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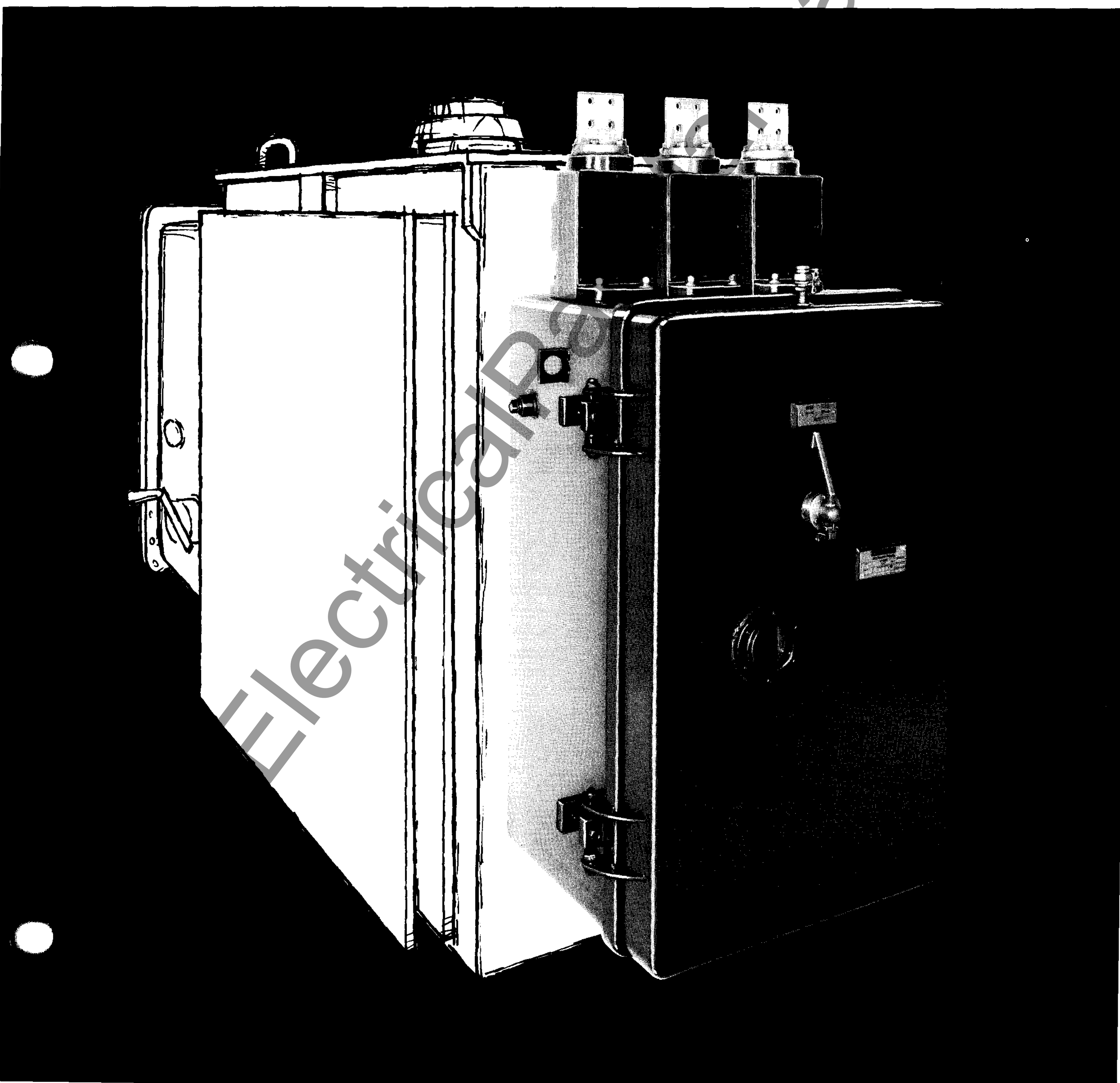
125/216 and 277/480 Volts
Y-Connected Secondary Network Systems

CMD Network Protector



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Application
The Westinghouse CMD Network Protector is designed to assure service continuity in 125/216- and 277/480-volt, Y-connected secondary network systems. These systems, in either distributed grid or spot network form, are commonly used in such areas of high load density as metropolitan and suburban business districts.

Suburban loads were formerly almost entirely residential, and power outages caused little more than personal inconvenience. Now, the suburban load includes not only shopping plazas, industry, and broadcasting, but such vital services as hospitals and airports. For these critical loads, power interruptions can have serious consequences to public safety. Spot networks will supply the reliability requirements at these important loads.

At the same time, the need to provide ever increasing amounts of electrical power at the utilization voltage—without increasing equipment size—has resulted in a shift from 125/216-volt to 277/480-volt systems. With this trend toward the higher voltage a change in operating and maintenance procedures is required, because of the difference in arcing characteristics at 480-volts as compared to those at 125/216-volts. For example, while an arc in a 216-volt system is normally self-extinguishing, an arc in a 480-volt system will usually burn until it is interrupted by an extinguishing device or until it totally consumes the arcing material.

To keep in step with the change in network application, Westinghouse makes a major change in design philosophy, by introducing drawout design to the network protector industry. The CMD network protector represents upgraded personal safety and increased equipment dependability in the art of network protector technology.

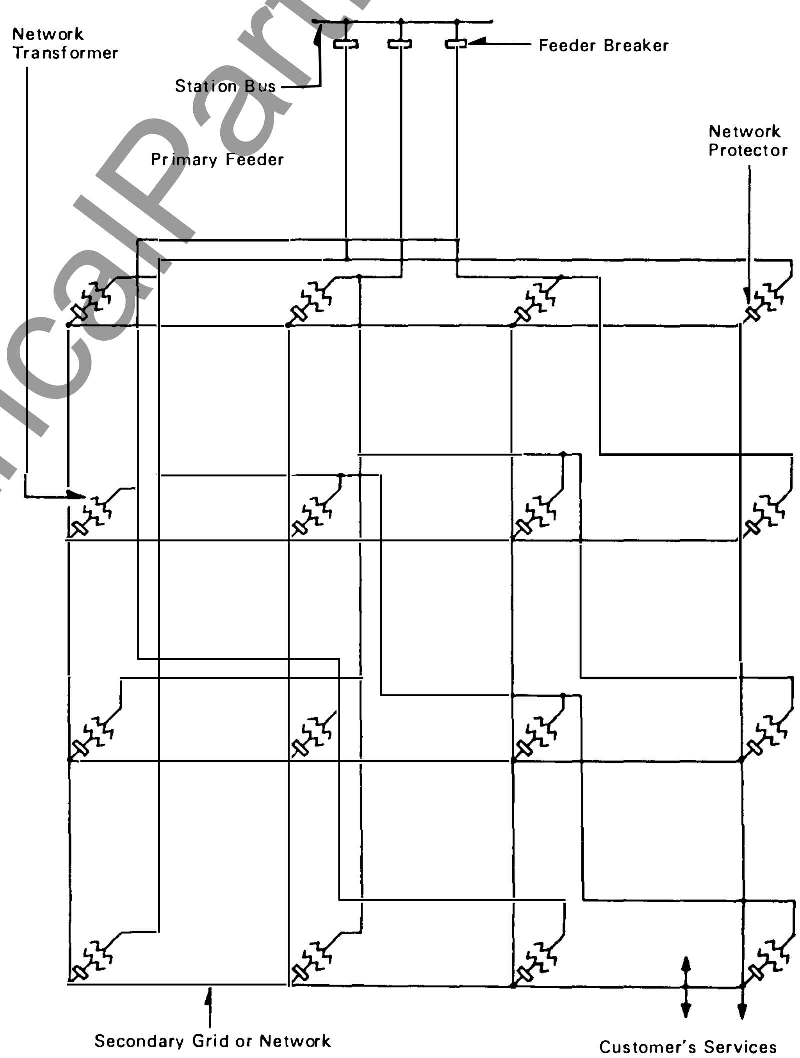
The design of the Westinghouse CMD assures that neither personnel nor tools will come into contact with energized protector components when disconnecting the drawout unit from service. In addition, the Westinghouse CMD has been designed to assure maximum reliability while it is in service. It will close and trip positively for safer and easier maintenance in the field.

Secondary network systems using the Westinghouse CMD Network Protector are the most dependable in use today. In the event of a fault on a primary system (cable or network transformer) the Westinghouse CMD Network Protector will open, due to reverse power flow, to isolate the fault from the network system. Loss of the feeder will not result in service outage at any load on the secondary network. The other primary feeders will carry the load until the faulted feeder can be repaired and be returned to service.

The CMD Network Protector consists basically of an air circuit breaker, a breaker operating mechanism, network relays and control equipment. It is available in both semi-dust-tight and submersible enclosures, for either separate or transformer throat mounting.

Better Regulation . . . Less Voltage Dip. Each consumer's service is supplied from at least two directions. Services supplied from a transformer location have a minimum of three paths of supply. Because of these multiple paths for load currents, abrupt changes in load, such as motor-starting currents, cause much less voltage disturbance than on a radial system. The voltage dip resulting from a given starting current may be 70 percent less in a network system than in a radial system.

Less Transformer Capacity Required. In normal operation, the loads along the secondary mains are divided among the various network transformers in such a way that the best possible voltage conditions and lowest losses are obtained. Since all of the secondary mains are connected together, many more consumers are supplied from the same secondary mains in a network system than in a radial system. The sum of the peak loads on the transformers is correspondingly lower in the network system than in a radial system supplying the same loads, because of the diversity in demand among the larger number of consumers. Therefore, less transformer capacity may be required in a network system than in a radial system in the same area, particularly if three or more feeders supply the network system.



Typical Schematic Diagram for Heavy-duty A-C Low Voltage Network

Operation
A short circuit on any one feeder will cause all the network protectors on that feeder to open on reverse energy, provided the total power on the three-phase feeder is in the reverse direction.

When the feeder cable is repaired properly, the network protectors on that feeder will automatically reclose when the feeder circuit-breaker at the substation is closed, if correct voltage conditions exist at the network transformer.

If when repairing the cable, the phases are reversed, the network protectors on that feeder will not reclose automatically as long as the network remains energized.

Likewise, if a voltage less than network voltage is restored to the feeder, the network protector on that feeder will not reclose automatically. It could be closed manually if the CN-33 trip contact is not made.

If a feeder from a separate source is to be connected to an energized network, the incoming voltage must be slightly higher than the network voltage and in proper phase relation with it. If a feeder is being connected to a dead network, it is sufficient to have the incoming voltage high enough to operate the closing mechanism.

The substation operator can disconnect feeders by simply opening the feeder circuit breakers, thus de-energizing the feeders so that they may be easily worked on. By thus opening the feeders one at a time, service need not be disturbed. Also, at times of light load, the substation operator may load the system more economically by disconnecting some of the feeders. The network protectors open automatically when a feeder breaker is opened, due to the reverse magnetizing energy of the transformers. However, when the BN relay is used, several minutes will elapse before tripping occurs, depending upon the time setting of this relay.

When the load increases, the substation operator may bring more feeders into service by closing the substation feeder circuit breakers. The network protectors on those feeders will reclose automatically if the transformer voltage is higher than the network voltage by a certain minimum amount and in the proper phase relation with it.

The network protector fuses provide backup protection for clearing faults on the primary feeder in the unlikely event the protector would fail to operate. For such conditions when the fuses are removed from the CMD network protector, the protector is disconnected from the low voltage network. Page 10 shows the time-current characteristic curves of the NPL fuse supplied with CMD protectors.

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Advantages

Exclusive drawout design—with positive safety interlocks, provides maximum protection against contact with energized components while disconnecting the unit for test or maintenance; assures maximum safety for operating personnel. All main current carrying and mechanical operating components are located behind a "dead-front" steel panel that minimizes the possibility of tools or hands from being inserted into an energized protector. The drawout unit is operated by a hand-cranked levering system, which cannot be engaged unless the circuit breaker is open and cannot be disengaged unless the drawout unit is either fully disconnected or fully connected.

Modular construction—simplifies field maintenance and/ or replacement of components of drawout unit. The network protector can be quickly put back in service reducing maintenance time to a minimum.

Spring-close operating mechanism—avoids partial closures. The CMD Spring-Close mechanism will not permit closing motion of the contacts to start until the closing springs are fully charged.

Externally-mounted silver-sand fuses—operate with no contamination of the protector, and will positively interrupt fault current to disconnect the protector from the network bus in abnormal situations.

Low-energy, direct-trip actuator—provides reliable, constant tripping effort, with minimum wear, over the complete range of tripping voltages.

Design Features

(1) Submersible enclosure.

(2) Extension rails.

(3) Drawout unit.

(4) Operation counter.

(5) OPEN-CLOSED breaker position indicator.

(6) Manual trip button.

(7) Control module withdrawn for inspection.

(8) JC contact.

(9) JA contact.

(10) Actuator for JA and JC contacts. With drawout unit in "connected" position (fully inserted into enclosure) and door closed, the external operating handle in AUTO position depresses the JA contact to put the network protection under the control of the relays. The JC contact is depressed when the external operating handle is moved to the CLOSE position to electrically close the protector (external handle is spring returned from CLOSE to AUTO position).

(11) When external operating handle is moved to the TRIP position, this linkage expands to mechanically operate the trip button on the front of the network protector.

(12) Window to view operation counter and OPEN-CLOSED indicator.

(13) New "picture-frame" door gasket.

(14) Air test valve.

(15) Shutter over levering shaft.

(16) Disconnect finger clusters.

(17) Silver-sand, non-display NPL fuse located within water-tight housing.

(18) Epoxy housing to enclose the NPL fuse and also serve as stand-off insulator for the network side terminal. Various spade configurations or threaded stud adapters are available for mounting on the top of this epoxy housing.

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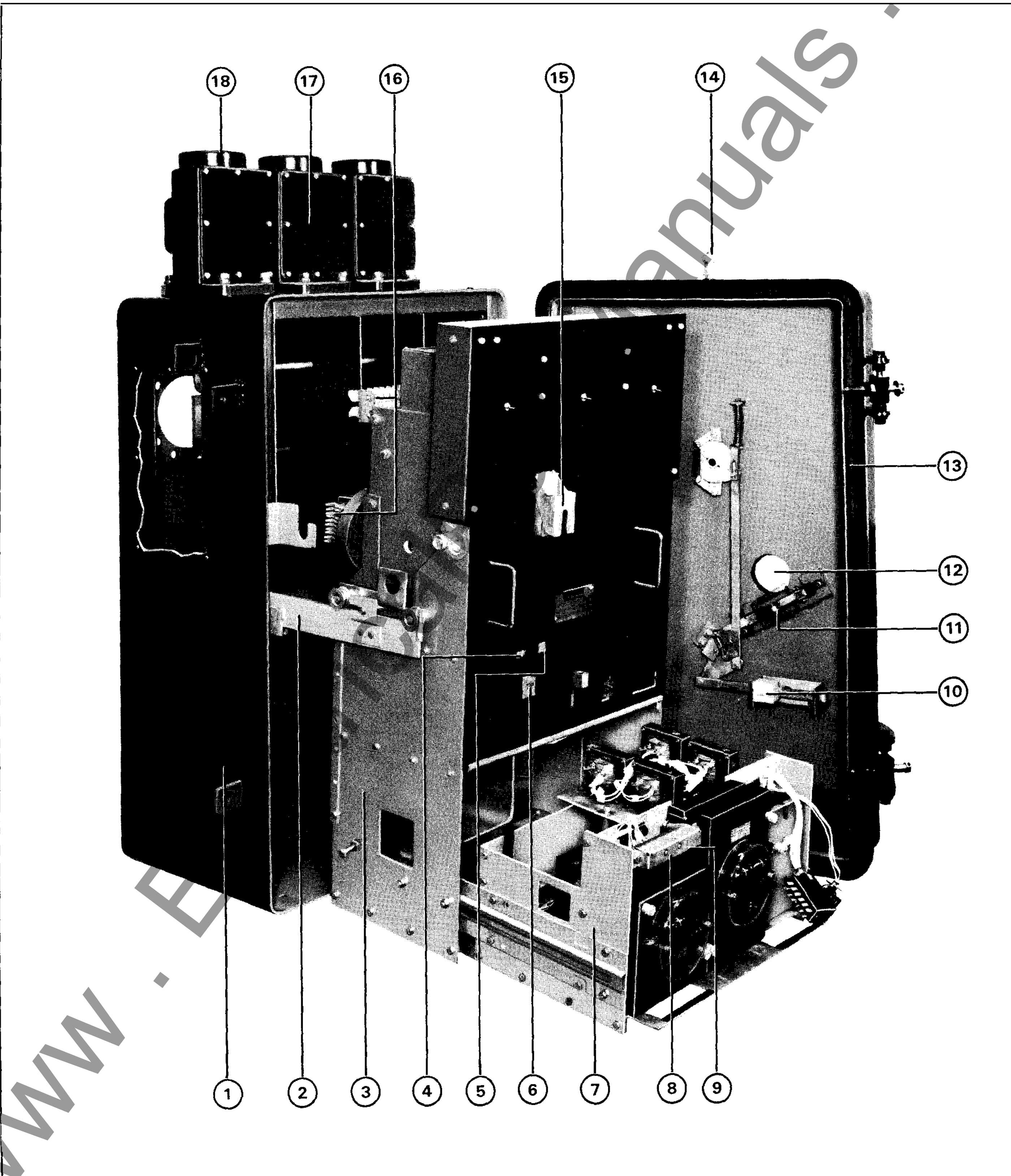
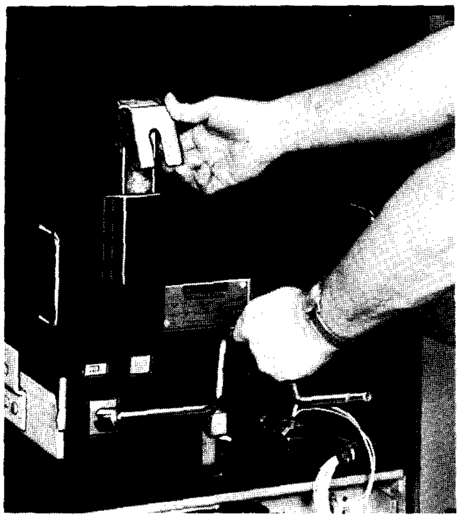
Design Features

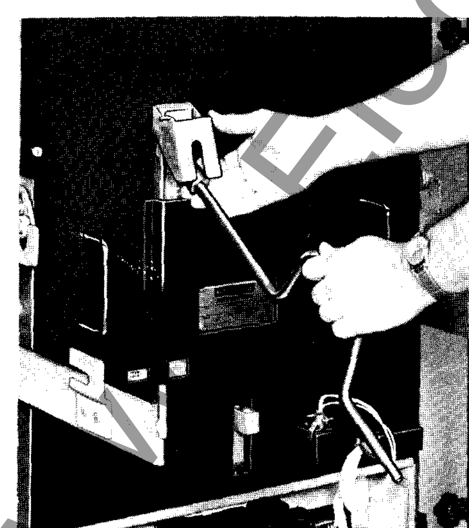


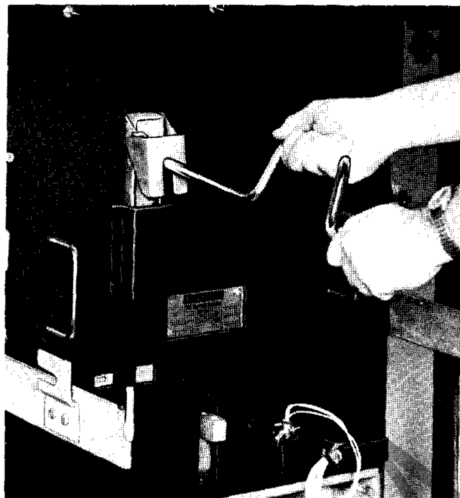
Design Features
The Westinghouse CMD is designed to improve the safety and reliability of network protectors on both spot networks and distributed grids. With present rollout type network protectors, removing the rollout unit from service involves unbolting energized network fuses and disconnect links. The Westinghouse CMD eliminates these operations.

Drawout Mechanism



The unique drawout design of the Westinghouse CMD makes it unnecessary for personnel to come into contact with energized parts when connecting or disconnecting the protector drawout unit. Special insulated tools or rubber gloves are not required to operate the drawout mechanism. With the drawout design, the front of the unit is covered by a protective steel barrier that cannot be removed until the drawout unit is levered-out. To gain access to the levering shaft, the manual trip button must be depressed and the shutter over the levering shaft must be raised to insert a special crank. The crank is held captive by the shutter until the drawout is fully disengaged. The protector breaker is held trip-free until the crank is removed thereby offering the maximum degree of safety. The drawout finger clusters remain on the drawout unit when it is removed from the protector enclosure.



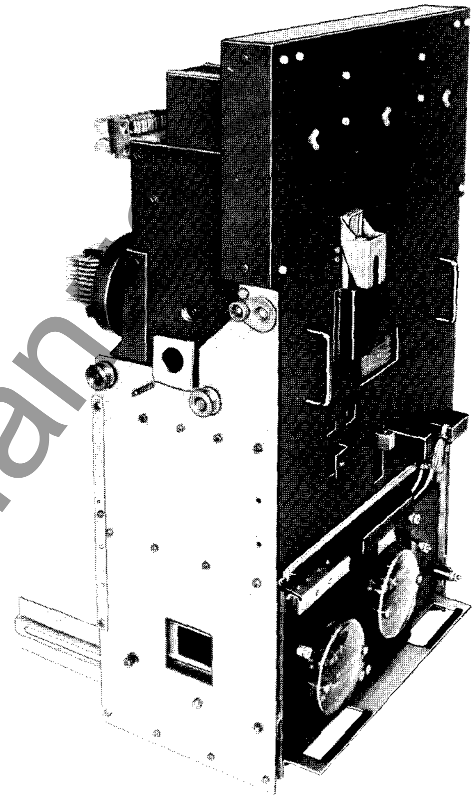


In addition to its safety advantages, the drawout design saves maintenance time. The Westinghouse CMD can be placed in or taken out of service in one-third of the time required by present rollout designs.

Spring-Close Mechanism
In the Westinghouse CMD Network Protector, the closing motor charges tension springs, the contact closing is controlled by a toggle-cam mechanism, which will not allow closure to begin until the springs contain sufficient energy to close and latch the contacts onto 25,000 amperes RMS symmetrical for an 1875A, CMD, 40,000 amperes RMS for a 2825A CMD.

With the Westinghouse CMD spring-close mechanism, the contact closing speed is independent of the speed of the spring-charging motor. The contacts either close and latch positively, or they do not attempt to close at all.

Modular Construction
The CMD drawout unit can be removed from its enclosure and returned to the service shop as a unit. It is equipped with lifting eyes and is designed to be free standing to facilitate storage and handling. Also, the three main components of the drawout unit —the pole unit module, the operating mechanism module, and the control module—are easily removable for replacement or repair.



The pole unit module, in the upper section of the drawout unit, contains three identical pole unit assemblies, each containing a contact system, arc interrupter, primary disconnect, current transformer, and supporting insulation. For maximum reliability of the unit, all phase-to-phase and phase-to-ground spacings of the power bus are one and one-half inches minimum.

The operating mechanism module, located in the middle section of the drawout unit, consists of an operating linkage and its tension springs, the closing motor (which charges the tension springs), and the direct trip actuator. Mechanism module is removable from the drawout unit as a complete assembly after disconnecting three pushrods and mounting hardware.

The control module is a slide-out assembly which can be removed from the drawout unit only when the drawout unit is withdrawn from the housing. It contains the motor auxiliary relay, auxiliary switches, phasing resistors, network relays, control and potential transformers for 480 volt operation, and the bulk of the control wiring. Complete removal permits interchangeability with a spare module for servicing on the site or in the repair shop.

For test purposes, the operating mechanism can also be charged manually to close the protector.

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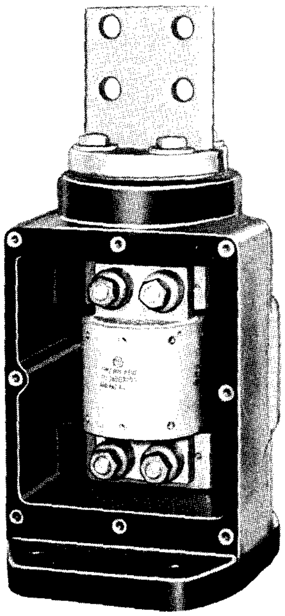
Externally-Mounted Silver Sand Fuses



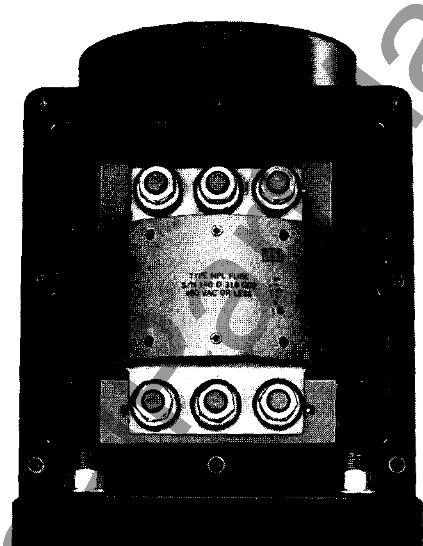
The Westinghouse NPL fuse provides back-up protection against possible relay or breaker malfunction, for faults on the primary feeder. This nonexpulsion silver-sand fuse, designed for use with the CMD Network Protector exclusively, matches the transformer safe-heating characteristics.

The fuses mount on top of the protector enclosure, in leak-tight molded epoxy housings which serve as stand-off insulators and terminal mounts. Locating the fuses outside the protector enclosure provides positive isolated fault interruption to assure the protection of the network bus. In the unlikely event of an internal fault in the protector or at the secondary bushings of the transformer, the fuse will operate and operate reliably to remove the unit from the network bus.

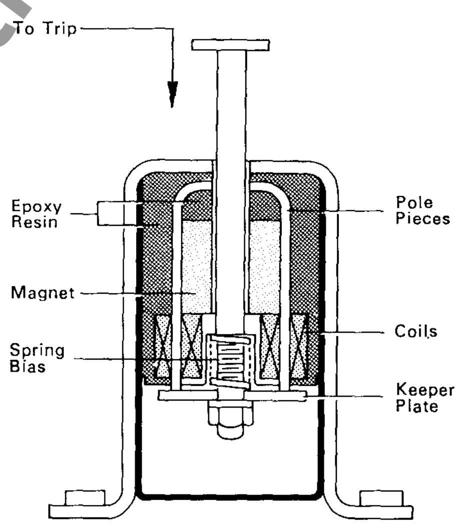
With the Westinghouse CMD and its NPL fuses there is no need for users to mount separate current-limiting fuses between the network protector and the network collector bus. Elimination of these separate fuses results in a substantial cost saving to the customer.

Although the external fuse housings isolate the fuses from the protector enclosure, a small vent hole between each fuse housing and the protector enclosure make it possible to pressure-test the enclosure and housings as a total assembly.

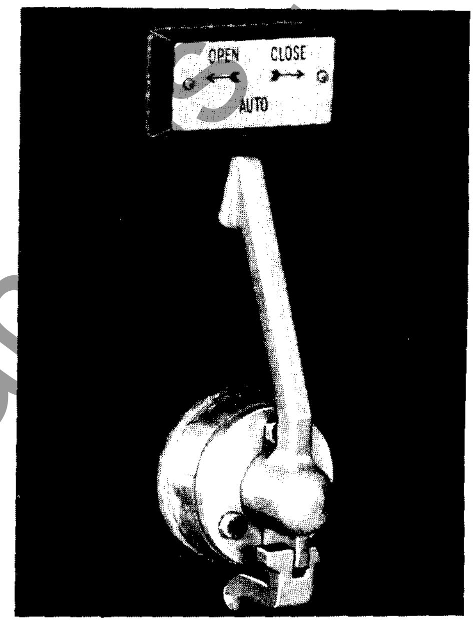
Located in the mechanism module, the Direct Trip Actuator operates on a flux-shifting principle to minimize wear and provide reliable tripping over the required range of tripping voltages (7.5%-106% of nominal). The actuator (shown in "protector closed" position) is held against the force of the bias spring, by a permanent magnet acting on the keeper plate. A trip signal from the CN-33 Master Relay energizes the coils wound around the pole pieces, shifting the magnetic flux and allowing the spring to drive the plunger down. The tripping force, generated entirely by the spring is independent of the tripping voltage.



Low-Energy Direct Trip Actuator



External Operating Handle



An external handle mounted on the enclosure door makes it possible to open or close the protector without opening the enclosure. The handle has three positions: OPEN, AUTO, and CLOSE.

When moved to the OPEN position, the handle trips the protector mechanically. The handle can be padlocked in the OPEN position.

When moved to the AUTO position, the handle operates an internal switch that places the protector under the control of the network relays. The handle can be padlocked in the AUTO position.

When moved to the CLOSE position, the handle operates an adjacent switch that closes the protector electrically. A spring returns the handle from the CLOSE position to the AUTO position, to return the protector to the control of the relays. The handle cannot be locked in the CLOSE position.

Anti-Close Device
The CMD Anti-Close Device prevents the protector from closing, either electrically or manually, if the trip contacts of the CN-33 master relay are closed. An auxiliary shunt trip, energized when the breaker is open and the master relay is calling for trip, opens the motor-closing circuit and holds the operating mechanism in the trip-free position. Thus, the protector cannot inadvertently be closed into an unsafe condition.

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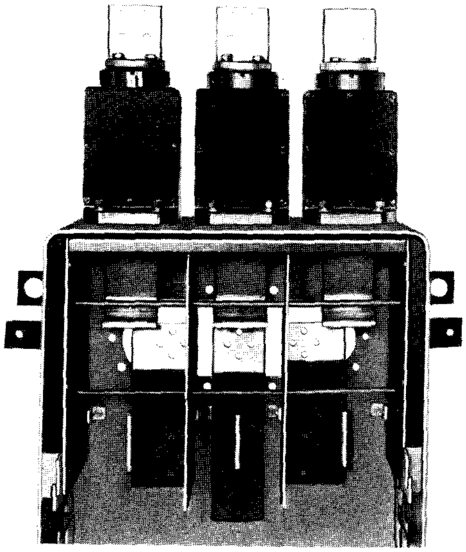
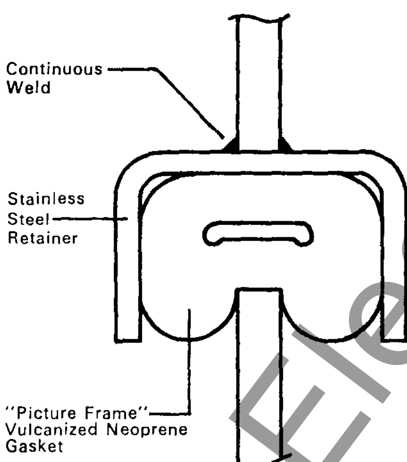
Barrier Insulation System



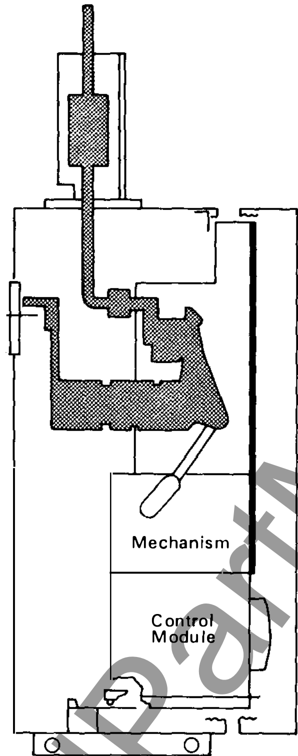
The individual pole units assemblies in the upper module are separated by Red Glass-polyester barriers extending from the front to the back of the enclosure. These barriers reduce personnel exposure during maintenance and provide additional reliability when the protector is in service.

Picture-Frame Door Gasket



A newly developed "picture-frame" door gasket mounted in a stainless steel retainer channel insures a water-tight seal on submersible enclosures. The one-piece gasket is cemented into a rectangular channel, which is continuously welded to the door. The channel provides a flat surface against which the gasket can seal with minimum pressure, prolonging gasket life, and adds rigidity to the door.

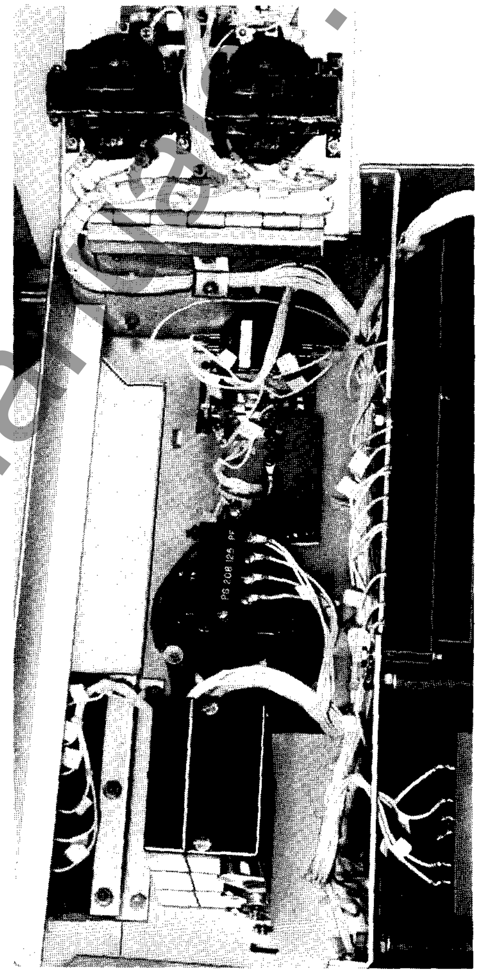
Reduced Current Path



The reduced and simplified current path through the CMD minimizes power losses and the possibility of faults on the bus. In transformer-mounted protectors (illustrated), the power bus is confined to the upper section of the protector, providing a minimum current loop and increasing personnel safety.

Control Module Details
The control module tray can be withdrawn from the drawout unit for inspection. Until the module is returned to its normal position the protector breaker is held trip-free. Control modules for use at 480Y/277 volts will be supplied with the necessary control and potential transformers to utilize class "H" insulated 216 volt relays. The modules are electrically connected to the protector mechanism through polarized plugs. For 216Y/125 volt protectors the control modules are supplied with interference plugs to prevent them from being connected to a 480Y/277 volt protector. All protectors will be factory wired with provisions for use with a remote trip and lockout scheme.

Teflon Insulated Control Wiring Harness



The Westinghouse CMD employs harness wiring, simplifying any rewiring that might become necessary throughout the life of the protector. The Teflon-insulated cable is rated 1000 volts and 200°C; this extra electrical and thermal margin provides long control wiring life. Teflon insulation is classified as "self-extinguishing."

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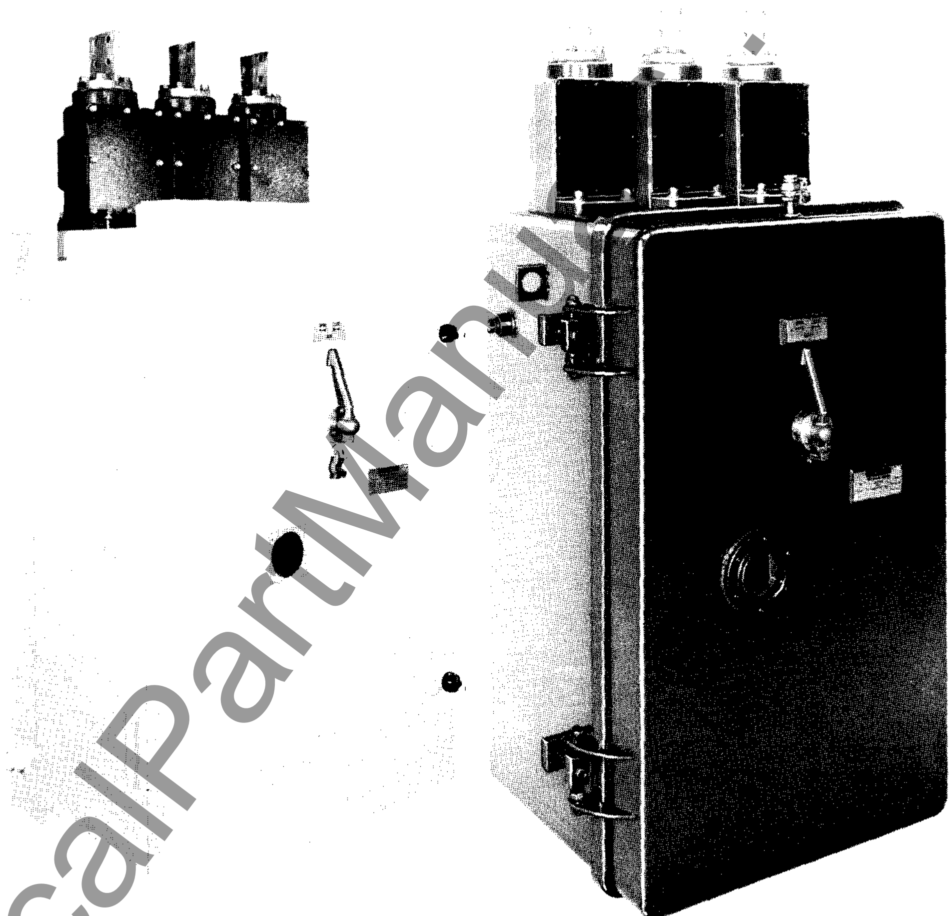
Choice of Enclosures and Mountings

The CMD Network Protector is available with two types of enclosures and in two mounting styles. For use above ground, or in vaults where no flooding occurs, a NEMA 1A semi-dust-tight enclosure is available. This enclosure will have a drip-proof top sheet. A waterproof, submersible enclosure is available for use in vaults, subways, and other locations susceptible to flooding. Each type of enclosure can be supplied for separate mounting or transformer throat mounting.

The mounting dimensions and terminal locations on the throat of the transformer-mounted units are those specified by NEMA Standard SG3.1-1962, reaffirmed 1971. Thus, the transformer-mounted CMD Network Protector will mate with any appropriately sized network transformer built with a NEMA standard low-voltage throat.



1875A NEMA 1A semi-dust-tight enclosure for transformer mounting

Submersible enclosure for transformer mounting

Available Ratings①

System Voltage	Protector Ratings	Interrupting Rating	Close and Latch Rating	Suggested Transformer Rating
216 V	1875 Amps.	30,000 Amps. RMS	25.000 Amps. RMS	500 KVA
480 V	1200 Amps.	30,000 Amps. RMS	25,000 Amps. RMS	750 KVA
480 V	1875 Amps.	30,000 Amps. RMS	25,000 Amps. RMS	1000 KVA
216 V	2825 Amps.	45,000 Amps. RMS	40,000 Amps. RMS	750 KVA
480 V	2825 Amps	45,000 Amps. RMS	40,000 Amps. RMS	1500 KVA

① The suggested transformer size associated with the above protectors is based on conventional electric utility practices for 125/216 and 277/480 Y-connected secondary networks.

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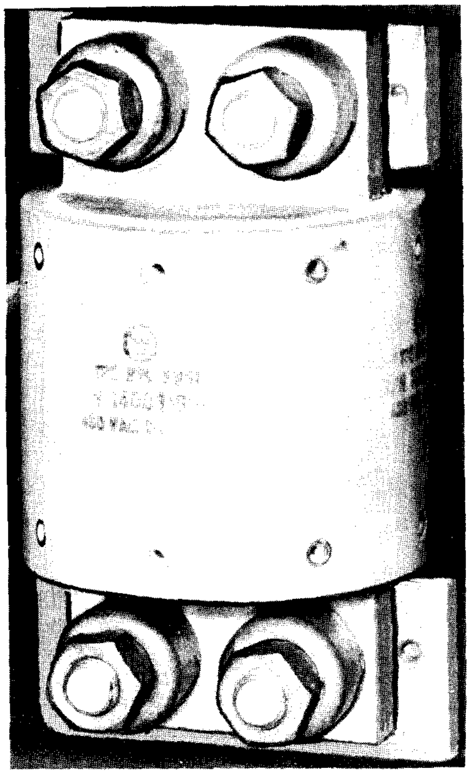
NPL Fuse

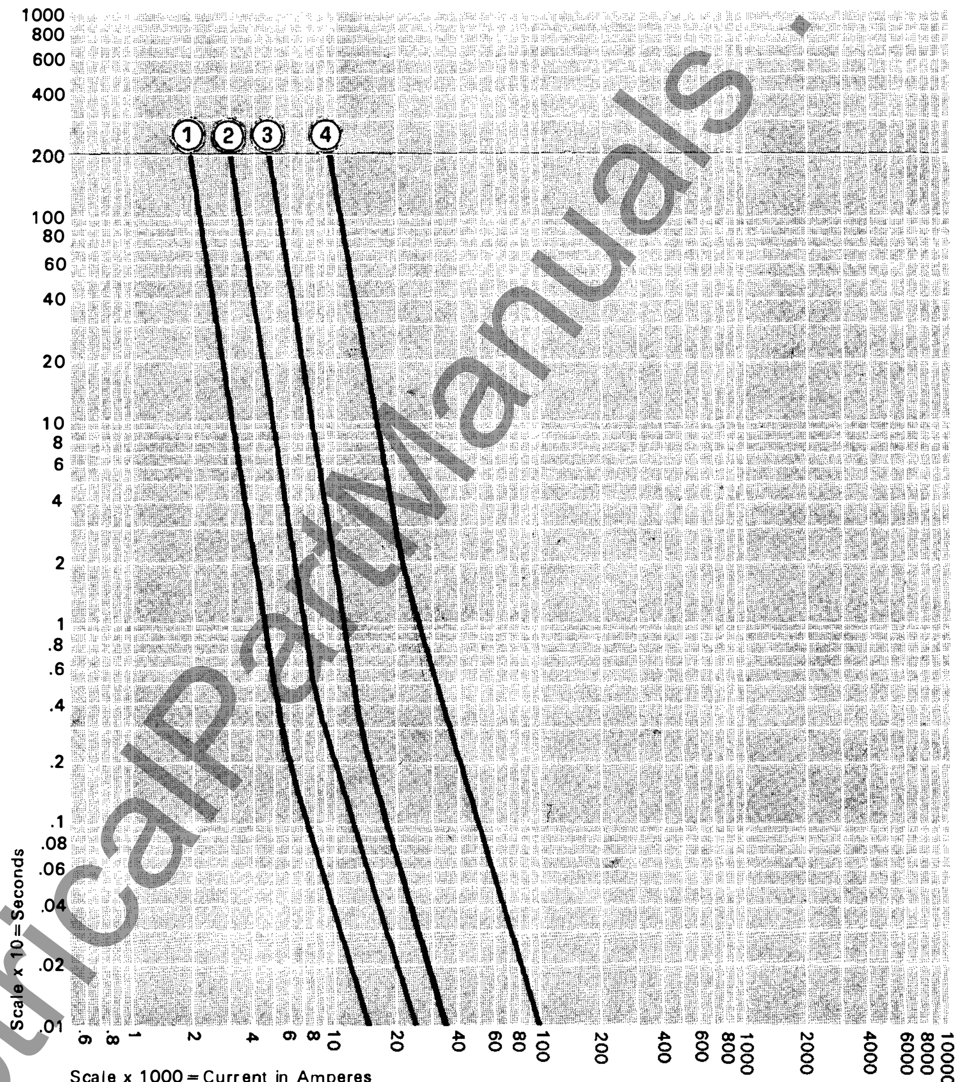


The NPL fuse has been designed as a non-expulsion, silver-sand type fuse. It is exclusively for use on the CMD network protector. Each end terminal is fabricated from high conductivity, impact extruded copper. High quality NEMA Grade G5 convolutely wound glass melamine tubing is permanently sealed to the terminal with RTV Silastic to eliminate possible sand leakage or moisture entry. The terminals and tube are secured together with stainless steel, high strength, spirally wound pins. All fuses are tested on an ultra-low resistance measuring instrument capable of resolving one-hundredth of a micro-ohm and evaluated on the basis of statistical probability techniques to insure uniformity.

Characteristics of the NPL fuse have been especially tailored for co-ordination with the transformer safe-heating curve and in consideration of the protector interrupting rating. This specially designed characteristic curve is less inverse than the ordinary melting characteristic of a silver-sand fuse. The curve is a function of the design of the unique, silver element used in its make-up.

The NPL fuse does not become current-limiting within the interrupting rating of the protector. The fuses have been successfully tested in its epoxy enclosure at a three-phase fault condition of 150,000 amperes at 600 volts.

Average Melting Curve of NPL Fuse



Curve No.*	Protector Current Rating	Fuse Style Numbers	Number of Mounting Holes in Fuse
216 Volts			
1	800	140D318G04	4
2	1200	140D318G05	4
3	1875	140D318G01	4
4	2825	140D318G02	6
480 Volts			
1	800	140D318G04	4
2	1200	140D318G05	4
3	1875	140D318G01	4
4	2825	140D318G02	6

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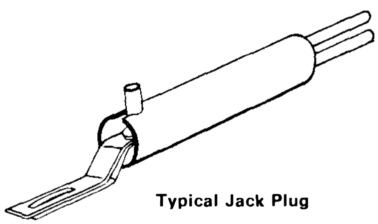
Relays
Each CMD protector will have the provision for mounting on its control module a CN-33 three-phase master relay, a CNJ single-phase phasing relay and provisions for mounting a BN desensitizing relay. The CN-33 and the CNJ together control the operation of the CMD so that:

1. The protector opens upon flow of reverse fault power:
2. The protector automatically recloses when conditions are such that power will flow into the network;
3. The protector will open upon flow of reverse magnetizing current of its associated transformer.

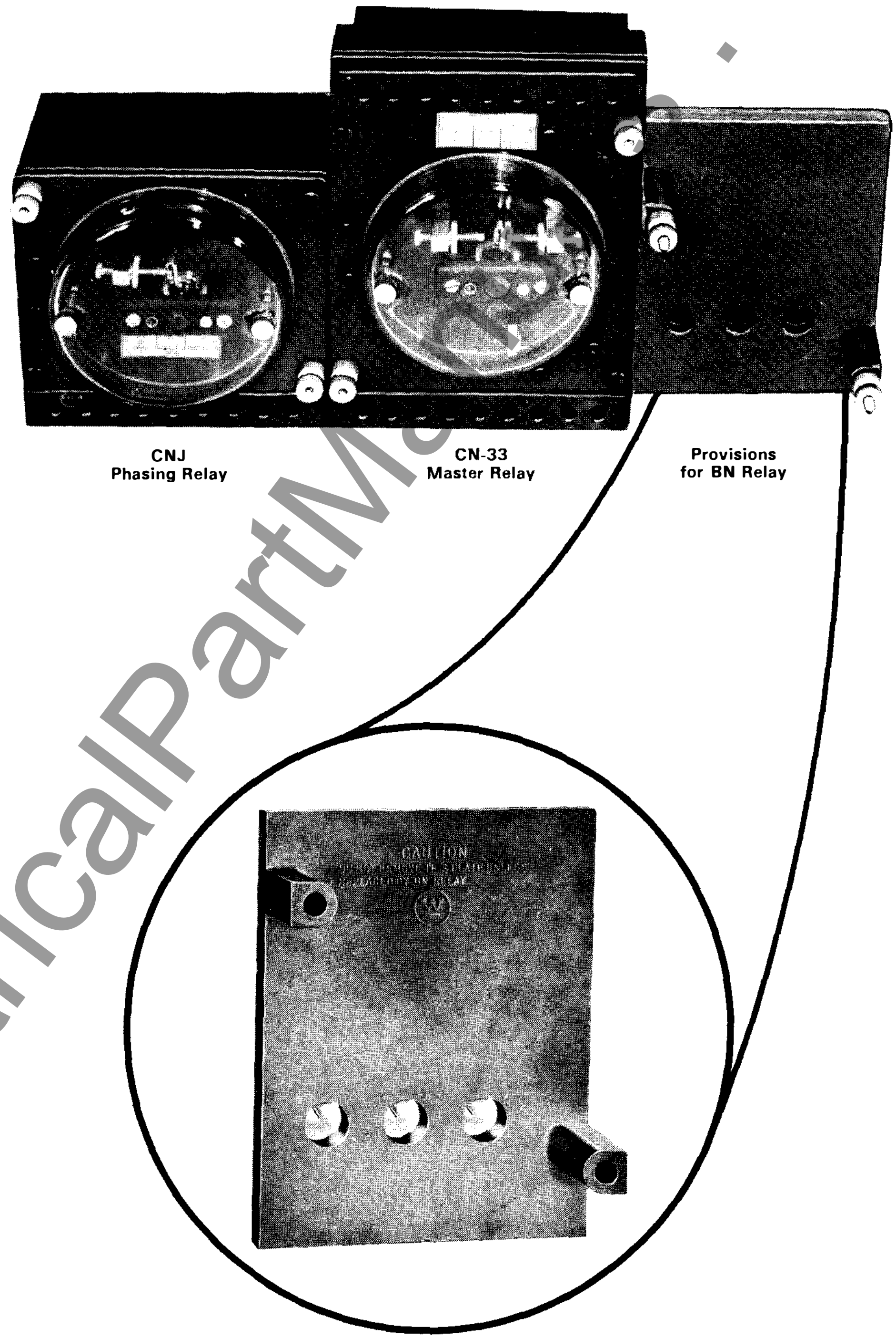
All CMD protectors will utilize 216 volt CN-33 and CNJ relays having Class "H" coil insulation.

A BN timing relay (optional) used in conjunction with the master and phasing relays prevents unnecessary protector operations caused by short duration, low magnitude power reversals.



Typical Jack Plug

Ammeter plate. Westinghouse type CMD network protectors can easily be adapted for instantaneous or recording type load checking. Pictured here is a connection plate equipped with three jack-type terminals. A jack plug, connected to the leads of a portable ammeter, can be inserted into one of the three jacks and phase current can be easily measured. Access to the "ammeter plate" is easy, whether in the quick-opening submersible housing or the ventilated protective housing.



CNJ Phasing Relay | **CN-33 Master Relay** | **Provisions for BN Relay**

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Type CN-33 Master Relay
The type CN-33 relay is a three-phase induction relay having three separate electromagnets acting on a single aluminum drum carried on a short horizontal shaft. The three electro-magnets are located radially and equally spaced about the drum with the potential coil and iron assemblies inside the drum and the current and phasing coil and iron assemblies outside the drum. The potential and phasing circuits cooperate when the protector is open to control the making of the master relay "closing" contacts. The potential and current circuits cooperate when the protector is closed to control the making of the master relay "tripping" contacts. The relay contacts are made of pure silver and are arranged for single-pole, double-throw operation.

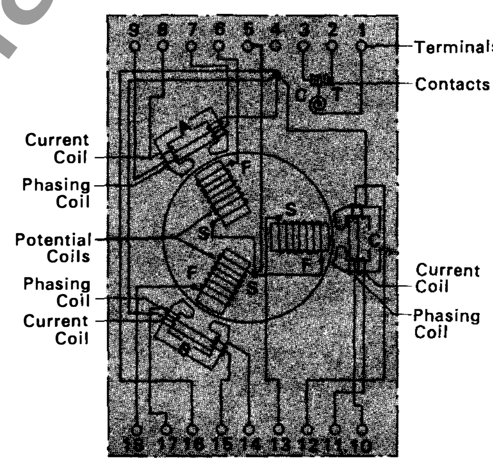
Chassis and Case Assembly. The entire assembly of electro-magnets, moving element, contacts and terminals is mounted on a single, flat steel plate. This plate bolts onto the front of the cast relay base which completely encloses all parts of the relay which are mounted behind the plate. The drum shaft extends through a hole in a moulded insulation plate located on the flat steel plate. One of the bearings for this shaft is located behind the steel plate and one in front of it. These bearings are of the knife-edge type, made of tool steel with the knife edges extending upward to prevent any accumulation of dirt between the bearing surfaces. The moving contacts of the relay are carried directly on that portion of the moving element shaft which extends through in front of the mounting plate, thus eliminating all gears from the relay. The stationary contacts and the stop screw which engages the reverse current adjusting springs are mounted on the front of the moulded insulation plate carried on the flat steel mounting plate. A shallow glass cover is mounted over the moulded insulation plate to protect the pure silver relay contacts, reverse current adjusting springs, and front bearing of the moving element shaft.

Permanent Magnets. In addition to the electromagnets and drum, two small permanent magnets for damping the movement of the drum are carried on the back of the mounting plate where they are protected by the relay base from dust, dirt and other foreign particles even when the glass cover of the relay is removed. These permanent magnets and a solid stop on the moving element, which limits the movement of the drum to a relatively small angle, prevent bouncing of the relay contacts.

Terminal Blocks. Moulded insulation terminal blocks are mounted on the two ends of the mounting plate. Silver tipped screws pass through threaded holes in small brass plates which are soldered on the ends of the relay coils and slipped into slots in the moulded blocks. These screws extend on through the terminal blocks and holes in the relay base where their silver tips engage with silver plated copper jaws backed up by steel springs located in moulded insulation terminal blocks mounted on the protector. These screws serve as plug or jack type connections, between the relay and protector wiring, but they are not used to mount the relays.

Mounting. The relay is mounted on two studs and held securely in place by two thumb nuts which when tightened, force the terminal screws firmly into engagement with their associated jaws. The heads of all terminal screws are accessible from the front of the relay. When screwed down in their normal position, the heads are completely surrounded by part of the moulded terminal blocks through which they pass. This minimizes the possibility of accidental contact with, or shorting between, screws. By partially removing the proper terminal screw or screws any circuit or circuits between the relay and protector can be opened. Before the head of the screw becomes flush with the surface of the terminal block, the circuit is opened. The screw remains connected to its associated relay circuit, however, even after it is backed out until its head extends above the surface of the mounting block so that a test clip can be connected to it under the screw head arranged for that purpose. This construction allows the terminal screws to be used as test switches and greatly facilitates testing and adjusting the relay when mounted on the protector. The relay can readily be mounted on or removed from the protector without disturbing any leads and without any possibility of connecting it improperly merely by removing the two thumb nuts from its mounting studs. After the relay has been taken off the protector, it can be completely removed from its base for inspection and maintenance without disturbing any parts or wiring details by removing the two screws which hold the steel mounting plate on the front of the base.

Type CN-33 Master Relay
internal connection wiring diagram



Rear View

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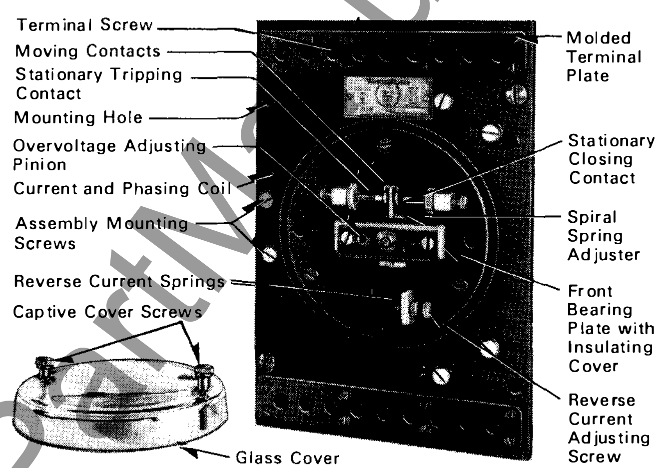
Operation

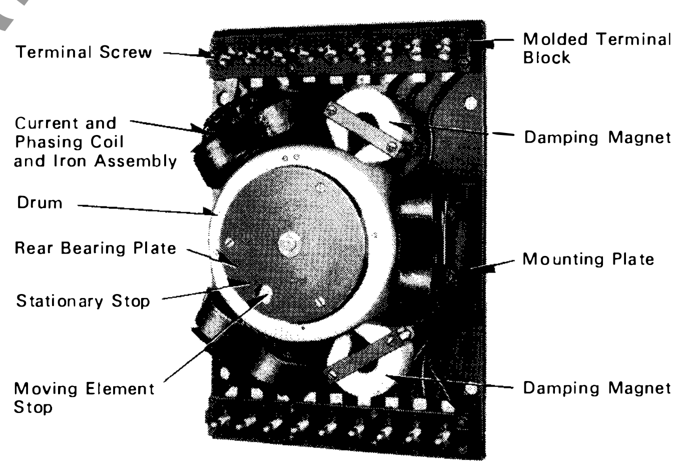
Adjustments. There are but two adjustments to be made on the type CN-33 relay, namely, the over-voltage adjustment and the reverse current adjustment. When the relay is completely de-energized the moving contact is held firmly against the stationary closing contact by means of a spiral spring around the moving element shaft. The inner end of this spring is fastened to the moving contact arm and the outer end is fastened to a spring adjuster which is carried on the front of the circular moulded insulation plate. This spring adjuster is of the friction type which has been used on many Westinghouse induction relays for years. Gear teeth on the adjuster engage a pinion, the insulated shaft of which extends through a hole in the front bearing plate. The spring tension is easily adjusted by rotating the pinion with a screwdriver without danger of grounding the spring assembly. This adjustment is located under the glass cover to prevent unauthorized changing of adjustments. By this method a continuous overvoltage adjustment having a range of approximately .75 to 3.2 volts 60° leading or .5 to 2.0 volts in phase with the network voltage, is obtained.

Three flat springs, placed side by side, are carried on the moving contacts. These, in conjunction with an adjustable thumb screw stop which can be located in any one of three tapped holes in its mounting block so that it will deflect one, two or all three of the springs, provide a continuous range of in-phase reverse current adjustment from about 0.1 to 10 per cent of the protector current transformer rating in amperes.

Closing Characteristics. Pages 14 and 15 show the operating characteristics of the type CN-33 network master relay. Curve No. 1 shows the closing characteristics of the relay. Lines drawn to it from the origin at various angles with the network voltage represent in both magnitude and phase position the transformer voltages which will produce a torque in the relay just sufficient to cause its closing contacts to make. The closing contacts will also make and connect the transformer to the network if the transformer voltage terminates above the closing curve. Any transformer voltage which does not terminate on or above the closing curve will produce a relay torque in the tripping direction which prevents the closing contacts from making and the network protector will remain open. The Curve No. 1-A in the same figure shows a small section of the closing curve plotted to a much larger scale so as to show the characteristics of the relay for the values of phasing voltage at which it normally operates. Lines drawn from the origin to this curve represent in magnitude and phase position the phasing voltage, that is, the voltage across the open contacts of the network protector necessary to produce a torque in the relay just sufficient to make its closing contacts. The upper end or line potential end of the network voltage vector is at the origin in this case. The network voltage vector cannot be shown in its true relation to this curve because of the large scale to which the curve is plotted. It will be noted by referring to Curve No. 1-A that the relay will just close its closing contacts with approximately 0.8 volt across the phasing circuit in phase with the network voltage. When the phasing voltage leads the network voltage by 60° it requires about 1.0 volt to close the closing



Type CN-33 Network Master Relay—front view with glass cover removed.



Type CN-33 Network Master Relay—rear view of relay removed from base.

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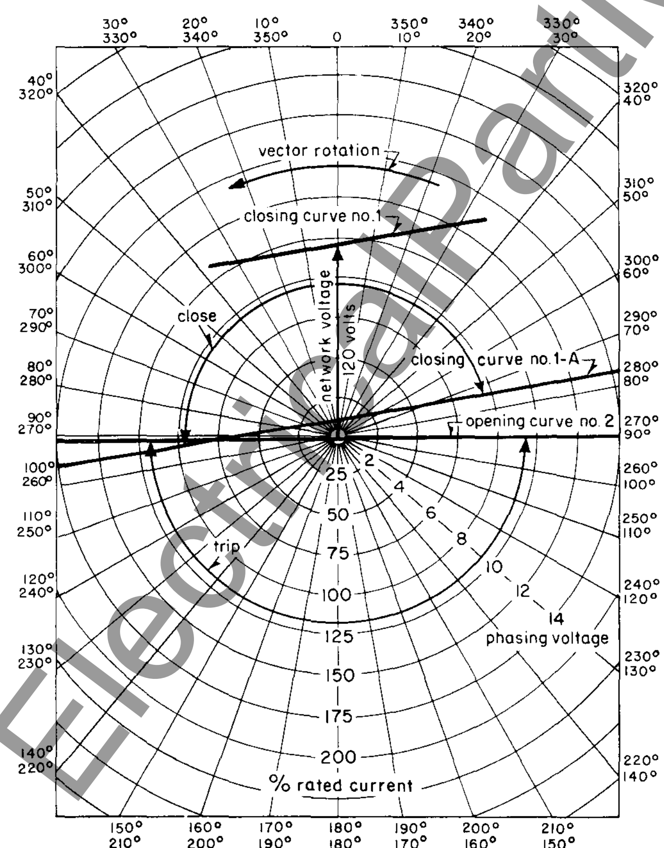
contacts. This voltage at 60° leading, however, means only a small angle between network and transformer voltages. This can readily be appreciated when it is pointed out that 10 volts across the phasing circuit leading the network voltage by 90° will throw the network and transformer voltages less than 5° out of phase.

Opening Characteristics. The opening or tripping characteristics of the type CN-33 relay are shown by Curve No. 2. Lines drawn from the origin to Curve No. 2 represent in magnitude and phase position the line currents which will produce a torque in the relay just sufficient to cause its tripping contacts to make. The tripping contacts will also make and disconnect the transformer from the network if the line current terminates below the opening curve. If, however, the line current does not cross the opening curve but terminates above it, the relay will close its closing contacts and maintain them closed as long as the line current amounts to one or two per cent of the protector rating. The curve shown on page 15 represent a small section of the opening curve just discussed plotted to much larger scales in order to show the operation of the relay on small current values, such as the magnetizing currents of network transformers. The magnetizing current of a 300 kva transformer bank will be about 12 amperes per phase minimum at 120 volts, and will lag the network voltage reversed between 60 and 70 degrees. A network protector rated at 1200 amperes would be used with such a bank, and it will be seen by referring to the opening curve that the relay will operate satisfactorily to trip the network protector when exciting current only is flowing.

On systems where the voltage of the primary feeders is fairly high, such as 11,000 volts or above, the charging current of the high tension feeder cables must be considered. When the station breaker is open this charging current will flow through the network transformer bank. In such cases, therefore, the current on which the relay must operate is not the magnetizing current of the transformer bank alone, but the vector sum of the magnetizing current and that part of the feeder charging current which flows through the associated protector. When the charging current predominates over the magnetizing current, the current on which the relay must operate is a leading reversal rather than a lagging reversal. By referring to the opening curves discussed, it will be seen that the relay will operate equally as well on leading reversals as on lagging reversals, provided the leading reverse current does not exceed approximately 250% of the rating of the protector, even if the current is almost 90° out of phase with the network voltage reversed.

For special system conditions that may be encountered in non-dedicated feeder applications, where the network transformers are wye-wye connected and/or single-phase protective devices are used on the primary feeder, many users prefer that the CN-33 relay be connected to exhibit the watt-var tripping characteristic. Under balanced three-phase conditions, the watt-var relay develops maximum tripping torque when the current leads the network line-to-line ground voltage by approximately 120 degrees. A network protector should have the fastest possible tripping time when used in a spot network which is fed from non-dedicated primary feeders because the protector must coordinate with primary system protective devices. Since the tripping time of the watt-var relay for most situations is faster than that of the watt relay, use of the watt-var relay usually makes possible the desired level of coordination.



Curves No. 1, No. 1-A and No. 2: Closing and tripping characteristics of the type CN-33 network master relay. Balanced three-phase conditions assumed.

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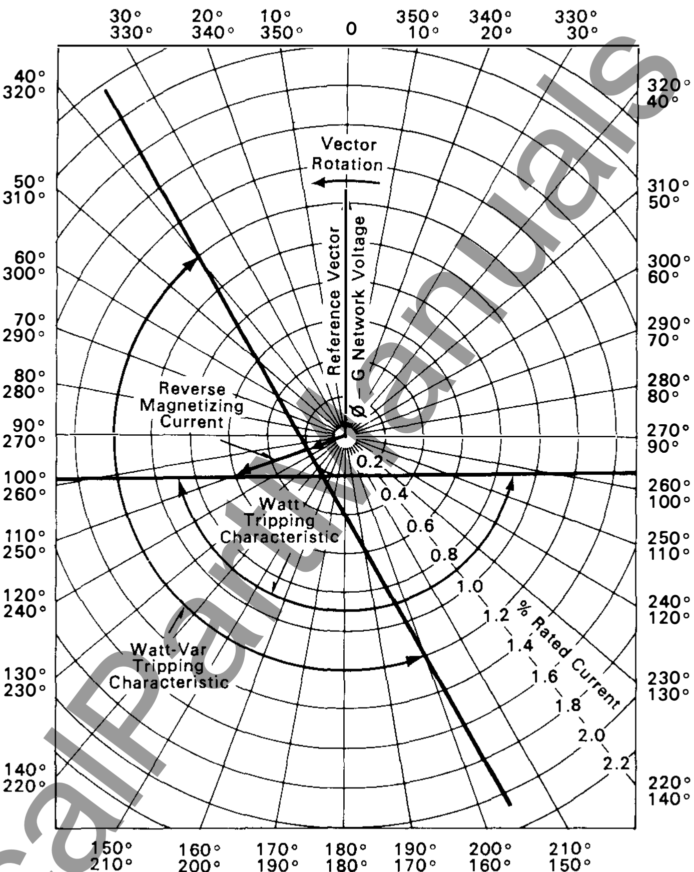
The magnitude of reverse current needed to activate the CN-33 tripping contact is adjustable from .1 percent to 10 percent of protector rated current. The curve below shows the two tripping characteristics (watt or watt-var) that can be exhibited by this CN-33 relay. Under balanced three-phase conditions, the watt relay develops maximum electrical torque in the tripping direction when phase current leads the network phase-to-ground voltage by approximately 180 degrees. The watt characteristic is standard and will be satisfactory for the majority of applications.

Type CNJ Phasing Relay

The type CNJ relay is a single-phase induction drum relay having two operating circuits—a potential circuit and a phasing circuit. It is equipped with single-pole, single-throw contacts which are held closely by means of a spiral spring when the relay is completely de-energized, just as are the closing contacts of the type CN-33 relay. The contacts of the phasing relay are connected in series with the closing contacts of the master relay. Therefore, in order to close the protector both relays must close their closing contacts. The phase angle characteristics of the type CNJ relay are such as to prevent the network protector from closing when the phasing voltage and the voltage of its associated transformer lag the network voltage appreciably. This is necessary to prevent pumping, that is, periodic closing and tripping of the protector without any change in load and voltage conditions on the system, other than those produced by the operation of the protector. An adjustment is provided to change the phase angle characteristics of the relay by means of changing taps on a resistor connected in series in the potential circuit and mounted in the case of the relay. This phase angle adjustment will not be used often, but will be found very convenient when needed and has been obtained with practically no complication of the relay. Only one other adjustment is provided in the phasing relay. This is the over-voltage adjustment, which is similar to that used on the master relay.

Construction. The CNJ relay is very similar in mechanical construction to the master relay and uses the same moving element and bearing construction. It has only one moulded insulation terminal block located in the lower end of the steel mountnig plate. The terminal construction is the same as that employed on the type CN-33 relay.

CN-33 Tripping Characteristics—with balanced three-phase conditions assumed



Operating Characteristics. The curves on page 16 show the normal operating characteristics of the type CNJ relay. The relay may be adjusted to have closing characteristics similar to any one of the four curves shown (no. 6, no. 7, no. 8, or no. 9). The network voltage, which is the voltage from ground to line "A" on the network side of the protector, is shown with the line potential end of the phasor at the origin. This voltage phasor could not be shown in its entirety because of the large scale used. Lines drawn from the origin to one of the curves represent in both magnitude and phase position the phasing voltages which will produce a torque in the relay just sufficient to close its contacts. Any phasing voltage which does not terminate on or to the left of the curve in the zone marked "close" will produce a relay torque to maintain the relay contacts open.

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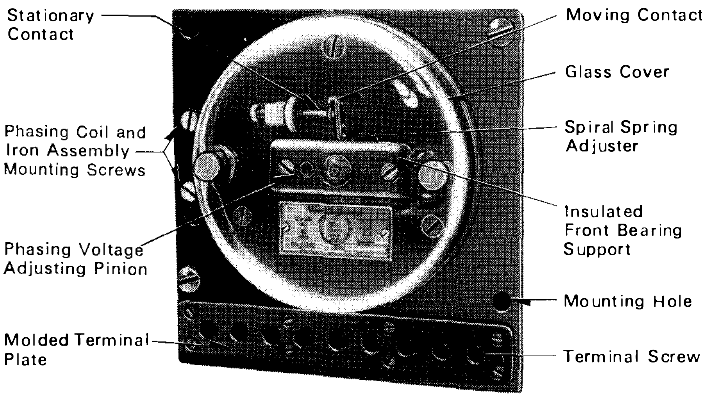
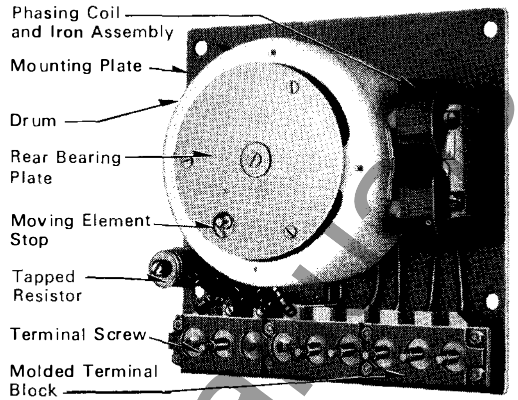
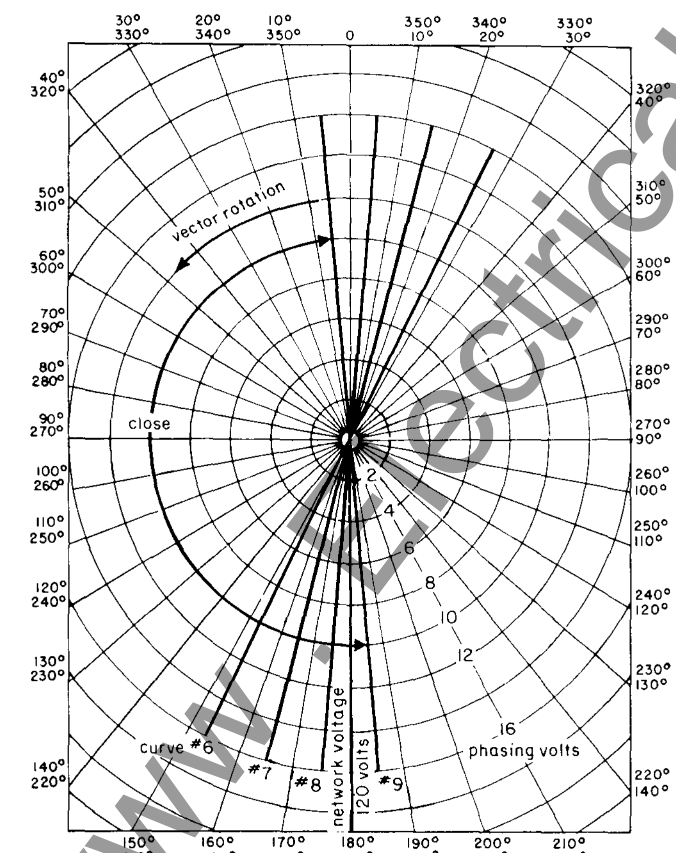


Type CNJ Network Phasing Relay—Front view with cover on.



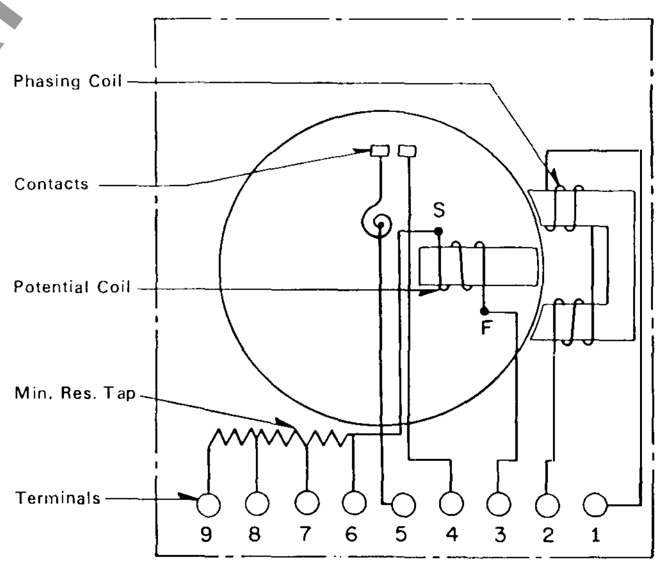
Type CNJ Network Phasing Relay—Rear view of relay removed from base.

It will be noted that the relay will keep its contacts closed when the phasing voltage is reduced to zero if a closing adjustment is used similar to that used when these curves were taken. The curves may be shifted parallel to themselves either to the right or left by means of the spring adjuster, however, if this is found to be desirable. The relay is connected in the factory to have a characteristic similar to that shown as curve no. 8 and given a similar adjustment. Any of the closing characteristics shown by curves no. 6, no. 7, no. 8 and no. 9, can be obtained by placing the terminal screw in any one of the terminals 6, 7, 8 or 9 shown in the wiring diagram. For example, if the terminal screw is placed in terminal 8 the relay will have closing characteristics as shown by curve no. 8.



Closing Characteristics of the Type CNJ Network Phasing Relay.

Internal Connection Wiring Diagram



Rear View

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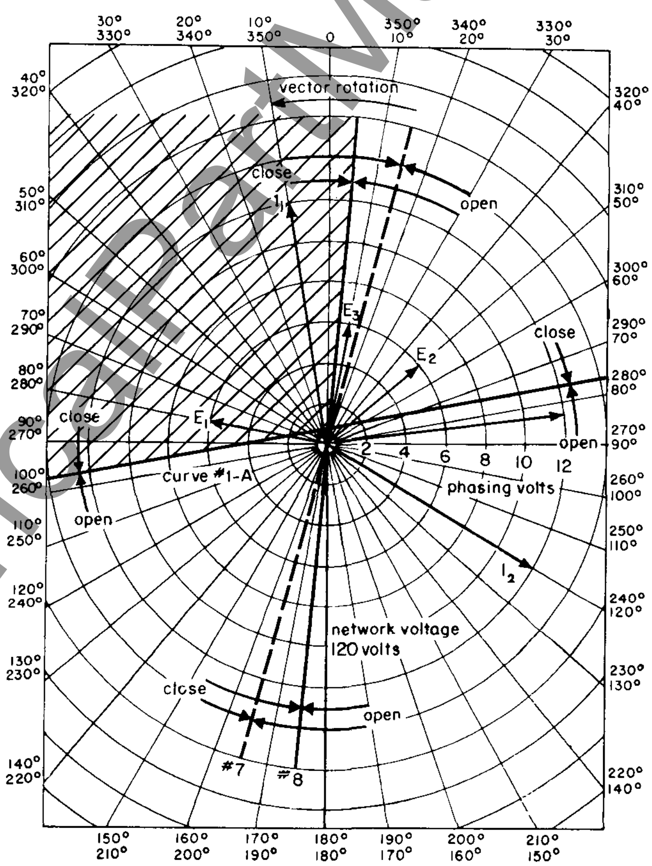
Co-ordinated Operations of CN-33 and CNJ Relays. The operation of the type CNJ relay in conjunction with the type CN-33 relay can best be explained by referring to the curves on page 17 which illustrate the closing characteristics of both the CNJ and CN-33 relays. Curve 1-A illustrates the closing curve of the type CN-33 relay, which is discussed in the instructions relating to the type CN-33 relay, and curve no. 8 illustrates the closing curve of the type CNJ relay. The area which lies in the "closing" zone common to both of these two curves is shaded. Thus a phasing voltage, such as E_1, which terminates in this shaded area will cause the type CNJ relay to make its contacts and the type CN-33 relay to make its closing contacts and thus cause the network protector to close. The current which will flow through the protector when it closes will lag the phasing voltage across the open protector by an angle approximately equal to the impedance angle of the system, and for a particular system this current may be as shown by the vector I_1. By noting the position of I_1, with respect to the network voltage and referring to curve no. 2 on page 14, it will be seen that such a current will keep the type CN-33 relay closing contacts closed and thus the operation of the network protector will be stable. A phasing voltage such as E_2, however, if the protector were manually closed, would cause a current I_2 to flow through the protector; and by referring again to curve no. 2 on page 14, it will be seen that this current would cause the type CN-33 relay to make its tripping contacts. The phasing voltage E_2, lying on the closing side of the curve no. 1-A, causes the type CN-33 relay to make its closing contacts. Thus, if the CN-33 relay alone controlled the network protector, the protector would pump under this condition. The type CNJ relay will not close its contacts, however, when acted upon by a phasing voltage such as E_2; and since the contacts of the two relays are connected in series and must be closed at the same time in order to allow the network protector to close, it will be seen that the type CNJ relay prevents pumping due to phasing voltages which appreciably lag the network voltage. It may be similarly shown that the closing characteristics of the type CN-33 relay prevent pumping from occurring when the phasing voltage leads the network voltage by more than 90°. It should be noted that the closing curve of the type CN-33 relay is such as to prevent the protector from closing under crossed-phase conditions, while the type CNJ relay used alone would allow the protector to close under certain crossed-phase conditions.

Under certain conditions a fairly large and very low power factor load may be carried by adjacent network protectors and cause the phasing voltage E_3 to exist across the protector under consideration. It will be seen, since this phasing voltage E_3 falls on the opening side of curve no. 8, that under this condition the phasing relay would prevent the protector from closing. In the event it is desirable to have the protector close so that its associated transformer can assist in carrying the load, curve no. 7 may be used for the type CNJ relay so as to allow the protector to close if such a change in characteristics will not cause pumping. It is to take care of such more or less special cases that the tapped resistor is provided in the phasing relay to change its closing characteristics.



Combined Closing Characteristics of the Types CN-33 and CNJ Network Relays.

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Type BN De-Sensitizing Relay

The type BN relay consists essentially of a thermal timing element and three overcurrent elements. The contacts of the timing element and the contacts of the three overcurrent elements are all in parallel.

All elements of the BN relay are mounted in a single, quick-detachable case with plug-type terminals similar to the Master and Phasing relays. When removed, it must be replaced with an auxiliary panel that completes the current and control circuits.

The instantaneous trip elements are small solenoid-operated contactors that can be adjusted by varying the position of their contacts and cores to operate at approximately 100 to 200 per cent of the protector rating in amperes.

The timing element consists of a bimetallic actuating spring and heating transformer. Its motion is opposed by a second piece of bimetal that supports a stationary contact and provides ambient temperature compensation. Operating time is varied by limiting the travel of the moving contact between adjustable top and bottom stationary contacts. The entire operating cycle employs both heating and cooling times of the bimetallic element so as to reduce errors that would otherwise result from the cumulative heating effects of successive operations. This is accomplished by an auxiliary relay, as shown in the wiring diagram.

The timing element introduces a time delay in the tripping operation of the protectors for low values of reversed current such as may occur because of fluctuating loads. The overcurrent elements permit tripping of the protector without intentional time delay for high values of reverse current such as will occur for faults in the network transformer or its associated primary feed.

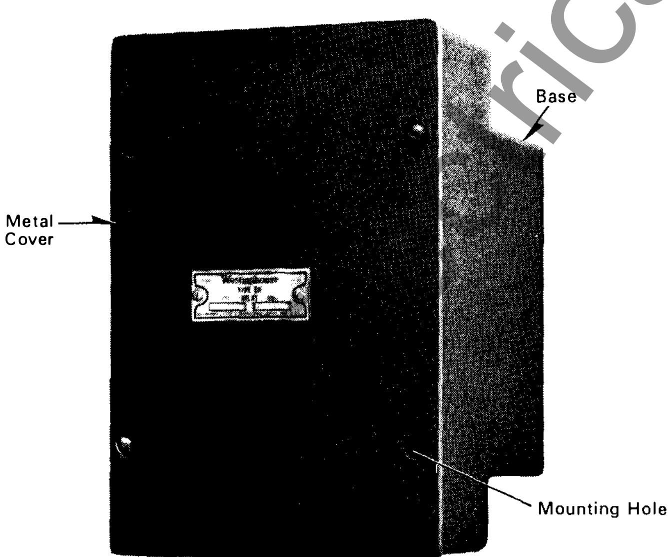
Operation. The paralled contacts of the timing element and the overcurrent elements are in series with the CN-33 master relay tripping contacts in the trip coil circuit as shown on page 19.

When the master relay tripping contacts are closed by a small value of reversed current, the timing element is energized. After a time delay of one to five minutes, determined by the adjustment of the thermal element, the timing contacts close and complete the circuit to the trip coil. The protector then trips, if the CN-33 trip contacts are still closed. If the CN-33 contacts open at any time during the time delay introduced by the thermal element of the BN relay, the timing is interrupted and the thermal element resets. Thus for momentary reversals of power through the protector, tripping is delayed so that many operations of the protector are avoided.

If the reversed current in any one or all of the poles of the protector exceeds the pick up setting of the corresponding instantaneous overcurrent elements in the BN relay, the circuit to the trip coil will be completed as soon as the CN-33 tripping contacts close. This provides fast operation of the protector for high values of reverse current which occur under fault conditions. The overcurrent elements can be set to pick up for currents above 100 to 200 per cent of the rated current of the protector.

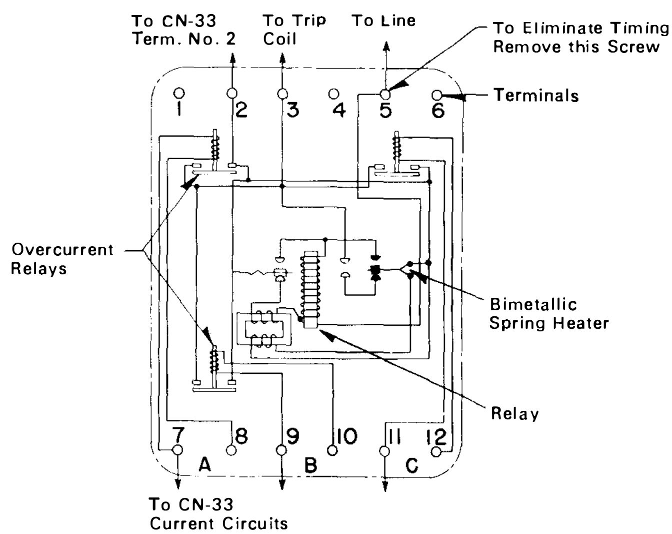
Sensitive tripping with time delay can be eliminated, if desired, by removing only the no. 5 terminal screw of the BN relay and substituting a dummy screw. The protector will then trip only when the totalized power through the protector is in the reversed direction and the current in at least one-pole exceeds the setting of the overcurrent elements.

Mounting. The standard type CM-22 network protector is supplied with a type CN-33 relay and a type CNJ relay and is provided with the necessary wiring and mounting facilities for the type BN relay so that this relay can be easily installed on the protector at any time should the need for it develop, by merely removing the terminal panel and plugging in the BN relay.



type BN desensitizing relay—front view with cover on.

Internal Connection Wiring Diagram



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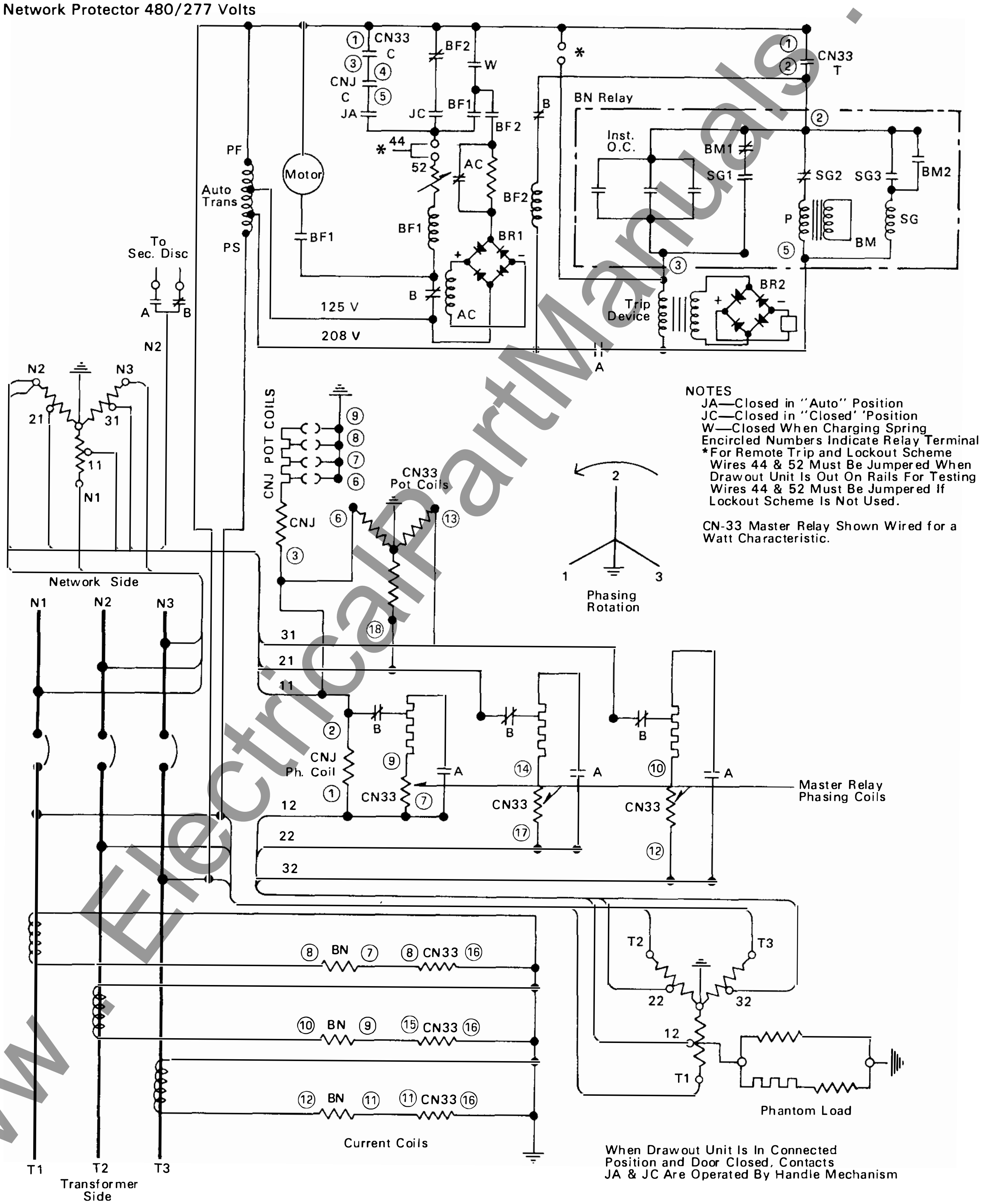
Typical Schematic Diagram—
CMD Network Protector 480/277 Volts



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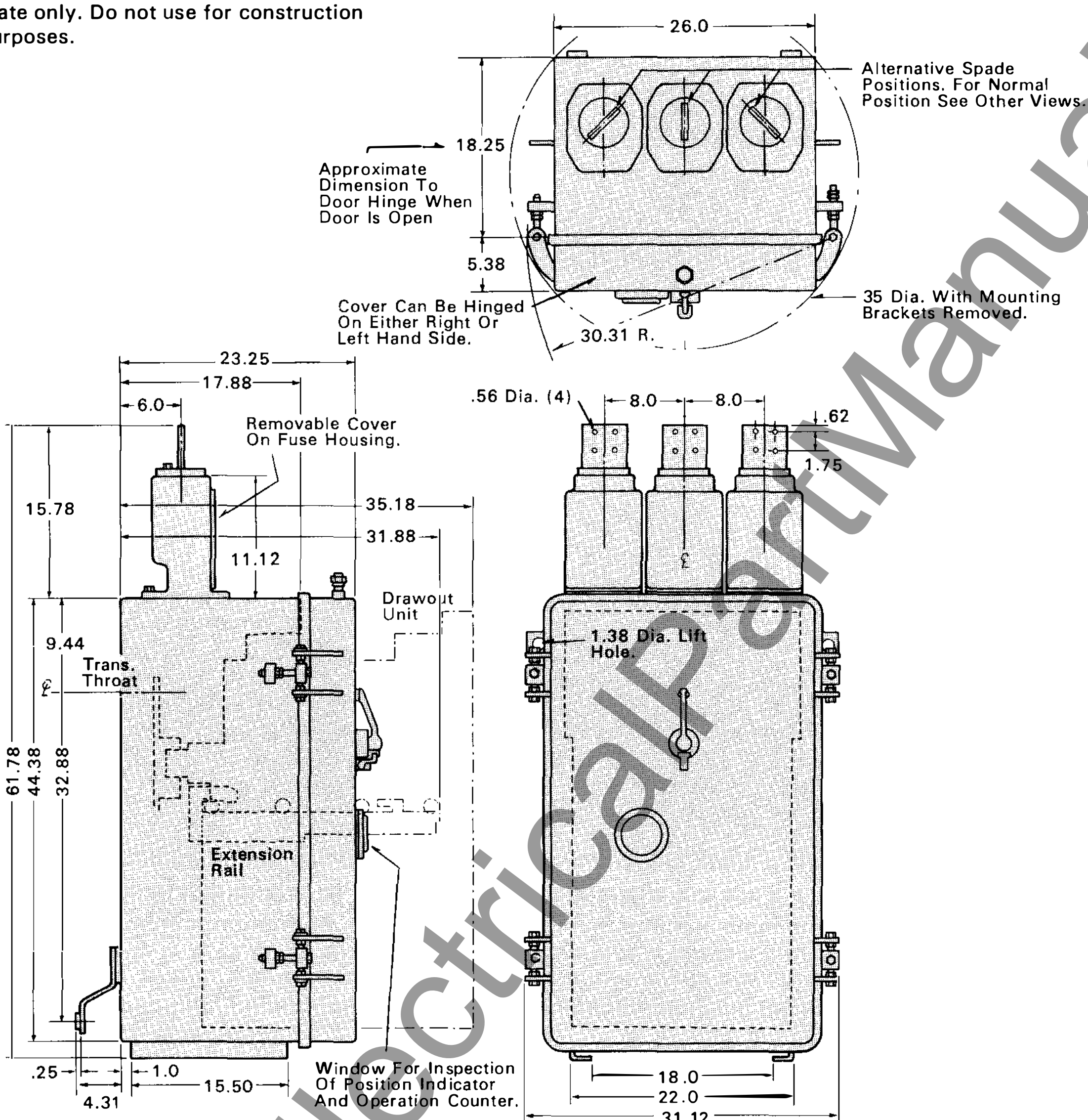
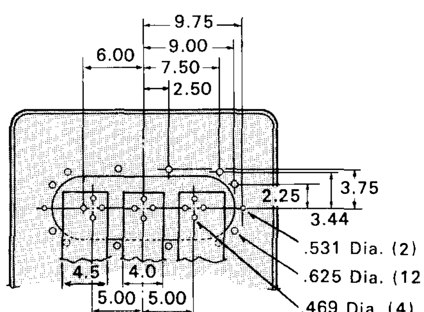
Dimensions in Inches
1200 and 1875 Amperes, transformer mounted, submersible enclosure. Approximate only. Do not use for construction purposes.





View Into Open Housing

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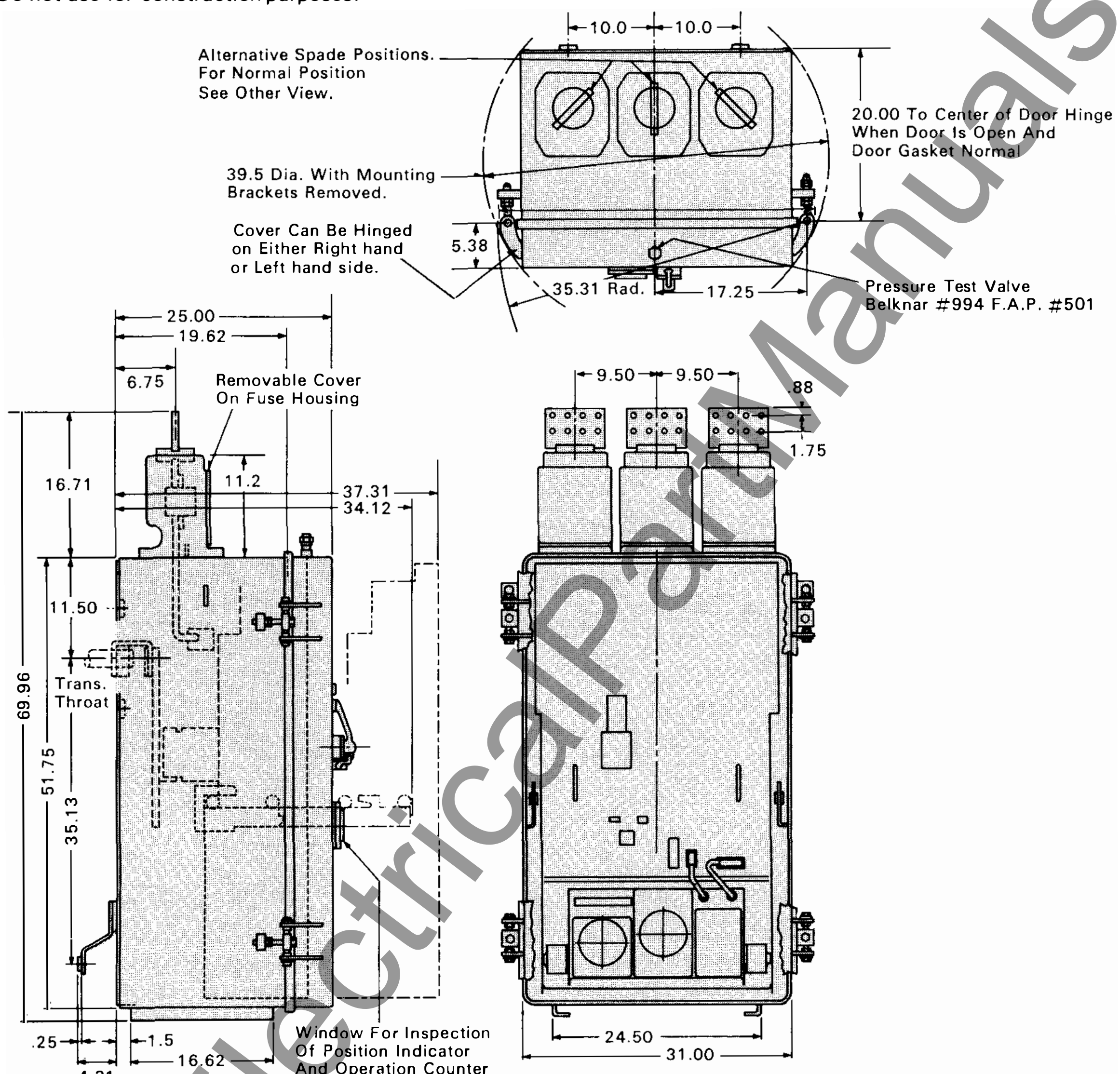
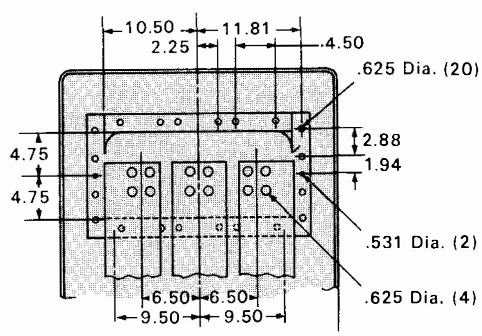
Dimensions in Inches
2825 Amperes, transformer mounted, submersible enclosure. Approximate only. Do not use for construction purposes.





View Into Open Housing

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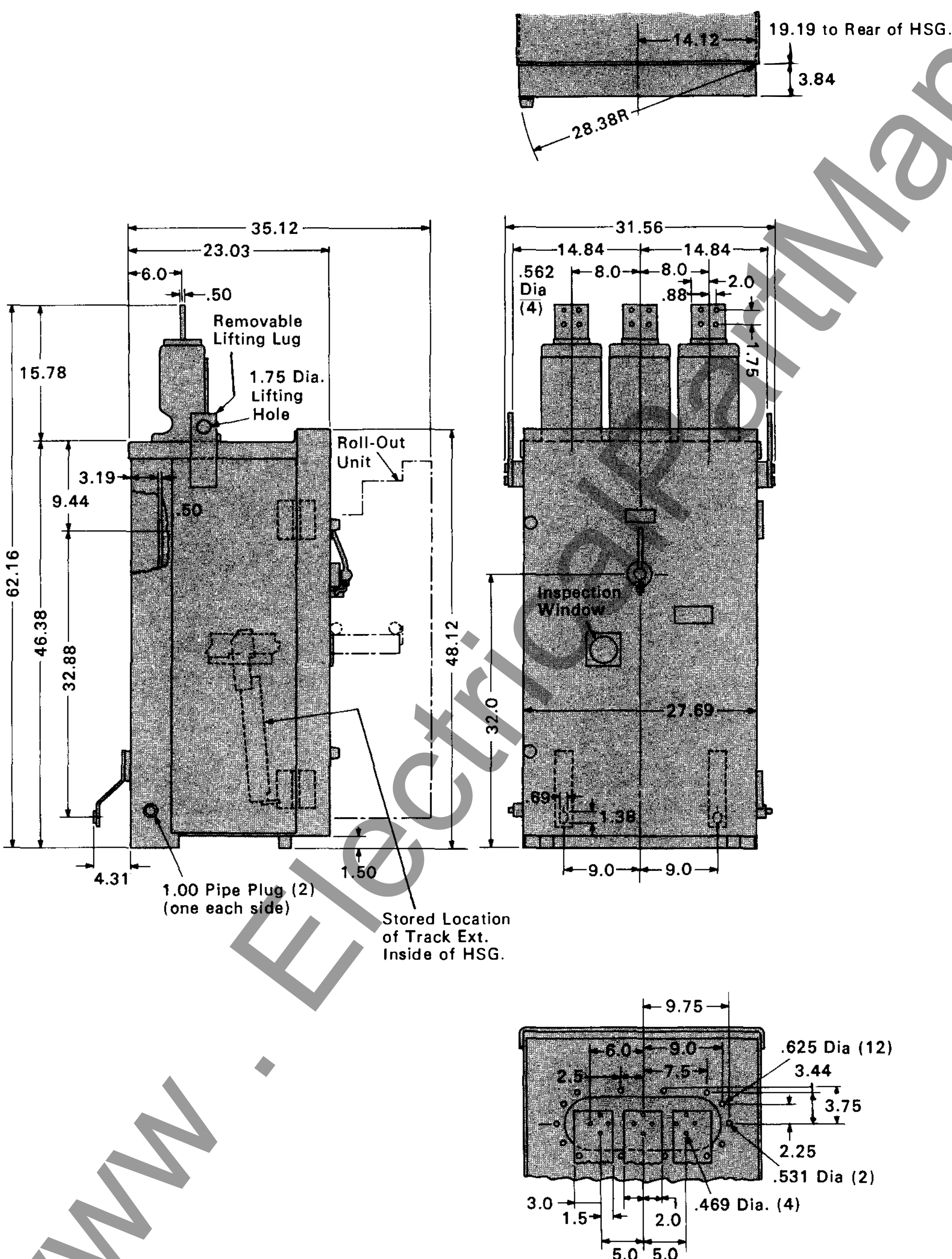
Dimensions in Inches
1200 and 1875 Amperes, transformer mounted, NEMA 1A. Approximate only. Do not use for construction purposes.



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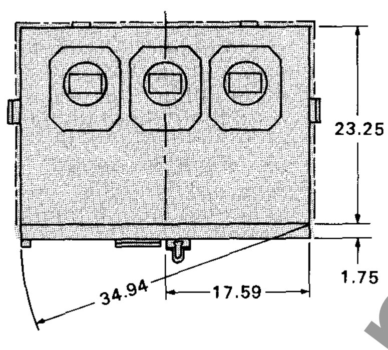
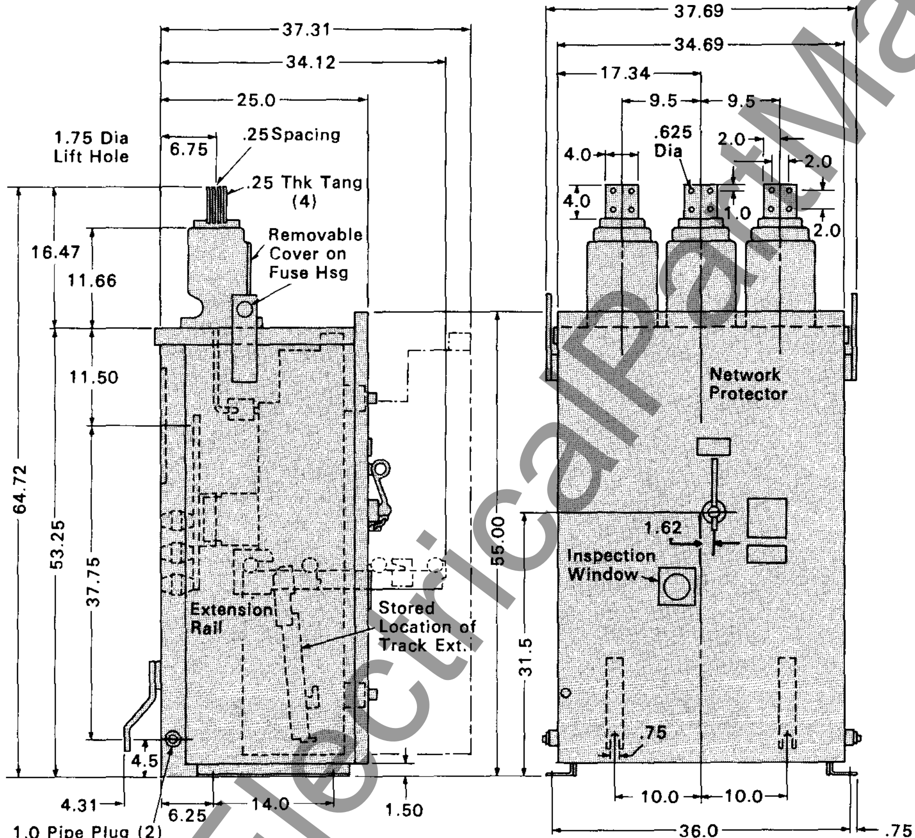
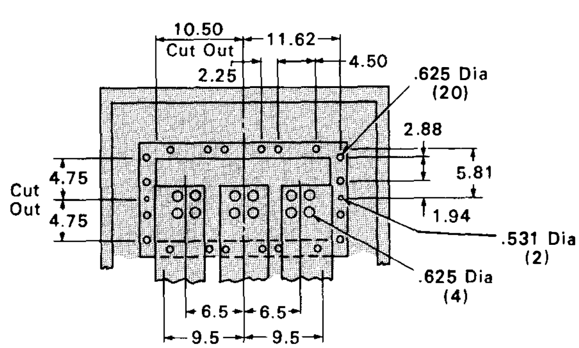
Dimensions in Inches
2825 Amperes, transformer mounted, NEMA 2A Semi-dusttight enclosure. Approximate only. Do not use for construction purposes.







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Further Information
Estimating prices: 35-520 Price List
Test Kit: Descriptive Bulletin 35-555
Renewal Parts RPD-35-552
Relay Instructions: IB35-580

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