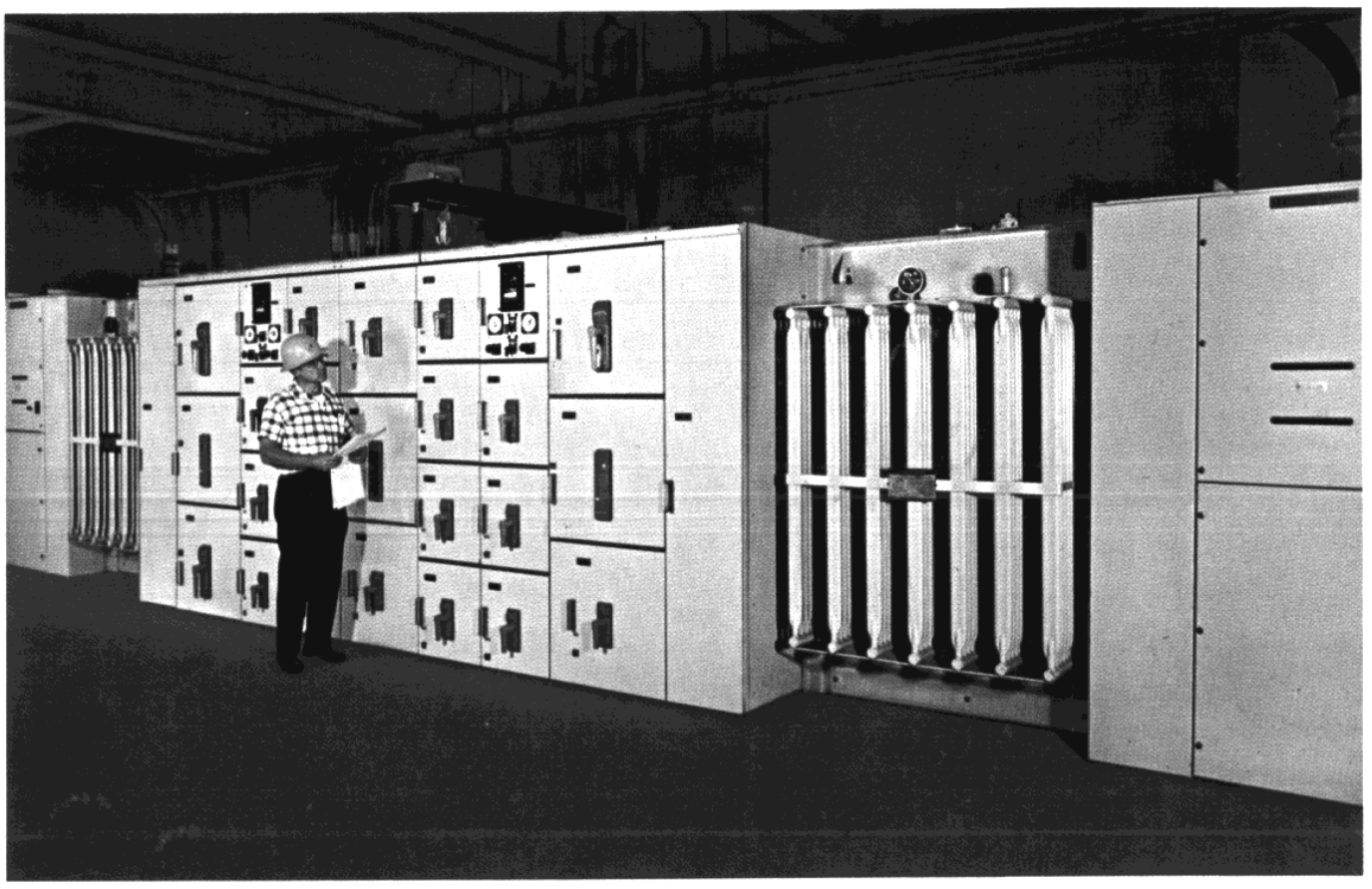
GEA-3592R

Load Center
Unit Substation Featuring

Powermaster AKD-5 Low Voltage Switchgear



GENERAL ELECTRIC

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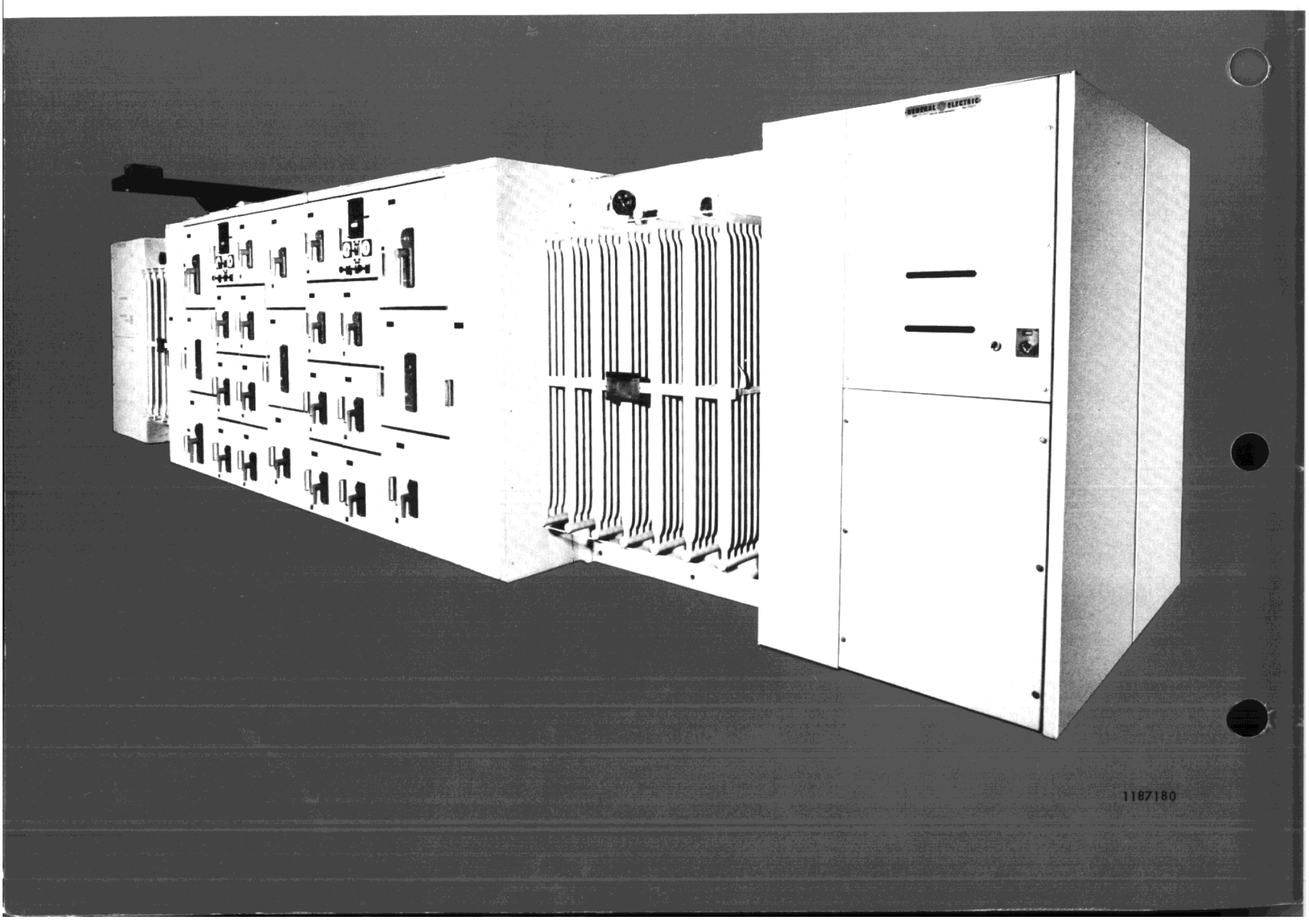


Profit and growth in your business is based upon dependable electric power

Electric power is a basic raw material of modern industrial production. When power stops, production and profits stop.

Only modern distribution equipment assures you of continuous, uninterrupted electric power. It lessens chances that short circuits will occur, and minimizes the effects of abnormal conditions.

As industry and commerce modernize and automate to handle growing loads, offset rising labor and material costs, and meet future manpower shortages, continuous, uninterrupted power becomes even more important. An outage in any part of a mechanized or automated production line is more likely to stop complete production. The median cost of shutdowns, according to 329 industrial plants surveyed several years ago was $88 per minute. This figure is no doubt higher today.

For continuous production, profit and growth in your business, you can't afford to be without dependable power distribution.

General Electric's Powermaster AKD-5 load center unit substation —key to dependable power distribution

Load center unit substations are the surest way to dependable power distribution in industrial plants and commercial buildings, and for power station auxiliaries and other applications requiring continuity of service.

A load center unit substation consists of an incoming line section, transformer, and low voltage section with metal-enclosed drawout power circuit breakers.

The function of the equipment is to transform power from the 2300- to 15,000-volt range down to 600 volts or less, and to provide protection and control for low voltage feeder circuits.

General Electric offers a complete line of load center unit substations, for indoor or outdoor installations. Standard designs free you from unnecessary purchasing and engineering details. Factory-assembly reduces installation time and cost. Mechanical and electrical coordination results in greater reliability. Workmanship and materials are protected by one over-all warranty. Expert field engineering is available to further assure proper application, installation and operation.

Compact design means G-E load center unit substations can be installed near the load area without using valuable production space.

Clean lines and colorful blue accent panels on a sand gray background provide a pleasing appearance.

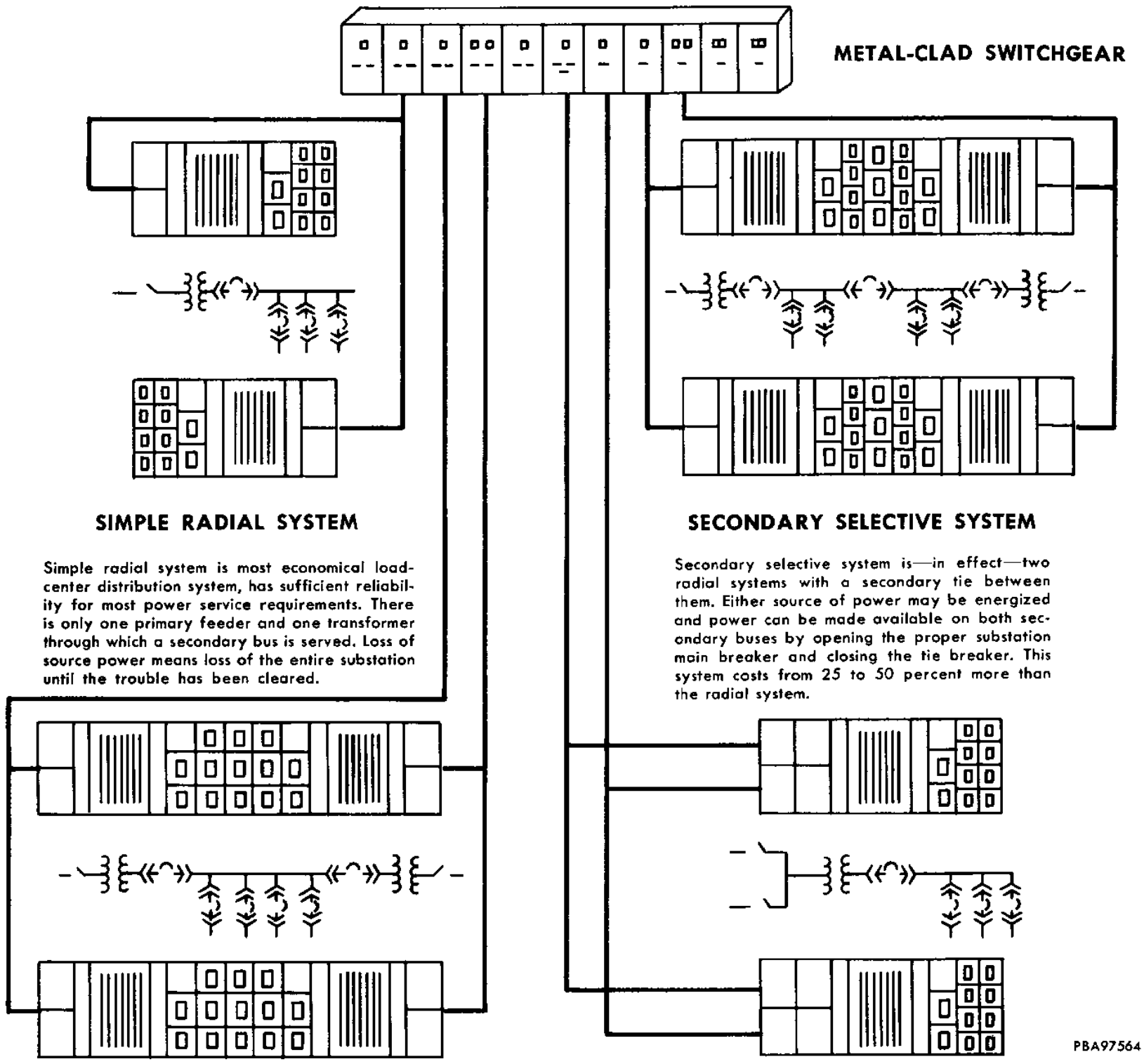
Compartmentation of major components in the low voltage section confines faults if they should occur and provides greater safety for operating personnel. Stored-energy breakers assure high-speed closing of breaker contacts independent of operating force, preventing unnecessary arcing and wear.

Your investment in G-E load center unit substations is an investment in dependable electrical power distribution for growth and profit today and tomorrow.

Service reliability results from co-ordinated substations used with basic circuits

Four basic circuits for power distribution have evolved from the many possible types and variations of substations and circuit arrangements.

The load center philosophy of power distribution—that is, the use of substations located in or near the load area—is basic to all of these arrangements providing good design at minimum cost. Power is supplied to the load center unit substations at the primary voltage level, stepped down to utilization voltage, and distributed to utilization devices on relatively short, low-voltage feeders. Selective co-ordination of protective devices is recommended where processes require continuous power. G-E load centers can be provided for any of these arrangements. Combinations of the various systems may be utilized.



SIMPLE RADIAL SYSTEM

Simple radial system is most economical load-center distribution system, has sufficient reliability for most power service requirements. There is only one primary feeder and one transformer through which a secondary bus is served. Loss of source power means loss of the entire substation until the trouble has been cleared.

SECONDARY SELECTIVE SYSTEM

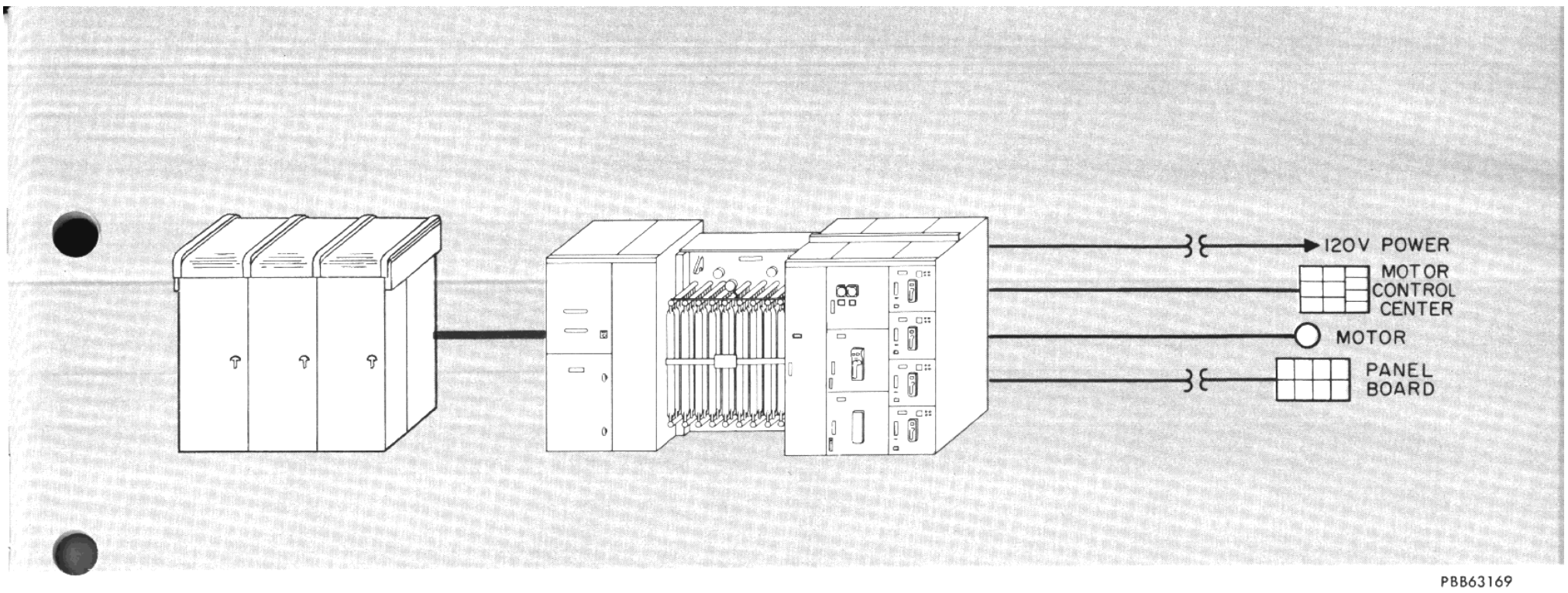
Secondary selective system is—in effect—two radial systems with a secondary tie between them. Either source of power may be energized and power can be made available on both secondary buses by opening the proper substation main breaker and closing the tie breaker. This system costs from 25 to 50 percent more than the radial system.

SPOT NETWORK SYSTEM

Spot network system parallels the transformer secondaries to provide continuous service for an outage of one primary circuit. Failure of transformer or primary feeder results in automatic removal of the faulty equipment., This system costs from 20 to 50 percent more than the radial system.

PRIMARY SELECTIVE SYSTEM

Primary selective system provides an alternate supply to the primary of each transformer. If a primary fault occurs, the associated primary breaker opens and interrupts service to half of the load area. The de-energized transformers . . . out of service . . . are manually switched to the other feeder. Cost is 15 to 40 percent more than radial systems.



PBB63169

Co-ordinated system provides best possible combination of continuous power, continuous protection

The highest degree of service reliability can be secured by the careful selection of main and feeder circuit breaker time-current characteristics with proper relation to one another. This is what is meant by circuit breaker co-ordination.

Electrical distribution systems—no matter how carefully constructed and thoroughly insulated—can have faults. With proper co-ordination, it is possible to protect the system from unnecessary downtime caused by faults. This is achieved by matching the characteristics of protective devices from the power source to utilization in order to achieve the highest degree of service reliability. This co-ordination is provided in addition to proper mechanical design of the equipment, insulation levels, thermal capacity and short-circuit bracing. Co-ordinated, the system provides the most desirable combination of continuous power and continuous protection.

General Electric load-center unit substations fit every application

STANDARD PRIMARY VOLTAGE RATINGS (Delta connected primary voltage ratings)

2400
4160
4800
6900
7200
12000
13200
13800

STANDARD KVA RATINGS AVAILABLE at all listed primary voltages shown at left

SECONDARY VOLTAGES			
208Y/120	240△	480Y/277	480△
112.5	112.5	112.5	112.5
150	150	150	150
225	225	225	225
300	300	300	300
500	500	500	500
750	750	750	750
1000	1000	1000	1000
		1500	1500
		2000	2000
		2500	2500

INCREASE IN TRANSFORMER CAPACITY PROVIDED BY COOLING FANS

Self-cooled KVA 3 ϕ	Percentage Increase in Capacity	
	Liquid Filled	Open Dry Type
750–2000	15%	33⅓%
2500	25%	33⅓%

NOTE: *500 KVA and below not normally furnished with provisions for fan cooling, since only a minor increase in KVA capacity can be achieved. Economics would generally dictate selection of next higher KVA size transformer.*

General Electric load center unit substations consist of several standard components factory-engineered and co-ordinated for integral connection in the field to form a complete unit. While load center unit substations are handled as a single packaged unit, it simplifies matters from the application engineering standpoint to consider the substation as made up of three sections:

(1) INCOMING HIGH VOLTAGE SECTION

(2) TRANSFORMING SECTION

(3) OUTGOING LOW VOLTAGE SWITCHGEAR SECTION

Each section will now be considered separately although all the sections are engineered and designed to function properly as one unit.

Variety of incoming-line sections available; one of them is sure to meet your requirements

The incoming-line section connects the substation with the incoming power supply. Where it will not be necessary to isolate the substation, a terminal compartment should be used to connect directly to the incoming high voltage line. If there are other substations on the incoming line, or if additional primary feeder load is to be added at a later date, the ability to isolate the substation is desirable and one of the following interrupter switches may be used: air switch, oil cutout, or liquid-filled switch.

General Electric LVP air-interrupter switches are designed for flexibility, economy, reliability

The most commonly used incoming-line section is the primary air-interrupter switch. Load center unit substations equipped with these switches are generally fed from metal-clad switchgear, which protects and switches the primary feeder circuit supplying the substation. This arrangement is the most economical and provides the greatest flexibility and reliability.

One basic type of air interrupter switch is available. The basic type of air interrupter switch covers the entire line. The LVP-100S features the inherent advantages of a stored energy mechanism (LVP-100) providing a positive controlled closing and opening stroke independent of the operator.

General Electric Type LVP-100 air-interrupter switches can be applied to load centers of all sizes, ratings and types ranging from 112.5 KVA through 3000 KVA at voltage ratings 2400 volts through 13,800 volts.

Each switch will receive incoming-line cables for either top or bottom entrance, and may be connected for either single or looping feed. Cables may be terminated with clamp-type terminals or potheads.

A window permits visual inspection of the interrupter switch to assure the operator of proper switch position.

Switch contacts are readily accessible for testing or phasing-out the transformer or line circuits.

The insulation medium of air eliminates leakage problems.

Current-limiting fuses may be included in the compartment under the interrupter switch. The properly selected combination fused switch provides interrupting capacity sufficient to clear the fault at the terminals. The fuse rating is selected to protect the transformer in case of a short circuit at the low voltage terminals.

Lightning arresters may be supplied within the switch compartment for added protection against surge voltages.

Key interlocking with low voltage power circuit breakers can be provided.

RATINGS—TYPE-LVP AIR-INTERRUPTER SWITCHES

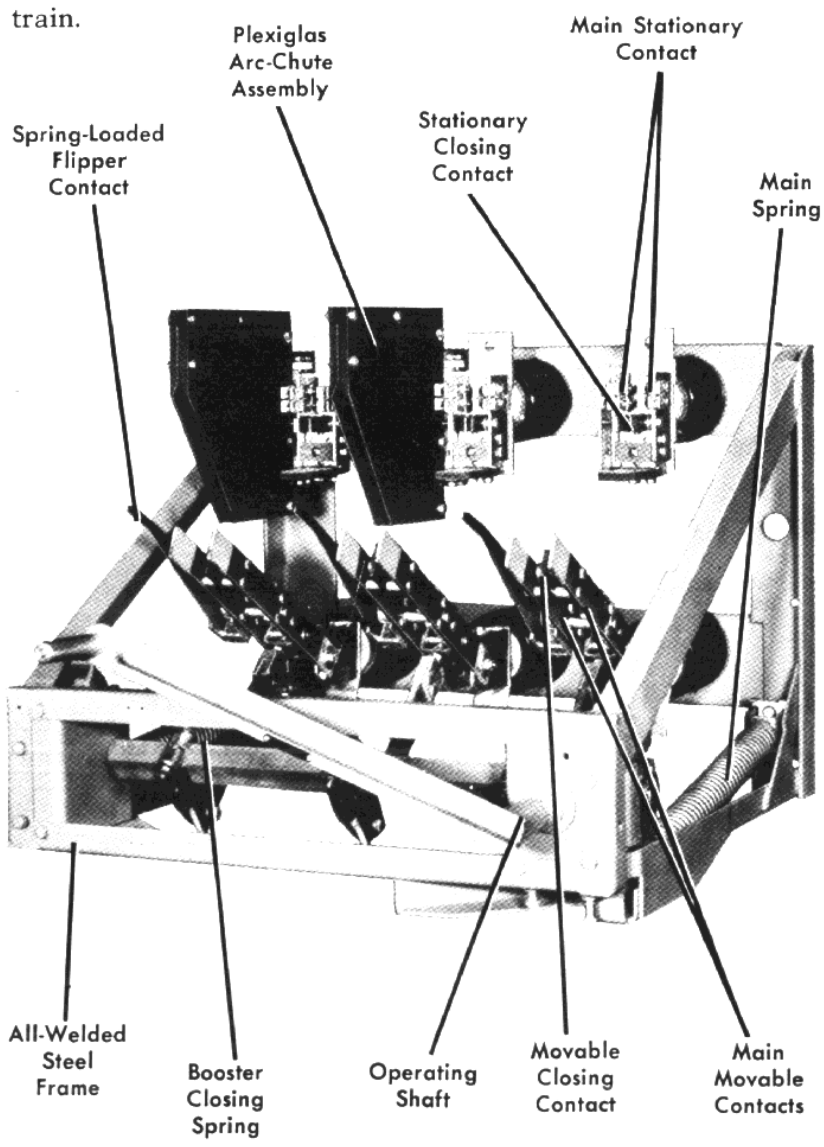
Voltage Class	LVP-100S, E	
	5 kv	15 kv
Maximum design voltage rating	5500 v	15,500 v
Basic impulse level	60 kv	95 kv
60-cycle test voltage (one minute withstand, dry)	19 kv	36 kv
Momentary (unfused) RMS asymmetrical	*40,000 amp	*40,000 amp
Momentary (fused) RMS asymmetrical	60,000 amp	50,000 amp
Fault close rating, RMS asymmetrical	*40,000 amp	*40,000 amp
Interrupting rating	600 amp	600 amp
Continuous current rating	*600 amp	*600 amp

* *LVP-100S and LVP-100M also available in 1200 ampere frame with 60,000 ampere momentary. 60,000 ampere fault close rating available for LVP-100S only.*

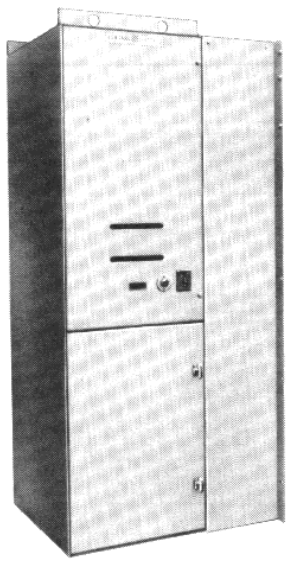
The type LVP-100 switch unit can be furnished electrically operated (LVP-100E) as well as manually operated. For the electrically operated switch a low-current motor with gear train is installed inside the front of the switch mechanism frame to drive the operating mechanism in lieu of the manual handle. Additional cubicles or protruding parts are not required.

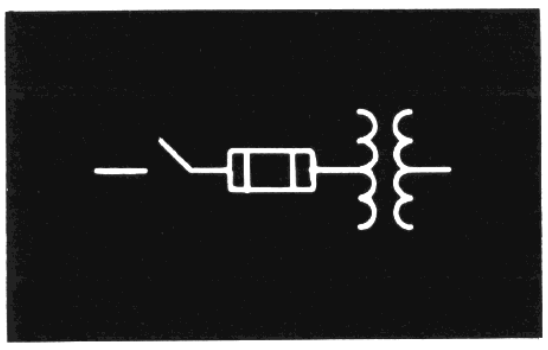
A choice of four motor operating voltages is available: 120 vac/125 vdc or 230 vac/250 vdc. A 14-contact auxiliary switch for control, signal and interlocking use is also furnished. An SBM switch will be included if required.

The electrically operated switch is available in the same ratings as the manually operated unit. It can also be operated with the manual handle by disengaging the motor and gear train.



Type SE100S stored energy operated air-interrupter switch rated 4.8KV, 600 amperes.

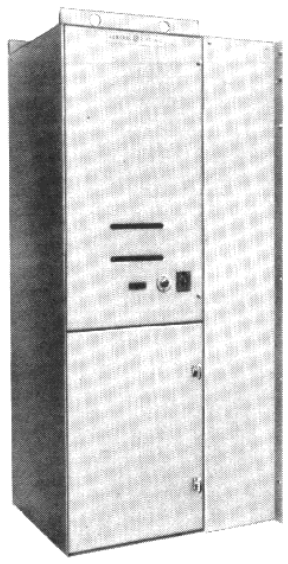


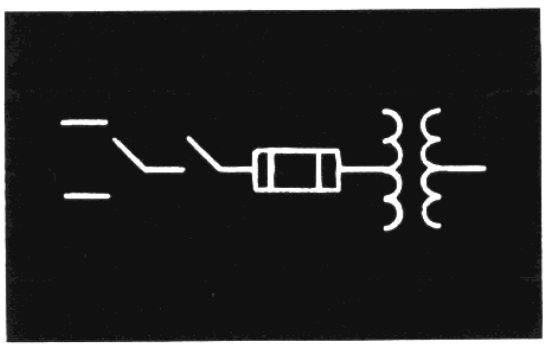


LVP-100
TWO-POSITION
AIR-INTERRUPTER SWITCH

The Type LVP air-interrupter switches are three-pole, two-position (open-closed) switches with all three poles operated simultaneously by a removable handle on the front of the switch compartment. The LVP switch provides a visible air break in the primary circuit when the substation is disconnected.

Two windows are provided on the front so that a flashlight can be used to illuminate the switch without a reflected glare in the operator's eyes as he views the position of the switch. A mechanical position indicator is also included. The LVP-100 switch meets NEMA Standard SG-6 for power switching equipment.

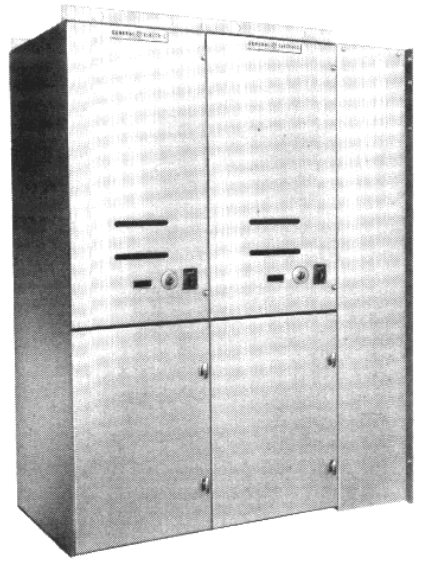




LVPS-100
AIR-INTERRUPTER
SELECTOR SWITCH

Where there are two separate incoming lines, the three-position (Line 1/Open/Line 2) Type LVPS air-interrupter selector switch provides maximum service continuity by allowing the operator to switch from one incoming line to the other in case of failure of the primary feed, or to OPEN for planned maintenance.

The switch consists of a two-position (open-closed) air-interrupter switch in series with a two-position (Line 1/Line 2) selector switch. The selector switch is a dead-break device mechanically interlocked so it cannot be operated unless the interrupter switch is OPEN. Both switches have front accessible operating shafts.



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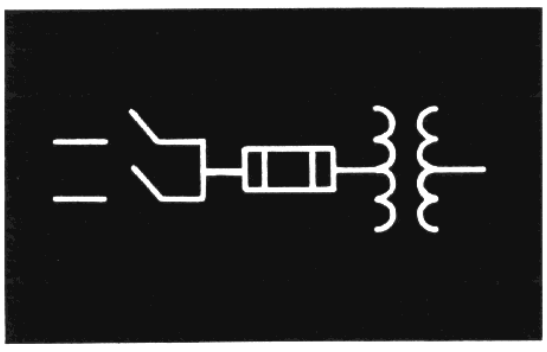
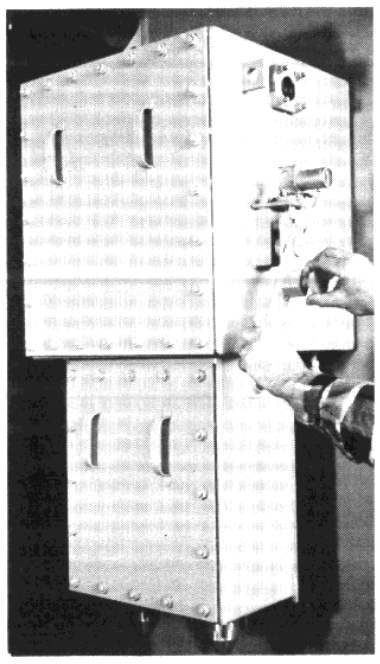


LVPD-100
DOUBLE BREAK
AIR-INTERRUPTER SWITCH

As an alternate to the LVPS, where there are two separate incoming lines, the three-position (Line 1/Open/Line 2) Type LVPD double interrupting switch provides maximum service continuity by allowing the operator to switch from one incoming line to the other in case of failure of a primary feeder, or to OPEN for planned maintenance.

The switch consists of two two-position (open-closed) air-interrupter switches connected in parallel on the load side, key-interlocked so both incoming line switches cannot be closed at the same time. The LVPD double break interrupter switch has the advantage of isolating two lines permitting maintenance of one while the other is energized and reducing the probability of transfer of a fault on one cable to the other.



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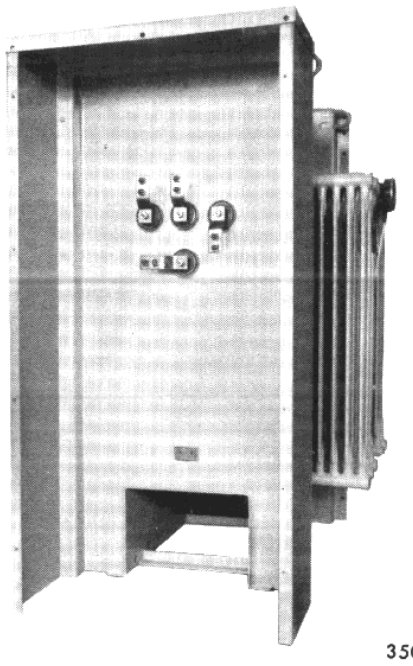

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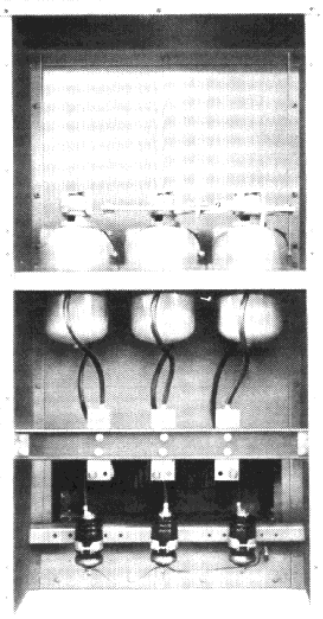

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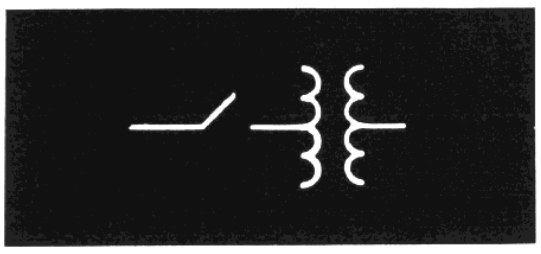


LIQUID-FILLED INTERRUPTER SWITCH

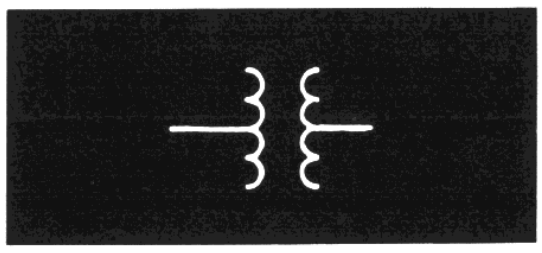
Type RM liquid-filled interrupter switch is available on either oil- or Pyranol* filled transformers and is filled with the same type insulating liquid as the transformer. The switch is a three-pole device and is available for two-position operation (open-closed) or three-position operation (Line 1/Open/Line 2, or Open/Closed/Cable ground).

The oil-filled switch is suitable for interrupting 400 amps at 5000 volts, 200 amps at 15,000 volts. When Pyranol filled, the switch is suitable for interrupting the magnetizing current of the transformer only, and is key-interlocked with the low voltage breaker or switch to prevent operation at load currents. Oil-filled switches can be key-interlocked or key-locked to prevent operation by unauthorized personnel.

Fuses cannot be used with the liquid-filled switch.

Cable entrance may be accomplished from above or below. A compound-filled terminal chamber (shown beneath the switch mechanism in the photo above) is an integral part of the switch construction. A double-size terminal chamber is available for looping feed.

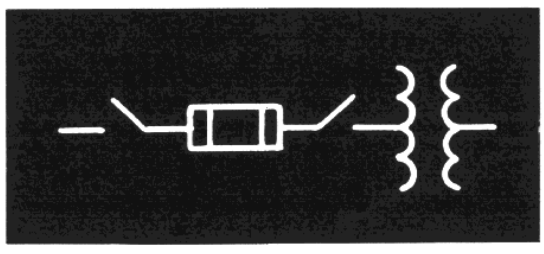
* Registered trademark of General Electric Co.



AIR-FILLED TERMINAL CHAMBER

An air-filled terminal chamber can be furnished where a substation will be protected by an individual metal-clad circuit breaker. However, if a second substation is to be added to the primary feeder at a later date, consideration should be given to equipping the first substation, initially, with an interrupter switch.

The end panel has been removed from the air-filled terminal chamber above to show the bushing arrangement. The compartment can be supplied with clamp-type terminals or potheads. The compartment is suitable for single or looping feed.



OIL CUTOUTS (FUSIBLE)

Oil cutouts may be used with either liquid-filled or dry-type transformers. The three-pole, two-position (open-closed) cutouts are gang operated by a handle accessible through a hinged door on the end of the compartment. All cables, contacts, and other live parts are completely metal enclosed. Contacts operate under oil, eliminating external arc flame during circuit interruption.

Recommendations on lightning protection for incoming lines

Protection of the incoming-line section and transformer against lightning surges is recommended for incoming-line sections connected to exposed circuits. A circuit is considered exposed if it is connected to any kind of open line, including aerial cable, either directly or through a cable, reactor, or regulator. A circuit connected to open-line wires through a power transformer or a metal sheathed cable is not considered exposed if adequate protection is provided on the line side of the transformer or at the junction of the cable and open-line wires. Circuits confined entirely to the interior of a building, such as an industrial plant, are not considered exposed and ordinarily require no lightning protection. However, lightning arresters may be required for an incoming-line section at altitudes above 3300 feet, even though the unit is not connected to an exposed circuit.

Distribution type lightning arresters are generally used but intermediate-type or station-type lightning arresters can be supplied.

Self-contained, current limiting fuses combined with Type LVP air interrupters provide maximum equipment protection

APPLICATION TABLES

AIR INTERRUPTER SWITCHES

FUSED SWITCHES

Using Type EJ Current Limiting Fuses

Nominal System Voltage	Fuse Interrupting Rating		Maximum KVA Ratings of Transformers Which Can Be Fused LVP-100 *
	Asym-metrical Amperes RMS	Equivalent 3-phase MVA	
2,400	60,000	155	1,500
4,160	60,000	270	2,500
4,800	60,000	310	2,500
6,900	80,000	600	1,500
7,200	80,000	620	1,500
12,000	40,000	520	2,500
13,200	40,000	572	2,500
13,800	40,000	600	2,500
12,000	50,000	650	2,500
13,200	50,000	715	2,500
13,800	50,000	750	2,500

* *KVA ratings of transformers based on 50% margin between transformer self-cooled full load primary current and fuse continuous current rating to provide for overloads, fan cooling, and maximum feeder breaker ratings for co-ordination.*

UNFUSED SWITCHES

Maximum Transformer KVA Ratings with which LVP Switches can be used

Nominal System Voltage	LVP-100S, E		
	All Self-cooled 100%	Fan-cooled	
		Liquid Filled 115% *	Open Dry 133%
2400 thru 13,000	3000	3000	3000

* *125% for 2500 and 3000 kva ratings.*

OIL-FILLED CUTOUTS

FUSED SWITCHES

Maximum Transformer KVA Ratings with Fused Oil-filled Cutouts*

Nominal System Voltage	Load Break Operation		
	All Self-cooled 100%	Fan-cooledϕ	
		Liquid Filled 115%	Dry Type 133%
2400	500	—	—
4160	750	750	ϕ
4800	1000	750	750
6900	2000	1500	1500
7200	2000	1500	1500
12,000	3000	3000	2500
13,200	3000	3000	2500
13,800	3000	3000	3000

UNFUSED SWITCHES

Maximum Transformer KVA Ratings with Unfused Oil-filled Cutouts*

Nominal System Voltage	#Load Break Operation		
	All Self-cooled 100%	Fan-cooled	
		Liquid Filled 115%	Dry Type 133%
2400	750	750	—
4160	750	750	—
4800	1000	750	750
6900	2000	1500	1500
7200	2000	1500	1500
12,000	3000	3000	2500
13,200	3000	3000	2500
13,800	3000	3000	3000

ϕ *Fans not available on 500 KVA and below on liquid-filled or dry type nor on any rating sealed dry type.*

* *The maximum transformer ratings in the tables are based on a 20% margin between the self-cooled or fan-cooled transformer primary current and the cutout or fuse rating. Note that 20% margin may not give desired co-ordination with feeder breaker for maximum transformer sizes listed.*

\# *Unfused cutouts are NOT recommended for ordinary load switching since short circuit protection is not provided. Kirk key interlocking with secondary switchgear (supplied upon request) is recommended where switching is done with cutouts equipped with blades. The cutouts then can be applied up to the full continuous rating of the blade.*

LIQUID-FILLED SWITCHES

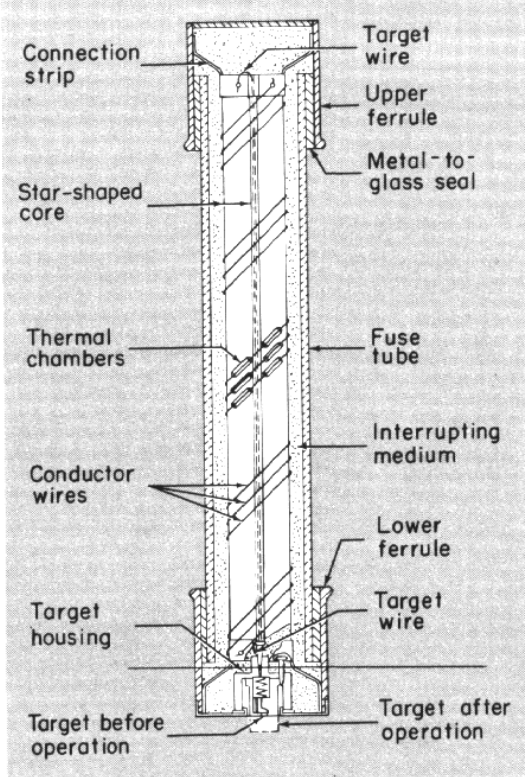
Maximum Transformer KVA Ratings with Unfused RM Liquid-filled Switches

Nominal System Voltage	Load Break Operation Oil-filled Only	
	Self-cooled 100%	Fan-cooled 115%
2400	1000	1000
4160	2000	2000
4800	2500	2000
6900	2000	1500
7200	2000	1500
12,000	3000	3000
13,200	3000	3000
13,800	3000	3000

NOTES:

1. *The maximum transformer ratings in the table are based on a 20% margin between the self-cooled or fan-cooled transformer primary current and the RM switch rating.*
2. *Oil-filled transformers are supplied with oil-filled switches and Pyranol filled transformers are supplied with Pyranol filled switches.*
3. *Pyranol filled switches are suitable for magnetizing current break only.*

TYPE EJ
CURRENT LIMITING FUSE



SELF-CONTAINED CURRENT LIMITING FUSES ASSURE MAXIMUM EQUIPMENT PROTECTION

SELF-CONTAINED — Interruption takes place quietly, entirely within the fuse container. No expulsion of gases takes place.

CURRENT LIMITING—Silver elements in a quartz sand filler enclosed in a glass or epoxy resin cylinder, develops an extremely high resistance path during interruption—thus minimizing let-through current which is potentially dangerous to the system.

Type EJ Fuse Continuous Current Ratings

Voltage ratings 2.4, 4.16, 4.8
20E, 25E, 30E, 40E, 50E, 65E, 80E, 100E 125E, 150E, 200E, 250E, 300E, 325, 375, 400, 450.

Voltage ratings 6.9, 7.2
20E, 25E, 30E, 40E, 50E, 65E, 80E, 100E, 125E, 150E, 200E.

Voltage ratings 12.0, 13.2, 13.8
20E, 25E, 30E, 40E, 50E, 65E, 80E, 100E, 125, 150, 175.

Transformers are available in a wide range of ratings . . .

in accordance with the latest application standards as recommended by ASA and NEMA

Information in this section is provided for general description of electrical characteristics and mechanical features normally furnished and tests normally made on load center transformers. The characteristics, features, and tests described in this section are those which will be furnished where purchaser's specifications do not specify otherwise. The product characteristics, features, and tests thus described are included in the price of the unit.

RATINGS

Data given in the tables below cover the most commonly applied load center transformers. Other ratings are available upon request.

TEMPERATURE RISE*

Standard kva ratings based on the temperature rises are listed below:

Rise	Liquid-filled	Open Dry	Gas Filled
Average winding-temperature rise by resistance	65 C	150 C	150 C

** Average ambient temperatures 30 C (40 C maximum) for any 24-hour period.*

STANDARD IMPEDANCES

Kva	High Voltage (Kv)	Percent Impedance
300–500	15 and Below	4.5*
750–2000	15 and Below	5.75

**Minimum impedance.*

STANDARD TAPS

Four 2½ percent rated kva taps in the high-voltage winding, two above and two below rated primary voltage.

STANDARD SOUND LEVELS

Self-cooled Rating, Kva	Sound Level, Decibels				
	Without Fans			With Fans Running	
	Liquid-filled	Dry-type		Liquid-filled	Open Dry-type
		Open	Gas Filled		
300	55			....	....
500	56			....	....
750	58	64	63	67	67
1000	58	64	63	67	67
1500	60	65	64	67	68
2000	61	66	65	67	69

WINDING INSULATION

Dielectric Tests for Transformers

Nominal System Voltage	BIL	Insulation Class	Low Frequency Test	Impulse Tests		
				Chopped Wave		Full Wave
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7
Kv	Kv	Kv	Kv	Kv Crest	Min. Time to Flashover, Micro-seconds	Kv Crest
1. LIQUID-FILLED TRANSFORMERS						
1.2	30	1.2	10	36	1.0	30
2.4	45	2.5	15	54	1.25	45
4.8	60	5	19	69	1.5	60
8.32	75	8.7	26	88	1.6	75
14.4	95	15	34	110	1.8	95
2. OPEN DRY-TYPE TRANSFORMERS						
1.2	10	1.2	4	10	1.0	10
2.4	20	2.5	10	20	1.0	20
4.8	25	5	12	25	1.0	25
8.32	35	8.7	19	35	1.0	35
14.4	50	15	31	50	1.25	50
3. GAS FILLED TRANSFORMERS						
1.2	30	1.2	10	30	1.0	30
2.4	45	2.5	15	45	1.25	45
4.8	60	5	19	60	1.5	60
8.32	75	8.7	26	75	1.6	75
14.4	95	15	34	95	1.7	95

PROVISION FOR FAN COOLING

Provision for increasing the continuous kva rating of load center transformers by the addition of cooling fans is inherent in the design of units rated 750 kva and above and includes:

1. Capacity in all current-carrying parts for the fan-cooled rating.
2. Provisions for relay for control of fans from top-liquid temperature indicator (for liquid transformers).
3. On open-dry type, provisions for mounting hottest spot temperature indicator.

The percentage increase in capacity provided by cooling fans is given in the following table:

Self-cooled Kva Three-phase	Percentage Increase in Capacity	
	Liquid-filled	Open Dry-type
750 2000	15	33⅓

NOTE: Fan cooling not available on gas filled units.

LIQUID TRANSFORMERS

Value-engineered 65 C transformer features welded glass bushings, lighter weight construction, thermally upgraded layer insulation

The General Electric liquid-filled load center transformer now offers both wire film insulation and thermally upgraded paper layer insulation. The combination of these two improvements now makes possible a smaller, lighter, 65 C transformer that offers increased life characteristics over the former 55 C paper- and cotton-insulated unit.

Both high and low voltage windings of the new unit contain a heavy coating of a superior wire film conductor insulation. Applied under rigid quality control conditions, the film has excellent thermal and adherence characteristics, and is practically immune to damage due to bending, scraping or burning. It offers outstanding resistance to moisture.

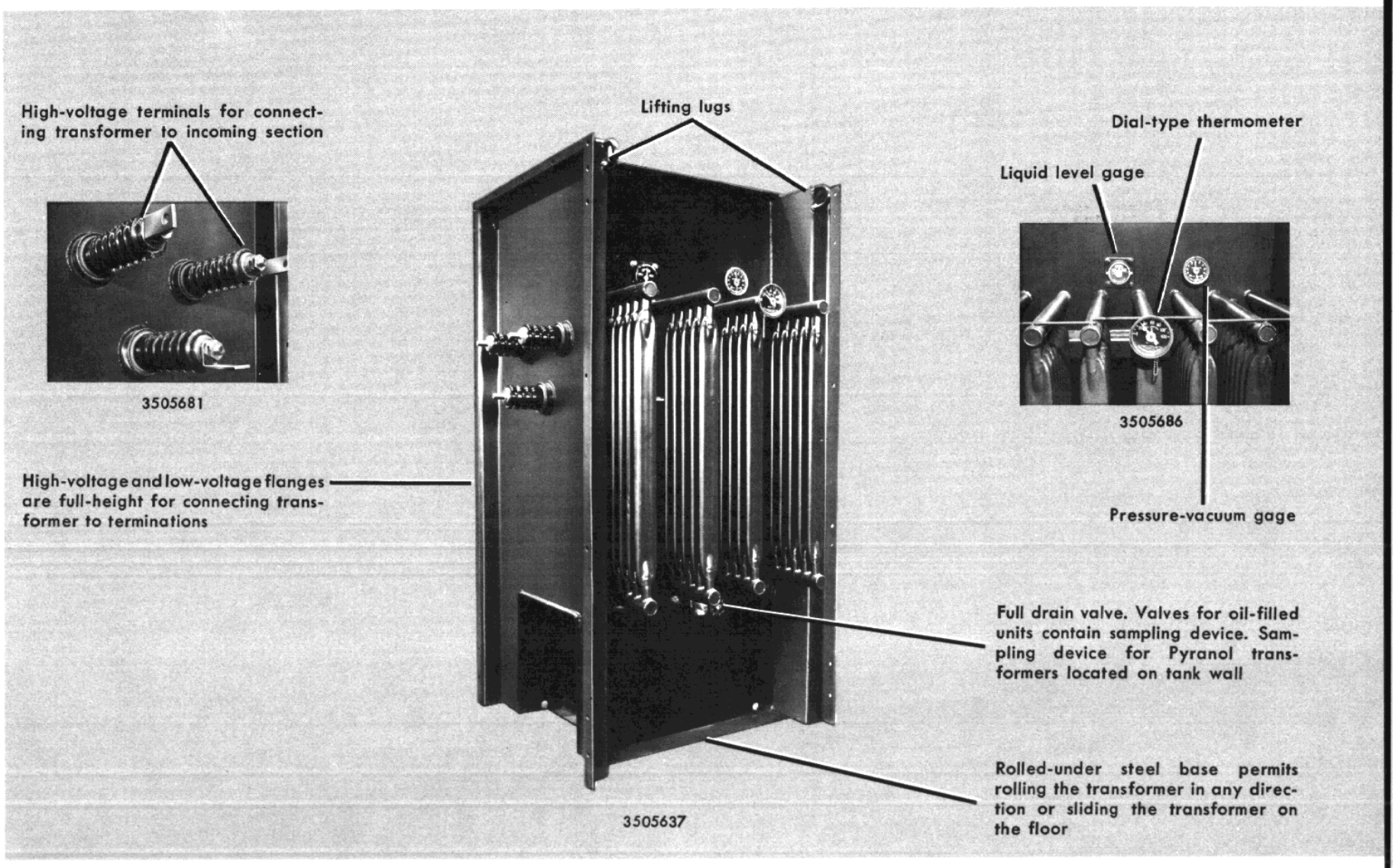
The core of the new design is plate-type having rectangular cross-section in both leg and yoke. The coils are rectangular and are wound as a unit with high voltage over low voltage. The low voltage winding is pressure rolled over the main support. The high voltage winding is wound under tension so that the combination forms a rigid unit.

A new circular welding process is used to weld glass bushings to the tank. This is an automatic process providing a leak-free weld. Welded bushings result in an essentially leak-free tank because there are no gasketed openings below the oil level.

Accessories are reversible in the field. Fans, when required, are supported on top of the tube headers and blow downward.

A mechanical pressure-relief device, furnished on all Pyranol units, is self-reclosing and self-resealing. The relief device is calibrated at the time of manufacture and operates with an accuracy of plus or minus 10%. The factory calibrated setting will not change during the life of the transformer.

The unit is available in oil and Pyranol ratings for either outdoor or indoor installation.



Liquid-type transformer for indoor or outdoor installation.

Feature reliability, compactness, reduced weight and are exceptionally quiet

Advanced manufacturing techniques have helped General Electric engineers design open dry-type transformers, rated 750 KVA and above, that are the smallest, lightest and quietest of their type.

Installation Cost Reduced

Carefully designed features simplify installation. The entire unit can be lifted by the lifting angle or channel bolted across the cover. With the cover or casing removed, the unit can be lifted using fittings in the top core clamps. The transformer can be rolled or skidded in the direction of its long axis by attaching cables to angles in the base. These same base angles give a good jacking surface.

Greater Reliability

The reliability of the open dry transformers is due to the high quality materials used. For example, the core laminations are a special grain-oriented silicon steel. The laminations are annealed in a special, roller-hearth furnace to improve core-plate insulation and relieve stresses caused by shipping and slitting. The anneal also flattens the laminations to reduce losses and make the core assembly smaller.

Improved Insulation System

Alpholite insulation is an inorganic material composed of asbestos bonded with aluminum phosphate. It can be formed into the many shapes required for the major insulation barriers between the core and winding, between the high and low voltage windings, and between phases. It is also used as spacer material to permit cooling ducts between conductor layers.

The Alpholite material is like a ceramic; hard, strong, and uniform in dielectric and mechanical properties. It performs well at the high operating temperatures of the open dry-type unit and is able to withstand the stresses of short-circuit currents.

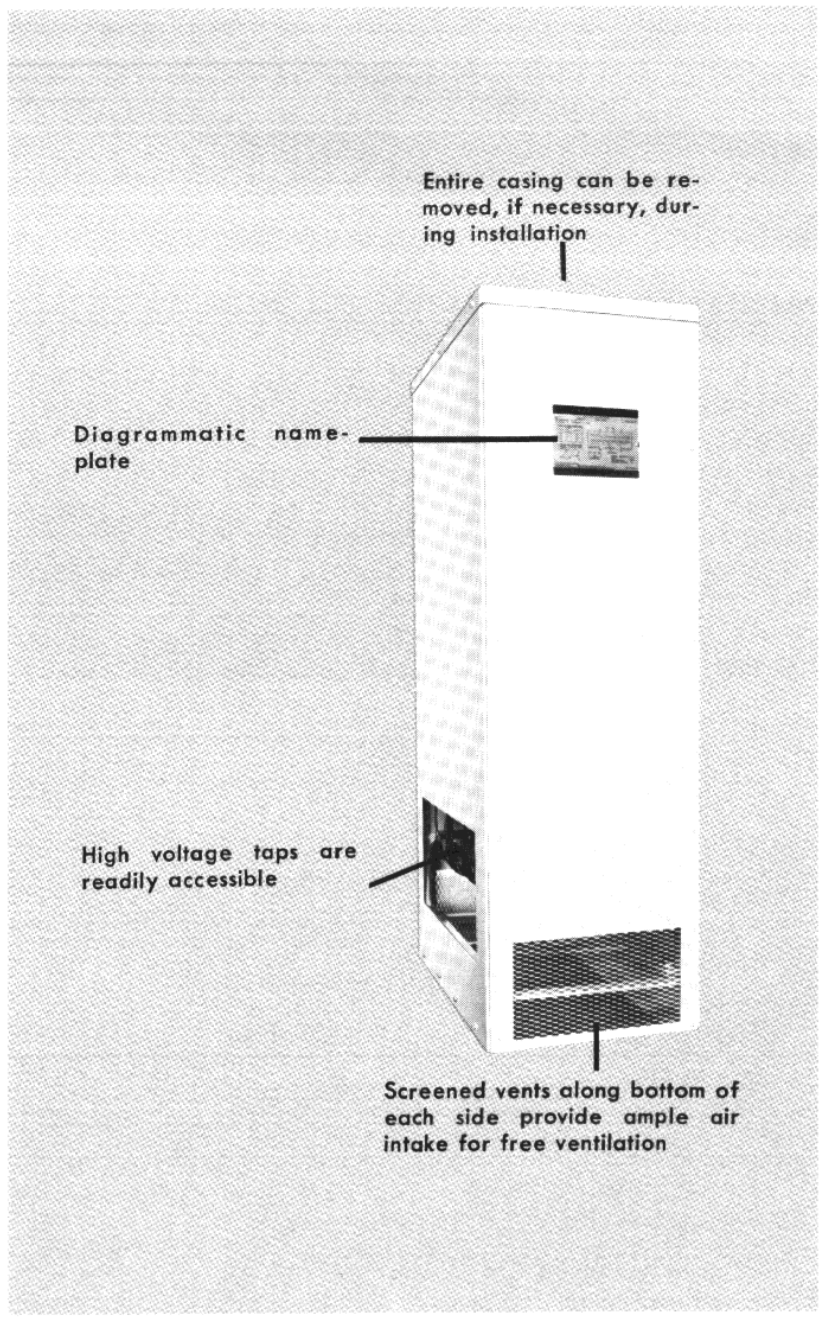
Inorganic, Class H materials used in the insulation system, combined with suitable resins, are fire resistant. The temperature rise of 150 C takes full advantage of the inherent qualities of the system, offering more KVA capacity per pound.

Low Noise Level

Indoor usage makes the sound level of open dry-type transformers important. General Electric's new open dry-type transformers have the lowest decibel levels of any transformer of their type, levels are at or below published industry standards.

In controlling sound, General Electric starts with the basic core steel. The molecular structure of steel and external stresses combine to produce magnetostriction—a phenomenon which causes cores to behave much like a tuning fork. They emit sound at frequencies which are even multiples of the power frequency. General Electric minimizes this effect by using a special grain-oriented silicon steel, annealing it to relieve stresses, and designing the core for electro-magnetic balance.

Transformer sound levels cannot be determined by listening or by routine tests. Factory ambient sounds, spurious reflections, or adverse weather conditions can all affect the measurement. At General Electric, a specially constructed anechoic chamber makes possible accurate sound-level testing which can be used in production and research.



Open dry-type transformer for 5 kv indoor installation. 3505779

GAS-FILLED DRY-TYPE UNITS

High impulse levels, safety, minimum maintenance offered by Fluorocarbon gas-filled transformer

General Electric's new gas-filled dry-type transformer provides increased insulation levels for dry-type units, outstanding safety features, and requires practically no maintenance. These units are ideal for rooftop or penthouse installations, in extremely dirty or corrosive atmospheres, or in other special applications where insulating liquids are not acceptable.

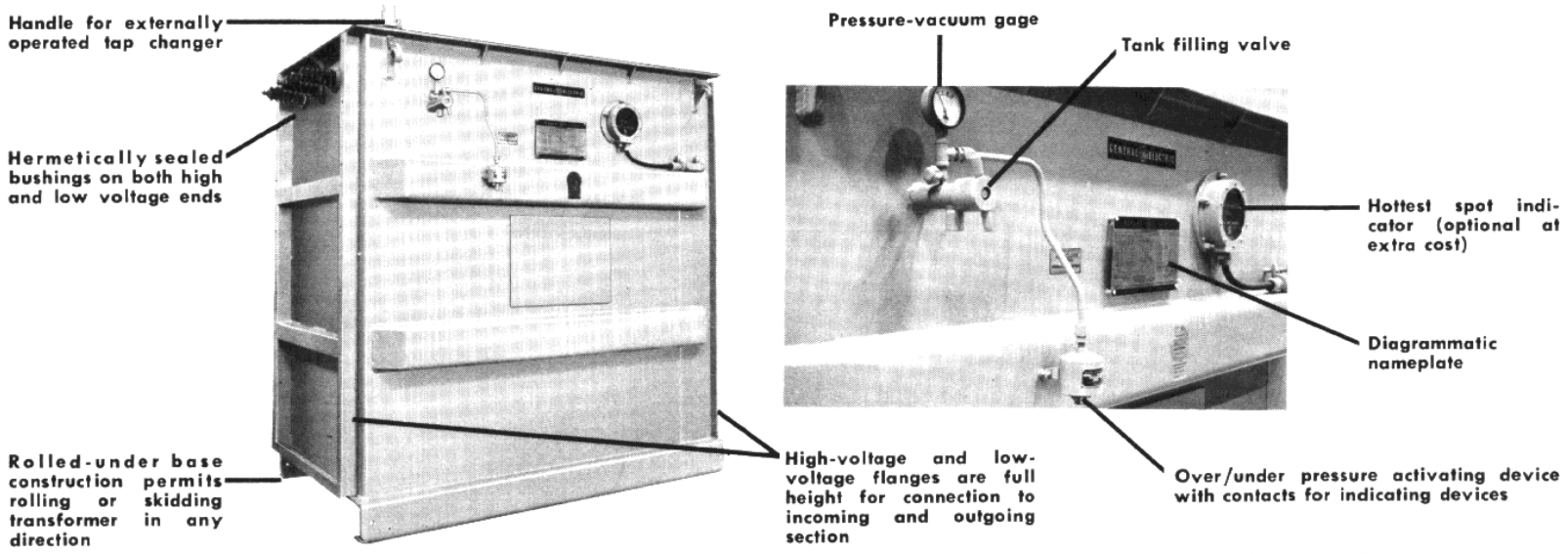
The use of a fluorocarbon type gas as an insulating and cooling medium has enabled General Electric to provide a gas-filled dry-type transformer with the following advantages:

Higher impulse levels: As an example, basic impulse level of the 15-kv class gas-filled transformer is 95 kv—50 kv is the NEMA Standard for open dry-type units.

Safer operation: Fluorocarbon gas is non-flammable, nonexplosive and nontoxic. It is stable even under abnormal operating temperatures.

Low maintenance: No planned maintenance is necessary other than a check to determine proper tank pressures, and occasional cleaning of the tank surfaces.

Light weight: Gas-filled units are up to 22% lighter than previous ratings filled with nitrogen. The 1000 kva gas-filled unit weighs 9300 lb—at least 2700 lb lighter than the lightest nitrogen-filled units of the same rating.



Choice of transformer determined by application

General Electric offers a complete line of load center transformers for all industrial and commercial applications.

Oil-filled transformers offer:

1. Lowest first cost; designed for outdoor installation or indoor vaults.
2. Sealed construction prevents oil contamination; can be installed in dusty or dirty locations.
3. Superior insulation system provides long life and extra capacity when needed.

Pyranol transformers offer:

1. Indoor or outdoor installation; Pyranol is nonflammable and nonexplosive.
2. Sealed construction prevents contamination of insulating liquid; can be installed in any location.
3. Superior insulation system provides long life and extra capacity when needed.

Open dry-type transformers offer:

1. Lightest weight unit available; ideal for mounting on overhead platforms or balconies.
2. Inorganic insulation provides long life, reduces fire hazard to the minimum.
3. Indoor installation in reasonably clean and dry locations; units are easy to clean and maintain.

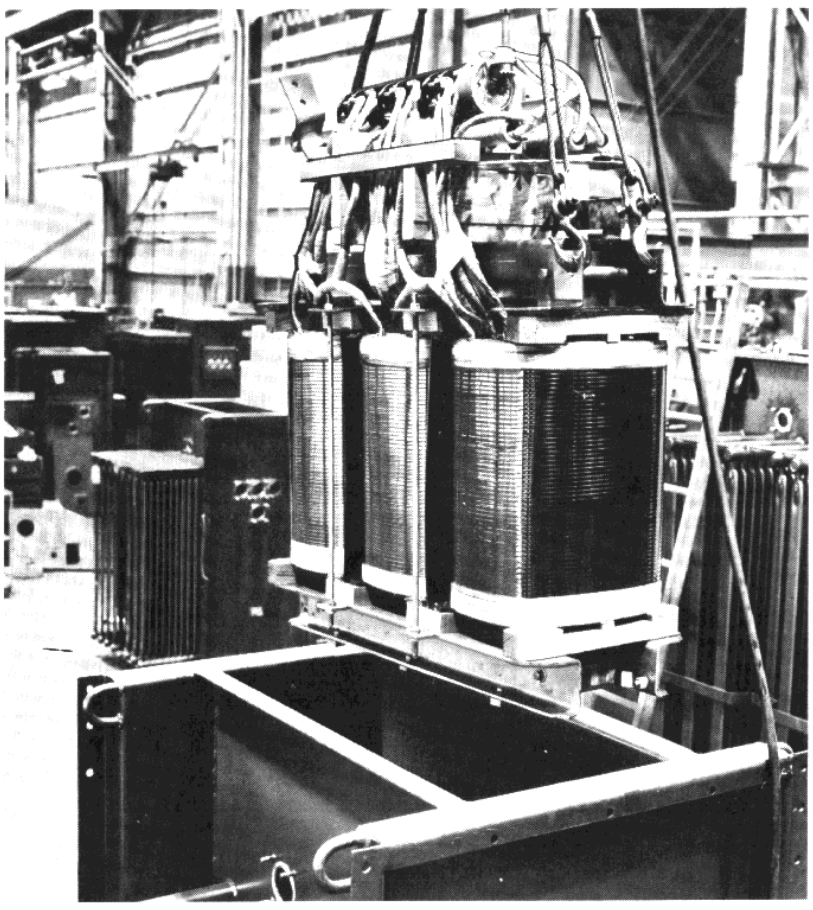
Gas-filled dry-type transformers offer:

1. Minimum maintenance, long life.
2. Universal installation; ideal for rooftop or other special applications where conventional units may be impractical.
3. High insulation levels make surge protection easy; fire and explosion resistant.

Transformer Comparison (Oil as Base)
(1000 Kva, 5 Kv Transformers)

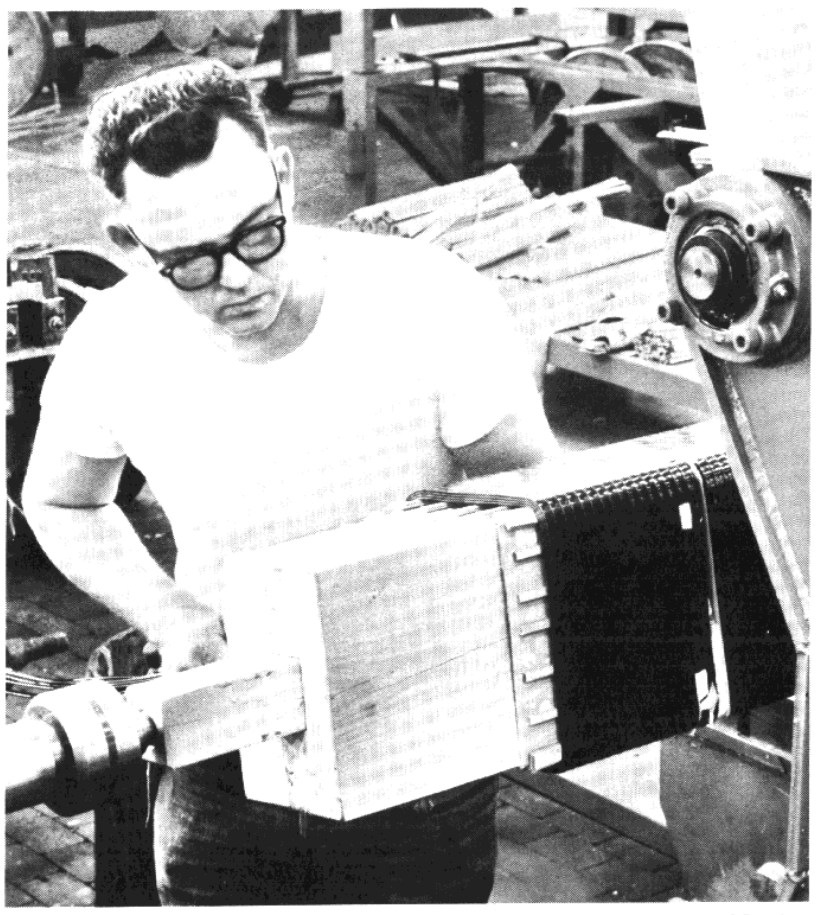
	Oil	Pyranol	Open Dry	Gas-Filled Dry
Price (Pct)	100	125	125	200
Weight (Lb)	5850	6650	4500	8600
Floor Dimensions (Inches)	49 x 72	49 x 72	31 x 55	73 x 52
Noise Levels (Db)	58	58	64	63
Impulse Levels (Kv)	60	60	25	60

Outstanding features of General Electric load center transformers assure long life, low cost and minimum maintenance



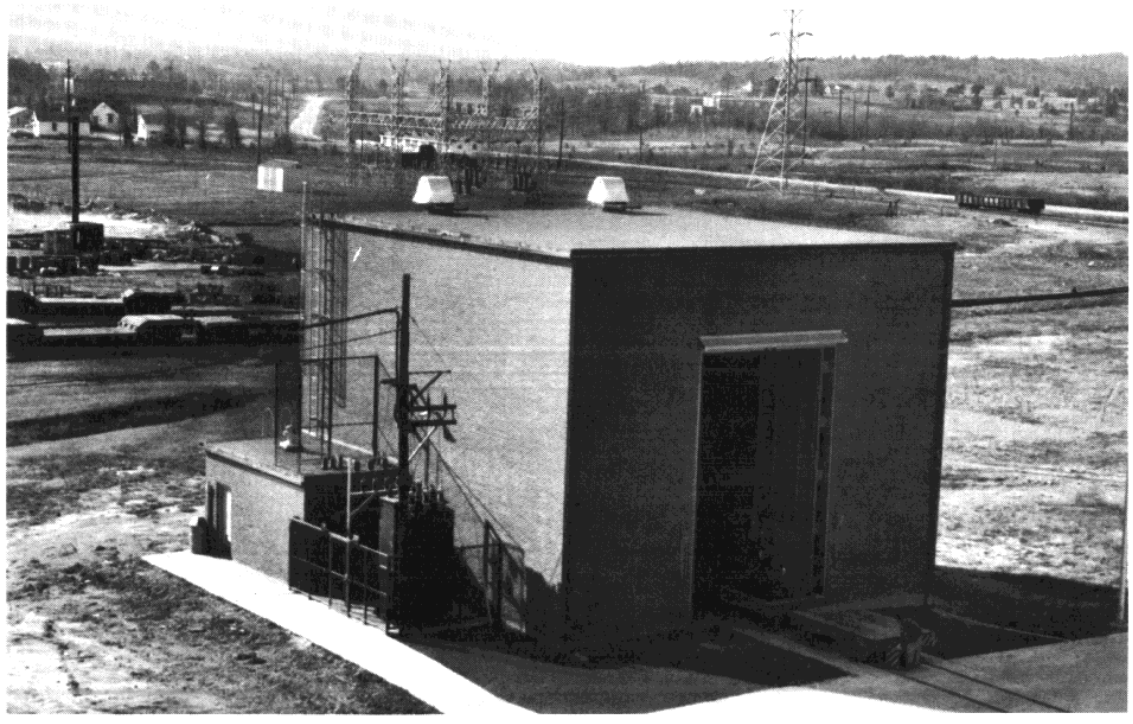
3505663

A THREE PHASE CORE AND COIL ASSEMBLY is pictured here as it is being lowered into the transformer tank during the final assembly process.



3505671

A PRESSURE ROLLER ASSEMBLY is used to assure accurate alignment in the coil operation for all value-engineered transformers.



3502000

GENERAL ELECTRIC'S DEVELOPMENT AND SOUND LABORATORY, shown above, is used for the quality control of all unit power transformers to assure consistent low sound level.

Improved load center reliability and service continuity is provided by Powermaster Type AKD-5 low voltage switchgear

New General Electric Powermaster Type AKD-5 low voltage switchgear incorporates many significant design advances to meet the needs of the modern power system. These advances reflect the results of an intensive study of field requirements for safer and more reliable switchgear.

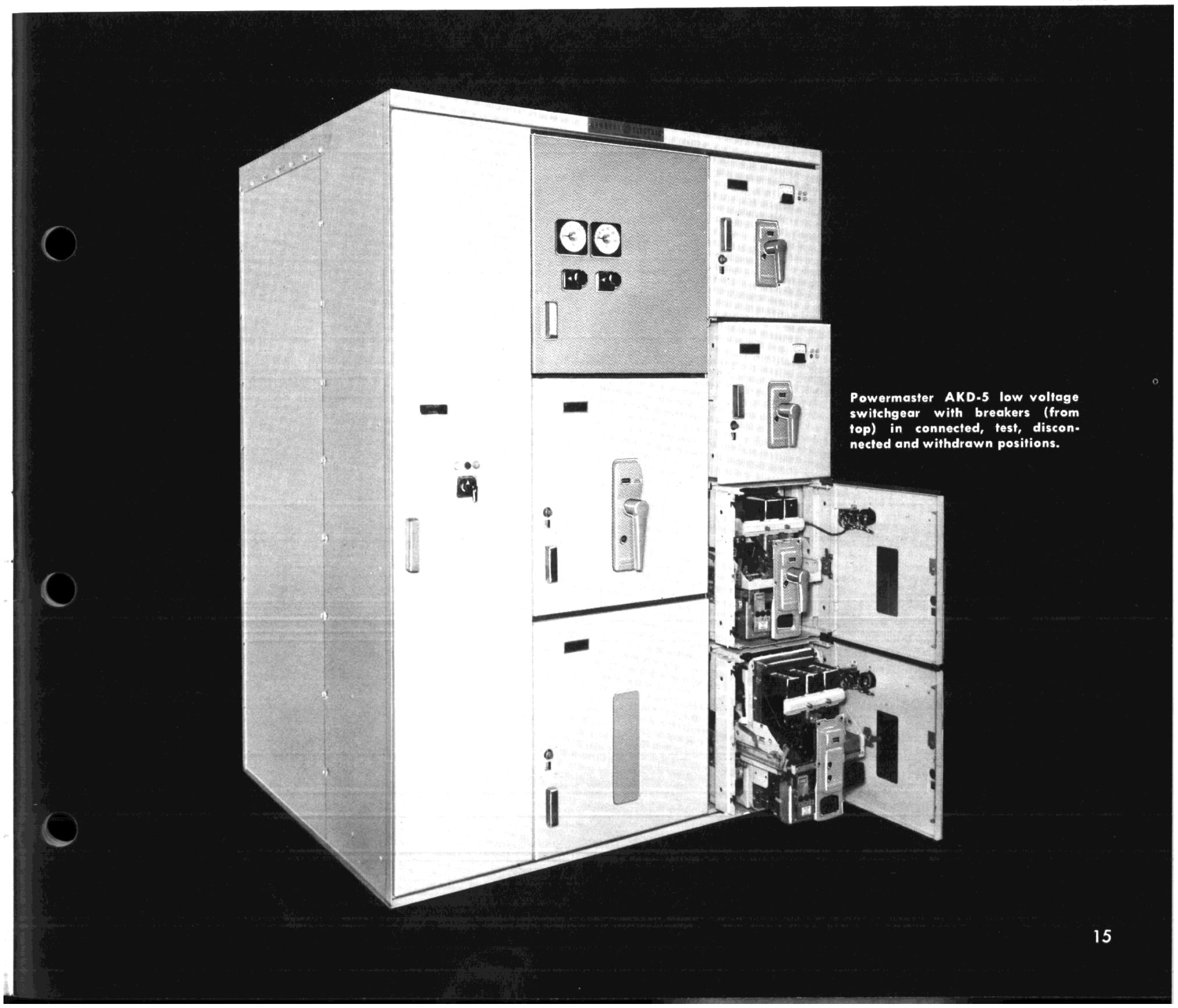
Field-proven features along with new design advances result in a load center that better meets your needs for reliability, safety and convenience—adding up to the highest degree of service continuity.

Highlighting the engineering advances in this equipment is a new concept in appearance design. Colorful blue accent panels on a light background make the load center attractive for any location. Its color and finish are extremely durable and won't show dirt readily.

Powermaster AKD-5 low voltage switchgear equipment is engineered for the men who will install and operate it. Man-sized, sturdy door handles with two-point latches make it easier to open and close compartment doors. Its control and selector switches are logically grouped with its instruments. Engraved, black lamacoid nameplates inserted in cardholders are large and legible.

Powermaster switchgear features industry's first complete line of stored-energy power circuit breakers. You can specify stored-energy breakers, either manually or electrically operated with either electro-mechanical or solid state trips, in ratings through 4000 amperes, 600 volts or below.

1187126



Powermaster AKD-5 low voltage switchgear with breakers (from top) in connected, test, disconnected and withdrawn positions.

Greater reliability is achieved through elimination of bolted bus connections and compartmentation of key functions

Low voltage drawout switchgear takes a most significant step forward by providing increased reliability through complete compartmentation.

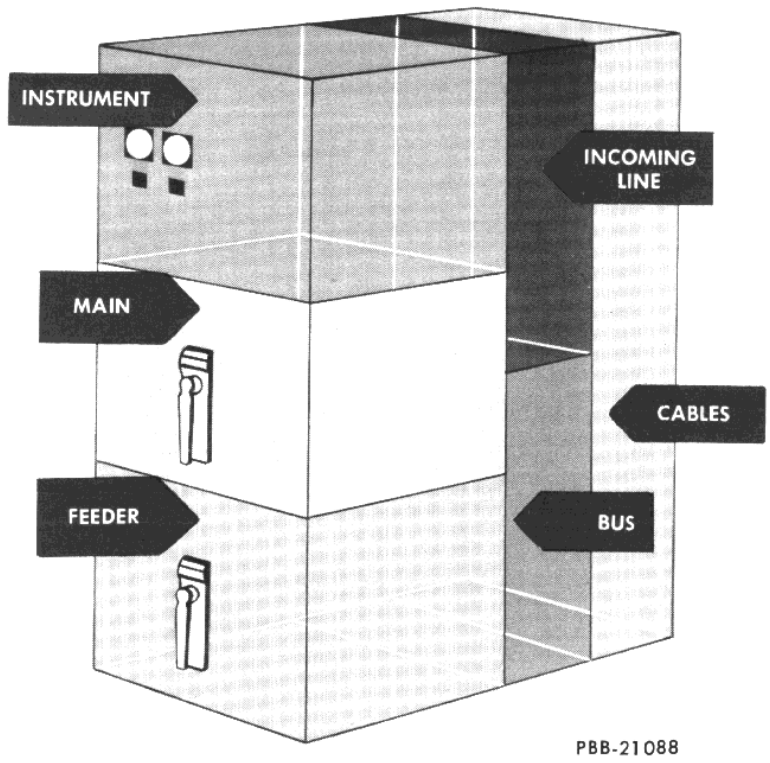
Compartmentation results in complete isolation of key functions embodied in the equipment—incoming line, main bus, breakers, instruments, and cable connections. It virtually eliminates one of the major causes of bus faults—the introduction of foreign objects such as tools, rodents, fishtapes, etc., to the bus system.

Isolation has been achieved by the addition of barriers to eliminate fault communication between functional components of the equipment, e.g., between incoming line and main bus. To further maintain isolation of outgoing feeders from the main bus, runback feeder conductors are insulated from the main bus.

In addition, power devices such as potential transformers, control power transformers, and associated fuses are housed in individual metal-enclosed auxiliary compartments.

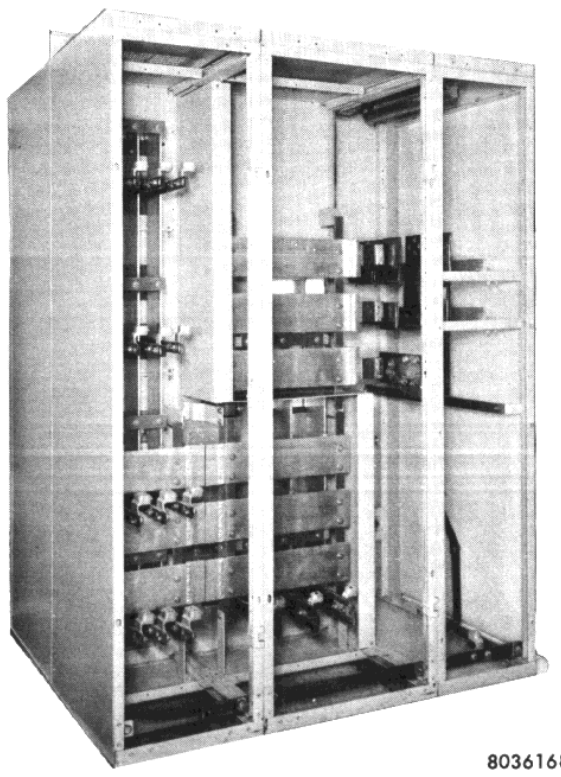
For greater reliability, buses are also aligned in a vertical plane to greatly reduce the accumulation of foreign material.

All incoming and main buses are aluminum, with copper conductors flash welded at the point of external connection. Joint maintenance is eliminated. This design results in the ultimate in electrical and mechanical characteristics. All load, transformer and shipping split connections are made on silvered copper conductors.



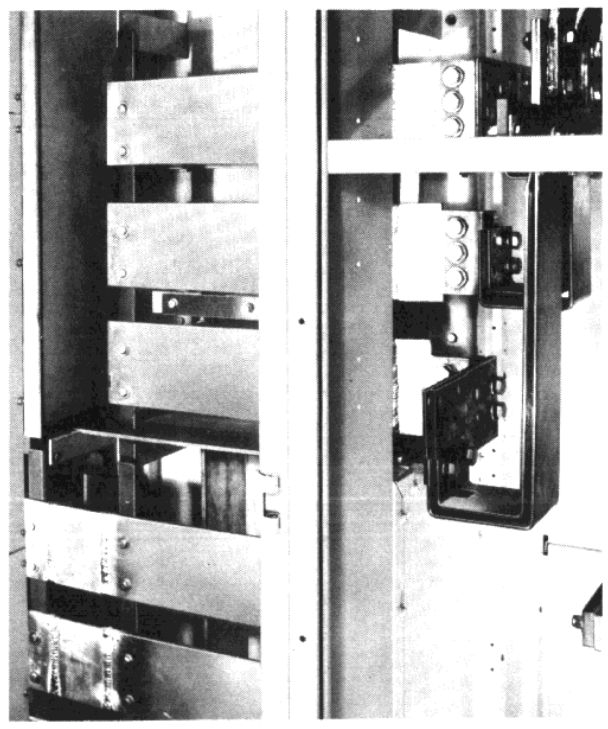
PBB-21088

COMPARTMENTATION is clearly shown in this isometric view. Isolating metal barriers provide complete compartmentation for the incoming line, power circuit breakers, cable terminations, and instruments.



8036168

NEW WELDED ALUMINUM BUS (shown with barriers between bus and cable compartments removed) provides high degree of electrical reliability. Welded joints assure excellent conductivity and reduce bus maintenance—no bolts to tighten. All connection points are of silvered copper. Bus is braced to withstand high short-circuit levels.



A-182314

NEW ISOLATED INCOMING LINE compartment reduces hazard of fault communication between main bus and incoming line, permits effective isolation of bus faults by main breaker. View shows rear bus compartment with barriers removed. Additional barriers increase the reliability of Powermaster low voltage switchgear by isolating the main bus in its own compartment. This blocks entry of foreign objects, guards against accidental contact with bus.

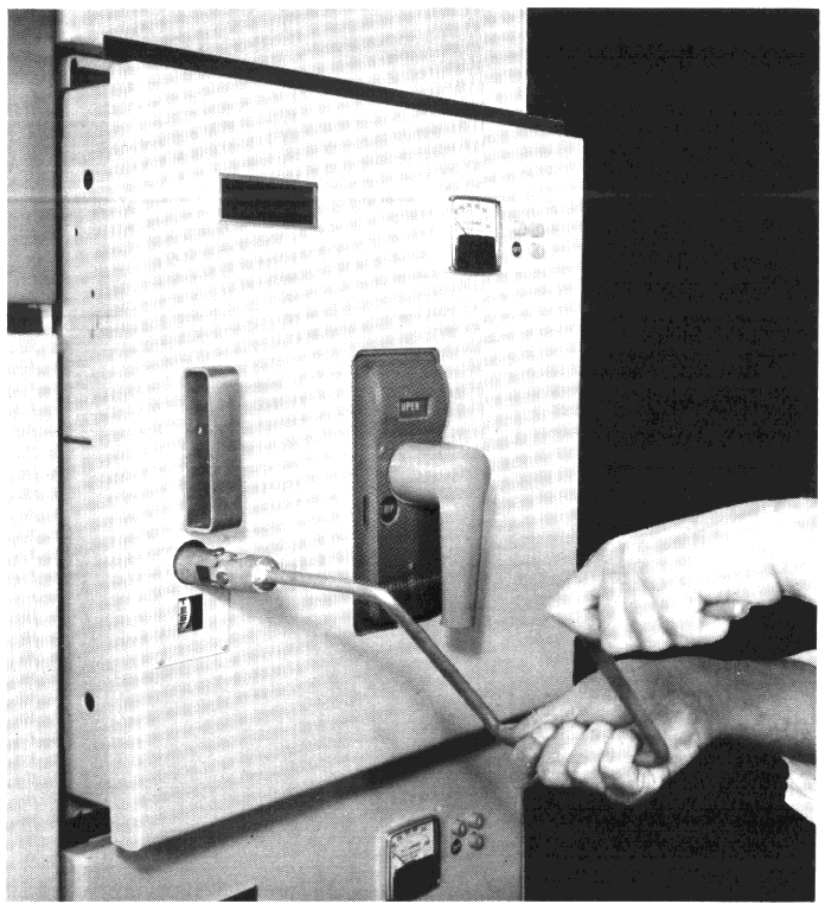
Closed-door drawout offers greater safety

Closed-door circuit breaker drawout mechanisms have a steel shield between the breaker and the operator for greater safety. Each circuit breaker cubicle contains a simple drawout mechanism which allows the operator to move the breaker from the CONNECT to the TEST and DISCONNECT positions—all with the door closed. Here's how the drawout mechanisms operate:

The operator must trip the breaker before operation can begin. Positive interlocks prevent withdrawing or inserting a breaker in the closed position. After tripping, the breaker may be withdrawn to the TEST position by operating the drawout mechanism located in the lower left of the cubicle. Note that not only the breaker but the inner housing is extended, thus keeping each breaker enclosed in metal during the complete racking operation.

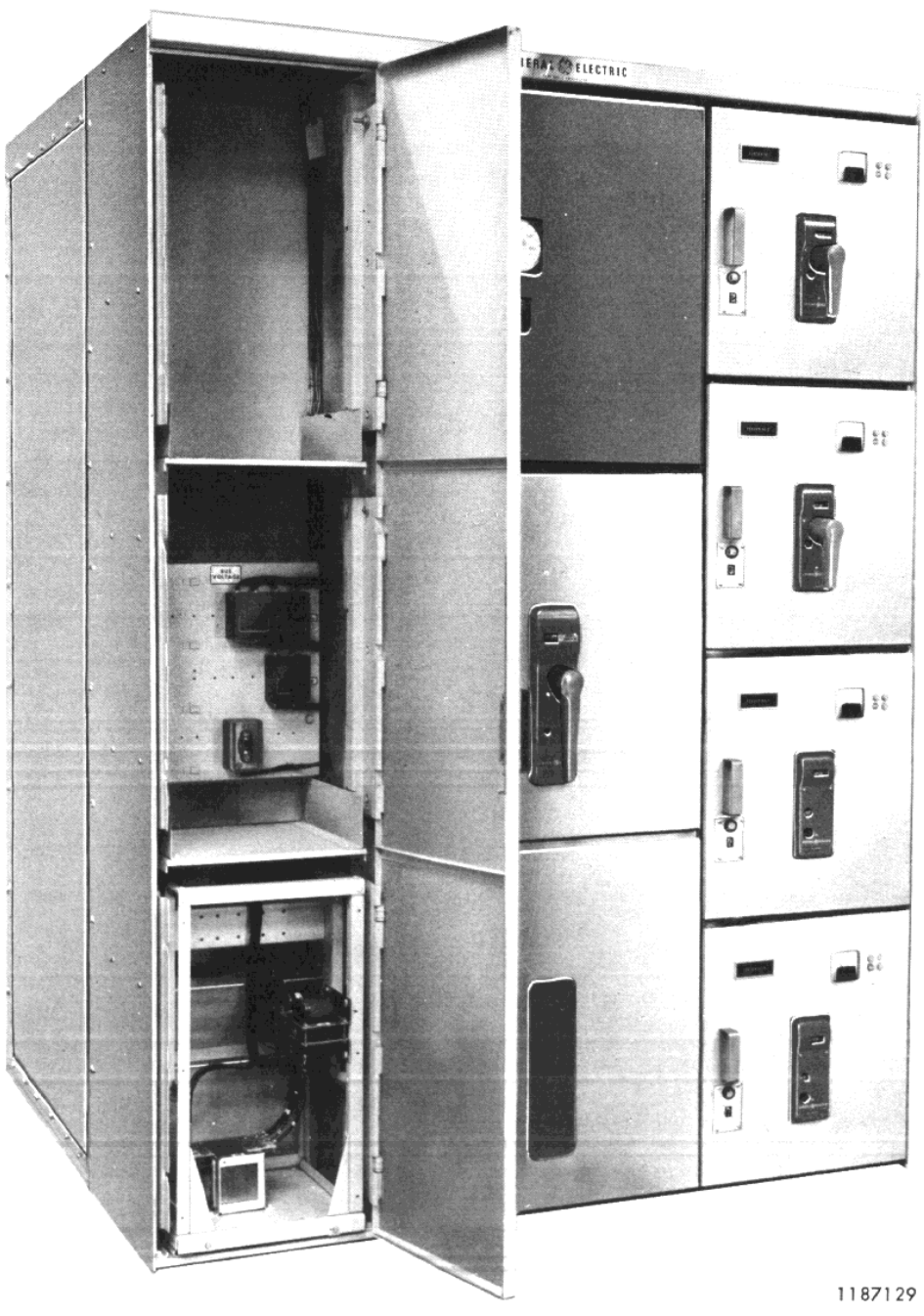
The breaker may be further withdrawn to the DISCONNECT position by a similar operation of the mechanism. A visual indicator shows you when the breaker has reached the TEST and DISCONNECT positions. The breaker can be stored in the DISCONNECT position with the compartment door closed which reduces dust contamination and allows aisles to be kept clear.

To return the breaker to the CONNECT position, the operating sequence is reversed.



8036171

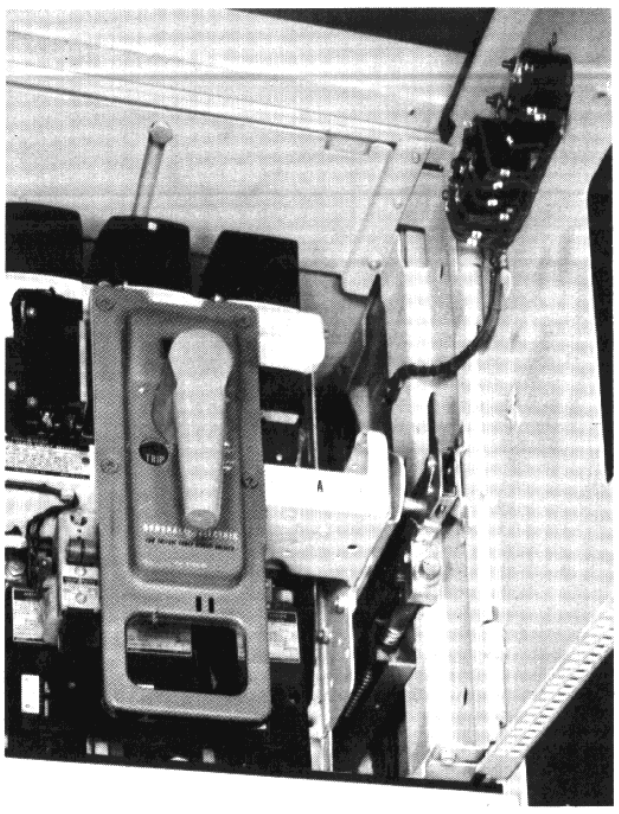
AK-2A-15 and AK-2A-25 racking mechanism.



1187129

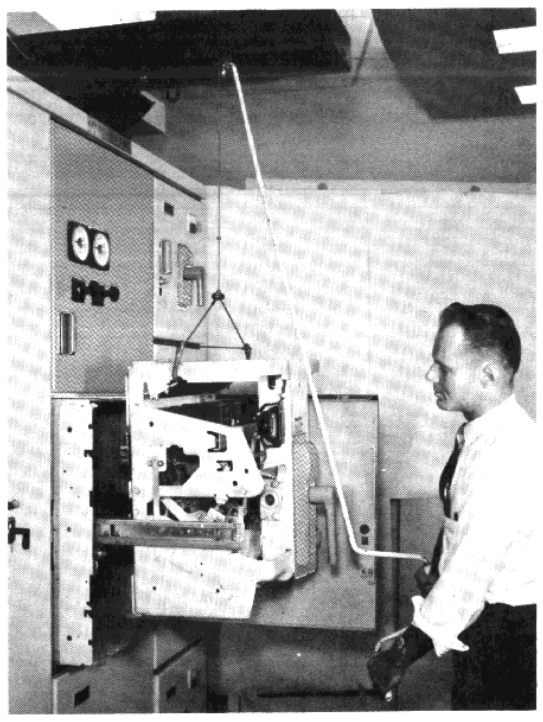
Powermaster AKD-5 low voltage switchgear provides complete compartmentation of the incoming line, main bus, breakers, instruments, and cable connections. Main breakers can be furnished with key interlocks to permit breaker operation in test and disconnect position, even with the bolt extended. Breakers and equipment are shipped separately to minimize handling procedures. Equipment is shipped in sections up to ten feet. Fully co-ordinated bus risers are available for arrangements using Type LVD busway.

Increased safety,



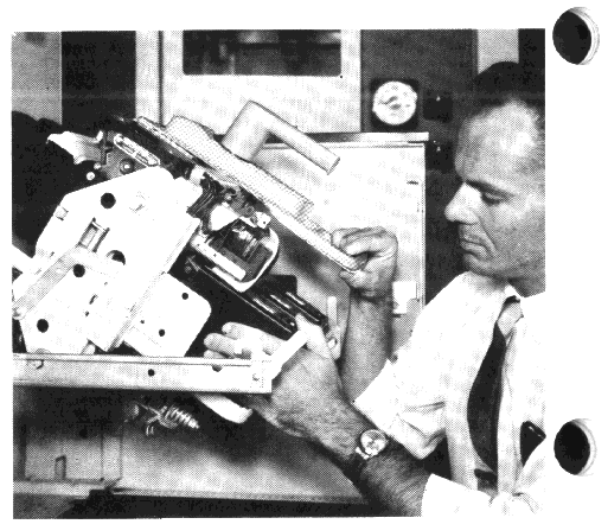
8036155

LOUVERS on recessed lower door flange rather than on the front of the door provides both ventilation and a solid steel protective barrier between the breaker and the operator. Also cuts down dust contamination in breaker compartments.



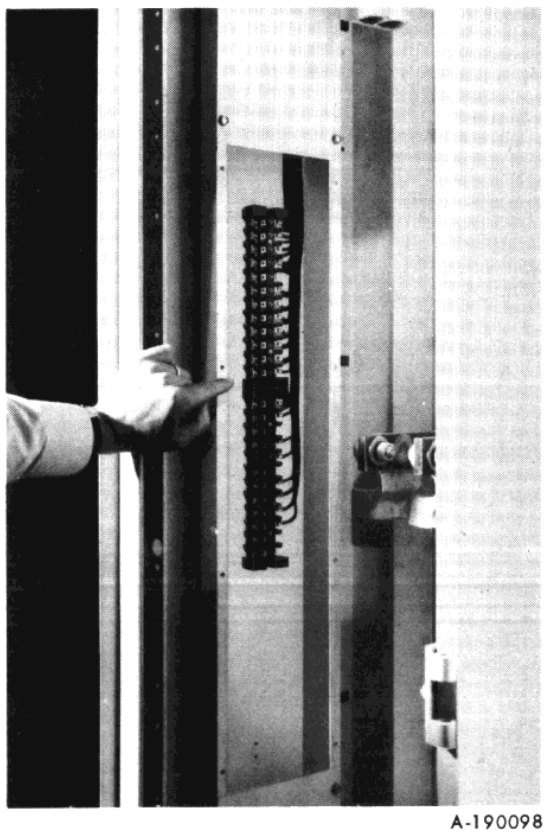
8036173

INTEGRAL BREAKER LIFTING DEVICE rolls on self-contained track to serve all breaker units. This new device eliminates the need for separate power circuit breaker handling facilities.



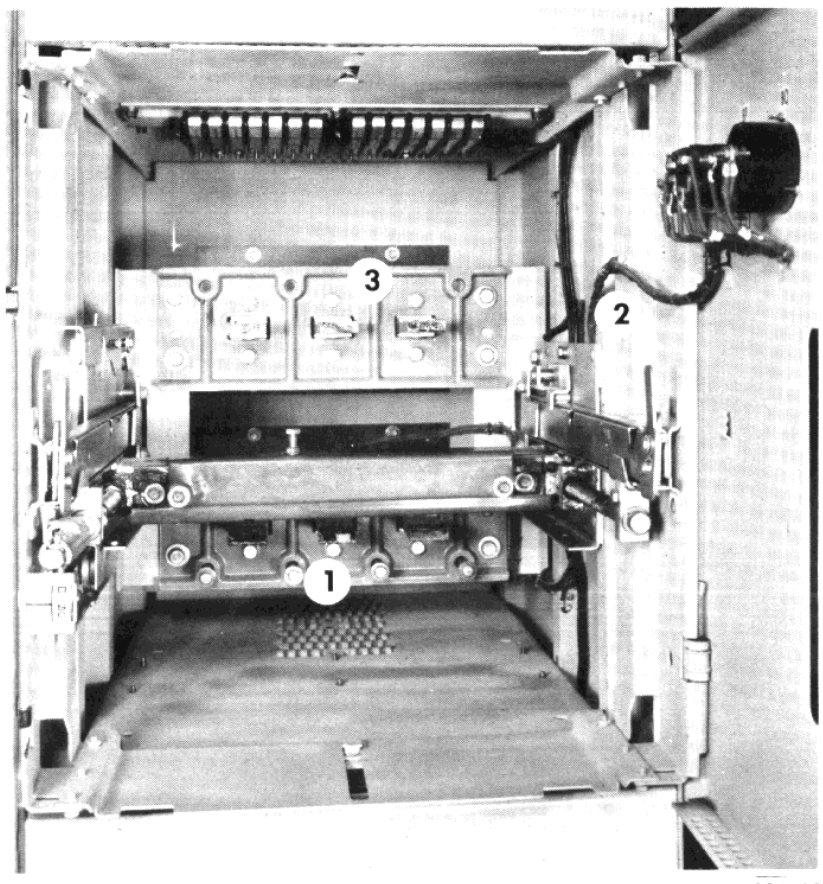
8036166

BREAKERS CAN BE TILTED in fully withdrawn position, permitting easy access to trip devices for inspection adjustment.



A-190098

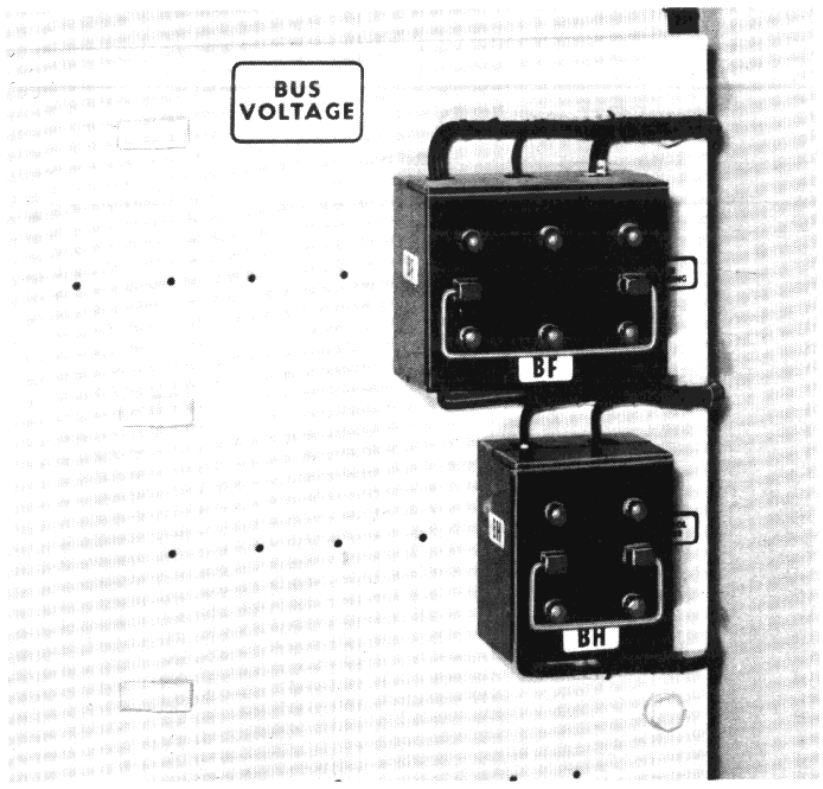
ENCLOSED WIRING TROUGH in rear compartment isolates secondary control circuits for safety, protection. Removable plates permit easy access to wiring connections.



8036165

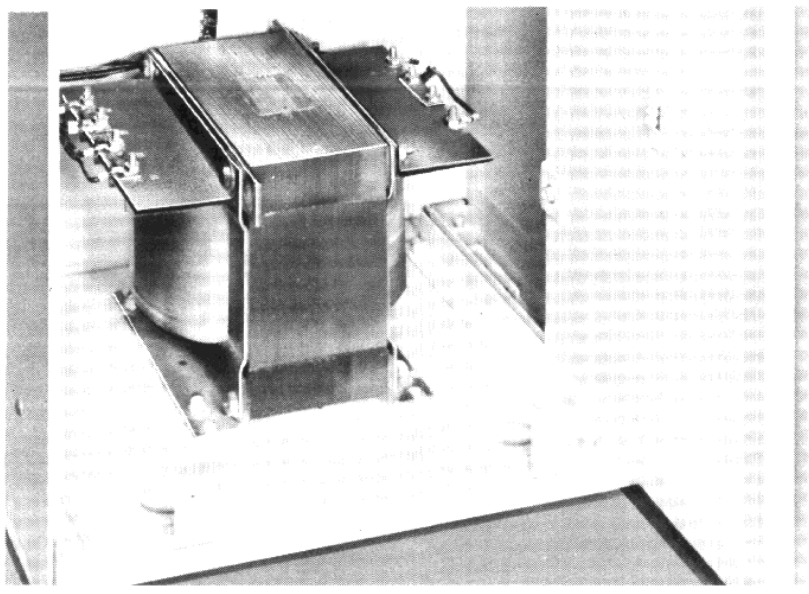
CURRENT TRANSFORMERS (1) mounted around stationary studs in breaker compartments are easily accessible from front. CONTROL FUSES (2) for power circuit breaker "close-and-trip" circuits are at front of individual breaker compartments for ready accessibility and easy identification with associated breaker. Fuses are accessible with breaker in connected position. Insulated cover prevents accidental contact. (Cover removed in photo.) POTENTIAL LEADS (3) are tapped and held in position behind stud shields.

new convenience



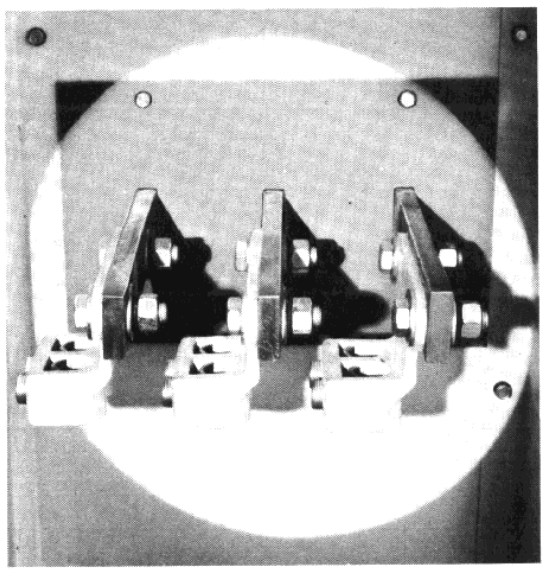
1159810

NEW CLASS-J CURRENT-LIMITING FUSES on primary side of auxiliary transformers are mounted in separate front compartment. Fuse holder provides dead-front protection and furnishes disconnect means for auxiliary transformer tray.



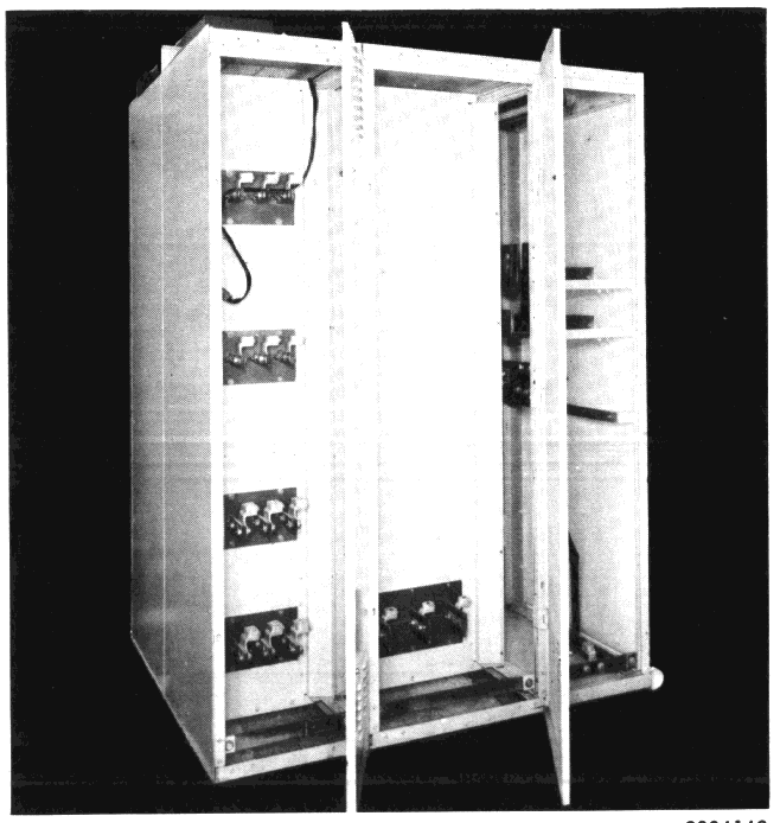
1187127

NEW AUXILIARY UNIT FOR POWER DEVICES contains control power and potential transformers on removable tray, permits access from the front for inspection or maintenance. (Shown with front cover removed.)



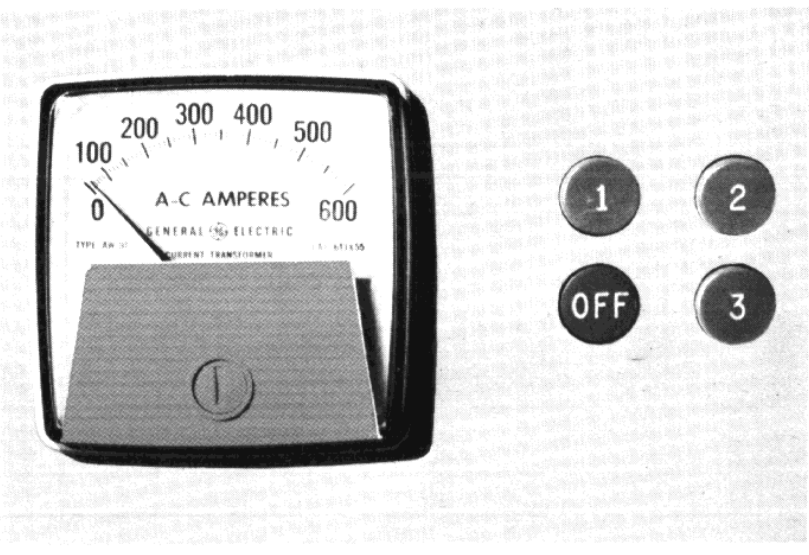
A-190119

MORE CABLE SPACE is provided by isolated terminal compartment. This new feature also allows straight cable runs to load studs.



8036163

ISOLATED CABLE COMPARTMENT prevents accidental contact with main bus when working on power connections. Runback conductor from breaker is taped to provide isolation of line and load side of feeders.



A-190127

CIRCUIT CURRENT INDICATION can be positively associated with its feeder by ammeter and new pushbutton selector switch on feeder breaker door. Instrument panel requirements are reduced, saving you valuable floor space.

Stored energy provides positive, high-speed closing of General Electric Type AK low voltage breakers

All frame sizes of General Electric low voltage power circuit breakers employ spring-operated, stored-energy mechanisms for manual or electrical operation. The stored-energy principle provides a quick-make, quick-break operating mechanism that assures positive high-speed closing of breaker, independent of the operating force. Positive, controlled closing prevents unnecessary arcing between movable and stationary contacts. This results in longer contact and breaker life.

Type AK-2A and AK-3A breakers are rugged switching and overload and short-circuit protective devices for main, tie or feeder circuits. They provide a means for switching circuits and equipment, disconnecting circuits for maintenance and construction and provide short-circuit protection. They also perform a wide variety of control functions such as motor starting and automatic throw-over.

ELECTRICALLY OPERATED STORED ENERGY

Electrical stored-energy breakers are operated by a motor or solenoid. In the smaller, more compact frame sizes (225-600 amp) a solenoid is used to conserve space. In the large frame sizes (1600-4000 amp) an a-c/d-c motor is used to keep control power requirements low (4 amp at 230 volts).

When the solenoid is energized, it charges the closing springs and drives the mechanism over center in one continuous motion. Motor-operated mechanisms are designed to automatically pre-charge the closing springs to a predetermined level. At the closing impulse, the springs are released and close the breaker. The motor or solenoid does ***not*** aid in the closing stroke; the springs supply all actual closing power. There is sufficient stored-energy in the charged springs to close the contacts under short-circuit conditions.

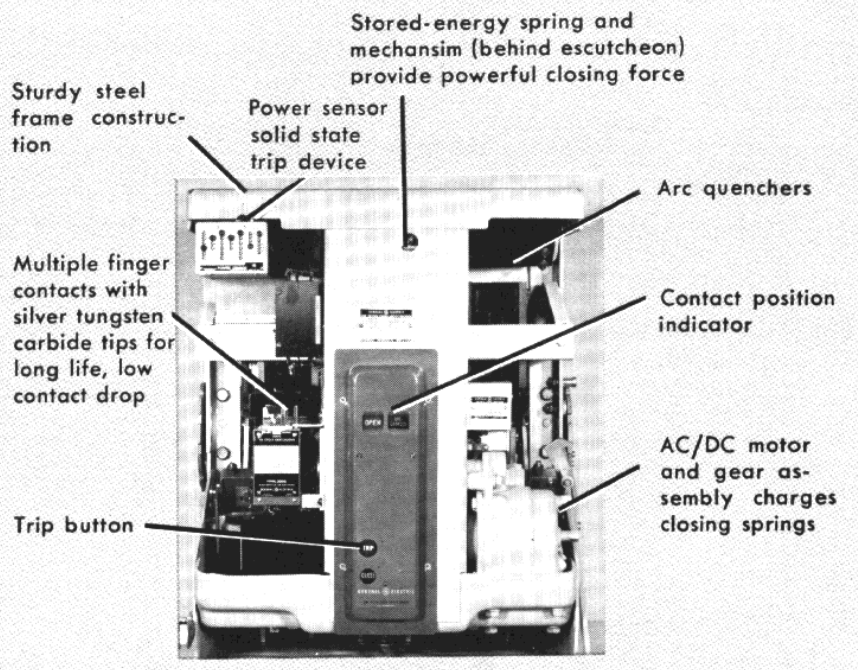
A second set of springs opens the contacts when the breaker receives a trip impulse. The breaker can be operated manually for maintenance by means of a detachable handle.

MANUALLY OPERATED STORED ENERGY

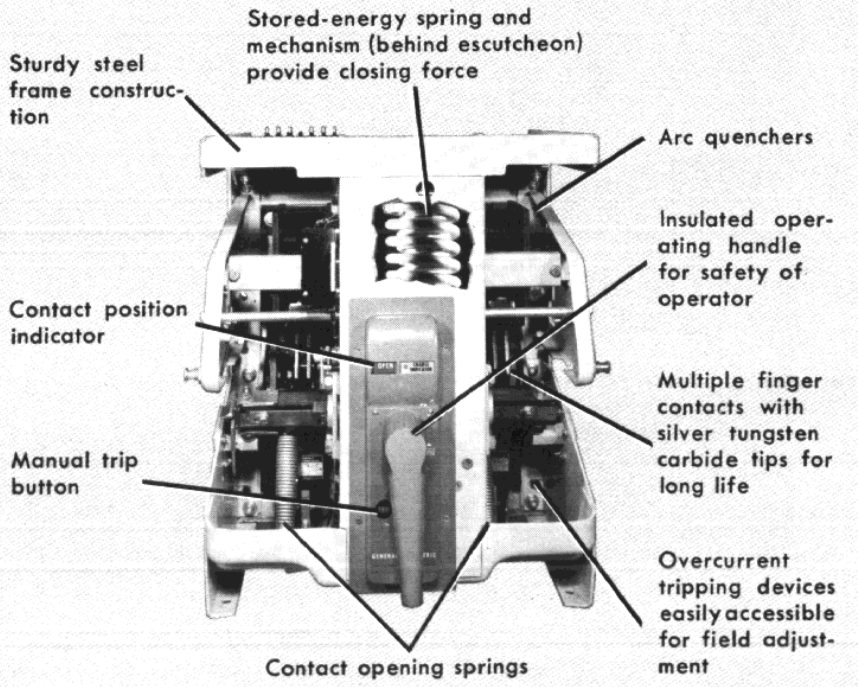
Manual stored-energy breakers are charged and closed by the operation of an insulated handle. In the AK-2A-15 and 25 breakers, charging of the closing springs takes place during the upward (CCW) and part of the downward strokes of the handle. At a predetermined point in the downward stroke near the vertical position of the handle, the springs become fully charged and are released to close the contacts.

In the AK-2A-50, 75 and 100 breakers, charging of the closing springs takes place during four upward and downward strokes of the handle. During the fourth downward stroke the springs are released to discharge and close the contacts. Until the springs are released in either of the mechanisms, there is no motion of the contacts. When the springs are released, the contacts move at a speed determined by the spring force and therefore independent of the operator. Upon receiving a tripping impulse, the breaker contacts are opened by separate opening springs.

Type AK-3A-50 electrically-operated power circuit breaker.



Type AK-2A-50 manually-operated power circuit breaker.



8030640

Type AKU fused circuit breakers provide reliable protection against high short-circuit currents

Field-proven Type AKU low voltage power circuit breakers are available with integrally mounted General Electric CLF® current limiting fuses for reliable overcurrent and short-circuit protection of circuits. These fused breakers may also be applied in motor branch circuits and in motor feeder circuits and are available in AKD-5 Powermaster switchgear construction.

RATINGS

TABLE A

Breaker Type	Frame Size Amperes	Voltage AC	Breaker Trip Coil Rating	*CLF Fuse Rating Amperes Min.	*CLF Fuse Rating Amperes Max.	Interrupting Rating Amperes—RMS Symmetrical
AKU-2A-25	600	up to 600	150–600	400	1200	200,000
AKU-2A-50	1600	up to 600	200–1600	400	2000	200,000

Note: Fuse performance under short-circuit conditions (Table A), is based on tests using General Electric CLF current limiting fuses of either NEMA Classes J or L, depending on the current rating.

** The maximum fuse rating is the largest fuse which tests show will result in proper performance of the breaker and fuse in combination under short-circuit conditions.*

TABLE B

Breaker Type	Overcurrent Trip Device Rating-Amperes	Magnetic Trips: EC Trip: Long Time Delay Band	Fuse Rating: Instantaneous Trip Setting 4X	6X	9X	12X	Long Time Delay Band	Power Sensor: Power Sensor Trip: Fuse Rating: Instantaneous Trip Setting 4X	6X	8X	10X	12X
AKU-25	150	1C	400	400	600	600	—(4)					
		1B	400	400	600	800	—					
	200	1C	400	600	600	1000	Min	350	450	500	600	600
		1B	400	600	1000	1000	Int	450	500	800	1000	1000
	300	1C	600	800	1000	1200	Min	500	800	1000	1000	1200
		1B	600	1000	1200	1200(1)	Int	800	1000	1200	1200	1200(1)
	400	1C	600	1000	1200(1)	1200(2)	Min	800	1000	1200	1200	1200(1)
		1B	800	1200	1200(2)	1200(2)	Int	1000	1200	1200(1)	1200(2)	1200(2)
	600	1C	1000	1200(1)	1200(2)	1200(3)	Min	1200	1200(1)	1200(2)	1200(3)	1200(3)
		1B	1200	1200(2)	1200(3)	1200(3)	Int	1200(1)	1200(2)	1200(3)	1200(3)	1200(3)
AKU-50	200	1C	400	600	600	1000	Min	800	800	800	800	800
		1B	400	600	1000	1000	Int	800	800	800	1000	1000
	300	1C	600	800	1000	1200	Min	800	800	1000	1000	1200
		1B	600	1000	1200	1600	Int	800	1000	1200	1200	1600
	400	1C	600	1000	1200(1)	1600	Min	800	1000	1200	1200	1600
		1B	800	1200	1600	2000	Int	1000	1200	1600	1600	1600
	600	1C	1000	1600	2000	2000(1)	Min	1200	1600	1600	2000	2000
		1B	1200	1600	2000	2000(2)	Int	1600	1600	2000	2000(1)	2000(2)
	800	1C	1200	2000	2000(1)	2000(2)	Min	1600	2000	2000	2000(1)	2000(2)
		1B	1600	2000	2000(2)	2000(3)	Int	1600	2000	2000(2)	2000(2)	2000(3)
	1000	1C	1600	2000	2000(2)	2000(3)	—(4)	—	—	—	—	—
		1B	2000	2000(2)	2000(2)	2000(3)	—(4)	—	—	—	—	—
	1200	1C	2000(1)	2000(2)	2000(3)	2000(3)	Min	2000	2000(2)	2000(3)	2000(3)	2000(3)
		1B	2000(1)	2000(2)	2000(3)	2000(3)	Int	2000(2)	2000(3)	2000(3)	2000(3)	2000(3)
	1600	1C	2000(1)	2000(2)	2000(3)	2000(3)	Min	2000(2)	2000(3)	2000(3)	2000(3)	2000(3)
		1B	2000(1)	2000(3)	2000(3)	2000(3)	Int	2000(3)	2000(3)	2000(3)	2000(3)	2000(3)

(1) In these ratings, the knee of the trip device curve passes through the minus 10% tolerance of the average melting curve of the fuse and it approaches or becomes target to the average melting curve.

(2) In these ratings, the average melting curve of the fuse passes through the knee of the trip device curve.

(3) For these combinations, the addition of short time-delay to the breaker tripping characteristic is recommended to improve the coordination with the fuse at the knee of the trip device curve. Contact the nearest General Electric sales office to obtain the specific breaker trip characteristics required for your application.

(4) Although these specific trip ratings are not available in Power Sensor, the next nearest rating or setting can generally be used.

NEW DESIGN MAKES FUSED BREAKER COMPACT, EASILY ACCESSIBLE

Integral mounting of current limiting fuses permits the breakers to be stacked the same as standard drawout breakers in AKD-5 Powermaster switchgear equipments with no increase in the height or depth of the equipment.

CO-ORDINATION OF POWER CIRCUIT BREAKER AND FUSE RESULTS IN SERVICE RELIABILITY

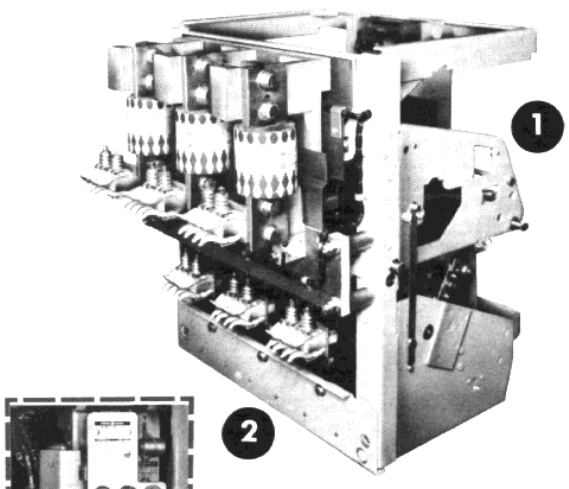
Properly co-ordinated circuit breakers and fuses avoid unnecessary blowing of fuses. In addition, the combination of CLF current limiting fuses and AK breakers are tested for proper performance when the available short-circuit current exceeds the interrupting rating of the breaker alone.

Time-current co-ordination of the breaker tripping characteristics and the fuse melting characteristics can usually be obtained through the use of a combination of long time delay and instantaneous tripping characteristics of the breaker. Where the required co-ordinations cannot be obtained through the use of long time-delay and instantaneous trip characteristics, combinations of long time-delay, short time-delay and instantaneous trip characteristics can be used.

Table B shows the minimum fuse rating which co-ordinates with a particular rating of the EC-2A overcurrent trip device. The commonly used combinations of long time-delay and instantaneous tripping characteristics were used in making up the table. Both the intermediate (1B) and the minimum (1C) long-time-delay bands of the EC-2A trip device are presented in combination with instantaneous trip settings from 4X through 12X.

Larger fuse ratings than those shown in the table may be used provided that the maximum fuse ratings for the breaker frame sizes (Table A) are not exceeded.

Table B has been prepared so that the knee of the trip device curve does not overlap the minus 10 per cent tolerance of the average melting curve of the fuse.

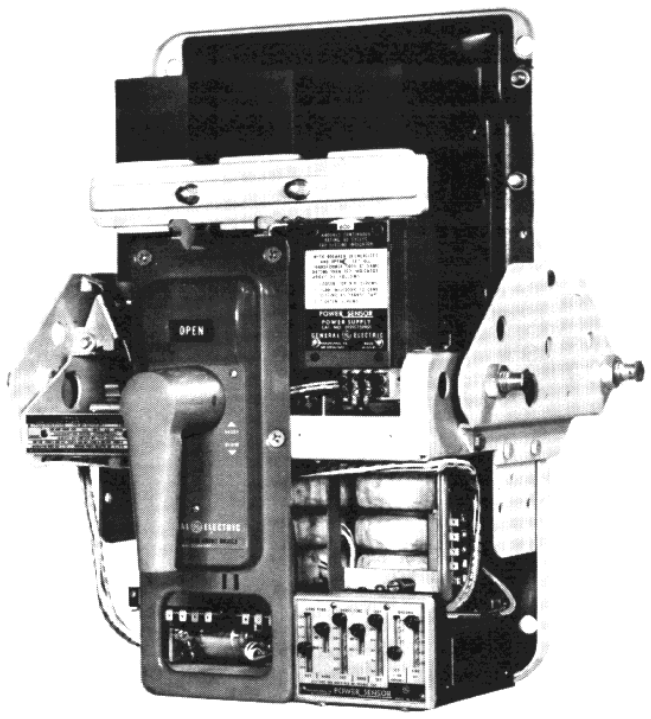


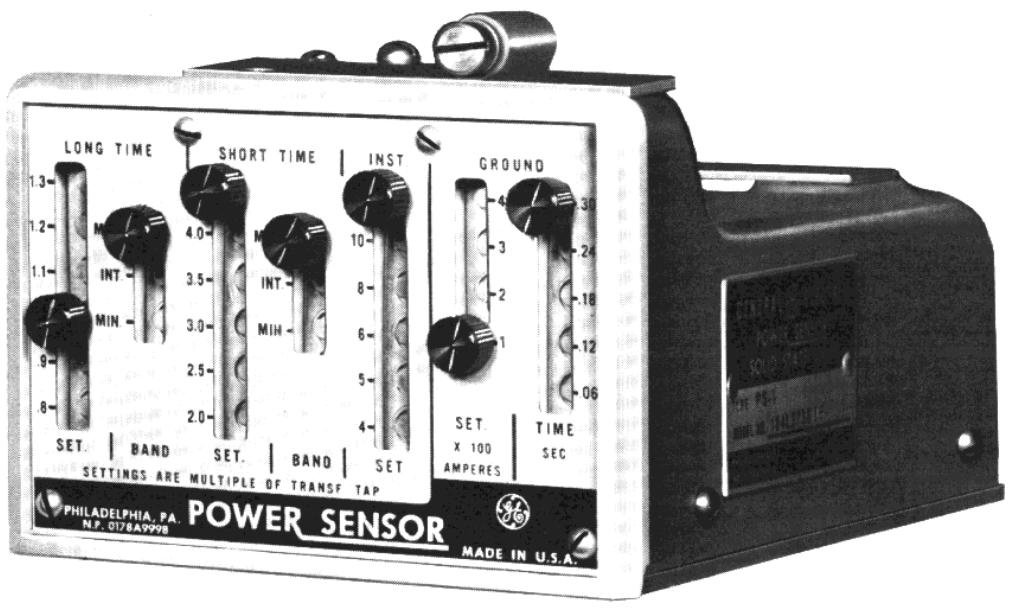
(1) Heavy-duty fuse mountings are shown in rear view of AKU-2A-50 circuit breaker. Fuses are easily accessible in the fully withdrawn position of breakers in AKD-5 equipments. (2) Open fuse lockout device on AKU-2A breaker protects against single phasing.

* Registered trademark of General Electric Co.

More power–more protection using POWER SENSOR

Overcurrent Trip Device



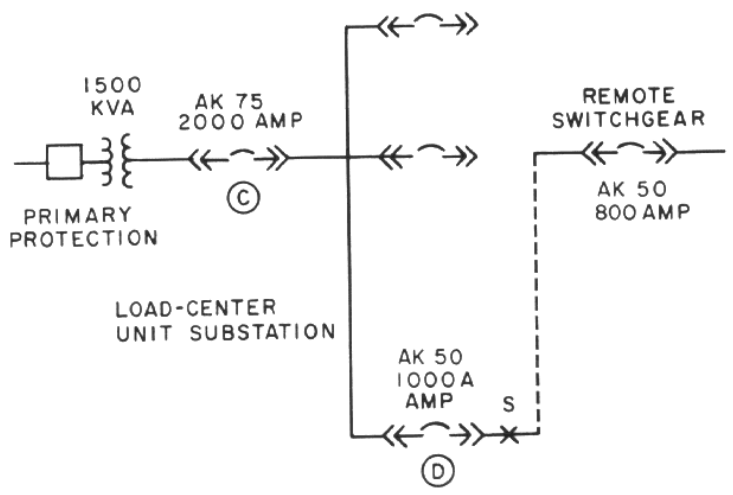


System application and coordination

The ideal electrical power distribution system is the selective system for the utmost in power continuity and reliability. The one-line diagram of a typical selective system is shown on the right.

The solid-state trip unit with its narrower operating band will permit closer co-ordination between the high voltage primary fuse or metal clad relay and the transformer main secondary breaker and feeder breaker. With an overcurrent fault at S the main breaker trip device (short time characteristic) can be selected so that it will not trip before the feeder breaker trips and isolates the fault. By comparison of the tripping curves, proper time values and bands may be selected to achieve this co-ordination throughout the entire short circuit range. Electromechanical devices have an inherently wider time band which results in some cases, in an area of overlap between tripping curves. Referring to the curves in Figure 1, an area of overlap results when attempting to coordinate a 1000 amp selective feeder device with a 2000 amp main breaker selective trip. Although the area of overlap is small, currents in this range could cause either the main breaker or feeder breaker to trip.

Figure 2 shows this same co-ordination plot with solid-state overcurrent trip devices. In this instance total selectivity is achieved with the absence of overlap between the time bands.



COMBINATIONS OF CHARACTERISTICS

The **POWER SENSOR** trip device will be available with combinations of trip characteristics which make it suitable for:

1. General purpose applications—where long time delay and instantaneous characteristics are used. Included in this type of application would be motor circuits.
2. Selective tripping applications—where long time-delay and short-delay characteristics are used. Applications such as a main breaker on a load center unit substation.
3. Ground fault tripping—where low level ground fault currents must be detected. Included on any solid-state trip unit as a factory supplied optional function.

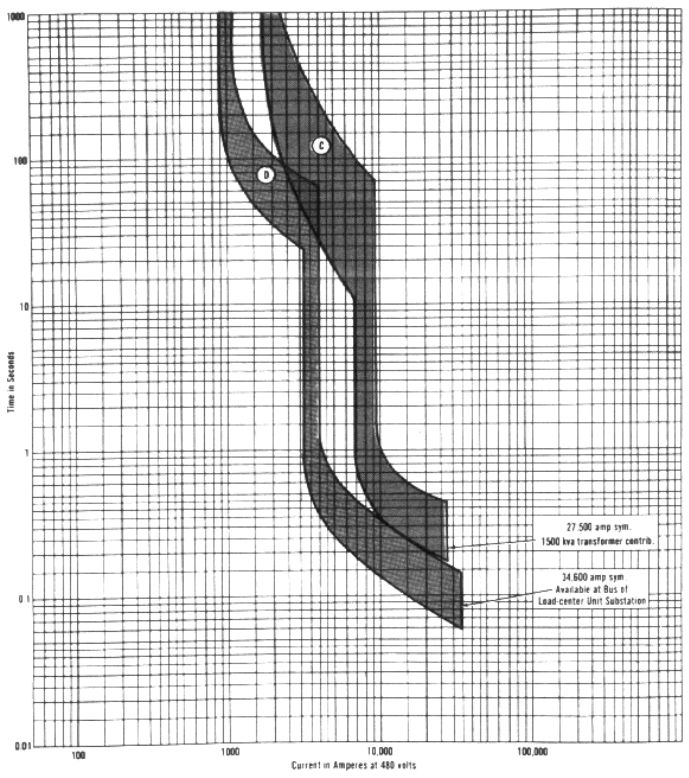


Fig. 1. Area of overlap with electromechanical trip device.

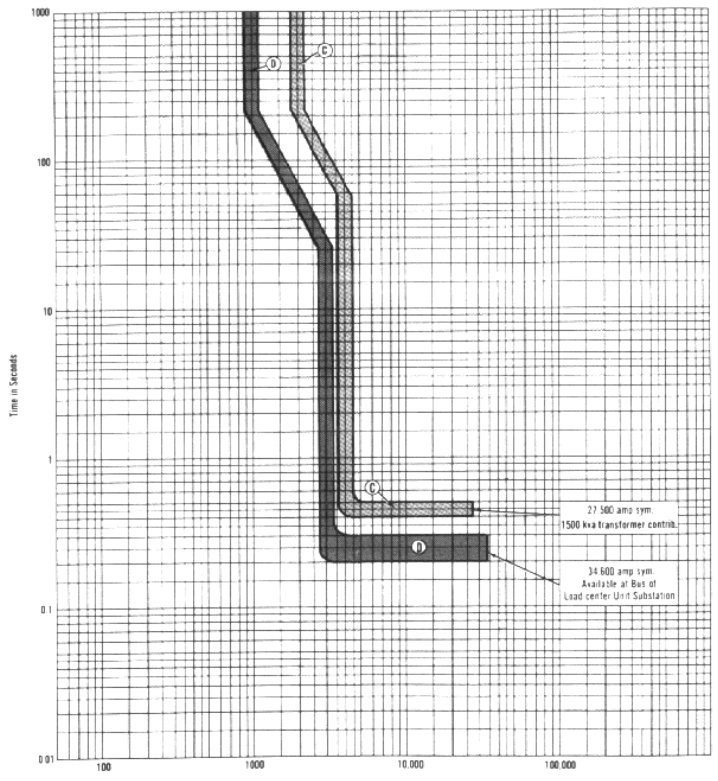


Fig. 2. No overlap in band width with solid-state trip device.

Full size transparencies of Power Sensor characteristics may be ordered from the nearest General Electric sales office under GEZ-4431.

Breaker Frame	Trip Rating-Amperes
AK-15, AK-25	45, 70, 90, 125, 175, **225**
AK-25, AK-50	200, 300, 400, 500, **600**
AK-50	600, 800, 1200, **1600**
AK-75	1500, 2000, 2500, **3000**
AK-100	2000, 2500, 3000, **4000**

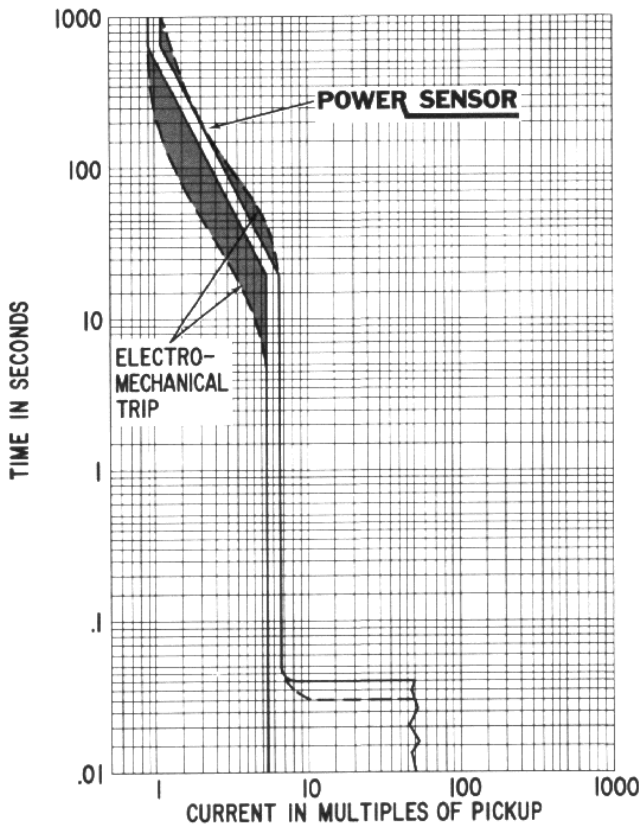


Fig. 3. Comparison of typical electromechanical tripping characteristics and Power Sensor characteristics.

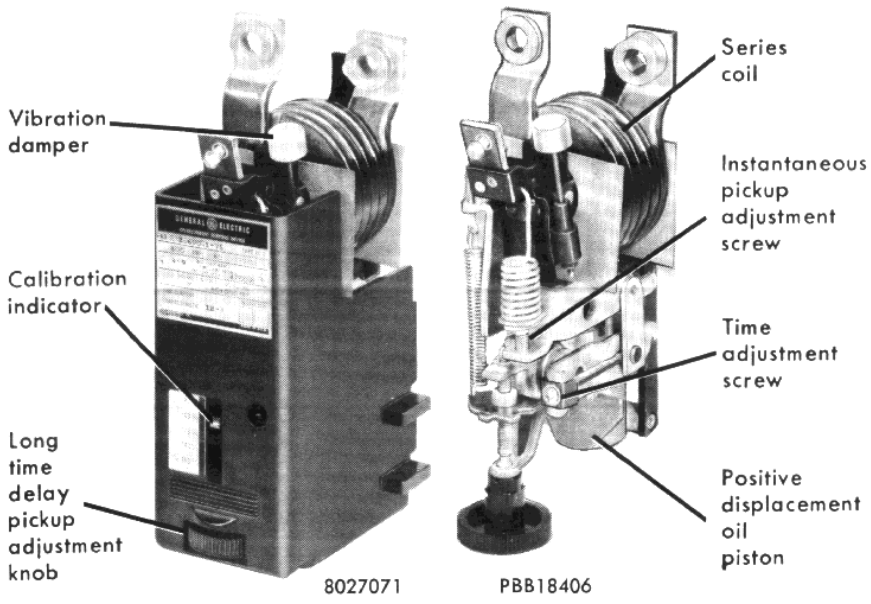
TABLE 1

Trip Characteristic† Solid State Trip Device	Range of Pickup Adjustment % of Tap Setting	Time Delay Band	Amount of Time Delay
Long time-delay	80-130% of trip device rating (Fixed point settings at 80, 90, 100, 110, 120 and 130%)	Maximum Intermediate Minimum	30 seconds 15 seconds 5 seconds
Short time-delay	200%(2X)—500%(5X) or 400%(4X)—1000%(10X) (Fixed point settings at 2X, 2½X, 3X, 3½X, 4X, & 5X and 4X, 5X, 6X, 7X, 8X & 10X)	Maximum Intermediate Minimum	24 cycles 12 cycles 4.8 cycles
Instantaneous	400%(4X)—1200%(12X) (Fixed point settings at 4X, 5X, 6X, 8X, 10X, 12X)		No Intentional Delay

△ Above are times at 600% of device rating measured at the lower limit of the band.

* Above times are at the lower limit of the band.

† The tolerance on all calibrated pickup settings, long time, short time and instantaneous, is ±10%.

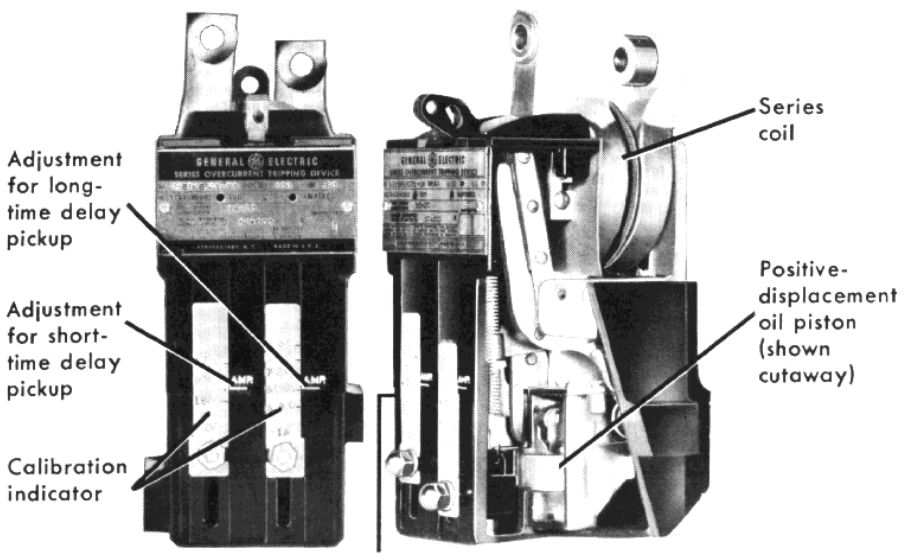


Type EC-2A Magnetic Overcurrent Tripping Device
Series trip for 225, 600, and 1600 amp frame size breakers

EC-2A FULLY ADJUSTABLE TRIP for all applications where the combination of long time delay and instantaneous, or instantaneous alone is required.

Available Characteristics	Range of Pickup Adjustment* (Tolerance ±10%)	Time Delay (Lower Limit of Band at 600% of Pickup Setting)	Factory Setting*
Long time	80–160% calibrated at 80, 100, 120, 140 and 160% of coil rating.	(1A) Maximum-adj. 15 to 38 sec. (1B) Intermediate-adj. 7.5 to 18 sec. (1C) Minimum-adj. 3.3 to 8.2 sec.	100% 1B—15 sec.
Instantaneous	6–12X coil rating 4–9X coil rating 9–15X coil rating 80–250% coil rating	Select one range—6 to 12X furnished unless otherwise specified	12X 9X 15X 100%

** Furnished unless otherwise specified.*



Type EC-1 Magnetic Overcurrent Tripping Device
Series Trip for 225, 600, and 1600 amp frame size breakers

EC-1 SELECTIVE TRIPS combine long time and short time elements for intentional delay up to interrupting rating of the breaker. For special applications, instantaneous may be added.

Available Characteristics	Range of Pickup Adjustment*	Time Delay (Lower Limit of Band)	Factory Setting
Long time	80–160%	(1A) Max. 30 sec. at 6 x pickup (1B) Inter. 15 sec. at 6 x pickup (1C) Min. 5 sec. at 6 x pickup	Must be specified
Short time	2–5 x coil rating 3–7 x coil rating 4–10 x coil rating	(2A) Max. 14 cycles at 2½ x pickup 2B) Inter. 9 cycles at 2½ x pickup (2C) Min. 4 cycles at 2½ x pickup	
Instantaneous	Non-adjustable	High Set	

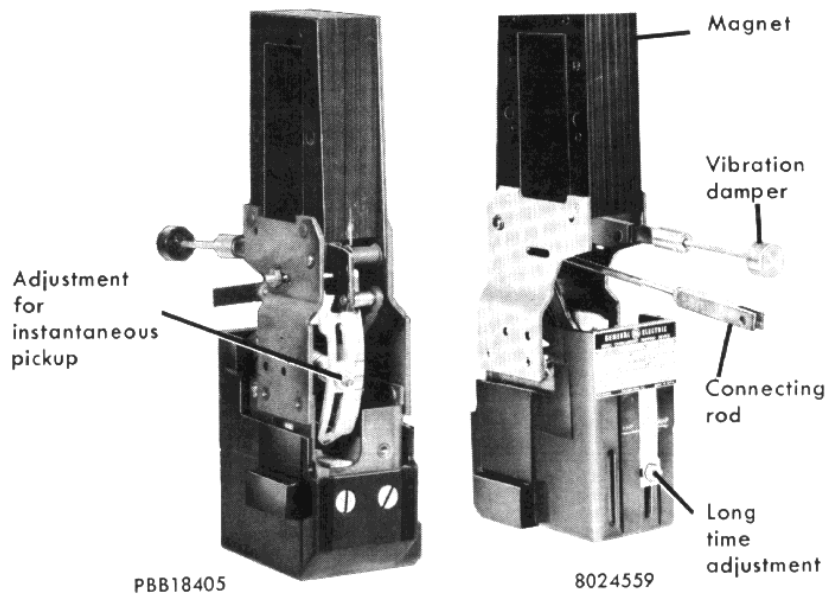
Type EC magnetic overcurrent trips are adjustable to meet a wide range of application requirements

Type EC overcurrent trip devices are magnetically operated, using a series coil or single conductor and an associated magnetic structure to provide tripping force. Three basic characteristics—long time delay, short time delay, and instantaneous—can be used in various combinations for a wide variety of applications.

LONG TIME DELAY is accomplished with a positive-displacement oil piston. Sealing of the assembly eliminates variations caused by atmospheric contamination, and silicone oil keeps variations in time delay due to changes in ambient temperature to a minimum.

SHORT TIME DELAY is accomplished with a rugged mechanical escapement.

INSTANTANEOUS TRIPPING is obtained when a tension spring yields to the force exerted on the magnetic armature at short circuit current levels, permitting the armature to move independently of the time delay piston. The full size transparencies of EC characteristics may be ordered from the nearest GE sales office under GEZ-4431.



Type EC-1B Magnetic Overcurrent Tripping Device
Trips for 3000 and 4000 amp frame size breakers

EC-1B FULLY ADJUSTABLE TRIP for all applications where combinations of long time delay, and instantaneous, or instantaneous alone is required—short time delay also available.

Available Characteristics	Range of Pickup Adjustment* (Tolerance ±15%)	Time Delay (Lower Limit of Band)	Factory Setting
Long time	80–160% calibrated at 80, 100, 120, 140 and 160% of coil rating	(1BB) Max. 4.5 sec. @ 6x pickup (1CC) Min. 2 sec. @ 6x pickup	100%—1BB
Short time	Three ranges available—select one 2, 3.5, 5X 3, 5, 7X 4, 7, 10X	(2AA) Max. 12 cycles @ 2½x pickup (2BB) Inter. 8 cycles @ 2½x pickup (2CC) Min. 4 cycles @ 2½x pickup	Must be spe
*Instantaneous	Three ranges available—select one 6–12X coil rating 4–9X coil rating 9–15X coil rating	Select one range— 6 to 12X furnished unless otherwise specified	12X 9X 15X

AK Breaker accessories meet specific needs, assure positive motor circuit control and protection

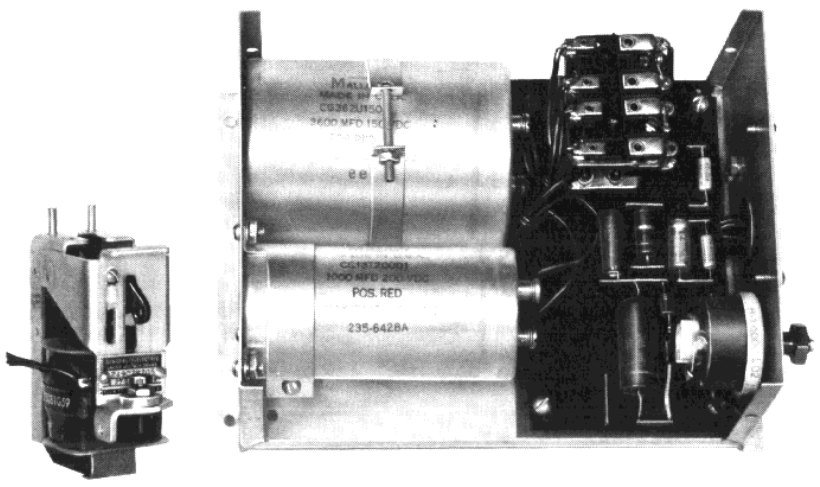
Complementing the complete AK Breaker accessories line are additional accessories such as position switches mounted in the equipment which function in the operating and withdrawn positions of the breaker, pushbuttons for local close-and-trip at the breaker, targets to indicate breaker position, and integral non-tripping alarm-contact over-current devices. Combined, these accessories assure that the AK Breaker provides the performance demanded for optimum motor control and protection in a variety of applications.

Essential among AK Breaker accessories are undervoltage trip devices, available in both instantaneous and time-delay forms. In motor starting applications, the time-delay form is normally used to prevent nuisance tripping on voltage dips. The undervoltage trip consists of a hinged armature which mechanically trips the breaker upon loss of voltage. (Until the coil is reenergized, the breaker will trip free if attempt is made to close it.) The AK Breaker static time-delay undervoltage device includes—in addition to the instantaneous device on the breaker—a remote-mounted accessory box containing capacitors, resistors, rectifiers, and relay. The device can be used for remote trip or for tripping from overload protective devices such as circuit-opening thermal overload relays. Uniquely, the static time-delay device is instantaneous when tripping from a protective device or remote switch, but time-delay when tripping from loss of voltage. It is, therefore, applicable if a Thermo-Tector* is used to protect a motor.

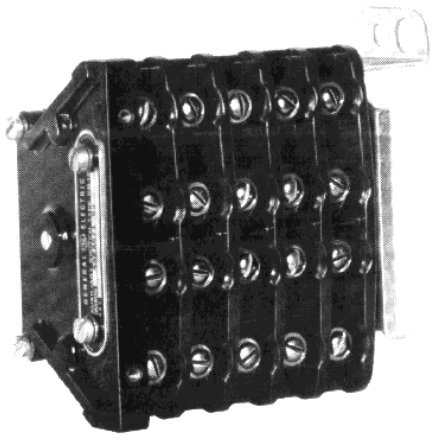
The time-delay undervoltage device has an input voltage rating of 208 or 230 volts at either 50 or 60 cycles. For any other source, a control power transformer rated 0.100 kva or above, with 230 volts secondary, must be used.

* Registered trademark of General Electric Co.

Electric lockout device to cross-interlock two or more breakers, or to prevent closing a circuit breaker manually or electrically until certain control-circuit conditions exist. The device prevents the breaker from being closed either manually or electrically unless the coil is energized, but it will not trip the breaker if the coil is deenergized while the breaker is closed.



Undervoltage trip devices featured in AK breakers are available in instantaneous form (left) and with time delay unit (right).



Auxiliary switches are devices with a rotary drum that provide necessary contacts of the "a" and "b" type to provide control in secondary circuits. Contacts operate as follows: "a" is closed when breaker is closed, "b" is open when the breaker is closed. Standard arrangements comprise four contacts (two stages), or ten contacts (five stages).

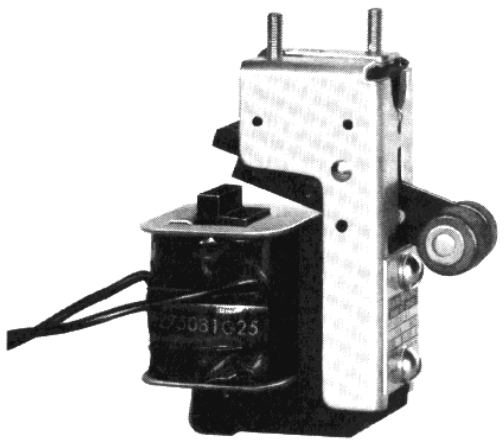
While alternate arrangements can be provided, two "a" and "b" switches are normally furnished on the four-contact switch with five of both types provided on a ten-contract switch. Special combinations of "a" and "b" contacts are available.

Interrupting ratings for one-stage auxiliary switches are:

TABLE II

Volts d-c	Non-Inductive	Inductive	Volts a-c	Non-Inductive	Inductive
125	11A△5	6.25A△5	115	75A△5	10A△5
250	2A	1.75A	230	50A△5	15A△5
			460	25A△5	5A

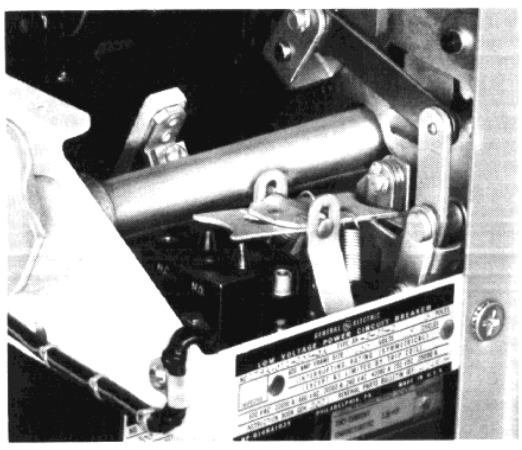
△ Limited to 20A continuous rating of switch on all breakers and to 5A continuous rating of No. 16 wire on drawout breakers.



Shunt trip device, standard on electrically-operated breakers and optional on manual types, features a hinged armature that trips the breaker instantaneously when its coil is energerized from a voltage source. Intended for remote electrical tripping from a control switch or push-button station, the device may also be used in conjunction with protective relays for automatic tripping. Operating currents are:

TABLE III

Volts	Voltage Operating Range Volts	Amperes	
		Inrush	Sustained
48 dc	28–60	4.5	4.5
125 dc	70–140	1.9	1.9
250 dc	140–280	1.0	1.0
115–60 cy	95–125	12.3	10.8
230–60 cy	190–250	6.9	5.7
460–60 cy	380–500	3.4	3.1
575–60 cy	475–625	2.8	2.5
208–60 cy	175–225	5.2	4.5
380–50 cy	315–410	2.9	2.6



Bell alarm device, used to close a bell circuit or other signaling device indicating automatic breaker tripping, is actuated by opening of the breaker. Used also for interlocking purposes, a lockout device is added to the alarm circuit to mechanically lock the breaker at "open" when the device is actuated. Current-closing rating of the contacts is 30 amperes at any voltage listed, with 10-ampere continuous current-carrying capacity and inductive interrupting ratings as indicated:

TABLE IV

Volts A-C			Volts D-C	
115	230	460	125	250
30A	15A	7A	2.5A	0.9A

Types IRT or TMC thermal relays, and IAC-66 overcurrent relays are typical of the special-design relays that can be featured on motor starting power circuit breakers. Among the numerous special-purpose types available are the types IAC and PJC ground sensor relays.

Armor-Clad* feeder busway

Rated 600 volts AC in either three- or four-pole construction, with half or full neutral, ARMOR-CLAD feeder busway is available in ratings ranging from 600 to 4000 amperes in aluminum, and 600 to 500 amperes in copper. Its short circuit ratings range up to 200,000 amperes.

ARMOR-CLAD feeder busway is a fully-enclosed, non-ventilated design. It is also, as standard, an outdoor, weather-proof and dust-resistant design.

STRAIGHT LENGTHS

Width dimension is a constant 5¼" for all ratings. Standard lengths are 10, 6, 5, 4, 3 and 1½ feet. However, any special length between 1½ feet and 12½ feet is available.

COPPER BUS BARS

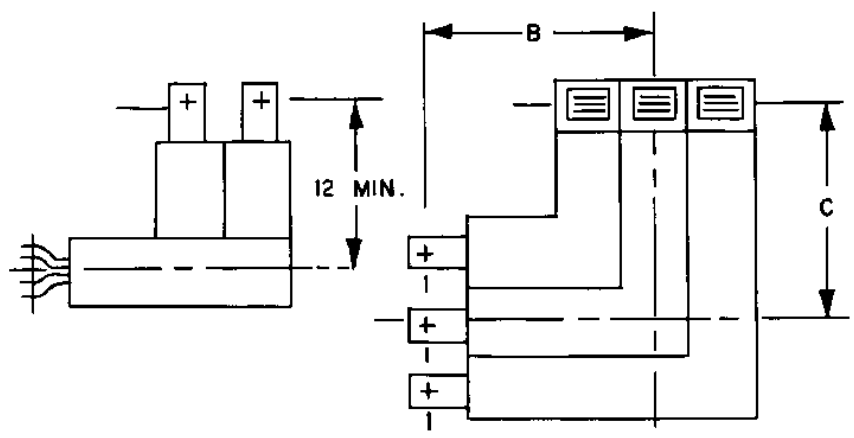
Ampere Rating	"A" Dim. (inches)	Weight Per Ft. (Lbs.)		
		3ø, 3W	3ø, 4W, H.N.	3ø, 4W, F.N.
600	5¾	13	13	14
800	6¼	14	15	16
1000	7	17	18	20
1200	8¼	21	23	25
1350	8½	22	24	26
1600	9¼	24	27	29
2000	14¼	32	35	38
2500	16¼	39	43	47
3000	18¼	46	51	56
4000	25¾	62	69	76
5000	30¼	77	86	95

ALUMINUM BUS BARS

Rating Ampere	"A" Dim. (inches)	Weight Per Ft. (Lbs.)		
		3ø, 3W	3ø, 4W, H. N.	3ø, 4W, F.N.
600	7	11	12	12
800	7¼	12	12	13
1000	8¼	13	14	14
1200	9¼	14	15	16
1350	10¼	16	17	18
1600	14¾	21	22	23
2000	16¾	23	25	26
2500	20¼	28	30	32
3000	25¾	35	37	39
4000	31	42	45	48

ELBOWS

COMBINATION FLATWISE/EDGEWISE ELBOWS



Ampere Rating	Aluminum		Copper	
	"B"	"C"	"B"	"C"
600	14	8	13	7
800	14	8	13	7
1000	14	8	14	8
1200	15	9	14	8
1350	15	9	14	8
1600	18	12	15	9
2000	19	13	17	11
2500	20	14	18	12
3000	23	17	19	13
4000	26	20	23	17
5000	—	—	25	19

WEATHERPROOF AS STANDARD

Because General Electric ARMOR-CLAD feeder busway is furnished completely weatherproofed as standard, there is no longer a need to specify a separate weatherproof incoming line busway for connection to outdoor transformers. And the standard weatherproof design of General Electric ARMOR-CLAD allows it to be installed as the building is being constructed, even before the roof goes on.

General Electric ARMOR-SEAL* polyurethane foam is used to completely seal the empty channel spaces of the busway housing. (See Fig. 4) ARMOR-SEAL* excludes entrance of water and prevents any possible moisture condensation. In addition, ARMOR-SEAL* is extruded around the insulated conductors at each joint where the conductors extend from the housing, again to prevent entrance of water. Further, special low durometer synthetic rubber is used to gasket the joint cap and other areas of each joint producing a water-tight sealed joint. All fittings with the exception of Power Takeoff boxes and devices are weatherproofed as standard.

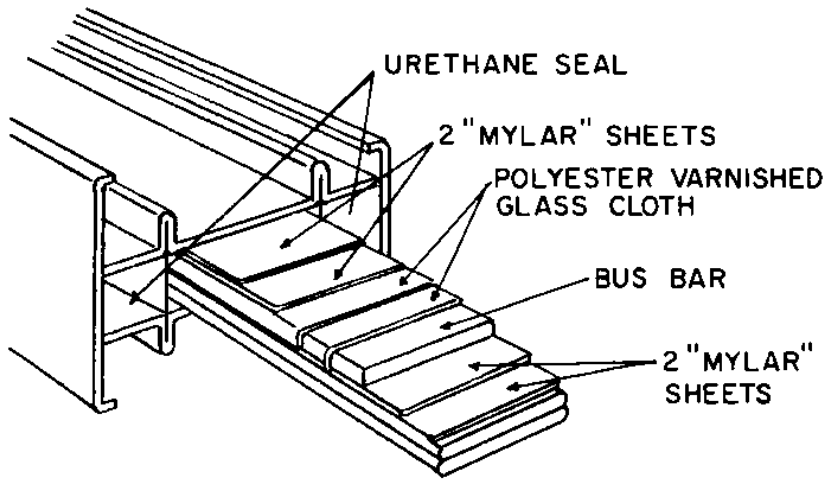


Fig. 4. Armor-Clad bus bars insulation

*Trademark of the General Electric Company.

Power circuit breaker application guide

TRANSFORMER SECONDARY BREAKER

A transformer secondary breaker is recommended for one or more of the following purposes:

1. To provide a fast method of removing all load from the transformer. Article 230-70 (g) of the NEC specifies that the disconnecting means for service conductors may consist of *not more* than six circuit breakers;

2. To provide required transformer secondary overcurrent protection in accordance with NEC Article 450-3;

3. To provide protection for faults on the main bus (a basic consideration);

4. To provide a disconnect for maintenance purposes;

5. To provide for throwover, automatic or manual, to an alternate source in the case of failure of a primary feeder or transformer (secondary selective circuit arrangement);

6. To back-up lower rated cascaded feeder breakers;

7. To simplify key interlocking schemes when the number of feeder breakers exceeds the practical limit.

The rating of the transformer secondary breaker should be based on the fact that forced cooling may be applied at some future time to increase the transformer rating as much as 33 percent.

GENERAL PURPOSE FEEDERS

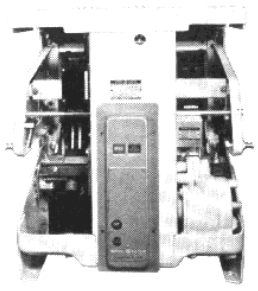
For a-c circuits, there should be one breaker pole with overcurrent trip in each ungrounded conductor. For polyphase circuits, it is essential that all phases be disconnected simultaneously; therefore multipole breakers are used.

The dual-magnetic trip (long time-instantaneous) with a 1B long time-delay characteristic is commonly used for general purpose a-c feeders. Instantaneous trip settings should be determined on the basis of the type of load and the type of protection desired. For instance, where arcing fault protection is a consideration, as low a setting as is consistent with the inrush characteristic of the load should be used.

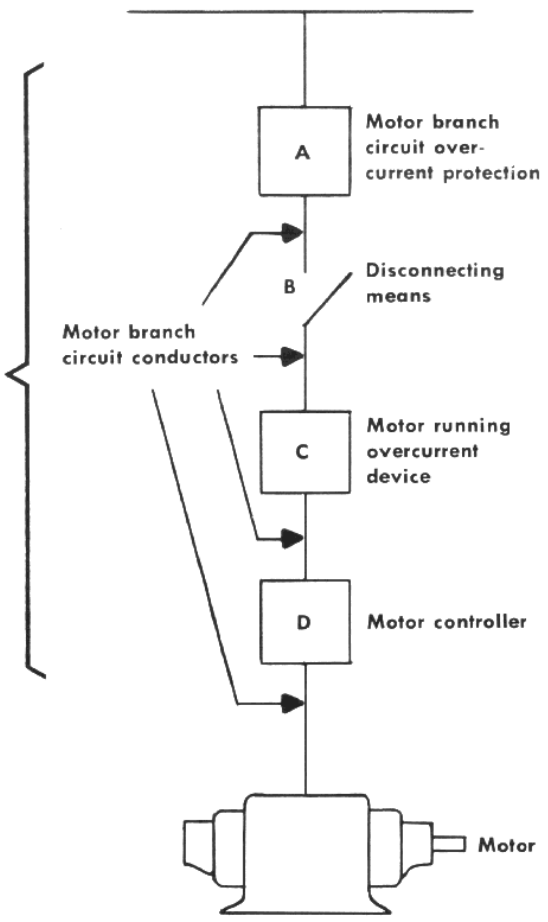
A-C MOTOR STARTING AND FEEDER BREAKERS

Low voltage power circuit breakers may be applied in motor branch circuits and in motor feeder circuits. They are particularly suited both economically and from a good system design viewpoint for motors rated above 100 hp.

A motor branch circuit is a circuit including a single motor and a single breaker. A motor feeder circuit is a circuit including a breaker which supplies more than one motor branch circuit. Circuit breakers may also be used for motor-running overcurrent protection and as the motor controller for starting, combining the function of elements A, B, C, and D in the motor-branch circuit diagram in accordance with NEC 430-1, shown above.



Type AK Starting Power Breaker



Elements of a motor-branch circuit

Because of the high inrush current associated with motor starting, only breakers with electrically or manually operated stored-energy mechanism should be used. All AK breakers listed in this bulletin are available with either of these types of mechanisms.

In single-motor circuits where the breaker is providing either branch circuit or motor-running overcurrent protection the breaker and its trip devices must have the following characteristics:

1. CONTINUOUS CURRENT-CARRYING CAPACITY at least 115% of motor full-load current (enclosed motors may have other service factors). See table on page 29 for the selection of the continuous current rating.

2. INTERRUPTING CAPACITY sufficient for available short-circuit current.

3. TRIP DEVICE CHARACTERISTICS with sufficient time delay in the overload trip to ride over the starting current of the motor. Instantaneous tripping for protection of the motor and its circuit, set low enough to protect, and not so low that tripping occurs on transient inrush. A setting of two times the locked rotor current is considered adequate for most conditions.

In applications where the AK low-voltage power circuit is performing the function of motor controller as well as motor branch circuit protection, the number of operations which the breaker can perform without maintenance should be considered. Based on closing currents up to 600% of the frame size rating and opening currents equal to the frame size rating, AK breakers will perform the number of operations indicated in chart below.

Frequently, a particular frame size of breaker will be used to control a motor considerably smaller in size than those shown under the column headed "Maximum HP at 440 Volts." In these cases the number of operations which the breaker can successfully perform before inspection and servicing will increase appreciably up to the no-load mechanical life of the device.

Additional protection for the motor may be obtained through the use of

TABLE V. Endurance and Maximum Horsepower Ratings of AK-2 Motor Starting Breakers

Induction Motor Starter Type	MAX Horsepower Ratings			Endurance At Max. Rated Horsepower (No. of Operations on Motor Starting Duty*)
	230V	460V	575V	
AK-15	75 hp	150 hp	200 hp	9000
AK-25	200 hp	400 hp	500 hp	9000
AKU-25**	150 hp	300 hp	400 hp	9000
AK-50	500 hp	1000 hp	1000 hp	9000
AKU-50**	250 hp	500 hp	600 hp	9000

*Number of operations before repair which may include replacement of interrupting unit parts. These numbers apply only to fully completed starts and not to interrupted starts such as jogging, inching, automatic sequencing or protective relay operations. See ASA-C-37.13

These endurance ratings do not eliminate the need for periodic maintenance as indicated in the applicable instruction book for the breaker.

**Motor ratings are limited by the maximum ratings of forces which can be used on AKU breakers.

TABLE VI. Trip Device Selection

To Full-voltage starting and running duty of 3-phase, 60-cycle, 40 C rise induction motors*

Horsepower Rating of 3-phase Alternating current Motors*** Induction Motors			Trip Coil Rating of Circuit Breaker Amperes With EC Trip	Settings of breakers equipped with Power Sensor Trips	Motor Full-Load Current Amp		Max. Permissible Locked-rotor Cur. 60 cycles Amperes**
230 Volts	460 Volts	575 Volts			Min.	Max.	
10	25	30	40	45 @ 90%	26	35	320
15	30	40	50	45 @ 110%	32	44	400
20	40	50, 60	70	70	45	61	560
25, 30	50, 60	75	90	90	58	78	720
40	75	100	125	125	80	109	1000
50	100	125	150	125 @ 120%	96	131	1200
60	....	150	175	175	112	152	1400
....	125	...	200	200	128	174	1600
75	150	200	225	225	144	196	1800
....	....	...	250	225 @ 110%	160	218	2000
100	200	250	300	300	192	261	2400
....	250	300	350	400 @ 90%	224	304	2800
125	....	350	400	400	256	348	3200
150	300, 350	400, 450	500	500	320	435	4000
200	400	500	600	600	384	522	4800
250	450, 500	600, 700	800	800	512	696	6400
300, 350	600, 700	800, 900	100	800 @ 120% 800 @ 130%	640	870	8000
400	800	1000	1200	1200	768	1044	9600
450, 500	900, 1000	...	1600	1600	1023	1392	12800

* Synchronous motor selection data available on request.

** Locked rotor currents are based upon motors having NEC Code letters A through J inclusive. If the locked rotor current exceeds this value, select the circuit breaker having the next higher continuous current rating, provided there is a calibration point on the breaker which does not exceed 140 per cent of the full-load current rating of sealed (hermetic-type) refrigeration compressors motors, and motors marked to have a temperature rise not over 40°C and not higher than 130 per cent of the full-load current rating for all other motors.

***Characteristics of motors rated in excess of 200 hp vary widely, and so no standard application tables can be developed. The numbers above are offered for guidance only.

Table VII. Thermal Relay Selection

For Standard 40 C Continuous Rated Motors (115% Service Factor)

IC2824-34N		CR124K028	
Coil Cat. No.	*Max. Motor Full Load CT Secondary Current	Heater Element Cat. No. CR123...	*Max. Motor Full Load CT Secondary Current
366A710		K2.49A	2.21
G21	2.20	K2.77A	2.40
G22	2.40	K3.01A	2.62
G23	2.65	K3.29A	2.89
G24	2.90	K3.62A	3.17
G25	3.20	K3.98A	3.49
G26	3.51	K4.38A	3.82
G27	3.84	K4.79A	4.21
G28	4.25	K5.27A	4.65
G29	4.68		

*CT Sec. $1 \frac{\text{Motor FLI}}{\text{CT Ratio}}$ Relays are adjustable over a range of 90% to 110% of the coil or heater rating.

separate thermal relays or thermo-tectors built into G-E motors. Either of these protective devices can be used to trip the breaker in response to abnormal conditions.

INHERENT MOTOR PROTECTION—THE THERMO-TECTOR**

The thermo-tector is a specially designed heat-sensing switch embedded in the stator windings of some G-E motors. It is responsive to rate-of-rise of temperature as well as actual temperature. It will protect for locked rotor, overload, high-ambient, loss of ventilation, and single phase operating conditions; in fact, any short- or long-time abnormal condition that can raise the temperature of a winding to a dangerous degree.

Each thermo-tector (there are at least three) has a single normally closed contact (circuit opening on rising temperature) that must be connected in the coil circuit of the motor controller. When using Type AK Power Circuit Breakers as motor controllers, the control is arranged so that the thermo-tector initiates trip of the circuit breaker by the undervoltage device or by the shunt trip device.

The branch circuit breaker for motors with inherent thermal protection should be provided with the usual instantaneous overcurrent trips set at twice locked rotor current and with long-time overcurrent trips for cable and for back-up protection and with sufficient delay to allow the motor to start. Since the breaker long-time trip element is not depended upon for motor running overcurrent or stalled rotor protection, the long-time trips can be set somewhat higher than usual for motor circuits, usually 150–200 percent of motor rating depending on the cable size.

** Registered trademark of General Electric Co.

GENERATOR CIRCUITS

The power circuit breaker for a generator should include quick-close mechanism for synchronizing and should have a continuous current rating of about 125 percent of the maximum current rating of the generator. Each pole of the breaker should be provided with overcurrent trip devices having the following characteristics:

1. Long time, set for 125 to 150 percent of the generator continuous current rating and for maximum time, for continued moderate overcurrent protection of the generator.

2. Short time, set at 2 to 2.5 times generator continuous current rating, as required for selectivity with feeder breakers, for protection against bus faults.

3. Instantaneous, set at 10 to 12 times generator continuous current rating, for generator circuit protection on internal faults fed from other sources in system.

The generator breaker must have an interrupting rating equal to or greater than the available short-circuit current at the breaker location from all power sources on the system, including motors. The initial value of short-circuit current calculated from the generator sub-transient reactance should be used in determining the interrupting rating required. This current may be 7 to 15 times the continuous current rating of the generator.

The short-circuit current from a generator is the large value determined by the sub-transient reactance. This current decays with time until it reaches a lower sustained value that is dependent on machine synchronous reactance and excitation system characteristics. The actual sustained value may be any value between substantially zero and about three times generator continuous current rating.

The plotted values of generator output current and time under short-circuit conditions is called the decrement curve. It determines the settings and time-current characteristics required on the generator and feeder breakers in a selective system. The decrement curve of a particular generator may not be available, but the two most important points, the initial value and the sustained value of short-circuit current, can be obtained from the manufacturer.

Self-excited generators (generator field or exciter field energized from generator voltage) require special consideration because of the rapid decrement of short-circuit current to zero. Proper tripping of the generator breaker, and selectivity between the generator and feeder breakers, can be obtained with such generators only if provision is made in the excitation system for forcing the generator to sustain short-circuit current of sufficient magnitude and duration to operate the overcurrent trip devices.

For better protection of the generator, induction type overcurrent relays with voltage restraint, type IJCV, may be used to provide tripping through a shunt trip device on the breaker. D-c tripping power, or capacitor trip, is required for reliable trip under short-circuit conditions. Suitable current and potential transformers and a lockout relay are required in addition to the IJCV relays.

When generators are operated in parallel with other sources, a reverse power relay should be included for anti-motoring protection. A shunt trip device, which may be a-c operated, is required on the breaker.

RESISTANCE WELDING MACHINE CIRCUITS

Certain forms of low voltage power circuit breakers are particularly adaptable to and recommended for the protection of circuits which feed welding machines for spot, seam, projection, and flash welding.

Welding-type breakers are equipped with instantaneous trips and will promptly and safely interrupt overcurrents or short circuits and permit immediate restoration of service.

Breakers with time delay electro-mechanical overcurrent trip devices are not recommended for use in circuits feeding welding machines because the relatively high intermittent welding currents can cause rapid wear in trip devices, resulting in calibration changes and nuisance tripping. Where overload protection is required, thermal overload relays and current transformers or Power Sensor tripping, provide better results.

RESISTANCE WELDING BREAKERS

Type of Breaker	Interrupting Rating RMS Symmetrical Amperes 60 Cycles A.C.			Range of Instantaneous Trip Calibration Amperes
	600 V	480 V	240 V	
AK-15Y1	14000	22000	25000	300 to 800, or
AK-25Y2	22000	30000	42000	600 to 1500
AK-25Y1	22000	30000	42000	600 to 1500, or
AK-50Y3	42000	50000	65000	1400 to 4000, or
				2000 to 5000
AK-50Y2	42000	50000	65000	1000 to 2500, or
				2000 to 5000, or
				4000 to 10000

Ground Fault Protection—solidly grounded systems

The need for ground fault protection in low voltage power distribution systems is very real and this protection is a commonly used technique to insure maximum continuity of service in line with good protection requirements.

Article 110-10 of the 1968 National Electric Code details the need for this type of protection in low voltage distribution systems.

The principal reason for this specialized form of overcurrent detection is the arcing type fault which can occur in solidly grounded low voltage systems and also in those grounded in other ways. This discussion will center on the solidly grounded system.

Arcing faults have two characteristics—high rates of energy release and possible low fault current levels—which make it necessary for protection methods to have two important features: a high degree of sensitivity to detect low-level arcing-fault current and fast operation to limit the destructive effects of the arc. The protective device that actually opens to prevent current flow to the fault must be fully rated to interrupt the maximum fault levels to be expected.

Setting of the instantaneous trips on circuit breakers as low as possible to just avoid nuisance tripping under normal conditions is the first step toward protecting against these low level arcing faults. To supplement this type of protection, a method is required to detect the flow of low level ground currents of values below the settings of the instantaneous trips. Two schemes are available—the GSR method employing current transformers and electromechanical relays and, where the Power Sensor* Solid State Trip Device is used, the ground sensor attachment to that device which employs a solid state sensing mechanism to provide tripping intelligence.

Table I—*Standard Circuit Arrangement*

Equipment Protected by GSR	With Window CT Applied to	CT Location in Fig. 1
Main bus	Ground return circuit	A
Busway	Ground return circuit	B
Cable	All outgoing phase conductors	C

The GSR System

The ground sensor relay (GSR) system is basically a system of current transformers and relays to sense ground-fault current and actuate the tripping circuit of the circuit protective device. Figure 1 shows typical arrangements for feeder and main GSR devices in a switchboard. This figure also shows the standard circuits which would be used. The specific location of the GSR and current transformer would vary, depending upon the type of equipment. The CT location for specific circuit arrangements is given in Table I.

Under normal operating conditions, no current flows in the equipment ground circuit of such equipments as switchboards, motor control centers, busways and conduits.

In a solidly grounded system, when an arcing fault occurs line-to-ground, current flows in the equipment ground circuit back to the grounded neutral of the transformer. The GSR overcurrent relay with its associated current transformer senses the current in the ground return circuit. When the magnitude of the current exceeds the pickup setting of the relay, the relay closes its contacts after a set time delay elapses, and applies line voltage tripping power to the shunt trip coil of the related protective device. This opens the device and disconnects the power from the faulted circuit or equipment.

The GSR system is a fully selective system. Referring to Fig. 5, GSR-O is instantaneous; no deliberate time-delay is used. GSR-1 is selective with GSR-O or with the breaker direct-acting trip; GSR-2 is selective with GSR-1 etc. The values of pick-up current and time-delay for GSR-1 have been chosen so that it will be selective with circuit breakers normally used in lighting panelboards and small distribution panelboards.

Ground Sensor Attachment to Power Sensor* Solid State Trip Service

The ground sensor component of the new solid-state overcurrent trip device

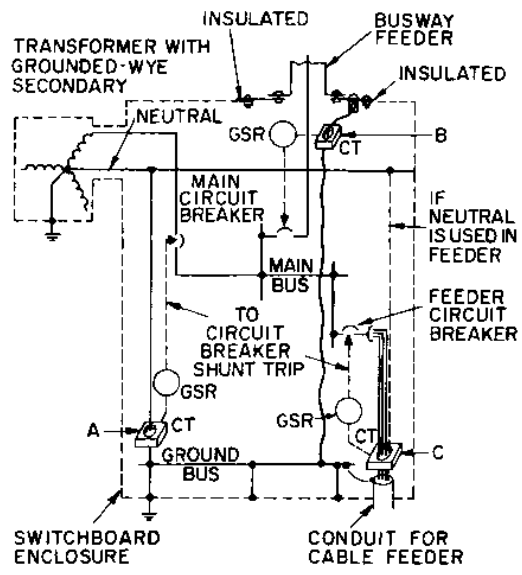


Fig. 5. Ground-fault protection in switchboard showing typical main breaker and feeder breaker GSR arrangements.

is not responsive to phase-to-phase currents but is instantly responsive to low-values of phase-to-ground currents. It is especially designed for fast, sensitive and selective ground-fault protection as an integral part of the solid-state over-current trip device for type AK low-voltage power circuit breakers.

The ground sensor component consists of three current sensors, one on each pole of the breaker, and associated solid-state circuitry. On four-wire systems, a fourth sensor is mounted on the neutral conductor of the circuit to take into account phase-to-neutral loads. These sensors are entirely separate and independent of the current sensors for the phase-overcurrent trip devices. The three (or four) sensors are connected in series, which means that the output voltage is directly proportional to a current flowing out on one conductor that does not return over one of the others; that is, the output voltage is proportional to the phase-to-ground current. This voltage actuates the solid-state components to measure the current level and length of time the current is flowing, and then to trip the breaker.

The solid state ground sensor is applied much like the GSR scheme with successive steps of coordination set into the system starting at the lowest downstream feeder employing the AK breaker. Up to 5 steps of coordination in series are possible using this solid state ground sensor.

The time current curves of the solid state ground sensor can be ordered from the nearest G. E. Sales office under GEZ-4431.

*Trademark of General Electric Co.

How to select switchgear

The application tables on the following pages list the proper low voltage power circuit breakers for load center applications. The power circuit breakers have been co-ordinated with transformer and system capacities—electrically, thermally, and mechanically.

BASIS FOR APPLICATION TABLES

Application tables are based on the following:

1. A three-phase bolted fault at the low voltage terminals of the substation;

2. Transformer impedances listed in table;

3. Only source of power to the secondary is the substation transformer;

4. Total connected motor kva does not exceed 50 percent of transformer rating at 208Y/120-volts and 100 percent of transformer rating at 240-, 480-, and 600-volts.

5. The motor contribution is taken as 2.0 times the normal current of the transformer at 208Y/120 volts and 4.0 times normal at 240, 480, and 600 volts;

6. Coil sizes are listed for a circuit breaker applied at its maximum interrupting rating at the specified circuit voltage. Smaller coils may be used if available short-circuit current is less;

7. Tabulated values of short circuit current are in terms of RMS **symmetrical amperes** per NEMA Standard SG-3.

SUBSTATION ELECTRICAL ARRANGEMENT

Substations are available in a selective, fully rated, or cascaded arrangement. Care should be taken to specify the arrangement that provides the balance of selectivity and protection required by the power system.

SELECTIVELY CO-ORDINATED SUBSTATIONS

A selectively coordinated substation uses fully rated breakers (breakers that are applied within their interrupting ratings), with long-time and short-time trip characteristics (LS) to delay the opening of the main circuit breaker until the faulted feeder has had an opportunity to clear. This provides service continuity for all but the faulted circuit.

Selectivity may be carried a step further in the substation by specifying selective feeder circuit breakers that incorporate long-time and short-time characteristics (LS) to allow downstream devices to clear faults within their area.

A refinement of the selective feeder incorporates the long-time, short-time with high-set instantaneous characteristics (LSI) to provide selectivity without sacrificing instantaneous fault protection.

APPLICATION RANGE—AK CIRCUIT BREAKERS

G-E Breaker Type	Voltage Rating 60 Cycles A.C.	Interrupting Rating in Amperes, RMS Symmetrical		Overcurrent Trip Device Rating—Amperes					Short-time Rating Amperes RMS Symmetrical	Short Circuit Limit for 2-step Cascade Operation Amperes RMS Symmetrical
		With Inst. Trips	Without Inst. Trips	Min. with Instantaneous Characteristic	Min. with 2C Short-time Characteristic	Min. with 2B Short-time Characteristic	Min. with 2A Short-time Characteristic	Max. Breaker Rating		
AK-15	600	14,000	9,000	15	100	125	150	225	9,000	25,000
AK-25		22,000	22,000	40	175	200	250	600	22,000	42,000
AK-50		42,000	42,000	200	350	400	500	1600	42,000	85,000
AK-75		65,000	65,000	2000	2000	2000	2000	3000	65,000	85,000
AK-100		85,000	85,000	2000	2000	2000	2000	4000	85,000	85,000
AK-15	480	22,000	9,000	20	100	125	150	225	9,000	42,000
AK-25		30,000	22,000	100	175	200	250	600	22,000	60,000
AK-50		50,000	50,000	400	350	400	500	1600	50,000	85,000
AK-75		65,000	65,000	2000	2000	2000	2000	3000	65,000	85,000
AK-100		85,000	85,000	2000	2000	2000	2000	4000	85,000	85,000
AK-15	240	25,000	9,000	30	100	125	150	225	9,000	50,000
AK-25		42,000	22,000	150	175	200	250	600	22,000	85,000
AK-50		65,000	50,000	600	350	400	500	1600	50,000	100,000
AK-75		85,000	65,000	2000	2000	2000	2000	3000	65,000	130,000
AK-100		130,000	85,000	2000	2000	2000	2000	4000	85,000	130,000

STANDARD CONTINUOUS CURRENT RATINGS (EC TRIP COIL RATINGS)*

G-E Breaker Type	Continuous Current Ratings (Observe minimum limits set by application tables above and on pages 27–30)
AK-15	15, 20, 30, 40, 50, 70, 90, 100, 125, 150, 175, 200, 225
AK-25	40, 50, 70, 90, 100, 125, 150, 175, 200, 225, 250, 300, 350, 400, 500, 600
AK-50	200, 225, 250, 275, 300, 350, 400, 500, 600, 800, 1000, 1200, 1600
AK-75	2000, 2500, 3000
AK-100	2000, 2500, 3000, 4000

*See p. 22 for P/S Tap Settings

Further, this combination of trip characteristics permits application of the breaker up to its interrupting rating with instantaneous trips, rather than the interrupting rating without instantaneous trips. This is called the Zone-Selective arrangement and is often desirable when the load-center feeder serves a motor control center.

FULLY RATED SUBSTATIONS

Fully rated arrangements use fully rated breakers with long-time and instantaneous trip characteristics (LI) on both main and feeder circuit breakers. The main circuit breaker may, or may not, trip for a feeder fault—depending on fault magnitude with respect to the instantaneous trip setting.

CASCADED SUBSTATIONS

Cascaded arrangements allow feeder breakers to be applied on circuits that are subject to fault currents in excess of the normal published interrupting rating of the breakers.

Under the cascade system a short circuit on the feeder circuit may trip the main breaker. NEMA standards state that the operation of breakers in excess of their interrupting rating (as in cascade) is limited to one operation after which inspection, maintenance or complete replacement may be required. It is further recommended that all feeders applied in cascade be power operated from a remote location.

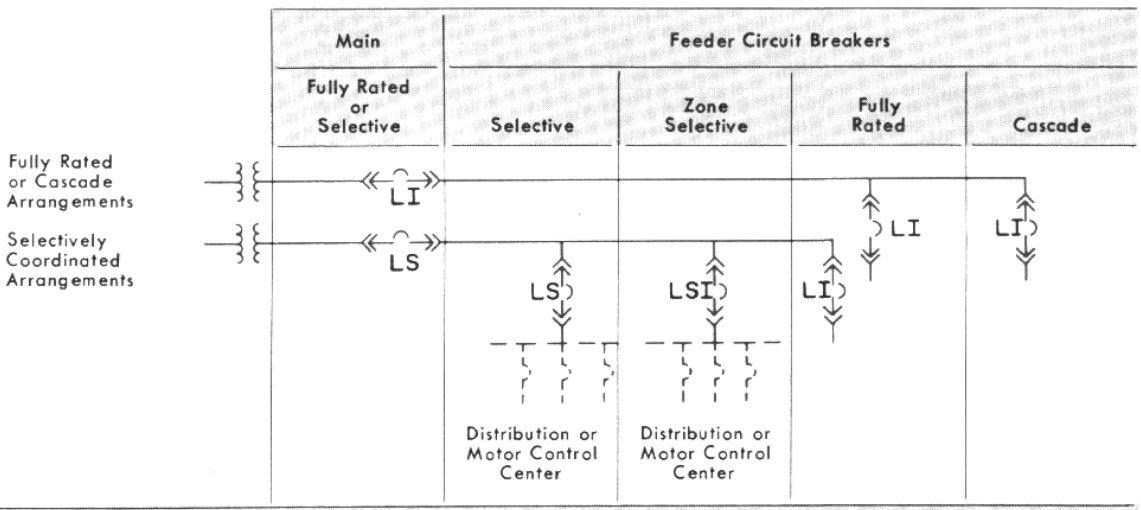
EXAMPLES

The tables make it easy to select the proper G-E breakers for use with each system. For instance, using a fully rated system, a 1000-kva, 480-volt load-center unit substation with a primary source having a 150 mvà maximum available short-circuit capacity, requires an AK-50 main breaker with AK-25 feeder breakers.

Should either the main circuit breaker, or feeder circuit breakers be equipped with selective trips, the appropriate breakers may be found under the columns headed Main-Selective, and Feeder-Selective or Zone-Selective. The main circuit breaker is the same size whether fully rated (LI) or selective (LS). However, the frame sizes of feeder breakers will depend upon whether they are applied as fully rated (LI), selective (LS) or zone selective (LSI).

Further, the tables indicate the main (LI) and cascaded feeder breakers (LI) for cascaded systems with a wide range of primary available short-circuit capacities and transformer sizes.

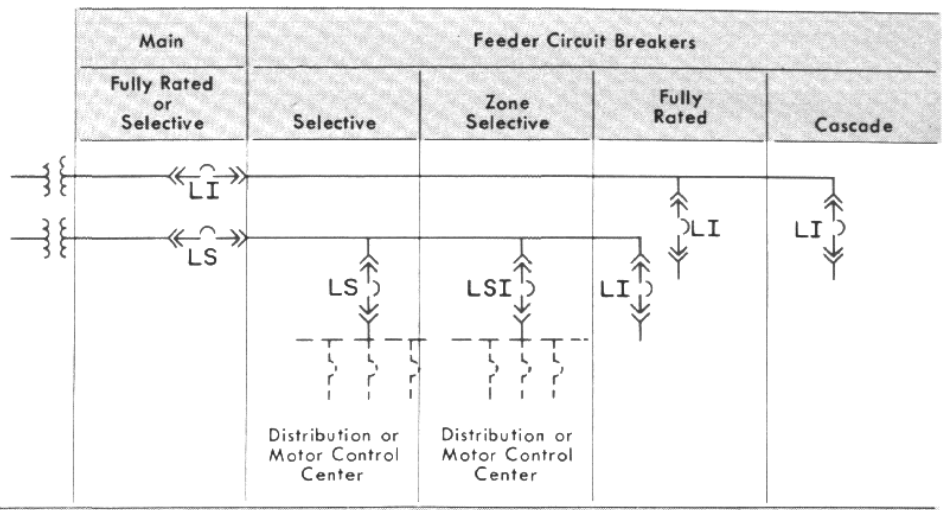
Application Table: 208 volts, three phase



Transformer Rating 3-phase Kva and Impedance Percent	Maximum Short-circuit Mva Available From Primary System	Normal-load Continuous Current Amp	Short-circuit Current RMS Symmetrical Amp			Long-time Instantaneous or Long-time Short-time	Long-time Short-time		Long-time Short-time Instantaneous		Long-time Instantaneous		Long-time Instantaneous	
			Trans-former Alone	50% Motor Load	Combined	Minimum* Breaker and Coil Size Recommended								
						Breaker	Breaker	Coil Size	Breaker	Coil Size	Breaker	Coil Size	Breaker	Coil Size
1	2	3	4	5	6	7	8		9		10		11	
300 **4.5%	50 100 150 250 500 750 Unlimited	833	16300 17300 17700 18000 18300 18400 18500	1700	18000 19000 19400 19700 20000 20000 20200	AK-50	AK-25	175	AK-15	100	AK-15	30	AK-15 is fully rated	30
500 **4.5%	50 100 150 250 500 750 Unlimited	1388	25300 27800 28700 29500 30200 30400 30800	2800	28000 29600 31500 32300 33000 33200 33600	AK-50	AK-50	350	AK-25	175	AK-25	150	AK-15	30
750 5.75%	50 100 150 250 500 750 Unlimited	2080	28700 32000 33300 34400 35200 35600 36200	4200	32900 36200 37500 38600 39400 39800 40400	AK-75	AK-50	350	AK-25	175	AK-25	150	AK-15	30
1000 5.75%	50	2780	35800	5600	41400	AK-75	AK-50	350	AK-25	175	AK-25	150	AK-15	30
	100 150		41100 43200		46700 48800				AK-50	350	AK-50	350		
	250 500 750 Unlimited		45100 46600 47300 48200		50700 52200 52900 53800		AK-75	2000					AK-25	150
1500 5.75%	50	4160	47600	8300	55900	No main breaker available	AK-75	2000	AK-50	350	AK-50	350	Cascade not possible since no main breaker available	
	100 150 250 500 750 Unlimited		57500 61700 65600 68800 69900 72400		65800 70000 73900 77100 78200 80700		AK-100	2000	AK-75	2000	AK-75	2000		

** If larger trip coils are required, see table — page 26.*
L = Long-time delay trip (overload tripping).
S = Short-time delay trip (selective fault tripping).
I = Instantaneous trip (high fault fast tripping).
***Minimum impedance.*

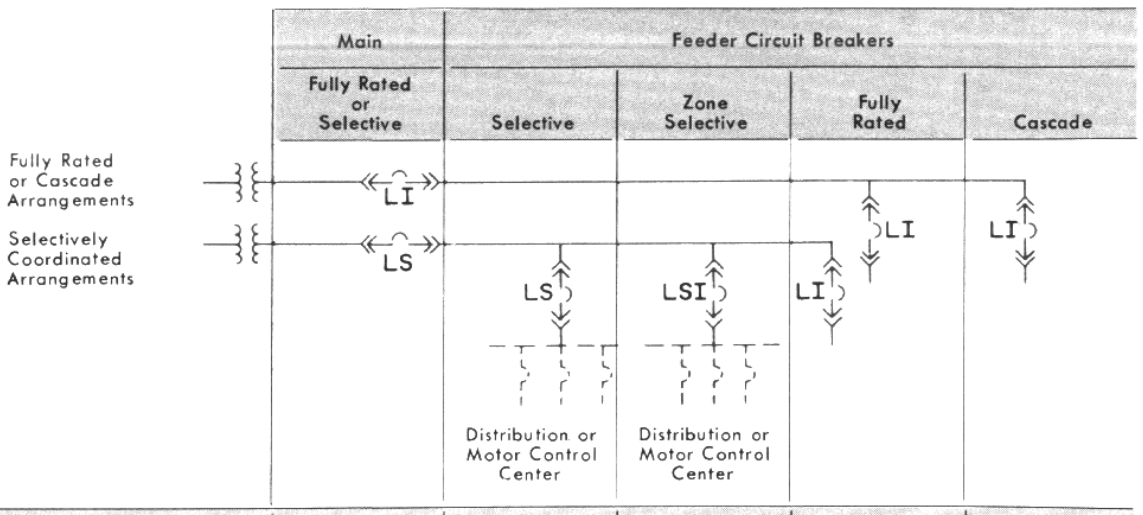
Application Table: 240 volts, three phase



Transformer Rating 3-phase Kva and Impedance Percent	Maximum Short-circuit Mva Available From Primary System	Normal-load Continuous Current Amp	Short-circuit Current RMS Symmetrical Amp			Long-time Instantaneous or Long-time Short-time	Long-time Short-time		Long-time Short-time Instantaneous		Long-time Instantaneous		Long-time Instantaneous	
			Trans-former Alone	100% Motor Load	Combined	Minimum* Breaker and Coil Size Recommended								
						Breaker	Breaker	Coil Size	Breaker	Coil Size	Breaker	Coil Size	Breaker	Coil Size
1	2	3	4	5	6	7	8		9		10		11	
300 **4.5%	50 100 150 250 500 750 Unlimited	722	14200 15000 15400 15600 15800 15900 16000	2900	17100 17900 18300 18500 18700 18800 18900	AK-50	AK-25	175	AK-15	100	AK-15	30	AK-15 is fully rated	30
500 **4.5%	50 100 150 250 500 750 Unlimited	1203	21900 24000 24900 25600 26100 26300 26700	4800	26700 28800 29700 30400 30900 31100 31500	AK-50	AK-50	350	AK-25	175	AK-25	150	AK-15	30
750 5.75%	50 100 150 250 500 750 Unlimited	1804	24900 27800 28900 29800 30600 30800 31400	7200	32100 35000 36100 37000 37800 38000 38600	AK-75	AK-50	350	AK-25	175	AK-25	150	AK-15	30
1000 5.75%	50	2406	31100	9600	40700	AK-75			AK-25	175	AK-25	150		
	100 150		35700 37500		45300 47100 48700		AK-50	350					AK-15	30
	250 500 750 Unlimited		39100 40500 41000 41900		50100 50600 51500		AK-75	2000	AK-50	350	AK-50	600	AK-25	150
1500 5.75%	50 100	3609	41300 49800	14400	55700 64200	AK-100	AK-75	2000	AK-50	350	AK-50	600	AK-25	150
	150 250 500 750 Unlimited		53500 56900 59700 60600 62800		67900 71300 74100 75000 77200		AK-100	2000	AK-75	2000	AK-75	2000		

* *If larger trip coils are required, see table* *page 26.*
L = Long-time delay trip (overload tripping).
S = Short-time delay trip (selective fault tripping).
I = Instantaneous trip. (high fault fast tripping)
***Minimum impedance.*

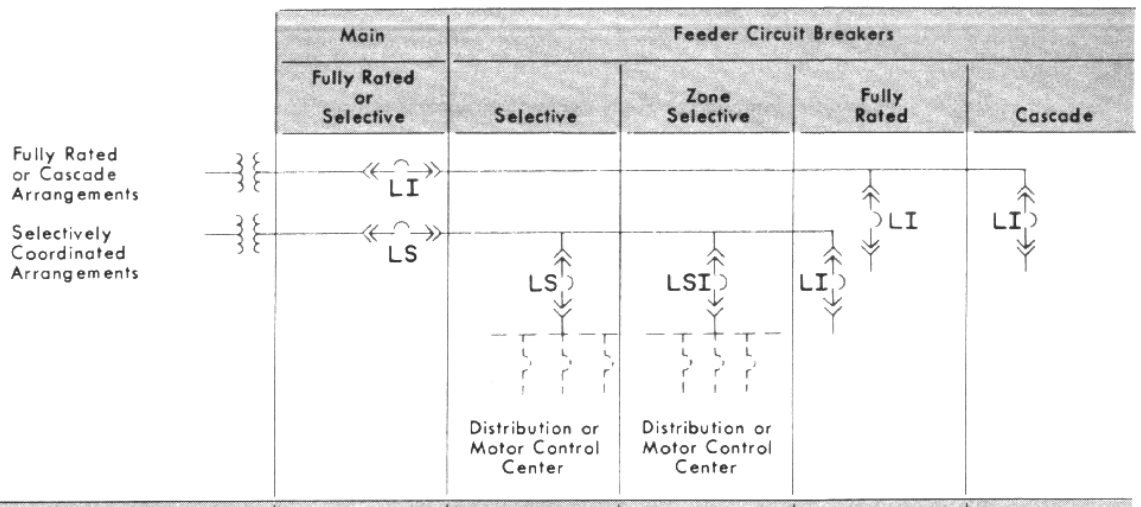
Application Table: 480 volts, three phase



Transformer Rating 3-phase Kva and Impedance Percent	Maximum Short-circuit Mva Available From Primary System	Normal-load Continuous Current Amp	Short-circuit Current RMS Symmetrical Amp			Long-time Instantaneous or Long-time Short-time	Long-time Short-time		Long-time Short-time Instantaneous		Long-time Instantaneous		Long-time Instantaneous	
			Transformer Alone	100% Motor Load	Combined	Minimum* Breaker and Coil Size Recommended								
						Breaker	Breaker	Coil Size	Breaker	Coil Size	Breaker	Coil Size	Breaker	Coil Size
1	2	3	4	5	6	7	8		9		10		11	
300 **4.5%	50 100	361	7100 7500	1400	8500 8900	AK-25	AK-15	100	AK-15	100	AK-15	20	AK-15 is fully rated	20
	150 250 500 750 Unlimited		7700 7800 7900 7900 8000		9100 9200 9300 9300 9400		AK-25	175						
500 **4.5%	50 100 150 250 500 750 Unlimited	601	10900 12000 12400 12800 13100 13200 13400	2400	13300 14400 14800 15200 15500 15600 15800	AK-50	AK-25	175	AK-15	100	AK-15	20	AK-15 is fully rated	20
750 5.75%	50 100 150 250 500 750 Unlimited	902	12500 13900 14400 14900 15300 15400 15700	3600	16100 17500 18000 18500 18900 19000 19300	AK-50	AK-25	175	AK-15	100	AK-15	20	AK-15 is fully rated	20
1000 5.75%	50	1203	15500	4800	20300	AK-50	AK-25	175	AK-15	100	AK-15	20	AK-15	20
	100 150 250 500 750 Unlimited		17800 18800 19600 20200 20500 20900		22600 23600 24400 25000 25300 25700		AK-50	350	AK-25	175	AK-25	100		
1500 5.75%	50	1804	20600	7200	27800	AK-75	AK-50	350	AK-25	175	AK-25	100	AK-15	20
	100 150 250 500 750 Unlimited		24900 26700 28400 29800 30300 31400		32100 33900 35600 37000 37500 38600				AK-50	350	AK-50	400		
2000 5.75%	50 100	2406	24700 31100	9600	34300 40700	AK-75	AK-50	350	AK-50	350	AK-50	400	AK-15	20
	150 250 500 750		34000 36700 39100 40000		43600 46300 48700 49600								AK-25	100
	Unlimited		41900		51500		AK-75	2000	AK-75	2000	AK-75	2000		
2500 5.75%	50 100	3008	28000 36400	12000	40000 48400	AK-100	AK-50	350	AK-50	350	AK-50	400		
	150 250 500 750		40500 44500 48100 49500		52500 56500 60100 61500		AK-75	2000	AK-75	2000	AK-75	2000	AK-25	100
	Unlimited		52300		64300								AK-50	400
3000 5.75%	50	3607	30700	14400	45100	AK-100	AK-50	350	AK-50	350	AK-50	400	AK-25	100
	100		41200		55600		AK-75	2000	AK-75	2000	AK-75	2000		
	150		46500		60900								AK-50	400
	250 500 750		51900 56800 58700		66300 71200 73100		AK-100	2000	AK-100	2000	AK-100	2000		
	Unlimited		62700		77100									

* *If larger trip coils are required, see table, page 26.*
L = Long-time delay trip (overload tripping).
S = Short-time delay trip (selective fault tripping).
I = Instantaneous trip (high fault fast tripping).
***Minimum impedance.*

Application Table: 600 volts, three phase



Transformer Rating 3-phase Kva and Impedance Percent	Maximum Short-circuit Mva Available From Primary System	Normal-load Continuous Current Amp	Short-circuit Current RMS Symmetrical Amp			Long-time Instantaneous or Long-time Short-time	Long-time Short-time		Long-time Short-time Instantaneous		Long-time Instantaneous		Long-time Instantaneous	
			Transformer Alone	100% Motor Load	Combined	Minimum* Breaker and Coil Size Recommended								
						Breaker	Breaker	Coil Size	Breaker	Coil Size	Breaker	Coil Size	Breaker	Coil Size
1	2	3	4	5	6	7	8		9		10		11	
300 **4.5%	50 100 150 250 500 750 Unlimited	289	5700 6000 6100 6200 6300 6400 6400	1200	6900 7200 7300 7900 7500 7600 7600	AK-25	AK-15	100	AK-15	100	AK-15	15	AK-15 is fully rated	15
500 **4.5%	50 100 150 250 500 750 Unlimited	481	8700 9600 10000 10200 10500 10500 10700	1900	10600 11500 11900 12100 12400 12400 12600	AK-25	AK-25	175	AK-15	100	AK-15	15	AK-15 is fully rated	15
750 5.75%	50 100	722	9900 11100	2900	12800 14000	AK-50	AK-25	175	AK-15	100	AK-15	15	AK-15 is fully rated	15
	150 250 500 750 Unlimited		11500 11900 12200 12300 12500		14400 14800 15100 15200 15400				AK-25	175	AK-25	40	AK-15	15
1000 5.75%	50 100 150 250 500 750 Unlimited	962	12500 14300 15000 15700 16200 16400 16800	3800	16300 18100 18800 19500 20000 20200 20600	AK-50	AK-25	175	AK-25	175	AK-25	40	AK-15	15
1500 5.75%	50	1444	16500	5800	22300	AK-50	AK-50	350	AK-50	350	AK-50	200	AK-15	15
	100 150 250 500 750 Unlimited		19900 21400 22700 23800 24200 25100		25700 27200 28500 29600 30000 30900								AK-25	40
2000 5.75%	50 100 150 250 500 750 Unlimited	1924	19700 24800 27200 29400 31200 32000 33500	7700	27400 32500 34900 37100 38900 39700 41200	AK-75	AK-50	350	AK-50	350	AK-50	200	AK-25	40
2500 5.75%	50 100 150	2406	22400 29200 32400	9600	32000 38800 42000	AK-75	AK-50	350	AK-50	350	AK-50	200	AK-25	40
	250 500 750 Unlimited		35700 38500 39600 41900		45300 48100 49200 51500		AK-75	2000	AK-75	200	AK-75	2000	AK-50	200
3000 5.75%	50	2886	24600	11500	36100	AK-75	AK-50	350	AK-50	350	AK-50	200	AK-25	40
	100 150 250 500 750 Unlimited		33000 37300 41600 45500 47000 50200		44500 48800 53100 57000 58500 61700		AK-75	2000	AK-75	2000	AK-75	2000	AK-50	200

** If larger trip coils are required, see table—page 26.*
L = Long-time delay trip (overload tripping).
S = Short-time delay trip (selective fault tripping).
I = Instantaneous trip (high fault fast tripping).
***Minimum impedance.*

Typical Dimensions

AIR INTERRUPTER SWITCH (LVP-100)

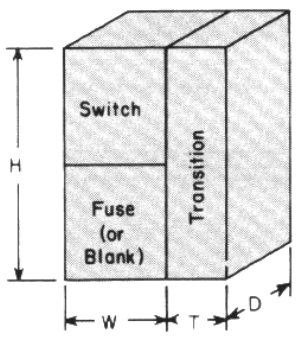


TABLE OF DIMENSIONS—AIR INTERRUPTER SWITCHES

Type Unit	Cable Arrangement	5 KV						15 KV					
		Indoor			Outdoor			Indoor			Outdoor		
		Wθ	H†	D	W	H	D	Wθ	H†	D	W	H	D
L V P	Above or Below	28	96	48	28	105	49½	36	96	55	36	105	51½
L V P D	Above or Below	56	96	48	56	105	49½	72	96	55	72	105	56½
L V P S	Above or Below	28	96	69½	28	105	71	36	102*	69½	36	106¾*	71

WEIGHTS INCLUDING TRANSITION UNIT

Type Unit	Voltage	Unfused* Unit Weight	Fused* Unit Weight
L V P	5 KV 15 KV	1400 1600	1600 1800
L V P S	5 KV 15 KV	1950 2150	2150 2350
L V P D	5 KV 15 KV	2800 3200	3000 3400

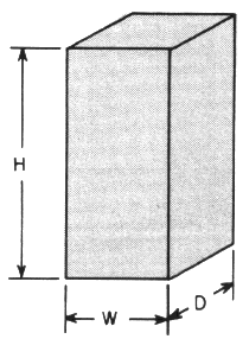
** Add 200 lbs. for outdoor units; add 100 lbs., if 1200 ampere switches required in place of 600 amperes.*

θ Add 16″ in width for outdoor transition compt., 16″ for indoor transition compt. for use with liq. or sealed dry transf. Add 10″ for indoor transition compt. for use with vent dry transf. All ¼″ end sheets.

** Dim. includes pull box required for all terminations except potheads.*

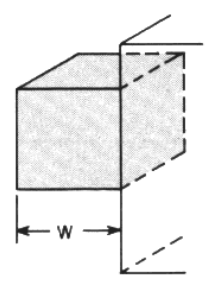
† Height is measured to top of cubicle; when potheads are required, they extend above the roof line when cables exit above; for cable exit below pothead is within cubicle.

OIL-FILLED CUTOUT



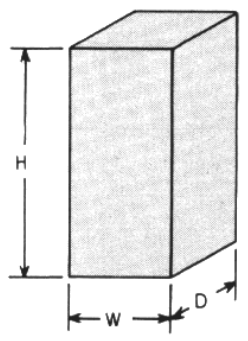
Dimensions		5KV		15KV	
		With Clamp Terminals	With Potheads	With Clamp Terminals	With Potheads
H		77″	77″	90″	90″
D		39″	39″	47″	47″
Wt.	Liq.	28″	28″	53″	61″
	Dry	23″	. . .	. . .	. . .
Wt.	Liq.	500 lb.	600 lb.	1300	1400
	Dry	500 lb.	. . .	. . .	. . .

LIQUID SWITCH



Dimension		One or Two Potheads
W		17″
Weight	Oil	600 lb.
	Pyranol	800 lb.

AIR FILLED TERMINAL COMPARTMENT



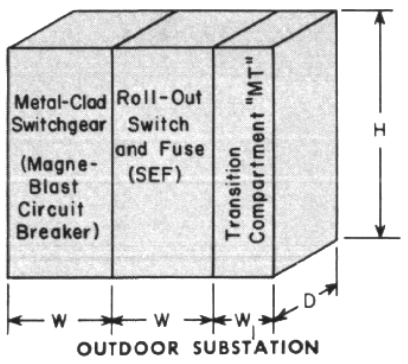
Transformer Type	Kv	Termination Type	Width W	Weight in Pounds
Liquid	5	Clamp-type	15″	200
Liquid	15	Clamp-type	22″	250
Liquid	5, 15	1 Pothead	22″*	350
Liquid	5, 15	2 Potheads	26″*	500
Dry	5, 15	Clamp-type	15″	200
Dry	5, 15	1 Pothead	22″	350
Dry	5, 15	2 Potheads	27″	500
Height all units same as transformer Depth all Units 39″				

**For bottom connections. Top: 15″ & 22″.*

POWER CIRCUIT BREAKER OR ROLL-OUT SWITCH

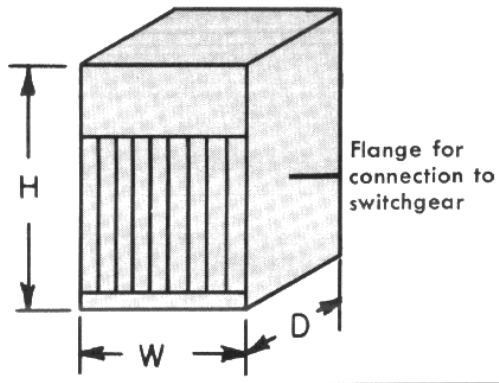
Power Circuit Breaker or Switch	INDOOR SUBSTATION						
	H	W	W_1	D	Front Aisle	Rear Aisle	Weight
AM-4.16-75	90″	20″	20″	64″	46	26	1650
AM-4.16-250	90″	26″	20″	74″	61	26	3150
AM-13.8-500	90″	36″	20″	80″	66	26	4900
AM-13.8-750	98″	36″	20″	86″	84	26	5200
SEF-4.8KV	68″	26″	20″	62″	52	26	1180
SEF-13.8KV	90″	36″	20″	71″	60	26	1800

NOTE
For outdoor dimensions refer to GEA-5664.



OUTDOOR SUBSTATION

Typical Dimensions



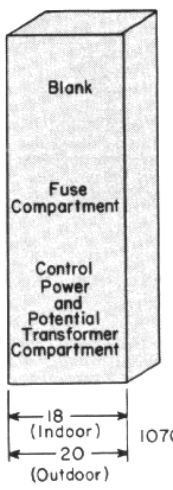
Transformer Rating	LIQUID FILLED (65 C RISE) (New Value-engineered Design)					OPEN DRY TYPE (150 C RISE)								GAS FILLED DRY (150 C RISE)							
Kva	Dim. in inches			Weightt		H		W		D		Weightt		H*		W		D		Weightt	
	H*	W**	D	Oil	Pyranol	5 kv	15 kv	5 kv	15 kv	5 kv	15 kv	5 kv	15 kv	5 kv	15 kv	5 kv	15 kv	5 kv	15 kv	5 kv	15 kv
112.5	77	39	39	2.38	2.73																
150	77	39	39	2.38	2.73																
225	77	39	44	2.62	3.03																
300	77	41	44	2.90	3.30	76	76	35	35	50	55	3.0	4.00	90	90	60	66	51	51	5.1	6.3
500	77	42	53	3.75	4.30	76	76	35	35	50	65	3.45	4.5	90	90	66	69	51	51	6.8	7.1
750	77	47	59	4.95	5.45	77	90	31	72	55	46	3.60	6.20	90	90	69	74	51	52	7.3	8.2
1000 208Y/120	77	49	64	6.15	6.80	77	90	31	74	55	46	4.50	7.40	90	90	73	74	52	52	8.6	9.3
1000	77	49	64	5.85	6.45	77	90	31	74	55	46	4.50	7.40	90	90	73	74	52	52	8.6	9.3
1500	77	53	68	7.50	8.35	90	90	74	83	46	48	8.60	10.20	112	112	80	80	52	52	12.5	12.7
2000	77	53	77	9.00	9.95	90	90	78	87	48	50	10.60	12.40	117	117	89	89	62	62	16.6	16.9

* *Add 4 in. to obtain height over highest non-removable part for Pyranol unit and gas-filled unit and 3.5 in. for oil-filled unit.*
** *Flange-to-flange but not including projecting bushings.*
† *Weight in thousands of pounds.*
These dimensions and weights apply only to standard NEMA design transformers as described on pages 5 and 10 to 14.

low voltage section

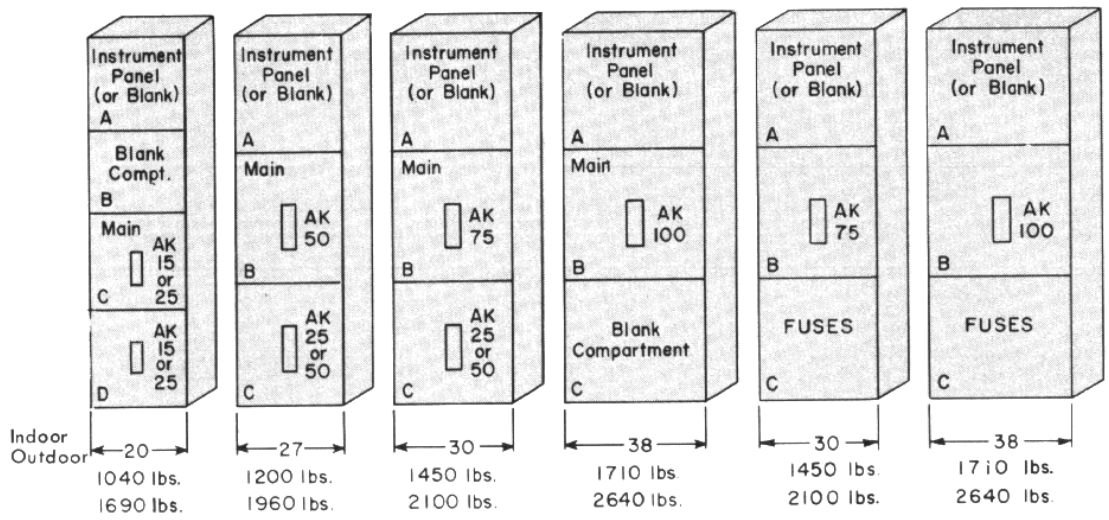
AUXILIARY UNIT

1. **Transition to transformer**
2. **Cable or busway entrance unit for free standing switchgear equipment.**



Shortest Possible Shipment Assured When You Select From These Standard Stack Arrangements

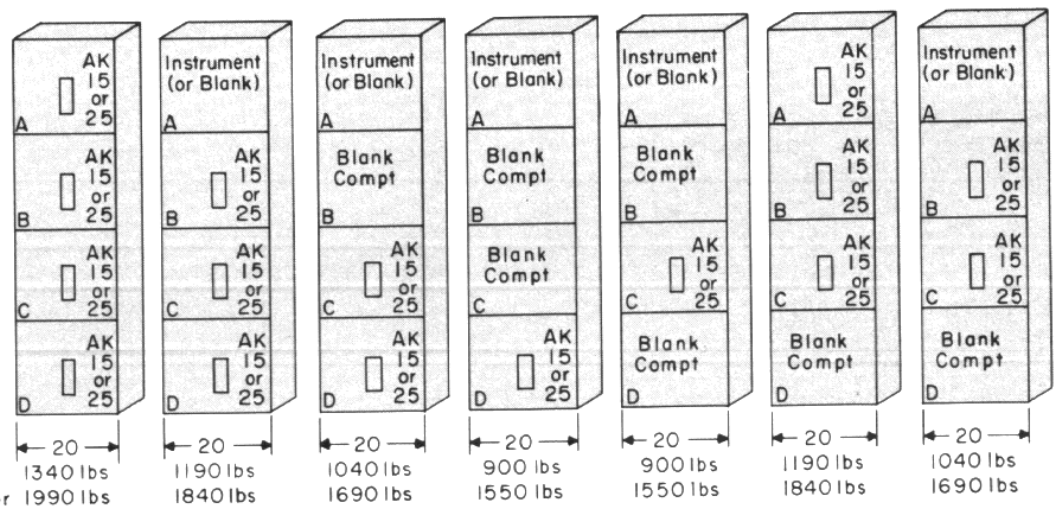
MAIN BREAKER UNITS



Indoor and Outdoor Width Dimension Identical

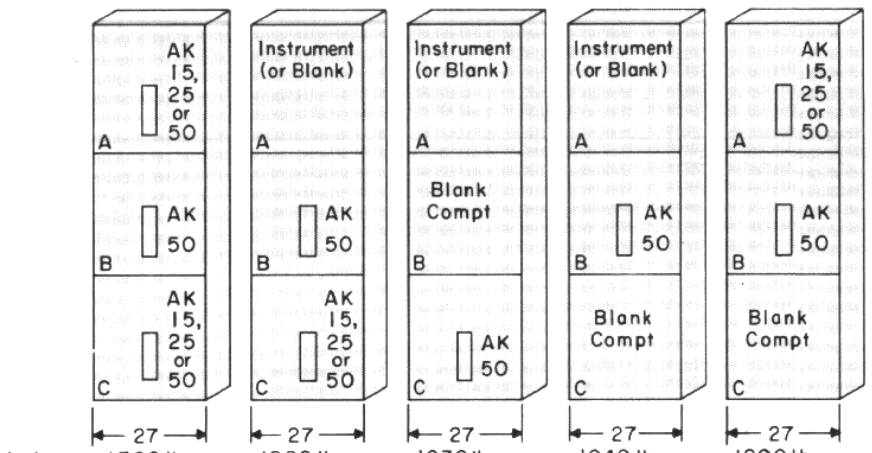
See page 35 for height and depth

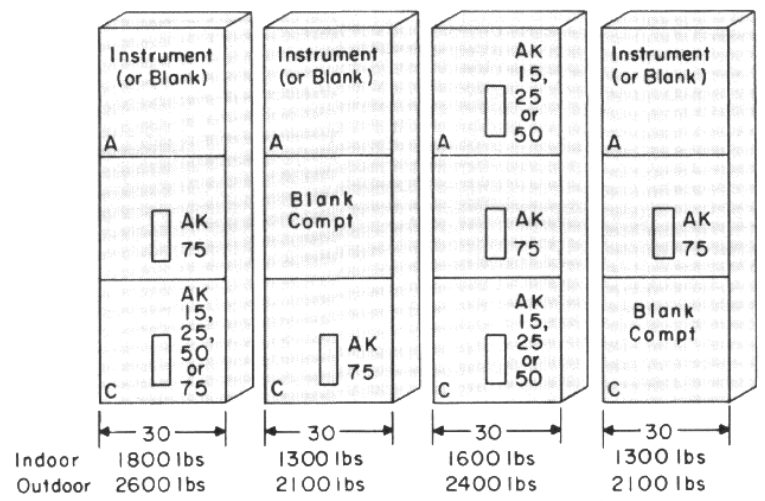
FEEDER BREAKER UNITS



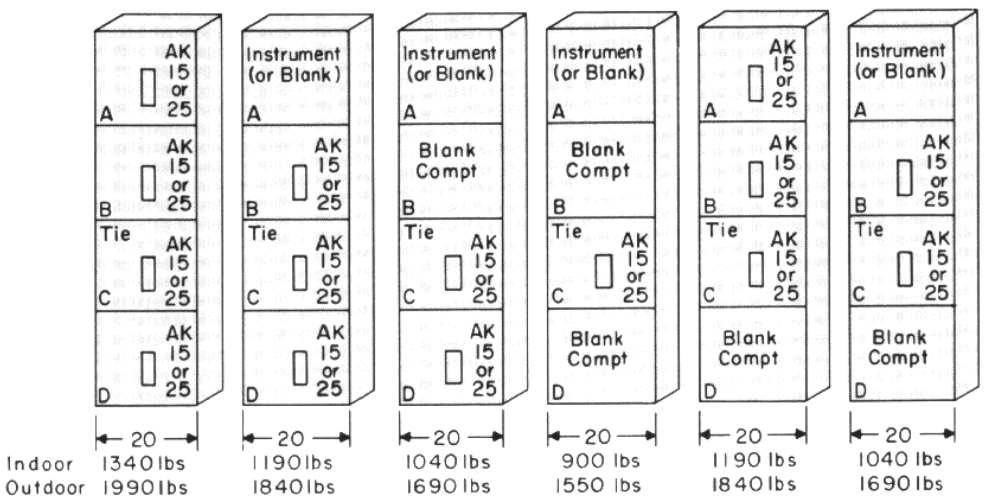
Typical Dimensions

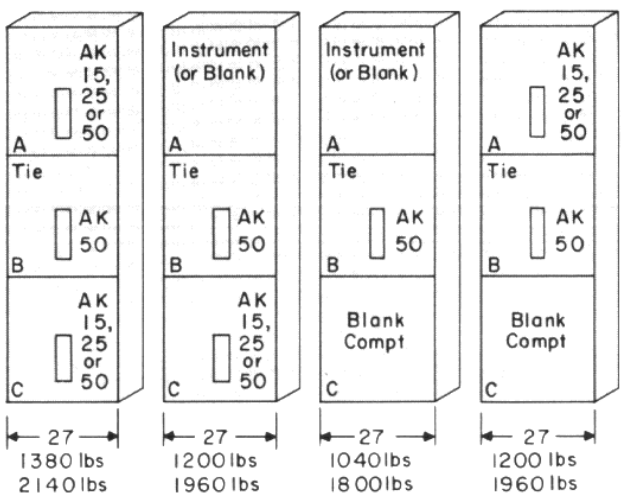
FEEDER BREAKER UNITS (CONT'D)

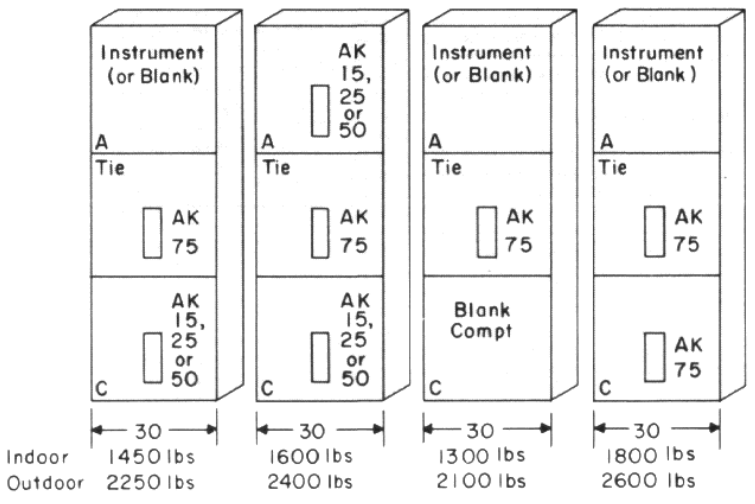




TIE BREAKER UNITS

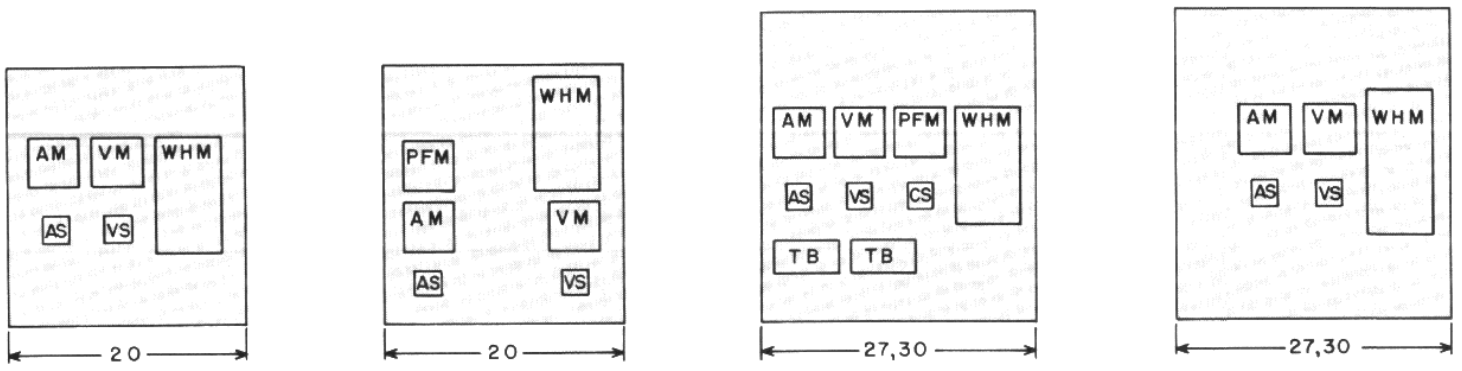






Typical Dimensions

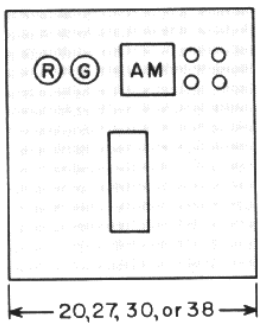
TYPICAL INSTRUMENT PANEL ARRANGEMENTS



The following devices are most generally used:

1—Ammeter
1—Voltmeter
1—Ammeter transfer switch
1—Voltmeter transfer switch
1—Watthour meter (2 or 3 element)
1—WHM demand attachment
1—Power factor meter
1—Current test block
1—Voltage Test block
1—Breaker control switch

BREAKER DOOR ARRANGEMENTS

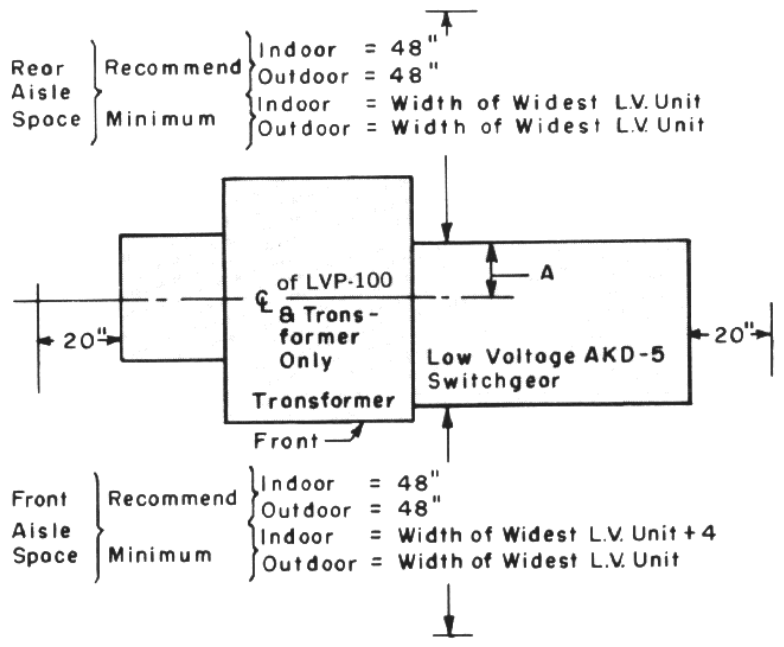


Any breaker door may be equipped with an ammeter and three-phase push-button transfer switch. Red and green close and trip indication lights are also available.

ADDITIONAL DIMENSIONS

All Breaker Units	Indoor	Outdoor
Height	91¾	114½
Depth	60	108½
"A" (see below)	19⅞	22⅝

TYPICAL FLOOR PLAN



Note: Only 200 KVA transformer extends beyond front of LV gear (1⅞")

STANDARD CABLE TERMINATIONS

For AK- and AKU-2A-15/25 Breakers		For AK- and AKU-2A-50 Breakers	
No. of Cables per Phase	Range (AWG or MCM)	No. of Cables per Phase	Range (AWG or MCM)
1	10–3	1	10–3
1	2–3/0	1	2–3/0
1, 2, 3 or 4	4/0–500	1, 2, 3 or 4	4/0–500
1 or 2	600–1000	1, 2, 3 or 4	600–1000

BREAKER WEIGHTS (Add to unit weights on pages 32, 33)

Type Operation	AK-2A-15	AK-2A-25	AK-2A-50	AK-2A-75	AK-2A-100
Manual	75	80	310	420	540
Electrical	80	95	352	480	600

FUSED BREAKER WEIGHTS

Type Operation	AKU-2A-25	AKU-2A-50	3000A. Fuse R/O For use with AK-2A-75 Bkr. (Bkr. in separate comp't)	4000A. Fuse R/O For use with AK-2A-100 Bkr. (Bkr. in separate comp't)
Manual	110	410	★300	★400
Electrical	125	450		

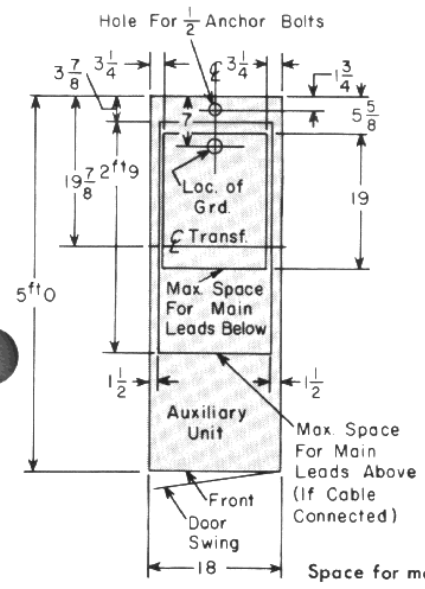
★*Add breaker weight from table above.*

Typical Dimensions

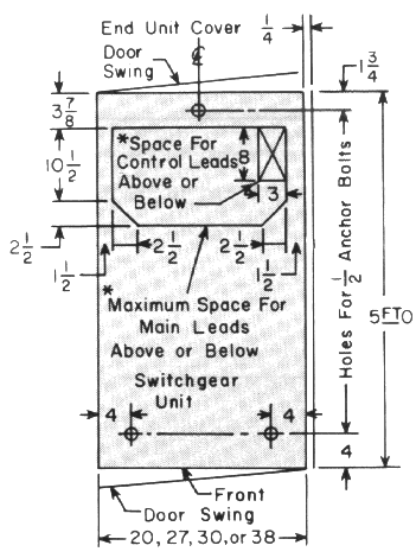
FLOOR PLAN AND CABLE SPACE

INDOOR UNITS

AUXILIARY UNIT



SWITCHGEAR UNIT

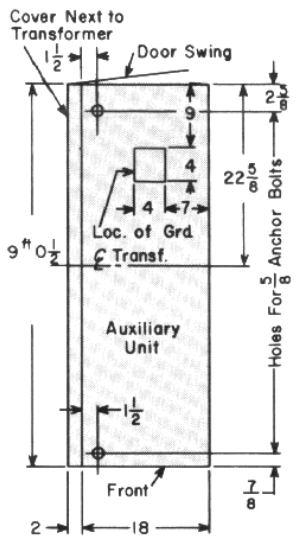


Space for main and control leads not present on 38" unit

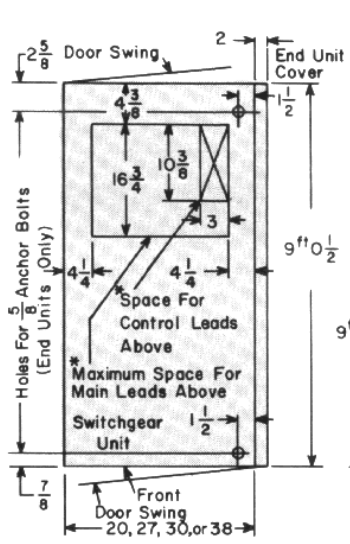
Units as shown are on right side of transformer. Left end units are same except end cover will shift to opposite end.

OUTDOOR UNITS

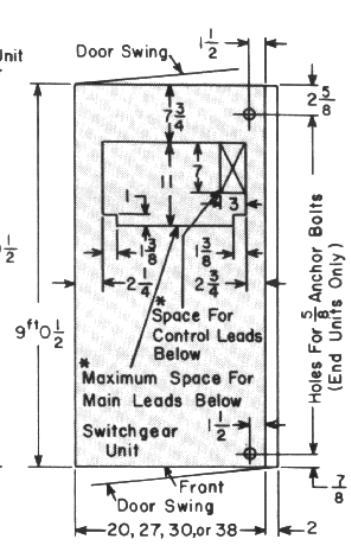
AUXILIARY UNIT



SWITCHGEAR UNIT (LEADS ABOVE)



SWITCHGEAR UNIT (LEADS BELOW)

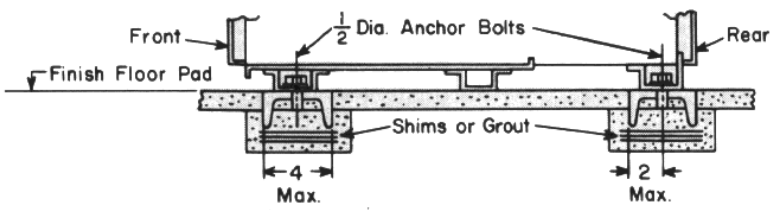


* Space for main and control leads not present on 38" unit

Units as shown are on right side of transformer. Left end units are same except 2" end cover will shift to opposite end. Anchor bolt holes will be located 1½" from end sheet.

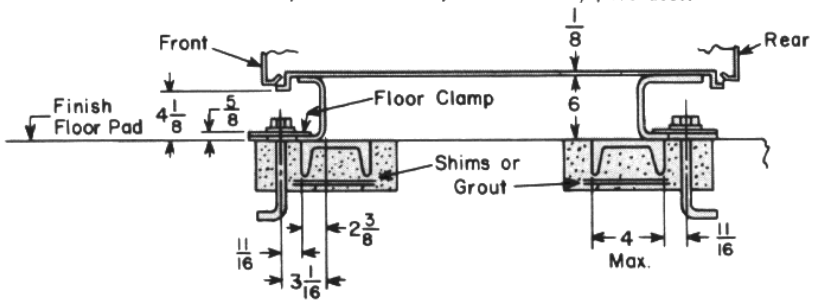
INDOOR METHOD OF ANCHORING

Anchor bolts, floor channels, and shims by purchaser.



OUTDOOR METHOD OF ANCHORING

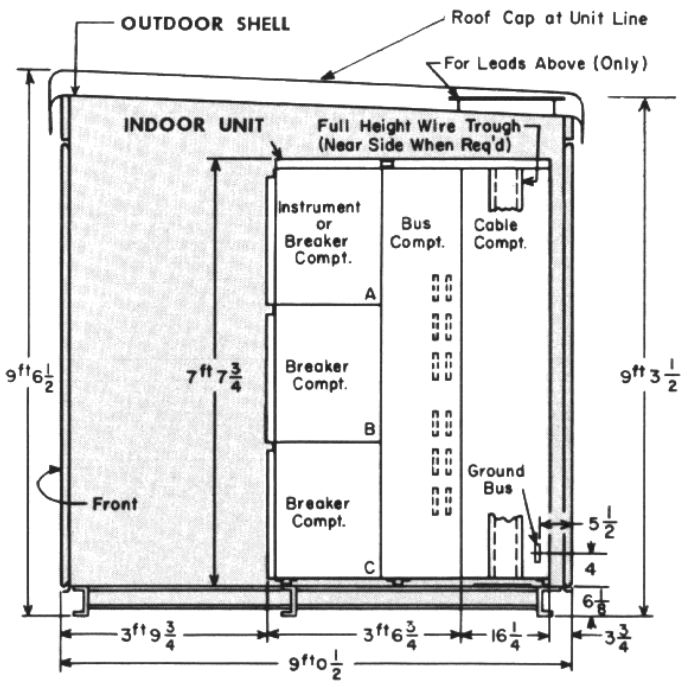
Anchor bolts, floor channels, and shims by purchaser.



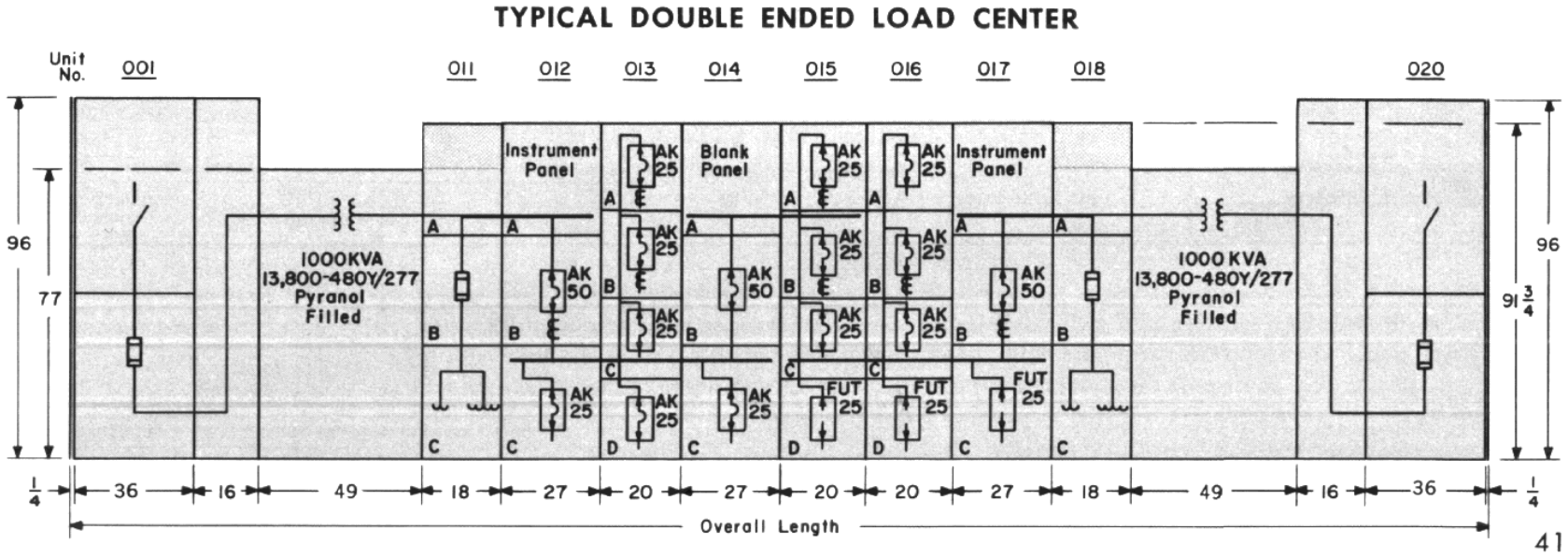
FOUNDATION DATA

Equipment is furnished with built-in channel, thus eliminating the need for floor steel when mounting directly on smooth, level floor. If embedded channels are desired, these should be set level with each other and should be level over their entire length. 4" x 5.4#/ft channels are recommended for leveling purposes. Finish floor should have slight pitch away from mounting channels and in no case should the finish floor be higher than mounting channels.

TYPICAL SIDE VIEW



TYPICAL DOUBLE ENDED LOAD CENTER



Descriptive specifications for AKD-5 "Powermaster" switchgear

GENERAL

The switchgear will be completely factory assembled and metal-enclosed, consisting of functionally compartmentalized units for the removable power circuit breaker elements, cable terminations, incoming, and main bus, and associated equipment devices as indicated below.

REMOVABLE BREAKER ELEMENTS

Each breaker element will consist of a three-pole electrically and mechanically trip-free power circuit breaker with a dual-magnetic (long-time-delay and instantaneous) overcurrent series-connected integral tripping device per pole, interpole barriers, arc quenchers, manual or electrical stored-energy closing mechanism, mechanical push-button trip, position indicator, and equipped for mounting on the drawout mechanism in the breaker compartment.

FUSED BREAKERS ONLY

Circuit breakers will be equipped with current limiting fuses, integrally, or separately mounted and co-ordinated with magnetic trip devices, so that faults within the rating of the circuit breaker will be interrupted by the breaker itself, while faults in excess of the breaker rating will be interrupted by the fuses. Each breaker shall be equipped with open fuse lock-out device and indicator to protect against single phasing and prevent reclosing until the fuse is replaced.

INTERCHANGEABLE BREAKER ELEMENTS

Removable breaker elements of the same size, rating, method of operation and type will be interchangeable.

EQUIPMENT DESIGN

Racking Mechanism: The closed-door drawout mechanism shall consist of an integral racking device to lock the removable element in the connected position and to overcome the mechanical resistance of making and breaking the contacts of the disconnecting devices. Positive mechanical interlocks of rugged design shall prevent the breaker from being racked in or out unless the breaker is tripped, and shall prevent the breaker from being closed while it is being racked in or out. The breaker drawout mechanism shall be of a design that permits the breaker to be racked from the connected to the test and disconnected positions with the door closed. Manual release shall be provided to hold the breaker in the test and disconnected positions. And a limit stop shall be provided in the fully withdrawn position. In this position, there shall be provisions for tilting the breaker for easy maintenance and inspection, or removal.

Breaker Compartments when specified for future breakers, shall be completely equipped for the future addition of a power circuit breaker element, including all necessary electrical connections. Insulating sleeves shall be furnished over the main stationary disconnect studs for breakers up to 1600 amperes.

Bus Compartment shall be provided to fully enclose the incoming line and main bus from the cable termination area.

Isolating Barriers shall be provided between the incoming line and main bus systems to prevent fault communication. Insulating sleeves shall be provided in feeder run-back conductor in the bus compartment to prevent fault communication in that area.

Bus and Connections: The incoming and main bus shall be welded aluminum. All bolted or pressure joints for buses, interconnections, disconnecting devices, and external connections to the equipment shall be copper with silver-to-silver high-pressure contacts. Insulated bus supports will be flame retardant polyester glass, designed and tested to withstand the mechanical stress produced by fault currents, as required.

Cable Compartments shall be isolated from the bus compartments and have ample space for cables or busways from above or below and shall be easily accessible from the hinged rear door.

Indoor Switchgear shall be provided with removable steel plates on the top and sides. A hinged rear door shall be provided for each cable compartment. A front hinged panel shall be provided for each breaker and metering compartment.

Outdoor Switchgear shall be the same as the indoor except that it shall be housed in a weatherproof enclosure with front and rear doors with rubber gaskets and mounted on a heavy steel floor frame. An aisle space inside the front door shall run the full length of the equipment for breaker maintenance and inspection. Each unit shall be ventilated by means of louvered openings located near the bottom of the doors and under the overhanging roof eaves. A screen-covered receptacle containing filter material shall be located behind each opening to retard the entrance of dust, rodents and foreign material. Each equipment shall include necessary space heaters, lamp receptacles and switch, and a double convenience outlet.

Cleaning and Painting: Metal surfaces shall be chemically cleaned and treated in a process which provides a phosphate coating. Immediately after the cleaning process, the surfaces shall be sprayed with a coating of sand gray Ostwald series No. 3CB synthetic-phenolic-alkyd paint. After assembly of the equipment and just before packing, the exterior surfaces of the switchgear shall be cleaned. Indoor switchgear shall be sprayed with a finish coat of sand gray lacquer, with dark gray door trim and blue Ostwald series No. 14PA on the main instrument panel. Outdoor switchgear shall be sprayed with a finish coat of dark blue-gray ASA No. 24 acrylic lacquer.

CONTROL DEVICES

Current Transformers shall in general be mounted in the breaker compartment to provide easy access for inspection and maintenance.

Potential and Control Power Transformers shall be mounted on a removable tray in the lower compartment of the auxiliary unit with primary current-limiting fuses in dead-front fuse holders mounted in the middle compartment.

Small Wiring, potential buses, and terminal blocks shall be provided as required, and shall be enclosed in metal wiring troughs with removable covers.

Fuses shall be provided as required for breaker control circuits and will be mounted inside of the breaker compartment to provide easy access for maintenance and inspection.

For additional details on products associated with Load Center Unit Substations, refer to the following publications:

Power for Production—GEA-7139
Metal-Clad—GEA-5664
Oil Fused Cut Outs—GEA-7191
Lightning Arresters
Station Type—GEA-1304
Intermediate Type GEA-2978
Liquid Filled Transformer—GEA-7279
Dry Type Transformers—GEA-7286
Selection & Application Guide—GEA-8534
Air Interrupters—GEA-8073
Current Limiting Power Fuses—GEA-7137
High Capacity Bus Way Systems—GEA-6736
Armor-Clad Feeder Busway—GEA-7933
POWER SENSOR Overcurrent Trip Device—GEA-8386
Motor Starting Breakers, Type AK-2—GEA-8222

Guide form specifications

HOW TO USE

The guide form specifications on these pages are nonrestrictive specifications which may be used to prepare bid specifications for load center unit substations or for separate drawout switchgear. When optional ratings and features are available the choice can be made by crossing out appropriate words in italics, filling in quantities and ratings, and selecting appropriate paragraphs. Low-voltage switchgear is designed in accordance with NEMA Standard SG 3-1958 and ASA Standard C-37.13-1963.

GENERAL

Each load center unit substation covered by these specifications shall be designed, tested, and assembled in accordance with applicable standards of NEMA, AIEE, and ASA, and shall be complete from the incoming-line termination to the outgoing feeder terminals. The control side of the switchgear and the nameplate side of the transformer shall be the front of the substation.

Each substation shall consist of the following sections which shall be designed for connection at the installation site:

(1) (2) Incoming Section(s)
(1) (2) Transformer Section(s)
One Outgoing Section.

LOAD CENTER UNIT SUBSTATION(S), (INDOOR) (OUTDOOR)

ARRANGEMENT

The unit substation will be arranged so that when facing the front of the substation, the incoming section will be on the (left) (right) of the transformer section.

The arrangement and one-line diagram are indicated on (drawing) (sketch) No. .....

(1) (2) INCOMING-LINE SECTION(S), (INDOOR) (OUTDOOR)

Each incoming-line section shall be designed in accordance with industry standards and shall include one of the following items:

Air interrupter switch(es), with stored-energy operating mechanism, (2-position, open-close) (and line selector switch, 3-position, close-open-close) (5 kv) (15 kv), 600 amperes continuous and interrupting rating (key interlocked with low voltage breakers).

—Set of three power fuses.

—Necessary (potheads) (clamp-type terminals) for (loop) (single) feed.

—Set of (distribution-) (intermediate-) (station-) type lightning arresters for (grounded) (ungrounded) ..... volt system.

* Registered trademark of General Electric Co.

—Set of compartment heaters.

—(Oil) (Pyranol*) filled interrupter switch, 2-position, open-close, rated 400 amperes (5 kv) (15 kv), (key interlocked with the low voltage breakers), with compound-filled terminal chamber for (single) (loop) feed.

—Air insulated terminal chamber.

—Necessary (potheads) (clamp-type terminals) for (loop) (single) feed.

—Set (distribution-) (intermediate-) (station-) type lightning arresters for (grounded) (ungrounded) ..... volt system.

—Set (fused) oil-filled cutouts, group-operated, 2-position, open-close, rated 200 amperes, (5 kv) (15 kv), (mechanically interlocked with the low voltage breakers).

—Necessary (potheads) (clamp-type terminals) for (loop) (single) feed.

—Set (distribution-) (intermediate-) (station-) type lightning arresters for (grounded) (ungrounded) ..... volt system.

(1) (2) TRANSFORMING SECTION(S) (OIL-IMMERSED) (PYRANOL-IMMERSED) (OPEN DRY-TYPE) (GAS FILLED) (INDOOR) (OUTDOOR).

Each transforming section shall be designed in accordance with industry standards, and shall include the following:

Rating
- Self-cooled (forced-air-cooled) ..... 00 kva
- Temperature rise ..... (65) (150) C
- Frequency ..... 60 Cycles
- Number of phases 3
- High voltage delta-connected ..... 00 volts
- Low voltage (wye-) (delta-) connected ..... 00 volts

Impedance—standard
Taps—4—2½%, 2 above and 2 below rated high voltage.
Accessories—standard.
Additional Equipment
- Forced-air cooling fans with automatic temperature control relay.
- Winding temperature indication, with sequence contacts.

ONE OUTGOING SWITCHGEAR SECTION (INDOOR) (OUTDOOR)

Each outgoing switchgear section shall be a factory-assembled drawout circuit breaker equipment with the components listed below.

The electrical arrangement of the circuit breakers shall be (selectively coordinated) (fully rated) or (cascaded).

For a selectively coordinated substation, curves shall be furnished which demonstrate coordination of the main breaker with the feeder breakers.

(1) (2) (transition compartment(s) (..... ft. of busway) for connection to transformer.

Air Circuit Breakers

All circuit breakers shall have stored-energy closing mechanisms, racking mechanism, mechanical interlocks, and 3 over-

current trip devices with time delay elements as specified for each breaker below.

In addition, all fused power circuit breakers shall include integrally or separately mounted current limiting fuse units coordinated with overcurrent trip devices so as to avoid unnecessary blowing of the fuses. Fused breakers shall include blown fuse indicator which locks out the circuit breaker until the fuse is replaced and the device reset.

Electrically operated breakers shall have (a control switch with indicating lamps) (a push button on the escutcheon of the breaker).

(1) (2) transformer secondary breaker(s).....amperes frame size (manually) (electrically) operated, (fused) (unfused) with long-time delay, (short-time delay) (instantaneous) elements in the overcurrent trip devices, (and*)

One bus tie breaker(s), ...amperes frame size normally (open)-(closed), (manually) (electrically) operated, (fused) (unfused) with long-time delay, (short-time delay) (instantaneous) elments in the overcurrent trips (and*)

NOTE: In double-ended substations, if the tie breaker is normally closed, or if there is no tie breaker, check the interrupting rating of all breakers. Also a directional fault detection relay, selective with main and tie breakers may have to be included for primary fault protection.

—Feeder breaker(s), ...amperes frame size (manually) (electrically) operated, (fused) (unfused) with long-time delay (short-time delay) (instantaneous) elements in the overcurrent trips (and*)

—Feeder breaker(s), ...amperes frame size (manually) (electrically) operated, (fused) (unfused) with long-time delay (short-time delay) (instantaneous) elements in the overcurrent trips (and*)

—Feeder breaker(s), ...amperes frame size (manually) (electrically) operated, (fused) (unfused) with long-time delay (short-time delay) (instantaneous) elements in the overcurrent trips (and*)

—Compartment(s) equipped for future breaker, ... amperes frame size (manually) (electrically) operated.

Feeder Cable and Busway Termination:

1—Set of clamp-type connectors for each breaker.

—Set(s) vertical conductors with provisions for termination of .....ampere busway.

Transformer Secondary Metering and Control:

—Current transformer(s).

—Ammeter(s) and transfer switch(es).

—Control power transformer(s).

—Potential transformer(s).

—Voltmeter(s) and transfer switch(es).

—Set of ground detector (lamps and transformers) (voltmeters).

—Watthour (demand) meter (2-) 2(½-) (3-) element.

Bus Tie Metering and Control:

Automatic throw-over control equipment with (1-) (3-) phase undervoltage indication for automatic transfer to the emergency source tie breaker and (manual) (automatic) return to the normal power source.

Control power automatic throw-over equipment to transfer the control bus from one control power source to another when one is de-energized.

Feeder Metering and Control:

—Ammeter(s) and transfer switch(es).

—Current transformers.

One Breaker lifting device.

Add auxiliary devices as required.

FUSED CIRCUIT BREAKER GUIDE FORM SPECIFICATIONS

Fused circuit breakers shall have stored-energy closing mechanisms, racking mechanisms, mechanical interlocks, three overcurrent trip devices and rear-mounted current limiting fuses in series. All low voltage power circuit breakers shall be equipped with an open fuse lockout device that is visible from the front of the breaker and capable of indicating which fuses are blown, tripping all three phases of the breaker upon the fuse blowing and preventing the circuit breaker from being reclosed on a single phase condition.

The circuit breaker shall be of the drawout type, capable of being racked to the disconnect position with the door closed. Interlocks will be provided to prevent connecting or disconnecting the circuit breaker unless the breaker is open. The breaker shall be prevented from being closed during any racking operation. A test position shall be provided to permit operating the breaker while it is disconnected from the power circuit. Current limiting fuses shall be readily accessible for maintenance without removing the circuit breaker from the equipment.

Each switchgear section shall be factory assembled with stored-energy closing of fused-drawout circuit breaker equipment with all components integrally mounted on a drawout tray listed as follows: .....main secondary breaker(s), ...amperes continuous current, ...amperes interrupting capacity at .....V: a-c (manually, electrically) operated, with CLF current limiting fuses.

.....Feeder breaker(s), ...amperes continuous current, ...amperes interrupting capacity at .....V a-c, (manually, electrically) operated, with CLF current limiting fuses.

General Electric's Switchgear Development Laboratory, Philadelphia, Pa.

T18347

New load center unit substation design is a product of extensive research, development and testing by General Electric

General Electric's new load center unit substation with AKD-5 low voltage switchgear is the product of extensive research, development and testing at the Company's Switchgear Development Laboratory in Philadelphia.

At this multi-million dollar facility, experimental equipment was tested under conditions similar to but far more rigorous than those encountered in service. Modifications and retesting continued until the new design was perfected, to assure you of superior reliability and service continuity.

Advances in load center unit substation transformer insulation and design are the product of General Electric's High Voltage Laboratory at Pittsfield, Mass. These advances include higher permissible operating temperatures, lower sound levels, and lighter weight for dry-type transformers.

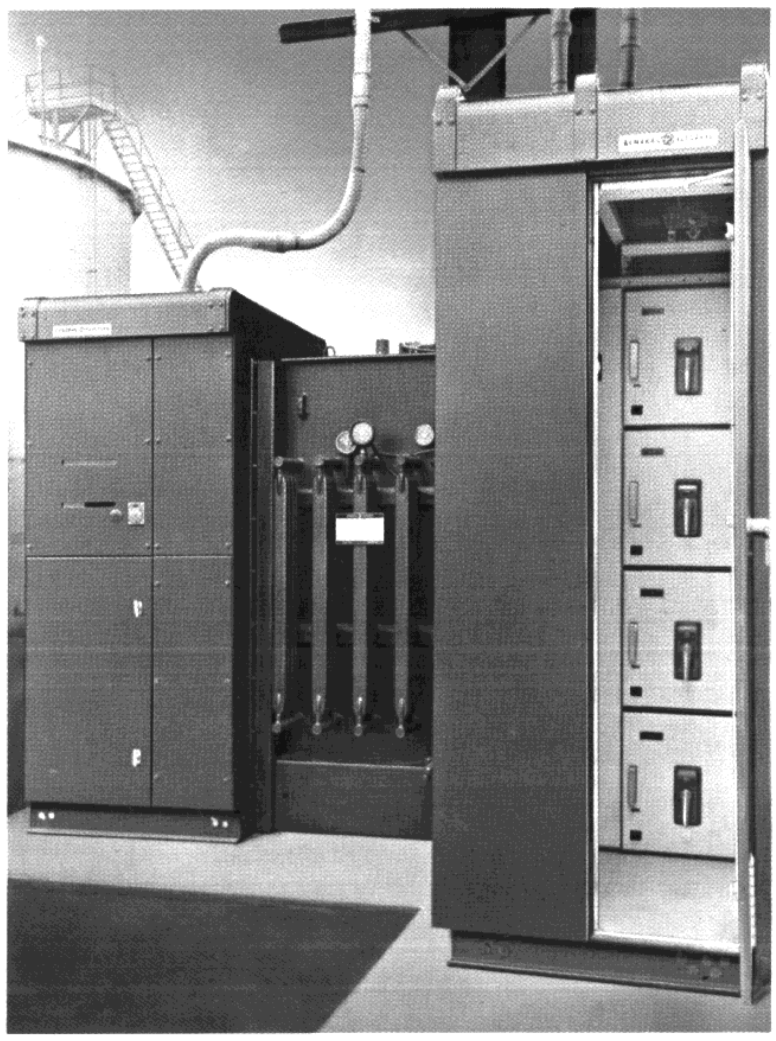
Just as important as development testing which contributed to this new design are production tests which each G-E load center unit substation undergoes at the factory—and at the Switchgear Development Laboratory on a spot-check basis. Individual components as well as the complete equipment are thoroughly tested to make sure you receive the co-ordinated, efficient power package you need for continuous power, production and profits.

AKD-5 Outdoor Load-center Unit Substation

Outdoor equipment is essentially an indoor unit mounted inside a weatherproof enclosure with front and back access doors. Walk-in aisle permits maintenance even in inclement weather.

Additional information on Powermaster AKD-5 Switchgear may be obtained by contacting your General Electric Sales Engineer.

SWITCHGEAR PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
PHILADELPHIA, PA. 19142



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