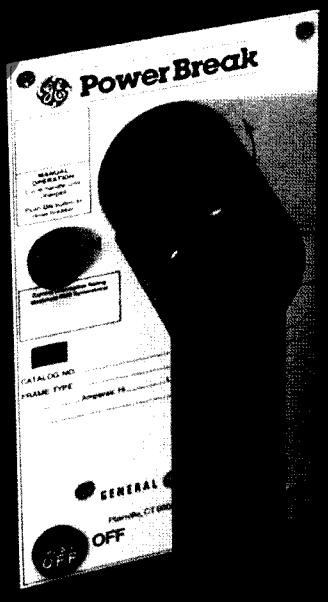
Power Break®

Insulated Case Circuit Breakers

Featuring
MicroVersaTrip® RMS-9 Programmer



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POWER BREAK® Circuit Breakers

Rugged, Durable Construction Combined with Accuracy, Versatility, and Coordination

The General Electric line of POWER BREAK® insulated case circuit breakers offers the rugged, reliable type of system protection critical for heavy-duty applications. POWER BREAK circuit breakers are rated up to 200,000 amperes rms symmetrical interrupting capacity without fuses or current limiters. The POWER BREAK design consists of five physical envelope sizes from 200 to 4000 amperes.

POWER BREAK is a versatile breaker, designed for a wide variety of applications with features such as—temperature insensitive trip units—push-to-open and close buttons—maximum five-cycle closing time—field installable rating plugs to change ampere ratings—U/L listed, field installable accessories—easy to operate, rotary, stored energy operating mechanism.

A full line of selective tripping characteristics can be used to provide overcurrent protection from overloads, short-circuits and ground faults. Additionally, trip indicators are available to aid in fault diagnosis.

POWER BREAK circuit breakers offer application flexibility for ac as well as dc power systems with ratings up to 700 volts dc and 750 volts ac.

The custom tailored support required for today's exacting applications is available with a full line of POWER BREAK draw-out structures, interlocks, internal accessories, electrical operators, connectors, and a solid-state test kit.

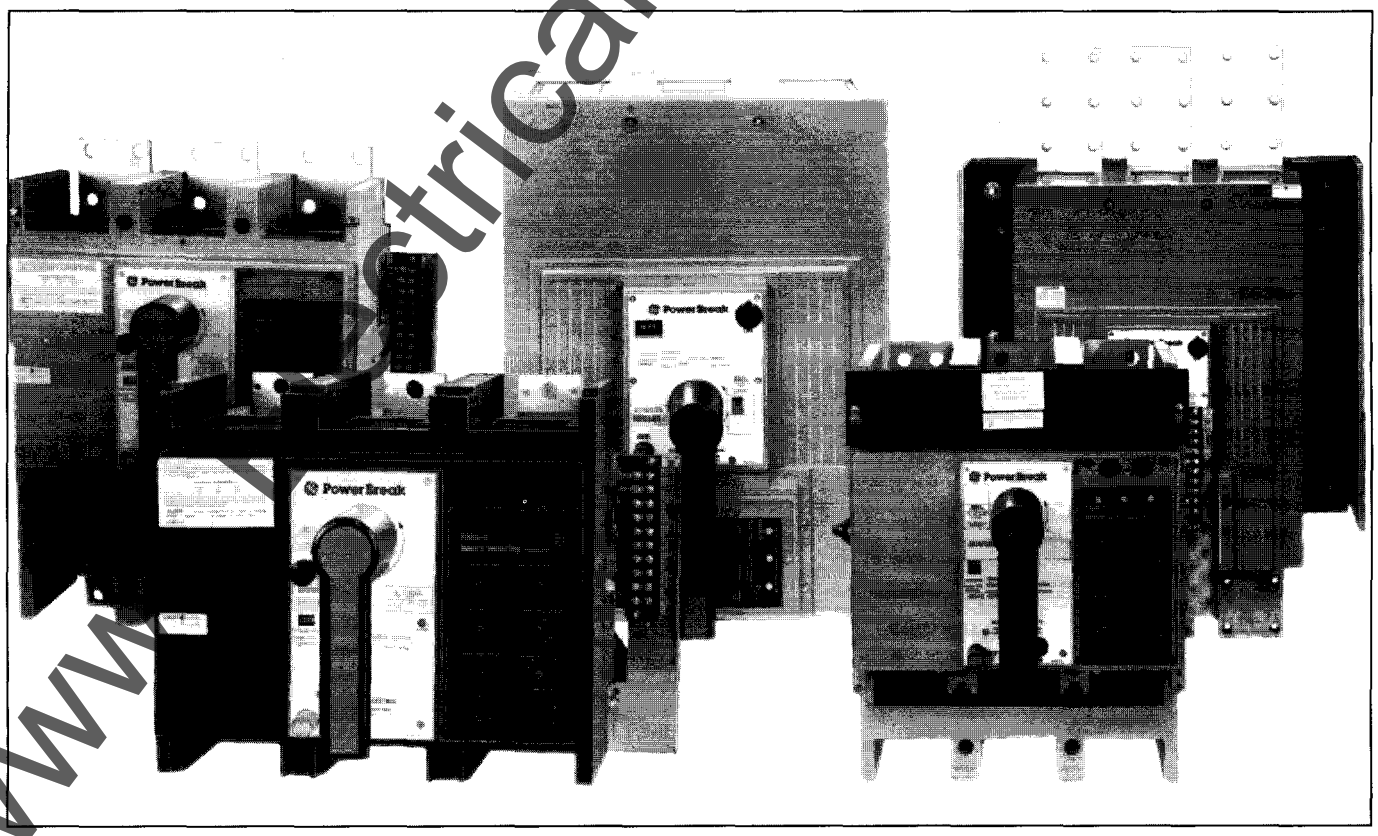

Fig 3.1 POWER BREAK Circuit Breakers

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Features and Characteristics

Key Features

1. **Increased Durability—Safety of Operation**
   High-dielectric strength, glass reinforced insulating case.
2. **High Arc Quenching Capability**
   Supported steel grids suppress arcs and cool gases rapidly, providing quick arc interruption and extended circuit breaker life.
3. **High Transient Voltage Withstandability**
   Interphase partitions mesh with breaker cover to completely isolate each pole.
4. **Preloaded Constant Pressure Pivot**
   Eliminates braid whip and fraying on high short-circuit current and repeated operations.
5. **Positive "On-Off" Position Indication**
   Green (OFF), Red (ON), eliminates any question about the position of the breaker contacts.
6. **Simple, Stored Energy Charging**
   Extra heavy duty, low torque handle mechanism.
7. **Easy Close Operation—Quick-Make**
   Push "ON" button to close breaker contacts. Allows 5 cycle maximum closing time from initiation of a close signal.
8. **Easy Open Operation—Quick-Break**
   Finger-tip "OFF" button instantly opens the breaker contacts.
9. **Interchangeable Rating Plug**
   MicroVersaTrip® RMS-9 programmers use a variety of field installable rating plugs to fix the frame continuous ampere rating.

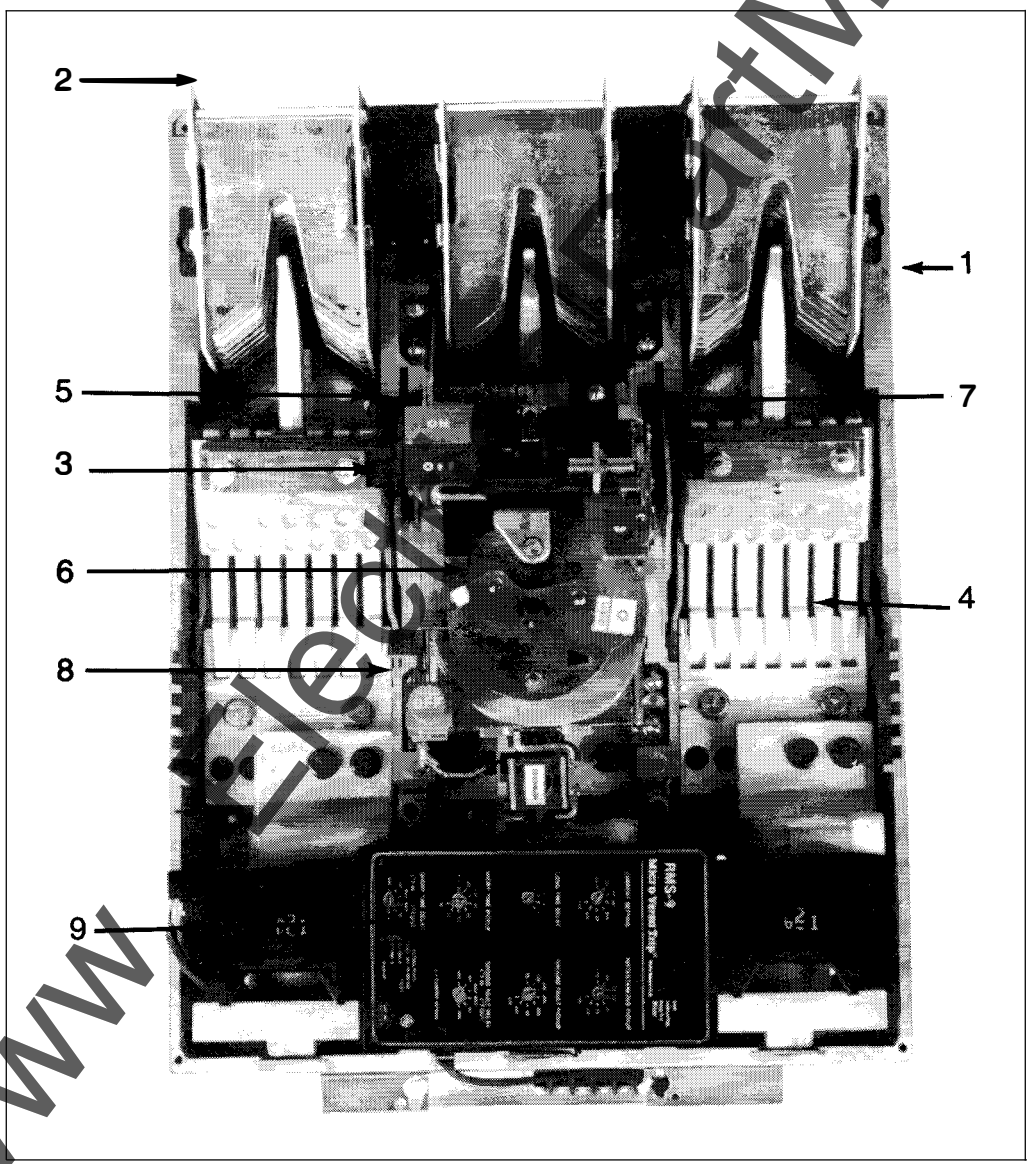

Fig. 4.1 POWER BREAK® Circuit Breaker Key Features

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Basic Configurations

POWER BREAK® is available in three basic configurations: MicroVersaTrip® RMS-9 solid-state trip; MagneTrip™ dual magnetic trip; and molded case switch. Each configuration is available in stationary or drawout construction with a full complement of control and signaling accessories. Standard rated breakers are designed to meet the majority of application requirements, calling for moderate short circuit conditions. They are furnished with grey case and cover.

Hi-Break® breakers, on the other hand, are specially designed to withstand the high stresses of, and safely interrupt, very high short-circuit current occasionally encountered. They are furnished with black case and cover.

Special Hi-Break breakers and molded-case switches are available for system voltages up to 750 Vac and 700 Vdc.

Table 5.1
Available Configurations

Frame Size (Amps)	MicroVersaTrip® RMS-9 100% (ac only)		MagneTrip™ 100% (ac or dc)			Molded Case Switch (ac or dc)		
	Std. Break	Hi-Break	Std. Break	Hi-Break	Special Hi-Break	Std. Break	Hi-Break	Special Hi-Break
800	Yes	Yes	No	No	No	Yes	No	No
1600	Yes	Yes	Yes	Yes	No	Yes	No	No
2000	Yes	Yes	Yes	Yes	No	Yes	No	No
2500	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3000	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4000	Yes①	Yes①	Yes②	Yes②	Yes②	Yes	Yes	Yes

① Draw-out construction only; stationary 4000A uses VersaTrip™ construction.
② 80% rated.

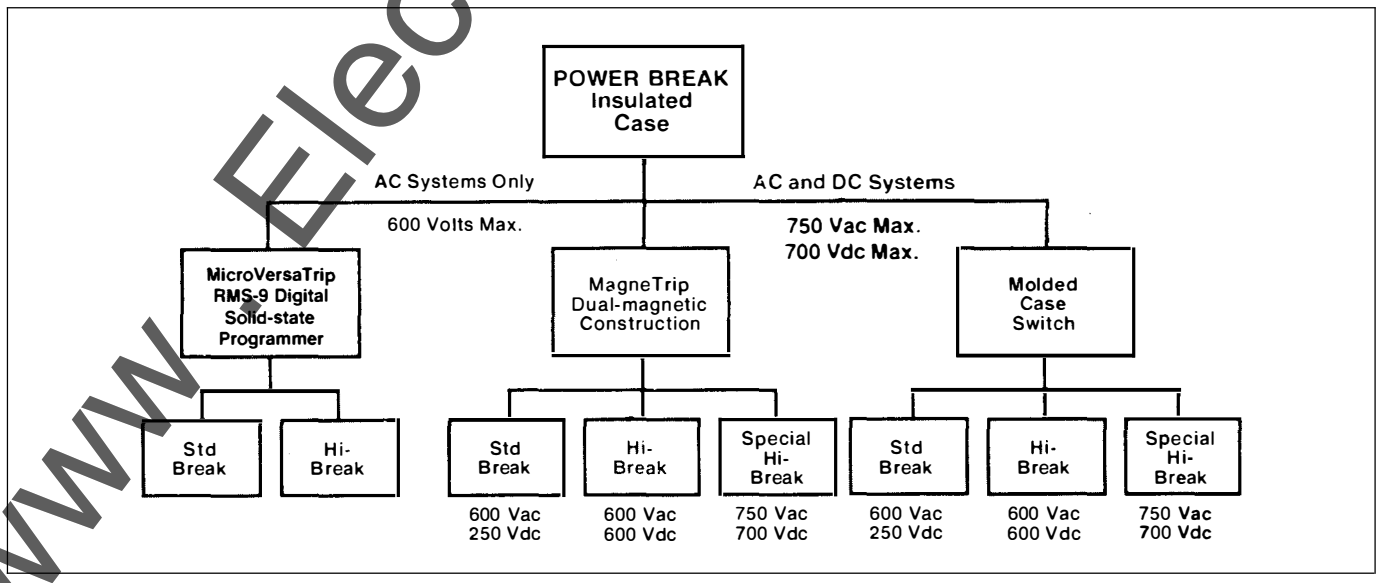

Fig. 5.1 The POWER BREAK Circuit Breaker Family

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Manual Operation

The circuit breaker is charged by a single 120° rotation of the handle for 800, 1600, and 2000 ampere envelope sizes, and by three 120° rotations for 3000 and 4000 ampere envelopes. Each handle movement is a stage in precharging a spring-loaded, quick-make, quick-break mechanism. To close the breaker contacts, and energize the load, simply push the "ON" button. To open the breaker, and de-energize the circuit, manually push the "OFF" button. both are provided on the front of the breaker. Each stage of operation (ON-OFF, "charged") is clearly shown by an indicator on the face of the circuit breaker.

Table 6.1
Sequence of Operation

Indicator	Main Br ak r Contacts	Condition of Charging Springs	Next Permissible Operating Function
OFF	Open	Discharged	Mechanism may be charged
CHG (Charged)	Open	Fully charged	Contacts may be closed
ON	Closed	Partially discharged	Contacts may be opened

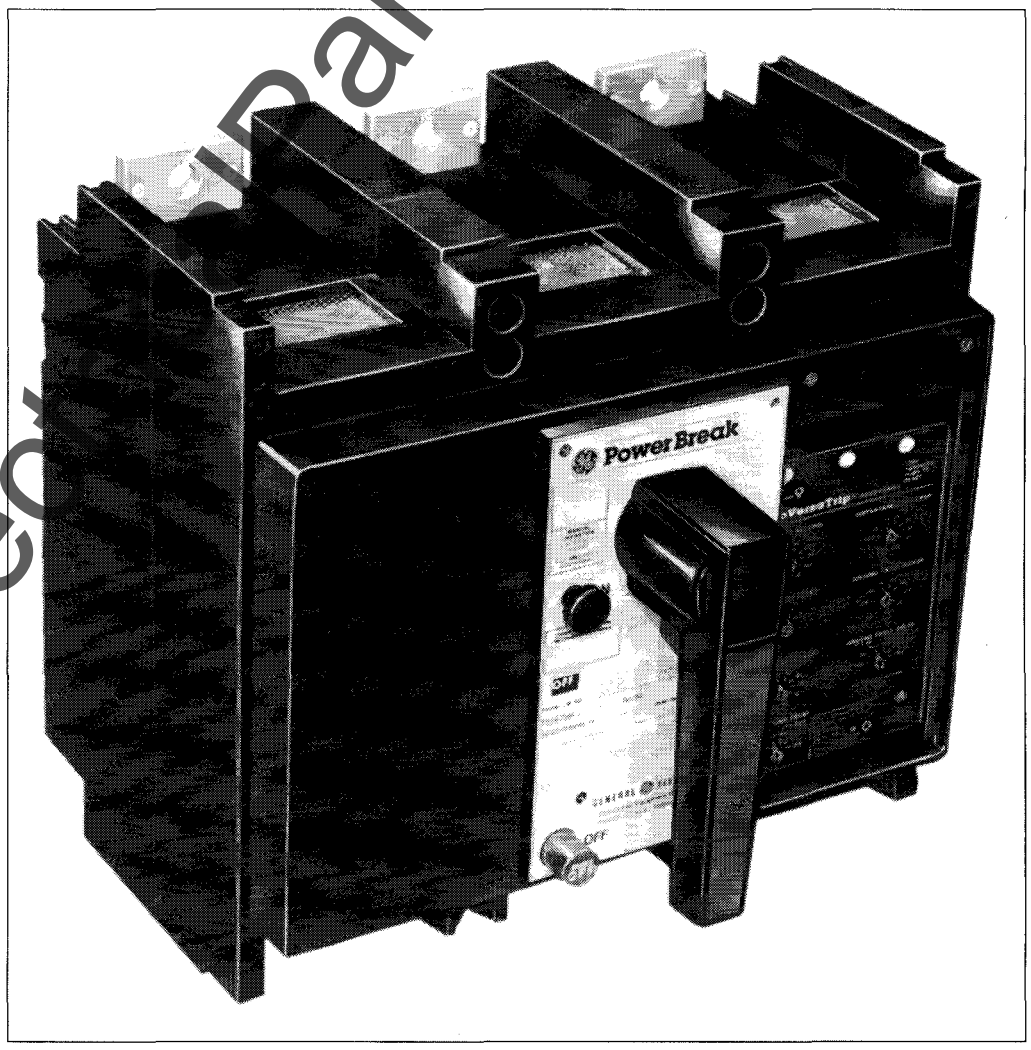

Fig. 6.1 800 Ampere Manually Operated Circuit Breaker

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Electrical Operation

The appearance of an electrically operated breaker is compatible with the manually operated POWER BREAK®. The motor operator is integrally mounted inside a heavy duty insulated case.

A motor charge, spring-close, stored-energy mechanism assures positive and complete closing of main contacts.

Five-cycle maximum closing time is standard. It fulfills requirements for generator synchronizing.

The independent charging action allows the mechanism to be charged without closing the breaker.

Remote electrical or local manual control (local controls placed on front of breaker) provide a completely separate system of mechanical operating functions, duplicating the control functions to "Open," "Charge," or "Close" breaker. A shunt trip is supplied as standard on electrically operated breakers for the remote electrical opening. (An undervoltage trip device will be substituted upon request.)

A terminal block is provided for wiring control circuits to remote operating stations.

A charging handle is provided as an integral part of an electrically operated circuit breaker for optional manual charging with no special tools or separate auxiliary handles required.

The manual charging handle is independent of the electrical drive mechanism. To engage the handle for manual charging simply depress the handle release button. Padlocking provisions for "ON" button and charging handle for prevention of manual operation of breaker by unauthorized personnel is standard.

Manual operation with the switchboard front panel in place or the hinged door closed, eliminates removing the front panel or opening the switchboard door for manual operation.

Note: For electrical control power requirements and wiring diagrams see pages 35-37.

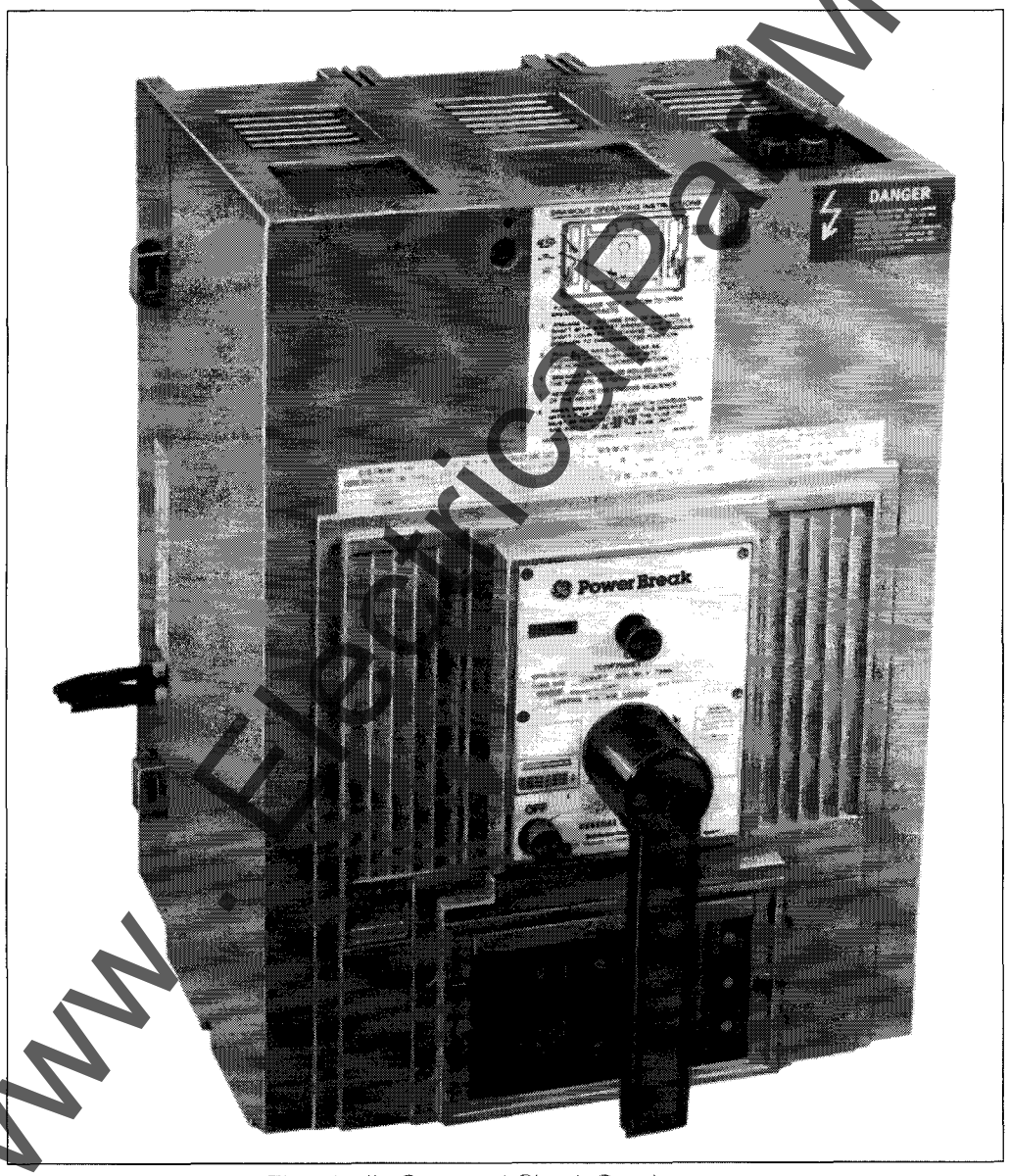

Fig. 7.1 3000 Ampere Electrically-Operated Circuit Breaker

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Features and Characteristics (Continued)

Draw-out Construction

TC and THC POWER BREAK® draw-out circuit breakers are for use in type TDOS and THDOS substructures, providing the convenience and safety inherent in draw-out breaker construction. They permit activation of a new feeder, rapid replacement of a circuit breaker, and facilitate inspection and maintenance of the draw-out breaker without making it necessary to de-energize the entire switchboard.

Features (see photos on p.9)

1. **Primary Disconnects:** Primary power is fed through multiple finger primary disconnects when connected to the primary stabs in the substructure.
2. **Secondary Disconnects:** Control power is provided through the secondary disconnects, 48 circuits max., in the test and connected positions only.
3. **Wheels:** The breaker has rollers which allow the unit to ride on the substructure retractable rails for easy removal and installation.
4. **Draw-out Mechanism:** A racking shaft powers a centrally mounted power screw, through a chain drive, into a fixed nut in the substructure. A special speed wrench is supplied with an integral 1/2" square drive socket for racking breaker in and out of the substructure.
5. **Wrench Interlock:** This interlock prevents engagement of the racking wrench when the breaker contacts are closed. This prevents disconnecting a closed breaker.
6. **Draw-out Position Indicator:** A draw-out position indicator indicates whether the breaker is in the connected, test or disconnected position.
7. **Draw-out Interlock:** This interlock will trip a closed circuit breaker. Tripping action will occur in either the connecting or disconnecting mode.
8. **Rejection Feature:** A built in rejection feature prevents insertion of a breaker into an incorrect substructure. This prevents (1) insertion of a standard-break breaker in a Hi-Break® substructure, (2) insertion of a higher ampere rated breaker in a lower ampere substructure (not shown).
9. **Programmer Disconnect Plug:** This accessory is provided only on MicroVersaTrip® RMS-9 draw-out breakers to provide zone selective interlocking for ground fault and short time or ground fault only.

   The programmer disconnect is available with all substructures required to accept MicroVersaTrip RMS-9 draw-out breaker units. The programmer disconnect allows separate circuit points for zone selective interlocking without having to sacrifice circuit points available through the secondary disconnect accessory. This accessory can be added on any substructure to permit upgrading to MicroVersaTrip RMS-9 breaker from a MagneTrip™ breaker.
10. **Padlock Device:** Padlocking is optionally provided to prevent movement of the breaker in the test and disconnected positions (not shown).
11. **Shutters:** Shutters are provided as an accessory to protect personnel from inadvertently contacting the primary stabs of an energized switchboard when the draw-out breaker unit is removed.
12. **By-Pass Switch:** A by-pass switch accessory has normally open (N.O.) and normally closed (N.C.) contacts, which change state when the draw-out circuit breaker is racked from the connected to the test position. The switch is available in 4-circuit, 8-circuit, or 12-circuit of which half are N.O. and the other half N.C. (not shown).
13. **Lifting Bar:** A lifting bar is available as an accessory and should be used to provide safe handling of the draw-out breaker.
14. **Substructure:** The substructure is a self-contained framework serving as a stationary receptacle for POWER BREAK draw-out breakers type TC or THC and provides convenience and safety inherent in draw-out construction. It permits easy activation of a new circuit in a spare compartment (hole-filler), rapid replacement of a circuit breaker, and facilitates inspection and maintenance of POWER BREAK insulated case draw-out circuit breakers without making it necessary to de-energize the entire switchboard.

    The substructure is designed for convenient mounting, with holes provided for bolting on a shelf or supports. Holes are also provided in the primary stab for bolting to busbars or terminal lugs.

    The substructure has retractable rails which aid in the installation of the draw-out breaker.

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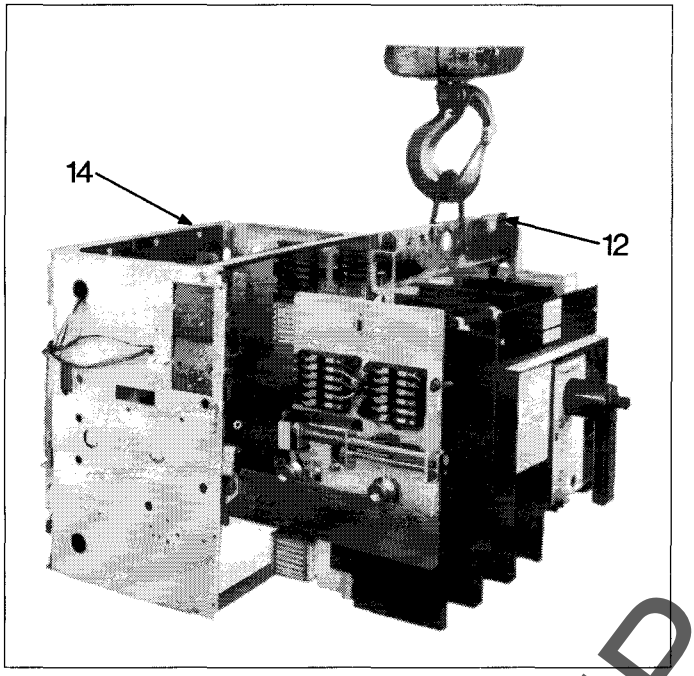

Fig. 9.1 1600 A. Draw-out Circuit Breaker and Substructure

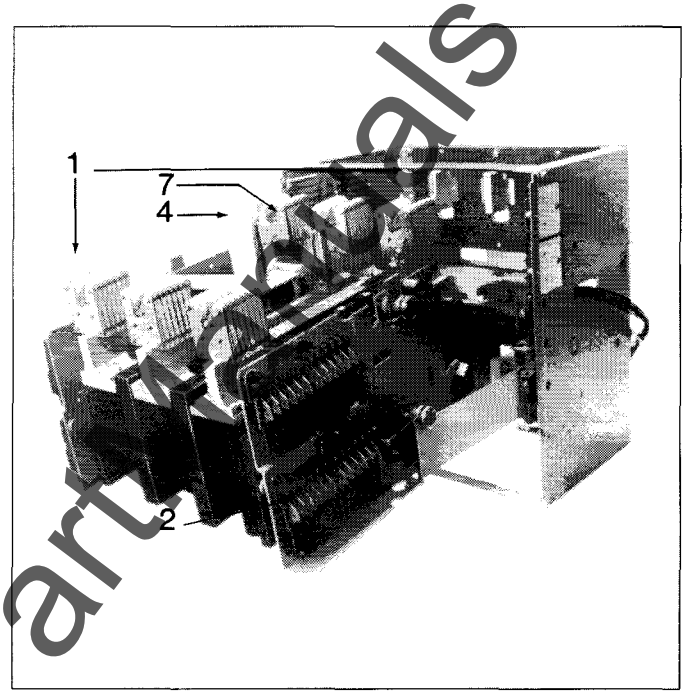

Fig. 9.2 Draw-out Breaker Rotated for Inspection

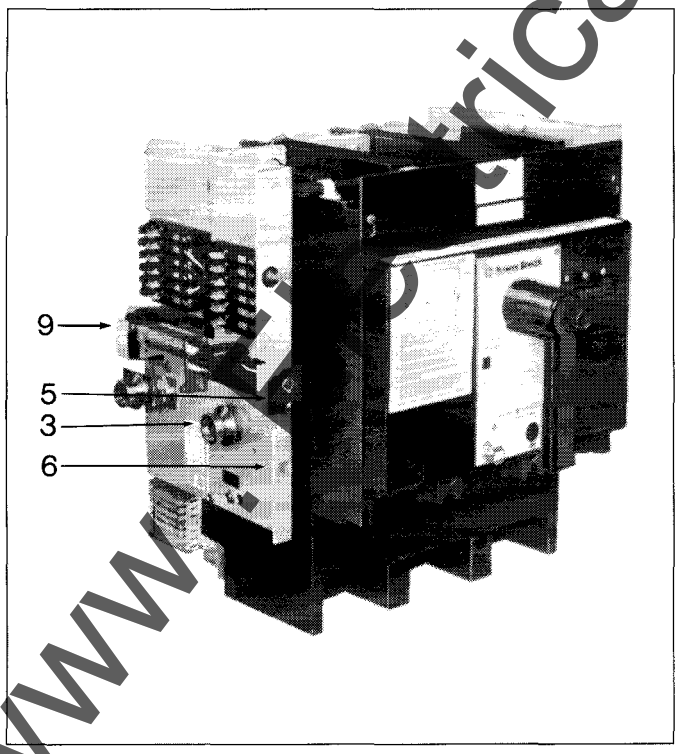

Fig. 9.3 1600 A. Draw-out Circuit Breaker

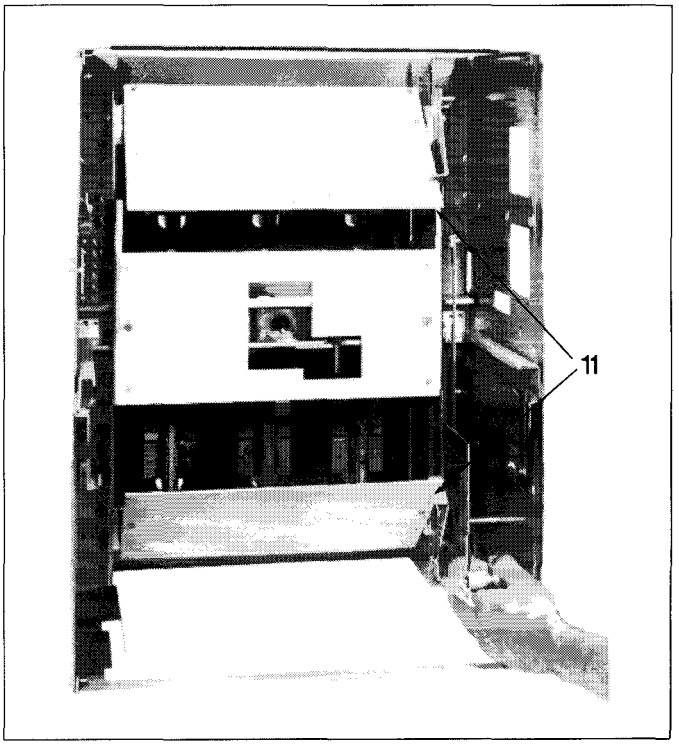

Fig. 9.4 Substructure with Optional Shutters (Shutters Partially Open)

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Trip Devices

MicroVersaTrip® RMS-9 Programmer

The MicroVersaTrip® RMS-9 system for POWER BREAK® insulated case circuit breakers consists of four parts: the protection programmer, flux-shift trip device, current sensors and rating plugs.

The programmer contains a current sensor-powered, solid-state logic unit and incorporates rotary adjustment switches for up to nine functions, as well as targets for mechanical fault trip indication.

MicroVersaTrip® RMS-9 represents the latest technology in digital solid-state programmers.

RMS Digital Sensing of Sinusoidal and Non-sinusoidal

MicroVersaTrip® RMS-9 provides accurate overload protection for both sinusoidal and non-sinusoidal currents by direct measurement of the true rms content of the current wave. This is accomplished by microprocessor digital sampling techniques. Therefore, the solid state microprocessor is not affected by component tolerance and does not require compensation for signal distortion. Since the design is based on complementary metal oxide (CMOS) technology, it is less sensitive to extraneous noise produced by lightning, instrumentation, radio, etc.

The solid state microprocessor technology and fast analog to digital converters make it possible to measure the magnitude of the phase current over a number of time periods within the cycle. The MicroVersaTrip® RMS-9 sampling rate of 27 per cycle for each phase allows for errors of less than 1% on systems with distortions through the 13th harmonic. This digital sampling technique provides the most accurate system protection for distribution systems that include ac and dc variable speed drives, rectifiers, induction heating, and other loads that cause non-sinusoidal currents.

Full Function Trip Unit Available with Various Protection Feature Combinations

The MicroVersaTrip® RMS-9 trip line of programmers provides maximum breaker to breaker selectivity and custom load protection. Short-time and Ground Fault functions include the flexibility of coordination with and without an I^2T ramp. POWER BREAK® circuit breakers are available with Standard Instantaneous

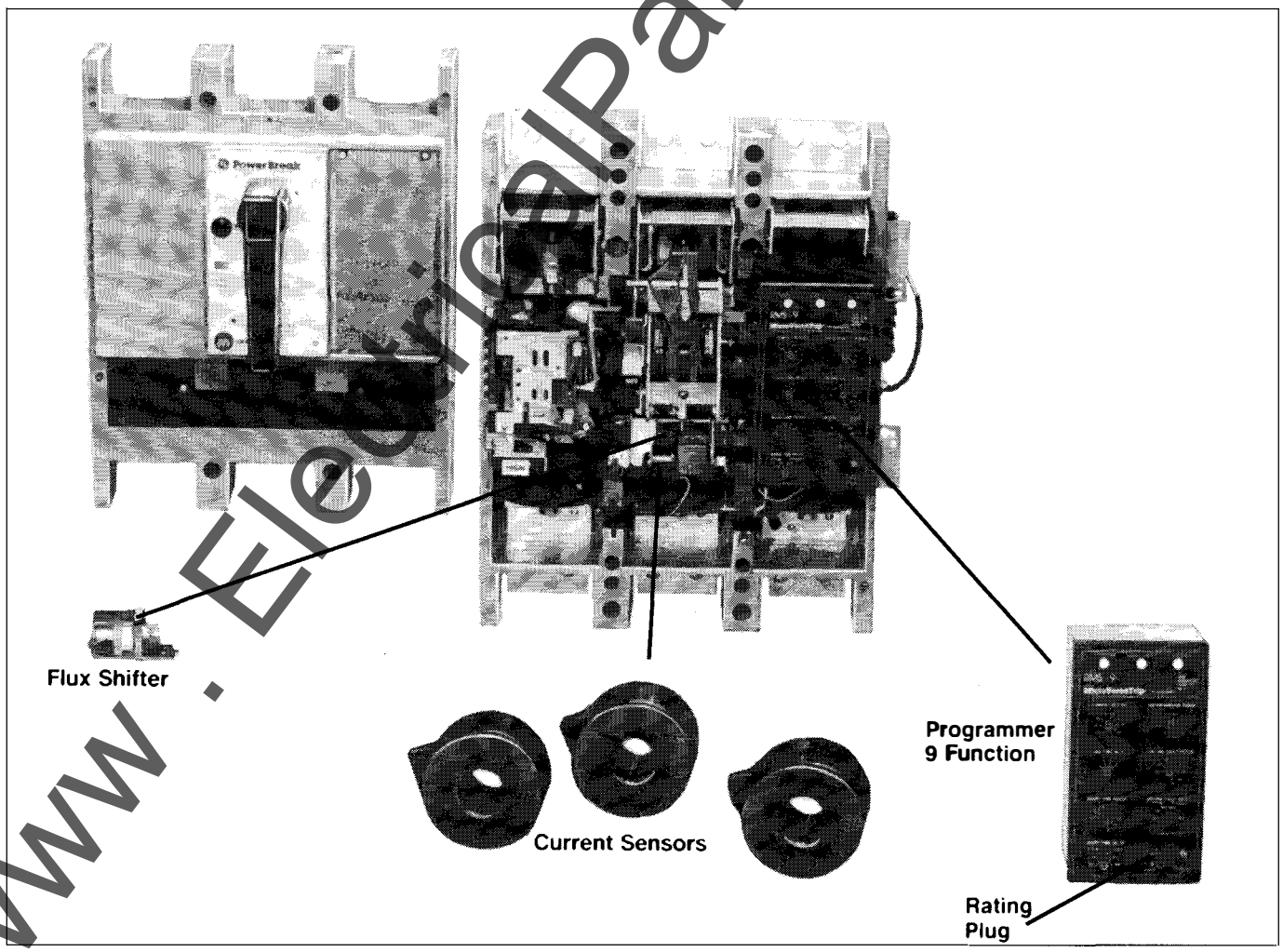

Fig. 10.1 MicroVersaTrip RMS-9 System Components

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or High Range Instantaneous, and Ground Fault. All programmers include a clear plastic cover with provisions for sealing for tamper-proof installation.

Current Sensors

Three toroidal current sensors provide maximum flexibility and reliability with minimum signal error. For sensors rated 2000A and less, the secondary output at rated input current is 200ma; for 2500, 3000, and 4000A sensors, secondary current is 400ma.

Flux-shift Trip Device

The flux-shifter is a low energy, positive action tripping device that is automatically powered and controlled by the protection programmer. The low energy signal from the programmer counteracts the strength of a permanent magnet in the flux-shifter, allowing a spring to unseal the magnet and trip the breaker.

Rating Plugs for Convenient Flexibility

All RMS-9 programmers utilize a broad range of field-installable rating plugs for future up-rating capability, minimum size cable selection, and an extra degree of coordination flexibility.

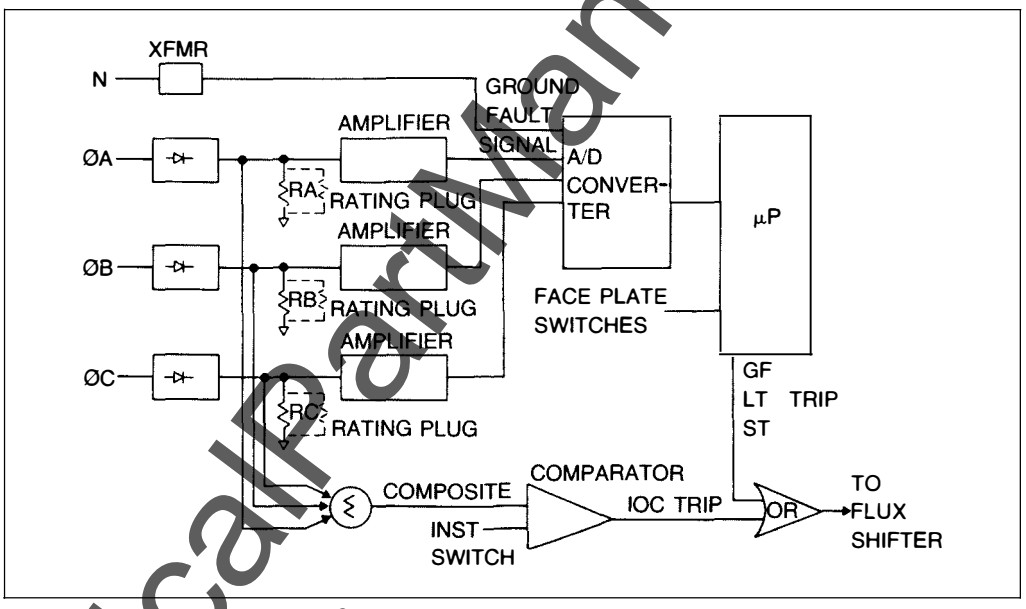

Fig. 11.1 MicroVersaTrip RMS-9 Block Diagram

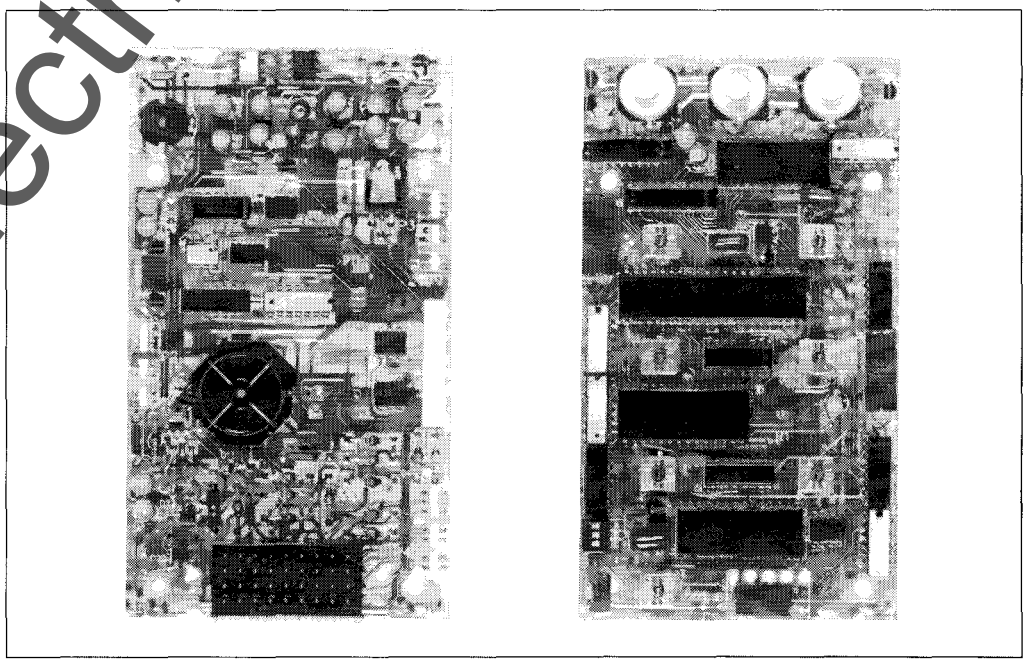

Fig. 11.1 Programmer Components: Power Supply Board, Logic Board

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MicroVersaTrip® RMS-9
Programmer Tripping Functions

1. Current Setting—Standard
2. Long-time Delay—Standard
3. Long-Time Pickup Light—Standard
4. Short-time Pickup—Optional
5. Adjustable Short-Time Delay with I^2t IN or OUT—Optional
6. Instantaneous Pickup—Standard
7. Ground Fault Pickup—Optional
8. Ground Fault Delay with I^2t IN or OUT—Optional
9. Rating Plug—Several plugs are available to easily change the breaker continuous ampere rating (see Table 13.2 and 18.2)
10. Test Jack (for use with test kit cat. no. TVRMS)
11. Fault Trip Annunciators—Optional

Not Shown:

- Adjustable High Range Instantaneous—Optional
- Zone Selective Interlock Optional

Available programmer function combinations are shown in Table 18.1

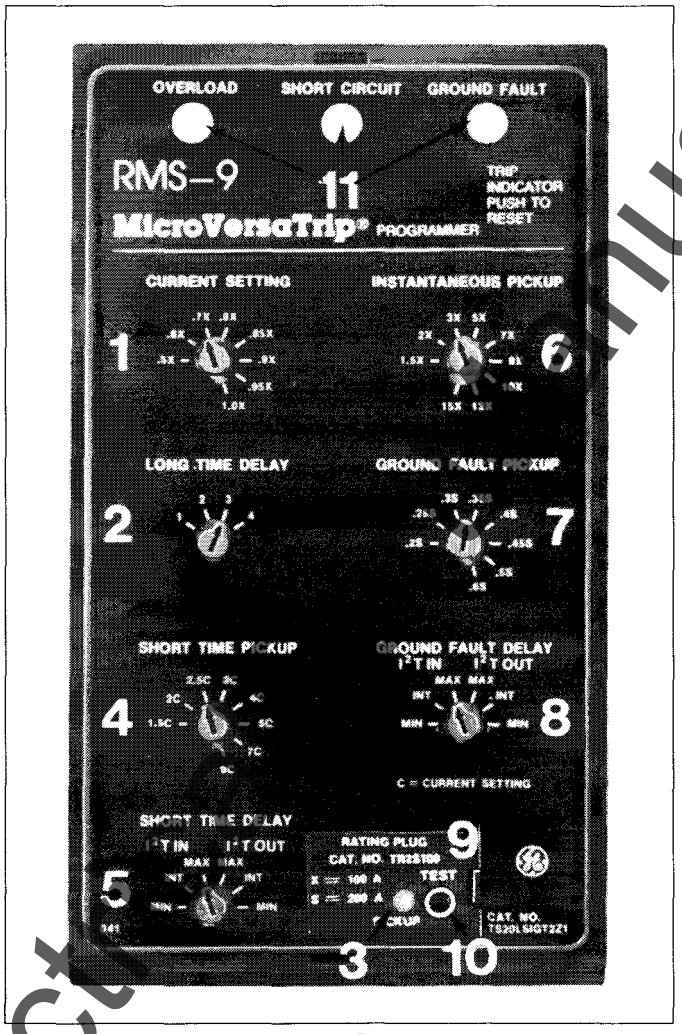

Fig. 12.1 MicroVersaTrip® RMS-9 Programmer

Table 12.1
Basic Frame Selection, Stationary or Draw-out, UL Listed, 100% Equipment Rated with MicroVersaTrip® RMS-9 Programmer

Frame Size	Frame Size (Amps)	Sensor Rating (Amps)	Stationary		Draw-out	
			Standard Break	Hi-Break®	Standard Break	Hi-Break®
800	800	200 400 800	TP82SS TP84SS TP88SS	THP82SS THP84SS THP88SS	TC82SS② TC84SS② TC88SS②	THC82SS② THC84SS② THC88SS②
1600	1600	1000 1600	TP1610SS TP1616SS	THP1610SS THP1616SS	TC1610SS TC1616SS	THC1610SS THC1616SS
2000①	2000	2000	TP2020SS	THP2020SS	TC2020SS	THC2020SS
3000	2500	1000 2000	TP2510SS TP2520SS	THP2510SS THP2520SS	TC2510SS TC2520SS	THC2510SS THC2520SS
		2500	TP2525SS	THP2525SS	TC2525SS	THC2525SS
	3000	3000	TP3030SS	THP3030SS	TC3030SS	THC3030SS
4000	4000	4000	TPSS9640③	THSS9640③	TC4040SS	THC4040SS

① Small frame size.
② Up to 24 secondary disconnects. For up to 48 secondary disconnects, use Cat. No. TCL__ __ SS or THCL__ __ SS.
③ 4000-amp stationary breaker uses VersaTrip programmer.

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Table 13.1
POWER BREAK® MicroVersaTrip® RMS-9 Programmer Characteristics

Current Setting		.5, .6, .7, .8, .85, .9, .95, 1.0 of Rating Plug Amp (X)		
Long-time	Pick up	Fixed at 1.1 of Current Setting (C)		
	Delay①	2.4, 4.9, 9.8, 20 Seconds		
Short-time	Pickup	1.5, 2, 2.5, 3, 4, 5, 7, 9, Multiple of Current Setting (C)		
	Delay (I^2t in)①	.40 Seconds		
	Delay (I^2t out)②	.10, .21, .35 Seconds		
Adjustable Instantaneous Pickup	Frame Amp Rating	800, 1600, 2000	2500, 3000	4000③
	Without Short-time (Multiple of rating plug amps (X))	1.5, 2, 3, 5, 7, 9, 10	1.5, 2, 3, 5, 7, 9, 10	1.5, 2, 3, 5, 7, 9
	With Short-time (Multiple of rating plug amps (X))	1.5, 2, 3, 5, 7, 9, 10, 13, 15	1.5, 2, 3, 5, 7, 9, 10, 13	1.5, 2, 3, 5, 7, 9
High Instantaneous Pickup	Frame Amp Rating	800, 1600, 2000	2500, 3000	4000③
	With Short-time (Multiple of frame ST rating (H))	.4, .6, .8, 1.0		
Ground Fault	Frame Amp Rating	800, 1600, 2000	2500, 3000	4000③
	Pickup (Multiple of sensor amp rating (S))	.2, .25, .3, .35, .4, .45, .5, .6	.2, .22, .24, .26, .28, .3, .34, .37	.2, .22, .24, .26, .28, .3
	Delay (I^2t in)④	.40 Seconds		
	Delay (I^2t out)②	.10, .21, .35 Seconds		

① Time delay shown at 600% of current setting at lower limit of band.
② Time delay shown at lower limit of each band. All tolerances are ± 10%. Ground fault pickup does not exceed 1200 amps.
③ 4000-amp stationary breaker uses VersaTrip programmer. See footnote ① to Table 18.1, page 18 for available characteristics.
④ Delay shown at 200% of pick-up setting at lower limit of band.
X = Rating plug amps
C = Current setting
S = Sensor amp rating
H = Frame short-time rating

Table 13.2
POWER BREAK® Rating Plug Selection

Frame Size (Amps)	Sensor Rating (Amps) (S)	Current Rating (Amps) (X)	Rating Plug Cat. No.
800	200	100 150 200	TR2S100 TR2S150 TR2S200
800	400	150 200 225 250 300 400	TR4S150 TR4S200 TR4S225 TR4S250 TR4S300 TR4S400
800	800	300 400 500 600 700 800	TR8S300 TR8S400 TR8S500 TR8S600 TR8S700 TR8S800
1600	1000	400 600 800 1000	TR10S400 TR10S600 TR10S800 TR10S1000
1600	1600	600 800 1000 1200 1600	TR16S600 TR16S800 TR16S1000 TR16S1200 TR16S1600
2000	2000	800 1000 1200 1600 2000	TR20S800 TR20S1000 TR20S1200 TR20S1600 TR20S2000
2500	1000	400 600 800 1000	TR10S400 TR10S600 TR10S800 TR10S1000
2500	2000	800 400 1200 1600 2000	TR20S800 TR20S1000 TR20S1200 TR20S1600 TR20S2000
2500	2500	1600 2000 800	TR25S1600 TR25S2000 TR25S2500
3000	3000	2000 2500 3000	TR30S2000 TR30S2500 TR30S3000
4000①	4000	1600 2000 2500 3000 4000	TR40S1600 TR40S2000 TR40S2500 TR40S3000 TR40S4000

① Draw-out breaker only.

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Current Setting (Long-Time Function)

Moving from left to right on the current axis, Figure 14.1, the upper part of the time current curve is the long-time region. The current setting is used to protect a circuit against low magnitude overcurrents. The breaker trips because the current has exceeded the current setting. If a breaker is protecting a motor, the accelerating time can be accommodated by setting the breaker to allow for a momentary delay while the motor has a chance to reach its normal operating speed or full load current.

Short-Time Function

The middle portion of the curve is the short-time function. It is used to protect against higher magnitude overcurrents and low-level short circuit faults. Overcurrent due to short circuits is generally in the order of ten or more times full-load current, and is measured as symmetrical rms (root mean square) short-circuit current.

Instantaneous Function

At the bottom of the time current curve is the protective device's instantaneous function. The instantaneous trip point determines the level at which the breaker will trip without an intentional time delay. This immediate interruption occurs only as a result of a severe overcurrent condition, such as a high-level short circuit, that would damage the electrical system if not interrupted.

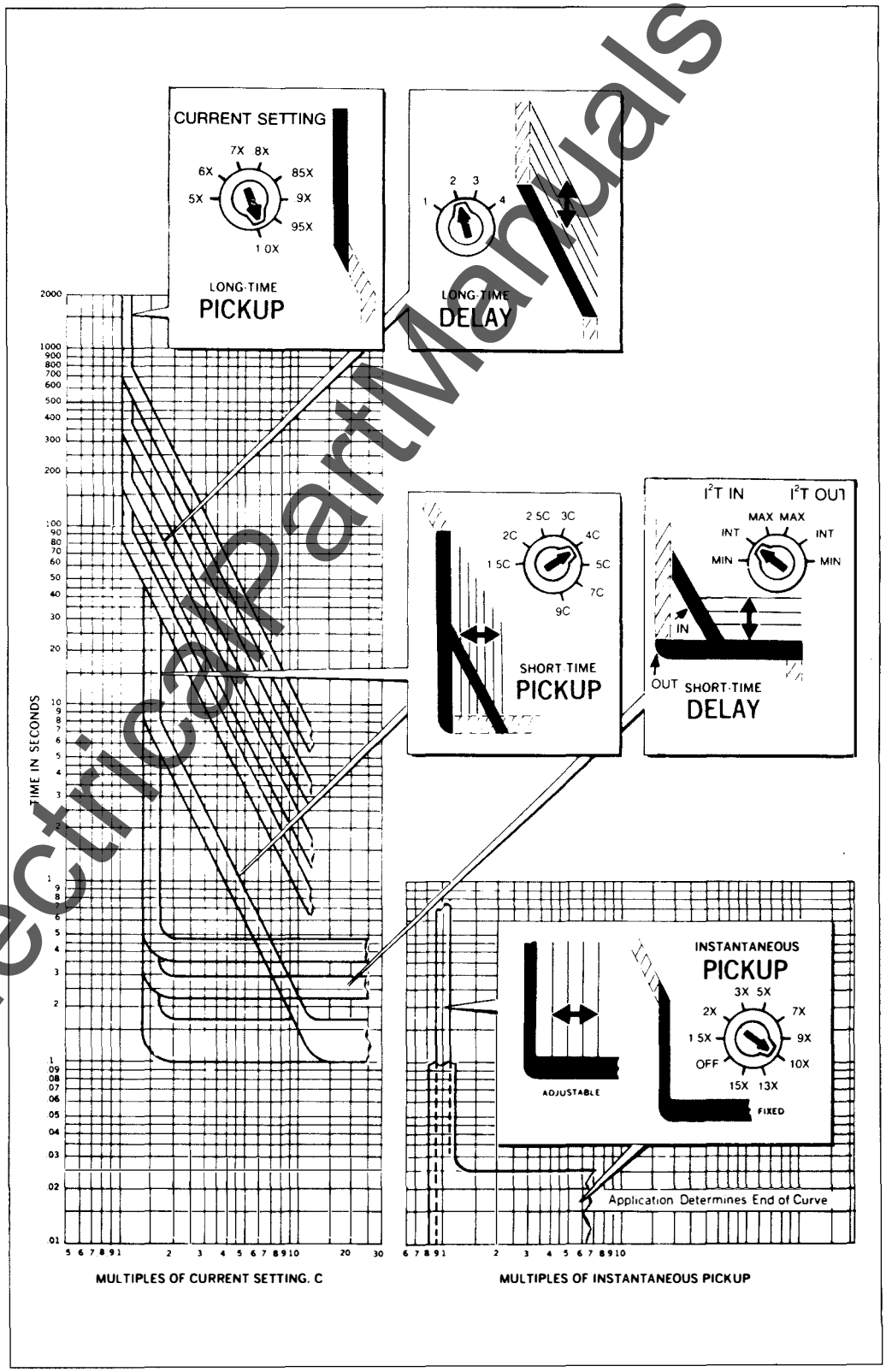

Fig. 14.1 Time Current Curve Definition — Overload and Short Circuit

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I^2t Function

An I^2t function is available with MicroVersaTrip® RMS-9. This provides a ramp function (I^2t=constant) in the short-time and ground fault characteristic (see Fig. 15.1) that allows maximum coordination with downstream thermal-magnetic protective devices that follow a curve instead of a square path. The I^2t function also allows tighter motor protection by accommodating the transient inrush while the short-time pickup remains just slightly higher than the steady state starting current. In other words, the path follows the hypotenuse instead of the right angle. When the square short-time path might intersect with a downstream fuse or breaker, the I^2t function permits the short-time delay path to veer in front of the time current curve for the downstream device. Without this function, coordination and selectivity would be difficult to attain.

Ground Fault Protection

A ground fault is unintentional current flowing from a circuit through a conducting path to ground. It is usually of a low magnitude (less than the long-time pickup value) and not sensed by the protective device. Using modern electronic trip devices, protection against ground faults can be built into a distribution protection system with ground fault pickup and delay functions added to the circuit breaker's fault interrupting capability. Before electronic trips came on the scene, a complex collection of external relays and current sensors were needed to sense a ground fault and signal a breaker to trip. Eight ground fault pickup levels and three delay bands with I^2t in and out allow full selectivity, ensuring that only the breaker closest to the ground fault will trip. Addition of zone selective interlocking for the ground fault function further enhances this protection by permitting "timed" tripping and closer back-up protection.

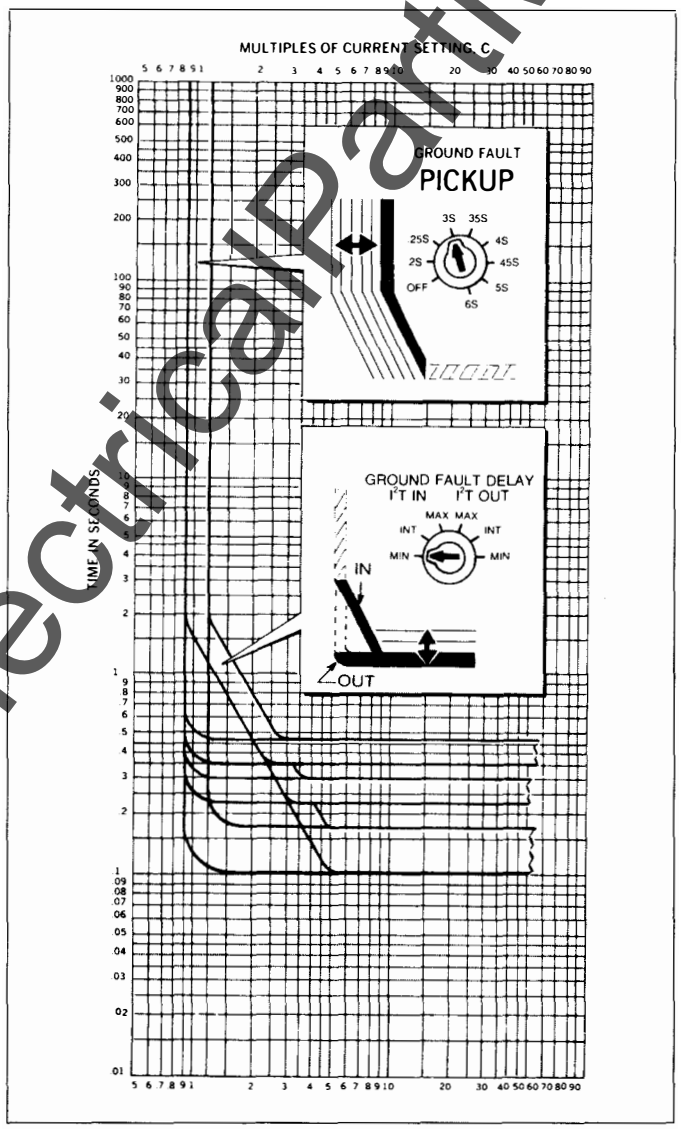

Fig. 15.1 Time Current Curve Detection — Ground Fault

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MicroVersaTrip® RMS-9 Programmer Tripping Functions (Continued)

Current Setting (Standard)

The adjustable current setting varies the level of current the breaker will carry indefinitely without tripping. It is adjustable in eight steps from 50–100% of rating plug rating.

Long-Time Delay (Standard)

This long-time delay adjustment varies the time it will take the breaker to trip under sustained overload conditions. It provides the function of withstanding momentary overloads such as motor starting, welding, or other overcurrent conditions without interrupting the service.

Long-Time Pickup Light (Standard)

The long-time pickup light provides visual indication that the breaker is experiencing an overload condition. Indication is provided by a light-emitting diode (LED). Light flashes when current value is 95% of pickup and is on continuously at 100% of pickup. Saves test and system start up time.

Short-Time Pickup (Optional)

This short-time pickup adjustment controls the level of high current the breaker can carry for short periods of time without tripping. Permits downstream breakers to clear short circuit faults without tripping out the upstream protective device.

Short-Time Delay (Optional)

The short-time delay adjustment is used in conjunction with the short-time pickup setting to provide a further refinement of coordination between circuit breakers. It establishes the time interval the breaker will wait before responding to the short-circuit current level selected on the short-time trip point adjustment.

Instantaneous Pickup (Standard)

The instantaneous trip point determines the level at which the breaker will trip without intentional time delay (0.025 seconds or less). This immediate interruption occurs only as a result of a severe overcurrent condition, thereby minimizing damage to the electrical system and equipment.

High Range Instantaneous (Optional)

Includes adjustable short-time pickup, adjustable short-time delay and a high-level instantaneous setting is adjustable in four steps from 40 to 100 percent of the circuit breaker frame short-time rating permitting maximum use of the breaker's short-time capability. This high level instantaneous function increases system protection without losing selectivity.

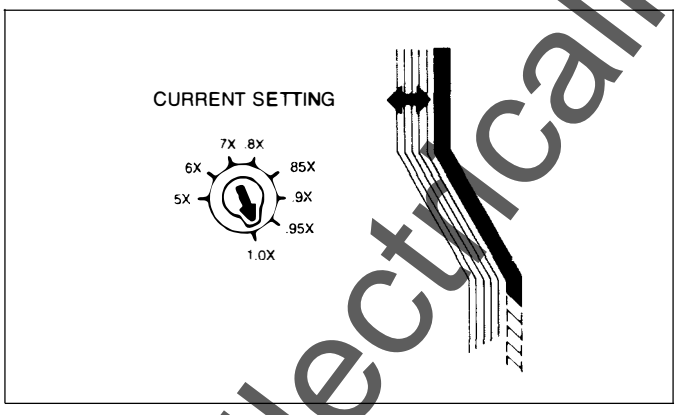

Fig. 16.1 Current Setting

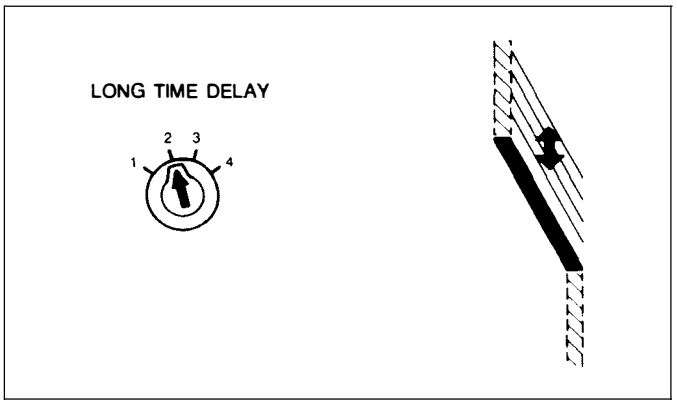

Fig. 16.2 Long-Time Delay

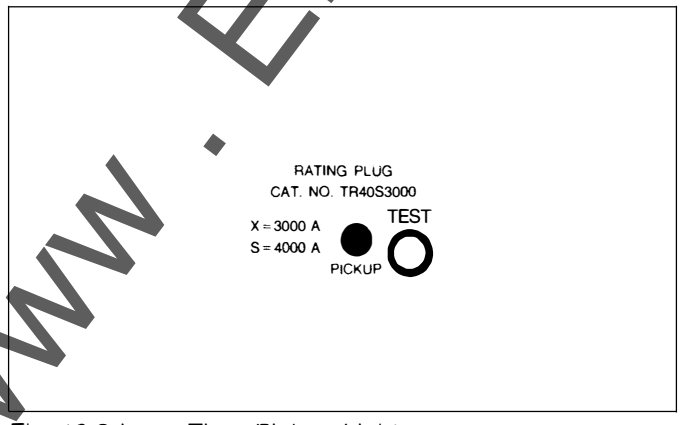

Fig. 16.3 Long-Time Pickup Light

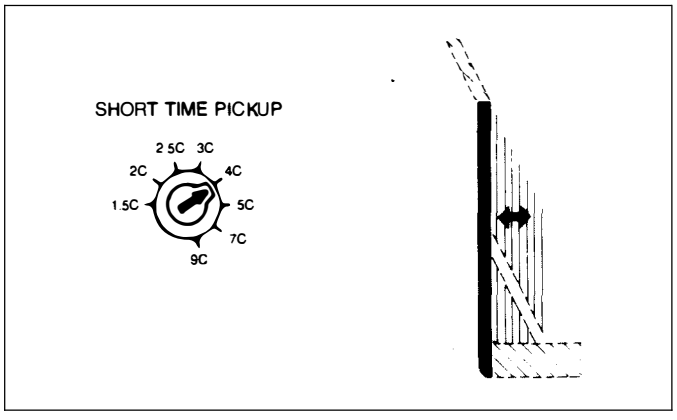

Fig. 16.4 Short-Time Pickup

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Ground Fault Pickup and Ground Fault Delay (Optional)

The ground fault pickup adjustment controls the level of ground fault current at which circuit interruption will occur. To comply with the 1987 National Electrical Code (NEC 230-95), no trip point exceeds 1200 amperes. The common square knee of the curve can be replaced with an I^2t function to facilitate coordination with downstream devices such as thermal-magnetic breakers and fuses whose time-current curves do not easily relate to the square-shape sensing characteristics common to solid state trip devices.

The ground fault delay adjustment is used to add a predetermined delay in time to the trip point once the ground fault pickup level has been reached. This provides tripping selectivity between main and feeder or other downstream breakers. The ground fault unit also includes as standard selectable inverse I^2t ramp to substantially improve coordination with downstream protective devices such as fuses and thermal magnetic circuit breakers.

Memory Circuit

Because of the highly intermittent and erratic nature of arcing ground faults, a memory circuit has been incorporated in all MicroVersaTrip® RMS-9 ground fault sensing circuits as standard. The memory circuit integrates arcing fault current with time, essentially summing the intermittent ground current spikes. In the diagrams, it can be seen how the memory function works.

Diagram A shows a typical ground fault with half-cycles, whole cycles and multiple cycles missing, as normally occurs.

Diagram B shows trip response of a typical ground fault function which does not include memory. The breaker never trips because the time delay circuits are reset with every missing cycle.

Diagram C shows response of MicroVersaTrip RMS-9 ground fault circuits to the same ground fault; the circuit's memory carries through the missing cycles and generates a trip signal after the preset time delay.

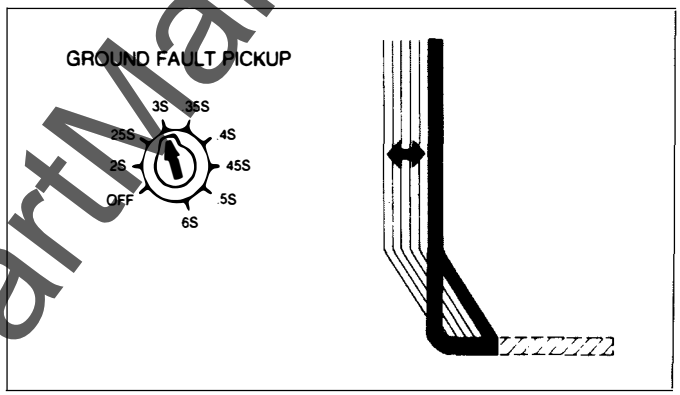

Fig. 17.3 Ground Fault Pickup

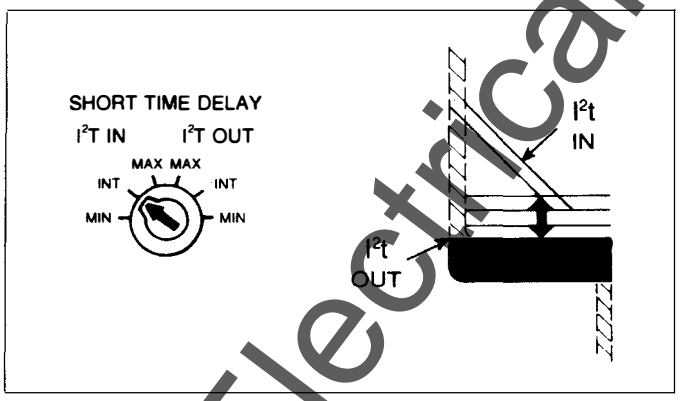

Fig. 17.1 Short-Time Delay

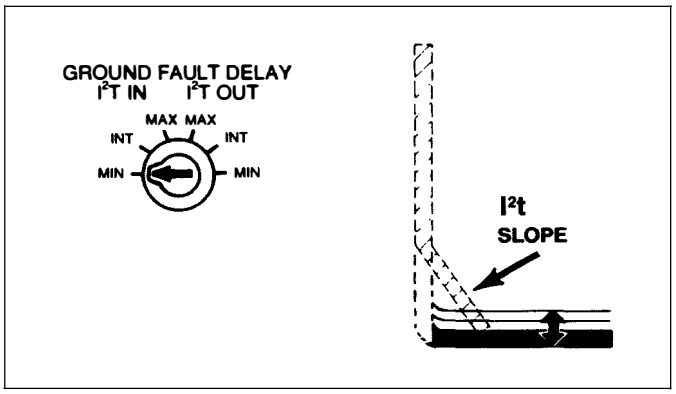

Fig. 17.4 Ground Fault Delay

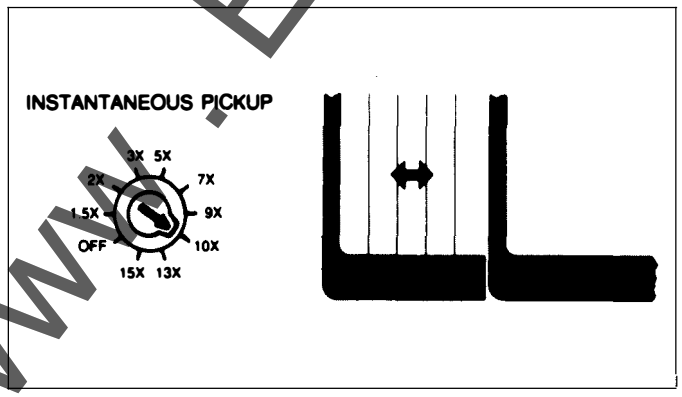

Fig. 17.2 Instantaneous Pickup

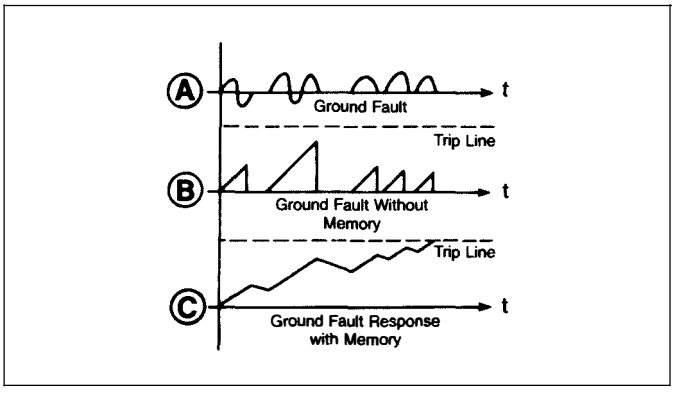

Fig. 17.5 Memory Circuit

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Fault Trip Indicators

Indicators are designed to reduce system downtime by analyzing any overcurrent fault and identifying its cause. Mechanical pop-out type indicators are available on the programmer for identifying overload or short circuit overcurrent faults when breakers are ordered without integral ground fault protection. Indicators are available to identify overload, short circuit and ground fault trips — for breakers supplied with integral ground fault protection. See Figure 18.1

Zone Selective Interlocking

The standard means of obtaining selectivity between main and feeder breakers is by incorporating programmers with time-coordinated trip characteristics. This consists of setting the farthest downstream breaker with a small time delay, and progressively increasing the time delay as you get closer to the main protective device. The disadvantage in this method is that the system must now endure the stress of the high current fault until time-out occurs.

The Zone Selective Interlock module, Figure 18.2, receives a signal from a downstream MicroVersaTrip® RMS-9 programmer (Logic 0) which causes the module to transmit a low-level interlock signal to a MicroVersaTrip RMS-9 programmer upstream. The interlock signal activates the LED portion of an LED-Transistor Opto-isolator in the upstream programmer causing the fixed delay band to shift from "MIN" to the programmer delay band setting (Figure 39.1 and 40.1). Both the Short-Time and Ground Fault functions are capable of being interlocked.

Zone selective interlocking is available for the ground fault function only, or for the ground fault and short time together.

Rating Plug (Standard)

Various ratings plugs are available to fix the ampere rating equal to or lower than the sensor ampere rating as in Table 18.2.

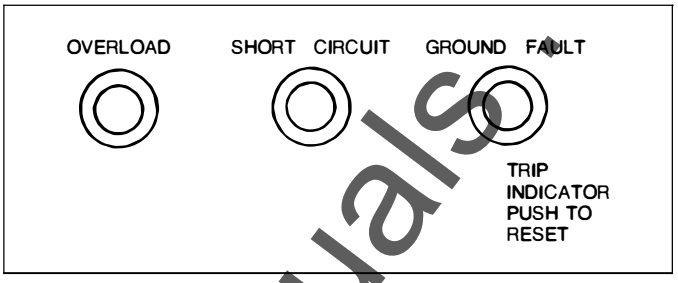

Fig. 18.1 Fault Trip Indicators

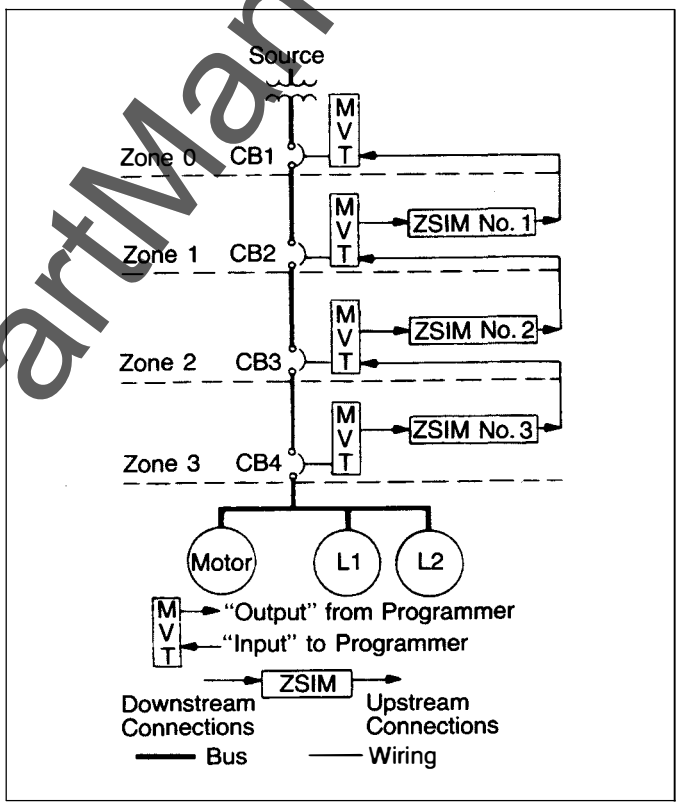

Fig. 18.2 Multi-Zone Interlocking

Table 18.1
POWER BREAK® Programmer Suffix Selection

Programmer Suffix①	Long-time (L)	Short-time (S)	Inst. (I)	High Inst. (H)	Ground Fault (G)	OL/SC Targets (T1)	OL/SC/GF Targets (T2)	GF Zone Interlock (Z1)	GF/ST Zone Interlock (Z2)
Adjustable Instantaneous									
LI	X		X						
LIT1	X		X			X			
LIG	X		X		X				
LIGT2	X		X		X		X		
LIGT2Z1	X		X		X		X	X	
LSI	X	X	X						
LSIT1	X	X	X			X			
LSIG	X	X	X		X				
LSIGT2	X	X	X		X		X		
LSIGT2Z1	X	X	X		X		X	X	
LSIGT2Z2	X	X	X		X		X		X
Adjustable High Range Instantaneous									
LSHT1	X	X		X		X			
LSHGT2	X	X		X	X		X		
LSHGT2Z1	X	X		X	X		X	X	
LSHGT2Z2	X	X		X	X		X		X

Suffix	Description
None	Adj. LT delay, adj. instantaneous
S or D	Adj. ST, adj. instantaneous Adj. ST, fixed instantaneous
G① or G3	Adj. GF, 3-phase, 4-wire Adj. GF, 3-phase, 3-wire
A2 or A3	Targets — overload, short circuit Targets — overload, short circuit, GF

① Available VersaTrip 4000-amp stationary breaker characteristic suffix.

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MagneTrip™ Trip Unit

POWER BREAK® with MagneTrip™ features dual magnetic trip construction suitable for ac or dc voltage applications. All breakers are UL listed as 100 percent rated (TPMM, THMM) breakers-Ref. NEC-220-10. Two tripping functions are supplied per pole, each independently adjustable; adjustable ampere setting (70–100%) plus either adjustable instantaneous or fixed instantaneous with adjustable short time.

The dual-magnetic trip construction consists of twin armatures hinged to a laminated magnetic structure. One armature is fastened to a dashpot. The fluid inside the dashpot is a silicone based oil that has a negligible viscosity change over a broad range of temperatures ensuring ambient insensitivity. During overload conditions, the oil-dashpot acts as a long time delay, allowing transient overcurrents to occur without tripping the breaker.

The second armature, restrained by a mechanism, will not trip the breaker during overload currents. However, when a short circuit occurs, magnetic forces overcome the restraint put on the armature by the mechanism and cause the armature to close instantaneously, overriding any time delay in tripping the breaker.

Each function is continuously adjustable with positive stops at the low and high ends.

All adjustable trip functions are front-accessible and shielded by a protective cover to avoid unauthorized entry.

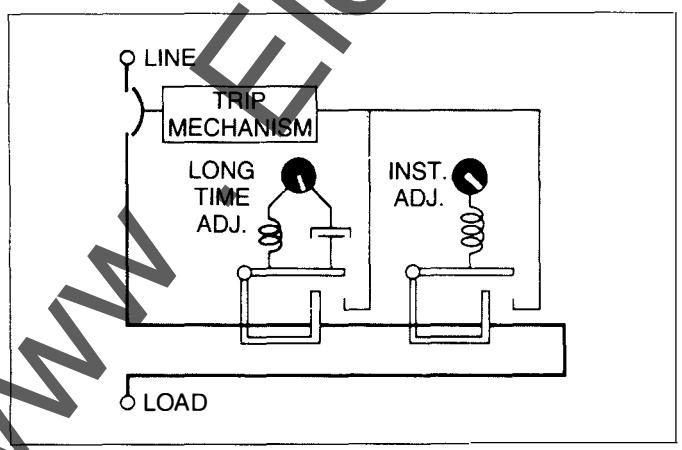

Fig. 19.1 Dual-Magnetic Trip Schematic

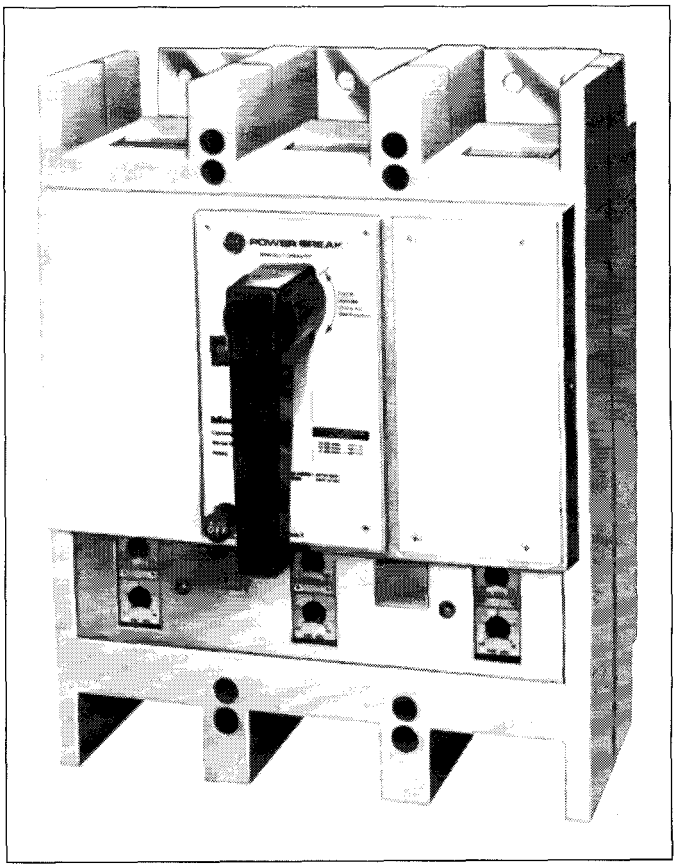

Fig. 19.2 POWER BREAK with MagneTrip, 1600A (with trip adjustment cover removed)

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Trip Devices (Continued)

MagneTrip™ Trip Unit (Continued)

Adjustable Trip Characteristics

- Ampere Setting
  The ampere setting adjusts the value of current the circuit breaker will carry indefinitely without tripping. The long-time delay rating is a direct function of this setting.
- Instantaneous Trip
  The instantaneous trip setting provides immediate interruption of high overcurrents (short circuits) in 26 milliseconds maximum (1.56 cycles). Its adjustment range is a function of the breaker nameplate ampere rating and independent of ampere setting. A fixed instantaneous override is applied to breakers ordered with adjustable short time.
- Short-time Delay
  The short-time delay adjustment automatically combines pick-up point and delay time. It is used to introduce a slight delay at higher current levels for greater system coordination purposes. This permits the downstream feeder to clear the fault rather than the main. A fixed instantaneous override function is standard.

Special Purpose MagneTrip™ Breakers

POWER BREAK® is available for 700 volt dc and 750 volt ac application. These are all of 3-pole construction with MagneTrip dual-magnetic trip units. These units are not UL listed since they are beyond the normal scope of UL 489 voltage ratings.

Used for disconnect purposes, POWER BREAK molded case switches are constructed without automatic overcurrent sensing mechanisms. All other POWER BREAK features have been incorporated.

High DC Interrupting Ratings

The 2500–4000 A MagneTrip dual-magnetic frame size circuit breakers have UL listed dc ratings up to 200kA @300-vdc and 65ka @ 600Vdc. See Table 30.3.

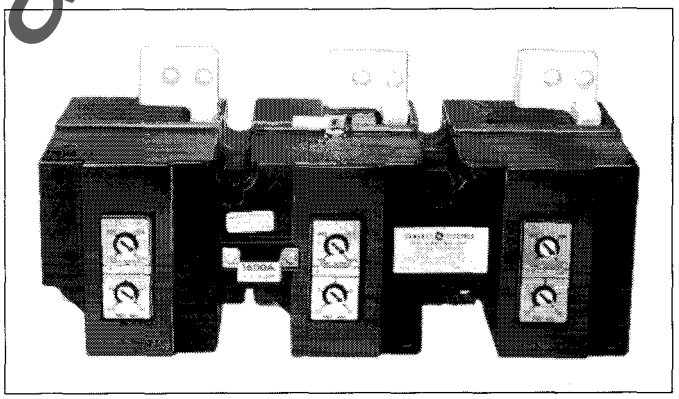

Fig. 20.1 MagneTrip Interchangeable Trip Unit for 2500 and 3000 A frames

Table 20.1
Trip Characteristics for MagneTrip™ Trip Unit

Frame Size (Amps)	Current Ratings (Amps)	Ampere Setting (Multiple of Current Rating)	Long time Delay (Seconds) ①	Short time		Adjustable Instantaneous Pickup (Multiple of Current Rating)	Optional Fixed Instantaneous Override (Amperes)
				Pickup (Multiple of Current Rating)	Delay (Seconds) ②		
1600	200,400,600 800,1000 1200 1600	0.7-1.0	4	3-10 3-8.2 3-7.5	0.04	3-10 3-8.2 3-7.5	None
2500	600,800,1000 1200 1600 2000 2500			3-10 3-8.2 3-7.5 3-6.8 2.3-5.5	0.07	3-10 3-8.2 3-7.5 3-6.8 2.3-5.5	42,000
3000	3000			3-5.3		3-5.3	
4000	3500 4000			2.5-4.5 2.2-4		2.5-4.5 2.2-4	

① Time delay shown at 600% of breaker current rating at lower limit of band.
② Time delay shown at 10X of breaker current rating at lower limit of band.

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Accessories

Stationary or Draw-out Breakers

Warning: When installing accessories, the breaker must be completely deenergized and disconnected from the electrical circuit. This is mandatory because breaker must be "ON" during certain stages of installation and testing.

Limited Access "ON" Button (Factory Installed)

The limited access (concealed) "ON" button (Fig. 21.1) provides limited manual accessibility to the "ON" button. It allows the breaker to be turned ON by qualified personnel by use of 1/8" diameter pin or rod. Manually operated devices may be ordered with an electrical accessory closing solenoid for remote closing operation.

Remote Close Solenoid (Factory-Installed)

This accessory provides an electrically operated solenoid which, when energized, closes the breaker. It is suitable for control interlock schemes in - which manual closing capability would be hazardous or not desirable. Manual close button is provided.

Padlock Function (Factory-Installed)

The OFF button padlock provision (Figure 21.2) prevents charging of the mechanism.

The OFF Button Padlock with Door Interlock is designed to prevent the panel door opening with the breaker "ON" or "CHARGED."

MicroVersaTrip® RMS-9 Programmer Sealing Provisions

All Power Break breakers with MicroVersaTrip® RMS-9 programmers have a sealable, clear plastic cover over the programmer. Sealing may be accomplished by attaching a sealing wire through the programmer window and the rim of the programmer, then through the screw head as shown in Figure 21.3.

Terminal Boards (Factory-Installed)

Up to 36 accessory circuits can be terminated on optional terminal boards.

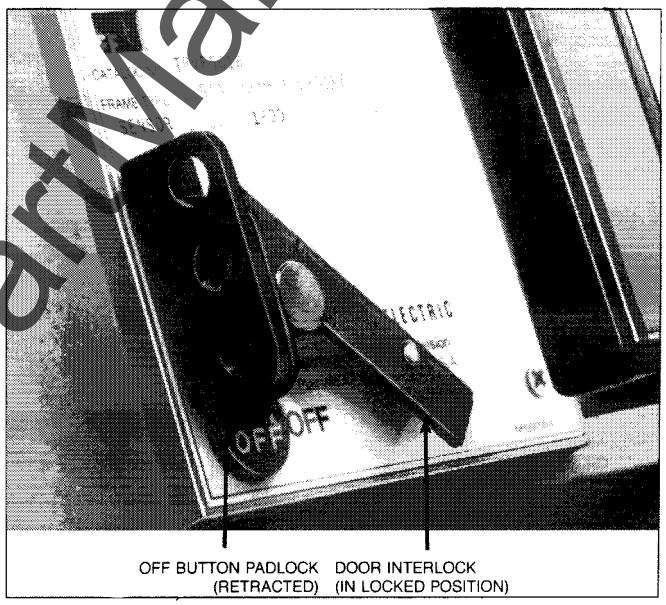

Fig. 21.2 Padlock Function

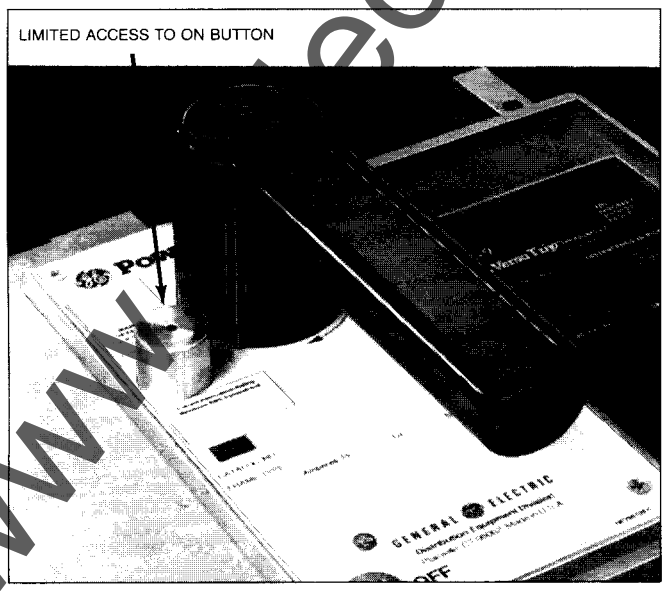

Fig. 21.1 Limited Access "ON" Button

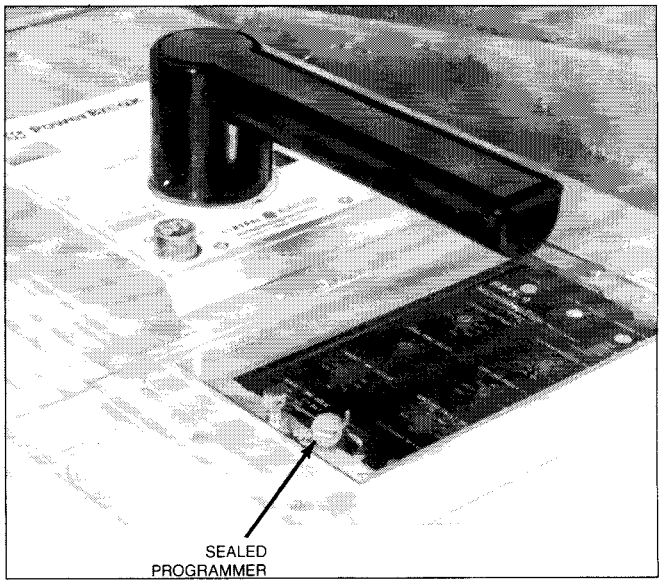

Fig. 21.3 Programmer Sealing Provision

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Kirk Key Provision (Factory-Installed)

The Kirk Key provision provides mounting means for customer supplied locks. On 800-2000A frames a slide covers the OFF Button when the bolt is extended and the key removed. On 2500-4000A frames, key action works directly on trip mechanism.

Table 22.1 Kirk Key Provision

Frame Size (Amps)	Key Provision Cat. No.	Max. No of Locks	ITE Lock Type	Remarks
800-2000	TPK01	1	Type F, zero-bolt projection, retracted and key retained	Mounted on front of breaker cover
	TPK02	2		
	TPK03	3		
	TPK04	4		
	TPK01B	1		Bottom-fed only
2500-4000	TSK16	6	Type F or FS, one-inch bolt projection, retracted and key retained	MagneTrip and Molded Case Switch
	TSK26	6		MicroVersaTrip RMS-9 only

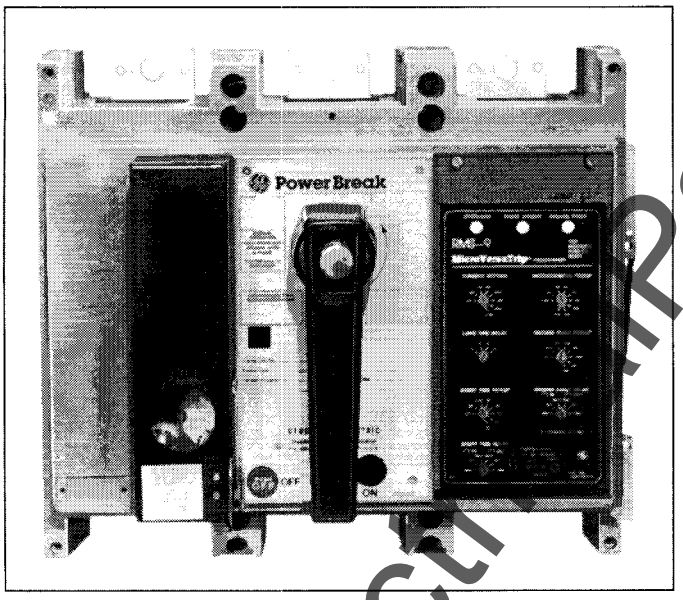

Fig. 22.1 TPK01 on 800A Frame Circuit Breaker

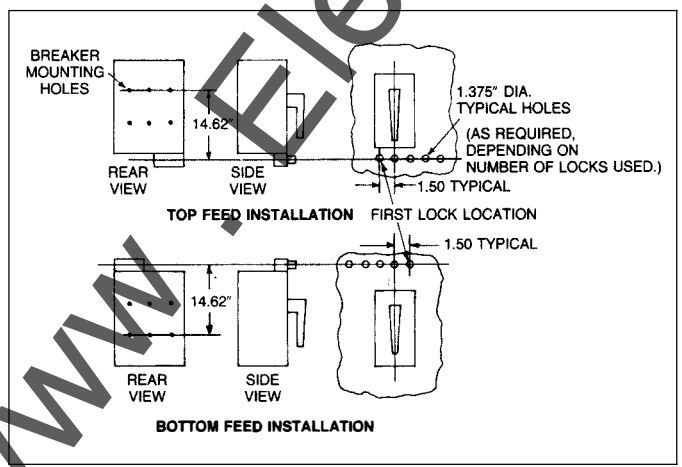

Fig. 22.2 Recommended Panel Cut-out — 2500-4000A Breakers

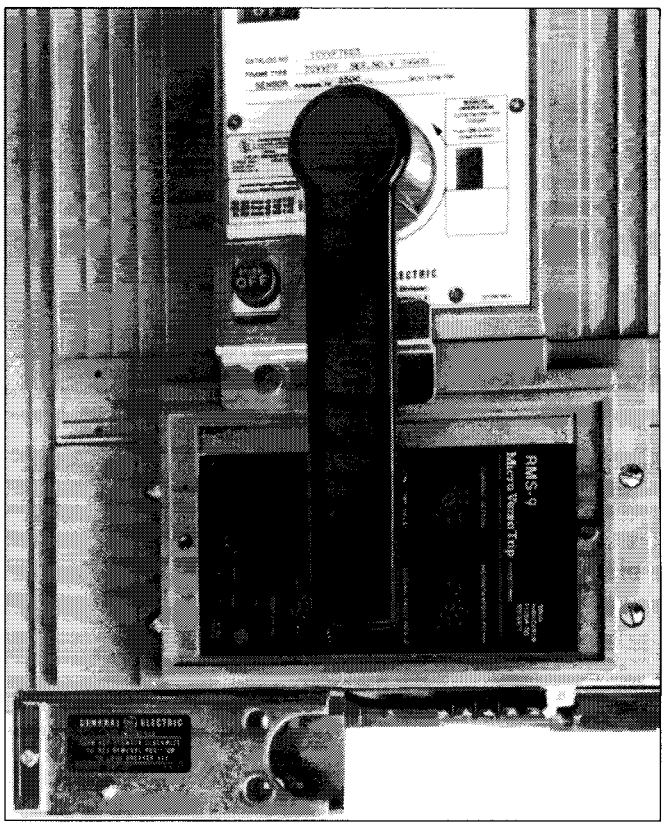

Fig. 22.3 TSK26 on 2500A Frame Circuit Breaker

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Control Leads

On stationary breakers, the control leads of internally mounted accessories exit the breaker in "pigtail" non-terminated form with 30-inch leads. Optional terminal blocks can be specified for stationary mounted breakers. For draw-out breakers, these leads are terminated at the secondary disconnect blocks. All leads are color coded as shown in Table 23.1

Undervoltage Release Device (UVR) (Field-Installable)

The undervoltage release device is used to open the circuit breaker when the supply voltage drops to 35-70 percent of the rated voltage. Resealing of the undervoltage release coil requires 80 percent of rated coil voltage.

Time Delay Unit For UVR

The time delay unit prevents nuisance tripping due to momentary loss of voltage. Two units with adjustable time delay are available—Cat. No. TD110A530 has 0.1 to 0.5 seconds delay and Cat. No. TD1000 has 0.1 to 1.0 seconds delay. Both units have 120 VAC input and *125 Vdc output* and must be used with the **125 Vdc UVR** catalog number.

Table 23.3
UVR Time Delay Units

Time Delay Unit Catalog Number	Adjustable Delay, Sec.
TD110A530	0.1 - 0.5
TD1000	0.1 - 1.0

Table 23.1
Circuit Breaker Accessory Lead Color Code

Accessory	Lead Color			Leads Per Accessory (30 Inches)
Shunt Trip	Black			2
Undervoltage Release	Blue			2
Auxiliary Switch	White-Common Red-OPEN (NO)① Brown/White-CLOSED (NC)①			3 per switch
Bell Alarm (Overcurrent Lock-Out)	Yellow-Common Purple-OPEN (NO)② Brown-CLOSED (NC)②			3
	Phase	Line End	Load End	
Blown Fuse Trip	A B C	Red Blue Yellow	Brown/White White Black	6
Closing Solenoid (Manual Devices Only)	White-Common Black-Remote Indication Orange-Remote Close			3

① NO - Normally open when circuit breaker is in "OFF" position.
NC - Normally closed when circuit breaker is in "OFF" position.
② NO - Normally open when circuit breaker is in an overcurrent tripped condition.
NC - Normally closed when circuit breaker is in an overcurrent tripped condition.

Table 23.2
Electrical Data — Undervoltage Release

Rated Voltage (60 Hz ac)	MA Current		Dropping Resistor (Ohmite Type 270)
	dc	ac	
120 Vac	—	25	none
240 Vac①	—	25	5,000 Ohms, 25 watt
480 Vac①	—	25	15,000 Ohms, 50 watt
600 Vac①	—	25	20,000 Ohms, 50 watt
12 Vdc	211	—	none
24 Vdc	104	—	none
48 Vdc	54	—	none
125 Vdc	24	—	none
250 Vdc①	24	—	5,000 Ohms, 25 watt

① Externally mounted dropping resistor supplied with device

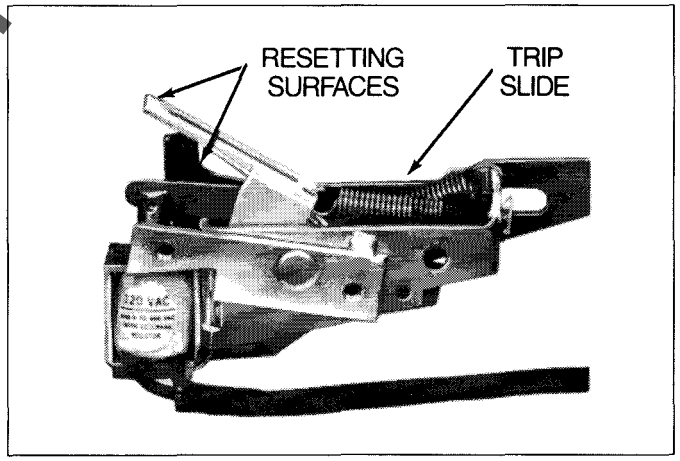

Fig. 23.1 Undervoltage Release Device (2500-4000A shown)

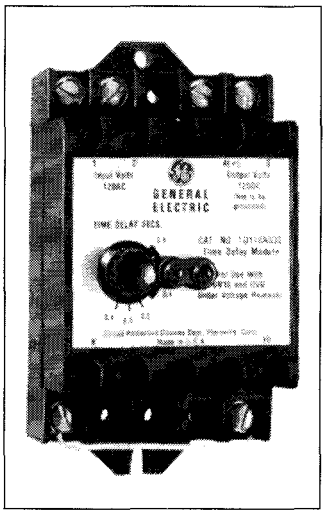

Fig. 23.2 Delay Unit, TDA110A530

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Shunt Trip Device (Field-Installable)

The shunt trip device provides remote control capability to trip the circuit breaker. A cutoff switch is supplied as part of the shunt trip to automatically remove power from its coil when the circuit breaker is tripped.

Bell Alarm with Lockout (Factory-Installed Only)

Single-pole, double-throw (AB-type) switch element. Used for remote indication of breaker trip when caused by overload, short circuit or ground fault conditions only. Switch element ratings are identical to those listed for Auxiliary Switch Accessories. Bell alarm distinguishes between overcurrent trip and manual/shunt/UVR trip.

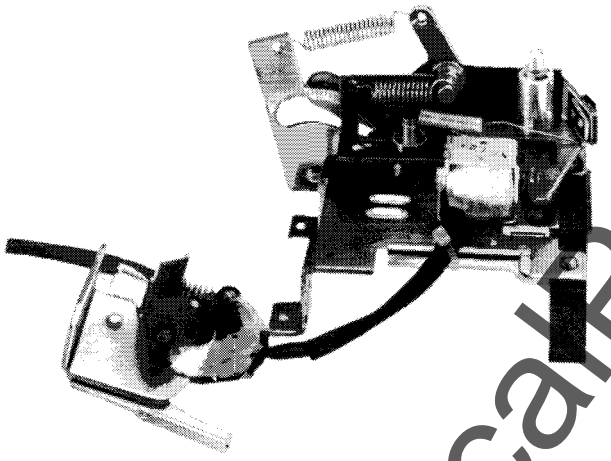

Fig. 24.1 Shunt Trip Device (800-2000A Shown)

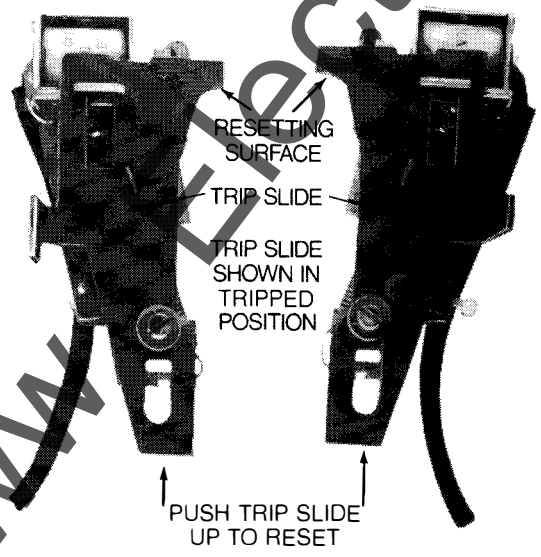

Fig. 24.2 Shunt Trip Device (2500-4000A Shown)

Table 24.1
Electrical Data for Shunt Trip Devices

Coil Identification Number	Voltage Rating	Coil Resistance Ohms ± 15%	Max Inrush Current Amps
G44	120 Vac	20	2.25
G44	240 Vac	20	4.50
G8	480 Vac	313	1.64
G8	600 Vac	313	2.05
G39	12 Vdc	1.6	6.90
G40	24 Vdc	5.2	2.18
G43	48 Vdc	20	1.09
G45	125 Vdc	130	1.00
G42	250 Vdc	658	0.40

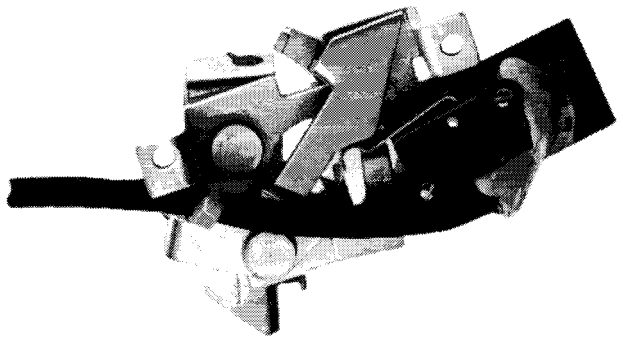

Fig. 24.3 Bell alarm with lockout (2500-4000A Frames)

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Blown Fuse Trip Device (Field-Installable)

The blown fuse trip device (three-coil shunt trip) is intended for use in applications where breakers and fuses are used in series. This accessory prevents single-phasing conditions by monitoring the fuses and automatically tripping the circuit breaker when a fuse blows. It does not protect from single-phasing of the power source.

Each coil of the blown fuse trip device is wired across a fuse so that the voltage across an open fuse energizes the solenoid core, releases the spring biased latch and trips the breaker. The fuse must be replaced and the breaker reset before it can be reclosed.

If the breaker is closed on an open fuse, the blown fuse trip device will automatically open the circuit breaker.

Auxiliary Switch (Field-Installable)

The auxiliary switch is used for remote indication of breaker main contact position—OPEN or CLOSED. No distinction is made between an open or tripped mode. A maximum of 12 switches can be installed per breaker. Each is single-pole, double-throw (AB-type) and rated as shown in Table 25.1. Two switch positions must be devoted to each shunt trip accessory (if used).

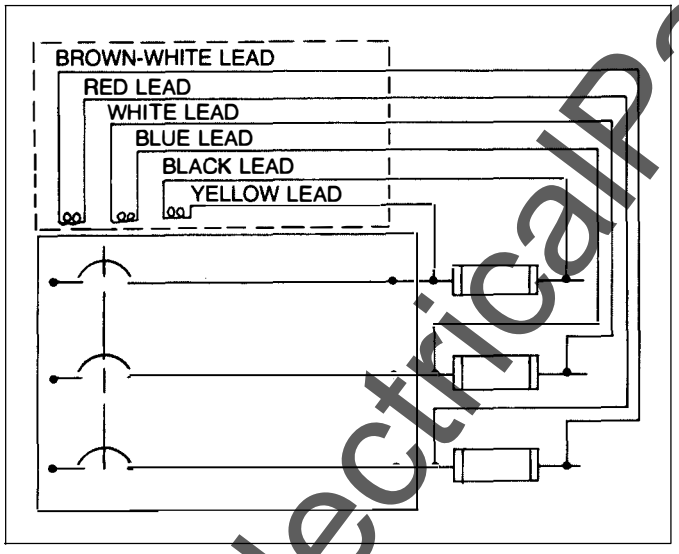

Fig. 25.1 Blown Fuse Trip Device Wiring Diagram

Table 25.1
Auxiliary Switch Electrical Data

Voltage	Number of Switch Elements	Maximum Ampere Rating Switch Elements
240 Vac Max. 250 Vdc Max.	1-12	6A at 240 Vac 1/4A at 250 volts dc 1/2A at 125 volts dc
600 Vac Max. 250 Vdc Max.	1-12	6A at 600 Vac 1/4A at 250 volts dc 1/2A at 125 volts dc Not UL listed

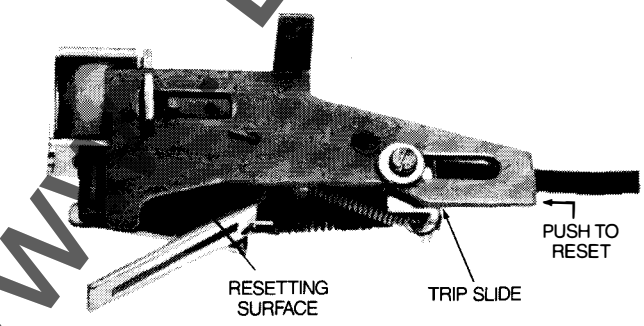

Fig. 25.2 Blown Fuse Trip Device (2500-4000A Shown)

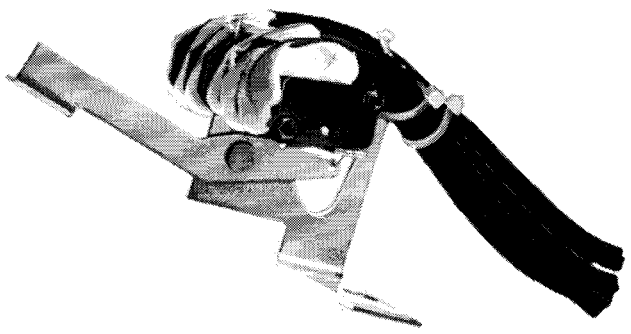

Fig. 25.3 Auxiliary Switch

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Disconnects

Primary power is fed through multiple finger primary disconnects when the breaker is in the connected position.

Control power is provided through the secondary disconnects in the test and connected positions only. Table 26.1 shows the number of secondary disconnects required for each auxiliary device installed in the circuit breaker.

Breaker secondary disconnects are supplied when the auxiliary devices shown in Table 26.1 are ordered with the breaker. Secondary disconnects are factory assembled to the breaker element, but are shipped separately for field mounting to the substructure element.

Programmer disconnects are available for all substructures required to accept MicroVersaTrip® RMS-9 draw-out breaker elements, and allow separate circuit points for zone selective interlocking functions. Table 26.2 shows the availability of substructure disconnects for MicroVersaTrip RMS-9 remote function zone interlocking and for auxiliary devices.

Control Circuit Numbering and Locations

Secondary disconnect control circuit numbers and locations are determined by using circuit index card, GEJ-3038 (for MicroVersaTrip RMS-9) or GEJ-4672 (for MagneTrip™ or molded case switches). Index Card GEJ-3038 is shown in Figure 27.2.

When a limited number of accessories are installed, the circuit index position is advanced to the lowest possible position number in the order shown on the circuit index card.

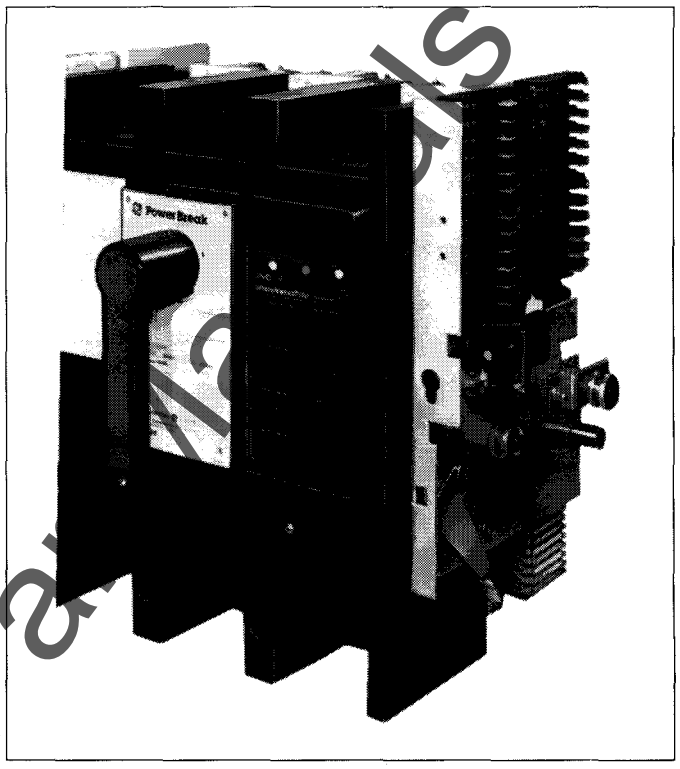

Fig. 26.1 Front View of 1600A Showing Secondary Disconnects

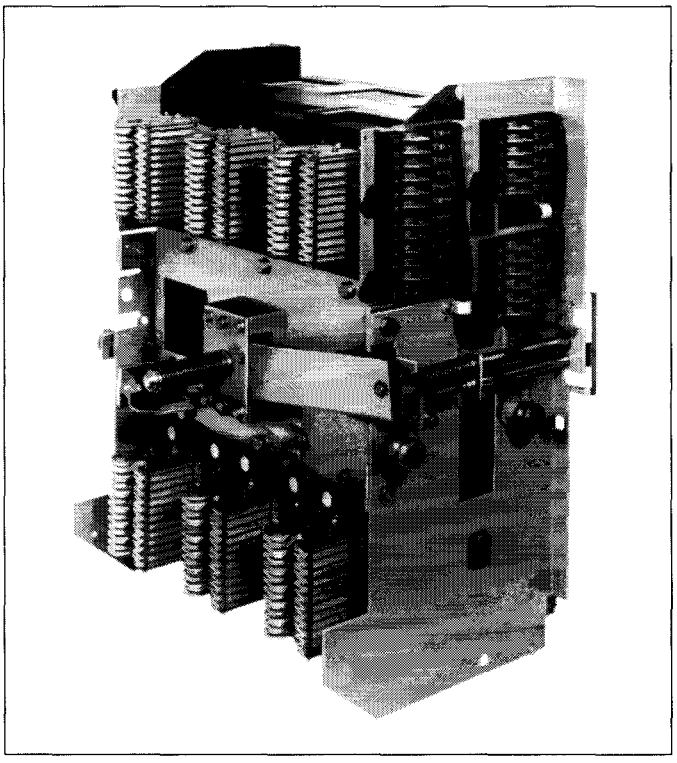

Fig. 26.2 Rear View of Above

Table 26.1
Number of Secondary Disconnect Circuits Required per Auxiliary Device

Device/Function	Required Number
Neutral Sensor Leads (MicroVersaTrip® only)	2
Electrical Operation	6
Auxiliary Switch per Element	3
Undervoltage Release	2
Bell Alarm	3
Shunt Trip	2
Blown Fuse Trip	6
Remote Close Solenoid and Charge Indication	3
Remote Charge Indication	2

NOTE: MicroVersaTrip RMS-9 draw-out breakers are provided as standard with secondary disconnect positions for possible neutral current sensor leads. (Position A, B on Block A).

Table 26.2
Secondary Disconnects

Field installation kits; 48 circuits maximum per draw out (24 maximum for small 800-ampere draw out).

Description	Cat. No.
Substructure Disconnect kit - 6 Circuits Breaker Disconnect kit - 6 Circuits	TDOSD6S① TDOSD6B
Substructure Disconnect for MicroVersaTrip RMS-9 with Zone Interlocking, Z1 or Z2 Suffix	TDOSVDO4

① Secondary disconnects for substructure portion must be ordered and priced separately.

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Referring to the example in Figure 27.1, a MicroVersaTrip® RMS-9 breaker is electrically operated and has a shunt trip, a two-stage auxiliary switch and a bell alarm. Positions A and B on secondary disconnect block A are reserved for the neutral sensor leads, whether used or not. The remaining four positions on Block A are used for terminal numbers 1–4 and terminals 5 and 6 are positioned at the first two positions on Block B. Next the six leads for the two-stage auxiliary switch are brought to the remaining four positions on Block B plus the first two positions on Block C. Next the three bell alarm leads (terminal numbers 33–35), are placed in the next three locations on Block C. Finally, the shunt trip (terminal numbers 36 and 37) are placed in the last location on Block C and the first position on Block D.

By-Pass Switch

A by-pass switch is available with normally open (N.O.) and normally closed (N.C.) contacts which change state between the connected and test position. The switch is available in 4, 8 or 12 circuits, each consisting of half N.O. and half N.C. contacts.

Shutters

Shutters are available for installation and service personnel protection from inadvertently contacting the primary stabs of an energized switchboard when the draw-out breaker is withdrawn and removed.

Other Accessories

The draw-out breaker and substructure is available with many optional accessories sometimes required for specific applications:

- Lifting Bar
  Provides safe, easy removal of breaker from substructures.
- Racking Tool
  Engages the end of the draw-out racking shelf to crank the breaker into or out of engagement with the substructure primary studs.
- Padlock Device
  Prevents engagement of the racking shaft wrench.
- Mechanical Interlock
  Provides interlocking of two breakers in (1) the same vertical section or (2) in adjacent sections.

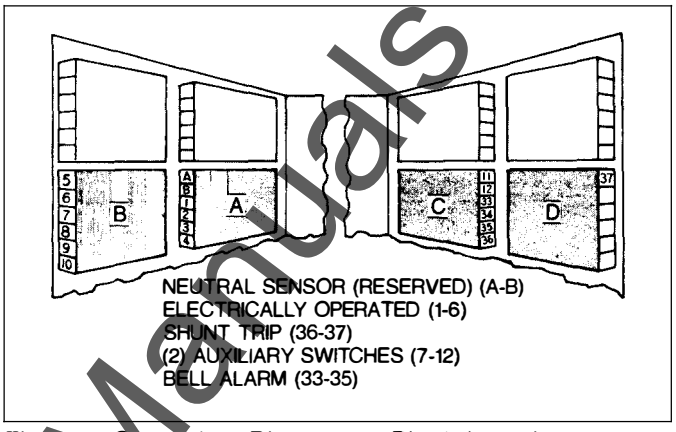

Fig. 27.1 Secondary Disconnect Block Locations (Shown in Substructure)

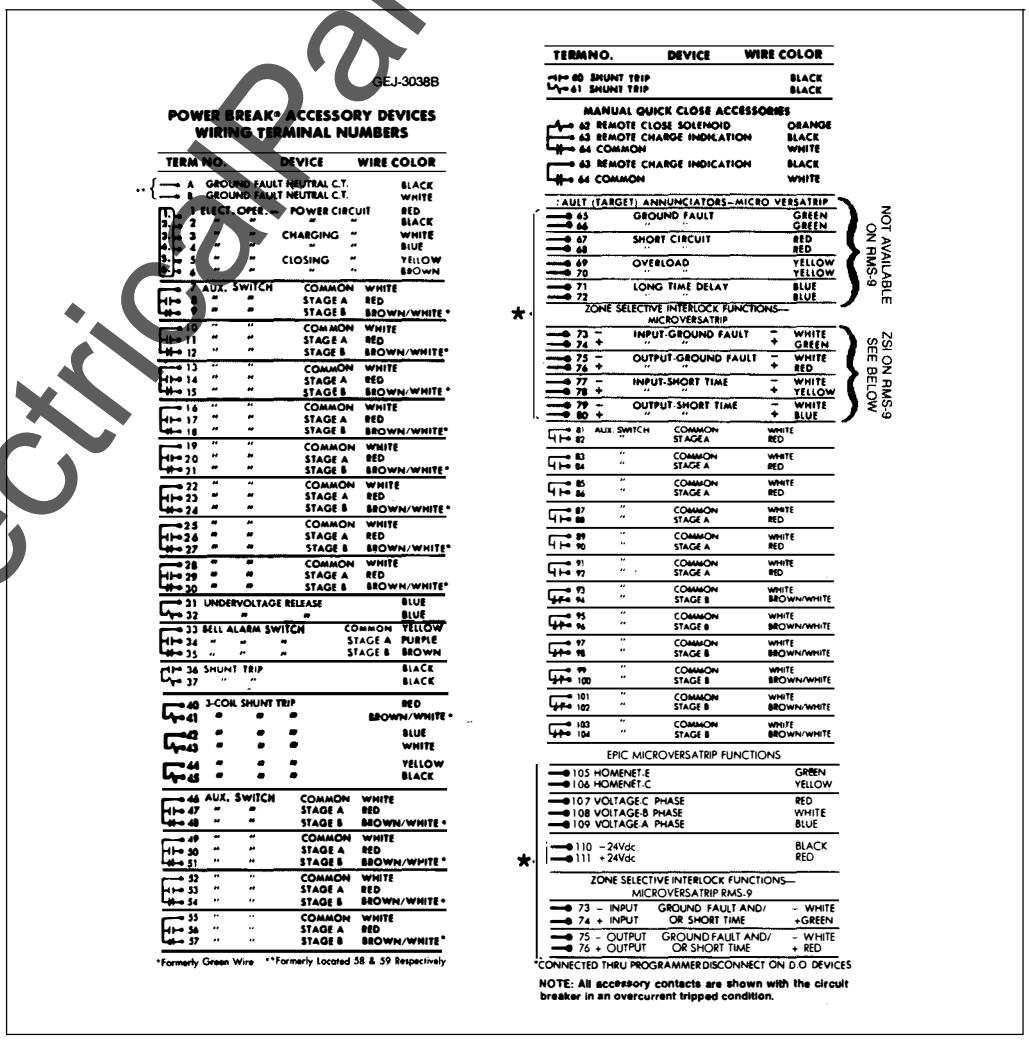

Fig. 27.2 Index Card for Control Circuit Numbering and Locations

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Current Rating Factors

Minimum circuit breaker current rating $I_{CB} = I_L x A x B x C x D x E$ where:

I_L = Actual full-load current or RMS current
A = Wire size factor
B = Ambient temperature rating factor
C = Frequency rating factor
D = Altitude rating factor
E = Load class rating factor

POWER BREAK® insulated case circuit breakers are designed to protect insulated cables; therefore, the characteristics of breakers are closely tied to the Underwriters' Laboratories specified size and type of wire for each rating as well as the load characteristics. The following factors should be considered when applying and using these circuit breakers:

Factors

A. Cable or bus size must be equal to, or greater than, that specified by Underwriters' Laboratories Inc. Standard for Safety 489. The cable or bus acts as a heat sink to help control the temperature of the breakers; reducing the size of the conductor raises the temperature. Breaker current rating and conductor size are a matched pair; any 75°C or higher type insulation may be used but the cross section must remain constant. See Table 29.1.

B. Ambient temperatures have an even wider effect on the rating of the breaker-cable system. High ambient temperatures may cause internal temperatures to exceed the temperature limits of the insulating materials. Low temperatures, on the other hand, substantially increase the current carrying ability of the system until other limiting factors occur, such as lubricant failure, binding due to differential contraction of parts, or excessive degradation of the case and cover strength. The effect of ambient temperature on the continuous current carrying ability of the breaker and cable system is shown on page 29 "FACTOR B-AMBIENT TEMPERATURE."

C. System operating frequency also has a major effect on the rating and performance of insulated case circuit breakers. Most circuit breakers may be directly applied at their published ratings on 50 or 60 Hertz systems, but should not be applied at other frequencies except as described on page 29 "FACTOR C-FREQUENCY RATING."

At nominal system frequencies less than 50 hertz but above direct current, solid-state trip devices become inoperative due to sensor saturation. On direct current systems, solid-state trip units are completely inoperative.

D. Another factor to be considered is the altitude at which the breaker will be applied. The design altitude for POWER BREAK circuit breakers is 0 to 6000 feet. At altitudes above 6000 feet the thin atmosphere affects the heat transfer of the breaker as well as its maximum voltage rating (see Table 29.6). So an additional derating is applied at altitude from 6000 to 15,000 feet. See Table 29.4.

E. Load type and duty cycle must also be considered in the application of POWER BREAK circuit breakers. Loads such as capacitors and electromagnets require a substantial, continuous current derating factor if the breaker is normally used to switch the load.

With loads such as resistance welders, the breaker continuous current rating must be no less than 125 percent of the welder 100 percent duty-cycle rating.

In general, where load protection in addition to cable protection is desired, the load characteristics and protection requirements must be fully evaluated. See Table 29.5.

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Table 29.1
Factor A: Wire Size

% ①	Factor A
50	1.40
60	1.25
70	1.15
80	1.07
90	1.02
100	1.00
125	0.99
150	0.97
200	0.97

① Applied wire cross-sectional area as a percentage of rated cross-sectional area.

Table 29.2
Factor B: Ambient Temperature①

Ambient Temperature①	Minimum Wire Insulation Rating②	Factor B
25°C	75°C	1.00
40°C	90°C	1.00
50°C	105°C	1.00
60°C	125°C	1.10
70°C③	125°C	1.15
80°C③	125°C	1.25

① Average air temperature over a 24-hour period outside the circuit breaker insulated case, but inside the enclosure.
② Cable (wire) *size* must be based on 75°C ampacities per Table 310-16 of 1987 National Electrical Code.
③ MagneTrip™ only. MicroVersaTrip® RMS-9 limited to 60°C.

Table 29.3
Factor C: Frequency Rating

Frequency	Factor C MicroVersaTrip RMS-9	Factor C MagneTrip
dc	—	1.00
50–60 HZ	1.00	1.00
150–180 HZ	1.07	—
200–240 HZ	1.25	—
300–350 HZ	1.40	—
400–450 HZ	1.51	—

Table 29.4
Factor D: Altitude Rating

Altitude above sea le el	Factor D
–100 to 6000 ft.	1.00
6001 to 10,000 ft.	1.04
10,001 to 15,000 ft.	1.08

Table 29.5
Factor E: Load Class Rating Total①

Load Type	Factor E
Switching Capacitors	1.50
Switching Electro-Magnetics	1.50
Single Motor Branch Circuit Protection (Normal Duty)	1.50
Single Motor Branch Circuit Protection (Heavy Duty)②	1.75
All Other Load Types③ (Normal Duty)	1.00

① E = product of load class rating factors which apply to the circuit in question.
② Use this factor for plugging duty or cycling loads with over 25 starts per hour where the rms current cannot be reliably calculated.
③ Voltage variations, such as voltage reduction on a constant kVA load or voltage increase on a fixed impedance load, may require Factor E > 1.

Table 29.6
Altitude Factor for Voltage

Altitude above sea level	Rated Voltage Correction Factor
–100 to 6000 ft.	1.00
6001 to 10,000 ft.	0.95
10,001 to 15,000 ft.	0.80

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Basic Ratings

POWER BREAK® with MicroVersaTrip® RMS-9 is rated both for short-time withstand current and interrupting capacity (RMS symmetrical). The maximum short-time rating shown is for 600 Vac, 50/60 Hz, 500 milliseconds duration. MicroVersaTrip® breakers have no dc rating due to current sensor saturation.

POWER BREAK with MagneTrip™ can be applied to either an ac source or dc source. With a special Hi-Break® construction, MagneTrip breakers have ratings up to 750 Vac and 700 Vdc.

Table 30.1
MicroVersaTrip® RMS-9 Interrupting Capacity in RMS Symmetrical kA

Max. Short-Time Rating (kA)①	Frame Size (Amps)				
	800	1600	2000	3000	4000
	25	30	30	42	42
Standard Break					
240 Vac	65	85	85	100	100
480 Vac	65	65	65	100	100
600 Vac	42	50	50	85	85
Hi-Break®					
240 Vac	100	125	125	200	200
480 Vac	100	100	100	150	150
600 Vac	65	65	65	100	100

① Applies to frames with "H" suffix

Table 30.2
POWER BREAK Molded Case Switch Withstand Ratings

Switch Frame Size (Amps)	Continuous Current Rating (Amps)	Short-time Rating, RMS Sym. Amps at 600 Vac Max. 500 ms Max	Suitable on 200,000 RMS Sym. Amp. Fault Circuit when Protected by Class L Fuses as Follows:		Short Circuit Withstand Rating when Protected by POWER BREAK MicroVersaTrip Breaker		
			Line Side Max. Fuse Amp Rating	Load Side Max. Fuse Amp Rating	Breaker Frame Size (Amps)	480 Vac	600 Vac
800	800	25,000	2000	800	800	100,000	65,000
1600	1600	30,000	2500	1600	2000	100,000	65,000
2000	2000	30,000	2500	2000	2000	100,000	65,000
2500	2000	42,000	2500	2500	4000	100,000	65,000
—	2500	42,000	2500	2500	4000	100,000	65,000
3000	3000	42,000	4000①	3000	4000	100,000	65,000
4000	4000	42,000	4000①	4000①	4000	100,000	65,000

① Hi-Break construction only

Table 30.3
MagneTrip Interrupting Capacities

Interrupting Capacities (KAIC)	Frame Size (Amps)		
	1600	3000	4000
Standard Break			
240 Vac	85	100	100
480 Vac	65	100	100
600 Vac	50	85	85
250 Vdc	22	42	42
Hi-Break			
240 Vac	125	200	200
480 Vac	100	150	150
600 Vac	65	100	100
250 Vdc	35	85①	85①
500 Vdc	—	65	65
600 Vdc	—	65	65
Special Hi-Break			
750 Vac	—	35	35
700 Vdc	—	65	65

① Also UL listed for 200KA at 300Vdc max. with circuit time constant of 6.6 milliseconds maximum

Table 30.4
(Ref. UL 489 - See UL Test Procedures, page 31)

Frame Size (Amps)	Bus Bars per Terminal	
	Number	Size in Inches
1600	2	1/4 × 3
2000	2	1/4 × 4
2500	2 4	1/4 × 5 1/4 × 2-1/2
3000	4	1/4 × 4
4000	4	1/4 × 5

Table 30.5
(Ref. UL 489 - See UL Test Procedures, page 31)

Frame Size (Amps)	Number of Cycles of Operation		
	With Current	Without Current	Total
800	500	3000	3500
1600	500	2000	2500
2000	500	2000	2500
2500	500	2000	2500
3000	400	1100	1500
4000	400	1100	1500

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POWER BREAK® circuit breakers are UL listed in accordance with UL Standard 489. This standard requires the breaker to meet or exceed endurance and interrupting criteria. POWER BREAK has been designed and tested to exceed these requirements.

UL 489 requirements for endurance capability without current (mechanical endurance) vary with frame rating. For an 800 ampere frame, the UL requirement is 3000 operations, while a 4000 frame requires 1100 operations. All POWER BREAK breakers exceed this requirement by meeting GE testing with a minimum of 10,000 mechanical operations.

UL Test Procedures

(Extracted from ANSI/UL Standard 489, Seventh Edition, September 15, 1986.)

The following information briefly describes the types of tests POWER BREAK insulated case circuit breakers, rated 800 through 4000 amperes, must successfully pass.

1. Calibration—tested at 200%, and 125% at 25°C. At 200%, an 800A breaker must trip in 14 minutes with the maximum trip time increasing to 24 minutes for frame sizes larger than 2000A. At 125%, all sizes (larger than 50 amperes) must trip within 2 hours.
2. Overload—50 operations making and breaking six times rated current at rated maximum voltage, 0.45-0.50 power factor for 800 and 1600A frame sizes; 2000 and 2500A frames, 25 operations at 6 times rated current; and, 3000 and 4000A frames, 3 operations at 6 times rated current plus 25 operations at 2 times rated current. Tests are conducted at one operation per minute, (make and break), but may be done in groups of five operations with 15 minute delay between groups.

   Overload test is conducted in a metal enclosure representing the minimum size enclosure for which the breaker is suitable. The ground fault fuse described in item 5 below must not rupture.
3. Calibration—200% of rated current.
4. Temperature Test—the circuit breaker after overload is outfitted with 4 feet minimum of rated copper cable per pole, line and load end, and rated current is passed through the breaker which is *not* in an enclosure. After temperatures have stabilized, the temperature rise on the cables at the connection to the breaker wiring terminals must not exceed 50°C rise, (75°C total in a 25°C room ambient), and the breaker must not trip. Cables are sized as shown in Table 33.1, page 33. When copper bus bars are used instead of cable for 1600-4000A breakers, they are sized per Table 30.4.
5. Endurance—the breaker must complete an endurance test (1) making and breaking rated current at rated voltage, .75-.80 lagging power factor and (2) additional no load (mechanical) on-off operations per Table 30.5 (page 30). No electrical or mechanical breakdown is permitted and a 30 ampere fuse, connected from the metal enclosure to the line lead least likely to arc to the enclosure, must not rupture.

   The rate of operation is one per minute except the 3000 and 4000A electrical test may be in groups of 5 with a delay in between after conducting the first 10 operations at one per minute.
6. 200% calibration repeated—breaker must trip within times outlined in item 1.
7. Interrupting Ability (short circuit)—for devices rated 600Vac (all POWER BREAK), each pole of the 3-pole unit must complete an "opening" operation (O) and a "close-open" operation (CO) of short circuit current (single-phase) in Table 31.1 at rated voltage. An "O" and "CO" operation using all three poles ("common" 3-phase tests) is also required on the same device used for the previous tests in items 1-6.

   Short circuit tests are acceptable if:

   (a) there is no electrical or mechanical breakdown;
   (b) the ground fuse has not opened;
   (c) the conductor insulation is not damaged;
   (d) there is continuity in the closed position at rated voltage; and,
   (e) a cotton pad covering any vent openings in the enclosure has not ignited.

   Short circuit tests are conducted with rated cable sizes (or bus for 1600A and larger breakers) using a maximum of four feet on the line side and a maximum of 10 inches on load side for 3-pole tests and four feet on load side for single-pole tests.
8. Trip-Out at 200% current—breaker must trip within same time limits as for the 200% calibration.
9. Dielectric Voltage Withstand—the tested breaker must withstand applied voltage of twice rated plus 1000 volts (2200 volts for 600V rated breaker) for one minute between:
   (a) line and load terminals,
   (b) poles of opposite polarity, and
   (c) live parts and the metal enclosure.

Performance — High Available Fault — Current (Hi-Break® POWER BREAK Breakers)

The UL Standard 489 specifies additional, optional requirements for evaluation of breakers on faults higher than the "standard" values shown in item 5.

Test sequence is as follows:

1. Calibration—200% of rated current.
2. Interrupting Capacity—short circuit tests are conducted to evaluate (1) maximum IC rating, (2) IC at maximum voltage, and (3) IC at maximum kVA. If one or more tests are covered by another (that is, for example, if maximum kVA occurs at maximum voltage test (3) can be omitted) they may be omitted. An "O" oper-

Table 31.1 Short Circuit Levels

Frame Sizes (Amps)	Power Factor, Lagging	3-Pole Circuit Breaker Available Short Circuit Current Sym. Amp.	
		1-Pole, 1-Phase	3-Pole, 3-Phase
800	.45-.50	8,660	10,000
1600	.25-.30	14,000	20,000
2000	.15-.20	14,000①	25,000
2500	.15-.20	20,000①	30,000
3000	.15-.20	25,000	35,000
4000	.15-.20	30,000	45,000

① Circuit power factor may be .25-.30

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Standards and Testing (Continued)

ation and a "CO" operation is required for each evaluation. Acceptable high available fault current ratings are, in RMS symmetrical kilo amperes: 7.5, 10, 14, 18, 22, 25, 30, 35, 42, 50, 65, 85, 100, 125, 150, 200.

3. Trip-Out—conducted at 250% of rated current. Breakers must trip within same time limits as for 200% calibration.
4. Dielectric Voltage Withstand—conducted at twice rated (test) voltage.

The preceding abbreviated outline of UL molded case circuit breaker performance evaluation does not address all of the details and numerous specific requirements of the standard. For a complete description of the requirements, obtain a copy of the UL Standard. See page 52 for address of UL and other standards organizations.

80% Versus 100% Ratings

A standard rated device is rated to carry 100% of its nameplate current for *short periods* (up to three hours maximum) when enclosed in equipment, such as a switchboard, and *80%* of its rating *continuously* per paragraph 220-10, 1987 National Electrical Code. This is where the term 80% device is derived.

On the other hand, *100% rated* devices are designed specifically to carry *100%* of their nameplate current rating when enclosed and tested in distribution equipment. Breakers with *100% continuous rating* are so marked on the front of the breaker. This marking includes minimum enclosure size, minimum ventilation (if any) and minimum cable sizes and temperature ratings to be used. The 1987 National Electrical Code, paragraph 210-22 (c), exception no. 2, and 220-10 (b) exception permits such use.

All POWER BREAK® circuit breakers equipped with Micro-VersaTrip® RMS-9 programmers or with dual magnetic trip units (except the 4000A MagneTrip™) are UL listed to carry 100% nameplate current continuously when installed in accordance with guidelines printed on the breaker. Tables 33.1 and 47.1 also detail the installation requirements for 100% rating.

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Cable Sizing and Power Factor Derating

Short circuit tests are conducted on available fault current circuits where the circuit power factor is 20% (lagging). Lower system short circuit power factors increase the instantaneous asymmetrical peak current to a value higher than the value as tested at 20%. The breaker may not be able to clear the fault at this lower power factor. Therefore the rated short circuit interrupting capacity must be derated for lower power factors as shown in Table 33.2.

Table 33.2 Interrupting Capacity Multiplying Factors for Low Power Factors

System Power Factor	Derating Factor (multiplier)
.20	1.00
.19	0.99
.18	0.98
.17	0.97
.16	0.96
.15	0.95
.14	0.93
.13	0.92
.12	0.91
.11	0.90
.10	0.89
.09	0.88
.08	0.87
.07	0.85

Table 33.1 Required Cable Size

Frame Size (Amps)	Sensor Ampere Rating or Rating Plug Ampere Rating	Cable Size and Quantity				Cable Minimum Temperature Rating °C Carrying 100% Continuously
		Copper Cables		Aluminum Cables		
		Qty.	Size (mcm)	Qty.	Size (mcm)	
800	200	1	3/0	1	250	75
	400	1	600	2	250	75
	600	2	350	2	500	75
	800	2	600 or	3	400	75
		3	300			
1600	800	3	300	3	400	75
	1000	3	400	4	350	75
	1200	4	350	4	500	75
	1600	5	400	5	600	90①
2000	2000	6	400	6	600	90①
2500	2000	6	400	6	600	75
	2500	7	500	8	600	90①
3000	3000	9	400 or	10	500 or	90①
		8	500	9	600	90①
4000	4000	11	500 or	13	500 or	90①
		10	600	12	600	90①

① 100% continuous load requires use of 90°C cable sized to 75°C ampacity; lugs must be marked CU9AL or AL9CU or AL9 denoting suitability with 90°C cable.

Table 33.3 — Properties of Conductors

Size AWG, MCM	Area Cir. Mils	Concentric Lay Stranded Conductors		Bare Conductors		Dc Resistance Ohms/M Ft. At 25°C, 77°F.		
		No. Wires	Dia. Each Wire Inches	Dia. Inches	Area Square Inches①	Copper		Aluminum
						Bare Conductor	Tinned Conductor	
250	250,000	37	.0822	.575	.260	.0431	.0449	.0708
300	300,000	37	.0900	.630	.312	.0308	.0374	.0590
350	350,000	37	.0973	.681	.364	.0320	.0320	.0505
400	400,000	37	.1040	.728	.416	.0270	.0278	.0442
500	500,000	37	.1162	.813	.519	.0216	.0222	.0354
600	600,000	61	.0992	.893	.626	.0180	.0187	.0295
700	700,000	61	.1071	.964	.730	.0154	.0159	.0253
750	750,000	61	.1109	.998	.782	.0144	.0148	.0236
800	800,000	61	.1145	1.030	.833	.0135	.0139	.0221
900	900,000	61	.1215	1.090	.933	.0120	.0123	.0197
1000	1,000,000	61	.1280	1.150	1.039	.0108	.0111	.0177
1250	1,250,000	91	.1172	1.289	1.305	.00863	.00888	.0142
1500	1,500,000	91	.1284	1.410	1.561	.00719	.00740	.0118
1750	1,750,000	127	.1174	1.526	1.829	.00616	.00634	.0101
2000	2,000,000	127	.1255	1.630	2.087	.00539	.00555	.00885

① Area given is that of a circle having a diameter equal to the over-all diameter of a stranded conductor. The values given in the table are those given in Handbook 100 of the National Bureau of Standards except that those shown in the 8th column are those given in Specification B33 of the American Society for Testing and Materials, and those shown in the 9th column are those given in Standard No. S-19-81 of the Insulated Power Cable Engineers Association and Standard No. WC3-1969 of the National Electrical Manufacturers Association.

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400 Hz Ratings and Internal Impedances

Table 34.1
Estimated 400 Hz Interrupting Ratings in RMS Symmetrical Amperes — Not UL Listed — POWER BREAK with MicroVersaTrip® RMS-9 Programmer Only

Frame Size (Amps)	Maximum Rating Plug Ampacity①	Standard Break			Hi-Break®		
		120/240	277/480	346/600	120/140	277/480	346/600
800	600	6,500	5,000	4,200	10,000	10,000	6,500
1600	1,000	8,500	6,500	5,000	12,500	10,000	6,500
2000	1,200	8,500	6,500	5,000	12,500	10,000	6,500
2500	1,600	10,000	10,000	8,500	20,000	15,000	10,000

① No additional thermal derating is required for above maximum rating plug ratings for frame sizes noted.
NOTE: 400-Hertz interrupting ratings are based on engineering judgement, taking into consideration the operating characteristics of insulated case circuit breakers and the worldwide lack of test facilities to verify performance.

Table 34.2
Internal Impedances and Power Losses — MicroVersaTrip® RMS-9

Frame Size (Amps)	Sensor Rating	R (Cold) $\Omega \times 10^{-6}$ Per Pole	Watts Hot Total-(3 Poles)
800	200	31	4.1
	400	31	16
	800	31	65
1600	1000	24	79
	1600	24	203
2000	2000	23	304
2500	1000	18	59
	2000	18	238
	2500	18	371
3000	3000	15	446
4000	4000	15	792

Table 34.3
Internal Impedances and Power Losses — MagneTrip™

Frame Size (Amps)	Trip Unit Rating	R (Cold) $\Omega \times 10^{-6}$ Per Pole	Watts Hot Total-(3 Poles)
1600	200	445	64
	400	232	134
	600	84	109
	800	70	161
	1000	53	191
	1200	51	264
	1600	26	240
3000	600	90	117
	800	96	221
	1200	48	249
	1600	36	332
	2000	24	346
	2500	23	745
4000	4000	17	979

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Application Data (Continued)

Miscellaneous Information and Control Power Requirements

Shock and Vibration

MicroVersaTrip® RMS-9 POWER BREAK® circuit breakers have the following shock and vibration capabilities:

- Shock
  Half sine shock pulses of 3 G's with duration of 10 ms and 2 G's with duration of 250 ms.
- Vibration
  Random vibration from 2 to 600 Hz to the acceleration density curve shown.
  MagneTrip™ POWER BREAK circuit breakers have reduced vibration capabilities in the front to back axis.

Humidity and Fungus

Ferrous parts are cadmium or zinc plated for corrosion protection with the exception of some parts made from alloy steels that are inherently corrosion resistant.

Current carrying parts are silver or tin plated for corrosion protection and to assure reliable electrical joints.

The molded cases and covers and all internal insulators are made from non-organic materials that are inherently fungus proof.

Control Power Requirements — Electrical Operation

The control power required for each motor operator may be determined from Table 35.1 and 35.2. If several motor operators are to be fed from the same source, it should be sized to accommodate all operators simultaneously, especially if they are wired for automatic charge.

The drop in source supply voltage from no load to the motor full load current level (ref. Tables) should not exceed 7%. Acceptable dc power sources are: three phase full wave rectified ac, dc generator, battery, or any other dc source with a peak-to-peak ripple voltage of not more than 15% of rated voltage at the motor full load current.

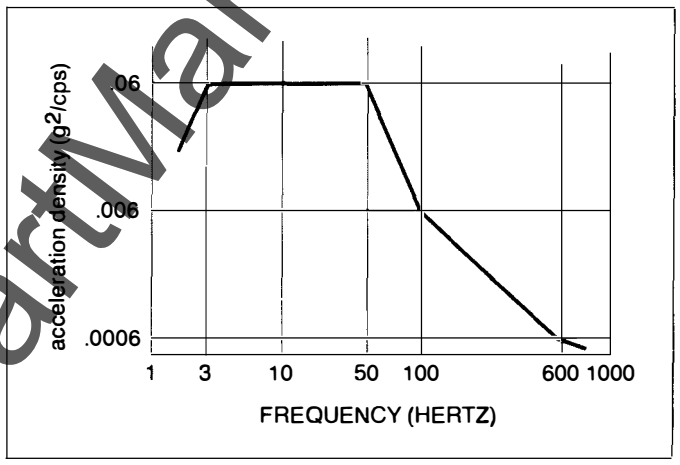

Fig. 35.1 Vibration Test Specification

Table 35.1
Control Power Required for Motor Operators 800-2000A Frame Sizes

Rated Voltage	Operating Voltage Range	Motor Current (Amps)			Close Solenoid (Peak) (Amps)	Fuses (Slo Blo) 125V	Nominal Charge Time (Sec.)	Maximum Close Time (Sec.)①	Maximum Opening Time (Sec.)①
		Locked Rotor	Full Load	Average					
120 Vac	102-132 Vac	8	2.5	1.5	3.0	2A	5.0	.083	.050
125 Vdc	100-140 Vdc	10	2.5	1.5	3.5	2A	6.0	.083	.050
72 Vdc	57-81 Vdc	13	3.0	2.0	5.0	3A	6.0	.083	.050
48 Vdc	38-58 Vdc	20	5.0	2.5	6.6	4A	6.0	.083	.050
24 Vdc	19-29 Vdc	24	7.0	3.0	13.2	6.5A	7.5	.083	.050

① At rated nominal or higher voltage; times may be longer at lower end of voltage range.

Table 35.2
Control Power Required for Motor Operators 2500-4000A Frame Sizes

Rated Voltage	Operating Voltage Range	Motor Current (Amps)			Close Solenoid (Peak) (Amps)	Fuses Type 3AB (Amps)②	Charge Time (Sec.)③	Close Time (Sec.)④	Maximum Opening Time (Sec.)⑤
		Locked Rotor①	Full Load	Average Load					
120 Vac	102-132 Vac	20	7.0	4.0	8.8	MDX 4	3.5	.083	.083
240 Vac	204-264 Vac	10	3.5	2.0	4.0	MDA 4	3.5	.083	.083
125 Vdc	100-140 Vdc	20	4.0	3.0	3.4	ABC 5	4.0	.083	.083
72 Vdc	57-81 Vdc	28	10	7.0	8.1	ABC 10	4.5	.083	.083
48 Vdc	38-58 Vdc	30	10	7.0	6.7	ABC 10	4.5	.083	.083
24 Vdc	19-29 Vdc	60	20	14	14.1	ABC 20	5.0	.083	.083

① Momentary motor reversing current is 150% locked rotor current.
② Recommended type is Bussman or equivalent. Do *not* use slo-blo fuses for type ABC.
③ Measured from sequence initiation to motor cutoff at 100% rated voltage.
④ Measured from sequence initiation to contact closure at 100% rated voltage.
⑤ Measured from sequence initiation to contact opening at 100% rated voltage.

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Wiring for Remote Operation

For proper operation the electrical circuit should be wired as shown. All customer supplied switches (or contacts) can be either momentary action or maintained contact. If momentary action switches are used, they should be 0.083 seconds minimum duration, with the exception of the charge contact for 120 and 240 Vac operators, which requires 0.25 sec. minimum duration. Momentary action switches are recommended to preclude inadvertent recharging and/or reclosing. These switches or contacts must be rated at least 1/4-amp at 125 Vdc for dc motor operators and suitable to handle motor current and voltage for ac motor operators.

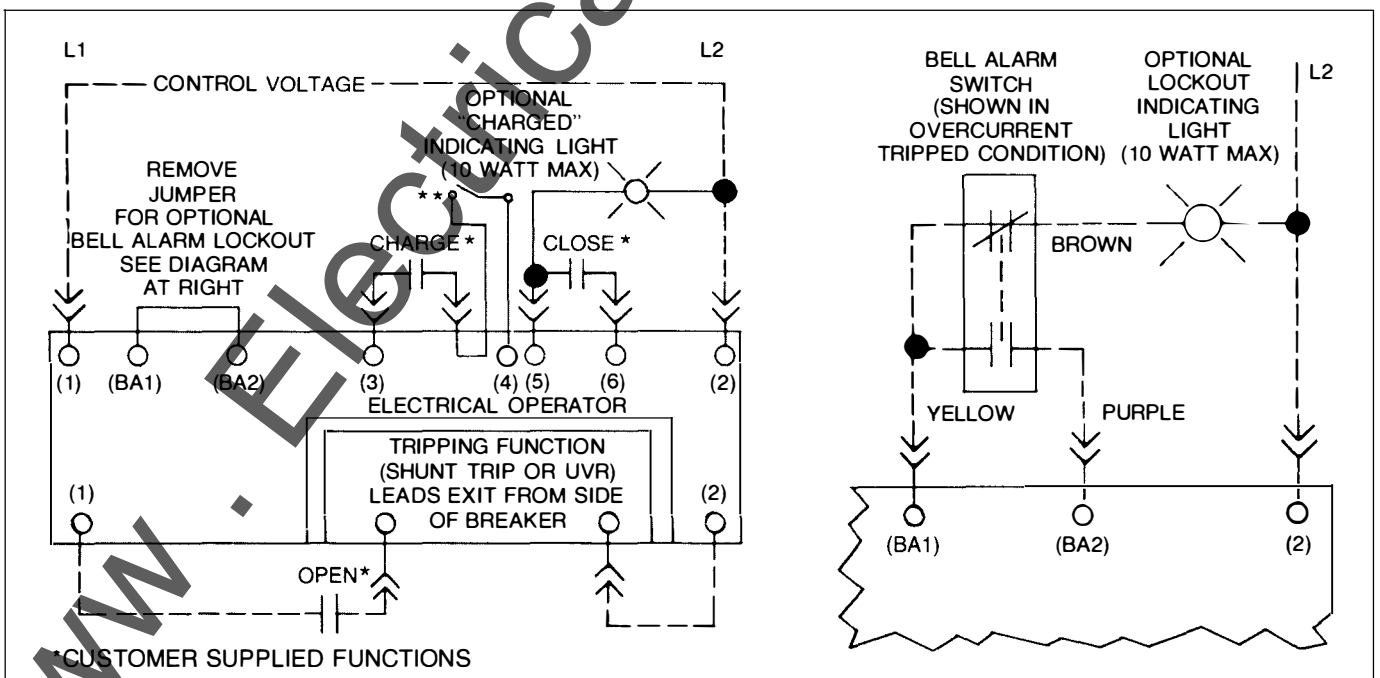
Caution:

1. Do not apply power to any terminals other than (1) and (2).
2. Observe proper polarity (+ at L1) on dc motor operators.
3. Do not wire breakers for both automatic charge and automatic close unless a bell alarm overcurrent lockout function is incorporated. Failure to do so may result in repeated closures into an overcurrent fault.
4. The bell alarm lockout and undervoltage release device both hold the breaker latch open when activated. To prevent continuous cycling when wired for automatic charging, the following is required:

   a) For bell alarm lockout— Interconnect bell alarm switch to motor operator terminal board as shown in Figures 36.1 or 37.1.

   b) For undervoltage release — do not wire breaker for automatic charge, or, if automatic charge is required, use an undervoltage relay in the charging unit.

NOTE:
The motor operator contains a feature which shuts off control power if the OFF button is held depressed. Thus, electrical operation is prevented if a "Kirk" lock or padlock accessory is used in the breaker locked OPEN condition. If the breaker is equipped with a draw-out interlock (TPDO-2), electrical operation is permitted only if the draw-out carriage is in the ENGAGED or TEST position.



*CUSTOMER SUPPLIED FUNCTIONS

**MANUALLY OPERATED TOGGLE SWITCH ON ELECTRICALLY OPERATED DRAW-OUT BREAKERS ONLY TO PREVENT MOTOR CHARGING WHEN DISENGAGING OR ENGAGING BREAKER.

Fig. 36.1 800-2000A Frame, AC or DC Power Source Wiring Diagrams

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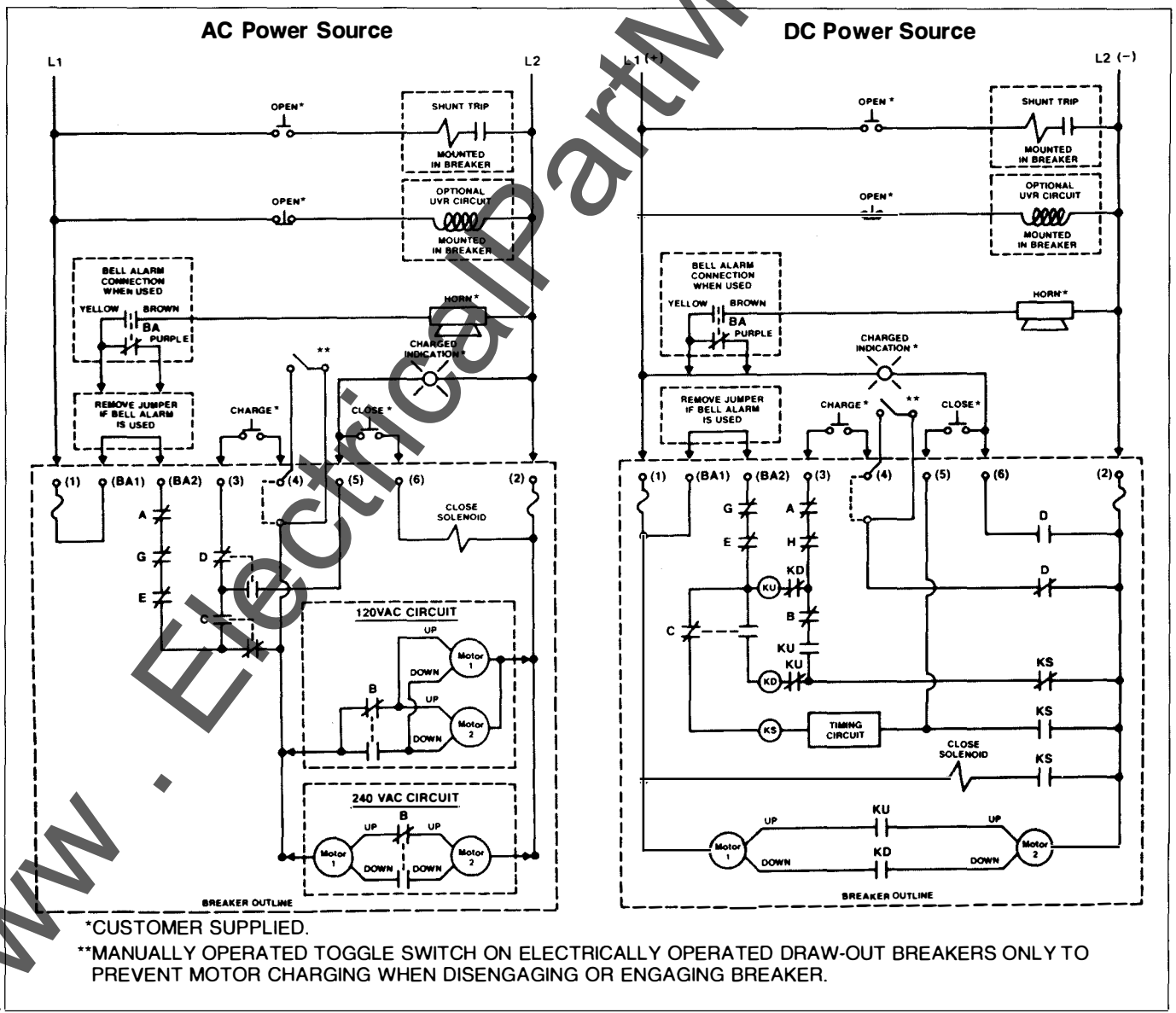

*CUSTOMER SUPPLIED.

**MANUALLY OPERATED TOGGLE SWITCH ON ELECTRICALLY OPERATED DRAW-OUT BREAKERS ONLY TO PREVENT MOTOR CHARGING WHEN DISENGAGING OR ENGAGING BREAKER.

Fig. 37.1 2500-4000A Frame, AC and DC Power Source Wiring Diagrams

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Time Current Tripping Characteristics

Insulated case circuit breaker time current curves are the engineering documents which define technical performance characteristics of the devices.

Information provided on the time current curve includes the following:

1. Product family type(s)
2. Specific device type(s)
3. Ampere ratings covered on curve
4. Overcurrent characteristics — long time, short time, instantaneous, etc.
5. Maximum total clearing time
6. Maximum and minimum temperature limits
7. Frequency ratings
8. Voltage ratings
9. Specific trip unit ratings
10. Trip unit adjustment ranges
11. Tolerances (band width)

Multiples of circuit breaker trip rating are shown on the top and bottom horizontal axis, with time in seconds on the vertical axis. Approximate minimum and maximum clearing time is readily determined from the characteristics curves. Tripping characteristics meet National Electrical Manufacturers Association and Underwriters' Laboratories, Inc. standards for rating and calibration.

Table 38.1
Time Current Curves

Trip Unit	600A-800A	1200A	1600A	2000A	2500A	3000A	4000A
MicroVersaTrip RMS-9							
• LI, LSI	GES-6235	GES-6235	GES-6235	GES-6235	GES-6235	GES-6235	GES-6235
• Ground Fault (G)	GES-6228	GES-6228	GES-6228	GES-6228	GES-6228	GES-6228	GES-6228
MagneTrip							
• Standard		GES-6164	GES-6164	GES-6166	GES-6167	GES-6167	GES-6167
• With Adjustable Short Time		GES-6168	GES-6168	GES-6169	GES-6170	GES-6171	GES-6171
Old Style (For Reference Only)							
MicroVersaTrip							
• LI, LSI①	GES-6199	GES-6199	GES-6199	GES-6199	GES-6199	GES-6199	GES-6199
• G	GES-6195	GES-6195	GES-6195	GES-6195	GES-6195	GES-6195	GES-6195
VersaTrip (MOD2)							
• All Breakers	GES-6168A	GES-6168A	GES-6187	GES-6187	GES-6186	GES-6187	GES-6187
• Ground Fault Option	GES-6189	GES-6189	GES-6189	GES-6189	GES-6190	GES-6191	GES-6191
VersaTrip-							
• All Breakers	GES-6163A	GES-6163A	GES-6162A	GES-6143A	GES-6143A	GES-6143A	GES-6144A
• Ground Fault Option	GES-6161	GES-6161	GES-6161	GES-6161	GES-6161	GES-6145A	GES-6145A
SelecTrip							
• Standard	GES-6140B	GES-6140B	GES-6140B	GES-6140B	GES-6140B	GES-6140B	
• With Adjustable Magnetic Delay	GES-6149A	GES-6149A	GES-6149A	GES-6149A	GES-6149A	GES-6149A	

Obsolete Devices:

S-2500 (600-2500 amps LI) GES-6117
S-2500 (600-2500 amps LSI) GES-6118
TPS (600-2500 amps LI) GES-6125
TPS (3000-4000 amps LI) GES-6126
THS (600-2500 amps LI) GES-6127
THS (600-2500 Amps LSI) GES-6131
THS (3000-4000 amps LI) GES-6128
THS (600-2500 amps LSI) GES-6129
THS (3000-4000 amps LSI) GES-6132
TPS (600-2500 amps LSI) GES-6130
Complete Set of Curves GEZ-7001

① For MicroVersaTrip with 4-function programmer, refer to GES-6198.

L = Long Time
S = Short Time
I = Instantaneous
G = Ground Fault

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Time Current Curves

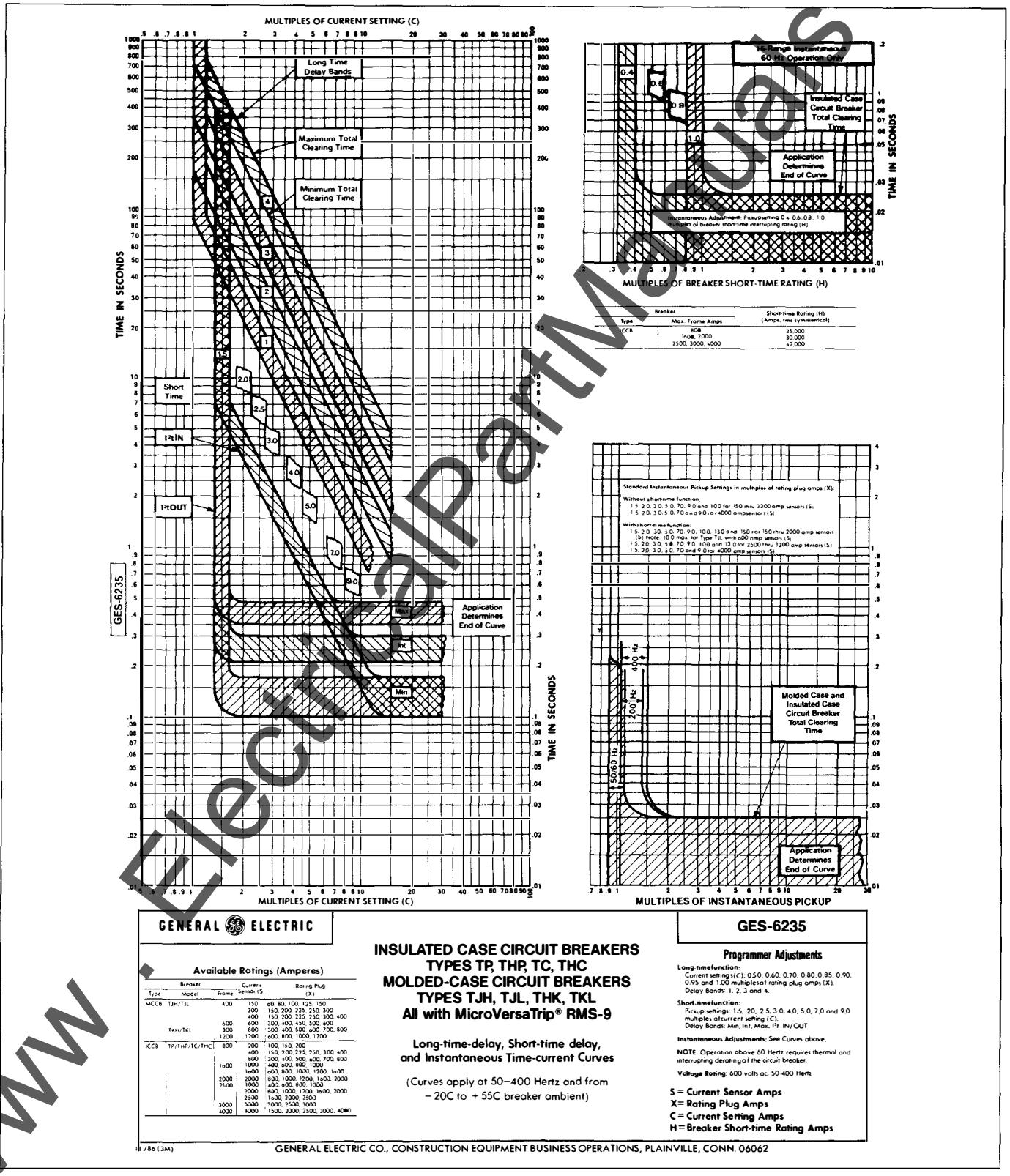

Fig. 39.1 MicroversaTrip® RMS-9 Phase Overcurrent Time Current Curve

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Time Current Curves (Continued)

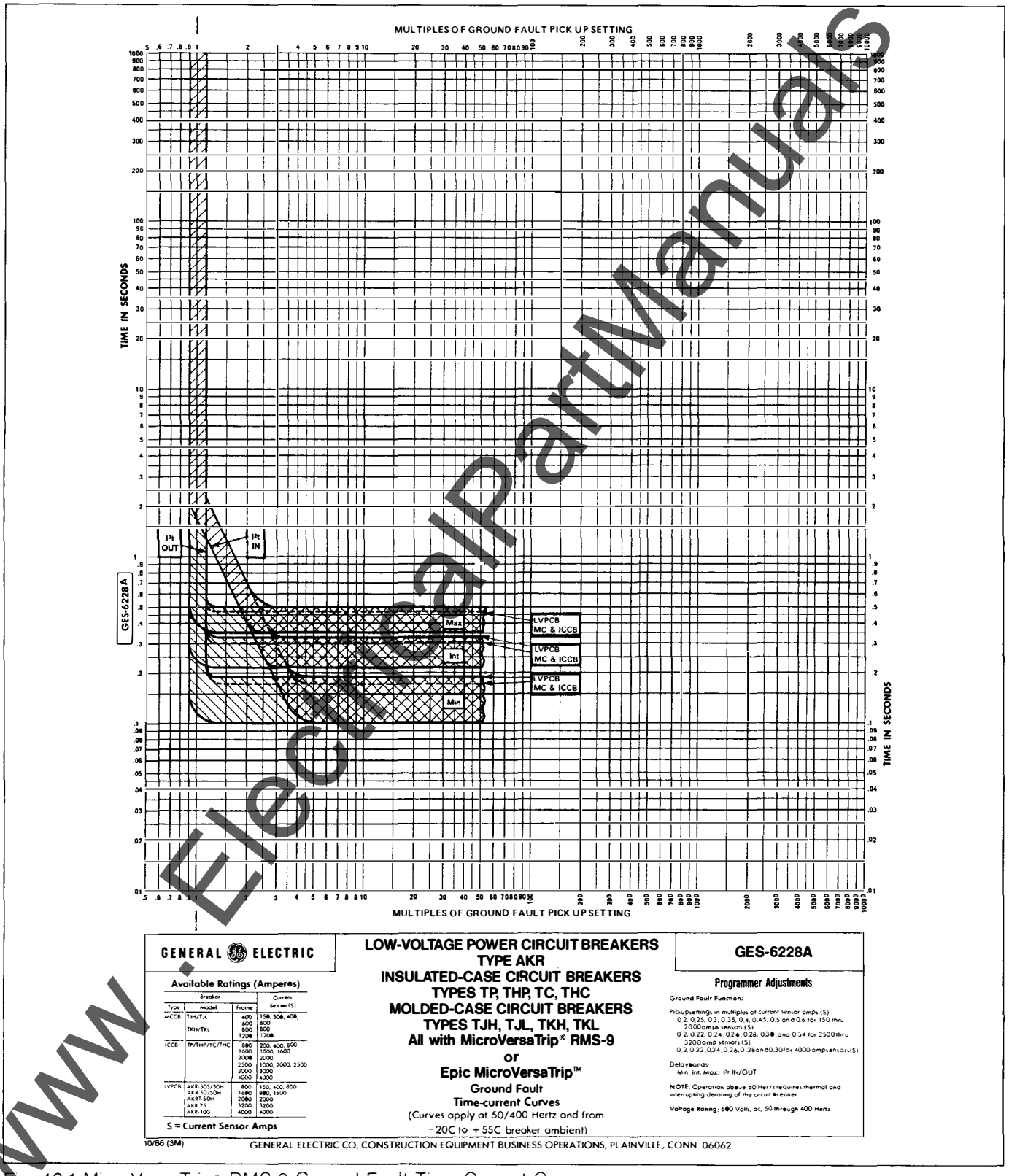

Fig. 40.1 MicroVersaTrip® RMS-9 Ground Fault Time-Current Curve

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Outline Dimension Drawings

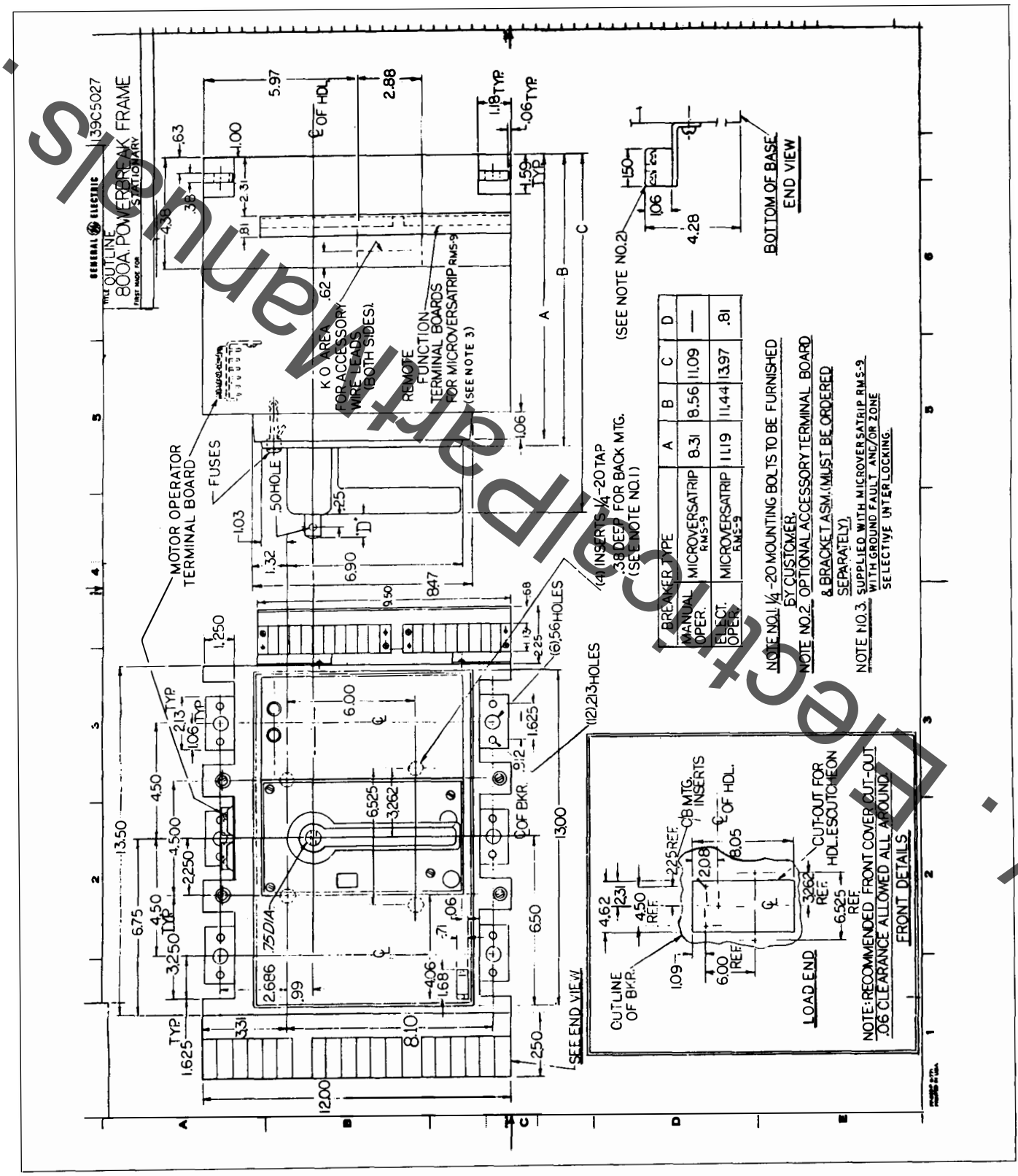

Fig. 41.1 800A Stationary Frame

Obsolete Replacement Manual

Outline Dimension Drawings (Continued)

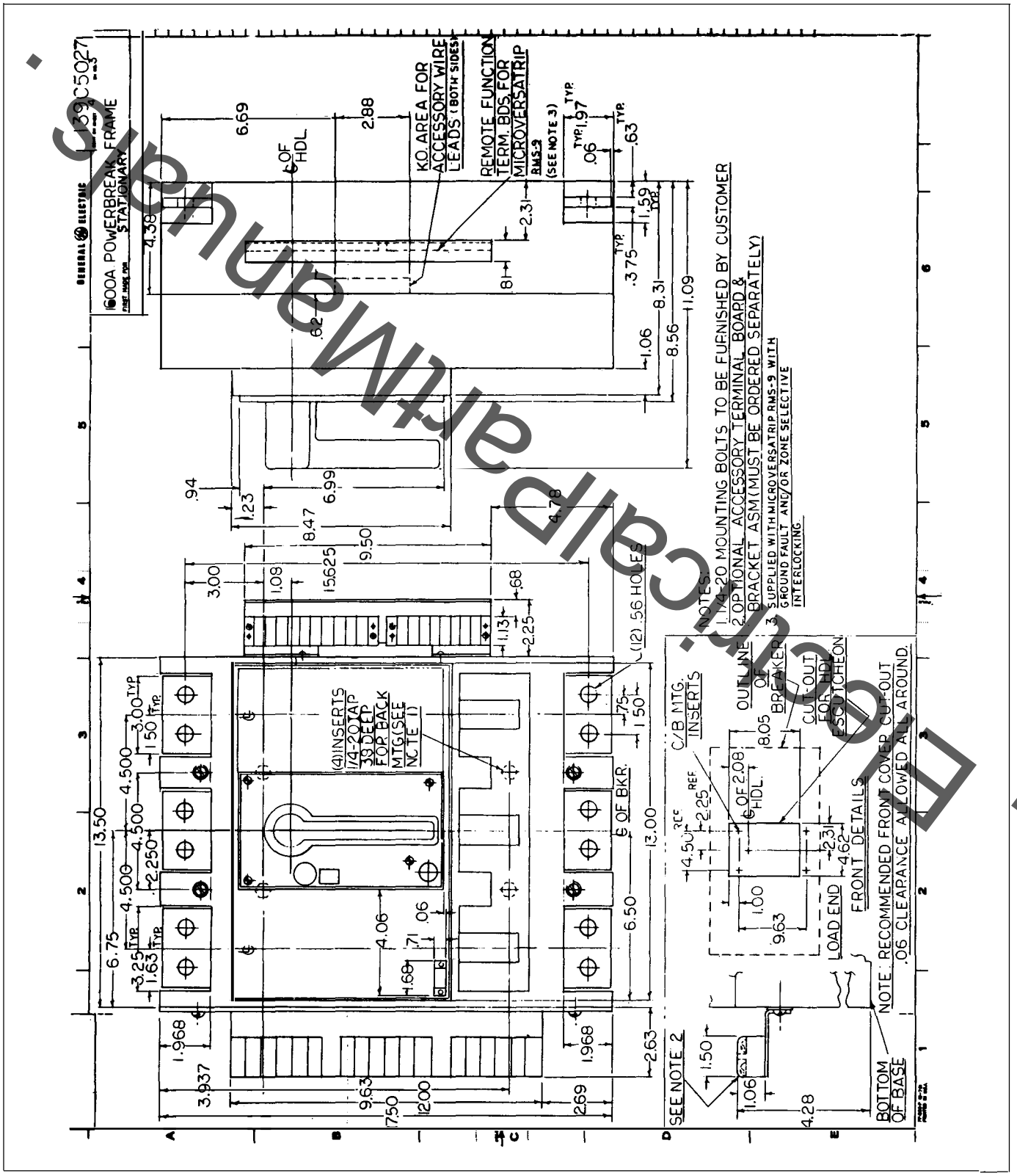

Fig. 42.1 1600A Stationary Frame

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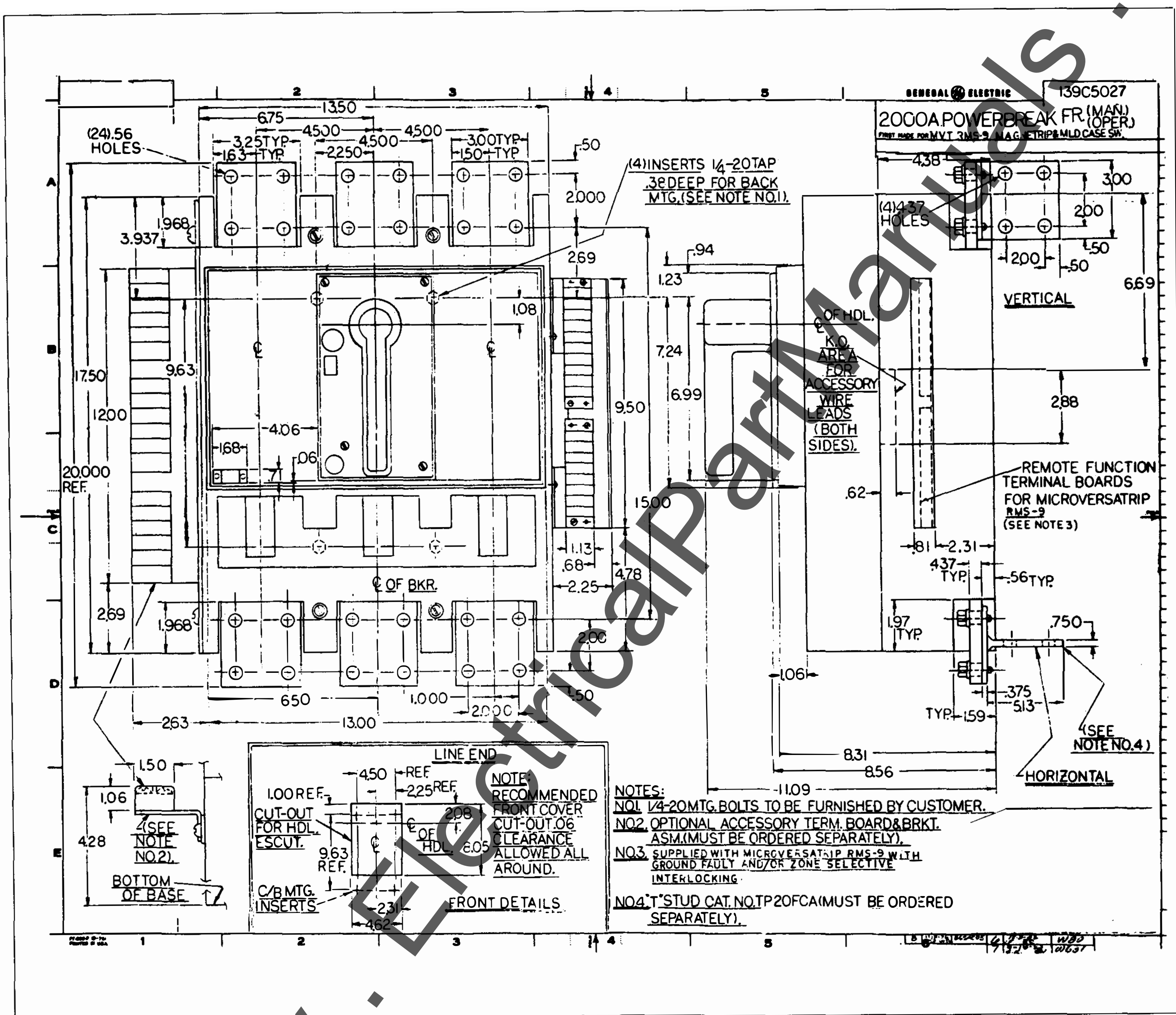

Fig. 43.1 2000A Stationary Frame

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Outline Dimension Drawings (Continued)

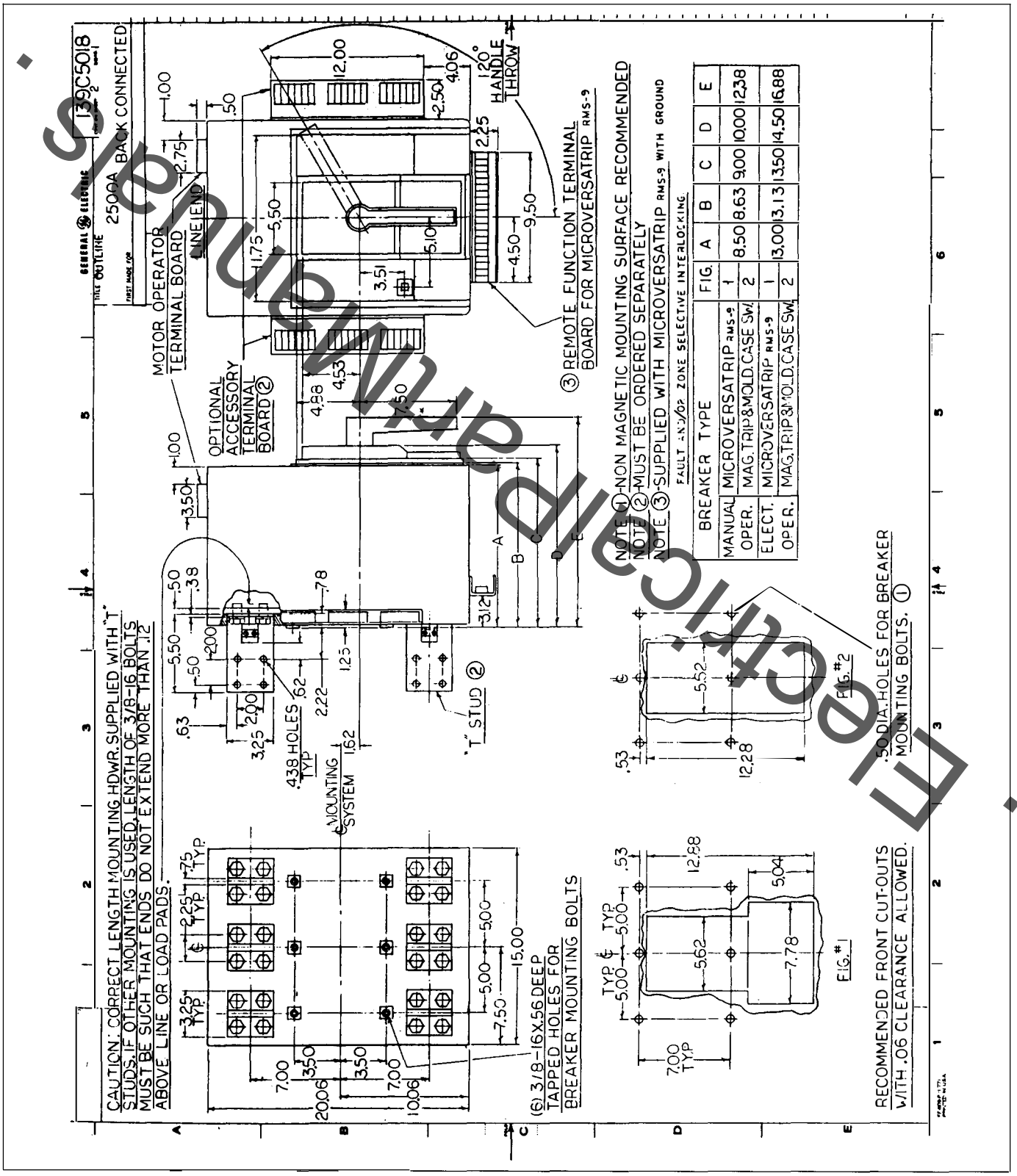

Fig. 44.1 2500A Stationary Frame

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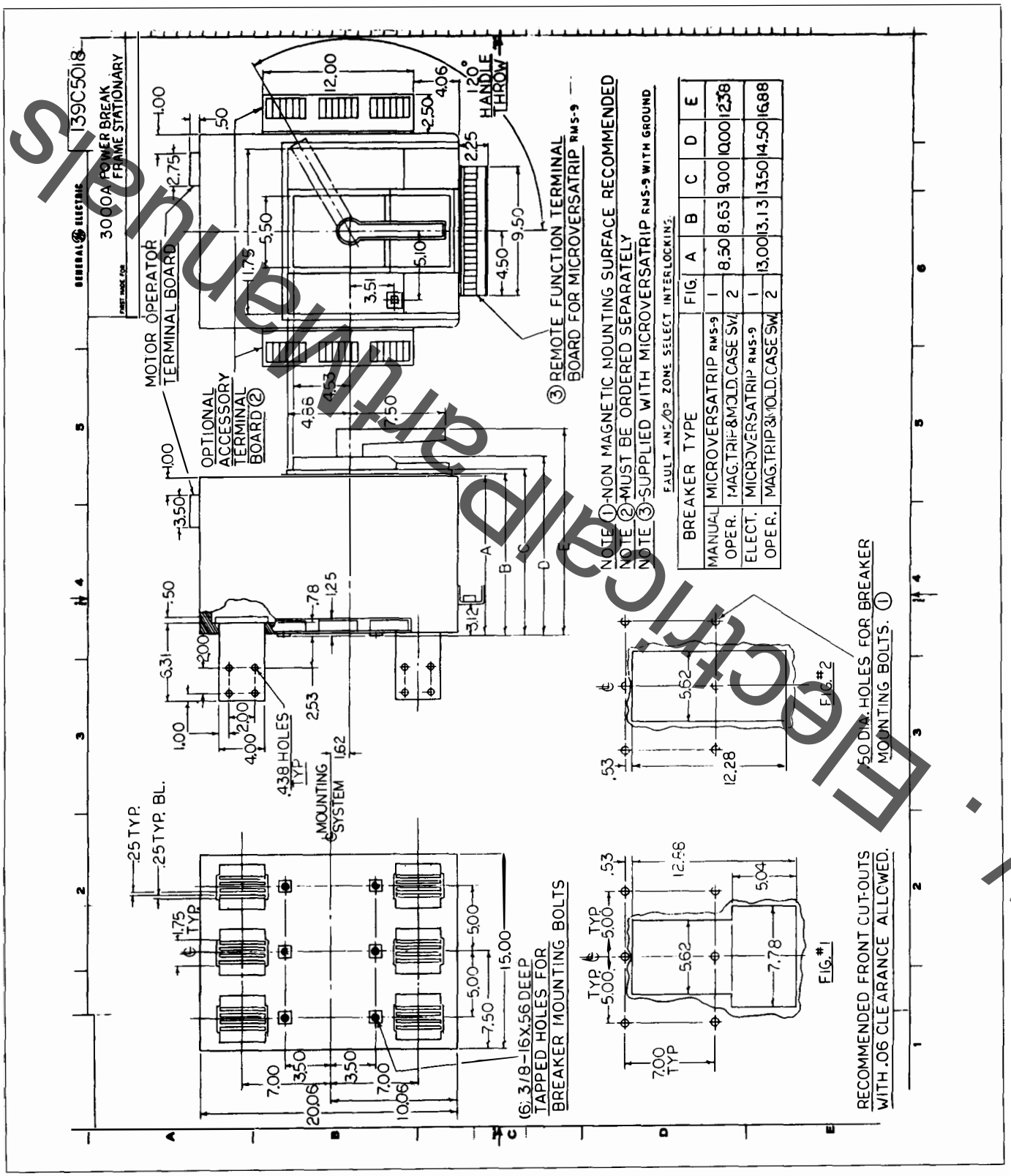

Fig. 45.1 3000A Stationary Frame

Electrical Distribution Systems

Outline Dimension Drawings (Continued)

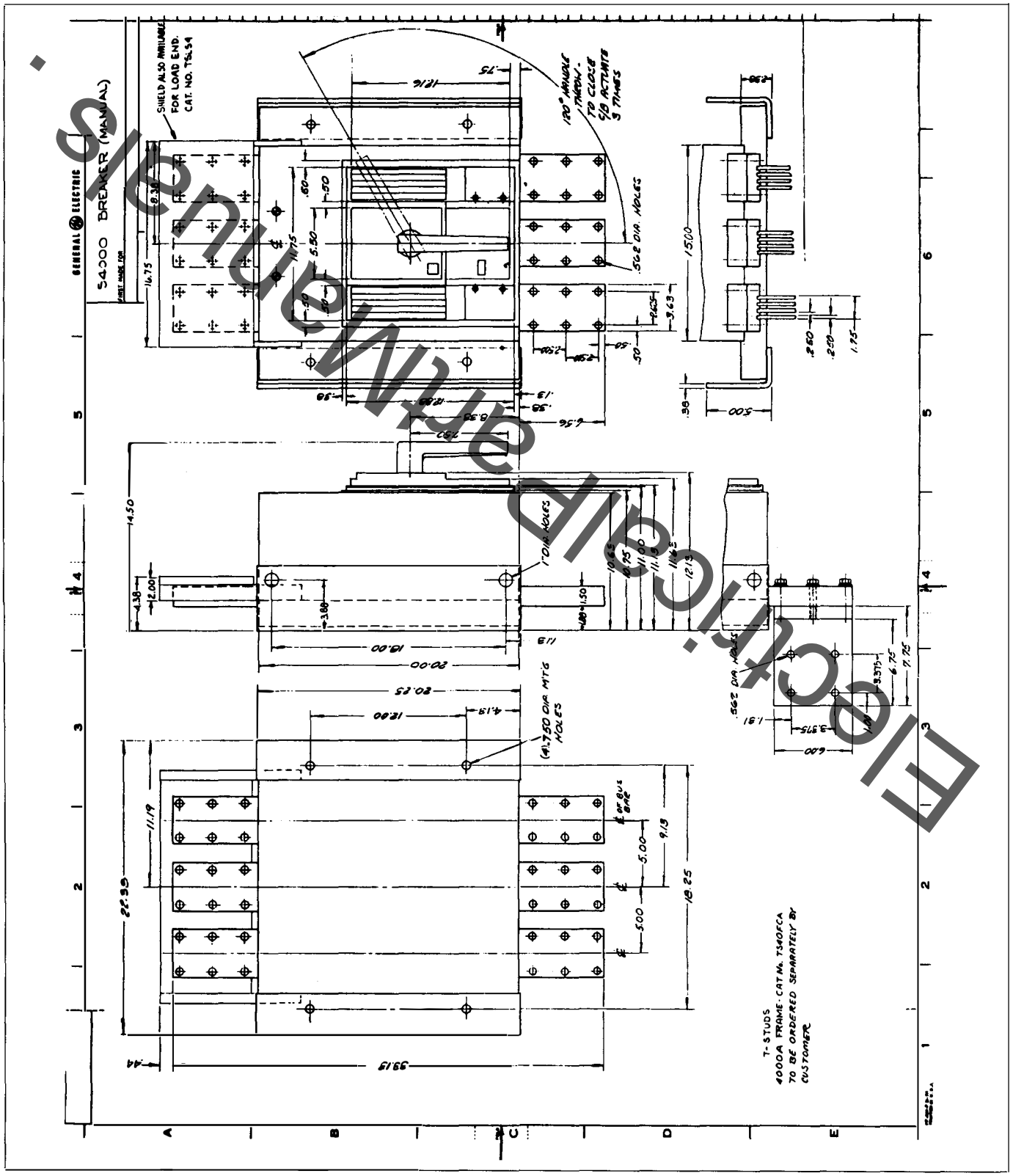

Fig. 46.1 4000A Stationary Frame

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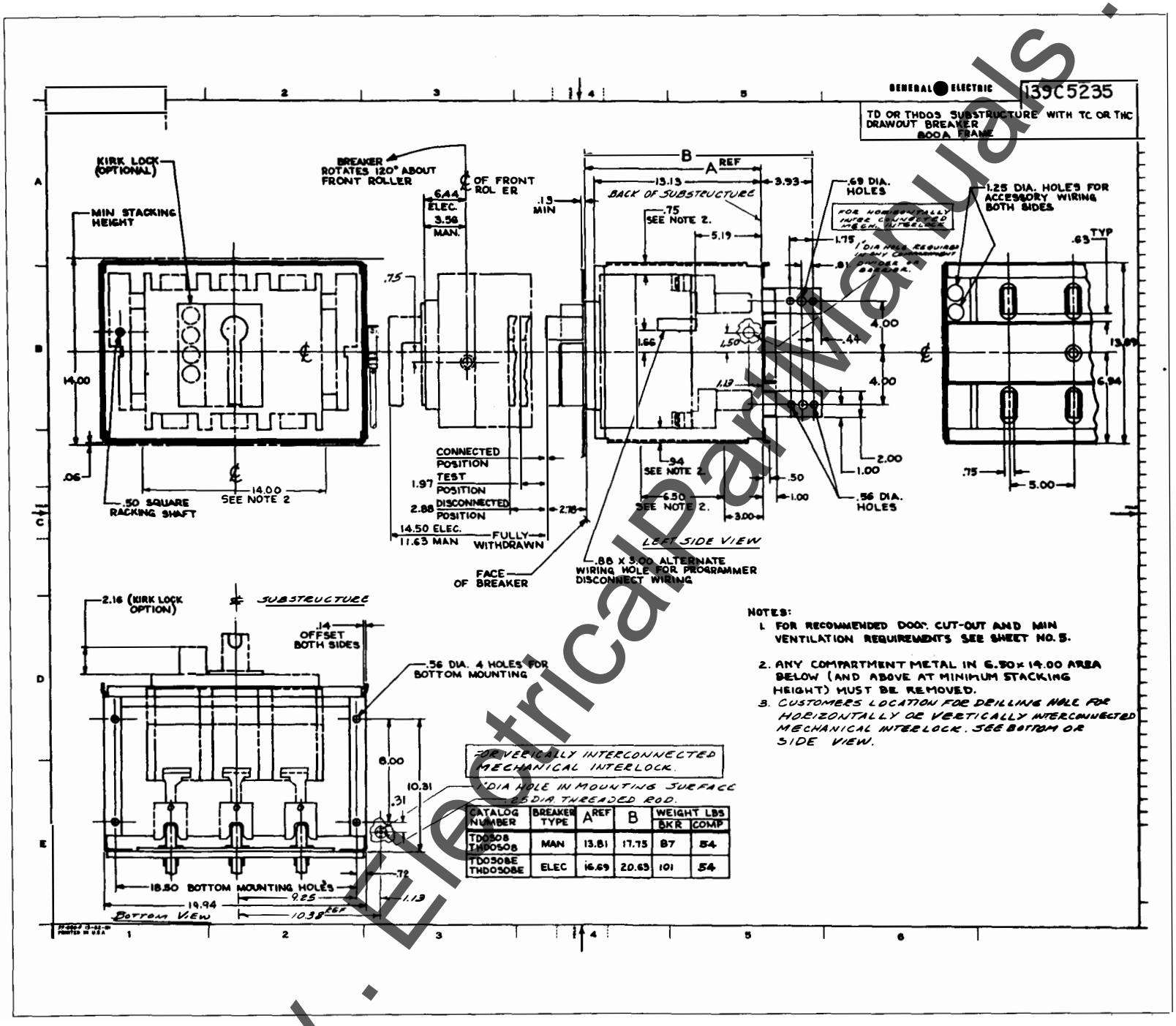

CATALOG NUMBER	BREAKER TYPE	A REF	B	WEIGHT LBS BKR	WEIGHT LBS COMP
TD0508 THD0508	MAN	13.81	17.75	87	54
TD0508E THD0508E	ELEC	16.69	20.63	101	54

Fig. 47.1 800A Draw-Out Frame

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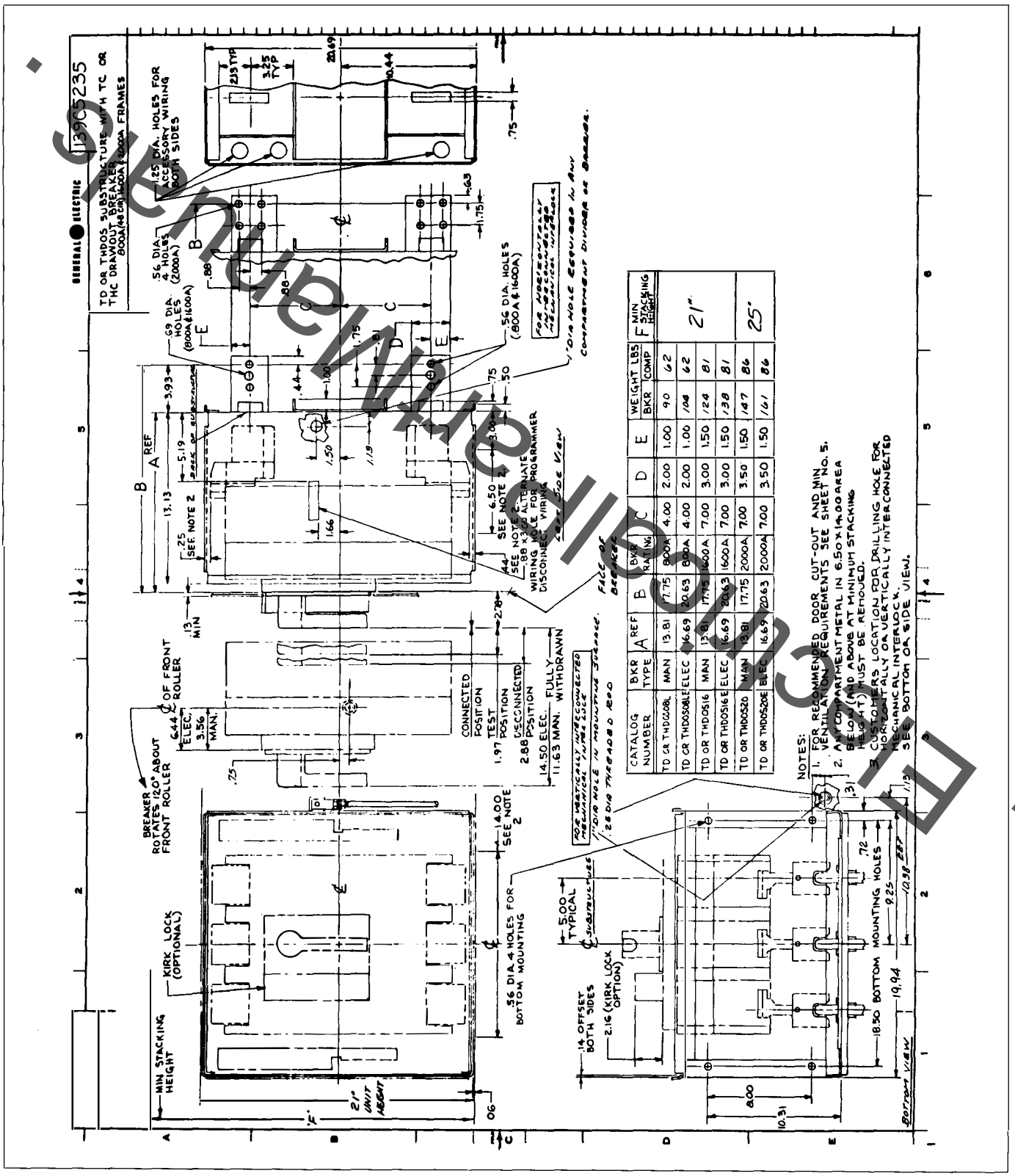
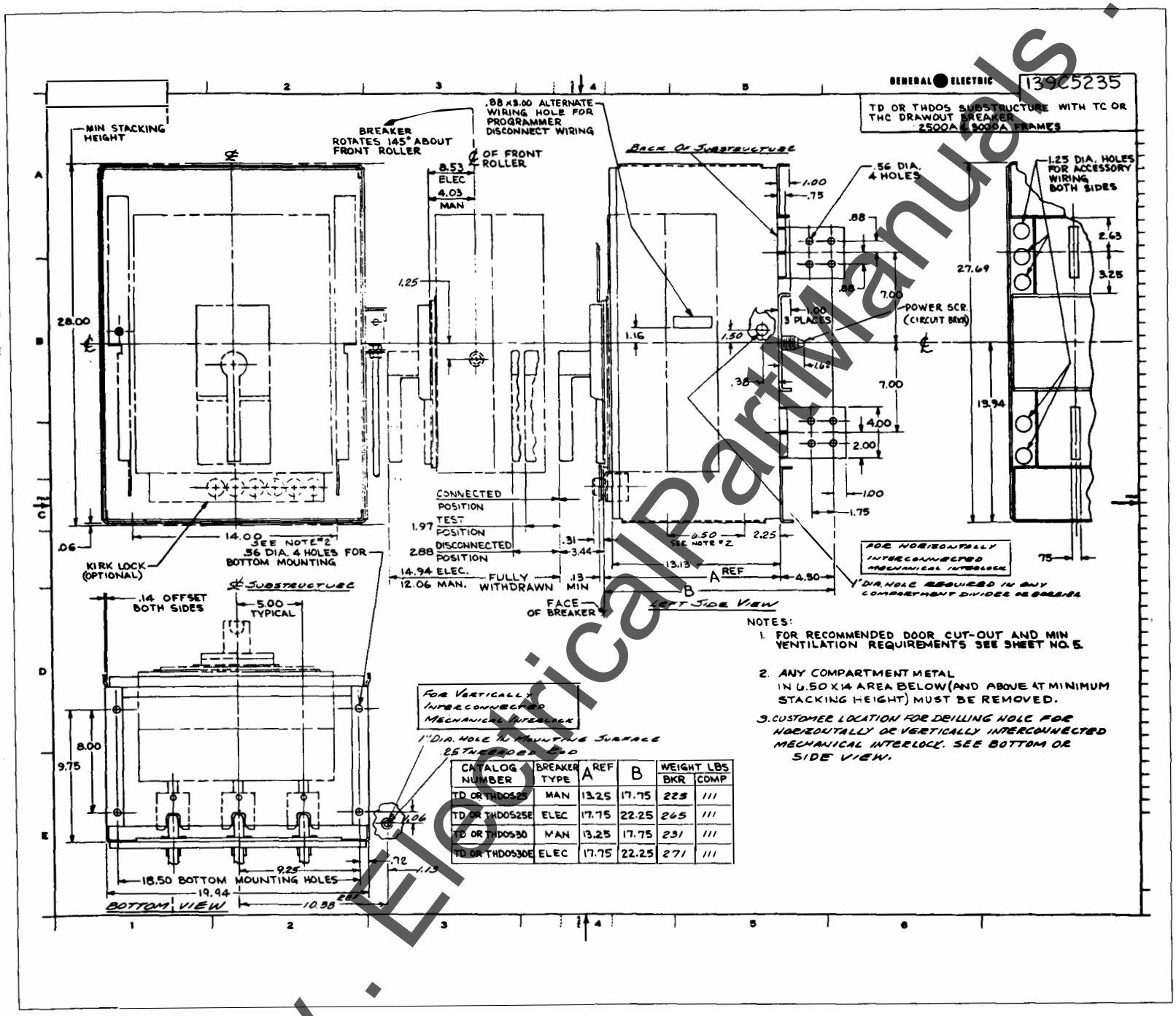
Outline Dimension Drawings (Continued)



CATALOG NUMBER	BKR TYPE	A REF	B BKR RATING	C	D	E	WEIGHT LBS BKR	WEIGHT LBS COMP	F MIN STACKING HEIGHT
TD OR THDO808L	MAN	13.81	17.75 800A	4.00	2.00	1.00	90	62	21"
TD OR THDO808LE	ELEC	16.69	20.63 800A	4.00	2.00	1.00	104	62	
TD OR THDO516	MAN	13.81	17.75 1600A	7.00	3.00	1.50	124	81	
TD OR THDO516E	ELEC	16.69	20.63 1600A	7.00	3.00	1.50	138	81	
TD OR THDO520	MAN	13.81	17.75 2000A	7.00	3.50	1.50	147	86	25'
TD OR THDO520E	ELEC	16.69	20.63 2000A	7.00	3.50	1.50	161	86	

Obsolete Drawing

Fig. 48.1 800A (48-Disconnect), 12000A, 1600A Draw-Out Frame



CATALOG NUMBER	BREAKER TYPE	A REF	B	WEIGHT LBS BKR	WEIGHT LBS COMP
TD OR THDOS25	MAN	13.25	17.75	225	111
TD OR THDOS25E	ELEC	17.75	22.25	265	111
TD OR THDOS30	MAN	13.25	17.75	231	111
TD OR THDOS30E	ELEC	17.75	22.25	271	111

Fig. 49.1 2500A and 3000A Draw-Out Frame

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Outline Dimension Drawings (Continued)

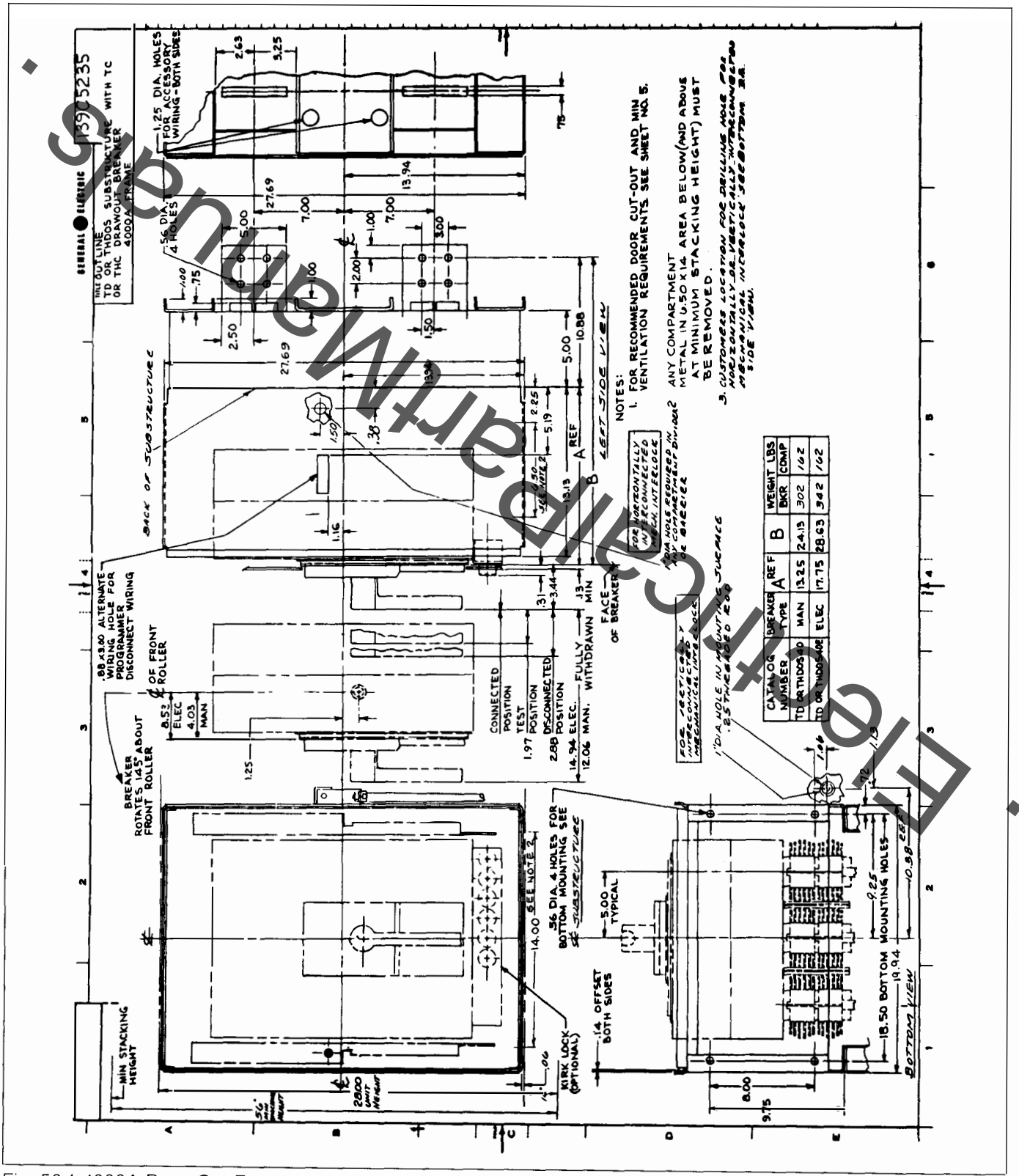
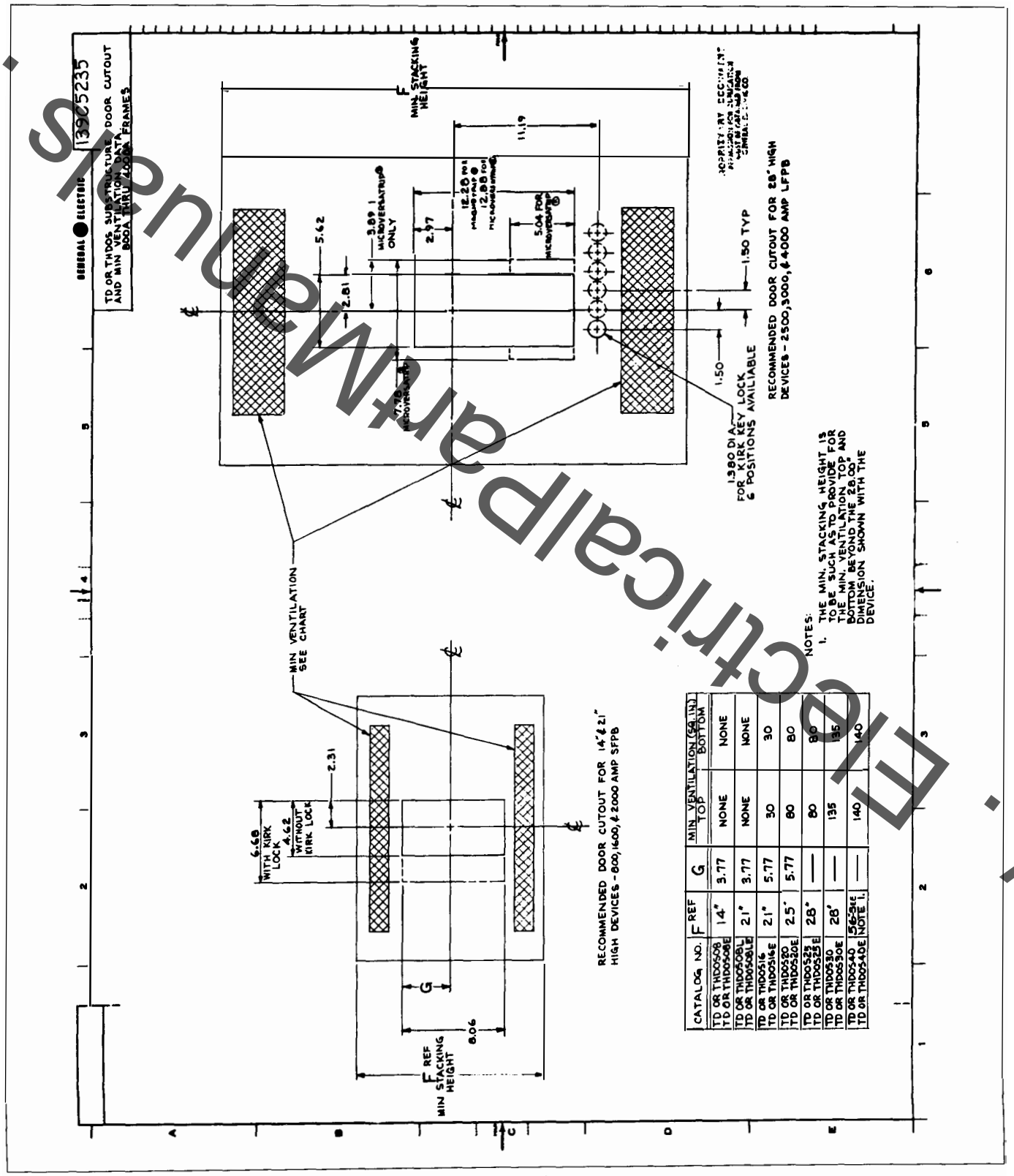


Fig. 50.1 4000A Draw-Out Frame



CATALOG NO.	F REF	G	MIN VENTILATION (SQ. IN.) TOP	BOTTOM
TD OR THD0508 TD OR THD0508E	14"	3.77	NONE	NONE
TD OR THD0508L TD OR THD0508LE	21"	3.77	NONE	NONE
TD OR THD0516 TD OR THD0516E	21"	5.77	30	30
TD OR THD0520 TD OR THD0520E	25"	5.77	80	80
TD OR THD0525 TD OR THD0525E	28"	—	80	80
TD OR THD0530 TD OR THD0530E	28"	—	135	135
TD OR THD0540 TD OR THD0540E	56 SEE NOTE 1.	—	140	140

Fig. 54.1 Door Cut-Out, Minimum Stacking Height and Ventilation Data

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Breaker Outline Dimension Drawing Numbers

Table 52.1
Outline Drawings

Frame Size	Stationary Breaker				Draw-out Breaker and Substructure Manual and Electrical
	Manual		Electrical		
	Line Top	Line Bottom①	Line Top	Line Bottom①	
800A	139C5027SH1	139C5027SH2	139C5027SH1	139C5027SH2	139C5235SH1 139C5235SH2
1600A 2000A	139C5027SH3 139C5027SH7	139C5027SH5 139C5027SH9	139C5027SH4 139C5027SH8	139C5027SH6 139C5027SH2	139C5235SH2
2500A	139C5018SH1	139C5018SH2	139C5018SH1	139C5018SH2	139C5235SH3
3000A	139C5018SH1	139C5018SH4	139C5018SH3	139C5018SH4	139C5235SH4
4000A	See Table 52.3 below				139C5235SH4

① Applicable to MagneTrip and Molded Case Switch only. All MicroVersaTrip● RMS-9 breakers are suitable for reverse feed.

Table 52.2
T-Studs for Stationary Breakers

Frame Size	Maximum Ampere Rating	T-Stud Catalog No.		Outline Drawing No.
		Front Connected	Back Connected	
800	800	TP08FCA	—	139C4172 Sh. 12
1600	1600	TP16FCA	—	139C4172 Sh. 12
2000	2000	TP20FCA	—	139C5027 Sh. 7
2500	2000 2500	TS20FCA TS25FCA	TS20BCA TS25BCA	139C5018 Sh.7 139C5018 Sh. 7
3000	3000	TS30FCA	Supplied as standard-not removable	139C5018 Sh.7
4000	4000	TS40FCA TS40LFCA	— —	139C5018 Sh. 7 139C5018 Sh. 7

Table 52.3
Stationary 4000A Outline Drawings

4000A	Front Connected—Magnetrip	
	Line Top—Manual	139C4105SH1
	Line Top—Electrical	139C4105SH2
	Line Bottom—Manual	139C4105SH3
	Line Bottom—Electrical	139C4105SH4
4000A	**Front Connected-Versatrip**	
	Line Top—Manual	139C4105SH10
	Line Top—Electrical	139C4105SH11
	Line Bottom—Manual	139C4105SH16
	Line Bottom—Electrical	139C4105SH17

Table 52.4
Lug Adapter Kits for Stationary Breakers

Breaker Frame Size	Adapter Catalog Number	Outline rawing No.
800A	TPLUGA08	139C4172 Sh. 11
1600A	TPLUGA16	139C4172 Sh. 11

Table 52.5
Neutral Sensors-MicroVersaTrip® RMS-9

Breaker Frame (Amps)	Sensor Rating (Amps)	Cat No.	Outline Drawing No.
800	200 400/200 600/300③ 800/400	TSVG302 TSVG304A TSVG306A TSVG308A	139C5016 Sh. 1
1600	800/400③ 1000/500 1200/600③ 1600/1000	TSVG808A TSVG810A TSVG812A TSVG816A	
2000	2000/1000	TSVG820A	
2500/3000	800/400③ 1000/500 1200/600③ 1600/1000③ 2000/1200 2500/1800 3000/2400	TSVG808A TSVG810A TSVG812A TSVG816A TSVG820A TSVG825A TSVG830A	
4000	4000/3000	TSVG940A②	139C5016 Sh. 2

① Match neutral current sensor rating (or tap setting) to circuit breaker sensor rating.
② Do not use with 4000-amp stationary TSSS/THSS. Use Cat. No. TSSG40.
③ For use with multiple source ground fault protection schemes. Rating does not match MicroVersaTrip RMS-9 frame sensor.

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Table 53.1
Electrical Formula — For Obtaining kW, kVA, Horsepower and Amperes

Wanted	Alternating Current Single Phase	Two-phase, four-wire	Direct Three-phase	Current
Kilowatts	$\frac{I \times E \times PF}{1000}$	$\frac{I \times E \times 2 \times PF}{1000}$	$\frac{I \times E \times 1.73 \times PF}{1000}$	$\frac{I \times E}{1000}$
kVA	$\frac{I \times E}{1000}$	$\frac{I \times E \times 2}{1000}$	$\frac{I \times E 1.73}{1000}$	$\frac{I \times E}{1000}$
Horsepower	$\frac{I \times E \times \% \text{ Eff.} \times PF}{746}$	$\frac{I \times E \times 2 \times \% \text{ Eff.} \times PF}{746}$	$\frac{I \times E \times 1.83 \times \% \text{ Eff.} \times PF}{746}$	$\frac{I \times E \times \% \text{ Eff.}}{746}$
Amperes from kVA	$\frac{kVA \times 1000}{E}$	$\frac{kVA \times 1000}{2 \times E}$	$\frac{kVA \times 1000}{1.73 \times E}$	$\frac{kVA \times 1000}{E}$
Amperes from kW	$\frac{kW \times 1000}{E \times PF}$	$\frac{kW \times 1000}{2 \times E \times PF}$	$\frac{kW \times 1000}{1.73 \times E \times PF}$	$\frac{kW \times 1000}{E}$
Amperes from Hp	$\frac{Hp \times 746}{E \times \% \text{ Eff.} \times PF}$	$\frac{Hp \times 746}{2 \times E \times \% \text{ Eff.} \times PF}$	$\frac{Hp \times 746}{1.73 \times E \times \% \text{ Eff.} \times PF}$	$\frac{Hp \times 746}{E \times \% \text{ Eff.}}$

KEY: E = Volts
I = Amperes
% Eff. = Percent Efficiency
PF = Power Factor
Hp = Horsepower

Table 53.2 shows minimum enclosure dimensions allowed under circuit breaker UL standard 489; the dimensions shown do not reflect enclosure dimensions offered by GE.

Table 53.2
Minimum Enclosure Dimensions

Max. Ampere Rating	Minimum Stationary Dimensions (Inches)			Minimum Ventilation Area (sq. in.)	Minimum Clearance to Ground(in)
	H	W	D		
800	21	22	10-1/2	—	4-1/2
1600	28	22	10-1/2	60	5
2000	35	22	8-3/4	—	5
2500	36	25	15-1/2	160	8
3000	40	32	15	240	8
4000	51	29	17	270	8

Note: Includes minimum clearance required to grounded metal from arc areas for standard Hi-Break or special Hi-Break.

Table 53.3
Bolt Torques

Breaker Frame	Terminal "T" Stud		Bus Connection	
	Bolt Size (DIA)	Torque (In-Lb)	Bolt Size (DIA)	Torque (In-Lb)
800	—	—	(1) 1/2 in.	300
1200-1600	(2) 3/8	200	(2) 1/2 in.	300
2000	(4) 3/8	200	(4) 1/2 in.	300
2500-3000①	(4) 3/8-16	200	(4) 3/8 in.	200
4000	(6) 1/2-13	300	(4) 1/2 in.	300

① 3000A Back-connected terminal studs are factory brazed to breaker.

Table 53.4
Approximate Net Weights

Frame Rating	Type	Weight (Lbs)	
		Stationary	Drawout
800A	Manual	50	87
800A	Electrical	64	101
1600A	Manual	82	124
1600A	Electrical	96	138
2000A	Manual	88	147
2000A	Electrical	102	161
2500A	Manual	175	225
2500A	Electrical	215	265
3000A	Manual	220	231
3000A	Electrical	260	271
4000A	Manual	320	302
4000A	Electrical	360	342

Note: For transformer short circuit curves, refer to GE publication GET-3550.

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Standards and References

Underwriters' Laboratories, Inc.

UL 489, Molded Case Circuit Breakers and Circuit Breaker Enclosures. Order from UL Publications Stock, 333 Pfingsten Road, Northbrook, Illinois 60062.

National Electrical Manufacturers Association (NEMA)

AB-1 Standards Publication—Molded Case Circuit Breakers. Order from NEMA Publications, 155 East 44th Street, New York, New York 10017.

Federal Specifications

W-C-375 B/GEN Circuit Breaker, Molded Case; Branch Circuit and Service. Order from General Services Administration, Specifications Distribution Unit, ROB, Rm 6662, 7th & D Sts., SW, Washington, DC 20407.

Institute of Electrical and Electronics Engineering (IEEE)

No. 45 Recommended Practice for Electrical Installation on Shipboard.
Order from IEEE Service Center, 445 Hoes Lane, Piscataway, New Jersey 08854.

National Electrical Code (NEC)

1987 Issue. Order from National Fire Protection Association, Batterymarch Park, Quincy, Ma. 02269.

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Guide Form Specifications

Circuit breakers shall be General Electric Insulated Case POWER BREAK® and shall be UL listed in accordance with UL standard 489 and meet the requirements of NEMA Standard AB1-1975.

POWER BREAK insulated case circuit breakers equipped with MicroVersaTrip® RMS-9 programmers shall include a microelectronic digital processor which is automatic and self-contained, and requires no external relaying, power supply, or accessories. Its printed circuit cards shall be conformally coated to resist moisture absorption, fungus growth, and signal leakage and shall have highly reliable fixed-point programmable controls with repetitive accuracy and precise unit settings. All electronics shall be housed within a metallic enclosure to protect against high-fault interruption arcs, magnetic interference, dust and other contaminants.

The protective programmer shall digitally measure the "true" heating value of the current with an error of less than 1% on systems with distortions through the 13th harmonic. Peak sensing devices are not acceptable. In addition, the protective programmer shall utilize interchangeable rating plugs to change the continuous current rating. The rating plug shall be front accessible, permitting changing without removing the breaker from its cubicle.

The protective programmer shall have the following minimum features:

- A long-time timing light that provides visual indication that the breaker is approaching an overload (flashing light) or is timing out to trip (continuous light) under an overload.
- A clear plastic cover that is sealable to prevent unauthorized tampering of settings.
- The capability of being tested with a portable test set while in service, with or without load current flowing.
- Eight adjustable current settings in discrete steps from 0.5 to 1.0 times the rating plug amperes.
- Four discrete long-time delay settings.

[Where specified, breaker shall have (1) adjustable short-time pickup and adjustable delay with I^2t IN/OUT switch, (2) adjustable ground fault pickup and adjustable delay with I^2t IN/OUT switch, (3) adjustable high instantaneous, (4) overload and short circuit and ground fault trip indicators, and/or zone selective interlocking for ground fault or for ground fault and short-time functions.]

Pick-up and delay settings shall be:

- Current setting — .5, .6, .7, .8, .85, .9, 1.0 times rating plug amperes
- Long-time delay — 1, 2, 3, 4
- Short-time pick up — 1.5, 2, 2.5, 3, 4, 5, 7, 9 times current setting
- Short-time delay — minimum, intermediate, maximum with or without I^2t slope
- Instantaneous pick up — multiples of rating plug amperes:
  - With short-time — 1.5, 2, 3, 5, 7, 9, 10, 13, 15 for 800-2000A frame ratings; 1.5, 2, 3, 5, 7, 9, 10, 13 for 2500 and 3000A frames; 1.5, 2, 3, 5, 7, 9 for 4000A frame
  - Without short-time — 1.5, 2, 3, 5, 7, 9, 10 for 800-3000A frame ratings; 1.5, 2, 3, 5, 7, 9 for 4000A frame
- Ground fault pick up — multiples of sensor ampere rating:
  - .2, .25, .3, .35, .4, .45, .5, .6 for 200-2000A sensors
  - .2, .22, .24, .26, .28, .3, .34, .37 for 2500 and 3000A sensors
  - .2, .22, .24, .26, .28, .3 for 4000A sensor
- Ground fault delay — minimum, intermediate, maximum with or without I^2t slope

Current sensors shall be of toroidal construction, encased in a plastic housing filled with epoxy to protect against damage and moisture and shall be integrally mounted on the breaker. [For four-wire ground fault, a fourth current sensor shall be included with construction similar to the phase overcurrent sensors.]

The ground fault function shall contain a memory circuit which integrates arcing fault current with time essentially summing intermittent ground-current spikes.

A hand-held, portable, plug-in test kit shall [be provided] [be available] for testing and verifying the MicroVersaTrip RMS-9 programmer settings. The test kit shall plug into the front of the programmer to permit testing while the breaker is in service using a no-trip or trip mode.

POWER BREAK insulated case circuit breakers with MicroVersaTrip RMS-9 programmers shall be rated to carry 100% current continuously and shall be [stationary] [draw-out] construction. These breakers shall be [standard break] [Hi-Break®] and have current interrupting ratings equal to or greater than specified at the system voltage.

When specified, the breakers shall be provided with an adjustable high instantaneous option permitting a maximum pickup equal to the breaker short-time rating. Breaker short-time ratings shall be as shown in Table 51.1.

The breaker shall be equipped with a field installable, UL listed interchangeable rating plug which shall fix the continuous current-carrying value of the circuit breaker frame as specified on the drawings.

Breakers shall be [manually] [electrically] operated and shall have a stored energy charging mechanism and independent closing function. The closing function shall be [local only via a closing button on the face of the breaker] [both local and remote]. [The local closing function shall employ a "hidden" ON button to preclude unintentional closing of a charged breaker.]

[Breakers shall be equipped with one or more of the following internal control accessories as specified on the drawings:

- Auxiliary switches
- Shunt trip
- Undervoltage release
- Bell alarm with lockout]

[One or more of the following external accessories shall be provided as specified on the drawings:

- Terminal blocks for terminating internal accessory leads on stationary breakers
- Door interlock and padlock or padlock only
- Kirk key provision
- Mechanical ("walking beam") interlock
- T-studs]

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MagneTrip™ POWER BREAK insulated case circuit breakers shall employ temperature insensitive, dual-magnetic trip units with adjustable ampere setting plus either adjustable instantaneous or fixed instantaneous with adjustable short-time functions. The long-time delay shall be achieved by use of a temperature insensitive silicone-filled dashpot.

MagneTrip POWER BREAK circuit breakers shall be UL listed to carry 100% current continuously and shall be so labeled.

MagneTrip breakers shall have UL listed ac and dc ratings, including 600 Vdc for 2500-4000A frame sizes.

Table 56.1
POWER BREAK Circuit Breakers with MicroVersaTrip RMS-9 Short Time Ratings

Circuit Breaker Envelope Size (Amps)	500 Millisecond Short-time Rating in KA rms Sym at 600 Vac Max.
800	25
1600, 2000	30
3000, 4000	42

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Other Appropriate Publications

General Instructions, Breakers and Accessories

Circuit Breaker Construction Details (800-4000A) GEF-4458
MicroVersaTrip® RMS-9 Programmer (800-4000A) ...GEH-4657
MagneTrip™ Trip Unit (2500-3000A) GEH-4658
POWER BREAK® Circuit Breaker (800-2000A) GEH-4693
  General Information
  Accessory Installation
POWER BREAK Circuit Breaker (2500-4000A) GEH-4694
  General Information
  Accessory Installation
POWER BREAK Draw-out Breakers (800-4000A) GEH-4698

Field Installed Accessories and Options

Padlock Accessory (2500-4000A) GEH-3394
Bell Alarm For MagneTrip (2500-4000A) GEH-3403
Terminal Board For Accessories (800-4000A) GEH-3407
Circuit Breaker Enclosure (800-4000A) GEH-3498
Lug Kits (2500-4000A) GEH-4303
Key Interlock Mounting (800-4000A) GEH-4324
Key Interlock Mounting (Old Style) (2500-4000A) GEH-4341
Bell Alarm For MicroVersaTrip RMS-9
  (2500-4000A) GEH-4358
Mechanical Interlock-Stationary Breakers
  (800-4000A) GEH-4383
Remote Close Option (2500-4000A) GEH-4544
Lug Kits (800-2000A) GEH-4546
POWER BREAK Draw-out Secondary Disconnect
  (800-4000A) GEH-4696
POWER BREAK Draw-out Substructure, Accessories
  (800-4000A) GEH-4697
POWER BREAK Draw-out Motor Cutoff Switch
  (800-4000A) GEH-4699
POWER BREAK Draw-out Mechanical Interlock
  (800-4000A) GEH-5006
MicroVersaTrip RMS-9 Portable Test Kit
  (Cat. No. TVRMS) GEK-97367
MicroVersaTrip Test Set (800-4000A)
  (not for MicroVersaTrip RMS-9) GEK-64464

Field Replacement Parts

Handle and Arc Chute (2500-4000A) GEF-4456
Cam, Latch, Reset Fork (2500-4000A) GEF-4459
Motor Operator Components (2500-4000A) GEF-4553
Handle (800-2000A) GEF-4557

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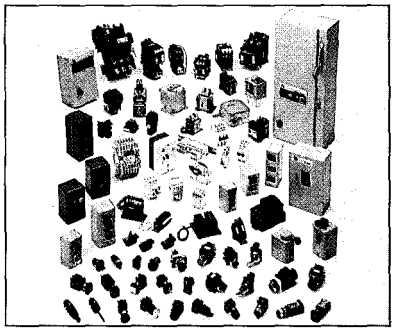

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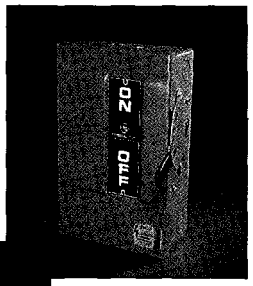

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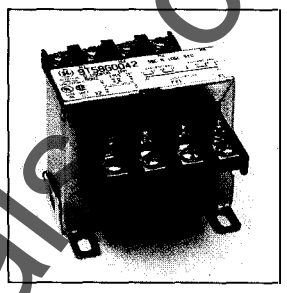

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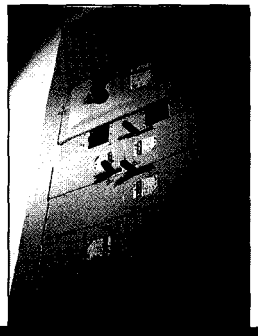

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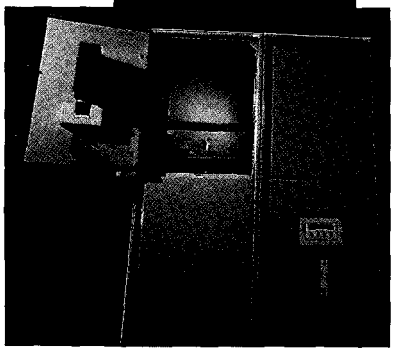

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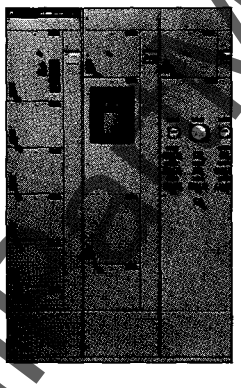

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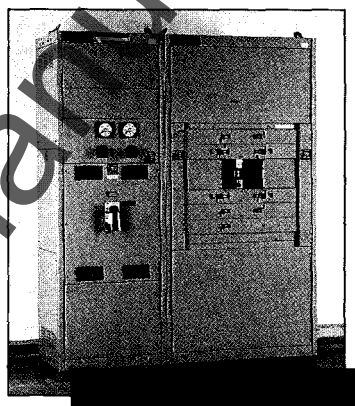

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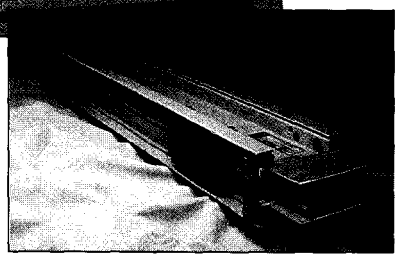

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