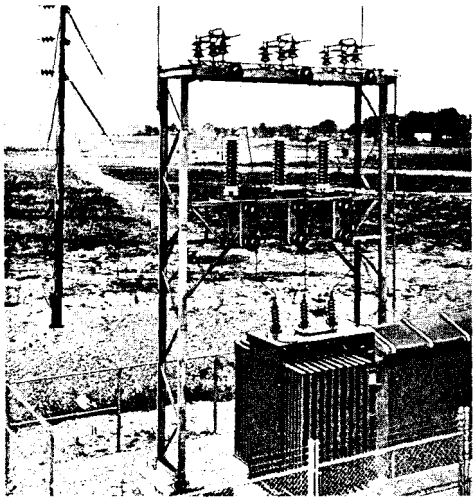
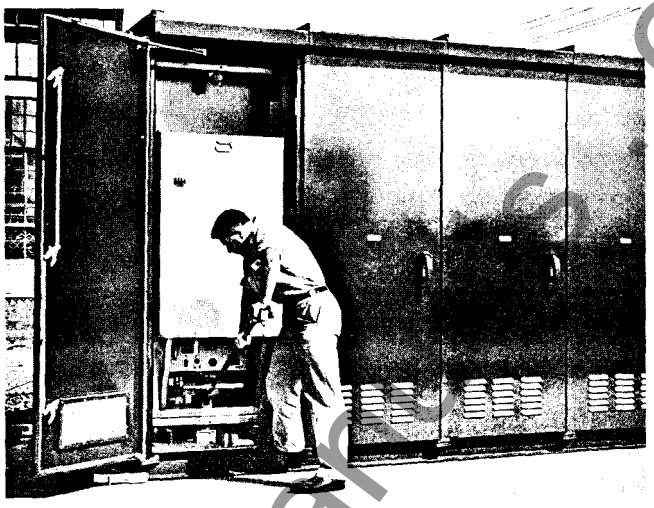
INCOMING SECTION





OUTDOOR STATION

This is a common method of terminating incoming powerlines ahead of primary unit substations. I-T-E can supply outdoor stations of steel or aluminum in any arrangement dictated by circuit requirements. Units are designed simply and economically, but in every case with ample strength for wind, ice and line loads. Disconnecting switches in ratings 6.9 through 69 kv available from I-T-E's broad line.

OIL SWITCH AND TERMINAL CHAMBER

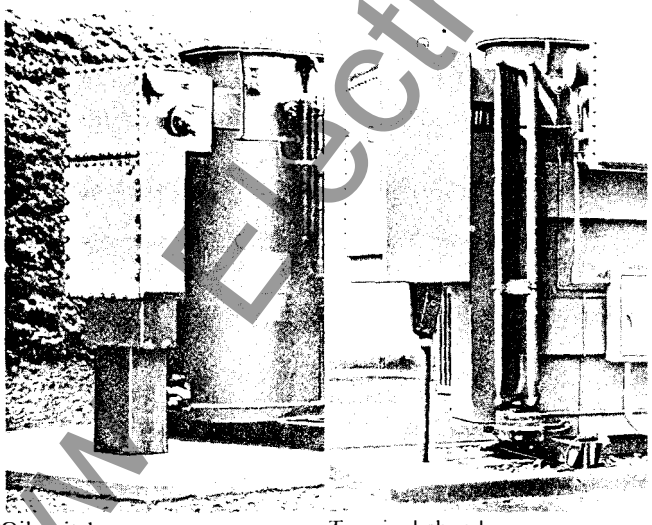
A combination of oil switch and terminal chamber provides for transformer isolation without service interruption on the high-voltage line. The switch is key-interlocked with the associated transformer power circuit breaker to prevent opening under load current. Oil switches are applicable as standardized equipment up to 15 kv and as nonstandardized equipment up to 69 kv. Terminal chambers for incoming cable are available air filled up to 15 kv, oil filled through 69 kv.

METAL-CLAD SWITCHGEAR

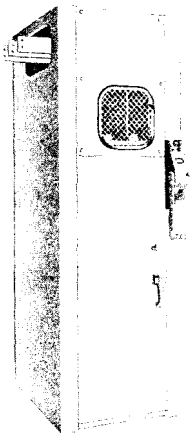
When incoming line voltage is 13.8 kv or less, I-T-E metal-clad switchgear with air-magnetic circuit breakers can be used as the primary disconnect. Throat-connected to the transformer primary, it protects the transformer from fault currents besides providing a means of transformer isolation. It also permits differential relaying. Range of ratings is 150 to 1000 mva in standard current ratings.

AIR INTERRUPTER SWITCH

I-T-E Type HPL-C air interrupter switches are furnished completely enclosed in metal and normally throat-connected to the transformer. The Type HPL-C switch closes into faults in complete safety for personnel. May be safely opened under full load. Available in a variety of arrangements, fused or unfused. Either current-limiting or non-current-limiting fuses are available, depending upon requirements. Ratings up to 14.4 kv, 2000 amp continuous and 95 BIL.



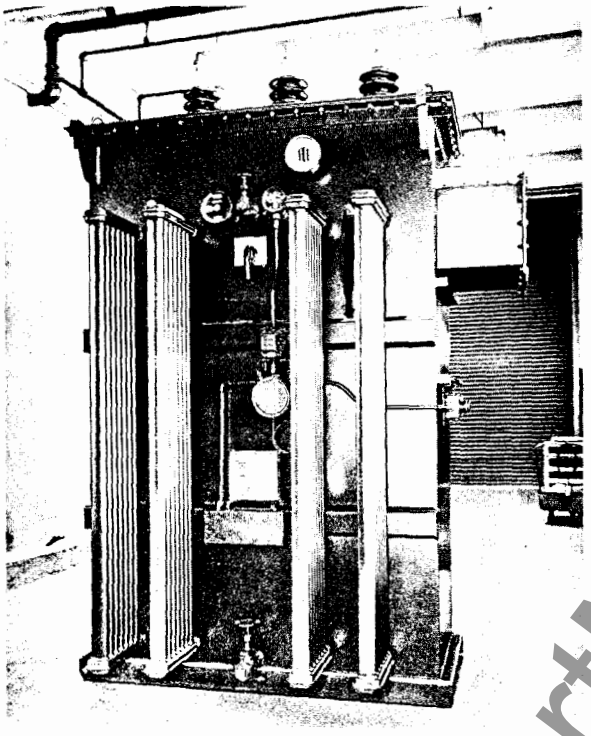
Oil switch



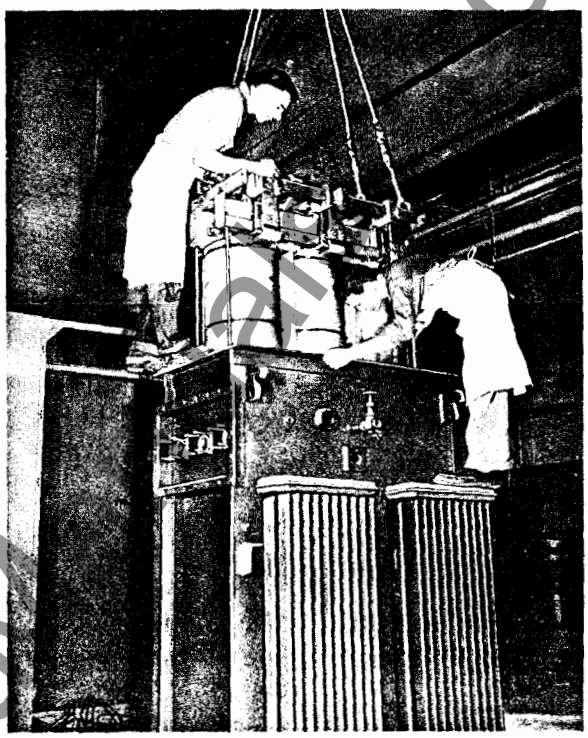
Terminal chamber

NEW

TRANSFORMER SECTION



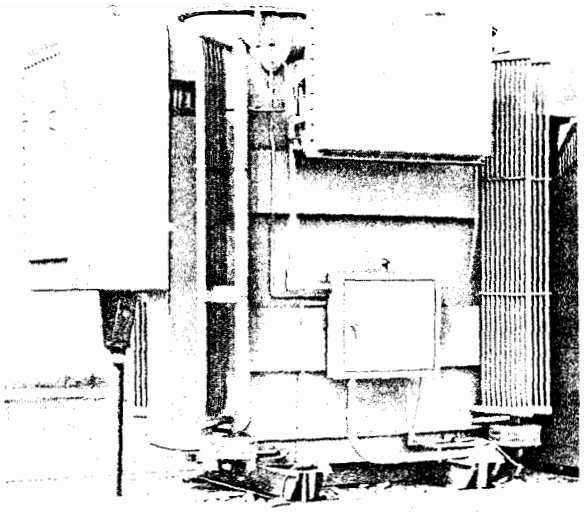
Typical I-T-E primary unit substation transformer



Tanking a core and coil assembly

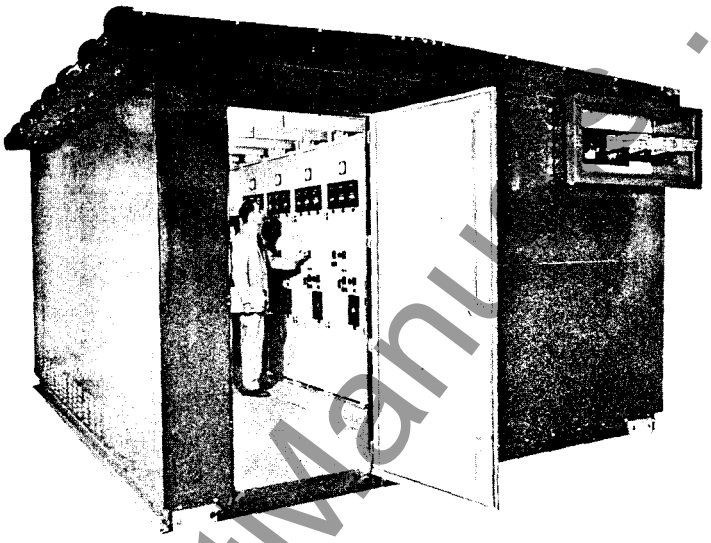
I-T-E supplies a full range of substation transformers manufactured in accordance with industry standards. They are available with or without provisions for tap changing under load.

I-T-E transformers are built to resist the heaviest stresses. As a result, you have less risk of trouble in service, virtual freedom from transformer damage due to abnormal stresses, and greater length of service. Of all transformer manufacturers, only I-T-E assembles cores on a flat bed prior to assembling coils. This insures better alignment of laminations in completed transformers for quieter operation and less heat generation. Tanks for liquid-filled transformers are double welded inside and out to prevent risk of leakage. Sides and cover are reinforced for extra strength.



Transformer with load ratio control ▶

OUTGOING SECTION



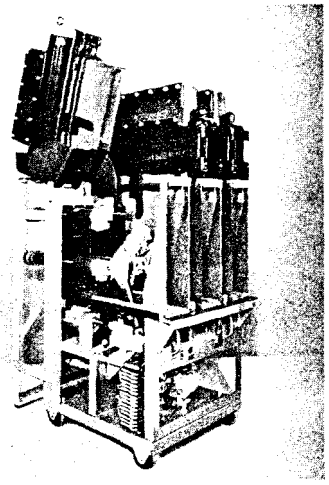
Better workmanship quickly identifies I-T-E switchgear. Equipment has a better appearance in the beginning . . . keeps it longer.

I-T-E metal-clad switchgear is available in a complete line, including walk-in and non-walk-in types. Ratings are continuous from 75 through 350 mva in the 4160 volt class and up to 1000 mva in the 13.8 kv class.

Horizontal drawout circuit breakers roll out easily on permanently attached wheels. Safety shutters automatically close over bus openings when breaker is moved to test position or away from enclosure. Breakers are fully interchangeable in same ratings. So power outage time can be kept to a minimum. This is possible because of the precise dimension control on I-T-E breakers and enclosures during manufacture.

All parts of I-T-E switchgear are accessible for quick, easy inspection. Both front and rear doors are hinged. Essential breaker components are mounted on the circuit breaker itself for easier access.

Horizontal drawout circuit breakers. One man can move breaker into or out of compartment in complete safety. Breakers cannot be moved in or out of connected position unless open.



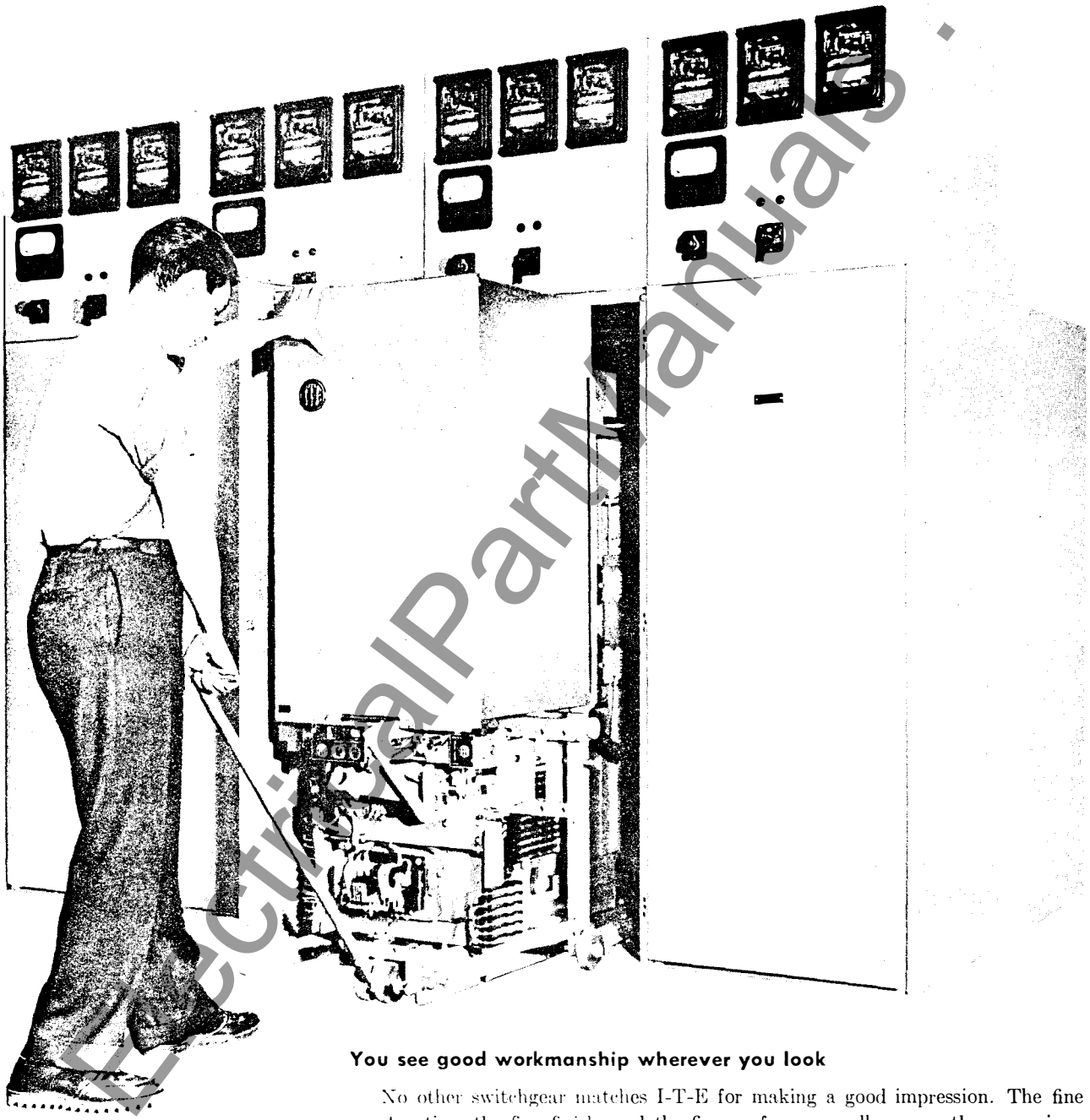
Simplified maintenance. Circuit breaker in 13.8 kv class illustrates pivoting arc chute assembly which gives easy access to contacts. Uniform magnetic flux density over entire length of arc chute speeds quenching of even high fault current arcs.

TABLE OF CONTENTS AND CHECKING LIST

Metal-Clad Switchgear

RATINGS

4160 Volts—75, 150, 250 and 350 MVA Interrupting
1200, 2000, 3000 Amperes continuous



You see good workmanship wherever you look

No other switchgear matches I-T-E for making a good impression. The fine construction, the fine finish, and the fine performance all express the care given every detail by the I-T-E engineers who design it and the I-T-E craftsmen who build it. Yet you will find when you buy I-T-E Switchgear that you pay no more. Truly I-T-E is the wisest choice you can make, plus the most economical buy.

I-T-E CIRCUIT BREAKER COMPANY
Printed in U.S.A.

Supersedes Section 7004

I-T-E 4160 VOLT SWITCHGEAR

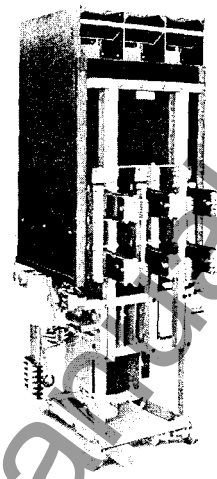
I-T-E switchgear not only looks better built—it is better. Study it closely. Check the details. Notice that the better construction aims to insure not only better performance, but easier operation and upkeep, greater safety, longer-lasting beauty in metal.

Horizontal drawout circuit breakers eliminate stooping, hard cranking, and the need for special handling trucks. And only I-T-E circuit breakers move so effortlessly on large wheels with needle bearings. Roll a breaker into the frame and it stops at test position—for safety—can't be fully connected if it is closed. Because it is precision made, the self-connecting secondary contacts mesh in test and operating positions automatically as the breaker moves. *The operator never has to put his hand down into the compartment.* And circuit breakers of equal rating are completely interchangeable from frame to frame.

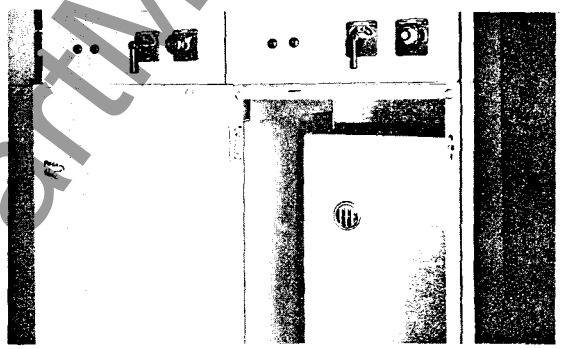
Notice the rugged structures. Each unit is self-supporting—strong enough to be shipped and handled with only ordinary precautions. No special bracing plates are required. Channel base is supplied with all I-T-E switchgear and when required is shipped in advance. So installation is simplified. Yet the switchboard can be added to with perfectly matching new panels as needed. Only I-T-E switchgear has such quality construction.

All doors and end panels are formed, with one or more 90-degree bends on each edge. Corner welds are ground and sanded to a smooth, flat finish. Front doors open wide for easy access. Even backdoors are formed and hinged. And throughout the structure finishes are oven baked for enduring beauty.

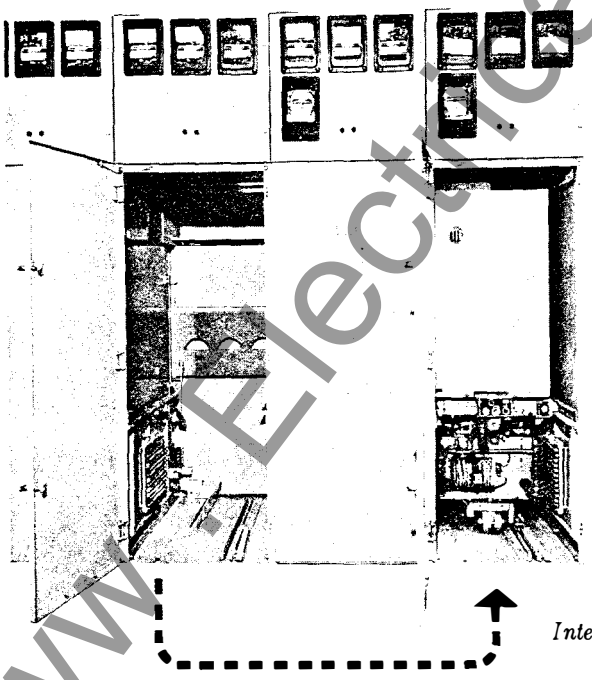
I-T-E switchgear is an investment that pays compliments to your good judgment throughout the years you live with it.



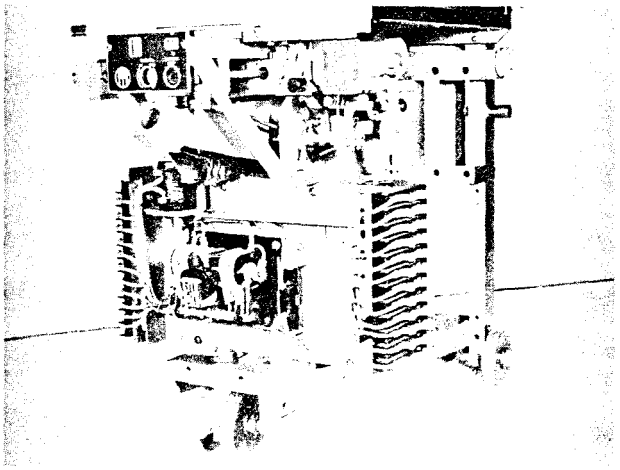
Sturdy breaker frames



Formed doors and panels

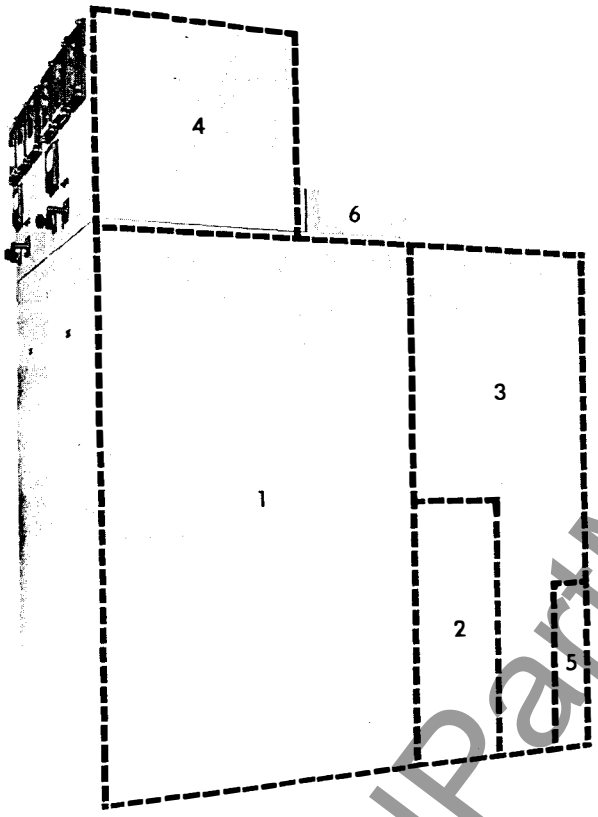


Interchangeable circuit breakers



Large wheels with needle bearings and self-connecting secondary contacts

ENGINEERED IN EVERY DETAIL FOR MAXIMUM OPERATOR SAFETY AND RESISTANCE TO FAULT DAMAGE



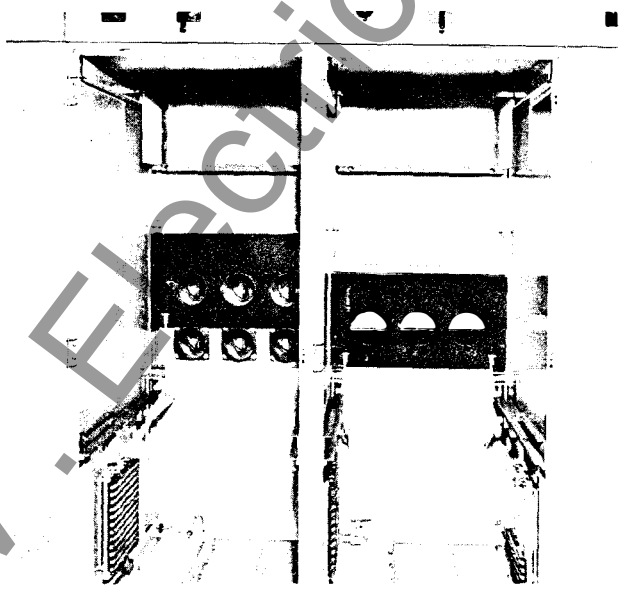
Complete isolation of the circuit breaker compartment

This side view of a typical switchgear frame shows how I-T-E isolates (1) the circuit breaker compartment; (2) bus compartment; (3) current transformer and cable terminal compartment; (4) instrument and control compartment; and (5) secondary wiring compartment completely in metal. Each circuit breaker is automatically grounded in both the operating and test positions. For further safety, there is a grounded metal barrier on the front of the breaker interphase barrier. The ground bus runs the length of the switchboard to insure minimum potential difference.

Notice too that the control compartment and circuit breaker compartment are not only isolated by metal enclosures, but have independent doors. Most of the instruments, controls and relays are mounted on the control compartment doors to take them out of the way of accidental bumping by passing personnel and minimize the risk of accidental tripping when opening the front doors.

Another safety measure is the exhaust chimney (6) on top, which quickly vents dangerous arc gases out of the structure.

Shutter open *Shutter closed*

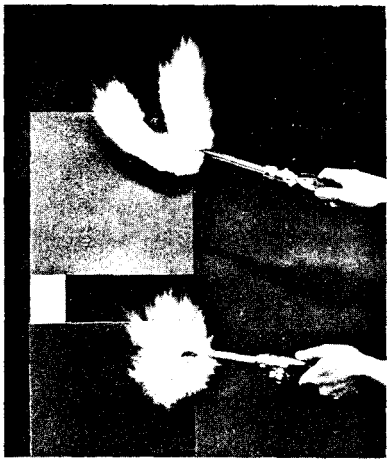


No high voltage in compartment unless the circuit breaker is actually connected

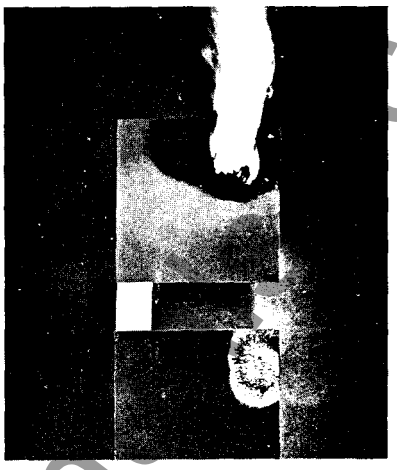
Each circuit breaker compartment is equipped with a grounded, metal shutter that automatically closes when the circuit breaker is withdrawn to test position and automatically opens when the circuit breaker is fully connected. Gravity operated, the shutter has two actuating arms, one on each side, to insure against hang-up. An operator could enter any I-T-E switchgear enclosure with the circuit breaker removed and be perfectly safe from contact with the primary voltage.

New Flametrap insulation snuffs out flame . . . leaves no toxic gases . . . gives you an extra measure of protection

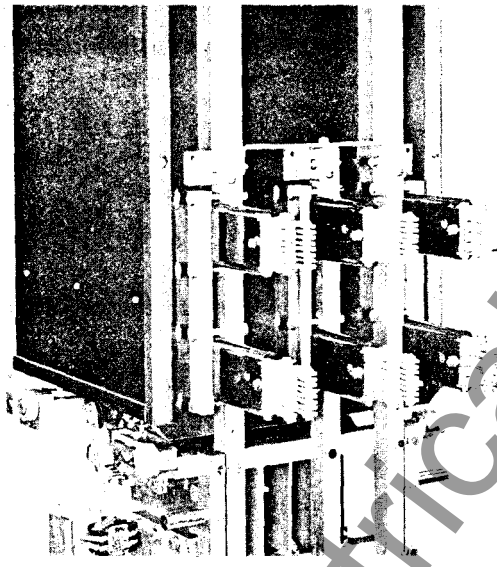
Used exclusively in I-T-E switchgear, Flametrap is today's most advanced flame retardant insulation. It shields your equipment from the damage that might otherwise occur in case of a runaway arc. See how it compares with conventional insulation. Flametrap will not support combustion but snuffs out in seconds after the source of heat is removed. And your circuits are still protected. Its special formulation resists high temperatures. Hence it shows less damage from arc exposure. And Flametrap gives off no toxic gases. So it is safer too.



Torches ignite Flametrap (bottom) and conventional insulation (top) simultaneously.

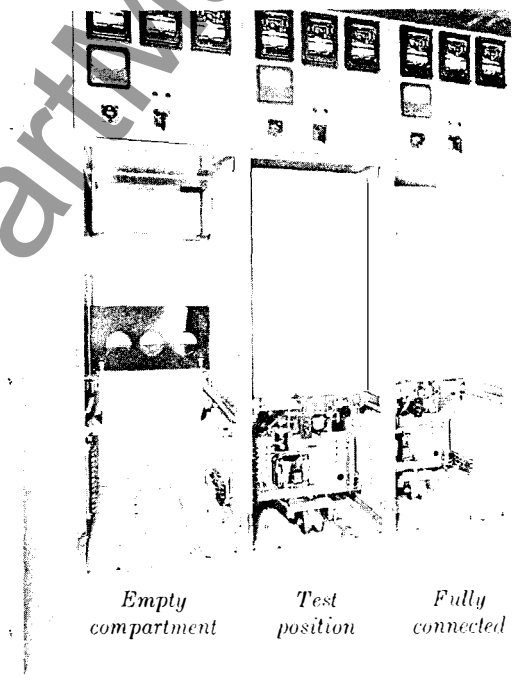


Seconds later, Flametrap has snuffed out, but conventional insulation still burns briskly.



Female primary disconnects located on the circuit breaker for easy, safe inspection

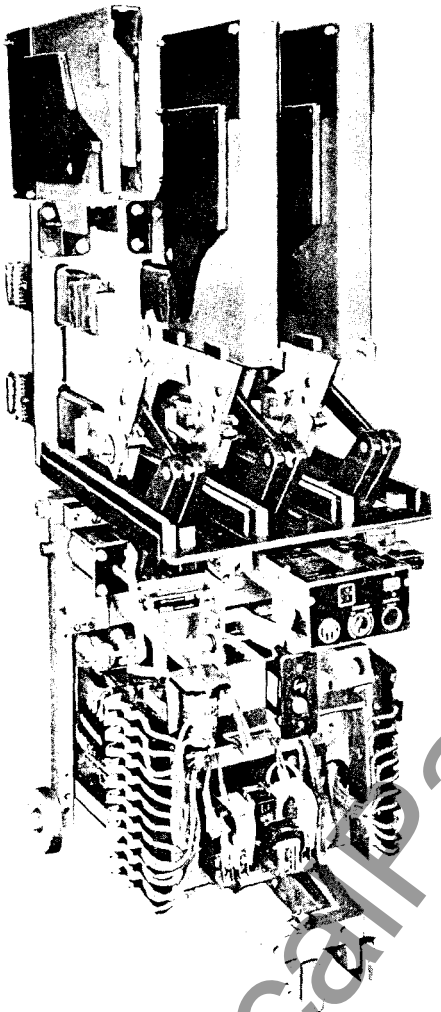
These self-aligning high-pressure disconnects on I-T-E circuit breakers play an important part in insuring firm, low-resistance connection with the primary buses. Fingers are heavily silverplated for good conductivity—as are the male disconnects too. Individual springs for each finger are located outside the current path. Because the female disconnects are on the circuit breaker itself instead of on the bus, you can inspect them every time you draw out a breaker. You don't have to shut down the whole switchboard.



Empty compartment *Test position* *Fully connected*

From test to fully connected positions in complete safety

You don't have to put your hand down into the working parts of an I-T-E switchboard to test a circuit breaker. Just move it into the compartment on its smooth-rolling wheels. It stops automatically at test position, and the spring-loaded secondary disconnects make complete contact. The safety shutter covering the primary bus apertures is still closed. With the easy turning crank, you rack the breaker into the fully connected position. Sturdy bolts hold it there. The breaker must be in the open position whenever it is racked or withdrawn or it trips automatically. So the operator is completely protected at all times.

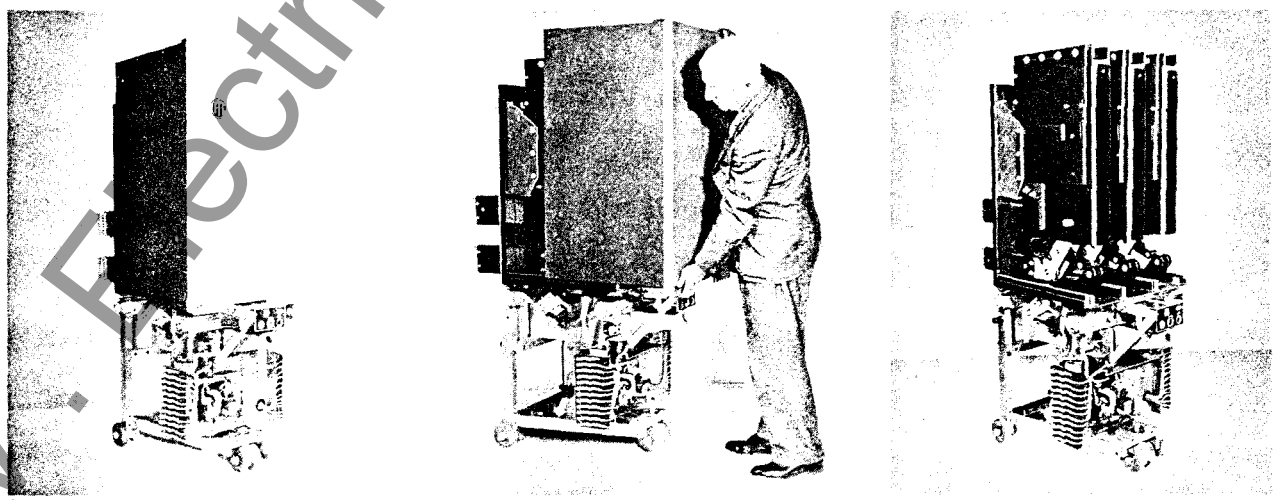


I-T-E PUTS EVERYTHING WHERE YOU CAN REACH IT

The greater accessibility of component parts of I-T-E switchgear is another indication of the greater engineering care that has gone into its design. An I-T-E circuit breaker, for example, is complete—with all components mounted right on the frame, instead of having some mounted in the enclosure. Upkeep and testing are thereby greatly simplified. And many man-hours can be saved during the lifetime of the equipment. This feature is a real contribution to the long-term greater economy of I-T-E switchgear.

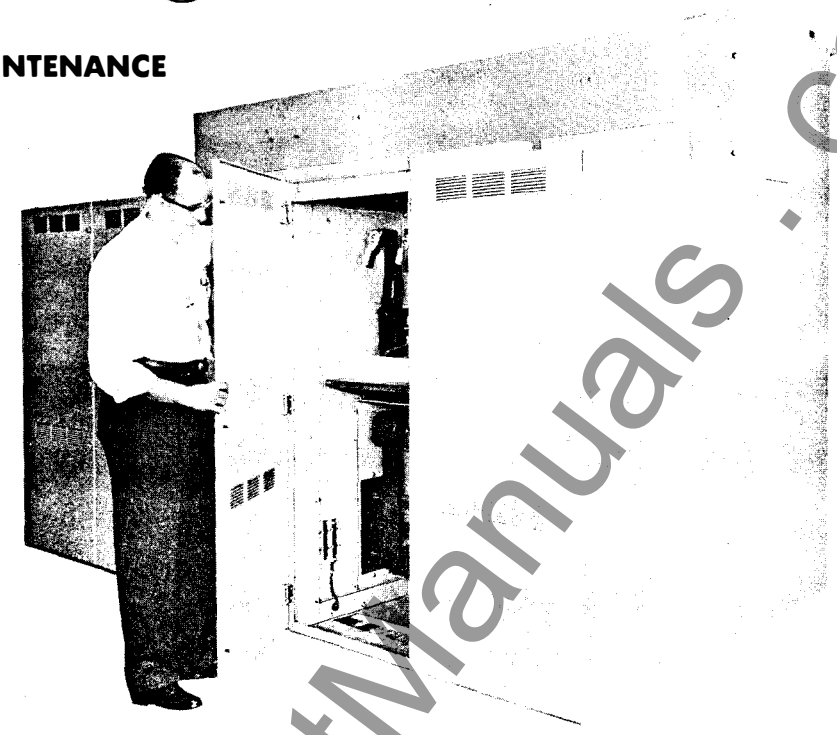
Right on the circuit breaker . . .

instead of inside the enclosure. You'll find all the essential components readily accessible for easy testing and servicing. This includes the closing relay (with double break contacts for your greater protection—another I-T-E exclusive), rectifier for the solenoid, and the capacitor trip device. Notice on this unit illustrated the hinged arc chutes that give quick, convenient access to contacts. They're standard on 75 and 350 mva ratings.



Interphase barrier removes easily for access to arc chutes

EASY INSPECTION AND MAINTENANCE



Hinged and louvered rear doors

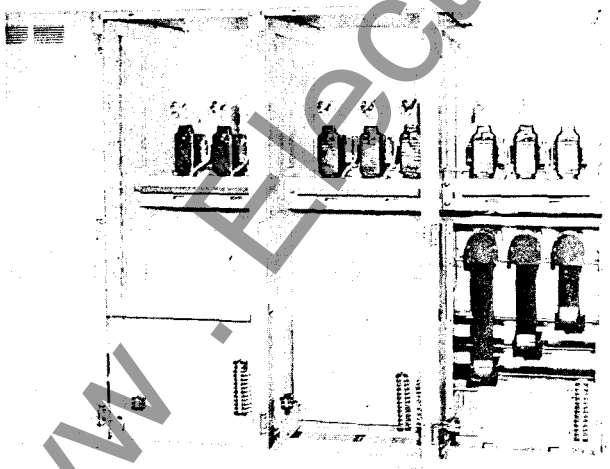
Why struggle with a 75-lb. sheet metal cover and grope for screw holes? Hinged rear doors with self-aligning, captive screws are standard equipment on I-T-E switchgear—cost you no more. This means faster access, easier inspection, less labor, saving of time, plus the obvious pride that you can feel in equipment that is better made.

Main bus compartment

Accessible through easily removable covers, as shown below. All bus connections are high-pressure, silver-plated, bolted joints covered with insulating boxes. No compound is required or used. This simplifies inspection and maintenance. The bus itself is hard drawn, round edged copper, insulated with Flametrap. It is braced to withstand the severe forces of short circuit currents equal to the highest rating of the circuit breakers in the switchboard.

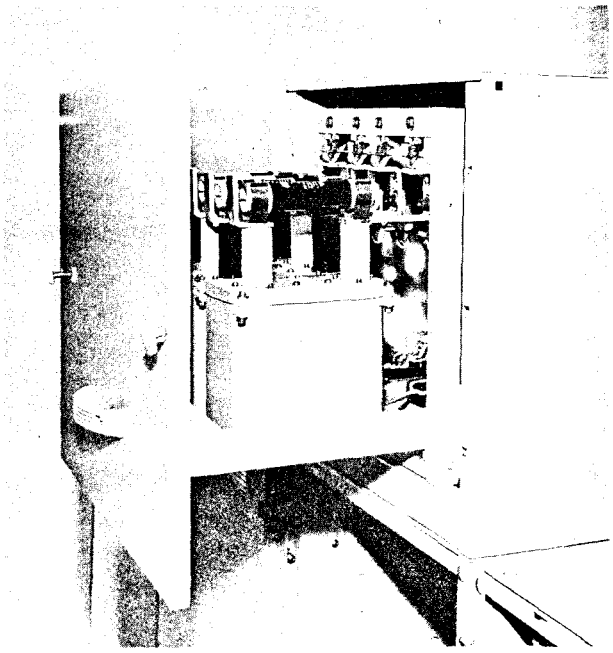
Cable compartment

This compartment has ample room for incoming and outgoing cable or bus duct connections, either top or bottom. Cable clamps, terminators, potheads or copper bus connections are readily adaptable.

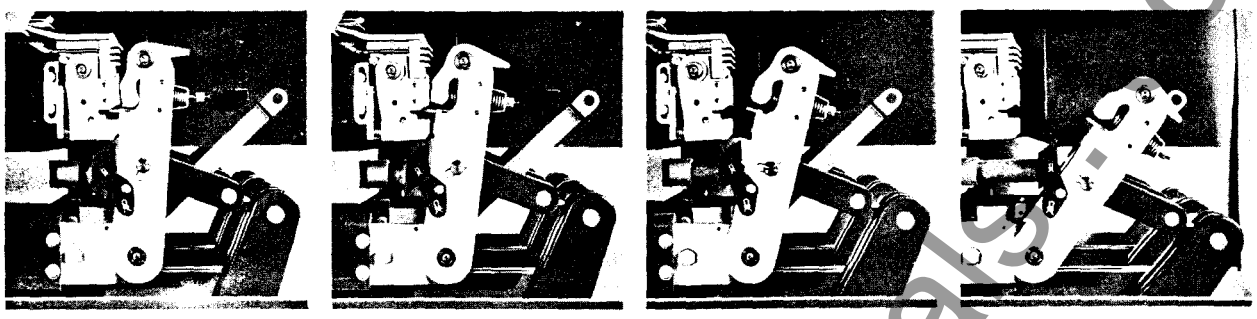


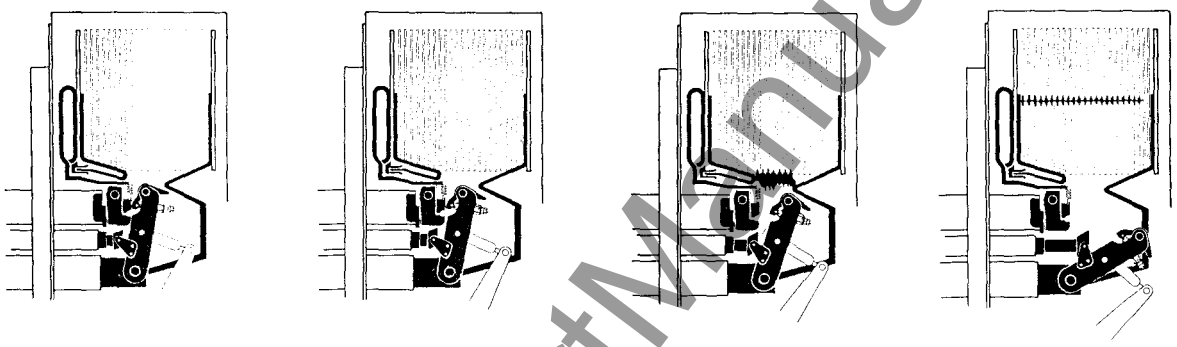
Drawer mounted potential transformers

These transformers are of dry type construction. Mounting them in separate compartments insures greater safety. Removable drawers add easier access and service. Opening the drawer automatically opens the circuit and grounds the transformers. This compartment is normally positioned at the rear of the switchboard on top of the large enclosure.



FROM FULLY CLOSED TO FULLY EXTINGUISHED IN 4 CYCLES



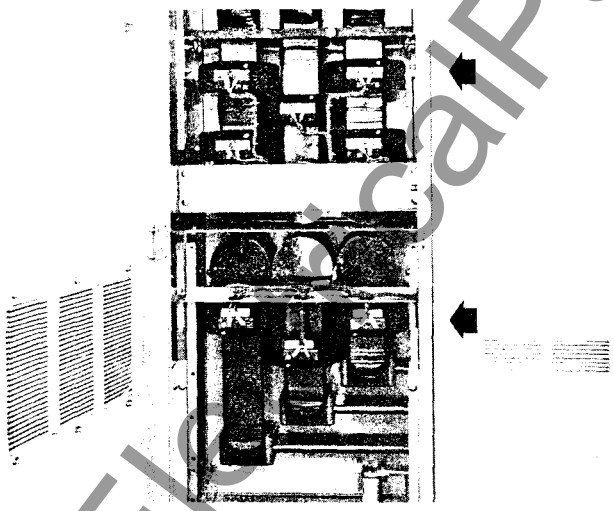


1. Circuit breaker is fully closed.

2. Main contacts begin to open. Arcing contacts are closed.

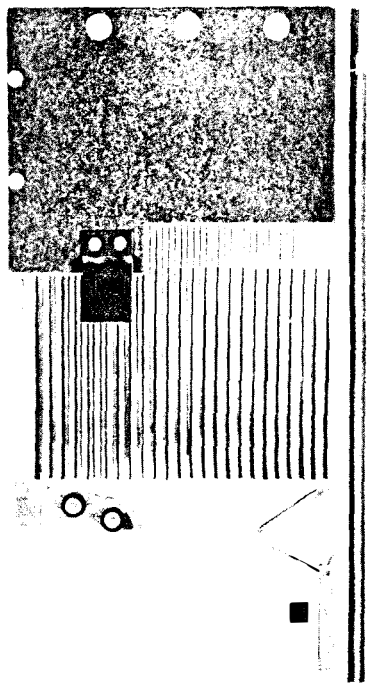
3. Arcing contacts open. Air blast and magnetic field drive arc into chute.

4. Arcing contacts are wide open. Arc is stretched, cooled, and extinguished.



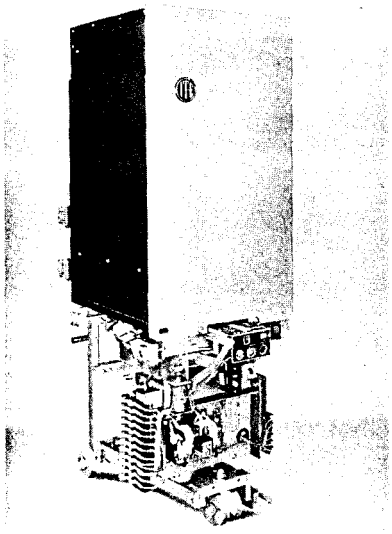
I-T-E switchgear permits location of current transformers on both sides of circuit breakers

Locating the current transformers on the main bus side as well as on the load side of the circuit breaker includes the circuit breaker in the protected zone. This means protection for the circuit breaker as well as the powerline in the event of a fault in the switchgear itself—an I-T-E feature which eliminates the need for an extra frame in obtaining this protection.



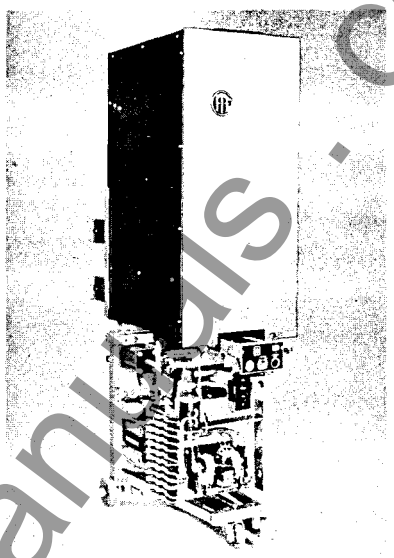
I-T-E's superior grade ceramic plates cool arc fast—insure long arc chute life.

Up to 350 mva—
and I-T-E was first to reach it in 4160 volt switchgear



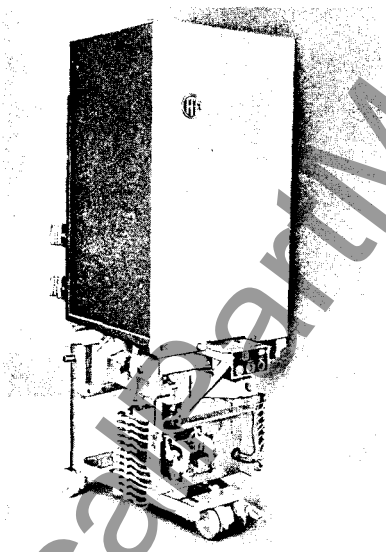
Model 5 HV-150

1200 and 2000 amp continuous, 150 mva interrupting capacity



Model 5 HV-75

1200 amp continuous, 75 mva interrupting capacity



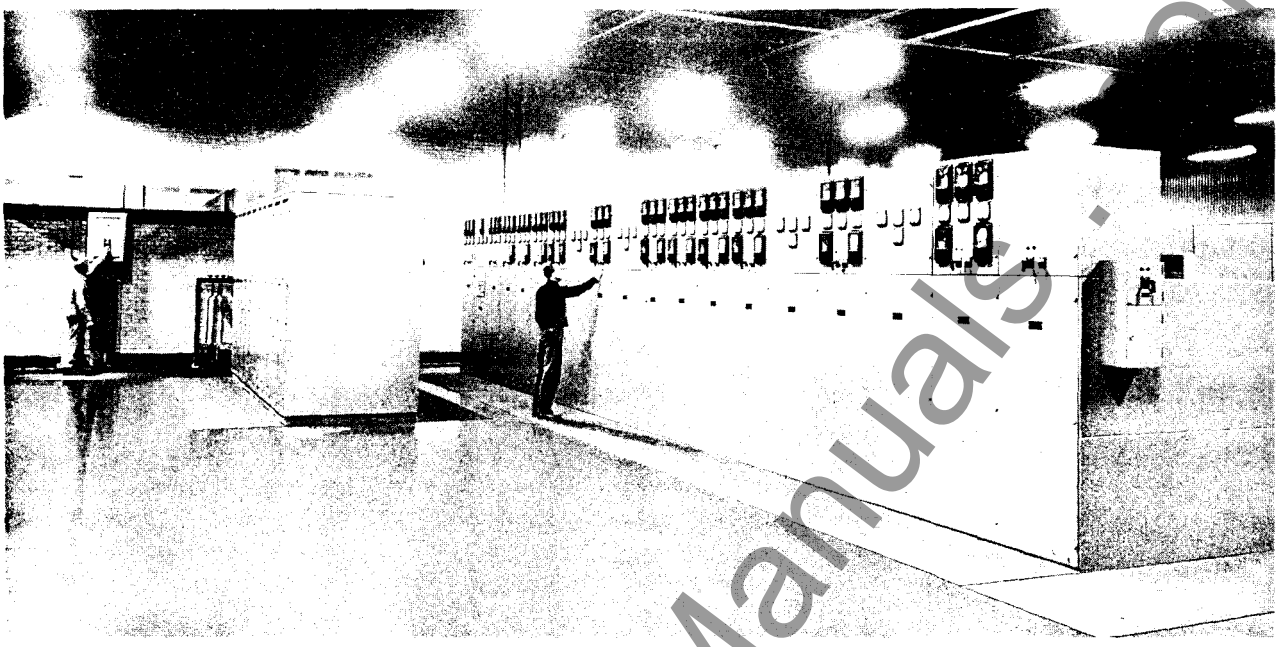
Model 5 HV-250

1200 and 2000 amp continuous, 250 mva interrupting capacity

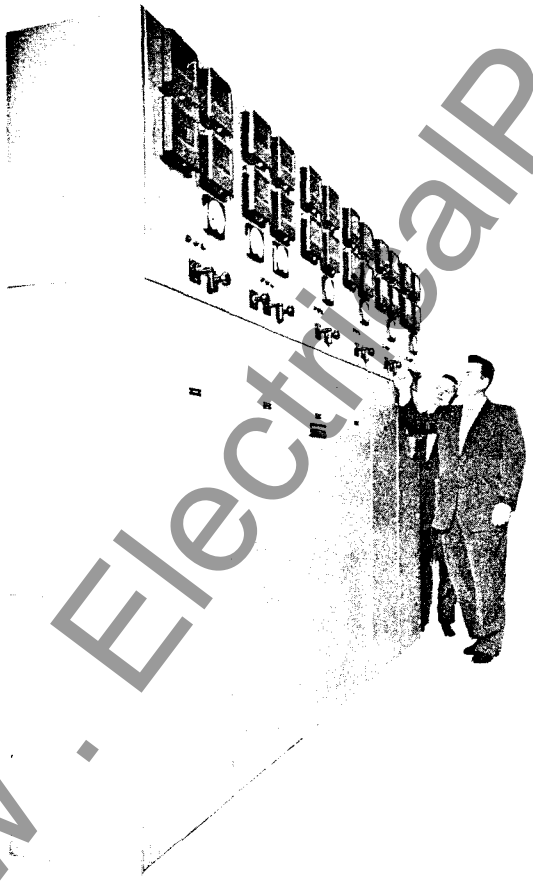
Model 5 HV-350

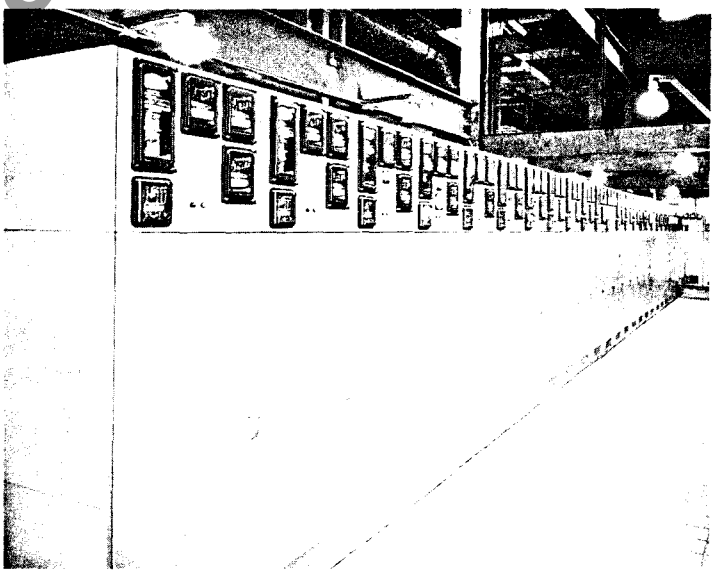
1200 and 3000 amp continuous, 350 mva interrupting capacity

Another important reason to specify I-T-E switchgear in the 4160 volt class is that I-T-E offers you a complete line. I-T-E circuit breakers cover the complete range of ratings—up to 350 mva, the highest offered today. This means that when you install I-T-E switchgear, you can be sure of having circuit breakers that meet the particular requirements of each circuit. Likewise if you ever need to expand your switchboard, you can get I-T-E circuit breakers to meet your future needs too. And behind the design of every I-T-E circuit breaker is an accumulation of experience and performance that adds extra assurance of dependability.

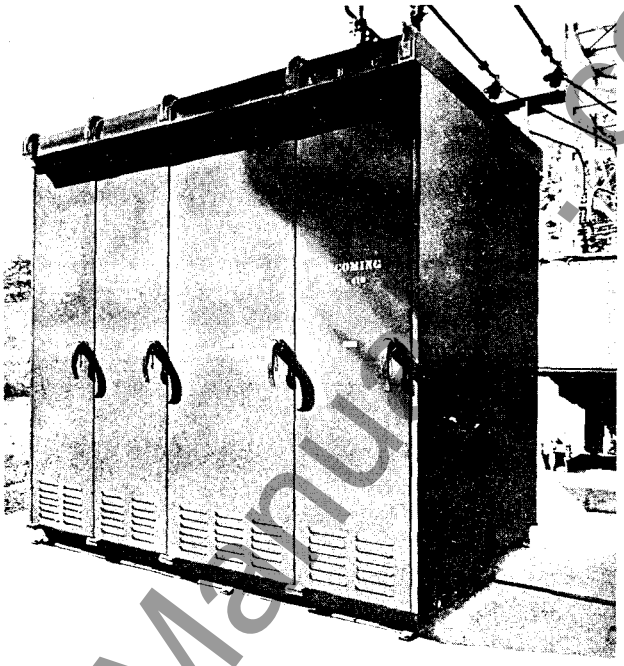


SOME TYPICAL INSTALLATIONS OF I-T-E 4160 VOLT INDOOR SWITCHGEAR





OUTDOOR SWITCHGEAR



Only I-T-E gives you all these advantages:

Doors completely gasketed with cellular neoprene sponge.

Side sheets and frames sealed with long-lasting, impregnated gaskets.

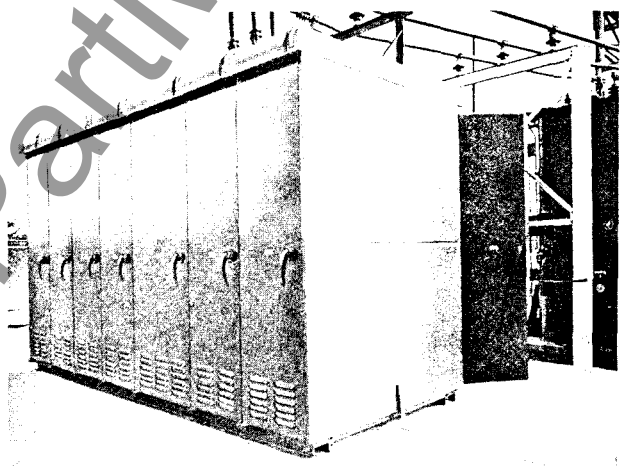
All parts treated for rust resistance, painted and baked prior to assembly to protect the metal against rust and corrosion, even between overlapping joints.

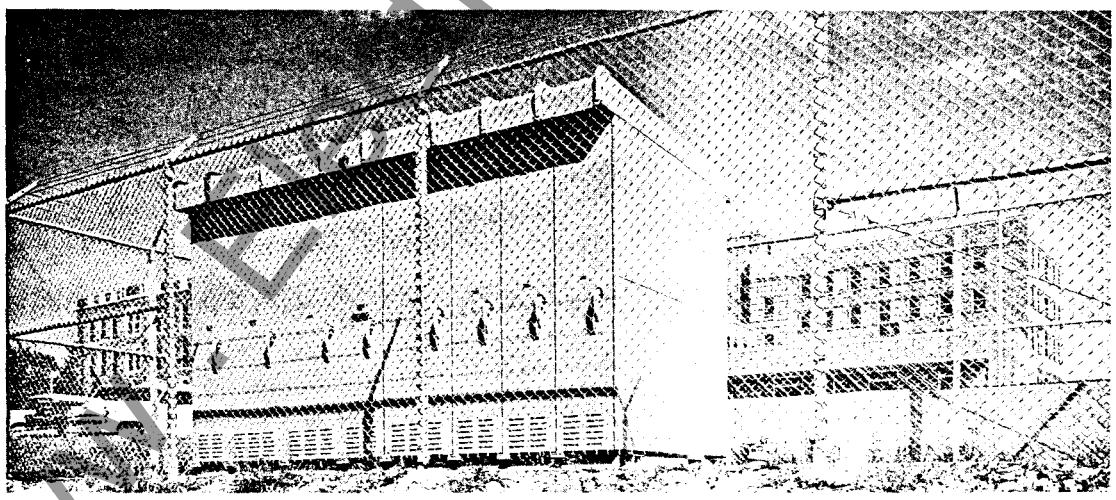
Bottom of the entire unit undercoated.

Front and rear doors hinged and louvered—louvers covered with glass fiber filters.

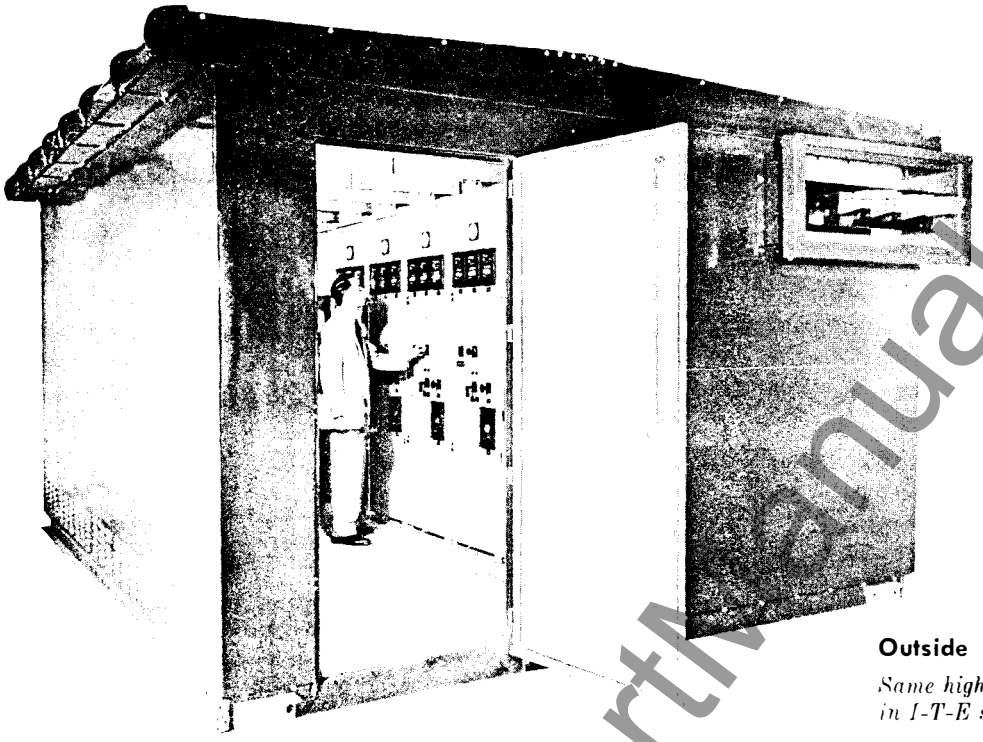
Interiors equipped with lights and convenient outlets.

Structures strong enough to be pier mounted.





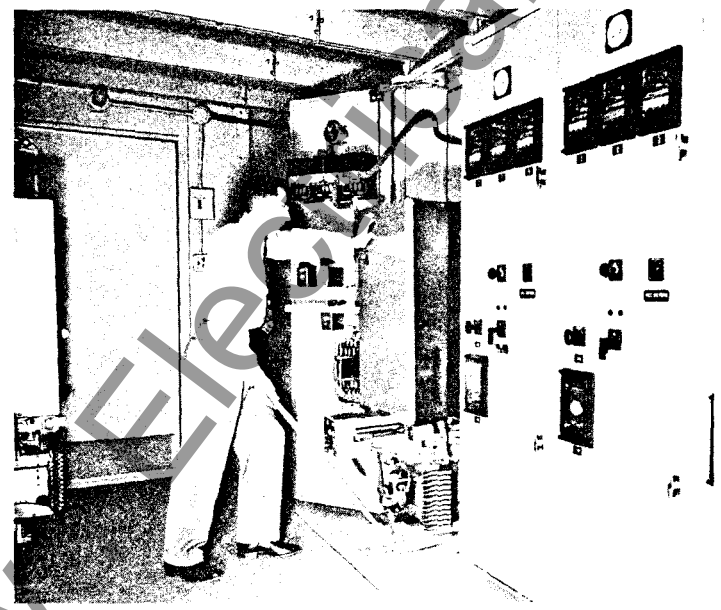
WALK-IN OUTDOOR CONSTRUCTION

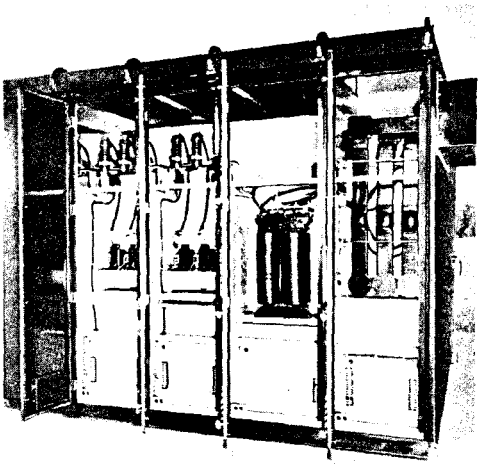


Outside

Same high-quality construction as used in I-T-E standard outdoor structures.

speeds maintenance of switchgear in bad weather





Hinged rear doors

Afford easy access to bus and cable compartments.

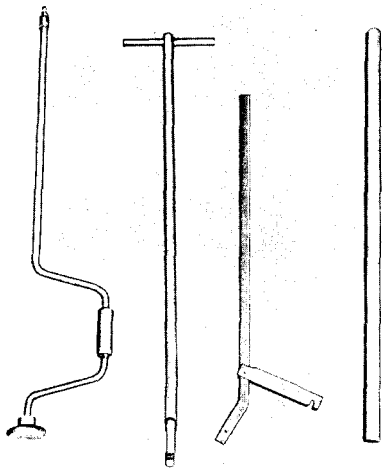
Inside

Spacious work area. Breakers can be withdrawn, inspected, maintained and stored.

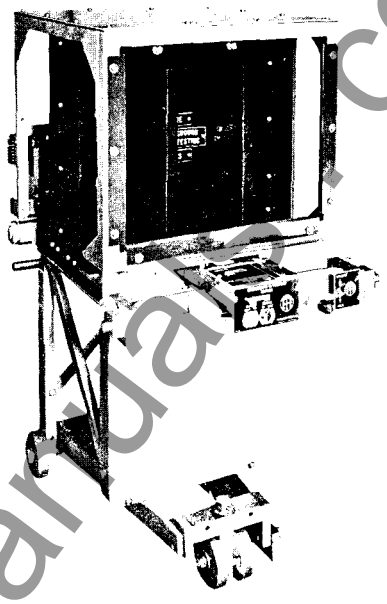
ACCESSORIES

Standard accessories

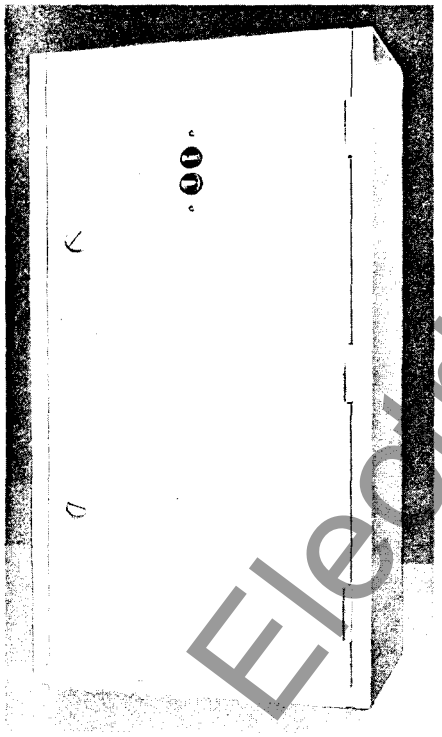
Supplied as standard equipment with every I-T-E metal-clad switchboard are the following:



1. **Circuit breaker racking crank**
2. **Towing handle**
3. **Levering device**
4. **Manual operating lever for maintenance**

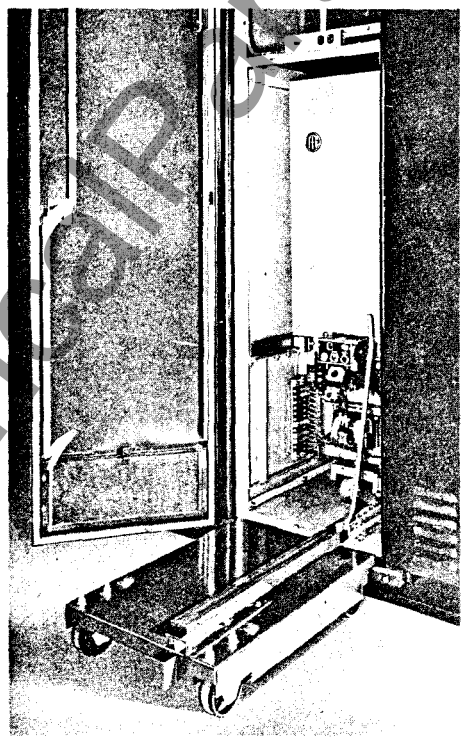


Grounding and testing device—manual

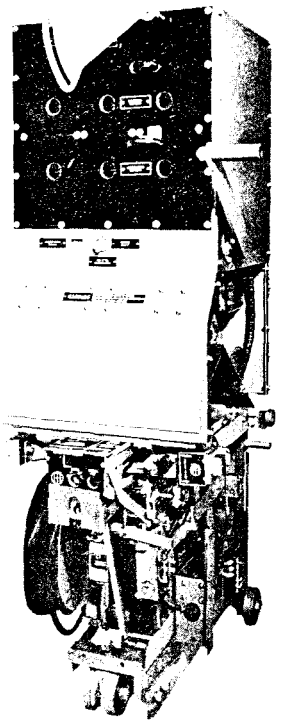


Test control station

Built for wall mounting. Permits testing of circuit breakers when out of compartments.



Outdoor removal truck



Grounding and testing device—electrical

SIMPLIFIED ORDERING GUIDE

FOR

STANDARDIZED I-T-E 4160 VOLT SWITCHGEAR

AND

PANEL LAYOUTS AND DIMENSIONS

FOR

STANDARDIZED UNITS

I-T-E CIRCUIT BREAKER COMPANY
Printed in U.S.A.

Supersedes Section 7004

SIMPLIFIED ORDERING GUIDE FOR STANDARDIZED I-T-E 4160 VOLT SWITCHGEAR

TYPICAL SPECIFICATION

General

The (indoor-outdoor) metal-clad switchgear described in this specification is intended for use on a (2400-4160) v, 3-phase (3-4) wire, (grounded-ungrounded) (60) cycle system. The switchgear shall be rated 4160 v and the horizontal drawout air circuit breakers shall have an interrupting capacity of (75-150-250-350) mva at 4160 v. The entire switchboard, including air circuit breakers, meters, relays, etc., shall be completely factory assembled and tested.

Applicable Standards

The switchgear equipment covered by these specifications shall be designed, tested and assembled in accordance with the latest applicable standards of ASA, AIEE and NEMA.

Stationary Structure

The switchgear shall consist of ( ) units assembled to form a rigid self-supporting structure. The steel sheets shall be No. 11 U. S. gage cold-rolled steel, annealed. Each breaker unit will be segregated by metal sheets into the following separate compartments: (1) circuit breaker; (2) main bus; (3) outgoing cables and current transformers.

Circuit Breaker Compartment

Each circuit breaker compartment shall be designed to house a horizontal drawout 4160 v air circuit breaker. A fixture shall be used to insure interchangeability of removable elements of the same type and rating. The circuit breakers shall be inserted and withdrawn from the compartments at the factory before shipment. The stationary primary disconnecting devices shall be mounted in insulated bushings. They shall be constructed of silver-plated extruded copper. All movable contact fingers and springs shall be mounted on the circuit breaker where they may easily be inspected. The entrance to the stationary primary disconnecting devices shall be automatically closed by a metal shutter when the circuit breaker is withdrawn to the test position or removed from the cell.

Cable Compartment

The bushings mounting the upper primary disconnecting devices shall extend through a nonmagnetic stainless steel sheet into the cable compartment. The current transformer terminals shall extend into the bushing. (Clamp type cable terminals shall be bolted to the current transformers by means of an adapter. An insulated cable support shall be furnished for primary cables as required.) (. . . potheads suitable for terminating . . . cable shall be furnished.)

Bus Compartment

Removable panels shall be provided for access to the bus compartment. The main bus shall be rated (1200-2000-3000) amp. All bus bars shall be completely silverplated, and bolted connections shall be used. The conductors shall be insulated by means of flame-retardant phenolic resin tubes. The inside surfaces of the tubes shall be covered with a semiconducting material to prevent corona. Flame-retardant bus supports shall support the insulated bus.

A completely silverplated ground bus shall extend through the length of the switchgear.

Doors and Panels—Indoor

The relays, meters, instruments, control switches, etc., shall be mounted on a formed front hinged panel. The rear doors shall be hinged and shall be of flanged construction. The formed end panels shall be fastened to the switchgear with concealed bolts. After a phosphate coating, one primer and two finish coats of paint shall be applied to all exterior panel surfaces. Each coat shall be baked at 300° F for 20 minutes. Color of finish shall be light gray ASA No. 61.

Doors and Panels—Outdoor

The relays, meters, instruments, control switches, etc., shall be mounted on a formed hinged panel. The panel shall be mounted in a compartment located on the opposite side of the switchgear from the circuit breaker compartment.

The front and rear gasketed exterior doors shall be provided with 3-point latches and doorstops. Glass fiber filters and screens shall cover the ventilators.

A rust-resisting primer and two finish coats of paint shall be applied to all exterior surfaces. Each coat shall be baked at 300° F for 20 minutes. The color of the finish coats shall be dark gray ASA No. 24.

Circuit Breakers

The air circuit breakers shall be rated (75-150-250-350) mva at 4160 v and shall have a maximum interrupting rating of 12,500, 25,000, 37,500, 50,000 amp and a momentary rating of 20,000, 40,000, 60,000, 80,000 amp. They shall have a continuous current rating of 1200, 2000, 3000 amp. Each pole of the circuit breaker shall be equipped with an arc chute containing specially designed ceramic plates to cool, stretch and extinguish the arc. The breakers will be electrically operated with a nominal closing voltage of ( ) v (a-c, d-c) and a nominal tripping voltage of ( ) v (a-c, d-c). A double break contact closing relay shall be mounted on the removable circuit breaker element. (For a-c operation the rectifiers will also be mounted on the circuit breaker carriage.)

The removable element shall be provided with a stainless steel guide bar which will engage a formed groove guide in the stationary housing. An interlock shall be furnished to prevent inserting or removing the circuit breaker while it is closed. An additional interlock shall be furnished to prevent accidentally inserting the racking bar into its socket while the circuit breaker is closed.

(*continued, page 103*)

SIMPLIFIED ORDERING GUIDE—Continued . . .

The circuit breaker shall be equipped with secondary disconnecting contracts which shall automatically engage in the operating and test positions to complete circuits as required.

Instrument Transformers

The current transformers shall have ratios as indicated on the attached single-line diagram. They shall have a mechanical rating equal to the momentary rating of the circuit breakers. The 1-second thermal rating of the current transformers shall be equivalent to the interrupting current rating of the circuit breakers. They shall have suitable metering and relaying accuracy. The potential transformers shall be of the drawout type and shall be equipped with current limiting fuses. They shall have an accuracy of 0.3W-0.3X, 0.3Y, and 1.2Z.

Control Wiring

No. 14 AWG switchboard wire with flameproof braid shall be used. The switchgear shall be provided with terminal blocks for outgoing control connections.

Unit A Swinging Instrument Panel

A swinging steel instrument panel will be mounted on the (right)-(left)-hand end of the switchboard for the following synchronizing instruments:

2 Voltmeters, 0-.....v scale
1 Synchroscope
2 Indicating lights
1 Frequency meter (optional)

Unit B Generator and Exciter Panels

The metal-clad switchgear for the control of one generator and one exciter will consist of two housings. The breaker unit will contain:

1 4160 v air circuit breaker,.....amp, 3-pole, electrically operated
1 Set of insulated bus,.....amp
3 Current transformers,...../5 ratio for overcurrent relays and instruments
1 Current transformer,...../5 ratio for voltage regulator (recommended for parallel operation)
3 Current transformers (optional for differential relays)
3 Current transformers (optional—to be connected in generator neutral for differential protection)
3 Relays, time overcurrent with voltage restraint
3 Differential relays (optional)

The auxiliary unit will contain:

1 A-c ammeter, 0-.....scale
1 Polyphase indicating wattmeter
1 Polyphase watthour meter,.....element
1 Polyphase varmeter
1 D-c field ammeter, 0-.....scale, and shunt
1 D-c voltmeter, 0-.....scale (optional)
1 Temperature indicator, 0-.....degrees scale (optional)
1 Auxiliary tripping relay for differential protection (optional)
1 Anti-motoring relay (optional) (recommended for parallel operation)
1 Overcurrent ground relay (optional)
1 Voltmeter switch
1 Ammeter switch
1 Synchronizing switch
1 Field breaker control switch with red and green indicating lights (if field breaker is electrically operated)
1 Governor motor switch
1 Generator breaker control switch with red and green indicating lights
1 Regulator transfer switch
1 Temperature indicator switch (optional)
1 Rheostat control consisting of one of the following:
  (a) Handwheel (when necessary) and provision for mounting of exciter field rheostat having not more than two plates of 12-in. maximum diameter
  (b) Control switch for electrically operated remote mounted rheostat
1 Space and mounting for voltage regulator
1 Provision for mounting field discharge resistor
2 Drawout type potential transformers,...../120 v, with current limiting fuses
1 Drawout type potential transformer,...../120 v, with current limiting fuses for use with voltage regulator
2 Drawout type potential transformers,...../120 v (optional for bus potential)
1 Set of insulated bus,.....amp
1 Drawout field breaker, electrically operated (mounted near generator) or (manual switch) or (manual circuit breaker)
3 Lightning arresters (optional for mounting at generator terminals)
1 Surge capacitor, 3-phase (optional for mounting at generator terminals)

Unit C Incoming Line Unit

The metal-clad switchgear for the control of an incoming line will contain:

1 4160 v air circuit breaker,.....amp, 3-pole, electrically operated
1 Set of insulated bus,.....amp
3 Current transformers,...../5 ratio
3 Overcurrent relays, instantaneous and time overcurrent
1 Breaker control switch with red and green indicating lights
1 Ammeter, 0-.....scale
1 Ammeter transfer switch
1 Voltmeter (optional)
1 Voltmeter switch (optional)
1 Watthour meter,.....element (optional)
3 Directional overcurrent relays (with) (without) instantaneous trip (optional not shown)
2 Drawout potential transformers,...../120 v ratio (optional) (mounted in superstructure)

(*continued, page 104*)

SIMPLIFIED ORDERING GUIDE—Continued . . .

Unit D Feeder Unit

The metal-clad switchgear for the control of a feeder circuit will contain:

1 4160 v air circuit breaker,.....amp, 3-pole, electrically operated
1 Set of insulated bus,.....amp
3 Current transformers,...../5 ratio
3 Overcurrent relays, instantaneous and time overcurrent
1 Breaker control switch with red and green indicating lights
1 Ammeter
1 Ammeter transfer switch

Unit E Bus Sectionalizing Unit

The metal-clad switchgear for bus sectionalizing will consist of two housings. The breaker unit will contain:

1 4160 v air circuit breaker,.....amp, 3-pole, electrically operated
1 Set of insulated bus,.....amp
1 Breaker control switch with red and green indicating lights
3 Current transformers,...../5 ratio (optional)
3 Overcurrent relays, instantaneous and time overcurrent (optional)
1 Ammeter (optional)
1 Ammeter switch (optional)

The auxiliary unit will contain:

1 Set of insulated transition bus,.....amp
2 Drawout potential transformers,...../120 v, with current limiting fuses, Bus 1 (optional)
2 Drawout potential transformers,...../120 v, with current limiting fuses, Bus 2 (optional)

Unit F Synchronous Motor Control—Full Voltage

The metal-clad switchgear for the control of a synchronous motor and its excitation will consist of two housings. The breaker unit will contain:

1 4160 v air circuit breaker,.....amp, 3-pole, electrically operated
1 Set of insulated bus,.....amp
3 Current transformers,...../5 ratio
2 Thermal overload relays with instantaneous trip type TMC
1 Overcurrent relay, instantaneous and time overcurrent, for ground fault protection
1 Induction type undervoltage relay or (phase sequence and undervoltage relay)
1 A-c ammeter, 0-.....scale
1 Ammeter switch
1 Breaker control switch with red and green indicating lights
1 Overcurrent relay, long time (optional—not shown)
3 Current transformers,...../5 ratio (optional for differential relays)

The auxiliary compartment for the field equipment will contain:

1 Field ammeter, 0-.....amp, and shunt
1 Wattmeter or varmeter
1 Field failure relay
1 Field application relay
1 Field thermal relay (where necessary)
1 Thermal type incomplete sequence relay
1 Field contactor
1 Field discharge resistor
1 Rheostat control consisting of one of the following:
  (a) Handwheel (when necessary) and provision for mounting of exciter field rheostat having not more than two plates of 12-in. maximum diameter
  (b) Control switch for electrically operated remote mounted rheostat
1 Set of insulated bus,.....amp
2 Drawout potential transformers,...../120 v (optional)
3 Differential relays (optional)
3 Current transformers mounted at motor (optional for differential relays)
1 Field forcing relay when required

Unit G Synchronous Motor Control—Reactor Start (Line Series) (Line Parallel) (Neutral)

The following additional equipment is required for reactor starting of a synchronous motor. The reactor shorting breaker unit will contain:

1 4160 v air circuit breaker,.....amp, 3-pole, electrically operated
1 Timing relay
1 Set of insulated bus,.....amp
1 Set of necessary primary connections to reactor
3 Current transformers,...../5 ratio (optional—necessary for line parallel-type connections)

The reactor unit will contain:

1 3-phase starting reactor,.....duty
1 Set of necessary primary connections to shorting breaker

Unit H Induction Motor Control—Full Voltage

The metal-clad switchgear for the control of an induction motor will contain:

1 4160 v air circuit breaker,.....amp, 3-pole, electrically operated
1 Set of insulated bus,.....amp
3 Current transformers,...../5 ratio
2 Thermal overload relays with instantaneous trip type TMC
1 Overcurrent relay, instantaneous and time overcurrent, for ground-fault protection
1 Induction type undervoltage relay or (phase sequence and undervoltage relay)
1 A-c ammeter, 0-.....scale
1 Ammeter switch
1 Breaker control switch with red and green indicating lights
1 Overcurrent relay, long time (optional—not shown)
3 Differential relays (optional—not shown)

(*continued, page 105*)

SIMPLIFIED ORDERING GUIDE—Continued . . .

3 Current transformers,..... ...../5 ratio (optional for differential relays)
3 Current transformers,...../5 ratio for mounting at motor (optional for differential relays)

Unit J Induction Motor Control—Reactor Start

The following additional equipment is required for reactor starting of an induction motor. The reactor shorting breaker unit will contain:

1 4160 v air circuit breaker, ...amp, 3-pole, electrically operated
1 Timing relay
1 Set of insulated bus,.....amp
1 Set of necessary primary connections to reactor
3 Current transformers,...../5 ratio (optional—necessary for parallel type connection)

The reactor unit will contain:

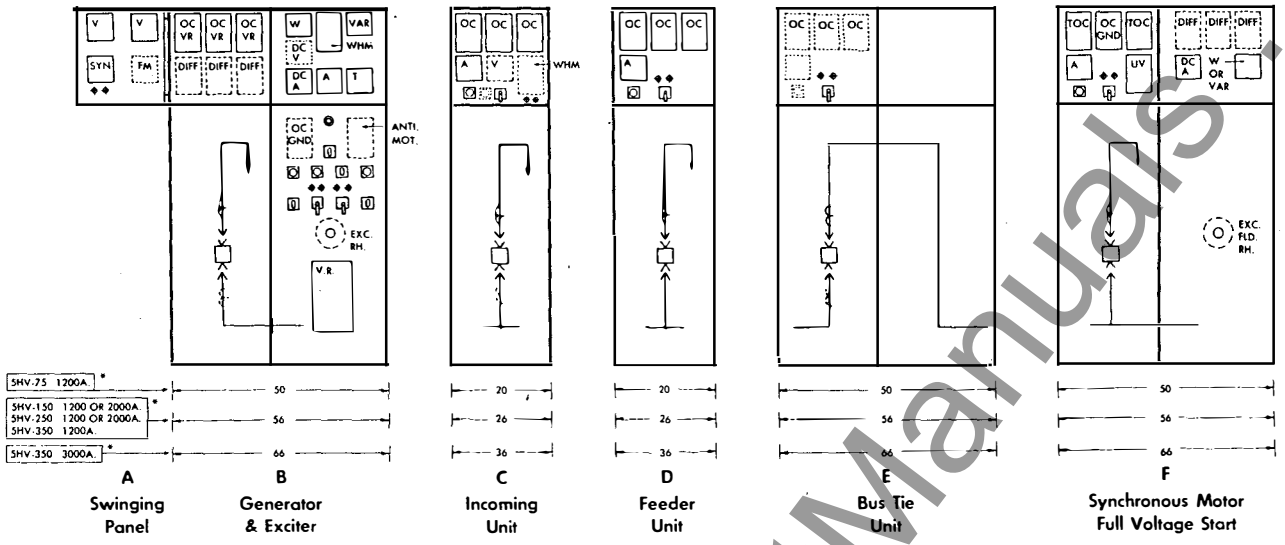
1 3-phase starting reactor,.....duty
1 Set of necessary primary connections to shorting breaker

Unit K Auxiliary Compartment

Auxiliary units will be furnished as required to house the following equipment:

- Drawout potential transformers
- Drawout control power transformer and current limiting fuses—5 kva
- Stationary mounted control power transformer with drawout current limiting fuses
- Tripping battery and charger
- Bus entrance
- Lightning arresters
- Surge capacitors
- Annunciators
- Relays
- Meters
- Instruments
- Utility company revenue metering

PANEL LAYOUTS AND DIMENSIONS FOR STANDARDIZED UNITS

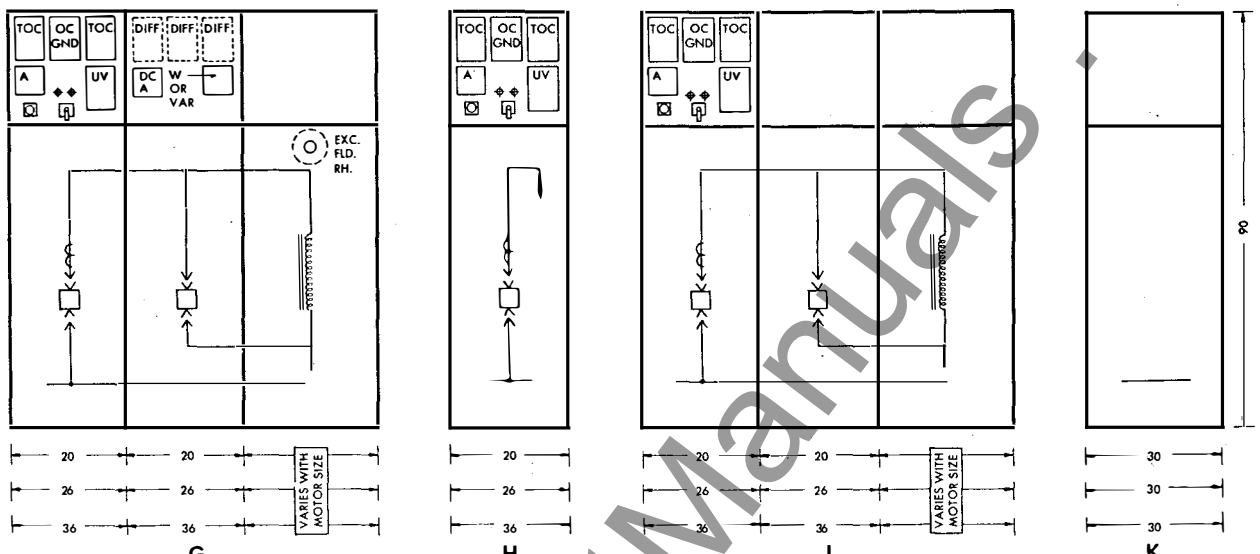


STANDARD 4160 VOLT AIR CIRCUIT BREAKERS				
TYPE	CURRENT RATING	I.C. AT 4160 V.		MOMENTARY CURRENT RATING
		MVA	CURRENT	
5HV-75	1200A	75	10,500A	20,000A
5HV-150	1200A	150	21,000A	40,000A
5HV-150	2000A	150	21,000A	40,000A
5HV-250	1200A	250	35,000A	60,000A
5HV-250	2000A	250	35,000A	60,000A
5HV-350	1200A	350	48,600A	80,000A
5HV-350	3000A	350	48,600A	80,000A
B.I.L. IS 60KV ONE MINUTE 60 CYCLE POTENTIAL TEST IS 19KV				

STANDARD CONTROL VOLTAGES	
CLOSING	TRIPPING
—	24 V d-c
—	48 V d-c
125 V d-c	125 V d-c
250 V d-c	250 V d-c
240 V a-c	CAPACITOR

*Panel layouts are shown for 5HV-150 & 5HV-250 units.
5HV-75 units contain the same panel equipment in a different arrangement.
5HV-350—3000A. units have a 90" high instrument panel. See Fig. 3.

PANEL LAYOUTS AND DIMENSIONS FOR STANDARDIZED UNITS



G Synchronous Motor Reactor Start
Line-Series Type

H Induction Motor Full Voltage Start

J Induction Motor Reactor Start
Line-Series Type

K Auxiliary Unit

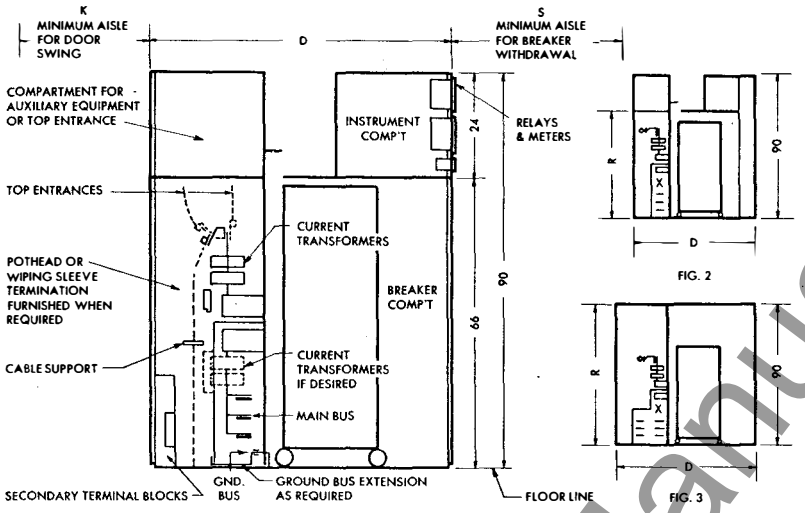
STANDARD INSTRUMENT TRANSFORMERS			
POTENTIAL	CURRENT		
2400 120	75-5	400-5	2000-5
4200-120	100-5	600-5	3000-5
	150-5	800-5	4000-5
	200-5	1200-5	
	300-5	1500-5	

STANDARD SINGLE PHASE CONTROL POWER TRANSFORMERS	
KVA	
5	2400—120/240
5	4160—120/240
10	2400—120/240
10	4160—120/240
15	2400—120/240
15	4160—120/240

SYMBOLS

A	AMMETER (A.C. IF NOT MARKED)
V	VOLTMETER (A.C. IF NOT MARKED)
W	WATTMETER
VAR	VARMETER
WHM	WATTHOUR METER
T	TEMPERATURE METER
FM	FREQUENCY METER
SYN	SYNCHROSCOPE
VR	VOLTAGE REGULATOR
OC	OVERCURRENT RELAY
OC-GND	GROUND (RESIDUAL) O-C RELAY
TOC	THERMAL OVERLOAD RELAY
OC-VR	O-C RELAY W/VOLT. RESTRAINT
UV	UNDERVOLTAGE RELAY
DIFF.	PERCENTAGE DIFFERENTIAL RELAY
ANTI.-MOT.	ANTI-MOTORING (POWER DIR.) RELAY

INDOOR SWITCHGEAR

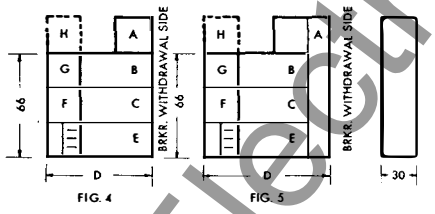


Dimensions—Indoor Circuit Breaker Enclosures

FIG. 1

BREAKER TYPE	MAIN BUS	FIG. NO.	D	R	WIDTH	S	K†
5HV-75	1200A	1	68	—	20	54	24
5HV-75	1200A	2*	78	66	20	54	24
5HV-150 & 5HV-250	1200 OR 2000A	1	68	—	26	54	30
5HV-150 & 5HV-250	1200 OR 2000A	2*	78	66	26	54	30
5HV-150 & 5HV-250	3000A	1	78	—	26	54	30
5HV-150 & 5HV-250Δ	3000A	2	88Δ	66	26	54	30
5HV-350 (1200A.)	2000 OR 3000A	3	88	90	26	54	30
5HV-350 (3000A.)	3000A	3	88	90	36	60	40

*Alternate arrangement for increased panel space.
ΔUse when line-up includes 5HV-350, 3000A. units.
xIndicates Bus location only.
†If switchgear line-up includes auxiliary compartments this dimension must be increased to a minimum of 34 in.



Location Chart for Indoor Auxiliary Units

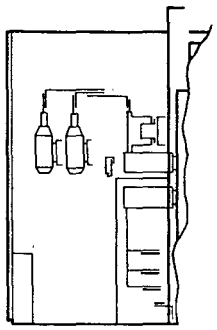
MAIN BUS	FIG.	D (in.)
1200 OR 2000A.	4	68
1200 OR 2000A.	5	78
3000A.	4	78
3000A.	5	88Δ

ΔUsed when switchgear line up includes 5HV-350, 3000A. units.

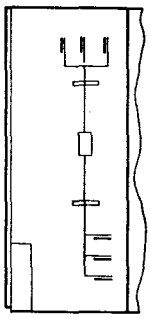
PREFERRED EQUIPMENT LOCATION	
Equipment	**Order of Preference**
*1, 2 OR 3 PT'S, OR 5KVA CPT & FUSES	C-B-E-G-F-H
BUS TRANSITION	F AND G (BOTH) SEE FIG. 7
*RELAYS & INSTRUMENTS	A-B-C-E
DRAWOUT FUSES (FOR CPT) 10KVA & UP	B
MECH. INTERLOCK ET BRKR. & STATIONARY CPT (10, 15 OR 25KVA) 1Ø	C & E (BOTH)
BATTERY CHARGER	B
TRIPPING BATTERY (48V)	C & E (BOTH)
INCOMING LINE FROM ABOVE	F & G (BOTH)
INCOMING LINE FROM BELOW	F & G IF CT'S USED (NEITHER IF NO CT'S.)
LIGHTNING ARRESTERS (STATION TYPE)	C & E (BOTH)

*Either instruments and relays or drawout units in B, C or E but not both.

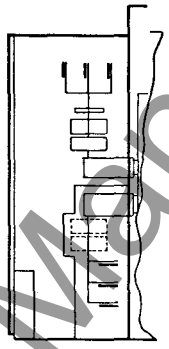
INDOOR SWITCHGEAR



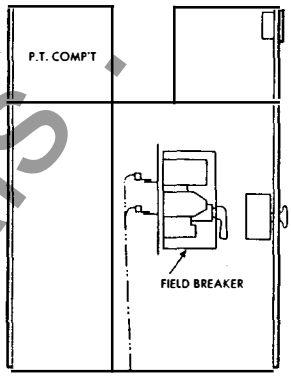
Unit with Double Potheads
(Increase Depth by 10 in.)
FIG. 6



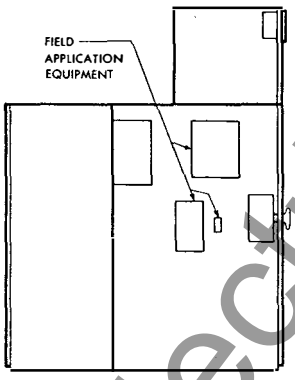
Auxiliary Unit
Bus Transition
FIG. 7



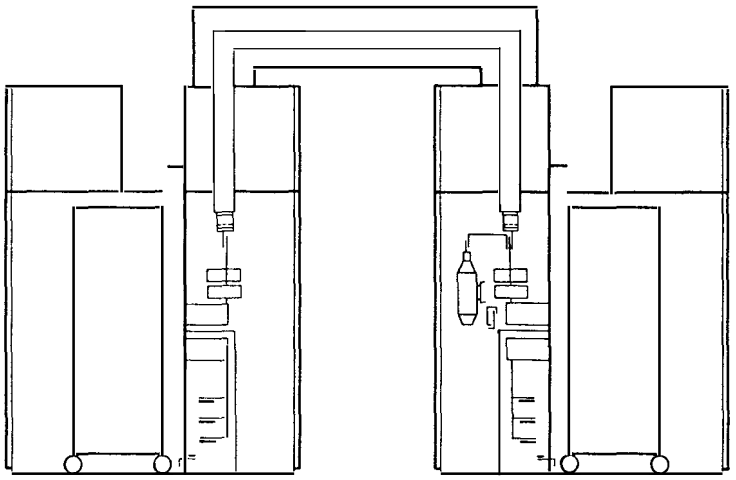
Breaker Unit
Bus Tie
FIG. 8



Auxiliary Unit
Generator Control
FIG. 9

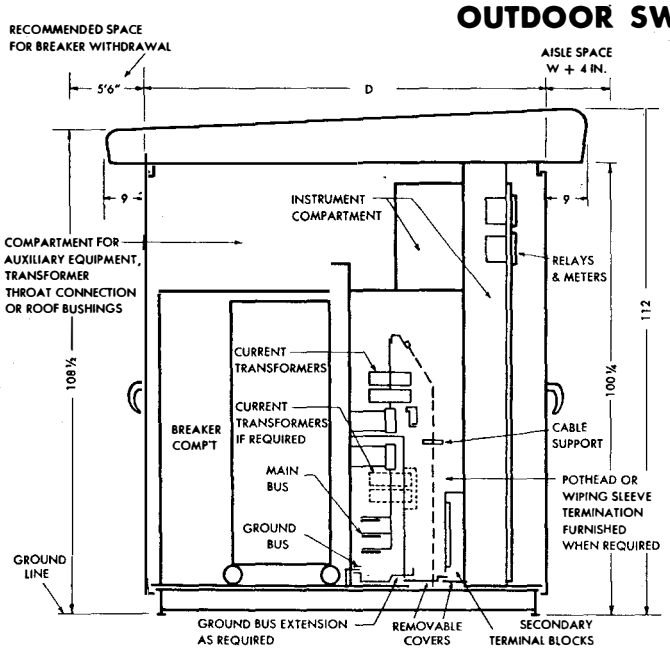


Auxiliary Unit
Full Voltage Start
Synchronous Motor Control
FIG. 10



Double Bus—Double Breaker
FIG. 11

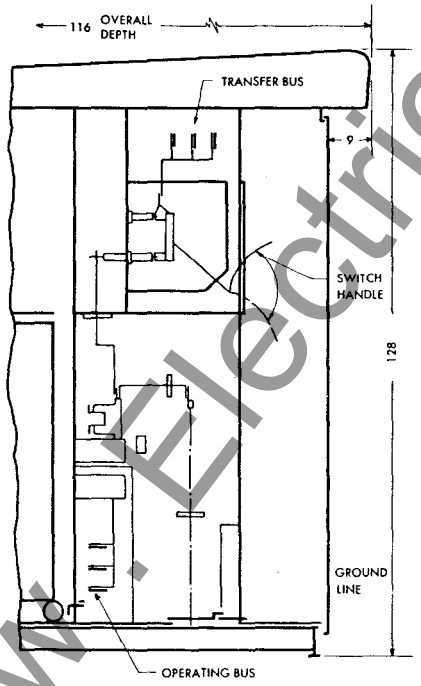
OUTDOOR SWITCHGEAR



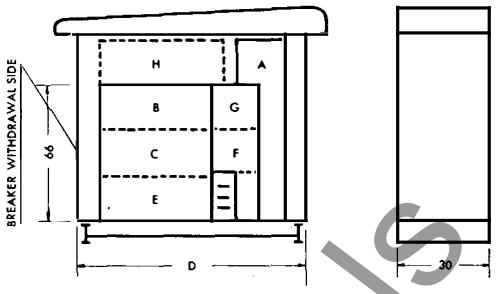
Dimensions—Outdoor Circuit Breaker Enclosures
FIG. 12

BREAKER TYPE	MAIN BUS	D	W WIDTH
5HV-75	1200A	88†	20
5HV-150 & 250	1200 or 2000	88†	26
5HV-150 & 250	3000A	98	26
5HV-350 (1200A)	2000 or 3000	98	26
5HV-350 (3000A)	3000A	98	36

†For units with double potheads increase this dimension by 10 inches.



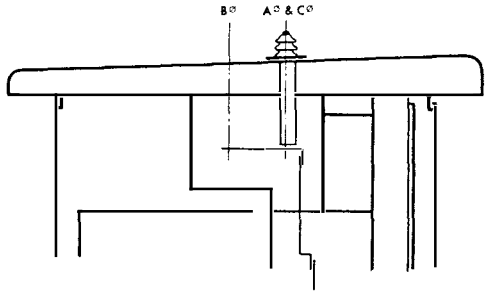
Unit with Transfer Bus & Disconnect Switch
FIG. 14



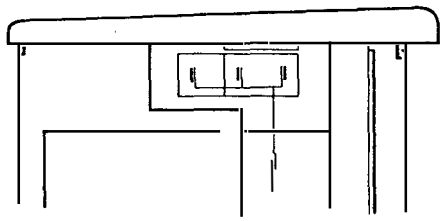
Location Chart for Outdoor Auxiliary Units
FIG. 13

MAIN BUS	D
1200 or 2000A	88
3000A	98

PREFERRED EQUIPMENT LOCATIONS	
Equipment	**Order of Preference**
1, 2 OR 3 PT'S, OR 5KVA CPT & FUSES	C-B-E-H
BUS TRANSITION	F & G (BOTH)
RELAYS & INSTRUMENTS	A
DRAWOUT FUSES (FOR CPT) 10KVA & UP	B
MECH. INTERLOCKED ET BRKR. & STATIONARY CPT (10, 15 OR 25KVA) 1Ø	C & E (BOTH)
BATTERY CHARGER	B
TRIPPING BATTERY (48V)	C & E (BOTH)
INCOMING LINE FROM BELOW	F & G (BOTH)
INCOMING LINE FROM ABOVE	F & G IF CT'S ARE USED (NEITHER IF NO CT'S)

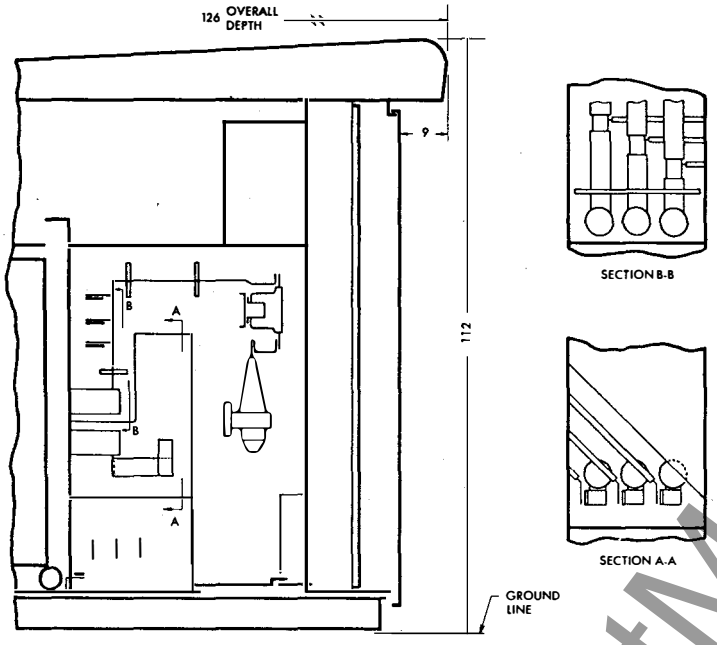


Unit with Roof Bushings
FIG. 15

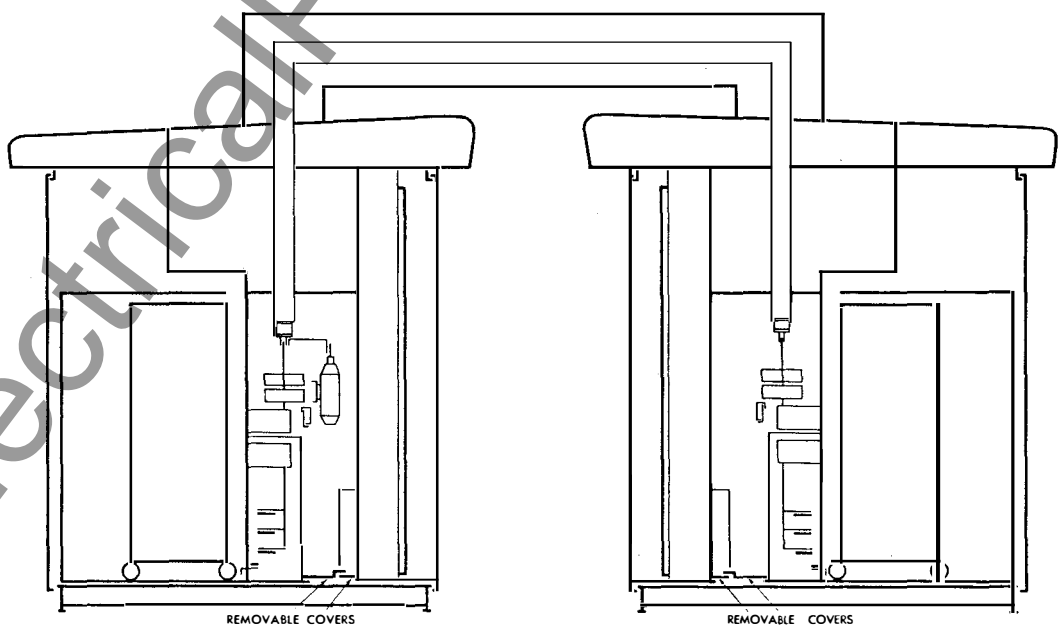


Unit with Provisions for Transformer Throat Connection (Right or Left Side of Unit)
FIG. 16

OUTDOOR SWITCHGEAR

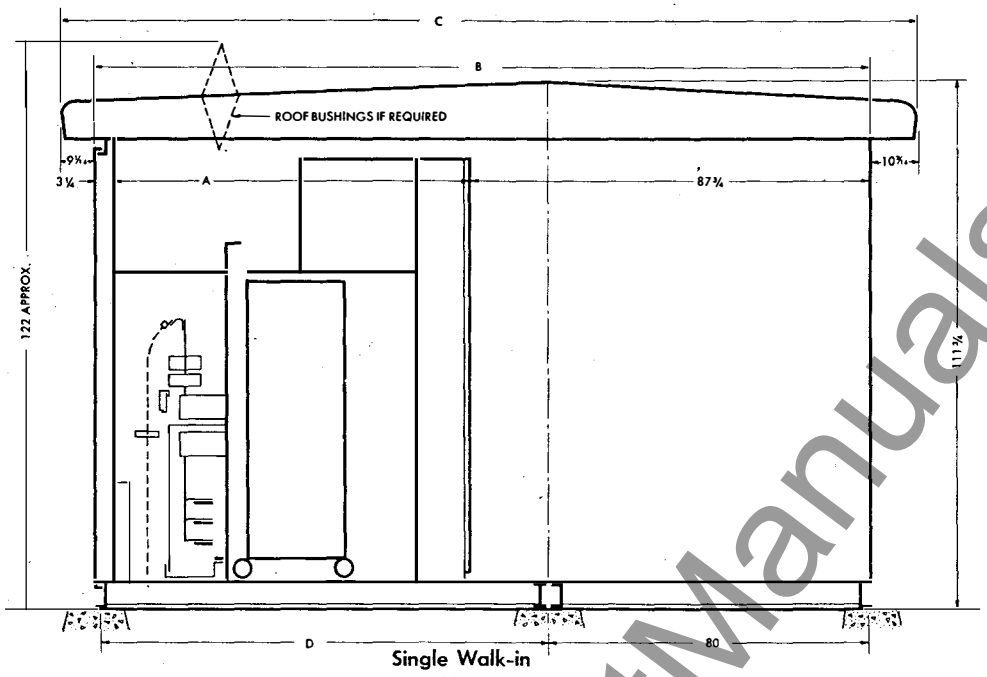


Ring Bus Unit
FIG. 17



Double Bus—Double Breaker
FIG. 18

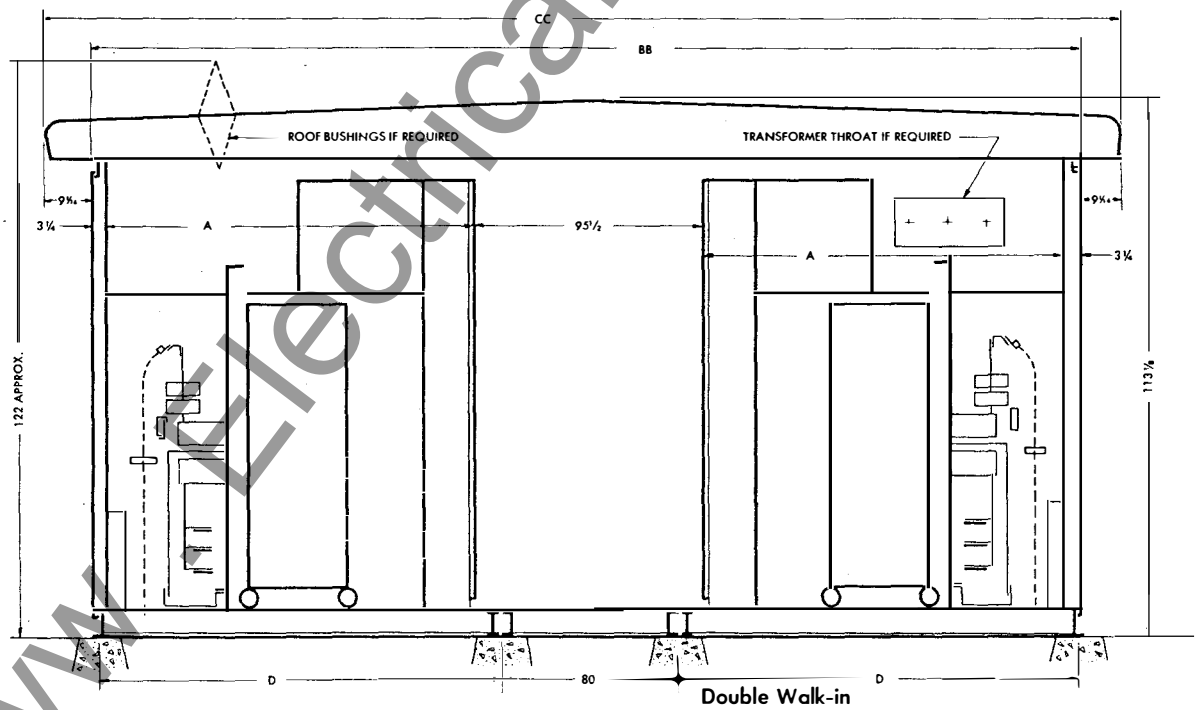
WALK-IN OUTDOOR CONSTRUCTION



Single Walk-in

FIG. 19

UNIT		W	POTHEAD WHEN REQ'D	A	B	C	D	BB	CC
BRKR. TYPE	MAIN BUS								
5HV-75	1200A	20	(1) 3/c OR (3) 1/c	77	168	187½	86⅝	256	274⅛
5HV-150 & 5HV-250	1200 OR 2000A	26	(1) 3/c OR (3) 1/c	77	168	187½	86⅝	256	274⅛
5HV-75	1200A	20	(2) 3/c OR (6) 1/c	87	178	197½	96⅝	276	294⅛
5HV-150 & 5HV-250	1200 OR 2000A	26	(2) 3/c OR (6) 1/c	87	178	197½	96⅝	276	294⅛
5HV-150 & 5HV-250	3000A	26	(2) 3/c OR (6) 1/c	87	178	197½	96⅝	276	294⅛
5HV-350	2000 OR 3000A	26	(1) 3/c OR (3) 1/c (2) 3/c OR (6) 1/c	87	178	197½	96⅝	276	294⅛
5HV-350	3000A	36	(2) 3/c OR (6) 1/c	87	178	197½	96⅝	276	294⅛



Double Walk-in

FIG. 20