Metalclad Switchgear Units

Indoor, Outdoor, Maintenance Aisle
5 kv and 15 kv

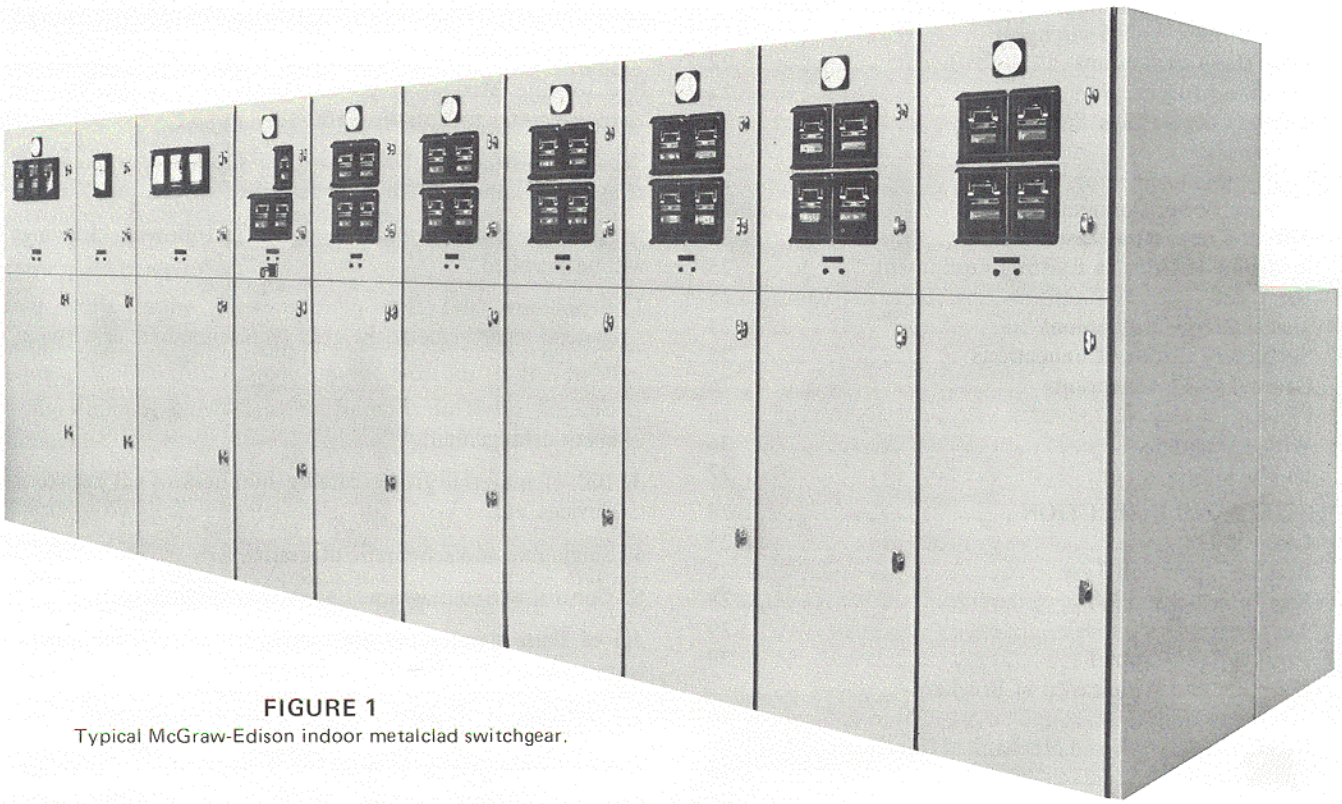


FIGURE 1
Typical McGraw-Edison indoor metalclad switchgear.

CONTENTS

(Continued on page 2)

These instructions do not claim to cover all details or variations in the equipment, procedure, or process described, nor to provide directions for meeting every possible contingency during installation, operation, or maintenance. When additional information is desired to satisfy a problem not covered sufficiently for the user's purpose, please contact your McGraw-Edison Power Systems Division sales engineer.

CONTENTS (cont'd.)

INSTALLATION (cont'd.)

INTRODUCTION

This book contains instructions for installing, operating, and maintaining Metalclad Switchgear Assemblies. It should be read carefully before installation and initial operation of these equipments.

For specific McGraw-Edison information on the breaker elements, refer to Bulletin S300-12-1.

Separate instruction books 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 which show the general arrangement, height, recommended aisle space, etc.
2. Section views of compartments showing general equipment arrangement.
3. Bill of material giving catalog numbers of all breakers, devices, etc.
4. Single-line and schematic diagrams.
5. Control wiring diagram.

All of these documents are needed for installation, operation, and maintenance of the equipment.

RECEIVING, HANDLING, AND STORAGE

Indoor switchgear is wrapped in a weatherproof covering. Outdoor shipping groups are designed with their own weatherproof enclosures and do not require further packing except at exposed points at the shipping break. Instrument panels on single row installations are suitably weather protected. The maintenance aisle itself will be shipped assembled or unassembled as indicated on the purchase order. If unassembled, the roof, floor, and wall pieces will be packed and shipped separately for field assembly. If assembled, steel cross braces and wood insert panels will be added to form a rigid, weatherproof assembly. Breakers, accessories, miscellaneous parts, and installation materials are packed and crated separately from the housings. Appendages such as bus runs and synchronizing panels, batteries and large internal equipment may also be packed and crated separately.

RECEIVING

Every case or package leaving the factory is plainly marked with case number, McGraw-Edison order number, and customer's order number. If 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 that 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 McGraw-Edison 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. Upon receipt of the

equipment an inspection should be made immediately to detect any damage sustained while enroute. If damage is found, claims should be filed at once with the transportation company and McGraw-Edison Power Systems Division, Canonsburg, Pa. 15317 should be notified promptly. Information on damaged parts, part number, case number, and McGraw-Edison order number should accompany the claim. This is especially important if the equipment is to be stored for a period before installation. *It is impossible to claim carrier damage after the equipment has been in the purchaser's possession for more than 15 days.*

INDOOR HANDLING

The weight of an indoor unit without a breaker is approximately 2000 pounds. Each shipping group is equipped with lifting angle on the bottom 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.

If requested at the time of order placement, the switchgear will be shipped on a skid.

Groups of units can then be lowered using long wedges fabricated from four-by-fours cut on the diagonal. With a large crow bar, each corner may be lowered alternately a fraction of an inch.

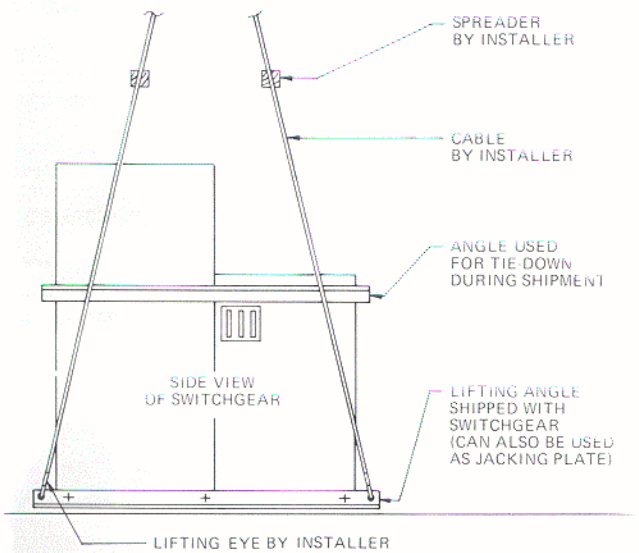


FIGURE 2
Methods of handling indoor equipment.

OUTDOOR HANDLING

The weight of an outdoor unit without a breaker is approximately 2500 pounds. Each shipping group is equipped with lifting lugs on each of four corners on the base. A cable spreader must be used when lifting with a crane to prevent upsetting the shipping group when it is lifted.

The first shipping group may be lifted into position with a crane or skidded into place on rollers. However, in moving in subsequent groups, the lifting lugs must be removed in order to place two groups immediately adjacent to one another. A method of lowering subsequent groups is the use of long wedges fabricated from four-by-fours cut on the diagonal. With a large crow bar, each corner may be lowered alternately a fraction of an inch.

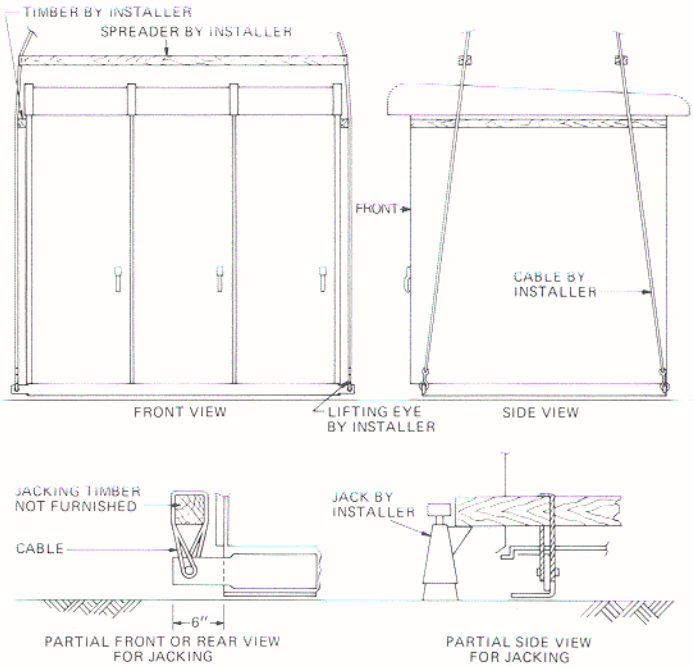


FIGURE 3
Methods of handling outdoor equipment.

INDOOR STORAGE

Indoor switchgear which cannot be installed and put into service immediately, should be stored in a dry, clean place, preferably indoors in a heated building. Adverse conditions such as dampness, temperature changes, and corrosive atmosphere should be carefully guarded against. If it is necessary to store the switchgear outdoors, special precautions are required to keep it clean and warm enough to prevent condensation. It will be necessary to cover the switchgear and install temporary heating equipment. During storage, the shipping groups should be placed on level surfaces to prevent unnecessary strain and possible distortion.

OUTDOOR STORAGE

Outdoor switchgear which cannot be installed and put into service immediately, should be stored taking certain precautions. Adverse conditions such as dampness, temperature changes, heavy dust, and corrosive atmosphere should be carefully guarded against. A temporary power connection made to the heaters already installed in the equipment will prevent condensation. The shipping groups should be placed on level surfaces to prevent unnecessary strain or distortion.

GENERAL STORAGE

Batteries should be uncrated and if filled with electrolyte put on trickle charge immediately upon receipt. Otherwise they should be inspected for damage and recrated for storage in a clean dry area.

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 switchgear has been subjected

to moisture it should be tested with either a 1000-volt or 2500-volt megger. A reading of at least 200 megohms should be obtained.

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

DESCRIPTION

INDOOR METALCLAD SWITCHGEAR CONSTRUCTION

Metalclad switchgear is equipment designed to control 5- and 15-kv circuits.

The switchgear consists of one or more units which are mounted side-by-side and connected mechanically and electrically to form a complete switchgear assembly.

Each circuit breaker unit consists of a stationary unit and a removable breaker element. The stationary unit is compartmented and includes the instrument panel, breaker compartment, and the bus and cable compartment. Each of these compartments is enclosed in grounded metal.

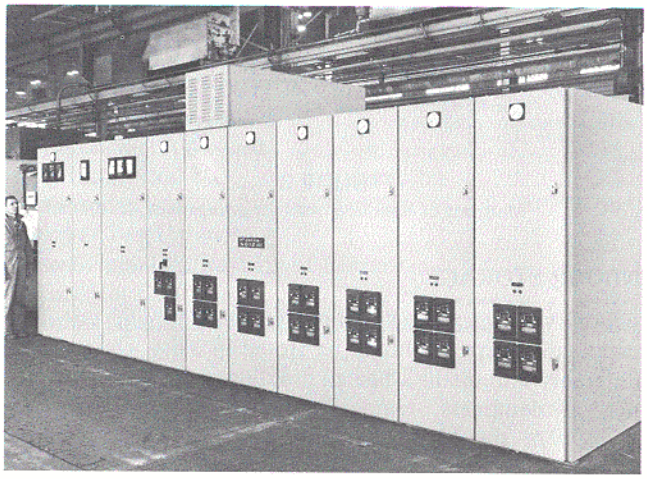


FIGURE 4
Installation of 15-kv indoor metalclad.

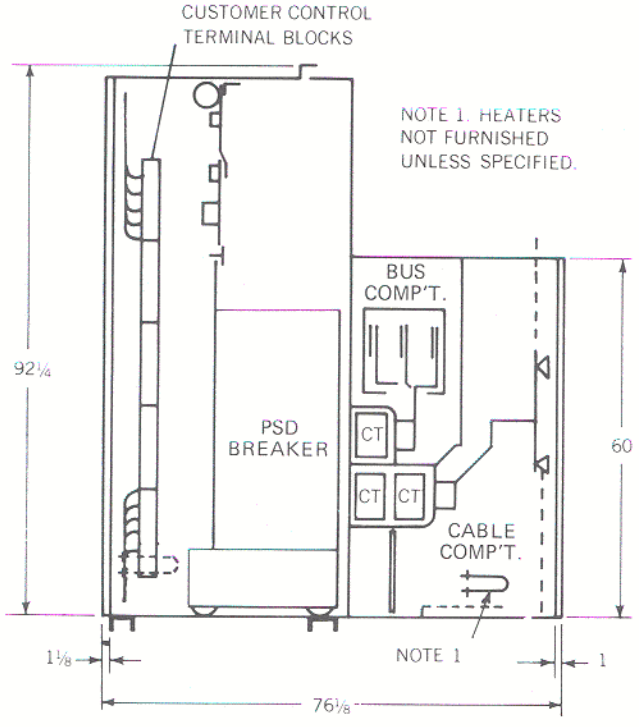


FIGURE 5
Typical 15-kv indoor metalclad breaker unit.

Moving and mating parts such as the shutter, interlocks, and auxiliary switch mountings are located in the breaker compartment. The breaker compartment contains major functioning equipment such as the breaker itself, stationary disconnect contacts, and current transformers. The supports for the main bus and main contacts are also a part of this compartment.

Control power switches and the like are mounted above the breaker in the front portion of the compartment. The instrument panel forms the front of the breaker compartment.

The line or cable compartment provides space for line connection through cable connectors, potheads, or bus duct.

If required, an upper rear compartment may be provided to house apparatus such as disconnect potential transformers, lightning arresters, special buses, etc.

CAUTION

Access to high-voltage sections is provided by bolted-on covers which should not be removed unless the circuits to be exposed are deenergized. Even though buses and connections are insulated they can induce a high voltage charge and must not be touched while energized.

OUTDOOR CONSTRUCTION

Figure 6 is a typical outdoor assembly. Outdoor switchgear is an assembly of steel panels, gasketed and caulked, to

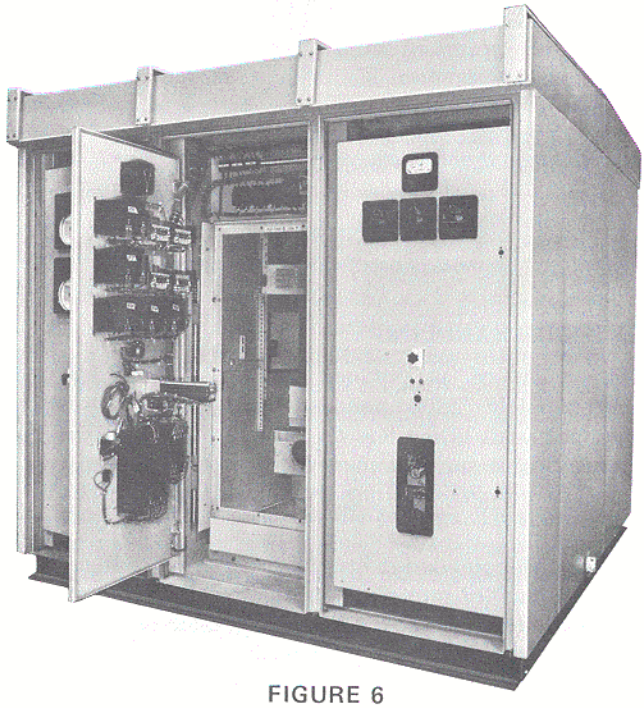


FIGURE 6
Typical McGraw-Edison 15-kv outdoor switchgear. (One unit door open to show instrument panel and bus side. Adjacent outer doors removed to show instrument panels.)

form a weatherproof enclosure around indoor units. The instrument panel is located on the side opposite the breaker drawout side. Weatherproof doors are located on both sides of each unit. A light and service receptacle are provided in each unit. Foundation requirements are simple. The structure is supported by base channels. A transport truck is supplied to move breakers in the switchyard and line them up to the height required for unit entry.

OUTDOOR MAINTENANCE AISLE CONSTRUCTION

Figure 9 is a section drawing of a typical sheltered aisle switchgear assembly. Outdoor maintenance aisle switchgear is an assembly of steel panels, gasketed and caulked to form a weatherproof assembly around indoor units and including an operating or maintenance aisle where equipment is accessible without exposure to weather. The aisle permits interchanging McGraw-Edison circuit breakers. A weatherproof door is located at each end of the aisle, each door being equipped with a "panic" latch mechanism permitting quick release from the inside when the door is padlocked on the outside.

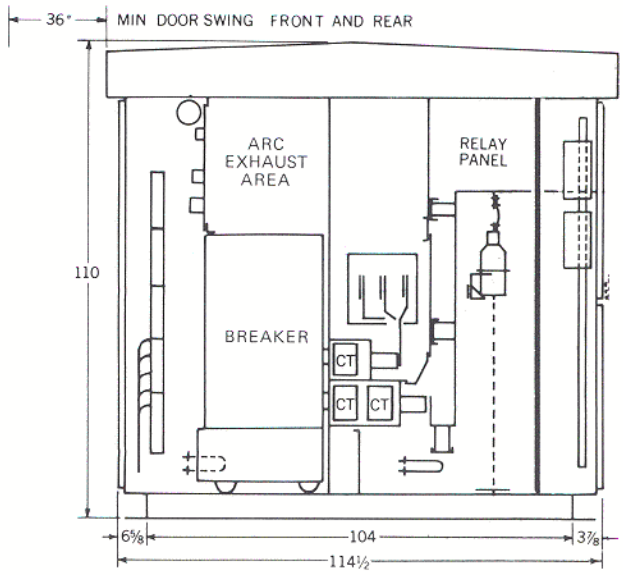


FIGURE 7

Section view of typical McGraw-Edison outdoor metalclad switchgear.

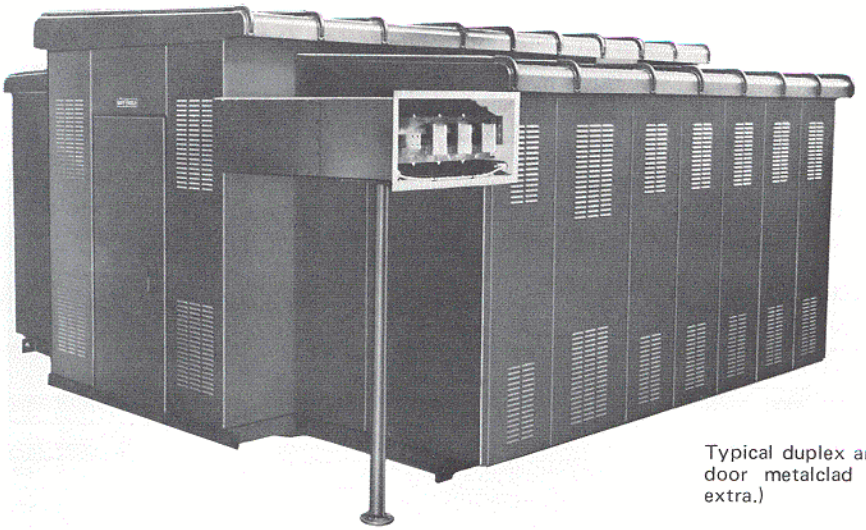


FIGURE 8

Typical duplex arrangement, McGraw-Edison maintenance aisle outdoor metalclad switchgear. (End aisle extension is an optional extra.)

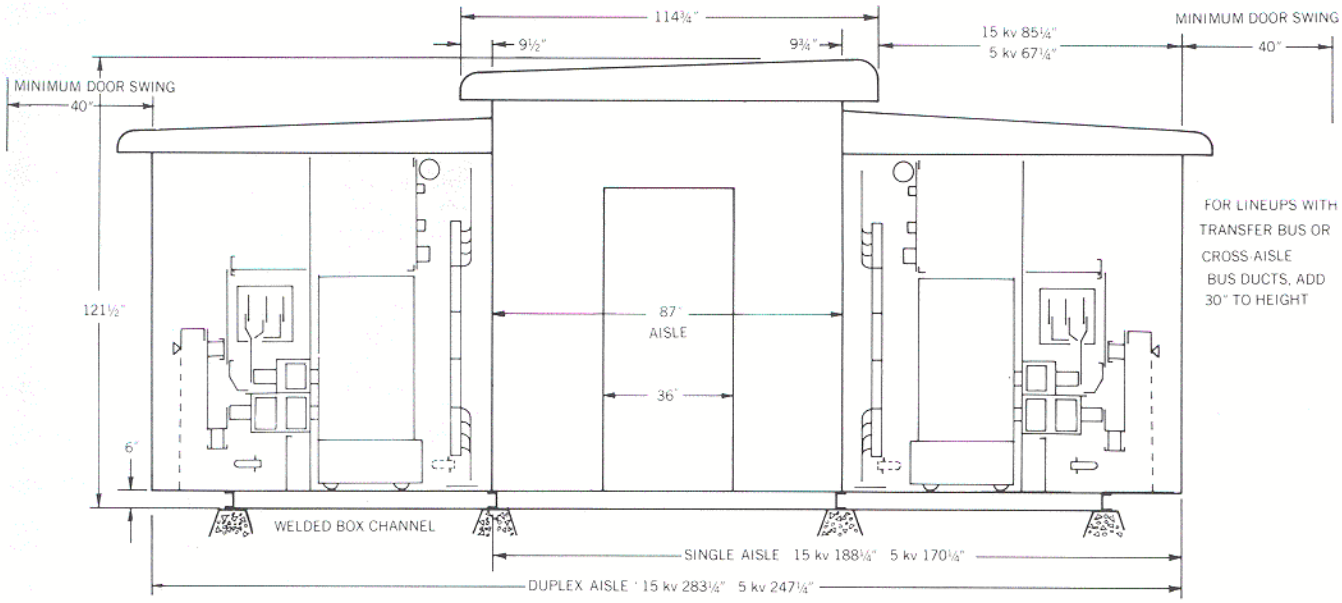


FIGURE 9

Typical duplex maintenance aisle section view. For single aisle remove either side of switchgear units.

CIRCUIT BREAKERS

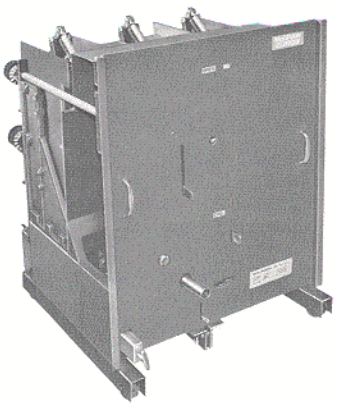


FIGURE 10

Typical McGraw-Edison VMC vacuum circuit breaker for metalclad switchgear installations.

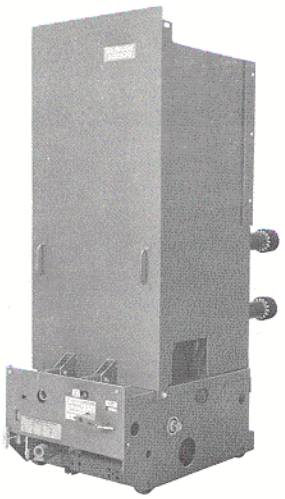


FIGURE 11

Typical McGraw-Edison PSD magnetic-air circuit breaker for metalclad switchgear installations.

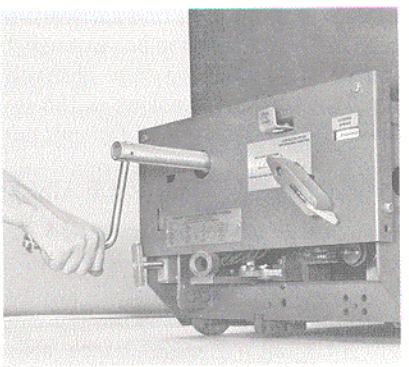


FIGURE 12

Racking a breaker is accomplished by a jackscrew-type mechanism.

The circuit breakers are horizontal drawout to provide maximum accessibility for maintenance with minimum service interruption. Refer to specific breaker instruction manual for breaker operating details.

The equipment is available in the ratings listed below. The ratings of the equipment and devices are based on usual service conditions as covered in ANSI Standards.

TABLE 1 – RATINGS

Nominal Voltage Class (kv)	Breaker Type	Continuous Rating (amps)	Interrupting Rating Class (Mva)	Rated Impulse Withstand (kv)	Rated One Minute Withstand (kv)
5	PSD 5-150	1200, 2000, 2500*	150	60**	19**
	PSD 5-250	1200, 2000, 2500*	250		
15	PSD 15-250	1200, 2000, 2500*	250	95**	36**
	PSD 15-500	1200, 2000, 2500*	500		
	VMC 15-500	1200	500	95**	36**

*Forced air cooled breaker. Self-cooled 2500- and 3000-amp switchgear main bus is available.

**These are factory test values. To prevent repeated stress of insulation standards recommend field testing at 75% of factory test value.

APPLICABLE TO ALL McGRAW-EDISON VACUUM INTERRUPTERS

X-radiation can result when voltage **in excess of the rated maximum voltage** is applied across the open-contact gap in a vacuum interrupter. Such radiation can become a health hazard on long exposure at close range. Refer to precautions outlined under TESTING AND INSPECTION Section.

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.

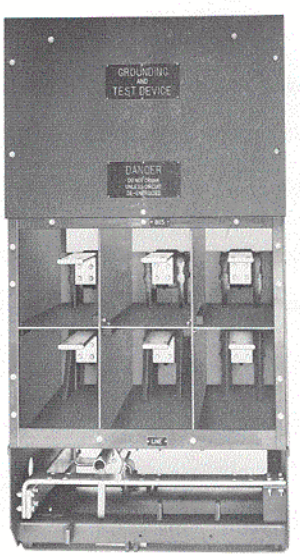


FIGURE 13

Simple ground and test device with both line and bus terminals exposed.

The six studs of the device provide access to the compartment line or load terminals. The studs are mounted behind a movable polyester-glass cover.

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

The device is rolled into the metalclad housing in place of the circuit breaker, and racked to the connected position by means of the circuit breaker racking crank.

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 the specific drawing supplied with the device.

CAUTION

Be certain studs are deenergized before moving cover to expose studs. Never ground a live stud.

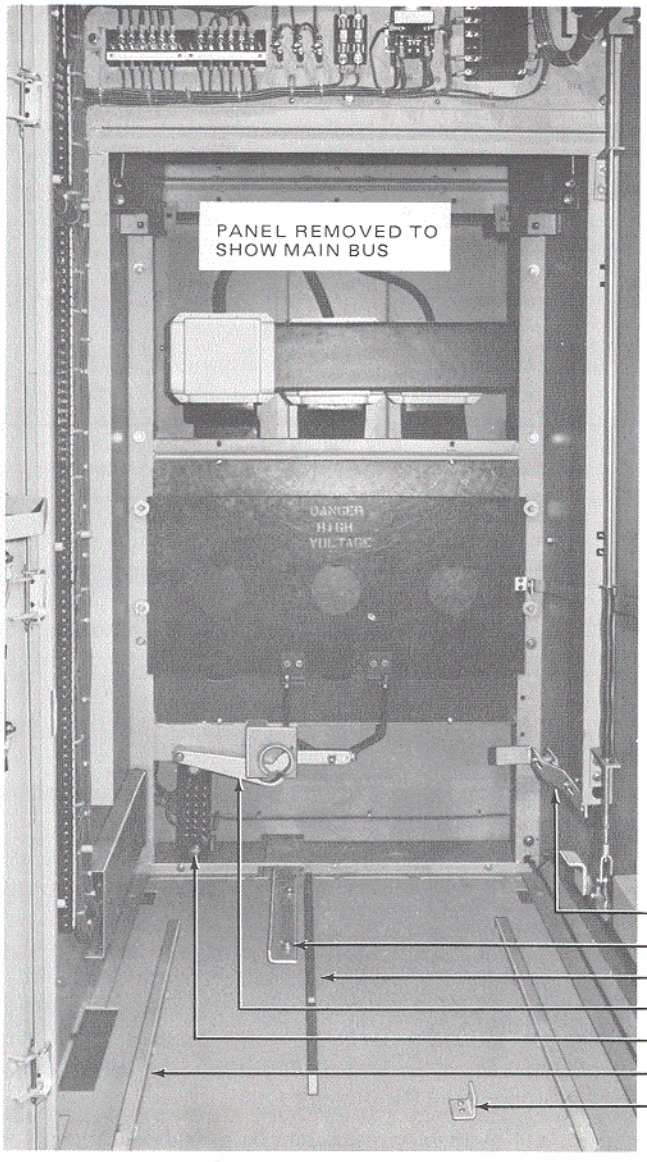


FIGURE 14
Front view of breaker compartment.

DUMMY REMOVABLE ELEMENT

Dummy removable elements, 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 and racking mechanism the same as an operating-breaker element. The device has no contacts and no operating mechanism and copper bars provide a solid connection between upper and lower studs. Racking the dummy element into the connected position provides a circuit path from cubicle line to load terminals.

CAUTION

Under no conditions must the dummy element be racked in or out when the bus or the unit is energized.

BREAKER COMPARTMENT

Shutter and Barrier

Mounted in front of the main contact supports are the glass-polyester barriers and shutter. A position-indicating arm is pivoted to the side of the compartment and linked to the shutter. The shutter is automatically raised by the action of the racking mechanism on the breaker against the cam surface of the shutter linkage when the breaker is racked into the connected position. When the breaker is racked out of the connected position, the shutter closes by the action of the racking mechanism. The barriers and shutter, when closed, provide a physical barrier to the main contact which may be "hot." See breaker instruction manual for racking instructions.

CAUTION

Do not remove or manually lift the shutter when switchgear is energized.

Secondary Disconnect Contacts

The secondary-disconnecting contacts are nickel-plated socket-type and are mounted in a block in the lower left rear of the breaker compartment. A similar secondary-disconnecting contact, but of the plug-type, is mounted on the breaker. They provide connections for the control leads between the removable breaker and the stationary housing. The plug on the breaker has two large guide pins, while the receptacle portion on the cubicle has two sockets that match the pins.

See the circuit breaker instruction book for description and operation of how to engage the secondary contact with the breaker in the test position.

Breaker Interlock Bar and Guide Rails

Associated with the racking-in mechanism is an interlock bar welded to the floor of the breaker compartment. It is notched at two places to provide a positive stop point for the breaker being racked into the "operate" or "test" position.

Also, welded to the floor of the breaker compartment are two rails which serve to guide the breaker into the compartment.

Main Disconnect Contacts

The 15-kv main disconnecting contacts and supports are shown below. The main disconnecting contacts are round, silver-plated studs located within the cylindrical porcelain supports.

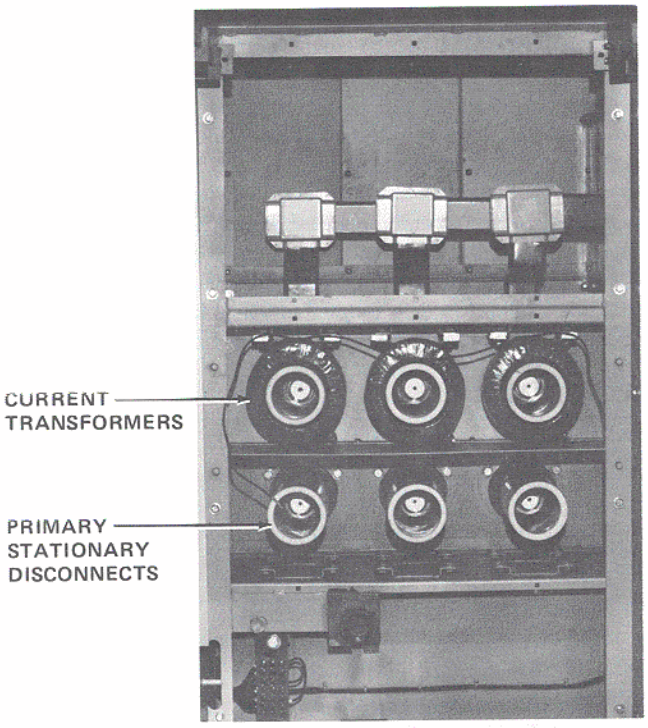


FIGURE 15

Typical feeder unit with barrier removed to show 1200-amp main bus. Shutter and CT barrier removed to show current transformer mounting on primary stationary disconnects.

CAUTION

Do not remove shutter unless switchgear is deenergized.

The rear of the contact is brazed to the tap to the main bus and is insulated. The contact assembly is secured within the bottle by a nut threaded onto the front of the contact. A special tool (Figure 12) is used to remove or replace the nut.

These main disconnecting contacts (in the compartment) engage the main disconnecting contacts of the breaker. The breaker contacts are self aligning finger clusters.

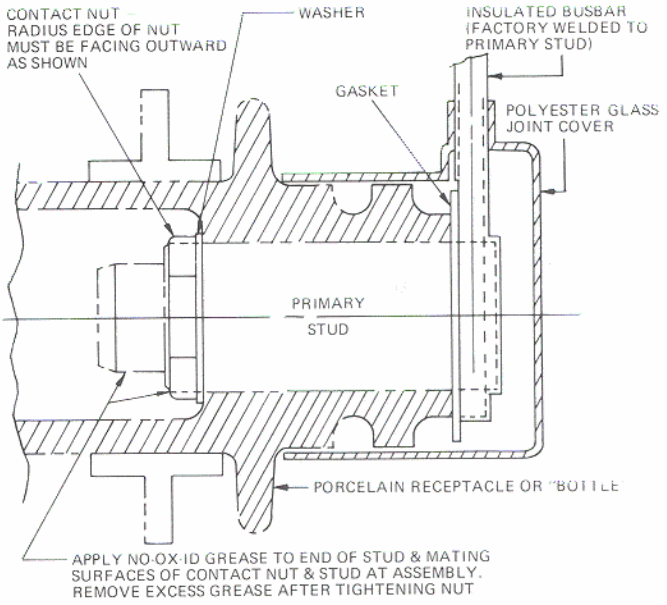


FIGURE 16

15-kv upper primary receptacle connection to main bus. (Lower receptacle is same concept.) 5-kv similar except polyester glass in lieu of porcelain.

Current Transformers

Bushing-type current transformers are positioned around the main contact supports as shown in Figure 5. They are removable from the front and may be mounted on the upper and/or lower main contact supports. If necessary, additional or special current transformers may be mounted in the cable compartment. (See figure 5).

CAUTION

1. Never contact current transformers when switchgear is energized.
2. Never disconnect current transformers secondary wiring when switchgear is energized.

Ground Fault Current Transformers (Through-Type)

Through-type current transformers are furnished where specified for sensitive protection against ground faults. These transformers are normally installed in a horizontal position 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.

BREAKER CONTROL AREA

This area is barriered off from high voltage by the breaker front barrier or by automatic shutters covering the breaker receptacles.

A fuse pullout for control-power cutoff and terminal blocks for customers' control leads are furnished as standard equipment in the control area. As required, additional equipment may be mounted in the control area; such as, capacitor trip devices, instantaneous or time undervoltage trip devices, control and transformer fuses, resistors, auxiliary or interposing relays, and thermostats. Heaters, to prevent condensation, are furnished as standard equipment on *outdoor* assemblies. One heater is mounted in the lower right front of the breaker compartment and another in the lower right part of the cable compartment (as seen when facing the compartment).

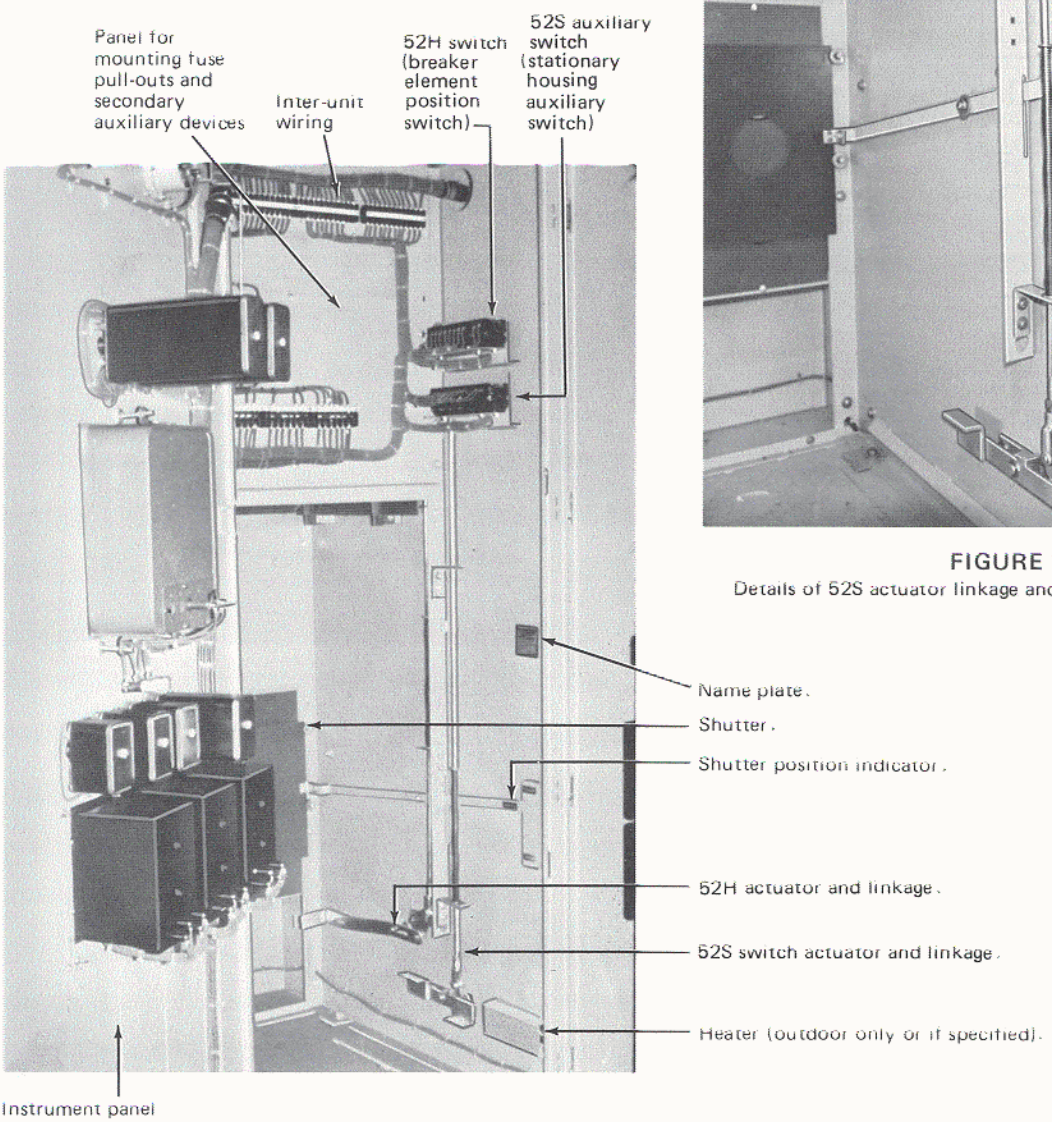


FIGURE 17
Breaker control area.

X-Y Antipumping Device

Normally this is a solid state device mounted on the breaker element. See breaker instruction book for location and details.

For a-c control, or if electro-mechanical X-Y relays are specifically ordered, the X-Y relays are mounted in the breaker control area. Refer to schematic and wiring diagrams for specific device and location.

Stationary Housing Auxiliary (52S) Switch

The 52S switch shown in Figures 17 and 18 is an assembly of a ten-stage switch and linkage. A cam, located on the side of the breaker truck, operates the linkage and switch. The linkage can be set up, as indicated in the purchase specifications, to provide operation in the connected position only or in both the connected and test positions. The 52S switch electrically indicates whether the breaker is closed or tripped.

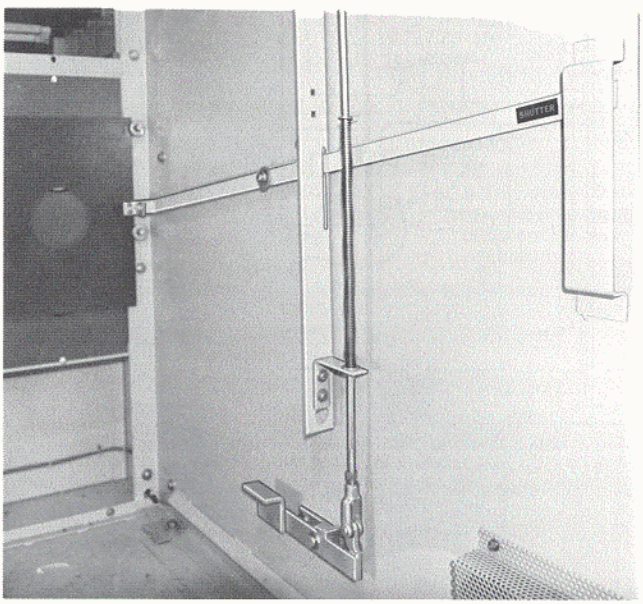


FIGURE 18
Details of 52S actuator linkage and shutter position indicator.

Removable Element Position Auxiliary (52H) Switch

The 52H switch shown in Figures 17 and 18 is an assembly of a ten-stage switch and linkage. It is operated by the motion of the breaker truck into or out of the connected position. As a result, the 52H switch electrically indicates whether or not the breaker is in the connected position.

AUXILIARY COMPARTMENT

Drawout Potential Transformers (PT)

Drawout potential transformers are enclosed within their own compartments. Generally, these compartments are located with control power transformers and control power fuse compartments in an auxiliary unit. They are mounted on wheeled-trucks linked to the compartment door. With the door closed, both the primary- and secondary-disconnecting contacts are engaged. Upon opening the door, the truck with the potential transformers is rolled toward the front; both the primary and secondary contacts are disengaged; and, the fuses and the primary winding of the transformer are grounded. A stop limits the forward rolling action. In this position, the fuses may be readily replaced. Figures 9 and 10 show typical arrangements.

Potential transformers may be mounted in separate units as shown, or in superstructure mounted above the breaker. If space permits, they may also be mounted above the rear cable compartment of a breaker compartment. In this position, they are only accessible from the rear of the basic metalclad assembly.

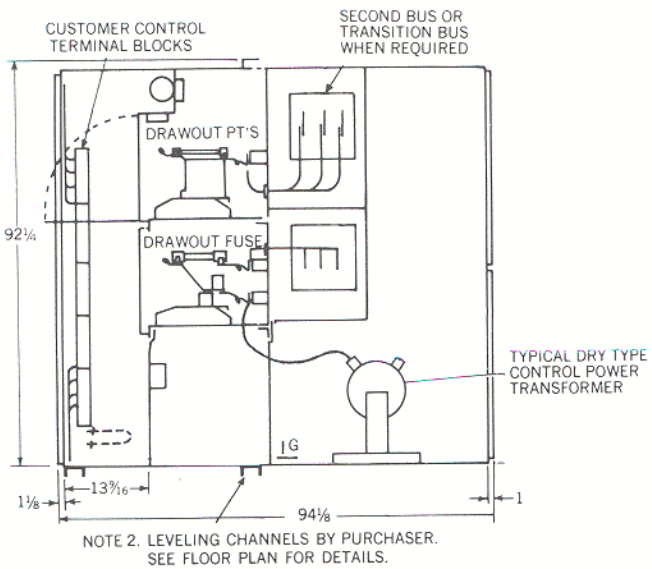


FIGURE 19
Typical auxiliary compartment.

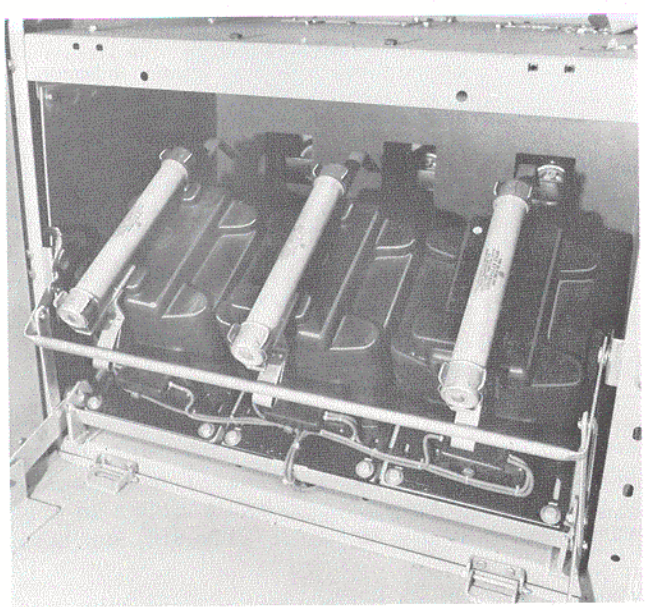


FIGURE 20
Details of door to PT truck linkages and fuse grounding bar.

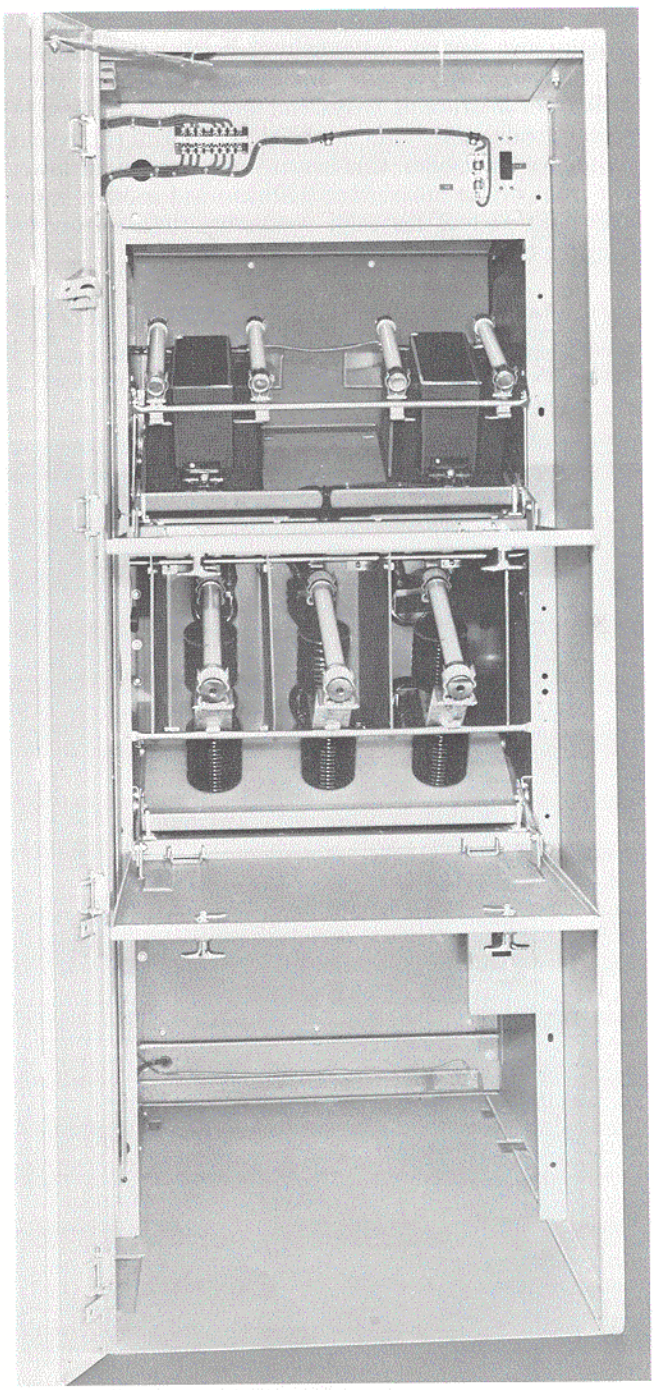


FIGURE 21
Potential transformers and primary fuses are mounted on wheeled trucks. The transformers disconnect when the door is opened.

Control Power Transformer and Fuses (CPT)

Control power (station auxiliary power) transformers are enclosed in their own compartments. Primary fuses are located in a separate isolated area of the same auxiliary compartment. The control power transformer is usually stationary on the floor of the unit. The low-voltage connections are made through a circuit breaker located in the immediate vicinity. The high-voltage connections are made through drawout-mounted control power fuses. The drawout assembly is mechanically interlocked with the secondary breaker. The fuses cannot be drawn out without the secondary loading being dropped.

With the fuse door closed, the fuse contacts are engaged. Upon opening the door, the truck with the control power fuses is rolled toward the front; the contacts are disengaged; and, the fuses are grounded. A stop limits the forward rolling action.

Figures 22 and 23 show typical arrangements.

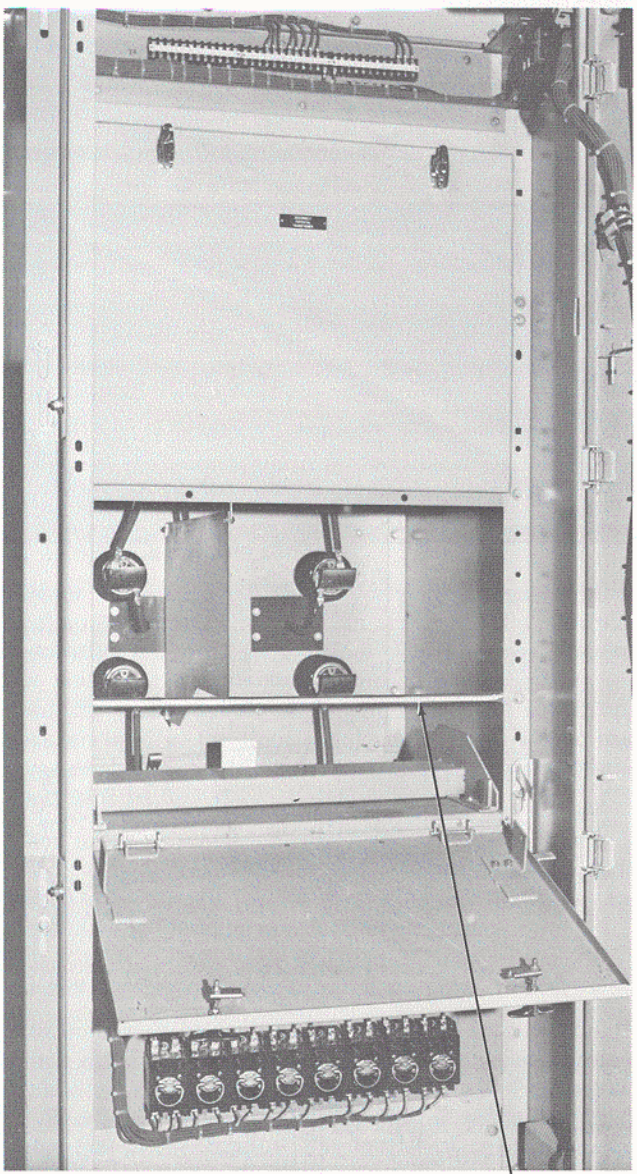


FIGURE 22

CPT primary fuse compartment (fuse truck removed).

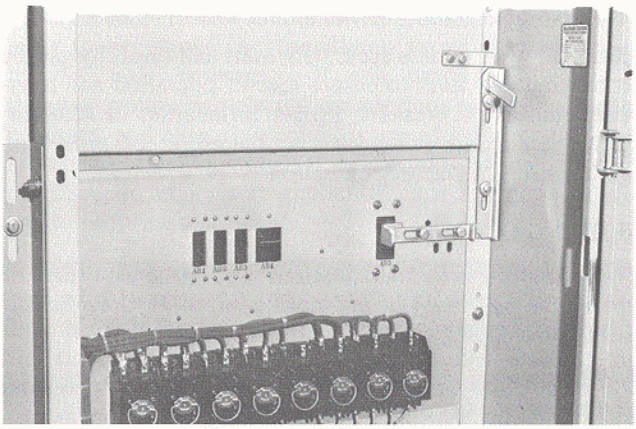


FIGURE 23

Details of mechanical interlock to prohibit opening CPT fuse panel unless main secondary breaker is open.

CABLE COMPARTMENT

CAUTION

Care must be exercised if opening cable compartment while switchgear is energized. Even though bus bars are insulated they carry a lethal capacitive charge.

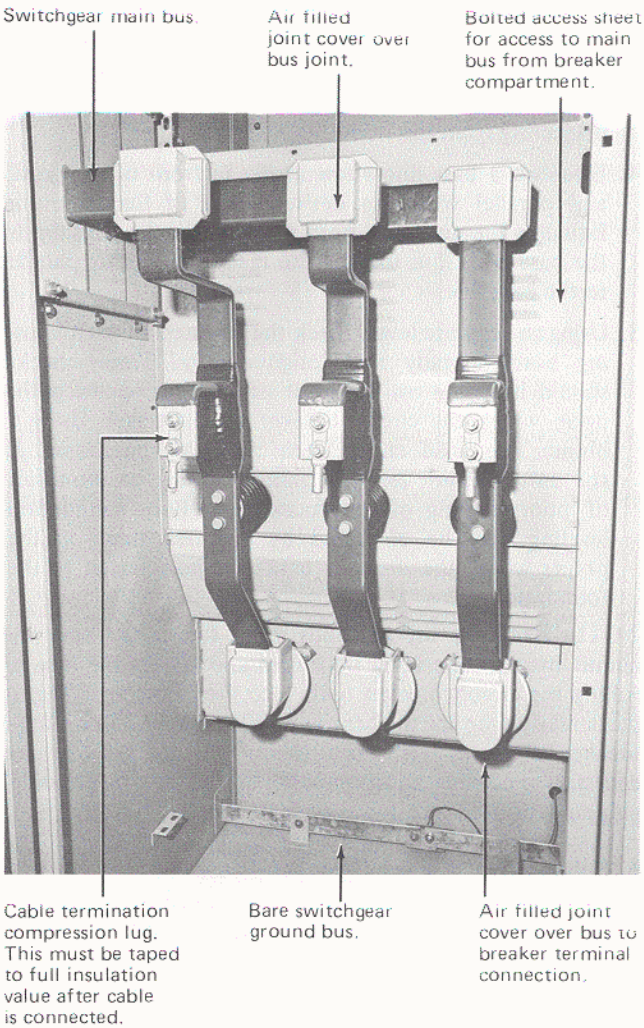


FIGURE 24

Typical 15-kv cable compartment.

INSTALLATION

Metalclad switchgear is accurately built and carefully gauged to be true and level to ensure ease of operation and interchangeability of breakers. Proper installation of McGraw-Edison metalclad switchgear is, therefore, of *prime importance* for satisfactory operation.

SHIPPING GROUPS

The following recommendations and general order of operations will assist in the installation of McGraw-Edison metalclad shipping groups:

1. When several shipping groups of the switchgear are to be arranged in one continuous line-up, the center shipping group should be installed first. The other shipping groups should then be installed in successive order on either side of the center group. When installing a unit substation, the power transformer and the adjacent metalclad group should be first lined up and set in position in accordance with the dimensions on the base plan drawing for the installation. The additional groups should then be installed.
2. Remove crating and packing material from the groups to be erected. If skids were included on indoor gear, they should not be removed if rollers are to be used. Remove control and power conduit area covers.
3. Move the first group into position either by crane or by pipe rollers (See RECEIVING HANDLING and STORAGE Section). The rollers, if used, should be high enough to allow the switchgear to pass over the conduits projecting from the floor.
4. Establish a base line a few inches in front of the group and parallel with the desired front of the structure. Equalize the distances from the front of the housings to the base line, thus making the face of the group parallel to the base line.
5. Using an accurate level, check the levelness of each housing both laterally and longitudinally. These checks should be made on the floor of the unit on the paths upon which the circuit breaker wheels travel. Using a plumb line, also check each unit for plumbness. If the units are not level or plumb, it may be the result of poor leveling of the foundation. Poor foundation leveling may be corrected by inserting shims at the points where the units or base members fasten to the foundation.

NOTE: Excessive use of shims raises the units above the circuit breaker operating floor area and affects the ease of rolling the circuit breaker units into their housings. This is particularly true for the heavier 2000-amp and 15-kv circuit breaker elements. If more than 3/16 inch shims are necessary, consideration should be given to grinding, chipping, or otherwise lowering high points.

6. Subsequent shipping groups should be moved into position and the procedure as outlined above for the first group repeated. The groups should be bolted together with the tie bolts provided and given a final check for levelness and plumbness. The complete assembly should then be fastened to the foundation by welding or bolting (weatherproof outdoor equipment per instructions in INSTALLATION section).

With the housings all in place, anchored and bolted together, check the hinged doors or instrument panels for free swing and floor clearance. A binding door usually indicates a door jamb out of plumb. This should be checked and corrected. Next, check the shutters for free operation by manually opening and closing them. Check the secondary-control disconnecting block for freedom to align itself by compressing it against the backing springs. Check the primary-disconnecting contacts for foreign matter and freedom from damage. Open the hinged rear covers of the units, inspect the bus and line compartments, and remove any foreign material.

Proceed with the installation of the main bus at the shipping breaks. Refer to MAIN BUS CONNECTIONS.

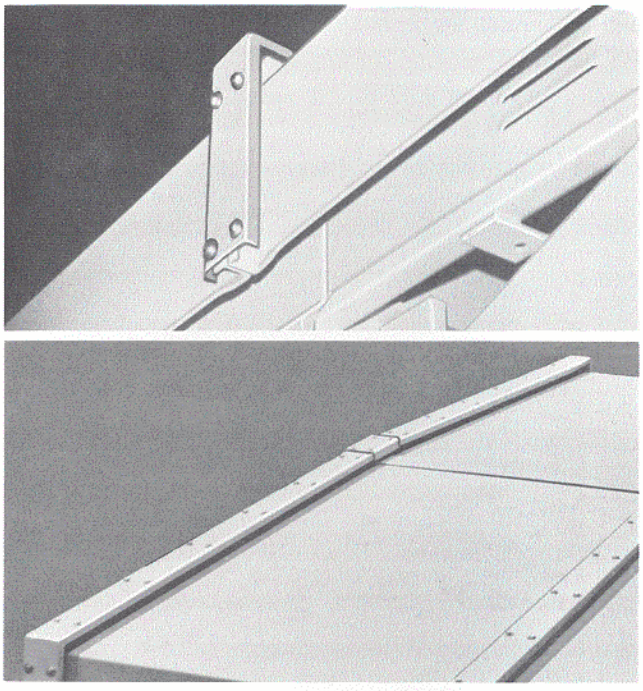


FIGURE 25
Roof seam cover and cap.

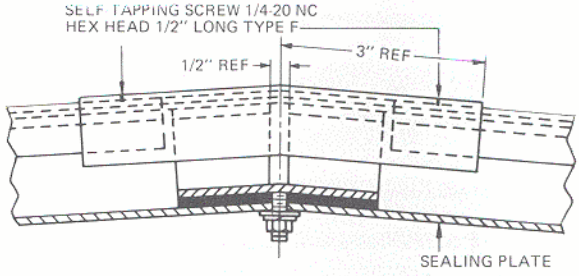


FIGURE 26
Roof peak trim cap arrangement.

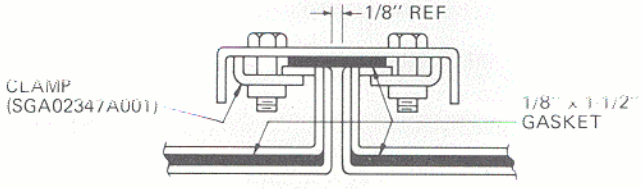


FIGURE 27
Detail of trim cap.

OUTDOOR WEATHERPROOFING OF SHIPPING SPLIT

After completing the installation of shipping groups as indicated, the weatherproofing parts should be assembled. Seams between units should be caulked. Roof seam cover and cap should be put in place and bolted. See Figures 25, 26, and 27 .

FOUNDATIONS

General

The recommended aisle space required at the front and rear of the units is shown on the floor plan drawing furnished for each specific order. Space must be provided at the front to permit insertion and withdrawal of the circuit breakers and their transfer to other cubicles; space at the rear for installation of cables, for inspection and maintenance, and, in some cases, for drawout potential transformers.

The foundation upon which the switchgear is to be mounted may be a concrete floor, pad, footers, or pillars depending on the type of gear.

It must have sufficient strength to withstand the weight of the structure plus the shock or impact resulting when circuit breakers open under short circuit conditions.

Careful preparation of the foundation is vitally important for simplicity of erection, ease of operation, and good performance. The foundation should consist of rugged floor steel channels embedded in an accurate and true concrete floor. The entire concrete floor upon which the switchgear will be erected must be true and flat, preferably level and in no place should it vary more than 3/16 inch in any square yard and must not project above the level of the supporting floor channel steel.

Special attention should also be paid to the accurate leveling of the floor adjacent to the cubicles on the breaker drawout side since the rapidity and convenience in installing and removing the circuit breakers will be facilitated by a smooth, hard floor surface.

Figures 28 through 38 show typical recommended floor steel arrangements. The base plan approved for a particular installation is shown on the floor plan drawings. Welding the units to the floor steel is preferred to eliminate the need for accurate bolt alignment. The steel supporting channels used in the floor should be brought to the true plane of the finished floor, leveled, and held there until the concrete is set.

When installing metalclad switchgear on existing floors, it will usually be desirable to pour a new finish floor with embedded channels or to cut slots in the floor for embedding and leveling new support channels.

Control and Power Conduit Entrances

Provisions must be made in the foundation for the conduits which carry the main cables, control wiring, and ground cable when such conduits enter the switchgear from below. A floor-plan or base-plan drawing is made for each metalclad switchgear order. This shop drawing must be used for determining the final conduit layout spacing of floor channels and floor space required for each metalclad line-up.

Conduits should project above the finished floor approximately two inches for indoor switchgear and approximately eight inches above the foundation for outdoor or maintenance aisle switchgear. It will simplify moving the shipping groups into place if the conduits are flush with the concrete, and extension conduits are added after the units are in their final location. Otherwise, extreme care must be exercised to make sure the units clear the tops of the conduits during placement.

If more than one control conduit is required per unit, they must be aligned in the space allotted for them on the floor plan. It is desirable to provide a blocked-out slot in the floor or to provide clearance holes around the secondary conduits so that minor bending of the conduits can be made when the switchgear is installed. The space available for conduits is quite limited and minor bending of the conduits is sometimes necessary to correct errors in locating the conduits and for accumulated positive tolerances in long switchgear assemblies.

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 through 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.

Indoor Arrangements (use specific order drawings for construction)

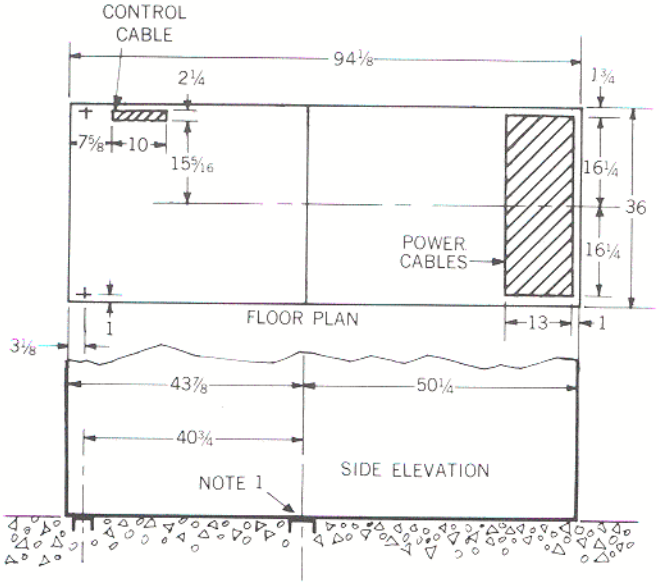


FIGURE 28
15-kv 1200- or 2000-amp (standard).

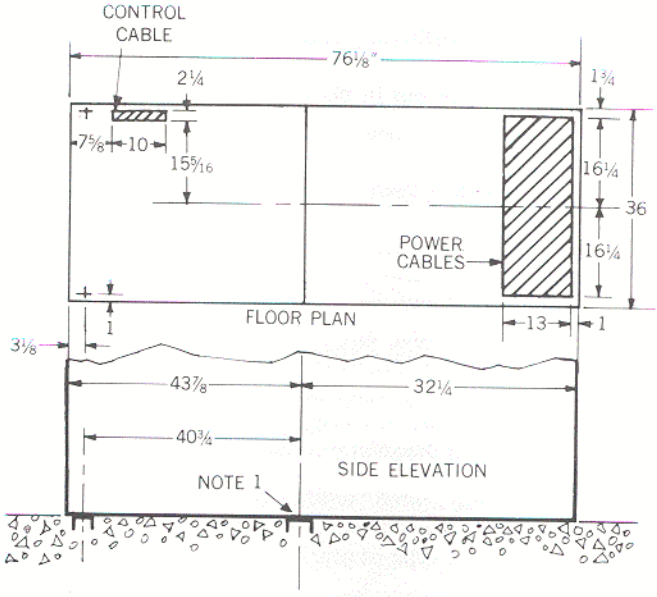


FIGURE 30
5-kv 2000-amp.

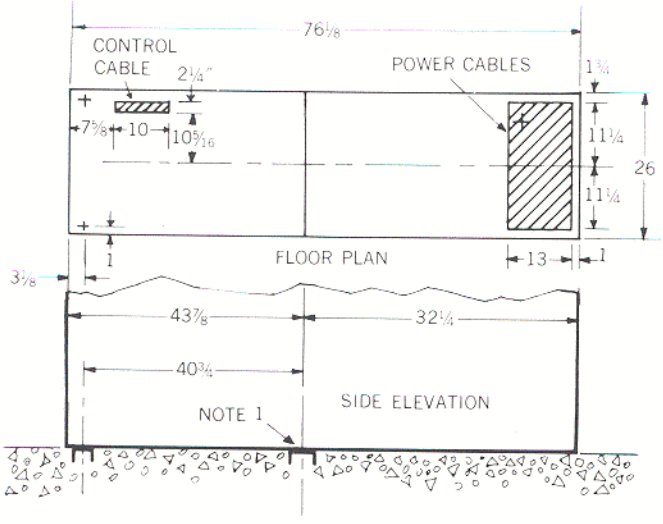


FIGURE 29
5-kv 2000-amp (standard).

NOTES:

1. Floor steel supplied by purchaser unless otherwise specified. 4" 5.4# recommended.
2. Welding switchgear to floor steel recommended.
3. Alternate of bolting switchgear to floor steel tap channels for 3/8 bolt or weld nut (3/8 or 1/2) to underside of channels.
4. Concrete of the area to be covered by the housings should be level with or slightly below the mounting surface of the floor steel. Aisle in front of the housings should receive special finishing attention to eliminate bumps or hollows and to keep it level with the surface of the front floor channel. A smooth level surface contributes greatly to the ease of circuit breaking handling.
5. Cover plates for power and control cable areas not furnished unless specified.
6. Consider door swing the width of the cubicle in both front and rear of switchgear and also drawout space of at least 6 feet for breaker element.

Weights

Rating		Breaker or Auxiliary Unit (Without Breaker) (lb)	Breaker (lb)
(kv)	(amp)		
5	1200	1300	833
5	2000	1900	1044
15	1200	2140	1255*
15	2000	2440	1372

Impact weights

Air-magnetic: 1 x breaker weight = vertical upward force
1-1/2 x breaker weight = vertical downward force
Vacuum: 1 x breaker weight = vertical upward force
1 x breaker weight = vertical downward force

*Vacuum (VMC) breaker weighs 660 pounds

Outdoor Arrangements (use specific order drawings for construction)

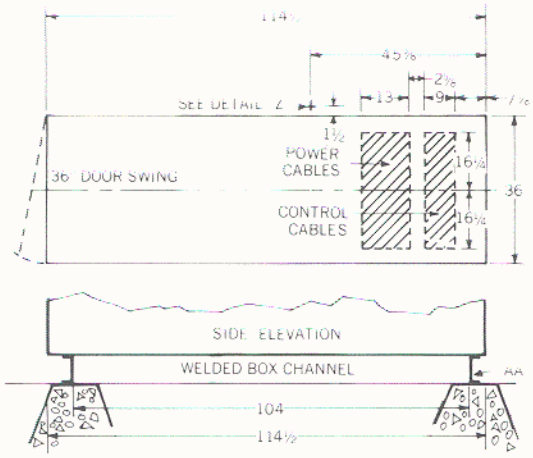


FIGURE 31
15-kv floor plan (standard).

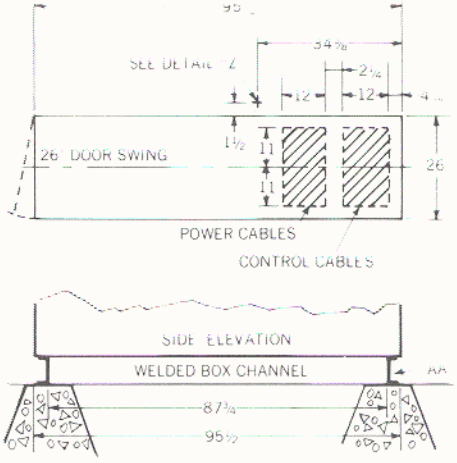


FIGURE 33
5-kv floor plan (standard).

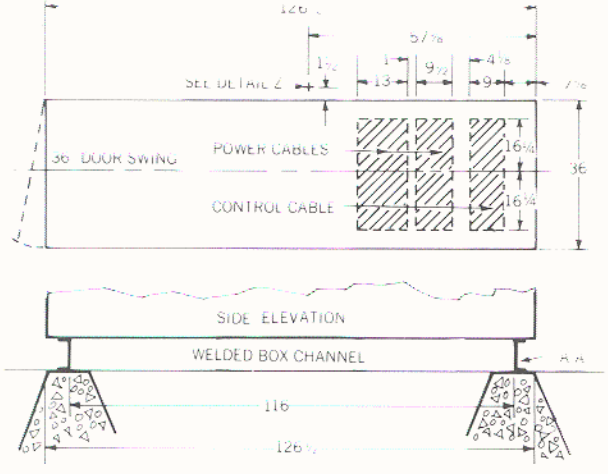


FIGURE 32
15-kv floor plan (double pothead).

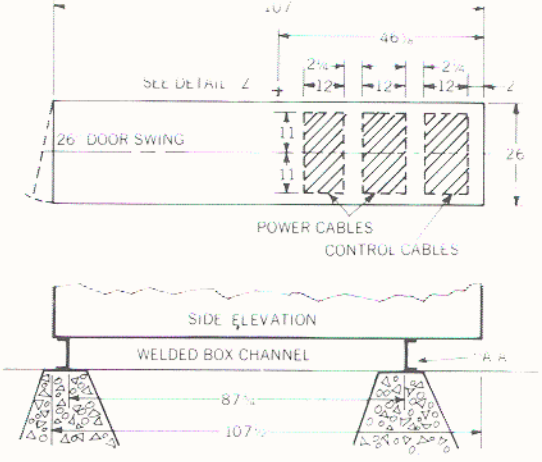


FIGURE 34
5-kv floor plan (double pothead).

Weights

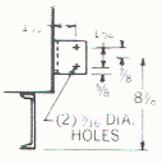
Rating (kv)	Rating (amp)	Breaker or Auxiliary Unit (Without Breaker) (lb)	Breaker (lb)
5	1200	2300	833
5	2000	2500	1044
15	1200	3130	1255*
15	2000	3450	1372

Impact weights

Air-magnetic: 1 x breaker weight = vertical upward force
1-1/2 x breaker weight = vertical downward force

Vacuum: 1 x breaker weight = vertical upward force
1 x breaker weight = vertical downward force

*Vacuum (VMC) breaker weighs 660 pounds.



DETAIL "Z"
TYP. GRD. CONN.
BOTH ENDS

Maintenance Aisle Arrangements
(use specific order drawings for construction)

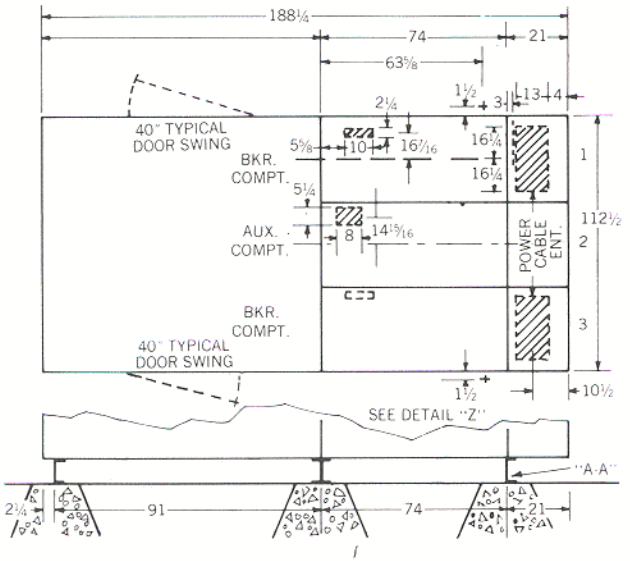


FIGURE 35
Typical 15-kv floor plan.

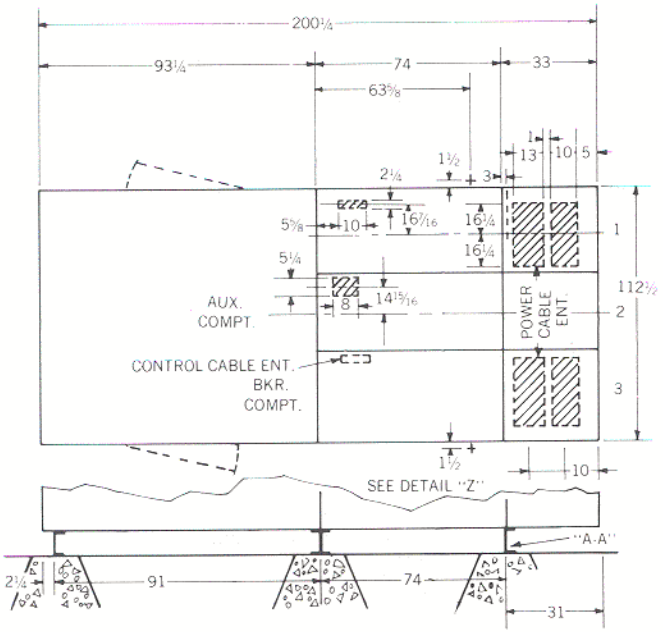


FIGURE 36
Typical 15-kv floor plan with twelve-inch extension for double potheads.

Weights

Rating		Breaker or Auxiliary Unit (Without Breaker) (lb)		Breaker
(kv)	(amp)	Single	Duplex	(lb)
5	1200	2980	5260	833
5	2000	3180	5460	1044
15	1200	3950	7100	1255*
15	2000	4150	7500	1372

Impact weights

Air-magnetic: 1 x breaker weight = vertical upward force
1-1/2 x breaker weight = vertical downward force

Vacuum: 1 x breaker weight = vertical upward force
1 x breaker weight = vertical downward force

*Vacuum (VMC) breaker weighs 660 pounds.

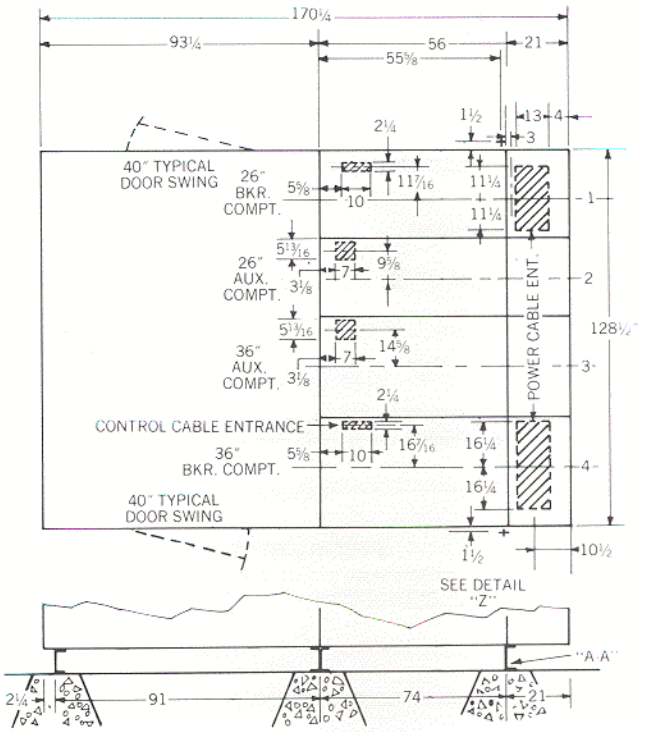


FIGURE 37
5-kv standard floor plan.

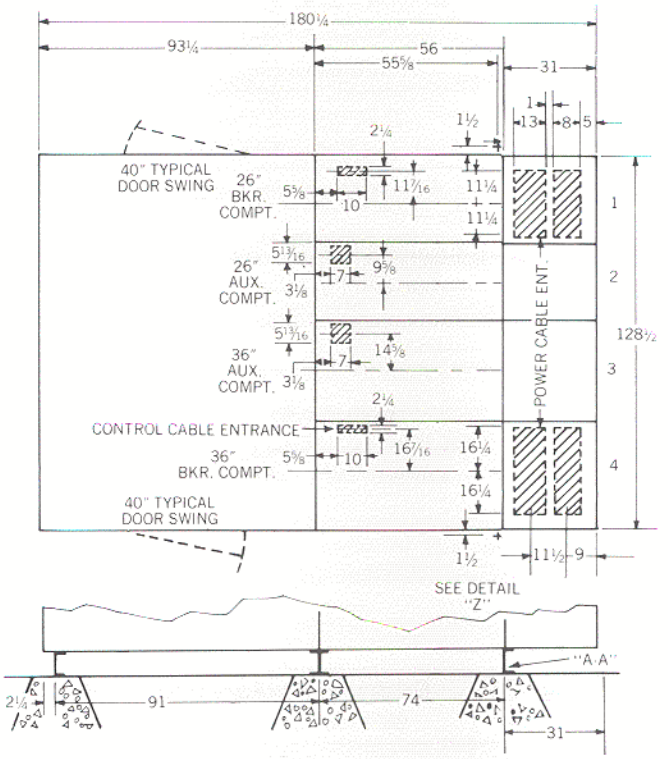
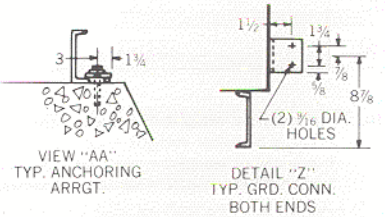


FIGURE 38
5-kv floor plan with ten-inch extension for double potheads.



ERECTION OF ASSEMBLED MAINTENANCE AISLE (SINGLE AISLE)*

*For Duplex Aisle see disassembled aisle erection section

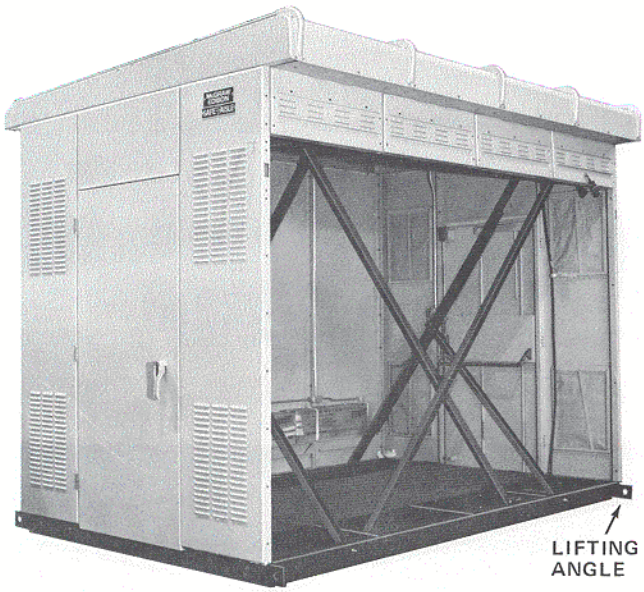


FIGURE 39

Assembled maintenance aisle prepared for shipment with shipping braces and lifting angles in place.

1. Install switchgear units first as outlined for outdoor switchgear. Then aisle section should be moved into place. If there are three or more shipping groups, *move the center-most piece in first.*

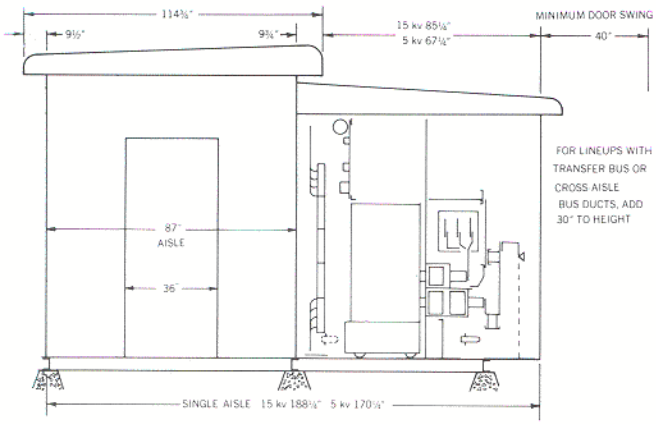


FIGURE 40

Section view of aisle connected to switchgear.

2. Place the aisle assembly immediately in front of and as close as possible to the switchgear units. *Remove the lifting angles* and butt the aisle assembly up to the units.
3. Remove the floor filler plates immediately in front of the units and bolt the channel base (Figure 41) to the unit base with the bolts provided. Replace the floor filler plates.
4. Remove the floor filler plates on the aisle side opposite the units and anchor the base to the foundation.

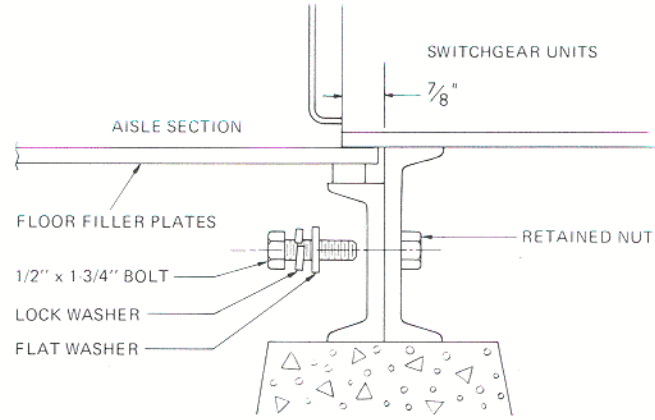


FIGURE 41

Bolting aisle channel base to unit base.

5. If aisle is shipped in more than one section, bolt the bases together.
6. Bolt the aisle-end walls to the switchgear walls. Caulk all bolted seams with caulking provided including wall to floor seams.

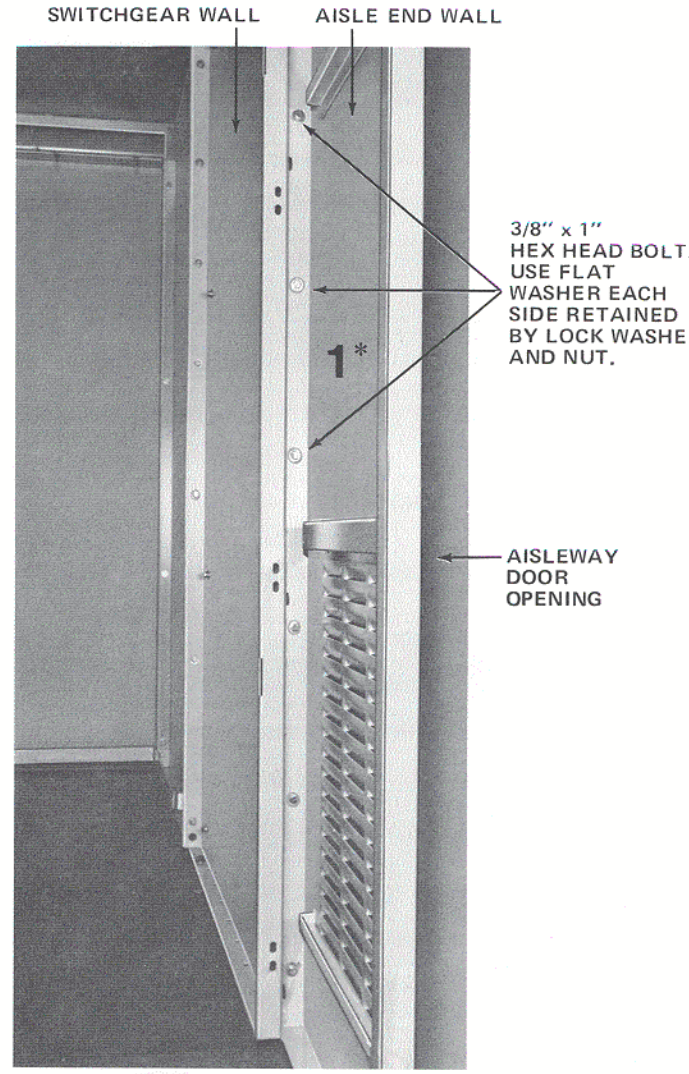


FIGURE 42

Aisle-end walls bolted to the switchgear walls.
*See Figure 50 for panel reference.

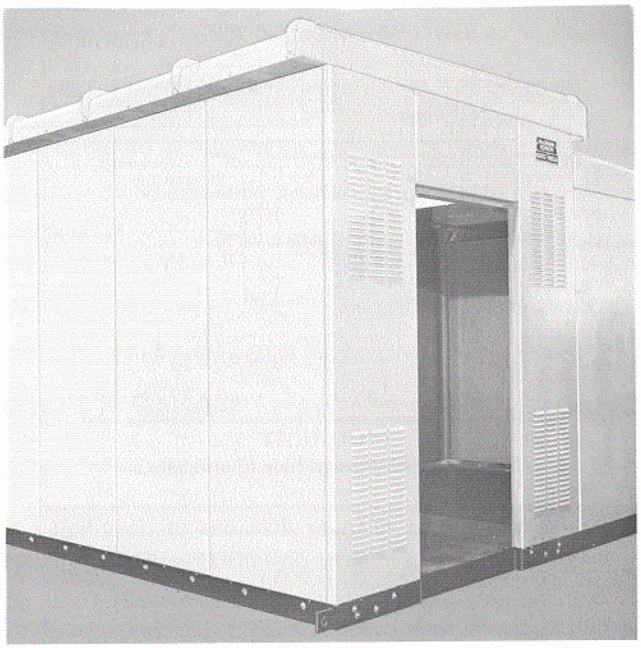
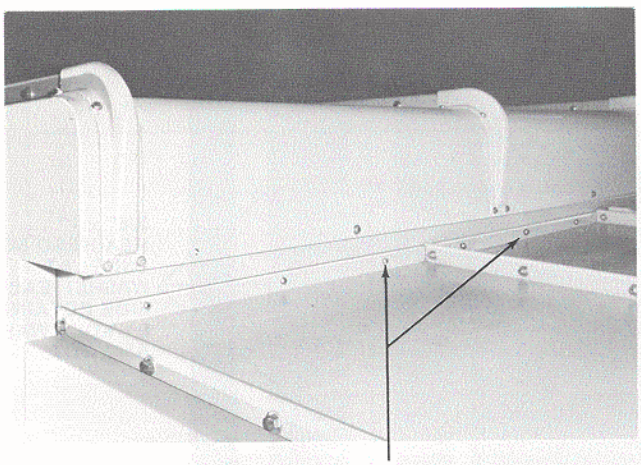


FIGURE 43
Aisle wall joined to switchgear wall.



3/8" x 1" HEX HEAD BOLTS, USE FLAT WASHER EACH SIDE RETAINED BY LOCK WASHER AND NUT.

FIGURE 44
Aisle roof bolted to the top of the units.

7. Bolt the aisle roof to the top of the units and caulk jointure seams. (Figure 44).
8. If aisle is shipped in two sections join walls and roof together as shown in Figure 45 and apply caps over roof seams. Use *gasketing* between roof seams. Use caulking under rounded end caps.
9. Remove the shipping braces from the maintenance aisle assembly and discard.
10. Check all seams for tightness by checking for light cracks.
11. Refer to the wiring diagram for completion of the interior wiring.
12. Install filter in end walls and roof overhangs.
13. Install 200-watt bulbs (by purchaser) for aisle illumination.

FIGURE 46
Interior view of completed aisle assembly.

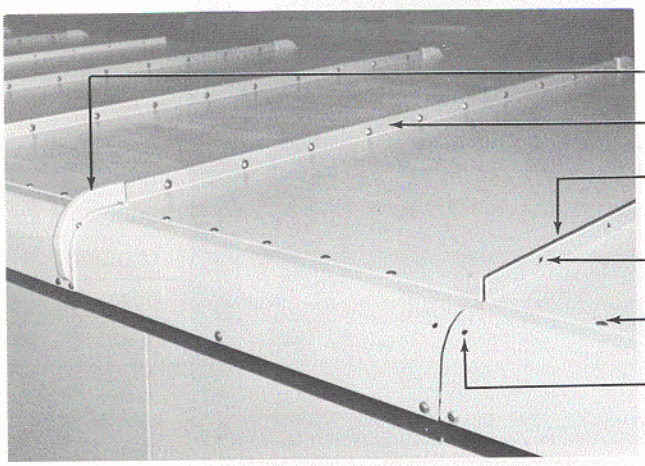


FIGURE 45
Wall and roof joint.

ERECTION OF DIS-ASSEMBLED MAINTENANCE AISLE ASSEMBLY AND DUPLEX AISLE SWITCHGEAR*

*For Duplex assembly omit steps 3 and 6

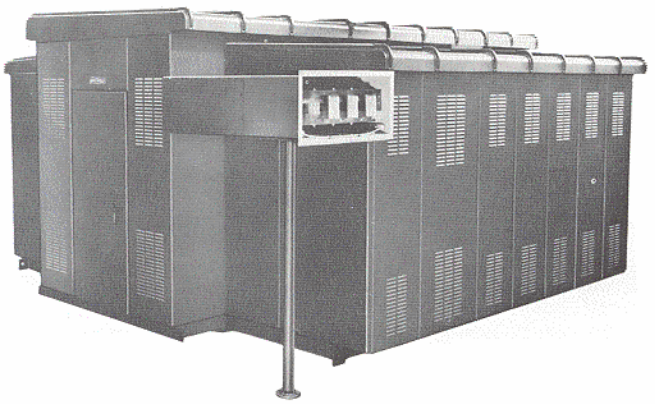


FIGURE 47

Duplex maintenance aisle assembly. (End aisle extension of 26" is optional extra price feature).

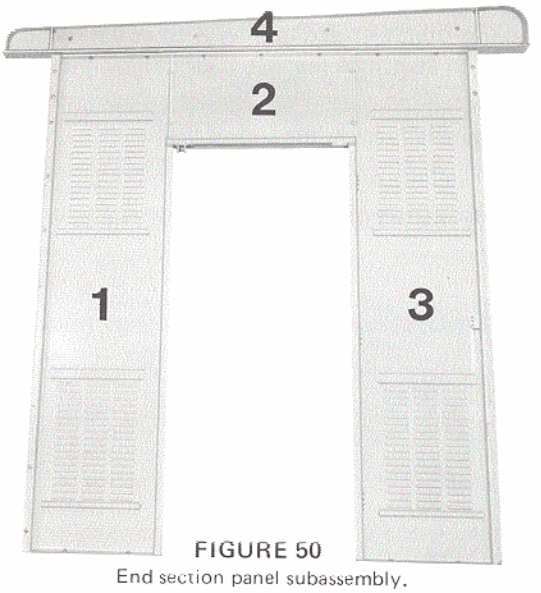


FIGURE 50

End section panel subassembly.

Panel numbers are for reference and orientation in Figures 42, 49, 50, 51, 52, 53 and 61.

If an assembled aisle is not contracted for in the purchase, it is shipped disassembled in parts for erection in the field. The following erection procedure applies.

1. Install switchgear units first as outlined for outdoor switchgear.
2. Referring to the floor plan drawing supplied, place the aisle base(s) on the foundation and complete bolting of the aisle base(s) to the switchgear bases (Figure 48) BE SURE ALL BASES ARE LEVEL.

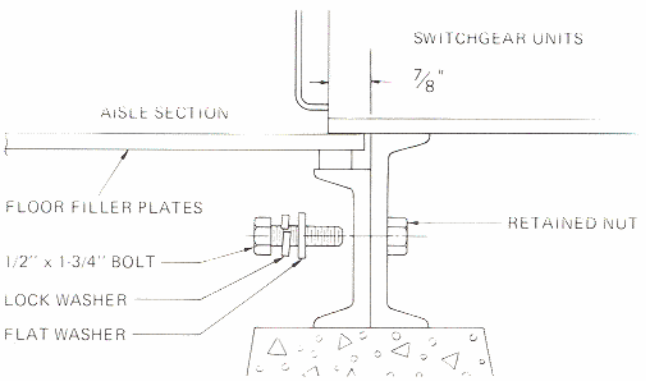


FIGURE 48

Bolting aisle channel base to unit base.

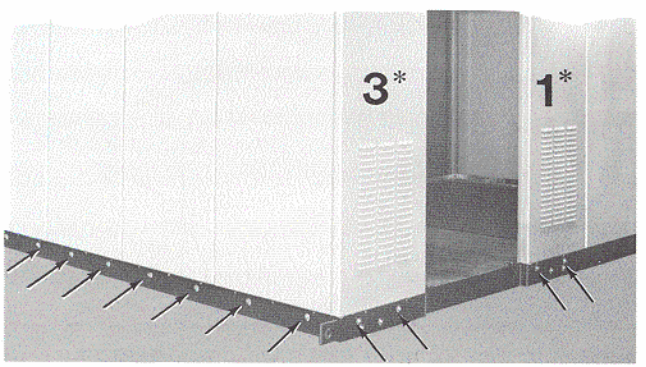


FIGURE 49

Location of bolts for wall support angles.
*See Figure 50 for panel reference.

3. Assure that aisle wall support angles are installed completely around aisle base in preparation for mounting walls. Loosen support angle bolts for adjusting aisle walls during assembly. See Figure 49.
4. Subassemble the (4) panels forming each end section. Use 3/8" X 1" hex-head bolts with flat washer on each side. Fasten with lock washer and nut. Caulk seams between panels with caulking provided. See Figure 50.
5. Install one-end wall (assembly with door) to switchgear units and to base. Apply caulking between wall and units before bolting. *DO NOT TIGHTEN BOLTS.* See Figure 51.

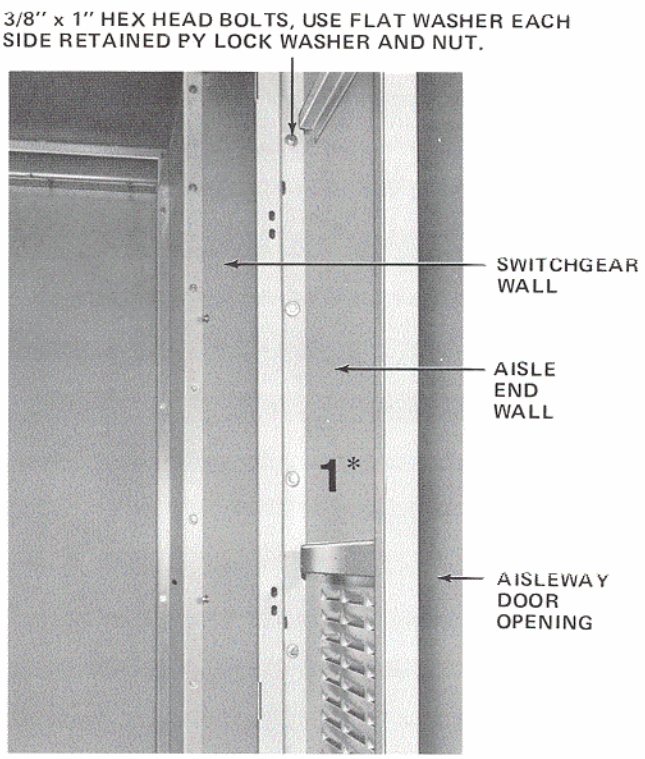


FIGURE 51

Aisle-end walls bolted to the top of the units.
*See Figure 50 for panel reference.

6. Working from installed end wall, erect back wall panels bolting to aisle wall support angles and to previous wall.

NOTE: Put tinnerman nut retainers in square holes of panel and keep square holes in the end of the panels at top.

Apply caulking between seams before bolting.

DO NOT TIGHTEN BOLTS COMPLETELY.

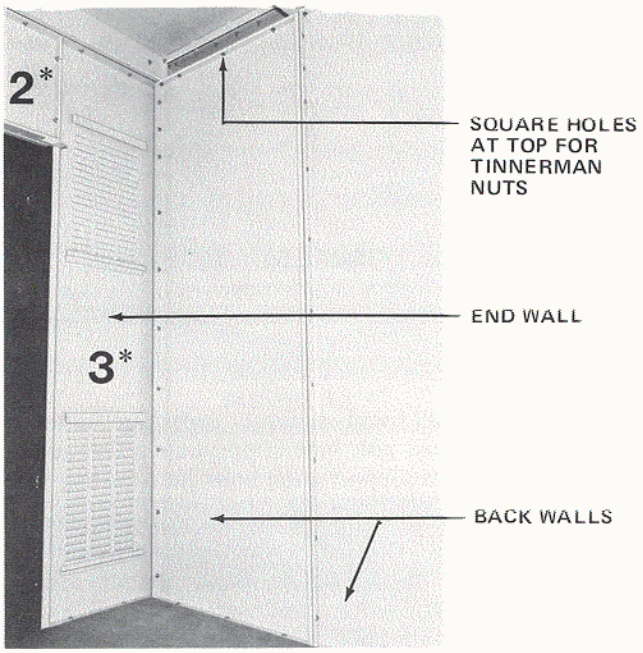


FIGURE 52

Bolting back walls together. Use 3/8" x 1" hex head bolts and flat washer each side. Fasten with lockwasher and nut.
*See Figure 50 for panel reference.

Install roof support channel supports to each back wall panel as it is installed to give rigidity to back wall assembly.

Work completely around assembly in one direction until opposite end wall is bolted to switchgear units.

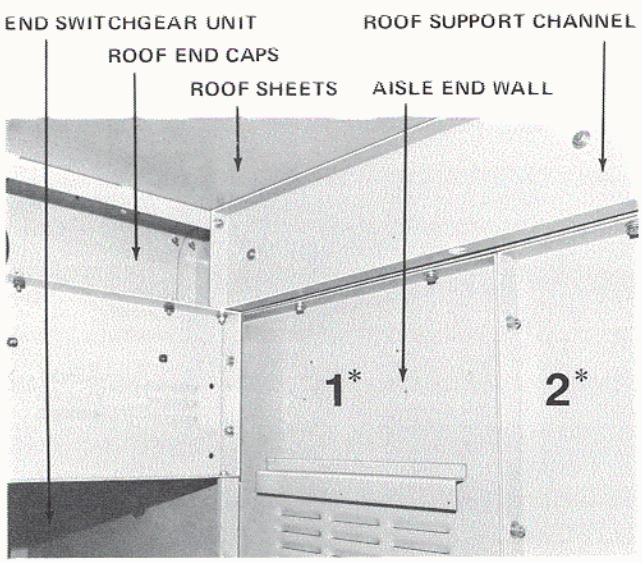


FIGURE 53

Bolting of end roof support channel, interior view.
*See Figure 50 for panel reference.

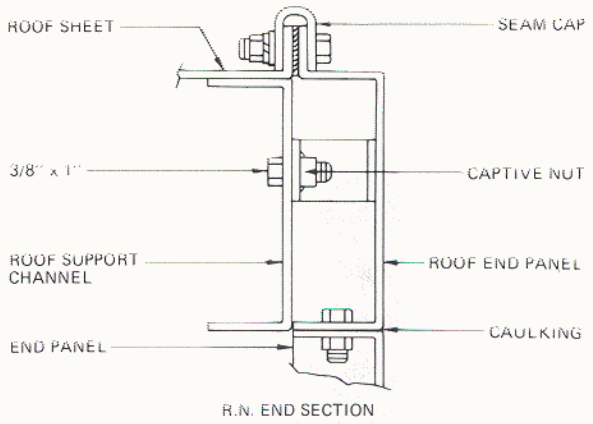


FIGURE 54

Roof end section.

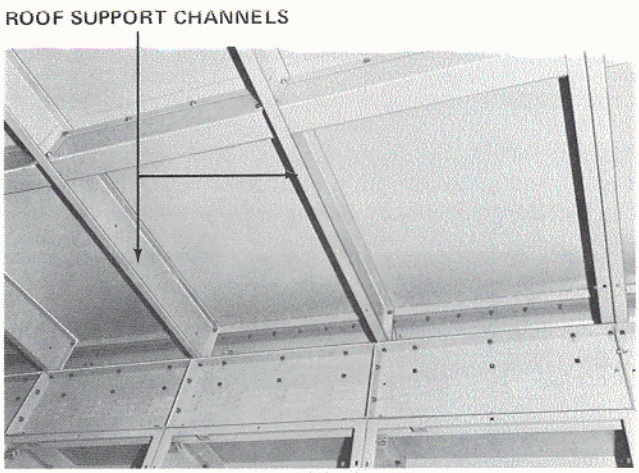


FIGURE 55

Location and bolting of intermediate roof support channels to switchgear units.

7. Install roof sheets starting at one end. Apply gasketing between each two sheets (no caulking required). Place seam caps over jointure and bolt using 3/8" X 1-1/4" hex-head bolts.

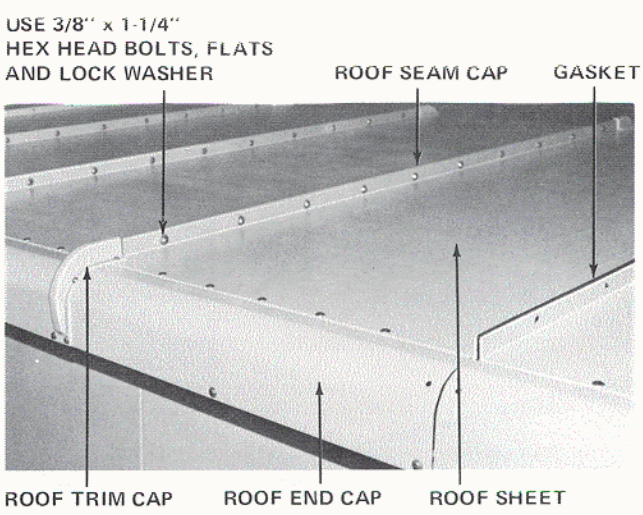


FIGURE 56

Bolting of roof sheets and seam caps.

8. Bolt soffit pieces and roof end caps tightly in place. *Caulk joints before bolting.*

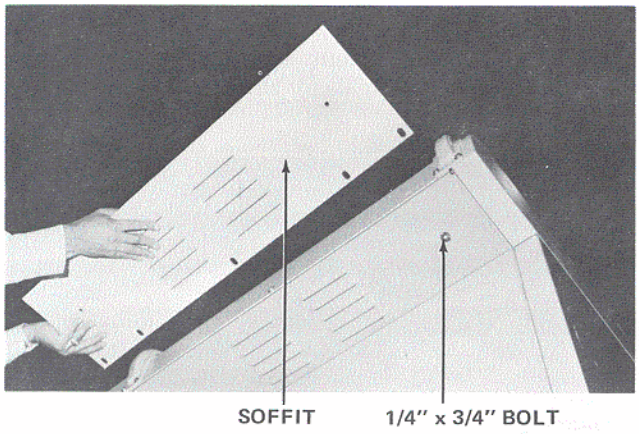


FIGURE 57
Illustration of soffit piece. See Figure 60 for interior bolts.

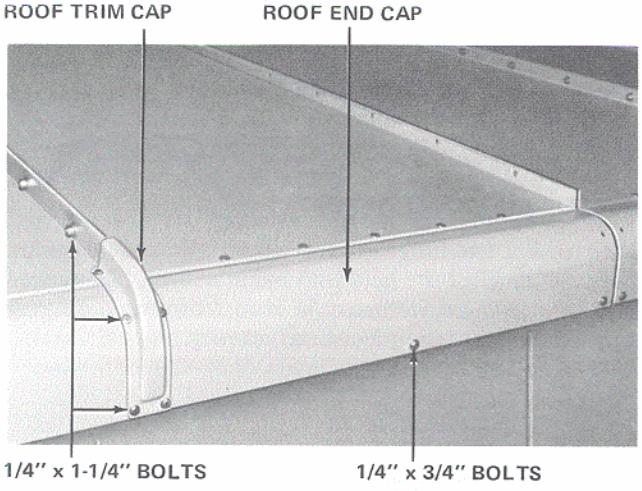


FIGURE 58
Bolting roof end caps and trim caps.

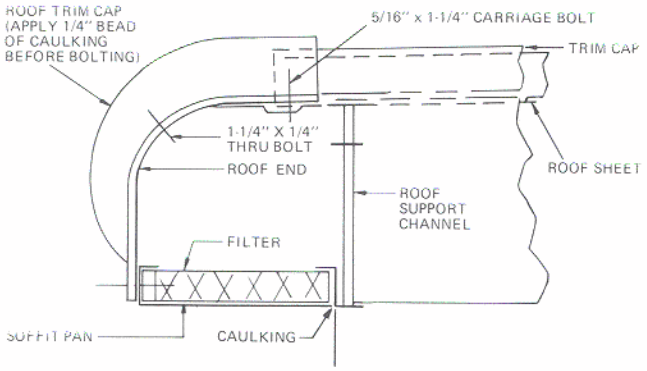


FIGURE 59
Roof end caps and trim caps — cross section.

9. Bolt roof trim caps in place. *Apply caulking under trim cap before bolting.* Use 1/4" X 1-1/4" hex-head bolts.
10. Tighten all wall bolts previously left untightened.
11. Assemble the interconnecting roof support angles. The angles also serve as wire trough and light fixture mountings.

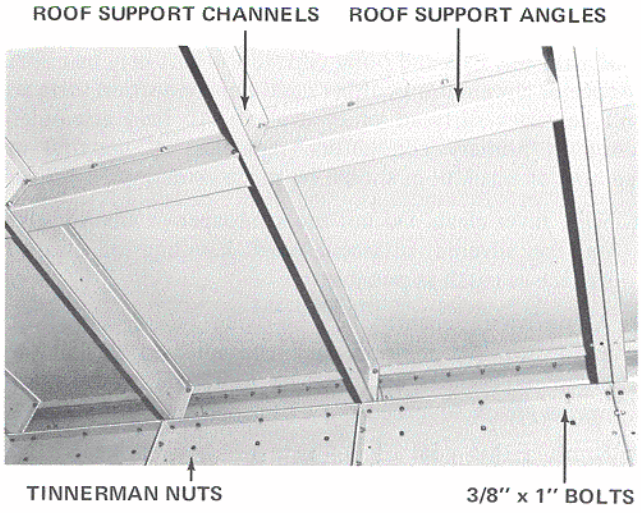


FIGURE 60
Location of roof support angles and interior bolts of soffit.

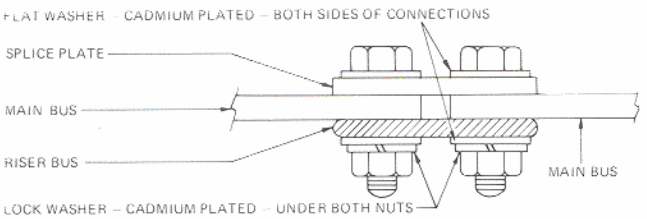
12. Complete the aisle assembly by installing the doors. Adjust the latch plate on the base for proper entry of the door latch rod. Be sure the doors are properly fitted and hinge bolts are tight.
13. Check the aisle assembly for light cracks. This is best done at night by placing a source of light by the seams and checking the exterior seams to see if light is visible from the outside.
14. Install filters over aisle-end walls, louvers, and above each soffit piece.
15. Refer to the maintenance aisle wiring diagram for completion of the interior wiring.
16. Install 200-watt bulbs (by purchaser) for aisle illumination.

FIGURE 61
Interior view of completed aisle assembly.
*See Figure 50 for panel reference.

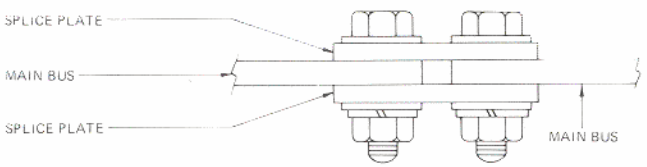
MAIN BUS CONNECTIONS

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.

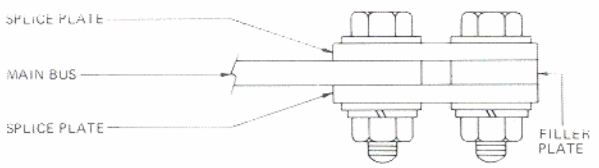
1. Wipe silver clean. Do not use sandpaper or any abrasive on the silvered surface. Avoid handling of cleaned surface as much as possible.
2. A sufficient quantity of no-oxide grease should be applied to the joint at each contact area so that the complete contact area will be thoroughly sealed with excess grease squeezed out of the joint when tightened.
3. Brush a thin coat of no-oxide grease 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 metalclad bars are normally silver plated. Unplated bars, either copper or aluminum, should not be used to connect to silver plated bars.
5. All field assembled primary joints and terminations must be insulated for the operating voltage. There are two methods of insulating joints: air-filled joint covers where applicable and taped joints for all others.



BREAKER UNIT WITH BUS RISER



AUXILIARY UNIT WITHOUT BUS RISER



END UNIT WITH FILLER PLATE

FIGURE 62
Main bus bolting.

Six-inch Bus Bars

	Aluminum 2000a and above	Copper 2000a and above
Bolt Material	Stainless Steel	Bronze
Hex Head Bolt Size*	½–13 2", 2¼", 2½" (as required)	½–13 2", 2¼", 2½" (as required)
Bolt Torque (foot-pounds)	50 ±10%	50 ±10%

Three-inch Bus Bars

	Aluminum 2000a and above	Copper 2000a and above
Bolt Material	Stainless Steel	Bronze
Hex Head Bolt Size*	⅜–16 2", 2¼", 2½" (as required)	⅜–16 2", 2¼", 2½" (as required)
Bolt Torque (foot-pounds)	30 ±10%	30 ±10%

*Apply bolt, flat and split washers as indicated.

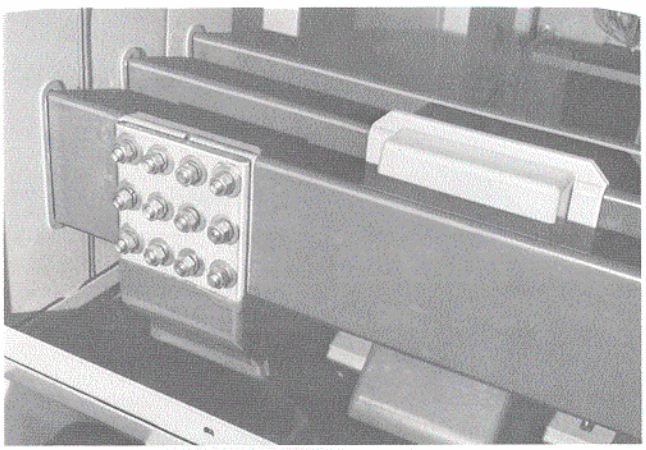


FIGURE 63
Typical bolted joint for six-inch 2000-amp main bus.

AIR FILLED JOINT COVERS

Joint covers are furnished for all main bus connections. They are air filled and held with nylon screws into a tapped hole. *For end connections be sure to insert filler plug supplied in open end to block end opening.*

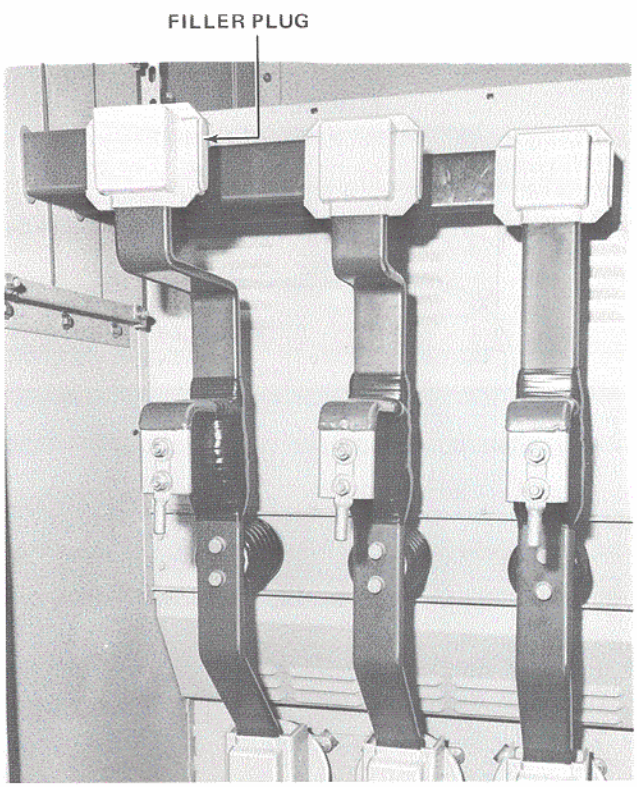


FIGURE 64
Air filled joint covers.

TAPING CONNECTIONS

General

For unusual configurations such as flexible connections, connections to potheads or cable terminations there is no standard insulating joint cover and the following procedures apply for taping these connections:

1. Prepare all joints as outlined under main bus connections and bolting.
2. Fill all cavities around bolts and nuts with aluminum foil to form a smooth surface for taping, thus giving a smooth contour for taping.
3. Adequate lighting and the use of a 9" X 5" mirror will help insure correct taping on the far side of the joint.
4. Start taping at the left or top of each joint. By so doing, all even numbered layers will end on the left or top of the joint, thus helping to distinguish between progressive layers.
5. Each layer should extend slightly past the previous layer so that the finished joint thickness tapers toward the ends of the joint.
6. The tape of a finished joint should cover approximately two (2) inches of insulation on each side of the bare conductor. This overlap should, also, be used over the porcelains of roof bushings, potheads, etc.
7. When applying the tape, stretch the tape to approximately one-half (1/2) its original width. After the required number of #23 tape layers are applied, wrap one (1) one-half lapped layer of #33 tape over the #23 tape. Be sure to stretch the #33 tape slightly and to cover the #23 tape completely. DO NOT STRETCH LAST INCH. Tape should be cut with shears or a sharp knife.

Flexible Connectors

Approximate Quantity of Tape Required

3" BUS – Two Flexible Connectors
- 5-kv Equipment
  - 4-1/2 lapped layers of 3M, #23 Tape (2 rolls) plus
  - 1-1/2 lapped layers of 3M, #33 Tape (1/4 roll)
- 15-kv Equipment
  - 8-1/2 lapped layers of 3M, #23 Tape (4 rolls) plus
  - 1-1/2 lapped layers of 3M, #33 Tape (1/4 roll)

6" BUS
- For six-inch bus double the above quantities

Note: If connecting two pieces of McGraw-Edison equipment, tape is supplied by McGraw-Edison.

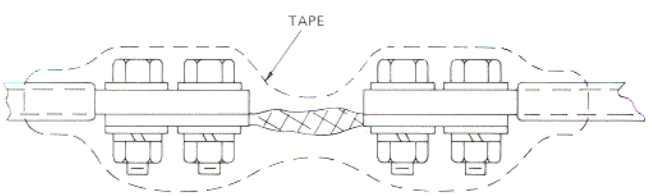


FIGURE 65
Flexible connector taping, side view.

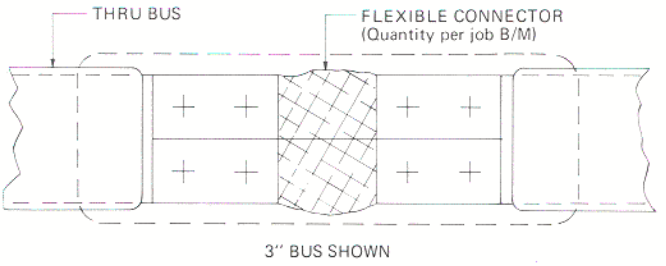


FIGURE 66
Flexible connector taping, top view.

Main Power Connections

Metalclad switchgear is usually provided with either solderless cable connectors or potheads for terminating main power cables.

Before making-up the connections, the phase of each cable should be determined. Normally, metalclad switchgear is supplied with connections for phase rotation 1-2-3 unless otherwise required on the particular order.

When forming cables for termination within switchgear assemblies, avoid sharp turns, corners, and edges in order to prevent damage to or weakening of the cable insulation. The cable manufacturer's instructions should be followed closely in determining the minimum bending radii of cables and the proper tapering of insulation to establish necessary voltage gradients. Such instructions will vary with the type and size of cable involved as well as with the service voltage for which the cable is designed to operate.

Solderless-Type Connectors: Solderless connectors are normally furnished for terminating non-leaded cable. In addition, insulating clamps may be provided to separate the cables and support their weight. The cable manufacturer's instructions should be consulted for the exact details required in terminating any given type of power cable. Cable support clamps, when supplied, may be drilled at the factory if the outside diameter of the cable is known. Since it is frequently impossible for the factory to determine the exact outside diameter of the cable that will be used, these insulating clamps will be supplied with pilot holes and must be redrilled to the exact size in the field.

After drilling, the insulating clamps should be saw-cut longitudinally through to centerline of the drilled holes to facilitate installation and to provide proper clamping action. The complete connection must be taped in accordance with instructions shown below.

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.

Approximate Quantity of Tape Required

5-kv Equipment
4-1/2 lapped layers of 3M, #23 Tape (1-1/2 rolls) plus
1-1/2 lapped layer of 3M, #33 Tape (1/4 roll)
15-kv Equipment
8-1/2 lapped layers of 3M, #23 Tape (3 rolls) plus
1-1/2 lapped layer of 3M, #33 Tape (1/4 roll)

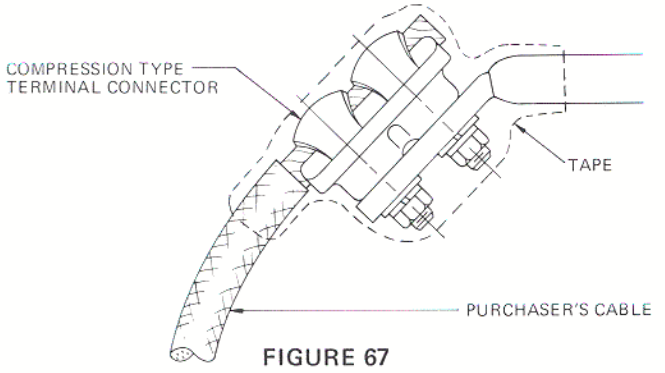


FIGURE 67
Terminal connector taping.

Potheads: Connections of cable into potheads should be made in accordance with the pothead manufacturer's instructions included in the supplementary instructions provided with the switchgear or with the potheads. Flexible connectors are provided to connect the potheads aerial lugs to the switchgear conductors so as to avoid strain on the pothead insulators. The flexible connectors should be taped as outlined below. The necessary tape will be supplied.

Approximate Quantity of Tape Required

3" BUS
5-kv Equipment
4-1/2 lapped layers of 3M, #23 Tape (3 rolls) plus
1-1/2 lapped layer of 3M, #33 Tape (1/2 roll)
15-kv Equipment
8-1/2 lapped layers of 3M, #23 Tape (6 rolls) plus
1-1/2 lapped layer of 3M, #33 Tape (1/2 roll)
6" BUS
For six-inch bus double the above quantities.

Note: If potheads are supplied as part of order, tape is supplied by McGraw-Edison.

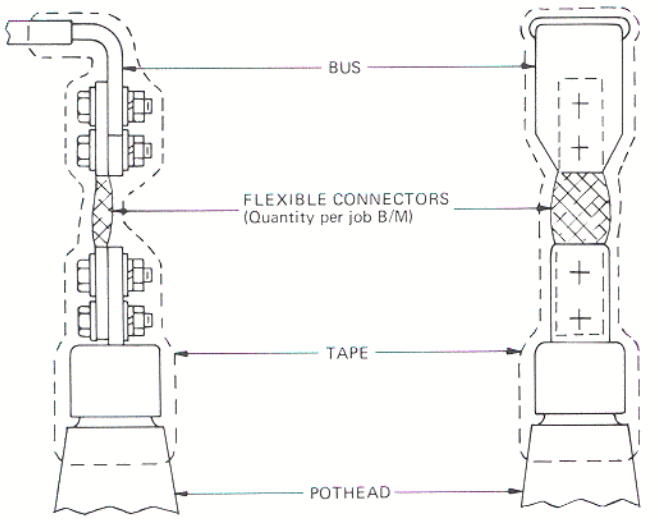


FIGURE 68
Three-inch bus and related pothead taping.

THROAT CONNECTION ASSEMBLY

Refer to TAPING CONNECTIONS in this section for taping connections joining switchgear bus to transformer terminals.

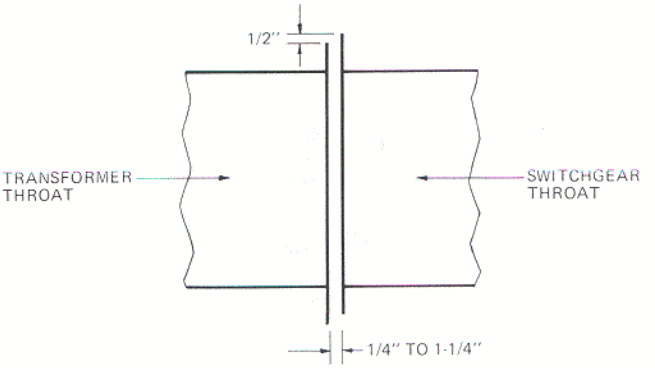


FIGURE 69
Throat flange positioning.

The switchgear throat-flanged joint connection is designed to permit plus-or-minus 1/2-inch variation in any direction. When the two flanges are in position, there should be 1/4 to 1-1/4 inches between flanges at the widest separation and the flanges *should not* be in metal-to-metal contact.

The flange on the switchgear throat need not necessarily center, but should not project beyond the other flange by more than 1/2 inch.

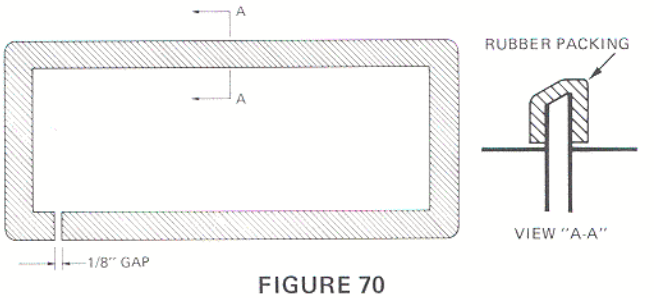


FIGURE 70
Wrapping the flange joint.

Wrap the flange joint at the two bus-duct sections with the rubber packing supplied. Begin at a lower corner and wrap around the edges of the flanges. Cut off excess sheet to leave 1/8-inch gap at the starting corner. Bind in place on two sides with tape.

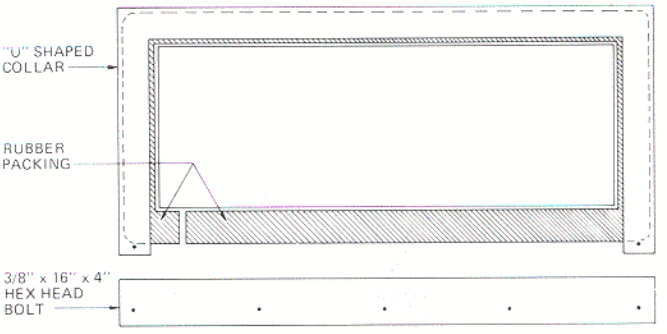


FIGURE 71
Collar installation.

Slide the "U-shaped" collar down packing from the top and complete by bolting bottom place. The 1/8-inch gap provides for drainage of possible moisture condensation.

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.

> **CAUTION**
>
> Before any covers are removed or any doors opened that would permit access to the primary circuits, it is essential that the circuit or circuits be deenergized 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.

For outdoor and maintenance aisle installations the end enclosure sheet/or aisle wall should be retained for reinstalling on the newly added unit.

BUS DUCT

Bus ducts connecting between groups of metalclad switchgear, or between metalclad 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 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.

Hangers or support posts are not supplied unless specifically contracted for in the original order.

Some bus ducts are provided with heaters. Connect these heaters in accordance with the wiring diagrams furnished with the equipment before energizing the bus duct.

MISCELLANEOUS EQUIPMENT

As mentioned under RECEIVING, HANDLING and STORAGE appendages such as batteries, supervisory control equipment and synchronizing panels may be packed and shipped separately. They should be uncrated and installed in accordance with the drawings supplied with the order. Also specific instruction books are supplied covering handling details for this equipment.

SECONDARY CONTROL CONNECTIONS

The internal secondary and control wiring on metalclad switchgear is factory wired in accordance with the schematic diagrams. Wiring to remote apparatus is factory connected to terminals or terminal blocks.

Secondary and control cables from remote apparatus must be field connected to these terminals or terminal blocks. The field connections must be mechanically strong and should be thoroughly checked before energizing.

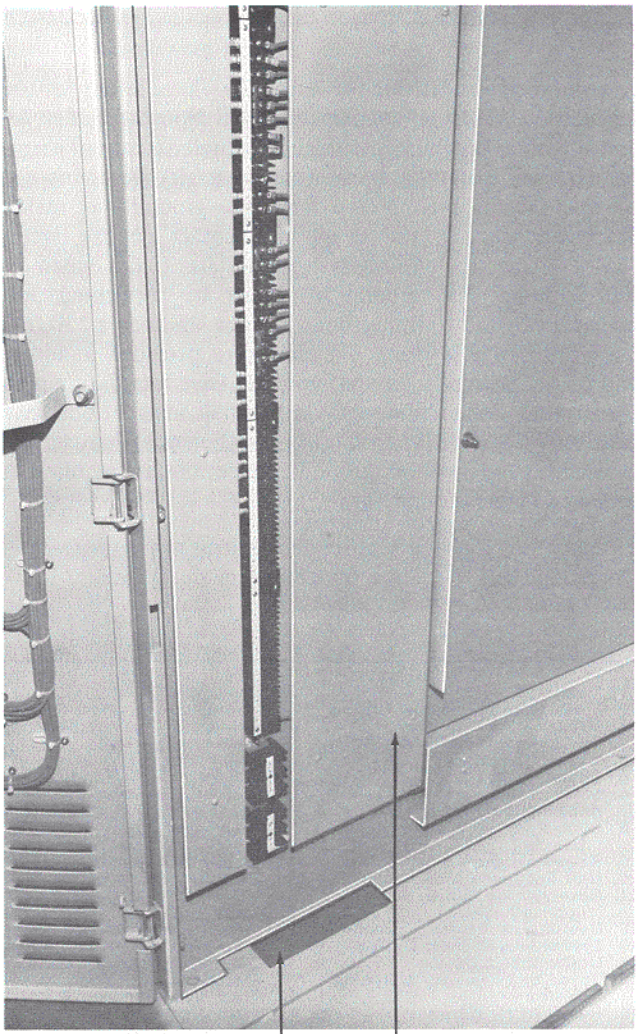


FIGURE 72
Control wiring terminal blocks for customer connections (bottom exit.)

After the complete line-up has been assembled and tested at the factory, the control cables at the shipping break 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 unit. Terminal boards located in this unit are then used to make the inter-unit connections.

GROUND BUS CONNECTIONS

CAUTION

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 ensure that all parts of the equipment, other than live parts, are at ground potential.

A ground bus is provided through the entire length of the installation. This is connected to all housing parts. All control circuits which should be grounded (current transformers and potential transformer neutrals) are connected to the ground bus. A tap from the ground bus makes automatic contact with a ground contact on the circuit breaker unit to effectively ground its frame when in the housing. The ground bus must be connected permanently to the station ground by not less than a 250,000 circular mil cable using the connector provided at either end of the assembly for that purpose. (See foundation plan for ground connection detail). In small installations, one connection to the ground bus is sufficient. When ten or more units are involved, ground connections are required at each end of the ground bus.

Three-phase, four-wire, grounded-neutral systems may use the ground bus to ground the neutral of the system.

Pothead bodies are automatically grounded through their mounting. If additional cable sheath grounding is desired, it should be connected to the ground bus. The sheath of single-conductor, lead-covered cable should be grounded at only one point. If that location is external to the switchgear, insulation spacers are required between the wiping sleeve and the pothead body. These spacers are furnished if the condition is known at the time of order placement.

Refer to Ground Fault Current Transformers in the DESCRIPTION Section for additional grounding instructions.

PHASING

Standard phasing of bus bars and panel arrangement of relays is 1, 2, 3 left-to-right, front-to-back and top-to-bottom when facing the breaker drawout side of the switchgear.

WIRING DIAGRAMS

The first digit designates the terminal to which the wire is attached. The letter designates the device to which it is routed and the last digit identifies the terminal on that device.

ANSI DEVICE FUNCTION NUMBERS

1. Master Element
2. Time-Delay Starting or Closing Relay
3. Checking or Interlocking Relay
4. Master Contactor
5. Stopping Device
6. Starting Circuit Breaker
7. Anode Crcut Breaker
8. Control Power Disconnecting Device
9. Reversing Device
10. Unit Sequence Switch
11. Reserved for future application
12. Over-Speed Device
13. Synchronous-Speed Device
14. Under-Speed Device
15. Speed or Frequency Matching Device
16. Reserved for future application
17. Shunting or Discharge Switch
18. Accelerating or Decelerating Device
19. Starting-to-Running Transition Contactor
20. Electrically Operated Valve
21. Distance Relay
22. Equalizer Circuit Breaker
23. Temperature Control Device
24. Reserved for future application
25. Synchronizing or Synchronism-Check Device
26. Apparatus Thermal Device
27. Undervoltage Relay
28. Flame Detector
29. Isolating Contactor
30. Annunciator Relay
31. Separate Excitation Device
32. Directional Power Relay
33. Position Switch
34. Master Sequence Device
35. Brush-Operating or Slip-Ring Short-Circuiting Device
36. Polarity Device
37. Undercurrent or Underpower Relay
38. Bearing Protective Device
39. Mechanical Condition Monitor
40. Field Relay
41. Field Circuit Breaker
42. Running Circuit Breaker
43. Manual Transfer or Selector Device
44. Unit Sequence Starting Relay
45. Atmospheric Condition Monitor
46. Reverse-Phase or Phase-Balance Current Relay
47. Phase-Sequence Voltage Relay
48. Incomplete Sequence Relay
49. Machine or Transformer Thermal Relay
50. Instantaneous Overcurrent or Rate-of-Rise Relay
51. A-C Time Overcurrent Relay
52. A-C Circuit Breaker
53. Exciter or D-C Generator Relay
54. Reserved for future application
55. Power Factor Relay
56. Field Application Relay
57. Short-Circuiting or Grounding Device
58. Rectification Failure Relay
59. Overvoltage Relay
60. Voltage or Current Balance Relay
61. Reserved for future application
62. Time-Delay Stopping or Opening Relay
63. Liquid or Gas Pressure or Vacuum Relay
64. Ground Protective Relay
65. Governor
66. Notching or Jogging Device
67. A-C Directional Overcurrent Relay
68. Blocking Relay
69. Permissive Control Device
70. Electrically Operated Rheostat
71. Liquid or Gas-Level Relay
72. D-C Circuit Breaker
73. Load-Resistor Contactor
74. Alarm Relay
75. Position Changing Mechanism
76. D-C Overcurrent Relay
77. Pulse Transmitter
78. Phase Angle Measuring or Out-of-Step Protective Relay
79. A-C Reclosing Relay
80. Liquid or Gas Flow Relay
81. Frequency Relay
82. D-C Reclosing Relay
83. Automatic Selective Control or Transfer Relay
84. Operating Mechanism
85. Carrier or Pilot Wire Receiver Relay
86. Locking-Out Relay
87. Differential Protective Relay
88. Auxiliary Motor or Motor Generator
89. Line Switch
90. Regulating Device
91. Voltage Directional Relay
92. Voltage and Power Directional Relay
93. Field Changing Contactor
94. Tripping or Trip-Free Relay
95.
96.
97. Used only on specific applications on individual installations where none of the assigned numbered functions from 1 to 94 are suitable.
98.
99.

NOTES:

Suffix letters X, Y or Z are added to the appropriate device function numbers to denote separate auxiliary relays.

Example: 27X, 52Y, 79Z.

If two or more devices with the same function number and suffix letter (if used) are present in the same equipment, they may be distinguished by numbered suffixes. Example: 27-1, 27-2, 27X-1, 27X-2.

MISCELLANEOUS DEVICE DESIGNATIONS

52/X	CLOSING RELAY
52/Y	ANTI-PUMP RELAY
52/CC	BREAKER CLOSING COIL
52/TC	BREAKER TRIP COIL
52/M	BREAKER PUMP MOTOR
52/SS	MOTOR CUTOFF HIGH PRESSURE SWITCH
52/S	CONTROL CUTOFF LOW PRESSURE SWITCH CLOSED WHEN PRESSURE IS SUFFICIENT FOR CLOSING
52/a	NORMALLY OPEN AUXILIARY SWITCH CONTACT
52/b	NORMALLY CLOSED AUXILIARY SWITCH CONTACT
52/ae	ADVANCE MAKE "a" CONTACT—CLOSES DURING FIRST 15° OF CLOSING MOTION

MISCELLANEOUS DEVICE DESIGNATIONS (Continued)

52/be	ADVANCE BREAK "b" CONTACT—OPENS DURING FIRST 15° OF CLOSING MOTION
52/Sa, 52/Sb	STATIONARY SWITCH—MECHANISM OPERATED IN TEST, OPERATE OR BOTH POSITIONS AS INDICATED
52/Ha, 52/Hb	HOUSING SWITCH—TRUCK OPERATED, SHOWN WITH BREAKER IN TEST OR WITHDRAWN POSITION
52/UV	UNDERVOLTAGE TRIP
24	BUS TIE BREAKER
W/VS	WATT-VAR SWITCH
PTD	POTENTIAL TEST DEVICE
CTD	CURRENT TEST DEVICE
VRR	VOLTAGE REGULATING RELAY
LTC	LOAD TAP CHANGER
PST	PHASE SHIFTING TRANSFORMER
ETM	ELAPSED TIME METER
201X	SUPERVISORY CLOSING DEVICE
294X	SUPERVISORY TRIPPING DEVICE
43LS	LOCAL—SUPERVISORY TRANSFER SWITCH
43MA	MANUAL—AUTOMATIC TRANSFER SWITCH
87L	PILOT WIRE RELAY
85/74-R	PILOT WIRE RECEIVING AND ALARM RELAY
85/74-S	PILOT WIRE SENDING AND ALARM RELAY
50/CO	INSTANTANEOUS RELAY CUTOFF DEVICE
79/CO	RECLOSER RELAY CUTOFF DEVICE

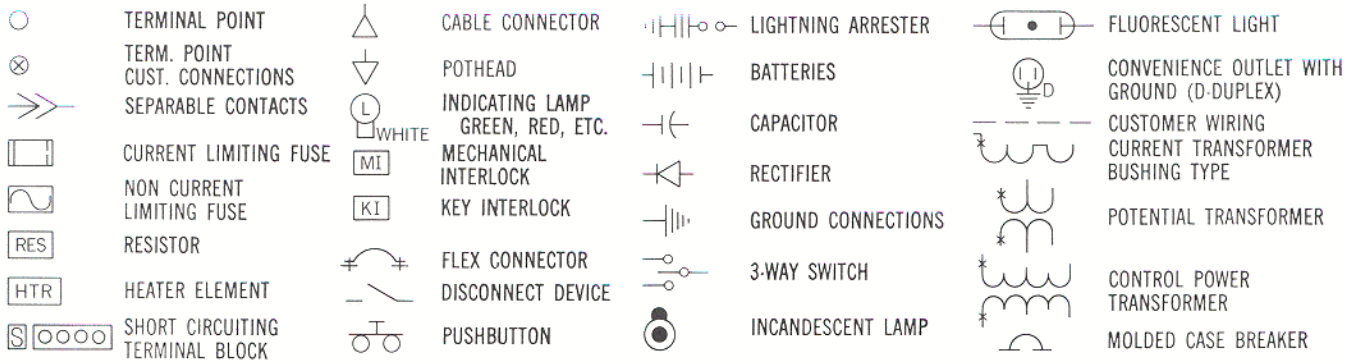


DIAGRAM ABBREVIATIONS *

A	AMPERE
AC	ALTERNATING CURRENT
ACB	AIR CIRCUIT BREAKER
Am	AMMETER
ANN	ANNUNCIATOR
ARM	ARMATURE
AS	AMMETER SWITCH
AUTO	AUTOMATIC
AUTO RECL	AUTOMATIC RECLOSING
AUTO T	AUTO-TRANSFORMER
AUX	AUXILIARY
BASw	BELL ALARM SWITCH
BAT	BATTERY
BAT CHG	BATTERY CHARGER
BB	BENCH BOARD
BC	BACK CONNECTED
BCT	BUSHING CURRENT TRANSFORMER
BD	BOARD
BE	BREAKER END
BKR	BREAKER
BPD	BUSHING POTENTIAL DEVICE
BRKT	BRACKET
BV	BACK VIEW
C	CURRENT
CAB	CABINET
CAL	CALIBRATING
CAP	CAPACITOR; CAPACITY
CAT	CATALOG
CC	CLOSING COIL
CKT	CIRCUIT
CNTOR	CONTACTOR
CO	CUT OUT
COMP	COMPENSATOR
COMPT	COMPARTMENT
CONN	CONNECT; CONNECTION
CONT	CONTINUED; CONTROL
CONV	CONVERTER
CPT	CONTROL POWER TRANSFORMER
CR	CONTROL RELAY
CS	CONTROL SWITCH
CT	CURRENT TRANSFORMER
c	CYCLE
DC	DIRECT CURRENT
DD	DISCONNECTING DEVICE
DEV	DEVICE
DIAG	DIAGRAM
DIFF	DIFFERENTIAL
DIR	DIRECTION; DIRECTIONAL
DISC	DISCONNECT
DISCH	DISCHARGE
Dm	DEMAND METER
DO	DRAWOUT
DPDT	DOUBLE POLE DOUBLE THROW
DPST	DOUBLE POLE SINGLE THROW
DSw	DISCONNECT SWITCH
DSCT	DOUBLE SECONDARY CURRENT TRANSFORMER
DWG	DRAWING
DX	DUPLEX
ELEC	ELECTRIC
ELEM	ELEMENTARY
EMER	EMERGENCY
ENCL	ENCLOSURE
EQ	EQUALIZER
EQUIP	EQUIPMENT
EXC	EXCITER; EXCITATION
EXIST	EXISTING
FB	FUSE BLOCK
FC	FRONT CONNECTED
FDR	FEEDER
FIG	FIGURE
FLD	FIELD
FLEX	FLEXIBLE
fm	FREQUENCY METER
f	FREQUENCY
FRWK	FRAMEWORK
FU	FUSE
FUT	FUTURE
FV	FRONT VIEW
FWD	FORWARD
G	GENERATOR
GD	GROUND DETECTOR
GOV	GOVERNOR
GRD	GROUND
HC	HOLDING COIL
hp	HORSE POWER
HR	HAND RESET
HTR	HEATER
HV	HIGH VOLTAGE
IMPR	IMPEDOR
INC	INCOMING
INST	INSTANTANEOUS; INSTRUMENT
INT CONN	INTERNAL CONNECTION
IT	INSULATING TRANSFORMER
kV	KILOVOLT
kVA	KILOVOLT-AMPERE
kVAh	KILOVOLT-AMPERE HOUR
kVAhm	KILOVOLT-AMPERE HOUR METER
kVAm	KILOVOLT-AMPERE METER
kvar	KILOVOLT-AMPERE REACTIVE
kvarh	KILOVAR HOUR
kW	KILOWATT
kWh	KILOWATT HOUR
kWhm	KILOWATT HOUR METER
L	LAMP; LOWERING
LA	LIGHTNING ARRESTER
LC	LATCH CHECK
LH	LEFT HAND
LIR	LOAD INDICATING RESISTOR
LLM	LOAD LIMITING RESISTOR
LRC	LOAD RATIO CONTROL
LSw	LIMIT SWITCH
LSR	LOAD SHIFTING RESISTOR
LSS	LEFT SIDE SHEET
LT	LIGHT
LTG	LIGHTING
LV	LOW VOLTAGE
mAm	MILLIAMMETER
MAN	MANUAL
MAN OP	MANUALLY OPERATED
MC	METAL-CLAD
MCM	THOUSAND CIRCULAR MILS
MECH	MECHANICAL MECHANISM
μF	MICROFARAD
MFR	MANUFACTURER
MG	MOTOR GENERATOR
MISC	MISCELLANEOUS
M	MOTOR
MTD	MOUNTED
mV	MILLIVOLT
NC	NORMALLY CLOSED
NEG	NEGATIVE
NEUT	NEUTRAL
NO	NORMALLY OPEN NUMBER
NOR	NORMAL
NP	NAMEPLATE
OC	OVERCURRENT
OCB	OIL CIRCUIT BREAKER
OPER	OPERATE
OVLD	OVERLOAD
Φ	PHASE
PB	PUSH BUTTON
PB STA	PUSH BUTTON STATION
PCB	POWER CIRCUIT BREAKER
PF	POWER FACTOR
PFD	PREFERRED
PFm	POWER FACTOR METER
PH	POTHEAD
PNEU	PNEUMATIC
PNL	PANEL
POS	POSITION; POSITIVE
POS Sw	POSITION SWITCH
POT	POTENTIAL
PRI	PRIMARY
PT	POTENTIAL TRANSFORMER
PU	PICKUP
PWR	POWER
RCD	REVERSE CURRENT DEVICE
RE	RECEPTACLE
REAC	REACTOR
REC	RECORDING
RECL	RECLOSING
RECT	RECTIFIER
REG	REGULATOR
RES	RESISTANCE; RESISTOR
REV	REVERSE; REVISE
RH	RIGHT HAND
RHEO	RHEOSTAT
RSS	RIGHT SIDE SHEET
RTD	RESISTANCE TEMPERATURE DETECTOR
RV	REAR VIEW
s	SECONDS
SEC	SECONDARY
SECT	SECTION
SEQ	SEQUENCE
SER	SERIES
SH	SHUNT
SI	SEAL-IN DEVICE
SOL	SOLENOID
SP	SPARE
SPDT	SINGLE POLE DOUBLE THROW
SPST	SINGLE POLE SINGLE THROW
STA	STATION; STATIONARY
STAB	STABILIZER
STD	STANDARD
STG	STARTING
STR	STRUCTURE
SUB STA	SUBSTATION
SUPV	SUPERVISORY
Sw	SWITCH
SWBD	SWITCHBOARD
SWR BKT	SWINGING BRACKET
SWGR	SWITCHGEAR
SYM	SYMBOL
SYN	SYNCHRONISM; SYNCHRONIZING; SYNCHRONOUS; SYNCHROSCOPE
SYN CONV	SYNCHRONOUS CONVERTER
SS	SYNCHRONIZING SWITCH
TB	TERMINAL BLOCK
TC	TRIP COIL
TD	TESTING DEVICE
TDC	TIME DELAY CLOSING
TDO	TIME DELAY OPENING
TEL	TELEPHONE
TELE	TELEMETER
TEMP	TEMPERATURE
TERM	TERMINAL
Tm	TEMPERATURE METER
TPST	TRIPLE POLE SINGLE THROW TRANSFORMER
UV	UNDERVOLTAGE
UVD	UNDERVOLTAGE DEVICE
V	VOLT
VA	VOLT-AMPERE
vac	VACUUM
V ADJ R	VOLTAGE ADJUSTING RHEOSTAT
var	VOLT-AMPERE REACTIVE
varh	VAR HOUR
varm	VARMETER
Vm	VOLTMETER
V REG	VOLT REGULATOR
VS	VOLTMETER SWITCH
W	WATT; WIRE
WhDm	WATTHOUR DEMAND METER
Whm	WATTHOUR METER
Wm	WATTMETER
Wt	WEIGHT

*Most Commonly Used Abbreviations.

UNBLOCKING

Many pieces of equipment are blocked or braced for shipment. Apparatus, such as potential-transformer drawout carriages, CPT fuse carriages, meters, and relays, must be scrutinized for forms of blocking or bracing which must be removed.

TESTING AND INSPECTION

GENERAL

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 deenergized while the tests are in progress.

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 test on the equipment depends 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 ac high potential tests, the voltage should not exceed 75% of the ANSI factory test voltage. For the power circuit, the ANSI factory test voltage of 13.8 kv gear is 36 kv; 5-kv gear is 19 kv.

APPLICABLE TO ALL McGRAW-EDISON VACUUM INTERRUPTERS

X-radiation can result when voltage in excess of the rated maximum voltage is applied across the open-contact gap in a vacuum interrupter. Such radiation can become a health hazard on long exposure at close range. When performing high-voltage tests on vacuum interrupters, personnel safety can be insured by noting the following information and taking the necessary precautions.

1. American National Standards C37.09-1964 and C37.09a "A-C High Voltage Circuit Breakers" allows tests after delivery at 75% of rated low-frequency withstand voltage. At this voltage radiation is negligible. The following general precautions should be observed:
   a. Interrupters should be mounted in their respective operating structures and within the normal apparatus enclosure.
   b. Open circuit tests should be run only with contact open to their recommended open-contact gap.
   c. Normal electrical safety precautions should be observed.
2. Above 37.5 kv radiation injurious to personnel may be emitted. If testing is performed above 37.5 kv additional radiation shielding is required.
3. Vacuum interrupter testing above 50 kv rms is not recommended.

Potential and control power transformers, lightning arresters and surge capacitors 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 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. For inspection and maintenance a test jumper or test cabinet can be used. See ACCESSORIES in this Section.

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 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.

The operation of McGraw-Edison metalclad switchgear has the advantages of flexibility, safety, and ease of maintenance, plus the ease of testing and checking out control circuits.

All circuits breakers with the same rating and control wiring are identical and interchangeable so that it is possible to replace any breaker or housing with another of the same rating and control wiring.

During operation, all live parts are enclosed by barriers which permit the operator to perform his duties with maximum safety. Separate covers or doors are provided over each different compartment so that any compartment or section may be exposed without exposing other high voltage areas.

All circuit breakers are equipped for electrical operation. A maintenance operating handle is provided to permit slow operation of the breaker during maintenance. See breaker instruction manual for details of this device.

The control circuits may be checked accurately and safely by moving the breaker to the TEST position where the

main contacts are disconnected and the control circuits can be completed by moving the secondary contact assembly to the engaged position. See breaker instruction manual for details.

ACCESSORIES

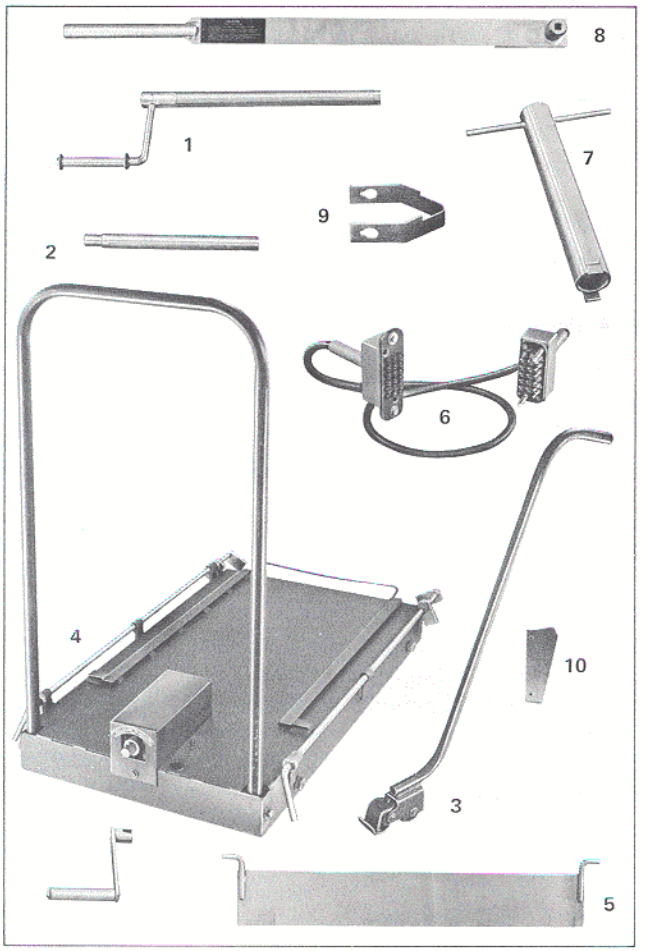


FIGURE 73
Accessories.

One set of the following accessories is supplied with each installation of metalclad switchgear:

1. Racking-in device handle – For operation of the racking-in device which controls the circuit breaker movement in the compartment between the disconnected, or test, and connected positions.
2. Hand pump handle – For hand-charging spring for initial stored-energy closing if the control power source is not available and for maintenance closing.
3. Handling dolly (indoor and outdoor maintenance aisle only) – Functions as a caster wheel to raise the front wheels of the circuit breaker off the floor for ease in maneuvering after withdrawal of the circuit breaker from the housing.
4. Transport truck (outdoor metalclad only) – A truck with a manually adjustable bed height, two swivel wheels, and latch arms which secure the truck to the housing and the breaker to the truck. Facilitates withdrawal of the circuit breaker from housing which is elevated from the pad by the channel base.
5. Entrance ramp – For directing breaker up and into an indoor breaker compartment.
6. Test jumper (when specified) – For electrical operation of a circuit breaker at a remote location from the switchgear. It contains the necessary devices for closing and tripping the breaker and a cable and receptacle for connecting to the breaker secondary contacts.

   Set of test plugs (when specified) – For testing drawout-type instruments and relays.
7. Special T-wrench – For removing the locking nuts on the studs of the stationary primary disconnecting contacts to permit removal.
8. Maintenance handle – For slow-closing and slow-opening the breaker during maintenance.
9. Arc chute lift bracket – For lifting the arc chutes.
10. Arc chute tilt bracket – For securely holding 5-kv arc chutes in the tilted position during inspection.

BREAKER TEST CABINET (Optional Extra)

This is an enclosure housing a control switch for electrically testing operation of breaker elements outside the units. Also included is a secondary receptacle and cable for connecting the breaker to the test pushbuttons.

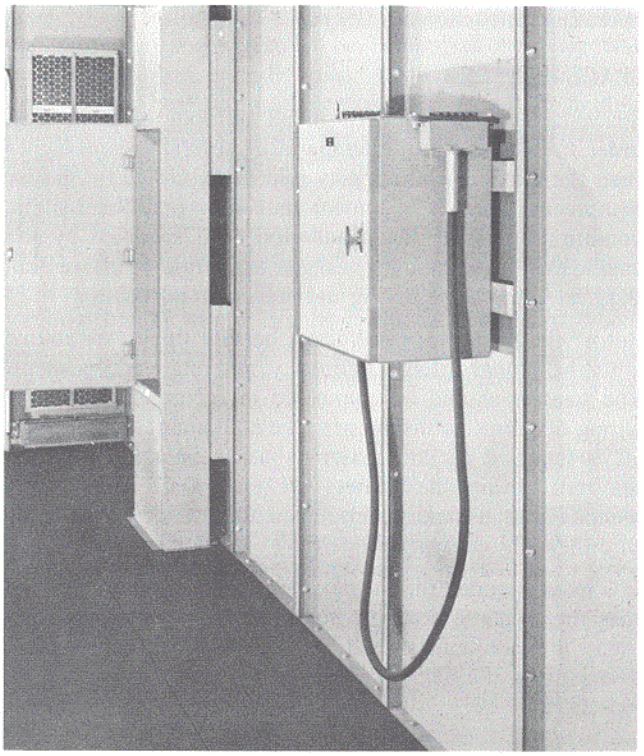


FIGURE 74
Typical breaker test cabinet.

INSERTION AND WITHDRAWAL OF BREAKER FROM HOUSING

No attempt should be made to place the circuit breaker into the unit until the installation is complete. If attempted earlier, trouble may occur from foreign material in the housing, from an unlevel foundation, or from distortion caused during shipment or handling.

As a check to prevent the insertion of a breaker into a switchgear housing of a different rating, an interference interlock is provided. For safety, since the interlock does not coordinate control wiring, always refer to shop drawings, order information, or schemes to make certain that the breaker and housing are coordinated for operation together.

For indoor and maintenance installations, the handling dolly (figure 69) may be used to assist the alignment between the breaker and the housing. After aligning, remove the handling dolly so as to eliminate the possibility of defeating the interlocks.

For outdoor installations, since the breaker must be on the transport truck (figure 69), the breaker will automatically be aligned when the transport truck is properly attached to the housing. To properly attach the transport truck to the outdoor housing, visually align the height using the jack built into the truck. Turning the levers on either side of the truck will lock it onto the housing and release the breaker.

The breaker is now ready for insertion into the TEST position and then into the fully energized position. This procedure is described in the circuit breaker instructions.

BREAKER OPERATION AND MECHANICAL INTERLOCKS

Refer to circuit breaker instruction book for detailed operating instructions.

SPACE HEATERS

Space heaters are provided in all outdoor equipment in order to keep the inside temperature several degrees higher than the outside. Heaters may also be furnished for indoor equipment when it is known that abnormal atmospheric conditions exist at the installation or if 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 packing materials inside the units have been removed before the heaters are energized. It is recommended that heaters be inspected four times a year to be sure they are operating properly.

It is recommended that heaters be energized at all times and that thermostatic controls not be used. If thermostats are used, the contacts should be set to open above 100F deenergizing the heaters when strong sunlight beats on the switchgear.

INSPECTION AND MAINTENANCE

SAFETY PRECAUTIONS

When inspecting, repairing, and performing maintenance on metalclad switchgear, the fact that dangerous voltages exist must be kept in mind and precautions taken to ensure that no personnel come in contact with a "live" high-tension part. Common general precautions for high voltage work are:

1. All connections should be considered "live" until the crew expecting to work on them is assured that the circuits are "dead," and until every possible precaution has been taken to see that there is no chance of a circuit being energized while the crew is working. Especially consider backfeed possibilities via potential or control power transformers connected to other sources.
2. Switches which have been opened to deenergize a circuit to permit work on equipment should be locked or blocked open and a suitable visible warning device placed thereon.
3. Do not work on parts normally carrying current at high voltage until these parts have been disconnected from the system and connected to the ground bus. Provisions should, therefore, be made by the purchaser for connecting adequate flexible ground leads so as to reach every part of the switching equipment.
4. A good and realiable ground connection is necessary for every switchgear installation. It should be of sufficient capacity to take care of any abnormal condition that might occur on the system and should be independent of the grounds used for any other apparatus. See GROUND BUS CONNECTIONS in the INSTALLATION Section.

ACCESS TO SWITCHGEAR PARTS

High Voltage Parts

McGraw-Edison metalclad switchgear is designed so that internal compartments provide metal isolation between the circuit breaker compartment, the main bus, and the primary line terminations. Access to high-voltage parts is provided by removable covers and barriers *WHICH SHOULD NOT BE REMOVED UNLESS THE PARTS TO BE EXPOSED ARE "DEAD."*

> **CAUTION**
>
> Even though bus bars are insulated they carry high voltage capacitive charge when energized.

Main Contacts and Current Transformers

Both the stationary main disconnecting contacts and the toroidal-type current transformers are located just behind the insulating shutter and molded barriers as shown in figure 14. Upper and/or lower contacts and transformers are easily exposed. For this reason *CAUTION MUST BE EXERCISED. DO NOT EXPOSE ANY CONTACTS OR TRANSFORMERS UNLESS ALL HIGH VOLTAGE PARTS ARE DEENERGIZED.*

Drawout Potential Transformers and Fuses

Simply opening the hinged door automatically disconnects and grounds the moving high-voltage parts. The cable and stationary contacts are accessible either by removing back covers or by removing the complete transformer and cradle or fuse and cradle assembly. *DO NOT ATTEMPT REMOVAL UNLESS DEENERGIZED.*

Control Equipment

With the exception of apparatus such as current transformers and rear-mounted heaters, control equipment and wiring is in general accessible without exposing high-voltage parts.

INSPECTION AND MAINTENANCE SCHEDULE

To assure high quality service, a definite maintenance schedule, systematically followed, is essential. Plant, operating, and local conditions vary to such an extent that a schedule must be prepared to suit the specific conditions. The following inspection and maintenance requirements will be helpful in setting up the program.

The maintenance schedules for circuit breakers, relays, meters, etc., are outlined in their individual instruction books. These schedules, effectively coordinated with the overall maintenance schedule, will minimize shut down time and operating inconvenience.

The switchgear installation should be given a thorough overall maintenance check at least annually, when plant, operating, and local conditions are normal. Where conditions are abnormal, more frequent inspection and maintenance is necessary. The following items require attention:

Buses and Connections

Deenergize the primary circuits and remove cover plates from the primary compartments. Before cleaning, inspect for symptoms which might indicate overheating or weakened insulation. Megger tests, between phases and to ground, are suggested for checking the insulation. Remove dust from buses, connections, supports, and enclosure surfaces. A vacuum cleaner with a long nozzle will be of assistance. Wipe clean with a solvent (Stoddard's or equivalent). After buses have been dusted and wiped clean, take megger readings again between phases and to ground.

The megger readings should be taken and recorded before and after cleaning the equipment and, insofar as possible, under similar conditions and at successive intervals. The recorded information should include the megger readings, the temperature, and the humidity (either by definite reading or by description). A series of these test readings will indicate any tendency toward a reduction in the dielectric strength of the insulation.

The limits in the dielectric strength vary with the extent and design of the bus structure. In contrast with small installations, the longer switchgear assemblies have a more extensive bus structure, with a greater number of parallel insulation resistance paths to ground, resulting in lower megger readings. This further emphasizes the value of a series of readings that establish a normal insulation resistance level from which any deviation can be detected.

Periodic high-potential tests are not required and are recommended only after repair of high-voltage buses or insulation, or when a change in megger readings indicates it to be advisable. High-voltage tests should not exceed 75% of the factory test values given in ANSI standards for switchgear. Transformer primary fuses should be removed during high-potential tests.

Main Disconnecting Contacts and Supports

Remove each breaker from its housing. Deenergize primary circuits and expose primary contacts and their porcelain supports (or bottles).

CAUTION

Do not remove or manually lift the shutter when switchgear is energized.

Wipe clean with a cloth moistened in solvent (Stoddard's or equivalent). Inspect for abnormal wear or overheating. Discoloration of the surfaces is not harmful unless corrosion due to atmospheric conditions is severe, leaving deposits on the surface. If necessary, deposits can be removed by buffing with a crocus cloth.

Breaker Elements

Refer to breaker instruction manual for recommended maintenance. RADIATION WARNING applies to VMC-Type vacuum circuit breakers.

Other Disconnecting Contacts

Inspect all primary and secondary disconnecting contacts (such as those on drawout transformers) for abnormal wear, fatigue, or overheating. Replace if necessary. Otherwise treat the same as Main Disconnecting Contacts.

Control Contactors

Contacts should be inspected and dressed or replaced when the surface becomes pitted. Unless repetitive duty has been experienced, little attention should be required.

Instruments, Relays, and Other Panel-Mounted Devices

Individual devices should be maintained according to the specific instructions supplied for each device. Remove all relay covers and inspect the interiors for dust or dirt. This operation can most readily be performed by relay test personnel during periodic relay tests. Control switches, transfer switches, and instrument switches should have their contacts inspected and dressed when necessary. Refer to specific instruction manual for dressing procedure.

Secondary Wiring

Check all wiring connections for tightness including those at the current and potential transformers and at the terminal blocks where circuits leave the switchgear. Make sure that all secondary wiring connections are properly connected to the switchgear ground bus where so indicated.

Mechanical Parts

Visually check and manually operate mechanical moving parts such as the shutter, 52S and 52H switch assemblies, the position interlock, hinged doors, and the drawout features of the transformers and fuses.

Ventilation

Check all filters, grillwork, and air passages for obstructions and accumulations of dirt. Clean or replace filters if necessary.

Battery and Charging Equipment

The control battery is such an important item in switchgear operation that it must be given special periodic attention if it is to have a long life and provide reliable service. Periodic inspections and tests are recommended in the battery supplier's instructions. At the same time the battery is checked, inspect the battery charger and remove any accumulations of dust and dirt. On all chargers having a manual-transfer switch for setting the charging rate, ensure that the selector switch is returned to the proper floating charge rate at the end of the periodic inspection. Serious

damage to the control battery can occur if the charger is left on a high-charging rate for an extended period of time.

Abnormal Conditions

Local conditions such as high humidity, salt-laden atmosphere, corrosive gases, heavy dust, capacitor or reactor switching or switching more than once a week, are considered to be abnormal, and require more frequent inspections.

It is suggested that inspections be carried out at quarterly intervals until an accurate maintenance schedule for a specific installation can be established.

Under certain abnormal ambient conditions such as dusty areas the maintenance schedule can become so frequent as to interfere with normal operating schedules. In such cases it is suggested that the switchgear be enclosed in a relatively airtight room in which the air is pressurized to approximately +5 psi relative to the normal atmospheric pressure. This arrangement alleviates the contaminating conditions and results in a more realistic maintenance schedule. Consideration should also be given to cooling the air where the ambient temperature is relatively high, thus further improving operating environment.

RECORDS

It is important that a continuing record be kept of the condition of the switchgear, pertinent readings, component failures, etc. This will aid in determining replacement parts requirements, the need for special maintenance at other than scheduled periods, and provides the information necessary to establish an accurate maintenance schedule for a specific installation.

LUBRICATION

McGraw-Edison metalclad switchgear is designed so that lubrication is not required under normal conditions. However, abnormal local conditions such as high humidity, salt-laden atmosphere, corrosive gases, or severe circuit operating conditions may demand the use of lubricants. In such cases, a dry or powdered lubricant should be used on moving or mating mechanical parts and a thin film of vaseline on disconnecting contacts. The application of the lubricants should be held to a minimum to reduce the accumulation of dust and dirt.

RENEWAL PARTS

When ordering renewal or spare parts, include as much information as possible. In many cases the identification of the new part can be obtained from the number on the old part. Always include a description of the part, specify the rating, housing number, and shop-order number of the metalclad housing in which the part is to be used.

The following parts are suggested as spares for a typical installation. The size and complexity of the particular installation will cause variations. As a further guide, spare-parts lists are usually included in the specific instructions for individual devices.

1 – Set of breaker-element parts. See breaker-instruction book for recommendations.

1 – Set of primary fuses for potential- and control-power transformers.

1 – Package of indicating lamps.

1 – Set of contacts for control-instrument-and auxiliary-switches.

1 – Set of contacts and coils for auxiliary relays. Refer to specific relay instruction manual.

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