13.8 KV Metal-Clad Switchgear

Fig. 22 (899B745)

MAIN BUS ASSEMBLY

For 4.16 kv, 7.2 kv and 13.8 kv equipment.

(a) Remove compartment covers.

(b) Bolt splice plates and bus bars together, following assembly instructions as given under CONNECTIONS. Also see Fig. 24 and Table A, Fig. 23.

TABLE A

BOLT TORQUE VALUES FOR METAL-CLAD SWGR.

BOLT SIZE	TORQUE FOOT POUNDS	MATERIAL
3/8"-16	15-25	STEEL
1/2"-13	30-45	COPPER
5/8"-11	35-45	ALUMINUM COMPOUND

Fig. 23

(c) There are two means of insulating bus joints for both 4.16 kv and 13.8 kv equipment.

1 - Taped joints Fig. 26.

2 - PVC (POLYVINYL CHLORIDE) boots Fig. 26A.

I-TAPED JOINTS for 13.8 KV EQUIPMENT

(1) Prepare all joints as outlined under "CONNECTIONS".

(2) Fill all cavities around bolts and nuts with A50H119 compound to form a smooth surface for taping, thus preventing air voids. This compound is not an insulating medium and should not be used for that purpose.

(3) "T" Joint - Place 4" wide double thick Irrathene tape over the A50H119 compound as shown in Fig. 25. (This is not required for 4.16 joints).

(4) Wrap with insulating tape provided maintaining tension on the tape while wrapping, as shown in Fig. 26. Where there are sharp angles apply additional layers to obtain equivalent of the insulation on the flat surfaces.

(5) Over the insulating tape, apply one layer of glass tape, half lap as a protective covering as shown in Fig. 26.

(6) Over the glass tape, brush a heavy coat of U310 (brown) varnish. Varnish may be thinned, if necessary with XYLENE D5B9.

(7) Replace all covers previously removed.

II-PVC (POLYVINYL CHLORIDE) BOOT INSULATION for 13.8 KV EQUIPMENT

(1) PVC boots for 13.8 equipment can only be applied to those assemblies furnished with the molded bus barrier, Figure 36. This barrier is distinguished by the raised surface around each bus bar. Those assemblies not furnished with this barrier will have to be taped. See above.

(2) Prepare all joints as outlined under "CONNECTIONS".

(3) Place the PVC boot over the joint as shown in Fig. 25A.

(4) Secure the PVC boot with self-locking fasteners furnished. Joint insulation is now complete.

(5) Replace all covers previously removed.

(6) Boots will be furnished for standard configurations, however special conditions must be taped.

III-PVC (POLYVINYL CHLORIDE) BOOT INSULATION for 4.16 KV EQUIPMENT

The instructions for the bolted joint and application of the PCV boot is the same as outlined for the 13.8 equipment except there are no restrictions on the bus barrier.

IV-TAPED JOINTS for 4.16 KV EQUIPMENT

(1) The instructions for the bolted joint and application of the tape insulation is the same as outlined for the 13.8 equipment except use 1/2 the amount of insulating tape and use the U-311 (black varnish). Refer to Table in Fig. 26.

(2) In unit substations, the connection bars should be assembled in the transition compartment (Figure 19 and 20) and the connections at the transformer terminals taped and painted as indicated above. The conduit for secondary circuits should also be assembled in or below the transition compartment.

CLEANING BUS INSULATION

Main bus bars are insulated with a high temperature thermoplastic material having excellent dialectric and mechanical properties. When cleaning is necessary only denatured alcohol or iso propyl alcohol should be used to remove any foreign materials from the insulation surface.

BUS DUCT

Bus ducts connecting between groups of metal-clad switchgear, or between metal-clad switchgear and other apparatus, should be installed as shown on the arrangement drawings furnished with the ducts. Supports should be provided as indicated on the drawings.

All joints in the bus, including adjustable joints, should be assembled and insulated as described above for main buses. Adjustable joints are provided in long runs of bus duct to allow for variations in building construction, etc. These joints should be loosened before installation of the duct, then tightened after being set in the position required by the fixed points at the ends of the duct.

Outdoor bus ducts must be gasketed at the joints between shipping sections. Coat both sides of the flat gasket and the flanges of both duct sections with Sterling U310 or U311 varnish before assembly. Bolt the two duct sections together. Remove the top cover from one duct section and place 3/8" elastic compound bead along top of joint slightly overlapping the sides. Bolt top cover in place and fasten roof cap in place over the joint. See Fig. 23A. When top covers are removed after installation for inspection the 3/8" elastic compound bead must be replaced to insure a tight seal.

Removable front and rear covers of vertical sections of bus duct must also be gasketed. Coat both sides of the gasket, the flange of the duct, and the edges of the inside surface of the cover with Sterling U310 or U311 varnish before assembly. Do not bolt these covers in place until all interior assembly work on the duct is completed and access will no longer be required.

Outdoor bus ducts of the 13.8 kv class are provided with heaters. Connect these heaters in accordance with the wiring diagrams furnished with the equipment before energizing the bus duct.

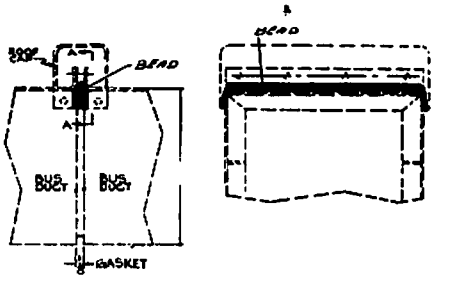


Fig. 23A Bus Duct Gaskets

PRIMARY CABLES

The primary cable connections in indoor switchgear are reached by removing the rear bolted covers. In outdoor switchgear with rear enclosures the hinged instrument panel, if present, must be swung open and the bolted covers behind it removed.

Before any primary cable connections are made, the cables should be identified to indicate their phase relationship with the switchgear connections. This is necessary to insure that motors will rotate in the proper direction and that the phase rotation is the same when interconnecting two different sources of power.

There are two common methods of making primary cable connections:

(a) Potheads (see GEI 28838H) are used when it is desired to hermetically seal the end of the cable to make a moisture-proof connection between the cable and switchgear bus. A pothead also prevents seeping of oil from the end of oil impregnated varnish cambric or paper insulated cable

(b) Clamp type terminals and wiping sleeve or cable clamp.

No insulation materials are furnished for cable terminations. When potheads are supplied as part of switchgear insulation materials are furnished for the bar terminations to the pothead studs.

In all cases carefully follow the cable manufacturer's recommendations for installation of the type of cable being used,

A typical example of terminating a shielded cable is shown in figures 28 and 29.

If the cable is aluminum, the conductor surface must be carefully abraided and the cable covered liberally with a joint compound recommended by the cable manufacturer.

INSULATING PRIMARY CABLE TERMINATIONS

All field assembled joints for primary cable terminations should be prepared as outlined under "CONNECTIONS". Upon completion of the cable termination, care must be exercised when taping the exposed termination.

(1) Check to see that a sufficient area of insulating tape extends beyond the painted glass tape furnished by the factory. (2" for 5KV, 3" for 15KV). It may be necessary to remove the current transformer primary conductor insulating support to obtain proper insulation joint overlap. Replace support upon completion of joint. Refer to fig. 26.

(2) All terminations should be insulated as outlined in table fig. 26 for correct layers of insulating and glass tape.

(3) The instructions for application of the tape insulation is the same as outlined for "Taped Joints" items 1, 2, 4, 5, 6 and 7.

POTHEADS

Potheads are mounted on an adapter plate extending across the width of the metal-clad unit as shown in Fig. 27. Where necessary the adapter plate is split into two parts to facilitate the installation of the potheads.

Three-Conductor Potheads

Installation procedures for a three-conductor lead-sheathed cable with a wiping sleeve cable entrance fitting on the pothead is outlined in GEI-28838H. This is the type most generally used. The factory does not furnish insulating materials for completing stress cones and cable terminations. In all cases carefully follow the cable manufacturer's recommendation for installation of the type cable being used. A suggested procedure for shielded cables is outlined below. Refer to fig. 28 and 29 for reference.

TERMINATION WITHOUT POTHEAD

The factory does not furnish insulating materials for completing the primary cable termination at the cable clamp or for stress cones. In all cases carefully follow the cable manufacturer's recommendation for installation of the type cable being used. A suggested procedure for shielded cables is outlined below. Refer to fig. 28 and 29 for reference.

Single Conductor

1. Cut cable to proper length.

2. Remove jacket and cable tape for distance of A plus B plus 3 inches, plus length to be inserted into terminal lug.

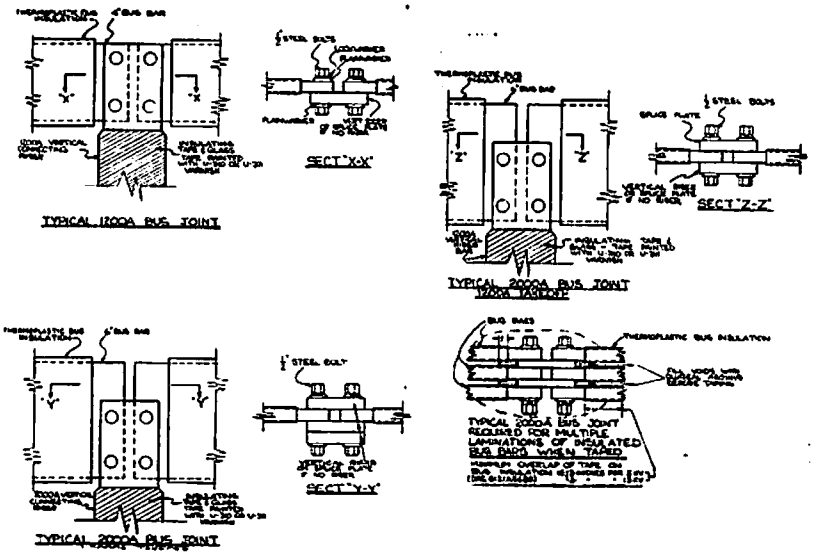


Fig. 24 (132C7770) Method of Making Bus Bar Connections

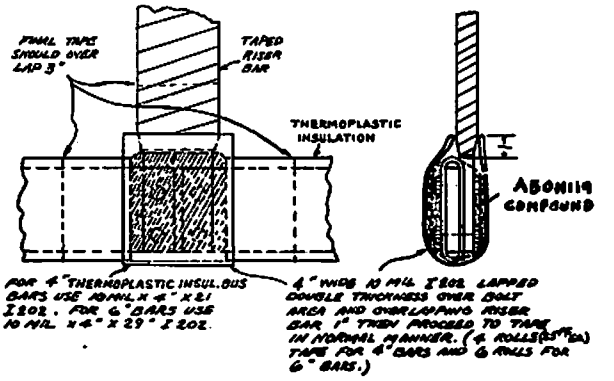


Fig. 25 (104A2714) 13.8 kv Taped Joints

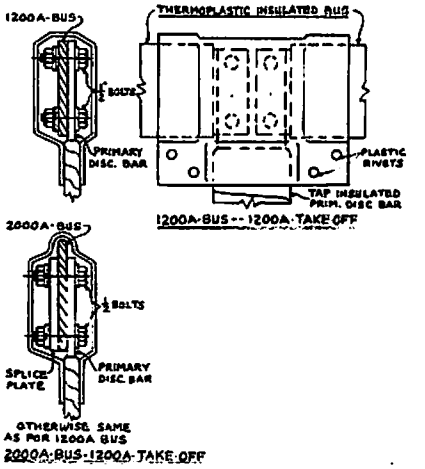


Fig. 25A (208A8953) 4.16 kv and 13.8 kv Bus Insulating Boot

3. Unwrap shielding tape to point M, cut and solder it in place avoiding excessive heat on insulation. Remove outer semi-conducting tape for same distance. Thoroughly clean surface from which the semi-conducting tape was removed.

4. Remove insulation and inner semi-conducting tape to expose conductor for distance of one inch plus length to be inserted into terminal lug.

5. Attach terminal lug to conductor. If the cable is aluminum, the conductor surface must be carefully abraided and the cable covered liberally with a joint compound recommended by the cable manufacturer.

6. Taper insulation for one inch as shown. See Fig. 28.

7. Apply end seal. Clean surface over which splicing tape is to be applied and coat with G.E. No. A50P68 adhesive cement or equivalent. When solvent evaporates, build up with splicing tape GE8380 or equivalent, as shown.

Rated kv Phase to Phase	Dimensions in Inches	
	A* Indoors Dry Locations	B
2 to 5	5	2
6 to 10	9	3
11 to 15	13	4

* For ungrounded neutral use 1.33 times the dimensions in selecting distance A.

See Fig. 28 and 29.

8. Build stress cone. Clean cable surface and coat with G.E. No. A50P68 adhesive cement or equivalent. When solvent evaporates, build up cone with splicing tape GE-8380 or equivalent, for length B plus B. Between points M and P, tape is applied so that wrapped thickness at N is equal to 75% of the original insulation thickness - and so that the cone tapers to zero thickness at points M and P. Apply one layer No. 33 Scotch tape or equivalent, half lapped. Obtain a smooth wrapping but do not stretch tape more than necessary.

9. Pass a turn of tightly drawn braid around exposed portion of shielding tape at point M and solder in place. Then apply shielding braid in tightly drawn 1/6 inch lap wrappings to point N and spot solder. Terminate the braid by cutting 1/2 inch beyond soldering point. Turn down and solder loose ends to preceding turns. Wrap four to six turns of No. 19 AWG tinned copper wire around shielding braid and solder. Solder all turns of braid together along three lengthwise lines equally spaced around braided surface.

10. Solder ground strip over shielding tape near cable covering. Cover stress cone with one layer No. 33 Scotch tape, half lapped. Obtain a smooth wrapping but do not stretch tape more than necessary. Add two layers of splicing tape.

11. Pencil jacket for 1/2 inch as shown. Clean surface. Take particular care in cleaning outside jacket surface in order to entirely remove black wax finish. Coat with G.E. No. A50P68 adhesive cement or equivalent. When solvent evaporates, apply splicing tape GE8380 or equivalent and make sheath seal as shown on drawing. Apply one layer No. 33 Scotch tape or equivalent, half lapped. Obtain a smooth wrapping but do not stretch tape more than necessary.

12. Over entire termination, apply two layers of No. 33 Scotch tape or equivalent, half lapped, in manner to shed water. Obtain a smooth wrapping but do not stretch tape more than necessary.

TERMINATION WITHOUT POTHEAD MULTI-CONDUCTOR

The factory does not furnish insulating materials for completing the primary cable terminations at the clamp terminal or for the stress cones. Refer to Fig. 29 for reference.

Make termination as indicated for single-conductor except - substitute the following for paragraphs 10, 11 and 12;

Pencil jacket 1/2 inch. Clean surface over which sheath moisture seal is to be applied. Take particular care in cleaning outside jacket surface in order to entirely remove black wax finish. Coat with G.E. No. A50P68 adhesive cement or equivalent. Allow to dry. Apply splicing tape GE8380 or equivalent to make moisture seal as shown. This is done by starting wrapping tape near end of jacket and wrapping over ground wires for 1-1/2 inches. Bend ground wires out and back over taping just applied and continue applying lapped layers of tape to completion of moisture seal including a complete tape seal in crotch formed between the three conductors. Bond and ground the ground wires.

For a multi-conductor cable not having ground wires, the individual terminations should have grounding strips applied as for a single-conductor termination. These grounding strips are to be joined together to a common ground. This common ground must then be grounded.

GROUND FAULT CURRENT TRANSFORMERS (THROUGH-TYPE)

Through-type current transformers (see Fig. 27) are furnished where specified for sensitive protection against ground faults. These transformers are normally installed in a horizontal position directly above or below the primary cable terminals, so that the primary cable or cables can pass through them. One transformer is required for each three-phase circuit.

Where armored cable is used, the armor must be terminated and grounded before the cable passes through the transformer. Armor clamps are furnished for this purpose when specified.

When lead or other conducting sheath cable, or cable with shielding tape or braid is used, it is recommended that the sheath or shield be grounded solidly to the switchgear ground bus. The ground lead should be bonded to the sheath or shield on the side of the current transformer away from the primary terminals. In cases where the ground cannot be applied before the cable passes through the transformer, bond the lead to the sheath or shield between the transformer and the primary terminals. The ground conductor must then be passed back along the cable path through the current transformer before being connnected to the ground bus.

Where potheads are used in units provided with ground fault current transformers, the pothead mountings must be insulated from ground.

CONTROL CABLES

When control conduits enter the unit from below, the conduit should not extend more than 4 inches above the floor. The control cables may be pulled through the conduits before or after the switchgear is installed, whichever is more convenient.

Connect the cables to the terminal blocks in accordance with the wiring diagrams furnished for the requisition.

If the control conduits enter from above, drill the top and bottom covers of the front enclosure wiring trough to suit the conduits. Fasten the conduits to the bottom cover with locknuts.

The cables from the control power source to the switchgear should be large enough to avoid excessive voltage drop when the circuit breakers are operated. See testing instructions.

Where units have been split for shipment, any control or other secondary leads which must connect across the split will be arranged with terminal blocks in the cross trough or convenient side sheet so that the wires can be reconnected. The wires will be cut to length and formed before being folded back so that a minimum of time will be required for reconnecting them.

GROUND BUS

The ground bus is bolted to the rear of the frame near the bottom. It is arranged so that connections to the station ground can be made in any unit. Where the equipment is shipped in more than one group, the sections of ground bus must be connected by using the splice plates furnished with the equipment. Assemble the ground bus joints as outlined under "Connections" (Page 19). Ground bus connections are made in the lower portion of the cable entrance compartment. The switchgear ground bus must be connected to the station ground bus by a conductor having a current carrying capacity equal to that of the switchgear ground bus. It is very important that the equipment be adequately grounded to protect the operator from injury when short circuits or other abnormal occurrences take place and to insure that all parts of the equipment, other than live parts, are at ground potential.

LIGHTNING PROTECTION

It will be the responsibility of the purchaser to provide suitable lightning arresters to protect the switchgear from damage due to lightning. The General Electric Company's recommendations as to the types

of circuits requiring lightning protection, and a list of recommended lightning arresters, are contained in Bulletin GER-141 copies of which are available upon request.

When lightning arresters are furnished the primary cable terminal will be insulated at the factory unless it must be disconnected for shipment. When this connection is completed in the field it will be necessary to insulate the primary connection before the switchgear is energized.

ROOF ENTRANCE BUSHING

When assembling the connection bar end of roof entrance bushings inside of the switchgear and other terminations where porcelain insulators are used, insulation should be applied as follows:

(1) Prepare the connection bars as outlined under "CONNECTIONS".

(2) Fill all cavities around the contact nuts and connection bars with A50-H119 compound. Form a smooth surface for taping, thus preventing air voids. The compound is not an insulating medium and should not be used for that purpose.

(3) Wrap joint with insulating tape provided, maintaining tension on the tape while wrapping as shown in fig. 26 where there are sharp angles apply additional layers to obtain equivalent of the insulation on the flat surfaces.

(4) Over the insulating tape, apply one layer of glass tape, half lap as a protective covering as shown in fig. 26.

(5) Over the glass tape, brush a heavy coat of U-310 brown (for 15KV) or U-311 black (for 5KV). varnish. See fig 25B.

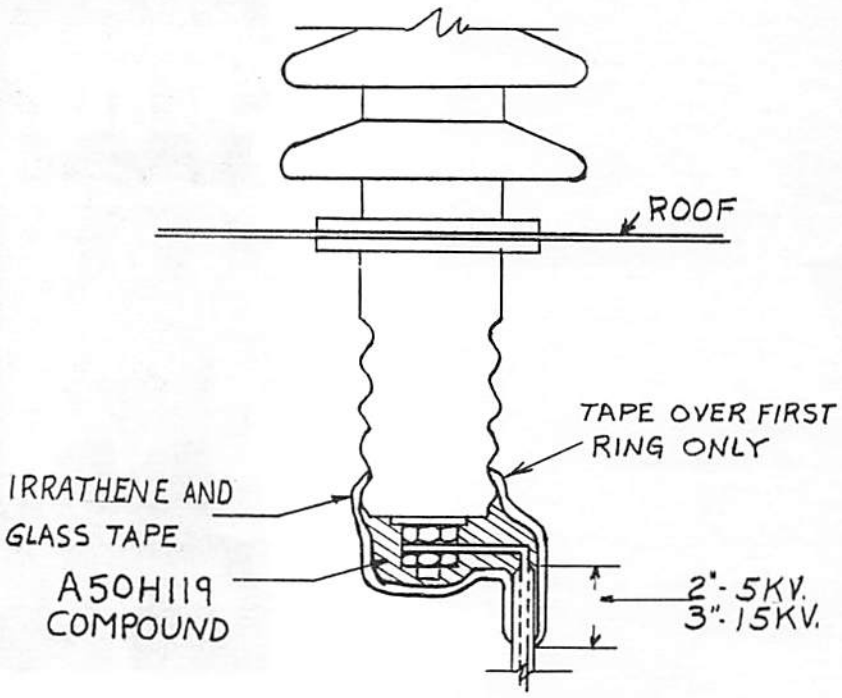
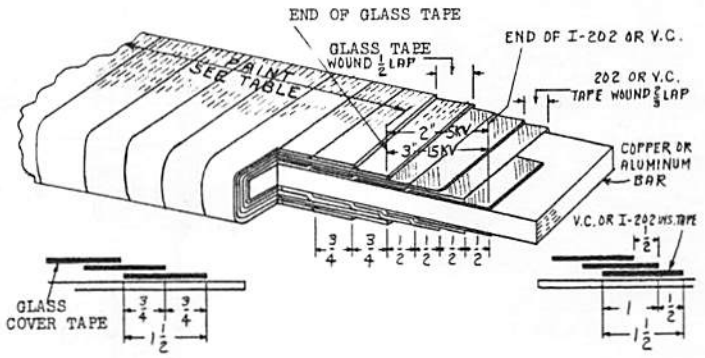


Fig. 25B Taping of Roof Entrance Termination



INSULATION LEVEL	INSULATION LAYERS (NOTE 1) I-202 NOTE 2	GLASS NOTE 3	V.C. NOTE 4	PAINT APPLY ONE COAT LIBERALLY
5000V	2	1	4	STERLING U-311 BLACK
15,000V	4	1	7	STERLING U-310 BROWN

NOTE 1:
I-202 & V.C. - One layer, wound 2/3 lap requires 3 turns around bar in one width of tape. One layer thickness is 3 times tape thickness.
GLASS - One layer, wound 1/2 lap requires 2 turns around bar in one width of tape. One layer thickness is 2 times tape thickness.

NOTE 2:
Irrathene #202, width 1 1/2" thickness 0.010". Keep tension on tape at all times while applying.

NOTE 3:
Glass A2L12B width 1 1/2" thickness 0.004".

NOTE 4:
Varnished cambric A22A11A (#992) width 1 1/2", thickness 0.012".

Fig. 26 (K6500514) Insulation of Connection Bars

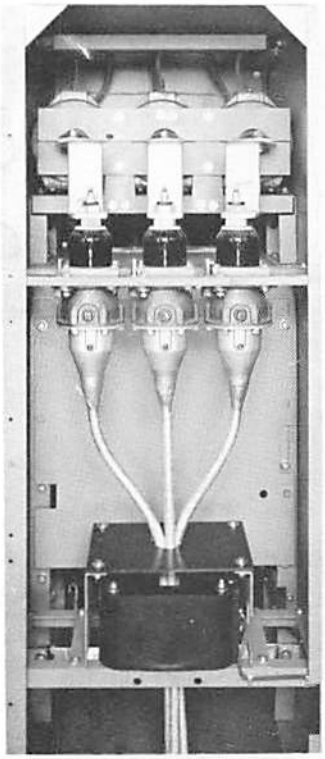


Fig. 27 (8026383) Rear View of Unit Showing Through-Type Current Transformers

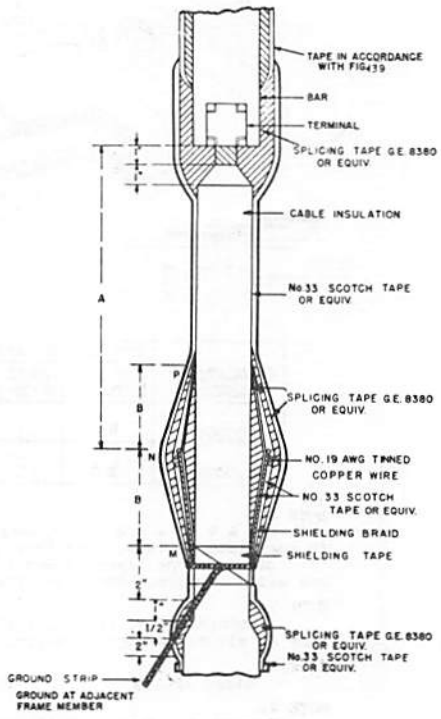


Fig. 28 (B230046C) Termination Without Pothead Single-Conductor

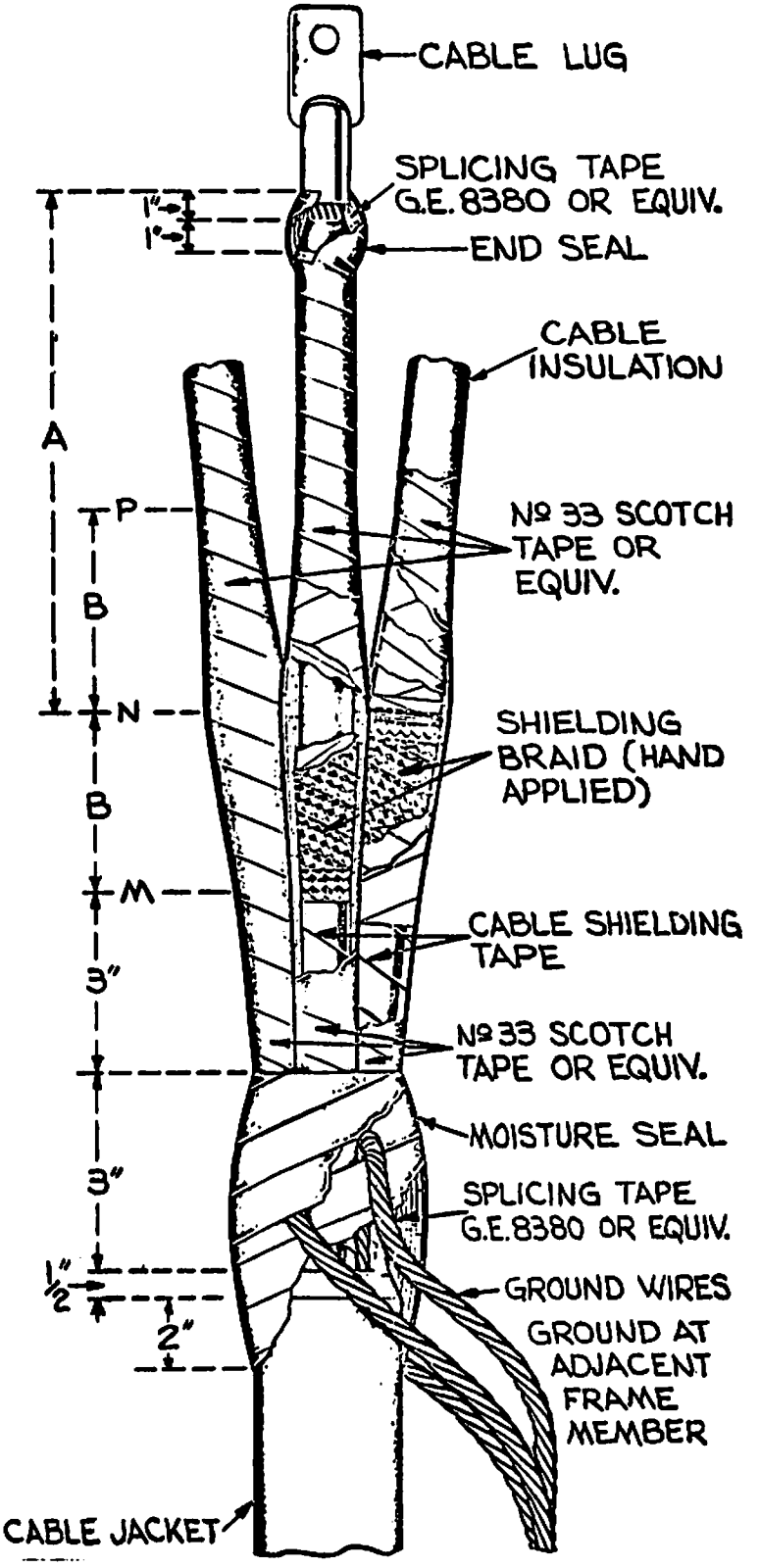


Fig. 29 (B232004C) Termination Without Pothead Multi-Conductor

DOOR ALIGNMENT

If for any reason it is necessary to realign the doors of metal-clad switchgear during installation the procedure given in the following paragraphs should be followed.

After checking that the switchgear is level and plumb as described above, start at either end of the switchgear lineup and realign each door individually as required.

The top of each door should be level with the adjacent doors; the sides of each door plumb; the surface of each door flush with the adjacent doors; and the space between adjacent doors equalized to permit their free swing and present a neat appearance. The door stops should be adjusted to permit a door swing of approximately 105°.

Doors may be raised or lowered vertically, or moved forward or backward horizontally, by loosening the hinge mounting nuts on the left side sheet and shifting the hinge and door assembly as allowed by the slotted holes in the hinge.

Doors may be shifted to the right or left by adding or removing washers or shims from between the hinge and side sheet.

Doors may be plumbed by slightly bending the appropriate hinges. To do this, open the door and insert a drift pin in either of the two holes in the hinge. Pulling forward on the drift pin will move the door to the right, and pushing back will move the door to the left. Adjust each hinge individually as required to plumb the door.

When properly aligned, the doors of outdoor switchgear should be tightly seated on the gasket all around. After aligning such doors, close and latch the door and check the seal by running a 3" x 5" card, shipping tag, IBM card, or some similar card around the edge of the door. If the card will pass between the door and the gasket, the door is improperly adjusted, and should be readjusted until the card will no longer pass through.

TESTING AND INSPECTION

After the equipment has been installed and all connections made, it should be tested and inspected before putting in service. Although the equipment and devices have been completely tested at the factory, a final field test should be made to be sure that the equipment has been properly installed and that all connections are correct and have not become loose in transportation. The primary equipment should be completely de-energized while the tests are in progress.

Directions for testing devices such as relays, instruments and meters are given in the instruction book furnished for each device. The settings of the protective relays must be coordinated with the other relays on the system and therefore these relays must be set by the purchaser. General instructions on setting the relays are given in the relay instruction books. Special instruction books are furnished for complicated automatic equipments, describing the sequence of operation of the devices required to perform the desired function.

When transformers are furnished to supply the control power, the primary taps should be selected so that the control voltage indicated on the wiring diagram is obtained on the secondary of the transformer. When a battery is used to supply the control power, the cables from the battery to the switchgear should be large enough to avoid excessive voltage drop. The voltage at the terminals of the breaker closing coils, when the breaker is being closed, should not be less than 112.5 volts for 125 volt coils and 225 volts for 250 volt coils.

The operation of the breaker with its associated devices may be tested in the unit while the equipment is energized by use of the test coupler which is furnished.

SOLENOID OPERATED BREAKER

Lower the breaker to the test or down position. Attach the test coupler to connect the breaker secondary disconnecting device to that on the structure.

STORED ENERGY OPERATED BREAKER

Lower the breaker to the down position and withdraw the breaker 2 1/4" until a notch in the spring discharge cam releases the breaker interlock. Attach the test coupler to connect the breaker secondary disconnecting device to that on the structure.

High potential tests to check the integrity of the insulation are not necessary if the insulation instructions in this book are carefully followed. Should the purchaser desire to make high potential tests, the test voltage should not exceed 14 kv A.C. for 4.16 kv and 27 kv A. C. for 13.8 equipments. These voltages are 75% of factory test voltages and are in accordance with ANSI standards.

Potential transformers and control power transformers must be disconnected during high voltage testing.

OPERATION

The operation of metal-clad switchgear is similar to that of other types except that it provides maximum safety to the operator and the feature of easy removal and replacement of the circuit breaker.

All circuit breaker removable elements of the same type and rating which have duplicate wiring may be interchanged.

BREAKER POSITIONING

To place the breaker in the operating position, proceed as given below.

The elevating mechanism is accurately leveled and checked at the factory and should need no adjustment. Do not install or remove the breaker or make adjustments unless the breaker is open.

Rub a small amount of contact lubricant D50H47 on the silvered portion of the breaker studs to form a thin coating for contact purposes.

Lower the elevating mechanism lifting brackets until the lifting brackets are in the fully lowered position. The breaker should then enter the housing freely. After first assuring that the breaker is in the open position, push the breaker into the unit until it rests against the rear of the front lifting saddle of the elevating mechanism.

The clearance between the interference block on the breaker and the interference block on the interlock lock mechanism (view X-X Figure 29) should be from 1/16" to 1/8". At this point the breaker positive interlock roller should be centered in the bottom "VEE" of the interlock cam plate.

To elevate the breaker, operate the elevating control selector switch on the elevating motor to "RAISE". A clutch handle just above the elevating motor (clutch handle is under the elevating motor in the 1000 MVA Unit) is then pulled forward until a motor limit switch closes and the motor clutch engages to raise the breaker in the unit. Carefully raise the breaker and while elevating note that the shutter slides open and the breaker studs center with respect to the openings in the stationary disconnecting devices or injury to the contacts may result.

The clutch handle is held in the forward position until a limit switch on the structure opens to stop the motor at the end of the upward travel of the breaker.

The motor selector switch must not be used to energize or interrupt the motor circuit at any time.

When the breaker is fully elevated the clearance between the breaker lifting rail and the upper stop bolts should not be more than 1/8" and not less than 3/32".

The positive interlock roller should be centered in the upper "VEE" and the interlock roller should have 1/16" clearance to the stationary interference plate directly under it.

To lower the breaker, proceed the same as for raising except operate the selector switch to "LOWER". The clutch must be held in the engaged position; otherwise, a spring will return it to its normal position, opening the electrical circuit to the motor.

The breaker may be raised or lowered by an emergency hand crank which can be inserted after removing the motor. The motor is removed by unlatching the motor assembly from its support and disconnecting the motor lead plug. After removing the motor, pull the clutch forward and insert the manual crank into the end of the clutch coupling. The breaker must be open before the crank can be inserted and held in the clutch coupling.

After the breaker is lowered and withdrawn from the unit inspect the contact surfaces of both the breaker studs and the stationary disconnecting devices.

(a) Each segment of the stationary disconnecting device should make a heavy impression in the contact lubricant D50H47 on the breaker studs. Contact wipe should start not less than 1/8" from top of the contact ball although each contact need not start at the same location. See Fig. 11.

(b) The wipe of the breaker stud

inside the stationary disconnecting device, as indicated by the contact lubricant D50H47, should be 3/4" to 7/8". This indicates that the breaker studs contacted at the full pressure center of the silver band on the stationary disconnecting device. See Fig. 11.

(c) Should the inspection of the contacts show that the breaker is not being raised to the proper position, readjust the upper stop bolts and limit switches to raise or lower the breaker to the proper location. Lock the stop bolts in the new position.

(d) If proper contacting cannot be attained by the above methods, additional adjustments will be necessary.

DO NOT MAKE ANY ADJUSTMENT. COMMUNICATE WITH THE NEAREST GENERAL ELECTRIC CO OFFICE FOR ADDITIONAL INFORMATION.

POSITIVE INTERLOCK GENERAL

The positive interlock functions to prevent raising or lowering a breaker except when the primary contacts are open. It also prevents closing primary contacts when the breaker is being raised or lowered by blocking the operating mechanism mechanically and electrically.

POSITIVE INTERLOCK ASSEMBLY FOR SOLENOID OPERATE BREAKERS

To place the breaker in the operating position, proceed as given below. The elevating mechanism is accurately leveled and checked at the factory and should require no adjustment. Do not install or remove the breaker or make adjustments unless the breaker primary contacts are open.

Lower the elevating mechanism lifting brackets until the lifting brackets are in the fully lowered position. The breaker should then enter the housing freely. After first assuring that the breaker primary contacts are in the open position, insert the breaker into the unit until it rests against the rear of the front lifting saddle of the elevating mechanism.

The interlock should be checked to see that the removable element is obstructed from being raised to or lowered from the operating position when the primary contacts are closed.

BEFORE PROCEEDING WITH THIS CHECK IT IS NECESSARY THAT THE PRIMARY CIRCUITS BE DE-ENERGIZED.

Using the maintenance closing device, close the breaker and snap the selector switch to "RAISE" position and pull the clutch handle forward. Movement must be stopped by the breaker interlock roller before the contacts of the motor limit switch close and before the sliding clutch and motor connector engage. A mimimun of 1/16" should be maintained between the two clutch parts when the positive interlock is blocked by the breaker interlock roller. See Fig. 15 for dimension.

Trip the breaker manually and elevate to the operating position. AGAIN IT IS EMPHASIZED THAT THE PRIMARY CIRCUITS MUST BE DE-ENERGIZED BEFORE MAKING THIS CHECK OF THE POSITIVE INTERLOCK.

Electrically close the breaker. Snap the selector switch to "LOWER" position and pull the clutch handle forward. Again, a definite stop should be encountered preventing the motor circuit limit switch from energizing the motor circuit and lowering the breaker.

If the interlock does not function as indicated above DO NOT MAKE ANY ADJUSTMENT. COMMUNICATE WITH THE NEAREST GENERAL ELECTRIC CO. OFFICE FOR ADDITIONAL INSTRUCTIONS.

POSITIVE INTERLOCK ASSEMBLY FOR STORED ENERGY

To place the breaker in the operating position, proceed as given below. The elevating mechanism is accurately leveled and checked at the factory and should require no adjustment. Do not install or remove the breaker or make adjustments unless the breaker primary contacts and or closing springs are discharged.

Lower the elevating mechanism lifting brackets until the lifting brackets are in the fully lowered position. The breaker should then enter the housing freely. After first assuring that the breaker primary contacts are in the open position, insert the breaker into the unit until it rests against the rear of the front lifting saddle of the elevating mechanism.

BEFORE PROCEEDING WITH THIS CHECK IT IS NECESSARY THAT THE PRIMARY CIRCUITS BE DE-ENERGIZED.

When entering a breaker into a unit for elevating the spring discharge cam (on the left hand side of the unit) will hold the breaker interlock trip free and the closing springs discharged until the breaker is 1/4" off the breaker floor rail. (See detailed description of Spring Discharge Cam under separate heading).

AGAIN IT IS EMPHASIZED THAT THE PRIMARY CIRCUITS MUST BE DE-ENERGIZED BEFORE MAKING THIS CHECK OF THE POSITIVE INTERLOCK.

Elevate the breaker to the raised position and electrically close the breaker. The positive interlock should be checked to see that the removable element is obstructed from being lowered from the operating position.

Snap the selector switch to "LOWER" position and pull the clutch handle forward. A definite stop should be encountered preventing the motor circuit limit switch from energizing the motor circuit and lowering the breaker.

A mimimun of 1/16" must be maintained between the sliding clutch and the motor connector when the positive interlock is blocked by the breaker interlock roller. See Fig. 15 for dimension. Trip the breaker manually and lower the breaker to the fully lowered position. During the last 1/4" of travel the spring discharge cam will discharge the stored energy springs and maintain the breaker trip free as long as the breaker remains in the unit. If the interlock does not function as indicated above.

DO NOT MAKE ANY ADJUSTMENT. COMMUNICATE WITH THE NEAREST GENERAL ELECTRIC CO. OFFICE FOR ADDITIONAL INFORMATION.

STATIONARY AUXILIARY SWITCH

On units equipped with stationary auxiliary switches (Fig.30A)the clearance between the end of the switch mechanism operating rod and the operating plunger on the circuit breaker should be 0 to 1/8" with the circuit breaker in the raised and open position.

Any adjustment in this dimension must be made on the auxiliary switch setting. Care should be taken to prevent destroying interchangeability of the circuit breaker by excessive adjustment.

A stationary auxiliary switch test position link is furnished as an accessory for use when the circuit breaker is in the test position.

SPRING DISCHARGE CAM

The spring discharge cam is mounted on the left hand side of the unit and operates in conjunction with a spring discharge interlock on the breaker.

When entering a breaker into a unit, to elevate to the operating position, the spring discharge cam will hold the breaker interlock trip free and the closing springs discharged until the breaker is 1/4" off the floor rails. At this point the positive interlock is blocking the spring charging and closing circuit open.

When lowering the breaker from the operating position the breaker must be open before the elevating mechanism can be operated. While the breaker is being lowered the springs are still charged but the positive interlock blocks the breaker from closing. When the breaker is about 1/4" from the floor rails the spring discharge interlock holds the breaker trip free, discharges the closing springs and holds them discharged so long as the breaker remains in its unit.

To operate the breaker in the test position it is pulled forward, (out of the unit) about 2 1/4" until a notch in the spring discharge cam releases the breaker interlock and the breaker can be operated manually, or, by assembling the test coupler, electrically. In the test position a mechanical block prevents operating the elevating mechanism.

If after test operations the breaker is left closed and/or its closing springs charged, it will be automatically tripped and held trip free while the springs are discharged when it is reinserted in; or while being withdrawn from its unit.

KEY LOCKS

Key locks for breaker units can be furnished when requested.

The purpose of this device is to prevent a breaker from being closed in the connected position when the lock key is removed from the lock. The key lock consists of a metal support and key lock mounted on the top plate flange and adjacent to the elevating motor clutch.

To operate the key lock if the breaker is in the disconnected or test position the clutch handle is pulled forward allowing the key lock bolt to extend in back of the clutch handle. The key lock key can then be removed.

If the breaker is in the connected position the breaker must first be opened.

Snap the selector switch to the "off" position. The clutch handle can then be pulled forward allowing the key lock bolt to extend in back of the clutch handle. The key lock key can then be removed. With the clutch handle pulled forward the positive interlock cam plate has rotated the circuit breaker positive interlock shaft so as to mechanically and electrically block the breaker from closing.

To lower the breaker, snap the selector switch to "LOWER", pull the clutch forward and lower the breaker to the test position.

The key lock does not prevent operation of the breaker in the test position. However, if the breaker is elevated to the connected position the key lock will prevent its closing until the key is returned and the lock reset. See Fig. 15.

BREAKER INTERFERENCE STOPS

Stops are provided in the breaker unit to prevent the insertion of a breaker with a 1200A continuous current rating into a unit with a 2000A rating and vice-versa.

The stop plate is bolted to the left hand unit frame angle near the floor of all breaker units. A projection on the breaker frame will interfere with the unit stop plate when an attempt is made to insert an incorrect breaker into the unit.

The breaker rating should be checked against the unit rating and under no circumstances should the interference stop be removed to allow the breaker to be inserted.

TRANSFER TRUCKS

Circuit breaker transfer trucks are furnished with outdoor metal-clad switchgear to facilitate moving of circuit breakers from unit to unit or to maintenance areas. The platform at the front end of the transfer truck is adjustable in height. See Fig. 8, view A, for instructions for adjustment. The truck is equipped with two latches, one to hold the breaker on the truck and one to hold the truck to the metal-clad switchgear unit. Both latches engage automatically, and both are released by a single T-shaped foot pedal on the rear of the truck. Depressing the left side of the pedal unlatches the truck from the switchgear unit, and depressing the right side of the pedal unlatches the breaker from the truck. Trucks can be stored in breaker unit when breaker is in operating position.

SPACE HEATERS

Space heaters are provided in all outdoor equipment in order to keep the inside temperature several degrees higher than that outside. Heaters are also furnished for indoor equipment when it is known that abnormal atmospheric conditions exist at the installation, or when specified by the purchaser.

By maintaining a slight temperature differential, the heaters help facilitate drying and prevent condensation and the resulting corrosion and insulation deterioration which might occur.

Heaters are normally located at the sides of the breaker units, a few inches above the floor. In auxiliary compartments with a single rollout, the heaters will be in a space above the rollout. In auxiliary compartments with two rollouts, the heater will be in a space between the rollouts. Heaters may also be located in superstructure compartments, transition compartments, and in bus ducts if the operating conditions require them.

Before energizing the heaters, be sure the power source is of the proper voltage, frequency, and phase arrangement, and is connected in accordance with the wiring diagrams furnished with the equipment. Also, be sure to remove all cartons and miscellaneous material packed inside the units before energizing the heaters.

Heaters should be visually inspected several times a year to make sure they are operating properly.

It is recommended that the heaters be energized at all times and that thermostatic control not be used. If thermostatic control is used, the contacts of the thermostat should be set to close between 95 F and 100 F on falling temperature, de-energizing the heaters only when strong sunlight beats on the switchgear. Under no condition should a differential thermostat be used to control the heaters because under conditions of extremely high humidity this type of thermostat will not operate at all times to keep the heaters on enough to prevent condensation in the switchgear.

MAINTENANCE

A regular maintenance schedule should be established to obtain the best service and reliability from the switchgear. Plant operating and local conditions will dictate the frequency of inspection required. For specific information regarding the maintenance of devices, such as circuit breakers, relays, meters, etc., refer to the separate instruction book furnished for each device. The inspection cabinet, which is furnished, provides a convenient means for maintaining the circuit breakers. Under normal conditions the protective relays do not operate, therefore, it is important to check the operation of these devices regularly.

A permanent record of all maintenance work should be kept, the degree of detail depending on the operating conditions. In any event, it will be a valuable reference for subsequent maintenance work and for station operation. It is recommended that the record include reports of tests made, the condition of equipment and repairs and adjustments that were made.

BEFORE ANY COVERS ARE REMOVED OR ANY DOORS OPENED WHICH PERMIT ACCESS TO THE PRIMARY CIRCUITS, IT IS ESSENTIAL THAT THE CIRCUIT OR CIRCUITS BE DE-ENERGIZED AND BREAKERS BE WITHDRAWN TO A DISCONNECTED POSITION AND TAGGED.

IF WORK IS TO BE DONE ON REMOTE EQUIPMENT CONNECTED TO A UNIT, THE BREAKER FOR THAT UNIT SHOULD BE PLACED IN THE DISCONNECTED POSITION AND TAGGED. ALSO THE REMOTE EQUIPMENT SHOULD BE ISOLATED FROM ANY OTHER POWER SOURCES CONNECTED TO IT.

The primary circuits of metal-clad switchgear are insulated in order to reduce the size of the equipment. However, this insulation, except in one or two instances, requires a certain amount of air gap between phases and to ground to complete the insulation. Inserting any object in this air space, when equipment is energized, whether it be a tool or a part of the body, may under certain conditions, in effect, short circuit this air gap and may cause a breakdown in the primary circuit to ground and cause serious damage or injury or both.

Care should be exercised in the maintenance and checking procedures that accidental tripping or operation is not initiated.

The switchgear structure and connections should be given the following overall maintenance at least annually.

1. Thoroughly clean the equipment, removing all dust and other accumulations. Wipe clean the buses and supports. Inspect the buses and connections carefully for evidence of overheating or weakening of the insulation.

2. Measure the resistance to ground and between phases of the insulation of buses and connections. Since definite limits cannot be given for satisfactory insulation resistance values, a record must be kept of the reading. Weakening of the insulation from one maintenance period to the next can be recognized from the recorded readings. The readings should be taken under similar conditions each time if possible, and the record should include the temperature and humidity.

High potential tests are not required, but if it seems advisable, based on the insulation resistance tests or after repairs, the test voltage should not exceed 14 kv A.C. for 4.16 kv and 27 kv A. C. for 13.8 equipments. These voltages are 75% of factory test voltages and are in accordance with ANSI standards..

Potential transformers and control power transformers must be disconnected during high voltage testing.

3. Clean elevating mechanism and lubricate jack screws and gears with lubricant G.E. Co. #D50H15 (Atlantic Ref. Co. #52 or equal).

4. Check primary disconnecting device contacts for signs of abnormal wear or overheating. Clean contacts with silver polish. Discoloration of the silvered surfaces is not ordinarily harmful unless atmospheric conditions cause deposits such as sulphides on the contacts. If necessary the deposits can be removed with a good grade of silver polish.

Before replacing breaker, apply a thin coat of contact lubricant D50H47 to breaker studs for lubrication.

5. Check to see that all anchor bolts and bolts in the structure are tight. Check tightness and continuity of all control connections and wiring.

6. If the switchgear is equipped with heaters, check to see that all heaters are energized and operating.

OUTDOOR ACRYLIC PAINT FINISH

The outside of standard outdoor switchgear has acrylic paint finish, blue gray ASA #24, providing improved resistance to all atmospheric conditions, longer life and less maintenance than with ordinary paint finishes.

If it is desired to refinish acrylic painted switchgear, it is necessary to use one of the following procedures in order to secure the best adhesion of the paint to the original finish.

A. Refinishing with Acrylic Paint. It is recommended that refinishing be done with Du Pont acrylic paint of the desired color. Obtain materials and instructions for application from the Du Pont Company.

B. Refinishing with Alkyd or Oil Base Paints. Two methods are recommended:

1. Spray one sealer coat of Du Pont 233E75300 or equivalent which has been reduced to spraying viscosity with Du Pont 37692 or 37666 thinner. Air dry for one hour. Apply alkyd or oil base paint.

2. Spray one sealer coat of Arco 214-806 primer which has been reduced to spraying viscosity with Xylol. Air dry for one hour. Apply alkyd or oil base paint.

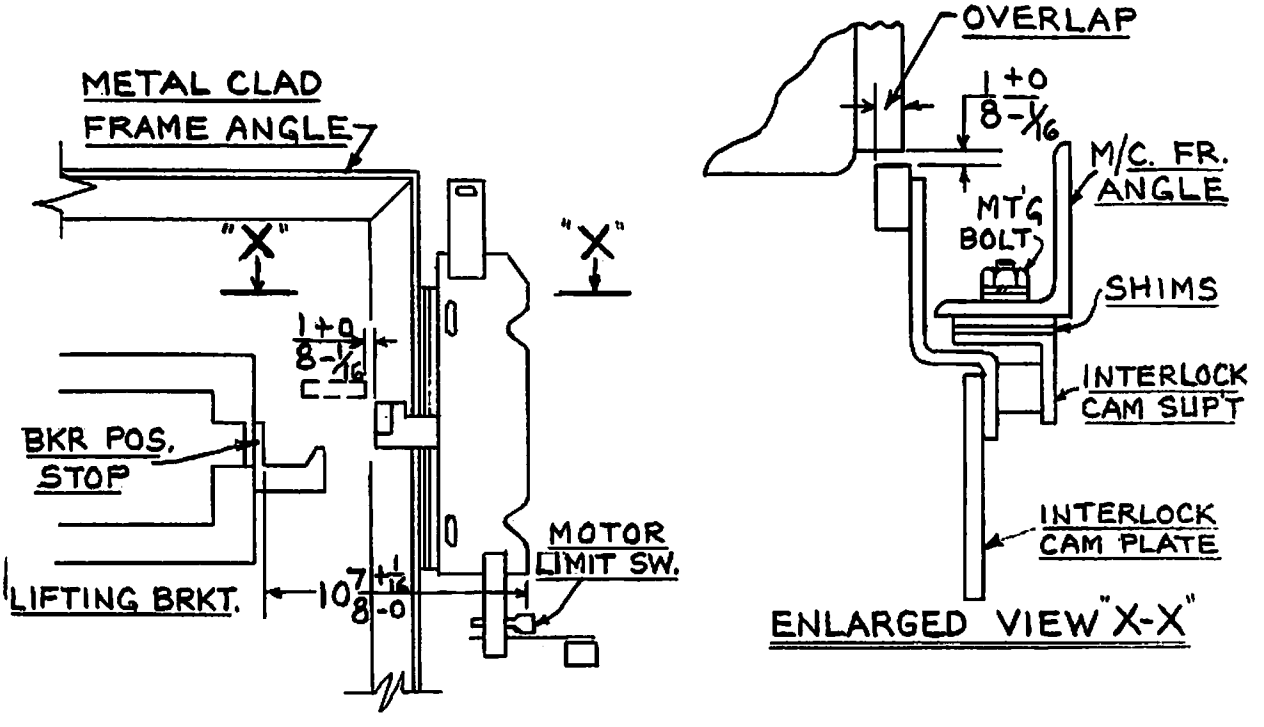


Fig. 29A (208A8952) Positive Interlock Adjustment

RENEWAL PARTS

ORDERING INSTRUCTIONS

1. RENEWAL PARTS SHOULD BE ORDERED FROM THE SWITCHGEAR PRODUCTS DEPARTMENT.
2. ALWAYS SPECIFY THE REQUISITION NUMBER ON WHICH THE EQUIPMENT WAS ORIGINALLY FURNISHED.
3. SPECIFY THE QUANTITY, REFERENCE NUMBER, DESCRIPTION AND THIS BULLETIN NUMBER.
4. STANDARD HARDWARE, SUCH AS SCREWS, BOLTS, NUTS, WASHERS, ETC., IS NOT LISTED. SUCH ITEMS SHOULD BE PURCHASED LOCALLY.
5. FOR PRICES, REFER TO THE NEAREST OFFICE OF THE GENERAL ELECTRIC COMPANY.
6. IF INSULATING MATERIAL, SUCH AS TAPE, VARNISH, COMPOUND, ETC., IS REQUIRED, IT MUST BE SPECIFIED SEPARATELY.
7. IF PARTS LISTED SEPARATELY ARE TO BE ASSEMBLED AT THE FACTORY, ORDER MUST SO STATE.
8. NOT ALL PARTS LISTED HEREIN WILL BE USED ON ANY ONE EQUIPMENT. PARTS NOT USED IN ORIGINAL EQUIPMENT SHOULD NOT BE ORDERED AS RENEWAL PARTS.

PRIMARY DISCONNECT DEVICES
(SEE FIG. NO. 11)

REF. NO.	DESCRIPTION
5	Front Primary Disconnect Device Assembly, 3 Pole, Complete with Connections
6	Rear Primary Disconnect Device Assembly, 3 Pole, Complete with Connections

NOTE: Insulating material required for Ref. Nos. 5 and 6 will be furnished with order.

POSITIVE MECHANICAL INTERLOCK
(FIG. NO. 30A)

REF. NO.	DESCRIPTION
3	Complete positive mechanical interlock assembly
4	Elevating mechanism motor (115-v d-c)
4	Elevating mechanism motor (230-v d-c)
4	Elevating mechanism motor (230-v d-c)
18	Spring only

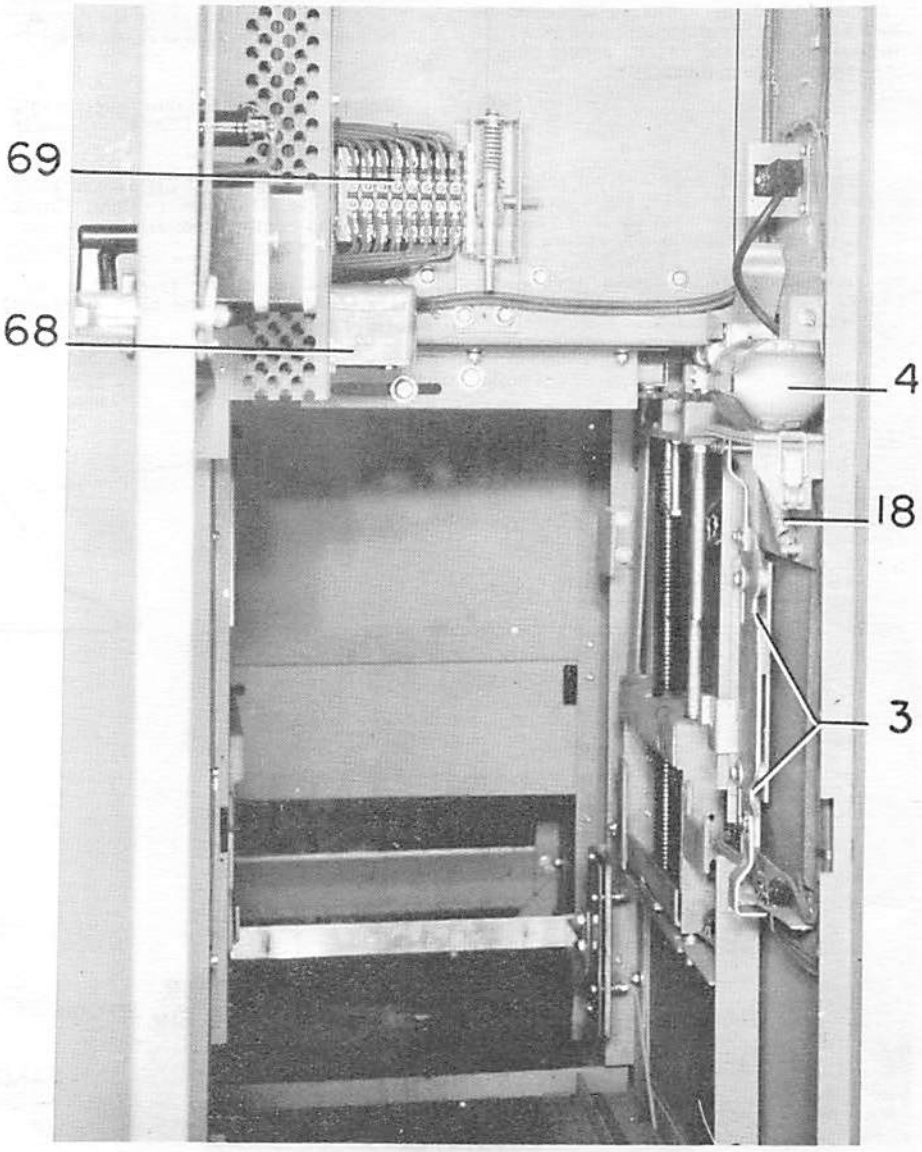
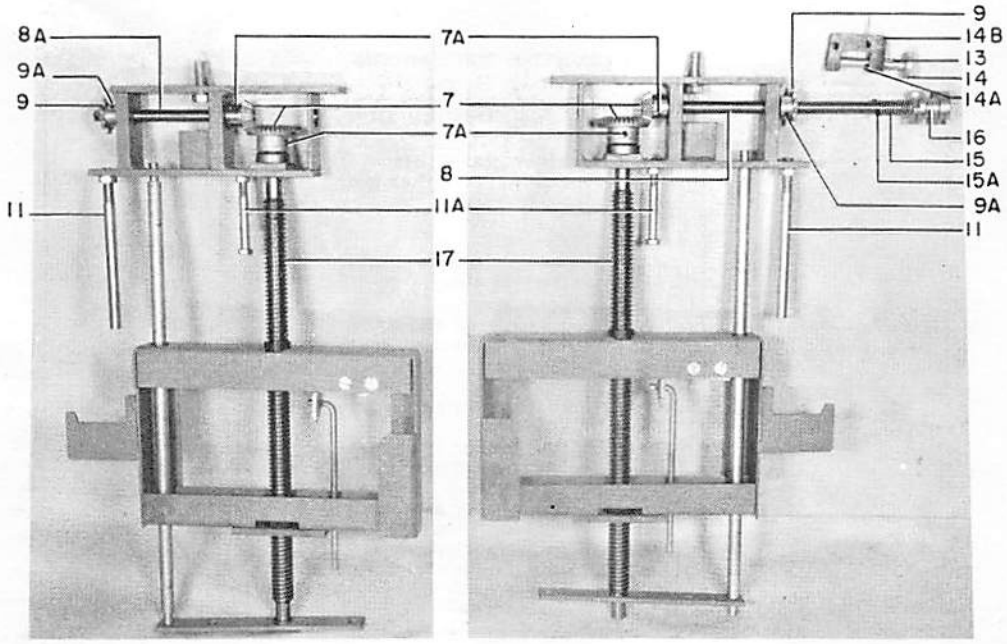
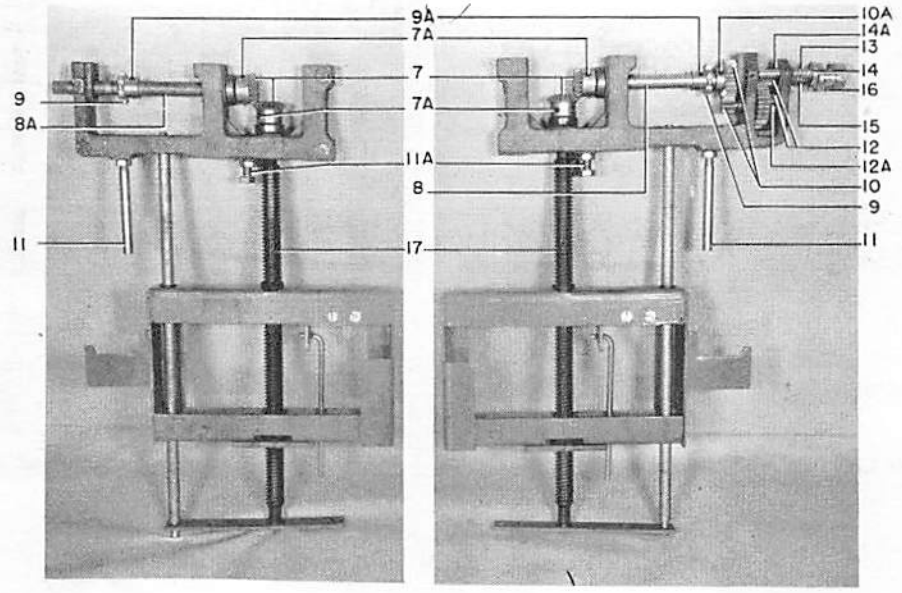


Fig. 30A View Showing Elevating Mechanism Motor and Control Unit



Complete Left Hand (Ref. No. 1) Complete Right Hand (Ref. No. 2)

Fig. 30 Elevating Mechanism for M-26 Equipments Rated 250 mva and M-36 Equipments Rated 1200A 500 mva



Complete Left Hand (Ref. No. 1A) Complete Right Hand (Ref. No. 2A)

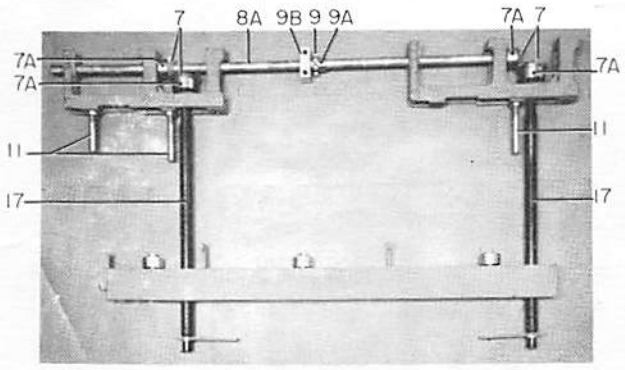
Fig. 31 Elevating Mechanism for M-36H Equipments Rated 750 mva, M-26H Equipments Rated 350 mva and M-36 Equipments Rated 500 mva 2000A

(See Page 32 for Parts Table)

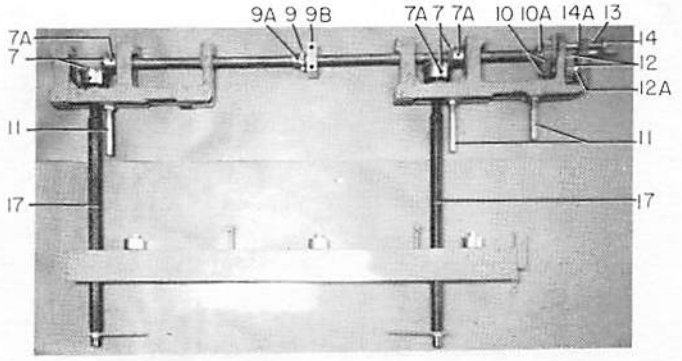
ELEVATING MECHANISMS
Figs. 30, 31, and 31A

REF. NO.	DESCRIPTION
7	Miter gears, pair
7A	Roll pin for miter gear
8	Shaft, right
8A	Shaft, left
9	Sprocket
9A	Roll pin for sprocket
9B	Bearing Block
10	Spur gear
10	Pinion gear and rod
10A	Roll pin for spur gear
11	Stop stud
11A	Stop bolt
12	Pinion gear and rod
12	Spur gear
12A	Roll pin for spur gear
13	Locking spring
14	Stop shaft
14A	Roll pin for stop shaft
14B	Stop shaft bracket
15	Clutch spring
15A	Roll pin for clutch spring
16	Slide Clutch
17	Jack Screw

IF PARTS ARE TO BE FURNISHED ASSEMBLED SPECIFY ON ORDER



Complete Left Hand (Ref. No. 1B)



Complete Right Hand (Ref. No. 2B)

Fig. 31A (8027408 & 8027409)

Fig. 31A Elevating Mechanism for M-36HH Equipments Rated 1000 MVA

Fig. 32(80...

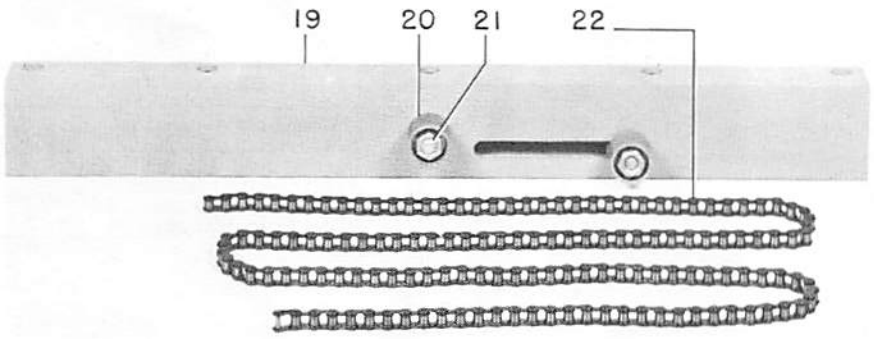


Fig. 32 Angle Bracket and Chain Drive

REF. NO.	DESCRIPTION
19	Bracket
20	Roller
21	Retainer
22	Chain

Fig. 33 (8039441)

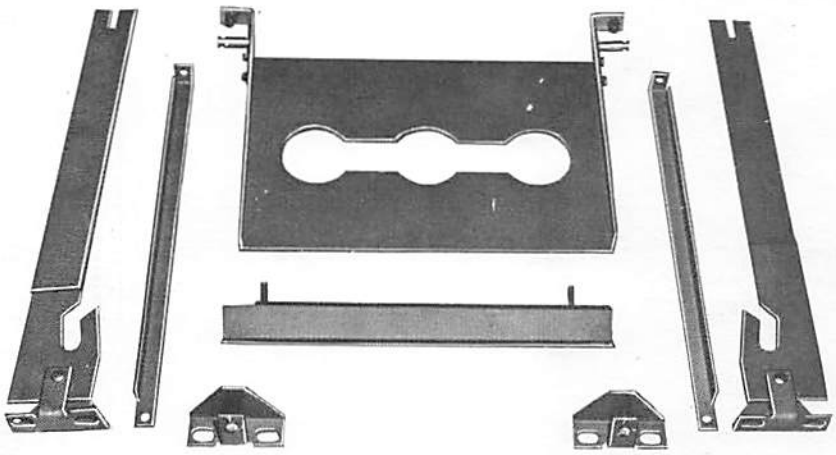


Fig. 33 Shutter Mechanism Assembly M-26

Fig. 34 (8039439)

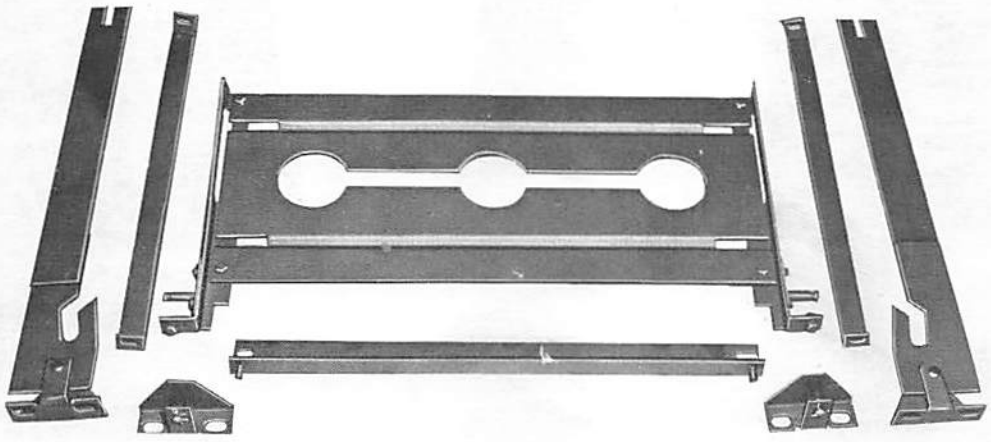


Fig. 34 Shutter Mechanism Assembly M-36

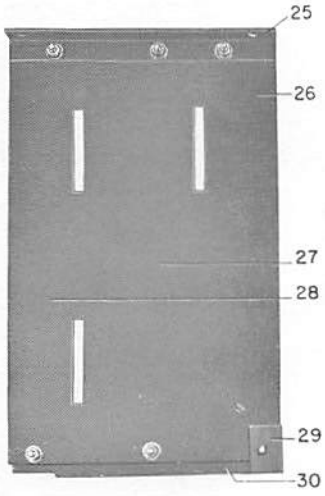


Fig. 35 Bus Support

REF. NO.	DESCRIPTION
25	Isolating barrier support angle
26	Rear isolating barrier
27	Intermediate isolating barrier
28	Front isolating barrier
29	Isolating barrier clip
30	Isolating barrier support

Fig. 35 (8020152)

REF. NO.	LOCATION	RATING	DESCRIPTION
38	int.	1200A.	1 connection bar, down
39	int.	1200A.	1 connection bar, up
40	end	1200A.	1 connection bar, down
41	end	1200A.	1 connection bar, up
42	int.	1200A.	no connection bar
43	end	1200A.	no connection bar
44	int.	1600A.	1 connection bar, down
45	int.	1600A.	1 connection bar, up
46	end	1600A.	1 connection bar, down
47	end	1600A.	1 connection bar, up
48	int.	1600A.	no connection bar
49	end	1600A.	no connection bar
50	int.	2000A.	1 connection bar, down
51	int.	2000A.	1 connection bar, up
52	end	2000A.	1 connection bar, down
53	end	2000A.	1 connection bar, up
54	int.	2000A.	no connection bar
55	end	2000A.	no connection bar
56	int.	2000A.	3 connection bars, down
57	int.	2000A.	3 connection bars, up
58	end	2000A.	3 connection bars, down
59	end	2000A.	3 connection bars, up
59A	*	*	Insulating boot
59B			Plastic rivet for boot

* Specify unit number and phase on which boot is to be used.

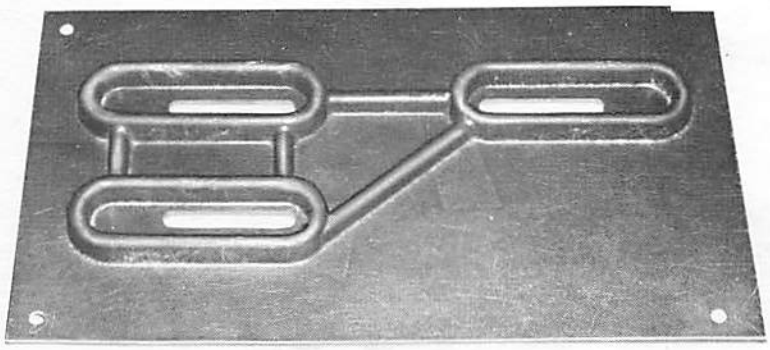


Fig. 36 Molded Bus Support
(4.16 or 13.8 kv Units)

Fig. 36 (8039440)

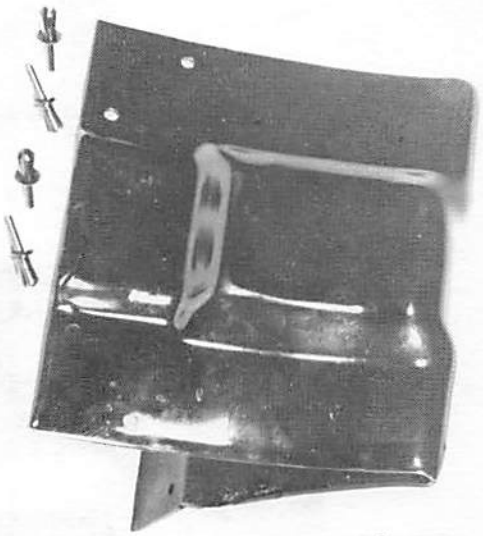
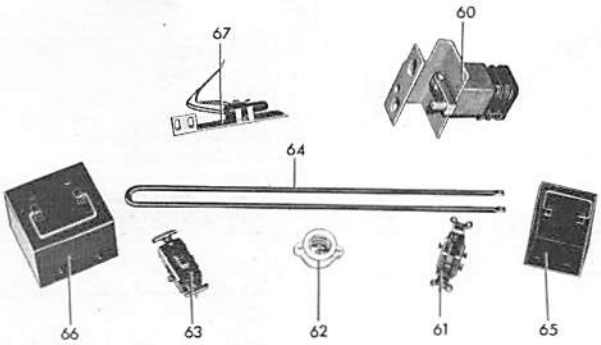


Fig. 37 Bus Connection Boot
4.16 kv and 13.8 kv

Fig. 37 (8026455)

Fig. 38 (8011607)

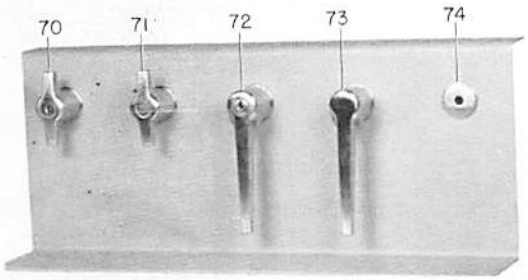


REF. NO.	DESCRIPTION
60	Limit Switch SB1 type
61	Light Switch
62	Keyless receptacle
63	Duplex receptacle
64	Strip heater
65	Fuse block, open type*
66	Fuse block, dead front*
67	Limit switch, mercury type
Fig. 30A 68	Complete secondary disconnect Device
Fig. 30A 69	Complete stationary auxiliary switch mechanism

*Specify amp rating of fuse and number of poles.

Fig. 39 Wiring Devices and Miscellaneous Parts

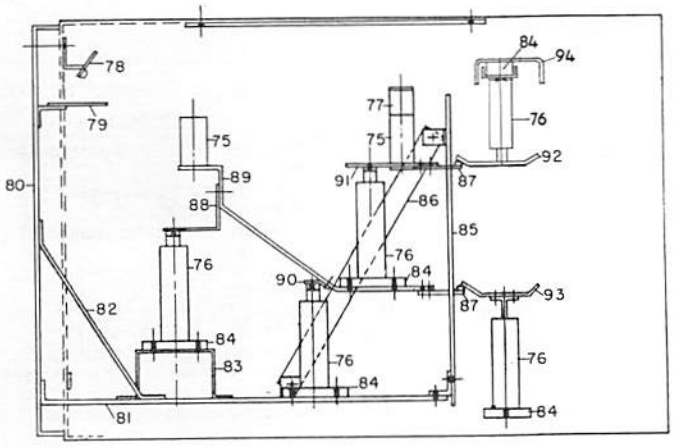
Fig. 39 (8039442)



REF. NO.	DESCRIPTION
70	Panel locking handle
71	Panel handle
72	Door locking handle
73	Door handle
74	Socket

Fig. 38 Door Handles and Locks

Fig. 40 (132C3709)



FUSE ROLLOUT UNIT

REF. NO.	DESCRIPTION
75	Fuse clip
76	Insulator
77	Ground Bar
78	Ground Finger
79	Barrier
80	Cover
81	Tray
82	Strap
83	Insulator Support
84	Insulator Clamp
85	Barrier
86	Compound Strap
87	Finger
88	Connection bar
89	Connection bar
90	Connection bar
91	Connection bar
92	Connection bar
93	Connection bar
94	Insulator Support

Fig. 40 Fuse Rollout Unit

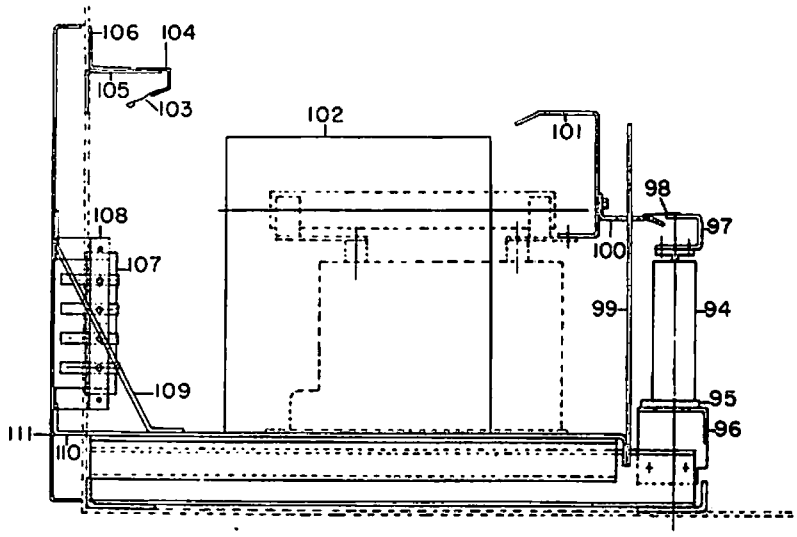


Fig. 41 Potential Transformer Rollout Unit

POTENTIAL TRANSFORMER ROLLOUT UNIT	
REF. NO.	DESCRIPTION
94	Insulator
95	Insulator clamp
96	Insulator support
97	Disconnect bar1
98	Finger
99	Barrier
100	Disconnect bar
101	Disconnect bar
102	Barrier
103	Ground finger
104	Ground finger support
105	Ground finger support
106	Barrier
107	Sec. disconnect (stationary)
108	Sec. disconnect (movable)
109	Brace
110	Tray
111	Cover

Fig. 41 (835C401)

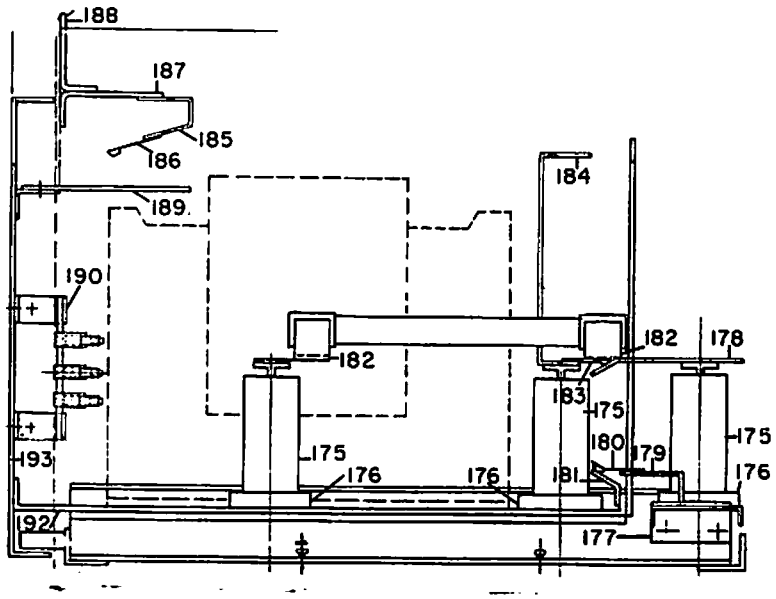


Fig. 42 Control Power Transformer Rollout Unit

CONTROL TRANSFORMER ROLLOUT UNIT	
REF. NO.	DESCRIPTION
175	Insulator
176	Insulator clamp
177	Insulator support
178	Contact bar
179	Ground finger support
180	Ground finger
181	Ground shoe contact
182	Fuse clip
183	Primary contact
184	Ground bar
185	Ground finger support
186	Ground finger
187	Cross angle
188	Barrier
189	Barrier
190	Sec. disconnect (movable)
191	Sec. disconnect (stationary) (not shown)
192	Tray
193	Cover

Fig. 42 (835C402)

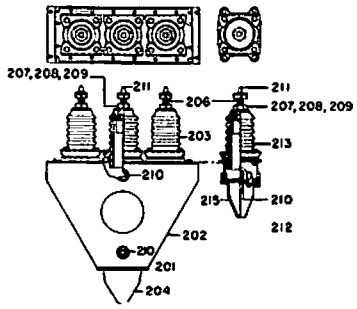


Fig. 43 Single and Triple-Conductor Potheads

SINGLE & TRIPLE-CONDUCTOR POTHEADS	
REF. NO.	DESCRIPTION
201	Triple-conductor pothead assembly
202	Body
203	Insulators and support
204	Wiping sleeve
205	Gaskets for triple-conductor pothead
206	Terminal
207	Contact nut
208	Washer
209	Palnut (3/4 in. - 12)
210	Pipe plug (3/4 in. std.)
211	Pipe plug (1/8 in. std.)
212	Single-conductor pothead assembly
213	Body and insulator
214	Gaskets for single-conductor pothead
215	Wiping sleeve

Fig. 43 (1103401)

INSTRUCTIONS
AND
RENEWAL PARTS

GEH-1802R
SUPERSEDES
GEH-1802P AND GEF-3837

METAL-CLAD SWITCHGEAR

Types M-26 and M-36
For Magne-blast Air Circuit Breaker
Types AM-4.16 and AM-13.8

SWITCHGEAR DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA, PA.

LIST OF ILLUSTRATIONS

CONTENTS

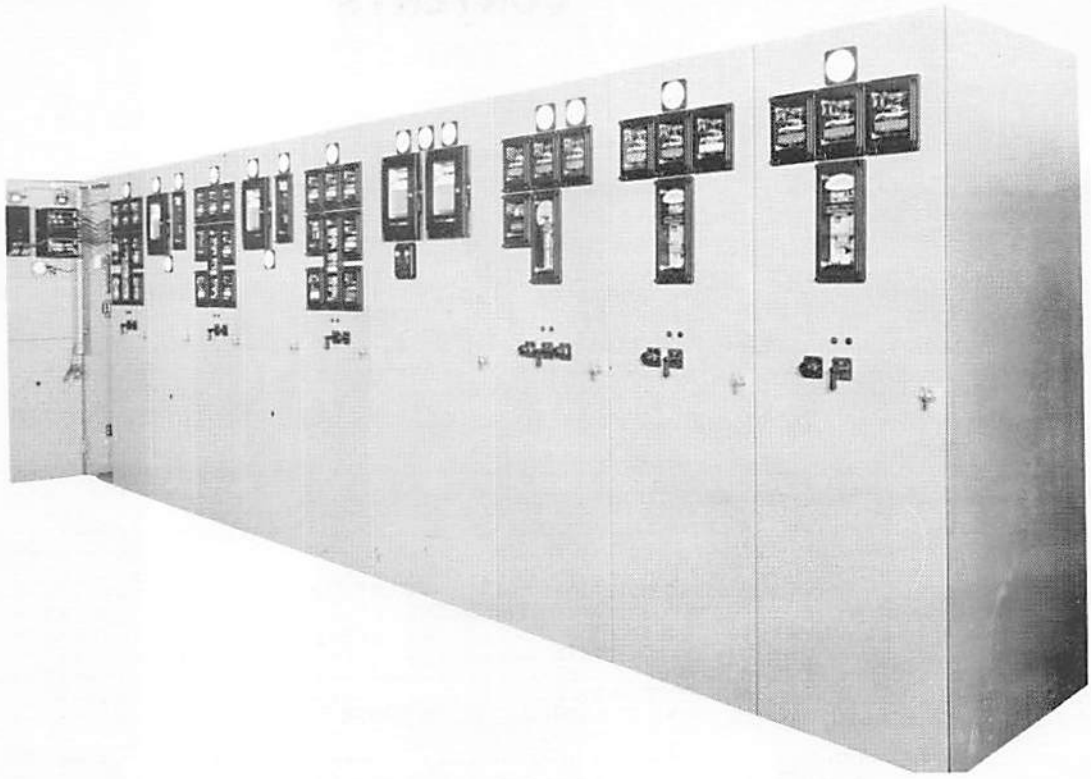


Fig. 1 (8021315)

Fig. 1 Typical Indoor Metal-clad Switchgear Equipment

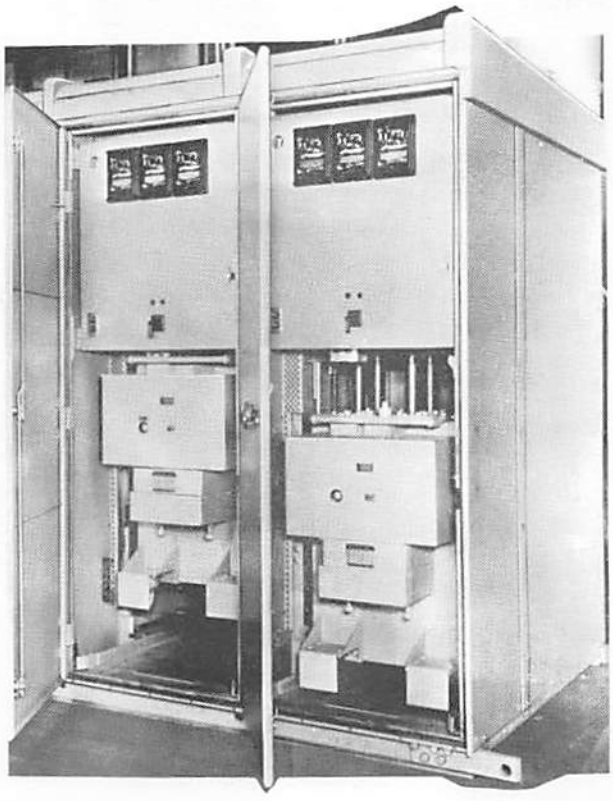


Fig. 2 (1169287)

Fig. 2 Typical Outdoor Metal-clad Switchgear Equipment - Front View

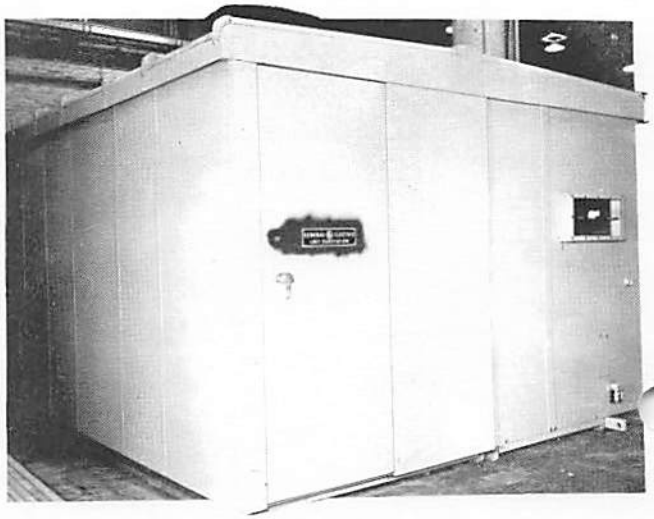


Fig. 3 (8025290)

Fig. 3 Typical Outdoor Metal-clad Switchgear Equipment With Protected Aisle - Side View

METAL-CLAD SWITCHGEAR
TYPES M26 AND M36
FOR MAGNE-BLAST AIR CIRCUIT BREAKER TYPES AM-4.16 AND AM-13.8

Metal-clad switchgear is equipment to control and protect various types of electrical apparatus and power circuits.

The switchgear consists of one or more units which are mounted side by side and connected mechanically and electrically together to form a complete switching equipment. Typical equipments are shown in Figures 1, 2 and 3.

The circuit breakers are easily removable to provide maximum accessibility for maintenance with minimum interruption of services. The switchgear is designed to provide maximum safety to the operator. All equipment is enclosed in grounded metal compartments.

The equipment is available in the ratings listed in the following table. The ratings of the equipment and devices are based on usual service conditions as covered in AIEE and NEMA standards. Operation at currents above the equipment rating will result in temperature rises in excess of NEMA standards, and is not recommended. For outdoor installation the same basic equipment is built into a weatherproof housing as in Figures 2 and 3.

CIRCUIT BREAKER	INTERRUPTING CAPACITY KVA	CURRENT	FIGURE
TYPE M-26			
AM-4.16-150	150,000	1200	4
AM-4.16-250	250,000	1200 - 2000	4
AM-4.16-350	350,000	1200 - 3000	5
TYPE M-36			
AM-13.8-150	150,000	1200	4
AM-13.8-250	250,000	1200	4
AM-13.8-250	500,000	1200 - 2000	4
AM-13.8-750	750,000	1200 - 2000	4
AM-13.8-1000	1,000,000	1200 - 3000	6
AM-7.2-250	250,000	1200	4
AM-7.2-500	500,000	1200 - 2000	4

Fig. 4 (8012851)

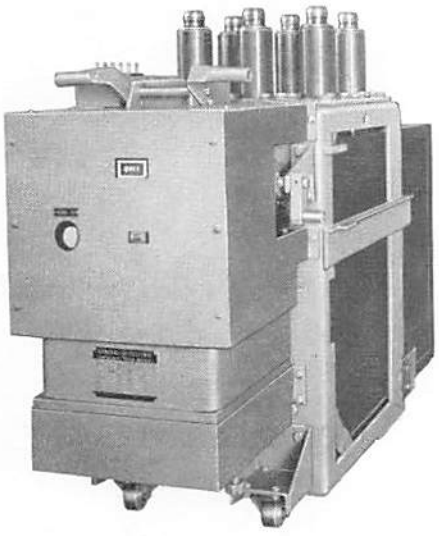


Fig. 4

Fig. 5 (8023154)

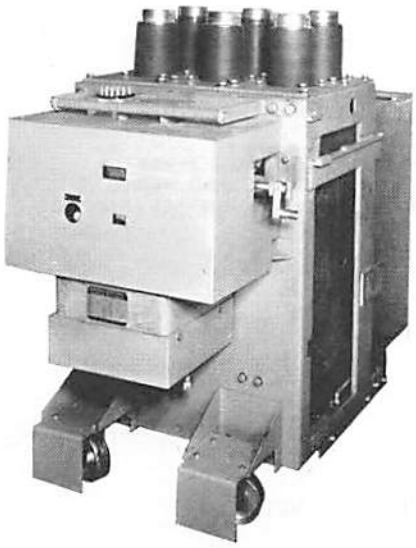


Fig. 5

Fig. 6 (8024212)

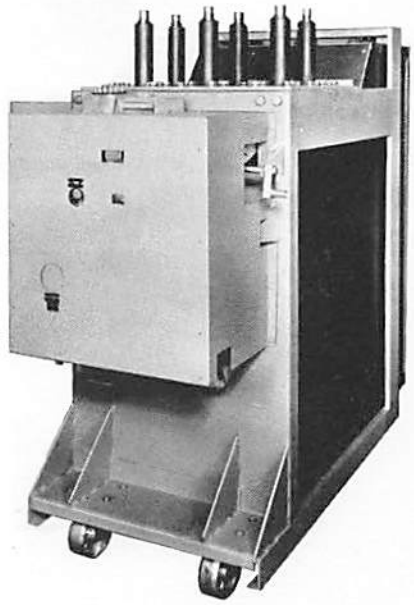
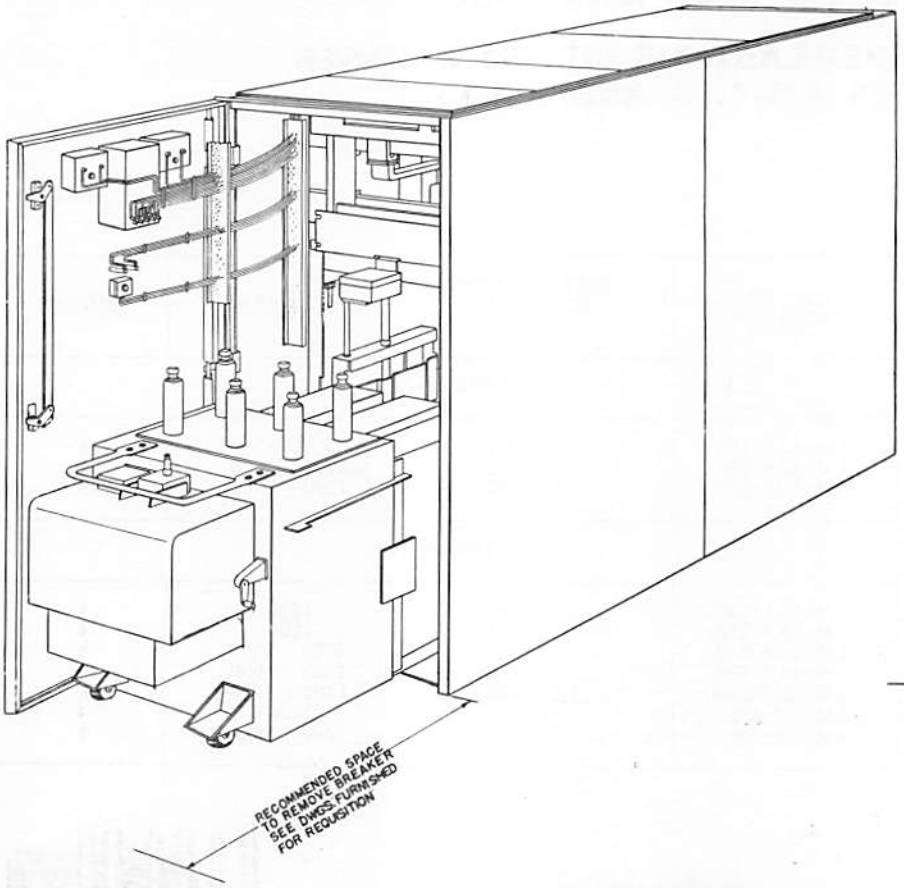


Fig. 6

Magne-blast Breakers

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.



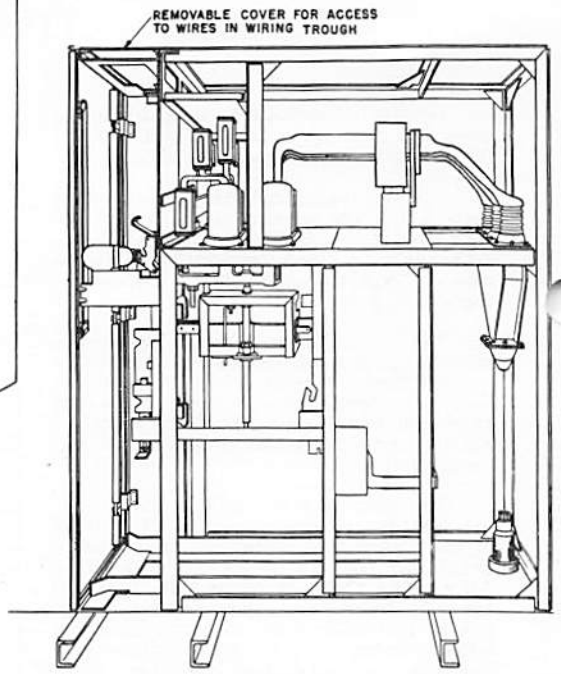
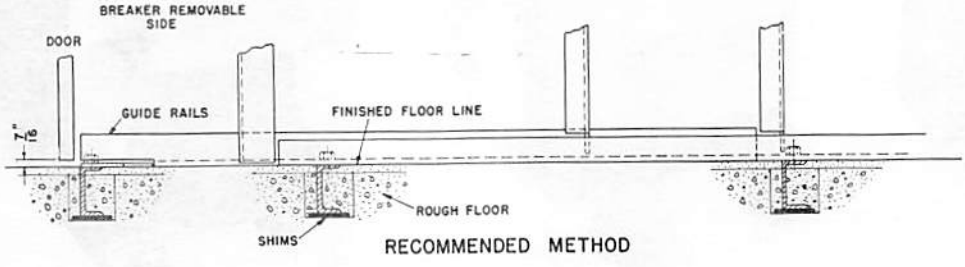


Fig. 7 (TT-6482630)

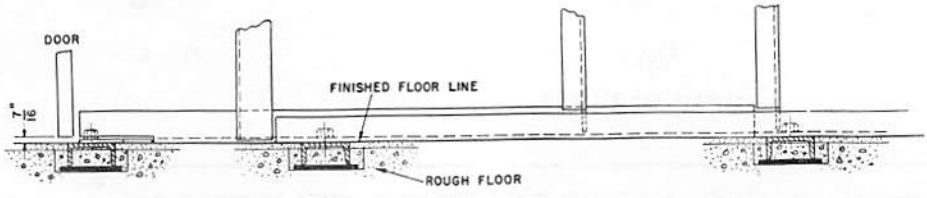
ALL FLOOR STEEL TO BE FURNISHED BY PURCHASER

CHANNELS SHOULD BE SET LEVEL WITH EACH OTHER AND SHOULD BE LEVEL OVER THEIR FULL LENGTH

ROUGH FLOOR THICKNESS AND REINFORCING DEPENDS ON LOADING AND OTHER NORMAL FACTORS, AND SHOULD BE DESIGNED IN ACCORDANCE WITH RECOMMENDED PRACTICE



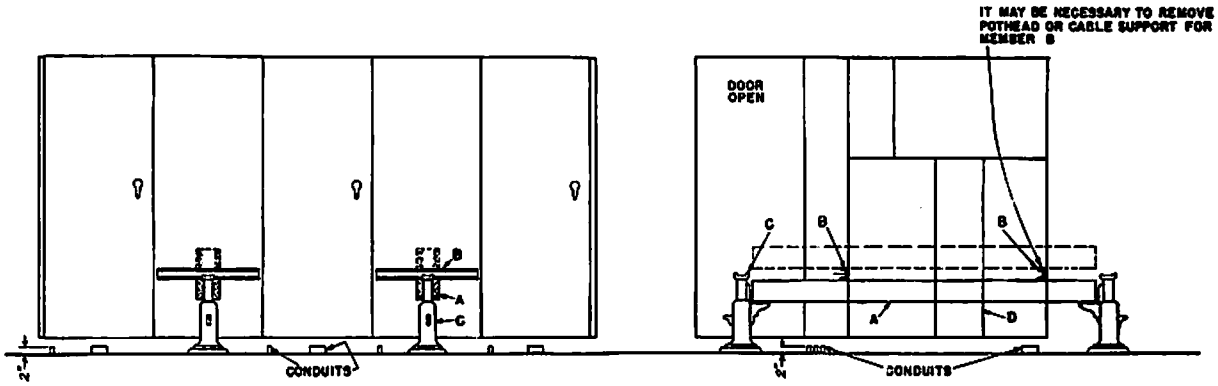
RECOMMENDED METHOD



ALTERNATE METHOD

NOTE: IT IS IMPERATIVE THAT FLOOR STEEL BE EVEN WITH FINISHED FLOOR AND THAT BOTH BE LEVEL

Fig. 7 Installation Details



METHOD OF LIFTING

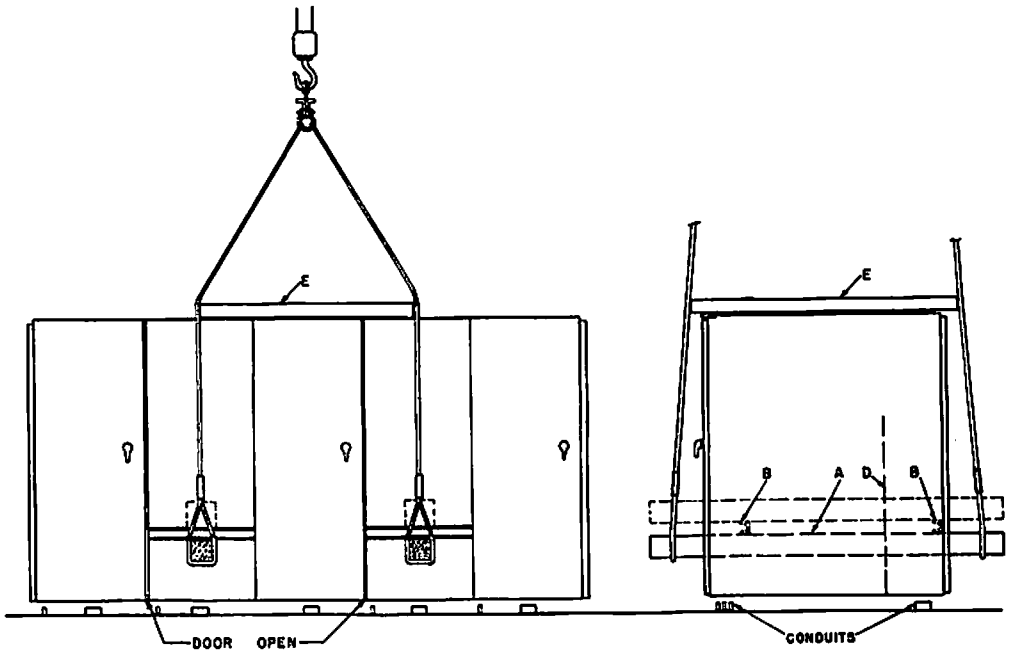
MEMBERS A-& C———TO BE FURNISHED BY PURCHASER
A- RAISING MEMBER - CHANNEL OR WOOD BEAM

B- 3" CHANNEL FURNISHED WITH GEAR

C- LIFTING JACKS
D- COVER TO BE REMOVED AND REASSEMBLED AFTER UNITS ARE IN PLACE

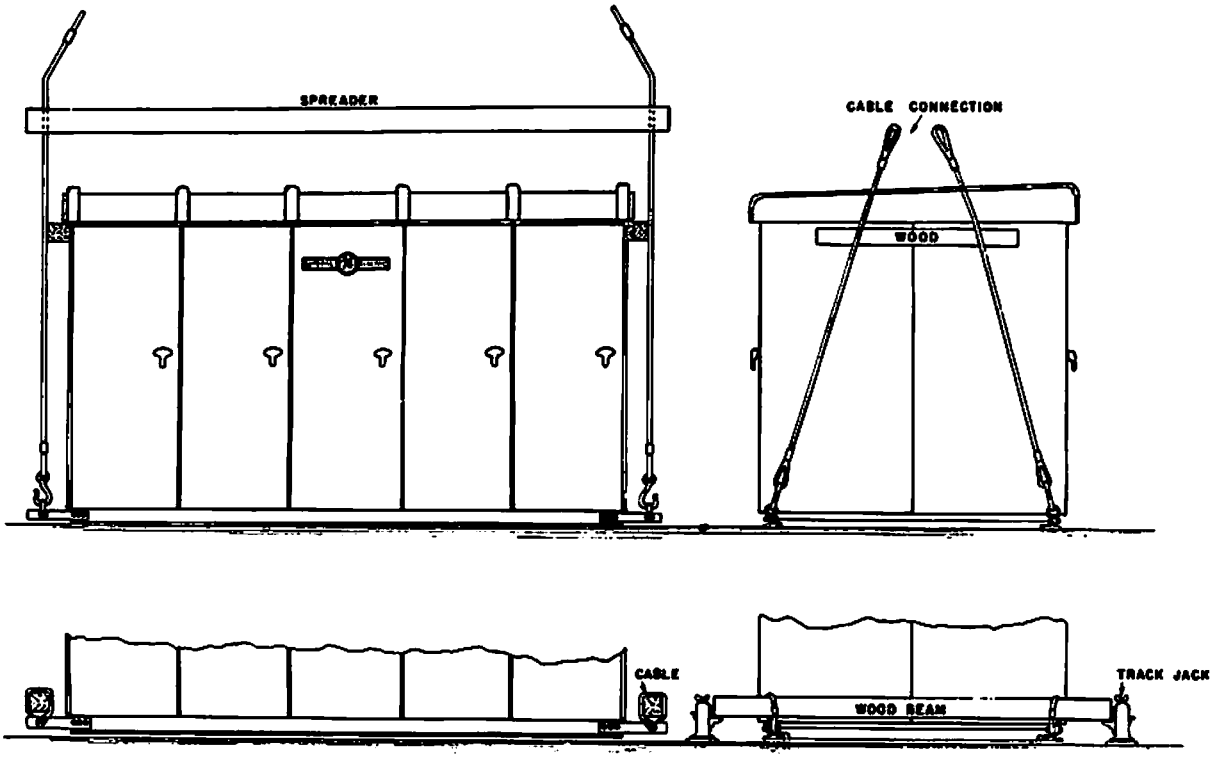
NOTE: WHEN LIFTING M-26 SWITCHGEAR LOCATE BEAM "A" ABOVE LIFTING CHANNELS "B"

Fig. 7 (TT-6482630)



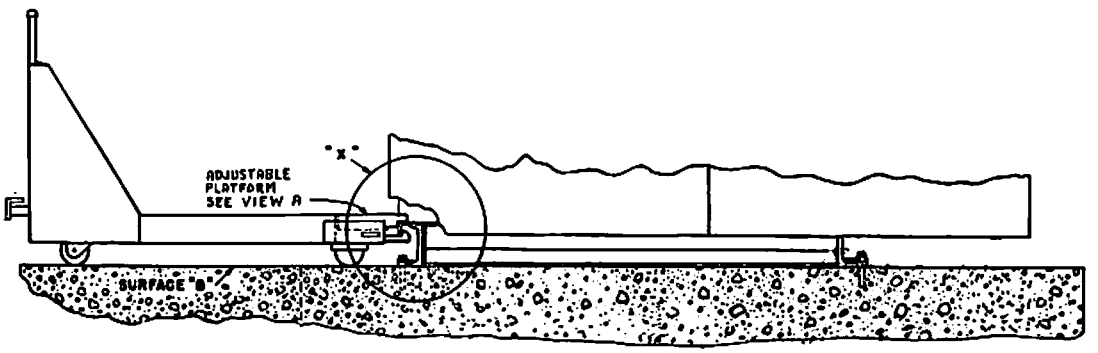
ALTERNATE METHOD OF LIFTING

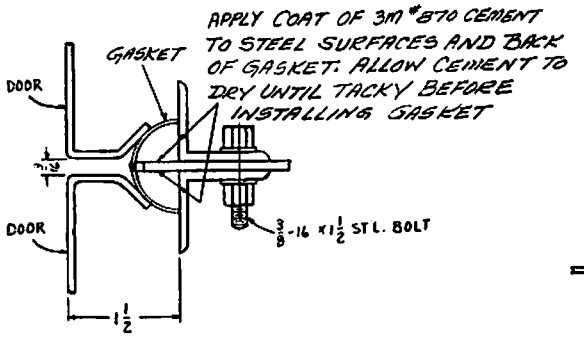
MEMBERS A & E TO BE FURNISHED BY PURCHASER
B - 3" CHANNEL FURNISHED WITH GEAR
D - COVER TO BE REMOVED AND REASSEMBLED AFTER UNITS ARE IN PLACE
E - SPREADER



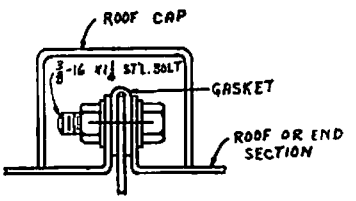
METHODS OF LIFTING

Fig. 8 (118D728 & TT-6482615)



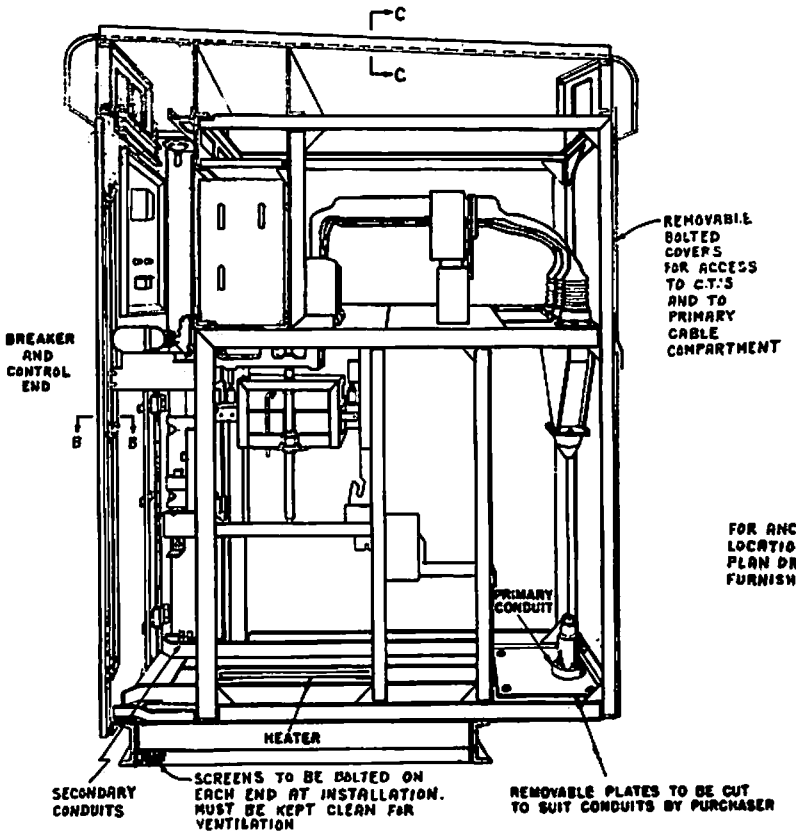


ENLARGED SEC. B-B
METHOD OF ASSEMBLING DOOR GASKET AT SHIPPING SPLITS

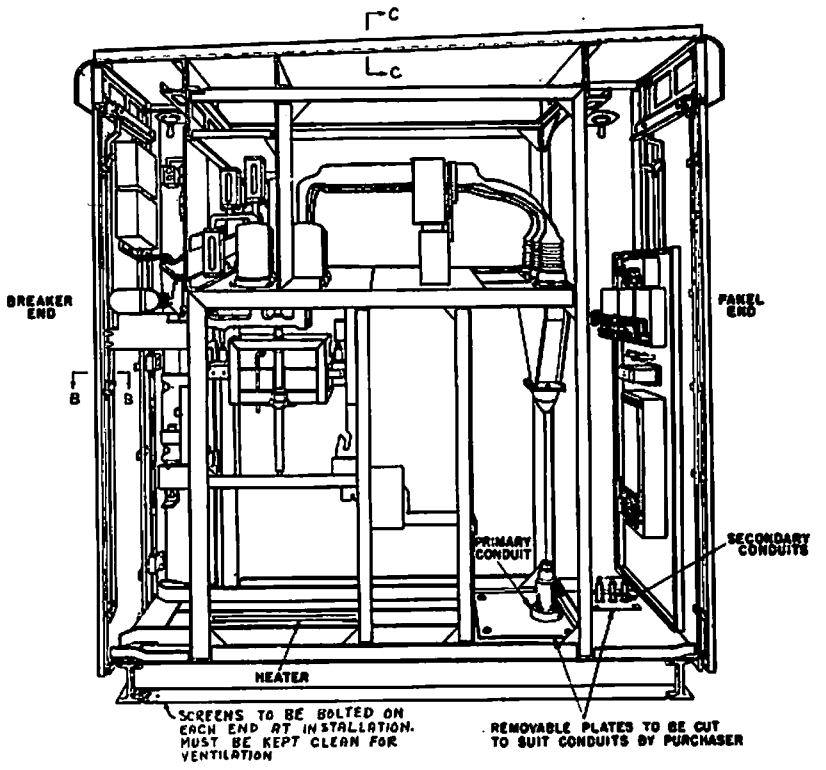


ENLARGED SEC. C-C
METHOD OF ASSEMBLING ROOF CAP AND GASKET AT SHIPPING SPLITS

Fig. 8 Installation Details



Without Rear Enclosure

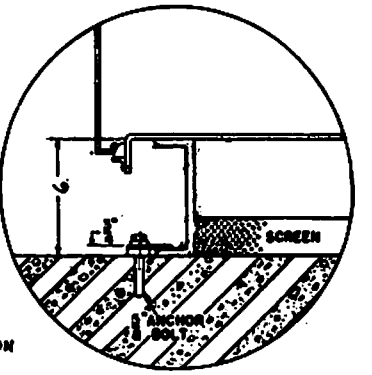


With Rear Enclosure

Fig. 8 (118RD728 & TT-6482615)

for Outdoor Metal-clad Switchgear

FOR ANCHOR BOLT LOCATIONS SEE FLOOR PLAN DRAWINGS FURNISHED WITH REQUISITION



VIEW "X"

SHOWING ANCHORING OF UNITS WITH CHANNEL BASE

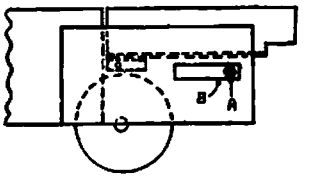
FOUNDATION DATA

AREA AND DEPTH OF SOIL BEARING SURFACES OF EACH FOUNDATION MUST BE ALTERED TO SUIT SOIL CONDITIONS.

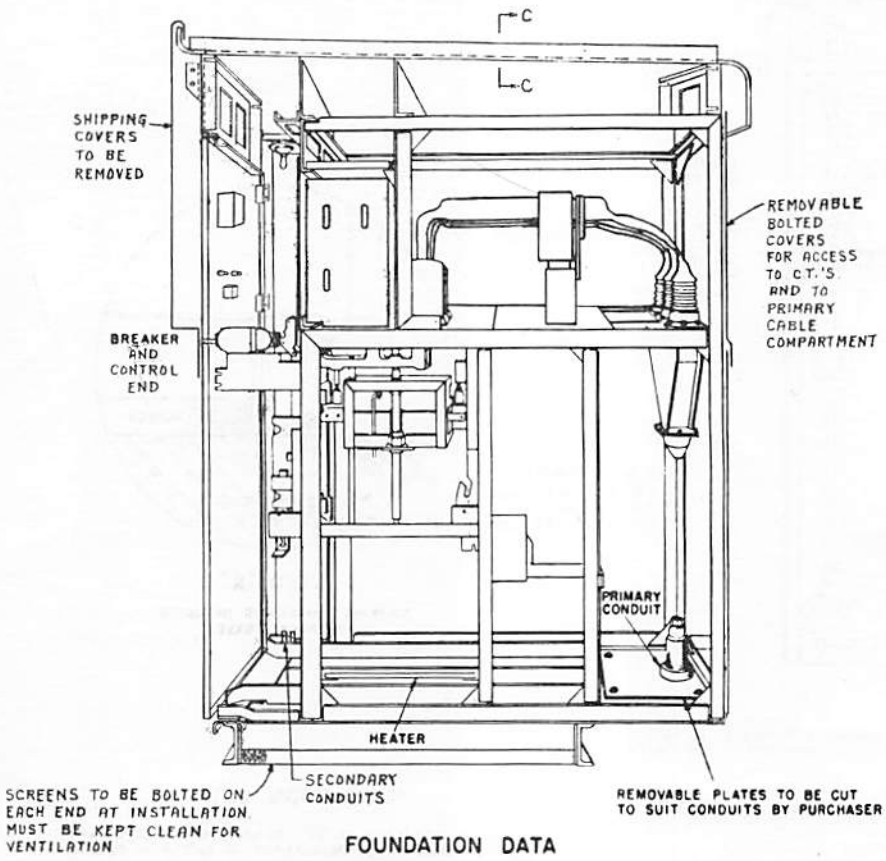
BOTTOM SURFACES OF FOUNDATIONS SHOULD BE BELOW FROST ACTION OR BACKFILLED WITH PERVIOUS MATERIAL AND ADEQUATELY DRAINED.

SURFACE "B" SHOULD BE LEVEL OVER ITS FULL LENGTH TO INSURE EASY HANDLING OF REMOVABLE ELEMENTS. CONCRETE PAD SHOULD BE REINFORCED IN ACCORDANCE WITH STANDARD PRACTICE.

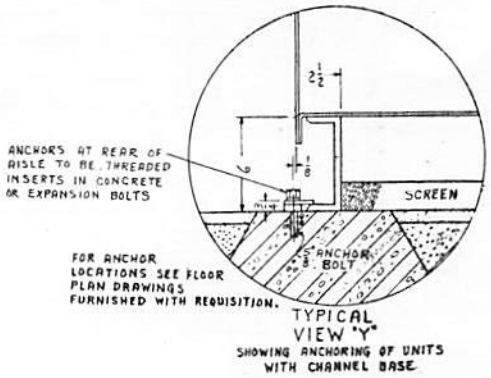
TO CHANGE HEIGHT OF TRUCK FLOOR LOOSEN NUT "A". ADJUST LEVER "B" TO GIVE DESIRED HEIGHT AND LOCK BY TIGHTENING NUT "A".



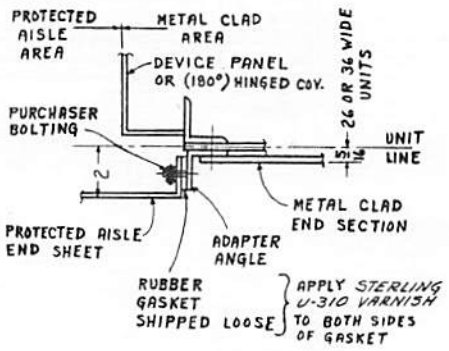
ADJUSTABLE PLATFORM VIEW "A"



FOUNDATION DATA

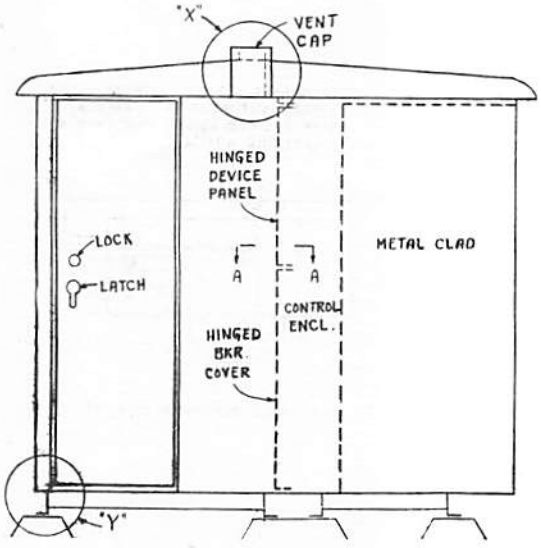


TYPICAL VIEW "Y"
SHOWING ANCHORING OF UNITS WITH CHANNEL BASE

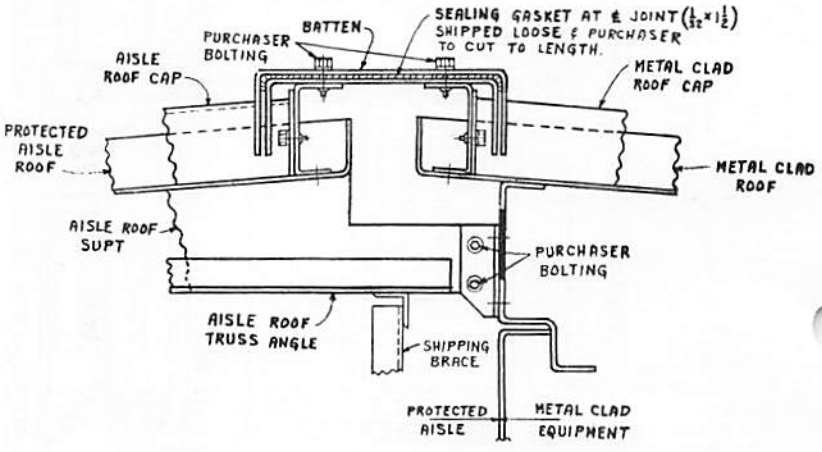


TYPICAL SECTION A-A

Fig. 9 (118RD727)



PROTECTED AISLE



VIEW "X"
ENLARGED INTERIOR SECTION SHOWING AISLE TO METAL CLAD BOLTING & VENTILATOR CAP ASSEMBLY

Fig. 9 Installation Details for Outdoor Metal-clad Switchgear with Protected Aisle

RECEIVING, HANDLING AND STORAGE

RECEIVING

Every case or crate leaving the factory is plainly marked at convenient places with case number, requisition number, customer's order, front or rear, and when for size and other reasons it is necessary to divide the equipment for shipment, with the unit number of the portion of equipment enclosed in each shipping case.

The contents of each package of the shipment are listed in the Packing Details. This list is forwarded with the shipment, packed in one of the cases. The case is especially marked and its number can also be obtained from the Memorandum of Shipment. To avoid the loss of small parts when unpacking, the contents of each case should be carefully checked against the Packing Details before discarding the packing material. Notify the nearest General Electric Company representative at once if any shortage of material is discovered.

All elements before leaving the factory are carefully inspected and packed by workmen experienced in the proper handling and packing of electrical equipment. Upon receipt of any apparatus an immediate inspection should be made for any damage sustained while enroute. If injury is evident or an indication of rough handling is visible, a claim for damage should be filed at once with the transportation company and the General Electric Company notified promptly. Information as to damaged parts, part number, case number, requisition number, etc., should accompany the claim.

HANDLING

Before uncrating, indoor equipment may be moved by a crane with slings under the skids. If crane facilities are not available, rollers under the skids may be used. Fig. 7 shows suggested method of handling the switchgear after it is removed from the skids.

Methods of handling outdoor equipment are shown in Fig. 8. After the equipment is in place the lifting plates should be removed and reassembled, "turned in" so that passageway at the ends of the equipment will not be obstructed.

STORAGE

If it is necessary to store the equipment for any length of time, the following precautions should be taken to prevent corrosion:

1. Uncrate the equipment.

2. Cover important parts such as jack screws, gears and chain of lifting mechanism, linkage and moving machine-finished parts with a heavy oil or grease.

3. Store in a clean, dry place with a moderate temperature and cover with a suitable canvas to prevent deposit of dirt or other foreign substances upon movable parts and electrical contact surfaces.

4. Batteries should be uncrated and put on trickle charge immediately on receipt.

5. If dampness or condensation may be encountered in the storage location, heaters should be placed inside the units to prevent moisture damage. Approximately 500 watts of heaters per unit will be required. Remove all cartons and other miscellaneous material packed inside units before energizing any heaters. If the equipment has been subjected to moisture it should be tested with a 1000v or 2500v megger. A reading of at least 200 megohms should be obtained.

6. Breakers should be prepared for storage separately. Refer to appropriate breaker instruction book.

DESCRIPTION

Each unit is made up of a secondary enclosure and a primary enclosure, as shown in Figure 10.

SECONDARY ENCLOSURE

The secondary enclosure is usually located at the breaker withdrawal side of the unit, although in certain units it may be on the side opposite to the breaker withdrawal area. It consists of a compartment with a hinged door or panel upon which are mounted the necessary instruments, control and protective devices. The terminal blocks, fuse blocks, and some control devices are mounted inside the enclosure on the side sheets and a trough is provided at the top to carry wiring between units.

PRIMARY ENCLOSURE

The primary enclosure contains the high voltage equipment and connections arranged in compartments to confine the effects of faults and so minimize the damage.

BREAKER REMOVABLE ELEMENT

The removable element consists of a circuit breaker with trip-free operating mechanism mounted directly on the breaker frame, interlock mechanism, the removable portion of the primary and secondary disconnecting devices, the operating mechanism control device, and necessary control wiring. The magne-blast breakers are equipped with wheels for easy removal and insertion. Refer to Figs. 4, 5 and 6.

The circuit breaker interlock mechanism is designed to obstruct the operator from lowering the breaker from the connected position or raising it from the disconnected position unless the breaker is in the open position. This interlock is also

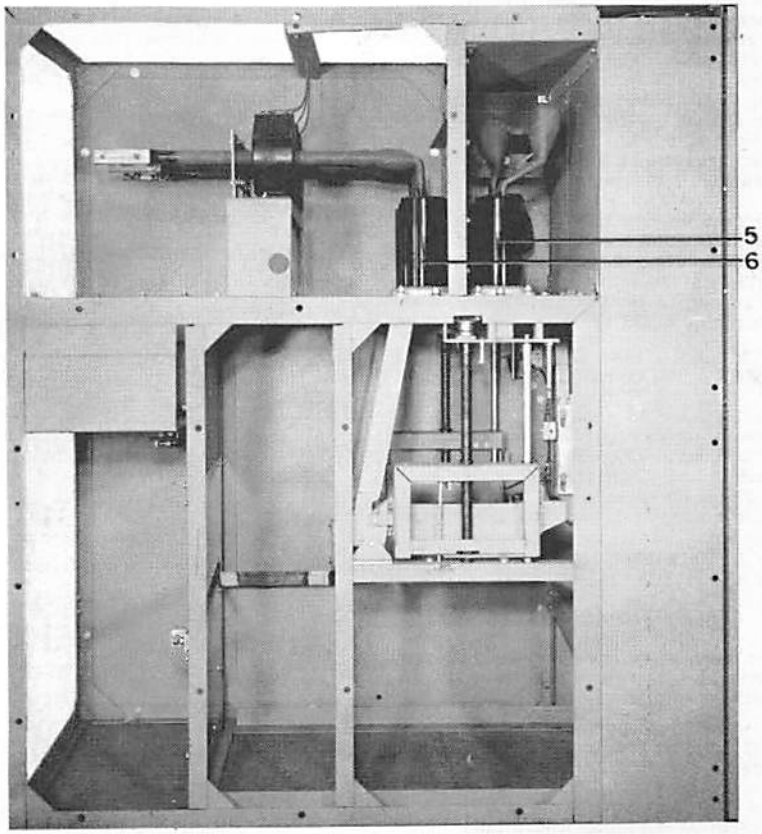


Fig. 10 Metal-clad Switchgear

Fig. 10 (8028600)

designed to keep the breaker in the open position while it is being elevated or lowered. With this arrangement it is imperative that the circuit breaker be tripped prior to any vertical travel of the removable element. A positive stop prevents overtravel of the removable element when raised to its connected position. The secondary disconnecting device coupler is used for connecting outside control circuits to the circuit breaker, operating mechanism, trip coil and auxiliary switches. This coupler makes contact automatically when the removable element is raised to the connected position. A control test jumper is furnished which is plugged into the coupler on the stationary and removable elements when it is desired to operate the breaker in the test position.

All removable elements furnished on a particular requisition and of like design and ratings are completely interchangeable one with the other. The removable as well as the stationary elements are built with factory jigs and fixtures thus insuring interchangeability.

BREAKER ELEVATING MECHANISM

The elevating mechanism for elevating or lowering the removable element to or from its connected position supports the removable element in the operating position. In the test position the breaker is lowered to the guide rails. This mechanism consists of heavy-duty steel jack screws on which are carried nuts to support the elevating carriage. The carriage is so designed that the removable element can be readily inserted or withdrawn after the carriage has been lowered to the disconnected position without necessitating the removal of any bolts, nuts or screws. The breaker cannot be lowered or raised until it has been tripped. The breaker cannot be closed except with the breaker in either the operating or test position.

Guide rails are built into the metal-clad frame to guide the removable breaker element into correct position before the breaker is raised into the operating position by means of the elevating mechanism which is motor operated.

PRIMARY DISCONNECTING DEVICE

The primary disconnecting devices utilize silver to silver contacts to insure against reduction of current carrying capacity due to oxidation of the contact surfaces. These contacts are of the high pressure line contact tube and socket design, the tube being backed up by heavy garter springs to insure contact pressure. Refer to Figure 11.

BUS COMPARTMENT

The main buses are enclosed in a metal compartment with removable front covers to provide accessibility.

The bus is supported by an insulating material which is practically impervious to moisture, and an excellent dielectric.

The bus insulation is molded on the bars except at the joints where the insulation is completed by means of compound filled boxes, molded boots or tape.

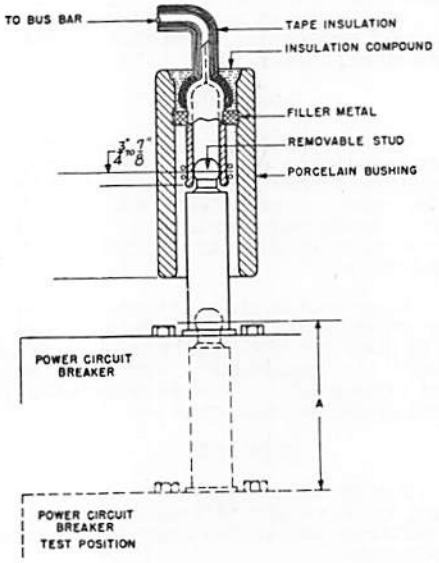


Fig. 11 Measurement of Adjustment of Primary Disconnecting Devices

CURRENT TRANSFORMER AND CABLE COMPARTMENT

The current transformers are mounted in a compartment isolated from the other equipment. Provision is made in this compartment for connecting the purchaser's primary cable by means of potheads or clamp type terminals.

POTENTIAL TRANSFORMER COMPARTMENT

Potential transformers are located in a compartment above the current transformers or in a separate unit adjacent to the breaker units.

The transformers are mounted on a movable support equipped with primary and secondary disconnecting devices. When the potential transformers are disconnected, they are at a safe striking distance from all live parts of the switchgear. In addition a grounding device is provided which contacts the fuses when the potential transformers are disconnected, effectively discharging the transformers. In this position the transformer fuses may be safely removed and replaced. A barrier mounted at the rear of the carriage moves with the carriage to a position in front of the stationary part of the primary disconnect device. See Figure 12.

DUMMY REMOVABLE ELEMENT

Dummy removable elements, Fig. 13, are used as a means of isolating circuits or bus sections, where operation is infrequent and a circuit breaker cannot be economically justified. The device consists of a framework to simulate the circuit breaker removable element with a set

Fig. 11 (121A6981)

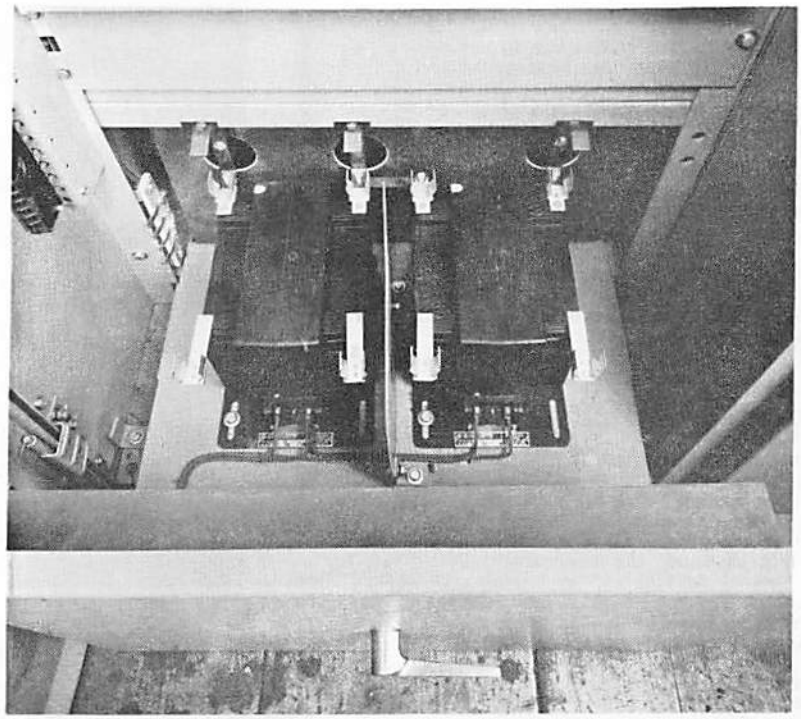


Fig. 12 (8028333)

Fig. 12 Potential Transformer Rollout Shown in Withdrawn Position

Fig. 13 (8026011)

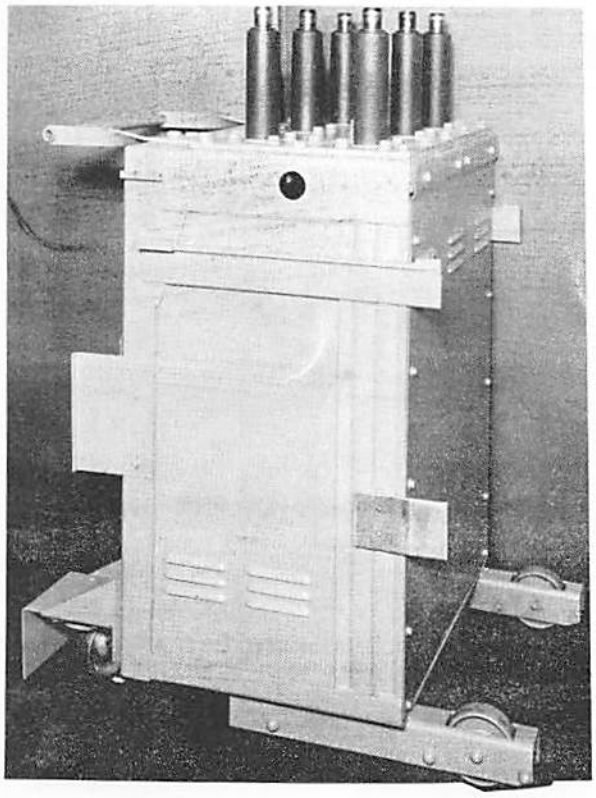


Fig. 13 Dummy Removable Element

of six studs similar to those on the magne-blast breakers. The lower end of the studs are connected, front to back, by copper bars which are fully insulated and metal-enclosed. The stationary structure is the same as for a circuit breaker. When the device is elevated into position, it connects the front set of metal-clad disconnecting devices to the rear set.

Under no conditions must the dummy element be elevated or lowered when the bus or the unit is energized. Key interlocks are applied to insure that all source of power are disconnected before the dummy element can be operated. Refer to Figure 15.

ROLLOUT FUSE-SWITCH UNITS

Rollout load-break disconnect switches, with or without current limiting fuses of high interrupting capacity, are sometimes used in metal-clad switchgear to protect and switch small transformers and circuits where circuit breakers cannot be economically or functionally justified.

The rollout switch is designated as type SE-10, and the units in which they are used are designated as type SEM-26 or SEM-36. For additional information on these equipments, refer to the supplementary instructions furnished.

FUSE DISCONNECTING DEVICE

Current limiting fuses with high interrupting rating are sometimes used in metal-clad switchgear to protect small transformers or circuits where circuit breakers cannot be economically or functionally justified.

Fig. 14 (8004507)

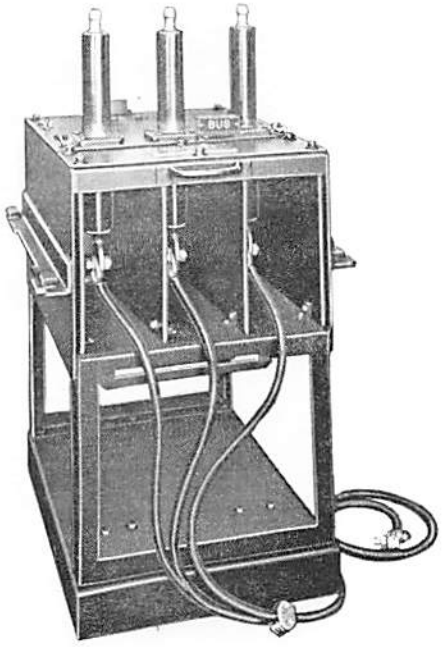


Fig. 14 Ground and Test Device
(Cable shown not furnished by G. E. Co.)

The fuses are mounted on a movable support equipped with disconnecting devices. Control power transformers of 15 kva and smaller may be mounted on the rollout with the fuses. See Figure 16.

When the fuses are disconnected, they are at a safe striking distance from all live parts of the switchgear. In addition a grounding device is provided which contacts the fuses after they are disconnected, effectively removing any static charge from the fuses. In this position the fuses may be safely removed and replaced. The disconnecting devices are capable of interrupting transformer magnetizing current, but should not be used to interrupt load current. Mechanical or key interlocks are applied to prevent operating the disconnecting device while the load is connected. This is genearally accomplished by interlocking so that the transformer secondary breaker must be locked in the open position before the disconnecting device can be opened or closed.

GROUNDING AND TEST DEVICE

The grounding and test device, Figure 14, provides a convenient means of grounding the cables or the bus in order to safeguard personnel who may be working on the cables or the equipment. The device can also be used for applying power for high potential tests or for fault location, to measure insulation resistance (Megger). By using potential transformers, it can also be used for phasing out cables.

The three studs of the device are similar to those of the magne-blast circuit breakers. The studs are mounted on a removable plate which can be placed in either of two positions. In one position the studs will engage the front (Bus) contacts only and in the other position the studs will engage the rear (Line) contacts only of a metal-clad unit.

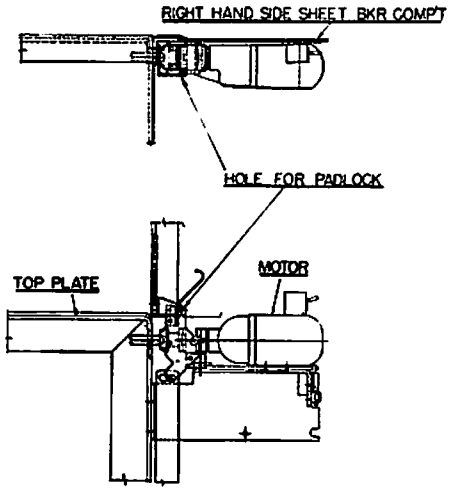
To indicate the proper placement of the studs on the device, opposite sides of the assembly are marked "Line" and "Bus". The word corresponding to the desired position must be toward the operator.

To use, the device is rolled into the metal-clad housing in place of the circuit breaker, and raised into or lowered from the connected position by means of the circuit breaker elevating mechanism.

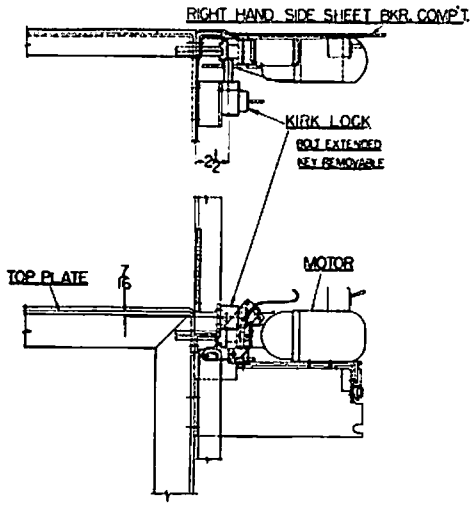
In addition to the device described above, there is available a form of grounding and testing device equipped with both bus and line side buildings, power operated grounding contacts, phasing receptacles, and a complete safety interlocking system. For details of construction and operation of this device, refer to GEI-38957 for 4.16 kv equipment, or GEI-50114 for 7.2 kv and 13.8 kv equipment.

TANDEM LOCK (WHEN FURNISHED) FOR OUTDOOR UNITS

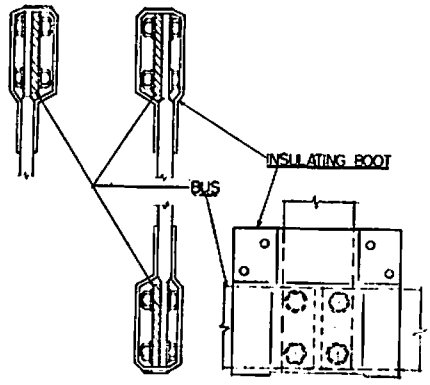
Outdoor metal-clad equipments with more than one unit may be provided with a tandem locking arrangement which makes it necessary to padlock only one door on each



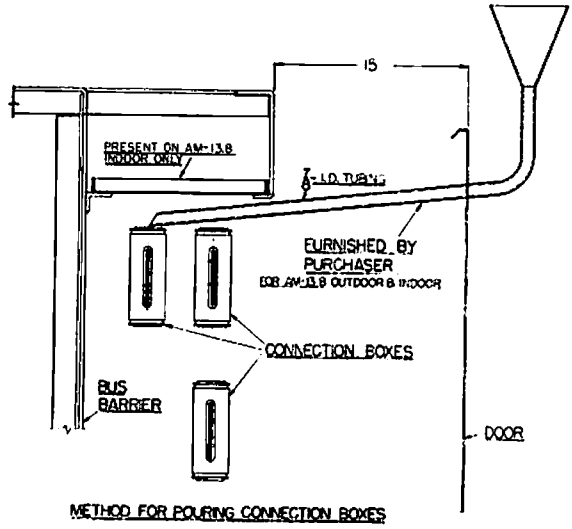
PADLOCKING ARRANGEMENT
PREVENTS RAISING OR LOWERING P.C.B. & DUMMY REMOVABLE ELEMENT



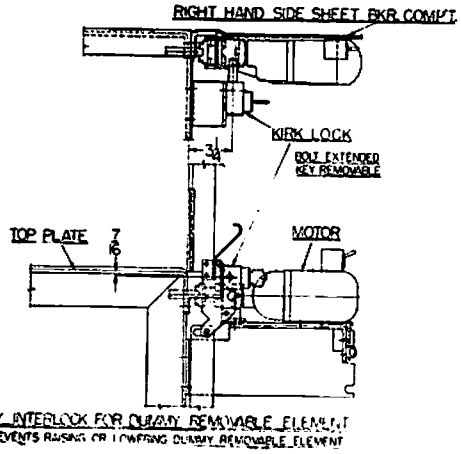
KEY INTERLOCK FOR P.C.B.
PREVENTS CLOSING BREAKER



4/6 BUS WITH PLASTIC INSULATING BOOT



METHOD FOR POURING CONNECTION BOXES



KEY INTERLOCK FOR DUMMY REMOVABLE ELEMENT
PREVENTS RAISING OR LOWERING DUMMY REMOVABLE ELEMENT

Fig. 15 (T-991368)

Fig. 15 Padlocking Arrangement, Key Interlocking and Method for Pouring Connection Boxes

Fig. 16 (8020825)

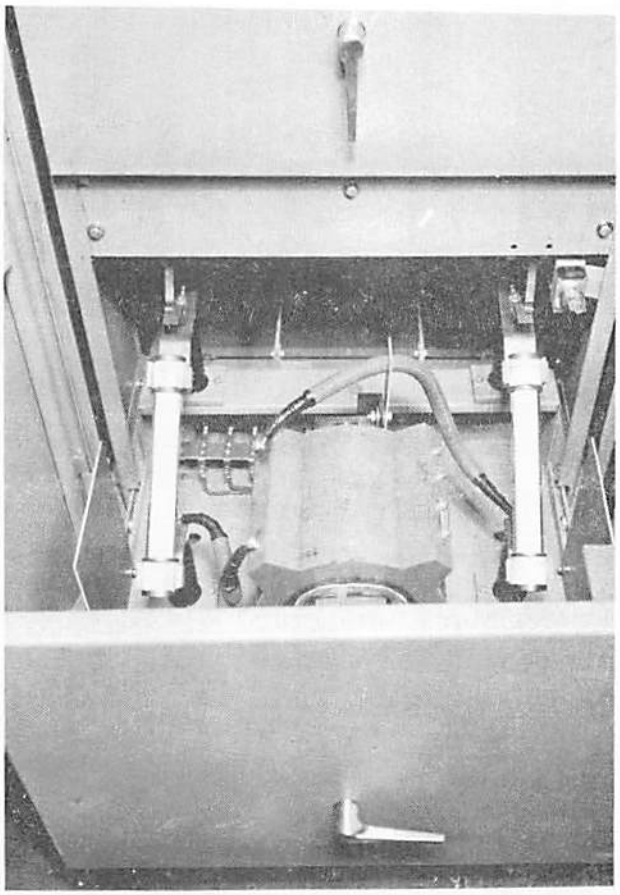


Fig. 16 Control Power Transformer Rollout Shown in Open Position

Fig. 17 (8011450)

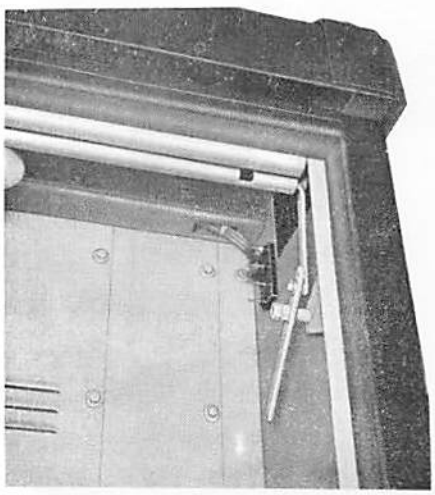


Fig. 17 Tandem Lock for Outdoor 13.8 Units

side. (In exceptionally long installations two or more locks may be required on each side). The unit containing the operating arm of the tandem lock is clearly marked on the drawings and also by nameplate on the equipment itself. Refer to Figure 17.

Before any door in the equipment can be opened, it is necessary to open the padlocked door and operate the tandem locking arm to the open position. In locking the equipment the reverse procedure should be used.

Where it is desired to separately lock any particular door, the tandem lock can be disconnected in that unit by unbolting a connecting clip between the tandem bar and the locking bar, and a separate padlock used on that door.

The light switches, front and rear, will be located in the units with the tandem lock.

INSTALLATION

Before any installation work is done, consult and study all drawings furnished by the General Electric Company for the particular requisition.

These drawings include arrangement drawings, wiring and elementary diagrams and a summary of the equipment. Mats, screens, railings, etc., which are external to the switchgear, but which may be required to meet any local codes, must be furnished by the purchaser.

LOCATION

The recommended aisle space required at the front and at the rear of the equipment is shown on the floor plan drawing furnished for the particular requisition. The space at the front must be sufficient to permit the insertion and withdrawal of the circuit breakers, and their transfer to other units. The space at the rear must be sufficient for installation of cables, for inspection and maintenance, and on some equipments to draw out potential transformers.

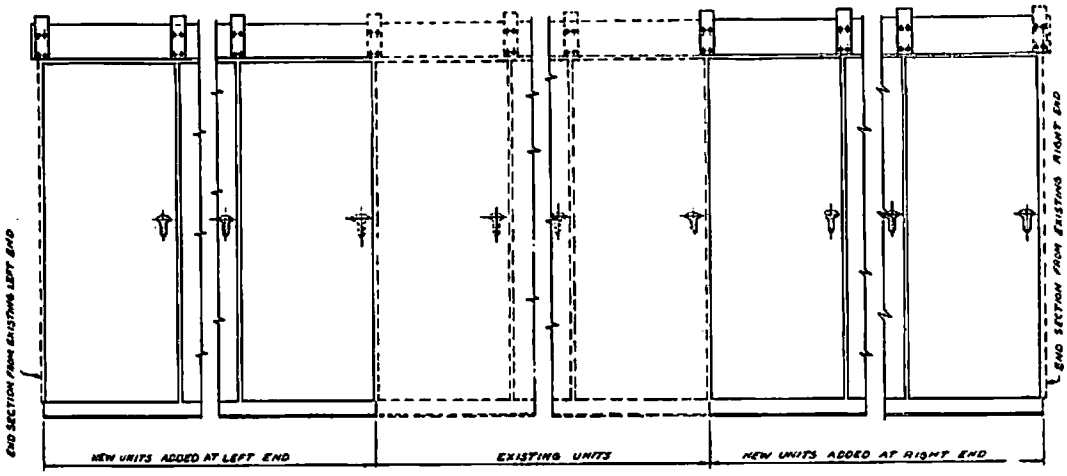
PREPARATION OF FLOOR - ANCHORING

Indoor Equipment

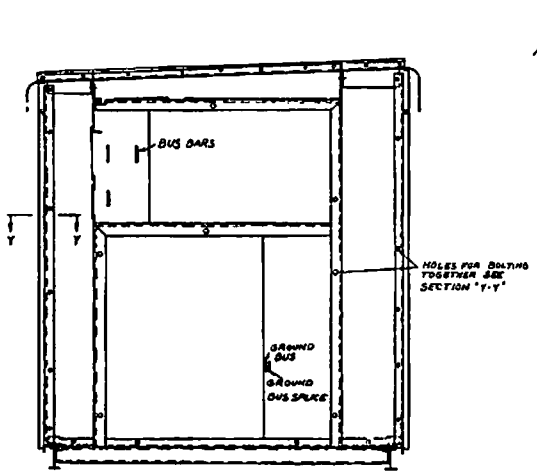
The station floor must be strong enough to prevent sagging due to weight of the switchgear structure and to withstand the impact stress caused by the opening of the circuit breakers under short circuit conditions. The impact loading is approximately 1-1/2 times the static load.

Suitable means must be provided by the purchaser for anchoring the equipment to the floor. It is essential that the floor be level to avoid distortion of the switchgear structure and the equipment be completely aligned prior to final anchoring. The recommended floor construction is shown in Figure 7. The floor channels must be level and straight with respect to each other. Steel shims should be used for final leveling of the switchgear if necessary. Care should be taken to provide a smooth, hard, and level floor under and in front of the units to facilitate installation and removal of the breaker. If the floor is not level and flush with the floor channels, it will be difficult to handle the breaker because it will not be level with respect to the stationary element.

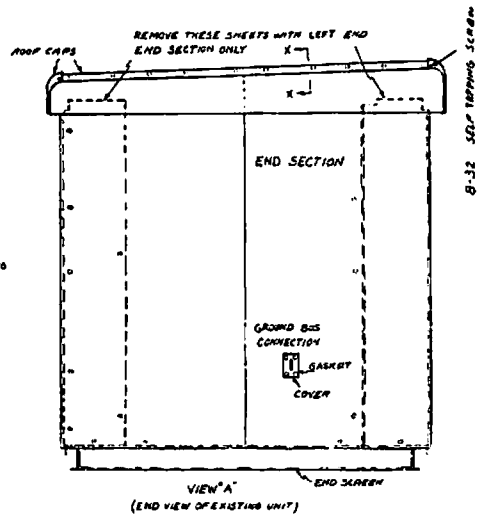
Recommended practice is to weld the switchgear structure to the floor channels, using a tack weld at points indicated for anchoring on the drawing. If welding facilities are not available the gear should be bolted to the floor channels.



FRONT VIEW
(PANEL END)

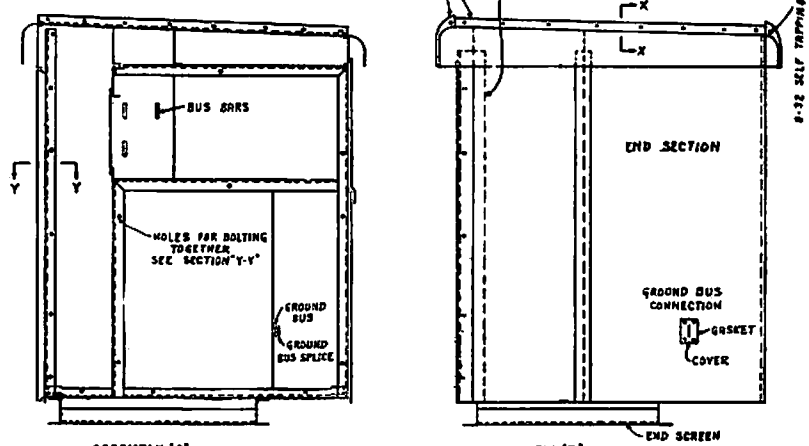


ASSEMBLY "B" ROOF CAPS REMOVED
(BOLTING OF UNITS TOGETHER)



VIEW "A"
(END VIEW OF EXISTING UNIT)

WITH REAR ENCLOSURE



ASSEMBLY "C" ROOF CAPS REMOVED
(BOLTING OF UNITS TOGETHER)

VIEW "D"
(END VIEW OF EXISTING UNIT)

PROCEDURE

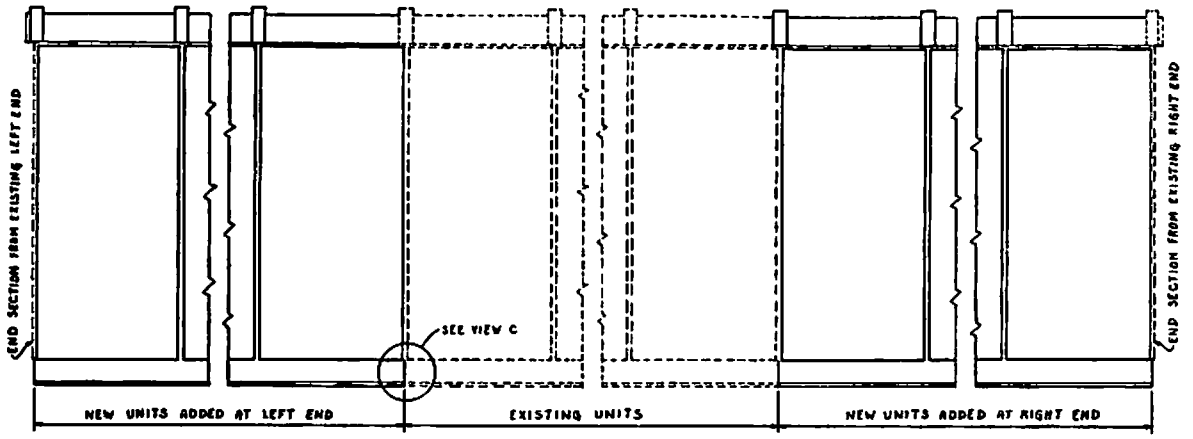
1. REMOVE ROOF CAP, END SCREEN, GROUND BUS CONNECTION, AND END SECTION. SEE VIEW "A" & VIEW "D"
2. SET NEW UNIT(S) IN PLACE AND BOLT TOGETHER AS SHOWN IN ASSEMBLY "B" & ASSEMBLY "C"
3. ASSEMBLE ITEMS LISTED IN PROCEDURE NO.1
4. ASSEMBLE NEW ROOF CAPS AS SHOWN IN VIEW "A" & VIEW "D".
5. ASSEMBLE GROUND BUS SPLICE BETWEEN EXISTING AND NEW GROUND BUS. AS SHOWN IN ASSEMBLY "B" & ASSEMBLY "C"
6. ASSEMBLE BUS BARS AND INSULATE PER INSTRUCTION BOOK.

ROOF CAP

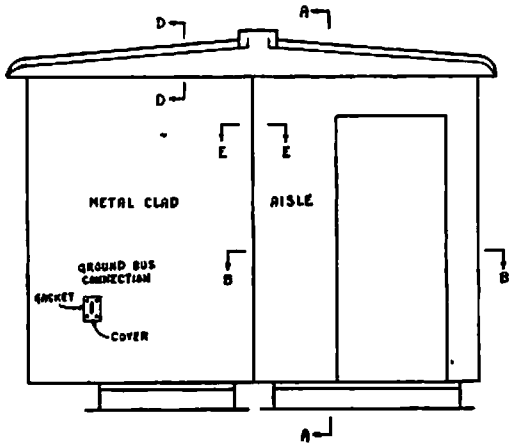
WITHOUT REAR ENCLOSURE

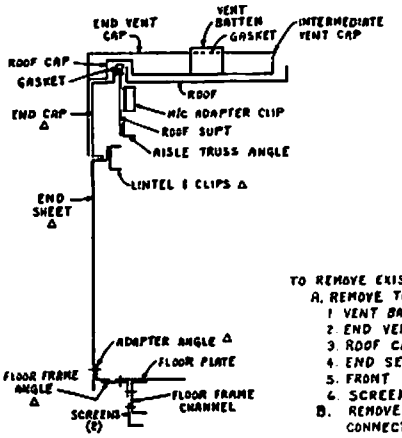
Fig. 18 (5450856)

Fig. 18 Outdoor Metal-clad Switchgear - Addition of Units to Line-up



FRONT VIEW





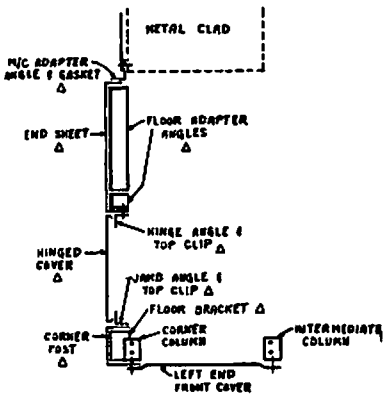
SECTION A-A

TO REMOVE EXISTING END SHEET (LEFT)
A. REMOVE THE FOLLOWING ITEMS FROM AISLE SECTION
1. VENT BATTEN
2. END VENT CAP
3. ROOF CAPS
4. END SECTION CONSISTING OF ITEMS MARKED Δ
5. FRONT COVER (MOVE TO NEW UNIT)
6. SCREENS (2)
B. REMOVE ROOF CAP, END SCREEN, GROUND BUS CONNECTION AND END SECTION FROM METAL CLAD SECTION

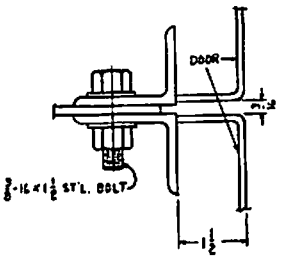
TO INSTALL NEW METAL CLAD UNITS (LEFT)
1. SET NEW UNIT(S) IN PLACE AND BOLT TOGETHER
2. ASSEMBLE ITEMS LISTED IN B
3. ASSEMBLE NEW ROOF CAPS
4. ASSEMBLE GROUND BUS SPLICE BETWEEN EXISTING AND NEW GROUND BUS
5. ASSEMBLE BUS BARS AND INSULATE PER INSTRUCTION BOOK

TO INSTALL NEW PROTECTED AISLE UNITS (LEFT)
1. INSTALL NEW FLOOR FRAMES AND FLOOR PLATE TIE DOWN ANGLE
2. REPLACE FLOOR FRAME ANGLE AT NEW END POSITION
3. INSTALL NEW FLOOR PLATES
4. ERECT NEW CORNER COLUMN (ANGLE)
5. ADD NEW AISLE TRUSS ANGLE AND METAL CLAD ADAPTER CLIP TO EXISTING END ROOF TRUSS AND SUPPORT
6. INSTALL NEW END AISLE TRUSS SUB-ASSEMBLY CONSISTING OF ROOF TRUSS ANGLE, ROOF SUPT, COLUMN CLIP, METAL CLAD ADAPTER CLIP AND ROOF SUPT CLIPS
7. REINSTALL THE ITEMS REMOVED IN A-6
NOTE:- USE NEW GASKETS AND ALSO INSTALL PREVIOUS END FRONT COVER ON FRONT OF NEW END UNIT
8. INSTALL WIRING AND LIGHTING TROUGH

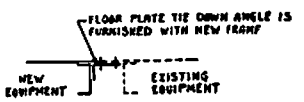
NOTE:- A SIMILAR PROCEDURE IS USED FOR RIGHT END ADDITIONS



SECTION B-B



SECTION E-E



INTERNAL VIEW C

Fig. 19 (7180393)

Fig. 19 Outdoor Metal-clad Switchgear with Protected Aisle

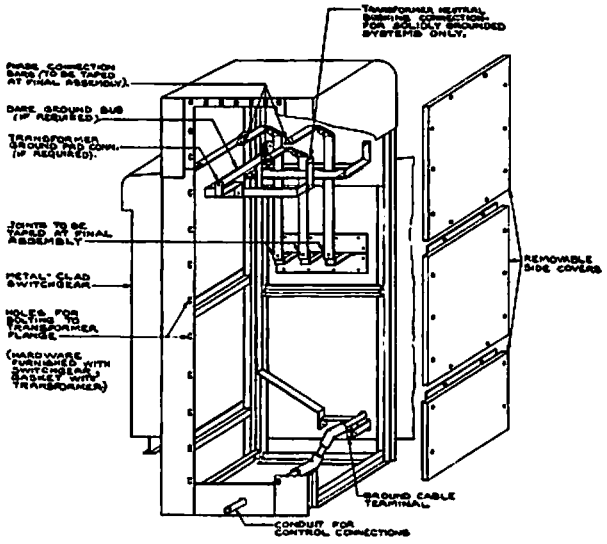


Fig. 20

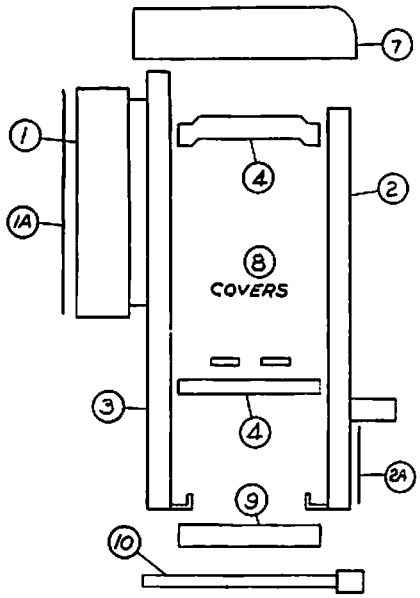


Fig. 21

Outdoor Transition Compartment

Provision should be made in the floor for conduits for primary and secondary cables, located as shown on the floor plan drawing furnished for the particular requisition. If desired, the conduits may be installed before the switchgear. Consideration should be given to conduits which might be required for future connections.

Outdoor Equipment

Outdoor equipments are furnished both with and without rear enclosures. Recommendations for foundations for both types are given in Fig. 8. Primary and secondary conduits should be installed in accordance with the requisition drawings, before the equipment is put into place.

Since outdoor equipments are provided with a 6" base, a transfer truck is required to place the breaker in the housing. The level adjustment on the truck is shown in Fig. 8.

When outdoor equipments are shipped in more than one section, the joint between sections must be weatherproofed. Assemble the gasket between the doors, using cement provided. Refer to Fig. 8, Section B-B. Assemble the gasket between the roof sections, bolt together and install the roof caps. Refer to Fig. 8, Section C-C.

Outdoor Equipment with Protected Aisle

When specified by the purchaser, outdoor equipment is furnished with an enclosed, weatherproof operating aisle. See Fig. 3. The aisle enclosure is shipped separately from the switchgear.

The following procedure outlines the steps necessary to install outdoor equipment with a protected aisle:

(1) Install the switchgear in accordance with the procedure given above for outdoor equipment.

(2) Remove the shipping covers from the control panels. Since the relay and instrument cases are not weather-proof, the control panels should be protected from inclement weather until the installation of the aisle enclosure is completed.

(3) Apply Sterling U-310 varnish to both sides of the gaskets furnished for the joint between the ends of the switchgear and the aisle enclosure and to the surfaces against which the gasket presses and hang the gaskets on the projecting studs at the ends of the switchgear lineup. See Fig. 9, section A-A.

(4) Move the aisle enclosure into position, guiding the holes in the end sheets over the studs on the switchgear lineup and guiding the roof sills between the support clips bolted to the upper front of the switchgear units above the control panels. This operation may be simplified by temporarily loosening the support clips. The floor of the aisle enclosure must fit under the hinged breaker cover of the metal-clad, so the aisle enclosure must be moved into position on a level with the switchgear units. If desired, this job may be simplified by removing the doors over the circuit breaker compartment. To remove these doors, loosen the two bolts holding the lower hinge, remove the hinge, and lower the door to remove the hinge pin from the upper hinge.

(5) Bolt the aisle enclosure in place at both ends, and bolt the roof sills to the support clips, tightening any support clips loosened in the previous operation. Replace any breaker compartment doors previously removed.

(6) If the aisle enclosure was shipped in more than one section, bolt the sections together and assemble the roof caps in the manner described above for roof joints in outdoor switchgear.

(7) Anchor the outside floor sill of the aisle enclosure with anchor bolts placed in accordance with the requisition drawing. See Fig. 9, view Y.

(8) Assemble the dome over the roof opening between the switchgear and the aisle enclosure. See Fig. 9, view X.

(9) Remove shipping braces from aisle enclosure. These braces should be left in place until the aisle enclosure is assembled in order to maintain alignment of the enclosure.

(10) Connect secondary wiring to lights, convenience outlets, etc., in accordance with the wiring diagrams furnished for the equipment.

Since the aisle floor is level with the floor of the switchgear units, no transfer truck is required for outdoor equipment with a protected aisle.

The above procedure describes installation of a protected aisle enclosure with switchgear on one side of the aisle only. If the aisle is common to two lineups of switchgear, the procedure will require slight modification. See the drawings furnished with the requisition for specific instructions.

Transition Compartments

Transition compartments for outdoor unit substations may be one of two types (Figs. 20 and 21). These compartments are normally shipped assembled. The full height compartment (Fig. 20) cannot be disassembled for installation. The throat type compartment (Fig. 21) can be installed in any of three ways, in accordance with the following instructions:

(a) Should the switchgear be positioned on its foundation prior to the power transformer, the complete transition can be mounted on the metal-clad as assembled. Remove covers #8. Apply Sterling U 310 varnish to both sides of gasket 2A, and to the surfaces against which the gasket presses. Bolt transition compartment to throat on metal-clad switchgear. Before jacking the power transformer into its final location, apply Sterling U 310 varnish to both sides of gasket 1A and to the surfaces against which the gasket presses, and place the gasket over the mounting studs on the transformer tank wall. Slide transformer in place, guiding the transformer mounting studs through the mounting holes in #1. Center rubber seal between

Fig. 21 (453A738)

Fig. 20 (261C416)

#1 and #3 before tightening nuts, maintaining 24" between transformer tank wall and end of metal-clad. Do not apply varnish to the rubber seal between #1 and #3. Cut secondary conduit #10 to length and assemble under the transition.

(b) Should the power transformer be positioned on its foundation prior to the switchgear, follow the procedure of paragraph (a) above, except move the switchgear up to the power transformer after assembling the transition compartment to the switchgear.

(c) If the power transformer and metal-clad switchgear are in place, disassemble transition as follows: Remove covers #8 and #9, adapter #1, dome #7, braces #4. Apply Sterling U 310 varnish to both sides of gasket #2A, and to the surfaces against which the gasket presses, before bolting #2 to metal-clad throat. Apply Sterling U 310 varnish to both sides of gasket #1A, and to the surfaces against which the gasket presses, and loosely fasten #1 and #1A to transformer tank. Slide throat of #3 into #1 and maintain approximately 4 1/2" from #3 to tank. Assemble braces #4 top and bottom to maintain size and proper alignment, then tighten #1 to transformer tank. Assemble connections, terminals, supports and complete all joints. Assemble dome #7, side covers #8 and bottom cover #9. Cut secondary conduit #10 to length and assemble under the transition.

Connect heaters located in 13.8 kv class transition compartment.

Indoor transition compartments are shipped assembled together with the adjacent metal-clad switchgear units.

BREAKER REMOVABLE ELEMENT

Before installing or operating the removable element consult the circuit breaker instructions for directions on installation and inspection. The operation of the interlock device is given below.

The elevating mechanism is accurately leveled and checked at the factory and should need no adjustment. Do not install or remove the breaker or make any adjustments unless the breaker is open.

Rub a small amount of contact lubricant D50H47 on the silvered portion of the breaker studs to form a thin coating for contacting purposes.

Lower the elevating mechanism lifting brackets until the lifting brackets are in the fully lowered or test position. The breaker should then enter the housing freely. Push the breaker into the housing until the wide part of the breaker supporting plate rests against the front part of the lifting bracket of the elevating mechanism. The clearance between the interference block on the breaker and the interference block on the interlock mechanism (dimension "X", Fig. 22) should be from 1/16" to 1/8".

Carefully raise the breaker to the connected position. The clearance between the breaker supporting plate and the stop bolts should be not more than 1/32". Then lower and remove it from the unit. When elevating, note that breaker studs center with respect to the stationary disconnecting device or injury to the contacts may result.

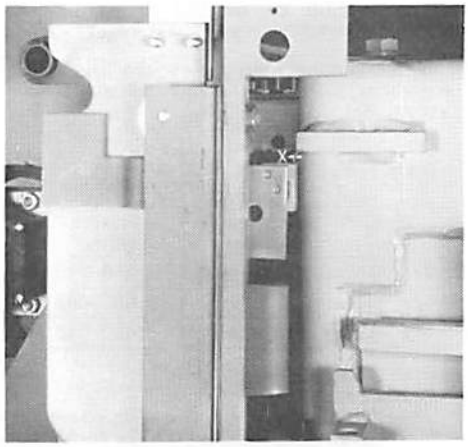


Fig. 22 Positive Interlock Mechanism Interference Block

Inspect the contact surfaces of both the breaker studs and the stationary disconnecting devices.

(a) Each segment of the stationary disconnecting device should make a heavy impression in the contact lubricant D50H47 on the breaker studs. Contact wipe should start not less than 1/8" from top of contact ball although each contact need not start at the same dimension.

(b) The wipe of the breaker stud inside the stationary disconnecting device, as indicated by the contact lubricant D50H47, should be 3/4" to 7/8". This indicates that the breaker studs contacted at the full pressure center of the silver band on the stationary disconnecting device. See Fig. 11.

(c) Should the inspection of the contacts show that the breaker is not being raised to the proper position, readjust the upper stop bolts and limit switches to raise or lower the breaker to the proper location. Lock the stop bolts in the new position.

(d) If proper contacting cannot be attained by the above methods, it is necessary to adjust the stationary disconnecting device tube. DO NOT MAKE ANY ADJUSTMENT. COMMUNICATE WITH THE NEAREST GENERAL ELECTRIC CO. OFFICE FOR ADDITIONAL INFORMATION.

The trip interlock should be checked to see that the removable element is obstructed from being raised to or lowered from the operating position. Using the manual closing device, close the breaker and then push it into place for elevating. Snap the selector switch to the "Raise" position and pull the clutch handle forward. A definite stop should be encountered preventing the motor circuit limit switch from energizing the circuit. Then trip the breaker manually and elevate to the raised position. Electrically close the breaker. Snap the selector switch to the "Lower" position and pull the clutch handle forward. Again, a definite stop should be encountered preventing the motor circuit limit switch from energizing the circuit.

If the interlock does not function as indicated above DO NOT MAKE ANY ADJUSTMENTS. COMMUNICATE WITH THE NEAREST GENERAL ELECTRIC CO. OFFICE FOR ADDITIONAL INFORMATION.

On units equipped with stationary auxiliary switches (Fig. 45A, reference #69), the clearance between the end of the switch mechanism operating rod and the operating plunger on the circuit breaker should be 0 to 1/8" with the circuit breaker in the raised and open position. Any adjustment in this dimension must be made on the circuit breaker. See instruction book furnished with circuit breaker for method of adjustment. Care should be taken to prevent destroying interchangeability of circuit breakers by excessive adjustment on one breaker.

TESTING CABINET

The testing cabinet, Fig. 23, should be installed on the wall at a location where maintenance and testing of the breaker can be conviently done. Conduits must be installed to carry cables to supply control power for testing.

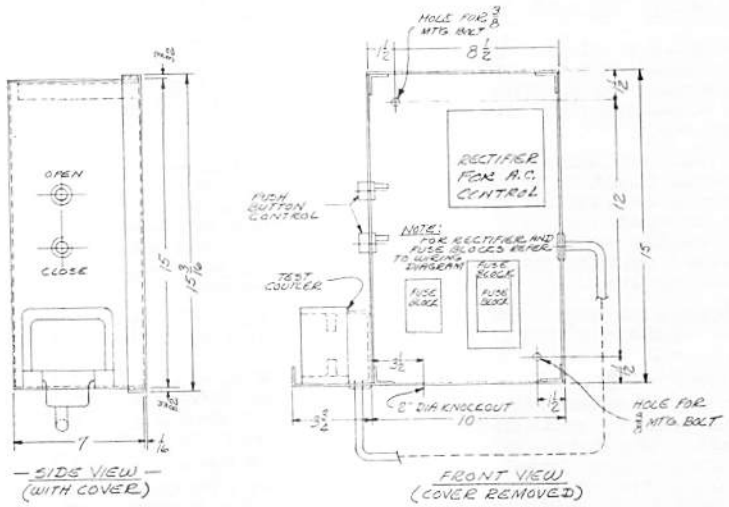


Fig. 23 Inspection Box for 13.8 KV Metal-clad Switchgear

Fig. 22 (8024804)

Fig. 23 (8998745)

ADDITION OF UNITS TO EXISTING EQUIPMENT

Before adding units to existing equipment, consult and study all drawings furnished with the equipment. In addition to the usual drawings furnished with new equipment, special drawings may be furnished covering complicated or special assembly work. Also, check to make sure all necessary parts are on hand.

BEFORE ANY COVERS ARE REMOVED OR ANY DOORS OPENED WHICH PERMIT ACCESS TO THE PRIMARY CIRCUITS, IT IS ESSENTIAL THAT THE CIRCUIT BE DE-ENERGIZED.

Figure 18 indicates the special procedures required to add new metal-clad units to outdoor equipment without protected aisle, and Figure 19 indicates the special procedures required to add new metal-clad units to outdoor equipment with protected aisle. For indoor equipment, it is usually necessary only to remove the end cover sheets and to re-assemble them on the new units after these are located and bolted to the existing units. Otherwise, the installation procedure is the same as described above.

When the units are in place and mechanical assembly is completed, assemble the main bus and other primary connections per the instructions below. (Removal of existing compound-filled connection boxes can be easily accomplished by packing the box in dry ice for 2 - 3 hours. Remove the dry ice and the cord tying the box in place, and strike the box with a hammer. The hardened box and compound will crack away from the joint.)

Secondary wiring and control bus connections should be made in accordance with the wiring diagrams furnished with the equipment.

CONNECTIONS

The main bus bars and other connection bars may be either copper or aluminum. In either case, the connection surfaces will be silver plated.

All field assembled joints in conductors, regardless of material or method of insulation, should be made as follows:

(1) Wipe silver clean. Do not use sandpaper or any abrasive on the silvered surface. Avoid handling of cleaned surface as much as possible.

(2) A sufficient quantity of D50H47 grease should be applied to the joint at each contact area so that the complete contact area will be thoroughly sealed with excess grease squeezed out of the joint when tightened.

(3) Brush a thin coat of D50H47 over the outside surfaces of the joint area and hardware covering the silvered area.

(4) In some cases external connections are made to metal-clad bus by bars. The metal-clad bars are normally silver plated. Unplated bars, either copper or aluminum, should not be used to connect to silver plated bars.

MAIN BUS ASSEMBLY

(1) For 13.8 kv or 7.2 kv equipment:
(a) Remove compartment covers.

(b) Bolt splice plates and bus bars together, following assembly instructions above. See also Fig. 25 and Table A, Fig. 24.

TABLE A
Torque Values for Metal-clad Switchgear
(Torque in Inch-Pounds)

Bolt Size	Copper or Steel	Aluminum or Compound
3/8"-16	180-300	180-240
1/2"-13	360-540	360-480
5/8"-11	420-600	420-540

Fig. 24

(c) Complete the taping of the vertical riser bars using insulating tape furnished (2/3 lap) stopping the tape at the bus bar. If the riser bars connect to the bus from below, sufficient tape should be added to prevent compound leakage when filling. Apply a layer of glass tape (1/2 lap) over the insulating tape, stopping the glass tape just inside molded splice cover.

(d) Place molded covers around the bolted splice joints. Note that compound filling space is at top of joint, and add filler pieces furnished for the purpose to the bottom of box and around bus bar laminations (Fig. 20) to prevent compound leakage while filling. Duxseal should be placed over the joints to make the box free of leaks while filling. The Duxseal should be removed after the compound has set. G.E. #860 cord should be used to hold the molded parts securely in place.

(e) Heat G.E. D50H49 compound (furnished) to minimum 200°C and maximum of 220°C. Avoid overheating the compound for the dielectric strength may be seriously affected. Pour the compound into the molded covers intermittently, allowing an interval of cooling to prevent formation of gas or air pockets. The final pouring should be level with the top of the box and should be done only after due allowance for shrinkage is made. Refer to Fig. 15.

(f) Paint the exposed glass tape on vertical riser bars with U310 or U311 varnish furnished.

(g) Taped joints may be used instead of boxed joints. If they are, insulate as follows:

(1) Fill all cavities around bolts and nuts with Duxseal compound to form smooth surface for taping, thus preventing air voids. This compound is not an insulating medium and should not be used for that purpose.

(2) Place 4" wide Irrathene tape over the Duxseal, as shown in Fig. 26.

(3) Wrap with insulating tape provided, as shown in Fig. 39. Where there are sharp angles, apply additional layers to obtain the equivalent of the insulation of the flat surfaces.

(4) Over the insulating tape, apply one layer of glass tape, half lap, as a binder.

(5) Over the glass tape, brush a good coat of U-310 varnish. Varnish may be thinned if necessary, with Xylene, D5B9.

(h) Replace all covers previously removed.

(2) For 4.16 kv equipment:

(a) Remove compartment covers.

(b) Bolt splice plates and bus bars together, following assembly instructions. See Fig. 25 and Table A, Fig. 24.

(c) Place flexible molded cover over joint, as shown in Fig. 15. Note that on joints where no tap is made from bus the opening in the molded cover should be at the top.

(d) Secure flexible cover with self-locking fasteners furnished. Joint insulation is now completed.

(e) Replace all covers previously removed.

(3) In unit substations, the connection bars should be assembled in the transition compartment (Fig. 20 and 21) and the connections at the transformer terminals greased, taped and painted as indicated above. The conduit for secondary circuits should also be assembled in or below the transition compartment.

BUS DUCT

Bus ducts connecting between groups of metal-clad switchgear, or between metal-clad switchgear and other apparatus, should be installed as shown on the arrangement drawings furnished with the ducts. Supports should be provided as indicated on the drawings.

All joints in the bus, including adjustable joints, should be assembled and insulated as described above for main buses. Adjustable joints are provided in long runs of bus duct to allow for variations in building construction, etc. These joints should be loosened before installation of the duct, then tightened after being set in the position required by the fixed points at the ends of the duct.

Outdoor bus ducts must be gasketed at the joints between shipping sections. Coat both sides of the flat gasket and the flanges of both duct sections with Sterling U310 or U311 varnish before assembly. Bolt the two duct sections together. Remove the top cover from one duct section and place 3/8" elastic compound bead along top of joint. Bolt top cover in place and fasten roof cap in place over the joint. See Fig. 24A.

Removable front and rear covers of vertical sections of bus duct must also be

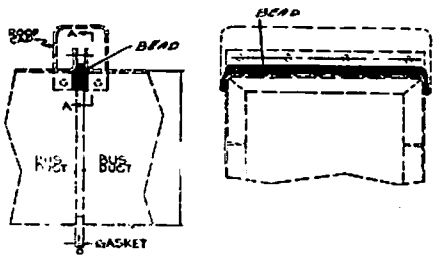


Fig. 24A Bus Duct Gaskets

Fig. 24A (121A6235)

gasketed. Coat both sides of the gasket, the flange of the duct, and the edges of the inside surface of the cover with Sterling U310 or U311 varnish before assembly. Do not bolt these covers in place until all interior assembly work on the duct is completed and access will no longer be required.

Outdoor bus ducts of the 13.8 kv class are provided with heaters. Connect these heaters in accordance with the wiring diagrams furnished with the equipment before energizing the bus duct.

PRIMARY CABLES

The primary cable connections in indoor switchgear are reached by removing the rear bolted covers. In outdoor switchgear with rear enclosures the hinged instrument panel, if present, must be swung open and the bolted covers behind it removed.

Before any primary cable connections are made, the cables should be identified to indicate their phase relationship with the switchgear connections. This is necessary to insure that motors will rotate in the proper direction and that the phase rotation is the same when interconnecting two different sources of power.

There are two common methods of making primary cable connections:

(a) Potheads (see Figs. 40 and 41) are used when it is desired to hermetically seal the end of the cable to make a moisture-proof connection between the cable and the switchgear bus. A pothead also prevents seeping of oil from the end of oil impregnated varnish cambric or paper insulated cable.

(b) Clamp type terminals and wiping sleeve or cable clamp.

In all cases carefully follow the cable manufacturer's recommendations for installation of the type of cable being used, as well as the instructions contained herein. See Figs. 43 and 44. If the cable is aluminum, the conductor surface must be carefully abraided and the cable covered liberally with a joint compound recommended by the cable manufacturer.

POTHEADS

Potheads are mounted on an adapter plate extending across the width of the metal-clad unit as shown in Fig. 10. Where necessary the adapter plate is split into two parts to facilitate the installation of the potheads.

Three-Conductor Potheads

The following description applies to the installation of a three-conductor lead-sheathed cable with a wiping sleeve cable entrance fitting on the pothead. This is the type most generally used. Instructions for installation of other types are included in the text following:

(a) Remove the wiping sleeve and cut the tapered end at a point where the cable will enter it freely, and file off sharp edges. Temporarily reassemble on the pothead.

(b) Train the cable in front of the pothead allowing it to extend about two inches above the top of the porcelain bushings. Handle with care and avoid sharp

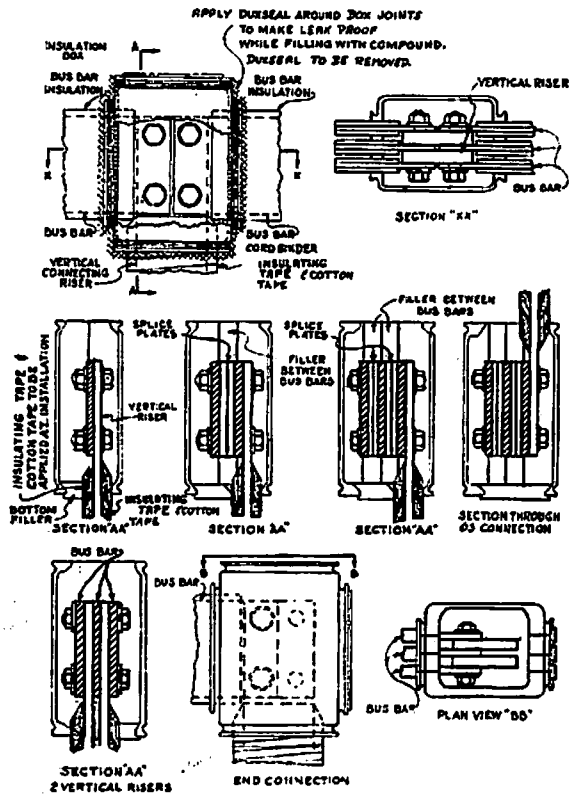


Fig. 25 Method of Making Bus Bar Connections

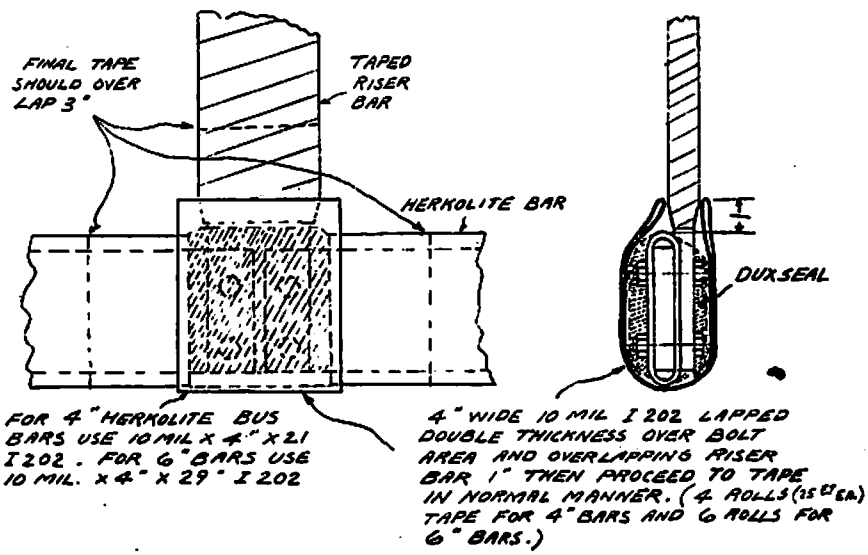


Fig. 26 13.8 KV Taped Joints

Fig. 27

Fig. 28

Fig. 29

Fig. 30

Fig. 27 (857623)
Fig. 28 (857622)
Fig. 29 (857621)

Fig. 31

Fig. 32

Fig. 33

Fig. 34

Fig. 30 (857618)
Fig. 31 (857611)
Fig. 32 (857606)

Fig. 35

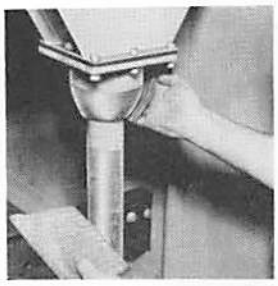


Fig. 36

Fig. 37

Fig. 38

Fig. 33 (857610)
Fig. 34 (857619)
Fig. 35 (857609)

bending which might damage the insulation. Mark a point on the lead sheath of the cable about 1-1/2 inch above the bottom of the wiping sleeve.

(c) Remove the pothead from the unit, disassemble the wiping sleeve and slip it and its gasket over the cable as shown in Fig. 27.

(d) Remove the lead sheath from the cable to the point marked in operation "b" as shown in Figs. 28 and 29 proceeding as follows:

First, make a cut around the cable half through the sheath at the reference point. Second, split the sheath lengthwise between the cut and the cable, holding the cutting tool at an angle to the cable radius to avoid damaging the insulation. Third, remove the sheath by catching the split edge with pliers and pulling directly away from the cable axis.

Clean and tin the outside of the lead sheath for about 3 inches and bell out the end of the lead sheath.

(e) Remove the belt and interphase insulation down to within 1-1/2 inches of the lead sheath as shown in Fig. 30. The last few layers should be torn off to avoid damaging the individual conductor insulation. To reinforce and protect the conductor insulation, wrap two layers of half lapped varnished cambric or irrathene tape over the factory insulation.

(f) Disassemble insulator support plate from pothead body. The insulators should not be removed from the support plate because they are factory assembled for proper compression of their gaskets. Place pothead body over cable and then fan out the conductors into approximately the final position, as shown in Figs. 31, 32. The middle conductor should be bowed slightly for final adjustment of length. Avoid sharp bends and damage to the insulation, particularly at the crotch.

(g) For system voltage above 7500 volts it is recommended that stress relief cones be built up when single-conductor or three-conductor shielded cable is used. Construct stress relief cones in accordance with the recommendations of the cable manufacturer. See Fig. 41 for one recommended method. On lower voltage cables, belling out the end of the lead sheath ordinarily provides sufficient stress relief. (Stress cone material will not be furnished with pothead).

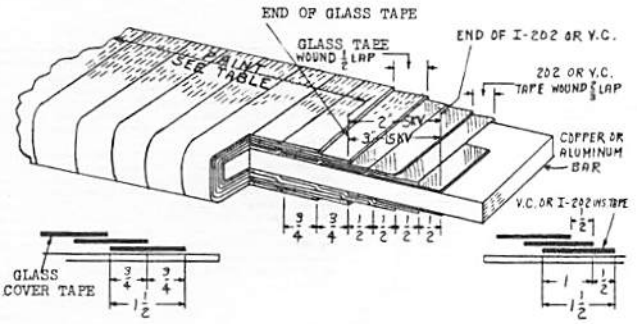
(h) Bolt pothead body to metal-clad adapter plate. Shape conductors into final position, then cut off each conductor to fit its terminals.

(i) Remove pothead terminals from insulators. Remove two inches of insulation from the end of each conductor and assemble pothead terminals to cables.

(j) Assemble gaskets where shown in Fig. 41 and bolt insulator support plate and wiping sleeve to pothead body. Compress gaskets by a partial turn on each bolt successively until the gasket is uniformly compressed to dimensions shown in Fig. 41. Check to be sure the terminal studs are seated properly on their gaskets, then screw contact nut in place after assembling top gaskets and washers. See Figs. 32, 33 and 34.

Fig. 36 (857604)
Fig. 37 (857607)
Fig. 38 (857608)

Fig. 39 (K-6500514)



INSULATION LEVEL	INSULATION LAYERS (NOTE 1) I-202 NOTE 2	GLASS NOTE 3	V.C. NOTE 4	PAINT APPLY ONE COAT LIBERALLY
5000V	2	1	4	STERLING U-311 BLACK
15,000V	4	1	7	STERLING U-310 BROWN

NOTE 1:
I-202 & V.C. - One layer, wound 2/3 lap requires 3 turns around bar in one width of tape. One layer thickness is 3 times tape thickness.
GLASS - One layer, wound 1/2 lap requires 2 turns around bar in one width of tape. One layer thickness is 2 times tape thickness.

NOTE 2:
Irrathene #202, width 1 1/2" thickness 0.010". Keep tension on tape at all times while applying.

NOTE 3:
Glass A2L12B width 1 1/2" thickness 0.004".

NOTE 4:
Varnished cambric A22A11A (#992) width 1 1/2", thickness 0.012".

Fig. 39 Insulation of Connection Bars

Fig. 40 (4194757)

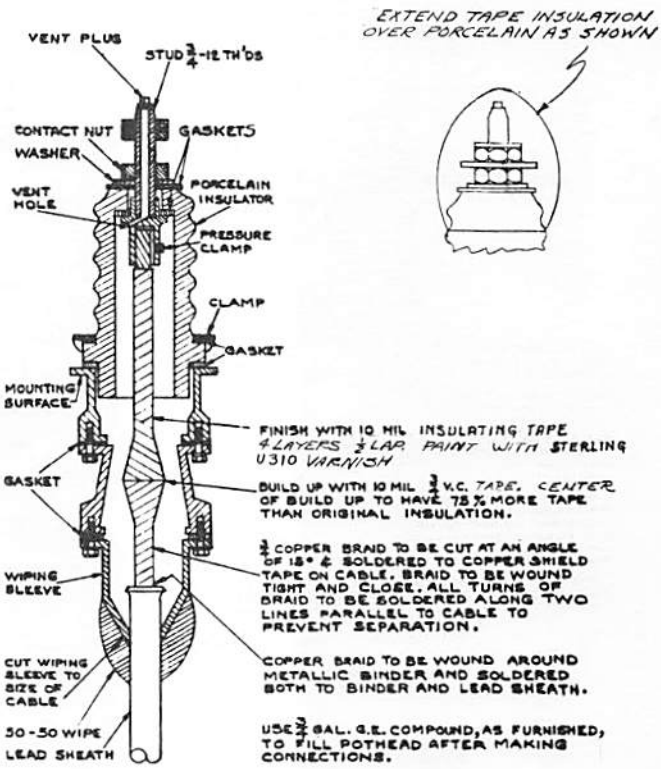


Fig. 40 Single-Conductor Pothead with Stress Cone

(k) Make a plumber's wiped joint between the wiping sleeve and the lead sheath of the cable, as shown in Figs. 35 and 36.

(l) Remove the 3/4" filling plug in the pothead body, the pipe plugs in the top of the studs and in the insulator support plate. Insert a stand pipe and funnel in the filling hole of sufficient height to extend above the top of the studs as shown in Fig. 37.

Heat compound to the pouring temperature, 165°C for #227 or 135-160°C for Novoid "X". Do not overheat compound as higher temperatures may injure cable insulation and also result in excessive shrinkage of the compound while cooling. Before and while filling, warm pothead body and stand pipe to prevent sudden chilling of compound which may result in the formation of air voids. The pothead may be warmed by playing a blowtorch over the body, taking care that no direct heat reaches the porcelains or gaskets.

Pour until the compound appears at the insulator support plate plug holes. Insert plugs and continue filling until it appears at holes at the top of terminal studs. Insert plugs and continue pouring while the pothead and compound cools to fill air voids which might form.

When the pothead has cooled, remove filling pipe and insert plug. Clean off compound which might have overflowed on the outside of the porcelains.

(m) Assemble pothead connection bars, applying grease as outlined under "Connections" (Page 20). See Fig. 39. Insulate connections as follows:

(1) Fill all cavities around bolts and nuts with Duxseal compound to form smooth surface for taping, thus preventing air voids. This compound is not an insulating medium and should not be used for that purpose.

(2) Wrap with I202 Irrathene tape provided, as shown in Figs. 39, 40 and 41, the number of layers depending on the voltage rating of the equipment. Where there are sharp angles, apply additional layers to obtain the equivalent of the insulation of the flat surfaces.

(3) Over the insulating tape, apply one layer of glass tape, half lap, as a binder.

(4) Over the glass tape, brush a good coat of varnish (U-310 for 15 kv and U-311 for 5 kv). Varnish may be thinned if necessary, with Xylene, D50B9.

Single-Conductor Potheads

The procedure for installation of single-conductor potheads is in general the same as described for three-conductor potheads.

Cable Entrances Other Than Wiping Sleeves

Stuffing box cable entrance fittings are used for cables other than lead sheathed. These fittings may be provided with or without armor clamps as necessary.

The fitting consists of a cast and machined base, one or more rubber or neoprene washers, and a packing nut which compresses the washers around the cable. These parts should be assembled on the cable in the above order, with the base nearest to the pothead. The packing nut should be tightened after the cable is located in the pothead and before any compound is poured.

Where an armor clamp is required, it is usually made an integral part of the packing nut. This requires that the packing nut and armor clamp be tightened on the cable before the assembly of the pothead is completed.

Cable Sheath or Conduit Grounding

Where three-conductor conducting sheath or shielded cables are used, or where non-conducting sheath cable is carried in metallic ducts or conduits, it is usually desirable that both ends of the cable sheath or conduit be grounded directly to the switchgear ground bus or structure or other apparatus. In some cases this may be accomplished by the mounting of potheads or terminating fittings on a grounded support. When such mounting cannot be arranged, a separate ground wire should be connected between the cable sheath or conduit and the switchgear ground bus.

Where single conductor conducting sheath cables are used, the same procedure should be observed, except that only one end of the sheath should be grounded. This also applies to single conductor non-conducting sheath cables in separate metallic conduits. Where three phases are carried by single conductors in a common metallic conduit, grounding procedure should be the same as that described for three conductor cables.

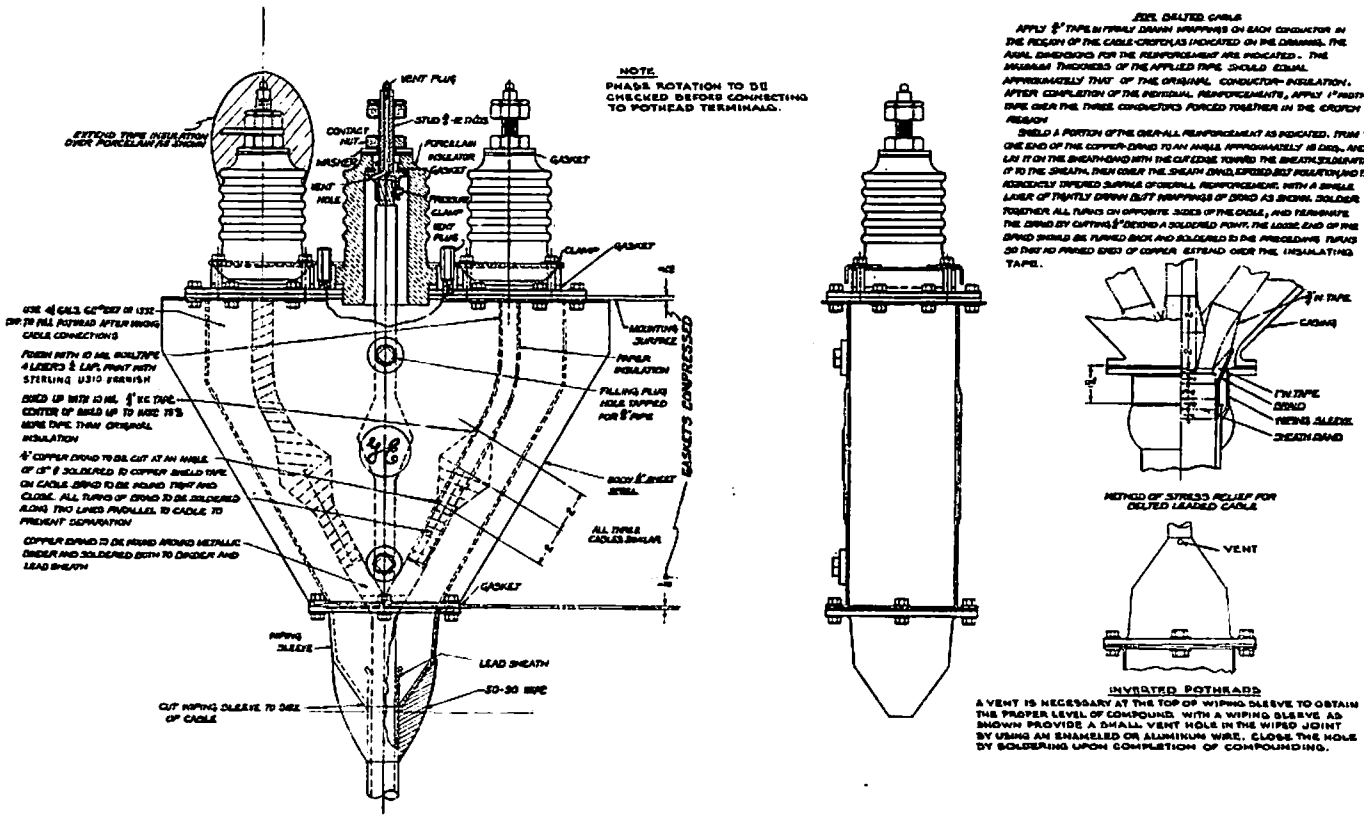


Fig. 41 (T-6595322)

Fig. 41 Triple-Conductor Pothead

TERMINATION WITHOUT POTHEAD SINGLE-CONDUCTOR

1. Cut cable to proper length.

2. Remove jacket and cable tape for distance of A plus B plus 3 inches, plus length to be inserted into terminal lug.

3. Unwrap shielding tape to point M, cut and solder it in place avoiding excessive heat on insulation. Remove outer semi-conducting tape for same distance. Thoroughly clean surface from which the semi-conducting tape was removed.

4. Remove insulation and inner semi-conducting tape to expose conductor for distance of one inch plus length to be inserted into terminal lug.

5. Attach terminal lug to conductor. If the cable is aluminum, the conductor surface must be carefully abraided and the cable covered liberally with a joint compound recommended by the cable manufacturer.

6. Taper insulation for one inch as shown.

7. Apply end seal. Clean surface over which splicing tape is to be applied and coat with G.E. No. A50P68 adhesive cement or equivalent. When solvent evaporates, build up with splicing tape GE8380 or equivalent, as shown.

Rated kv Phase to Phase	Dimensions in Inches	
	A*	
	Indoors Dry Locations	B
2 to 5	5	2
6 to 10	9	3
11 to 15	13	4

* For ungrounded neutral use 1.33 times the dimensions in selecting distance A.

8. Build stress cone. Clean cable surface and coat with G.E. No. A50P68 adhesive cement or equivalent. When solvent evaporates, build up cone with splicing tape GE-8380 or equivalent, for length B plus B. Between points M and P, tape is applied so that wrapped thickness at N is equal to 75% of the original insulation thickness - and so that the cone tapers to zero thickness at points M and P. Apply one layer No. 33 Scotch tape or equivalent, half lapped. Obtain a smooth wrapping but do not stretch tape more than necessary.

9. Pass a turn of tightly drawn braid around exposed portion of shielding tape at point M and solder in place. Then apply shielding braid in tightly drawn 1/6 inch lap wrappings to point N and spot solder. Terminate the braid by cutting 1/2 inch beyond soldering point. Turn down and solder loose ends to preceding turns. Wrap four to six turns of No. 19 AWG tinned copper wire around shielding braid and solder. Solder all turns of braid together along three lengthwise lines equally spaced around braided surface.

10. Solder ground strip over shielding tape near cable covering. Cover stress cone with one layer No. 33 Scotch tape, half lapped. Obtain a smooth wrapping but do not stretch tape more than necessary. Add two layers of splicing tape.

11. Pencil jacket for 1/2 inch as shown. Clean surface. Take particular care in cleaning outside jacket surface in order to entirely remove black wax finish. Coat with G.E. No. A50P68 adhesive cement or equivalent. When solvent evaporates, apply splicing tape GE8380 or equivalent and make sheath seal as shown on drawing. Apply one layer No. 33 Scotch tape or equivalent, half lapped. Obtain a smooth wrapping but do not stretch tape more than necessary.

12. Over entire termination, apply two layers of No. 33 Scotch tape or equivalent, half lapped, in manner to shed water. Obtain a smooth wrapping but do not stretch tape more than necessary.

Fig. 42 (8026383)

Fig. 43 (B230046C)

Fig. 44 (B232004C)

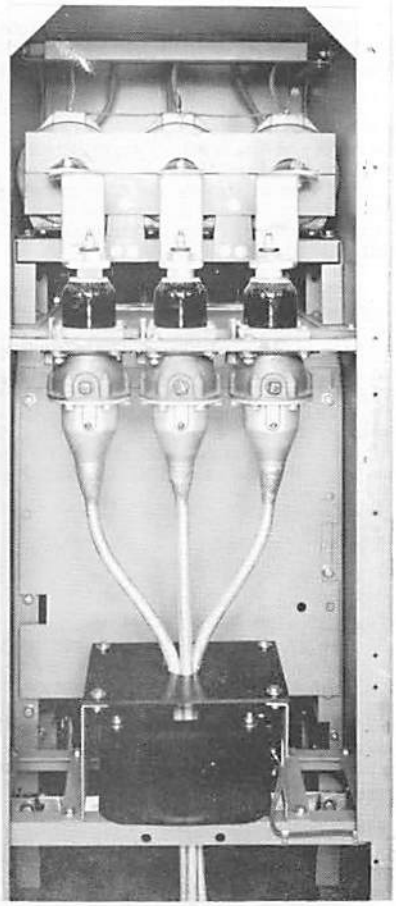


Fig. 42 Rear View of Unit Showing Through-Type Current Transformers

TERMINATION WITHOUT POTHEAD MULTI-CONDUCTOR

Make termination as indicated for single-conductor except - substitute the following for paragraphs 10, 11 and 12;

Pencil jacket 1/2 inch. Clean surface over which sheath moisture seal is to be applied. Take particular care in cleaning outside jacket surface in order to entirely remove black wax finish. Coat with G.E. No. A50P68 adhesive cement or equivalent. Allow to dry. Apply splicing tape GE8380 or equivalent to make moisture seal as shown. This is done by starting wrapping tape near end of jacket and wrapping over ground wires for 1-1/2 inches. Bend ground wires out and back over taping just applied and continue applying lapped layers of tape to completion of moisture seal including a complete tape seal in crotch formed between the three conductors. Bond and ground the ground wires.

For a multi-conductor cable not having ground wires, the individual terminations should have grounding strips applied as for a single-conductor termination. These

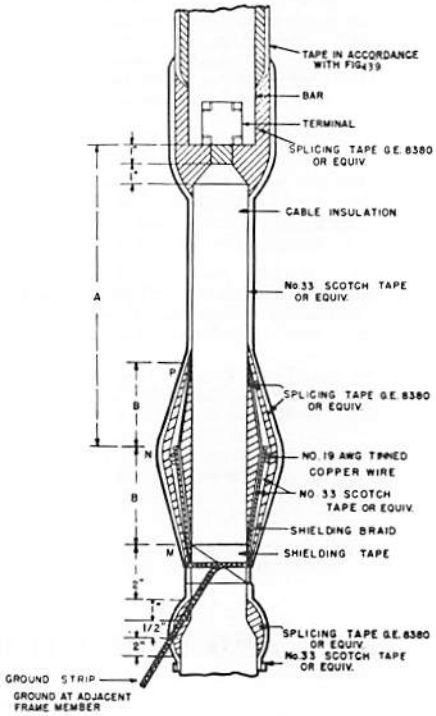


Fig. 43 Termination Without Pothead Single-Conductor

grounding strips are to be joined together to a common ground. This common ground must then be grounded.

GROUND FAULT CURRENT TRANSFORMERS (THROUGH-TYPE)

Through-type current transformers (see Fig. 42) are furnished where specified for sensitive protection against ground faults. These transformers are normally installed in a horizontal position directly above or below the primary cable terminals, so that the primary cable or cables can pass through them. One transformer is required for each three-phase circuit.

Where armored cable is used, the armor must be terminated and grounded before the cable passes through the transformer. Armor clamps are furnished for this purpose when specified.

When lead or other conducting sheath cable, or cable with shielding tape or braid is used, it is recommended that the sheath or shield be grounded solidly to the switchgear ground bus. The ground lead should be bonded to the sheath or shield on the side of the current transformer away from the primary terminals. In cases where the ground cannot be applied before the cable passes through the transformer, bond the lead to the sheath or shield between the transformer and the primary terminals. The ground conductor must then be passed back along the cable path through the current transformer before being connnected to the ground bus.

Where potheads are used in units provided with ground fault current transformers, the pothead mountings must be insulated from ground.

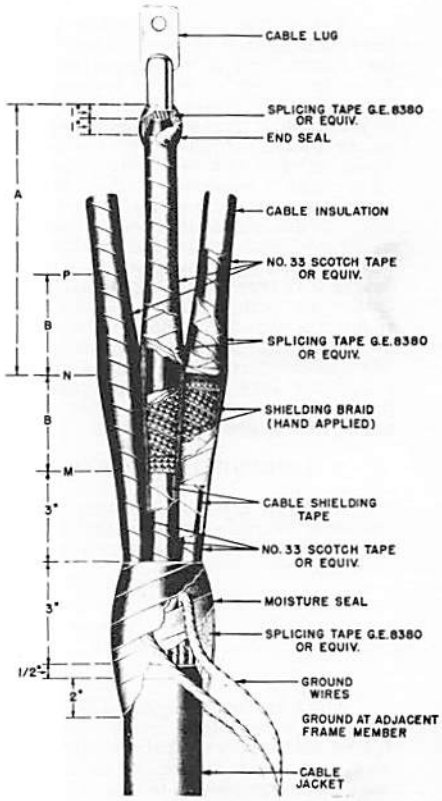


Fig. 44 Termination Without Pothead Multi-Conductor

CONTROL CABLES

When control conduits enter the unit from below, the conduit should not extend more than 4 inches above the floor. The control cables may be pulled through the conduits before or after the switchgear is installed, whichever is more convenient.

Connect the cables to the terminal blocks in accordance with the wiring diagrams furnished for the requisition.

If the control conduits enter from above, drill the top and bottom covers of the front enclosure wiring trough to suit the conduits. Fasten the conduits to the bottom cover with locknuts.

The cables from the control power source to the switchgear should be large enough to avoid excessive voltage drop when the circuit breakers are operated. See testing instructions.

Where units have been split for shipment, any control or other secondary leads which must connect across the split will be arranged with terminal blocks in the cross trough or convenient side sheet so that the wires can be reconnected. The wires will be cut to length and formed before being folded back so that a minimum of time will be required for reconnecting them.

GROUND BUS

The ground bus is bolted to the rear of the frame near the bottom. It is arranged so that connections to the station ground can be made in any unit. Where the equipment is shipped in more than one group, the sections of ground bus must be connected by using the splice plates furnished with the equipment. Apply grease and assemble joints as outlined under "Connections" (Page 20). Ground bus connections are made in the lower portion of the cable entrance compartment. The switchgear ground bus must be connected to the station ground bus by a conductor having a current carrying capacity equal to that of the switchgear ground bus. It is very important that the equipment be adequately grounded to protect the operator from injury when short circuits or other abnormal occurrences take place and to insure that all parts of the equipment, other than live parts, are at ground potential.

LIGHTNING PROTECTION

It will be the responsibility of the purchaser to provide suitable lightning arresters to protect the switchgear from damage due to lightning. The General Electric Company's recommendations as to the types of circuits requiring lightning protection, and a list of recommended lightning arresters, are contained in Bulletin GER-141, copies of which are available upon request.

DOOR ALIGNMENT

If for any reason it is necessary to realign the doors of metal-clad switchgear during installation the procedure given in the following paragraphs should be followed.

After checking that the switchgear is level and plumb as described above, start at either end of the switchgear lineup and realign each door individually as required.

The top of each door should be level with the adjacent doors; the sides of each door plumb; the surface of each door flush with the adjacent doors; and the space between adjacent doors equalized to permit their free swing and present a neat appearance. The door stops should be adjusted to permit a door swing of approximately 105°.

Doors may be raised or lowered vertically, or moved forward or backward horizontally, by loosening the hinge mounting nuts on the left side sheet and shifting the hinge and door assembly as allowed by the slotted holes in the hinge.

Doors may be shifted to the right or left by adding or removing washers or shims from between the hinge and side sheet.

Doors may be plumbed by slightly bending the appropriate hinges. To do this, open the door and insert a drift pin in either of the two holes in the hinge. Pulling forward on the drift pin will move the door to the right, and pushing back will move the door to the left. Adjust each hinge individually as required to plumb the door.

When properly aligned, the doors of outdoor switchgear should be tightly seated on the gasket all around. After aligning such doors, close and latch the door and check the seal by running a 3" x 5" card, shipping tag, IBM card, or some similar card around the edge of the door. If the card will pass between the door and the gasket, the door is improperly adjusted, and should be readjusted until the card will no longer pass through.

TESTING AND INSPECTION

After the equipment has been installed and all connections made, it should be tested and inspected before putting in service. Although the equipment and devices have been completely tested at the factory, a final field test should be made to be sure that the equipment has been properly installed and that all connections are correct and have not become loose in transportation. The primary equipment should be completely de-energized while the tests are in progress.

Directions for testing devices such as relays, instruments and meters are given in the instruction book furnished for each device. The settings of the protective relays must be coordinated with the other relays on the system and therefore these relays must be set by the purchaser. General instructions on setting the relays are given in the relay instruction books. Special instruction books are furnished for complicated automatic equipments, describing the sequence of operation of the devices required to perform the desired function.

When transformers are furnished to supply the control power, the primary taps should be selected so that the control voltage indicated on the wiring diagram is obtained on the secondary of the transformer. When a battery is used to supply the control power, the cables from the battery to the switchgear should be large enough to avoid excessive voltage drop. The voltage at the terminals of the breaker closing coils, when the breaker is being closed, should not be less than 112.5 volts for 125 volt coils and 225 volts for 250 volt coils.

The operation of the breaker with its associated devices may be tested in the unit while the equipment is energized by use of the test coupler which is furnished. Lower the breaker to the test or down position. Attach the test coupler to connect the breaker secondary disconnecting device to that on the structure.

High potential tests to check the integrity of the insulation are not necessary if the installation instructions in this book are carefully followed. If the purchaser wishes to make high potential tests the voltage should not exceed 75% of the AIEE factory test voltages.

Potential transformers and control power transformers must be disconnected during high voltage testing.

OPERATION

The operation of metal-clad switchgear is similar to that of other types except that it provides maximum safety to the operator and the feature of easy removal and replacement of the circuit breaker.

All circuit breaker removable elements of the same type and rating which have duplicate wiring may be interchanged.

BREAKER POSITIONING

To place the circuit breaker in operating position, proceed as given below:

Clean contacts and cover with a very thin coating of Contact Lubricant D50H47.

Push the breaker into the unit until it rests against the stop.

To raise the breaker, operate the elevating control selector switch on the elevating motor to "Raise". A clutch handle just above the elevating motor is then pulled forward until it closes the clutch limit switch and engages the motor to raise the breaker in the housing. The clutch handle is held in this position until a limit switch on the structure opens to stop the motor at the end of the upward travel of the breaker. The selector switch must not be used to energize or interrupt the motor circuit at any time.

To lower the breaker, proceed the same as for raising except operate selector switch to "Lower".

The clutch must be held in the engaged position; otherwise, a spring will return it to its normal position opening the electrical circuit to the motor.

The breaker may be raised and lowered by an emergency hand wrench which can be inserted after removing the motor.

The motor is removed by unlatching the motor assembly from the support and disconnecting the motor lead plug.

After removing the motor, pull the clutch forward and insert the manual wrench into the end of the clutch coupling. The breaker must be tripped before the wrench can be inserted and held in the clutch coupling.

TRANSFER TRUCKS

Circuit breaker transfer trucks are furnished with outdoor metal-clad switch-

gear to facilitate moving of circuit breakers from unit to unit or to maintenance areas. The platform at the front end of the transfer truck is adjustable in height. See Fig. 8, view A, for instructions for adjustment. The truck is equipped with two latches, one to hold the breaker on the truck and one to hold the truck to the metal-clad switchgear unit. Both latches engage automatically, and both are released by a single T-shaped foot pedal on the rear of the truck. Depressing the left side of the pedal unlatches the truck from the switchgear unit, and depressing the right side of the pedal unlatches the breaker from the truck.

SPACE HEATERS

Space heaters are provided in all outdoor equipment in order to keep the inside temperature several degrees higher than that outside. Heaters are also furnished for indoor equipment when it is known that abnormal atmospheric conditions exist at the installation, or when specified by the purchaser.

By maintaining a slight temperature differential, the heaters help facilitate drying and prevent condensation and the resulting corrosion and insulation deterioration which might occur.

Heaters are normally located at the sides of the breaker units, a few inches above the floor. In auxiliary compartments with a single rollout, the heaters will be in the space above the rollout. In auxiliary compartments with two rollouts, the heater will be on one of the rollouts, for greater accessibility. Heaters may also be located in superstructure compartments, transition compartments, and in bus ducts, if the operating conditions require them.

Before energizing the heaters, be sure the power source is of the proper voltage, frequency, and phase arrangement, and is connected in accordance with the wiring diagrams furnished with the equipment. Also, be sure to remove all cartons and miscellaneous material packed inside the units before energizing the heaters.

Heaters should be visually inspected several times a year to make sure they are operating properly.

It is recommended that the heaters be energized at all times and that thermostatic control not be used. If thermostatic control is used, the contacts of the thermostat should be set to close between 95 F and 100 F on falling temperature, de-energizing the heaters only when strong sunlight beats on the switchgear. Under no condition should a differential thermostat be used to control the heaters because under conditions of extremely high humidity this type of thermostat will not operate at all times to keep the heaters on enough to prevent condensation in the switchgear.

MAINTENANCE

A regular maintenance schedule should be established to obtain the best service and reliability from the switchgear. Plant operating and local conditions will dictate the frequency of inspection required. For specific information regarding the maintenance of devices, such as circuit breakers, relays, meters, etc., refer to the separate instruction book furnished for each device. The inspection cabinet, which is furnished, provides a convenient means for maintaining the circuit breakers. Under normal conditions the protective relays do not operate, therefore, it is important to check the operation of these devices regularly.

A permanent record of all maintenance work should be kept, the degree of detail depending on the operating conditions. In any event, it will be a valuable reference for subsequent maintenance work and for station operation. It is recommended that the record include reports of tests made, the condition of equipment and repairs and adjustments that were made.

BEFORE ANY COVERS ARE REMOVED OR ANY DOORS OPENED WHICH PERMIT ACCESS TO THE PRIMARY CIRCUITS, IT IS ESSENTIAL THAT THE CIRCUIT BE DE-ENERGIZED.

The primary circuits of metal-clad switchgear are insulated in order to reduce the size of the equipment. However, this insulation, except in one or two instances, requires a certain amount of air gap between phases and to ground to complete the insulation. Inserting any object in this air space, when equipment is energized, whether it be a tool or a part of the body, may under certain conditions, in effect, short circuit this air gap and may cause a breakdown in the primary circuit to ground and cause serious damage or injury or both.

Care should be exercised in the maintenance and checking procedures that accidental tripping or operation is not initiated.

The switchgear structure and connections should be given the following overall maintenance at least annually.

1. Thoroughly clean the equipment, removing all dust and other accumulations. Wipe clean the buses and supports. Inspect the buses and connections carefully for evidence of overheating or weakening of the insulation.

2. Measure the resistance to ground and between phases of the insulation of buses and connections. Since definite limits cannot be given for satisfactory insulation resistance values, a record must be kept of the reading. Weakening of the insulation from one maintenance period to the next can be recognized from the recorded readings. The readings should be taken under similar conditions each time if possible, and the record should include the temperature and humidity.

High potential tests are not required, but if it seems advisable, based on the insulation resistance tests or after repairs, the test voltage should not exceed 75% of the AIEE factory test voltage. Potential transformers and control power transformers must be disconnected during high voltage testing.

3. Clean elevating mechanism and lubricate jack screws and gears with lubricant G.E. Co. #D50H15 (Atlantic Ref. Co. #52 or equal).

4. Check primary disconnecting device contacts for signs of abnormal wear or overheating. Clean contacts with silver polish. Discoloration of the silvered surfaces is not ordinarily harmful unless atmospheric conditions cause deposits such as sulphides on the contacts. If necessary the deposits can be removed with a good grade of silver polish.

Before replacing breaker, apply a thin coat of contact lubricant D50H47 to breaker studs for lubrication.

5. Check to see that all anchor bolts and bolts in the structure are tight. Check tightness and continuity of all control connections and wiring.

6. If the switchgear is equipped with heaters, check to see that all heaters are energized and operating.

OUTDOOR ACRYLIC PAINT FINISH

The outside of standard outdoor switchgear has acrylic paint finish, blue gray ASA #24, providing improved resistance to all atmospheric conditions, longer life and less maintenance than with ordinary paint finishes.

If it is desired to refinish acrylic painted switchgear, it is necessary to use one of the following procedures in order to secure the best adhesion of the paint to the original finish.

A. Refinishing with Acrylic Paint. It is recommended that refinishing be done with Du Pont acrylic paint of the desired color. Obtain materials and instructions for application from the Du Pont Company.

B. Refinishing with Alkyd or Oil Base Paints. Two methods are recommended:

1. Spray one sealer coat of Du Pont 233E75300 or equivalent which has been reduced to spraying viscosity with Du Pont 37692 or 37666 thinner. Air dry for one hour. Apply alkyd or oil base paint.

2. Spray one sealer coat of Arco 214-806 primer which has been reduced to spraying viscosity with Xylol. Air dry for one hour. Apply alkyd or oil base paint.

RENEWAL PARTS

ORDERING INSTRUCTIONS

1. RENEWAL PARTS SHOULD BE ORDERED FROM THE HIGH VOLTAGE SWITCHGEAR DEPARTMENT.
2. ALWAYS SPECIFY THE REQUISITION NUMBER ON WHICH THE EQUIPMENT WAS ORIGINALLY FURNISHED.
3. SPECIFY THE QUANTITY, REFERENCE NUMBER, DESCRIPTION AND THIS BULLETIN NUMBER.
4. STANDARD HARDWARE, SUCH AS SCREWS, BOLTS, NUTS, WASHERS, ETC., IS NOT LISTED. SUCH ITEMS SHOULD BE PURCHASED LOCALLY.
5. FOR PRICES, REFER TO THE NEAREST OFFICE OF THE GENERAL ELECTRIC COMPANY.
6. IF INSULATING MATERIAL, SUCH AS TAPE, VARNISH, COMPOUND, ETC., IS REQUIRED, IT MUST BE SPECIFIED SEPARATELY.
7. IF PARTS LISTED SEPARATELY ARE TO BE ASSEMBLED AT THE FACTORY, ORDER MUST SO STATE.
8. NOT ALL PARTS LISTED HEREIN WILL BE USED ON ANY ONE EQUIPMENT. PARTS NOT USED IN ORIGINAL EQUIPMENT SHOULD NOT BE ORDERED AS RENEWAL PARTS.

PRIMARY DISCONNECT DEVICES (SEE FIG. NO. 10)

REF. NO.	DESCRIPTION
5	Front Primary Disconnect Device Assembly, 3 Pole, Complete with Connections
6	Rear Primary Disconnect Device Assembly, 3 Pole, Complete with Connections

NOTE: Insulating material required for Ref. Nos. 5 and 6 will be furnished with order.

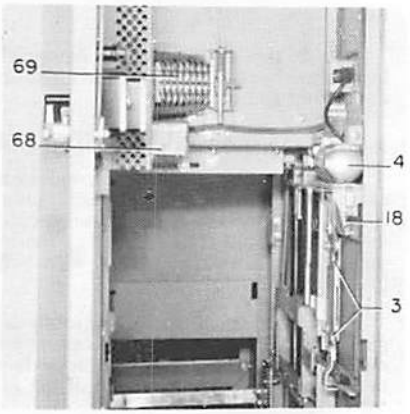
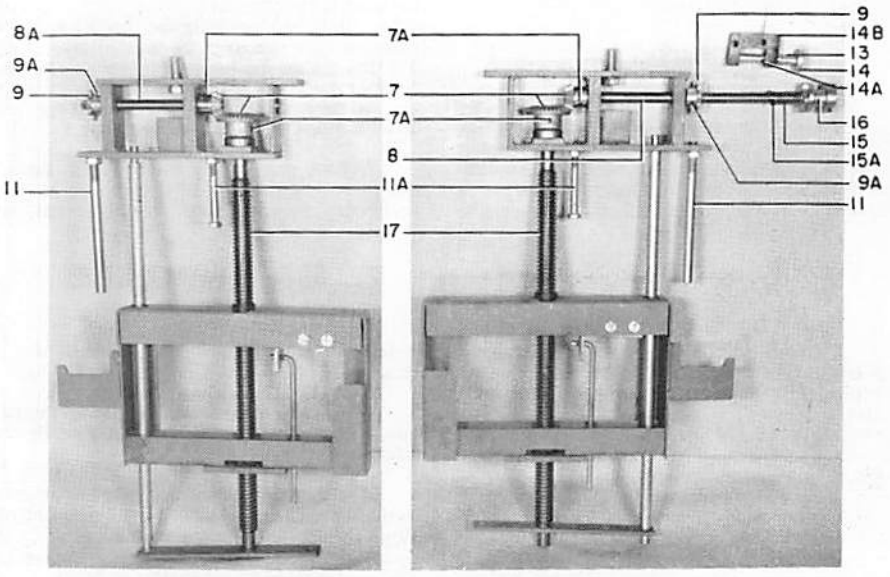


Fig. 45A View Showing Elevating Mechanism Motor and Control Unit

POSITIVE MECHANICAL INTERLOCK (FIG. NO. 45A)

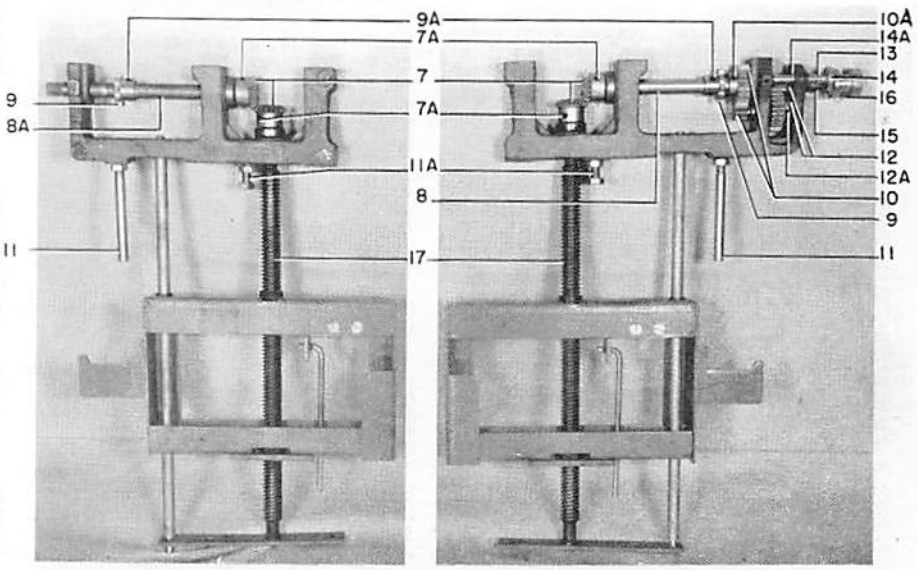
REF. NO.	DESCRIPTION
3	Complete positive mechanical interlock assembly
4	Elevating mechanism motor (115-v d-c)
4	Elevating mechanism motor (230-v d-c)
4	Elevating mechanism motor (230-v d-c)
18	Spring only



Complete Left Hand (Ref. No. 1) Complete Right Hand (Ref. No. 2)

Fig. 45A (8024142)

Fig. 45 Elevating Mechanism for M-26 Equipments Rated 250 mva or less and M-36 Equipments Rated 1200A 500 mva or less



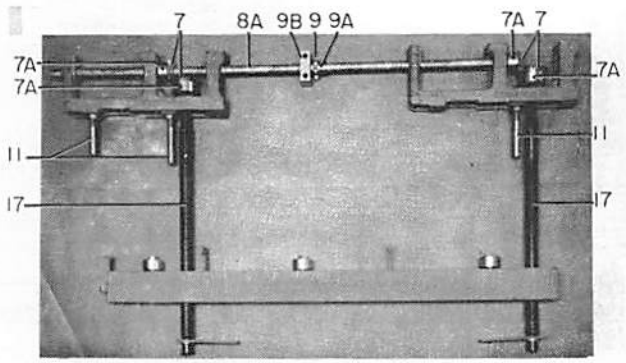
Complete Left Hand (Ref. No. 1A) Complete Right Hand (Ref. No. 2A)

Fig. 45 (8024360)

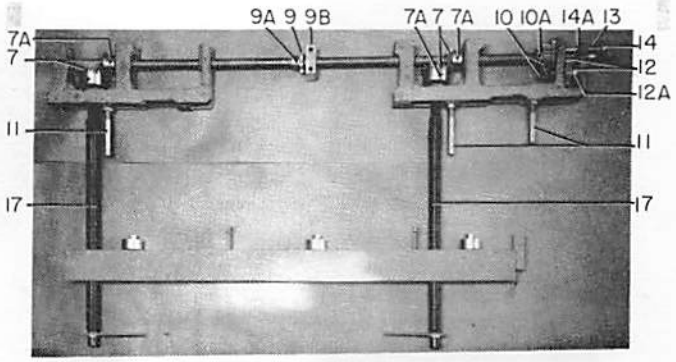
Fig. 46 (8024362)

Fig. 46 Elevating Mechanism for M-36H Equipments Rated 750 mva, M-26H Equipments Rated 350 mva and M-36 Equipments Rated 2000A

Fig. 46A (8027408 & 80274



Complete Left Hand (Ref. No. 1B)



Complete Right Hand (Ref. No. 2B)

Fig. 46A Elevating Mechanism for M-36HH Equipments Rated 1000 MVA

Fig. 47 (8024364)

ELEVATING MECHANISMS
Figs. 45, 46 and 46A

REF. NO.	DESCRIPTION
7	Miter gears, pair
7A	Roll pin for miter gear
8	Shaft, right
8A	Shaft, left
9	Sprocket
9A	Roll pin for sprocket
9B	Bearing Block
10	Spur gear
10	Pinion gear and rod
10A	Roll pin for spur gear
11	Stop stud
11A	Stop bolt
12	Pinion gear and rod
12	Spur gear
12A	Roll pin for spur gear
13	Locking spring
14	Stop shaft
14A	Roll pin for stop shaft
14B	Stop shaft bracket
15	Clutch spring
15A	Roll pin for clutch spring
16	Slide Clutch
17	Jack Screw

Fig. 48 (8024366)

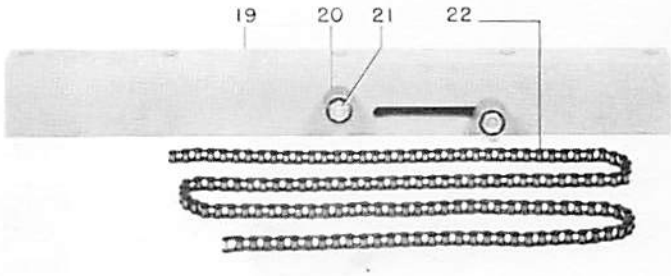


Fig. 47 Angle Bracket and Chain Drive

REF. NO.	DESCRIPTION
19	Bracket
20	Roller
21	Retainer
22	Chain

Fig. 49 (8027367)

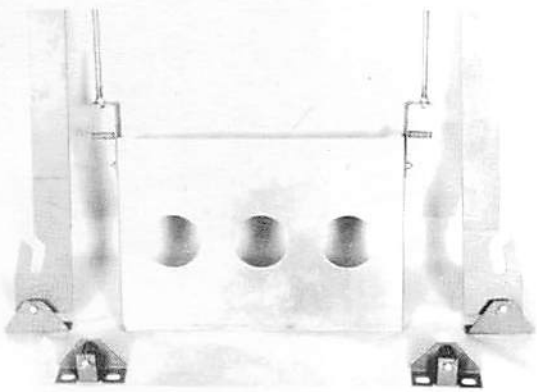


Fig. 48 Shutter Mechanism Assembly M-26

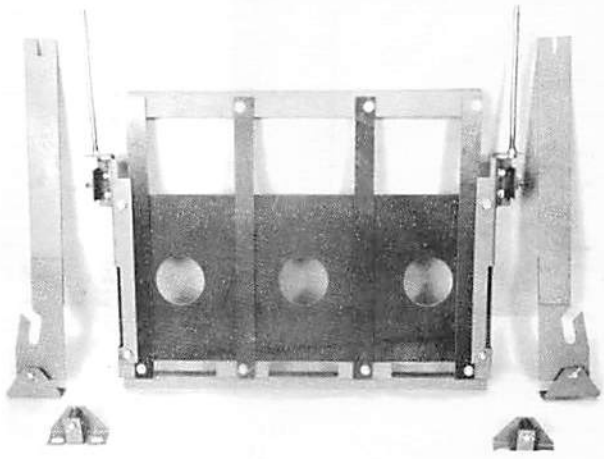


Fig. 49 Shutter Mechanism Assembly M-36

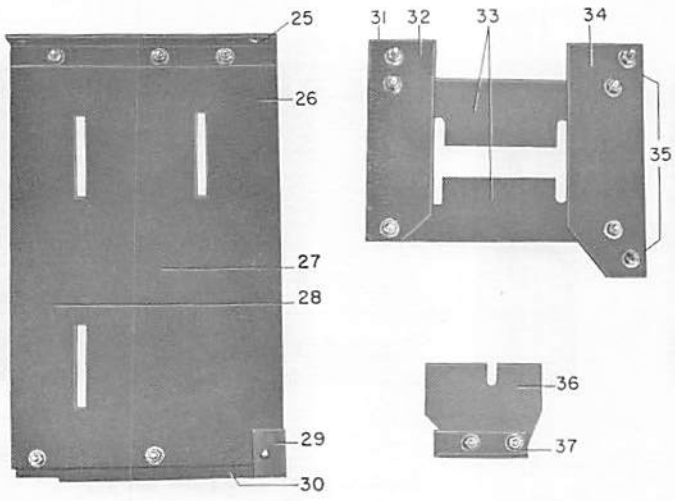


Fig. 50 Bus Supports

REF. NO.	DESCRIPTION
25	Isolating barrier support angle
26	Rear isolating barrier
27	Intermediate isolating barrier
28	Front isolating barrier
29	Isolating barrier clip
30	Isolating barrier support
31	Front support clip (not shown)
32	Front intermediate support
33	Intermediate support
34	Rear intermediate support
35	Rear support clip (not shown)
36	Lower intermediate support
37	Lower intermediate support clip

REF. NO.	LOCATION	RATING	DESCRIPTION
38	int.	1200A.	1 connection bar, down
39	int.	1200A.	1 connection bar, up
40	end	1200A.	1 connection bar, down
41	end	1200A.	1 connection bar, up
42	int.	1200A.	no connection bar
43	end	1200A.	no connection bar
44	int.	1600A.	1 connection bar, down
45	int.	1600A.	1 connection bar, up
46	end	1600A.	1 connection bar, down
47	end	1600A.	1 connection bar, up
48	int.	1600A.	no connection bar
49	end	1600A.	no connection bar
50	int.	2000A.	1 connection bar, down
51	int.	2000A.	1 connection bar, up
52	end	2000A.	1 connection bar, down
53	end	2000A.	1 connection bar, up
54	int.	2000A.	no connection bar
55	end	2000A.	no connection bar
56	int.	2000A.	2 connection bars, down
57	int.	2000A.	2 connection bars, up
58	end	2000A.	2 connection bars, down
59	end	2000A.	2 connection bars, up
59A	*	*	Insulating boot
59B			Plastic rivet for boot

* Specify unit number and phase on which boot is to be used.

Fig. 50 (8020152)

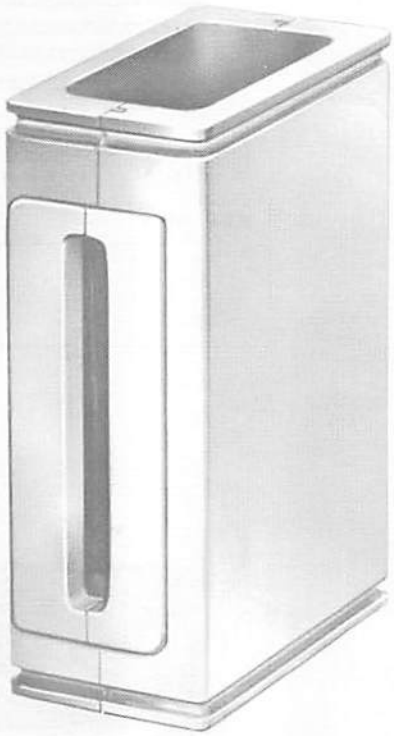


Fig. 51 (8012365)

Fig. 51 Bus Connection Box
(4.16 or 13.8 kv Units)

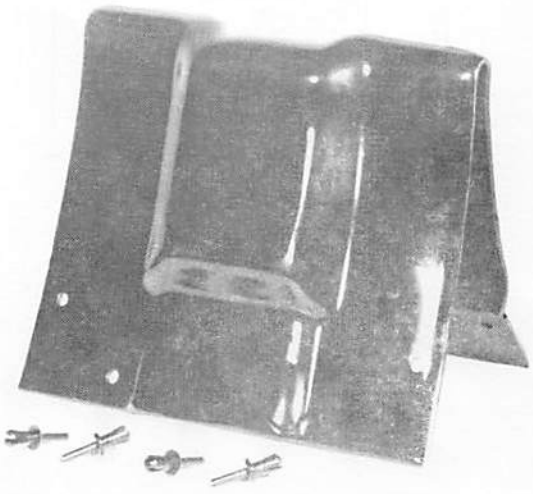


Fig. 52 (8026455)

Fig. 52 Bus Connection Boot
(4.16 kv Units Only)

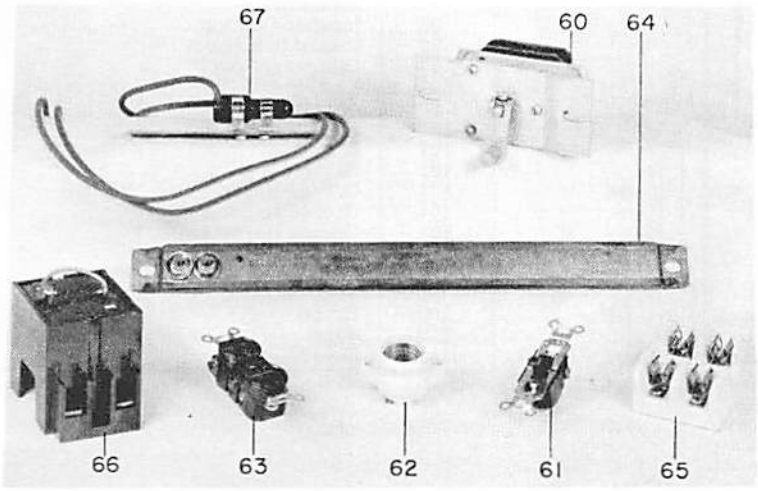


Fig. 53 Wiring Devices and Miscellaneous Parts

REF. NO.	DESCRIPTION
60A	Limit Switch SB1 type (upper)
60B	Limit switch SB1 type (lower)
61	Light switch
62	Keyless receptacle
63	Duplex receptacle
64	Strip heater
65	Fuse block, open type*
66	Fuse block, dead front*
67	Limit switch, mercury type
See Fig. 45A 68	Complete secondary disconnect device
See Fig. 45A 69	Complete stationary auxiliary switch and mechanism

* Specify amp rating of fuse and number of poles.

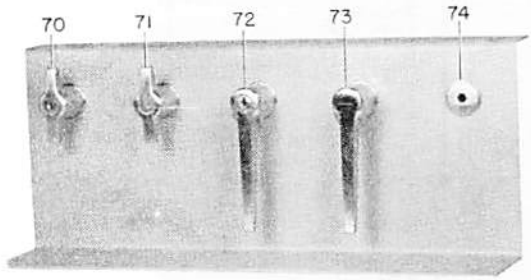


Fig. 54 Door Handles and Locks

REF. NO.	DESCRIPTION
70	Panel locking handle
71	Panel handle
72	Door locking handle
73	Door handle
74	Socket

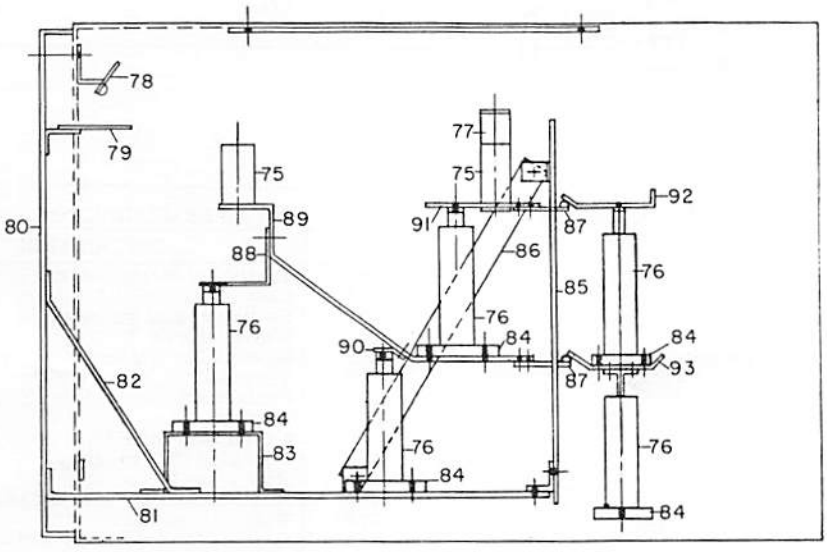


Fig. 55 Fuse Rollout Unit

FUSE ROLLOUT UNIT

REF. NO.	DESCRIPTION
75	Fuse clip
76	Insulator
77	Ground Bar
78	Ground Finger
79	Barrier
80	Cover
81	Tray
82	Strap
83	Insulator Support
84	Insulator Clamp
85	Barrier
86	Compound Strap
87	Finger
88	Connection bar
89	Connection bar
90	Connection bar
91	Connection bar
92	Connection bar
93	Connection bar

Fig. 53 (8024363)

Fig. 54 (8011607)

Fig. 55 (835C403)

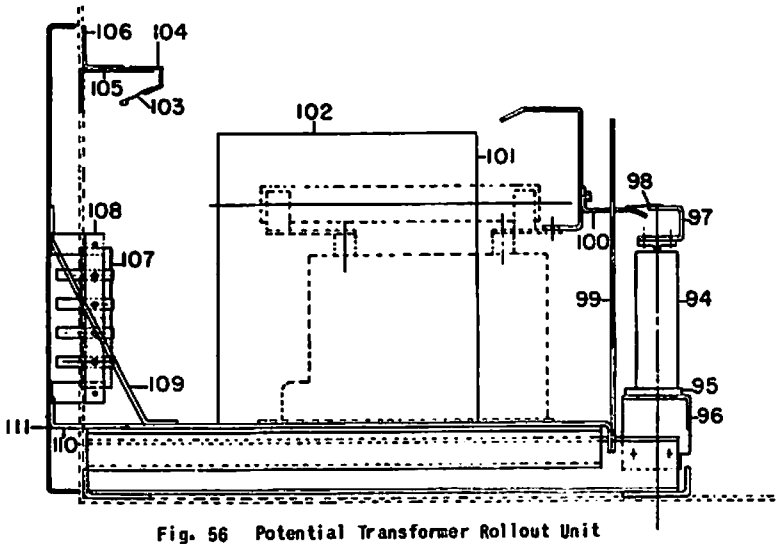


Fig. 56 Potential Transformer Rollout Unit

POTENTIAL TRANSFORMER ROLLOUT UNIT	
REF. NO.	DESCRIPTION
94	Insulator
95	Insulator clamp
96	Insulator support
97	Disconnect bar1
98	Finger
99	Barrier
100	Disconnect bar
101	Disconnect bar
102	Barrier
103	Ground finger
104	Ground finger support
105	Ground finger support
106	Barrier
107	Sec. disconnect (stationary)
108	Sec. disconnect (movable)
109	Brace
110	Tray
111	Cover

Fig. 56 (835C401)

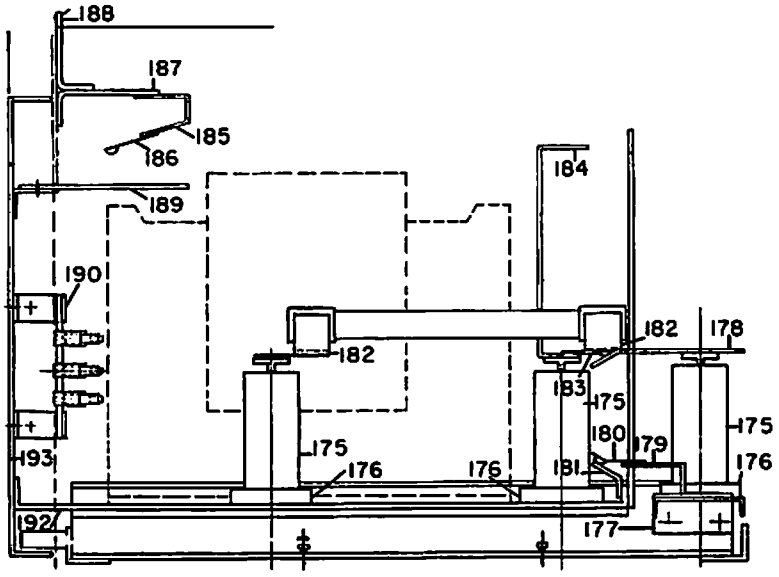


Fig. 57 Control Transformer Rollout Unit

CONTROL TRANSFORMER ROLLOUT UNIT	
REF. NO.	DESCRIPTION
175	Insulator
176	Insulator clamp
177	Insulator support
178	Contact bar
179	Ground finger support
180	Ground finger
181	Ground shoe contact
182	Fuse clip
183	Primary contact
184	Ground bar
185	Ground finger support
186	Ground finger
187	Cross angle
188	Barrier
189	Barrier
190	Sec. disconnect (movable)
191	Sec. disconnect (stationary) (not shown)
192	Tray
193	Cover

Fig. 57 (835C402)

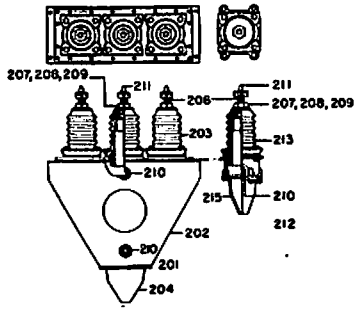


Fig. 58 Single and Triple-Conductor Potheads

SINGLE & TRIPLE-CONDUCTOR POTHEADS	
REF. NO.	DESCRIPTION
201	Triple-conductor pothead assembly
202	Body
203	Insulators and support
204	Wiping sleeve
205	Gaskets for triple-conductor pothead
206	Terminal
207	Contact nut
208	Washer
209	Palnut (3/4 in. - 12)
210	Pipe plug (3/4 in. std.)
211	Pipe plug (1/8 in. std.)
212	Single-conductor pothead assembly
213	Body and insulator
214	Gaskets for single-conductor pothead
215	Wiping sleeve

Fig. 58 (710340)

INSTRUCTIONS

GEH-1802K
(SUPERSEDES GEH-1802J AND GEF-3837)

METAL-CLAD SWITCHGEAR

Types M-26 and M-36
For Magne-blast Air Circuit Breaker
Types AM-4.16 and AM-13.8

MEDIUM VOLTAGE SWITCHGEAR DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA, PA.

LIST OF ILLUSTRATIONS

CONTENTS

OUTDOOR ACRYLIC PAINT FINISH

The outside of standard outdoor switchgear has an acrylic paint finish, blue gray ASA#24, providing improved resistance to all atmospheric conditions, longer life and less maintenance than with ordinary paint finishes.

If it is desired to refinish acrylic painted switchgear, it is necessary to use one of the following procedures in order to secure the best adhesion of the paint to the original finish.

A. Refinishing with Acrylic Paint. It is recommended that refinishing be done with DuPont acrylic paint of the desired color. Obtain materials and instructions for application from the DuPont Company.

B. Refinishing with Alkyd or Oil Base Paints. Two methods are recommended:

(1) Spray one sealer coat of DuPont 233E75300 or equivalent which has been reduced to spraying viscosity with DuPont 37692 or 37666 thinner. Air dry for one hour. Apply alkyd or oil base paint.

(2) Spray one sealer coat of Arco 214-806 primer which has been reduced to spraying viscosity with Xylol. Air dry for one hour. Apply alkyd or oil base paint.

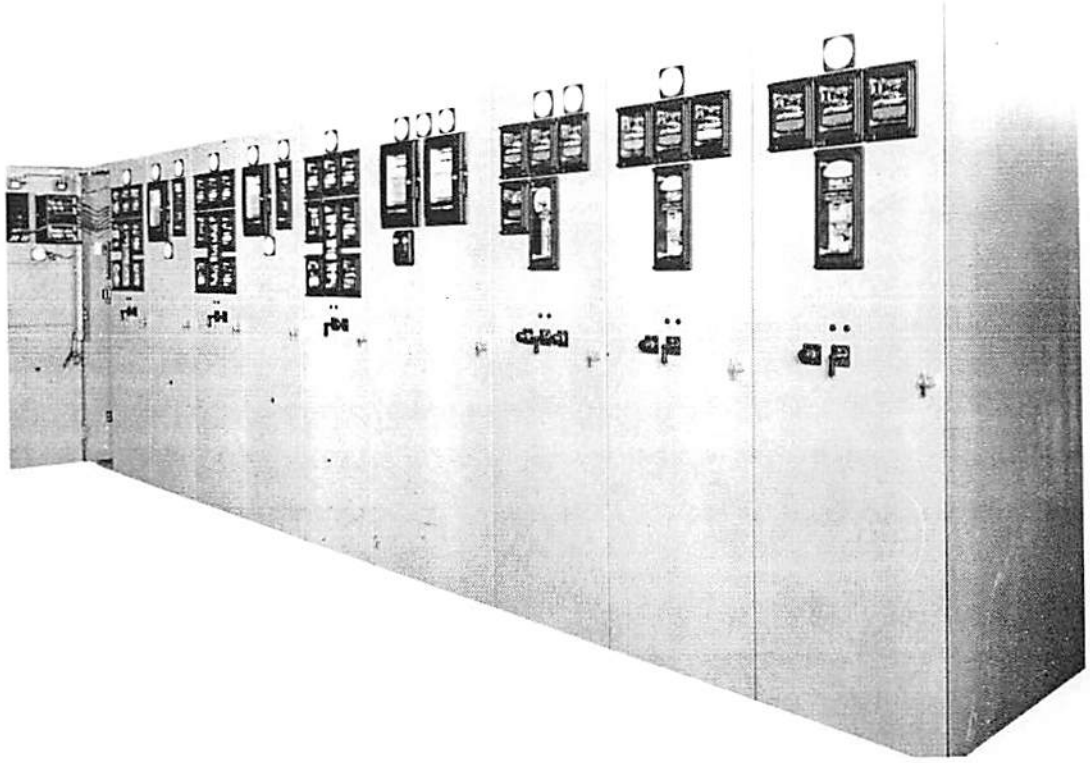


Fig. 1 (8021315)

Fig. 1 Typical Indoor Metal-clad Switchgear Equipment

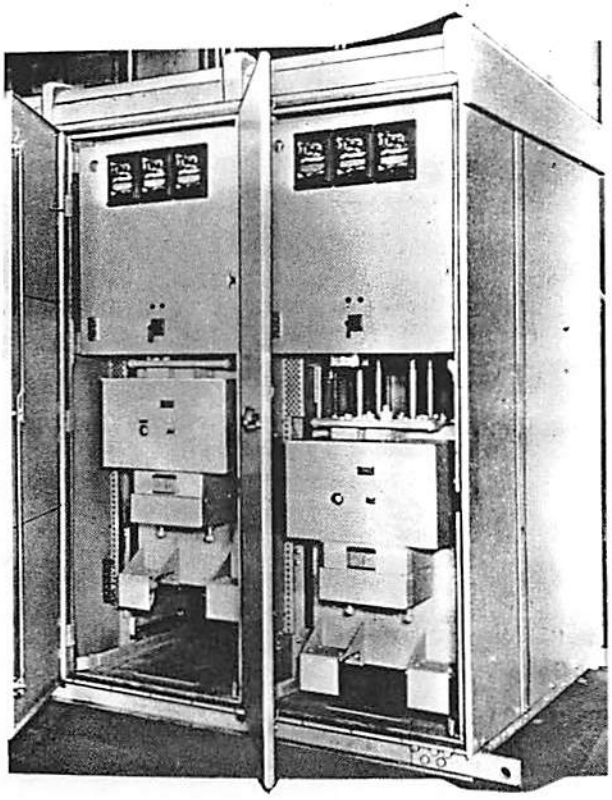


Fig. 2 (1169287)

Fig. 2 Typical Outdoor Metal-clad Switchgear Equipment - Front View

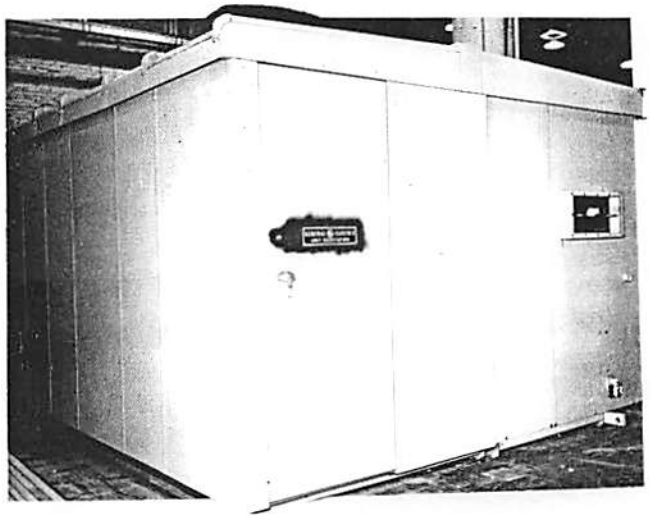


Fig. 3 (8025290)

Fig. 3 Typical Outdoor Metal-clad Switchgear Equipment With Protected Aisle - Side View

METAL-CLAD SWITCHGEAR
TYPES M26 AND M36
FOR MAGNE-BLAST AIR CIRCUIT BREAKER TYPES AM-4.16 AND AM-13.8

Metal-clad switchgear is equipment to control and protect various types of electrical apparatus and power circuits.

The switchgear consists of one or more units which are mounted side by side and connected mechanically and electrically together to form a complete switching equipment. Typical equipments are shown in Figures 1, 2 and 3.

The circuit breakers are easily removable to provide maximum accessibility for maintenance with minimum interruption of services. The switchgear is designed to provide maximum safety to the operator. All equipment is enclosed in grounded metal compartments.

The equipment is available in the ratings listed in the following table. The ratings of the equipment and devices are based on usual service conditions as covered in AIEE and NEMA standards. Operation at currents above the equipment rating will result in temperature rises in excess of NEMA standards, and is not recommended. For outdoor installation the same basic equipment is built into a weatherproof housing as in Figures 2 and 3.

TYPE M-26			
CIRCUIT BREAKER	INTERRUPTING CAPACITY KVA	CURRENT	FIGURE
TYPE M-26			
AM-4.16-150	150,000	1200	4
AM-4.16-250	250,000	1200 - 2000	4
AM-4.16-350	350,000	1200 - 3000	5
TYPE M-36			
AM-13.8-150	150,000	1200	4
AM-13.8-250	250,000	1200	4
AM-13.8-250	500,000	1200 - 2000	4
AM-13.8-750	750,000	1200 - 2000	4
AM-13.8-1000	1,000,000	1200 - 3000	6
AM-7.2-250	250,000	1200	4
AM-7.2-500	500,000	1200 - 2000	4

Fig. 4 (8012851)

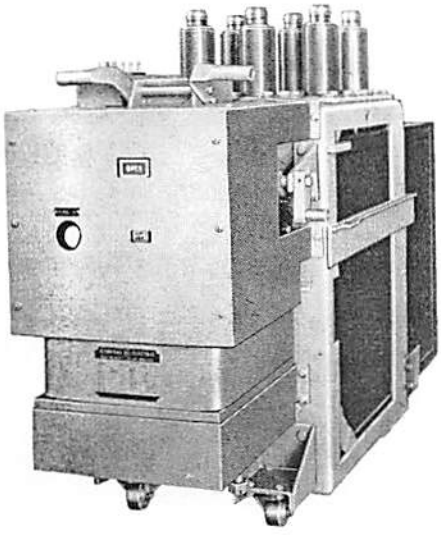


Fig. 4

Fig. 5 (8023154)

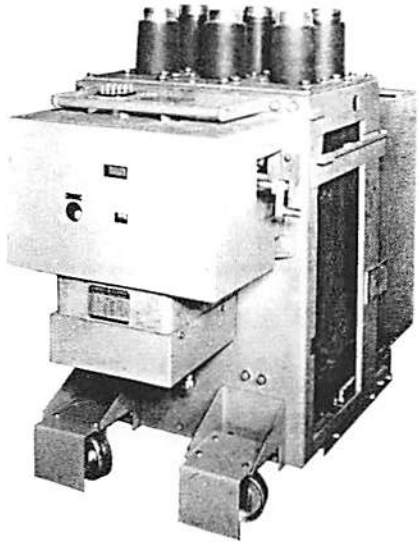


Fig. 5

Fig. 6 (8024212)

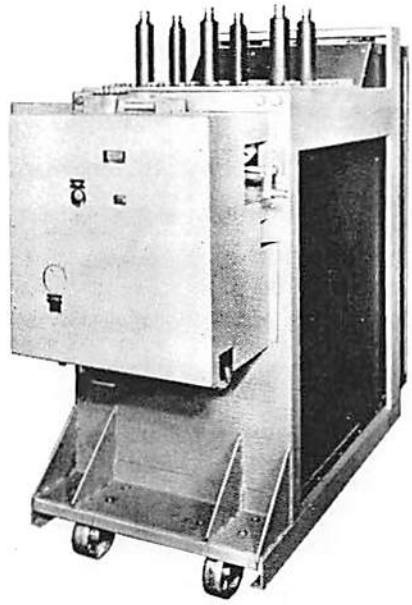
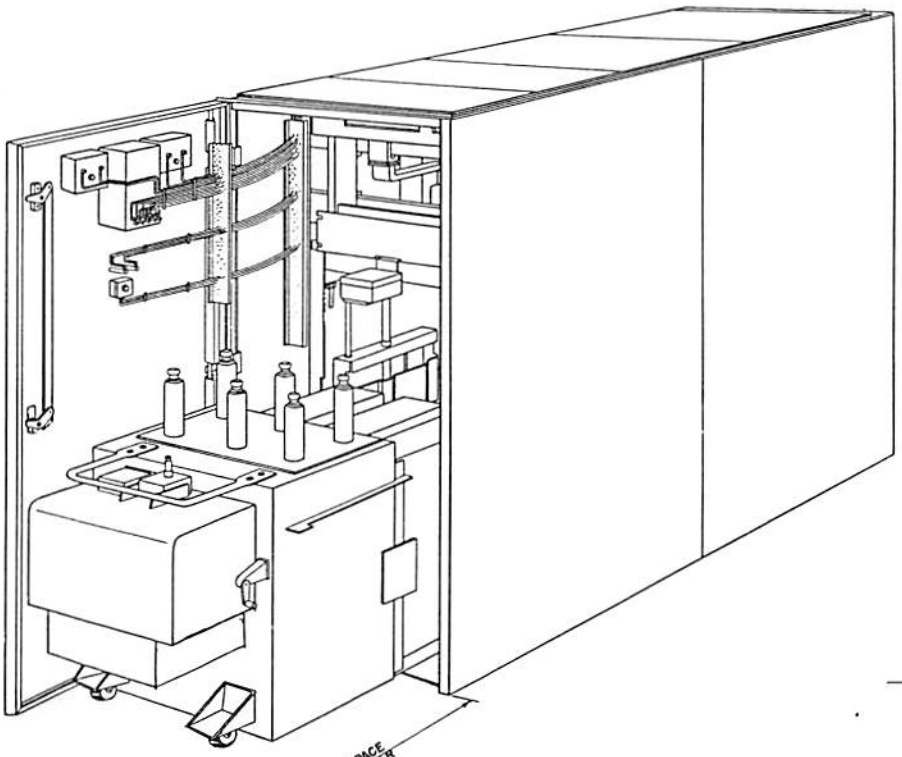


Fig. 6

Magne-blast Breakers

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.



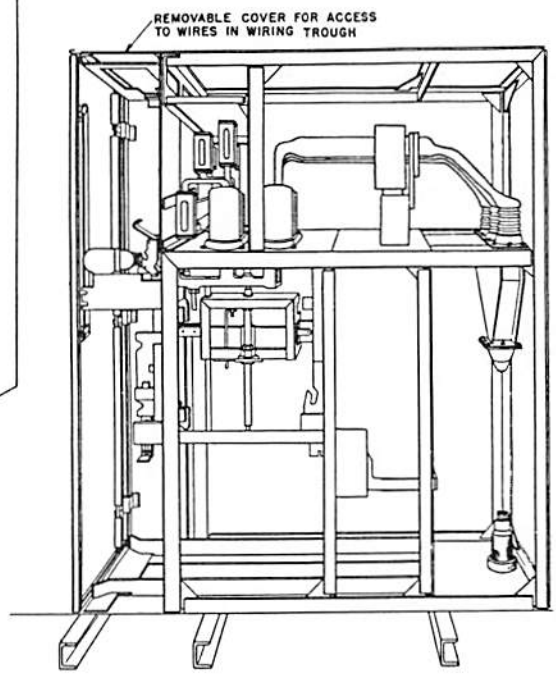
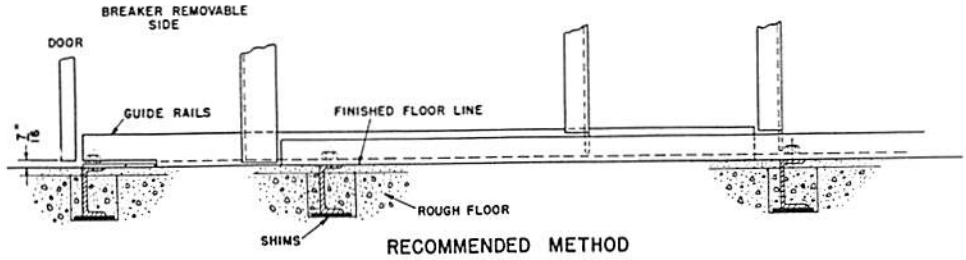


Fig. 7 (TT-6482630)

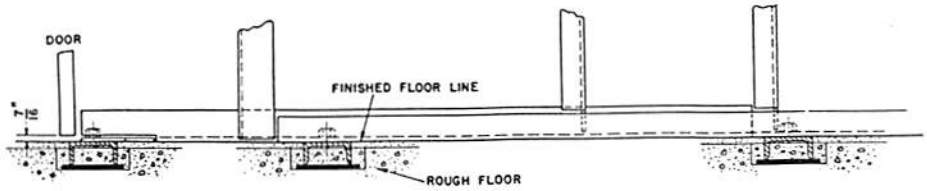
ALL FLOOR STEEL TO BE FURNISHED BY PURCHASER

CHANNELS SHOULD BE SET LEVEL WITH EACH OTHER AND SHOULD BE LEVEL OVER THEIR FULL LENGTH

ROUGH FLOOR THICKNESS AND REINFORCING DEPENDS ON LOADING AND OTHER NORMAL FACTORS, AND SHOULD BE DESIGNED IN ACCORDANCE WITH RECOMMENDED PRACTICE



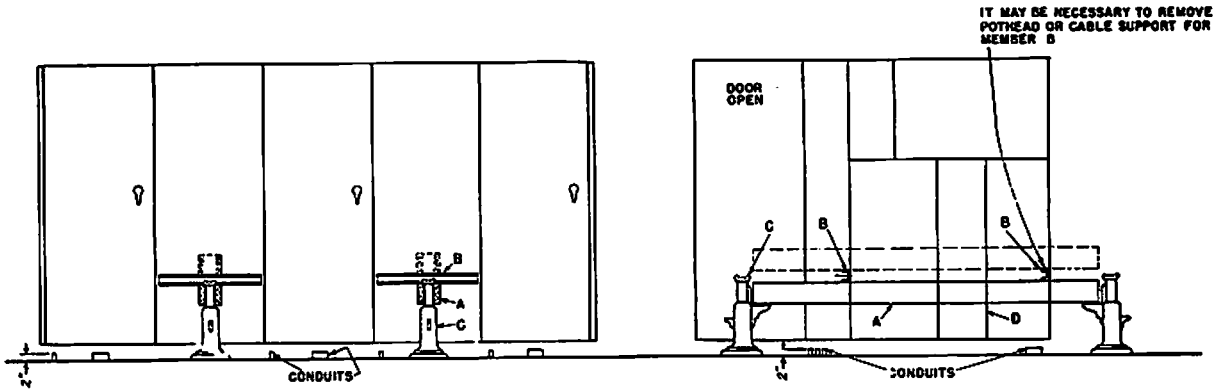
RECOMMENDED METHOD



ALTERNATE METHOD

NOTE: IT IS IMPERATIVE THAT FLOOR STEEL BE EVEN WITH FINISHED FLOOR AND THAT BOTH BE LEVEL

Fig. 7 Installation Details



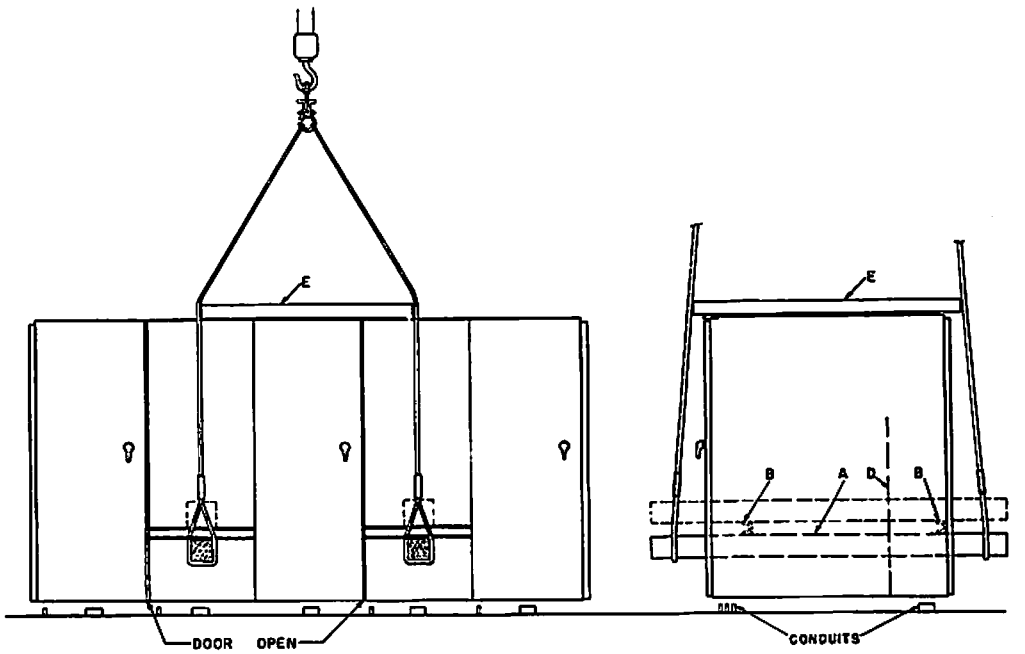
METHOD OF LIFTING

MEMBERS A-B C ——— TO BE FURNISHED BY PURCHASER
A - RAISING MEMBER - CHANNEL OR WOOD BEAM

B - 3" CHANNEL FURNISHED WITH GEAR

C - LIFTING JACKS
D - COVER TO BE REMOVED AND REASSEMBLED AFTER UNITS ARE IN PLACE

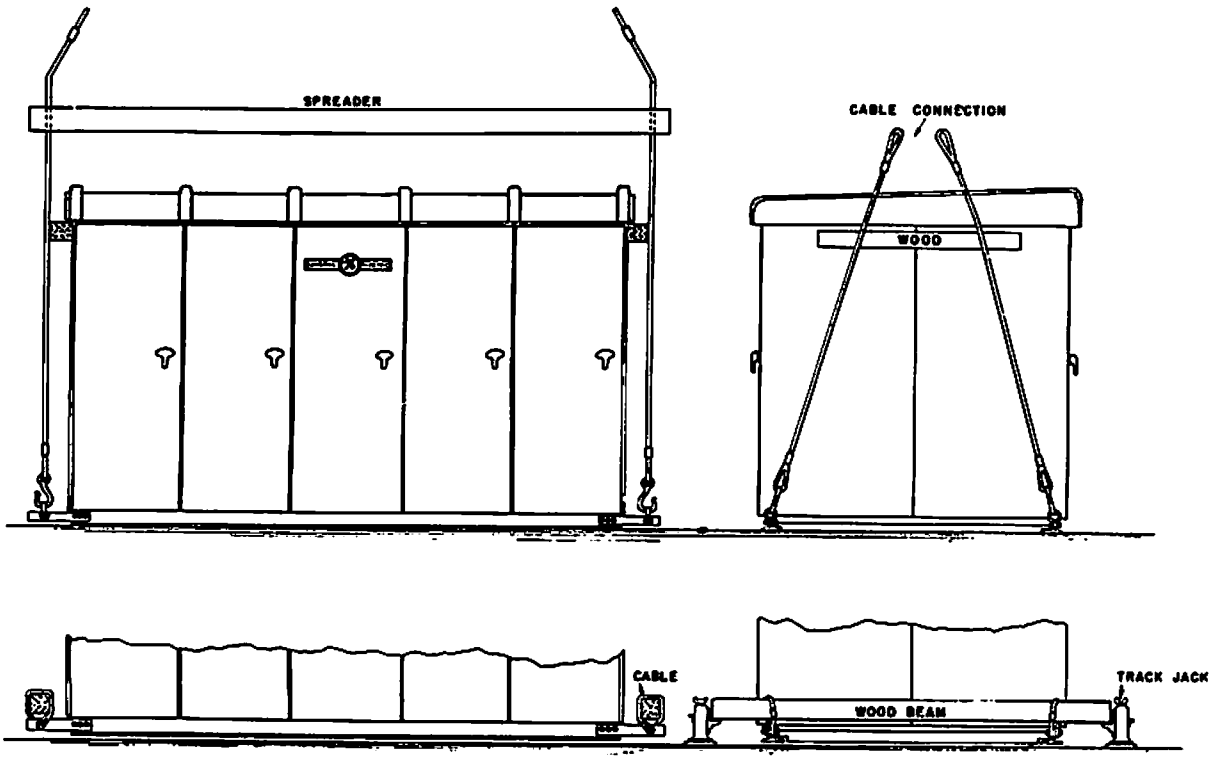
NOTE: WHEN LIFTING M-26 SWITCHGEAR LOCATE BEAM "A" ABOVE LIFTING CHANNELS "B"



ALTERNATE METHOD OF LIFTING

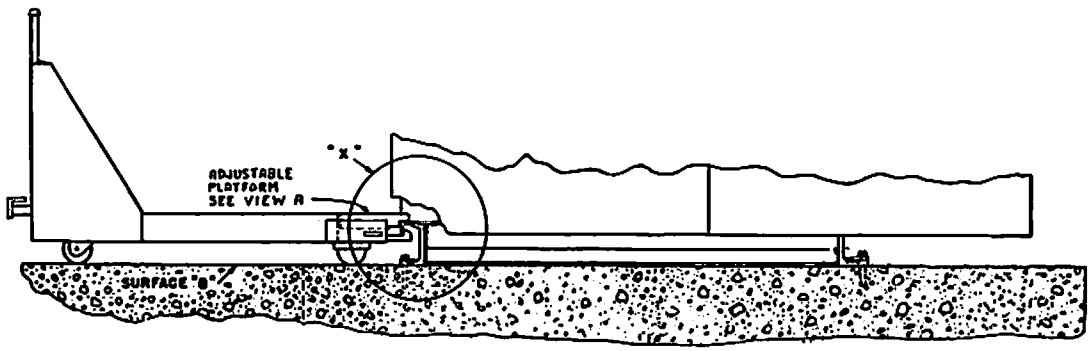
MEMBERS A & E TO BE FURNISHED BY PURCHASER
B - 3" CHANNEL FURNISHED WITH GEAR
D - COVER TO BE REMOVED AND REASSEMBLED AFTER UNITS ARE IN PLACE
E - SPREADER

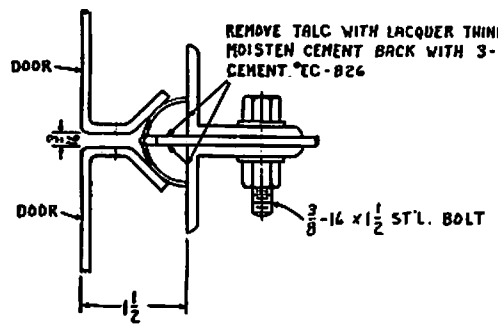
Fig. 7 (TT-6482630)



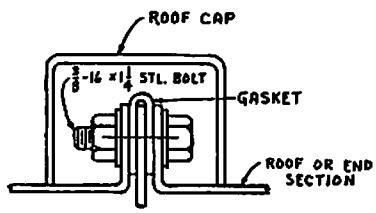
METHODS OF LIFTING

Fig. 8 (118R0728 & TT-6482615)



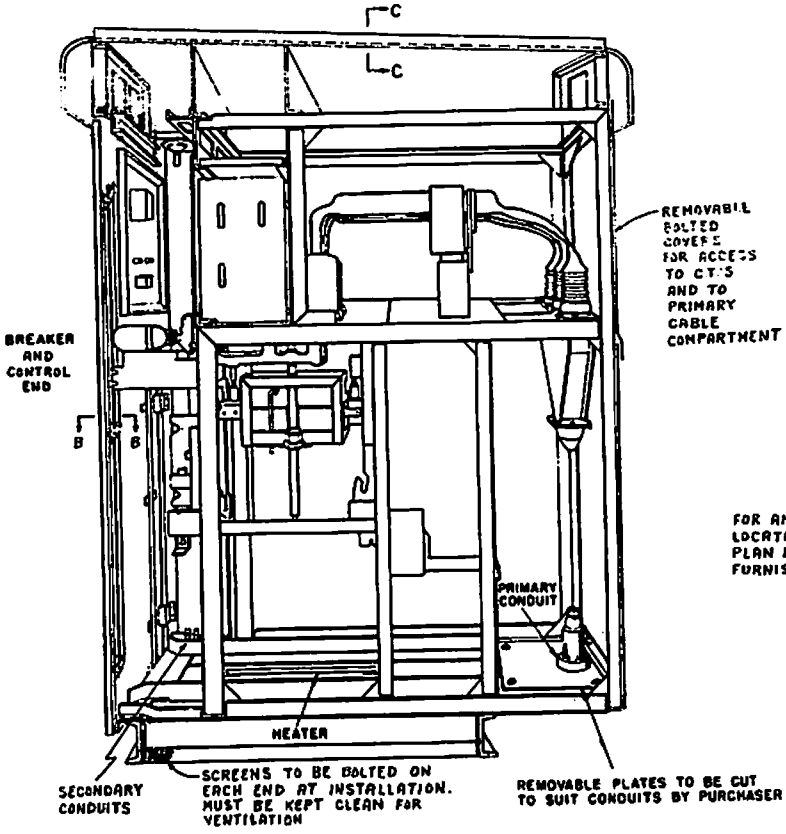


ENLARGED SEC. B-B

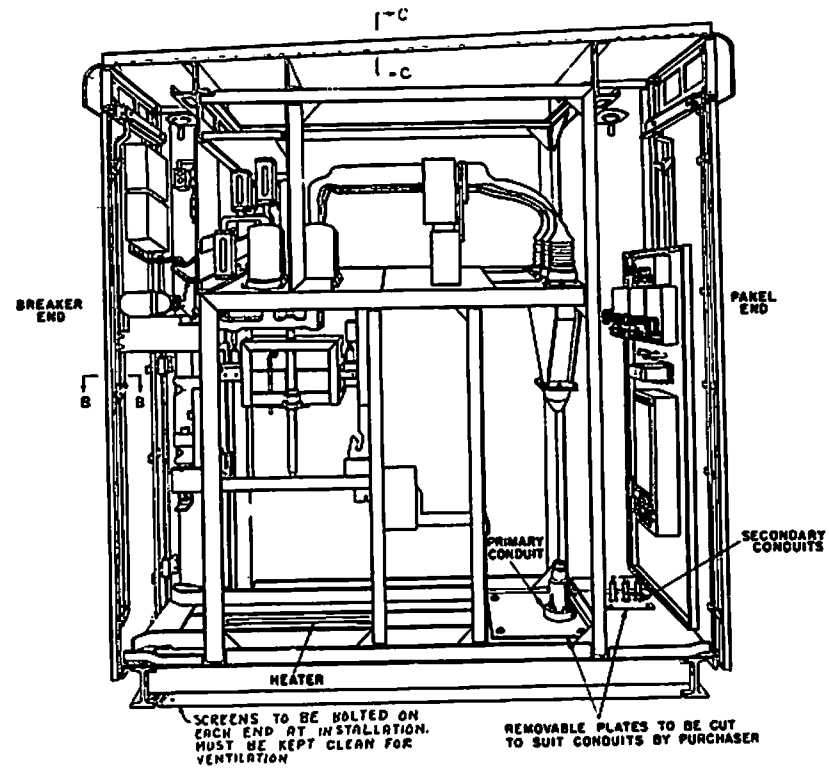


ENLARGED SEC. C-C

Fig. 8 Installation Details

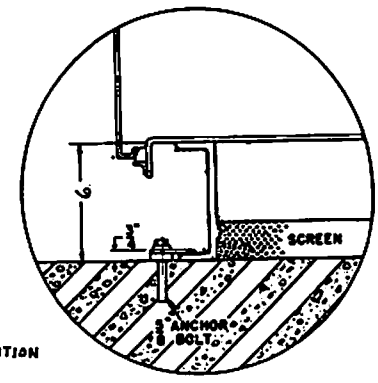


Without Rear Enclosure



With Rear Enclosure

FOR ANCHOR BOLT LOCATIONS SEE FLOOR PLAN DRAWINGS FURNISHED WITH REQUISITION



VIEW "X"

SHOWING ANCHORING OF UNITS WITH CHANNEL BASE

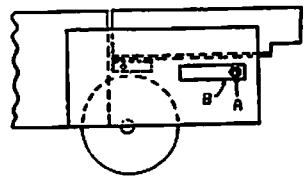
FOUNDATION DATA

AREA AND DEPTH OF SOIL BEARING SURFACES OF EACH FOUNDATION MUST BE ALTERED TO SUIT SOIL CONDITIONS.

BOTTOM SURFACES OF FOUNDATIONS SHOULD BE BELOW FROST ACTION OR BACKFILLED WITH PERVIOUS MATERIAL AND ADEQUATELY DRAINED.

SURFACE "B" SHOULD BE LEVEL OVER ITS FULL LENGTH TO INSURE EASY HANDLING OF REMOVABLE ELEMENTS. CONCRETE PAD SHOULD BE REINFORCED IN ACCORDANCE WITH STANDARD PRACTICE.

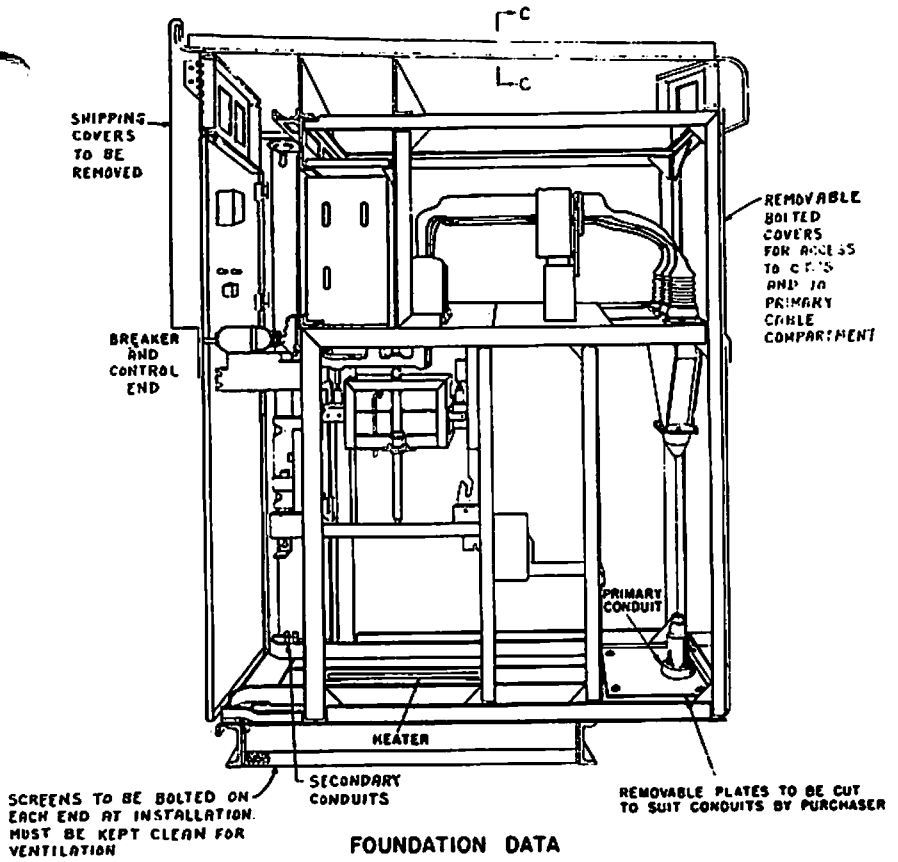
TO CHANGE HEIGHT OF TRUCK FLOOR LOOSEN NUT "A". ADJUST LEVER "B" TO GIVE DESIRED HEIGHT AND LOCK BY TIGHTENING NUT "A".



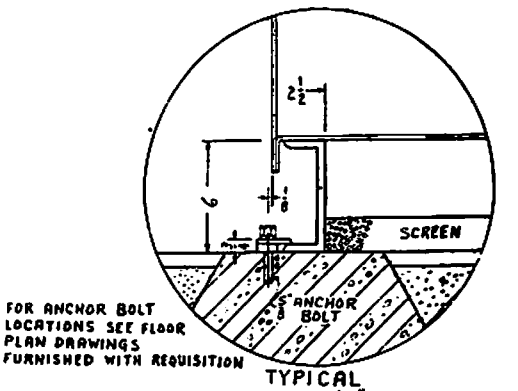
ADJUSTABLE PLATFORM VIEW "A"

Fig. 8 (118RD728 & TT-6482615)

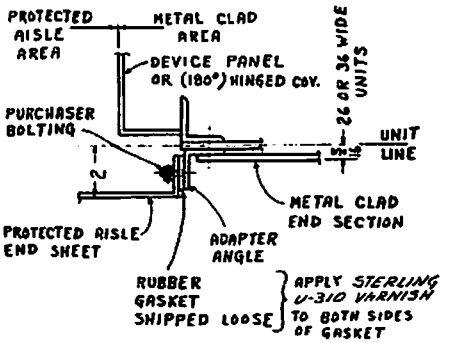
for Outdoor Metal-clad Switchgear



FOUNDATION DATA

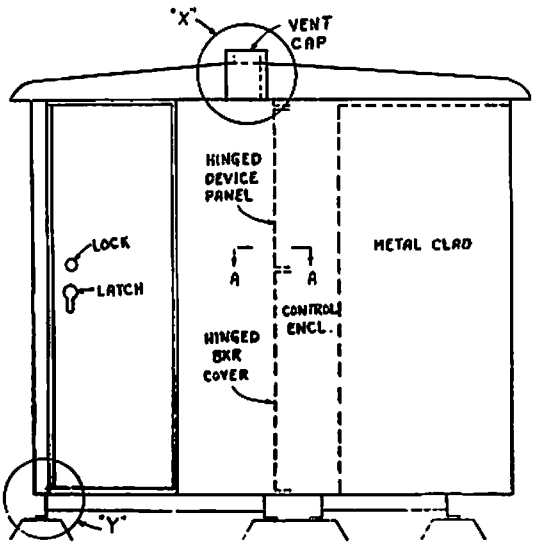


TYPICAL VIEW "Y"
SHOWING ANCHORING OF UNITS WITH CHANNEL BASE

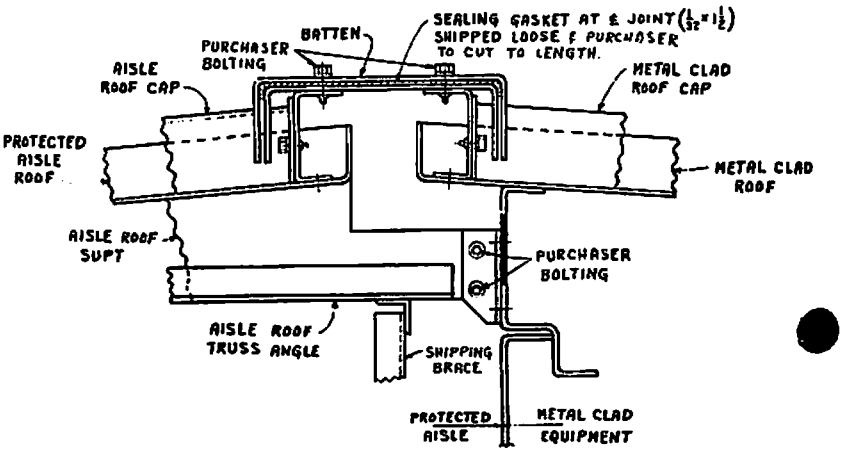


TYPICAL SECTION A-A

Fig. 9 (118RD727)



PROTECTED AISLE



VIEW "X"
ENLARGED INTERIOR SECTION SHOWING AISLE TO METAL CLAD BOLTING & VENTILATOR CAP ASSEMBLY

Fig. 9 Installation Details for Outdoor Metal-clad Switchgear with Protected Aisle

RECEIVING, HANDLING AND STORAGE

RECEIVING

Every case or crate leaving the factory is plainly marked at convenient places with case number, requisition number, customer's order, front or rear, and when for size and other reasons it is necessary to divide the equipment for shipment, with the unit number of the portion of equipment enclosed in each shipping case.

The contents of each package of the shipment are listed in the Packing Details. This list is forwarded with the shipment, packed in one of the cases. The case is especially marked and its number can also be obtained from the Memorandum of Shipment. To avoid the loss of small parts when unpacking, the contents of each case should be carefully checked against the Packing Details before discarding the packing material. Notify the nearest General Electric Company representative at once if any shortage of material is discovered.

All elements before leaving the factory are carefully inspected and packed by workmen experienced in the proper handling and packing of electrical equipment. Upon receipt of any apparatus an immediate inspection should be made for any damage sustained while enroute. If injury is evident or an indication of rough handling is visible, a claim for damage should be filed at once with the transportation company and the General Electric Company notified promptly. Information as to damaged parts, part number, case number, requisition number, etc., should accompany the claim.

HANDLING

Before uncrating, indoor equipment may be moved by a crane with slings under the skids. If crane facilities are not available, rollers under the skids may be used. Fig. 7 shows suggested method of handling the switchgear after it is removed from the skids.

Methods of handling outdoor equipment are shown in Fig. 8. After the equipment is in place the lifting plates should be removed and reassembled, "turned in" so that passageway at the ends of the equipment will not be obstructed.

STORAGE

If it is necessary to store the equipment for any length of time, the following precautions should be taken to prevent corrosion:

1. Uncrate the equipment.

2. Cover important parts such as jack screws, gears and chain of lifting mechanism, linkage and moving machine-finished parts with a heavy oil or grease.

3. Store in a clean, dry place with a moderate temperature and cover with a suitable canvas to prevent deposit of dirt or other foreign substances upon movable parts and electrical contact surfaces.

4. Batteries should be uncrated and put on trickle charge immediately on receipt.

5. If dampness or condensation may be encountered in the storage location, heaters should be placed inside the units to prevent moisture damage. Approximately 500 watts of heaters per unit will be required. Remove all cartons and other miscellaneous material packed inside units before energizing any heaters. If the equipment has been subjected to moisture it should be tested with a 1000v or 2500v meggar. A reading of at least 200 megohms should be obtained.

6. Breakers should be prepared for storage separately. Refer to appropriate breaker instruction book.

DESCRIPTION

Each unit is made up of a secondary enclosure and a primary enclosure, as shown in Figure 10.

SECONDARY ENCLOSURE

The secondary enclosure is usually located at the breaker withdrawal side of the unit, although in certain units it may be on the side opposite to the breaker withdrawal area. It consists of a compartment with a hinged door or panel upon which are mounted the necessary instruments, control and protective devices. The terminal blocks, fuse blocks, and some control devices are mounted inside the enclosure on the side sheets and a trough is provided at the top to carry wiring between units.

PRIMARY ENCLOSURE

The primary enclosure contains the high voltage equipment and connections arranged in compartments to confine the effects of faults and so minimize the damage.

BREAKER REMOVABLE ELEMENT

The removable element consists of a circuit breaker with trip-free operating mechanism mounted directly on the breaker frame, interlock mechanism, the removable portion of the primary and secondary disconnecting devices, the operating mechanism control device, and necessary control wiring. The magne-blast breakers are equipped with wheels for easy removal and insertion. Refer to Figs. 4, 5 and 6.

The circuit breaker interlock mechanism is designed to obstruct the operator from lowering the breaker from the connected position or raising it from the disconnected position unless the breaker is in the open position. This interlock is also

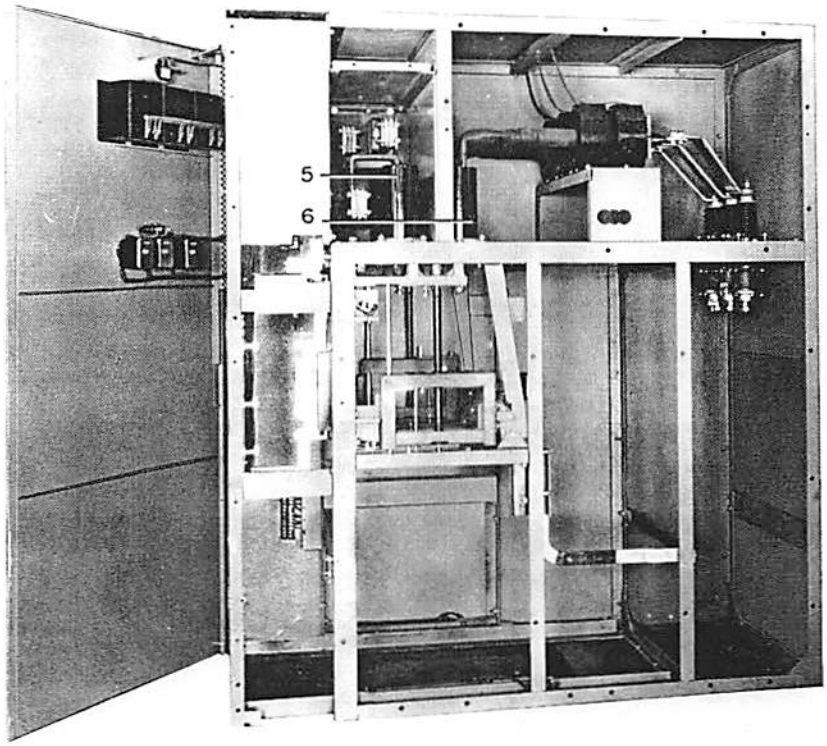


Fig. 10 Metal-clad Switchgear

Fig. 10 (8024805)

designed to keep the breaker in the open position while it is being elevated or lowered. With this arrangement it is imperative that the circuit breaker be tripped prior to any vertical travel of the removable element. Obviously if the mechanism is forced, it cannot perform its proper functions. A positive stop prevents overtravel of the removable element when raised to its connected position. The secondary disconnecting device coupler is used for connecting outside control circuits to the circuit breaker, operating mechanism, trip coil and auxiliary switches. This coupler makes contact automatically when the removable element is raised to the connected position. A control test jumper is furnished which is plugged into the coupler on the stationary and removable elements when it is desired to operate the breaker in the test position.

All removable elements furnished on a particular requisition and of like design and ratings are completely interchangeable one with the other. The removable as well as the stationary elements are built with factory jigs and fixtures thus insuring interchangeability.

BREAKER ELEVATING MECHANISM

The elevating mechanism for elevating or lowering the removable element to or from its connected position supports the removable element in the operating position. In the test position the breaker is lowered to the guide rails. This mechanism consists of heavy-duty steel jack screws on which are carried nuts to support the elevating carriage. The carriage is so designed that the removable element can be readily inserted or withdrawn after the carriage has been lowered to the disconnected position without necessitating the removal of any bolts, nuts or screws. The breaker cannot be lowered or raised until it has been tripped. The breaker cannot be closed except with the breaker in either the operating or test position.

Guide rails are built into the metal-clad frame to guide the removable breaker element into correct position before the breaker is raised into the operating position by means of the elevating mechanism which is motor operated.

PRIMARY DISCONNECTING DEVICE

The primary disconnecting devices utilize silver to silver contacts to insure against reduction of current carrying capacity due to oxidation of the contact surfaces. These contacts are of the high pressure line contact tube and socket design, the tube being backed up by heavy garter springs to insure contact pressure. Refer to Figure 11.

BUS COMPARTMENT

The main buses are enclosed in a metal compartment with removable front covers to provide accessibility.

The bus is supported by an insulating material which is practically impervious to moisture, and an excellent dielectric.

The bus insulation is molded on the bars except at the joints where the insulation is completed by means of compound filled boxes, molded boots or tape.

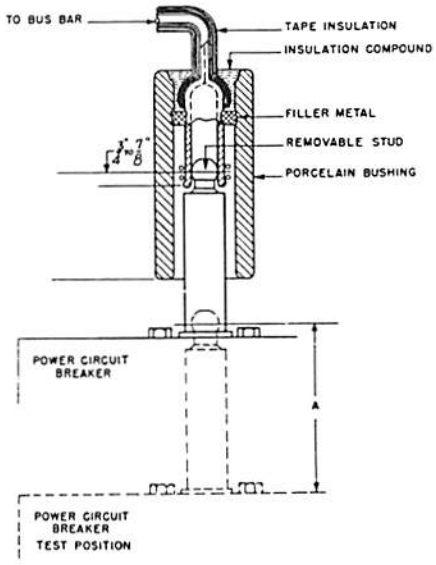


Fig. 11 Measurement of Adjustment of Primary Disconnecting Devices

CURRENT TRANSFORMER AND CABLE COMPARTMENT

The current transformers are mounted in a compartment isolated from the other equipment. Provision is made in this compartment for connecting the purchaser's primary cable by means of potheads or clamp type terminals.

POTENTIAL TRANSFORMER COMPARTMENT

Potential transformers are located in a compartment above the current transformers or in a separate unit adjacent to the breaker units.

The transformers are mounted on a movable support equipped with primary and secondary disconnecting devices. When the potential transformers are disconnected, they are at a safe striking distance from all live parts of the switchgear. In addition a grounding device is provided which contacts the fuses when the potential transformers are disconnected, effectively discharging the transformers. In this position the transformer fuses may be safely removed and replaced. When the carriage is drawn out it moves a barrier in front of the stationary part of the primary disconnecting device. See Figure 12.

DUMMY REMOVABLE ELEMENT

Dummy removable elements, Fig. 13, are used as a means of isolating circuits or bus sections, where operation is infrequent and a circuit breaker cannot be economically justified. The device consists of a framework to simulate the circuit breaker removable element with a set

Fig. 11 (121A6981)

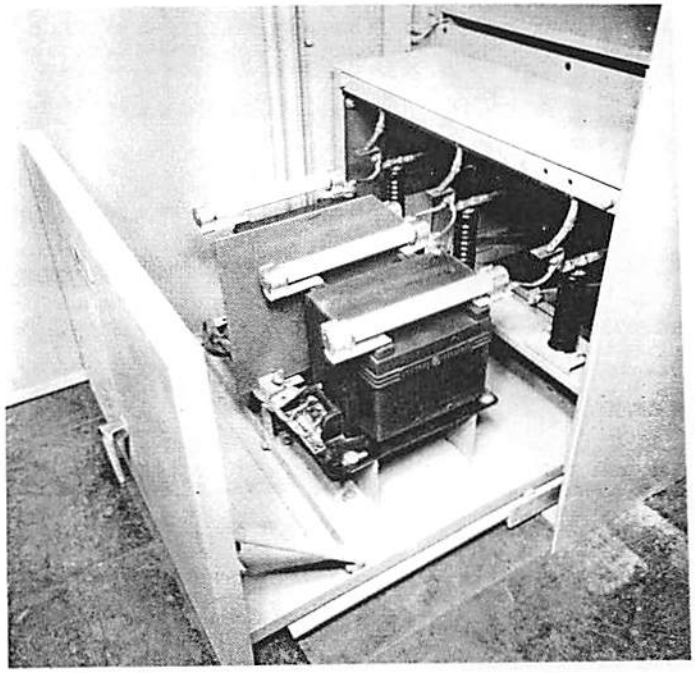


Fig. 12 (8911804)

Fig. 12 Potential Transformer Rollout Shown in Withdrawn Position

Fig. 13 (8026011)

Fig. 14 (8001507)

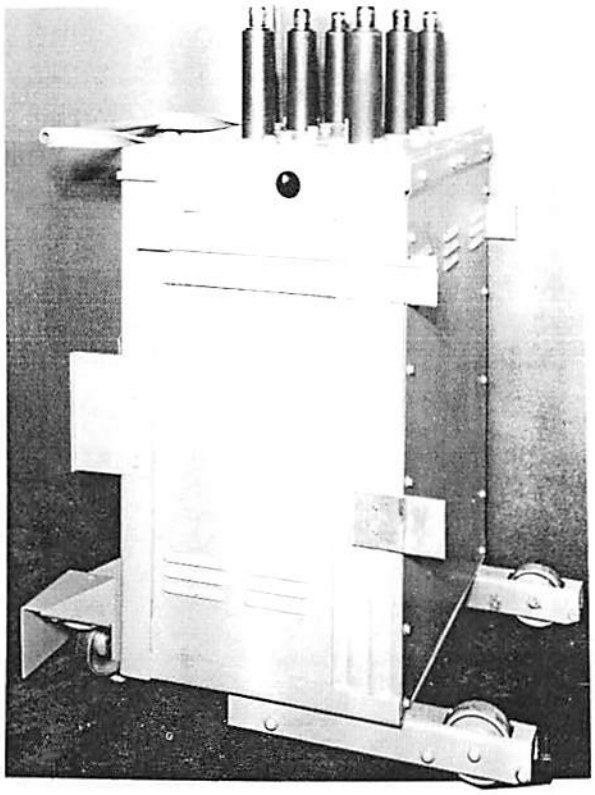


Fig. 13 Dummy Removable Element

of six studs similar to those on the magne-blast breakers. The lower end of the studs are connected, front to back, by copper bars which are fully insulated and metal-enclosed. The stationary structure is the same as for a circuit breaker. When the device is elevated into position, it connects the front set of metal-clad disconnecting devices to the rear set.

Under no conditions must the dummy element be elevated or lowered when the bus or the unit is energized. Key interlocks are applied to insure that all source of power are disconnected before the dummy element can be operated. Refer to Figure 15.

ROLLOUT FUSE-SWITCH UNITS

Rollout load-break disconnect switches, with or without current limiting fuses of high interrupting capacity, are sometimes used in metal-clad switchgear to protect and switch small transformers and circuits where circuit breakers cannot be economically or functionally justified.

The rollout switch is designated as type SE-8, and the units in which they are used are designated as type SEM-26 or SEM-36. For additional information on these equipments, refer to the supplementary instructions furnished.

FUSE DISCONNECTING DEVICE

Current limiting fuses with high interrupting rating are sometimes used in metal-clad switchgear to protect small transformers or circuits where circuit breakers cannot be economically or functionally justified.

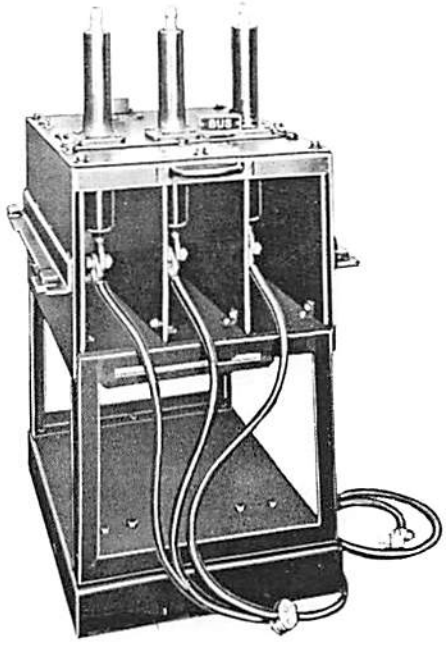


Fig. 14 Ground and Test Device
(Cable shown not furnished by G. E. Co.)

The fuses are mounted on a movable support equipped with disconnecting devices. Control power transformers of 15 kva and smaller may be mounted on the rollout with the fuses. See Figure 16.

When the fuses are disconnected, they are at a safe striking distance from all live parts of the switchgear. In addition a grounding device is provided which contacts the fuses after they are disconnected, effectively removing any static charge from the fuses. In this position the fuses may be safely removed and replaced. The disconnecting devices are capable of interrupting transformer magnetizing current, but should not be used to interrupt load current. Mechanical or key interlocks are applied to prevent operating the disconnecting device while the load is connected. This is genearally accomplished by interlocking so that the transformer secondary breaker must be locked in the open position before the disconnecting device can be opened or closed.

GROUNDING AND TEST DEVICE

The grounding and test device, Figure 14, provides a convenient means of grounding the cables or the bus in order to safeguard personnel who may be working on the cables or the equipment. The device can also be used for applying power for high potential tests or for fault location, to measure insulation resistance (Megger). By using potential transformers, it can also be used for phasing out cables.

The three studs of the device are similar to those of the magne-blast circuit breakers. The studs are mounted on a removable plate which can be placed in either of two positions. In one position the studs will engage the front (Bus) contacts only and in the other position the studs will engage the rear (Line) contacts only of a metal-clad unit.

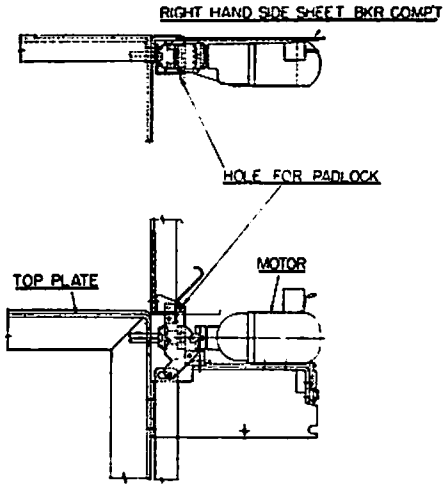
To indicate the proper placement of the studs on the device, opposite sides of the assembly are marked "Line" and "Bus". The word corresponding to the desired position must be toward the operator.

To use, the device is rolled into the metal-clad housing in place of the circuit breaker, and raised into or lowered from the connected position by means of the circuit breaker elevating mechanism.

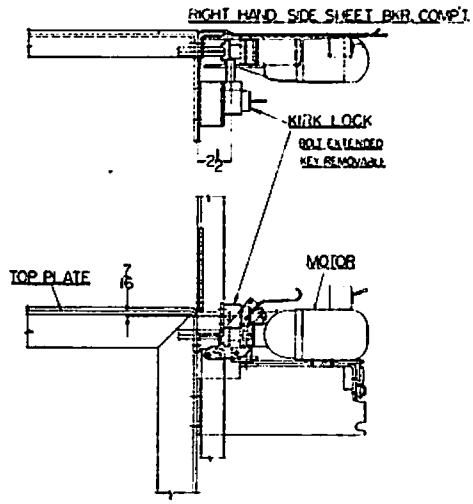
In addition to the device described above, there is available a form of grounding and testing device equipped with both bus and line side buildings, power operated grounding contacts, phasing receptacles, and a complete safety interlocking system. For details of construction and operation of this device, refer to GEI-38957 for 4.16 kv equipment, or GEI-50114 for 7.2 kv and 13.8 kv equipment.

TANDEM LOCK (WHEN FURNISHED) FOR OUTDOOR UNITS

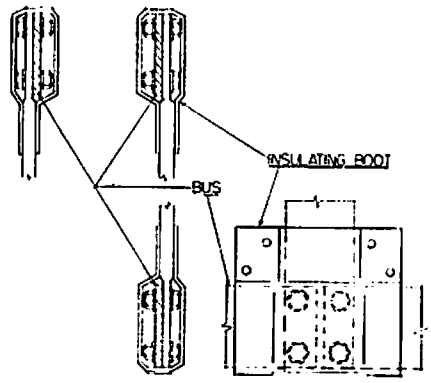
Outdoor metal-clad equipments with more than one unit may be provided with a tandem locking arrangement which makes it necessary to padlock only one door on each



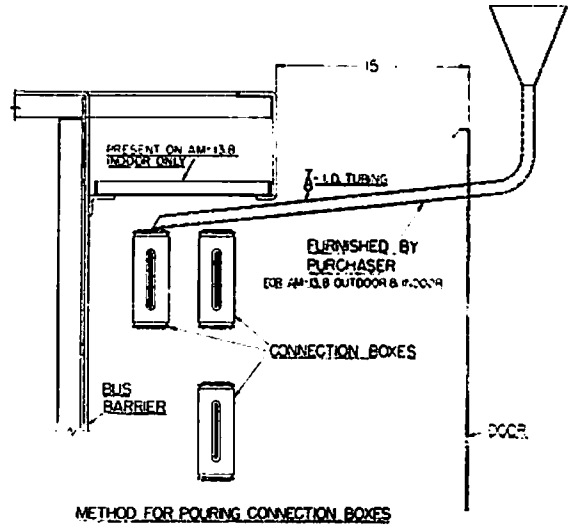
PADLOCKING ARRANGEMENT
PREVENTS RAISING OR LOWERING P.C.B. OR DUMMY REMOVABLE ELEMENT



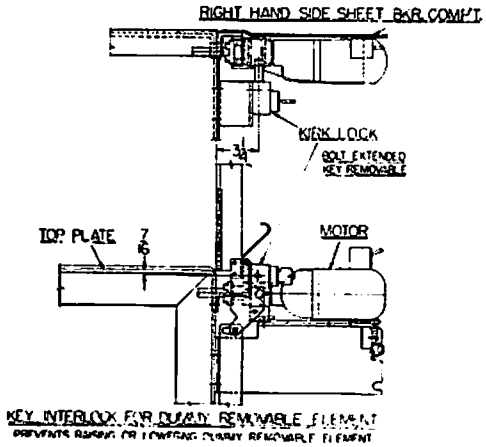
KEY INTERLOCK FOR P.C.B.
PREVENTS CLOSING BREAKER



4/6 BUS WITH PLASTIC INSULATING BOOT



METHOD FOR POURING CONNECTION BOXES



KEY INTERLOCK FOR DUMMY REMOVABLE ELEMENT
PREVENTS RAISING OR LOWERING DUMMY REMOVABLE ELEMENT

Fig. 15 (T-9917368)

Fig. 15 Padlocking Arrangement, Key Interlocking and Method for Pouring Connection Boxes

Fig. 16 (8020825)

Fig. 17 (8011450)

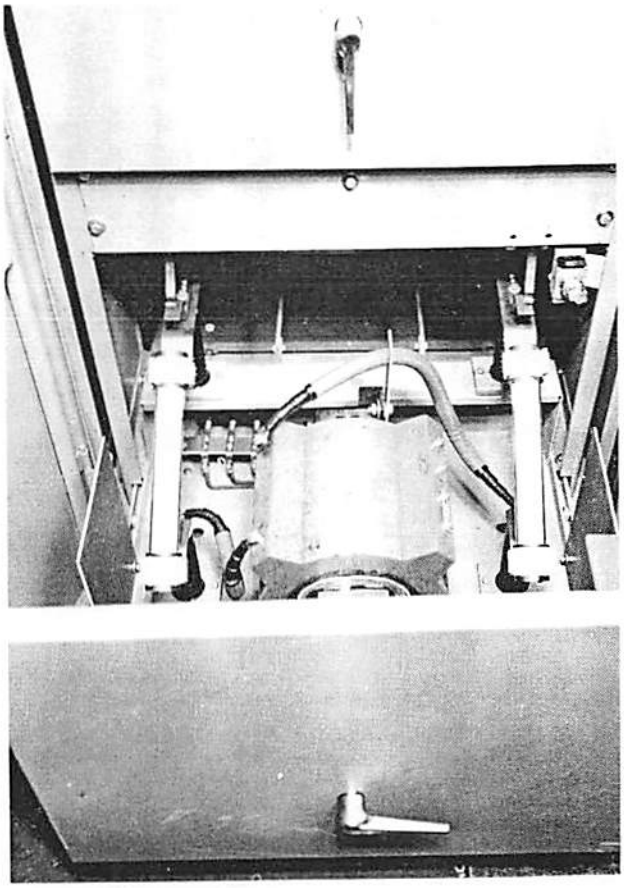


Fig. 16 Control Power Transformer Rollout Shown in Open Position

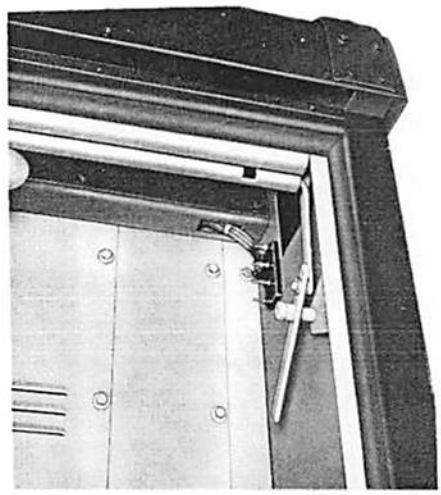


Fig. 17 Tandem Lock for Outdoor 13.8 Units

side. (In exceptionally long installations two or more locks may be required on each side). The unit containing the operating arm of the tandem lock is clearly marked on the drawings and also by nameplate on the equipment itself. Refer to Figure 17.

Before any door in the equipment can be opened, it is necessary to open the padlocked door and operate the tandem locking arm to the open position. In locking the equipment the reverse procedure should be used.

Where it is desired to separately lock any particular door, the tandem lock can be disconnected in that unit by unbolting a connecting clip between the tandem bar and the locking bar, and a separate padlock used on that door.

The light switches, front and rear, will be located in the units with the tandem lock.

INSTALLATION

Before any installation work is done, consult and study all drawings furnished by the General Electric Company for the particular requisition.

These drawings include arrangement drawings, wiring and elementary diagrams and a summary of the equipment. Mats, screens, railings, etc., which are external to the switchgear, but which may be required to meet any local codes, must be furnished by the purchaser.

LOCATION

The recommended aisle space required at the front and at the rear of the equipment is shown on the floor plan drawing furnished for the particular requisition. The space at the front must be sufficient to permit the insertion and withdrawal of the circuit breakers, and their transfer to other units. The space at the rear must be sufficient for installation of cables, for inspection and maintenance, and on some equipments to draw out potential transformers.

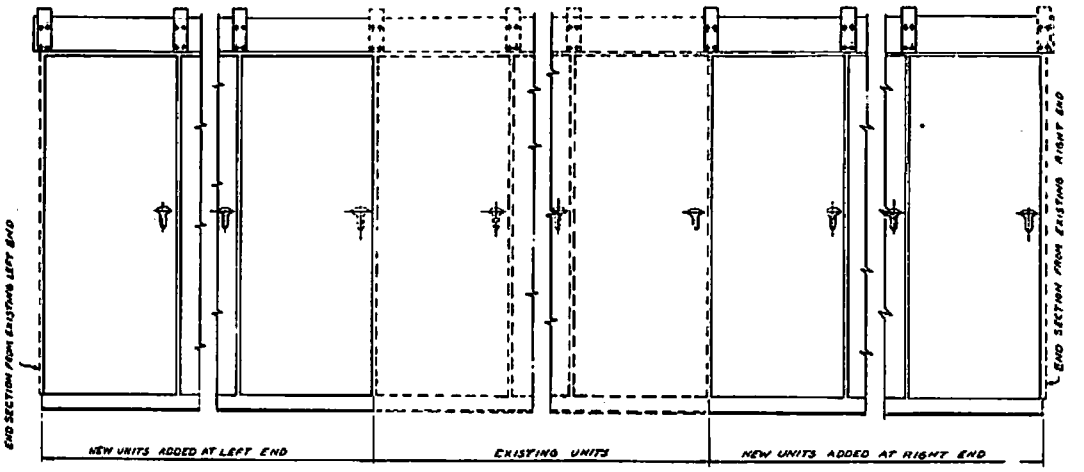
PREPARATION OF FLOOR - ANCHORING

Indoor Equipment

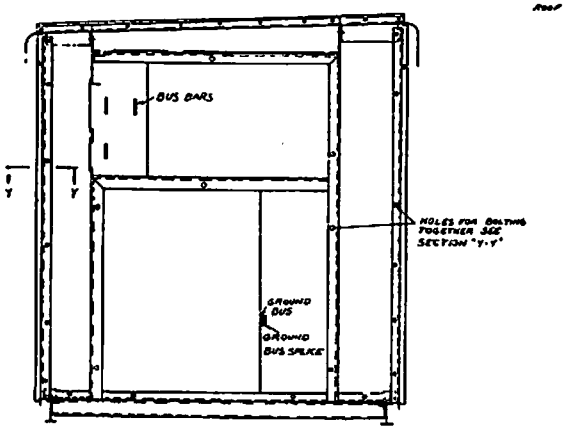
The station floor must be strong enough to prevent sagging due to weight of the switchgear structure and to withstand the impact stress caused by the opening of the circuit breakers under short circuit conditions. The impact loading is approximately 1-1/2 times the static load.

Suitable means must be provided by the purchaser for anchoring the equipment to the floor. It is essential that the floor be level to avoid distortion of the switchgear structure and the equipment be completely aligned prior to final anchoring. The recommended floor construction is shown in Figure 7. The floor channels must be level and straight with respect to each other. Steel shims should be used for final leveling of the switchgear if necessary. Care should be taken to provide a smooth, hard, and level floor under and in front of the units to facilitate installation and removal of the breaker. If the floor is not level and flush with the floor channels, it will be difficult to handle the breaker because it will not be level with respect to the stationary element.

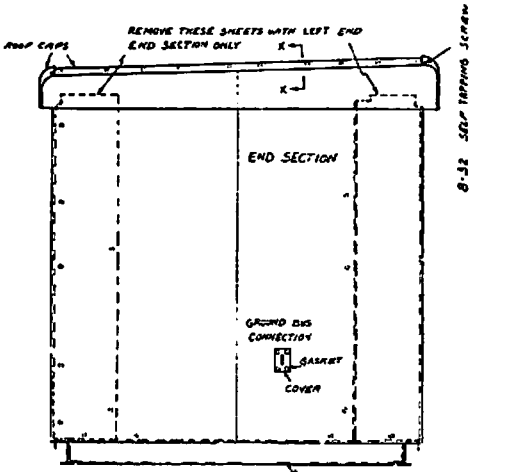
Recommended practice is to weld the switchgear structure to the floor channels, using a tack weld at points indicated for anchoring on the drawing. If welding facilities are not available the gear should be bolted to the floor channels.



FRONT VIEW
(PANEL END)

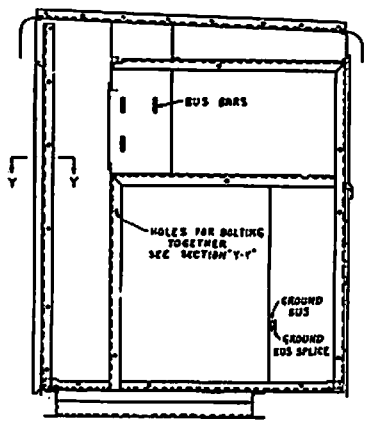


ASSEMBLY "B" ROOF CAPS REMOVED
(BOLTING OF UNITS TOGETHER)

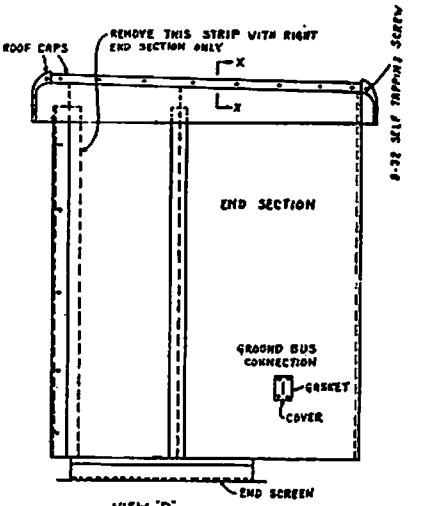


VIEW "A"
(END VIEW OF EXISTING UNIT)

WITH REAR ENCLOSURE



ASSEMBLY "C" ROOF CAPS REMOVED
(BOLTING OF UNITS TOGETHER)



VIEW "D"
(END VIEW OF EXISTING UNIT)

ROOF CAP

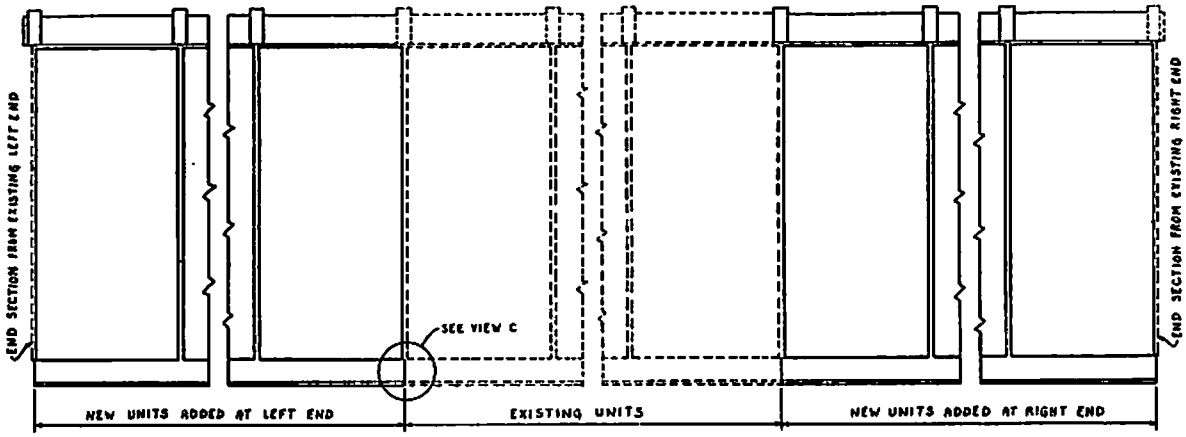
WITHOUT REAR ENCLOSURE

PROCEDURE

1. REMOVE ROOF CAP, END SCREEN, GROUND BUS CONNECTION, AND END SECTION. SEE VIEW "A" & VIEW "D"
2. SET NEW UNIT(S) IN PLACE AND BOLT TOGETHER AS SHOWN IN ASSEMBLY "B." & ASSEMBLY "C"
3. ASSEMBLE ITEMS LISTED IN PROCEDURE NO.1
4. ASSEMBLE NEW ROOF CAPS AS SHOWN IN VIEW "A" & VIEW "D".
5. ASSEMBLE GROUND BUS SPLICE BETWEEN EXISTING AND NEW GROUND BUS. AS SHOWN IN ASSEMBLY "B" & ASSEMBLY "C"
6. ASSEMBLE BUS BARS AND INSULATE PER INSTRUCTION BOOK.

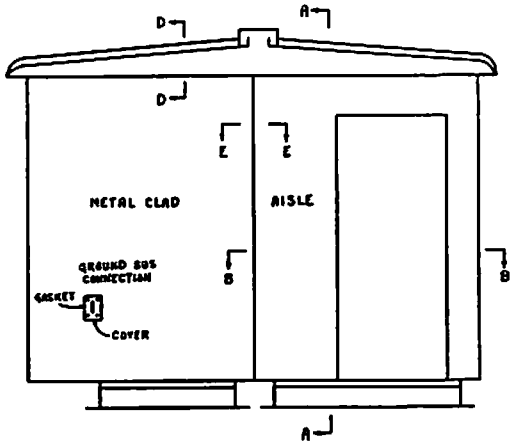
Fig. 18 (5450856)

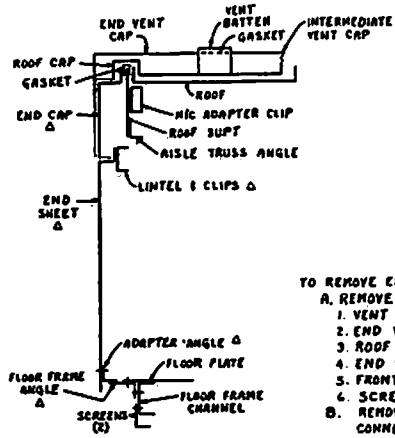
Fig. 18 Outdoor Metal-clad Switchgear - Addition of Units to Line-up



FRONT VIEW

Fig. 19 (7180393)





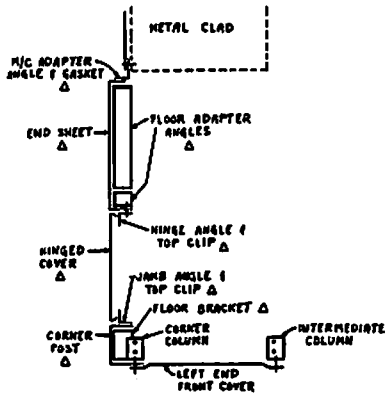
SECTION A-A

TO REMOVE EXISTING END SHEET (LEFT)
A. REMOVE THE FOLLOWING ITEMS FROM AISLE SECTION
1. VENT BATTEN
2. END VENT CAP
3. ROOF CAPS
4. END SECTION CONSISTING OF ITEMS MARKED Δ
5. FRONT COVER (MOVE TO NEW UNIT)
6. SCREENS (2)
B. REMOVE ROOF CAP, END SCREEN, GROUND BUS CONNECTION AND END SECTION FROM METAL CLAD SECTION

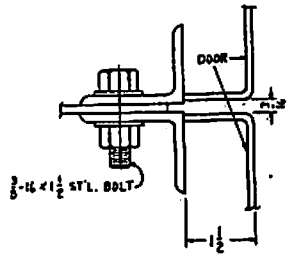
TO INSTALL NEW METAL CLAD UNITS (LEFT)
1. SET NEW UNIT(S) IN PLACE AND BOLT TOGETHER
2. ASSEMBLE ITEMS LISTED IN B
3. ASSEMBLE NEW ROOF CAPS
4. ASSEMBLE GROUND BUS SPLICE BETWEEN EXISTING AND NEW GROUND BUS
5. ASSEMBLE BUS BARS AND INSULATE PER INSTRUCTION BOOK

TO INSTALL NEW PROTECTED AISLE UNITS (LEFT)
1. INSTALL NEW FLOOR FRAMES AND FLOOR PLATE TIE DOWN ANGLE
2. REPLACE FLOOR FRAME ANGLE AT NEW END POSITION
3. INSTALL NEW FLOOR PLATES
4. ERECT NEW CORNER COLUMN (ANGLE)
5. ADD NEW AISLE TRUSS ANGLE AND METAL CLAD ADAPTER CLIP TO EXISTING END ROOF TRUSS AND SUPPORT
6. INSTALL NEW END AISLE TRUSS SUB-ASSEMBLY CONSISTING OF ROOF TRUSS ANGLE, ROOF SUPT, COLUMN CLIP, METAL CLAD ADAPTER CLIP AND ROOF SUPT CLIPS
7. REINSTALL THE ITEMS REMOVED IN A-4
NOTE:- USE NEW GASKETS AND ALSO INSTALL PREVIOUS END FRONT COVER ON FRONT OF NEW END UNIT
8. INSTALL WIRING AND LIGHTING TROUGH

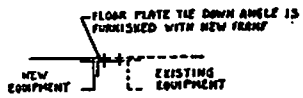
NOTE:- A SIMILAR PROCEDURE IS USED FOR RIGHT END ADDITIONS



SECTION B-B



SECTION E-E



INTERNAL VIEW C

Fig. 19 Outdoor Metal-clad Switchgear with Protected Aisle

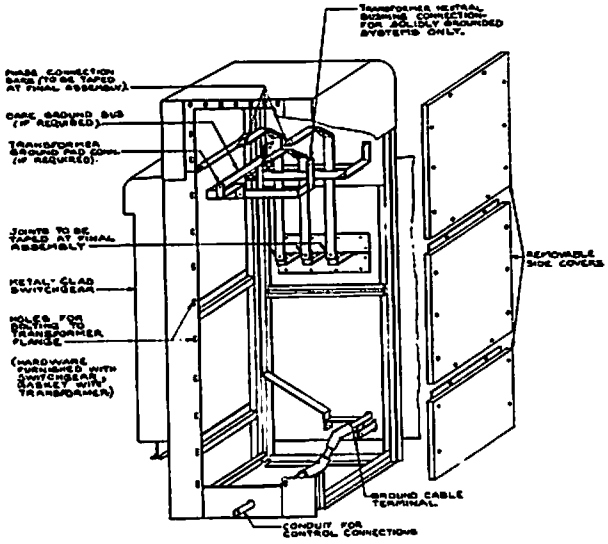


Fig. 20

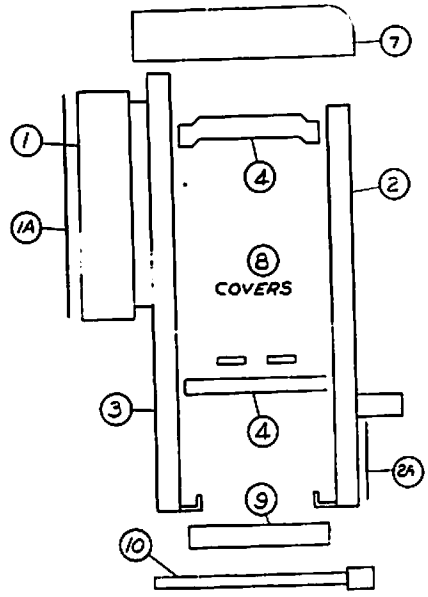


Fig. 21

Outdoor Transition Compartment

Provision should be made in the floor for conduits for primary and secondary cables, located as shown on the floor plan drawing furnished for the particular requisition. If desired, the conduits may be installed before the switchgear. Consideration should be given to conduits which might be required for future connections.

Outdoor Equipment

Outdoor equipments are furnished both with and without rear enclosures. Recommendations for foundations for both types are given in Fig. 8. Primary and secondary conduits should be installed in accordance with the requisition drawings, before the equipment is put into place.

Since outdoor equipments are provided with a 6" base, a transfer truck is required to place the breaker in the housing. The level adjustment on the truck is shown on Fig. 8.

When outdoor equipments are shipped in more than one section, the joint in the roof between sections must be weatherproofed. Assemble the gasket between the roof sections and bolt together. See Fig. 8.

Outdoor Equipment with Protected Aisle

When specified by the purchaser, outdoor equipment is furnished with an enclosed, weatherproof operating aisle. See Fig. 3. The aisle enclosure is shipped separately from the switchgear.

The following procedure outlines the steps necessary to install outdoor equipment with a protected aisle:

(1) Install the switchgear in accordance with the procedure given above for outdoor equipment.

(2) Remove the shipping covers from the control panels. Since the relay and instrument cases are not weather-proof, the control panels should be protected from inclement weather until the installation of the aisle enclosure is completed.

(3) Apply Sterling U-310 varnish to both sides of the gaskets furnished for the joint between the ends of the switchgear and the aisle enclosure and to the surfaces against which the gasket presses and hang the gaskets on the projecting studs at the ends of the switchgear lineup. See Fig. 9, section A-A.

(4) Move the aisle enclosure into position, guiding the holes in the end sheets over the studs on the switchgear lineup and guiding the roof sills between the support clips bolted to the upper front of the switchgear units above the control panels. This operation may be simplified by temporarily loosening the support clips. The floor of the aisle enclosure must fit under the hinged breaker cover of the metal-clad, so the aisle enclosure must be moved into position on a level with the switchgear units. If desired, this job may be simplified by removing the doors over the circuit breaker compartment. To remove these doors, loosen the two bolts holding the lower hinge, remove the hinge, and lower the door to remove the hinge pin from the upper hinge.

(5) Bolt the aisle enclosure in place at both ends, and bolt the roof sills to the support clips, tightening any support clips loosened in the previous operation. Replace any breaker compartment doors previously removed.

(6) If the aisle enclosure was shipped in more than one section, bolt the sections together and assemble the roof caps in the manner described above for roof joints in outdoor switchgear.

(7) Anchor the outside floor sill of the aisle enclosure with anchor bolts placed in accordance with the requisition drawing. See Fig. 9, view Y.

(8) Assemble the dome over the roof opening between the switchgear and the aisle enclosure. See Fig. 9, view X.

(9) Remove shipping braces from aisle enclosure. These braces should be left in place until the aisle enclosure is assembled in order to maintain alignment of the enclosure.

(10) Connect secondary wiring to lights, convenience outlets, etc., in accordance with the wiring diagrams furnished for the equipment.

Since the aisle floor is level with the floor of the switchgear units, no transfer truck is required for outdoor equipment with a protected aisle.

The above procedure describes installation of a protected aisle enclosure with switchgear on one side of the aisle only. If the aisle is common to two lineups of switchgear, the procedure will require slight modification. See the drawings furnished with the requisition for specific instructions.

Transition Compartments

Transition compartments for outdoor unit substations may be one of two types (Figs. 20 and 21). These compartments are normally shipped assembled. The full height compartment (Fig. 20) cannot be disassembled for installation. The throat type compartment (Fig. 21) can be installed in any of three ways, in accordance with the following instructions:

(a) Should the switchgear be positioned on its foundation prior to the power transformer, the complete transition can be mounted on the metal-clad as assembled. Remove covers #8. Apply Sterling U 310 varnish to both sides of gasket 2A, and to the surfaces against which the gasket presses. Bolt transition compartment to throat on metal-clad switchgear. Before jacking the power transformer into its final location, apply Sterling U 310 varnish to both sides of gasket 1A and to the surfaces against which the gasket presses, and place the gasket over the mounting studs on the transformer tank wall. Slide transformer in place, guiding the transformer mounting studs through the mounting holes in #1. Center rubber seal between

#1 and #3 before tightening nuts, maintaining 24" between transformer tank wall and end of metal-clad. Do not apply varnish to the rubber seal between #1 and #3. Cut secondary conduit #10 to length and assemble under the transition.

(b) Should the power transformer be positioned on its foundation prior to the switchgear, follow the procedure of paragraph (a) above, except move the switchgear up to the power transformer after assembling the transition compartment to the switchgear.

(c) If the power transformer and metal-clad switchgear are in place, disassemble transition as follows: Remove covers #2 and #9, adapter #1, dome #7, braces #4. Apply Sterling U 310 varnish to both sides of gasket #2A, and to the surfaces against which the gasket presses, before bolting #2 to metal-clad throat. Apply Sterling U 310 varnish to both sides of gasket #1A, and to the surfaces against which the gasket presses, and loosely fasten #1 and #1A to transformer tank. Slide throat of #3 into #1 and maintain approximately 4 1/2" from #3 to tank. Assemble braces #4 top and bottom to maintain size and proper alignment, then tighten #1 to transformer tank. Assemble connections, terminals, supports and complete all joints. Assemble dome #7, side covers #8 and bottom cover #9. Cut secondary conduit #10 to length and assemble under the transition.

Connect heaters located in 13.8 kv class transition compartment.

Indoor transition compartments are shipped assembled together with the adjacent metal-clad switchgear units.

BREAKER REMOVABLE ELEMENT

Before installing or operating the removable element consult the circuit breaker instructions for directions on installation and inspection. The operation of the interlock device is given below.

The elevating mechanism is accurately leveled and checked at the factory and should need no adjustment. Do not install or remove the breaker or make any adjustments unless the breaker is open.

Rub a small amount of contact lubricant D50H47 on the silvered portion of the breaker studs to form a thin coating for contacting purposes.

Lower the elevating mechanism lifting brackets until the lifting brackets are in the fully lowered or test position. The breaker should then enter the housing freely. Push the breaker into the housing until the wide part of the breaker supporting plate rests against the front part of the lifting bracket of the elevating mechanism. The clearance between the interference block on the breaker and the interference block on the interlock mechanism (dimension "X", Fig. 22 should be from 1/16" to 1/8".

Carefully raise the breaker to the connected position. The clearance between the breaker supporting plate and the stop bolts should be not more than 1/32". Then lower and remove it from the unit. When elevating, note that breaker studs center with respect to the stationary disconnecting device or injury to the contacts may result.

Fig. 22 (8024804) ...ve Interference Mechanism ...erence Block

Inspect the contact surfaces of both the breaker studs and the stationary disconnecting contacts.

(a) Each segment of the stationary disconnecting device should make a heavy impression in the contact lubricant D50H47 on the breaker studs. Contact wipe should start not less than 1/8" from top of contact and although each contact need not start at the same dimension.

(b) The ends of the breaker studs inside the stationary disconnecting device as indicated by the contact lubricant D50H47, should be ... 7/8". This indicates that the breaker studs contacted the full pressure contact of the silver bars in the stationary disconnecting device. See Fig. 11.

(c) Should the inspection of the contacts show that the breaker is not being raised to the proper position, readjust the upper stop bolts and limit switches to raise or lower the breaker to the proper location. Lock the stop bolts in the new position.

(d) If proper contacting cannot be attained by the above methods, it is necessary to adjust the stationary disconnecting device tube. DO NOT MAKE ANY ADJUSTMENT. COMMUNICATE WITH THE NEAREST GENERAL ELECTRIC CO. OFFICE FOR ADDITIONAL INFORMATION.

The trip interlock should be checked to see that the removable element is obstructed from being raised to or lowered from the operating position. Using the manual closing device, close the breaker and then push it into place for elevating. Snap the selector switch to the "Raise" position and pull the clutch handle forward. A definite stop should be encountered preventing the motor circuit limit switch from energizing the circuit. Then trip the breaker manually and elevate to the raised position. Electrically close the breaker. Snap the selector switch to the "Lower" position and pull the clutch handle forward. Again, a definite stop should be encountered preventing the motor circuit limit switch from energizing the circuit.

If the interlock does not function as indicated above DO NOT MAKE ANY ADJUSTMENTS. COMMUNICATE WITH THE NEAREST GENERAL ELECTRIC CO. OFFICE FOR ADDITIONAL INFORMATION.

On units equipped with stationary auxiliary switches (Fig. 45A, reference #69), the clearance between the end of the switch mechanism operating rod and the operating plunger on the circuit breaker should be 0 to 1/8" with the circuit breaker in the raised and open position. Any adjustment in this dimension must be made on the circuit breaker. See instruction book furnished with circuit breaker for method of adjustment. Care should be taken to prevent destroying interchangeability of circuit breakers by excessive adjustment on one breaker.

TESTING CABINET

The testing cabinet, Fig. 23, should be installed on the wall at a location where maintenance and testing of the breaker can be conviently done. Conduits must be installed to carry cables to supply control power for testing.

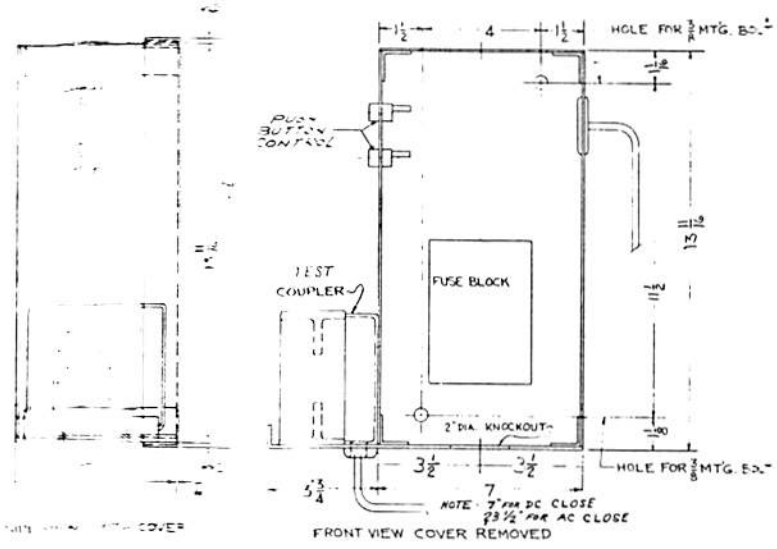


Fig. 23 (M-6515226) ...tion Box for 13.8 KV Metal-clad Switchgear

ADDITION OF UNITS TO EXISTING EQUIPMENT

Before adding units to existing equipment, consult and study all drawings furnished with the equipment. In addition to the usual drawings furnished with new equipment, special drawings may be furnished covering complicated or special assembly work. Also, check to make sure all necessary parts are on hand.

BEFORE ANY COVERS ARE REMOVED OR ANY DOORS OPENED WHICH PERMIT ACCESS TO THE PRIMARY CIRCUITS, IT IS ESSENTIAL THAT THE CIRCUIT BE DE-ENERGIZED.

Figure 18 indicates the special procedures required to add new metal-clad units to outdoor equipment without protected aisle, and Figure 19 indicates the special procedures required to add new metal-clad units to outdoor equipment with protected aisle. For indoor equipment, it is usually necessary only to remove the end cover sheets and to re-assemble them on the new units after these are located and bolted to the existing units. Otherwise, the installation procedure is the same as described above.

When the units are in place and mechanical assembly is completed, assemble the main bus and other primary connections per the instructions below. (Removal of existing compound-filled connection boxes can be easily accomplished by packing the box in dry ice for 2 - 3 hours. Remove the dry ice and the cord tying the box in place, and strike the box with a hammer. The hardened box and compound will crack away from the joint.)

Secondary wiring and control bus connections should be made in accordance with the wiring diagrams furnished with the equipment.

CONNECTIONS

The main bus bars and other connection bars may be either copper or aluminum. In either case, the connection surfaces will be silver plated.

All field assembled joints in conductors, regardless of material or method of insulation, should be made as follows:

(1) Wipe silver clean. Do not use sandpaper or any abrasive on the silvered surface. Avoid handling of cleaned surface as much as possible.

(2) A sufficient quantity of D50H47 grease should be applied to the joint at each contact area so that the complete contact area will be thoroughly sealed with excess grease squeezed out of the joint when tightened.

(3) Brush a thin coat of D50H47 over the outside surfaces of the joint area and hardware covering the silvered area.

(4) In some cases external connections are made to metal-clad bus by bars. The metal-clad bars are normally silver plated. Unplated bars, either copper or aluminum, should not be used to connect to silver plated bars.

MAIN BUS ASSEMBLY

(1) For 13.8 kv or 7.2 kv equipment:
(a) Remove compartment covers.

(b) Bolt splice plates and bus bars together, following assembly instructions above. See also Fig. 25 and Table A, Fig. 24.

TABLE A
Torque Values for Metal-clad Switchgear
(Torque in Inch-Pounds)

Bolt Size	Copper or Steel	Aluminum or Compound
3/8"-16	180-300	180-240
1/2"-13	360-540	360-480
5/8"-11	420-600	420-540

Fig. 24

(c) Complete the taping of the vertical riser bars using insulating tape furnished (2/3 lap) stopping the tape at the bus bar. If the riser bars connect to the bus from below, sufficient tape should be added to prevent compound leakage when filling. Apply a layer of cotton tape (1/2 lap) over the insulating tape, stopping the cotton tape just inside molded splice cover.

(d) Place molded covers around the bolted splice joints. Note that compound filling space is at top of joint, and add filler pieces furnished for the purpose to the bottom of box and around bus bar laminations (Fig. 20) to prevent compound leakage while filling. Duxseal should be placed over the joints to make the box free of leaks while filling. The Duxseal should be removed after the compound has set. G.E. #860 cord should be used to hold the molded parts securely in place.

(e) Heat G.E. D50H49 compound (furnished) to minimum 200°C and maximum of 220°C. Avoid overheating the compound for the dielectric strength may be seriously affected. Pour the compound into the molded covers intermittently, allowing an interval of cooling to prevent formation of gas or air pockets. The final pouring should be level with the top of the box and should be done only after due allowance for shrinkage is made. Refer to Fig. 15.

(f) Paint the exposed cotton tape on vertical riser bars with U310 or U311 varnish furnished.

(g) Taped joints may be used instead of boxed joints. If they are, insulate as follows:

(1) Fill all cavities around bolts and nuts with Duxseal compound to form smooth surface for taping, thus preventing air voids. This compound is not an insulating medium and should not be used for that purpose.

(2) Place 4" wide Irrathene tape over the Duxseal, as shown in Fig. 26.

(3) Wrap with insulating tape provided, as shown in Fig. 39. Where there are sharp angles, apply additional layers to obtain the equivalent of the insulation of the flat surfaces.

(4) Over the insulating tape, apply one layer of white cotton tape, half lap, as a binder.

(5) Over the white cotton tape, brush a good coat of U 310 varnish. Varnish may be thinned if necessary, with Xylene, D5B9.

(h) Replace all covers previously removed.

(2) For 4.16 kv equipment:

(a) Remove compartment covers.

(b) Bolt splice plates and bus bars together, following assembly instructions. See Fig. 25 and Table A, Fig. 24.

(c) Place flexible molded cover over joint, as shown in Fig. 15. Note that on joints where no tap is made from bus the opening in the molded cover should be at the top.

(d) Secure flexible cover with self-locking fasteners furnished. Joint insulation is now completed.

(e) Replace all covers previously removed.

(3) In unit substations, the connection bars should be assembled in the transition compartment (Fig. 20 and 21) and the connections at the transformer terminals greased, taped and painted as indicated above. The conduit for secondary circuits should also be assembled in or below the transition compartment.

BUS DUCT

Bus ducts connecting between groups of metal-clad switchgear, or between metal-clad switchgear and other apparatus, should be installed as shown on the arrangement drawings furnished with the ducts. Supports should be provided as indicated on the drawings.

All joints in the bus, including adjustable joints, should be assembled and insulated as described above for main buses. Adjustable joints are provided in long runs of bus duct to allow for variations in building construction, etc. These joints should be loosened before installation of the duct, then tightened after being set in the position required by the fixed points at the ends of the duct.

Outdoor bus ducts must be gasketed at the joints between shipping sections. Coat both sides of the gasket and the flanges of both duct sections with Sterling U310 varnish before assembly. Bolt the two duct sections together, then fasten roof cap in place over the joint.

Outdoor bus ducts of the 13.8 kv class are provided with heaters. Connect these heaters in accordance with the wiring diagrams furnished with the equipment before energizing the bus duct.

PRIMARY CABLES

The primary cable connections in indoor switchgear are reached by removing the rear bolted covers. In outdoor switchgear the hinged instrument panel, if present, must be swung open and the bolted covers behind it removed.

Before any primary cable connections are made, the cables should be identified to indicate their phase relationship with the switchgear connections. This is necessary to insure that motors will rotate in the proper direction and that the phase rotation is the same when interconnecting two different sources of power.

There are two common methods of making primary cable connections:

(a) Potheads (see Figures 40 and 41) are used when it is desired to hermetically seal the end of the cable to make a moisture-proof connection between the cable and the switchgear bus. A pothead also prevents seeping of oil from the end of oil impregnated varnish cambric or paper insulated cable.

(b) Clamp type terminals and wiping sleeve or cable clamp.

In all cases carefully follow the cable manufacturer's recommendations for installation of the type of cable being used, as well as the instructions contained herein. See Figs. 43 and 44. If the cable is aluminum, the conductor surface must be carefully abraided and the cable covered liberally with a joint compound recommended by the cable manufacturer.

POTHEADS

Potheads are mounted on an adapter plate extending across the width of the metal-clad unit as shown in Fig. 10. Where necessary the adapter plate is split into two parts to facilitate the installation of the potheads.

Three-Conductor Potheads

The following description applies to the installation of a three-conductor lead-sheathed cable with a wiping sleeve cable entrance fitting on the pothead. This is the type most generally used. Instructions for installation of other types are included in the text following:

(a) Remove the wiping sleeve and cut the tapered end at a point where the cable will enter it freely, and file off sharp edges. Temporarily reassemble on the pothead.

(b) Train the cable in front of the pothead allowing it to extend about two inches above the top of the porcelain bushings. Handle with care and avoid sharp bending which might damage the insulation. Mark a point on the lead sheath of the cable about 1-1/2 inch above the bottom of the wiping sleeve.

(c) Remove the pothead from the unit, disassemble the wiping sleeve and slip it and its gasket over the cable as shown in Figure 27.

(d) Remove the lead sheath from the cable to the point marked in operation "b" as shown in Figures 28 and 29 proceeding as follows:

First, make a cut around the cable half through the sheath at the reference point. Second, split the sheath lengthwise between the cut and the cable, holding the cutting tool at an angle to the cable radius to avoid damaging the insulation. Third, remove the sheath by catching the split edge with pliers and pulling directly away from the cable axis.

Clean and tin the outside of the lead sheath for about 3 inches and bell out the end of the lead sheath.

Fig. 25 (K-6500903)

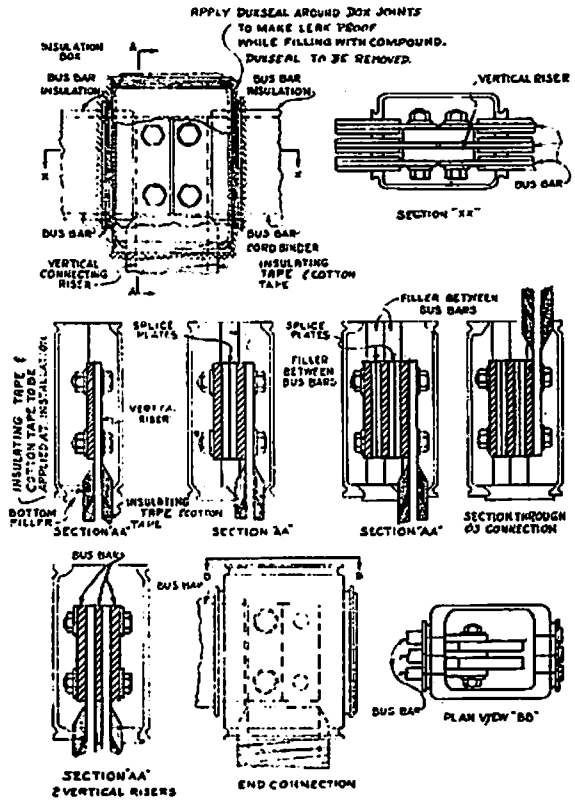


Fig. 25 Method of Making Bus Bar Connections

Fig. 26 (10MA2714)

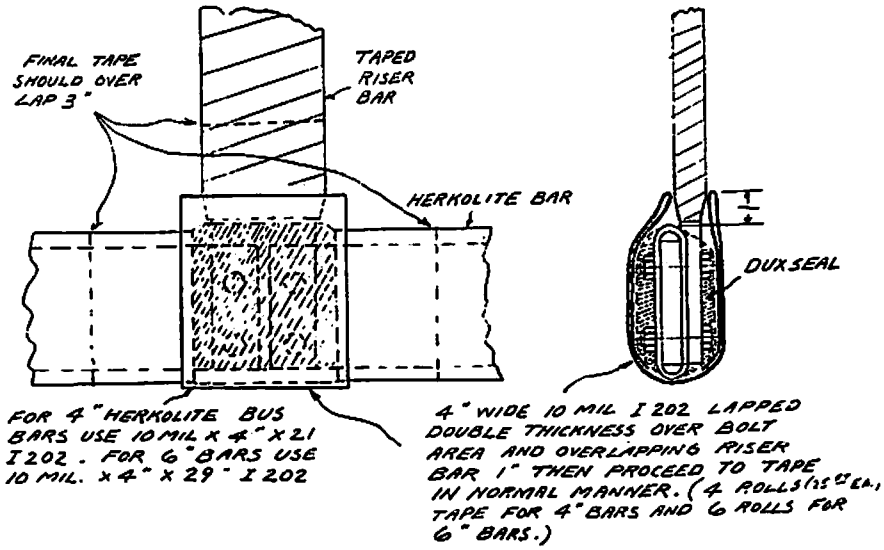


Fig. 26 13.8 KV Taped Joints

Fig. 27

Fig. 28

Fig. 29

Fig. 30

Fig. 31

Fig. 32

Fig. 33

Fig. 34

Fig. 35

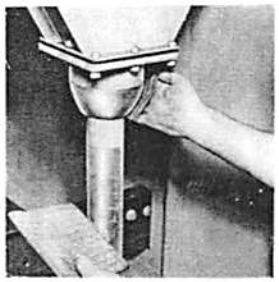


Fig. 36

Fig. 37

Fig. 38

(e) Remove the belt and interphase insulation down to within 1-1/2 inches of the lead sheath as shown in Figure 30. The last few layers should be torn off to avoid damaging the individual conductor insulation. To reinforce and protect the conductor insulation, wrap two layers of half lapped varnished cambric or irrathene tape over the factory insulation.

(f) Disassemble insulator support plate from pothead body. The insulators should not be removed from the support plate because they are factory assembled for proper compression of their gaskets. Place pothead body over cable and then fan out the conductors into approximately the final position, as shown in Figs. 31, 32. The middle conductor should be bowed slightly for final adjustment of length. Avoid sharp bends and damage to the insulation, particularly at the crotch.

(g) For system voltage above 7500 volts it is recommended that stress relief cones be built up when single-conductor or three-conductor shielded cable is used. Construct stress relief cones in accordance with the recommendations of the cable manufacturer. See Figure 41 for one recommended method. On lower voltage cables, belling out the end of the lead sheath ordinarily provides sufficient stress relief. (Stress cone material will not be furnished with pothead).

(h) Bolt pothead body to metal-clad adapter plate. Shape conductors into final position, then cut off each conductor to fit its terminal.

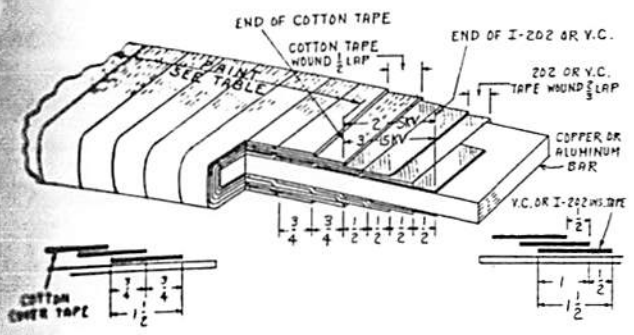
(i) Remove pothead terminals from insulators. Remove two inches of insulation from the end of each conductor and assemble pothead terminals to cables.

(j) Assemble gaskets where shown in Fig. 41 and bolt insulator support plate and wiping sleeve to pothead body. Compress gaskets by a partial turn on each bolt successively until the gasket is uniformly compressed to dimensions shown in Fig. 41. Check to be sure the terminal studs are seated properly on their gaskets, then screw contact nut in place after assembling top gaskets and washers. See Figures 32, 33 and 34.

(k) Make a plumber's wiped joint between the wiping sleeve and the lead sheath of the cable, as shown in Figures 35 and 36.

(l) Remove the 3/4" filling plug in the pothead body, the pipe plugs in the top of the studs and in the insulator support plate. Insert a stand pipe and funnel in the filling hole of sufficient height to extend above the top of the studs as shown in Figure 37.

Heat #227 or #1332 compound to the pouring temperature, 165°C. Do not overheat compound as higher temperatures may injure cable insulation and also result in excessive shrinkage of the compound while cooling. Before and while filling, warm pothead body and stand pipe to prevent sudden chilling of compound which may result in the formation of air voids. The pothead may be warmed by playing a blowtorch over the body, taking care that no direct heat reaches the porcelains or gaskets.



INSULATION LEVEL	INSULATION LAYERS (NOTE 1) I-202 NOTE 2	COTTON NOTE 3	V.C. NOTE 4	PAINT APPLY ONE COAT LIBERALLY
5000V	2	1	4	STERLING U-311 BLACK
15,000V	4	1	7	STERLING U-310 BROWN

NOTE 1:
I-202 & V.C. - One layer, wound 2/3 lap requires 3 turns around bar in one width of tape. One layer thickness is 3 times tape thickness.
COTTON - One layer, wound 1/2 lap requires 2 turns around bar in one width of tape. One layer thickness is 2 times tape thickness.

NOTE 2:
Irrathene #202, width 1 1/2" thickness 0.010". Keep tension on tape at all times while applying.

NOTE 3:
Cotton A2A1D10 (#650-116) width 1 1/2" thickness 0.007".

NOTE 4:
Varnished cambric A22A11A (#992) width 1 1/2", thickness 0.012".

Fig. 39 Insulation of Connection Bars

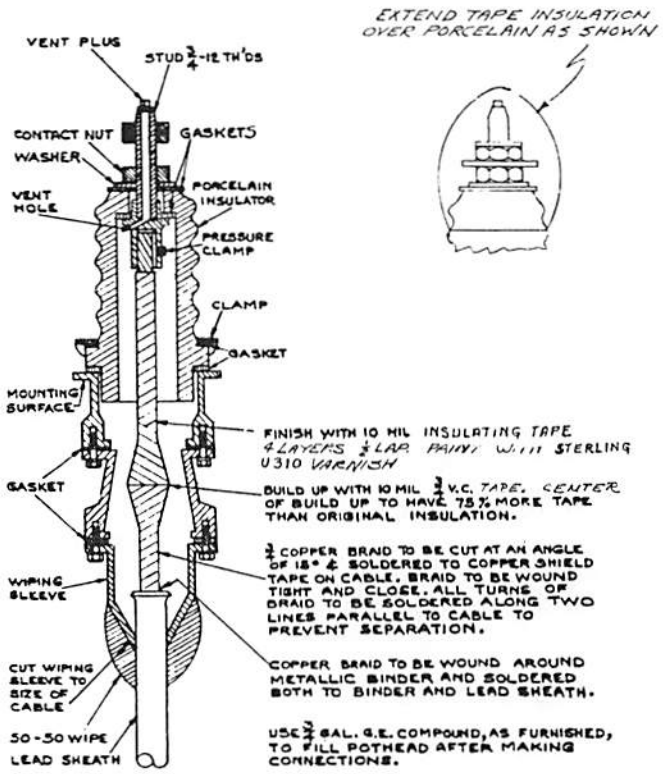


Fig. 40 Single-Conductor Pothead with Stress Cone

Pour until the compound appears at the insulator support plate plug holes. Insert plugs and continue filling until it appears at holes at the top of terminal studs. Insert plugs and continue pouring while the pothead and compound cools to fill air voids which might form.

When the pothead has cooled, remove filling pipe and insert plug. Clean off compound which might have overflowed on the outside of the porcelains.

(m) Assemble pothead connection bars, applying grease as outlined under "Connections" (Page 18). See Fig. 38. Insulate connections as follows:

(1) Fill all cavities around bolts and nuts with Duxseal compound to form smooth surface for taping, thus preventing air voids. This compound is not an insulating medium and should not be used for that purpose.

(2) Wrap with I202 Irrathene tape provided, as shown in Figs. 39, 40 and 41, the number of layers depending on the voltage rating of the equipment. Where there are sharp angles, apply additional layers to obtain the equivalent of the insulation of the flat surfaces.

(3) Over the insulating tape, apply one layer of white cotton tape, half lap, as a binder.

(4) Over the white cotton tape, brush a good coat of varnish (U-310 for 15 kv and U-311 for 5 kv). Varnish may be thinned if necessary, with Xylene, D5B9.

Single-Conductor Potheads

The procedure for installation of single-conductor potheads is in general the same as described for three-conductor potheads.

Cable Entrances Other Than Wiping Sleeves

Stuffing box cable entrance fittings are used for cables other than lead sheathed. These fittings may be provided with or without armor clamps as necessary.

The fitting consists of a cast and machined base, one or more rubber or neoprene washers, and a packing nut which compresses the washers around the cable. These parts should be assembled on the cable in the above order, with the base nearest to the pothead. The packing nut should be tightened after the cable is located in the pothead and before any compound is poured.

Where an armor clamp is required, it is usually made an integral part of the packing nut. This requires that the packing nut and armor clamp be tightened on the cable before the assembly of the pothead is completed.

Cable Sheath or Conduit Grounding

Where three-conductor conducting sheath or shielded cables are used, or where non-conducting sheath cable is carried in metallic ducts or conduits, it is usually desirable that both ends of the cable sheatn or conduit be grounded directly to the switchgear ground bus or structure or other apparatus. In some cases this may be accomplished by the mounting of potheads or terminating fittings on a grounded support. When such mounting cannot be arranged, a separate ground wire should be connected between the cable sheath or conduit and the switchgear ground bus.

Where single conductor conducting sheath cables are used, the same procedure should be observed, except that only one end of the sheath should be grounded. This also applies to single conductor non-conducting sheath cables in separate metallic conduits. Where three phases are carried by single conductors in a common metallic conduit, grounding procedure should be the same as that described for three conductor cables.

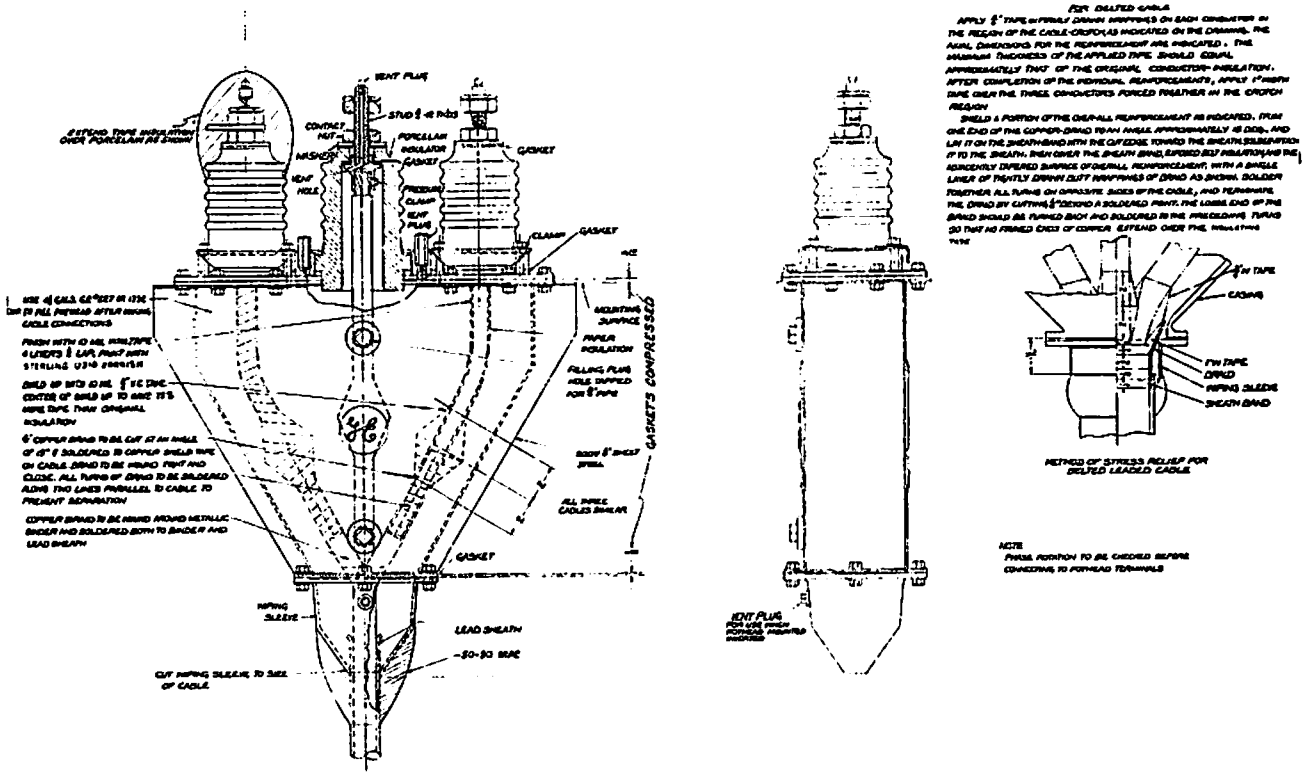


Fig. 41 (T-6595322)

Fig. 41 Triple-Conductor Pothead

TERMINATION WITHOUT POTHEAD SINGLE-CONDUCTOR

1. Cut cable to proper length.

2. Remove jacket and cable tape for distance of A plus B plus 3 inches, plus length to be inserted into terminal lug.

3. Unwrap shielding tape to point M, cut and solder it in place avoiding excessive heat on insulation. Remove outer semi-conducting tape for same distance. Thoroughly clean surface from which the semi-conducting tape was removed.

4. Remove insulation and inner semi-conducting tape to expose conductor for distance of one inch plus length to be inserted into terminal lug.

5. Attach terminal lug to conductor. If the cable is aluminum, the conductor surface must be carefully abraided and the cable covered liberally with a joint compound recommended by the cable manufacturer.

6. Taper insulation for one inch as shown.

7. Apply end seal. Clean surface over which splicing tape is to be applied and coat with G.E. No. A50P68 adhesive cement or equivalent. When solvent evaporates, build up with splicing tape GE8380 or equivalent, as shown.

Rated kv Phase to Phase	Dimensions in Inches	
	A	
	Indoors Dry Locations	B
2 to 5	5	2
6 to 10	9	3
11 to 15	13	4

8. Build stress cone. Clean cable surface and coat with G.E. No. A50P68 adhesive cement or equivalent. When solvent evaporates, build up cone with splicing tape GE-8380 or equivalent, for length B plus B. Between points M and P, tape is applied so that wrapped thickness at N is equal to 75% of the original insulation thickness - and so that the cone tapers to zero thickness at points M and P. Apply one layer No. 33 Scotch tape or equivalent, half lapped. Obtain a smooth wrapping but do not stretch tape more than necessary.

9. Pass a turn of tightly drawn braid around exposed portion of shielding tape at point M and solder in place. Then apply shielding braid in tightly drawn 1/6 inch lap wrappings to point N and spot solder. Terminate the braid by cutting 1/2 inch beyond soldering point. Turn down and solder loose ends to preceding turns. Wrap four to six turns of No. 19 AWG tinned copper wire around shielding braid and solder. Solder all turns of braid together along three lengthwise lines equally spaced around braided surface.

10. Solder ground strip over shielding tape near cable covering. Cover stress cone with one layer No. 33 Scotch tape, half lapped. Obtain a smooth wrapping but do not stretch tape more than necessary. Add two layers of splicing tape.

11. Pencil jacket for 1/2 inch as shown. Clean surface. Take particular care in cleaning outside jacket surface in order to entirely remove black wax finish. Coat with G.E. No. A50P68 adhesive cement or equivalent. When solvent evaporates, apply splicing tape GE8380 or equivalent and make sheath seal as shown on drawing. Apply one layer No. 33 Scotch tape or equivalent, half lapped. Obtain a smooth wrapping but do not stretch tape more than necessary.

12. Over entire termination, apply two layers of No. 33 Scotch tape or equivalent, half lapped, in manner to shed water. Obtain a smooth wrapping but do not stretch tape more than necessary.

Fig. 42 (8026383)

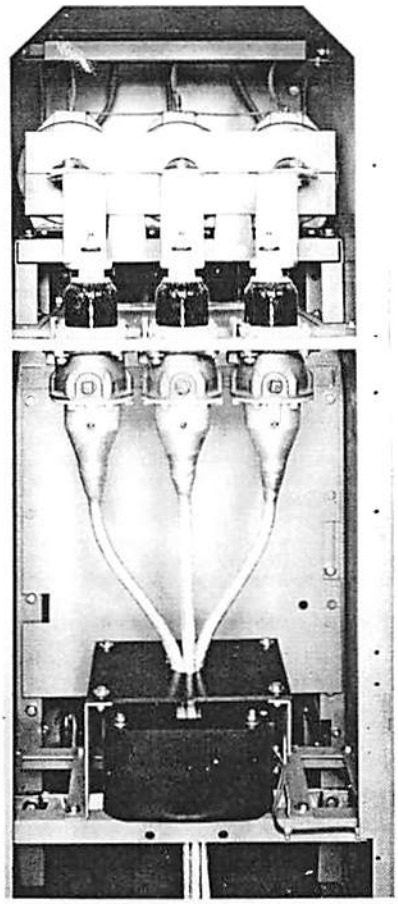


Fig. 42 Rear View of Unit Showing Through-Type Current Transformers

Fig. 43 (B230046C)

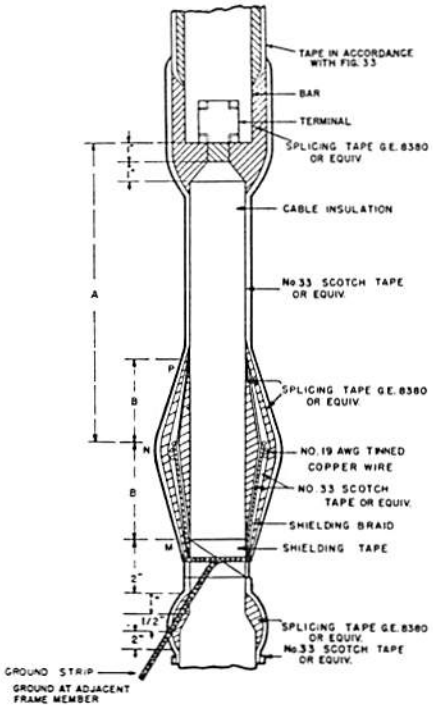


Fig. 43 Termination Without Pothead Single-Conductor

Fig. 44 (B232004C)

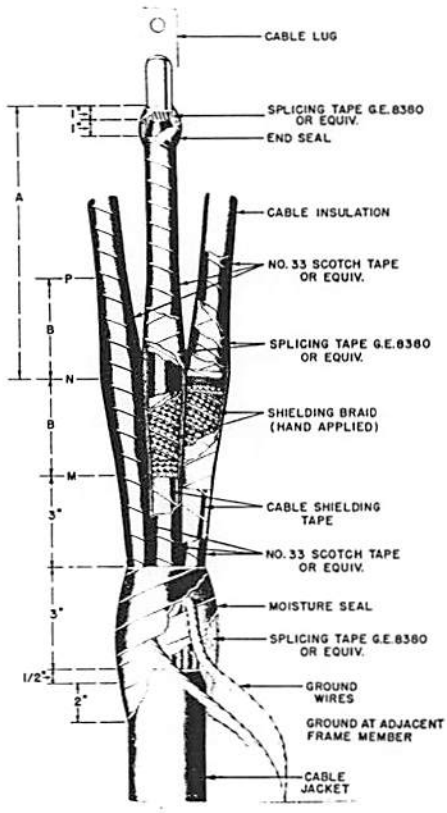


Fig. 44 Termination Without Pothead Multi-Conductor

TERMINATION WITHOUT POTHEAD MULTI-CONDUCTOR

Make termination as indicated for single-conductor except - substitute the following for paragraphs 10, 11 and 12;

Pencil jacket 1/2 inch. Clean surface over which sheath moisture seal is to be applied. Take particular care in cleaning outside jacket surface in order to entirely remove black wax finish. Coat with G.E. No. A50P68 adhesive cement or equivalent. Allow to dry. Apply splicing tape GE8380 or equivalent to make moisture seal as shown. This is done by starting wrapping tape near end of jacket and wrapping over ground wires for 1-1/2 inches. Bend ground wires out and back over taping just applied and continue applying lapped layers of tape to completion of moisture seal including a complete tape seal in crotch formed between the three conductors. Bond and ground the ground wires.

For a multi-conductor cable not having ground wires, the individual terminations should have grounding strips applied as for a single-conductor termination. These grounding strips are to be joined together to a common ground. This common ground must then be grounded.

GROUND FAULT CURRENT TRANSFORMERS (THROUGH-TYPE)

Through-type current transformers (see Fig. 42) are furnished where specified for sensitive protection against ground faults. These transformers are normally installed in a horizontal position directly above or below the primary cable terminals, so that the primary cable or cables can pass through them. One transformer is required for each three-phase circuit.

Where armored cable is used, the armor must be terminated and grounded before the cable passes through the transformer. Armor clamps are furnished for this purpose when specified.

When lead or other conducting sheath cable, or cable with shielding tape or braid is used, it is recommended that the sheath or shield be grounded solidly to the switchgear ground bus. The ground lead should be bonded to the sheath or shield on the side of the current transformer away from the primary terminals. In cases where the ground cannot be applied before the cable passes through the transformer, bond the lead to the sheath or shield between the transformer and the primary terminals. The ground conductor must then be passed back along the cable path through the current transformer before being connnected to the ground bus.

Where potheads are used in units provided with ground fault current transformers, the pothead mountings must be insulated from ground.

CONTROL CABLES

When control conduits enter the unit from below, the conduit should not extend more than 4 inches above the floor. The control cables may be pulled through the conduits before or after the switchgear is installed, whichever is more convenient.

Connect the cables to the terminal blocks in accordance with the wiring diagrams furnished for the requisition.

If the control conduits enter from above, drill the top and bottom covers of the front enclosure wiring trough to suit the conduits. Fasten the conduits to the bottom cover with locknuts.

The cables from the control power source to the switchgear should be large enough to avoid excessive voltage drop when the circuit breakers are operated. See testing instructions.

Where units have been split for shipment, any control or other secondary leads which must connect across the split will be arranged with terminal blocks in the cross trough or convenient side sheet so that the wires can be reconnected. The wires will be cut to length and formed before being folded back so that a minimum of time will be required for reconnecting them.

GROUND BUS

The ground bus is bolted to the rear or the frame near the bottom. It is arranged so that connections to the station ground can be made in any unit. Where the equipment is shipped in more than one group, the sections of ground bus must be connected by using the splice plates furnished with the equipment. Apply grease and assemble joints as outlined under "Connections" (Page 20). Ground bus connections are made in the lower portion of the cable entrance compartment. The switchgear ground bus must be connected to the station ground bus by a conductor having a current carrying capacity equal to that of the switchgear ground bus. It is very important that the equipment be adequately grounded to protect the operator from injury when short circuits or other abnormal occurrences take place and to insure that all parts of the equipment, other than live parts, are at ground potential.

LIGHTNING PROTECTION

It will be the responsibility of the purchaser to provide suitable lightning arresters to protect the switchgear from damage due to lightning. The General Electric Company's recommendations as to the types of circuits requiring lightning protection, and a list of recommended lightning arresters, are contained in Bulletin GER-141, copies of which are available upon request.

DOOR ALIGNMENT

If for any reason it is necessary to realign the doors of metal-clad switchgear during installation the procedure given in the following paragraphs should be followed.

After checking that the switchgear is level and plumb as described above, start at either end of the switchgear lineup and realign each door individually as required.

The top of each door should be level with the adjacent doors; the sides of each door plumb; the surface of each door flush with the adjacent doors; and the space between adjacent doors equalized to permit their free swing and present a neat appearance. The door stops should be adjusted to permit a door swing of approximately 105°.

Doors may be raised or lowered vertically, or moved forward or backward horizontally, by loosening the hinge mounting nuts on the left side sheet and shifting the hinge and door assembly as allowed by the slotted holes in the hinge.

Doors may be shifted to the right or left by adding or removing washers or shims from between the hinge and side sheet.

Doors may be plumbed by slightly bending the appropriate hinges. To do this, open the door and insert a drift pin in either of the two holes in the hinge. Pulling forward on the drift pin will move the door to the right, and pushing back will move the door to the left. Adjust each hinge individually as required to plum the door.

TESTING AND INSPECTION

After the equipment has been installed and all connections made, it should be tested and inspected before putting in service. Although the equipment and devices have been completely tested at the factory, a final field test should be made to be sure that the equipment has been properly installed and that all connections are correct and have not become loose in transportation. The primary equipment should be completely de-energized while the tests are in progress.

Directions for testing devices such as relays, instruments and meters are given in the instruction book furnished for each device. The settings of the protective relays must be coordinated with the other relays on the system and therefore these relays must be set by the purchaser. General instructions on setting the relays are given in the relay instruction books. Special instruction books are furnished for complicated automatic equipments, describing the sequence of operation of the devices required to perform the desired function.

When transformers are furnished to supply the control power, the primary taps should be selected so that the control voltage indicated on the wiring diagram is obtained on the secondary of the transformer. When a battery is used to supply the control power, the cables from the battery to the switchgear should be large enough to avoid excessive voltage drop. The voltage at the terminals of the breaker closing coils, when the breaker is being closed, should not be less than 112.5 volts for 125 volt coils and 225 volts for 250 volt coils.

The operation of the breaker with its associated devices may be tested in the unit while the equipment is energized by use of the test coupler which is furnished. Lower the breaker to the test or down position. Attach the test coupler to connect the breaker secondary disconnecting device to that on the structure.

High potential tests to check the integrity of the insulation are not necessary if the installation instructions in this book are carefully followed. If the purchaser wishes to make high potential tests the voltage should not exceed 75% of the AIEE factory test voltages.

Potential transformers and control power transformers must be disconnected during high voltage testing.

OPERATION

The operation of metal-clad switchgear is similar to that of other types except that it provides maximum safety to the operator and the feature of easy removal and replacement of the circuit breaker.

All circuit breaker removable elements of the same type and rating which have duplicate wiring may be interchanged.

BREAKER POSITIONING

To place the circuit breaker in operating position, proceed as given below:

Clean contacts and cover with a very thin coating of Contact Lubricant D50H47.

Push the breaker into the unit until it rests against the stop.

To raise the breaker, operate the elevating control selector switch just inside the door on the right hand side to "Raise". A clutch handle just above the elevating motor is then pulled forward until it closes the clutch limit switch and engages the motor to raise the breaker in the housing. The clutch handle is held in this position until a limit switch on the structure opens to stop the motor at the end of the upward travel of the breaker. The selector switch must not be used to energize or interrupt the motor circuit at any time. See Fig. 22.

To lower the breaker, proceed the same as for raising except operate selector switch to "Lower".

The clutch must be held in the engaged position; otherwise, a spring will return it to its normal position opening the electrical circuit to the motor.

The breaker may be raised and lowered by an emergency hand wrench which can be inserted after removing the motor.

The motor is removed by unlatching the motor assembly from the support and disconnecting the motor lead plug.

After removing the motor, pull the clutch forward and insert the manual wrench into the end of the clutch coupling. The breaker must be tripped before the wrench can be inserted and held in the clutch coupling.

TRANSFER TRUCKS

Circuit breaker transfer trucks are furnished with outdoor metal-clad switch-

gear to facilitate moving of circuit breakers from unit to unit or to maintenance areas. The platform at the front end of the transfer truck is adjustable in height. See Fig. 8, view A, for instructions for adjustment. The truck is equipped with two latches, one to hold the breaker on the truck and one to hold the truck to the metal-clad switchgear unit. Both latches engage automatically, and both are released by a single T-shaped foot pedal on the rear of the truck. Depressing the left side of the pedal unlatches the truck from the switchgear unit, and depressing the right side of the pedal unlatches the breaker from the truck.

SPACE HEATERS

Space heaters are provided in all outdoor equipment in order to keep the inside temperature several degrees higher than that outside. Heaters are also furnished for indoor equipment when it is known that abnormal atmospheric conditions exist at the installation, or when specified by the purchaser.

By maintaining a slight temperature differential, the heaters help facilitate drying and prevent condensation and the resulting corrosion and insulation deterioration which might occur.

Heaters are normally located at the sides of the breaker units, a few inches above the floor. In auxiliary compartments with a single rollout, the heaters will be in the space above the rollout. In auxiliary compartments with two rollouts, the heater will be on one of the rollouts, for greater accessibility. Heaters may also be located in superstructure compartments, transition compartments, and in bus ducts, if the operating conditions require them.

Before energizing the heaters, be sure the power source is of the proper voltage, frequency, and phase arrangement, and is connected in accordance with the wiring diagrams furnished with the equipment. Also, be sure to remove all cartons and miscellaneous material packed inside the units before energizing the heaters.

Heaters should be visually inspected several times a year to make sure they are operating properly.

It is recommended that the heaters be energized at all times and that thermostatic control not be used. If thermostatic control is used, the contacts of the thermostat should be set to close between 95 F and 100 F on falling temperature, de-energizing the heaters only when strong sunlight beats on the switchgear. Under no condition should a differential thermostat be used to control the heaters because under conditions of extremely high humidity this type of thermostat will not operate at all times to keep the heaters on enough to prevent condensation in the switchgear.

MAINTENANCE

A regular maintenance schedule should be established to obtain the best service and reliability from the switchgear. Plant operating and local conditions will dictate the frequency of inspection required. For specific information regarding the maintenance of devices, such as circuit breakers, relays, meters, etc., refer to the separate instruction book furnished for each device. The inspection cabinet, which is furnished, provides a convenient means for maintaining the circuit breakers. Under normal conditions the protective relays do not operate, therefore, it is important to check the operation of these devices regularly.

A permanent record of all maintenance work should be kept, the degree of detail depending on the operating conditions. In any event, it will be a valuable reference for subsequent maintenance work and for station operation. It is recommended that the record include reports of tests made, the condition of equipment and repairs and adjustments that were made.

BEFORE ANY COVERS ARE REMOVED OR ANY DOORS OPENED WHICH PERMIT ACCESS TO THE PRIMARY CIRCUITS, IT IS ESSENTIAL THAT THE CIRCUIT BE DE-ENERGIZED.

The primary circuits of metal-clad switchgear are insulated in order to reduce the size of the equipment. However, this insulation, except in one or two instances, requires a certain amount of air gap between phases and to ground to complete the insulation. Inserting any object in this air space, when equipment is energized, whether it be a tool or a part of the body, may under certain conditions, in effect, short circuit this air gap and may cause a breakdown in the primary circuit to ground and cause serious damage or injury or both.

Care should be exercised in the maintenance and checking procedures that accidental tripping or operation is not initiated.

The switchgear structure and connections should be given the following overall maintenance at least annually.

1. Thoroughly clean the equipment, removing all dust and other accumulations. Wipe clean the buses and supports. Inspect the buses and connections carefully for evidence of overheating or weakening of the insulation.

2. Measure the resistance to ground and between phases of the insulation of buses and connections. Since definite limits cannot be given for satisfactory insulation resistance values, a record must be kept of the reading. Weakening of the insulation from one maintenance period to the next can be recognized from the recorded readings. The readings should be taken under similar conditions each time if possible, and the record should include the temperature and humidity.

High potential tests are not required, but if it seems advisable, based on the insulation resistance tests or after repairs, the test voltage should not exceed 75% of the AIEE factory test voltage. Potential transformers and control power transformers must be disconnected during high voltage testing.

3. Clean elevating mechanism and lubricate jack screws and gears with lubricant G. E. Co. #D50H15 (Atlantic Ref. Co. #52 or equal).

4. Check primary disconnecting device contacts for signs of abnormal wear or overheating. Clean contacts with silver polish. Discoloration of the silvered surfaces is not ordinarily harmful unless atmospheric conditions cause deposits such as sulphides on the contacts. If necessary the deposits can be removed with a good grade of silver polish.

Before replacing breaker, apply a thin coat of contact lubricant D50H47 to breaker studs for lubrication.

5. Check to see that all anchor bolts and bolts in the structure are tight. Check tightness and continuity of all control connections and wiring.

6. If the switchgear is equipped with heaters, check to see that all heaters are energized and operating.

RENEWAL PARTS

ORDERING INSTRUCTIONS

1. RENEWAL PARTS SHOULD BE ORDERED FROM THE MEDIUM VOLTAGE SWITCHGEAR DEPARTMENT.
2. ALWAYS SPECIFY THE REQUISITION NUMBER ON WHICH THE EQUIPMENT WAS ORIGINALLY FURNISHED.
3. SPECIFY THE QUANTITY, REFERENCE NUMBER, DESCRIPTION AND THIS BULLETIN NUMBER.
4. STANDARD HARDWARE, SUCH AS SCREWS, BOLTS, NUTS, WASHERS, ETC., IS NOT LISTED. SUCH ITEMS SHOULD BE PURCHASED LOCALLY.
5. FOR PRICES, REFER TO THE NEAREST OFFICE OF THE GENERAL ELECTRIC COMPANY.
6. IF INSULATING MATERIAL, SUCH AS TAPE, VARNISH, COMPOUND, ETC., IS REQUIRED, IT MUST BE SPECIFIED SEPARATELY.

PRIMARY DISCONNECT DEVICES
(SEE FIG. NO. 10)

REF. NO.	DESCRIPTION
5	Front Primary Disconnect Device Assembly, 3 Pole, Complete with Connections
6	Rear Primary Disconnect Device Assembly, 3 Pole, Complete with Connections

NOTE: Insulating material required for Ref. Nos. 5 and 6 will be furnished with order.

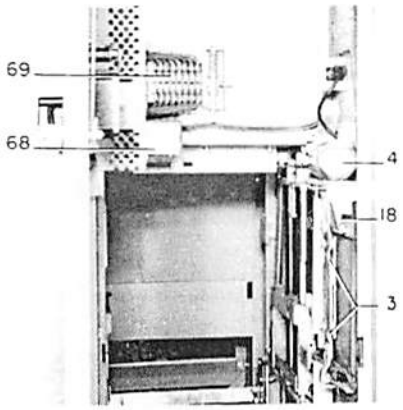


Fig. 45A View Showing Elevating Mechanism Motor and Control Unit

POSITIVE MECHANICAL INTERLOCK
(FIG. NO. 45A)

REF. NO.	DESCRIPTION
3	Complete positive mechanical interlock assembly
4	Elevating mechanism motor (115-v d-c)
4	Elevating mechanism motor (230-v d-c)
4	Elevating mechanism motor (230-v d-c)
18	Spring only

ELEVATING MECHANISMS

REF.NO.	DESCRIPTION
7	Miter gears, pair
7A	Groov pin for miter gear
8	Shaft, right
8A	Shaft, left
9	Sprocket
9A	Groov pin for sprocket
10	Spur gear
10	Pinion gear and rod
10A	Groov pin for spur gear
11	Stop stud
11A	Stop bolt
12	Pinion gear and rod
12	Spur gear
12A	Groov pin for spur gear
13	Locking spring
14	Stop shaft
14A	Groov pin for stop shaft
14B	Stop shaft bracket
15	Clutch spring
15A	Groov pin for clutch spring
16	Slide clutch
17	Jack screw

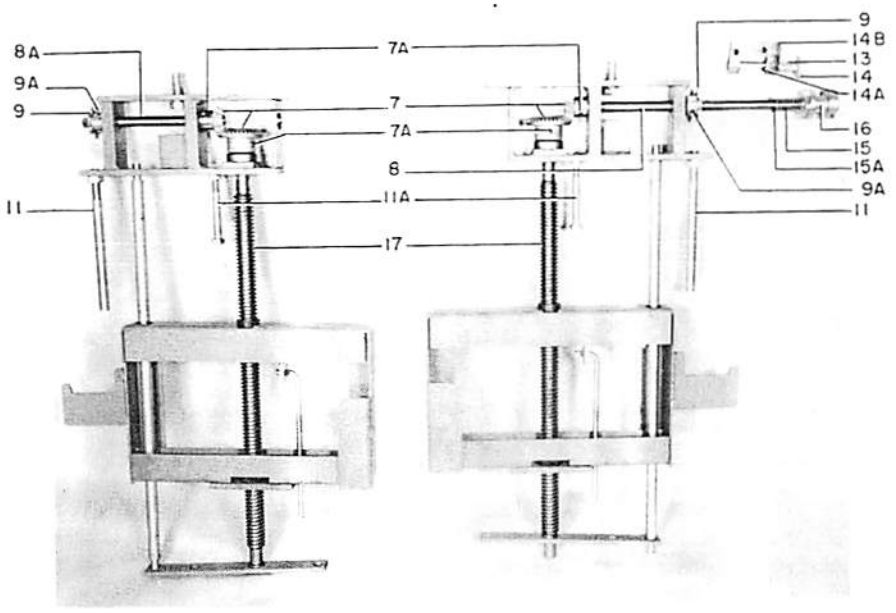


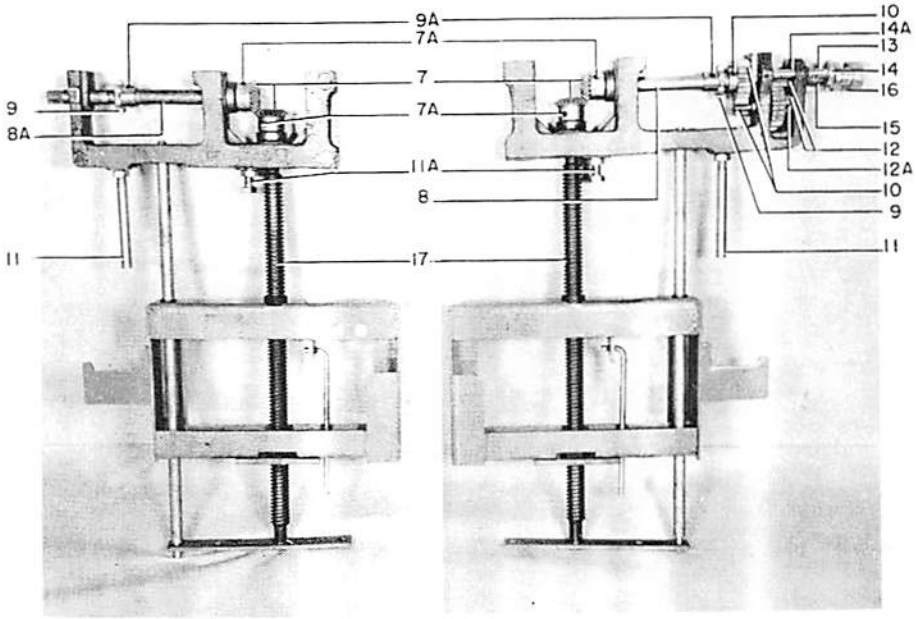
Fig. 45A (8024142)

Complete Left Hand (Ref. No. 1)

Complete Right Hand (Ref. No. 2)

Fig. 45 (8024360)

Fig. 45 Elevating Mechanism for M-26 Equipments Rated 250 mva or less and M-36 Equipments Rated 1200A 500 mva or less



Complete Left Hand (Ref. No. 1A)

Complete Right Hand (Ref. No. 2A)

Fig. 46 Elevating Mechanism for M-36H Equipments Rated 750 mva, M-26 Equipments Rated 350 mva and M-36 Equipments Rated 2000A

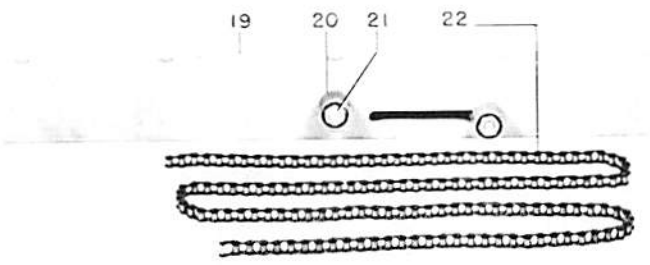


Fig. 47 Angle Bracket and Chain Drive

REF. NO.	DESCRIPTION
19	Bracket
20	Roller
21	Retainer
22	Chain

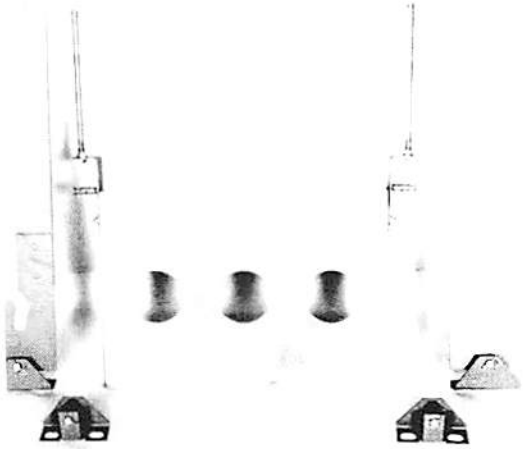


Fig. 48 Shutter Mechanism Assembly M-26

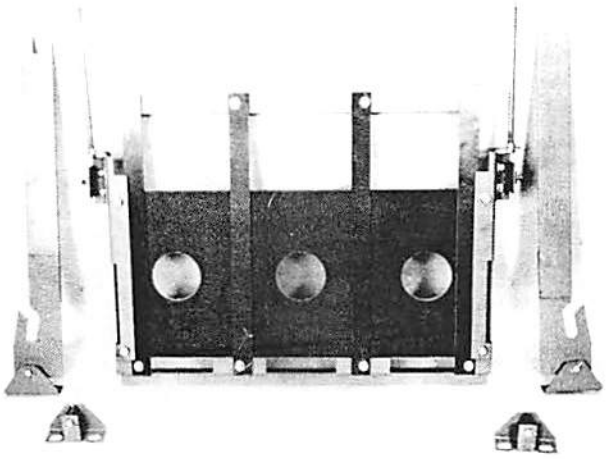
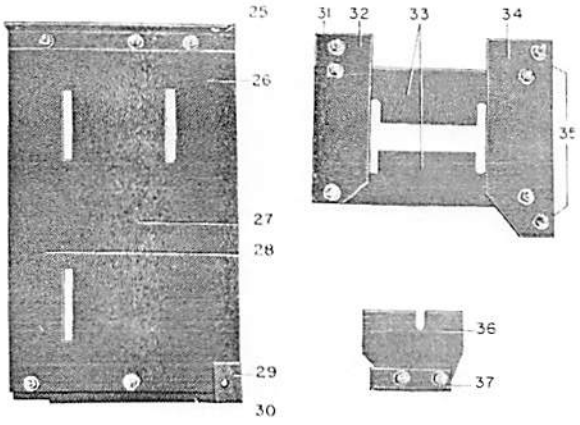


Fig. 49 Shutter Mechanism Assembly M-36



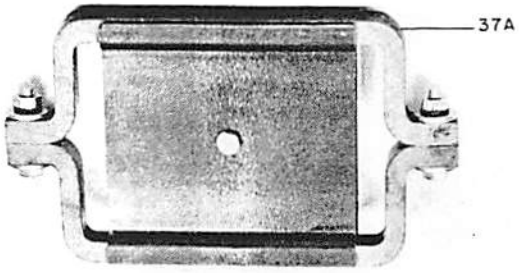


Fig. 50 Bus Supports

REF. NO.	DESCRIPTION
25	Isolating barrier support angle
26	Rear isolating barrier
27	Intermediate isolating barrier
28	Front isolating barrier
29	Isolating barrier clip
30	Isolating barrier support
31	Front support clip (not shown)
32	Front intermediate support
33	Intermediate support
34	Rear intermediate support
35	Rear support clip (not shown)
36	Lower intermediate support
37	Lower intermediate support clip
37A	Intermediate clamp assembly (supersedes but does not replace Ref. Nos. 31 - 35)

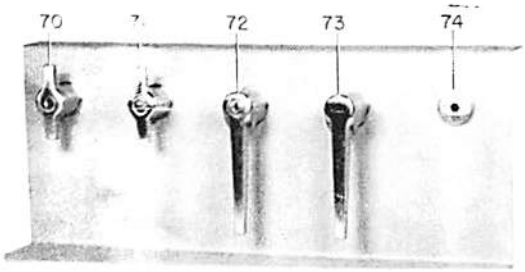


Fig. 51 Door Handles and Locks

REF. NO.	DESCRIPTION
70	Panel locking handle
71	Panel handle
72	Door locking handle
73	Door handle
74	Socket

Fig. 47 (8024364) Fig. 48 (8024366) Fig. 49 (8024367) Fig. 50 (8020152 & 8024361) Fig. 51 (8011607)

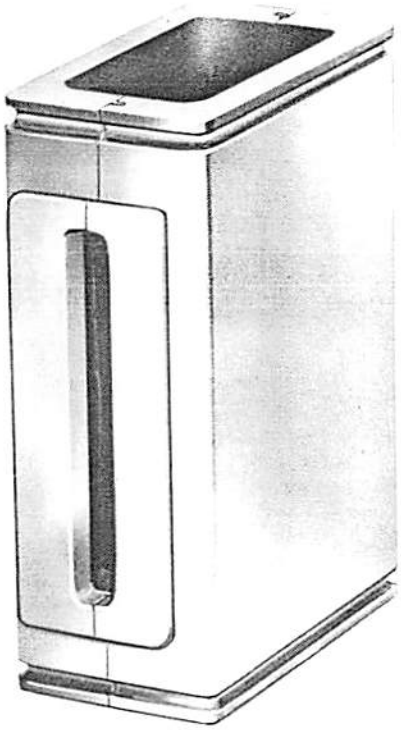


Fig. 52 Bus Connection Box
(4.16 or 13.8 kv Units)

REF. NO.	LOCATION	RATING	DESCRIPTION
38	int.	1200A.	1 connection bar, down
39	int.	1200A.	1 connection bar, up
40	end	1200A.	1 connection bar, down
41	end	1200A.	1 connection bar, up
42	int.	1200A.	no connection bar
43	end	1200A.	no connection bar
44	int.	1600A.	1 connection bar, down
45	int.	1600A.	1 connection bar, up
46	end	1600A.	1 connection bar, down
47	end	1600A.	1 connection bar, up
48	int.	1600A.	no connection bar
49	end	1600A.	no connection bar
50	int.	2000A.	1 connection bar, down
51	int.	2000A.	1 connection bar, up
52	end	2000A.	1 connection bar, down
53	end	2000A.	1 connection bar, up
54	int.	2000A.	no connection bar
55	end	2000A.	no connection bar
56	int.	2000A.	2 connection bars, down
57	int.	2000A.	2 connection bars, up
58	end	2000A.	2 connection bars, down
59	end	2000A.	2 connection bars, up
59A	specify		Insulating boot
59B			Plastic rivet for boot

Fig. 52 (8012365)

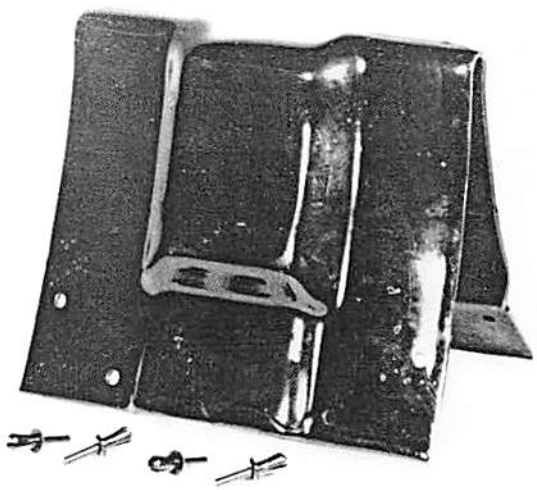


Fig. 53 Bus Connection Boot
(4.16 kv Units Only)

Fig. 53 (8026455)

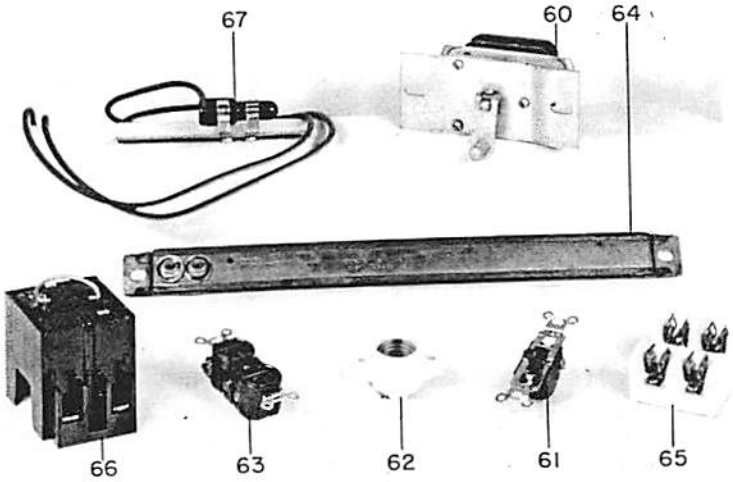


Fig. 54 Wiring Devices and Miscellaneous Parts

REF. NO.	DESCRIPTION
60A	Limit Switch SB1 type (upper)
60B	Limit switch SB1 type (lower)
61	Light switch
62	Keyless receptacle
63	Duplex receptacle
64	Strip heater
65	Fuse block, open type
66	Fuse block, dead front
67	Limit switch, mercury type
See Fig. 45A 68	Complete secondary disconnect device
See Fig. 45A 69	Complete stationary auxiliary switch and mechanism

Fig. 54 (8024363)

Fig. 55 (262C753)

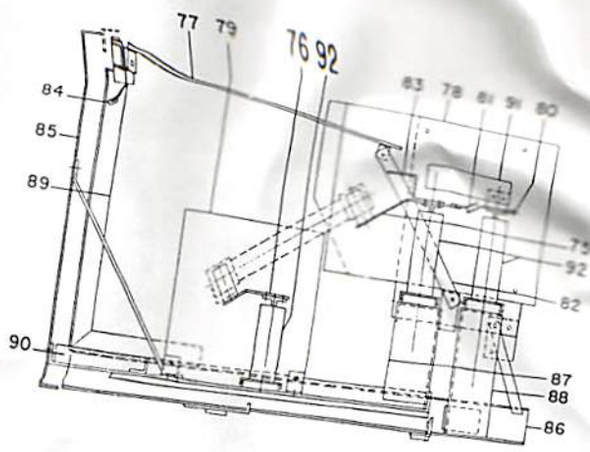


Fig. 55 Fuse Rollout Unit

Fig. 56 (262C829)

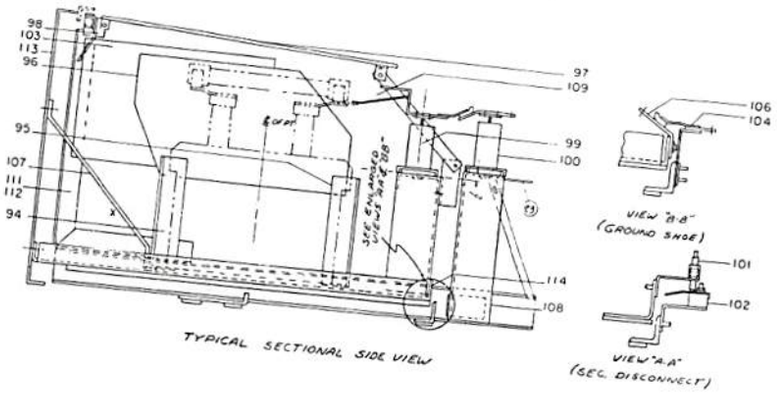


Fig. 56 Potential Transformer Rollout Unit

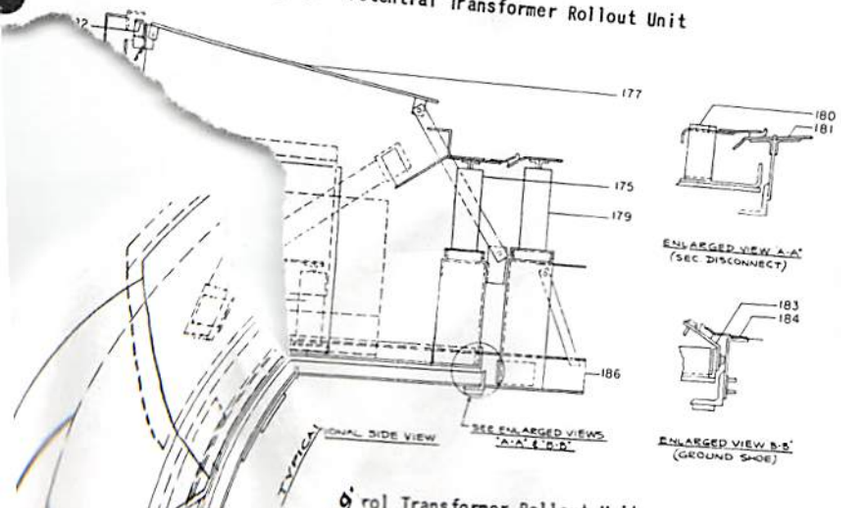


Fig. rol Transformer Rollout Unit

REF.NO.	DESCRIPTION
	FUSE ROLLOUT UNIT
75	Fuse support (upper)
76	Fuse support (lower)
77	Shutter
78	Transformer
79	Barrier
80	Barrier
81	Contact
82	Shutter support
83	Ground shoe
84	Ground contact
85	Cover
86	Frame
87	Support
88	Support
89	Support
90	Carriage
91	Arc Quencher
92	Insulator
	POTENTIAL TRANSFORMER ROLLOUT UNIT
94	Barrier support
95	Barrier support
96	P.T. barrier
97	Shutter
98	Shutter support
99	Contact (movable)
100	Contact (stationary)
101	Sec. disconnect (movable)
102	Sec. disconnect (stationary)
103	Barrier
104	Contact
106	Ground shoe
107	Support
108	Frame and carriage
109	P. T. braid (specify length)
111	Support
112	Support
113	Cover
114	Carriage
	CONTROL TRANSFORMER ROLLOUT UNIT
175	Fuse support (upper)
176	Fuse support (lower)
177	Shutter
178	Transformer
179	Contact
180	Contact
181	Contact
182	Shutter support
183	Ground shoe
184	Ground contact
185	Cover
186	Frame
187	Support
188	Support
189	Support
190	Carriage
191	Barrier
	SINGLE & TRIPLE-CONDUCTOR POTHEADS
201	Triple-conductor pothead assembly
202	Body
203	Insulators and support
204	Wiping sleeve
205	Gaskets for triple-conductor pothead
206	Terminal
207	Contact nut
208	Washer
209	Palnut (3/4 in. - 12)
210	Pipe plug (3/4 in. std.)
211	Pipe plug (1/8 in std.)
212	Single-conductor pothead assembly
213	Body and insulator
214	Gaskets for single-conductor pothead
215	Wiping sleeve
216	Adapter for mechanical entrance fittings

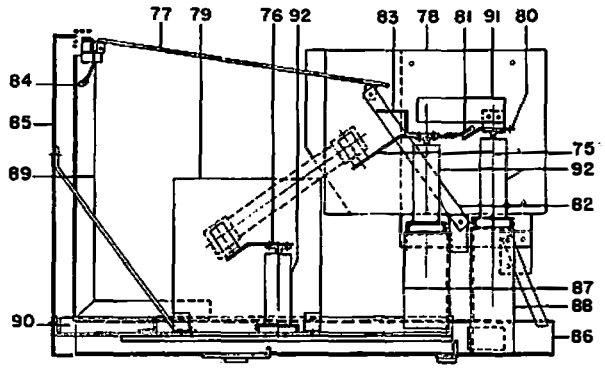


Fig. 55 (262C753) Fuse Rollout Unit

Fig. 55 Fuse Rollout Unit

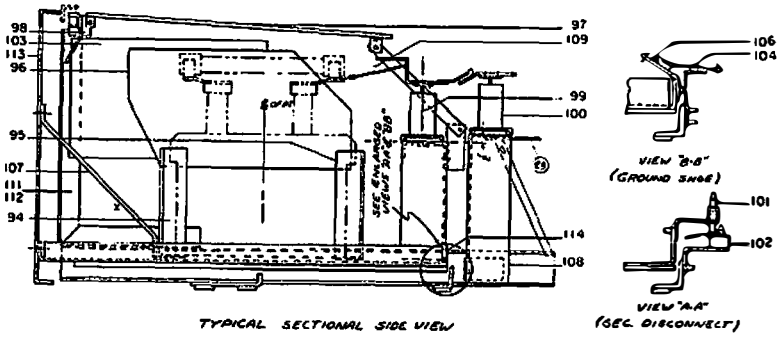


Fig. 56 (262C829) Potential Transformer Rollout Unit

Fig. 56 Potential Transformer Rollout Unit

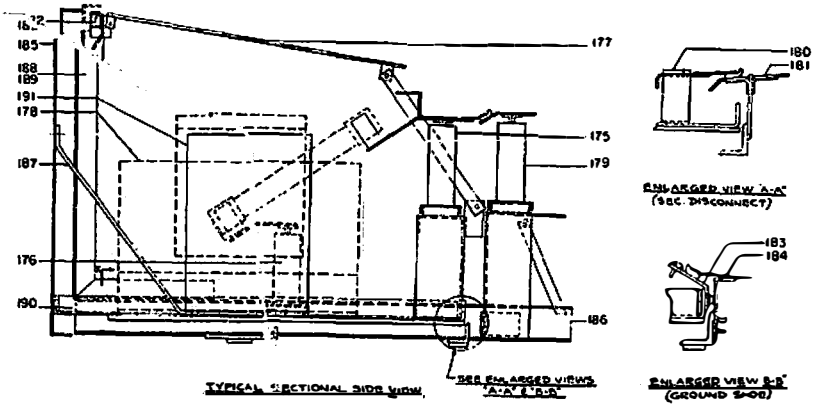


Fig. 57 (262C822) Control Transformer Rollout Unit

Fig. 57 Control Transformer Rollout Unit

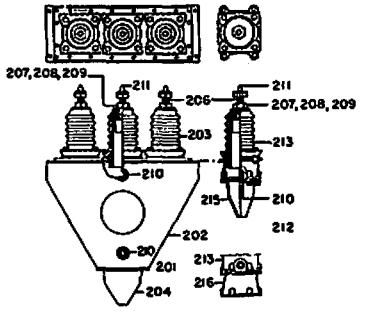


Fig. 58 (1103401) Single and Triple-Conductor Potheads

Fig. 58 Single and Triple-Conductor Potheads

REF.NO.	DESCRIPTION
	FUSE ROLLOUT UNIT
75	Fuse support (upper)
76	Fuse support (lower)
77	Shutter
78	Transformer
79	Barrier
80	Barrier
81	Contact
82	Shutter support
83	Ground shoe
84	Ground contact
85	Cover
86	Frame
87	Support
88	Support
89	Support
90	Carriage
91	Arc Quencher
92	Insulator
	POTENTIAL TRANSFORMER ROLLOUT UNIT
94	Barrier support
95	Barrier support
96	P.T. barrier
97	Shutter
98	Shutter support
99	Contact (movable)
100	Contact (stationary)
101	Sec. disconnect (movable)
102	Sec. disconnect (stationary)
103	Barrier
104	Contact
106	Ground shoe
107	Support
108	Frame and carriage
109	P. T. braid (specify length)
111	Support
112	Support
113	Cover
114	Carriage
	CONTROL TRANSFORMER ROLLOUT UNIT
175	Fuse support (upper)
176	Fuse support (lower)
177	Shutter
178	Transformer
179	Contact
180	Contact
181	Contact
182	Shutter support
183	Ground shoe
184	Ground contact
185	Cover
186	Frame
187	Support
188	Support
189	Support
190	Carriage
191	Barrier
	SINGLE & TRIPLE-CONDUCTOR POTHEADS
201	Triple-conductor pothead assembly
202	Body
203	Insulators and support
204	Wiping sleeve
205	Gaskets for triple-conductor pothead
206	Terminal
207	Contact nut
208	Washer
209	Palnut (3/4 in. - 12)
210	Pipe plug (3/4 in. std.)
211	Pipe plug (1/8 in std.)
212	Single-conductor pothead assembly
213	Body and insulator
214	Gaskets for single-conductor pothead
215	Wiping sleeve
216	Adapter for mechanical entrance fittings

INSTRUCTIONS
AND
RENEWAL PARTS

GEH-1802H
(SUPERSEDES GEH-1802G AND GEF-3837)

METAL-CLAD SWITCHGEAR

Types M-26 and M-36
For Magne-blast Air Circuit Breaker
Types AM-4.16 and AM-13.8

CONTENTS

MEDIUM VOLTAGE SWITCHGEAR DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA, PA.

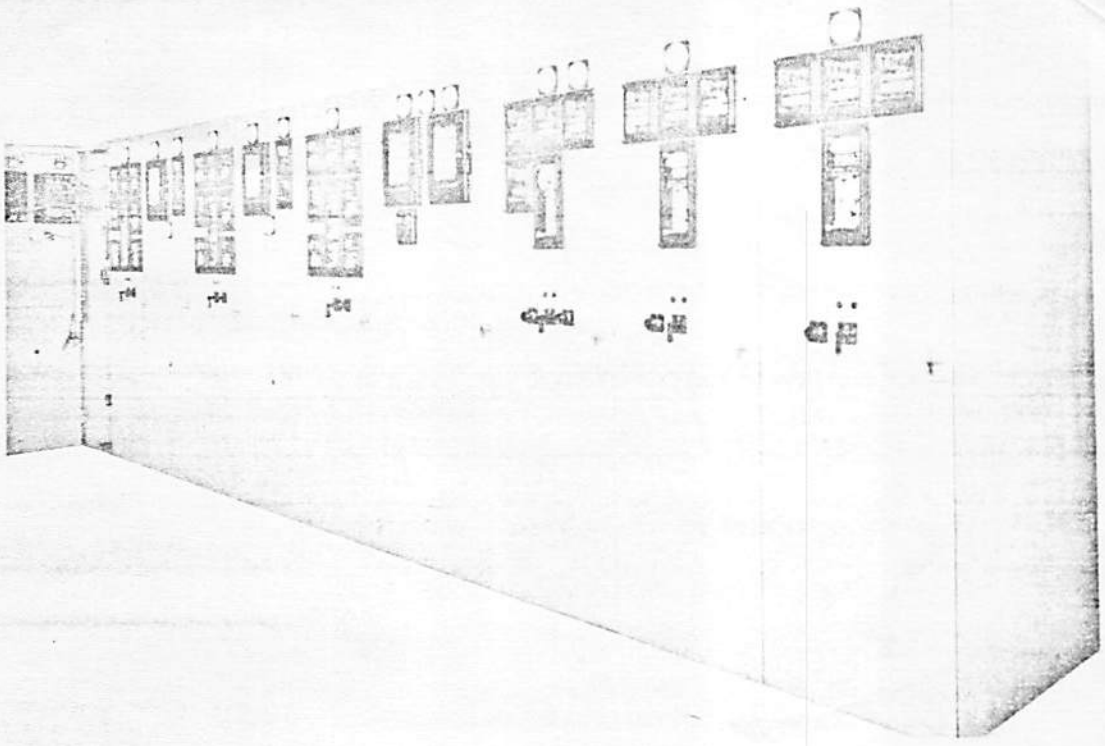


Fig. 1 (8021315)

Fig. 1 Typical Indoor Metal-clad Switchgear Equipment

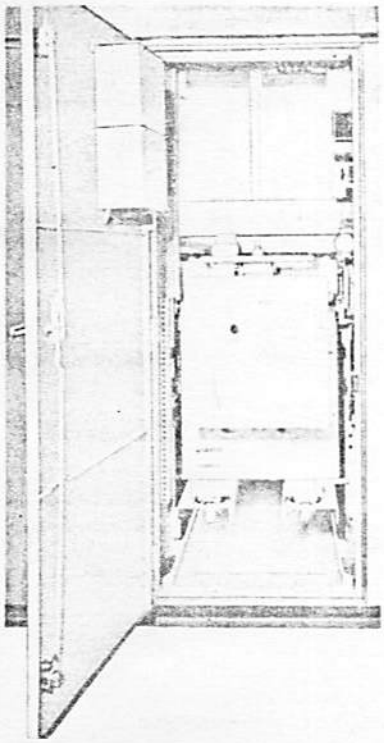


Fig. 2 (8020218)

Fig. 2 Typical Outdoor Metal-clad Switchgear Equipment Front View

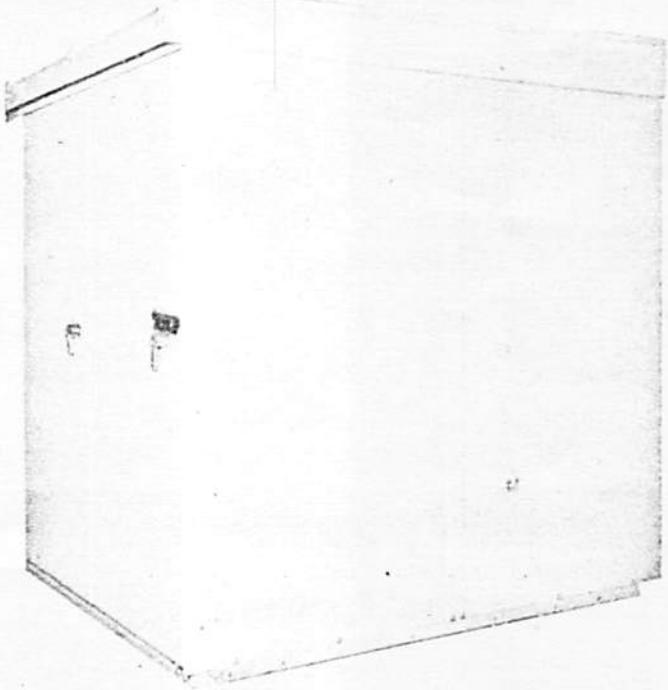


Fig. 3 (8024572)

Fig. 3 Typical Outdoor Metal-clad Switchgear Equipment Side View

METAL-CLAD SWITCHGEAR
TYPES M26 AND M36
FOR MAGNE-BLAST AIR CIRCUIT BREAKER
TYPES AM-4.16 AND AM-13.8

Metal-clad switchgear is equipment to control and protect various types of electrical apparatus and power circuits.

The switchgear consists of one or more units which are mounted side by side and connected mechanically and electrically together to form a complete switching equipment. Typical equipments are shown in Figures 1, 2 and 3.

The circuit breakers are easily removable to provide maximum accessibility for maintenance with minimum interruption of services. The switchgear is designed to provide maximum safety to the operator. All equipment is enclosed in grounded metal compartments.

The equipment is available in the ratings listed in the following table. The ratings of the equipment and devices are based on usual service conditions as covered in AIEE and NEMA standards. Operation at currents above the equipment rating will result in temperature rises in excess of NEMA standards, and is not recommended. For outdoor installation the same basic equipment is built into a weatherproof housing as in Figures 2 and 3.

TYPE M26				
CIRCUIT BREAKER	TYPE	INTERRUPT CAPACITY KVA	CURRENT	FIGURE
AM-4.16-150	Magne-blast	150,000	1200 - 2000	4
AM-4.16-250	Magne-blast	250,000	1200 - 2000	4
TYPE M36				
CIRCUIT BREAKER	TYPE	INTERRUPT CAPACITY KVA	CURRENT	FIGURE
AM-13.8-150	Magne-blast	150,000	1200 - 2000	4
AM-13.8-250	Magne-blast	250,000	1200 - 2000	4
AM-13.8-500	Magne-blast	500,000	1200 - 2000	4
AM-13.8-750	Magne-blast	750,000	1200 - 2000	4
AM-7.2-250	Magne-blast	250,000	1200 - 2000	4
AM-7.2-500	Magne-blast	500,000	1200 - 2000	4

RECEIVING, HANDLING AND STORAGE

RECEIVING

Every case or crate leaving the factory is plainly marked at convenient places with case number, requisition number, customer's order, front or rear, and when for size and other reasons it is necessary to divide the equipment for shipment, with the unit number of the portion of equipment enclosed in each shipping case.

The contents of each package of the shipment are listed in the Packing Details. This list is forwarded with the shipment, packed in one of the cases. The case is especially marked and its number can also be obtained from the Memorandum of Shipment. To avoid the loss of small parts when unpacking, the contents of each case should be carefully checked against the Packing Details before discarding the packing material. Notify the nearest General Electric Company representative at once if any shortage of material is discovered.

All elements before leaving the factory are carefully inspected and packed by workmen experienced in the proper handling and packing of electrical equipment. Upon

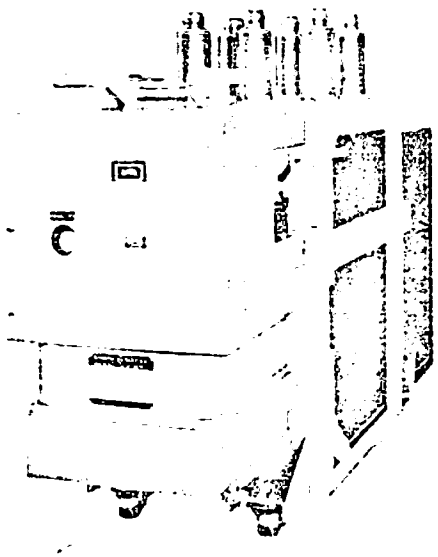


Fig. 4 (8012851) Magne-blast Breaker

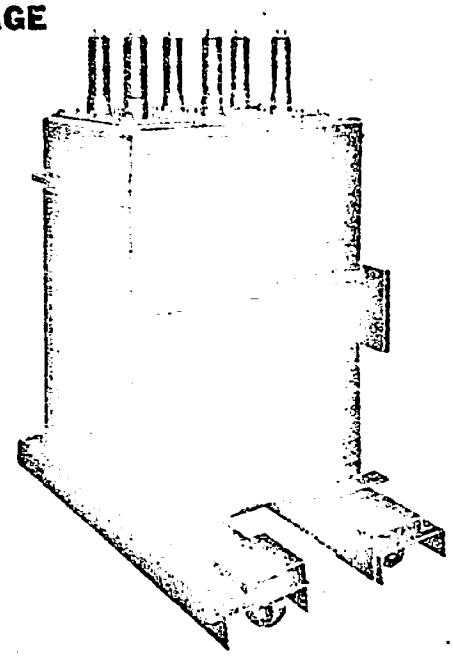
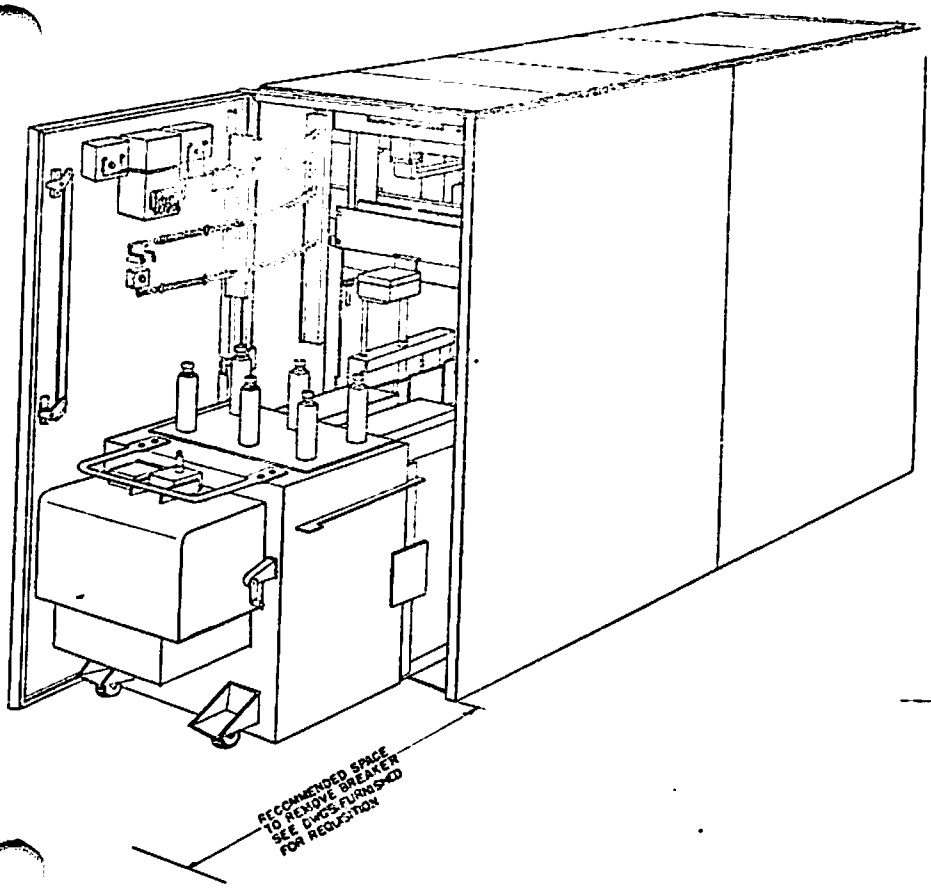
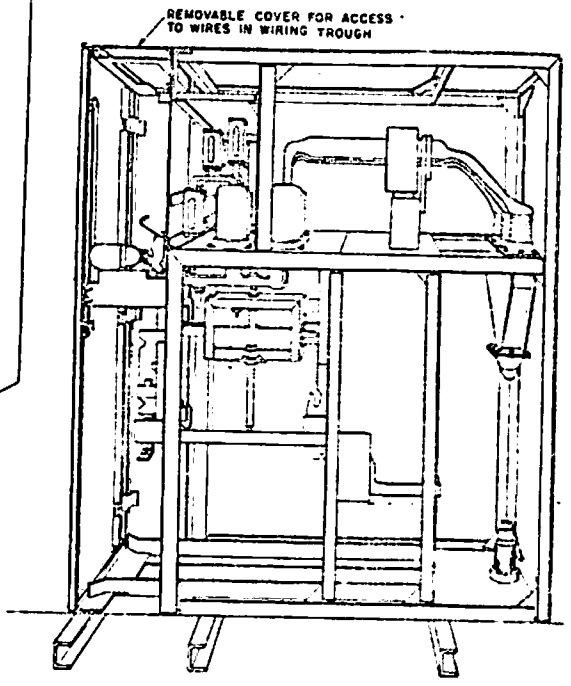


Fig. 5 (8012975) Dummy Removable Element

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

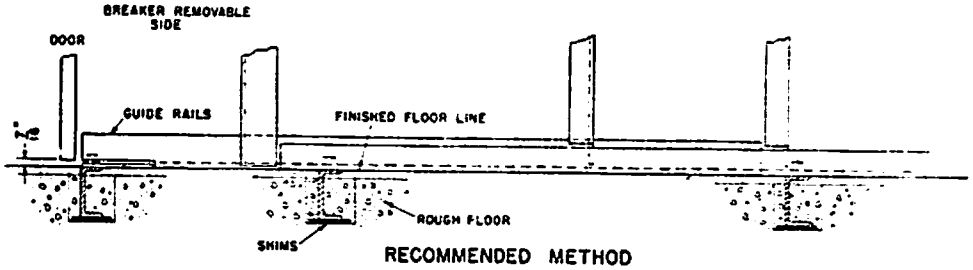




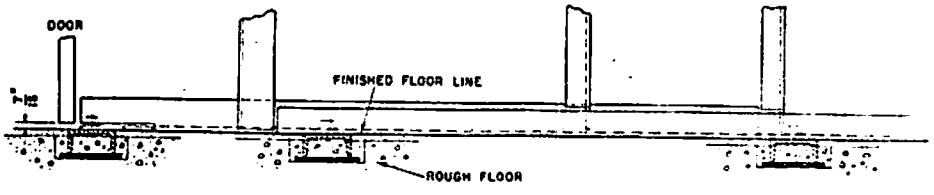
ALL FLOOR STEEL TO BE FURNISHED BY PURCHASER

CHANNELS SHOULD BE SET LEVEL WITH EACH OTHER AND SHOULD BE LEVEL OVER THEIR FULL LENGTH

ROUGH FLOOR THICKNESS AND REINFORCING DEPENDS ON LOADING AND OTHER NORMAL FACTORS, AND SHOULD BE DESIGNED IN ACCORDANCE WITH RECOMMENDED PRACTICE



RECOMMENDED METHOD

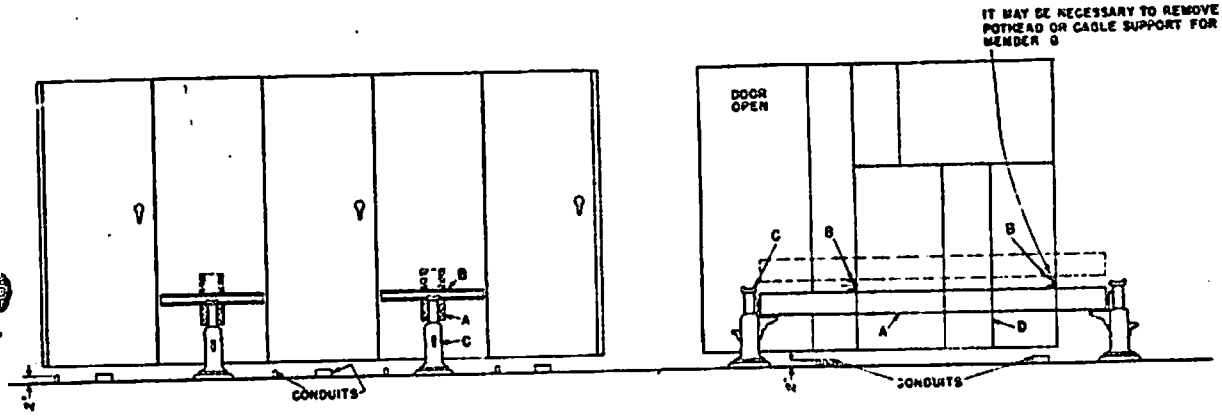


ALTERNATE METHOD

NOTE: IT IS IMPERATIVE THAT FLOOR STEEL BE EVEN WITH FINISHED FLOOR AND THAT BOTH BE LEVEL

Fig. 6 (TT-6W82533)

Fig. 6 Installation Details



METHOD OF LIFTING

MEMBERS A-B C——TO BE FURNISHED BY PURCHASER
A- RAISING MEMBER - CHANNEL OR WOOD BEAM

B- 3" CHANNEL FURNISHED WITH GEAR

C- LIFTING JACKS
D- COVER TO BE REMOVED AND REASSEMBLED AFTER UNITS ARE IN PLACE

NOTE: WHEN LIFTING M-26 SWITCHGEAR LOCATE BEAM "A" ABOVE LIFTING CHANNELS "B"

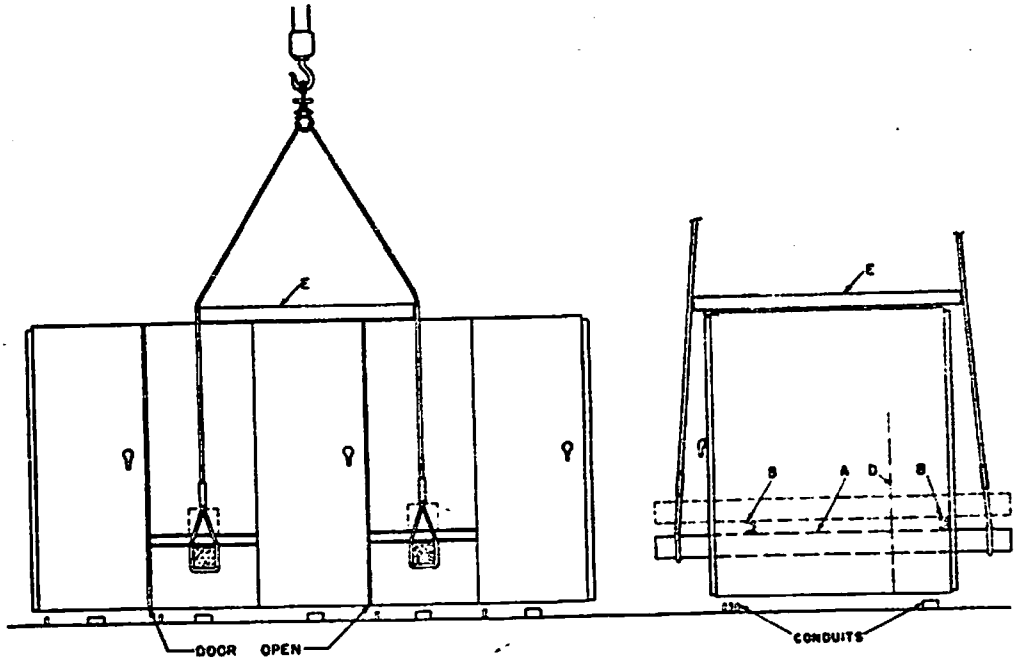
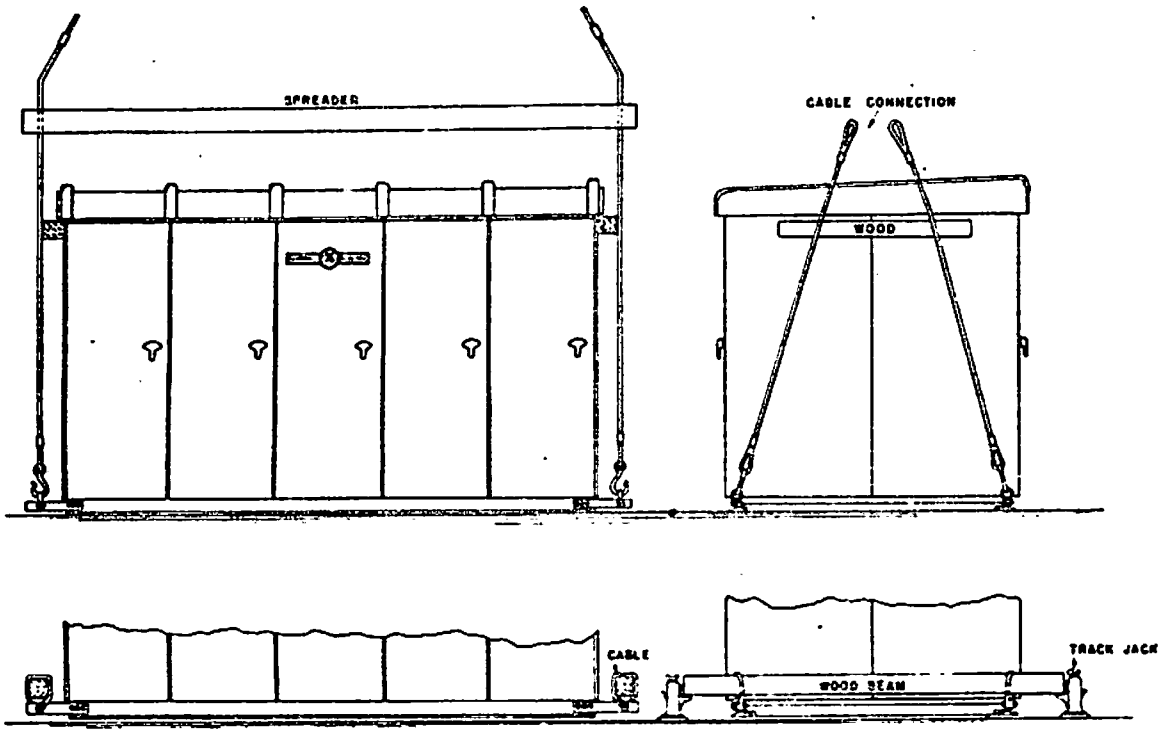


Fig. 6 (TT-6482630)

ALTERNATE METHOD OF LIFTING

MEMBERS A & E TO BE FURNISHED BY PURCHASER
B - 3" CHANNEL FURNISHED WITH GEAR
D - COVER TO BE REMOVED AND REASSEMBLED AFTER UNITS ARE IN PLACE
E - SPREADER



METHODS OF LIFTING

Fig. 7 (TT-6482615)

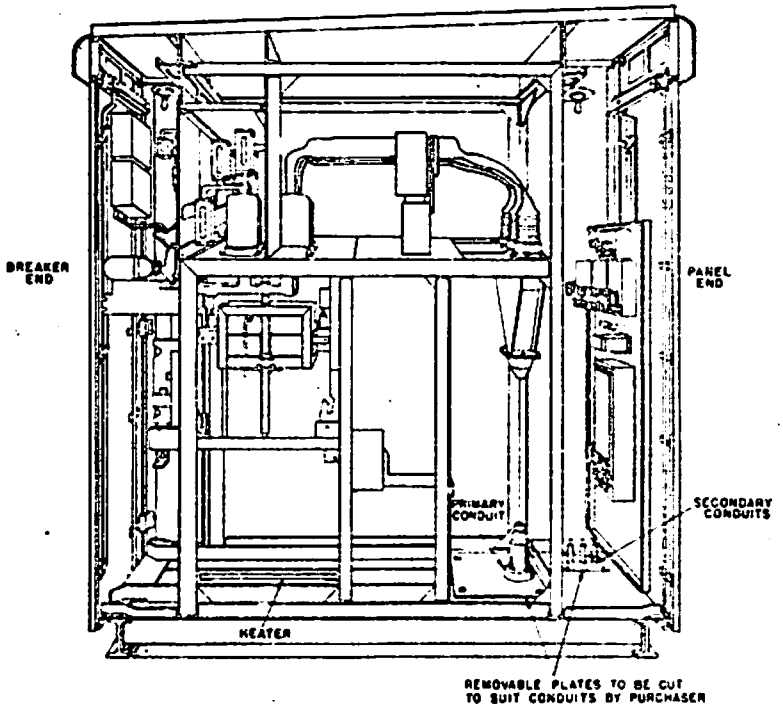
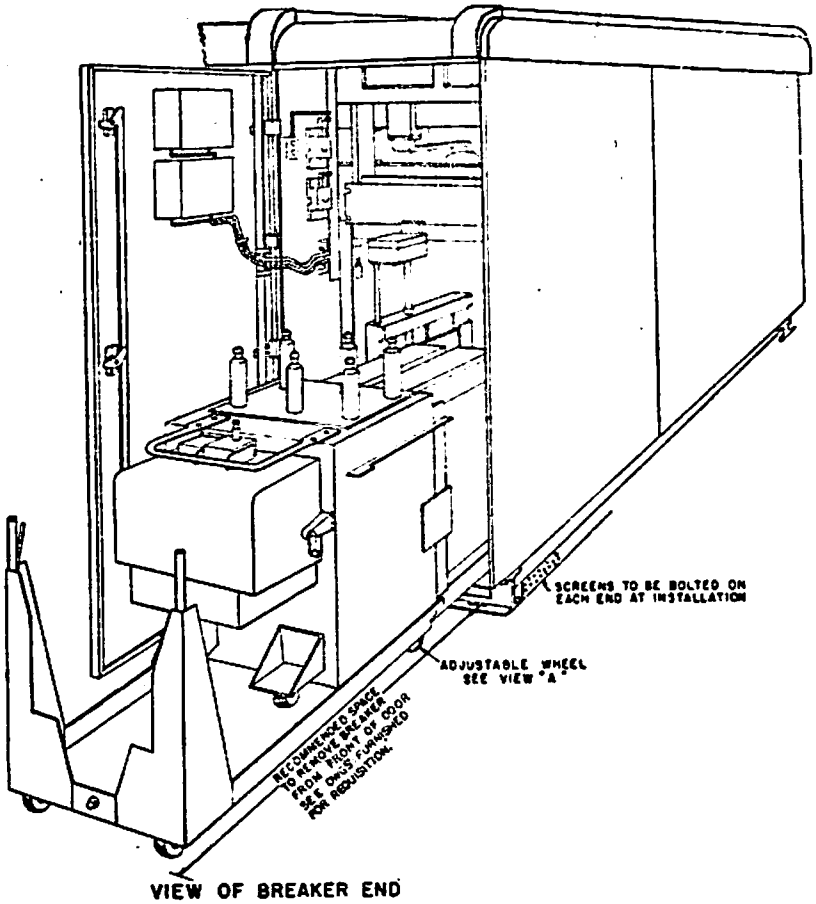
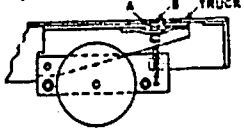


Fig. 7 Installation Details

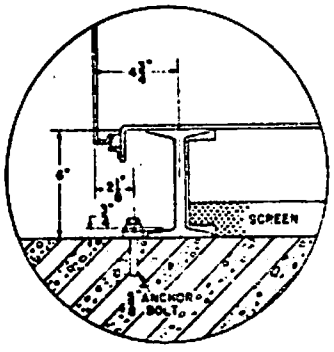


VIEW OF BREAKER END

TO CHANGE HEIGHT OF TRUCK FLOOR, LOOSEN NUT "A" THRU OPENING IN TRUCK FLOOR, ADJUST SLOTTED SCREW "B" WITH SCREW DRIVER TO GIVE DESIRED HEIGHT, AND LOCK BY TIGHTENING NUT "A".



ADJUSTABLE WHEEL VIEW "A"



VIEW "X"

SHOWING ANCHORING OF UNITS WITH I BEAM BASE

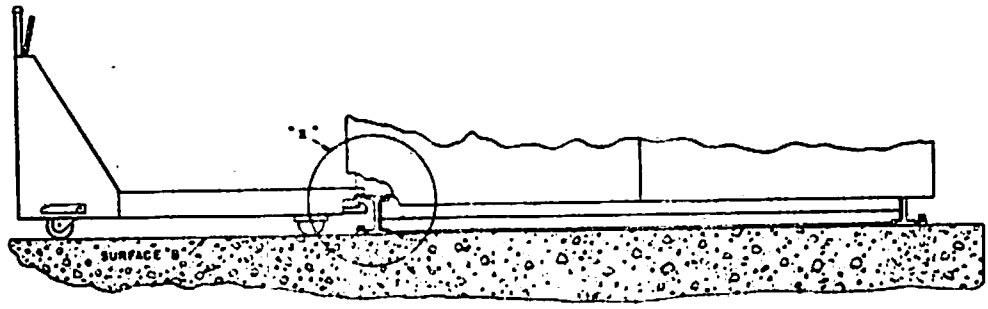
Fig. 7 (TT-6W2615)

FOUNDATION DATA

AREA AND DEPTH OF SOIL BEARING SURFACES OF EACH FOUNDATION MUST BE ALTERED TO SUIT SOIL CONDITIONS.

BOTTOM SURFACES OF FOUNDATIONS SHOULD BE BELOW FROST ACTION OR BACKFILLED WITH PERVIOUS MATERIAL AND ADEQUATELY DRAINED.

SURFACE "B" SHOULD BE LEVEL OVER ITS FULL LENGTH TO INSURE EASY HANDLING OF REMOVABLE ELEMENTS. CONCRETE PAD SHOULD BE REINFORCED IN ACCORDANCE WITH STANDARD PRACTICE.



eipt of any apparatus an immediate inspection should be made for any damage sustained while enroute. If injury is evident or an indication of rough handling is visible, a claim for damage should be filed at once with the the transportation company and the General Electric Company notified promptly. Information as to damaged parts, part number, case number, requisition number, etc., should accompany the claim.

HANDLING

Before uncrating, indoor equipment may be moved by a crane with slings under the skids. If crane facilities are not available, rollers under the skids may be used. Fig. 6 shows suggested method of handling the switchgear after it is removed from the skids.

Methods of handling outdoor equipment are shown in Fig. 7. After the equipment is in place the lifting plates should be removed and reassembled, "turned in" so that passageway at the ends of the equipment will not be obstructed.

STORAGE

If it is necessary to store the equipment for any length of time, the following precautions should be taken to prevent corrosion:

1. Uncrate the equipment.
2. Cover important parts such as jack screws, gears and chain of lifting mechanism, linkage and moving machine-finished parts with a heavy oil or grease.
3. Store in a clean, dry place with a moderate temperature and cover with a suitable canvas to prevent deposit of dirt or other foreign substances upon movable parts and electrical contact surfaces.
4. Batteries should be uncrated and put on trickle charge immediately on receipt.
5. If dampness or condensation may be encountered in the storage location, heaters should be placed inside the units to prevent moisture damage. Approximately 500 watts of heaters per unit will be required. Remove all cartons and other miscellaneous material packed inside units before energizing any heaters.

DESCRIPTION

Each unit is made up of a secondary enclosure and a primary enclosure, as shown in Figure 8.

SECONDARY ENCLOSURE

The secondary enclosure is usually located at the breaker withdrawal side of the unit, although in certain units it may be on the side opposite to the breaker withdrawal area. It consists of a compartment with a hinged door or panel upon which are mounted the necessary instruments, control and protective devices. The terminal blocks, fuse blocks, and some control devices are mounted inside the enclosure on side sheets and a trough is provided at the top to carry wiring between units.

PRIMARY ENCLOSURE

The primary enclosure contains the high voltage equipment and connections arranged in compartments to confine the effects of faults and so minimize the damage.

BREAKER REMOVABLE ELEMENT

The removable element consists of a circuit breaker with trip-free operating mechanism mounted directly on the breaker frame, interlock mechanism, the removable portion of the primary and secondary disconnecting devices, the operating mechanism control device, and necessary control wiring. The magne-blast breakers are equipped with wheels for easy removal and insertion. Refer to Fig. 4.

The circuit breaker interlock mechanism is designed to obstruct the operator from lowering the breaker from the connected position or raising it from the disconnected position unless the breaker is in the open position. This interlock is also designed to keep the breaker in the open position while it is being elevated or lowered. With this arrangement it is imperative that the circuit breaker be tripped prior to any vertical travel of the removable element. Obviously if the mechanism is forced, it cannot perform its proper functions. A positive stop prevents overtravel of the removable element when raised to its connected position. The secondary disconnecting device coupler is used for connecting outside control circuits to the circuit breaker, operating mechanism, trip coil and auxiliary switches. This coupler makes contact automatically when the removable element is raised to the connected position. A control test jumper is furnished which is plugged into the coupler on the stationary and removable elements when it is desired to operate the breaker in the test position.

All removable elements furnished on a particular requisition and of like design and ratings are completely interchangeable one with the other. The removable as well as the stationary elements are built with factory jigs and fixtures thus insuring interchangeability.

BREAKER ELEVATING MECHANISM

The elevating mechanism for elevating or lowering the removable element to or from its connected position supports the removable element in the operating position. In the test position the breaker is lowered to the guide rails. This mechanism consists of heavy-duty steel jack screws on which are carried nuts to support the elevating carriage. The carriage is so designed that the removable element can be readily inserted or withdrawn after the carriage has been lowered to the disconnected position without necessitating the removal of any bolts, nuts or screws. The breaker cannot be lowered or raised until it has been tripped. The breaker cannot be closed except with the breaker in either the operating or test position.

Guide rails are built into the metal-clad frame to guide the removable breaker element into correct position before the breaker is raised into the operating position by means of the elevating mechanism which is motor operated.

PRIMARY DISCONNECTING DEVICE

The primary disconnecting devices utilize silver to silver contacts to insure against reduction of current carrying capacity due to oxidation of the contact surfaces. These contacts are of the high pressure line contact tube and socket design, the tube being backed up by heavy garter

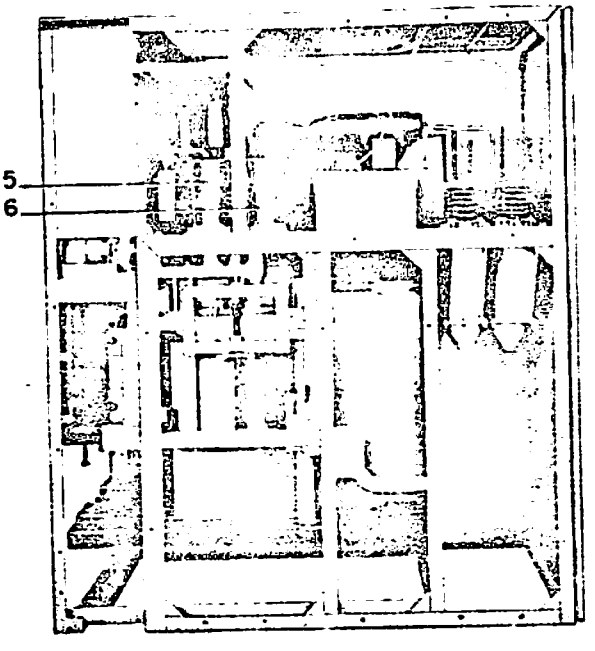


Fig. 8 (8012673)

Fig. 8 Metal-clad Switchgear

springs to insure contact pressure. Refer to Figure 9.

BUS COMPARTMENT

The main buses are enclosed in a metal compartment with removable front covers to provide accessibility.

The bus is supported by an insulating material which is practically impervious to moisture, and an excellent dielectric.

The bus insulation is molded on the bars except at the joints where the insulation is completed by means of compound filled boxes or molded boots.

CURRENT TRANSFORMER AND CABLE COMPARTMENT

The current transformers are mounted in a compartment isolated from the other equipment. Provision is made in this compartment for connecting the purchaser's primary cable by means of potheads or clamp type terminals.

POTENTIAL TRANSFORMER COMPARTMENT

Potential transformers are located in a compartment above the current transformers or in a separate unit adjacent to the breaker units.

The transformers are mounted on a movable support equipped with primary and secondary disconnecting devices. When the potential transformers are disconnected, they are at a safe striking distance from all live parts of the switchgear. In addition a grounding device is provided which contacts the fuses when the potential transformers are disconnected, effectively discharging the transformers. In this position the transformer fuses may be safely removed and replaced. When the carriage is drawn out it moves a barrier in front of the stationary part of the primary disconnecting device. See Figure 10.

DUMMY REMOVABLE ELEMENT

Dummy removable elements, Fig. 5, are used as a means of isolating circuits or bus sections, where operation is infrequent and a circuit breaker cannot be economically justified. The device consists of a framework to simulate the circuit breaker removable element with a set of six studs similar to those on the metal-clad breakers. The lower end of the studs are connected, front to back, by copper bars which are fully insulated and metal-enclosed. The stationary structure is the same as for a circuit breaker. When the device is elevated into position, it connects the front set of metal-clad disconnecting devices to the rear set.

Under no conditions must the dummy element be elevated or lowered when the bus or the unit is energized. Key interlocks are applied to insure that all sources of power are disconnected before the dummy element can be operated. Refer to Figure 12.

FUSE DISCONNECTING DEVICE

Current limiting fuses with high interrupting rating are sometimes used in metal-clad switchgear to protect small transformers or circuits where circuit

Fig. 9 Refer to Fig. 36, GEI-25390

Fig. 10 (8020155)

Fig. 11 (8029235)

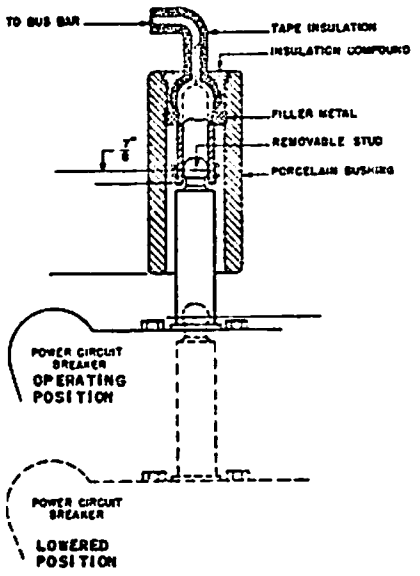


Fig. 9 Measurement of Adjustment of Primary Disconnecting Devices

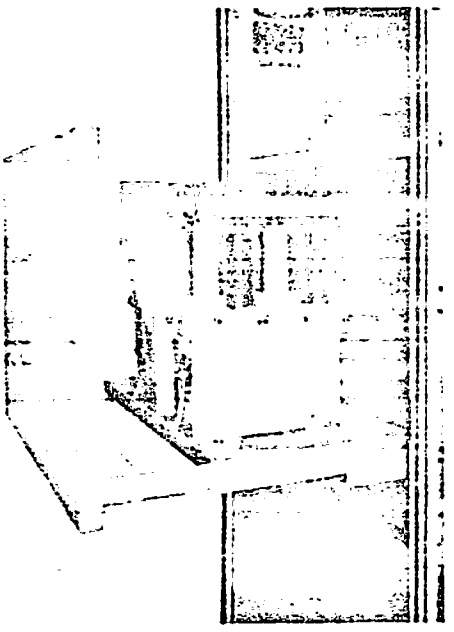


Fig. 10 Potential Transformer Rollout Shown in Withdrawn Position

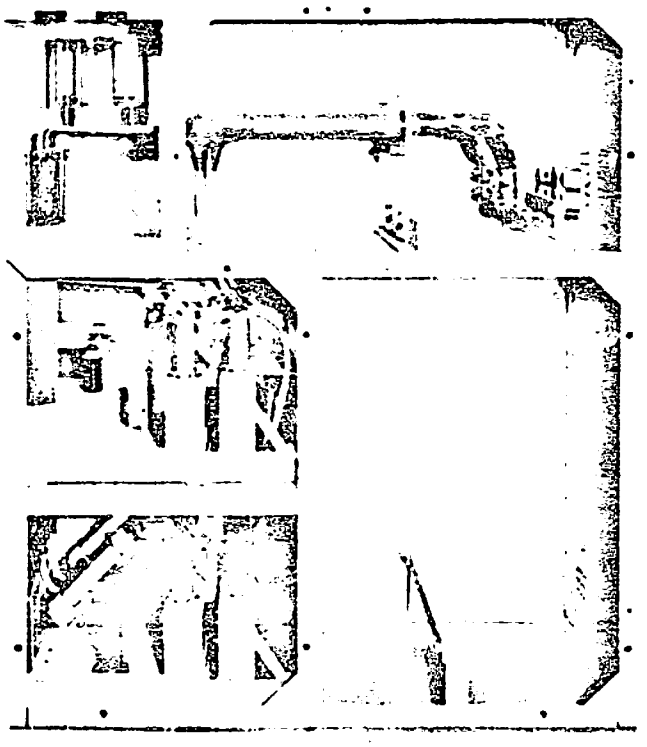
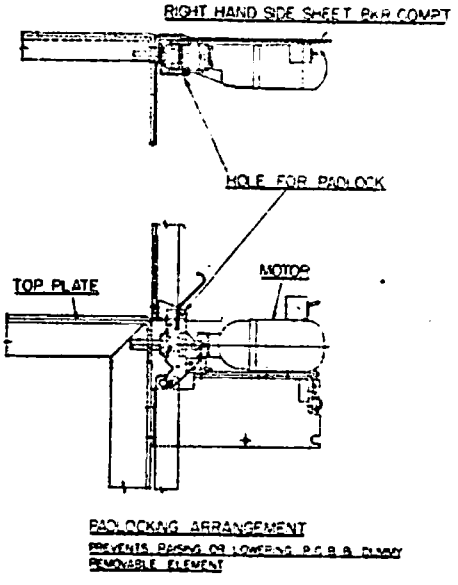
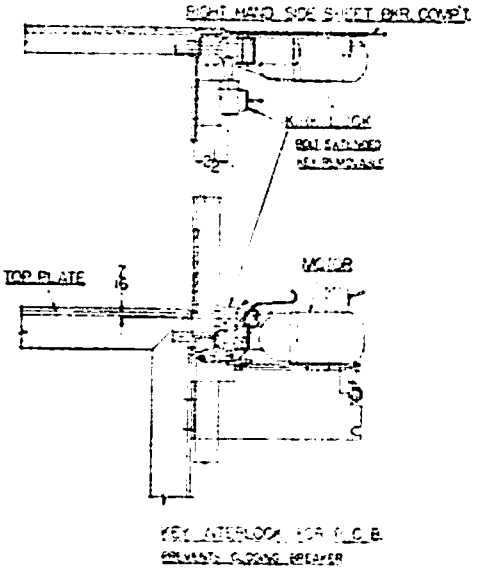
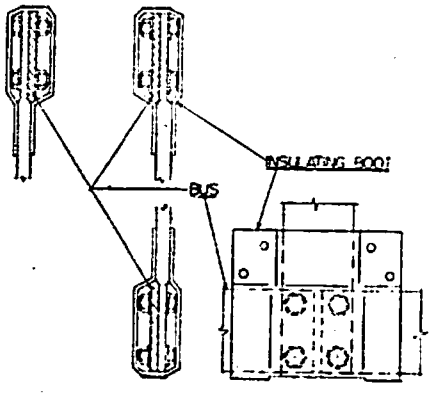


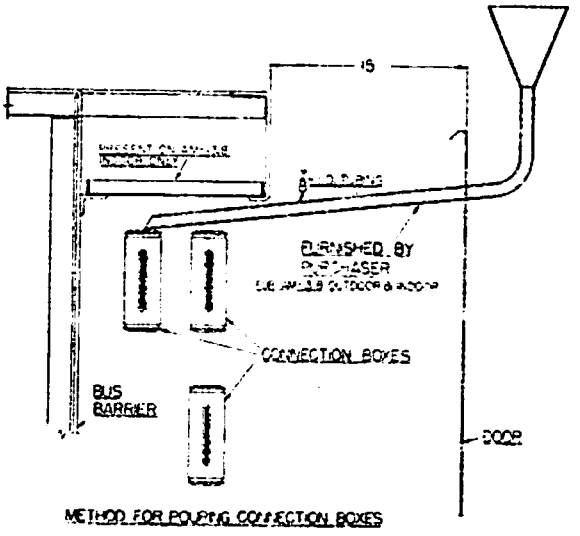
Fig. 11 Potential Transformer and Fuse Rollout Unit



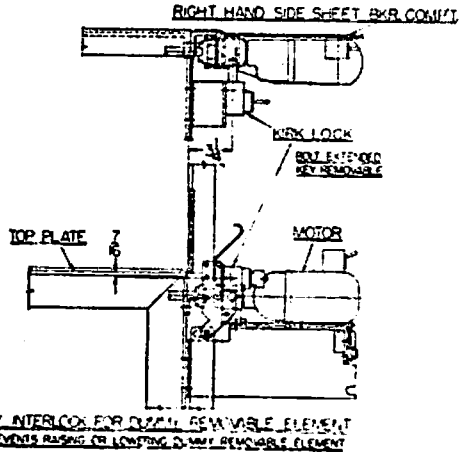




4/6 BUS WITH PLASTIC INSULATING BOOT



METHOD FOR POURING CONNECTION BOXES



KEY INTERLOCK FOR DUMMY REMOVABLE ELEMENT
PREVENTS RAISING OR LOWERING DUMMY REMOVABLE ELEMENT

Fig. 12 (T-991268)

Fig. 12 Padlocking Arrangement, Key Interlocking And Method For Pouring Connection Boxes

eakers cannot be economically or functionally justified.

The fuses are mounted on a movable support equipped with disconnecting devices. When the fuses are disconnected, they are at a safe striking distance from all live parts of the switchgear. In addition a grounding device is provided which contacts the fuses after they are disconnected, effectively removing any static charge from the fuses. In this position the fuses may be safely removed and replaced. The disconnecting devices are capable of interrupting transformer magnetizing current, but should not be used to interrupt load current. For larger transformers arc quenchers are furnished to assist the disconnecting devices in interrupting the magnetizing current. Mechanical or key interlocks are applied to prevent operating the disconnecting device while the load is connected. This is generally accomplished by interlocking so that the transformer secondary breaker must be locked in the open position before the disconnecting device can be opened or closed.

GROUNDING AND TEST DEVICE

The grounding and test device, Figure 13, provides a convenient means of grounding the cables or the bus in order to safeguard personnel who may be working on the cables or the equipment. The device can also be used for applying power for high potential tests or for fault location, to measure insulation resistance (Megger). By using potential transformers, it can also be used for phasing out cables.

The three studs of the device are similar to those of the metal-clad circuit breakers. The studs are mounted on a removable plate which can be placed in either of two positions. In one position the studs will engage the front (Bus) contacts only and in the other position the studs will engage the rear (Line) contacts only of a metal-clad unit.

To indicate the proper placement of the studs on the device, opposite sides of the assembly are marked "Line" and "Bus". The word corresponding to the desired position must be toward the operator.

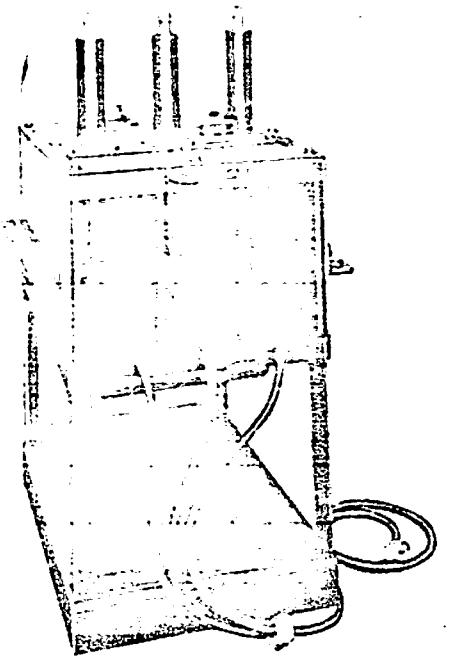


Fig. 13 Ground And Test Device
(Cable shown not furnished by G. E. Co.)

To use, the device is rolled into the metal-clad housing in place of the circuit breaker, and raised into or lowered from the connected position by means of the circuit breaker elevating mechanism.

In addition to the device described above, there is available a form of grounding and testing device equipped with both bus and line side buildings, power operated grounding contacts, phasing receptacles, and a complete safety interlocking system. For details of construction and operation of this device, refer to GEI-38957 for 4.16 kv equipment, or GEI-50114 for 7.2 kv and 13.8 kv equipment.

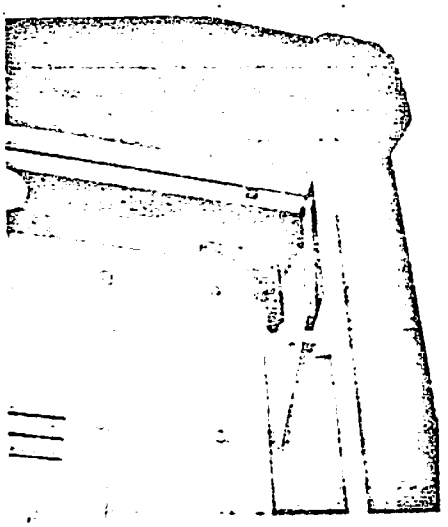


Fig. 14 Tandem Lock For Outdoor 13.8 Units

TANDEM LOCK (WHEN FURNISHED) FOR OUTDOOR UNITS

Outdoor metal-clad equipments with more than one unit may be provided with a tandem locking arrangement which makes it necessary to padlock only one door on each side. (In exceptionally long installations two or more locks may be required on each side). The unit containing the operating arm of the tandem lock is clearly marked on the drawings and also by nameplate on the equipment itself. Refer to Figure 14.

Before any door in the equipment can be opened, it is necessary to open the padlocked door and operate the tandem locking arm to the open position. In locking the equipment the reverse procedure should be used.

Where it is desired to separately lock any particular door, the tandem lock can be disconnected in that unit by unbolting a connecting clip between the tandem bar and the locking bar, and a separate padlock used on that door.

The light switch, front and rear, will be located in the units with the tandem lock.

INSTALLATION

Before any installation work is done, consult and study all drawings furnished by the General Electric Company for the particular requisition.

These drawings include arrangement drawings, wiring and elementary diagrams and a summary of the equipment. Mats, screens, railings, etc., which are external to the switchgear, but which may be required to meet any local codes, must be furnished by the purchaser.

LOCATION

The recommended aisle space required at the front and at the rear of the equipment is shown on the floor plan drawing furnished for the particular requisition. The space at the front must be sufficient to permit the insertion and withdrawal of the circuit breakers, and their transfer to other units. The space at the rear must be sufficient for installation of cables, for inspection and maintenance, and on some equipments to draw out potential transformers.

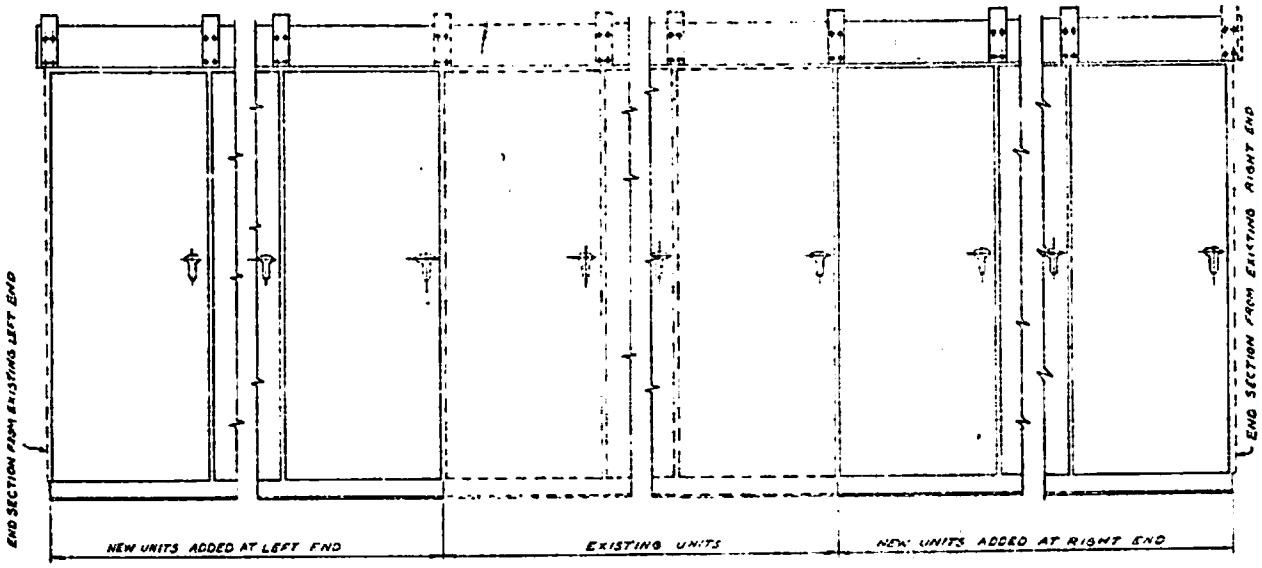
PREPARATION OF FLOOR - ANCHORING

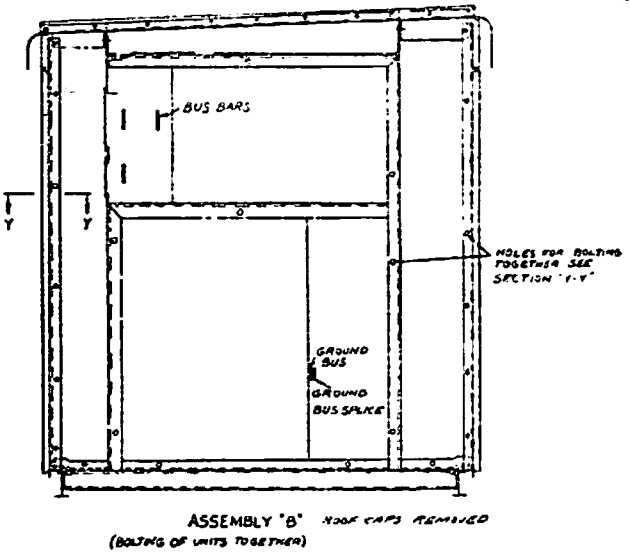
Indoor Equipment

The station floor must be strong enough to prevent sagging due to weight of the switchgear structure and to withstand the impact stress caused by the opening of the circuit breakers under short circuit conditions. The impact loading is approximately 1-1/2 times the static load.

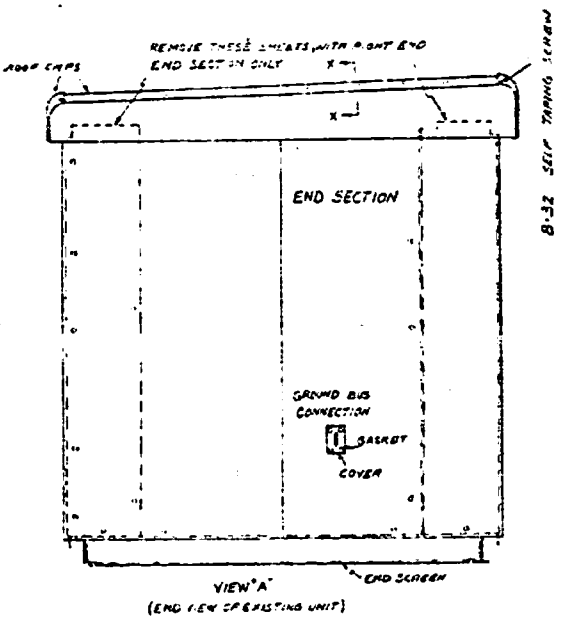
Suitable means must be provided by the purchaser for anchoring the equipment to the floor. It is essential that the floor be level to avoid distortion of the switchgear structure and the equipment be completely aligned prior to final anchoring. The recommended floor construction is shown in Figure 6. The floor channels must be level and straight with respect to each other. Steel shims should be used for final leveling of the switchgear if necessary. Care should be taken to provide a smooth, hard, and level floor under and in front of the units to facilitate installation and removal of the breaker. If the floor is not level and flush with the floor channels, it will be difficult to handle the breaker because it will not be level with respect to the stationary element.

Recommended practice is to weld the switchgear structure to the floor channels, using a tack weld at points indicated for anchoring on the drawing. If welding facilities are not available the gear should be bolted to the floor channels.





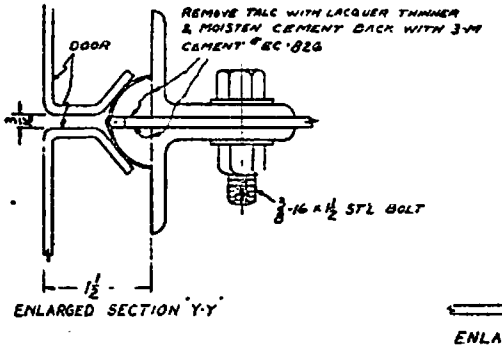
ASSEMBLY "B" ROOF CAPS REMOVED
(BOLTING OF UNITS TOGETHER)



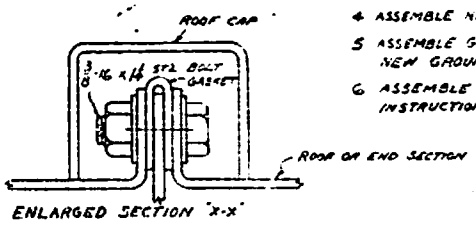
VIEW "A"
(END VIEW OF EXISTING UNIT)

PROCEDURE

1. REMOVE ROOF CAP, END SCREEN, GROUND BUS CONNECTION, AND END SECTION (INCLUDING COMPARTMENT SIDE SHEETS ON LEFT END ONLY). SEE VIEW "A."
2. SET NEW UNIT(S) IN PLACE AND BOLT TOGETHER AS SHOWN IN ASSEMBLY "B."
3. ASSEMBLE ITEMS LISTED IN PROCEDURE NO. 1
4. ASSEMBLE NEW ROOF CAPS AS SHOWN IN VIEW "A."
5. ASSEMBLE GROUND BUS SPLICE BETWEEN EXISTING AND NEW GROUND BUS AS SHOWN IN ASSEMBLY "B"
6. ASSEMBLE BUS BARS AND CONNECTION BOXES PER INSTRUCTION BOOK FIG 12 & 20



ENLARGED SECTION "Y-Y"



ENLARGED SECTION "X-X"

Fig. 15 (5450856)

Fig. 15 Outdoor Metal-clad Switchgear - Addition of Units to Line-up

Fig. 16 (261C416)

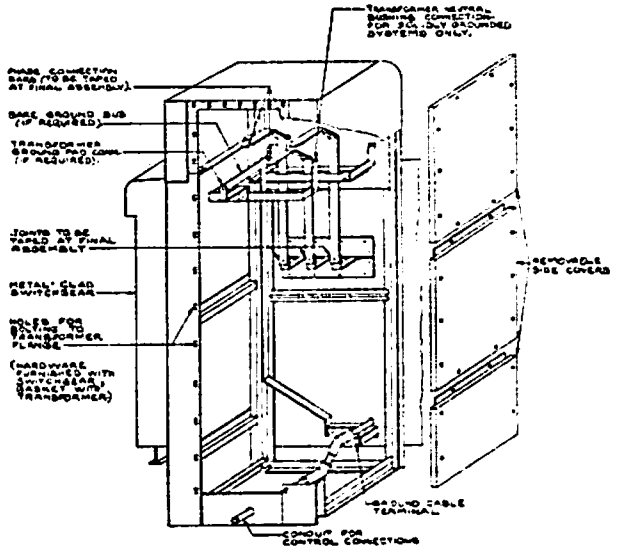


Fig. 16

Fig. 16A (453A738)

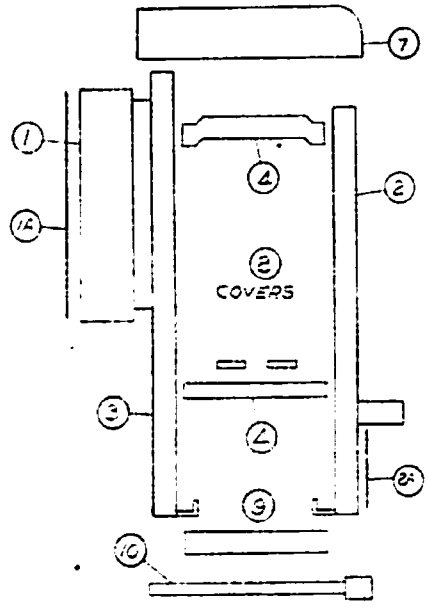


Fig. 16A

Outdoor Transition Compartment

Provision should be made in the floor for conduits for primary and secondary cables, located as shown on the floor plan drawing furnished for the particular requisition. If desired, the conduits may be installed before the switchgear. Consideration should be given to conduits which might be required for future connections.

Outdoor Equipment

Recommendations for the foundations for outdoor equipment are given in Fig. 7. Primary and secondary conduits should be installed in accordance with the requisition drawings, before the equipment is put into place.

Since outdoor equipments are provided with a 6" base, a transfer truck is required to place the breaker in the housing. The level adjustment on the truck is shown on Fig. 7.

When outdoor equipments are shipped in more than one section, the joint in the roof between sections must be weatherproofed. Apply G.E. #1201 Glyptal* varnish to the gaskets which are furnished and assemble the gasket between the roof sections and bolt together. See Figure 15. Joints between transformer throats and the switchgear should be weatherproofed in the same manner. Refer to Figures 16 and 16A.

Transition Compartments

Transition compartments for outdoor unit substations may be one of two types (Fig. 16 and 16A). These compartments are normally shipped assembled. The full height compartment (Fig. 16) cannot be disassembled for installation. The throat type compartment (Fig. 16A) can be installed in either of two ways, in accordance with the following instructions:

(a) Should the switchgear be positioned on its foundation prior to the power transformer, the complete transition can be mounted on the metal-clad as assembled. Remove covers #8 and apply Glyptal* varnish #1201 to gasket 2A before bolting transition to metal-clad throat. Before jacking the power transformer into its final location, apply Glyptal * varnish #1201 to gasket 1A and place over mounting studs on transformer tank wall. Slide transformer in place guiding the transformer mounting studs through the mounting holes in #1. Center rubber seal between #1 and #3 before tightening nuts, maintaining 24" between transformer tank wall and end of metal-clad.

(b) If the power transformer and metal-clad switchgear are in place, disassemble transition as follows: Remove covers #8 and #9, adapter #1, dome #7, braces #4. Apply Glyptal* varnish #1201 to gasket #2A before bolting #2 to metal-clad throat. Apply Glyptal* varnish #1201 to gasket #1A and loosely fasten #1 and #1A to transformer tank. Slide throat of #3 into #1 and maintain approximately 4 1/2" from #3 to tank. Assemble braces #4 top and bottom to maintain size and proper alignment, then tighten #1 to transformer tank. Assemble copper terminals, supports and complete all joints. Assemble dome #7, side covers #8 and bottom cover #9. Cut secondary conduit #10 to length and assemble under the transition.

Indoor transition compartments are shipped assembled together with the adjacent metal-clad switchgear units.

BREAKER REMOVABLE ELEMENT

Before installing or operating the removable element consult the circuit breaker instructions for directions on installation, adjustments and inspection. The operation of the interlock device is given below.

The elevating mechanism is accurately leveled and checked at the factory and should need no adjustment. Do not install or remove the breaker or make any adjustments unless the breaker is open.

Rub a small amount of contact lubricant D50H47 on the silvered portion of the breaker studs to form a thin coating for contacting purposes.

Lower the elevating mechanism lifting brackets until the lifting brackets are in the fully lowered or test position. The breaker should then enter the housing freely. The lower limit switch can be adjusted, if necessary, to allow the breaker to enter the housing. Push the breaker into the housing until it rests against the stop at the rear of the elevating mechanism frame. The stop has been adjusted at the factory so that the breaker will be in the correct position relative to the lifting brackets. Raise the lifting brackets until the breaker is lifted clear of the floor. Check to see that the breaker is properly seated on the lifting brackets.

Carefully raise the breaker to the connected position where the breaker plate or support solidly meets the upper stop bolts on the frame and then lower and remove it from the unit. When elevating, note that breaker studs center with respect to the stationary disconnecting device or injury to the contacts may result.

Inspect the contact surfaces of both the breaker studs and the stationary disconnecting devices.

(a) Each segment of the stationary disconnecting device should make a heavy impression in the contact lubricant D50H47 on the breaker studs.

(b) The wipe of the breaker stud inside the stationary disconnecting device, as indicated by the contact lubricant D50H47, should be 7/8". This indicates that the breaker studs contacted at the full pressure center of the silver band on the stationary disconnecting device. The maximum permissible variation in the wipe is 3/32".

(c) Should the inspection of the contacts show that the breaker is not being

* Registered trade-mark of General Electric Company.

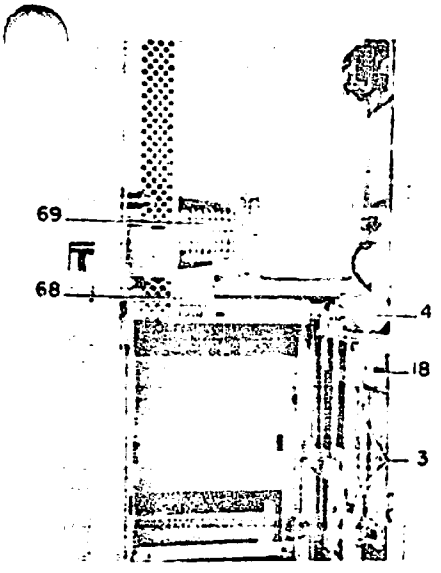


Fig. 17 View Showing Elevating Mechanism Motor and Control Unit

raised to the proper position, readjust the upper stop bolts and limit switches to raise or lower the breaker to the proper location. Lock the stop bolts in the new position.

(d) If proper contacting cannot be attained by the above methods, it is necessary to adjust the stationary disconnecting [illegible] tube. DO NOT MAKE ANY ADJUSTMENT. COMMUNICATE WITH THE NEAREST GENERAL ELECTRIC CO. OFFICE FOR ADDITIONAL INFORMATION.

The trip interlock should be checked to see that the removable element is obstructed from being raised to or lowered from the operating position unless the breaker has been tripped open. The breaker is provided with an arm which is pushed forward or pulled back when the breaker is open or closed. This arm engages and holds a vertical bar when pulled back (breaker closed) and prevents the clutch from being pulled forward to engage the motor. When the breaker has been tripped, the clutch can raise the vertical bar and engage the motor. A limit switch on the vertical bar closes the electrical circuit to the motor, if the elevating control selector switch has been moved to either "raise" or "lower". Refer to Figure 17.

TESTING CABINET

The testing cabinet, Figure 19, should be installed on the wall at a location where maintenance and testing of the breaker can be conviently done. Conduits must be installed to carry cables to supply control power for testing.

ADDITION OF UNITS TO EXISTING EQUIPMENT

Figure 15 indicates the special procedures involved to add new metal-clad units to an existing outdoor equipment. For indoor equipment, it is usually necessary only to [illegible] the end cover sheets and to re-as[illegible] them on the new units after these a[illegible]located and bolted to the existing units. Otherwise, the installation procedure is the same as described above.

CONNECTIONS

The main bus bars and other connection bars may be either copper or aluminum. In either case, the connection surfaces will be silver plated.

All field assembled joints in conductors, regardless of material or method of insulation, should be made as follows:

(1) Wipe silver clean. Do not use sandpaper or any abrasive on the silvered surface. Avoid handling of cleaned surface as much as possible.

(2) A sufficient quantity of D50H47 grease should be applied to the joint at each contact area so that the complete contact area will be thoroughly sealed with excess grease squeezed out of the joint when tightened.

(3) Brush a thin coat of D50H47 over the outside surfaces of the joint area and hardware covering the silvered area.

MAIN BUS ASSEMBLY

(1) For 13.8 kv or 7.2 kv equipment:
(a) Remove compartment covers.
(b) Bolt splice plates and bus bars together, following assembly instructions above. See also Fig. 20 and Table A, Fig. 18.

TABLE A
Torque Values for Metal-clad Switchgear
Torque in Inch-Pounds)

Bolt Size	Copper or Steel	Aluminum or Compound
3/8"-16	180-300	180-240
1/2"-13	360-540	360-480
5/8"-11	420-600	420-540

Fig. 18

(c) Complete the taping of the vertical riser bars using insulating tape furnished (2/3 lap) stopping the tape at the bus bar. If the riser bars connect to the bus from below, sufficient tape should be added to prevent compound leakage when filling. Apply a layer of cotton tape (1/2 lap) over the insulating tape, stopping the cotton tape just inside molded splice cover.

(d) Place molded covers around the bolted splice joints. Note that compound filling space is at top of joint, and add filler pieces furnished for the purpose to the bottom of box and around bus bar laminations (Fig. 20) to prevent compound leakage while filling. Duxseal should be placed over the joints to make the box free of leaks while filling. The Duxseal should be removed after the compound has set. G. E. #860 cord should be used to hold the molded parts securely in place.

(e) Heat G. E. D50H49 compound (furnished) to minimum 200°C. and maximum of 220°C. Avoid overheating the compound for the dielectric strength may be seriously affected. Pour the compound into the molded covers intermittently, allowing an interval of cooling to prevent formation of gas or air pockets. The final pouring should be level with the top of the box and should be done only after due allowance for shrinkage is made. Refer to Figure 12.

(f) Paint the exposed cotton tape on vertical riser bars with U310 or U311 varnish furnished.

(g) Replace all covers previously removed.

(2) For 4.16 kv equipment:

(a) Remove compartment covers.

(b) Bolt splice plates and bus bars together, following assembly instructions above. See also Fig. 20 and Table A, Fig. 18.

(c) Place flexible molded cover over joint, as shown in Fig. 12. Note that on joints where no tap is made from bus the opening in the molded cover should be at the top.

(d) Secure flexible cover with self-locking rivets furnished. Joint insulation is now completed.

(e) Replace all covers previously removed.

(3) In unit substations, the connection bars should be assembled in the transition com-

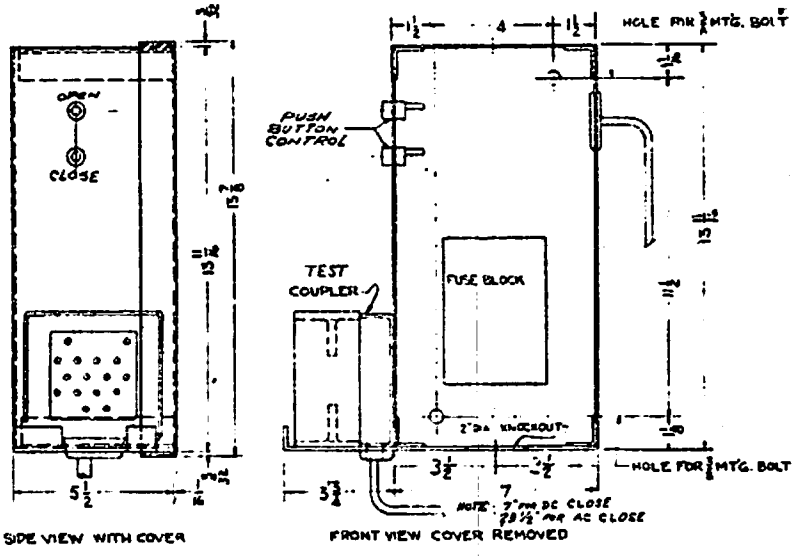


Fig. 19 Inspection Box for 13.8 KV Metal-clad Switchgear

Fig. 17 (8024142)
Fig. 19 (M-6515226)

artment (Fig. 16) and the connections at the ansformer terminals greased, taped and inted as indicated above. The conduit for secondary circuits should also be assembled in or below the transition compartment.

PRIMARY CABLES

The primary cable connections in indoor switchgear are reached by removing the rear bolted covers. In outdoor switchgear the hinged instrument panel, if present, must be swung open and the bolted covers behind it removed.

Before any primary cable connections are made, the cables should be identified to indicate their phase relationship with the switchgear connections. This is necessary to insure that motors will rotate in the proper direction and that the phase rotation is the same when interconnecting two different sources of power.

There are two common methods of making primary cable connections:

(a) Potheads (see Figures 34 and 35) are used when it is desired to hermatically seal the end of the cable to make a moisture-proof connection between the cable and the switchgear bus. A pothead also prevents seeping of oil from the end of oil impregnated varnish cambric or paper insulated cable.

(b) Clamp type terminals and wiping sleeve or cable clamp. In all cases carefully follow the cable manufacturer's recommendations for installation of the type of cable being used, as well as the instructions contained herein. See Figs. 37 and 38.

POTHEADS

Potheads are mounted on an adapter plate extending across the width of the metal-clad unit as shown in Figure 8. The adapter plate is split into two parts to facilitate the installation of the potheads. The potheads will usually be shipped arranged for cables to enter from below; however, the steel and copper are usually interchangeable for the potheads arranged for cable entrance from above.

Three-Conductor Potheads

The following description applies to the installation of a three-conductor lead-sheathed cable with a wiping sleeve cable entrance fitting on the pothead. This is the type most generally used. Instructions for installation of other types are included in the text following:

(a) Remove the wiping sleeve and cut the tapered end at a point where the cable will enter it freely, and file off sharp edges. Temporarily reassemble on the pothead.

(b) Train the cable in front of the pothead allowing it to extend about two inches above the top of the porcelain bushings. Handle with care and avoid sharp bending which might damage the insulation. Mark a point on the lead sheath of the cable about 1-1/2 inch above the bottom of the wiping sleeve.

(c) Remove the pothead from the unit, disassemble the wiping sleeve and slip it and its gasket over the cable as shown in Figure 21.

(d) Remove the lead sheath from the cable to the point marked in operation "b" as shown in Figures 22 and 23 proceeding as follows:

First, make a cut around the cable half through the sheath at the reference point. Second, split the sheath lengthwise between the cut and the cable, holding the cutting tool at an angle to the cable radius to avoid damaging the insulation. Third, remove the sheath by catching the split edge with pliers and pulling directly away from the cable axis.

Clean and tin the outside of the lead sheath for about 3 inches and bell out the end of the lead sheath.

(e) Remove the belt and interphase insulation down to within 1-1/2 inches of the lead sheath as shown in Figure 24. The last few layers should be torn off to avoid damaging the individual conductor insulation. To reinforce and protect the conductor insulation, wrap two layers of half lapped varnished cambric or irrathene tape over the factory insulation.

(f) Disassemble insulator support plate from pothead body. The insulators should not be removed from the support plate because they are factory assembled for proper compression of their gaskets. Place pothead body over cable and then fan out the conductors into approximately the final position, as shown in Figs. 25, 26. The middle conductor should be bowed slightly for final adjustment of length. Avoid sharp bends and damage to the insulation, particularly at the crotch.

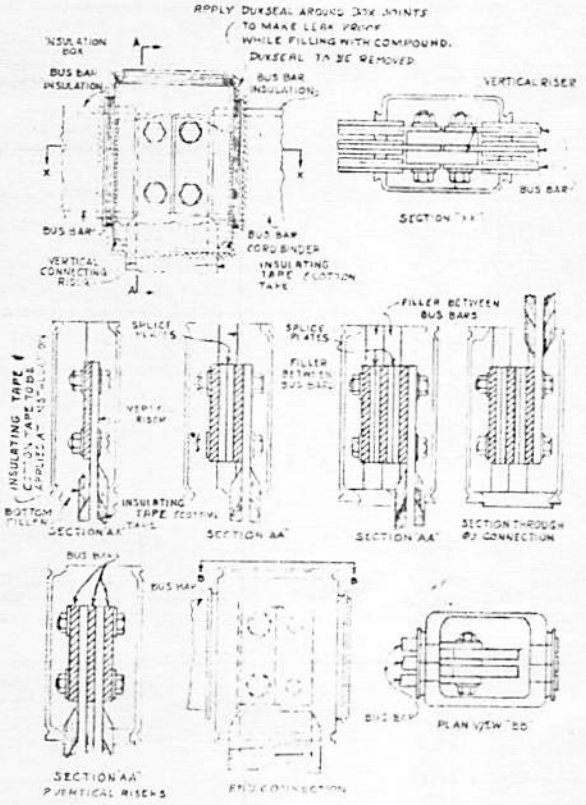


Fig. 20 Method of Making Bus Bar Connections

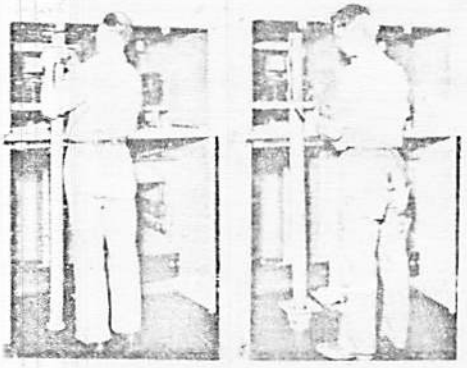


Fig. 21 Fig. 22

Fig. 23 Fig. 24

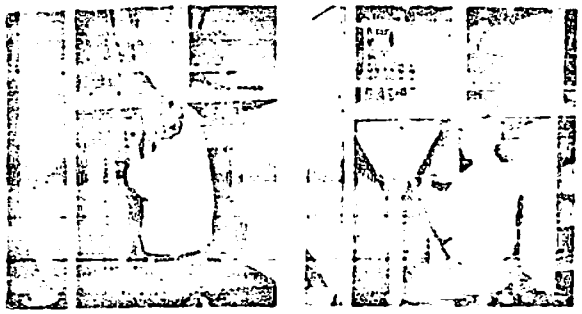


Fig. 25

Fig. 26

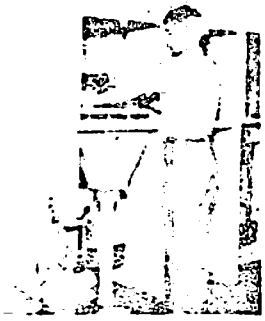


Fig. 27

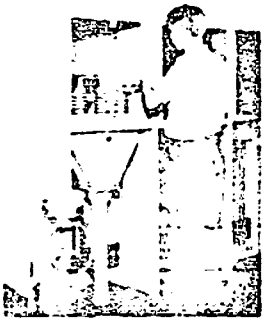


Fig. 28

Fig. 25 (857611)
Fig. 26 (857604)

Fig. 29

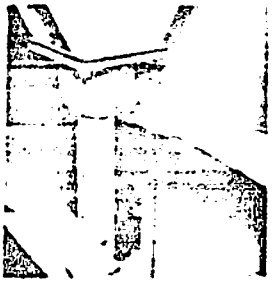


Fig. 30

Fig. 31

Fig. 32

Fig. 27 (857610)
Fig. 28 (857619)

(g) For system voltage above 7500 volts it is recommended that stress relief cones be built up when single-conductor or three-conductor shielded cable is used. Construct stress relief cones in accordance with the recommendations of the cable manufacturer. See Figure 35 for one recommended method. On lower voltage cables, belling out the end of the lead sheath ordinarily provides sufficient stress relief. (Stress cone material will not be furnished with pothead).

(h) Bolt pothead body to metal-clad adapter plate. Shape conductors into final position, then cut off each conductor to fit the terminal.

(i) Remove pothead terminals from insulators. Remove two inches of insulation from the end of each conductor and assemble pothead terminals to cables.

(j) Assemble gaskets where shown in Fig. 1 and bolt insulator support plate and sealing sleeve to pothead body. Compress gaskets by a partial turn on each bolt successively until the gasket is uniformly compressed to dimensions shown in Fig. 35. Next, to wire the terminal studs are sealed properly on their gaskets, then [illegible] nut in place after assembling [illegible] and washers. See Figures 26, 27 and 29.

(k) Make a plumber's wiped joint between the sealing sleeve and the lead sheath of the cable, as shown in Figures 29 and 30.

(l) Remove the 3/4" filling plug in the [illegible] the pipe plugs in the top of [illegible] the insulator support plate. [illegible] and funnel in the filling [illegible] height to extend above the [illegible] as shown in Figure 31.

[illegible] #127 or #1332 compound to the [illegible] temperature, 165°C. Do not overheat to higher temperatures may injure cable insulation and also result in excessive shrinkage of the compound while cooling. Before and while filling, warm pothead body and stand pipe to prevent sudden chilling of compound which may result in the formation of air voids. The pothead may be warmed by playing a blowtorch over the body, taking care that no direct heat reaches the porcelains or gaskets.

Pour until the compound appears at the insulator support plate plug holes. Insert plugs and continue filling until it appears at holes at the top of terminal studs. Insert plugs and continue pouring while the pothead and compound cools to fill air voids which might form.

When the pothead has cooled, remove filling pipe and insert plug. Clean off compound which might have overflowed on the outside of the porcelains.

(m) Assemble pothead connection bars, applying grease as outlined under "Connections" (Page 14). See Fig. 32. Insulate connections as follows:

(1) Fill all cavities around bolts and nuts with Duxseal compound to form smooth surface for taping, thus preventing air voids. This compound is not an insulating medium and should not be used for that purpose.

(2) Wrap with insulating tape provided, as shown in Figures 33, 34 and 35, the number of layers depending on the voltage rating of the equipment. Where there are sharp angles, apply additional layers to obtain the equivalent of the insulation of the flat surfaces.

(3) Over the insulating tape, apply one layer of white cotton tape, half lap, as a binder.

(4) Over the white cotton tape, brush a good coat of varnish (U-310 for 15 KV and U-311 for 5 KV). Varnish may be thinned if necessary, with Xylene, D5B9.

Single-Conductor Potheads

The procedure for installation of single-conductor potheads is in general the same as described for three-conductor potheads.

Cable Entrances Other Than Wiping Sleeves

Stuffing box cable entrance fittings are used for cables other than lead sheathed. These fittings may be provided with or without armor clamps as necessary.

The fitting consists of a cast and machined base, one or more rubber or neoprene washers, and a packing nut which compresses the washers around the cable. These parts should be assembled on the cable in the above order, with the base nearest to the pothead. The packing nut should be tightened after the cable is located in the pothead and before any compound is poured.

Where an armor clamp is required, it is usually made an integral part of the packing nut. This requires that the packing nut and armor clamp be tightened on the cable before the assembly of the pothead is completed.

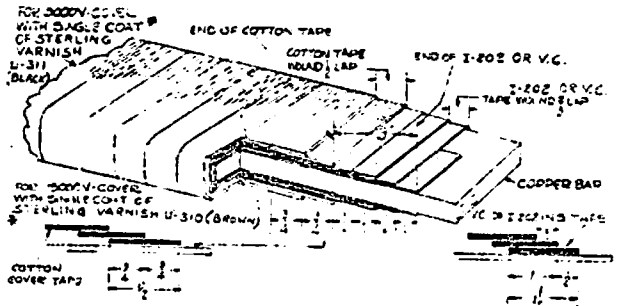
Cable Sheath or Conduit Grounding

Where three-conductor conducting sheath or shielded cables are used, or where non-conducting sheath cable is carried in metallic ducts or conduits, it is usually desirable that both ends of the cable sheath or conduit be grounded directly to the switchgear ground bus or structure or other apparatus. In some cases this may be accomplished by the mounting of potheads or terminating fittings on a grounded support. When such mounting cannot be ar-

Fig. 29 (857609)
Fig. 30 (857604)

Fig. 31 (857607)
Fig. 32 (857608)

Fig. 33 (K-6500514)



INSULATION LEVEL	INSULATION LAYERS V.C.	COTTON TAPE	I-202
5000 V.	4	1	2
15000 V.	7	1	4

NOTE FOR FABRICATION & ASSEMBLY

V.C. IS BLACK VARNISHED CLOTH (CAMBRIC) TAPE #992 WIDTH 1½" THICKNESS 0.012 COTTON TAPE IS WHITE G.E.A.2A/DO WIDTH 1 1/2"

*ONE LAYER (HOUND 2/3 LAP) REQUIRES 3 TURNS AROUND BAR IN ONE WIDTH OF TAPE. THE THICKNESS OF ONE LAYER IS 3 TIMES THE THICKNESS OF THE TAPE.

NOTE FOR INSTALLATION

I-202 BLACK IRRATHENE TAPE WIDTH 1½" THICKNESS .010 COTTON TAPE IS WHITE G.E. A2A/DO WIDTH 1½"

♦ APPLY LIBERALLY

SINCE THE INSULATING PROPERTIES OF V.C. AND IRRATHENE ARE DIFFERENT, CARE MUST BE TAKEN TO INSURE THAT THE CORRECT TAPING INSTRUCTIONS (ABOVE) ARE FOLLOWED.

Fig. 33 Insulation of Connection Bars

Fig. 34 (914A767)

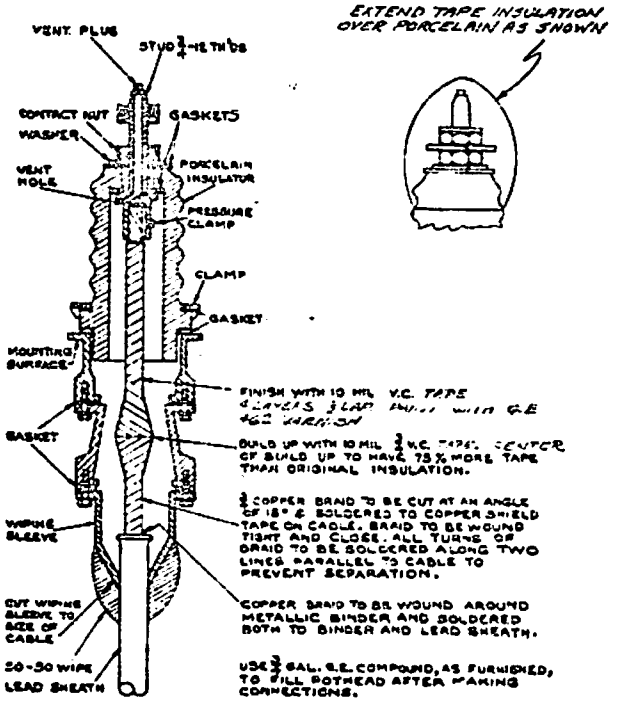
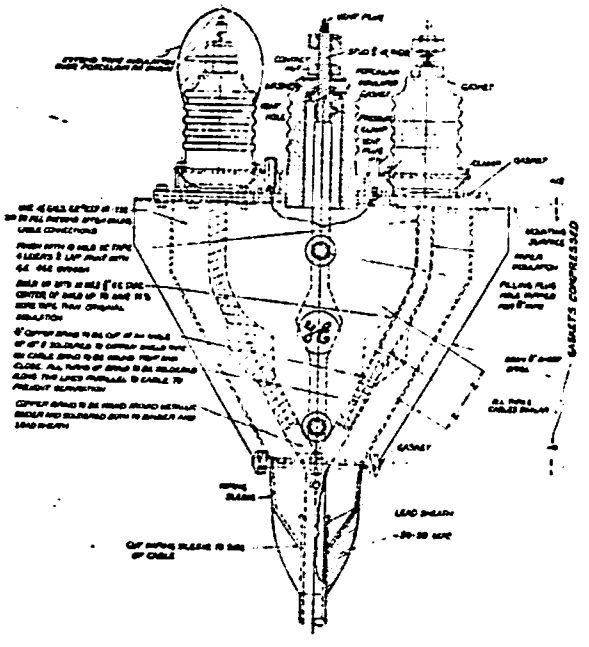
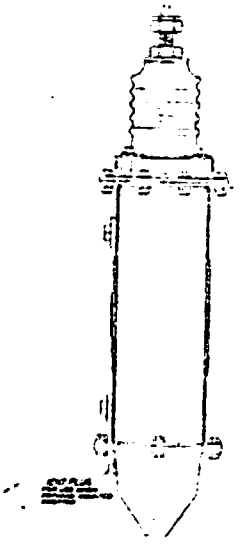


Fig. 34 Single-Conductor Pothead With Stress Cone

Fig. 35 (T-659322)





FOR BELTED CABLE

APPLY ½" TAPE IN FIRMLY DRAWN WRAPPINGS ON EACH CONDUCTOR IN THE REGION OF THE CABLE CROTCH AS INDICATED ON THE DRAWING. THE AXIAL DIMENSIONS FOR THE REINFORCEMENT ARE INDICATED. THE MINIMUM THICKNESS OF THE APPLIED TAPE SHOULD EQUAL APPROXIMATELY THAT OF THE ORIGINAL CONDUCTOR INSULATION. AFTER COMPLETION OF THE INDIVIDUAL REINFORCEMENTS, APPLY 1" MOTH TAPE OVER THE THREE CONDUCTORS FORCED TOGETHER IN THE CROTCH REGION.

SHIELD A PORTION OF THE OVERALL REINFORCEMENT AS INDICATED. PREPARE ONE END OF THE COPPER BRAID TO AN ANGLE APPROXIMATELY 45° AND LAY IT ON THE SHEATH BAND WITH THE CUT EDGE TOWARD THE SHEATH SOLDER FILLET IF IS THE SHEATH. THEN COVER THE SHEATH BAND EXPOSED SELF INSULATION AND THE ADJACENTLY TAPERED SURFACE OF OVERALL REINFORCEMENT WITH A SINGLE LAYER OF TIGHTLY DRAWN BUTT WRAPPINGS OF BRAID AS SHOWN. SOLDER TOGETHER ALL TURNS ON OPPOSITE SIDES OF THE CABLE, AND TERMINATE THE BRAID BY CUTTING ½" BELOW A SOLDERED POINT. THE LOOSE END OF THE BRAID SHOULD BE TURNED BACK AND SOLDERED TO THE PRECEDING TURNS SO THAT NO FRAYED ENDS OF COPPER EXTEND OVER THE VARNISHED CLOTH.

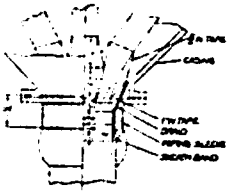


Fig. 35 Triple-Conductor Pothead

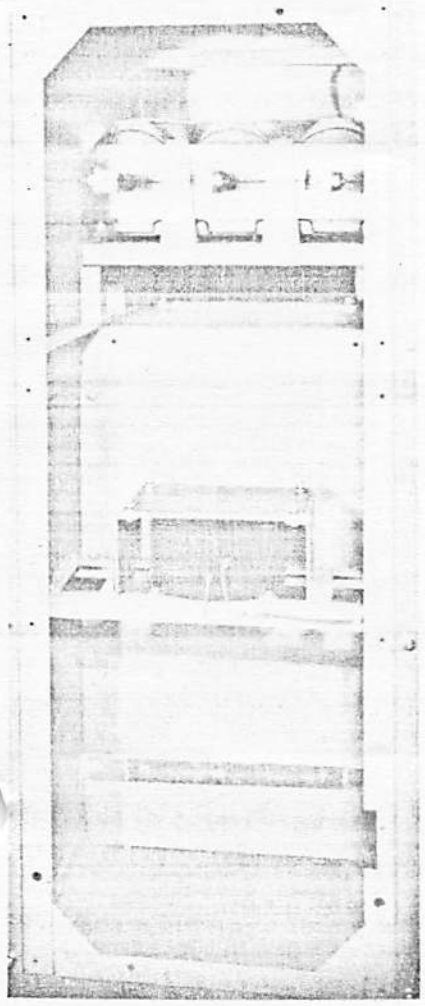


Fig. 36 Rear View of Unit Showing Through Type Current Transformers

ranged, a separate ground wire should be connected between the cable sheath or conduit and the switchgear ground bus.

Where single conductor conducting sheath cables are used, the same procedure should be observed, except that only one end of the sheath should be grounded. This also applies to single conductor non-conducting sheath cables in separate metallic conduits. Where three phases are carried by single conductors in a common metallic conduit, grounding procedure should be the same as that described for three conductor cables.

TERMINATION NONLEADED CABLE SINGLE-CONDUCTOR

1. Cut cable to proper length.

2. Remove jacket and cable tape for distance of A plus B plus 3 inches, plus length to be inserted into terminal lug.

3. Unwrap shielding tape to point M, cut and solder it in place avoiding excessive heat on insulation. Remove outer semi-conducting tape for same distance. Thoroughly clean surface from which the semi-conducting tape was removed.

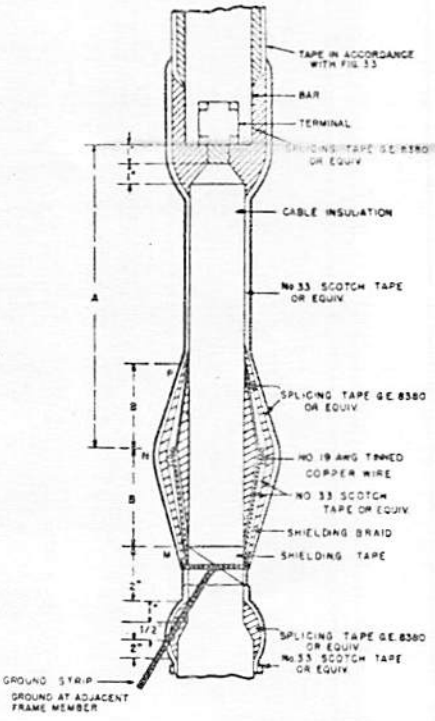
4. Remove insulation and inner semi-conducting tape to expose conductor for distance of one inch plus length to be inserted into terminal lug.

5. Attach terminal lug to conductor.

6. Taper insulation for one inch as shown.

7. Apply end seal. Clean surface over which splicing tape is to be applied and coat with G. E. No. A50P68 adhesive cement or equivalent. When solvent evaporates, build up with splicing tape GE8380 or equivalent, as shown.

8. Build stress cone. Clean cable surface and coat with G.E. No. A50P68 adhesive



Rated kv Phase to Phase	Dimensions in Inches	
	A	
	Indoors Dry Locations	B
2 to 5	5	2
6 to 10	9	3
11 to 15	13	4

Fig. 37 Termination Non-Leaded Cable Single-Conductor

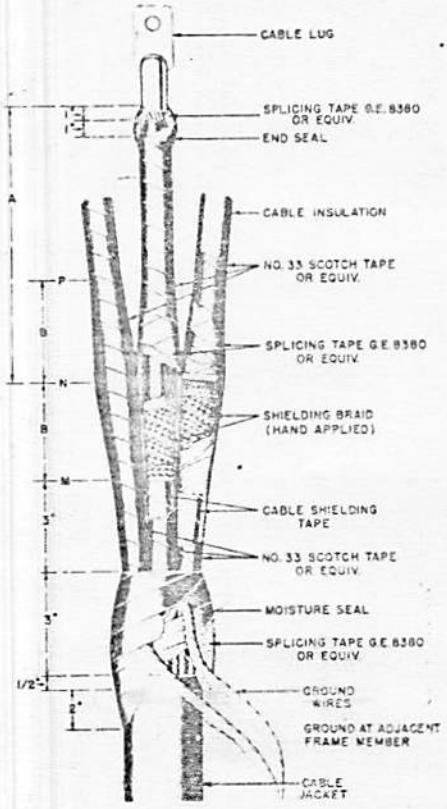


Fig. 38 Termination Non-Leaded Cable Multi-Conductor

cement or equivalent. When solvent evaporates, build up cone with splicing tape GE-8380 or equivalent, for length B plus B. Between points M and P, tape is applied so that wrapped thickness at N is equal to 75% of the original insulation thickness - and so that the cone tapers to zero thickness at points M and P. Apply one layer No. 33 Scotch tape or equivalent, half lapped. Obtain a smooth wrapping but do not stretch tape more than necessary.

9. Pass a turn of tightly drawn braid around exposed portion of shielding tape at point M and solder in place. Then apply shielding braid in tightly drawn 1/16 inch lap wrappings to point N and spot solder. Terminate the braid by cutting 1/2 inch beyond soldering point. Turn down and solder loose ends to preceding turns. Wrap four to six turns of No. 19 AWG tinned copper wire around shielding braid and solder. Solder all turns of braid together along three lengthwise lines equally spaced around braided surface.

10. Solder ground strip over shielding tape near cable covering. Cover stress cone with one layer No. 33 Scotch tape,

Fig. 36 (802A207)
Fig. 37 (B-232004-C)
Fig. 38 (B-232004-C)

lapped. Obtain a smooth wrapping do not stretch tape more than necessary. Add two layers of splicing tape.

11. Pencil jacket for 1/2 inch as shown. Clean surface. Take particular care in cleaning outside jacket surface in order to entirely remove black wax finish. Coat with G.E. No. A50P68 adhesive cement or equivalent. When solvent evaporates, apply splicing tape GE8380 or equivalent and make sheath seal as shown on drawing. Apply one layer No. 33 Scotch tape or equivalent, half lapped. Obtain a smooth wrapping but do not stretch tape more than necessary.

12. Over entire termination, apply two layers of No. 33 Scotch tape or equivalent, half lapped, in manner to shed water. Obtain a smooth wrapping but do not stretch tape more than necessary.

TERMINATION NONLEADED CABLE MULTI-CONDUCTOR

Make termination as indicated for single-conductor except - substitute the following for paragraphs 10, 11 and 12;

Pencil Geoprene jacket 1/2 inch. Clean surface over which sheath moisture seal is to be applied. Take particular care in cleaning outside jacket surface in order to entirely remove black wax finish. Coat with G.E. No. A50P68 adhesive cement or equivalent. Allow to dry. Apply splicing tape GE8380 or equivalent to make moisture seal as shown. This is done by starting tape near end of jacket and wrapping over ground wires for 1-1/2 inches. Bend ground wires out and back over taping just applied and continue applying lapped layers of tape to completion of moisture seal including a complete tape seal in crotch formed between the three conductors. Bond and ground the ground wires.

For a multi-conductor cable not having ground wires, the individual terminations should have grounding strips applied as for a single-conductor termination. These grounding strips are to be joined together to a common ground. This common ground must then be grounded.

GROUND FAULT CURRENT TRANSFORMERS (THROUGH TYPE)

Through type current transformers (see Fig. 36) are furnished where specified for sensitive protection against ground faults. These transformers are normally installed in a horizontal position directly above or below the primary cable terminals, so that the primary cable or cables can pass through them. One transformer is required for each three-phase circuit.

Where armored cable is used, the armor must be terminated and grounded before the cable passes through the transformer. Armor clamps are furnished for this purpose when specified.

When lead or other conducting sheath cable, or cable with shielding tape or braid is used, it is recommended that the sheath or shield be grounded solidly to the switchgear ground bus. The ground lead should be bonded to the sheath or shield on the side of the current transformer away from the primary terminals. In cases where the ground cannot be applied before the cable passes through the transformer, bond the lead to the sheath or shield between the transformer and the primary terminals. The ground conductor must then be passed back along the cable path through the current transformer before being connnected to the ground bus.

Where potheads are used in units provided with ground fault current transformers, the pothead mountings must be insulated from ground.

CONTROL CABLES

When control conduits enter the unit from below, the conduit should not extend more than 4 inches above the floor. The control cables may be pulled through the conduits before or after the switchgear is installed, whichever is more convenient.

Connect the cables to the terminal blocks in accordance with the wiring diagrams furnished for the requisition.

If the control conduits enter from above, drill the top and bottom covers of the front enclosure wiring trough to suit the conduits. Fasten the conduits to the bottom cover with locknuts.

The cables from the control power source to the switchgear should be large enough to avoid excessive voltage drop when the circuit breakers are operated. See testing instructions.

Check over all screws and nuts connecting the control wiring to make sure that none have been loosened in shipment.

Where units have been split for shipment, any control or other secondary leads which must connect across the split will be arranged with terminal blocks in the cross trough or convenient side sheet so that the wires can be reconnected. The wires will be cut to length and formed before being folded back so that a minimum of time will be required for reconnecting them.

GROUND BUS

The ground bus is bolted to the rear or the frame near the bottom. It is arranged so that connections to the station ground can be made in any unit. Where the equipment is shipped in more than one group, the sections of ground bus must be connected by using the splice plates furnished with the equipment. Apply grease and assemble joints as outlined under "Connections" (Page 14). Ground bus connections are made in the lower portion of the cable entrance compartment. The switchgear ground bus must be connected to the station ground bus by a conductor having a current carrying capacity equal to that of the switchgear ground bus. It is very important that the equipment be adequately grounded to protect the operator from injury when short circuits or other abnormal occurrences take place and to insure that all parts of the equipment, other than live parts, are at ground potential.

LIGHTNING PROTECTION

It will be the responsibility of the purchaser to provide suitable lightning arresters to protect the switchgear from damage due to lightning. The General Electric Company's recommendations as to the types of circuits requiring lightning protection, and a list of recommended lightning arresters, is contained in Bulletin GER-141, copies of which are available upon request.

OPERATION

The operation of metal-clad switchgear is similar to that of other types except that it provides maximum safety to the operator and the feature of easy removal and replacement of the circuit breaker.

All circuit breaker removable elements of the same type and rating which have duplicate wiring may be interchanged.

BREAKER POSITIONING

To place the circuit breaker in operating position, proceed as given below:

Clean contacts and cover with a very thin coating of Contact Lubricant D50H28.

Push the breaker into the unit until it sts against the stop.

To raise the breaker, operate the elevating control selector switch just inside the door on the right hand side to "Raise". A clutch handle just above the elevating motor is then pulled until it engages the motor at which time it closes the clutch limit switch to start the motor and raise the breaker in the housing. At the end of the upward travel, a limit switch on the structure opens to stop the motor. See Figure 17.

To lower the breaker, proceed the same as for raising except operate selector switch to "Lower".

The clutch must be held in the engaged position; otherwise, a spring will return it to its normal position opening the electrical circuit to the motor.

The breaker may be raised and lowered by an emergency hand wrench which can be inserted after removing the motor.

The motor is removed by unlatching the motor assembly from the support and disconnecting the motor lead plug.

After removing the motor, pull the clutch forward and insert the wrench over the end of the clutch shaft. The breaker must be tripped before the clutch can be engaged with the wrench.

SPACE HEATERS

Space heaters are provided in all outdoor equipment in order to keep the inside temperature several degrees higher than that outside. This helps prevent condensation and the resultant corrosion which might occur. The heaters should be turned on at all times. Heaters are also furnished for indoor equipments when it is known that abnormal atmospheric conditions exist at the installation.

TESTING AND INSPECTION

After the equipment has been installed and all connections made, it should be tested and inspected before putting in service. Although the equipment and devices have been completely tested at the factory, a final field test should be made to be sure that the equipment has been properly installed and that all connections are correct and have not become loose in transportation. The primary equipment should be completely de-energized while the tests are in progress.

Directions for testing devices such as relays, instruments and meters are given in the instruction book furnished for each device. The settings of the protective relays must be coordinated with the other relays on the system and therefore these relays must be set by the purchaser. General instructions on setting the relays are given in the relay instruction books. Special instruction books are furnished for complicated automatic equipments, describing the sequence of operation of the devices required to perform the desired function.

The General Electric Company will not be responsible for defects in devices not manufactured by the Company when such devices are specified by the purchaser. All questions relative to such devices should be referred to the manufacturer.

The extent of the tests on the equipment as a whole will depend on the type and function of the equipment.

When transformers are furnished to supply the control power, the primary taps should be selected so that the control voltage indicated on the wiring diagram is obtained on the secondary of the transformer. When a battery is used to supply the control power, the cables from the battery to the switchgear should be large enough to avoid excessive voltage drop. The voltage at the terminals of the breaker closing coils, when the breaker is being closed, should not be less than 112.5 volts for 125 volt coils and 225 volts for 250 volt coils.

The operation of the breaker with its associated devices may be tested in the unit while the equipment is energized by use of the test coupler which is furnished. Lower the breaker to the test or down position. Attach the test coupler to connect the breaker secondary disconnecting device to that on the structure.

High potential tests to check the integrity of the insulation are not necessary if the installation instructions in this book are carefully followed. If the purchaser wishes to make high potential tests the voltage should not exceed 75% of the AIEE factory test voltages.

Potential transformers must be disconnected during high voltage testing.

MAINTENANCE

A regular maintenance schedule should be established to obtain the best service and reliability from the switchgear. Plant, operating and local conditions will dictate the frequency of inspection required. For specific information regarding the maintenance of devices, such as circuit breakers, relays, meters, etc., refer to the separate instruction book furnished for each device. The inspection cabinet, which is furnished, provides a convenient means for maintaining the circuit breakers. Under normal conditions the protective relays do not operate, therefore, it is important to check the operation of these devices regularly.

A permanent record of all maintenance work should be kept, the degree of detail depending on the operating conditions. In any event, it will be a valuable reference for subsequent maintenance work and for station operation. It is recommended that the record include reports of tests made, the condition of equipment and repairs and adjustments that were made.

BEFORE ANY COVERS ARE REMOVED OR ANY DOORS OPENED WHICH PERMIT ACCESS TO THE PRIMARY CIRCUITS, IT IS ESSENTIAL THAT THE CIRCUIT BE DE-ENERGIZED.

The primary circuits of metal-clad switchgear are insulated in order to reduce the size of the equipment. However, this insulation, except in one or two instances, requires a certain amount of air gap between phases and to ground to complete the insulation. Inserting any object in this air space, when equipment is energized, whether it be a tool or a part of the body, may under certain conditions, in effect, short circuit this air gap and may cause a breakdown of the primary circuit to ground and cause serious damage or injury or both.

Care should be exercised in the maintenance and checking procedures that accidental tripping or operation is not initiated.

The switchgear structure and connections should be given the following overall maintenance at least annually.

1. Thoroughly clean the equipment, removing all dust and other accumulations. Wipe clean the buses and supports. Inspect the buses and connections carefully for evidence of overheating or weakening of the insulation.

2. Measure the resistance to ground and between phases of the insulation of buses and connections. Since definite limits cannot be given for satisfactory insulation resistance values, a record must be kept of the reading. Weakening of the insulation from one maintenance period to the next can be recognized from the recorded readings. The readings should be taken under similar conditions each time if possible, and the record should include the temperature and humidity.

High potential tests are not required, but if it seems advisable, based on the insulation resistance tests or after repairs, the test voltage should not exceed 75% of the AIEE factory test voltage. The potential transformer must be disconnected during the high voltage testing.

3. Clean elevating mechanism and lubricate jack screws and gears with lubricant G.E. Co. #D50H15 (Atlantic Ref. Co. #52 or equal).

4. Check primary disconnecting device contacts for signs of abnormal wear or overheating. Clean contacts with silver polish. Discoloration of the silvered surfaces is not ordinarily harmful unless atmospheric conditions cause deposits such as sulphides on the contacts. If necessary the deposits can be removed with a good grade of silver polish.

Before replacing breaker, apply a thin coat of contact lubricant A50H47 to breaker studs for lubrication.

5. Check to see that all anchor bolts and bolts in the structure are tight. Check tightness and continuity of all control connections and wiring.

RENEWAL PARTS

ORDERING INSTRUCTIONS

1. RENEWAL PARTS SHOULD BE ORDERED FROM THE MEDIUM VOLTAGE SWITCHGEAR DEPARTMENT.
2. ALWAYS SPECIFY THE REQUISITION NUMBER ON WHICH THE EQUIPMENT WAS ORIGINALLY FURNISHED.
3. SPECIFY THE QUANTITY, REFERENCE NUMBER, DESCRIPTION AND THIS BULLETIN NUMBER.
4. STANDARD HARDWARE, SUCH AS SCREWS, BOLTS, NUTS, WASHERS, ETC., IS NOT LISTED. SUCH ITEMS SHOULD BE PURCHASED LOCALLY.
5. FOR PRICES, REFER TO THE NEAREST OFFICE OF THE GENERAL ELECTRIC COMPANY.
6. IF INSULATING MATERIAL, SUCH AS TAPE, VARNISH, COMPOUND, ETC., IS REQUIRED, IT MUST BE SPECIFIED SEPARATELY.

PRIMARY DISCONNECT DEVICES (SEE FIG. NO. 8)

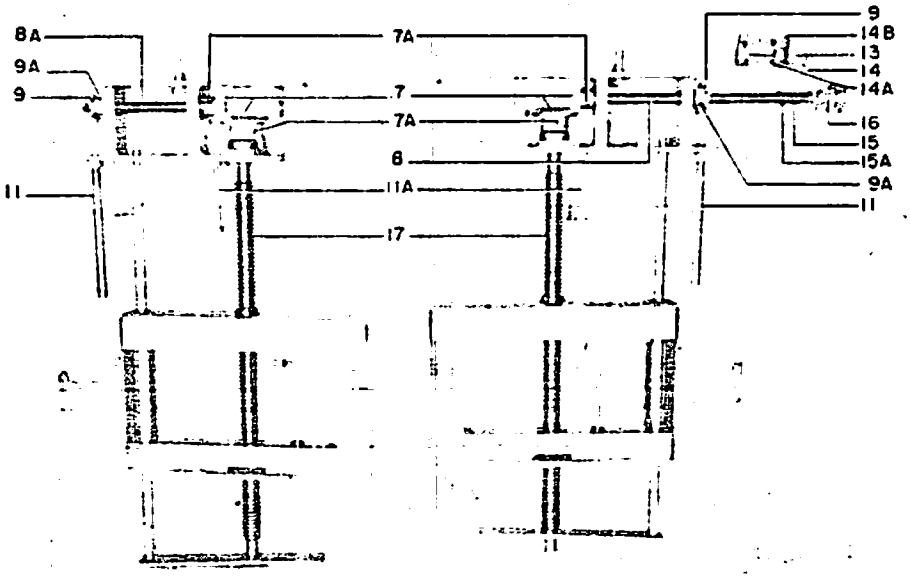
REF. NO.	DESCRIPTION
5	Front Primary Disconnect Device Assembly, 3 Pole, Complete with Connections
6	Rear Primary Disconnect Device Assembly, 3 Pole, Complete with Connections

NOTE: Insulating material required for Ref. Nos. 5 and 6 will be furnished with order.

POSITIVE MECHANICAL INTERLOCK (FIG. NO. 17)

REF. NO.	DESCRIPTION
3	Complete positive mechanical interlock assembly
4	Elevating mechanism motor (115-v d-c)
4	Elevating mechanism motor (230-v d-c)
4	Elevating mechanism motor (230-v d-c)
18	Spring only

Fig. 39 (8024360)



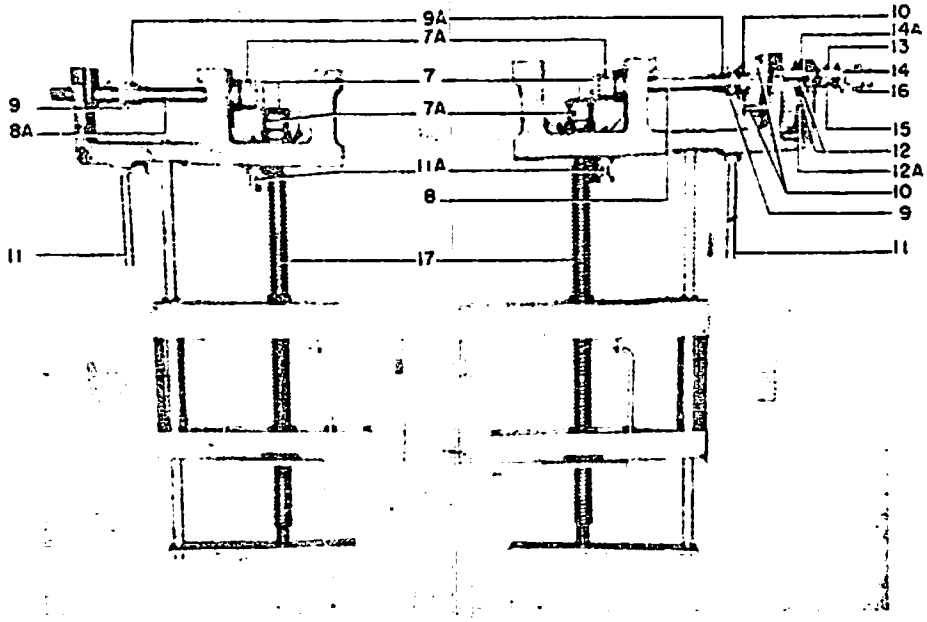
Complete Left Hand (Ref. No. 1) Complete Right Hand (Ref. No. 2)

Fig. 39 Elevating Mechanism for M-26 Equipments Rated 250 mva or less and M-36 Equipments Rated 1200A 500 mva or Less

ELEVATING MECHANISMS

REF.NO.	DESCRIPTION
7	Miter gears, pair
7A	Groov pin for miter gear
8	Shaft, right
8A	Shaft, left
9	Sprocket
9A	Groov pin for sprocket
10	Spur gear
10	Pinion gear and rod
10A	Groov pin for spur gear
11	Stop stud
11A	Stop bolt
12	Pinion gear and rod
12	Spur gear
12A	Groov pin for spur gear
13	Locking spring
14	Stop shaft
14A	Groov pin for stop shaft
14B	Stop shaft bracket
15	Clutch spring
15A	Groov pin for clutch spring
16	Slide clutch
17	Jack screw

Fig. 40 (8024362)



Complete Left Hand (Ref. No. 3) Complete Right Hand (Ref. No. 4)

Fig. 40 Elevating Mechanism for M-36M Equipments Rated 750 mva, M-26 Equipments Rated 350 mva and M-36 Equipments Rated 2000A

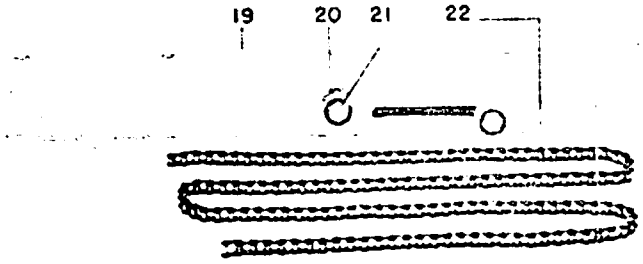


Fig. 41 Angle Bracket and Chain Drive

REF. NO.	DESCRIPTION
19	Bracket
20	Roller
21	Retainer
22	Chain

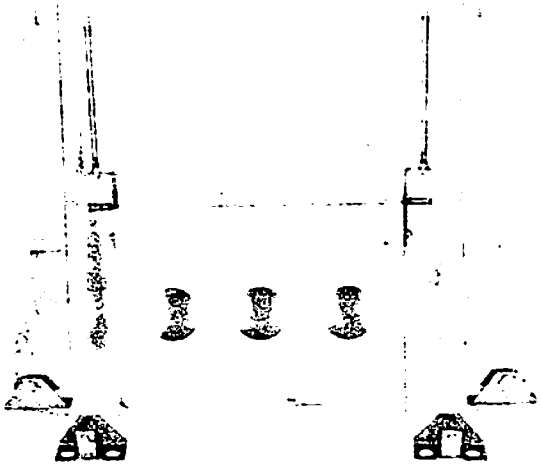


Fig. 42 Shutter Mechanism Assembly M-26

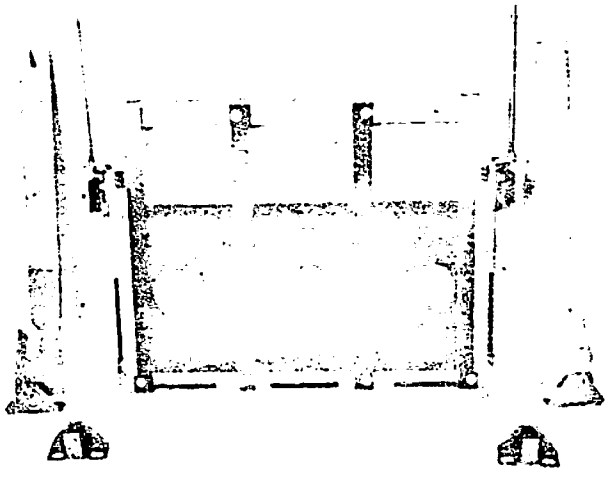


Fig. 43 Shutter Mechanism Assembly M-36

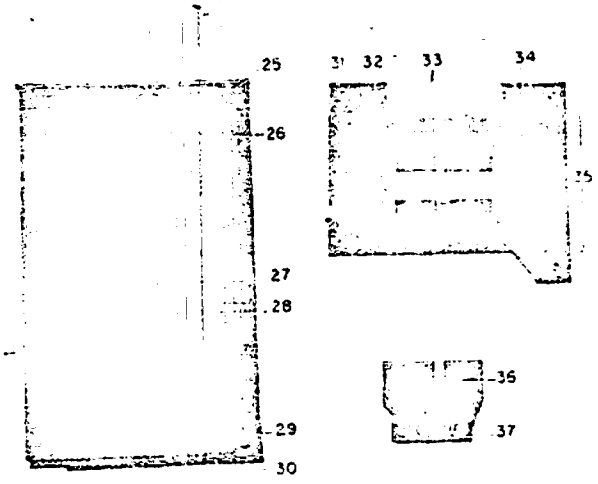


Fig. 41 (8029364)

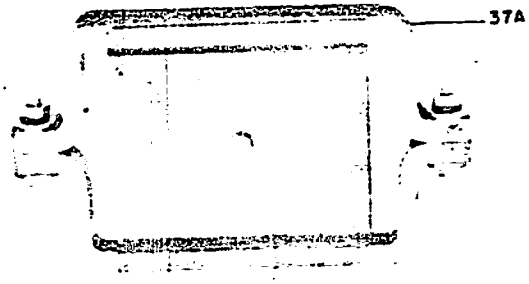


Fig. 42 (8029366)

Fig. 44 Bus Supports

REF. NO.	DESCRIPTION
25	Isolating barrier support angle
26	Rear isolating barrier
27	Intermediate isolating barrier
28	Front isolating barrier
29	Isolating barrier clip
30	Isolating barrier support
31	Front support clip (not shown)
32	Front intermediate support
33	Intermediate support
34	Rear intermediate support
35	Rear support clip (not shown)
36	Lower intermediate support
37	Lower intermediate support clip
37A	Intermediate clamp assembly (supersedes but does not replace Ref. Nos. 31 - 35)

Fig. 43 (8029367)

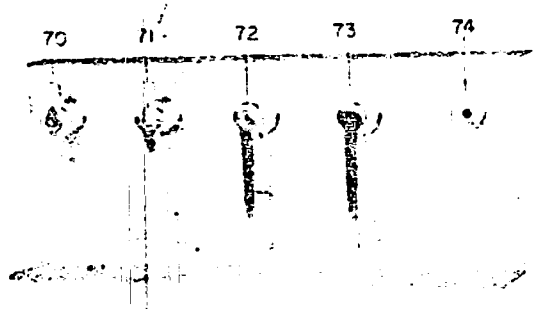


Fig. 45 Door Handles and Locks

REF. NO.	DESCRIPTION
70	Panel locking handle
71	Panel handle
72	Door locking handle
73	Door handle
74	Socket

Fig. 44 (8020152 & 8029361)

Fig. 45 (8011607)

REF. NO.	LOCATION	RATING	DESCRIPTION
38	int.	1200A.	1 connection bar, down
39	int.	1200A.	1 connection bar, up
40	end	1200A.	1 connection bar, down
41	end	1200A.	1 connection bar, up
42	int.	1200A.	no connection bar
43	end	1200A.	no connection bar
44	int.	1600A.	1 connection bar, down
45	int.	1600A.	1 connection bar, up
46	end	1600A.	1 connection bar, down
47	end	1600A.	1 connection bar, up
48	int.	1600A.	no connection bar
49	end	1600A.	no connection bar
50	int.	2000A.	1 connection bar, down
51	int.	2000A.	1 connection bar, up
52	end	2000A.	1 connection bar, down
53	end	2000A.	1 connection bar, up
54	int.	2000A.	no connection bar
55	end	2000A.	no connection bar
56	int.	2000A.	2 connection bars, down
57	int.	2000A.	2 connection bars, up
58	end	2000A.	2 connection bars, down
59	end	2000A.	2 connection bars, up
59A	specify		Insulating boot
59B			Plastic rivet for boot

Fig. 46 (8012365)

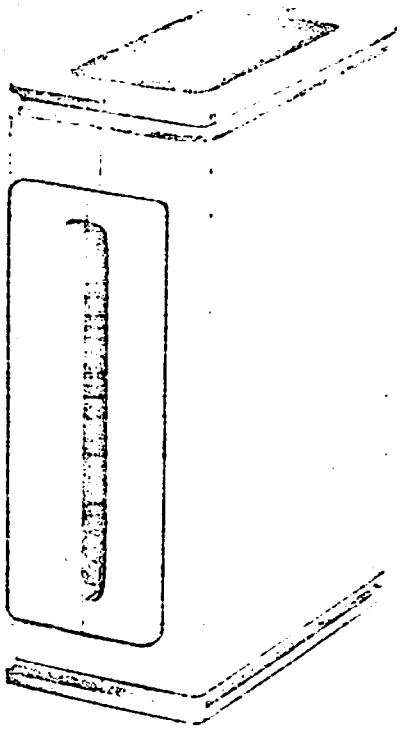


Fig. 46 Bus Connection Box (4.16 or 13.8 KV Units)

Fig. 47 (8024365)

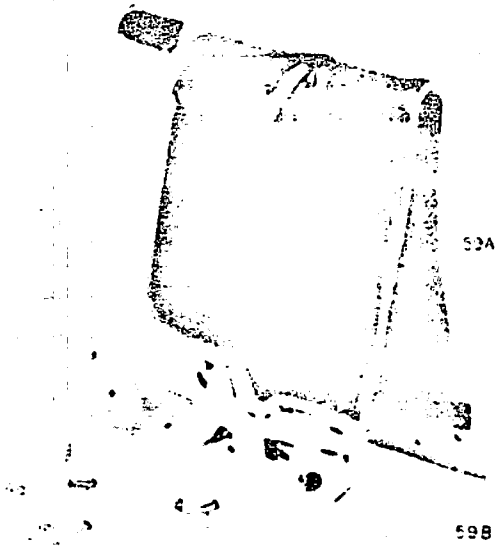


Fig. 47 Bus Connection Boot (4.16 KV Units Only)

Fig. 48 (8024363)

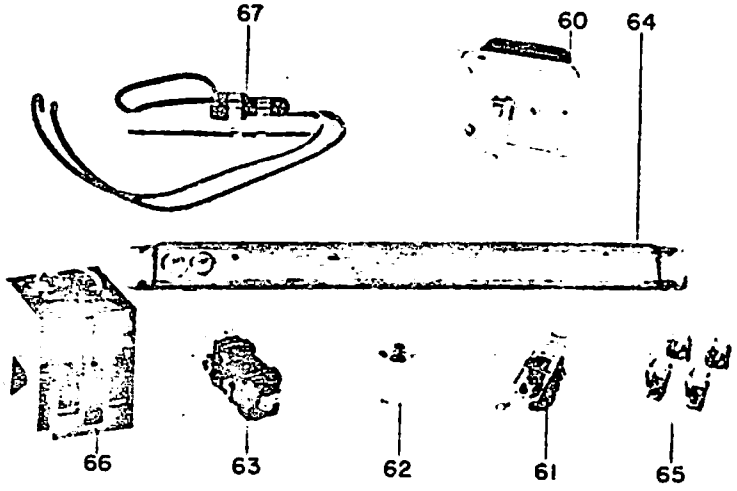


Fig. 48 Wiring Devices and Miscellaneous Parts

REF. NO.	DESCRIPTION
60A	Limit Switch SB1 type (upper)
60B	Limit switch SB1 type (lower)
61	Light switch
62	Keyless receptacle
63	Duplex receptacle
64	Strip heater
65	Fuse block, open type
66	Fuse block, dead front
67	Limit switch, mercury type
See Fig. 17 (68	Complete secondary disconnect device
See Fig. 17 (69	Complete stationary auxiliary switch and mechanism

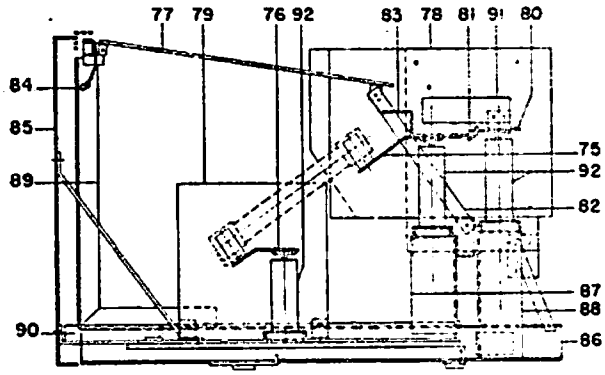


Fig. 49 Fuse Rollout Unit

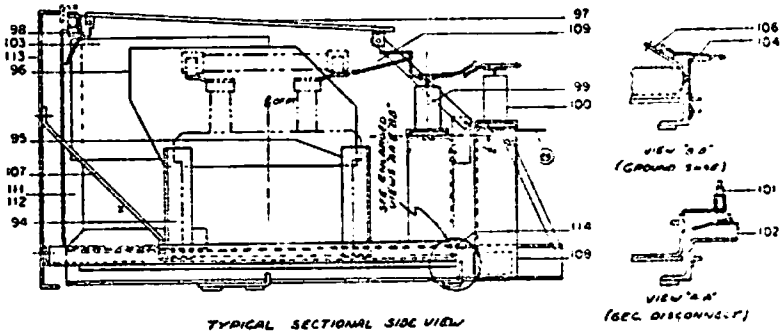


Fig. 50 Potential Transformer Rollout Unit

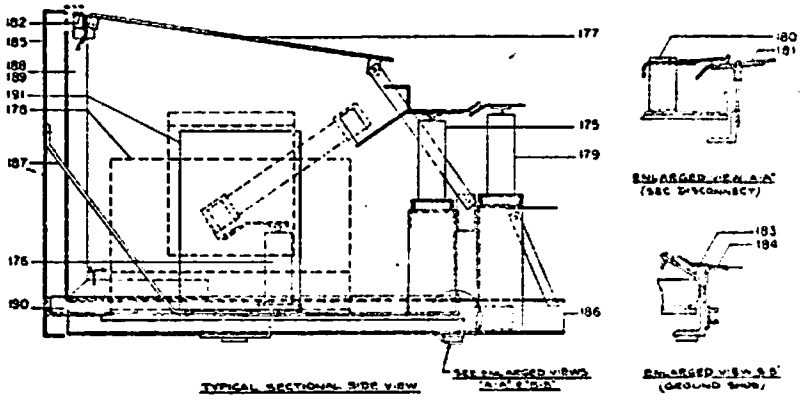


Fig. 51 Control Transformer Rollcut Unit

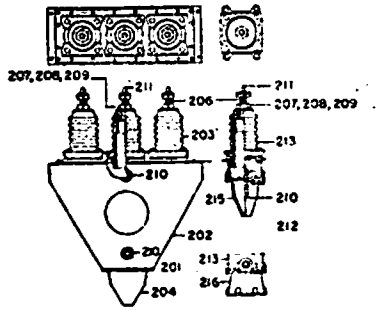


Fig. 52 Single and Triple-Conductor Potheads

REF.NO.	DESCRIPTION
	FUSE ROLLOUT UNIT
75	Fuse support (upper)
76	Fuse support (lower)
77	Shutter
78	Transformer
79	Barrier
80	Barrier
81	Contact
82	Shutter support
83	Ground shoe
84	Ground contact
85	Cover
86	Frame
87	Support
88	Support
89	Support
90	Carriage
91	Arc Quencher
92	Insulator
	POTENTIAL TRANSFORMER ROLLOUT UNIT
94	Barrier support
95	Barrier support
96	P.T. barrier
97	Shutter
98	Shutter support
99	Contact (movable)
100	Contact (stationary)
101	Sec. disconnect (movable)
102	Sec. disconnect (stationary)
103	Barrier
104	Contact
106	Ground shoe
107	Support
108	Frame and carriage
109	P. T. braid (specify length)
111	Support
112	Support
113	Cover
114	Carriage
	CONTROL TRANSFORMER ROLLOUT UNIT
175	Fuse support (upper)
176	Fuse support (lower)
177	Shutter
178	Transformer
179	Contact
180	Contact
181	Contact
182	Shutter support
183	Ground shoe
184	Ground contact
185	Cover
186	Frame
187	Support
188	Support
189	Support
190	Carriage
191	Barrier
	SINGLE & TRIPLE-CONDUCTOR POTHEADS
201	Triple-conductor pothead assembly
202	Body
203	Insulators and support
204	Wiping sleeve
205	Gaskets for triple-conductor pothead
206	Terminal
207	Contact nut
208	Washer
209	Palnut (3/4 in. - 12)
210	Pipe plug (3/4 in. std.)
211	Pipe plug (1/8 in std.)
212	Single-conductor pothead assembly
213	Body and insulator
214	Gaskets for single-conductor pothead
215	Wiping sleeve
216	Adapter for mechanical entrance fittings

Fig. 49 (262C753)

Fig. 50 (262C829)

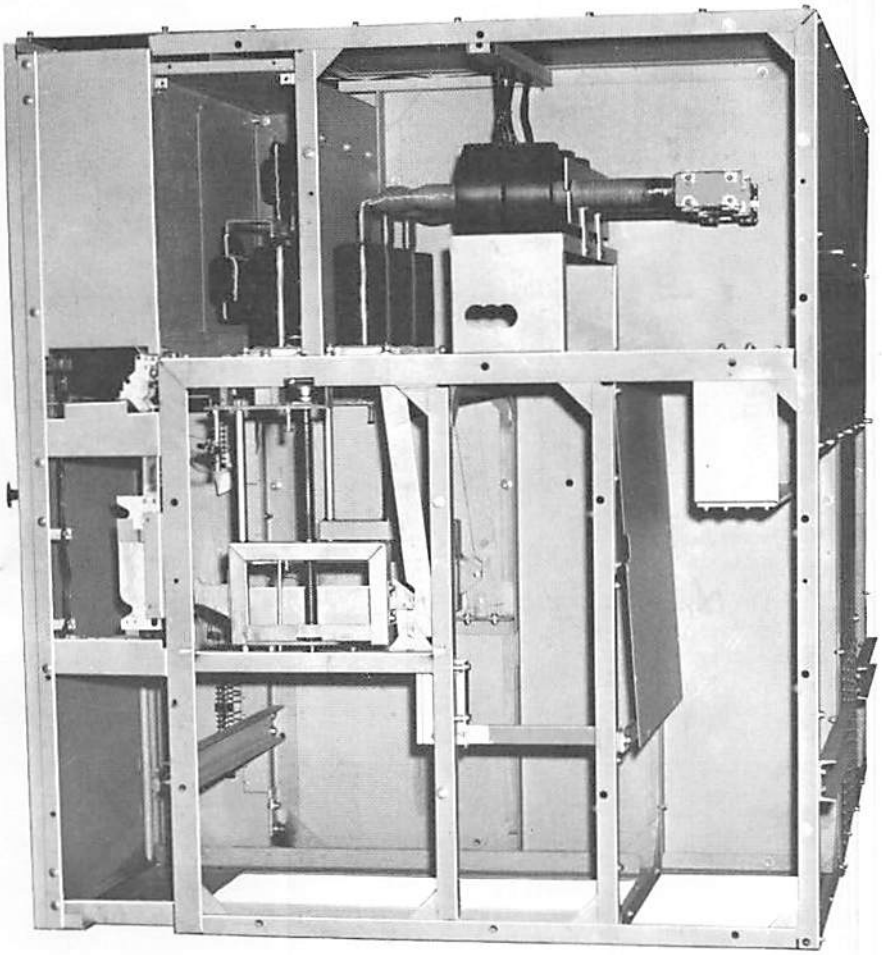
Fig. 51 (262C822)

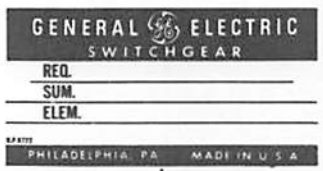
Fig. 52 (110340)

RENEWAL PARTS

GEF-4351B
Supersedes GEF-4351A

METAL-CLAD SWITCHGEAR
TYPES M-26 AND M-36





ORDERING INSTRUCTIONS

1. Always specify the complete nameplate data of the equipment.
2. Specify the quantity, catalog number (if listed), reference number (if listed), description, and this bulletin number.
3. Standard hardware, such as screws, bolts, nuts, washers, etc., is not listed in this bulletin. Such items should be purchased locally.
4. For prices, refer to the nearest office of the General Electric Company.

GENERAL ELECTRIC

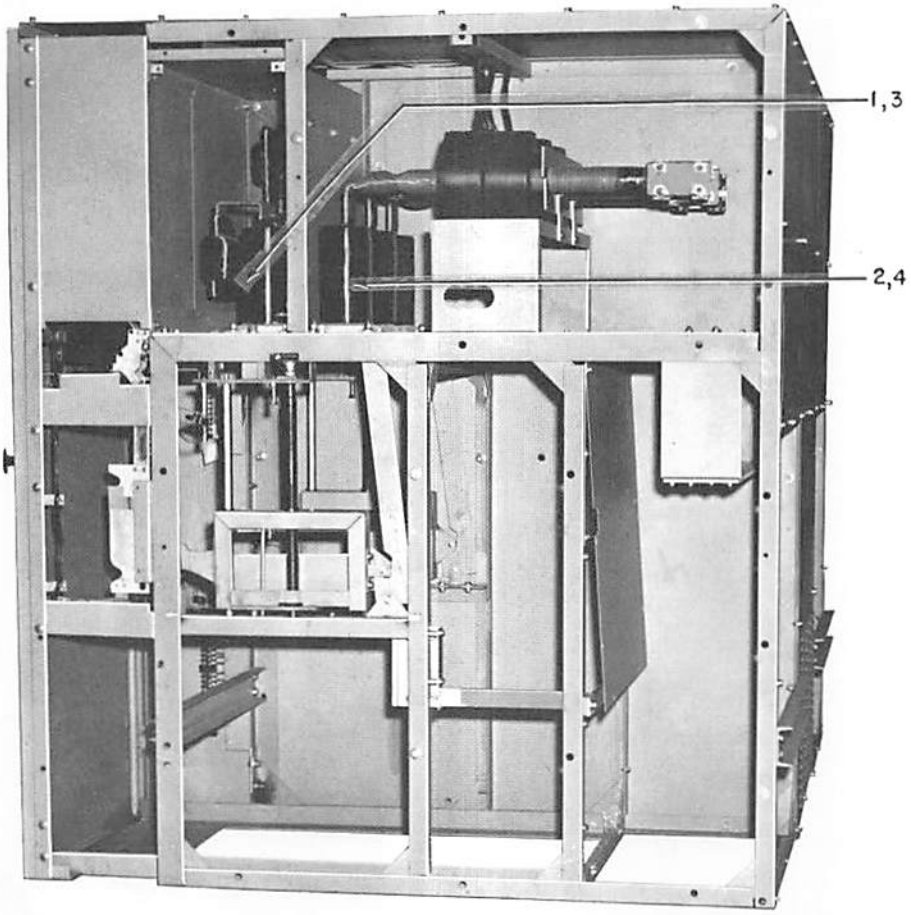


Fig. 1 Metal-clad switchgear

NOTE: The NP data listed below must be supplied for identification.

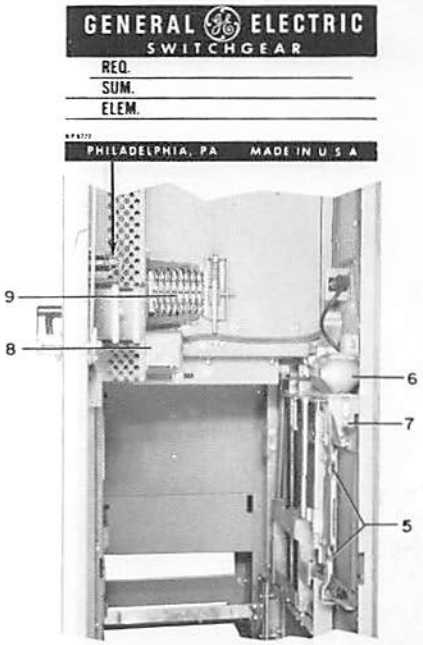


Fig. 2 Motor and control unit

Ref. No.	KV	Amps	Ordering Number	Description
1	4.16	1200	733-328X600	Front primary disconnect
1	4.16	2000	328X601	Front primary disconnect
1	4.16	3000	328X602	Front primary disconnect
1	13.8	1200	328X603	Front primary disconnect
1	13.8	2000	328X604	Front primary disconnect
1	13.8	2500	328X605	Front primary disconnect
1	13.8	3000	328X606	Front primary disconnect
2	4.16	1200	328X607	Rear primary disconnect
2	4.16	2000	328X608	Rear primary disconnect
2	4.16	3000	328X609	Rear primary disconnect
2	13.8	1200	328X610	Rear primary disconnect
2	13.8	2000	328X611	Rear primary disconnect
2	13.8	2500	328X612	Rear primary disconnect
2	13.8	3000	328X613	Rear primary disconnect
3	4.16	1200	328X614	Front installation accessories
3	4.16	2000	328X615	Front installation accessories
3	4.16	3000	328X616	Front installation accessories
3	13.8	1200	328X617	Front installation accessories
3	13.8	2000	328X618	Front installation accessories
3	13.8	2500	328X619	Front installation accessories
3	13.8	3000	328X620	Front installation accessories
4	4.16	1200	328X621	Rear installation accessories
4	4.16	2000	328X622	Rear installation accessories
4	4.16	3000	328X623	Rear installation accessories
4	13.8	1200	328X624	Rear installation accessories
4	13.8	2000	328X625	Rear installation accessories
4	13.8	2500	328X626	Rear installation accessories
4	13.8	3000	328X627	Rear installation accessories

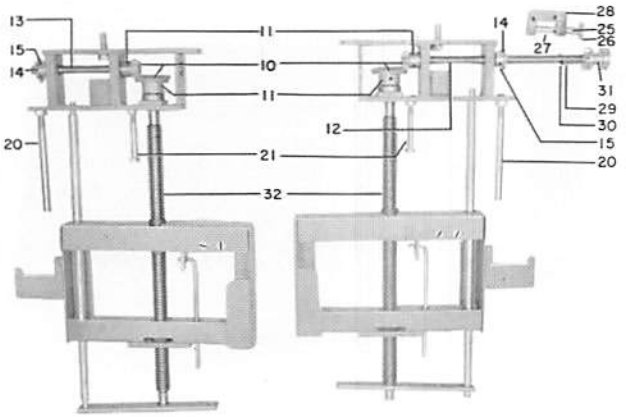


Fig. 3 Elevating mechanism for M-26 equipments rated 250 mva and M-36 rated 1200A 500 mva

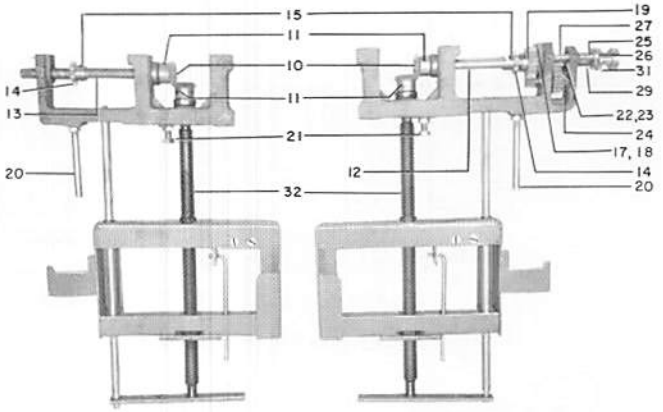


Fig. 4 Elevating mechanism for M-36H equipments rated 750, M-26H rated 350 mva and M-36 rated 500 mva 2000A

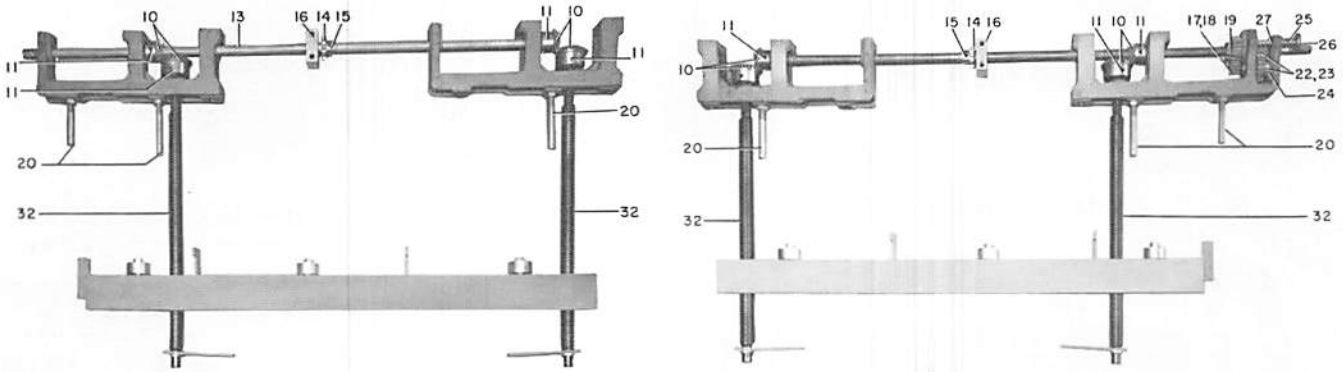


Fig. 5 Elevating mechanism for M-36HH equipments rated 1000 mva

Ref. No.	Ordering Number	Description
5	733-328X628	Positive mechanical interlock assembly, complete
6	328X629	Elevating mechanism motor
7	328X630	Spring
8	328X631	Complete secondary disconnect device
9	328X632	Complete stationary auxiliary switch mechanism
10	328X633	†Miter gears, pair
11	328X634	Roll pin for miter gears
12	328X635	Shaft, right
13	328X636	Shaft, left
14	328X637	Sprocket
15	328X638	Roll pin for sprocket
16	328X639	Bearing block
17	328X640	Spur gear
18	328X641	Pinion gear and rod
19	328X642	Roll pin for spur gear
20	328X643	Stop stud
21	328X644	Stop bolt
22	328X645	Pinion gear and rod
23	328X646	Spur gear
24	328X647	Roll pin for spur gear
25	328X648	Locking spring
26	328X649	Stop shaft
27	328X650	Roll pin for stop shaft
28	328X651	Bracket for stop shaft
29	328X652	Clutch spring
30	328X653	Roll pin for clutch spring
31	328X654	Slide clutch
32	328X655	Jack screw

†Whenever gears mesh, they must be ordered as a pair.

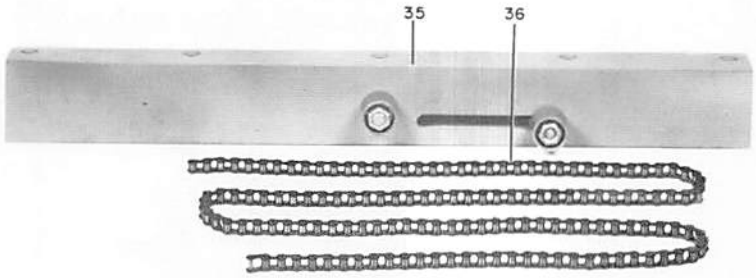


Fig. 6 Angle bracket and chain

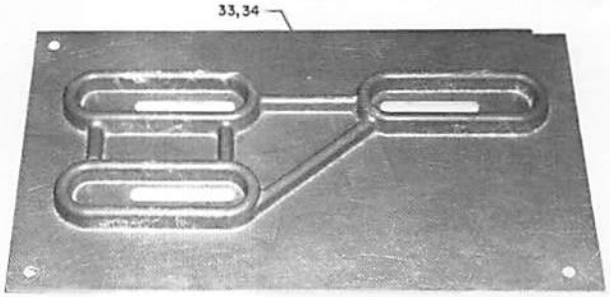


Fig. 10 Bus support, molded

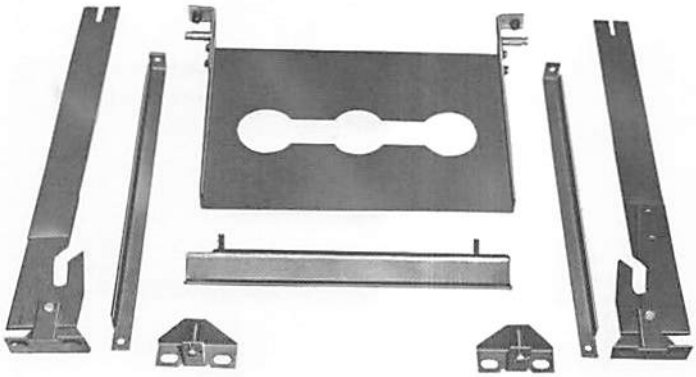


Fig. 7 Shutter mechanism M-26 (Ref. 37)

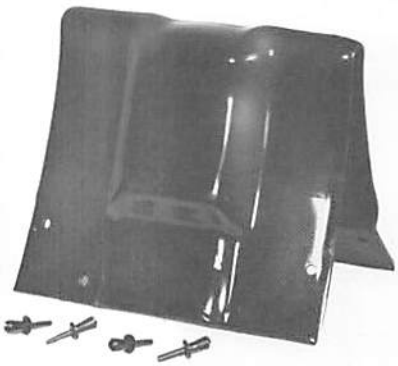


Fig. 11 Bus connection boot (4.16 KV and 13.8 KV)
Specify unit No. and phase on which boot is to be used

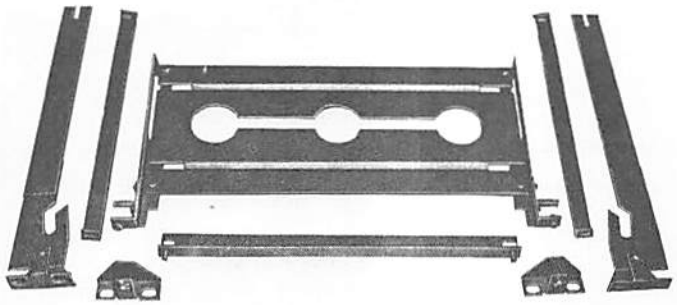


Fig. 8 Shutter mechanism M-36 (Ref. 38)

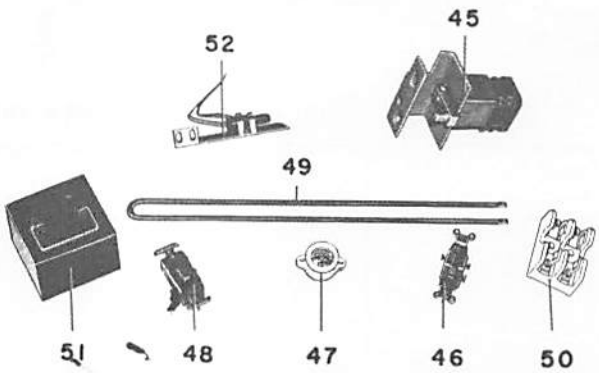


Fig. 12 Wiring devices and miscellaneous

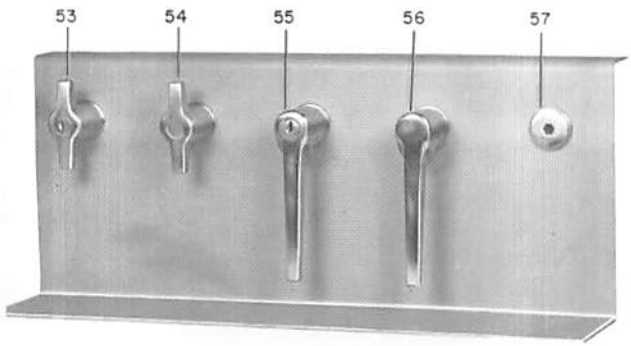


Fig. 13 Door handles and locks

Ref. No.	Ordering Number	Description
33	733-328X656	Bus support, 5KV
34	328X657	Bus support, 15KV
35	328X658	Bracket assembly
36	328X659	Chain
37	328X660	Shutter mechanism assembly (M26)
38	328X661	Shutter mechanism assembly (M36)
45	328X668	Limit switch, Type SB1
46	328X669	Light switch
47	328X670	Keyless receptacle
48	328X671	Duplex receptacle
49	328X672	Strip heater
50	328X673	‡Fuse block, open type
51	328X674	‡Fuse block, dead front
52	328X675	Limit switch, mercury type
53	328X676	Panel locking handle
54	328X677	Panel handle
55	328X678	Door locking handle
56	328X679	Door handle
57	328X680	Socket

‡Specify amp rating of fuse and number of poles.

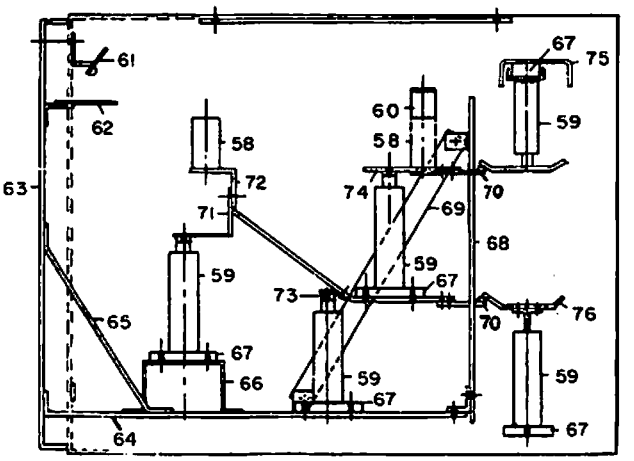


Fig. 14 Fuse rollout unit

‡ ROLLOUT UNIT

Fig. No.	Ref. No.	Ordering Number for	5K	15KV	Description
14	58	733-328X681	G1	G2	Fuse clip
14	59	328X682	G1	G2	Insulator
14	60	328X683	G1	G2	Ground bar
14	61	328X684	G1	G2	Ground finger
14	62	328X685	G1	G2	Barrier
14	63	328X686	Δ	G2	Cover
14	64	328X687	G1	G2	Tray
14	65	328X688	G1	G2	Strap
14	66	328X689	Δ	G2	Insulator support
14	67	328X690	Δ	G2	Insulator clamp
14	68	328X691	G1	G2	Barrier
14	69	328X692	G1	G2	Compound strap

‡All rollout units and potheads can be either 5 KV or 15 KV. When ordering give complete ordering number plus G1 for 5 KV and G2 for 15 KV.
ΔDoes not apply to 5 KV unit.
*Not shown.

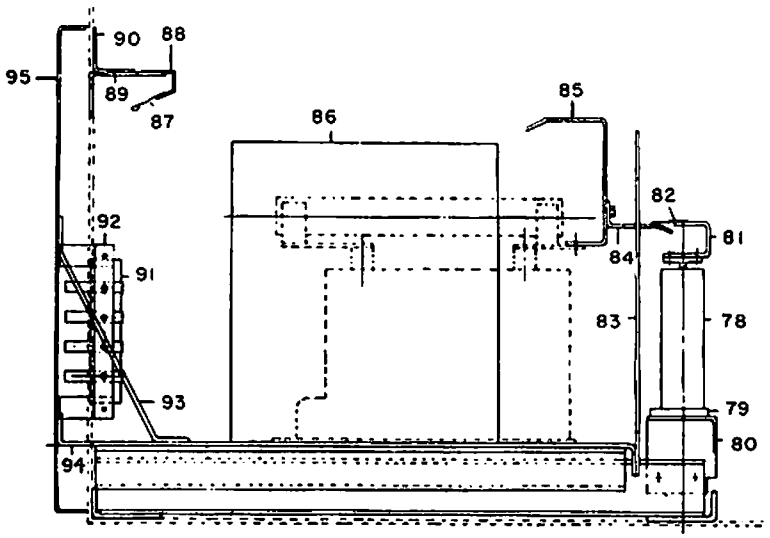


Fig. 15 Potential transformer rollout unit

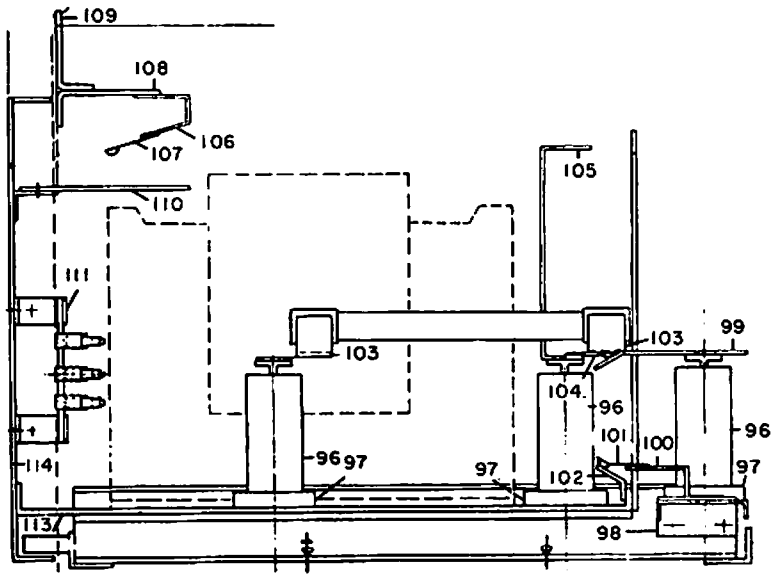


Fig. 16 Control power transformer rollout unit

NOTE: Figure No. 17 and Ref. No's. 115 thru 129 have been removed and these parts are no longer avialable.

‡ ROLLOUT UNIT (Cont'd)

Fig. No.	Ref. No.	Ordering Number for	5K	15KV	Description
14	70	733-328X693	G1	G2	Finger
14	71	328X694	⚠	G2	Connection bar
14	72	328X695	G1	G2	Connection bar
14	73	328X696	⚠	G2	Connection bar
14	74	328X697	G1	G2	Connection bar
14	75	328X698	G1	G2	Connection bar
14	76	328X699	G1	G2	Connection bar
15	78	328X701	G1	G2	Insulator
15	79	328X702	⚠	G2	Insulator clamp
15	80	328X703	G1	G2	Insulator support
15	81	328X704	G1	G2	Disconnect bar
15	82	328X705	G1	G2	Finger
15	83	328X706	G1	G2	Barrier
15	84	328X707	G1	G2	Disconnect bar
15	85	328X708	G1	G2	Disconnect bar
15	86	328X709	⚠	G2	Barrier
15	87	328X710	G1	G2	Ground finger
15	88	328X711	G1	G2	Ground finger support
15	89	328X712	G1	G2	Ground finger support
15	90	328X713	G1	G2	Barrier
15	91	328X714	G1	G2	Secondary disconnect (stationary)
15	92	328X715	G1	G2	Secondary disconnect (movable)
15	93	328X716	G1	G2	Brace
15	94	328X717	G1	G2	Tray
15	95	328X718	G1	G2	Cover
16	96	328X719	G1	G2	Insulator
16	97	328X720	⚠	G2	Insulator clamp
16	98	328X721	G1	G2	Insulator support
16	99	328X722	G1	G2	Contact bar
16	100	328X723	G1	G2	Ground finger support
16	101	328X724	G1	G2	Ground finger
16	102	328X725	G1	G2	Ground shoe contact
16	103	328X726	G1	G2	Fuse clip
16	104	328X727	G1	G2	Primary contact
16	105	328X728	G1	G2	Ground bar
16	106	328X729	G1	G2	Ground finger support
16	107	328X730	G1	G2	Ground finger
16	108	328X731	⚠	G2	Cross angle
16	109	328X732	G1	G2	Barrier
16	110	328X733	⚠	G2	Barrier
16	111	328X734	G1	G2	Secondary disconnect (movable)
*	112	328X735	G1	G2	Secondary disconnect (stationary)
16	113	328X736	G1	G2	Tray
16	114	328X737	G1	G2	Cover

‡ All rollout units can be either 5 KV or 15 KV. When ordering give complete ordering number plus G1 for 5 and G2 for 15 KV.
⚠ Does not apply to 5 KV unit.
* Not shown.

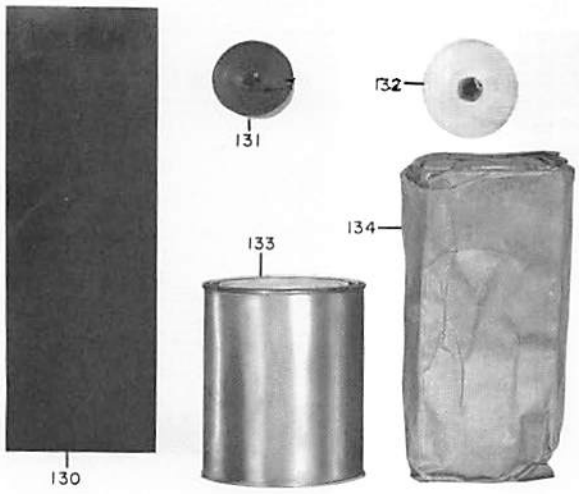
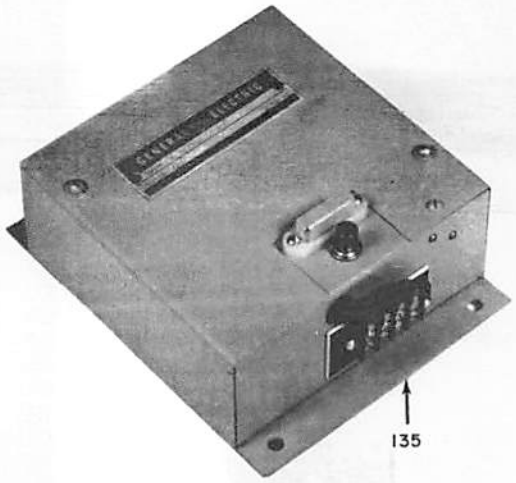


Fig. 18 Taping material for bus connection joints

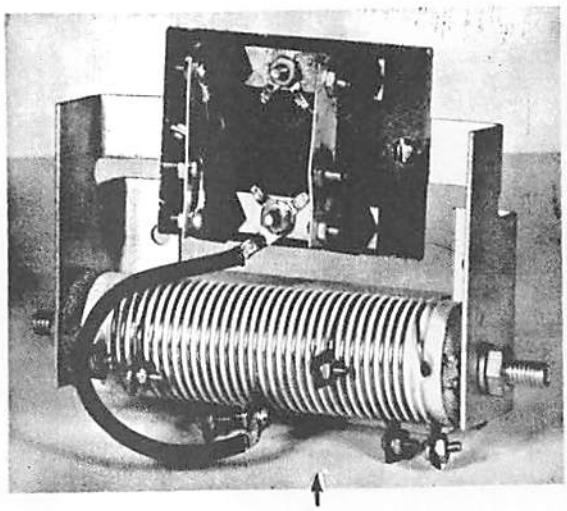


Refer to GEI-77065

Fig. 19 Auto–charged trip device

Refer to GEI-88760

Fig. 20 Capacitor trip device



Refer to GEI-77007C

Fig. 21 Silicon rectifiers for circuit breaker closing service

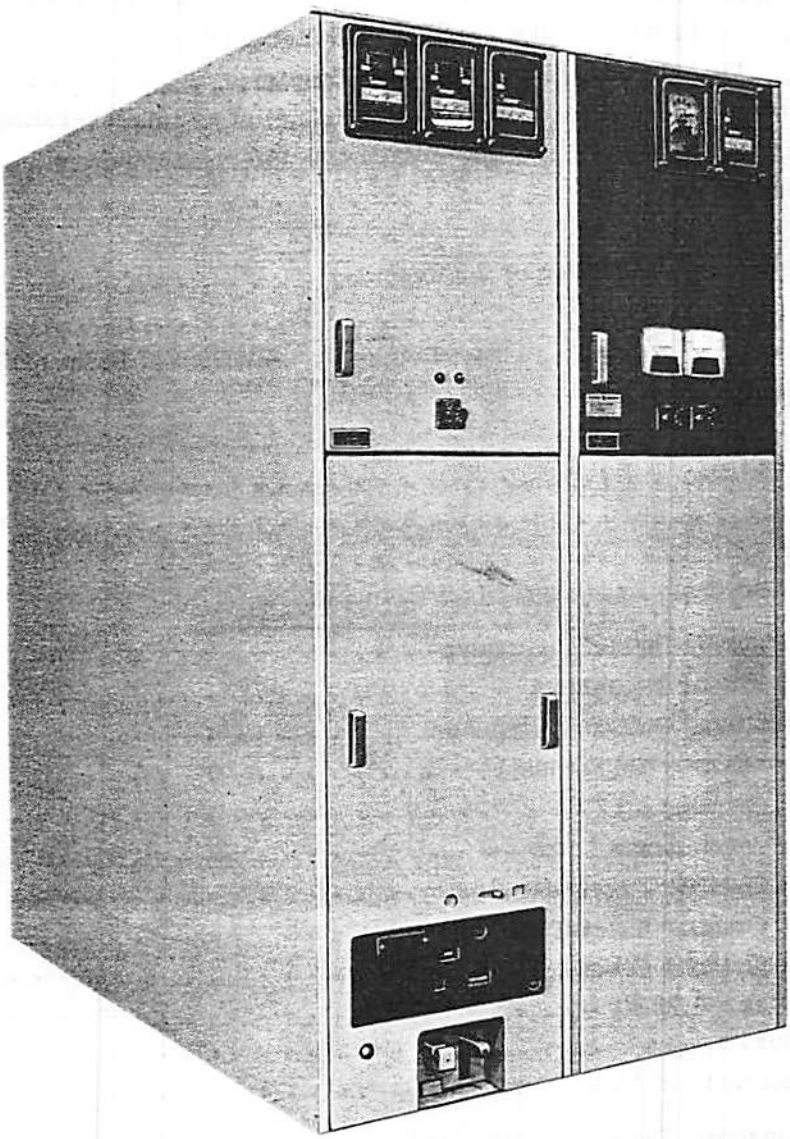
ACCESSORIES

Ref. No.	Ordering Number	Description
130	733-328X753	Irrathene ® tape (I-202) 4 in. wide by 21 in. long piece (for 1200 amp joint)
130	328X754	Irrathene tape (I-202) 4 in. wide by 29 in. long piece (for 2000 amp joint)
131	328X755	Irrathene tape (I-202) 1 1/2 in. wide by 25 ft roll
132	328X756	Glass cloth tape (A2L12B) 1 1/2 in. wide by 36 yd roll
133	328X757	Black insulating varnish (U-311) (for 2.4 KV and 4.16 KV)
133	328X758	Brown insulating varnish (U-310) (for 7.2 KV and 13.8 KV)
134	328X759	Packing compound (A50H119) 5 lb package
135	328X760	Auto charged trip device (ST-230)
136	328X761	Capacitor trip device
137	328X762	Silicon rectifier assembly for circuit breaker closing service

INSTRUCTIONS

GEI-88775A

MC-4.76 Horizontal Drawout Metal-Clad Switchgear



MEDIUM VOLTAGE SWITCHGEAR DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA, PA.

CONTENTS

TABLES AND ILLUSTRATIONS

PHOTOGRAPHS

MC-4.76 HORIZONTAL DRAWOUT METAL-CLAD SWITCHGEAR

SECTION I

INTRODUCTION

This book contains instructions for installing, operating and maintaining MC-4.76 Horizontal Drawout Metal-Clad equipments. It should be carefully read before installation and initial operation of these equipments.

For application and specification information refer to GEA-8629 MC-4.76 Metal-Clad Switchgear.

Separate publications will be supplied for breakers, relays and other devices not described in this publication.

In addition to instruction books, the following drawings will be supplied:

1. Front view and floor plan drawings - these show the general arrangement, height, recommended aisle space, etc.

2. Summary of switchgear equipment - this is a partial parts list, giving catalog numbers of all breakers, devices, etc.

3. When required:

   (a) Control wiring diagram.

   (b) Elementary or schematic wiring diagrams.

All of these documents are needed for installation, operation and maintenance of the equipment.

SECTION II

RECEIVING, HANDLING, STORAGE

Every case or package leaving the factory is plainly marked with case number, requisition number and customer's order number. If for any reason it is necessary to divide the equipment for shipment, the unit numbers of the portion of the equipment enclosed in each shipping package are marked on the package.

The contents of each package of the shipment are listed in the packing details attached to the package. To avoid the loss of small parts when unpacking, the contents of each case should be checked against the packing details before discarding the packing material. Notify the nearest General Electric Company representative at once if any shortage of material is discovered.

All equipment leaving the factory is carefully inspected and packed by personnel experienced in the proper handling and packing of electrical equipment. An inspection should be made immediately upon receipt of any apparatus for any damage sustained while enroute. If injury is evident or an indication of rough handling is visible a claim for damage should be filed at once with the transportation company and the General Electric Company notified promptly. Information on damaged parts, part number, case number and requisition number should accompany the claim.

HANDLING

The indoor switchgear units are most conveniently handled by a crane. Lifting angles are provided on the top of the switchgear. A cable spreader must be used when lifting with a crane in order to obtain a vertical pull on the lifting angles. Otherwise the lifting angles will be bent.

If crane facilities are not available the equipment may be moved into position by means of construction rollers placed under the shipping skid. Where overhead clearance is too low the shipping skid may be removed and the equipment moved by rollers placed under the channel sections in the bottom of the gear. These channels are parallel with the front of the equipment so movement of the equipment using the floor plate channels and rollers can only be accomplished in one direction, i.e. parallel to the front. The rollers should be spaced so that the channel sections only are in contact with the rollers since a direct application of the rollers in the space between the channels may tear or distort the floor plates. Jacks may also be used to handle the equipment when a crane is not available. Methods of handling are shown in Figures 1 and 3.

All outer crating should be removed after the equipment has been moved to the desired location. Methods of handling outdoor equipment as shown in Figure 3 are much the same as for indoor equipment except that lifting plates are provided at the base of the structure instead of at the top of the

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

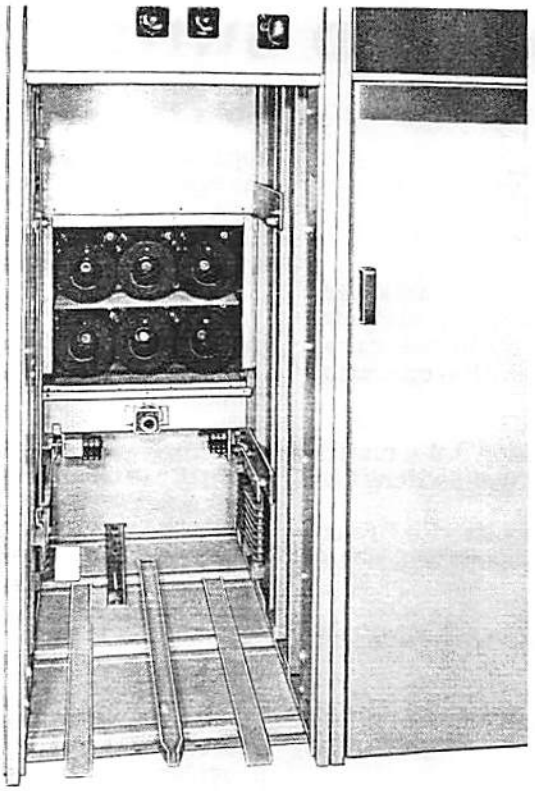
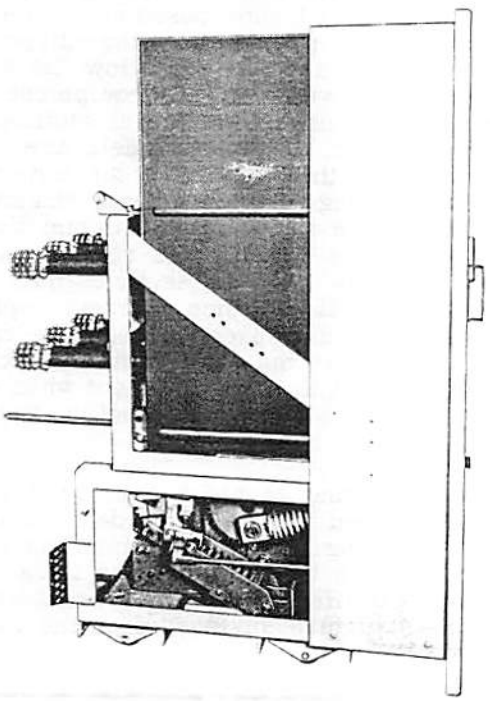
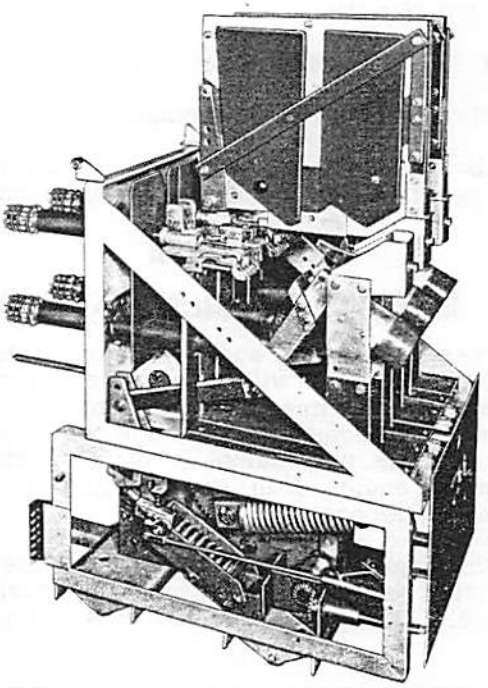


Figure A (8036879) Indoor Unit



AMH-4.76-250 Magne Blast Breaker
(8036884)

Figure B



AMH-4.76-250 Magne Blast Breaker
With Front Cover, Box Barrier &
Arc Chute Removed.
(8036886)

Figure C

units.

STORAGE

If it is necessary to store the equipment for any length of time, the following precautions should be taken to prevent breakage, corrosion, damage or deterioration:

1. Uncrate the equipment. Check thoroughly for damage.
2. Store in a clean dry place with moderate temperature and cover with a suitable canvas to prevent dust, dirt, water or other foreign substances from entering the switchgear.
3. Batteries should be uncrated and put on trickle charge immediately on receipt.
4. If dampness or condensation may be encountered in the storage location, heaters should be placed inside the units to prevent moisture damage. Approximately 500 watts of heaters per unit will be required. Remove all cartons and other miscellaneous material packed inside units before energizing any heaters. If the equipment has been subjected to moisture it should be tested with a 1000 V or 2500 V megger. A reading of at least 200 megohms should be obtained. On outdoor switchgear dampness or condensation can be prevented by making a temporary power supply connection to the heaters already installed in the equipment.

SECTION III
DESCRIPTION

Metal-Clad switchgear is equipment designed to control medium voltage circuits.

The switchgear consists of one or more units which are mounted side by side and connected mechanically and electrically to form a complete switching equipment.

Each Metal-Clad unit consists of a stationary housing and a removable breaker element. The stationary housing is compartmented and contains the instrument panel, bus compartment, breaker compartment and cable or termination compartment. Each of these compartments is enclosed in grounded sheet metal.

The switchgear is designed to provide maximum safety to the operator.

The circuit breakers are easily removable to provide maximum accessibility for maintenance with minimum service interruption.

The equipment is available in the ratings listed in Table 1. The ratings of the equipment and devices are based on usual service conditions as covered in ASA and NEMA Standards.

For outdoor use the same basic equipment is enclosed in a weatherproof steel housing.

The principal parts and features of the Metal-Clad equipment are described in greater detail in the following paragraphs.

HOUSING

The Metal-Clad housings are made of formed steel panels riveted or bolted together to form rigid, self-supporting units with metal barriers between the different enclosures.

Each unit is basically divided into a secondary and a primary enclosure as described below.

Secondary Enclosure

The secondary enclosure is located above the breaker compartment on the breaker withdrawal side of the unit. It consists of a compartment with a hinged and latched door on which can be mounted instruments, control and protective devices. Terminal blocks, fuse blocks and some control devices are mounted inside the enclosure and a trough is provided at the top to carry wiring between units.

Primary Enclosure

The primary enclosure contains the high voltage equipment and connections. It consists of the breaker compartment, the bus compartment and the cable termination compartment. Each of these compartments is separated from the others by metal barriers for maximum reliability and safety.

RATINGS FOR HORIZONTAL DRAWOUT METAL-CLAD SWITCHGEAR

CIRCUIT BREAKER	NOMINAL 3 PHASE KVA CLASS	RATED CONTINUOUS CURRENT AT 60 CYCLES
TYPE MC-4.76		
AMH 4.76-250	250,000	1200 2000

TABLE I

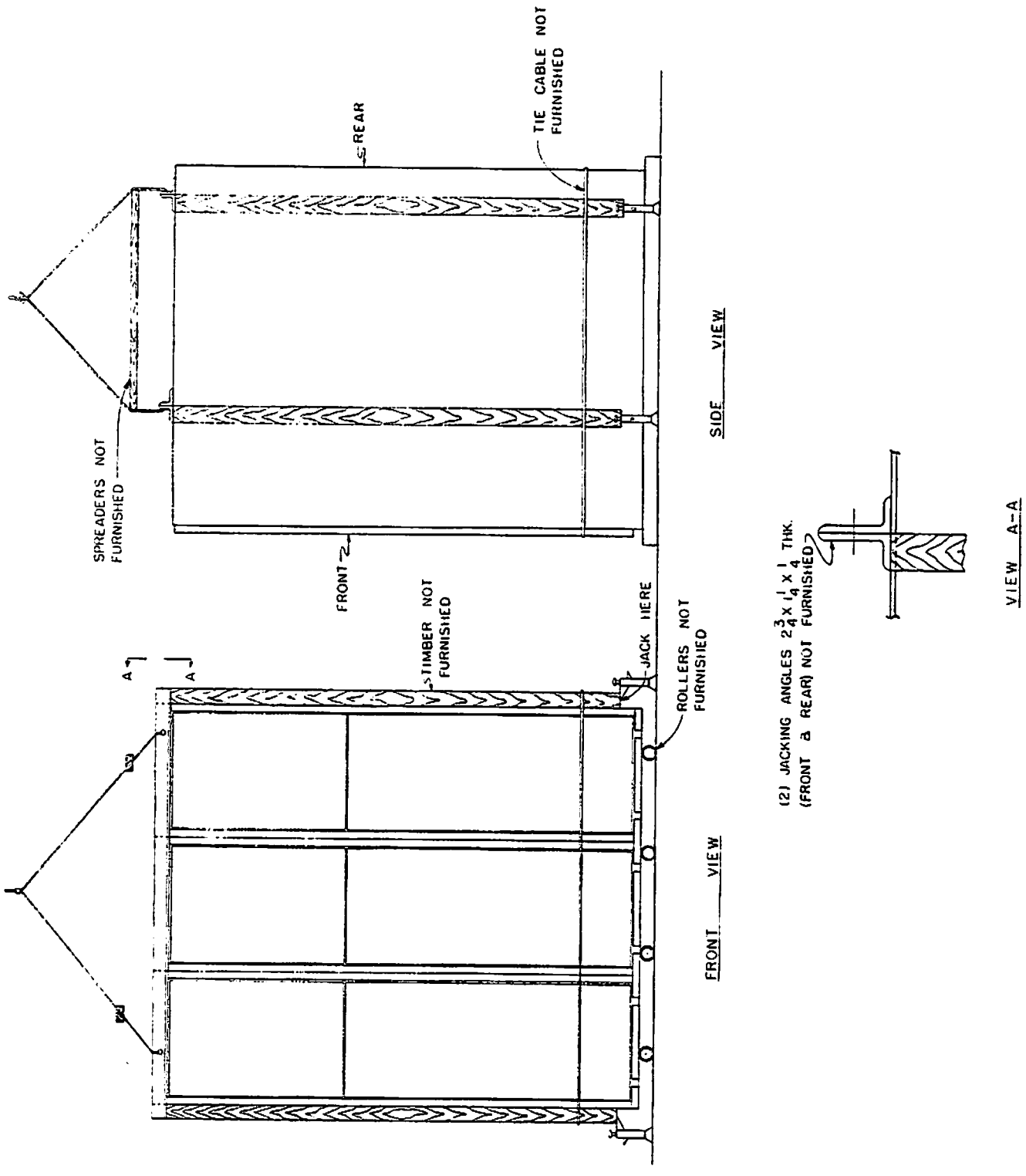
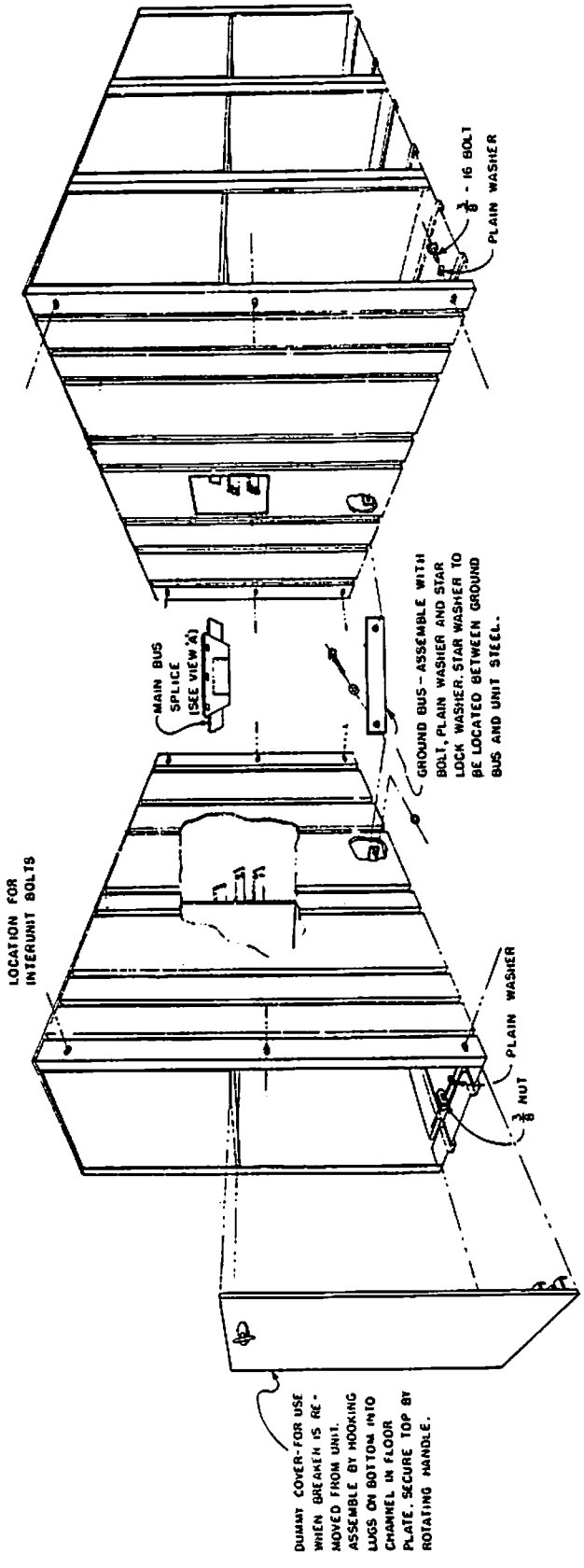
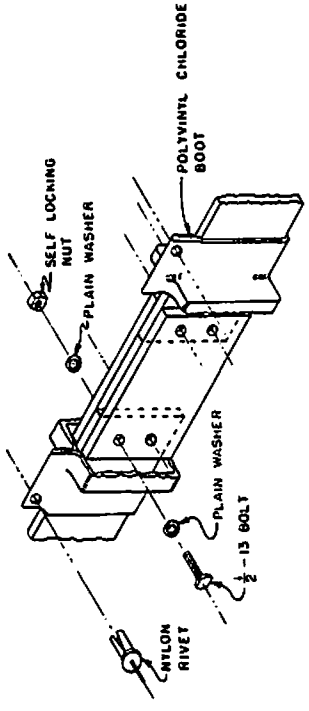


Figure 1 Installation and Handling Indoor Equipment





VIEW 'A'

Figure 2. (673D515-185) Installation of Indoor Equipment

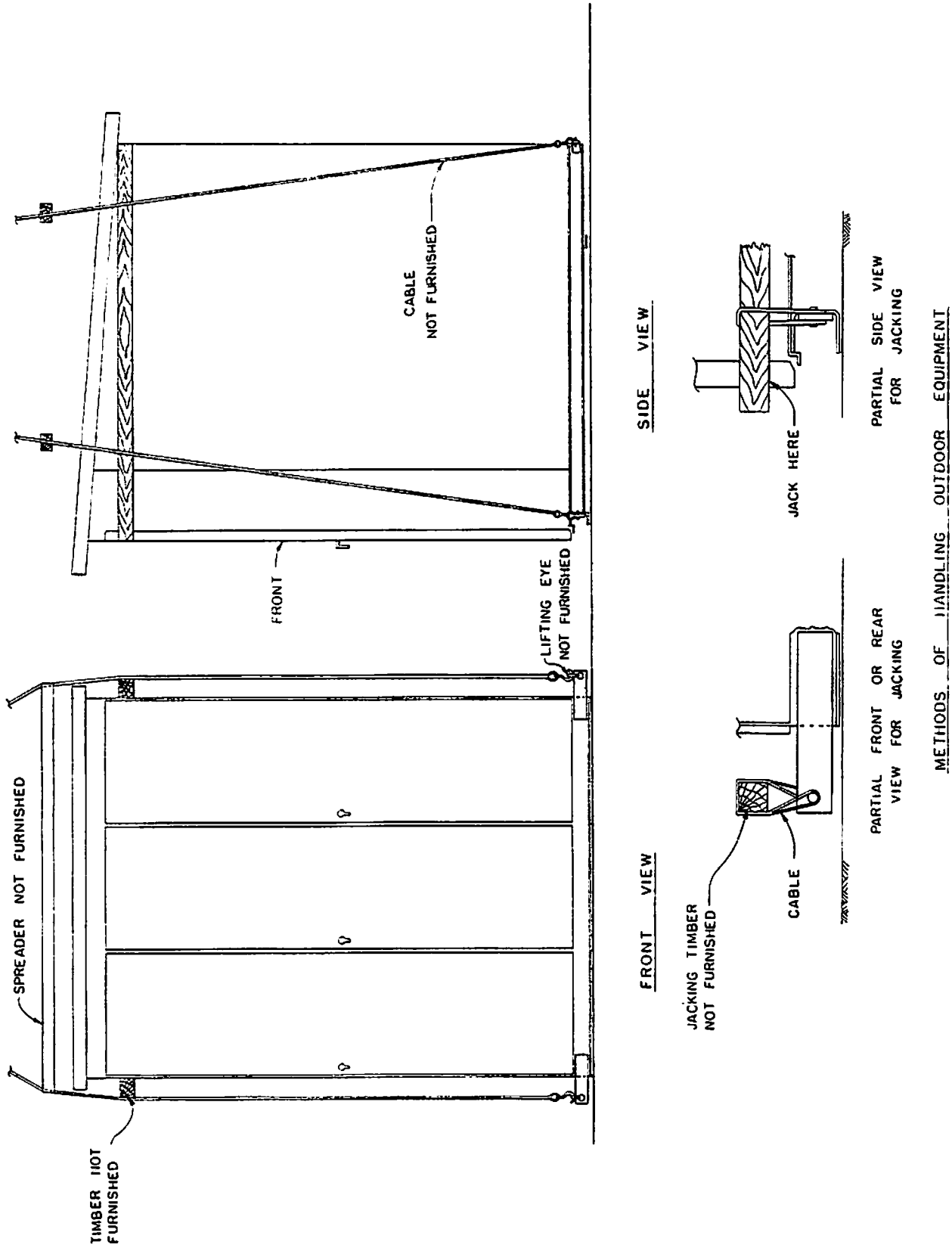

CABLE
NOT FURNISHED
FRONT
LIFTING EYE
NOT FURNISHED
SIDE VIEW
SPREADER NOT FURNISHED
TIMBER NOT
FURNISHED
FRONT VIEW
JACK HERE
PARTIAL SIDE VIEW
FOR JACKING
JACKING TIMBER
NOT FURNISHED
CABLE
PARTIAL FRONT OR REAR
VIEW FOR JACKING
METHODS OF HANDLING OUTDOOR EQUIPMENT
(673D0515-186) Lifting & Jacking Outdoor Equipment

Figure 3

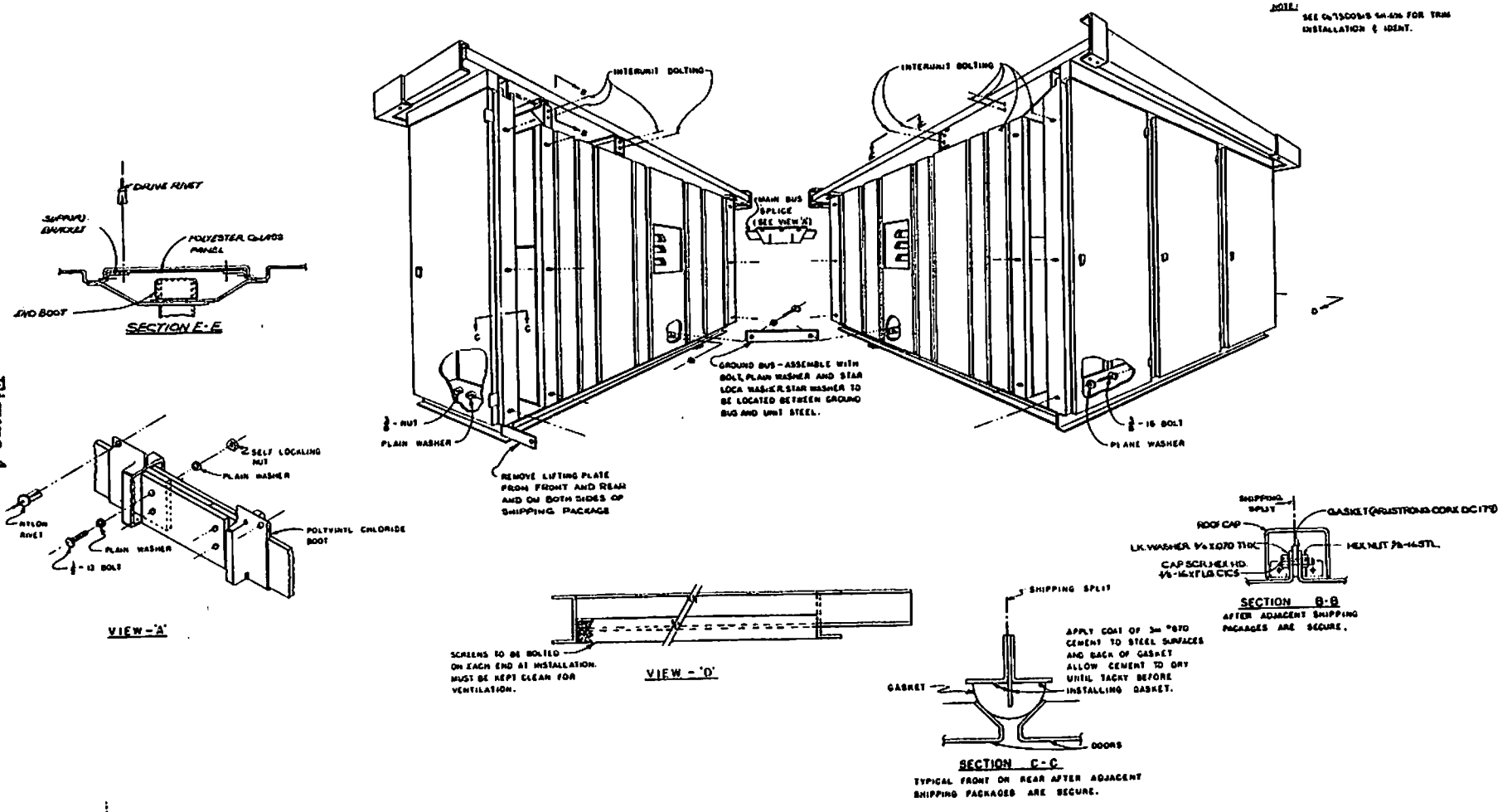

DRIVE RIVET
SUPPORT BRACKET
POLYESTER GLASS PANEL
END BOOT
SECTION E-E
INTERUNIT BOLTING
MAIN BUS SPLICE (SEE VIEW 'A')
GROUND BUS - ASSEMBLE WITH BOLT, PLAIN WASHER AND STAR LOCK WASHER. STAR WASHER TO BE LOCATED BETWEEN GROUND BUS AND UNIT STEEL.
PLAIN WASHER
REMOVE LIFTING PLATE FROM FRONT AND REAR AND ON BOTH SIDES OF SHIPPING PACKAGE
PLANE WASHER
NOTE:
SEE INSTRUCTIONS GEI-476 FOR TRIM INSTALLATION & IDENT.
SELF LOCKING NUT
PLAIN WASHER
NYLON RIVET
PLAIN WASHER
POLYVINYL CHLORIDE BOOT
VIEW - 'A'
SCREENS TO BE BOLTED ON EACH END AT INSTALLATION. MUST BE KEPT CLEAN FOR VENTILATION.
VIEW - 'D'
SHIPPING SPLIT
ROOF CAP
GASKET (ARMSTRONG CORK DC 179)
LK. WASHER
HEX NUT
CAP SCREW HD.
SECTION B-B
AFTER ADJACENT SHIPPING PACKAGES ARE SECURE.
SHIPPING SPLIT
APPLY COAT OF 3m 870 CEMENT TO STEEL SURFACES AND BACK OF GASKET ALLOW CEMENT TO DRY UNTIL TACKY BEFORE INSTALLING GASKET.
GASKET
DOORS
SECTION C-C
TYPICAL FRONT OR REAR AFTER ADJACENT SHIPPING PACKAGES ARE SECURE.

Figure 4

Breaker Removable Element

The removable element consists of a circuit breaker with a trip-free operating mechanism, an interlock mechanism, the removable portion of the primary and secondary disconnecting devices, the operating mechanism control device and necessary control wiring, the racking mechanism jackscrew, the racking mechanism stop pin and foot release pedal, the racking mechanism position indicator and pins and rollers for operating the housing shutters, auxiliary switch and position switch. The breakers are mounted on fixed wheels for easy insertion and removal. The front panel on the breaker becomes the front cover of the housing when the breaker is in the connected position.

Secondary Disconnecting Device

Stationary secondary connection blocks are mounted in the breaker compartment as shown in Figure 5. Co-operating spring loaded sliding finger contacts are mounted on the breakers. Both stationary and movable contacts are silver plated.

Primary Disconnecting Device

The primary disconnecting device utilizes silver to silver contacts to insure against reduction of current carrying capacity due to oxidation of the contact surfaces. The device consists of a plurality of silver plated copper fingers supported longitudinally at their center by a non-magnetic metal spider which spaces and supports the contact fingers. The fingers are locked to the breaker studs in a semi-circular groove machined in the outward end of the studs. A double set of stainless steel garter springs holds the fingers in place in the grooved stud end. A second set of two garter springs provides the pressure on the outward ends of the fingers when the finger assembly is pushed over the ball end of the stationary studs in the house. The articulated action of the sliding contact fingers permits considerable misalignment of the breaker studs and the house studs with no loss of contact pressure.

Bus Compartment

The main buses are enclosed in sheet metal compartments with removable covers to provide accessibility.

The buses are rectangular aluminum bars continuous for the shipping split length of the gear. Primary terminations are welded to the main bus bars by shielded aluminum arc welding. Copper terminations at the ends of the main bus bars are assembled to the aluminum bars by flash butt welding. Each phase of the bus in shipping split length is insulated with a filled epoxy compound applied by dipping in a fluid bed. The three-phase buses are enclosed in a single sheet metal compartment with removable covers on the rear. The buses are supported at each unit line by a track resistant polyester glass barrier support. These compound barriers effectively isolate each unit of the switchgear.

All bolted joints in the buses are made with silver plated copper to copper connections. These joints occur only at shipping splits. Molded polyvinyl chloride boots are used to insulate the bolted main bus joints and the ends of the bus.

Current Transformers

Provision is made for six current transformers which are mounted over the primary disconnect terminations in the breaker compartment. These transformers are accessible by removing the shutter assembly. The primary power source should be de-energized before any work is done on the current transformers. Additional current transformers, when required, can be mounted in the rear cable compartment in the gear.

Shutters

Grounded metal shutters which cover the primary terminations are provided in all breaker compartments. These shutters are automatically actuated to open and close with the movement of the breaker into or out of the compartment.

The shutter consists of a slotted stationary metal barrier and a movable metal barrier which slides vertically. This movable barrier is connected to a cam arm on each side of the compartment. Rollers mounted on brackets to the breaker frame contact the shutter cam arms as the breaker is moved into the house. The motion of the cam arms raises the movable shutter plate so that the breaker primary disconnects can pass through the shutter openings and into contact with the stationary disconnects in the house. As the breaker is retracted from the house the movable shutter is driven downward by the cam arm and roller to close the shutter openings. The motion of the shutter is complete by the time the breaker reaches the test position. When the breaker is withdrawn from the house the primary terminations in the compartment are completely barriered off by the grounded metal plates which comprise the shutter.

These shutters are intended to prevent access to primary conductors in compartments even when the breakers are removed. No attempt should be made to tamper with the shutters or to defeat their purpose unless all energy sources have been removed from the primary terminations.

Potential Transformer Compartment

Potential transformers can be located in the upper rear of a breaker compartment or in the front and upper rear of an auxiliary compartment.

The potential transformers are mounted on a swing down door. The compartment is equipped with primary and secondary disconnect devices. One to three transformers can be mounted on each swing down door. The doors are counterbalanced with torsion bars so that only a portion of the weight of the transformers must be lifted to close the door. When the doors are swung open the transformers are disconnected and are at a safe striking distance from all live parts in the gear. As the

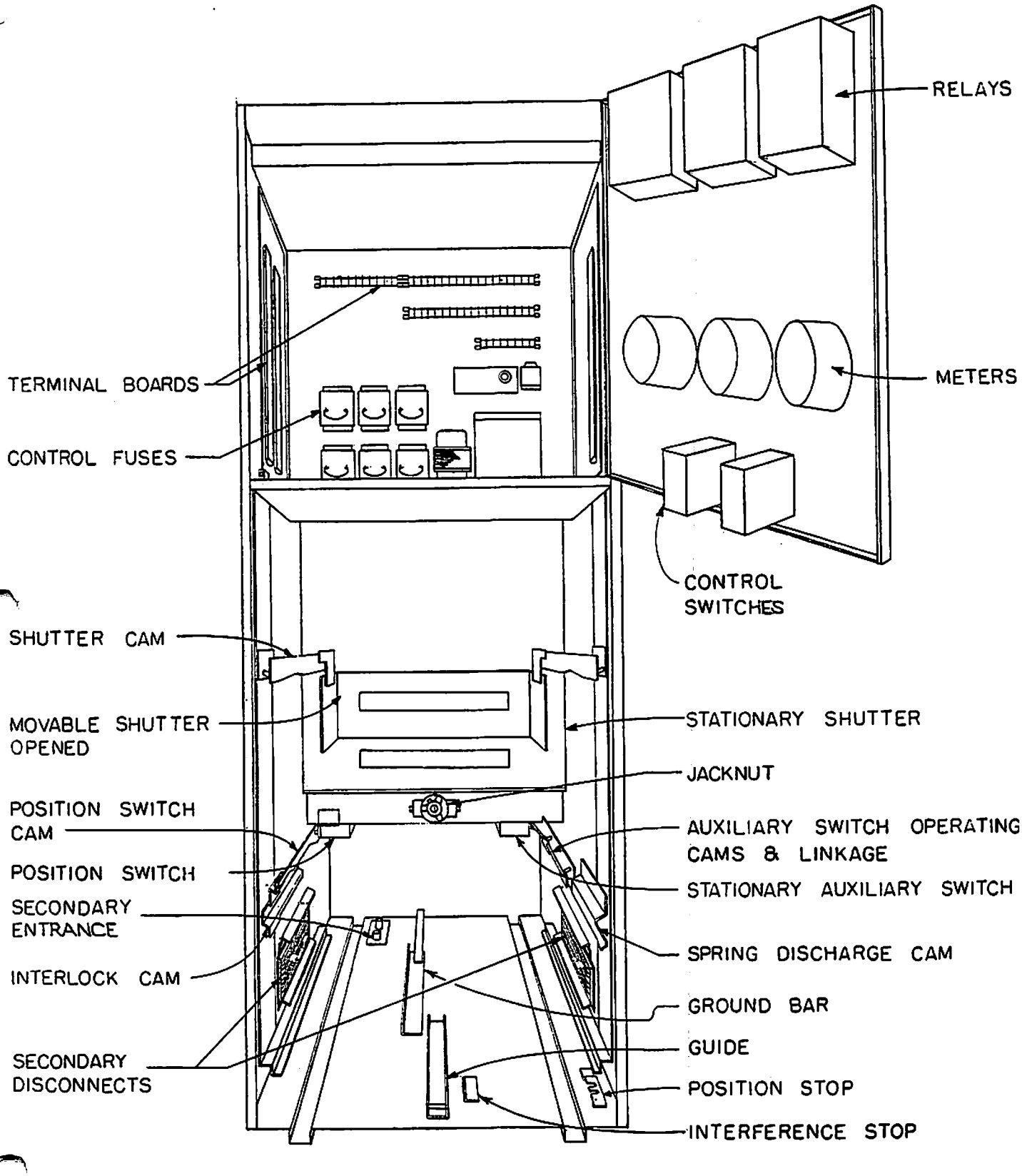


Figure 5. (0673D0515-183) Breaker Compartment 4.76 KV

door is swung open the end of the fuse on the potential transformers strikes against a grounding device which effectively removes all charge from the transformers. In the open position the transformer fuses may be safely removed and replaced. All live parts are barriered off by a polyester glass partition in the rear of the compartment. Connections to the transformers are made through cables which are bolted to the stationary disconnect parts behind the polyester glass partition. The same swing out assembly can be used either in the front in an auxiliary unit or in the top rear of an auxiliary unit or breaker unit.

Control Power Transformers

Control power transformers can be mounted in the lower front of the auxiliary unit or in the upper rear of the breaker or auxiliary units. The control power transformers in this gear are stationary mounted in the compartment with the associated fuses mounted on a swing down door. This swing down door also mounts a non-automatic circuit breaker switch which is interlocked with the door latch so that the door cannot be opened unless the switch is open and the control power transformer secondary circuit is de-energized. A grounding device removes the static charge from the fuses as the door is opened.

With the door swung open the fuses are readily accessible for removal and replacement.

Transformers with ratings up to 25 KVA can be mounted in the lower front auxiliary position. In the upper rear position the size of the transformer is limited to 15 KVA.

Dummy Removable Element

Dummy removable elements are used as a means of isolating circuits or bus sections when operation is infrequent and a circuit breaker cannot be economically justified. The device consists of a framework with a set of six studs similar to those on the breakers to simulate the circuit breaker removable element. The studs are connected in each phase by fully insulated copper bars. The units are metal enclosed. The stationary structure in the compartment is the same as for a circuit breaker. When the device is racked into the house a connection is made from the bus to the load side in each phase.

The dummy element should never be moved into or out of the house when the bus in energized. A key interlock system is used to insure that all sources of power are disconnected before the dummy element can be moved.

Handling Dolly

A fifth wheel dolly is furnished with each equipment to aid in handling the breakers when moving them outside of the housing. This dolly consists of a wheel mounted in a bracket to which is attached a tubular handle. A pin on the top of the wheel bracket is engaged in a hole in the lifting block which is fixed in the center front of the breaker. Lowering the dolly handle then raises the front of the breaker and permits turning. The dolly is intended for use when the breaker is outside of the house. It may be used to line the breaker up with the house to be sure that the breaker guide and the house guide are aligned and engaged but should be removed when this alignment is attained and before the breaker is pushed into the disconnect position.

Transfer Truck

The transfer truck is supplied with outdoor equipment to facilitate handling of the breaker elements. The truck has two fixed and two swivel wheels. A latching member on the front of the truck lines the truck up with the guide in the outdoor house and by hooking over a pin in the guide holds the truck to the outdoor house while the breaker is being moved into or out of the house. A second latching hook in the rear of the truck secures the breaker to the transfer truck during movement external to the outdoor housing.

The truck is approximately the same height as the outdoor switchgear base but the hinged front ramp will allow plus or minus 1/4 inch variations between the height of the concrete pad and the floor of the outdoor equipment.

Outdoor Equipment

Outdoor Metal-Clad switchgear is constructed with a basic indoor equipment completely enclosed in a weatherproof steel housing. It is available in three styles:

1. Standard Outdoor
2. Protected Aisle Outdoor
3. Common Aisle Outdoor

The standard outdoor enclosure provides a minimum depth equipment. There is a weatherproof hinged door on the front (breaker withdrawal) side of each unit. Opening this door gives access to the breaker and the instrument control panel. The breaker can be moved to the disconnect position for storage within the outdoor enclosure. The breakers must be removed from the outdoor housings for inspection and maintenance. A transfer truck is provided for breaker removal.

The equipment is completely factory assembled in shipping split groups of one to five units. If the full equipment is greater than five units the shipping split groups must be assembled and bolted together in the field. Instructions for assembling and bolting the shipping sections together are given in Figure 4.

The protected aisle outdoor equipment provides a walk-in aisle enclosure in front of the basic indoor units. The depth of this aisle permits transfer of the breakers from one unit to another and provides space for inspection and maintenance of the breakers within the enclosure. An access door

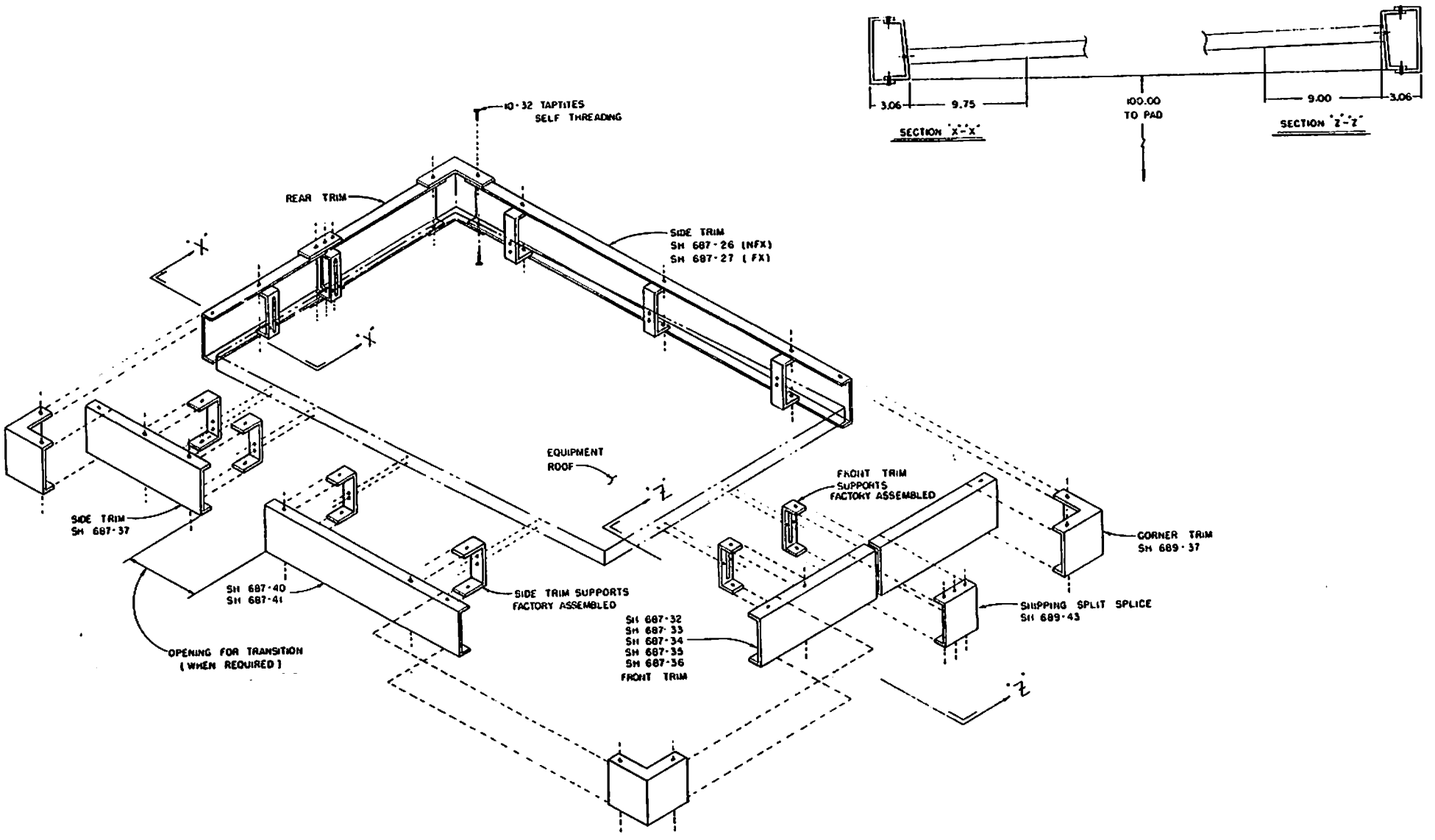


Figure 6. (0673D0515-696) Installation of Appearance Trim

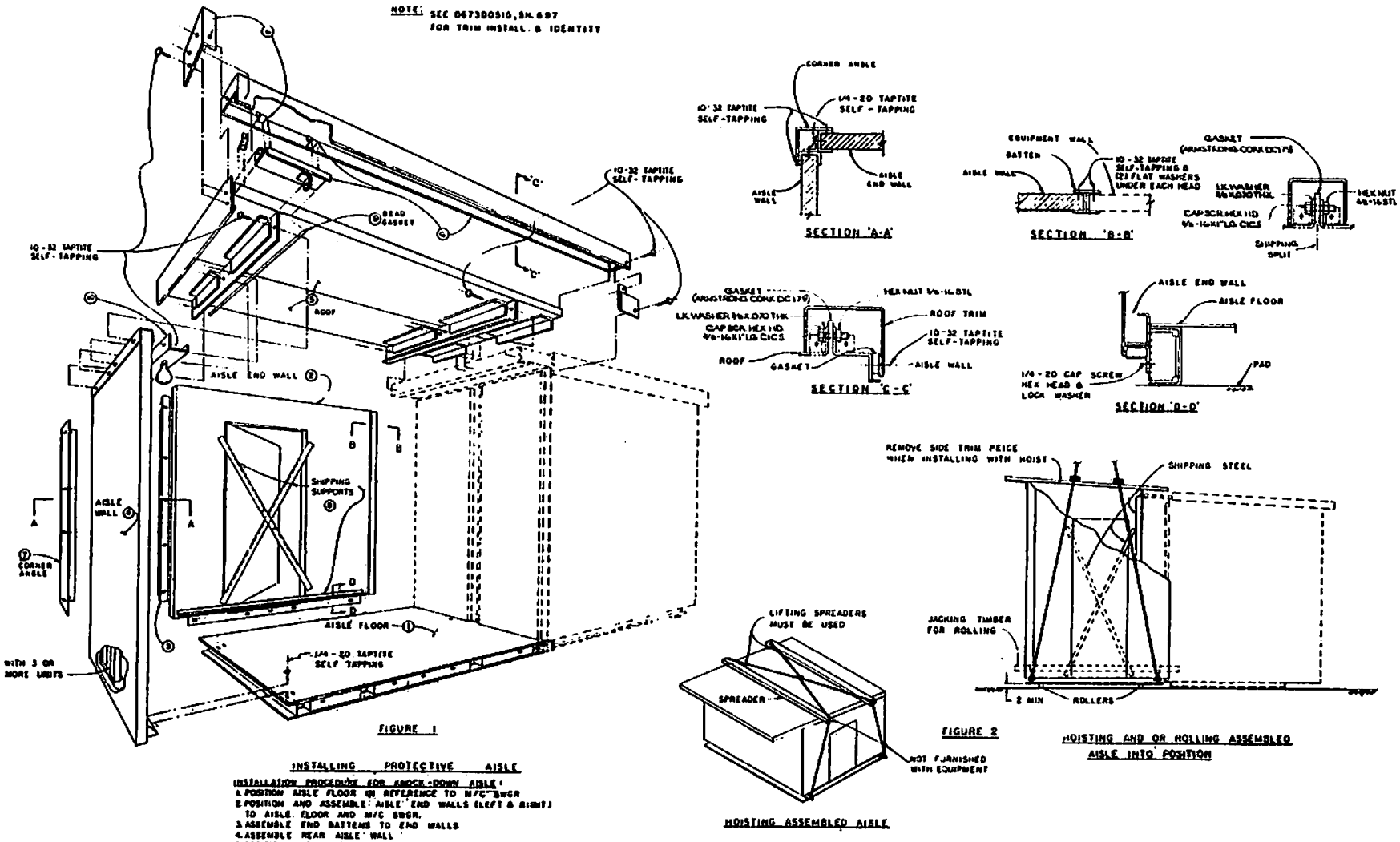


Figure 7. (0673D0515-017) Installation of Aisle

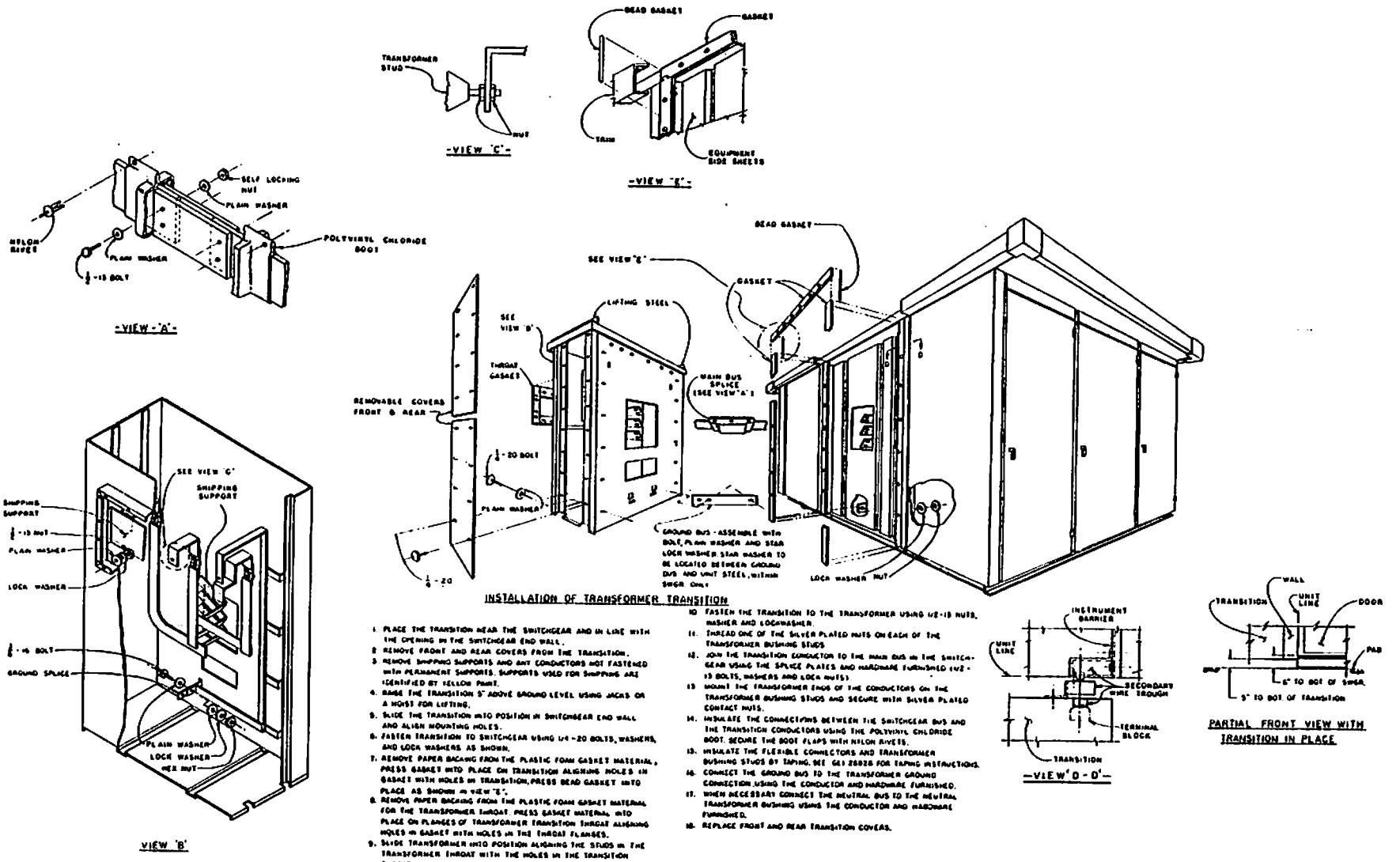


Figure 8. (0673D0515-018) Installation of Outdoor Transition

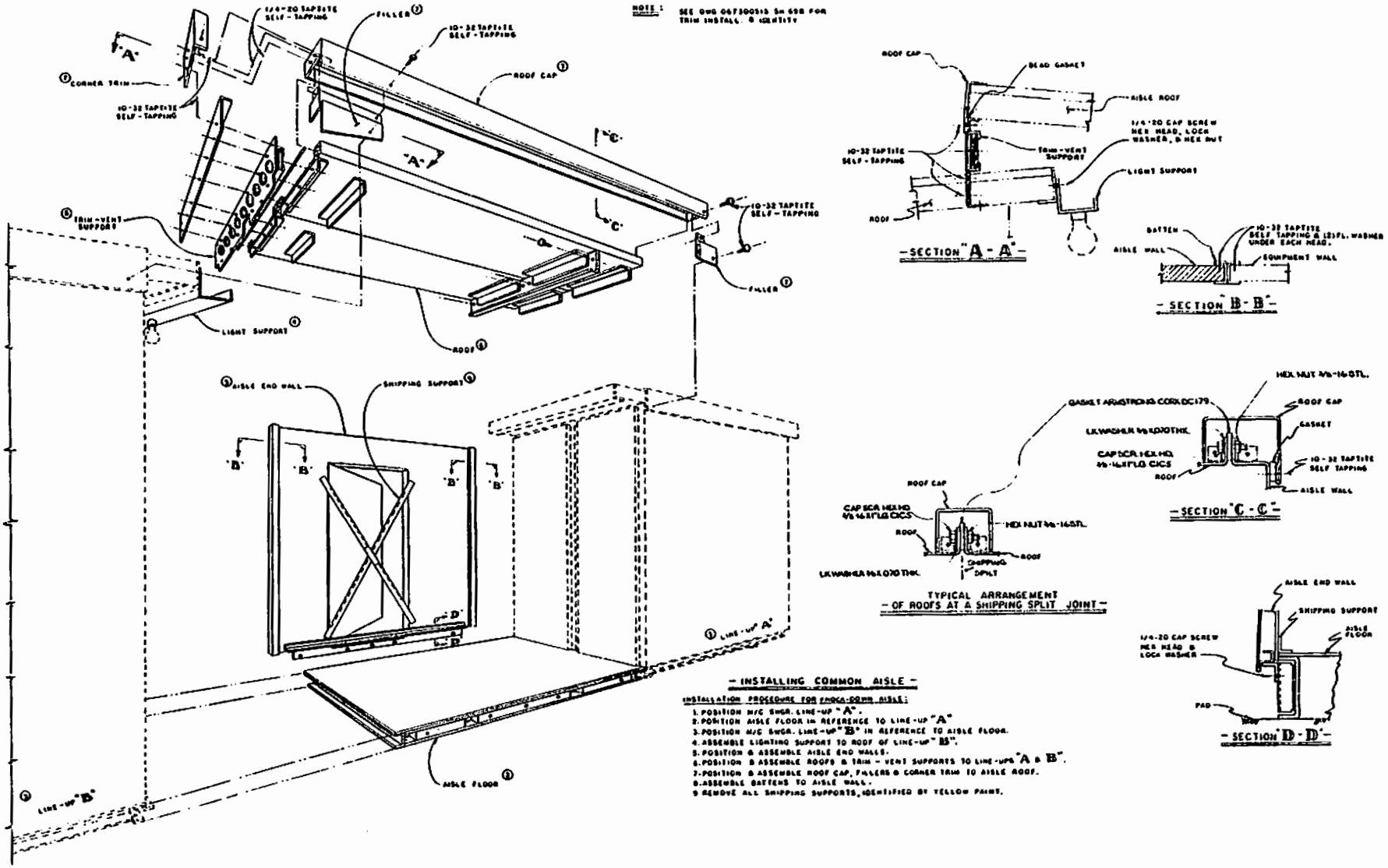


Figure 9. (0673D0515-019) Installation of Common Aisle

is located at each end of the aisle. The basic indoor portion with its weatherproof enclosure is factory assembled in shipping split lengths. The aisle portion, which consists of prefabricated end panels, front wall, roof and floor base, is shipped knocked down for assembly in the field. The assembly method is shown in Figure 7.

Common aisle equipment is similar to protected aisle except that there are two lineups of basic indoor equipment with outdoor enclosures arranged face-to-face and joined by the aisle enclosure. The aisle enclosure permits transfer of breakers from one lineup to the other or between units in the same lineup. Access doors are located in the end walls of the aisle enclosure. The basic indoor equipments with outdoor enclosure are factory assembled. The prefabricated aisle is shipped knocked down and is field assembled after the basic equipments have been set in place. Assembly instructions are given in Figure 9.

Installation of Outdoor Transition

The conductor material and the enclosure for making connections from the switchgear lineup to the transformer may be either factory assembled or shipped knocked down for assembly in the field. In either case the assembly of the transition and the connections to the transformer would be made as illustrated in Figure 8.

Transitions for indoor switchgear are similar to those used with the outdoor gear except that the weather resistant gaskets are omitted from the indoor installation.

Installation of Appearance Trim on Outdoor Switchgear

A horizontal trim band for installation at the top of the outdoor switchgear is furnished in knocked down form for installation in the field. The method of assembly is shown is Figure 6.

Test Cabinet

The test cabinet is designed for wall mounting and provides a means for operating the breaker when the breaker is removed from the housing. The cabinet includes push buttons to close and trip the breaker and fuse blocks to protect the control power cables. A multiconductor cable is equipped with secondary disconnecting devices for connection to the breaker.

Secondary Coupler

An extension cable with secondary couplers, one of which can be attached to the stationary secondary blocks in the house and the other to the breaker secondary disconnects, is furnished so that the breaker can be operated outside the house with the box barriers and arc chutes removed.

Breaker Maintenance Operating Handle

This handle provides a means of charging the stored energy breaker operating springs manually and with gag pins in place permits slow closing of the breaker contacts to permit checking of the contact wipe.

Rackout Mechanism Operating Handle

This handle is used to manually operate the breaker racking mechanism. It is a crank type handle with a cross pin in the end which engages in slots in the coupling on the end of the racking mechanism jackscrew.

Position Switch

A cam operated position switch can be furnished as an accessory when requested. The purpose of this switch is to indicate the position of the breaker in the house.

The switch is located in the rear of the breaker compartment on the left-hand side. The switch operating cam is mounted on the left-hand side of the house and is actuated by a fixed pin on the breaker frame. As the breaker is moved into the house the breaker pin lifts the cam and sequentially operates the switch, first opening one circuit and then closing a second. The switch mechanism is spring returned to its original position as the breaker is moved out of the house.

Auxiliary Switch

A stationary auxiliary switch can be furnished in the equipment when requested. This switch is operated by an arm off of the breaker mechanism and can be used for remote indication of the position of the breaker contacts or for control circuits which are dependent upon the position of the breaker contacts. The switch is spring returned to its original position when the breaker is opened.

The auxiliary switch is mounted in the breaker compartment. The operating linkage is mounted on the right-hand side of the compartment. The linkage is arranged so that the auxiliary switch can be operated when the breaker is in either the test position or the connected position in the house. A crank on the side of the breaker contacts the operating linkage in the house and the auxiliary switch is operated when the breaker closes or opens. The switch can be made to operate only in the connected position, if desired, by removal of the front bell crank and connecting link.

Breaker Interference Stops

Stops are provided in the breaker compartment to prevent the insertion of the breaker with a 1200A continuous current rating into a house with a 2000A rating and vice-versa.

The stop block is bolted to the floor of the breaker compartment. A projection on the breaker frame will hit against the interference stop if an attempt is made to insert an incorrect breaker into the house. The breaker rating should be checked against the house rating and under no circumstances should the interference stop be removed to allow the breaker to be inserted.

Key Lock

The key lock for the breaker is located in the instrument compartment above the breaker compartment in the Metal-Clad unit. See Figure10. The purpose of the breaker key lock is to prevent the breaker from being closed in the connected position when the key lock key is removed from the lock. The key lock mechanism consists of a series of links and levers which extend from the lock in the upper compartment to a blocking link fixed to the stationary interlock cam plate on the lower left side of the breaker compartment.

To operate the key lock if the breaker is in the disconnected or test position the key lock slide is pulled forward and the key lock key is turned and removed.

If the breaker is in the connected position the breaker must first be opened. The jackscrew shutter slide can then be pushed to the open position. This moves the interlock linkage on the breaker to the tripped position and away from the key lock blocking link in the house. With the jackscrew shutter slide held in this position it is then possible to pull the key lock slide forward and turn and remove the key lock key. The breaker then cannot be closed while in the connected position until the key is returned and the key lock is reset. The key lock does not prevent operation of the breaker in the test or disconnect positions. The breaker can be operated in these positions even when the key lock key is removed. However, if the breaker is moved to the connected position the key lock will prevent its closing until the key is returned and the lock reset.

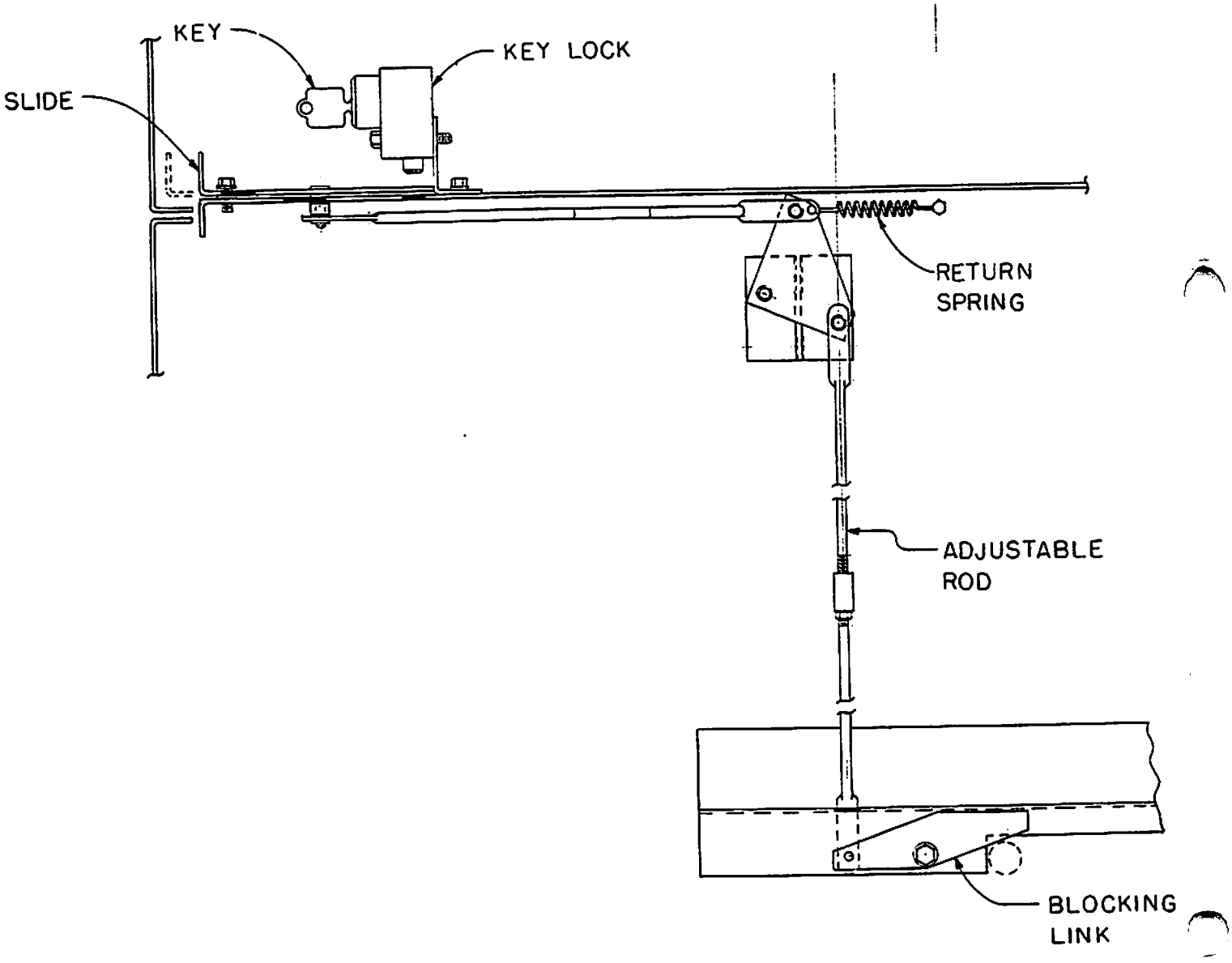


Figure 10 (0673D0515-182) Breaker Key Lock 4.76 KV

SECTION IV
INSTALLATION

Metal-Clad switchgear is accurately built and carefully gauged to be true and level to insure ease of operation and interchangeability of breakers and housing. It is therefore essential that the foundation on which it is installed be true and level to avoid distortion of the switchgear structure.

Location

The recommended aisle space required at the front and rear of the equipment is shown on the floor plan drawing furnished for the particular requisition.

Space must be provided at the front to permit insertion and withdrawal of the circuit breakers and their transfer to other units. Space at the rear is required for installation of cables, for inspection and maintenance and in some equipments for draw-out potential transformers.

Preparation of Floor - Anchoring

The floor or foundation on which the switchgear is to be erected must be strong enough to prevent sagging due to the weight of the switchgear structure and to withstand the shock stress caused by the opening of the breakers under short circuit fault conditions. The shock loading is approximately 1-1/2 times the static load.

The recommended floor construction is shown in Figure 11. The floor channels must be level and true. Installation and removal of the breakers will be facilitated if the floor in front of the units is smooth, hard, level and flush with the floor channels.

Provision should be made in the floor for conduits for primary and secondary cables. The location of these conduits can be determined from the floor plan drawing which is furnished for each metal-clad switchgear requisition. If desired, the conduits may be installed prior to the installation of the switchgear. Consideration should be given to installing conduits which might be required for future connections. Conduits should project approximately two inches above the finished floor for indoor switchgear and approximately eight inches above the foundation for outdoor switchgear. If practical, the shipping skid should be left on the equipment until it is at its final location. The remainder of the crating should be carefully removed so as not to damage instruments or devices mounted on the front of the equipment.

The skid is bolted to the equipment through the anchor bolt holes used for final installation. The bolts in the rear can be reached by removing the rear covers. The bolts in the front of the breaker units are available when the breakers are out of the compartments. In auxiliary units the front doors must be opened for access to the anchor bolts.

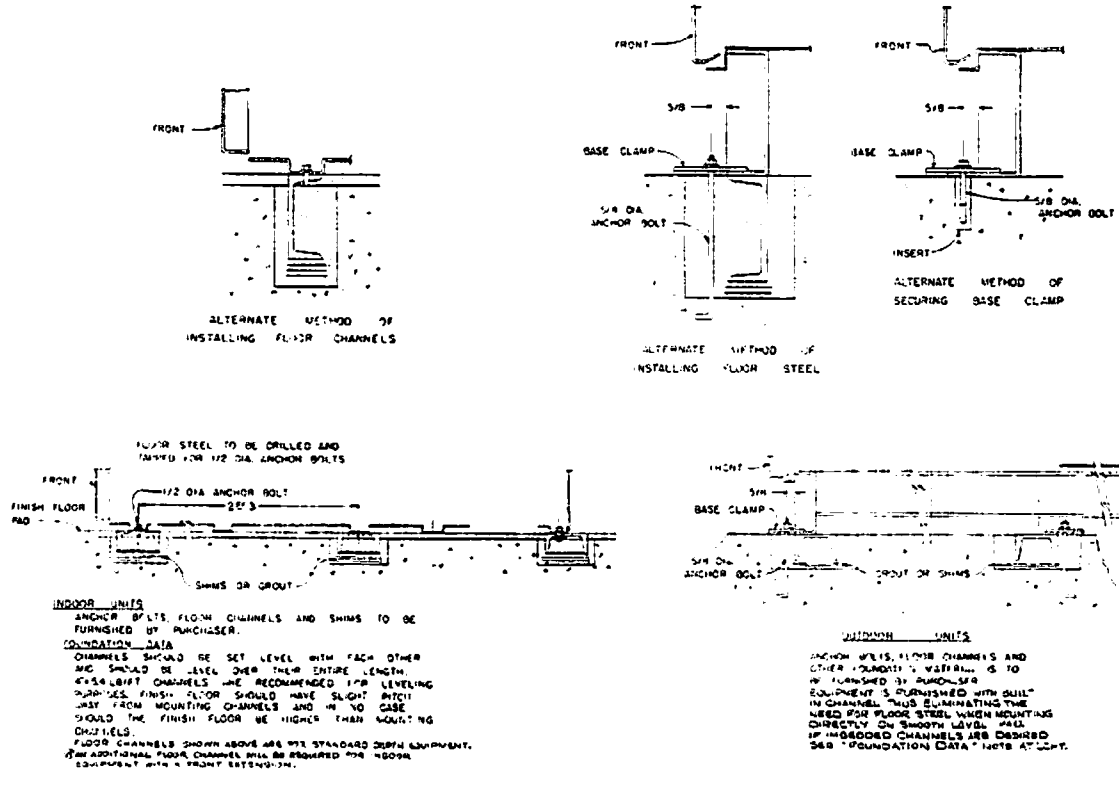


Figure 11 (0673D0515-206) Foundation Floor

The housings for both indoor and outdoor metal-clad switchgear, when correctly installed, should be true and plumb and present a good appearance. The front panels should be flush and square. The entire assembly should be securely fastened to the floor channels or base pad.

The recommended method of fastening the gear to the floor channels is by welding. A tack weld should be made at the points indicated for anchoring on the drawings. If welding facilities are not available the units should be bolted to the floor channels using the anchor holes provided at the front and rear. One half inch diameter bolts should be used.

The tracks in the breaker compartments should be checked for levelness both front to back and side to side. Any misalignment of the tracks in either direction can cause difficulty in inserting the breaker or possible malfunction of the various interlocking systems. Steel shims should be used if necessary to level the tracks. Also the plumbness of the house with respect to the tracks should be checked and suitable compensations made.

Whenever possible up to five units will be shipped as a single factory assembled package. If the complete switchgear assembly consists of three or more shipping groups the middle group should be the first located. The other shipping groups should then be installed in order in each direction from the center of the structure. The switchgear sections should be placed on the foundation with the aid of a crane, rollers or jacks as shown in Figure 1 for indoor equipment and Figure 3 for outdoor equipment. All shipping supports, lifting lugs and lifting angles should be removed from the switchgear.

Connections

The switchgear sections should then be connected and bolted together as follows:

1. Bolt the steel sections together using 3/8-16 bolts, lockwashers and nuts at the points shown on the installation drawing Figure 2.
2. Connect the main buses together using the splice plates and hardware furnished with the equipment. The silvered surfaces on both the main bus and the splice plates should be wiped clean. Sandpaper or abrasives should not be used on the silvered surfaces. After cleaning apply D50H47 contact grease to the surfaces in sufficient quantity that the contact area will be thoroughly sealed with excess grease squeezed out of the joint when tightened. The bolts should be tightened to the torque values shown in Table II. After the bolts have been securely tightened, the joints are insulated using the molded polyvinyl chloride boots which are furnished. These boots are placed over the bolted joints and the boot flaps are secured with nylon plastic rivets.
3. The ground bus connections between sections should be made using the splice bars and hardware furnished.
4. The control cables should be routed and connections made at the shipping splits. After the complete lineup has been assembled and tested in the factory, the control cables are disconnected and the cable folded back into the end unit of the shipping split. On site the cable should be unfolded and routed into the next adjacent shipping split unit. Terminal boards located in this unit are then used to make the interunit connections. A connection diagram is furnished to indicate the connections to be made.
5. Bus ducts and primary cable conduits should be lined up and connections made to the equipment. Hardware for connecting a bus duct to the switchgear is furnished with the bus duct.
6. The primary cable connections are made in the rear of the switchgear. The bolted rear covers must be removed for access to the cable area. Before any primary cable connections are made the cables should be identified to indicate their phase relationship with the switchgear connections. This is necessary to insure that motors will rotate in the proper direction and that the phase rotation is the same when interconnecting two sources of power.

BOLT TORQUE VALUES FOR METAL-CLAD SWITCHGEAR

BOLT SIZE	TORQUE FOOT POUNDS	MATERIAL
3/8 - 16	20 - 25	Steel Copper Compound
1/2 - 13	50 - 70	
5/8 - 11	80 - 90	

TABLE II

There are two common methods of making primary cable connections:

1. Potheads are used when it is desired to hermetically seal the end of the cable to make a moisture-proof connection between the cable and the switchgear bus. A pothead also prevents seepage of oil from the end of oil impregnated varnish cambric or paper insulated cable.

2. Clamp type terminals and wiping sleeve or cable clamp.

Instructions for making connections using potheads or clamp type terminals are given in instruction book GEI-28838.

Breaker Removable Element

After the installation of the stationary equipment is complete, the removable breaker elements should be installed in their proper compartments. Breakers are assigned to definite compartments when an order is engineered. Each breaker is assigned a part or mark number. This number is shown on the breaker sheets of the summary, the breaker nameplate and on the identification card on the breaker shipping carton. Breakers of identical design and rating are interchangeable one with the other.

Test Cabinet

The test cabinet should be installed on the wall at a location where maintenance and testing of the breaker can be conveniently done. Conduits must be installed to carry cables to supply control power for testing.

Addition of Units to Existing Equipment

Before adding units to existing equipment all drawings furnished with the equipment should be reviewed. In addition to the usual drawings furnished with new equipment, special drawings may be furnished covering complicated or special assembly work.

The end cover sheets on the indoor equipment are designed so they can be removed from the outside. The ends of the main bus are insulated and protected with a polyester glass panel so that removal of the external steel end sheet does not expose the energized bus. After the end sheets have been removed the new units can be set in place. The procedure for making the main bus connections is shown in Figure12. With the new equipment in place the bus in the existing equipment should be de-energized while the units are being bolted together and the main bus connections and control cable connections between the existing equipment and the new equipment are made. Since the existing equipment need not be entered until it is necessary to make the bus connections, the down time on the existing equipment can be held to a minimum.

Before any covers, other than the end cover sheets, or any doors are opened which would permit access to the primary circuits in the existing gear, it is essential that the circuit be de-energized.

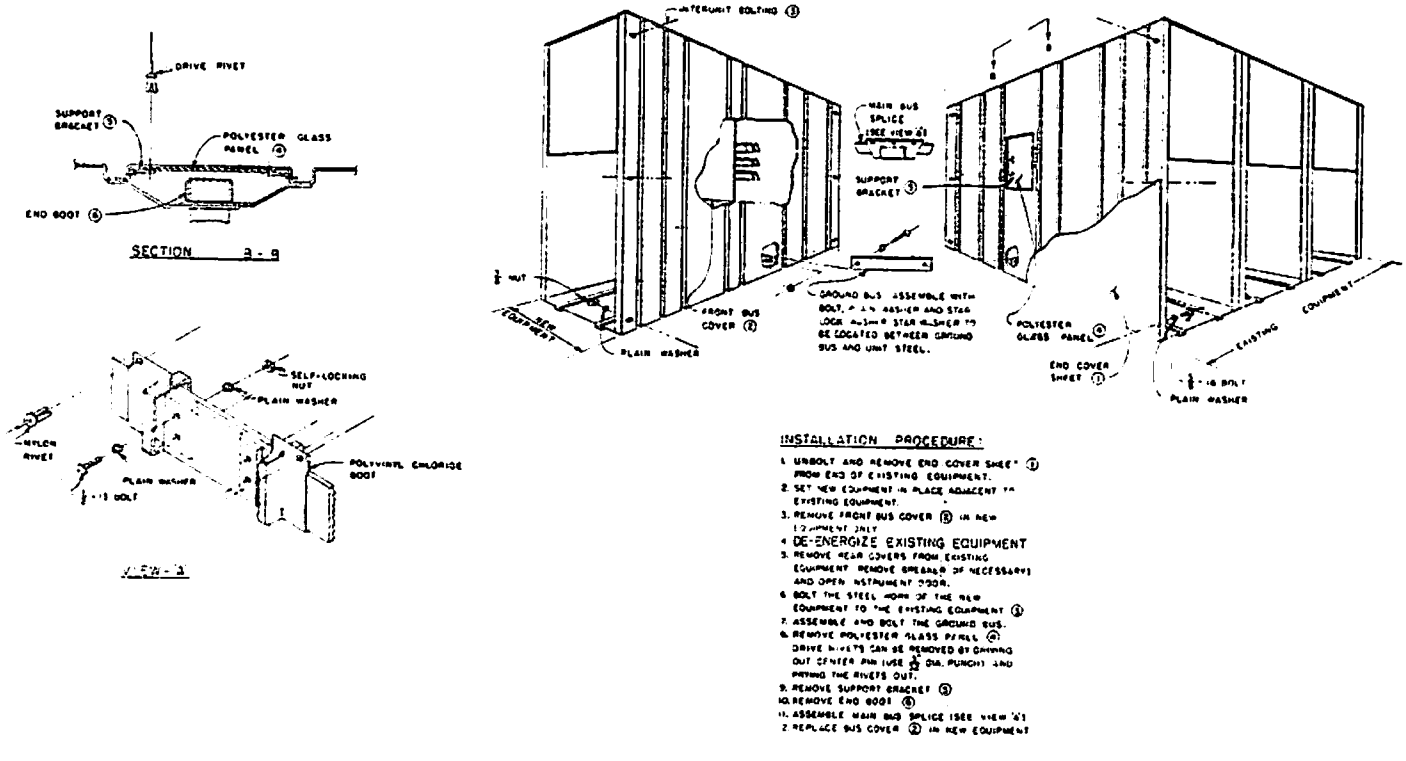


Figure 12 (0673D0515-189) Main Bus Connections in Match and Lineup

SECTION V
TESTING & INSPECTION

After the equipment has been installed and all connections made, it must be tested and inspected before putting it in service. Although the equipment and devices have been completely tested at the factory, a final field test should be made to be sure that the equipment has been properly installed and that all connections are correct. The primary equipment should be completely de-energized while the tests are in progress.

BEFORE ENERGIZING SWITCHGEAR BE SURE THAT ALL JOINTS AND BUS ENDS ARE COVERED WITH THE POLY VINYL CHLORIDE BOOTS PROVIDED FOR INSULATION AT THESE POINTS. ALSO A POLYESTER GLASS INSULATING BARRIER IS PROVIDED FOR INSULATION BETWEEN THE BUS ENDS AND THE STEEL END COVERS. IT IS IMPERATIVE THAT THIS SHIELDING BARRIER BE IN PLACE BEFORE THE BUS IS ENERGIZED.

Directions for testing relays, instruments and meters are given in the instruction books furnished for each device. The settings of the protective relays must be coordinated with the other relays on the system and, therefore, these relays must be set by the purchaser. General instructions on setting the relays are given in the relay instruction books. Special instruction books are furnished for complicated automatic equipments. These instructions describe the sequence of operation of the devices required to perform the desired function.

The extent of the tests on the equipment depend on the type and function of the equipment. Tests which should be performed on all equipments should include breaker operation, switchgear meggering, phasing and grounding checks.

High potential tests to check the integrity of the insulation are not necessary if the installation instructions are carefully followed. If this test is required by local codes or the purchaser wishes to make 60 cycle A.C. high potential tests the voltage should not exceed 75% of the ASA factory test voltage. For the power circuit the ASA factory test voltage for 4.76 KV gear is 19 KV.

Potential and control power transformers must be disconnected during high voltage testing.

When transformers are furnished to supply the control power, the primary taps should be selected so that the control voltage indicated on the wiring diagram is obtained on the secondary of the transformer. When a battery is used to supply control power, the cables from the battery to the switchgear should be large enough to avoid excessive voltage drop.

Breaker Operation Test

All breaker compartments have a test position in which the primary disconnects are disengaged while the secondary contacts are engaged. This TEST position permits complete testing of the electrical control circuit without energizing the primary power circuit. When the breaker is first put into service, its control circuit should be thoroughly tested while in this position to make sure that all closing and tripping circuits are complete and functioning properly.

The TEST position is not suitable for inspection and maintenance of the breaker and should, therefore, be used only for testing breaker operation.

Key Interlocks

After initial installation of the switchgear equipment, all necessary interlock keys should be inserted into the appropriate locks and all spare keys should be placed in the hands of a responsible person. Refer to the key interlock schematic on the front view furnished with the equipment to determine the sequence of operation and the correct number of operating keys required. This precaution is necessary since improper use of spare keys will defeat the interlock scheme.

SECTION VI
OPERATION

Breaker Positioning and Racking

The breaker is positioned by centering it with the compartment and lining up the guide element on the breaker with the guide in the house. For the 4.76 KV breaker a single guide channel is centered in the house. This guide channel mates with a similar piece fixed to the bottom of the breaker frame. The breaker guide is flared to aid in aligning it with the house guide.

When the breaker has been aligned with the house through the engagement of the guide elements the breaker should be rolled into the house until the stop pin engages in the stop block on the floor of the house. The stop pin is spring loaded and biased so that its engagement in the stop block is automatic as the breaker is rolled in. The breaker is then in the disconnect position. As the breaker reaches the disconnect position the racking jackscrew shaft engages with the jacknut in the house. This nut is spring loaded and self aligning. It is retracted as it is struck by the end of the jackshaft. The spring backed nut is automatically fed onto the shaft when the shaft is rotated by the operating handle.

DAMAGE TO THE JACKSCREW THREADS MAY OCCUR IF THE STOP POSITION FOOT PEDAL IS HELD DEPRESSED WHEN THE BREAKER IS INSERTED INTO THE HOUSE.

To move the breaker from the disconnect position it must be first determined that the breaker is open. The sliding shutter which covers the handle socket on the front end of the jackshaft must then be pushed aside and the handle crank inserted. The sliding shutter is part of the interlock mechanism and cannot be moved aside unless the breaker is in the open position. After the

crank handle has been inserted the stop pin must be released. This is done by stepping on the foot pedal while simultaneously rotating the crank handle clockwise. After a slight movement of the breaker the foot pedal should be released. By continuing to rotate the handle the breaker will be moved into the test position. When this position is reached the stop pin will again drop into the stop block. With the breaker in the test position the secondary contacts on the breaker are in contact with the stationary secondary blocks in the house. The breaker can be electrically operated providing the crank handle has been removed and the jackscrew shutter is permitted to close. The shutters covering the primary disconnects in the house are closed.

To move the breaker from the test position the breaker must be open. The jackscrew shutter is then pushed aside and the handle inserted. The stop pin is released by the foot pedal and the crank handle is turned clockwise. By continuing to turn the crank handle the breaker is moved to the connected position. When this position is reached a collar on the jackshaft is jammed against the jacknut and further rotation of the crank handle is impossible. If the motion of the breaker into the house should be halted between the test and the connect positions a fixed cam in the house holds the interlock mechanism in the tripped position even though the racking handle has been removed and the breaker cannot be closed. When the breaker reaches the fully connected position the primary and the secondary disconnects are both engaged and closing of the breaker will energize the primary circuit.

The breaker is removed from the house in a manner similar to that used to insert it. The breaker must first be open, then the jackscrew shutter is retracted, the operating crank is inserted and by counterclockwise rotation of the crank the breaker is moved out of the house. The stop pin will again automatically engage with the stop block in the test position and must be retracted with the foot pedal to move the breaker to the disconnect position. The stored energy mechanism operating springs on the breaker are automatically discharged between the disconnect and test positions by a house mounted cam. This discharge of the stored spring energy will occur each time the breaker is moved into or out of the house.

Space Heaters

Space heaters are provided in all outdoor equipment in order to keep the inside temperature several degrees higher than that outside. Heaters may also be furnished for indoor equipment when it is known that abnormal atmospheric conditions exist at the installation or when specified by the customer.

By maintaining a slight temperature differential the heaters facilitate drying and prevent condensation.

Before the heaters are energized be sure the power source is of the proper voltage, frequency and phase arrangement. The heaters should be connected in accordance with the wiring diagrams furnished with the equipment. Also be sure all cartons and miscellaneous material packed inside the units have been removed before the heaters are energized.

Heaters should be visually inspected several times a year to be sure they are operating properly.

It is recommended that heaters be energized at all times and that thermostatic control not be used. If thermostatic control is used the contacts of the thermostat should be set to close between 95 and 100 F on falling temperature de-energizing the heaters only when strong sunlight beats on the switchgear. Under no condition should a differential thermostat be used to control the heaters because under extremely high humidity conditions this type of thermostat will not operate at all times to keep the heaters on enough to prevent condensation in the switchgear.

SECTION VII

MAINTENANCE

A regular maintenance schedule should be established to obtain the best service and reliability from the switchgear. An annual check and overall maintenance procedure for the switchgear, devices and all connections should be followed as a minimum requirement. Equipment subject to highly repetitive operation may require more frequent maintenance.

A permanent record of all maintenance work should be kept. The record should include a list of periodic checks and tests made, date made, condition of the equipment and any repairs or adjustments that were performed. This record will be a valuable reference for subsequent maintenance work and for station operation.

For specific information regarding the maintenance of devices, such as breakers, relays, meters and instruments refer to the separate instruction book for each device.

BEFORE ANY COVERS ARE REMOVED OR ANY DOORS OPENED WHICH PERMIT ACCESS TO THE PRIMARY CIRCUITS, IT IS ESSENTIAL THAT BREAKERS BE WITHDRAWN TO THE DISCONNECTED POSITION AND TAGGED.

IF WORK IS TO BE DONE ON REMOTE EQUIPMENT CONNECTED TO A UNIT, THE BREAKER FOR THAT UNIT SHOULD BE PLACED IN THE DISCONNECTED POSITION AND TAGGED. ALSO THE REMOTE EQUIPMENT SHOULD BE ISOLATED FROM ANY OTHER POWER SOURCES CONNECTED TO IT.

The primary circuits of metal-clad switchgear are insulated in order to reduce the size of the equipment. This insulation, however, in most instances requires a certain amount of air gap between phases and to ground to complete the insulation. Inserting any object in this air space when equipment is energized whether it is a tool or a part of the body may, under certain conditions, short circuit this air gap and may cause a breakdown in the primary circuit to ground and cause serious damage or injury or both. The solid insulation surrounding an energized conductor must never be relied on to provide protection to personnel.

Care should be exercised in the maintenance and checking procedures that accidental tripping or operation is not initiated.

The switchgear structure and connections should be given the following overall maintenance at least annually.

Breaker and Instrument Compartments

Breakers - Test and inspect all breakers for proper operation as follows:

De-energize equipment completely except for test circuits.

(a) Operate each breaker while in the TEST position and check all functions. This is particularly important for breakers that normally remain in either the open or closed position for long periods of time.

(b) Remove the breaker from its compartment to a clean maintenance area. The test cabinet provides a convenient means for operating the breakers when they are removed from the compartments. The maintenance operation should be performed in accordance with the procedure suggested in the appropriate breaker maintenance manual.

Instruments, Instrument Transformers & Relays

Since under normal conditions, the protective relays do not operate, it is important that the operation of these devices be checked regularly.

Check and inspect all devices to see that they are functioning properly. Check device mounting. Check that all electrical connections are tight.

Breaker Compartment Interiors

(a) Thoroughly clean the interior of the breaker and instrument compartments. Use a vacuum cleaner and clean rags only. Do not use steel wool or oxide papers. Blowing with compressed air is not recommended.

(b) Check indicating devices, mechanical and key interlocks.

(c) Check primary disconnecting device contacts for signs of abnormal wear or overheating. Discoloration of the silver surfaces is not normally harmful unless atmospheric conditions cause deposits such as sulphides on the contact surfaces. If necessary, deposits can be removed with a good grade of silver polish. Otherwise, wiping with a lint free cloth will suffice.

Before replacing the breaker, apply a thin coat of contact lubricant D50H47 to the house studs and the finger disconnects on the breaker.

Bus Compartment

(a) Remove covers and check buses and connections for evidence of overheating or weakening of the insulation.

(b) Check that all bus mounting bolts and splice connection bolts are tight.

(c) After cleaning, megger and record the resistance to ground and between phases of the insulation of buses and connections. Since definite limits cannot be given for satisfactory insulation resistance values, a record should be kept of the readings. Weakening of the insulation from one maintenance period to the next can be recognized from the recorded readings. The readings should be taken under similar conditions each time and the record should include temperature and humidity.

Cable and Bus Duct Terminal Compartment

Inspect all main cable connections for signs of overheating and, when possible, check that connections are tight.

Overall Switchgear

(a) Check that all secondary control wiring connections are tight. Check continuity.

(b) Check to see that all anchor bolts and bolts in the structure are tight.

(c) If the switchgear is equipped with heaters check to see that all heaters are energized and operating.

(d) Check the ground bus connection and mounting bolts for tightness. Clean the ground bus.

(e) Clean and inspect all painted surfaces. Retouch where necessary.

Paint Refinishing

Indoor and Outdoor Primer

1. Remove all loose paint, rust, scale, oil or grease. Sand scratches smooth with fine wet or dry sandpaper before priming.

2. Materials

   (a) Synthetic phenolic, alkyd paint 214-488 Sand Gray as made by Arco Co.

   (b) Thinner, Xylol made by Standard Oil Co.

   (c) Viscosity 30 seconds Zahn #2 cup.

3. Application

   (a) Primer is preheated to 185°F and sprayed with DeVilbiss type hot spray unit.

   (b) Air dry 30 minutes.

   (c) Thickness of paint coating 0.45 to 0.65 mils.

Indoor Finish Coat

1. Materials

   (a) Sand Gray lacquer 246-84296 as make by DuPont Co.

   (b) Blue lacquer 254-84299 as make by DuPont Co.

   (c) Lacquer thinner

   (d) Viscosity Sand Gray 25 seconds Zahn #2 cup. Blue 27 seconds Zahn #2 cup.

2. Application

   (a) Spray one wet coat.

   (b) Air dry 30 minutes.

   (c) Thickness 1.00 mil.

Outdoor Finish

1. This finish is applied to surfaces previously cleaned and primed.

2. Materials

   (a) Acrylic Sealer 881-007 as made by DuPont Co.

   (b) Acrylic Lacquer 890-5001 as made by Du Pont Co.

   (c) Acrylic thinner E-615 as made by Geo. Senn Co.

3. Application - Sealer Coat

   (a) Reduce sealer to spraying viscosity using 1 parts 881-007 to 1 parts E-615.

   (b) Spray one coat of sealer.

   (c) Air dry one hour.

4. Application - Finish Coat

   (a) Reduce 1 part 890-5001 to 1 part E-615 to spraying viscosity of 21 seconds Zahn #2 cup.

   (b) Apply one coat of finish.

   (c) Air dry 30 minutes.

   (d) Thickness of finish coat 1.00 mil.

GENERAL ELECTRIC SALES OFFICES

READY TO ASSIST YOU ... When You Have Electrical Problems ... Need Further Information ... Require Ordering Instructions

KEY TO SALES OPERATIONS

- A - Agency & Distributor
- C - Components Sales
- I - Industrial Sales
- M - Marine & Defense Facilities Sales
- S - Installation and Service Engineering
- U - Electric Utility Sales

ALABAMA

A C I S U	Birmingham 35205	2151 Highland Ave.
I	Huntsville 35801	3322 Memorial Pkwy S.
A I S	Mobile 36606	1311 S. Beltline Hwy.

ARIZONA

A C I S U	Phoenix 84012	3550 N. Central Ave.
A I S U	Tucson 85711	40 No. Swan Rd.

ARKANSAS

A C I S	N. Little Rock 72119	120 Main St.
U	Pine Bluff 71602	P.O. Box 1033

CALIFORNIA

A	Burlingame 94010	770 Airport Blvd.
C	Burlingame 94010	1675 Rollins Rd.
A I	Emeryville 94608	5000 Shellmound St.
A I	Fresno 93728	1532 N. West Ave.
C	Los Angeles 90015	543 W. Olympic Blvd.
A I M S U	Los Angeles 90054	212 N. Vignes St.
A	Oakland 94621	8105 Edgewater Dr.
A	Ontario 91764	314 West E St.
S	Palo Alto 94303	360 San Antonio Rd.
A S U	Sacramento 95814	2401 "J" St.
A M S U	San Diego 92103	3550 First Ave.
A I M S U	San Francisco 94106	235 Montgomery St.
A	Santa Clara 95050	1400 Coleman Ave.

COLORADO

A C I S U	Denver 80206	201 University Blvd.

CONNECTICUT

I U	Hamden 06518	2905 Dixwell Ave.
A	Hartford 06105	764 Asylum Ave.
C I S U	Meriden 06450	1 Pressage Dr.

DISTRICT OF COLUMBIA

I M U	Washington 20005	777-14th St., N.W.

FLORIDA

A I S U	Jacksonville 32207	4040 Woodcock Dr.
A S U	Miami 33134	4100 W. Flagler St.
A	Orlando 32803	401 N. Fern Creek Ave.
U	Pensacola 32502	P.O. Box 1027
A C I S U	Tampa 33609	2106 S. Lois Ave.

GEORGIA

A C I S U	Atlanta 30309	1880 Peachtree Rd. N.W.
A	Macon 31204	1720 Riverside Dr.
A I S U	Savannah 31405	5002 Paulsen St.

IDAHO

A U	Boise 83701	1524 Idaho St.

ILLINOIS

A I M S U	Chicago 60650	840 S. Canal St.
C	Oakbrook 60521	1200 Harger Rd.
A I U	Peoria 61605	2008 N.E. Perry Ave.
A I	Rockford 61108	4223 E. State St.
U	Springfield 62701	601 E. Adams St.
A	Springfield 62701	425 1/2 So. Fifth St.

INDIANA

A C S U	Evansville 47714	2709 Washington Ave.
C	Fort Wayne 46804	1635 Broadway
S	Fort Wayne 46807	3606 S. Calhoun St.
A U	Fort Wayne 46606	6001 S. Anthony Blvd.
A I S U	Indianapolis 46207	3750 N. Meridian St.
C	Indianapolis 46240	1310 E. 86th St.
A C	South Bend 46601	430 N. Michigan St.

IOWA

U	Cedar Rapids 52401	210 Second St., S.E.
C	Davenport 52722	P.O. Box 748
A I S	Davenport	1039 State St., Bettendorf 52722
A U	Des Moines 50310	3839 Merle Hay Rd.
U	Sioux City 51101	520 Pierce St.

KANSAS

C	Overland Park 66204	7219 Metcalf St.
A	Wichita 67211	820 E. Indianapolis Ave.
U	Wichita 67202	104 S. Broadway Suite 1408

KENTUCKY

A U	Lexington 40502	443 S. Ashland Ave.
A C I S U	Louisville 40218	2300 Meadow Dr.

LOUISIANA

A U	Alexandria 71301	2001 MacArthur Dr.
I S	Baton Rouge 70806	8312 Florida Blvd.
I	Lake Charles 70604	1424 Ryan St.
I S	Monroe 71201	1028 N. Sixth St.
A I S	New Orleans 70123	4747 Earhart Blvd.
U	New Orleans 70112	225 Baronne St.
M	New Orleans 70150	930 Inter. Trade Mart
A S U	Shreveport 71104	2620 Centenary Blvd.

MAINE

U	Augusta 04330	152 State St.
I	Bangor 04402	77 Central St.
A	Portland 04102	Thompson's Point

MARYLAND

I S U	Baltimore 21201	1 N. Charles St.
A U	Columbia 21403	10221 Wincopin Circle
U	Hagerstown 21740	P.O. Box 477
A	Salisbury 21801	P.O. Box 424

MASSACHUSETTS

I U	Boston 02117	31 St. James Ave.
I	Springfield 01103	120 Maple St.
A C I M S	Wellesley 02181	1 Washington St.

MICHIGAN

A C I S U	Detroit 48202	700 Antoinette St.
I	Flint 48502	601 S. Saginaw St.
A C I	Grand Rapids 49506	2821 Madison Ave., S.E.
S U	Jackson 49201	210 W. Franklin St.
S	Kalamazoo 49003	P.O. Box 2083
A I S	Saginaw 48601	1230 S. Washington Ave.

MINNESOTA

I S U	Duluth 55802	300 W. Superior St.
U	Fergus Falls 56537	201 1/2 Lincoln Ave., W.
C	Minneapolis 55424	4016 W. 65th St.
A I S U	Minneapolis 55416	1500 Lilac Dr., S.

MISSISSIPPI

U	Gulfport 39502	P.O. Box 33
A S	Jackson 39206	333 No. Mart Plaza
U	Jackson 39201	Rm. 717 Electric Bldg.

MISSOURI

A	Joplin 64802	310 Wall St.
A I S U	Kansas City 64105	911 Main St.
A C I S U	St. Louis 63101	1015 Locust St.

MONTANA

A	Billings 59101	313 Transwestern Life Bldg.
A I S U	Butte 59701	103 N. Wyoming St.

NEBRASKA

A I S U	Omaha 68102	409 S. 17th St.

NEVADA

U	Las Vegas 89106	1711 S. 6th St.

NEW HAMPSHIRE

U	Manchester 03104	46 Bay St.

NEW JERSEY

C	East Orange 07017	58 Meimore Gardens
A I S U	Millburn 07041	25 E. Willow St.

NEW MEXICO

A I M S U	Albuquerque 87108	120 Madeira Dr., N.E.

NEW YORK

A I M S U	Albany 12201	11 Computer Dr. West
U	Binghamton 13902	40 Front St.
A I S U	Buffalo 14202	625 Delaware Ave.
A	Elmsford 10523	44 N. Central Ave.
A	Harrison 10528	600 Mamaroneck Ave.
C	Maryvale 13211	P.O. Box 5658 E. Molloy Rd.
I M S U	New York 10022	641 Lexington Ave.
C	Rochester 14618	3380 Monroe Ave.
A I S U	Rochester 14604	228 East Ave.
A I S U	Syracuse 13201	3532 James St.
A	Vestal 13850	P.O. Box 607

NORTH CAROLINA

A C I S U	Charlotte 28207	141 Providence Rd.
A I	Greensboro 27405	601 Summit Ave.
A U	Raleigh 27603	120 N. Boylan Ave.

NORTH DAKOTA

U	Bismarck 58501	418 Rosser Ave.
A	Fargo 58102	112 University Dr.

OHIO

A I	Akron 44320	342 White Pond Dr.
I U	Canton 44703	515 Third St., N.W.
A C I S U	Cincinnati 45208	2621 Victory Pkwy.
C	Cleveland 44116	20950 Center Ridge Rd.
A I M S U	Cleveland 44114	1000 Lakeside Ave.
C	Columbus 43215	937 Burrell Ave.
A I S U	Columbus 43216	1210 Morse Rd.
A C I U	Dayton 45439	3430 S. Dixie Hwy.
C	Mansfield 44903	166 Park Ave., W.
U	North Canton 44720	7900 Whipple Ave. N.W.
U	Toledo 43604	420 Madison Ave.
A I S	Youngstown 44507	272 E. Indianola Ave.

OKLAHOMA

A S U	Oklahoma City 73106	2000 Classen Blvd.
A I	Tulsa 74105	3138 S. Peoria Ave.
U	Tulsa 74103	420 Main St.
S	Tulsa 74105	P.O. Box 7646, Southside Station
C	Tulsa 74135	3315 E 47th Place

OREGON

A I S U	Eugene 97402	1170 Pearl St.
A U	Medford 97501	107 E. Main St.
A C I S U	Portland 97210	2929 N.W. 29th Ave.

PENNSYLVANIA

A I U	Allentown 18102	1444 Hamilton St.
A	Camp Hill 17011	1521 Cedar Cliff Dr.
A	Erie 16501	5001 E. Lake Rd.
I	Erie 16501	1001 State St.
I U	Johnstown 15902	941 Oak St.
C	Philadelphia 19114	2617 Welsh Rd.
A I M S U	Philadelphia 19102	3 Penn Center Plaza
C	Pittsburgh 15234	300 Mt. Lebanon Blvd.
A I S U	Pittsburgh 15222	300 6th Ave. Bldg.
A	Williamsport 17701	2109 Park Ave.
C	York 17403	1617 E. Market St.

RHODE ISLAND

A	Providence 02904	1006 Charles St., N.

SOUTH CAROLINA

A I U	Columbia 29205	2725 Devine St.
S	Columbia 29204	Middleburgh Office Mall
A I	Greenville 29606	1605 Laurens Rd.

SOUTH DAKOTA

A	Sioux Falls 57105	513 Main Ave.

TENNESSEE

U	Chattanooga 37402	832 Georgia Ave.
A C I M S	Chattanooga 37411	5800 Bldg. Eastgate Center
I	Kingsport 37664	1170 E. Eastman Rd.
A U	Knoxville 37921	1301 Hannah Ave., N.W.
A I S U	Memphis 38116	3385 Airways Blvd.
A	Murfreesboro 37130	117 N.W. Broad St.
A U	Nashville 37203	1717 West End Bldg.
C	Nashville 37204	2920 Sidco Drive
M	Oak Ridge 37830	253 Main St., East

TEXAS

S U	Abilene 79601	442 Cedar St.
S U	Amarillo 79101	303 Polk St.
A I S U	Beaumont 77704	1285 Calder Ave.
S U	Corpus Christi 78401	205 N. Chaparral St.
A C I S U	Dallas 75247	8101 Stemmons Freeway
I S U	El Paso 79903	213 N. Stanton St.
A	El Paso 79902	2800 N. Stanton St.
A	Fort Worth 76107	100 N. Univ. Dr.
S U	Fort Worth 76102	408 W. 7th St.
A C I S U	Houston 77027	4219 Richmond Ave.
A I	Lubbock 79408	500 E. 50th St.
A S	Midland 79704	122 N. "N" St.
A S U	San Antonio 78204	419 S. Main Ave.

UTAH

A I S U	Salt Lake City 84110	431 S. Third E St.

VERMONT

U	Rutland 05702	38 1/2 Center St.

VIRGINIA

A M S	Newport News 23601	311 Main St.
A I S U	Richmond 23230	1503 Willow Lawn Dr.
A I S U	Roanoke 24015	2018 Colonial Ave., SW

WASHINGTON

A I M S U	Seattle 98188	112 Andover Park, E.
A I S U	Spokane 99220	E. 1605 Trent Ave.

WEST VIRGINIA

A I S	Charleston 25328	306 MacCorkle Ave., SE
I U	Fairmont 26555	310 Jacobs Bldg.
A	Huntington 25701	Sixth Ave. & Ninth St.
I	Wheeling 26003	40 16th St.

WISCONSIN

A I S U	Appleton 54911	3003 W. College Ave.
U	Madison 53704	2038 Pennsylvania Ave.
C	Milwaukee 53218	Mayfair Plaza, 2421 N. Mayfair Rd.
A I S U	Milwaukee 53202	615 E. Michigan St.

CANADA

Canadian General Electric Company, Ltd.
Toronto

GENERAL ELECTRIC SERVICE SHOPS

WHEN YOU NEED SERVICE... These GE service shops will repair, recondition, and rebuild your electric apparatus. The facilities are available day and night, seven days a week, for work in the shops or on your premises. Latest factory methods and genuine GE renewal parts are used to maintain performance of your equipment. For full information about these services, contact your nearest service shop or sales office.

ALABAMA

- *Birmingham 35211 ... 1500 Mims Ave., S.W.
- *Mobile 36609 ... 721 Lakeside Drive

ARIZONA

- *(Phoenix) Glendale 85019 ... 4911 W. Colter St.
- *Phoenix 85019 ... 1840 W. Clarendon St.
- *Tucson 85713 ... 2942 So. Palo Verde Ave.

CALIFORNIA

- *Los Angeles 90301 ... 5900 Stanford Ave.
- *(Los Angeles) Anaheim 92805 ... 3501 E. LaPalma Ave.
- *(Los Angeles) Inglewood 90301 ... 228 W. Florence Ave.
- *Sacramento 95814 ... 99 North 17th St.
- *(San Francisco) Oakland 94608 ... 1650 34th St.

COLORADO

- *Denver 80205 ... 3353 Larimer St.

CONNECTICUT

- *(Southington) Plantsville 06479 ... 570 Atwater St.

FLORIDA

- *Jacksonville 32203 ... 3020 W. Beaver St.
- *(Miami) Hialeah 33010 ... 1062 East 28th St.
- *Tampa 33601 ... 19th & Grant Sts.

GEORGIA

- *(Atlanta) Chamblee 30341 ... 5025 Peachtree Industrial Blvd.

ILLINOIS

- *Chicago 60638 ... 6045 S. Nottingham Ave.

INDIANA

- *Ft. Wayne 46803 ... 1731 Edsall Ave.
- *Indianapolis 46222 ... 1740 W. Vermont St.

IOWA

- *(Davenport) Bettendorf 52722 ... 1025 State St.

KENTUCKY

- *Louisville 40209 ... 3900 Crittenden Drive

LOUISIANA

- *Baton Rouge 70814 ... 10955 North Dual St.
- *New Orleans 70114 ... 1115 DeArmas St.

MARYLAND

- *Baltimore 21230 ... 920 E. Fort Ave.

MASSACHUSETTS

- *Δ(Boston) Medford 02155 ... 3900 Mystic Valley Pkwy.

MICHIGAN

- *Δ(Detroit) Riverview ... 18075 Krause Ave.
- *Flint 48505 ... 1506 E. Carpenter Rd.

MINNESOTA

- *Duluth 55807 ... 50th Ave. W & St. Louis Bay
- *Minneapolis 55430 ... 2025 49th Ave., N.

MISSOURI

- *Kansas City 64120 ... 3525 Gardner Ave.
- *St. Louis 63110 ... 1115 East Road

NEW JERSEY

- *New Brunswick 08902 ... 3 Lawrence St.

NEW MEXICO

- *Albuquerque 87109 ... 4420 McLeod Rd., NE

NEW YORK

- *Albany 12205 ... 1097 Central Avenue
- *(Buffalo) Tonawanda 14150 ... 115 Milens Rd.
- *(Long Island) Old Bethpage 11804 ... 183 Bethpage-Sweet Hollow Rd.
- *(New York City) North Bergen, N.J. 07032 ... 6003 Tonnelle Ave.
- *(New York City) Clifton, N.J. 07012 ... 9 Brighton Rd.
- *ΔSchenectady 12305 ... 1 River Road
- *Syracuse 13208 ... 1015 S. Hiawatha Blvd.

NORTH CAROLINA

- *Charlotte 28208 ... 2328 Thrift Rd.

OHIO

- *Cincinnati 45202 ... 444 West 3rd St.
- *ΔCleveland 44125 ... 4477 East 49th St.
- *Columbus 43229 ... 6060 Hentley Rd.
- *Toledo 43605 ... 405 Dearborn Ave.
- *Youngstown 44507 ... 272 E. Indianola Ave.

OKLAHOMA

- *Tulsa 74145 ... 3220 S. 100th East Ave.

OREGON

- *Eugene 97402 ... 570 Wilson St.
- *Portland 97210 ... 2727 NW 29th Ave.

PENNSYLVANIA

- *Allentown 18103 ... 668 E. Highland St.
- *(Delaware Valley) Cherry Hill, N.J. 08034 ... 1790 E. Marlton Pike
- *Johnstown 15902 ... 941 Oak Street
- *Philadelphia 19124 ... 1040 East Erie Ave.
- *(Pittsburgh) West Mifflin 15122 ... 4830 Buttercup Hollow Rd.
- *York 17403 ... 54 N. Harrison St.

SOUTH CAROLINA

- *(Charleston) No. Charleston 29401 ... 2490 Debonair St.

TENNESSEE

- *Knoxville 37914 ... 1621 Governor John Sevier Hwy.
- *Memphis 38107 ... 708 North Main St.

TEXAS

- *Beaumont 77705 ... 1490 W. Cardinal Dr.
- *Corpus Christi 78401 ... 118 Waco Street
- **Dallas 75235 ... 3303 Manor Way
- *Houston 77036 ... 5534 Harvey Wilson Dr.
- *Houston 77036 ... 5539 Harvey Wilson Dr.
- *Midland 79701 ... 704 S. Johnston St.

UTAH

- **Salt Lake City 84110 ... 301 S. 7th West St.

VIRGINIA

- **Richmond 23224 ... 2403 Ingram Ave.
- *Roanoke 24013 ... 1004 River Ave., SE

WASHINGTON

- **Seattle 98134 ... 3422 First Ave., South
- *Spokane 99211 ... E. 4323 Mission St.

WEST VIRGINIA

- **Charleston 25328 ... 306 MacCorkle Ave., SE

WISCONSIN

- *(Appleton) Menasha 54952 ... 1725 Racine St.
- *Milwaukee 53207 ... 235 W. Oklahoma Ave.

*Electrical/Mechanical Service Shop †Instrumentation Shop ΔSpecial Manufacturing Shop

GENERAL ELECTRIC COMPANY, PHILADELPHIA, PA.

GEH-230Z
Supersedes GEH-230Y

INSTRUCTIONS

INSTRUMENT TRANSFORMERS

BUTYL-MOLDED AND COMPOUND-FILLED, 600-V THROUGH 15-KV

INTRODUCTION

These instructions apply to indoor and outdoor instrument transformers of butyl-molded and other dry-type constructions. For information on the installation and care of transformers with unusual ratings of frequency, secondary voltage, current, or on installations where unusual conditions exist (refer to American Standards for Instrument Transformers, ASA C57.13–1954, section 13-00), consult the nearest sales office of the General Electric Company. When special information is requested, give the complete nameplate data in order to identify the transformer.

BEFORE INSTALLATION

INSPECTION

Before installation, transformers should be inspected for physical damage that may have occurred during shipment or handling. During shipping, transformers usually are supported only by the base or mounting supports, except that certain butyl-molded types may be shipped from the factory supported by butyl surfaces. Transformers should be dry and the surface of the bushings should be clean. All butyl surfaces should be considered the same as the surface of a porcelain bushing in regard to cleanliness and dryness.

DRYING OUT

Transformers that have been submerged in water should be dried out before installation. Wet asphalt-impregnated or varnish-impregnated transformers may be dried by self-heating. To do this, allow the transformer to stand not less than twelve hours in a room of constant temperature. Measure and record the room temperature and resistance of the secondary winding. Short-circuit the primary winding and apply a controllable voltage to the secondary winding. Adjust the voltage so that sufficient current will flow in the winding to raise its temperature to approximately 80 C. The rate of temperature rise should not exceed 6 C per half-hour. The winding temperature should be held at approximately 80 C until the transformer is dry. It will usually require 24 to 48 hours to dry a transformer.

The amount of current necessary to obtain a winding temperature of 80 C varies because of the differences in heat dissipation and current densities in the different types of transformers. It is advisable to start with a current not greater than two amperes in the secondary of a potential transformer, or not greater than five amperes in the secondary of a current transformer. Gradually increase this current until the proper heating is obtained. Increases of current should be made cautiously with frequent checking of the rise in temperature of the winding.

The temperature of the winding may be determined conveniently by the "resistance change" method. Since the resistance of a copper winding increases approximately 1 percent for each 2 1/2 C, the temperature rise may be calculated by measuring the "before" and "after" resistances and finding the percentage increase in resistance. For example, if the "after" resistance is 0.244 ohm and the resistance at the start (room) temperature is 0.200 ohm, the percentage increase is

$$\frac{0.244-0.200}{0.200} = 0.22 = 22\%,$$

which corresponds to a temperature rise of 22 x 2 1/2 = 55 C (approximately). The approximate winding temperature at any time is the temperature rise at that time added to the ambient (room) temperature.

Butyl-Molded Transformers

Butyl-molded transformers, particularly designs for outdoor use, are relatively impervious to moisture. If, due to unusual circumstances, insulation tests indicate the possibility of the entrance of moisture into a butyl-molded transformer, refer to the nearest General Electric Apparatus Sales Office for detailed information on proper procedure.

TESTING

If it is desired to make insulation tests after the drying out period, or at any other time, these tests

may be made in accordance with American Standards for Instrument Transformers, ASA C57.13–1954. (Note: Periodic field tests of insulation should not exceed 65 percent of the ASA test voltage. Incoming tests of new equipment should not exceed 75 percent of the ASA test voltage.)

Convenient methods for testing polarity are given in American Standards C-57.13, the Electrical Metermen's Handbook published by Edison Electric Institute, and General Electric publication GET-97.

For ratio and phase angle tests, refer to Electrical Metermen's Handbook and General Electric publications GET-97 and GET-1725.

Certificates

A certificate of test is supplied with many types of butyl-molded potential and current transformers. The certificate is in the form of a tag attached to each transformer. The tag shows the ASA accuracy classification of the transformer, the burden at which it has been tested, and the actual test results of ratio correction factor and phase angle. The tag is perforated and can be detached as a 3- by 5-in. card for filing.

INSTALLATION

SAFETY PRECAUTIONS

Always consider an instrument transformer as a part of the circuit to which it is connected, and do not touch the leads and terminals or other parts of the transformer which are not grounded.

The butyl surface of transformers should be considered the same as the surface of a porcelain bushing, since a voltage stress exists across the entire butyl surface from terminals to grounded metal parts.

Do not open the secondary circuit of a current transformer while the transformer is energized. This precaution is advisable since current transformers may develop open-circuit secondary voltages which may be hazardous to personnel or injurious to the transformer or equipment connected in the secondary circuit.

Always ground the metallic cases and frames of instrument transformers. The secondaries should be grounded close to the transformers. However, when secondaries of transformers are interconnected, there should be only one grounded point in this circuit.

MOUNTING

Instrument transformers should be mounted so that connections can be made to the power or distribution lines in such a manner as to avoid placing appreciable strains upon the terminals of the transformers. For high-current transformer ratings, 2000 amperes and above, there may be some interference from the electric field of the return bus unless the bus centers are kept at a minimum distance of 15 inches apart; for ratings above 5000 amperes this distance should be not less than 24 inches. If this type transformer is used with more than one primary turn, the loop should be at least 24 inches in diameter. Make sure that the secondary leads are twisted closely together and carried out without passing through the field of the primary conductors. It is not necessary that the bus exactly fill the window, but the bus or buses should be centralized. For ratings of 1000 amperes or less these precautions are generally unnecessary.

CONNECTIONS

SECONDARY CONNECTIONS

The resistance of all primary and secondary connections should be kept as low as possible to prevent overheating at the contacts, and to prevent an increase in the secondary burden.

The resistance voltage drop of the secondary leads should be included in calculating the secondary volt-ampere burden carried by instrument transformers. The total burden should be kept within limits suited to the transformers used.

Short-circuiting Device

Many current transformers are provided with a device for short-circuiting the secondary terminals, and are shipped from the factory with this device in short-circuiting position. When the transformer is installed and the primary circuit is energized, the shorting device should be opened only after a suitable burden, such as an ammeter, wattmeter, watthour meter, relay, etc., is connected to the transformer secondary terminals.

On some designs the secondary cover is interlocked with the secondary hardware, so that the lead openings in the cover will be 180 degrees from the usable position unless the short-circuiting device is open. The short-circuiting device should be replaced for safety before the burden is removed from the transformer secondary.

Dual-ratio current transformers with mid-tapped secondary windings are completely inoperative when either portion of the secondary winding is short-circuited. On current transformers with multiple secondary taps, short-circuit at least one half the secondary winding before making or removing connections at the secondary terminals when the transformer is energized.

On dual-ratio or multiple-ratio current transformers with secondary taps, all short-circuiting devices must be in the open position for normal operation, so that no portion of the winding is short-circuited.

PRIMARY BY-PASS PROTECTION

Thyrite® primary by-pass protectors are recommended for the proper protection of current transformers which are so located as to be exposed to the effect of surge currents. They are especially recommended for low primary-current ratings, as these ratings have a relatively high winding impedance.

Thyrite primary by-pass protectors consist of one or more Thyrite disks which are connected in parallel with the primary winding of the transformer. When high-frequency or steep-front voltage surges occur, the characteristic of the Thyrite is such that an appreciable part of the surge current is by-passed through the protector. A high-surge voltage, which might result in failure within the primary winding, is thus prevented from building up across the winding.

GROUNDING

Grounding of instrument transformers should be made in accordance with AIEE Standard No. 52, March, 1951, Application Guide for Grounding of Instrument Transformer Secondary Circuits and Cases.

POLARITY

In wiring instrument transformer circuits, it is necessary to maintain the correct polarity relation between the line and the devices connected to the secondaries. For this reason, the relative polarity of each winding of a transformer is indicated by a marker H_1 (or a white spot) on or near one primary terminal, and a marker X_1 (or a white spot) near one secondary terminal; and in some cases by white bushings. See Figure 1. Where taps are present, all terminals will be marked in order. The primary terminals will be H_1, H_2, H_3, etc.; the secondary terminals X_1, X_2, X_3, etc.; and the tertiary terminals, if present, Y_1, Y_2, Y_3, etc. H_1 always indicates the same instantaneous polarity as X_1 and Y_1.

When connection is made to a secondary terminal having a polarity marking similar to a given primary terminal, the polarity will be the same as if the primary service conductor itself were detached from the transformer and connected directly to the secondary conductor. In other words, at the instant when the current is flowing toward the transformer in a primary lead of a certain polarity, current will tend to flow away from the transformer in the secondary lead of similar polarity.

When connecting instrument transformers with meters or instruments, refer to the Instructions furnished with the meters or instruments involved.

AMBIENT TEMPERATURE

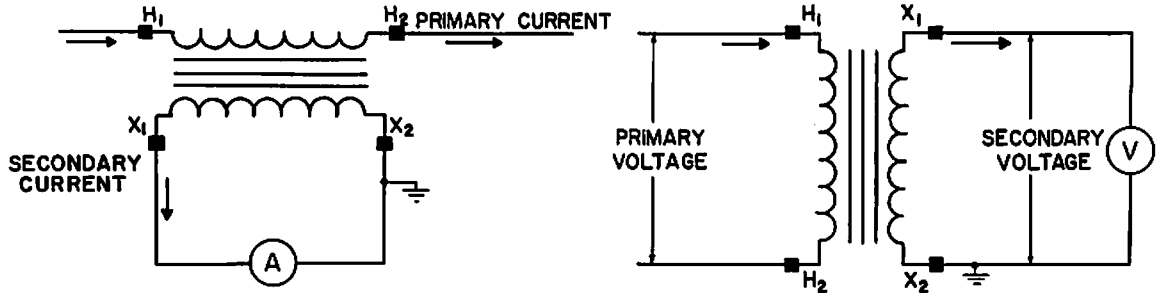
All General Electric transformers are designed to operate at either or both the ambient temperatures, as indicated by the Company, at the standard rating or ratings for the corresponding ambient temperatures, provided the altitude does not exceed 3300 feet. Refer to American Standards for Instrument Transformers, ASA C57.13–1954, section 13-00. Generally, the allowable ambient temperatures and ratings are marked on the transformer nameplate.

FUSES

Potential transformer fuses are intended primarily to protect the line rather than the transformer, although the modern fuse will afford protection to the transformer in a large number of cases.

The fuses on butyl-type transformers, rated at 0.6-kv through 2.5-kv Insulation Class, are provided with molded butyl fuse enclosures which are secured to the transformer by the spring action of the fuse clips.

Each fuse and its enclosure may be removed as a unit from the transformer, using a fiber fuse puller or by hand if suitable protection is provided for the operation. The fuse is then removed through an opening in one end of the enclosure.



CURRENT TRANSFORMER POTENTIAL TRANSFORMER

Fig. 1. Elementary Connections of Instrument Transformers

When replacing the fuse and enclosure, be sure that the plastic insulating piece, fastened under the transformer fuse clip, is inserted between the end of the fuse and the open end of the fuse enclosure. Then press the enclosure firmly onto the transformer to seat the fuse into both clips.

The fuses of some dry-type transformers, 2400 volts and below, are supported by a hinged cover. If it is necessary to replace a fuse while the transformer is connected to an operating circuit, the cover should be opened by use of an insulating hook, which should be of sufficient length to prevent the operator from being burned in case a short circuit exists in the transformer.

In testing fuses for continuity of circuit, not more than 0.25 ampere should be used.

In replacing fuses, be certain that the voltage rating of the fuse is the one nearest above the line-to-line voltage of the circuit, regardless of the rated voltage of the transformer. Do not use fuses of higher voltage ratings, as undesirable overvoltages may result should the fuse blow. One permissible exception to this general rule is the use of Size A, Type EJ-1 fuse in the Types JE-2 and JVM-2 transformers. In this case the Size A fuse can be used on either 2400-volt, delta circuits or 2400/4160-volt, solidly grounded Y circuits.

MAINTENANCE

After instrument transformers for indoor use have been installed, they should need no care other than keeping them clean and dry. Transformers for outdoor installations should receive the same care in operation as power transformers of similar design and of similar voltage rating.

CLEANING BUSHINGS

Porcelain bushings may be cleaned by means of a wet cloth or by use of carbon tetrachloride* or ammonia. After cleaning a bushing, wash thoroughly with clean water to remove foreign material from the surface.

Butyl-molded transformers may be cleaned by scrubbing the butyl surface with detergent and a stiff brush to remove accumulated dirt or oil film. Remove the detergent by washing with clean water. Then apply a light grade of silicone oil (G-E Silicone Liquid, SF-92 or equal) to the butyl surface.

DEMAGNETIZING

If by accident a current transformer becomes magnetized, it should be demagnetized before being used for precision work. Connect at least 50 ohms resistance in series with the meters or instruments in the secondary circuit. Bring the primary current up to as near full load as possible and gradually reduce the series resistance until it reaches zero, being careful not to open the secondary circuit in the process. For best results, gradually reduce the primary current to zero before disconnecting the resistance circuit.

Demagnetizing JAR-O Auxiliary Transformers

Due to the wide range of current ratios available in the Type JAR-O current transformer and the lack of standards for demagnetizing the odd ratios available, the following method is necessary to protect personnel and transformers from excessively high voltages that could develop. See Fig. 2.

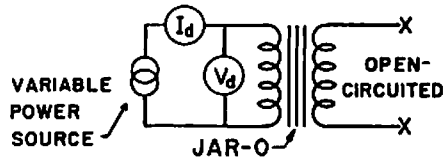


Fig. 2. Schematic diagram for demagnetizing JAR-O transformers

Key to Fig. 2.

I_d = ammeter for reading demagnetizing current.

V_d = voltmeter for reading demagnetizing voltage.

The I_d reading shall not exceed:

$$\frac{\text{Rated current of the winding energized}}{50}$$

The V_d reading shall not exceed:

$$\frac{160}{\text{Rated current of the winding energized}}$$

For example, for demagnetizing any 5-ampere JAR-O winding, do not exceed 32 volts and 0.1 ampere. The core will be adequately demagnetized when either the voltage or the current is increased to over 80% of the maximum value shown in the applicable formula (see above), and then gradually reduced to zero.

DIFFERENTIAL PROTECTION

Standard General Electric current transformers may be used for differential protection through a considerable range of burden and overcurrent. The range is limited by the difference in burden, the maximum overcurrent, and the mechanical and thermal short-time rating. Information regarding these points may be obtained from the G-E publication GET-97 or from the nearest sales office of the company.

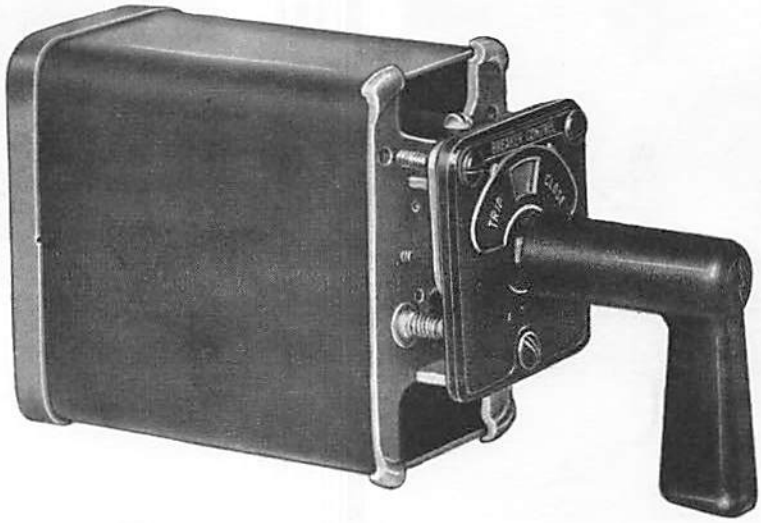
* Precautions against toxic vapors should be taken when using carbon tetrachloride.

INSTRUCTIONS

GEH-908M

CONTROL AND INSTRUMENT SWITCHES

Types
SB-1, SB-9,
and SB-10



LOW VOLTAGE SWITCHGEAR DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA, PA.

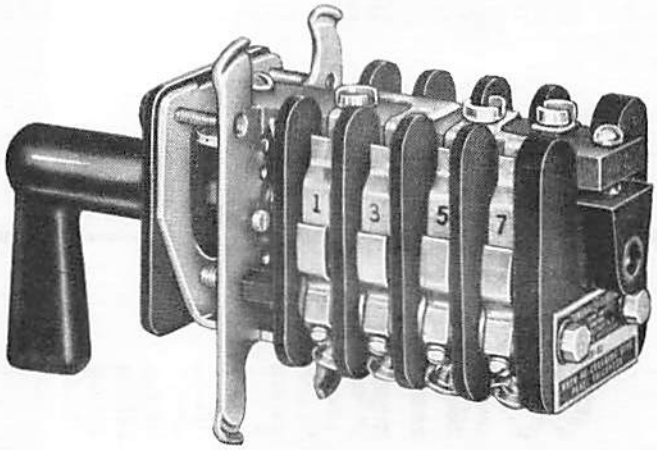


Fig. 1 (8008678) Type SB-1 Switch Without Cover

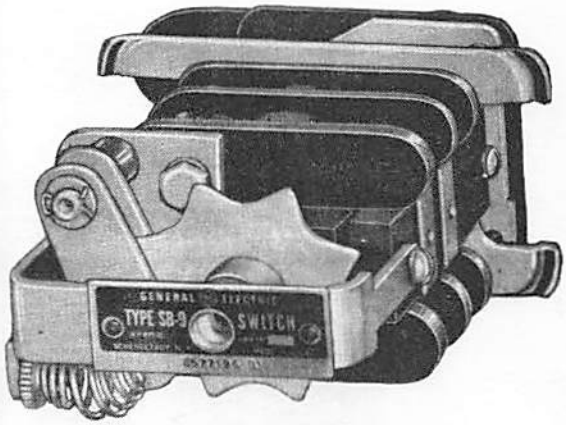


Fig. 2 (8008677) Type SB-9 Switch Without Cover

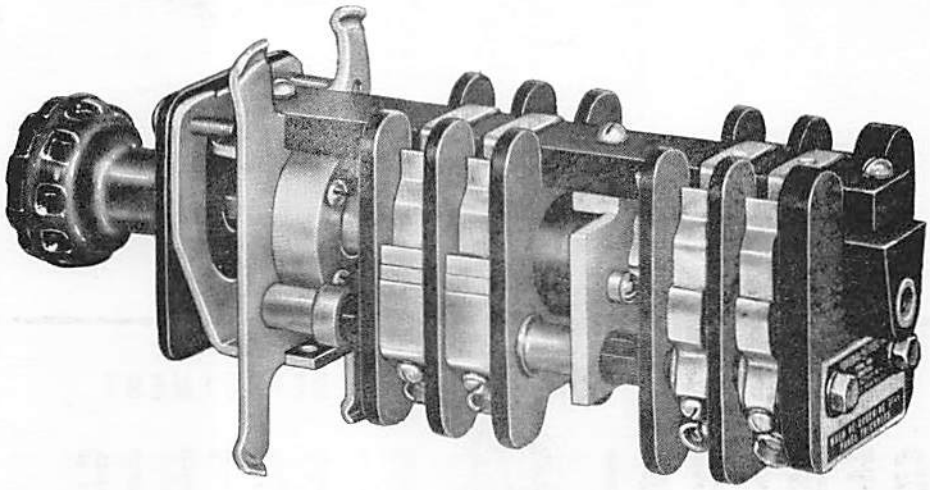


Fig. 3 (8008679) Type SB-10 Switch Without Cover

CONTROL AND INSTRUMENT SWITCHES

TYPES SB-1, SB-9, AND SB-10

INTRODUCTION

The Type SB-1 switches (see cover illustration and Fig. 1) are multi-pole rotary switches with cam-operated contacts. They have their positioning device or return spring located between the front support and first barrier while the Type SB-9 (see Fig. 2) has the positioning device or return spring located at the rear of the switch. The Type SB-9 also has better insulation to ground, more substantial bearings, and long life cams.

The Type SB-10 switches (see Fig. 3) combine contacts operated by rotation of the shaft, as in the SB-1 and 9 switches, with contacts operated by a lateral motion (push or pull) of the shaft. Only two lateral positions of the shaft are possible. Interlocks are usually provided so the push-pull contacts can be operated only in specific rotary positions of the switch, and also the rotary contacts can be operated in only one lateral position of the shaft---either push or pull.

NOTE: Instructions for Type SB-1 switches also apply to superseded Type SB-7 switches.

APPLICATION

The Type SB-1, SB-9 and SB-10 switches are primarily intended for the control of electrically operated circuit breakers, small motors, magnetic switches and similar devices, and for the transfer of meters, instruments and relays. The Type SB-1 switch is suitable for most applications, but where the switch is subject to abnormally frequent operation (approximately 100 operations or more per hour), more durable cams are required, in which case the Type SB-9 switch should be ordered.

RATINGS

All switches are rated 600 volts, 20 amperes continuous, and 250 amperes for 3 seconds.

The interrupting rating depends on several factors; namely, voltage, current, and inductance of the circuit. It is often necessary to connect several contacts in series to secure sufficient interrupting capacity. The interrupting ratings in the table below are based on the inductance of the average trip coil.

INTERRUPTING RATINGS - AMPERES

CIRCUIT VOLTS	NON-INDUCTIVE CIRCUIT			INDUCTIVE CIRCUIT		
	NUMBER OF CONTACTS					
	1	2 in Series	4 in Series	1	2 in Series	4 in Series
24 d-c	6.0	30.0	——	4.0	20.0	30.0
48 d-c	5.0	25.0	40.0	3.0	15.0	25.0
125 d-c	2.7	11.0	25.0	2.0	6.25	9.5
250 d-c	0.75	2.0	8.0	0.7	1.75	6.5
600 d-c	0.25	0.45	1.35	0.15	0.35	1.25
115 a-c	40.0	75.0	——	24.0	50.0	——
220 a-c	25.0	50.0	——	12.0	25.0	40.0
440 a-c	12.0	25.0	——	5.0	12.0	20.0
550 a-c	6.0	12.0	——	4.0	10.0	15.0

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

RECEIVING AND STORAGE

RECEIVING

Immediately upon receipt of a switch, examine it for any damage sustained in transit. If injury or rough handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest General Electric Apparatus Sales Office.

The switches are completely assembled and packed in individual cartons before shipment.

STORAGE

If the switches are for stock purposes or not for immediate installation, they should be left in the shipping carton and stored in a clean dry location.

DESCRIPTION

CONSTRUCTION

All types of these switches are built up of a series of individual stages, each nested into the other, plus a common fixed contact support, operating shaft, front support and rear support (see Fig. 5). The complete stack is tied together with two tie bolts threaded into the front support. Each rotary stage consists of an insulating barrier carrying one or two moving contacts, and two or three cams on the shaft which operates the moving contacts. A push-pull stage is similar to the rotary stage except only one cam is used. Each moving contact and its associated fixed contact on the fixed contact support constitute a complete switch contact.

CONTACT IDENTIFICATION

The movable contacts are marked for identification following a standard system. Starting with the stage next to the panel, the contacts on the right side--looking toward the rear--are given odd numbers beginning with "1" (see Fig. 1), and the contacts on the left side even numbers beginning with "2". Occasionally, a contact is omitted from a stage. If so, the corresponding number is also omitted.

ENCLOSURES AND MOUNTING

The basic switch design is for panel mounting and includes a molded cover as shown on the front cover. When requested, switches are furnished assembled in various enclosures, such as the fabricated-metal enclosure for wall mounting, the watertight enclosure, and the explosion-proof enclosure. When conditions require the switch to be operated immersed in oil, it is furnished mounted in an enclosure similar to the watertight enclosure except that the lower removable portion is filled with oil.

Switches for panel mounting are furnished with shafts and mounting screws suitable for mounting on panels 1/8 inch to 3/16 inches thick. When requested, shafts and mounting screws are furnished for 1, 1-1/2, or 2 inch panels. For intermediate thicknesses of panels, spacers are furnished to fill the excess space between the front support and the panel.

INSTALLATION

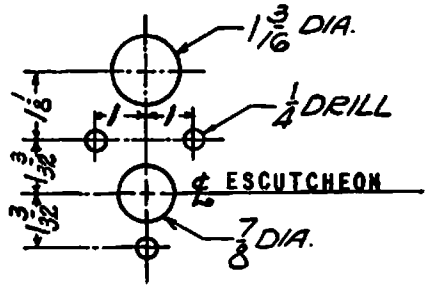
For panel-mounted switches, holes should be provided in the panel as shown in Fig. 4. The shaft hole is shown with a 1-1/8 inch diameter. This is done to provide one panel hole for all switches. The removable handle and lock handle switches require the 1-1/8 inch diameter hole, while a 1/2 inch diameter hole suffices for all other switches. For switches furnished in metal enclosures, mounting dimensions should be obtained from the approved outline drawings, or from the switches themselves.

To mount a fixed-handle switch on a panel, first remove the handle and escutcheon, including where provided, the position-indicating pointer and curved spring washer (saddle spring). Next, hold the switch in place on the back of the panel and insert the mounting screws through the escutcheon and panel into the switch front support, but do not tighten the mounting screws. Attach the pointer, saddle spring and handle. Align the escutcheon on the panel. Insert the mounting screws through the escutcheon and panel and place the spacers (if used) on the screws before putting the switch in place.

When mounting removable-handle switches be certain that the shaft of the switch is properly positioned, so the handle is easily removed, before the mounting screws are tightened.

Switches with a key lock in the handle have the handle attached to the escutcheon so the two parts are removed or installed as a unit. The shaft and handle are joined by a slotted coupling on the back of the escutcheon and these parts should be lined up before inserting the mounting screws.

When a back-of-board locking mechanism and separate (Yale) lock are furnished with a switch, the panel drilling shown in Fig. 4 is required. The lock should be installed first. Turn the key until the lever at the back of the lock is entirely within the barrel diameter, and remove the two knurled rings. Insert the barrel through the panel, from the front, with the spacing ring (where used) at the front of the lock and fasten it in place by tightening the knurled rings on the barrel behind the panel. With the cylinder in the locked position the lever on the back of the barrel should extend on the vertical center line towards the switch shaft. Turn the



PANEL DRILLING
FRONT VIEW

Fig. 4 (116A132-4) Panel Drilling (Front View)

switch shaft to a locked position and mount the switch on the panel as directed in a previous paragraph, being careful to put the pin on the lock lever into the slot in the locking bolt of the mechanism. Operate the switch and check to see that the locking bolt will easily enter each slot in the locking wheel. It may be necessary to loosen the lock and shift its position slightly to secure satisfactory operation of the locking mechanism. When the mechanism operates correctly, the lock must be re-tightened on the panel.

OPERATION

Type SB-1 and SB-9 switches are rotary cam-operated switches. Rotation of the switch shaft causes contacts to close or open according to the shape and setting of the cams in the various stages. Each stage has one or two contacts with two or three cams. On drawings these cams are designated A, B and C (see Fig. 5). Cam (A) is the one nearest the panel and is the closing cam for the even numbered contacts. The (B) cam is next and is the opening cam for both contacts; cam (C) is farthest from the panel and is the closing cam for the odd numbered contacts. When a contact is omitted, its corresponding closing cam is omitted and a spacer substituted.

When the total rotation of the switch is more than 150 degrees, there is, due to the common opening cam (B), a certain limitation to the opening and closing of the contacts (see Fig. 6). If the No. 2 contact is closed at zero degree, then after the shaft has been rotated 180 degrees, the notch in the cam (B), which allows the contact to close, will be opposite the No. 1 contact and there will be nothing to hold the No. 1 contact open. Therefore, the No. 1 contact must be closed at this point or it must be omitted from the switch. In other words, whatever happens to one contact at any point in the periphery of the switch rotation must happen to its companion contact in the same stage when the switch is rotated 180 degrees from that point.

Generally, it is possible to design the switch so those contacts that close 180 degrees opposite each other are in the same stage, but sometimes it is necessary to design the switch with only one contact per stage.

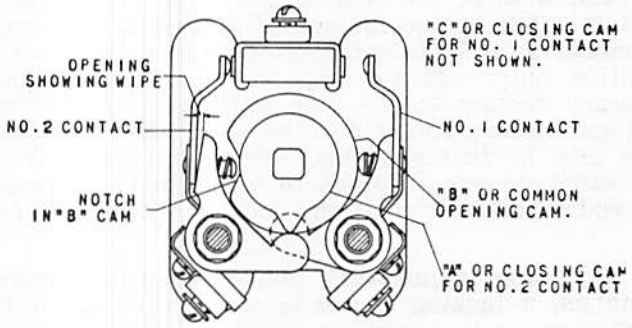


Fig. 6 (K-6507946) Typical Section Showing Operation Of Cams - Front View

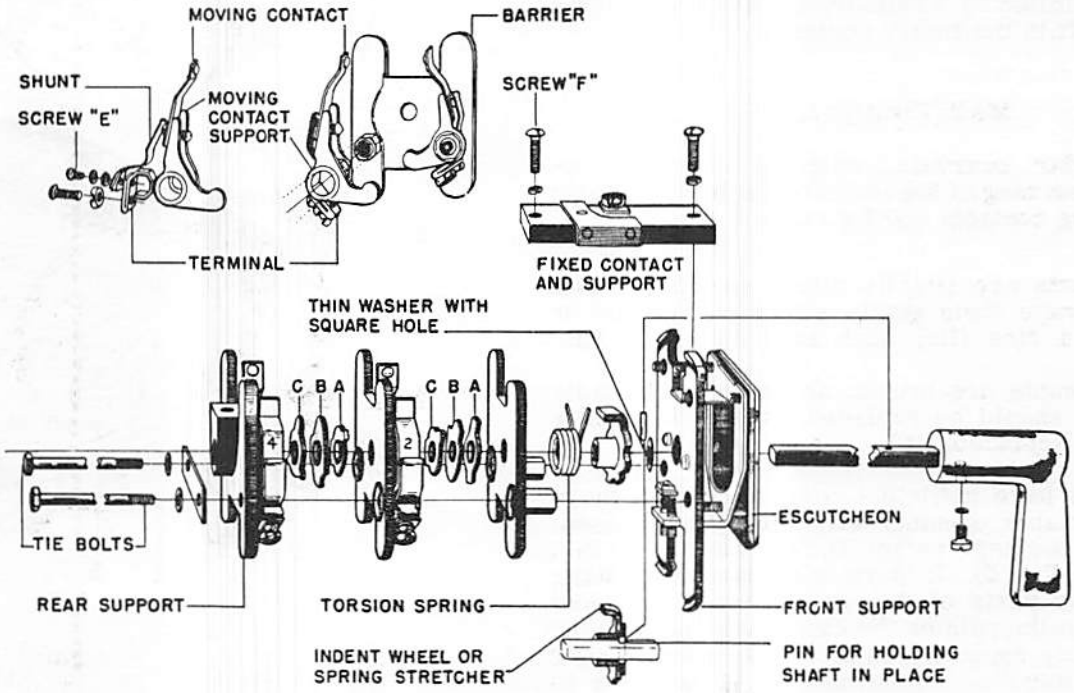


Fig. 5 (8009283) Exploded View Of Type SB-1 Switch

Some applications, particularly of momentary contact switches, which have a torsion spring to return the switch to a central-neutral position, require a contact action which lags behind the switch motion (lost motion or slip contacts). Such contacts use cams with a special loose fit on the shaft. When the shaft has turned far enough to close or open these contacts, it can be rotated 45 degrees in the reverse direction without moving the cams, but beyond this point, the cam moves with the shaft, and the contacts either open or close as the case may be.

Momentary contact switches have a torsion spring that returns the switch to a central or neutral position when the handle is released after operation to a side position or positions. This torsion spring is designed for a maximum of 90 degrees operation to each side of the central position. The torsion spring may have one end cut off or tied back in such a manner as to be effective on one side of the central position only. That is, the switch may have momentary contact to one side of the central position and maintaining contacts to the other side. Switches may also be furnished that are spring return from the extreme-end positions to a position in between the end position or positions and the central position.

In some momentary contact (spring return) switches, a locking device is provided by which the shaft may be held against the action of the torsion spring by pulling out the handle when the switch is turned to one of the side positions.

Type SB-10 switches, in addition to rotary contacts using SB-1 cams, have contacts operated by pulling out or pushing in the switch handle. The push-pull contacts are located at the front of the switch, with closing action provided by leaf springs and opening action by a cylindrical cam which slides over the shaft to the rotary contacts.

MAINTENANCE

At regular intervals, switches should be inspected for burning of the contacts, for broken shunts on the moving contacts and for contact wipe.

If contacts are slightly pitted, or coated with sulphide, scrape them gently with a sharp knife or dress with a fine file, such as a #00 dental file.

If the shunts are broken or the contacts badly pitted, they should be replaced as directed under "Repair and Replacement".

Contacts have sufficient wipe as long as there is an appreciable opening, with the contact closed, between the moving contact and the moving contact support (see Fig. 6). If there is no opening, it indicates that the parts of the moving contact support that bears on the cam or the cam itself has become worn and needs replacing as directed under "Repair and Replacement". Sometimes it is possible to secure a temporary repair by bending the moving contact so it has a smaller separation from the fixed contact when in the open position.

REPAIR AND REPLACEMENT

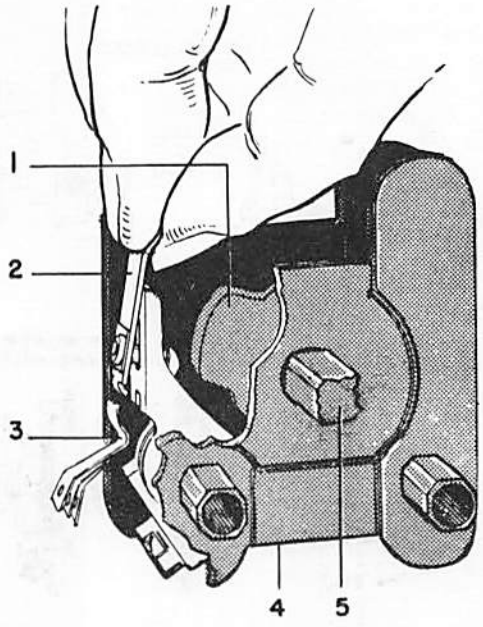
MOVABLE CONTACTS

If a movable contact is burned, or has a broken shunt, replace the entire contact assembly. To do this, position the switch so the contact to be replaced is open. Remove screw (E, Fig. 5) and its clamping washer. Press in on the top of the contact to release the tongue at the lower end and pull the assembly upward and off (see Fig. 7).

To replace the new contact assembly, slide it downward with its shoe (1, Fig. 8) on the inside of the support (3, Fig. 8), until the tongue (2, Fig. 8) at the lower end of the contact drops into the holding notch (4, Fig. 8) on the support. Bring the loose end of the shunt (3, Fig. 7) down to the terminal and fasten it in place with the clamping washer and screw (E). Avoid creasing or kinking the thin metal strips of the shunt. Operate the switch and observe whether the contacts meet squarely and simultaneously. The contacts can be adjusted by bending slightly with smooth-faced pliers. After adjustment there should be an appreciable opening, with the contacts closed, between the moving contact and the moving contact support.

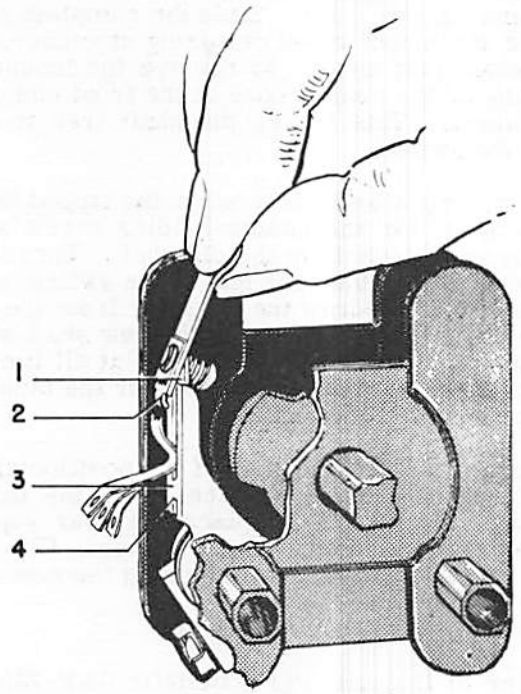
FIXED CONTACTS

Damage to a fixed contact requires replacement of the complete assembly of fixed contacts and support. Remove screws (F, Fig. 5), change assemblies and replace the screws. Operate the switch and check the contact alignment.



1. Cam
2. Movable Contact
3. Shunt
4. Barrier
5. Operating Shaft

Fig. 7 Removing Contact Finger



1. Shoe
2. Tongue
3. Support
4. Holding Notch

Fig. 8 Installing New Contact Finger

On some switches the ball and spring of the positioning device are carried in the fixed-contact support. Care must be exercised to prevent losing the ball and spring when removing the fixed-contact support. The ball and spring are replaced best, after the new fixed-contact support has been assembled on the switch, by removing the spring retainer on the top of the fixed-contact support, inserting the ball and spring, and replacing the retainer.

CAMS, BARRIERS, MOVING-CONTACT SUPPORTS, ETC.

When cams, barriers, moving-contact supports, etc., need to be replaced or changed, the switch should be removed from the panel and disassembled on a bench and re-assembled with replacement parts. The moving-contact support and terminal are tightly assembled on the barrier in the factory. It is practically impossible to remove them from the barrier without damage to the parts or the barrier. If any of the parts require replacement it is best to secure a complete assembled replacement unit, including the barrier, moving contact support, and terminal, from the factory.

SWITCH DIS-ASSEMBLY

Before dis-assembling the switch, secure a drawing showing the cam arrangement in all the stages of the switch. Turn the switch shaft to the switch position corresponding to the cam arrangement. This is a twelve-o'clock position unless otherwise noted on the drawing. Remove the handle and fixed-contact support. Unscrew the tie bolts from the switch support, but leave them in the switch. Stand the switch on the bench, resting on the rear support, and slip the front support off the shaft being careful to hold the shaft in the switch so as not to pull it out of the cams in the rear stages. Do not lose the ball from the positioning device. Slide the shaft out just enough to remove the pin, through the shaft, which seats in the counterbore in the indent wheel or spring-stretcher (refer to Fig. 5). Do not slide the shaft out of the cams in the rear stage. Push the shaft back into the switch and slip off the indent wheel and thin washer that is assembled between the indent wheel and front support. Remove the first barrier to expose the cams for contacts No. "1-2".

Check these cams against the cam arrangement drawing. Be sure the cam arrangement drawing is fully understood before disturbing the cams.

On the drawing, the cams for each stage are usually shown in horizontal rows of three cams, or two cams and a spacer. Beside each horizontal row are the numbers of the contacts, such as "1-2", with which the cams are used. The vertical rows are lettered "A", "B", and "C". Cam (A) is the one removed first, working from the front end of the switch, cam (B) next, and cam (C) last (see Fig. 5). Unless otherwise stated, the position of the cams on the drawing are for the twelve-o'clock switch position.

Remove the cams from the first stage, and after making sure there are no jumpers holding the barriers together, remove the barriers. Continue removing cams and barriers until the damaged part is reached

SWITCH ASSEMBLY

To assemble the switch, place the rear support on the bench, with the rear side down, and with the bolt heads against the bench, so they are retained in the rear support, with the threaded ends extending vertically. Place the end of the shaft in the rear support so the shaft stands vertically. Turn the shaft to the twelve-o'clock position, or to the switch position that agrees with the cam arrangement as stated on the drawing. The cams for the rear stage may now be assembled in the exact position shown on the drawing, cam (C) first, cam (B) second, and cam (A) last. The remaining barriers and corresponding cams are similarly assembled. When the front barrier, which carries no contacts, is in place, assemble the indent wheel (or spring stretched and torsion spring) with the counterbored end toward the front of the support. Pull the shaft out just enough to permit the locking pin to be inserted through the shaft. Push the shaft back into the switch and slide the thin washer over the shaft. Slide the front support into place. Hold the stack of barriers together and turn the switch to a horizontal position with the moving contacts pointed up.

If it is a maintaining-contact switch with a large indent wheel, that is, with the ball and spring

in the fixed-contact support, or if it is a spring-return switch, the tie bolts may now be screwed into the front support. Before tightening the tie bolts be sure the barriers are all properly nested.

If the switch is a maintaining-contact switch with a small indent wheel, slide the front support forward enough so the ball may be placed into the socket in the front support and line up a notch in the indent wheel with the ball in the front support. Then the front support may be slid back into place against the front barrier. Make sure the barriers are all properly nested before tightening the tie bolts.

The fixed contacts and support may now be assembled on the switch. If the switch has a position where all the contacts are open, turn it to this position to assemble the fixed contacts and support.

SHAFT CHANGE

When it is necessary to change the switch shaft, that is, install a longer or shorter shaft, the switch may be dis-assembled as directed, or the new shaft may be used to push out the old shaft as follows:

If there is room enough behind the panel to work on the switch, it is not necessary to remove the switch. Otherwise the switch must be removed to a bench vise where the front support can be supported firmly, with the fixed contact at the top.

Remove the fixed-contacts and support. Remove the rear support, being careful to leave the rear cams on the shaft. Slide the complete stack, including the indent wheel or spring stretcher, back on the shaft just enough to remove the locking pin that seats in the counterbore in the front end of the indent wheel. This leaves the shaft free to move through the switch.

First, check and make sure the tapped hole in the new shaft for the handle-holding screw aligns correctly with the hole in the old shaft. Then insert the new shaft into the rear end of the switch, and at the same time withdraw the old shaft from the front of the switch. The front end of the new shaft should touch the rear end of the old shaft at all times so that all the cams are on one shaft or the other and never loose within the switch.

Replace the locking pin. If the positioning ball has become dislodged, replace it in the manner previously described. Replace the rear support, tie bolts, and fixed contacts and support. Check for proper operation of the switch using the new shaft.

RENEWAL PARTS

Refer to Renewal Parts Bulletin GEF-2357. In the absence of a renewal parts bulletin address the nearest General Electric Sales Office, specify the quantity required, describe the part and give the complete data from the nameplate at the rear of the switch.

INSTALLATION

TYPE AB-30

AMMETERS AND VOLTMETERS

(THIS PUBLICATION FORMERLY IDENTIFIED AS GEH-1560)

Cut and drill the panel as indicated in Fig. 1. All drilling and wiring on the switchboard should be completed before mounting the instruments. The instruments must be mounted in a level position.

These instruments are practically unaffected by stray fields, but it is advisable to keep wires carrying heavy current as far as possible from all indicating instruments. When the instrument is mounted in a level position, any deviation from zero should be corrected by means of the zero adjustment.

Connect the instrument as shown in the appropriate diagram.

GROUNDING CASES OF A-C INSTRUMENTS

If transformers are used on circuits of over 150 volts, connect the grounded side of the secondary circuits to the instrument case. Use No. 12 Awg copper wire. Grounding connections should be made in accordance with the provisions of the National Electric Code.

A-C AMMETERS

When the circuit exceeds 30 amperes or 650 volts, a current transformer of the ratio indicated on the nameplate must be used.

A-C VOLTMETERS

When the circuit exceeds 750 volts, a potential transformer of the ratio indicated on the instrument nameplate must be used.

An external Form-3 resistor must be used on instruments rated 750 volts.

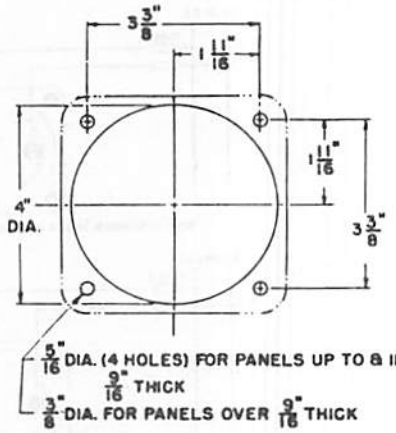


Fig. 1. Cut-out and panel drilling dimensions

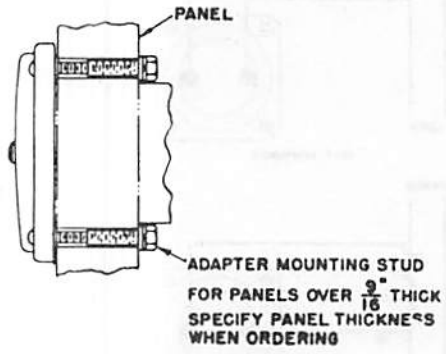


Fig. 2. Adaptor mounting stud

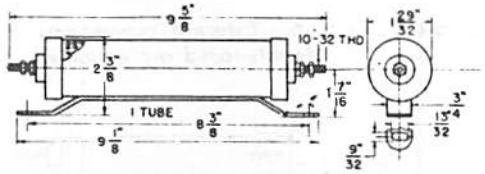


Fig. 3. Dimensions of single-tube, Form-3 resistor

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

GENERAL ELECTRIC

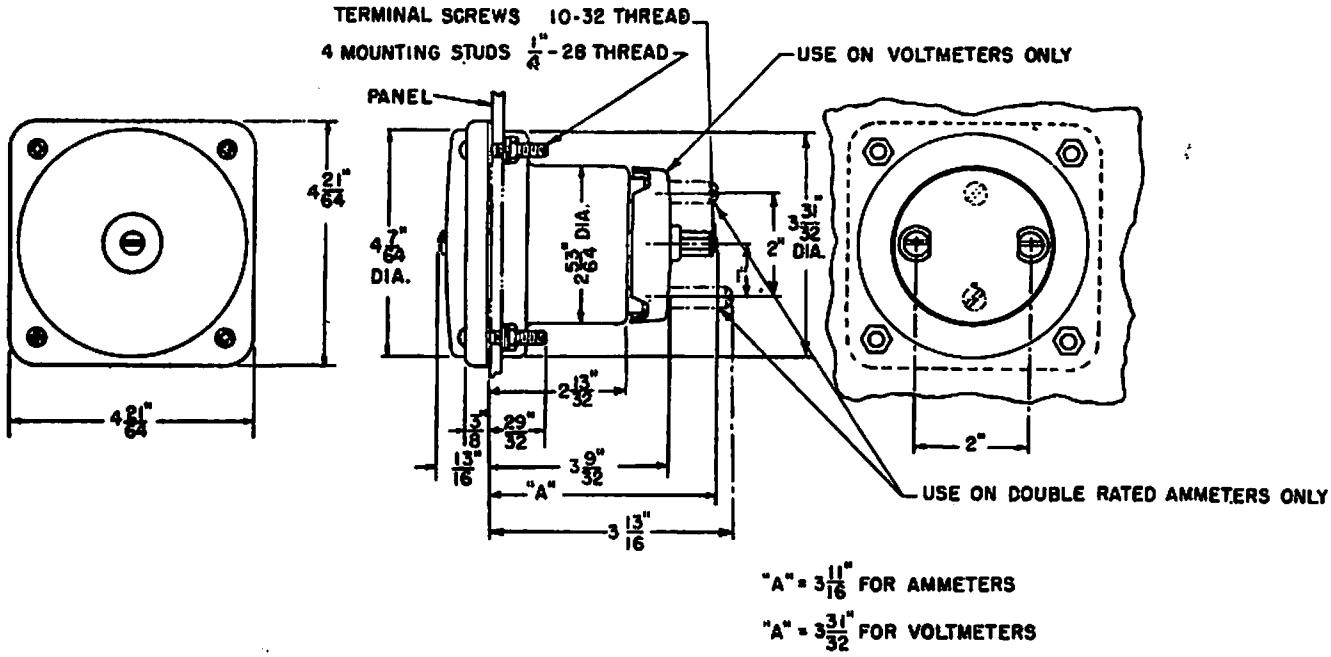


Fig. 4. Dimensions of Type AB-30 ammeters and voltmeters

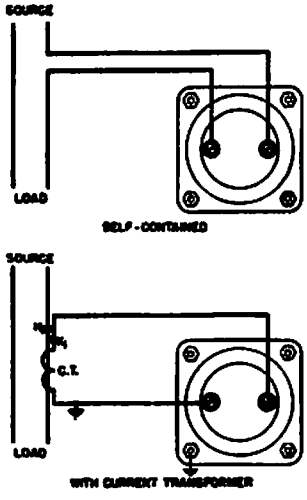


Fig. 5. External connections of a-c ammeter

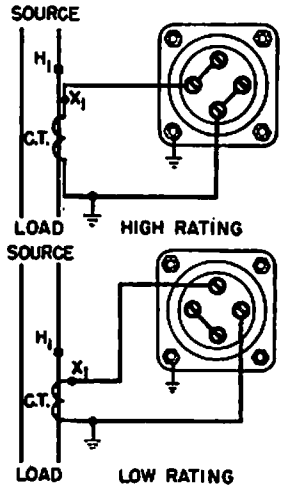


Fig. 6. External connections of double-rated a-c ammeter

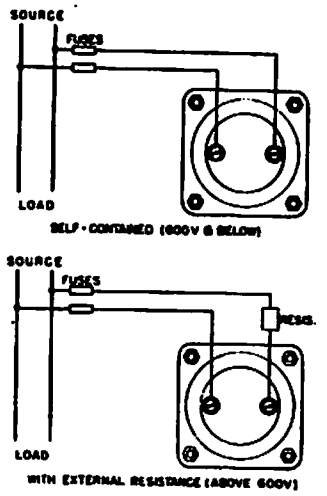


Fig. 7. External connections of a-c voltmeter

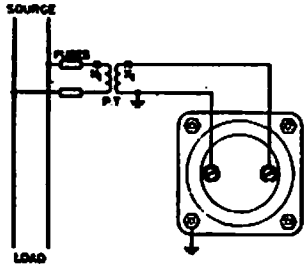


Fig. 8. External connections of a-c voltmeter with potential transformer

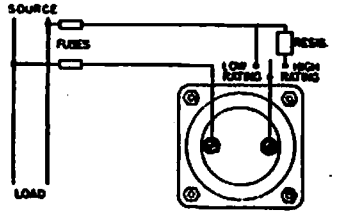


Fig. 9. External connections of double-rated a-c voltmeter without potential transformer

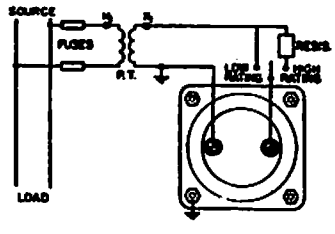


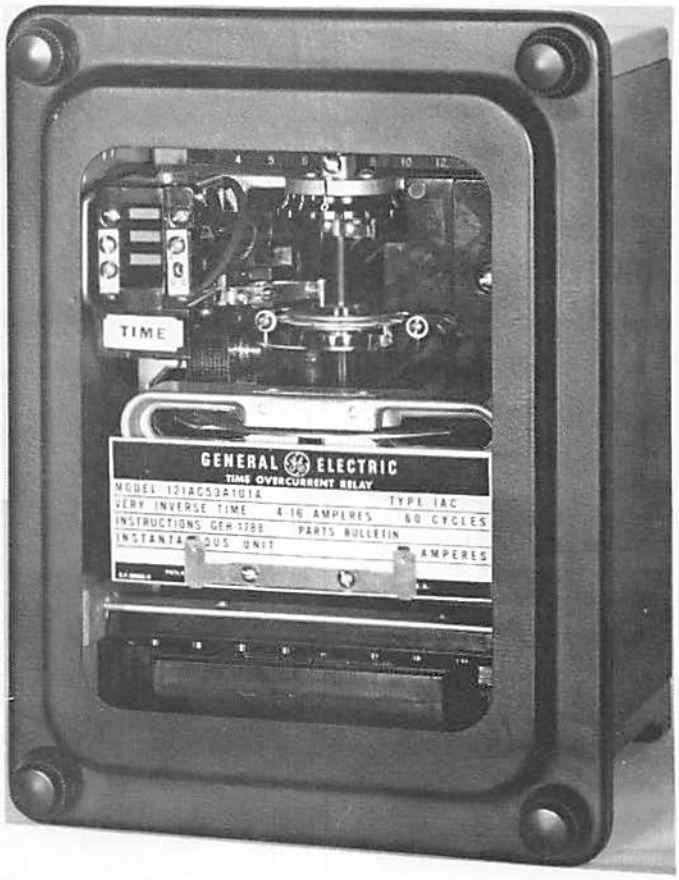
Fig. 10. External connections of double-rated a-c voltmeter with potential transformer

PRINTED IN U.S.A.

INSTRUCTIONS

GEH-1788D
SUPERSEDES GEH-1788C

TIME OVERCURRENT RELAYS



Types

IAC53A
IAC53B
IAC53C
IAC53R
IAC54A
IAC54B

SWITCHGEAR DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA, PA.

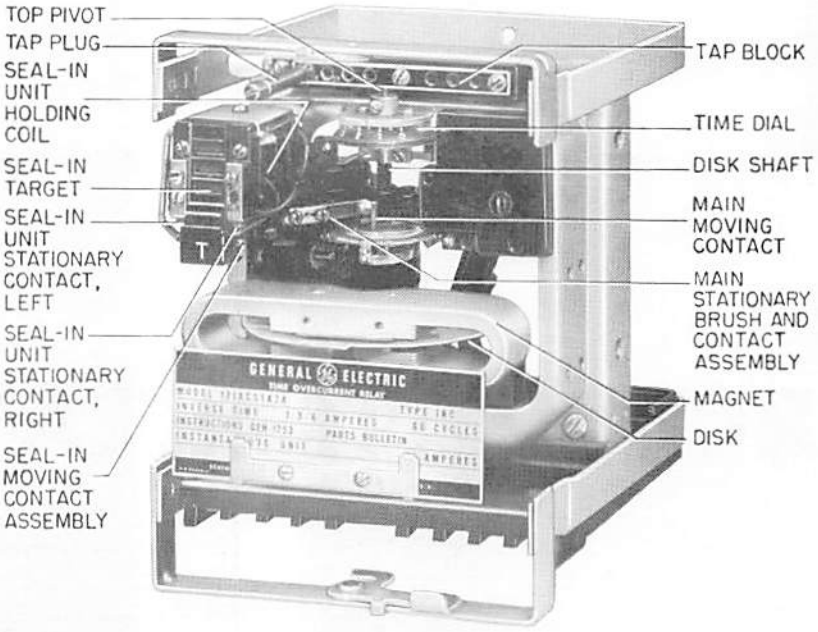


Fig. 1 The Induction Unit for Type IAC Relays (Front View)

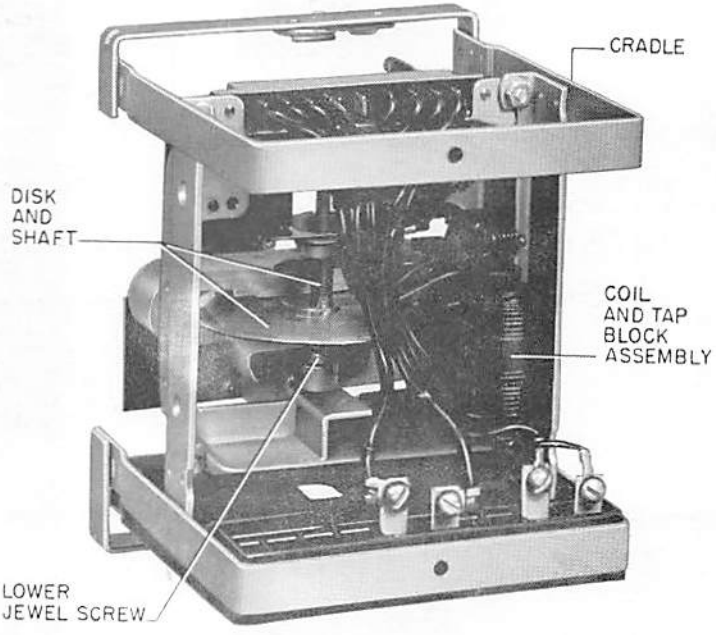


Fig. 2 The Induction Unit for Type IAC Relays (Rear View)

Fig. 1 (8022525)

Fig. 2 (8022528)

Cover (8035285)

TIME OVERCURRENT RELAYS
TYPE IAC

INTRODUCTION

Type	Contact Circuits	Instan. Unit	A-C Trip Unit	Induc. Unit	Outline & P. D.	Int. Conn.
IAC53A(-)A	One	No	No	One	Fig. 20	Fig. 12
IAC53B(-)A	One	Yes	No	One	Fig. 20	Fig. 13
IAC53C(-)A	One	No	Yes	One	Fig. 20	Fig. 14
IAC53R(-)A	One	Yes	Yes	One	Fig. 21	Fig. 15
IAC54A(-)A	Two	No	No	One	Fig. 20	Fig. 16
IAC54B(-)A	Two	Yes	No	One	Fig. 21	Fig. 17

The Types IAC53 and IAC54 relays are time overcurrent relays with a very-inverse time characteristic. They are employed to protect against overcurrent on single-phase and poly-phase circuits. The various relays described in this instruction book differ in the number of circuits they close, and if an instantaneous unit and/or an a-c tripping unit is included.

These relays consist of an induction unit or an induction unit with an instantaneous unit which permits instantaneous tripping for exteremely high currents, or an induction unit with an a-c tripping unit for use where d-c power is unavailable or a-c tripping is preferred. Since practically all Type IAC relays are composed of various combinations of the above (that is, the induction unit, the instantaneous unit and the a-c tripping unit), 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.

INDUCTION UNIT

INTRODUCTION

The induction unit is the basic unit in all Type IAC relays. Figs. 1 and 2 show 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 a permanent magnet acting on the disk to give the correct time delay.

There is a seal-in unit mounted on the front to the left of the shaft. This unit has its coil in series and its contacts in parallel with the main contacts such that when the main contacts close the seal-in unit picks up and seals in. When the seal-in unit 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 Type IAC relays, supplying the very 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. 3.

RATINGS

The induction unit is designed to use any one of three operating coils, each having a different combination of taps as follows, 4, 5, 6, 7, 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.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

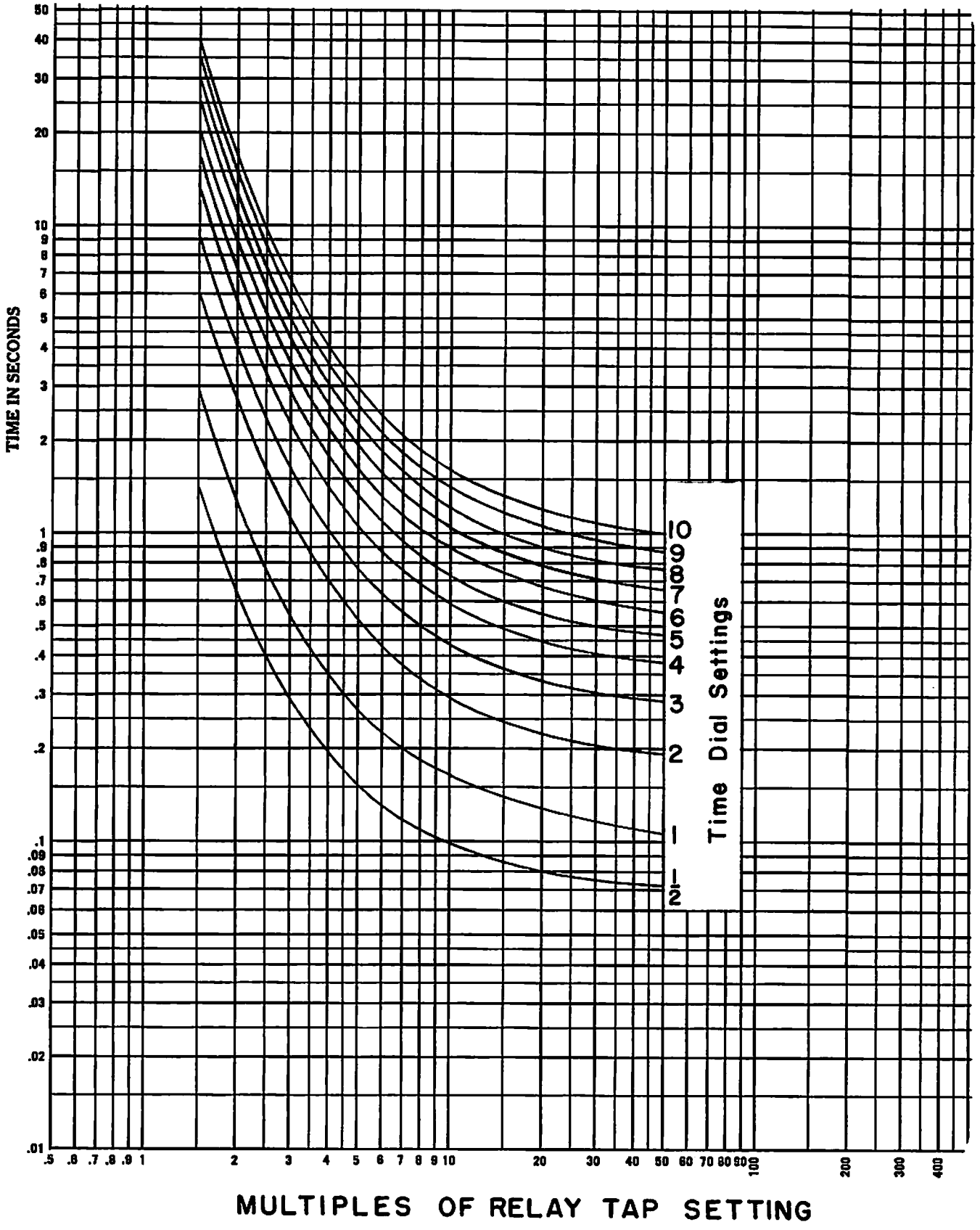


Fig. 3 (0888B0279)

Fig. 3 Time-Current Curves for Type IAC Relays with Very-Inverse-Time Characteristics

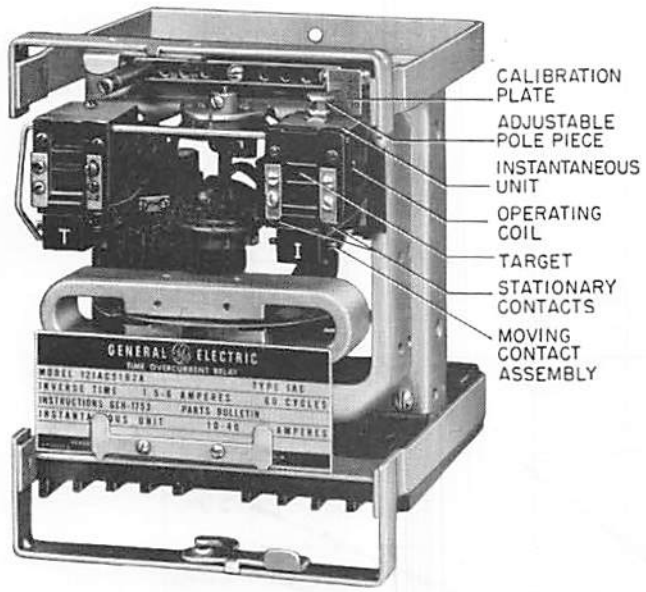


Fig. 4 (8022527)

Fig. 4 Type IAC Relay with an Instantaneous Unit (Front View)

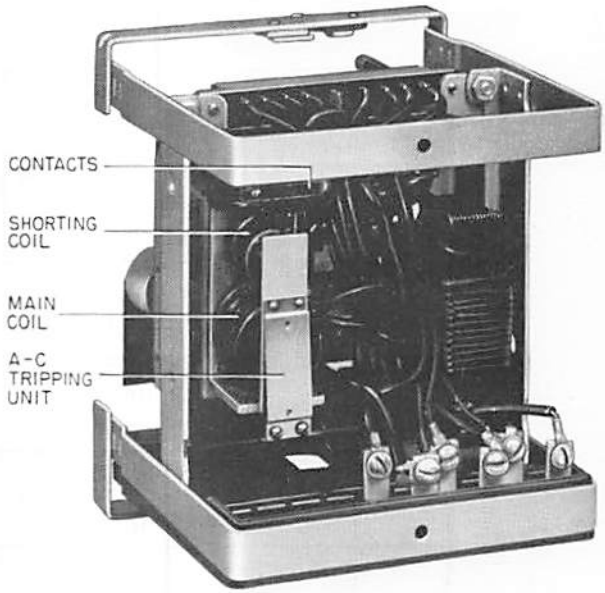


Fig. 5 (8022526)

Fig. 5 Type IAC Relay with an A-C Trip Unit (Rear View)

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, a-c or d-c	
	2-Amp Tap	0.2 Amp Tap
Tripping Duty	30	5
Carry Continuously	3	0.3
Operating Range	2-30	0.2-2
Resistance	0.13	7
Impedance at 60 cy	0.53	52

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. 6.

Coil Amps	Freq.	Tap	Amps	Volt Amps	Imp. Ohms	PF
4-16	60	4	5	2.0	0.08	0.50
	50	4	5	1.7	0.07	0.50
	25	4	5	1.3	0.05	0.61
1.5-6	60	1.5	5	14.5	0.58	0.42
	50	1.5	5	12.0	0.48	0.42
	25	1.5	5	9.0	0.36	0.55
0.5-2	60	0.5	5	105.0	4.20	0.35
	50	0.5	5	86.0	3.45	0.34
	25	0.5	5	82.0	3.28	0.55

INSTANTANEOUS UNIT

INTRODUCTION

The instantaneous unit is a small instantaneous hinge-type unit which may be mounted on the right front side of the induction unit (See Fig. 4). 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 unit operates, closing the contact circuit and raising its target into view.

* Denotes change since superseded issue.

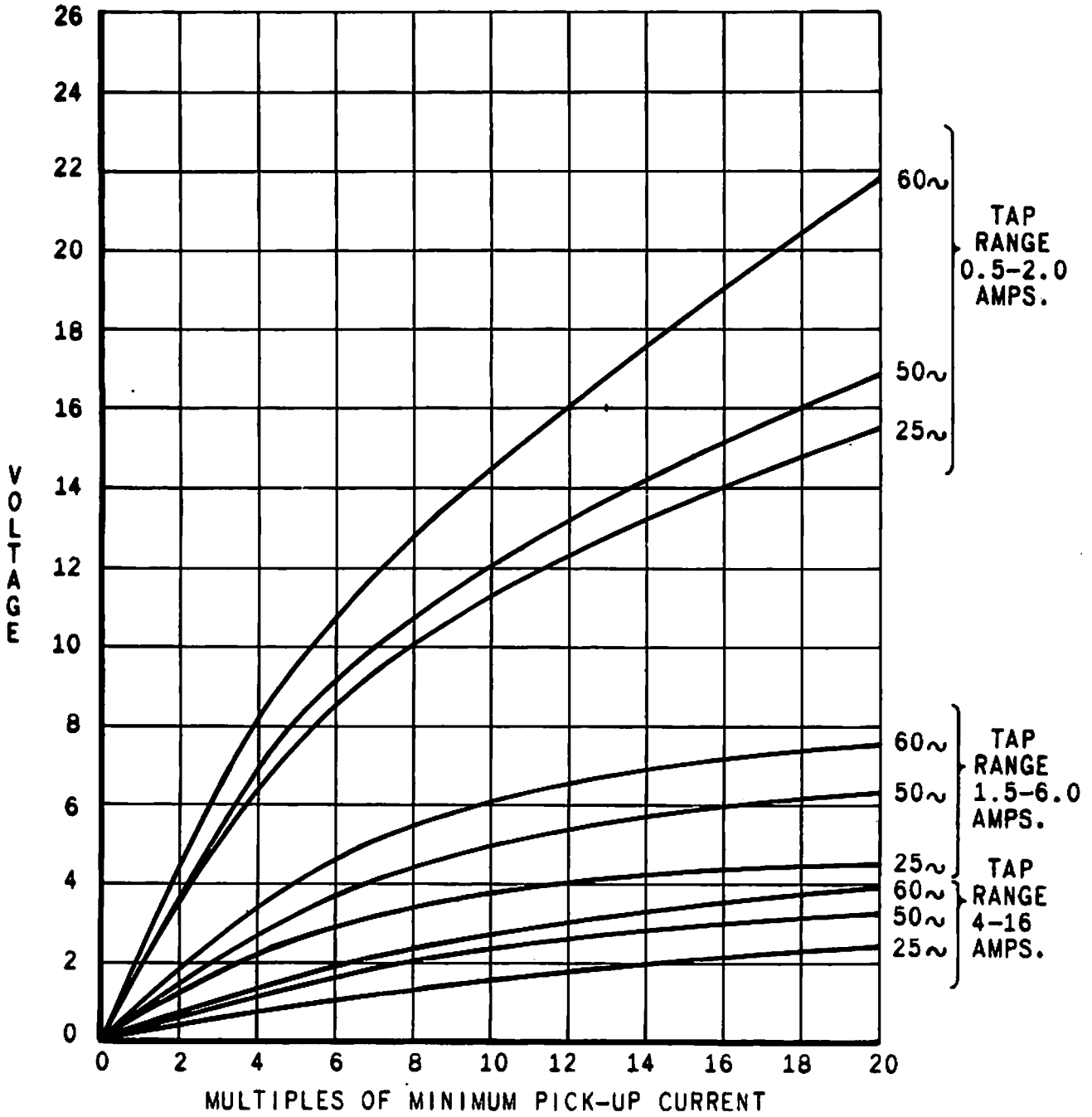


Fig. 6 Saturation Curves for Lowest Taps of the Induction Unit of Type IAC Relays with Very-Inverse-Time Characteristics

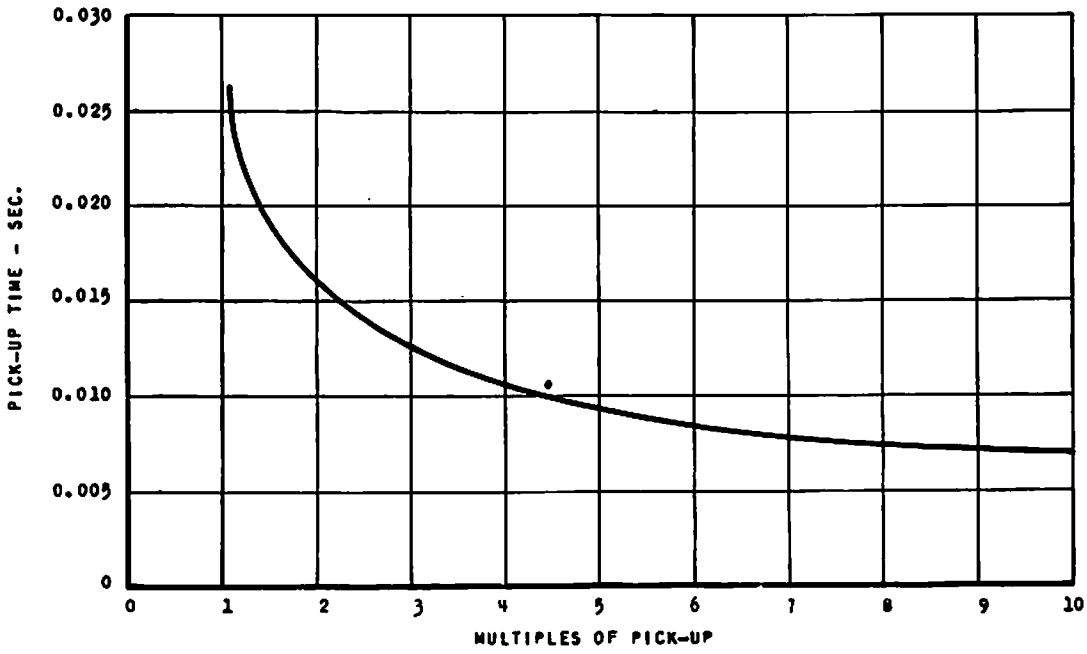


Fig. 7 (K-6306872)

Fig. 7 Time-Current Characteristics of the Instantaneous Unit

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

OPERATING CHARACTERISTICS

The instantaneous unit operates over a 4 to 1 range and has its calibration stamped on a scale mounted beside the adjustable pole piece. Time-current characterisitcs are shown in Fig. 7.

RATINGS

The instantaneous unit is designed to use either of two coils having pick-up ranges of 10 to 40, or 20 to 80 amperes, respectively. The current-closing rating of the contacts is 30 amperes for voltage not exceeding 250 volts.

BURDENS

Burden data on the instantaneous-unit 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	0.68	0.027	0.98
20-80	60	5	0.20	0.008	0.95
	50	5	0.20	0.008	0.95
	25	5	0.18	0.007	0.98

A-C TRIPPING UNIT

INTRODUCTION

The a-c tripping unit is a Type REA relay unit designed to energize a circuit-breaker trip coil from its associated current transformer upon the operation of the main unit of the Type 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 unit is mounted on the rear of the frame opposite the tapped operating coil of the induction unit (see Fig. 5). The operation of this unit is illustrated in Fig. 11. The secondary current circulates through the induction unit current coil and the main coil of the Type REA auxiliary tripping unit, returning through the Type REA contacts to the current transformer. Normally, most of the flux generated by the main Type 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 Type REA unit is short-circuited and current flows in this coil by transformer action, causing a redistribution of flux which actuates the armature and the Type REA contacts. The opening of the Type REA contacts causes the secondary current to flow through the trip coil which trips the breaker.

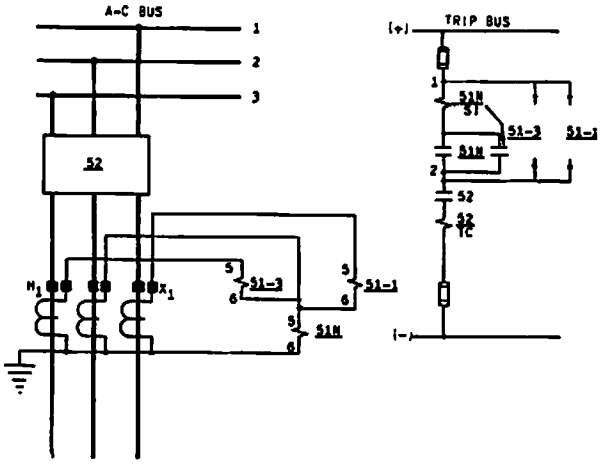


Fig. 8 External Connections Of Three Type IAC53A Relays Used For Phase-To-Phase And Ground Overcurrent Protection Of A 3-Phase Circuit

Device Function Numbers for Use with ALL External Diagrams

50 - Instantaneous Unit
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.

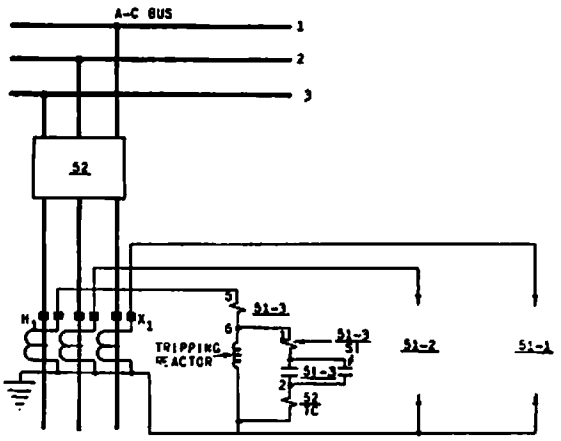


Fig. 9 External Connections Of Three Type IAC53A Relays Used In Conjunction With Tripping Reactors For Protection Of A 3-Phase Circuit

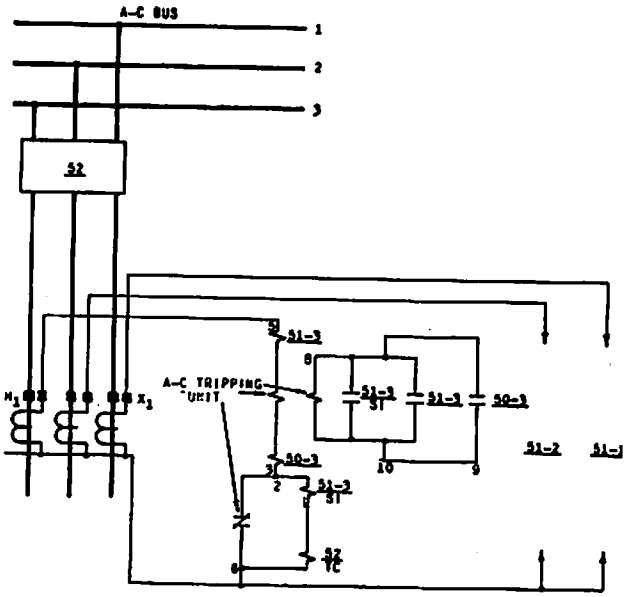


Fig. 10 External Connections Of Three Type IAC53R Relays Used For 3-Phase Circuit Protection

Fig. 8 (K-6375667)
Fig. 9 (K-6375668)
Fig. 10 (K-6375669)

APPLICATION

The a-c tripping unit 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.

RATINGS

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

BURDENS

Burdens of the Type REA unit are given in the following table:

Frequency	Amps	Impedance in Ohms	PF	Volt-Amperes
60	5	0.49	0.80	12.2
50	5	0.33	0.80	8.3
25	5	0.23	0.62	5.8

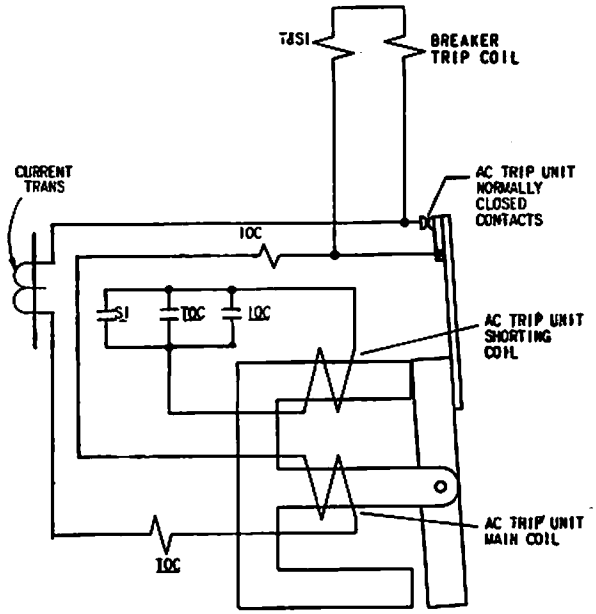


Fig. 11 (K-6154766)

Fig. 11 Diagram Illustrating Operation of Type IAC Relays having an A-C Tripping Unit

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 a relay, examine it for any damage sustained in transit. If injury or damage resulting from rough handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest General Electric Apparatus Sales Office.

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.

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 Figs. 19 and 20.

CONNECTIONS

The internal connection diagrams for the various relay types are shown in Figs. 12 to 17 inclusive. Typical wiring diagrams are given in Figs. 8 to 10 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.

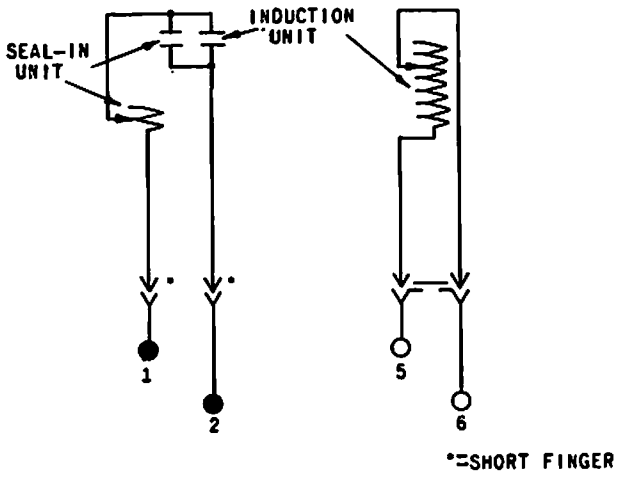


Fig. 12 Internal Connections For Type IAC53A Relay (Front View)

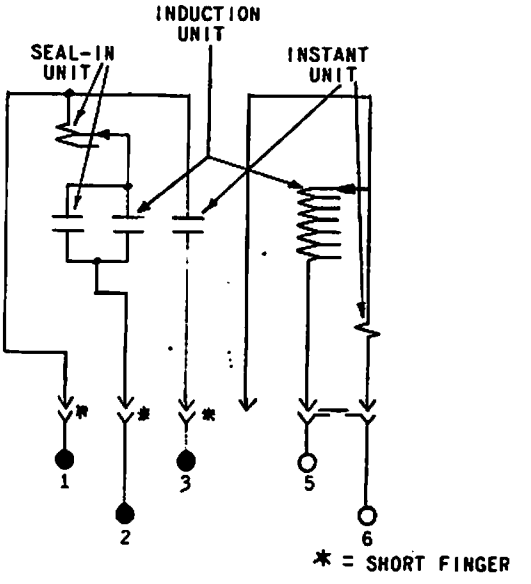


Fig. 13 Internal Connections For Type IAC53B Relay (Front View)

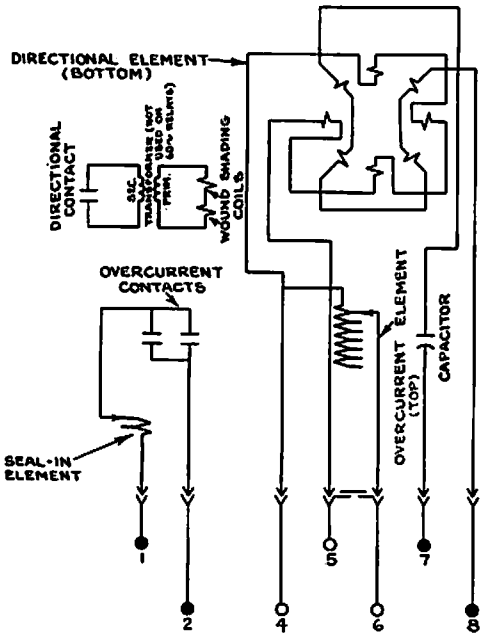


Fig. 14 Internal Connections For Type IAC53C Relay (Front View)

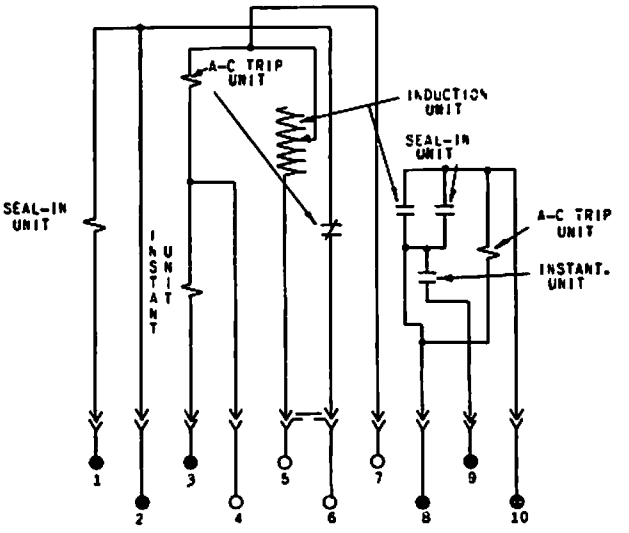


Fig. 15 Internal Connections For Type IAC53k Relay (Front View)

Fig. 12 (K-6209658)

Fig. 13 (K-6209661)

Fig. 14 (K-6209669)

Fig. 15 (K-6209294)

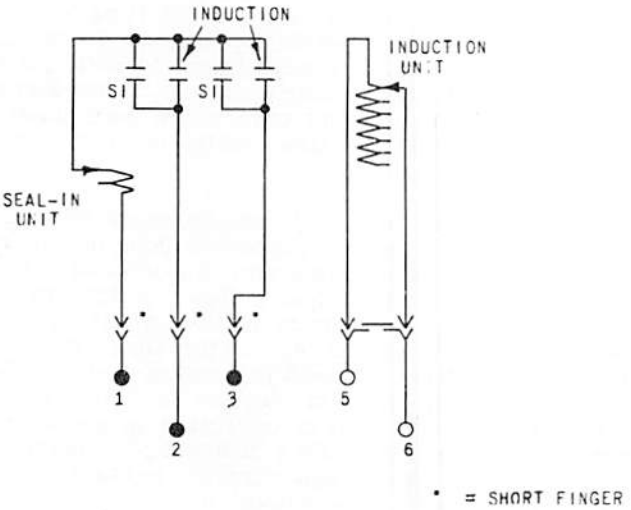


Fig. 16 (K-6209662)

Fig. 16 Internal Connections for Type IAC54A

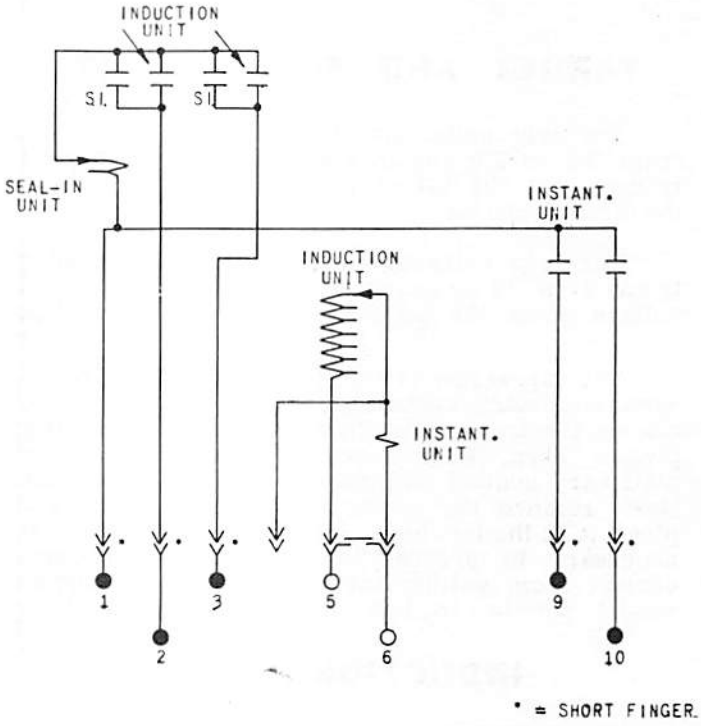
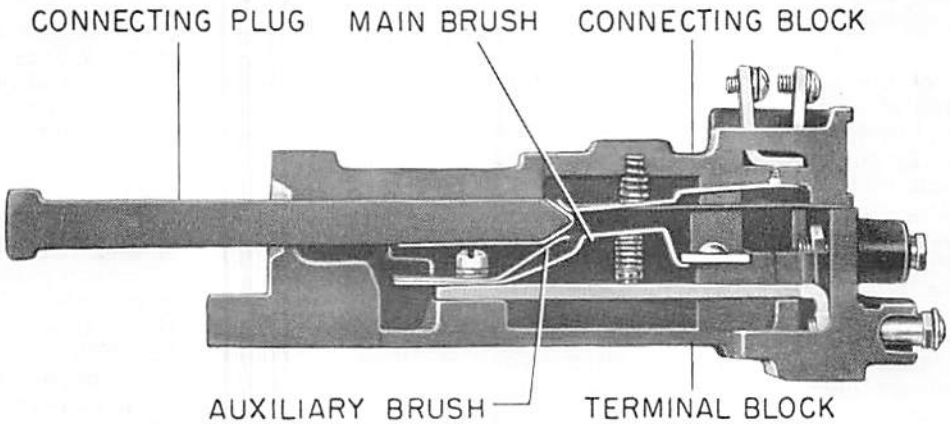


Fig. 17 (K-6209663)

Fig. 17 Internal Connections for Type IAC54B

*CAUTION:

Every circuit in the drawout case has an auxiliary brush. It is especially important on current circuits and other circuits with shorting bars that the auxiliary brush be bent high enough to engage the connecting plug or test plug before the main brushes do. This will prevent CT secondary circuits from being opened.



NOTE: AFTER ENGAGING AUXILIARY BRUSH, CONNECTING PLUG TRAVELS 1/4 INCH BEFORE ENGAGING THE MAIN BRUSH ON THE TERMINAL BLOCK.

Fig. 18 (8025039)

*Fig. 18 Cutaway of Drawout Case Showing Position of Auxiliary Brush

*Denotes change since superseded issue.

ADJUSTMENTS

TARGET AND SEAL-IN UNIT

For trip coils operating on currents ranging from 0.2 to 2.0 amperes at the minimum control voltage, set the target and seal-in tap screw 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 screw in the 2-ampere tap.

The tap screw is the screw holding the right-hand stationary contact of the seal-in unit. 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.

INDUCTION UNIT

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 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 tool 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 per cent 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 the 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 toward the main shaft of the unit decreases the time, while moving it away 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 dfifference 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. 3 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. 3, 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 1.0 second 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 amperes. Since there is no 7.5 ampere tap, the 8-ampere tap is used. To find the proper time-dial setting to give 1.0-second 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. 3), it will be seen that 7.8 times the minimum operating current gives 1.0-second time delay when the relay is set on 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.

INSTANTANEOUS UNIT

Select the current above which is desired to have the instantaneous unit operate and set the adjustable pole piece so that the top of 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 inch 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 UNIT

The a-c tripping unit 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:

CONTACT ADJUSTMENT

With the unit 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.

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 unit. Tighten the bracket screws securely after the proper adjustment has been obtained.

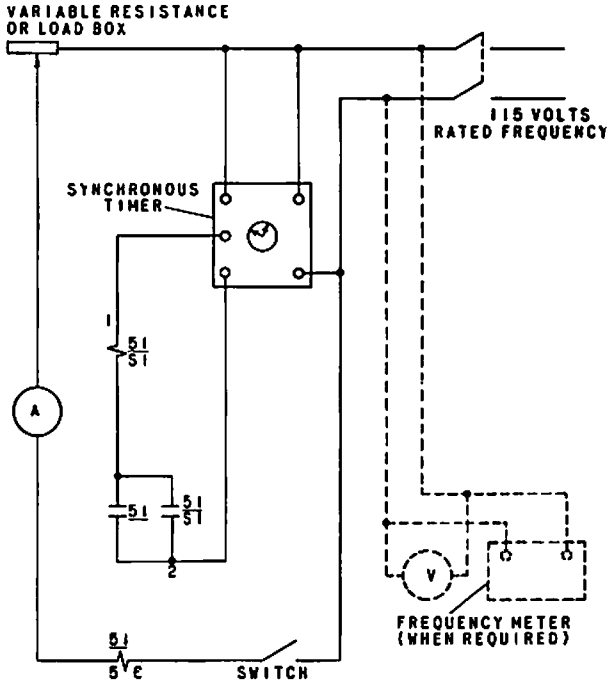


Fig. 19 (K-6154399)

Fig. 19 Test Connections for Type IAC Relays such as Type IAC53A

OPERATION

The pick-up 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. 19.

Before the relay is put into service it should be given a 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.

MAINTENANCE

DISK AND BEARINGS

The lower jewel may be tested for cracks by exploring its surface with the point of a fine needle. 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.

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 is included in the standard relay tool kit obtainable 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. 19.

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 the quantity required and describing the parts by catalogue numbers as shown in Renewal * Parts Bulletin No. GEF-3883.

* Denotes change since superseded issue.

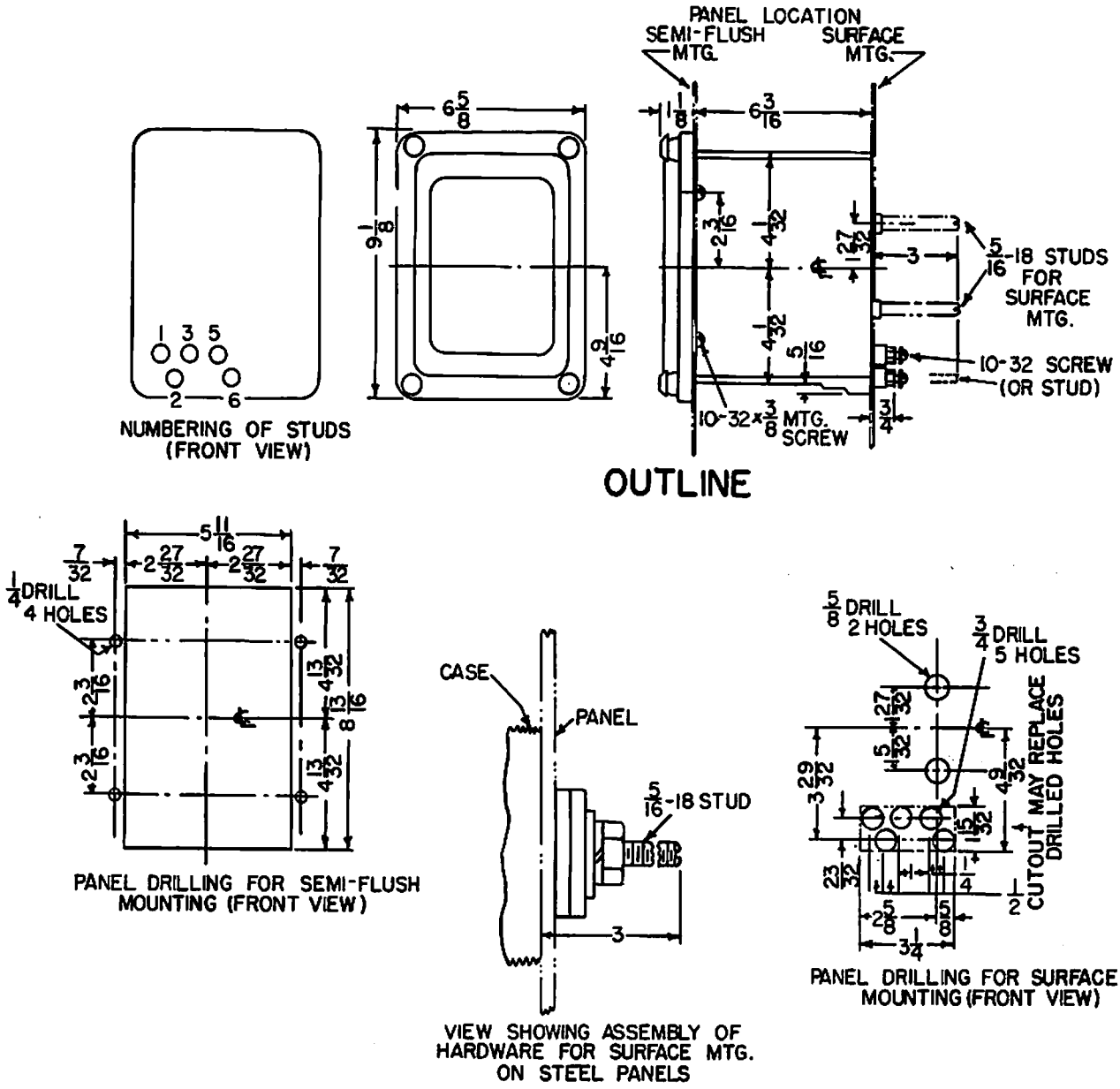


Fig. 20 (K-6209270)

Fig. 20 Outline and Panel Drilling Dimensions for Relay Types IAC53A, IAC53B, IAC53C and IAC54A

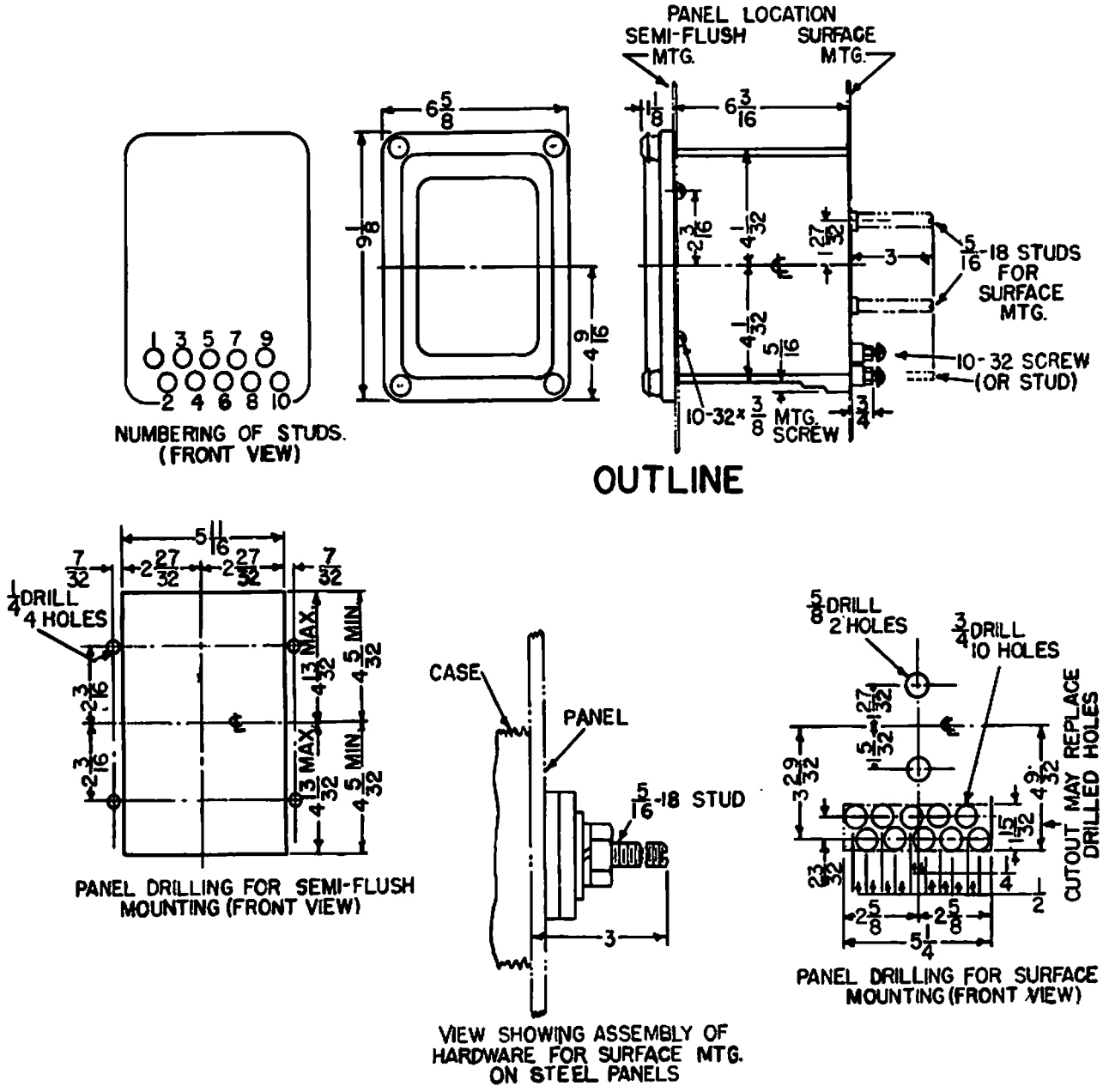


Fig. 21 (K-6209271)

Fig. 21 Outline and Panel Drilling Dimensions for Relay Types IAC53R and IAC54B

INSTRUCTIONS

THYRITE* MAGNE-VALVE INTERMEDIATE-CLASS LIGHTNING ARRESTERS

MODEL 9LA2H-SERIES

DESCRIPTION

The unit furnished with these instructions is of the latest design of the Form 2H Thyrite intermediate-class arrester.

The Thyrite lightning arrester consists of a stack of one or more arrester units connected in series, the number depending on the voltage and operating conditions of the circuit. Terminals for line and ground connections are furnished.

Three single-pole arresters are required for a three-phase installation. The arresters are of single-pole design. They are suitable for indoor or outdoor service.

Each arrester unit consists essentially of a permanently sealed porcelain housing equipped with pressure relief and containing a number of Thyrite valve-element disks and magnetic-gap elements in series. Metal fittings cemented on the housing provide means for bolting the arrester units into a stack.

Each arrester unit is shipped assembled. No charging or testing operation is required before placing them in service.

STORAGE

Units, if left in shipping containers, should be stored indoors.

INSTALLATION

Since the Form 2H intermediate-class arresters (Model No. 9LA2H series) incorporate Thyrite valve elements of improved characteristics, these arrester units should NOT be connected in series with units of the earlier Models 9LA2D, 9LA2F, or 9LA2G arresters in the same stack.

Where existing arresters of these earlier designs are to be increased in voltage rating by the addition of arrester units, the new Form 2H units should be assembled in one stack, and units from the existing arrester should be used for the additions to the other stacks so that units of the same Form designation will be in series.

LOCATION

Install arresters electrically as close as possible to the apparatus being protected. Line and ground connections should be short and direct.

GROUNDING

The arrester ground should be connected to the apparatus grounds and the main station ground, utilizing a reliable common ground network of low resistance. The efficient operation of the lightning arrester requires permanent low-resistance grounds. Intermediate-class arresters should be provided with a ground of a value not exceeding five ohms.

FOUNDATION FOR BASE MOUNTING

The footings of all piers or supports should extend below the frost line and be elevated above the ground line sufficiently to prevent splash on the units. The minimum elevation recommended is one foot; however, this must be governed by climate and locality.

The top of the foundation must be level, or provision made for leveling the base before assembly of the arrester units.

BRACKET-MOUNTED

When bracket-mounted arresters are bolted to a supporting structure, the structure as well as the finished assembly should be rigid to prevent excessive swaying of the arrester.

* Registered Trade-mark of General Electric Co.

SUSPENSION MOUNTING

If it is desired to suspend the arrester, a special eyebolt cap, Cat. No. 482B865G1, is required. Either the top or bottom end may be operated at line potential. The nameplate end of the unit should always be down so that the porcelain petticoats will shed water.

Suspend arresters flexibly with a non-rigid type of attachment, to minimize mechanical strains in the arrester stack.

NAMEPLATES

The unit nameplate on the bottom bolting lug of each individual unit applies to the arrester unit only and should correspond to the model number given in the memorandum of shipment and to the model number comprising the complete arrester.

The main arrester nameplate (angle-shaped) bears identification to correspond to the model number and voltage rating of the completely assembled arrester.

When arresters are modified, the angle-shaped nameplates should always be changed for proper identification.

THE MAXIMUM LINE-TO-GROUND RATING MUST NEVER BE EXCEEDED.

CLEARANCES

The clearances given on the assembly drawing are the minimum recommended. The arrangement of the foundation plan can be modified if desired.

The term "clearance" means the actual distance between any part of the arrester or disconnecting device at line potential, and any object at ground potential or other phase potential.

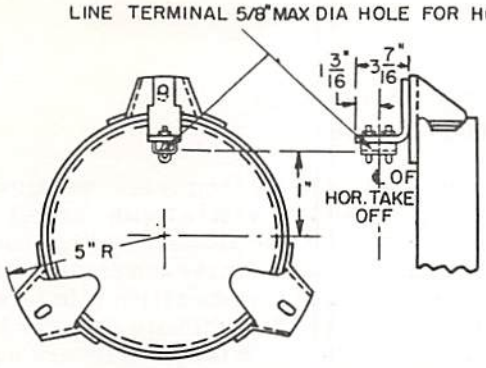
ASSEMBLY

1. Set the arrester level. If the feet of the arrester do not seat evenly on the foundation, do not distort them by tightening the foundation bolts, but shim underneath and grout with concrete if necessary.

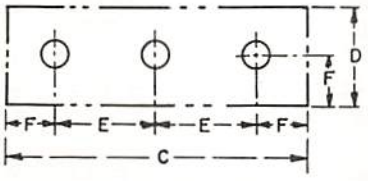
DIMENSIONS AND CLEARANCES

Arrester Rating Kv	Model	Approximate Dimensions in Inches			Minimum Clearance* (In Inches)	Minimum Space for 3-phase Installations (In Inches)				
		Fig.	A	B		Fig.	C	D	E	F
20	9LA2H57	1	24 11/16	21 1/4	9 1/2	5	68	29	19 1/2	14 1/2
25	9LA2H59		26 11/16	23 1/4	11		74	32	21	16
30	9LA2H61		32 1/16	28 5/8	13		82	36	23	18
37	9LA2H62		37 5/16	33 7/8	15 1/2		92	41	25 1/2	20 1/2
40	9LA2H81	2	45 15/16	42 1/2	17 1/2		100	45	27 1/2	22 1/2
50	9LA2H64		49 15/16	46 1/2	19 1/2		108	49	29 1/2	24 1/2
60	9LA2H65		60 11/16	57 1/4	24		126	58	34	29
73	9LA2H66		71 3/16	67 3/4	28		142	66	38	33
97	9LA2H67	3	94 7/16	91	37		247	107	70	53 1/2
109	9LA2H68	3	104 15/16	101 1/2	41 1/2		265	116	74 1/2	58
121	9LA2HD69	4	------	-----	46		283	125	79	62 1/2

* These clearances applying both line-to-line and line-to-ground are for altitudes below 3300 feet (1000 meters). Add 3 percent to clearances in inches for each additional 1000 feet altitude above 3300 feet.

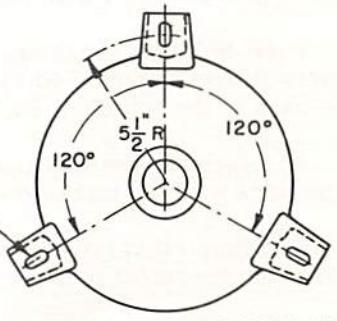


DETAIL OF LINE TERMINAL BRACKET FOR ARRESTERS 73 KV AND BELOW

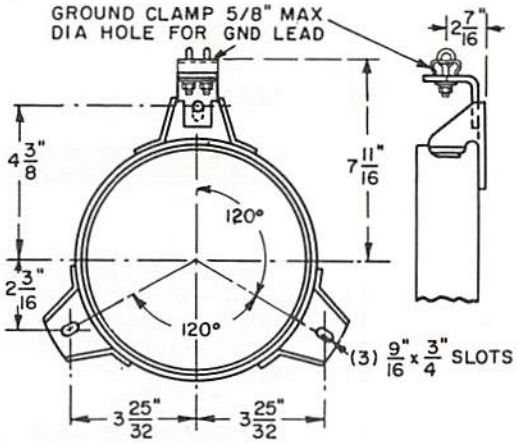


MINIMUM SPACE REQUIRED FOR 3 PHASE INSTALLATION

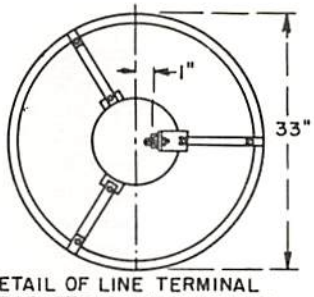
Fig. 5



PLAN VIEW OF BOTTOM UNIT FITTING 121 KV ARRESTER



DETAIL OF ARRESTER BOTTOM FITTING AND GROUND TERMINAL FOR ARRESTERS 20-109 KV



DETAIL OF LINE TERMINAL BRACKET AND GRADING RING FOR ARRESTERS RATED 97, 109 AND 121 KV

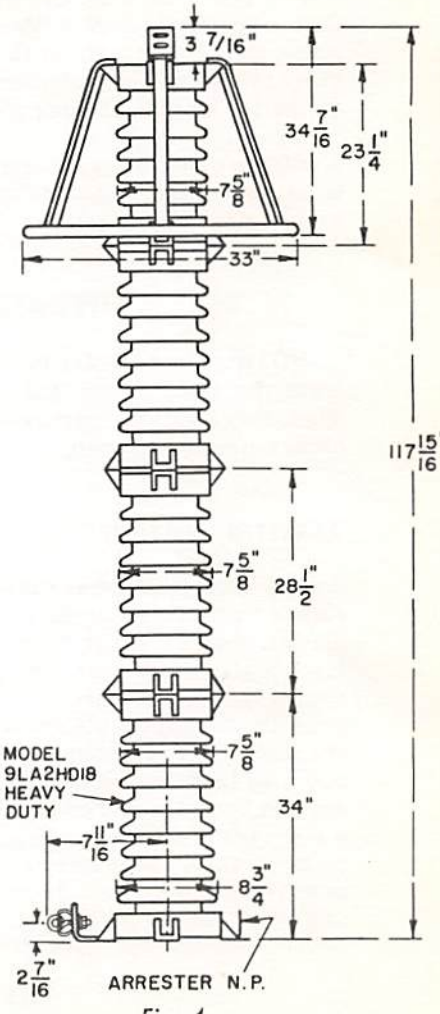


Fig. 4

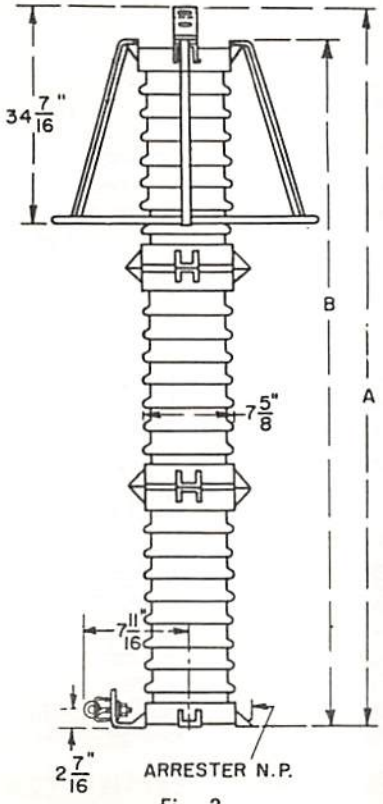


Fig. 3

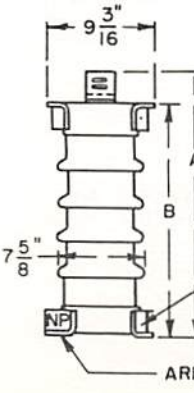


Fig. 1

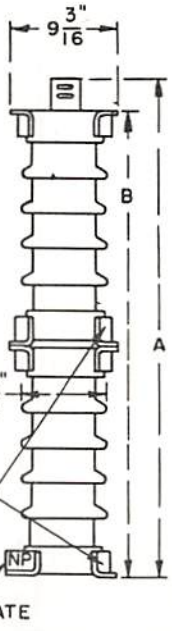


Fig. 2

A suggested method of leveling and equalizing the bearing on the lugs of the arrester unit is to thread a nut on each foundation bolt before putting the unit in place. This will permit accurate leveling irrespective of any slight unevenness in the foundation. After the arrester is completely assembled, the foundation may be grouted in with concrete.

2. Assemble the required number of units in a stack in accordance with the instructions.

Base-mounted arresters, rated 121 kv, have an extra, heavy-duty unit with cast fittings, which should be used at the bottom of each single-pole stack.

3. Assemble the cap and/or grading ring in accordance with the instructions.

4. Connect the arrester to the line through a suitable line connector or switch.

When connecting the arrester to an energized line, it is imperative that a quick, positive, single connection be made to avoid possible damage to the arrester. Information relative to a suitable device can be obtained from the nearest General Electric Company sales office. Where a rigid connection is made to the line side of the arrester, it should be of correct length so that no excessive strain is placed on the top of the arrester stack.

Where installations require a long lead from line to arrester, the "hairpin-loop" connection will provide improved protection.

OPERATION

NOTE: The arrester is alive unless disconnected from the line. When guard rails or screens are used, they should be grounded and suitable electrical clearances maintained.

ARRESTER VOLTAGE

The Thyrite intermediate-class arrester is designed to limit the surge voltages to a safe value by discharging the surge current to ground, and to interrupt the small power-frequency follow current at the first current zero. The arrester rating is a definite limit of its ability to interrupt power-follow current. It has no short-time overvoltage rating and may be damaged if the power-frequency voltage applied to the arrester exceeds its rating, even for a few cycles after a surge sparks over the gaps. It is important, therefore, to assure that the system power-frequency voltage from line to ground under any condition of switching, fault, or overvoltage, never exceeds the arrester's rating. In case of doubt as to the application, consult the nearest sales office of the General Electric Company.

ARRESTERS OPERATED AT REDUCED VOLTAGES

Arresters supplied for temporary operation at a lower voltage should be erected with correct electrical clearances for the ultimate voltage but with correct number of units for the temporary voltage. When the time of temporary operation is to be short, it is recommended that the ultimate arrester be installed and the units which temporarily are not required be short-circuited.

Care should be taken that all short-circuiting connections are removed when the arrester is changed to ultimate voltage.

MAINTENANCE

Before inspecting or handling the arrester, disconnect it from the line, and, as a safety precaution, ground the line end.

The Thyrite arrester requires no special care except for routine cleaning of the outside of the porcelain housing in contaminated areas. Hence, the porcelain housing should be kept clean and the line and ground connections tight.

Energized arrester stacks may be hot-washed.

When replacing the arrester in service, remove the temporary ground from the line end, before connecting the arrester to the line.

The arrester or units do not require any testing, and NO TEST WHICH APPLIES POWER VOLTAGE IN EXCESS OF THE ARRESTER VOLTAGE RATING (STATED ON THE NAMEPLATE) SHOULD BE MADE WITHOUT CONSULTING THE GENERAL ELECTRIC COMPANY. There is no simple field test which will indicate the operating characteristics or protective levels of the arrester.

SUPPLY UNITS

When ordering renewal units, reference should be made to the model number found on the nameplate on the bottom foot of each unit.

Refer any questions relative to the condition of the internal parts of these arresters to the nearest sales office of the General Electric Company.

DISTRIBUTION PROTECTIVE EQUIPMENT DEPARTMENT

GENERAL ELECTRIC

PITTSFIELD, MASS.

2-63 (5M)

INSTRUCTIONS

GEI-10951L
SUPERSEDES GEI-10951K

CURRENT-LIMITING FUSE UNITS TYPES EJ-1 AND EJO-1

INTRODUCTION

A Type EJ-1 fuse unit--for indoor use-- or a Type EJO-1 fuse unit--for indoor or outdoor use--consists of a Pyrex glass or melamine fibreglass fuse tube having metal ferrules at each end and containing current-responsive elements surrounded by a quartz filler. When the fuse functions, the arc resulting from the melting of the current-responsive elements is cooled by the adjacent filler and extinguished without any expulsion of gases or material from the tube. The maximum current passing through the fuse before the arc is extinguished is limited to a value considerably lower than the maximum short-circuit current usually available in the circuit.

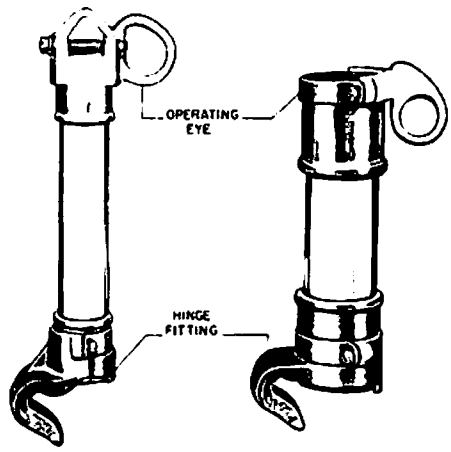
APPLICATION

Fuse unit, Types EJ-1 and EJO-1, with suffix "E" on the current rating conform with the 1960 High Voltage Fuse Standards. They will carry current up to their "E" ampere rating continuously; fuse units rated 100E amperes and below will melt at a current between 200% and 240% of the rating in five minutes, and fuse units rated 125E amperes and above will melt at a current between 220% and 264% of their rating in ten minutes.

For a given application the recommended voltage rating of the fuse unit is that nearest to, but greater than, the line-to-line circuit voltage. In no case should the line-to-line voltage be less than 70 per cent of the nominal voltage of the fuse unit nor greater than the maximum design voltage rating.

When the fuse units are rated 25/60 cycles, they may be used on systems from 25 to 60 cycle frequency. When rated for 60 cycles only, they may be used on frequencies of either 50 or 60 cycles.

The "E" current rating must be equal to or larger than the maximum load current in the circuit, and at the same time, the current-responsive element must also be of sufficient size so as not to be damaged by magnetizing inrush current of associated transformers. For detailed application data, and also for time-current and current-limiting curves, refer to the nearest General Electric Sales Office.



Size C 4800 Volts Size D 2400 Volts

Fig. 1 Type EJ-1 Fuse Units Assembled with Fittings for Type EK-3C and EK-3D Fuse Disconnecting Switches

Fig. 1 (35A210)

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

DISTRIBUTION PROTECTIVE EQUIPMENT DEPARTMENT

GENERAL ELECTRIC

PITTSFIELD, MASS.

RATINGS

Fuse units are made in several different diameters of tube and ferrule assemblies. Each ferrule diameter is designated by a "size" letter, with the relation between size and letter being shown in Table 1. The tabulation also shows the voltage ratings for which each size is manufactured.

* May also be used on 4300 volt solidly-grounded neutral circuits when mounted in porcelain housing on G-E Type JE-2 or JE-32 potential transformers.

TABLE 1

Size	Ferrule Diameter	Maximum Design Rating, Volts
A	13/16"	600, 2750 *
B	1 9/16"	2750, 5500, 8250, 15,500
C	2"	2750, 5500, 8250, 15,500, 25,800
D	3"	2750, 5500, 8250, 15,500, 25,800 38,000
DD	2-3" in Parallel	2750, 5500, 8250, 15,500, 25,800 38,000
EE	2-4" in Parallel	15,000

INSTALLATION

A suitable fuse support is required to use the fuse unit. With Type EK-3 and EKO-3 fuse disconnecting switches, fittings for the fuse unit are furnished to make it suitable for use as a disconnecting blade. To attach these fittings to a Size C or Size D fuse unit, slide them on the ferrules of the fuse unit and clamp in place in the position shown in Fig. 1. With a Size DD fuse unit, attach the hinge fitting to the bottom ferrule of one tube and the operating eye to the top ferrule of the other tube, as shown in Fig. 2. In all cases, the hinge fitting should be located at the end of the fuse containing the indicating target, for ease of viewing from below. The target end of Size D, DD and some C fuse units has a concave appearance (see left side of Fig. 3 as distinguished from the flat cap closing the other end, or ends in the case of Size DD) of the fuse tube. The remaining C size fuses and the B size fuses have button indicators.

Unless special means are provided for disconnecting the entire fuse support or switch from all sources of power, the fuse unit should be removed and inserted only with insulated fuse tongs.

OPERATION

When a fuse unit functions, it should be replaced by a complete new unit. Always use a fuse tongs for handling unless special means are provided for disconnecting the fuse support from all sources of power. If used in a fuse disconnecting switch, the fittings should be removed from the blown unit and transferred to a replacing unit. The time required to replace a blown fuse unit in a disconnecting switch may be considerably shortened if a spare fuse unit with fittings in place is kept on hand at each installation.

The indicating target provided at one end of the larger sizes of fuse units, operates when the fuse unit functions. Its operation is provided by a separate mechanism within the fuse tube, and is not due to any pressure developed by the main fuse elements in functioning. The appearance of the target for some size C and larger fuse units is shown, before and after operation, in Fig. 3. Size B and the remainder of the size C fuse units have an indicator consisting of a small plunger which projects from the end of the fuse unit after the fuse unit functions.

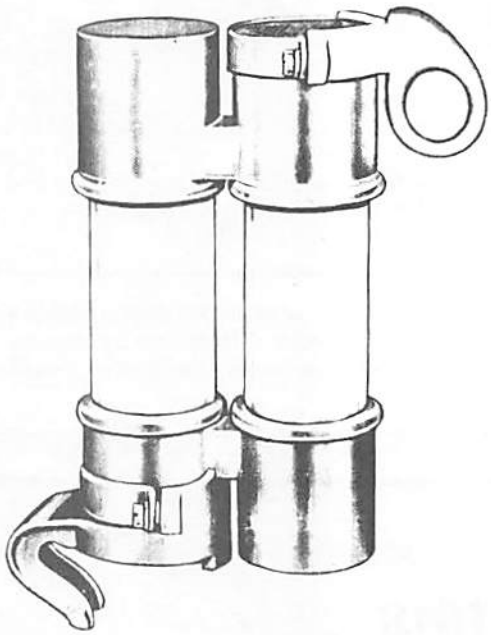
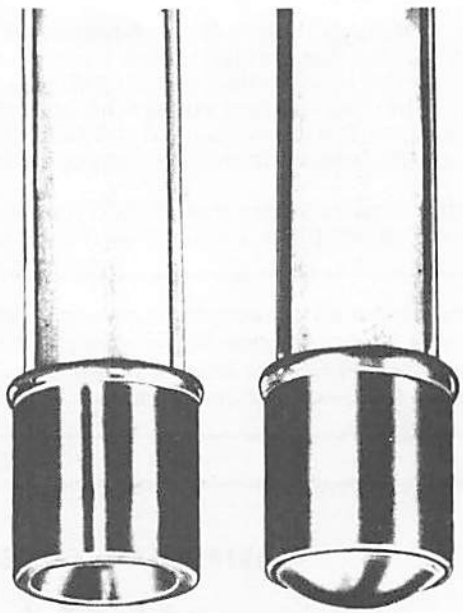


Fig. 2 Size DD Fuse Unit Assembled with Fittings for Type EX-3DD Fuse Disconnecting Switch



Before Operation After Operation

Fig. 3 Indicating Targets of Size C Fuse Units

INSTRUCTIONS

GEI-88760A
SUPERSEDES GEI-88760

CAPACITOR TRIP DEVICE

SWITCHGEAR DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA, PA.

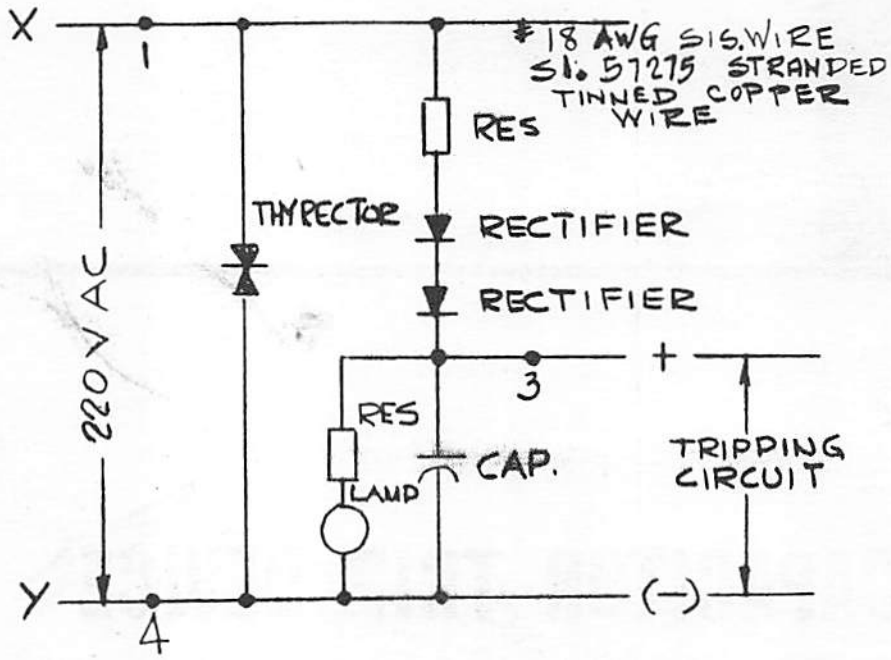
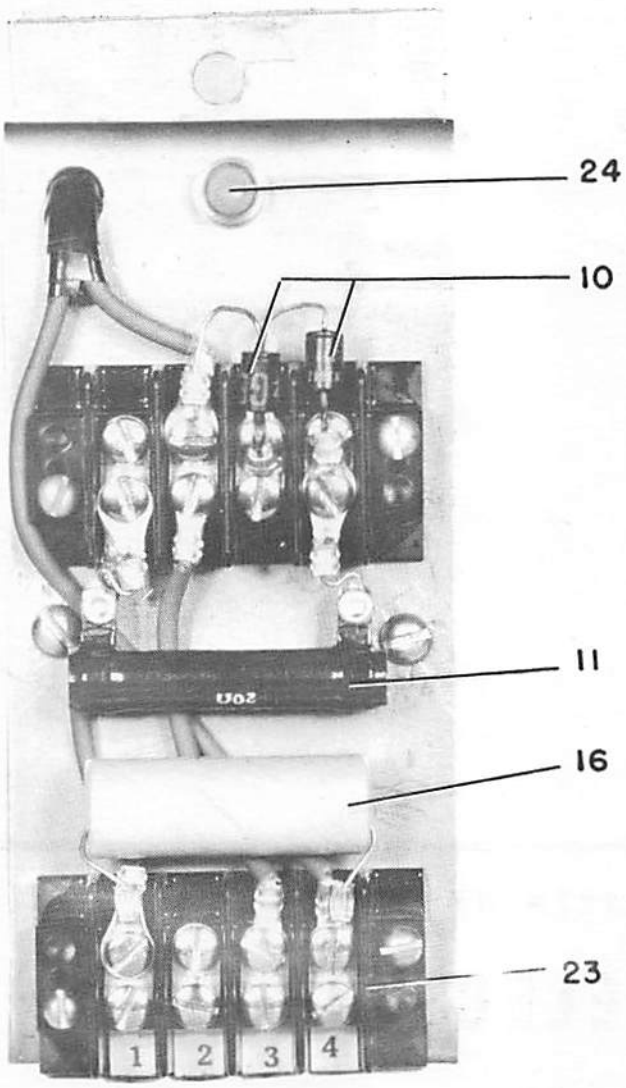


Fig. 1 Elementary Diagram

Fig. 1 (105C938)



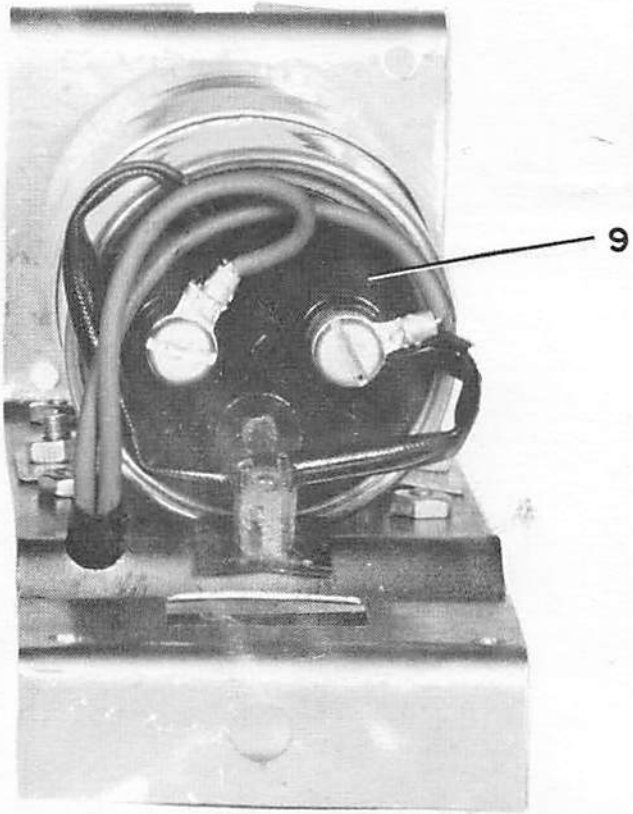


Fig. 2 Capacitor Trip Device

Fig. 2 (8914721A&B)

CAPACITOR TRIP DEVICE

INTRODUCTION

The capacitor trip device is a device designed for use in tripping the operating mechanism of a circuit breaker, its purpose being to provide sufficient electrical energy to operate the trip coil of the mechanism.

The device is primarily for use with circuit breakers which require some form of a-c power for their closing operation, i.e. circuit breakers having either a stored energy closing mechanism with an a-c operated release coil or an a-c solenoid operated closing mechanism. It may also be used with circuit breakers employing other means of closing. However it might be necessary to observe certain operating procedures as outlined under "Operation and Checking".

In addition to circuit breaker tripping, the unit may be used to operate hand or electric reset devices such as lockout relays.

It is recommended that each circuit breaker or other device be provided with its individual capacitor trip device. Exceptions to these recommendations are particular combinations of circuit breakers and lockout relays which tests have indicated can be operated reliably from a single tripping unit.

OPERATION AND CHECKING

The unit is connected directly to the 230 volt a-c source through the input terminals 1 and 4, and the leads to the trip circuit from terminals 3 and 4.

The operation of the unit is completely automatic and requires only an occasional check to determine if it is functioning normally. A neon light is supplied near the top of the unit. This light is energized continuously and will glow if the voltage across the capacitor is above the minimum tripping voltage. This shows the readiness of the unit to trip the breaker and does not indicate if the a-c source is available. A constant visible check of the a-c line is available by the indicating lamp on the metal-clad door or panel.

NOTE: The energy storage capacitor used in this unit is a special high grade, low leakage, industrial type electrolytic capacitor. One characteristic of electrolytic capacitors is that they tend to unform when left de-energized for extended periods. Although these units have been completely formed at the factory, they may have been idle for a considerable period of time. It is therefore recommended that immediately prior to putting a unit into operation, it is energized from the 230 volt a-c source for a period of at least two (2) hours or more.

NOTE: During testing of the unit with its associated circuit breaker, do not have the tripping circuit completed when applying a-c voltage to a discharged unit. Also, supervision of the trip coil in the usual manner with the red indicating light should be avoided.

MAINTENANCE

Voltage measurements should be made with a vacuum tube voltmeter to assure accuracy. The unit should be energized with a-c power for at least one hour before any measurements are attempted.

1. The a-c input voltage can be measured at terminals 1 and 4 and should be from 190v to 250v a-c.
2. The d-c output voltage should be measured at terminals 3 and 4. With the a-c line energized, the output voltage should be from 260v to 350v d-c.

RENEWAL PARTS

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

ORDERING INSTRUCTIONS

1. ALWAYS SPECIFY THE COMPLETE NAMEPLATE DATA.
2. SPECIFY THE QUANTITY, CATALOG NUMBER (IF LISTED), REFERENCE NUMBER (IF LISTED), AND DESCRIPTION OF EACH PART ORDERED, AND THIS BULLETIN NUMBER.
3. STANDARD HARDWARE, SUCH AS SCREWS, BOLTS, NUTS, WASHERS, ETC., IS NOT LISTED IN THIS BULLETIN. SUCH ITEMS SHOULD BE PURCHASED LOCALLY.
4. FOR PRICES, REFER TO THE NEAREST OFFICE OF THE GENERAL ELECTRIC COMPANY.

PART NUMBERS

(Ref. to Figures 1 and 2)

Ref. No.	Catalog No.	Description
9	0456A0864 P102	Capacitor
10	0456A0864 P128	Rectifier
11	0456A0864 P034	Resistor
16	0456A0864 P106	Thyrector
23	0456A0864 P032	Terminal Board
24	0456A0864 P109	Indicator Light

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

GENERAL ELECTRIC SALES OFFICES

GEZ-2500L

READY TO ASSIST YOU . . . When You Have Electrical Problems . . . Need Further Information . . . Require Ordering Instructions

SALES OFFICE CODE KEY
- * Industrial Equipment (including Agent and Distributor) Sales
- † Electric Utility Equipment Sales
- § Marine and Defense Equipment Sales
- ‡ Component Sales Operation

ALABAMA
- *†‡ Birmingham 35205 ..... 2151 Highland Ave.
- * Mobile 36602 ..... 704 Government St.

ARIZONA
- *†‡ Phoenix 85012 ..... 3550 N. Central Ave.
- *† Tucson 85711 ..... 151 S. Tucson Blvd.

ARKANSAS
- *‡ North Little Rock 72114 ..... 1900 E. Washington
- † Pine Bluff 71602 ..... P. O. Box 1033

CALIFORNIA
- * Fresno 93728 ..... 1532 N. West Ave.
- *† § Los Angeles 90054 ..... 212 N. Vignes St.
- ‡§ Los Angeles 90005 ..... 3325 Wilshire Blvd.
- * Oakland 94612 ..... 409 Thirteenth St.
- * Redwood City 94063 ..... 55 Veterans Blvd.
- *† Sacramento 95816 ..... 2407 "J" St.
- *† § San Diego 92103 ..... 2560 First Ave.
- *†‡§ San Francisco 94106 ..... 235 Montgomery St.
- * San Jose 95128 ..... 2155 So. First St.

COLORADO
- *†‡§ Denver 80201 ..... 201 University Blvd.

CONNECTICUT
- *† Hamden 06518 ..... 2905-2921 Dixwell Ave.
- *†‡ Hartford 06105 ..... 764 Asylum Ave.

DISTRICT OF COLUMBIA
- *† § Washington 20005 ..... 777—14th St., N.W.

FLORIDA
- § Cocoa Beach (Cape Canaveral Office) ..... 1325 N. Atlantic Ave.
- * Coral Gables 33146 ..... 250 Bird Road
- *† Jacksonville 32202 ..... 1901 Hill St.
- † Miami 33134 ..... 4100 West Flagler St.
- † Pensacola 32503 ..... First Bank Bldg.
- †‡ Tampa 33609 ... Henderson Blvd. at Lois Ave.
- * Tampa 33609 ..... 2106 S. Lois Ave.

GEORGIA
- *†‡ Atlanta 30309 ..... 1860 Peachtree Rd., N.W.
- * Macon 31202 ..... 682 Cherry St.
- *† Savannah 31405 ..... 5002 Paulsen St.

IDAHO
- *† Boise 83706 ..... 1524 Idaho St.

ILLINOIS
- *†‡§ Chicago 60680 ..... 840 S. Canal St.
- *† Peoria 61603 ..... 2008 N.E. Perry Ave.
- * Rockford 61105 ..... 4223 East State St.
- † Springfield 62701 ..... 607 E. Adams St.

INDIANA
- *†‡ Evansville 47714 ..... 2709 Washington Ave.
- ‡ Fort Wayne 46807 ..... 1635 Broadway
- *† Fort Wayne 46806 ..... 3606 S. Calhoun St.
- *†‡ Indianapolis 46207 ..... 3750 N. Meridian St.
- *‡ South Bend 46601 ..... 430 N. Michigan St.

IOWA
- *† Cedar Rapids 52401 ..... 210 Second St., S.E.
- *†‡ Davenport 52805 ..... 1039 State St., Bettendorf, Iowa
- *† Des Moines 50310 ..... 3839 Merle Hay Rd.
- † Sioux City 51101 ..... 520 Pierce St.

KANSAS
- *† Wichita 67211 ..... 820 E. Indianapolis Ave.

KENTUCKY
- *† Lexington 40503 ..... 465 E. High St.
- *†‡ Louisville 40218 ..... 2300 Meadow Dr.

LOUISIANA
- *† Alexandria 71302 ..... 720 Murray St.
- * Baton Rouge 70815 ..... 633 Oak Villa Blvd.
- * Lake Charles ..... 1424 Ryan St.
- *† § New Orleans 70112 ..... 837 Gravier St.
- * New Orleans 70125 ..... 4747 Earhart Blvd.
- *† Shreveport 71101 ..... 400 Travis St.

MAINE
- *† Augusta ..... 152 State St.
- * Bangor 04402 ..... 77 Central St.

MARYLAND
- *†‡ Baltimore 21201 ..... 1 North Charles
- † Hagerstown ..... 49 East Franklin St.

MASSACHUSETTS
- *†‡§ Boston 02117 ..... 31 St. James Ave.
- * Springfield 01103 ..... 120 Maple St.
- * Worcester 01605 ..... 288 Grove St.

MICHIGAN
- *†‡ Detroit 48202 ..... 700 Antoinette St.
- * Flint 48503 ..... 316½ W. Court St.
- *‡ Grand Rapids 49508 2821 Madison Ave., S.E.
- *† Jackson 49201 ..... 210 W. Franklin St.
- * Kalamazoo ..... 927 S. Burdick St.
- † Lansing 48901 ... 501 Bank of Lansing Bldg.
- * Saginaw 48607 Second National Bank Bldg.

MINNESOTA
- *† Duluth 55802 ..... 14 W. Superior St.
- † Fergus Falls 56537 ... 106 E. Washington St.
- *†‡ Minneapolis 55402 ..... 12 S. Sixth St.

MISSISSIPPI
- † Gulfport 39502 ..... P.O. Box 33
- † Jackson 39201 ..... 210 S. Lamar St.

MISSOURI
- * Joplin 64802 ..... 212½ W. Fifth St.
- *†‡ Kansas City 64105 ..... 106 W. Fourteenth St.
- *‡ St. Louis 63101 ..... 1015 Locust St.

MONTANA
- *† Billings 59101 ..... 303 N. Broadway
- *† Butte 59701 ..... 103 N. Wyoming St.

NEBRASKA
- *† Omaha 68102 ..... 409 S. Seventeenth St.

NEVADA
- † Las Vegas 89106 ..... 1711 S. 8th St.

NEW HAMPSHIRE
- † Manchester 03104 ..... 1662 Elm St.

NEW JERSEY
- *†‡ East Orange 07017 ..... 26 Washington St.

NEW MEXICO
- *† Albuquerque 87108 120 Madeira Drive, N.E.

NEW YORK
- *† § Albany 12203 ..... 8 Colvin Ave.
- † Binghamton 13902 ..... 19 Chenango St.
- *†‡ Buffalo 14202 ..... 625 Delaware Ave.
- *† § New York 10022 ..... 570 Lexington Ave.
- *†‡ Rochester 14604 ..... 89 East Ave.
- *†‡ Syracuse 13206 ..... 3532 James St.
- * Utica 13501 ..... 1001 Broad St.
- ‡ Waverly 14892 ..... P.O. Box 308

NORTH CAROLINA
- *†‡ Charlotte 28202 ..... 129 W. Trade St.
- * Greensboro 27405 ..... 801 Summit Ave.
- *† Raleigh 27602 ..... 16 W. Martin St.

NORTH DAKOTA
- † Bismarck 58501 ..... 418 Rosser Ave.

OHIO
- *† Akron 44313 ..... 2858 W. Market St.
- *† Canton 44701 ..... 515 Third St., N.W.
- *†‡ Cincinnati 45206 ..... 2621 Victory Pkwy.
- *†‡§ Cleveland 44104 ..... 4966 Woodland Ave.
- *† Columbus 43215 ..... 395 E. Broad St.
- ‡ Columbus 43212 ..... 937 Burrell Ave.
- *‡ Dayton 45402 ..... 11 W. Monument Ave.
- *†‡ § Dayton 45402 ..... 118 W. First St.
- ‡ Mansfield 44906 ..... 564 Park Ave., West
- *†‡ Toledo 43606 ..... 3125 Douglas Rd.
- * Youngstown 44507 ..... 272 E. Indianola Ave.

OKLAHOMA
- *† Oklahoma City 73106 ..... 2000 Classen Blvd.
- *† Tulsa 74114 ..... Columbia Bldg., 2651 E. 21st St.

OREGON
- *† Eugene 97401 ..... 1170 Pearl St.
- *† Medford 97501 ..... 107 E. Main St.
- *†‡ Portland 97210 ..... 2929 N.W. 29th Ave.

PENNSYLVANIA
- *† Allentown 18102 ..... 732 North 16th St.
- * Erie 16501 ..... 1001 State St.
- *† Johnstown 15902 ..... 841 Oak St.
- *†‡§ Philadelphia 19102 ..... 3 Penn Center Plaza
- *†‡ Pittsburgh 15222 The Oliver Bldg., Mellon Sq.
- § Pittsburgh 15228 ..... 733 Washington Rd.
- *‡ York 17403 ..... 56 N. Harrison St.

SOUTH CAROLINA
- *† Columbia 29201 ..... 1310 Lady St.
- * Greenville 29602 ..... 108 W. Washington St.

TENNESSEE
- *†‡§ Chattanooga 37402 ..... 832 Georgia Ave.
- * Kingsport 37662 ..... 322 Commerce St.
- *† Knoxville 37916 ..... 1301 Hannah Ave., N.W.
- *† Memphis 38104 ..... 1420 Union Ave.
- * Murfreesboro ..... P.O. Box 1040
- *‡ Nashville 37203 ..... 1717 W. End Bldg.
- § Oak Ridge ..... 253 Main St., East

TEXAS
- † Abilene 79601 ..... 442 Cedar St.
- *† Amarillo 79101 ..... 403 Amarillo Blvd.
- *† Beaumont 77701 ..... 1385 Calder Ave.
- † Corpus Christi 78401 ..... 205 N. Chaparral
- *†‡ Dallas 75207 ..... 8101 Stemmons Freeway
- *† El Paso 79901 ..... 215 N. Stanton St.
- † Fort Worth 76102 ..... 408 W. Seventh St.
- *†‡§ Houston 77027 ..... 4219 Richmond Ave.
- * Lubbock 79408 ..... 500 E. 50th St.
- * Midland ..... 122 North N St.
- *† San Antonio 78204 ..... 419 S. Main Ave.

UTAH
- *† § Salt Lake City 84110 ..... 200 S. Main St.

VERMONT
- † Rutland ..... 38½ Center St.

VIRGINIA
- * § Newport News 23601 ..... P.O. Box 1038, 311 Main St.
- *† Richmond 23230 ..... 3001 W. Broad St.
- *† Roanoke 24005 ..... 920 S. Jefferson St.

WASHINGTON
- † Pasco 99301 ..... 824 W. Lewis St.
- *† § Seattle 98104 ..... 710 Second Ave.
- * Spokane 99220 ..... S. 162 Post St.
- † Spokane 99220 ..... E. 1805 Trent St.

WEST VIRGINIA
- * Charleston 25328 ... 306 MacCorkle Ave., S.E.
- *† Fairmont 26555 ..... 310 Jacobs Bldg.
- * Wheeling ..... 40 Fourteenth St.

WISCONSIN
- *† § Appleton 54910 ..... 510 W. College Ave.
- † Madison 53703 ..... 340 W. Washington Ave.
- *†‡ Milwaukee 53233 ..... 940 W. St. Paul Ave.

CANADA: Canadian General Electric Company, Ltd., Toronto

HAWAII: American Factors, Ltd., P.O. Box 3230, Honolulu 96801

GENERAL ELECTRIC SERVICE SHOPS

WHEN YOU NEED SERVCE . . . These G-E service shops will repair, recondition, and rebuild your electric apparatus. The facilities are available day and night, seven days a week, for work in the shops or on your premises. Latest factory methods and genuine G-E renewal parts are used to maintain peak performance of your equipment. For full information about these services, contact your nearest service shop or sales office.

ALABAMA
- Birmingham 35211, P.O. Box 3687 ..... 7—18th St., S.W.

ARIZONA
- (Phoenix) Glendale 85301 ..... 4911 West Colter St.

CALIFORNIA
- Los Angeles 90001 ..... 6900 Stanford Ave.
- *(Los Angeles) Ontario ..... Ontario International Airport
- Oakland 94608 ..... 3400 Wood St.
- Sacramento 95814 ..... 99 North 17th St.
- San Francisco 94103 ..... 1098 Harrison St.

COLORADO
- Denver 80205 ..... 3353 Larimer St.

CONNECTICUT
- (Southington) Plantsville 06479 ..... 370 Atwater St.

FLORIDA
- Jacksonville 32203 ..... P.O. Box 2932, 2020 W. Beaver St.
- (Miami) Hialeah 33010 ..... 1062 E. 28th St.
- Tampa 33601 ..... P.O. Box 1245

GEORGIA
- (Atlanta) Chamblee 30005 ..... 5035 Peachtree Industrial Blvd.

ILLINOIS
- Chicago 60632 ..... 4360 W. 47th St.

INDIANA
- Ft. Wayne 46803 ..... 1731 Edsall Ave.
- Indianapolis 46222 ..... 1740 W. Vermont St.

IOWA
- (Davenport) Bettendorf 52722 ..... 1025 State St.

KANSAS
- *(Strother) Arkansas City ..... G.E. Co., P.O. Box 797

KENTUCKY
- Louisville 40209 ..... 3900 Crittenden Drive

LOUISIANA
- New Orleans 70117 ..... 1115 De Armas St.

MARYLAND
- Baltimore 21230 ..... 920 E. Fort Ave.

MASSACHUSETTS
- (Boston) Medford 02155 ..... 3960 Mystic Valley Parkway

MICHIGAN
- Detroit 48202 ..... 5950 Third St.

MINNESOTA
- Minneapolis 55430 ..... 2025—49th Ave., N.

MISSOURI
- Kansas City 64120 ..... 3525 Gardner Ave.
- St. Louis 63110 ..... 1115 East Road

NEW YORK
- Albany 12205 ..... 1097 Central Ave.
- Buffalo 14211 ..... 318 Urban St.
- *(New York) Linden, N. J. ..... 1611 W. Elizabeth Ave.
- (New York) North Bergen, N. J. 07047 ..... 6001 Tonnelle Ave.
- Schenectady (Instrumentation Service) 12305 ..... 1 River Road

NORTH CAROLINA
- Charlotte 28208 ..... 2328 Thrift Road

OHIO
- Cincinnati 45202 ..... 444 W. Third St.
- *Cincinnati 45232 ..... 260 W. Mitchell Ave.
- Cleveland 44125 ..... 4477 East 49th St.
- Columbus 43223 ..... P.O. Box 6198, 2128 Eakin Rd.
- Toledo 43605 ..... 405 Dearborn Ave.
- Youngstown 44507 ..... 272 E. Indianola Ave.

OREGON
- Portland 97210 ..... 2727 N.W. 29th Ave.

PENNSYLVANIA
- Allentown 18103 ..... 668 E. Highland St.
- Johnstown 15902 ..... 841 Oak St.
- Philadelphia 19124 ..... 1040 E. Erie Ave.
- (Pittsburgh) Homestead 15120 ..... 4930 Buttermilk Hollow Rd., RD #1, West Mifflin, Pa. 15122
- York 17403 ..... 54 N. Harrison St.

TEXAS
- Corpus Christi 78401 ..... 115 Waco St.
- Dallas 75235 ..... 3202 Manor Way
- Houston 77020 ..... 5534 Harvey Wilson Drive
- Midland 79704 ..... 704 S. Johnston St.

UTAH
- Salt Lake City 84104 ..... 301 S. 7th West St.

VIRGINIA
- Richmond 23224 ..... 1403 Ingram Ave.
- Roanoke 24007 ..... P.O. Box 1327, 115 Albermarle Ave., S.E.

WASHINGTON
- Seattle 98134 ..... 3422 First Ave., S.
- *Seattle 98108 ..... 220 Dawson St.
- Spokane 99206 ..... E. 4323 Mission St.

WEST VIRGINIA
- Charleston 25328 ..... 306 MacCorkle Ave.

WISCONSIN
- Appleton 54910 ..... Midway Industrial Area ..... P.O. Box 83 County Trunk P
- Milwaukee 53233 ..... 940 W. St. Paul Ave.

GENERAL ELECTRIC COMPANY, PHILADELPHIA, PA.

11-64