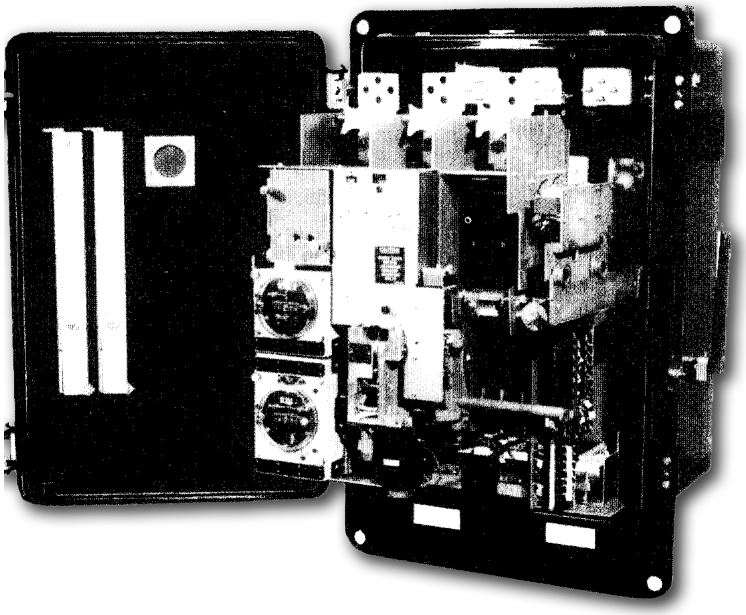
Instruction Booklet **IB 35-500-1F**

Effective November 2010
Supersedes IB 35-500-1E 7/94

Type CM-22 Network Protectors 800 to 3500 Amperes



Read and understand these instructions before attempting any assembly, operation, or maintenance of the Network Protector.

See important disclaimer of warranties and limitation of liability on page 2

See important safety information on pages 3 and 4.

Powering Business Worldwide

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NOTE

This instruction booklet covers equipment manufactured on the effective date of this I.B. and as such is different in some details from those units supplied in past years. These differences are primarily notable in the housing and network-side terminators. The breaker elements, in the same frame size, are interchangeable. Understand and appreciate these differences before performing the procedures described herein.

These instructions do not purport to cover all possible contingencies which may arise during installation, operation or maintenance, and all details and variations of this equipment. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Cutler-Hammer representative should be contacted.

SAFETY INFORMATION

WARNING

FAILURE TO FOLLOW INSTRUCTIONS CONTAINED HEREIN COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, AND/OR PRODUCT OR PROPERTY DAMAGE.

Keep this Instruction Book available to those responsible for the installation, maintenance and operation of the network protector. It should be consulted before any procedures are performed.

The installation, operation and maintenance of a network protector presents numerous potential unsafe conditions, including but not limited to the following:

- Improper operation
- Lethal voltages
- Moving parts
- Heavy components

Specialized procedures and instructions are required and must be adhered to when working on such apparatus.

WARNING

THE NETWORK PROTECTOR MUST BE COMPLETELY UNDERSTOOD AND RESPECTED IN ORDER TO ENSURE THE SAFETY OF THOSE WORKING ON IT. FAILURE TO FOLLOW INSTRUCTIONS COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, AND/OR PRODUCT OR PROPERTY DAMAGE.

Additionally, all applicable safety procedures such as OSHA requirements, regional and local safety requirements, safe working practices and good judgement must be used by personnel when installing, operating and/or maintaining such equipment.

Safety, as defined in this instruction book, involves instructions which are intended to prevent two conditions:

1. Personal injury or death.
2. Product or property damage (includes damage to the protector, other property and reduced protector life).

Safety notations are intended to alert personnel of possible personal injury, death or property damage. They have been inserted in the instructional text prior to the step in which the condition is cited.

The safety notations are headed by one of three hazard intensity levels which are defined as follows:

1. **DANGER:** immediate hazard which **will** result in severe personal injury, death, or property damage.
2. **WARNING:** hazard or unsafe practice which **could** result in severe personal injury, death or property damage.
3. **CAUTION:** hazard or unsafe practice which could result in minor personal injury, or property damage.

Some major safety concerns involving the network protectors are listed below. Refer to appropriate areas of this Instruction Book for further instructions.

1. Always perform appropriate electrical tests per Section 4.7 herein, using a three phase network protector test kit, **before** performing any installation or operation of the network protector.
2. CM-22 Network Protectors are designed to operate within the current and voltage limitations given on their nameplates. DO NOT apply these units to systems with currents and/or voltages exceeding these limits. See Table 1.
3. To perform work on CM-22 Network Protectors requires personnel with training and experience on energized equipment. ONLY QUALIFIED* electrical workers familiar with the construction and operation of such equipment and the hazards involved should be permitted to work on Type CM-22 Network Protectors.
4. There are several interlocks on the protectors. They are for personnel and/or equipment protection. UNDER NO CIRCUMSTANCES SHOULD THEY BE MADE INOPERATIVE.
5. Roll out protector's removable element before making any adjustments or doing maintenance of any nature.

*Qualified Persons as defined in the National Electrical Code.

6. Never energize the protector without the arc chutes and barriers in place.
7. Always be sure that all protector hardware is in place and bolted tightly before placing protector into its housing for operation.
8. Network Protectors are used where a large amount of power is distributed to high load density areas. As a result, any short circuit at any point in the system involves very high fault currents; thus, extreme care should be exercised when installing or working on an energized protector.
9. Extensive use has been made of barriers and interlocks in the CM-22 Network Protectors to provide greater safety to maintenance personnel. Keep barriers in place and immediately replace any that have been broken. Although barriers and interlocks are provided, insulated tools and insulated gloves are required to remove the rollout unit from the enclosure, and also when removing fuses, or at the initial installation of the protector on the system.
10. Before performing maintenance or removing a protector from service, de-energize the protector.
11. All Safety Codes, Safety Standards and/or Regulations as they may be applied to this type of equipment must be strictly adhered to.
12. While proper safety practices on a 216 volt system are extremely important, at 480 volts extraordinary care must be taken. See Para. 4.7.3 for further information.
13. BE SURE that any person performing any type of procedure involving a network protector has reviewed all applicable diagrams and instructions including, but not limited to, the specific schematic and wiring diagram and this Instruction Book.

Type CM-22 Network Protectors are manufactured with several built-in interlocks and safety features to reduce hazards and to provide proper operating sequences.

1. A mechanism bolt shutter prevents the mechanism assembly from being released and swung aside unless the handle and shaft are in the OPEN position.

2. A rollout safety feature prevents the removal of the breaker from the housing unless the extension rails are in position.

3. A drum switch on the operating handle prevents automatic closing of the protector when the handle is in the OPEN or CLOSE positions.

4. Facility for padlocking the handle in the OPEN, CLOSE or AUTO positions is provided.

WARNING

The network protectors described in this book were designed and tested to operate within their nameplate ratings. Operation outside of these ratings may cause the equipment to fail, resulting in death, severe personal injury and/or property damage.

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INTRODUCTION

PURPOSE

This instruction book is expressly intended to describe the installation, operation and maintenance of the Type CM-22 network protectors. Should any item not be sufficiently covered by these instructions and additional information is required, contact your local Cutler-Hammer office.

It is not the intent of this bulletin to describe the operation of a secondary network. For this, refer to Descriptive Bulletin 35-550. Information regarding operation, maintenance and testing of network relays is contained in Instruction Book 35-580A for electro-mechanical relays and I.B. 35-581A for solid-state relays.

For application information, consult your nearest Cutler-Hammer sales office, or see appropriate Standards.

WARNING

IT IS *NOT SAFE* TO OPERATE THE CM-22 NETWORK PROTECTORS UNLESS THEY ARE INSTALLED IN A SUITABLE METAL ENCLOSURE OF ADEQUATE STRENGTH TO WITHSTAND THE EFFECTS OF HIGH CURRENT SHORT CIRCUIT FORCES. FAILURE TO HAVE A SUITABLE METAL ENCLOSURE COULD CREATE A CONDITION CAUSING DEATH, SEVERE PERSONAL INJURY AND/OR PROPERTY DAMAGE.

The need to provide electrical power at the utilization voltage - without increasing equipment size - has resulted in a shift from 216Y/125V to 480Y/277V systems, and in some cases to 600Y/347V. 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 or 600 volts as compared to those at 216Y/125V. For example, while an arc in a 216-volt system is normally self-extinguishing, an arc in a 480-volt system or higher will usually burn until it is interrupted by an extinguishing device or until it totally consumes the arcing material. Because of this property of electricity **YOU MUST** read and fully understand the SAFETY INFORMATION on pages 3 and 4 of this Instruction Book.

The Cutler-Hammer CM-22 Network Protectors are designed to assure service continuity in 216Y/125V, 480Y/277V and 600Y/347V 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.

When a fault on a primary system (cable or network transformer) occurs, the associated CM-22 Network Protectors will open to isolate the fault from the network system. Loss of the feeder and the associated network protector trip will not result in service outage to any load on the secondary network. The other primary feeders will carry the load until the faulted feeder can be brought back into service.

The CM-22 Network Protectors consist basically of an air circuit breaker, a breaker operating mechanism, network relays and control equipment. It is available in ventilated, semi-dust-tight and submersible enclosures, for either separate or transformer throat mounting.

The protector is composed of a circuit breaker, a motor operated mechanism, a network master relay, and a network phasing relay, with the necessary wiring conveniently arranged for the addition of a de-sensitizing relay when required. Solid-state relays incorporate all relay functions in one device.

The circuit breaker is of simple construction with contacts of silver tungsten and metal arc transfer tips. The contact pressure is high to ensure good contact. Fuses are supplied for the purpose of giving an additional protection feature, in case the CM-22 breaker does not trip at the time of a fault on a feeder. Current transformers for operating the relays are located on the pole units. Means are provided for isolating the rollout unit conveniently from the energized bus so that the protector may be readily worked upon or tested in the field.

The mechanism is mechanically trip free. The latch is actuated by a shunt trip device, constructed to permit tripping at very low voltages. Accelerating springs are included in the breaker unit to aid in opening the circuit breaker contacts rapidly. For a description of ELECTRICAL TESTS refer to Para. 4.7.

Table 1 - NETWORK PROTECTOR RATINGS

The following table gives the maximum continuous current ratings of standard type CM-22 Network Protectors. The suggested transformer sizes are based on conventional electric utility practice for 216Y/125V, 480Y/277V and 600Y/347V Y-connected secondary networks. As a guide, it is usually desirable to rate the network protector approximately **130% to 150% of transformer rating.** The protectors are maximum rated devices, whereas the transformers have significant short time overload capacity.

Network Protector Amperes	Interrupting Rating Amperes	Transformer Rating — KVA		
		125/216V	277/480V	347/600V
800	30,000	225		500
1200	30,000	300		750
1600	30,000	500		1000
1875	30,000	500		1000
* 2000	60,000	500	1000	1500
* 2250	60,000	500	1000	1500
2500	60,000	750	1500	1500
2825	60,000	750	1500	2000
3000	60,000	750	2000	2000
3500	60,000	1000	2000	2500

* These ratings are now built on 2500 A. frame breaker

SECTION 1 - RECEIVING, HANDLING AND STORING

1.1 RECEIVING

Each unit shipped comprises a housing containing a rollout unit and complete with spade terminals or threaded studs.

Solid-state network relays are shipped mounted in position.

When receiving new network protectors, make a general inspection looking particularly for damage which may have occurred in handling and shipping. If any damage is found, file claim with carrier within 24 hours. If the unit is to be placed in storage for more than a few weeks, it should be inspected and tested thoroughly and any deficiencies reported.

1.2 HANDLING

1.2.1 Lifting the Breaker

To facilitate lifting, the roll-out unit frame contains two 1-3/8 inch diameter holes located on the roller brackets.

CAUTION

A SPREADER MUST BE USED WHEN LIFTING TO ENSURE THAT NO DAMAGE TO THE BARRIERS OR ARC CHUTES OCCURS. ALWAYS USE PROPER AND SAFE LIFTING DEVICES AND PROCEDURES APPROPRIATE TO THE WEIGHT BEING LIFTED, AS SHOWN IN PARA. 1.2.3.

1.2.2 Lifting the Enclosure

Two lifting brackets with lifting holes, 2 inch diameter, are located near the top at each side of the enclosure. Spreaders must be used on chains or slings to prevent damage to the network side terminals.

For shipping, CM-22 network protectors are usually packed in plywood enclosures on a wooden skid, designed for handling by forklift truck or crane and sling. Non-submersible units are packed in the upright position. Submersible units may be packed in the horizontal position or the upright position. To unpack, remove the plywood enclosure, detach the unit from the base, and lift to the upright position. All unpacked units should be transported and stored in the upright position.

1.2.3 Weights of Rollout Units and Enclosures

Table 2 - Typical Weights of Type CM-22 Network Protectors

Rollout Units	Pounds
800-1875A	400
2000-3000A	550
3500A	650

Enclosures (less rollout units)

Submerible 800-1875A	600
Submersible 2000-3000A	1330
Submersible 3500A	1700
Non-Submersible 800-1875A	450
Non-Submersible 2000-3000A	650
Non-Submersible 3500A	800

1.3 STORING

Submersible units may be stored as received with door tightly closed and with the shipping cover over the throat opening. Shipping covers should not be considered watertight, as they are for dust protection only. Protectors should be stored in a clean, dry location.

SECTION 2 - DESCRIPTION

2.0 GENERAL

Type CM-22 network protectors are air circuit breakers equipped with relays that operate in response to voltage across the protector or current through the protector. These relays cause the protector to close or to open as required by conditions between the network and the feeder transformers. Control power is taken directly from the system and therefore no separate power source is required.

CM-22 units are available as standard, for 216Y/125 volts, 480Y/277 volts or 600Y/347 volts at 60 Hertz; with other voltages as well as 50 Hertz units available upon request.

Fig. 1 shows a CM-22 Submersible Enclosure for transformer mounting. Fig. 2 shows a ventilated enclosure for transformer mounting.

WARNING

TYPE CM-22 NETWORK PROTECTORS ARE PROTECTIVE DEVICES. AS SUCH, THEY ARE MAXIMUM CURRENT RATED DEVICES. THEREFORE, THEY SHOULD NOT UNDER ANY CIRCUMSTANCES BE APPLIED OUTSIDE THEIR NAMEPLATE RATINGS. OPERATION OUTSIDE OF THESE RATINGS COULD CAUSE THE EQUIPMENT TO FAIL, RESULTING IN SEVERE PERSONAL INJURY, DEATH OR PROPERTY DAMAGE.

The normal power flow direction is in at the throat from the transformer, down to the transformer side disconnect link on the rollout unit, up through the breaker to the network side fuse and through the top of the enclosure to the out going terminal.

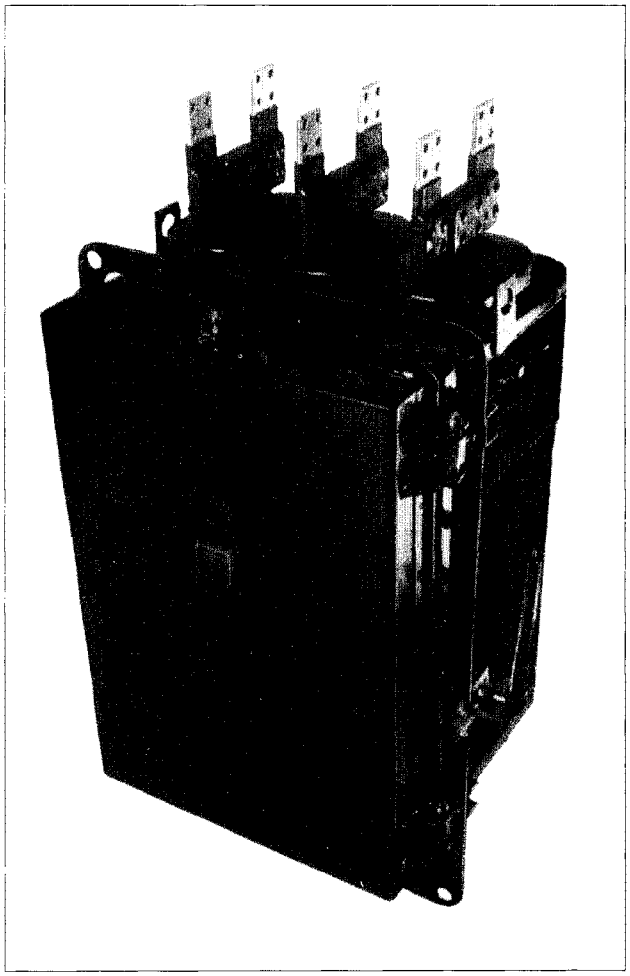


FIG. 1 *Front View of CM-22 Submersible Enclosure*

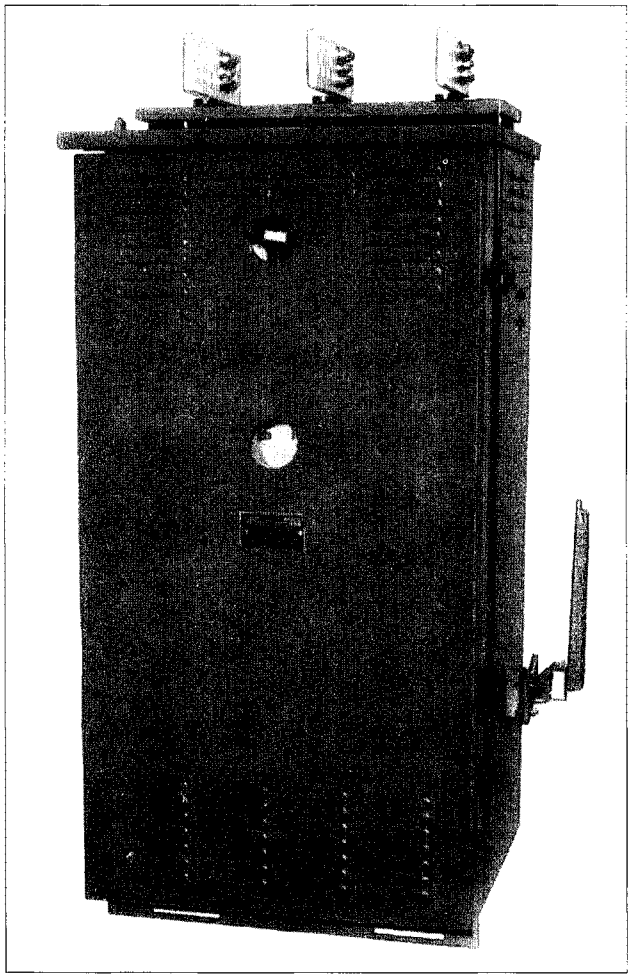


FIG. 2 *Front View of CM-22 Non-Submersible Enclosure*

2.1 CM-22 NETWORK PROTECTORS

The complete protector consists of the rollout unit and its associated enclosure.

2.1.1 Rollout Unit

The circuit breaker, mechanism and relay panel assembly is designed as a unit which, except for fuses and current transformers, is identical for ratings of 800, 1200, 1600 and 1875 ampere protectors. The relay panel is the same for all ampere ratings between 800 and 3500 amperes inclusive. The circuit breaker elements are identical for all ratings between 2000 and 3000 amperes on units made after 1986. A slight modification is made to provide the 3500-ampere rating. The interchangeable unit, called the rollout unit, is readily removable from the enclosure for inspection, maintenance and electrical tests. The removal of the disconnecting links at the bottom and the fuses at the top isolates the rollout unit completely. The further removal of four bolts permits the rollout unit to be removed from its mounting. Only perform these procedures in accordance with this Instruction Book. See Section 3.1.

2.1.2 Enclosures

The rollout unit may be mounted in any one of three types of enclosures:

- Submersible
- Ventilated
- Semi-Dust-Tight

All three types of enclosures are available for either transformer mounting or separate mounting.

Most CM-22 enclosures are equipped with **self-locking extension rails** on which the breaker can be rolled out to permit inspection or removal. These extension rails are removable and stored inside the enclosure door. The rails are manufactured from 3/8 x 3 inch steel bars which provide excellent rigidity to support the breaker. When positioned these extension rails self-lock without the use of any hardware; when removed, a rollout safety feature has been designed into the interior fixed rails to prevent any unintentional rollout of the breaker. Captive rails are also available.

The **standard Submersible housing** is a welded, ¼ inch thick mild steel, watertight enclosure. The door can be hinged from either side. The cast external operating handle can also be mounted on either side of the enclosure and may be padlocked in one of three positions - OPEN, AUTO or CLOSE. The door is provided with one or more windows for the inspection of fuses, operation counter and position indicator.

The **Submersible seal** is accomplished by means of a tubular neoprene gasket held by gasket retainers along the edge of the door. The gasket is compressed uniformly between the edges of the housing and the door by pressure applied through four or six clamping bolts. After the enclosure has been factory tested at 7 PSI internal pressure, two lock nuts on each clamping bolt are set to provide a positive stop. This assures a watertight seal to

be easily re-established each time the door is closed after inspection.

A unique feature of the special gasket retainer design is the **corner casting**. This investment casting blends into the outer and inner gasket retainer guides and assures the squareness of the door for a reliable, watertight seal. The corner casting, as well as the outer gasket retainer guide, is manufactured from stainless steel to prevent gasketing failure due to corrosion of the retainer.

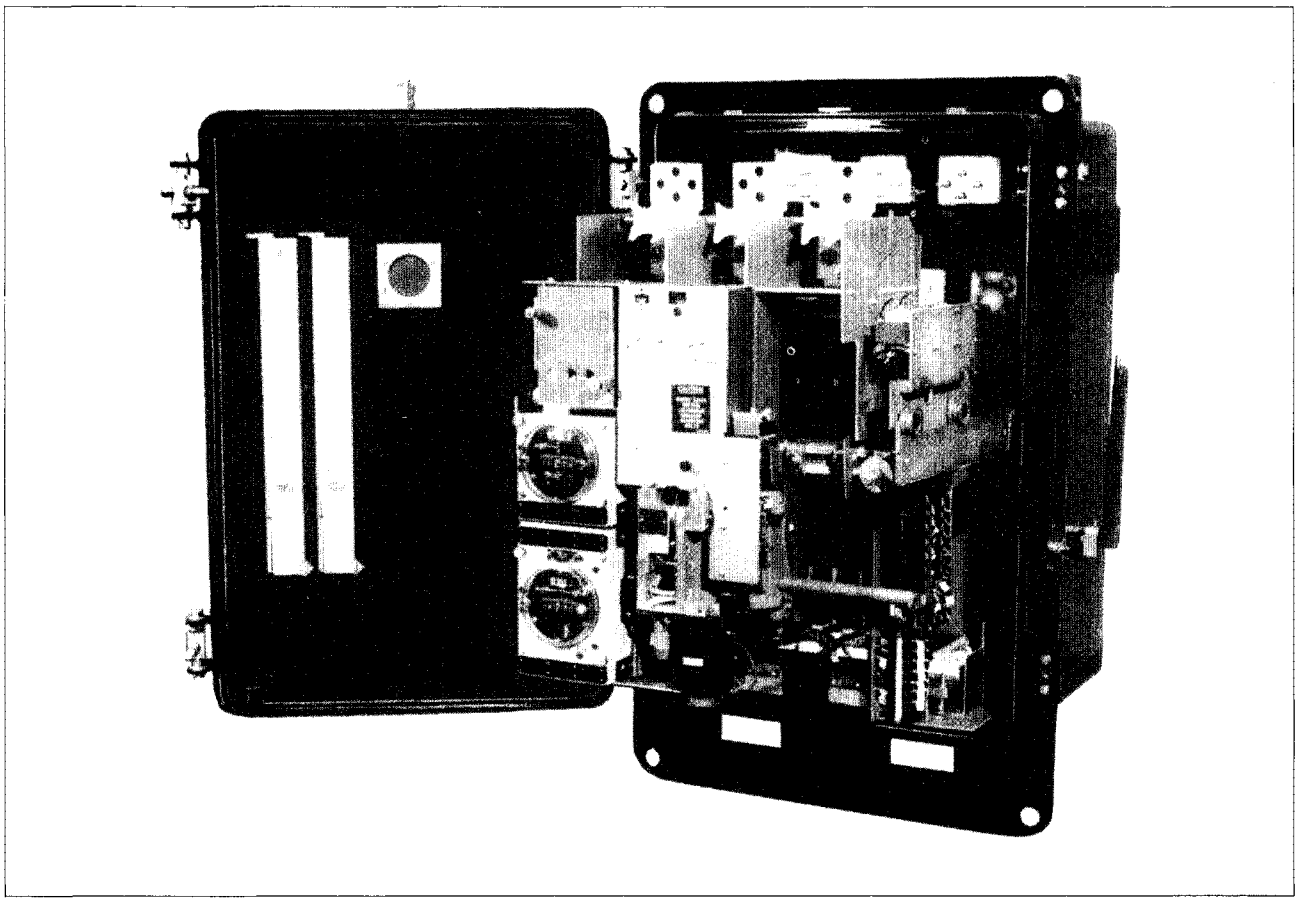
Another submersible design feature is the **picture frame** welded to the housing. This picture frame tightly envelops the four housing sides. This provides rigidity to the housing and maintains squareness of the opening and straight edges; this is extremely important to ensure a reliable, watertight seal.

Submersible ratings from 2000 to 3500 amperes incorporate cast cooling fins in the sides of the enclosure to aid in dissipation of internal heat. These cooling fins are designed to eliminate the possibility of crevice corrosion stemming from incomplete paint coverage of inaccessible areas.

To enhance the corrosion resistance on submersible units all **external hardware** and attachments are stainless steel or non-corrosive metals.

The enclosure utilizes **moulded epoxy bushings** with conductor terminations to suit customer specifications.

For extremely severe environmental applications, Cutler-Hammer can provide, as an optional extra, an **all-stainless steel enclosure.** This enclosure is manufactured from a corrosion-resistant, non-magnetic, type 316 stainless steel.



SECTION 3 - OPERATION

3.1 PROCEDURE TO REMOVE THE ROLLOUT UNIT FROM HOUSING

WARNING

WHEN THE ENCLOSURE IS NOT ATTACHED TO A TRANSFORMER, THE ENCLOSURE MUST BE SUPPORTED IN A WAY THAT WILL PREVENT TIPPING FORWARD WHEN THE DOOR IS OPEN AND THE ROLLOUT UNIT IS ON THE EXTENSION RAILS.

3.1.1 To Open Door

The quick opening enclosure is opened by loosening all the bolts, starting with the bolts on the hinged side. The hinge bolts are loosened until the bolts come against the stops. Then the bolts on the opening side are loosened until they are completely disengaged from the housing blocks.

3.1.2 Positioning Extension Rails

(Refer to Fig. 4, 5, 6).

Remove extension rails from storage location on door. Insert into position on the fixed enclosure rails. To do this enter slotted end onto fixed rail while holding the stop pin end up about 45°. (See Fig. 5). When in against fixed rail, lower stop pin end to horizontal, causing the small block between the slot plates to lock into notch on lower edge of fixed rail. Be certain that both extension rails are solidly attached to the fixed rails in the housing. DO NOT bend or force the rails into place. They should readily fit into position. Both rails are duplicate and interchangeable between left and right.

3.1.3 Removal of Rollout Unit from Enclosure

For detailed procedure refer to Para 4.7.3 in its entirety. Perform the following steps:

1. Place the operating handle in the OPEN position.
2. Remove the disconnecting links first and then the fuses.
3. Loosen the panel mounting bolts located near each corner of the main panel. During this operation it is necessary to open the relay panel by loosening the two bolts which fasten the relay panel to the circuit breaker, to gain access to the left hand side panel mounting bolts.
4. Once all panel mounting bolts are disengaged, swing the relay panel closed and retighten the mechanism red bolt and the relay panel left-hand hold down bolts.
5. Roll the breaker element onto the extension rails until the front rollers meet the rail stops.

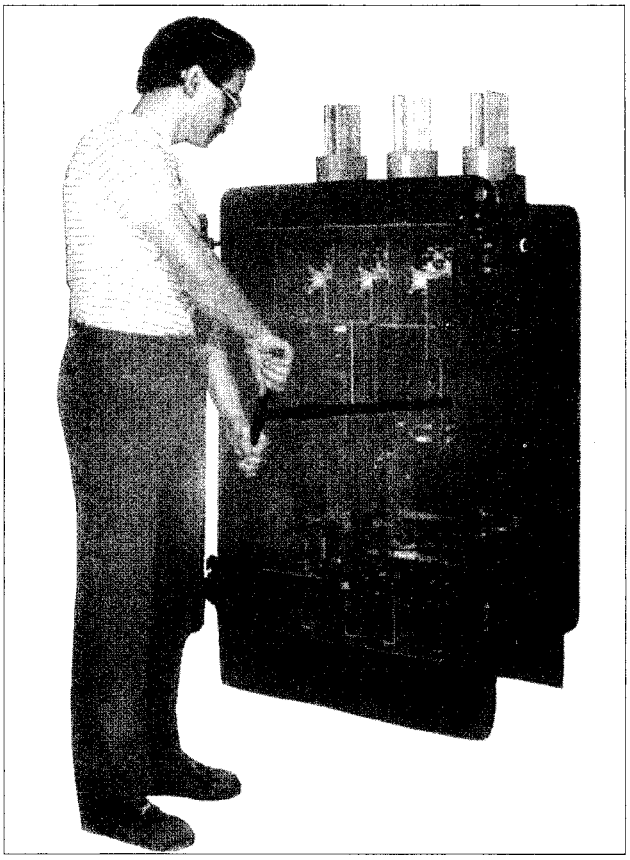


FIG. 4 *Using Insulated Wrench to Loosen Nuts*

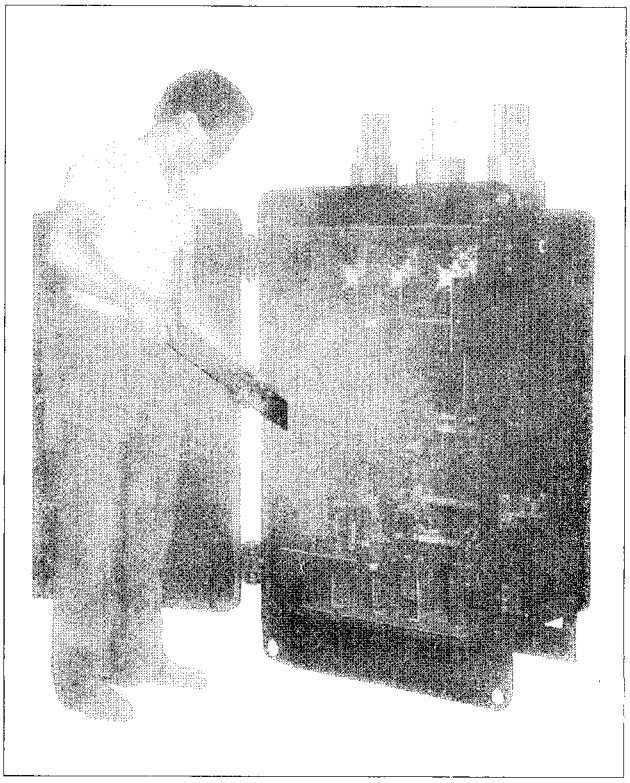


FIG. 5 *Inserting One Rail Into Position*

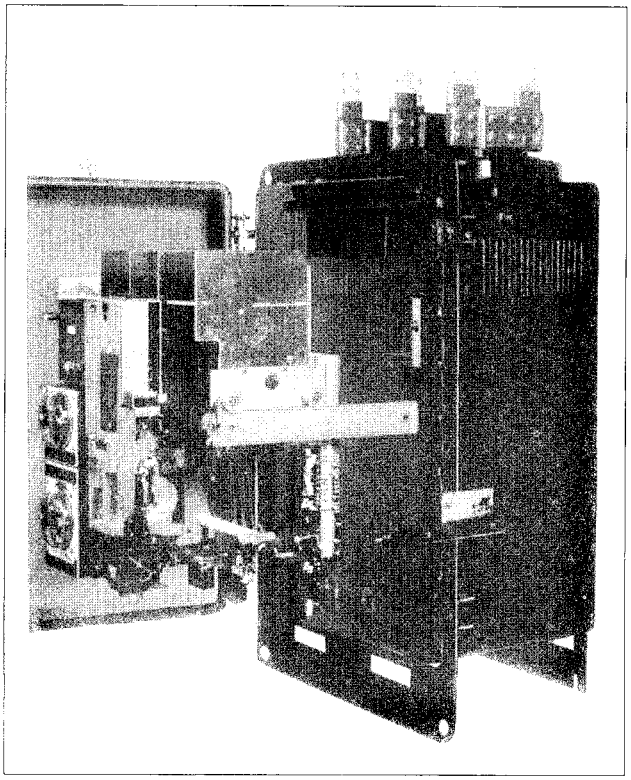


FIG. 7 *View With Breaker Out on Rails*

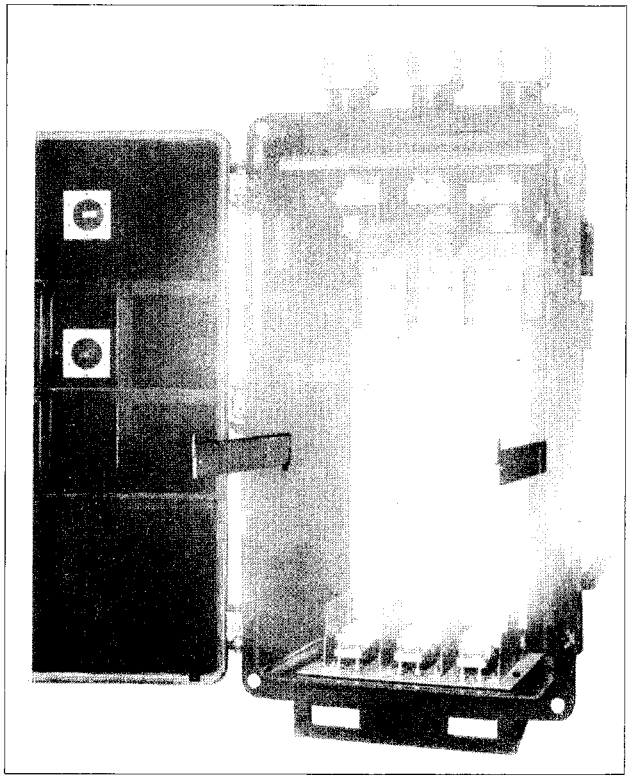


FIG. 6 *View of Both Rails in Place*

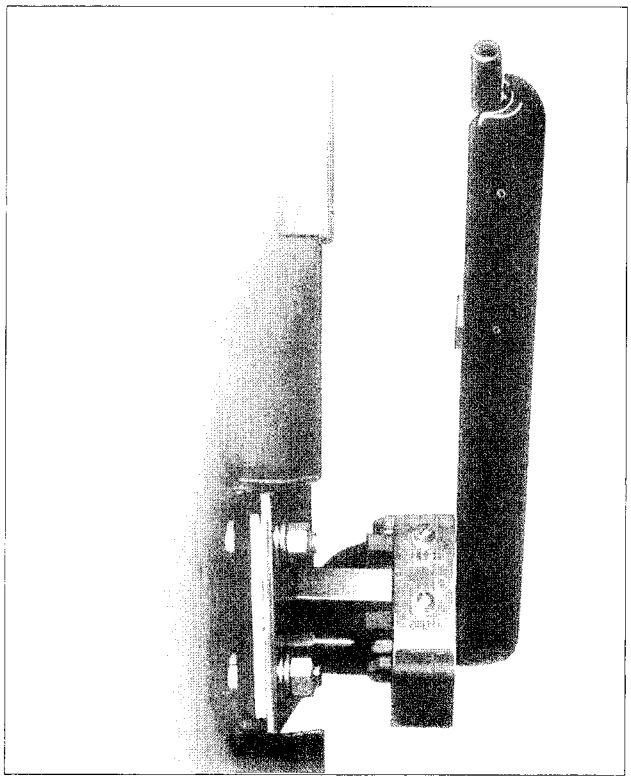


FIG. 8 *CM-22 Network Protector Operating Handle*

3.2 ENCLOSURE

3.2.1 Submersible Housings

The housing for the submersible protector is of welded sheet steel construction. The entire housing is white metal blasted and protected by a modified epoxy paint to minimize corrosion in service. A cover, which is arranged so that it may be hinged on either side, provides ready access to the interior of the housing. A watertight seal is provided between housing and cover by compressing a circular Neoprene gasket between machined surfaces on the housing and cover.

Neoprene, a synthetic rubber material, is highly resistant to the action of oils and other materials likely to be encountered in network protector applications. To prevent the gasket, which is secured to the cover by means of a gasket retainer, from sticking to the housing when the housing is clamped shut, the contacting surface of the gasket is coated with 130A Lubriplate. Unless wiped off, the lubricant need not be renewed through many openings and closings of the cover.

The cover is dished in order to obtain greater rigidity in the clamping direction. This coupled with a narrow bearing area between machined steel and gasket, produces a watertight seal with relatively few clamping bolts.

Sliding Hinge Centers

The quick opening housing with sliding hinge centers is opened by loosening all the bolts, starting with the bolts on the hinged side. The hinge bolts are loosened until the bolts come against the stops. Then the bolts on the opening side are loosened until they are completely disengaged from the housing blocks.

To close and seal the housing it is only necessary to tighten all bolts until they come against the stops. The bolts on the opening side are tapered on the end to facilitate entering the tapped holes in the housing blocks. Springs on the hinge bolts keep the hinged side of cover positioned correctly when the cover is open.

Cover

The cover is equipped with a window or windows for inspection of fuses, position indicator and operation counter. The window is of high impact polycarbonate clamped by gaskets for cushioning action and to keep the housing watertight.

3.2.2 Operating Handle

The external operating handle is normally located at the left side but provision is made for mounting it on the right hand side as well. An auxiliary shaft mounted in the housing connects the operating handle to the shaft on the protector. This shaft can be interchanged between the right and left hand side of the housing.

A packing gland tightened by means of a spanner nut provides a watertight seal between the housing and the handle shaft. The spanner nut is held in place by a locking clip. When the hand operating packing gland leaks, the locking clip must be removed, the spanner nut tightened until a watertight seal is obtained and the locking clip is replaced.

By removing a clamping bolt, the operating handle may be removed from its shaft in order to decrease the overall dimensions when handling the housing. Combined with the external operating handle is a locking flange, by means of which the protector may be locked in any of the three positions. The operating handle is interlocked to prevent rolling the protector in fully unless the protector is open and the operating handle is in the OPEN position.

The handle and shaft combination have three significant positions; OPEN, AUTO and CLOSE. A lever at the center of the shaft engages with a lever of the mechanism toggle in such a manner that the movement of the handle from the AUTO to the CLOSE position will push the mechanism toggle to the closed position in a manner similar to that performed by the motor in electrical operation. An interlock prevents the mechanism assembly from being released and swung aside unless the handle and shaft are in the OPEN position.

In the OPEN position, a second lever at the center of the shaft engages with a portion of the tripping mechanism in such a manner that the protector is tripped when the handle is moved to the OPEN position. The shaft also actuates a small drum switch at its left end in such a manner that the closing circuit of the motor is opened when the handle is in the OPEN or CLOSE positions, thereby preventing the mechanism from closing electrically when the handle is in these positions. In the CLOSE position of the handle, the protector is able to trip-free

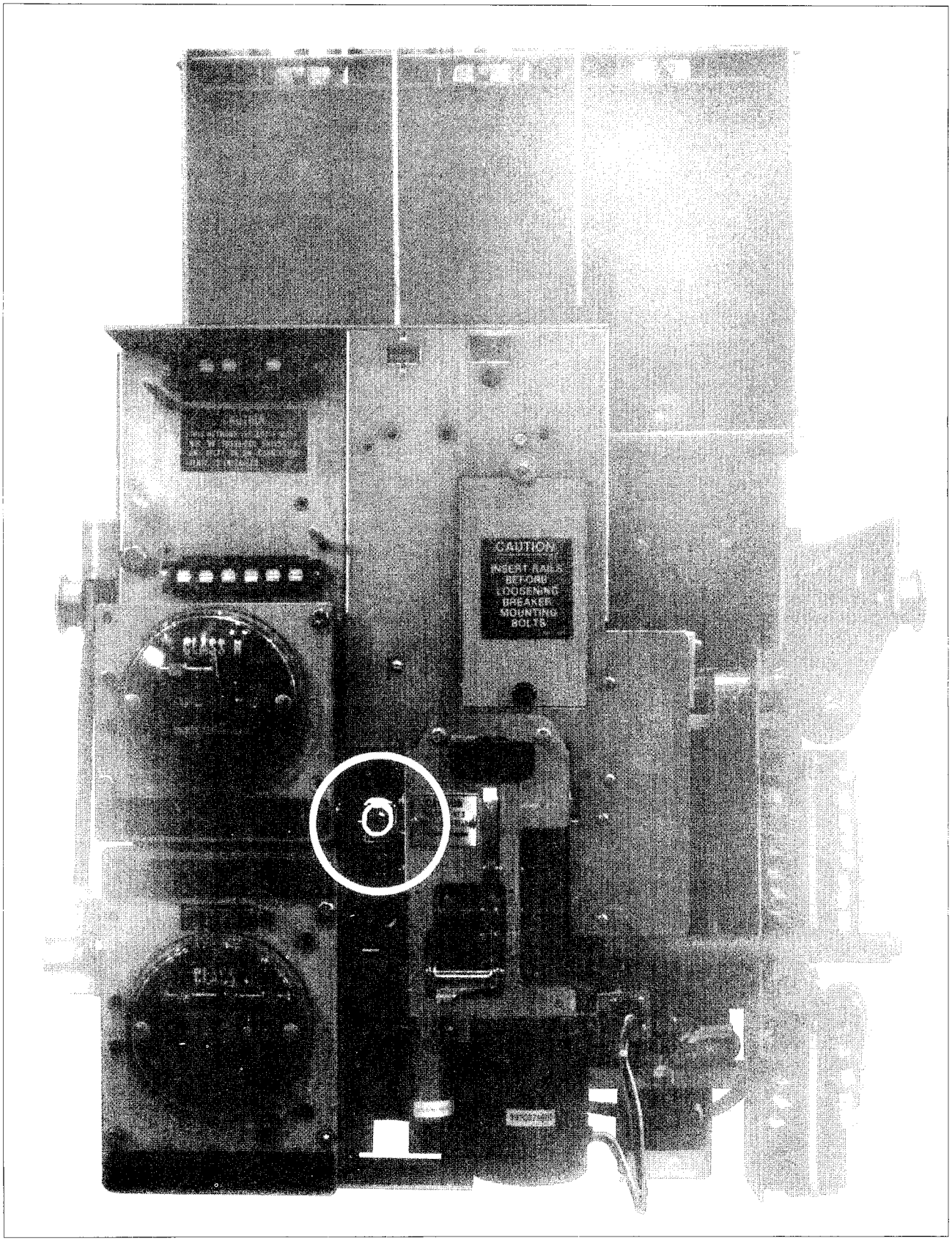


FIG. 9 *Red Mechanism Bolt*

from the mechanism, but the protector cannot then reclose automatically until the handle has been restored to the AUTO position.

3.2.3 Housing Details

The protector is mounted rigidly in the body of the housing. This part of the housing contains the mounting bosses, the rollout rails, the lifting lugs, the entrance bushings, the hinge details for the cover, the external operating handle and the provisions for mounting the housing. Transformer mounted housings have an opening in the back of the housing for mounting directly on to the low voltage throat of the transformer. Bus bars mounted in the housing connect the bottom of the protector to the transformer copper. Brackets are located near the rear bottom of the housing to provide additional support between protector and transformer. The separately mounted housing has four mounting lugs located two at the top and two at the bottom.

3.3 INTERLOCKS

The CM-22 network protector has two distinct mechanical interlocks which help provide for operator safety and promote proper equipment function.

WARNING

DO NOT ATTEMPT TO DEFEAT OR REMOVE ANY OF THE SPECIFIED INTERLOCKS. TO DO SO COULD CAUSE DEATH, SEVERE BODILY INJURY AND/OR EQUIPMENT DAMAGE.

3.3.1 Mechanism Bolt Shutter

(Refer to Fig. 9)

With the network protector outside operating handle in either the AUTO or CLOSE position, a shutter prevents an operator from gaining access to the red mechanism hold-down bolt. Once the handle is in the OPEN position, the shutter pivots downward permitting access to the red mechanism bolt.

3.3.2 Stationary Rail Interlock

A slot in the fixed rails prevents the unintentional rollout of the breaker from the enclosure if the operator fails to insert the moveable extension rails.

3.4 PROCEDURE TO SERVICE A CM-22 NETWORK PROTECTOR IF THE BREAKER FAILS TO OPEN

DANGER

READ THIS SECTION COMPLETELY BEFORE ATTEMPTING ANY EMERGENCY WORK ON THE NETWORK PROTECTOR.

IF THE BREAKER DOES NOT OPEN, IT BECOMES IMPERATIVE TO ISOLATE THE NETWORK PROTECTOR ELECTRICALLY FROM BOTH THE TRANSFORMER-SIDE AND THE NETWORK-SIDE POTENTIALS. UNDER THIS CONDITION THE ROLLEDOUT POSITION MUST NOT BE ALLOWED UNTIL ELECTRICAL ISOLATION ON BOTH SIDES IS ACHIEVED, THUS MAKING THE ROLLOUT UNIT COMPLETELY DEENERGIZED.

PERFORMING MAINTENANCE ON A CM-22 NETWORK PROTECTOR WITHOUT ISOLATING IT ELECTRICALLY CAN RESULT IN DEATH, SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE. DO NOT PROCEED UNTIL THE UNIT IS ELECTRICALLY ISOLATED. USE AN APPROVED DEVICE TO BE SURE OF THE ELECTRICAL ISOLATION BEFORE PROCEEDING.

DANGER

THE CM-22 "OPEN", "CLOSED" SEMAPHORE INDICATOR IS NOT DRIVEN BY THE CONTACT STRUCTURE BUT RATHER IS CONTROLLED THROUGH THE POSITION OF THE MECHANISM. HENCE, A SCENARIO CAN DEVELOP WHERE THE BREAKER CONTACTS HAVE WELDED/LOCKED CLOSED AND THE MECHANISM HAS TRIPPED. IN THIS SITUATION, THE SEMAPHORE WILL INDICATE "OPEN" BUT THE CONTACTS ARE CLOSED. A VISUAL CHECK OF THE RIGHT HAND PHASE, MAIN CONTACT STRUCTURE, WILL INDICATE THE TRUE BREAKER POSITION. THIS CHECK SHOULD BE PART OF YOUR STANDARD OPERATING PROCEDURE. A FAILURE TO VISUALLY CHECK THE TRUE BREAKER POSITION CAN CAUSE DEATH, SEVERE PERSONAL INJURY, OR PROPERTY DAMAGE.

3.5 OPERATING MECHANISM

The mechanism, auxiliary switch, relays, and other auxiliaries are assembled together in a unit at the front of the protector. This assembly is hinged at the right hand side and may be released and swung aside by releasing two captive bolts; one of these is at the left hand side of the mechanism frame and the other is at the left edge of the relay bracket. IT IS EXTREMELY IMPORTANT THAT THE BOLT ON THE MECHANISM IS SECURELY FASTENED BEFORE ANY ATTEMPT IS MADE TO CLOSE THE PROTECTOR EITHER MANUALLY OR ELECTRICALLY.

This bolt is painted red and a special nameplate mounted on the mechanism calls attention to this fact (See FIG. 9). The mechanism closes the circuit breaker by a pushing action only, there being no link or pin connection between the mechanism and the circuit breaker. The relays are mounted on special terminal blocks in such a manner that each relay may be readily removed without disturbing any permanent wiring. The mounting of the mechanism, relays, and auxiliaries together produces a clean and accessible circuit breaker and all devices are connected with a minimum of control wiring.

In normal operation on a network, the circuit breaker is closed by means of the motor and tripped by means of the shunt trip coil, both of which are controlled automatically by the relays and other auxiliaries. Rotation of the closing motor is always in the same direction and all resetting for the next operation is performed mechanically. When the motor circuit is energized for a closing operation, the rotation of the motor is transmitted through a worm gear to a crank carrying the closing roller at its outer end. Soon after starting to rotate, the crank engages the closing lever and carries it along, driving the toggle links toward a position of alignment. Motion of the toggle is confined to the middle and left links, the right hand link being held stationary by the latch. Before the middle link has reached the position for alignment with the stationary link, but after the middle and left links have passed over center, the roller on the closing crank passes out of engagement with the closing lever.

This leaves the main contacts, and the toggle which closes them, under heavy pressure which would instantly force open the breaker if it were not prevented by the latch. The latch in turn is held closed by a small latch toggle, which resets automatically by passing over center when the latch roller is in its lowest position.

A drum switch mounted on the crank of the motor closing mechanism serves to remove voltage from the motor when this crank reaches a position approximately 30° beyond the vertical position. When the crank has reached this position, the mechanism toggle is already safely in the latched position and hence the exact point of motor cut-off is not important and no adjustments are required. One pole of the auxiliary switch is connected in parallel with the drum switch just mentioned.

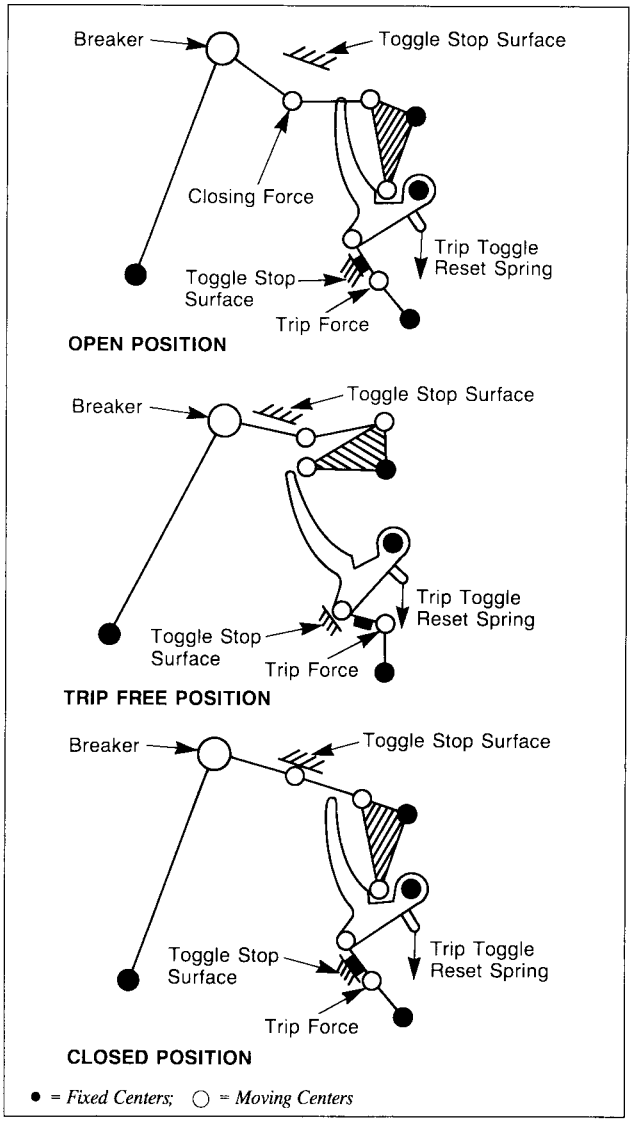


FIG. 10 *Simplified Diagrams of Operating Mechanism.*

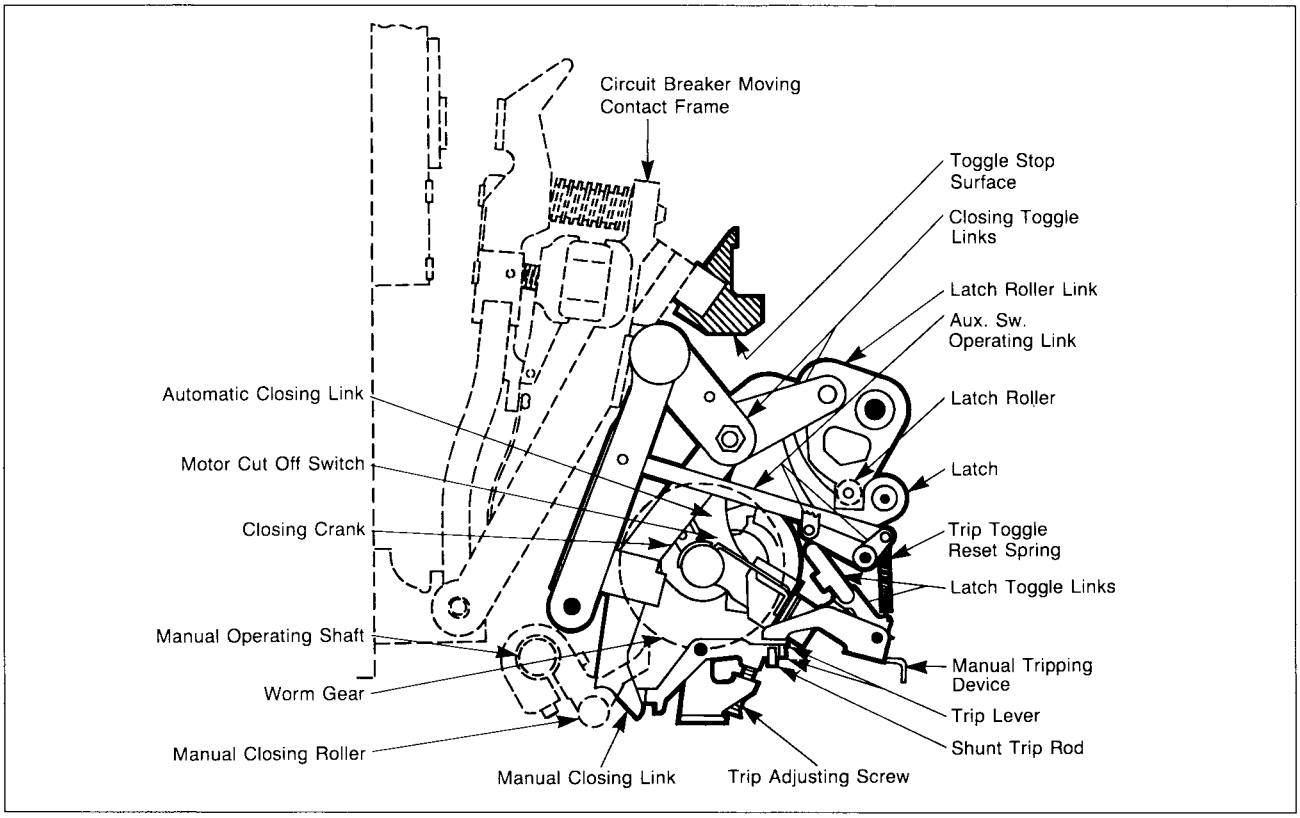
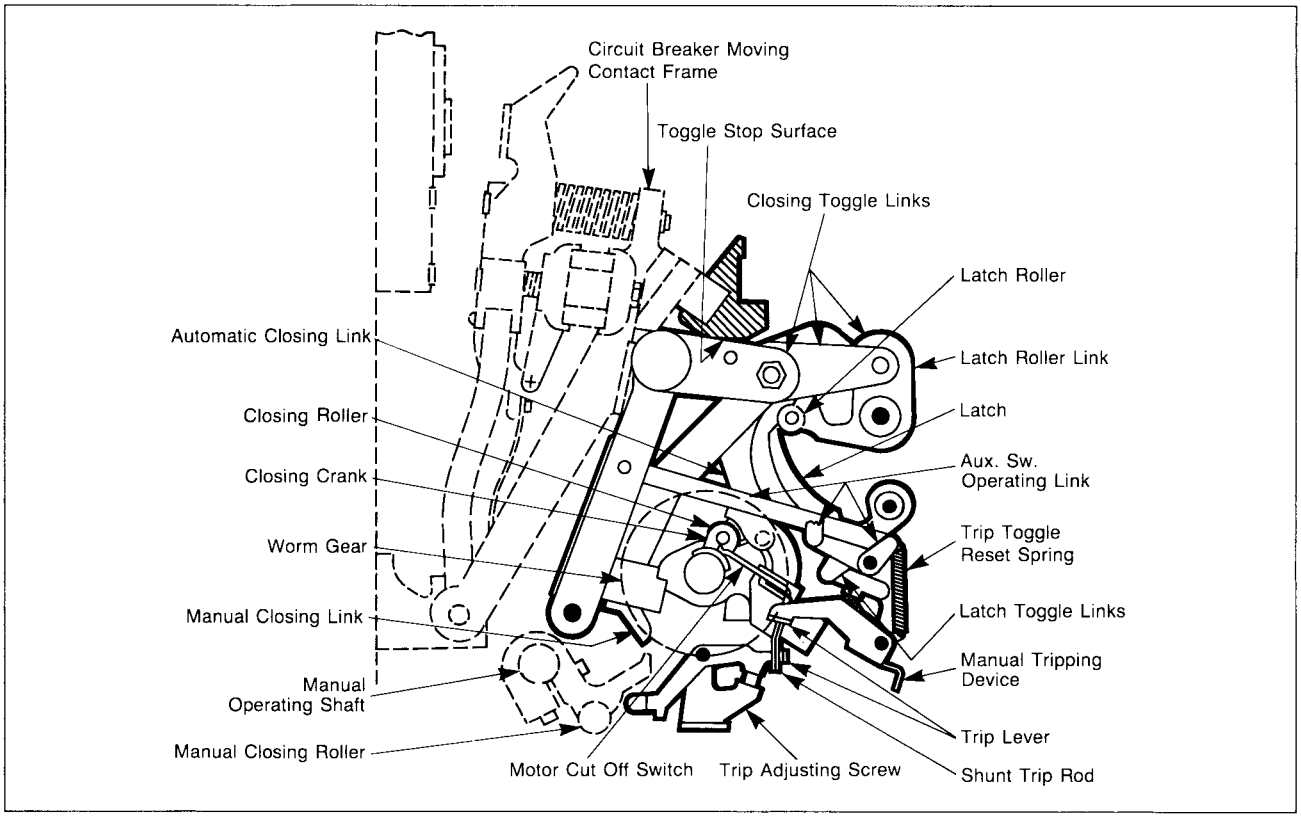


FIG. 11-a *Operating Mechanism - Protector Open*



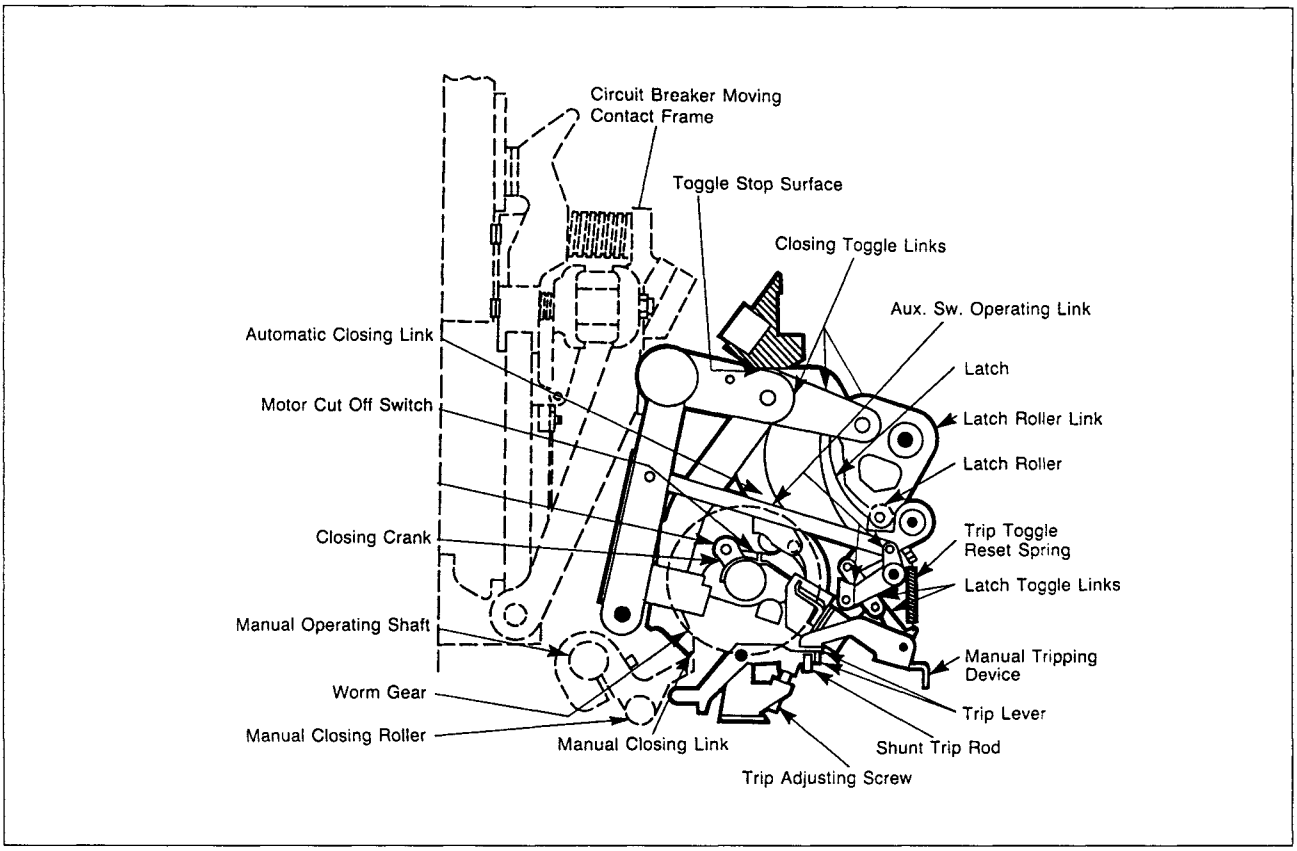


FIG. 11-c *Operating Mechanism - Protector Closed*

When the protector is tripped, this pole of the auxiliary switch makes contact. During the next protector closing operation it serves to complete the motor circuit until the drum switch makes contact. This auxiliary switch contact then opens well before the mechanism has closed and the cut-off of the motor is accomplished by the drum switch well after the mechanism has closed. The closing crank drifts approximately 45° beyond the point of motor cut-off. The exact stopping position of this crank is unimportant.

The three links in the main toggle have their center lines so located that the ends of the middle link move in opposite directions. When opening, the end links turn clockwise and the middle link counter-clockwise with reference to their shafts as seen from the side, shown in Fig. 11a. After tripping electrically, all of the links drop immediately to the position shown in Fig. 11a carrying the latch roller back to the reset position. This allows the latch to snap into place through the action of the helical spring supported between the latch and the latch toggle. Resetting for the next cycle of operations is then complete.

Fig. 11-b is included to show a typical momentary position of parts when the breaker is opening after tripping free while closing. There is no way of holding the mechanism in this position. Although the closing roller is shown in contact with the closing lever, the closing crank could be in the "off" position shown in Figs. 11a or 11c, as in ordinary shunt tripping, without changing anything else.

When the relay mechanism assembly is swung out, the mechanical connection between the operating mechanism and the circuit breaker ceases automatically. Since the mechanism operates the breaker simply by pressing on the movable contact frame or by releasing the pressure, it is not necessary to uncouple any parts when separating the operating mechanism from the breaker.

3.6 RELAY PANEL AND AUXILIARIES

Relays and auxiliary switches for controlling the operation of the breaker in response to circuit conditions are mounted on the same hinged assembly with the operating mechanism. Flexible cables, making the minimum necessary number of electrical connections between the terminal blocks, the control devices and the circuit being protected, are brought across the hinge point of the assembly. This arrangements permits free movements of the panel in and out on its hinges without putting any injurious stress on the conductors.

3.6.1 Main Auxiliary Switch

Two 4 pole type RC auxiliary switches are used as auxiliary contacts. Eight circuits are provided for, although they are not all used in the standard wiring arrangement. An optional third 4 pole auxiliary switch is also available. Contacts are made and opened by metal segments rotated between stationary fingers. Reference to the wiring diagrams, Figs. 12 and 13, will disclose the several opening and closing functions performed. Movement of the switch contacts is controlled by a mechanical linkage with the breaker operating mechanism.

Two auxiliary switch contacts, one "a" and one "b" connected to the network are normally brought out from the protector by means of a disconnect device located on the upper left hand side of the main panel. These circuits may be used for an interlock, remote position indication, or a supervisory system.

3.6.2 Closing Motor, Two Lead

The closing motor is a single phase commutator type vertical shaft motor with ball bearings. A single reduction of speed between motor and closing crank is made by a worm, coupled directly to the shaft of the motor, and a worm wheel mounted on the same shaft as the closing crank. Since the service does not require operation of the closing mechanism for any extended period of time, the motor is wound to develop an exceptionally high torque for its size. If operated too frequently for testing or similar purposes, the windings may overheat, but there is ample capacity for twenty consecutive operations. A centrifugal friction governor in the lower end bell prevents undesirably high speed on the upper range of voltage. The motor is tested for closing of the protector at 70% of the rated system voltage.

The friction governor built into the lower end of the motor is composed of two steel weights which act as brake shoes when the centrifugal force throws them out against the inner periphery of the small housing in which they are enclosed. The governor requires no adjustment and there is no brake lining material to wear out in this assembly. It is purely a speed limiting device. In some few instances surplus lubricant from the lower motor bearing may get onto the braking surfaces and cause the closing crank to travel abnormally far after the cut-off switch opens. If this condition is found, remove the brake drum and clean up the lubricant on the centrifugal weights and drum with a suitable solvent.

3.6.3 Closing Motor, Three Lead

The three lead motor is the same as the two lead motor except an additional common lead is brought out from the point between the armature and the field. This third lead is used to stop the motor electrically by momentarily short circuiting the armature through an adjustable 3 ohm resistor. The three motor leads are connected to a polarized four pole plug assembly for convenient disconnection for removal or replacement. The three lead motor has no mechanical brake assembly.

3.6.4 Shunt Trip Assembly

The shunt trip assembly unit, comprising the trip magnet with its coil, is mounted on a frame which also carries a trip lever, adjusting screw, and coil circuit contacts. The trip magnet is of the solenoid and plunger type with a stationary and a movable core. Adjustment of the screw fixes the position of the trip lever, which acts also as a stop for the latch toggle. Final adjustment of the set screw is made while the unit is in place on the mechanism.

While the shunt trip coil must operate satisfactorily at the maximum voltage of the circuit, it is designed to pick up positively at only 7½% of normal voltage. Normally any voltage high enough to pick up the movable core of the trip magnet is sufficient to drive the latch toggle over center and trip the breaker.

3.6.5 Manual Trip Lever

An extension of the shunt trip lever to the front of the mechanism frame forms a convenient manual tripping lever. Pressure on this part trips the breaker.

3.6.6 Auxiliaries

The motor circuit is controlled by a motor starting contactor, which in turn is controlled by the master and phasing relays, and also by the cutoff switch of the mechanism. The closing of the "closing" contacts of the relays energizes the coil of the contactor, which then closes its contacts. The closing of these contacts serves to close the circuit of the motor, and as soon as the drum switch on the crank makes contact, it seals the contactor in the closed position independently of the positions of the network relay contacts. The motor then closes the protector, and after the mechanism latches, the cutoff switch is opened, thus opening the contactor.

An operation counter is mounted at the front of the protector where it is visible through the window in the enclosure.

3.6.7 Position Indicator

"Open" and "Closed" positions of the breaker are identified by a position indicator that gives either a mechanical or colored light indication. For mechanical indication the words "open" and "closed" on a semaphore flag give the position indication. One word or the other is visible from the front of the protector depending on the breaker position. The colored light indication is obtained by mounting a small clear lamp behind colored lenses in the semaphore flag. When the protector is open the green lens is in front of the lamp, and when the protector is closed, the red lens is in front of the lamp.

On protectors 1875 ampere rating and below, a rawhide bumper on the mechanism acts as a stop for the moving contact assembly and keeps the shock of stopping the moving contact assembly from the toggle links of the mechanism when the protector opens. On the larger frame breakers (2000 amp and above), this rawhide bumper is replaced by an air dashpot assembly to limit re-rebound of the moving contact assembly when the breaker opens.

The operation and theory of the electro-mechanical master, phasing and de-sensitizing relays is completely covered by I.B. 35-580A for CN-33, CNJ and BN relays. The operation of the solid-state network relay is covered by I.B. 35-581A for MPCR relay.

3.7 OPERATING SEQUENCE

3.7.1 Closing Cycle

A closing cycle consists of the following sequence of operation:

1. The master relay closing contacts and if applicable the phasing relay contacts close, thereby completing the circuit to the coil of the motor starting contactor.

2. The contactor picks up its armature thereby closing its contacts.

3. The motor, being energized by the contactor, then rotates the closing crank to a point where the associated drum switch closes its contacts, thereby electrically sealing the contactor closed independent of the master relay, phasing relay or auxiliary switch contacts.

4. As the motor mechanism passes into the latched position, the drum switch opens the circuit of the contactor operating coil, and the auxiliary switch closes in the circuit of the shunt trip coil. The closing of the shunt trip circuit is in preparation for the tripping of the circuit breaker at some future time.

5. The opening of the contactor opens the circuit of the motor, thereby removing it from the line.

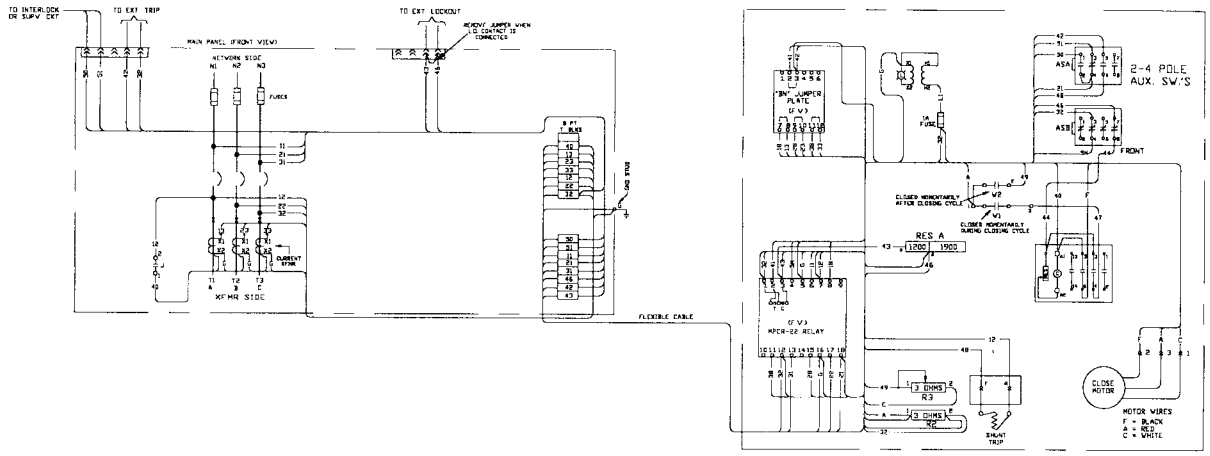
3.7.2 Tripping Cycle

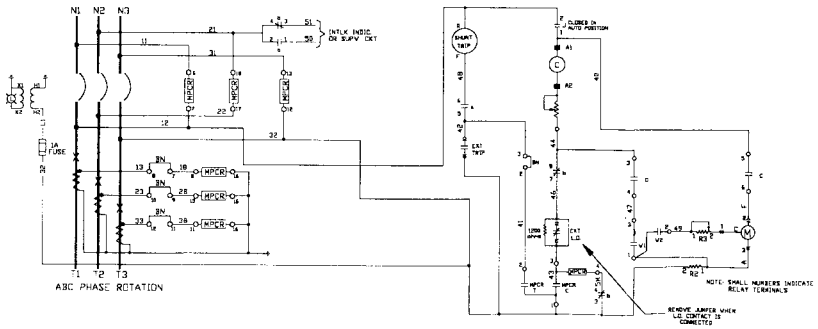
A tripping cycle consists of the following sequence of operations:

1. The master relay closes its tripping contacts (due to the system conditions prevailing), thereby closing the circuit through the shunt trip coil.

2. The opening of the circuit breaker and mechanism returns the auxiliary switches to their original position, thereby opening the circuit of the shunt trip coil and closing the circuit of the motor closing contactor, preparatory to the next closing operation.

SWINGING ASSEMBLY
(FRONT VIEW)

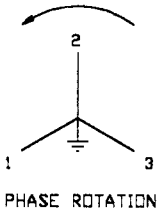




SCHEMATIC DIAGRAM

LEGEND

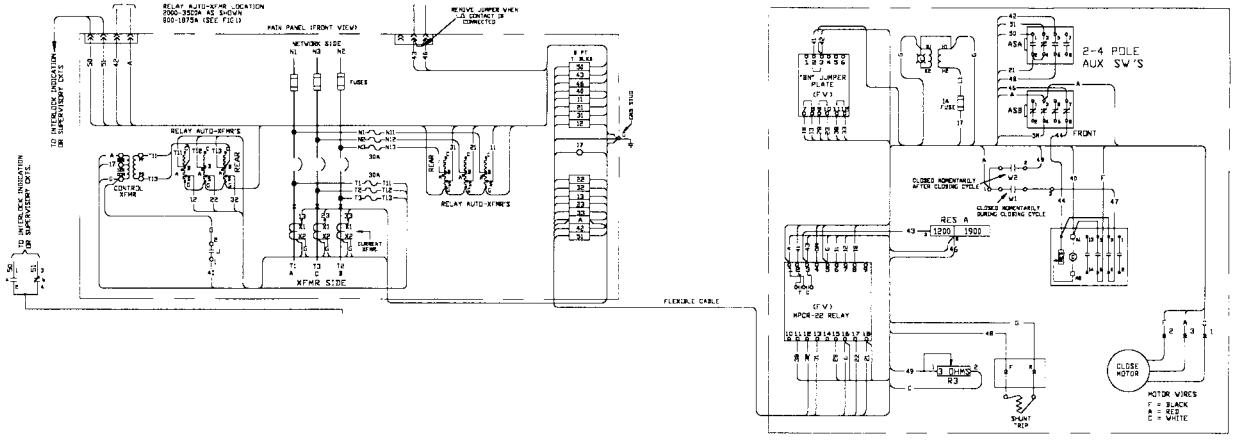
J	Aux. Sw. On Handle Shaft, Closed Only With Handle In "Auto" Position
C	Motor Control Contactor
W1	Motor Cutoff Switch
a	Aux. Switch Contact Open When Protector Is Open
b	Aux. Switch Contact Closed When Protector Is Open
BN	BN Relay
MPCR	MPCR-22 Relay
W2	Brake Switch
F	Front
R	Rear
R3	Adjust To Insure W2 Will Open After Close Operation

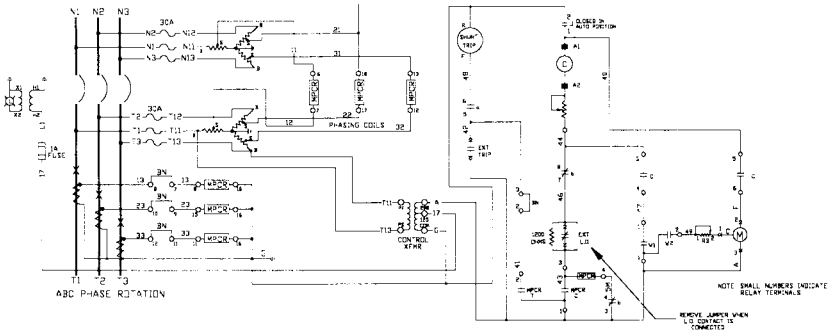


PHASE ROTATION

MPCR-22 Relay Provides All Network Functions

SWINGING ASSEMBLY
(FRONT VIEW)

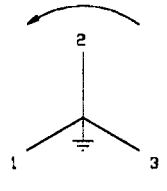




SCHEMATIC DIAGRAM

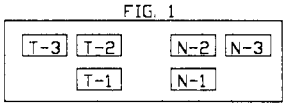
LEGEND

J	Aux. Sw. On Handle Shaft, Closed Only With Handle In "Auto" Position
C	Motor Control Contactor
W1	Motor Cutoff Switch
a	Aux. Switch Contact Open When Protector Is Open
b	Aux. Switch Contact Closed When Protector Is Open
BN	BN Relay
MPCR	MPCR-22 Relay
W2	Brake Switch
F	Front
R	Rear
R3	Adjust To Insure W2 Will Open After Close Operation



PHASE ROTATION

FIG. 1



MPCR-22 Relay Provides All Network Functions

SECTION 4 — MAINTENANCE

4.1 INSPECTION

Note: Review SAFETY INFORMATION on pages 3 and 4 before any inspection is performed.

Annual inspection and testing of CM-22 protectors is recommended for maintaining the protectors in the best operating condition. The shortest and most reliable procedure will be to first make a mechanical inspection and then make electrical tests of the protector operation. The procedure should include an overall operating test to precede replacing the protector in service; this is important in order to ensure that the protector is in the proper operating condition.

Note: A record of maintenance on each protector should be kept and should include "date", "operation counter reading", "condition found", and "work performed".

With the aid of a network protector portable test kit, complete electrical tests and relay calibrations may be made readily on the protector in the field. It is recommended that parts which function incorrectly, especially relays, be returned to the laboratory for any necessary repairs or adjustments. For description of methods of adjustment on the relays refer to the relay instruction book I.B. 35-580A for electro-mechanical relays and I.B. 35-581A for solid-state relays.

WARNING

BEFORE MAKING ANY INSPECTION OR TEST OF THE PROTECTOR OR RELAYS, IT IS IMPORTANT TO ISOLATE THE PROTECTOR FROM THE TRANSFORMER AND NETWORK FOR SAFETY DURING THE PROCEDURE. REFER TO PARA. 3.4. THE ISOLATION IS ACCOMPLISHED BY PLACING THE OPERATING HANDLE IN THE OPEN POSITION AND FIRST REMOVING THE LINKS FROM THE TRANSFORMER SIDE AND THEN THE FUSES FROM THE NETWORK SIDE OF THE PROTECTOR. NOTWITHSTANDING THIS PROCEDURE, WORK SHOULD BE DONE CAUTIOUSLY SINCE IT MUST BE ASSUMED THAT THERE IS VOLTAGE ON THE NETWORK LEADS, AS WELL AS THE TRANSFORMER LEADS. FOR DETAILED PROCEDURE, REFER TO PARA. 3.1.

WARNING

LOCK PROTECTOR IN OPEN POSITION, AND VERIFY THAT THE PROTECTOR IS OPEN AND DE-ENERGIZED BEFORE INSPECTION. FAILURE TO HAVE THE PROTECTOR IN THE OPEN AND DE-ENERGIZED POSITION COULD RESULT IN DEATH, SEVERE PERSONAL INJURY OR PROPERTY DAMAGE.

4.1.1 Circuit Breaker - Inspection

1. See that all electrical connections are tight.
2. See that all springs are in their proper places and that none are broken.
3. See that all nuts, pins and screws are in place and tight.
4. Check all current carrying parts for evidence of overheating.
5. See that all circuit-breaker contacts are clean and make good contact.
6. See that, when the breaker operates, the arcing contacts make contact before the secondary contacts and that the secondary contacts make before the main contacts.
7. Check all barriers and see that none are broken.
8. Check all connections on the terminal blocks and see that all are tight.

4.1.2 Relay and Mechanism Frame - Inspection

1. See that all electrical connections are tight.
2. See that all springs are in their proper places and that none are broken.
3. See that all nuts, pins and screws are in place and tight.
4. See that bumper is intact and extends above its socket.
5. Make certain that the red mechanism bolt is tight before operating the protector.
6. With the breaker open there should be a minimum of 1/64-inch clearance between the roller mechanism and the bearing plate on the moving contact assembly.
7. Check all barriers and see that none are broken.
8. Check the motor control relay and the cutoff switch to see that they are making good contact.

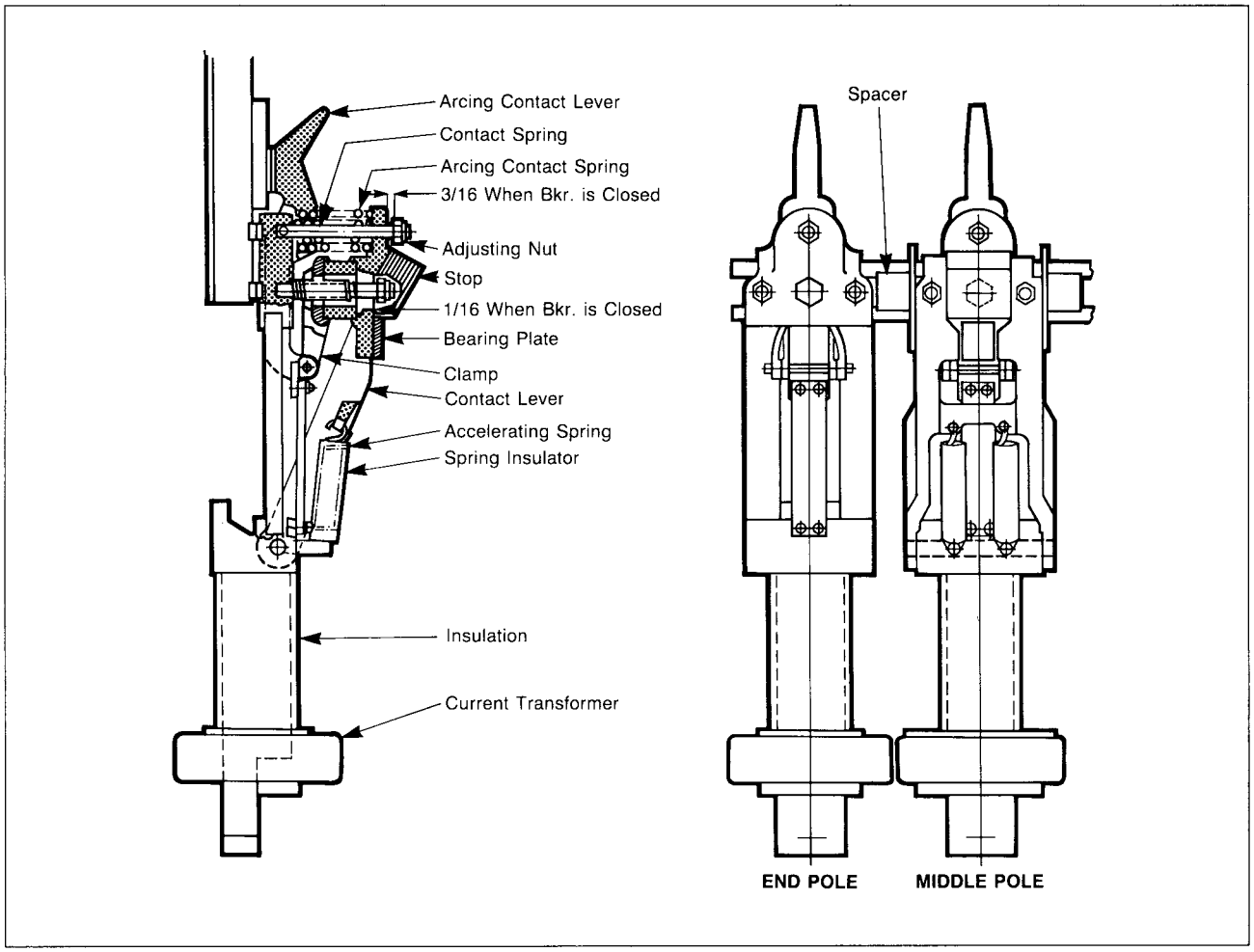


FIG. 14 *800-1875 Ampere Moving and Stationary Contact Assembly*

4.1.3 Enclosure - Inspection

1. See that all electrical connections are tight.
2. Check the fuses, links and terminals for evidence of overheating. If lead-alloy fuses are used, check for proper tension at the alloy element. (Refer to Para. 5.5.3)
3. Check enclosure parts for corrosion.
4. Check all barriers to see that none are broken.
5. Check the housing for watertightness.

4.2 MAINTENANCE

Note: Review SAFETY INFORMATION on pages 3 and 4 before any maintenance is performed.

4.2.1 Stationary and Moving Contacts 800 to 1875 Amperes Inclusive

1. *Flexible Connectors.* The flexible connectors to the main contacts should require little attention except that care should be taken to see that they are not damaged mechanically in any way. The design of these connectors is such that they have long life and hence replacements should be required only in very rare instances.

2. *Main Contacts.* It is important that the main contacts at all times be in good condition; a little attention, well directed, will keep them in good condition. The contacts should be protected from dirt and erosion.

In case the silver contacts become pitted, they must be made perfectly smooth before being placed in operation. Minor pitting may be repaired by a skilled workman using a very fine file or crocus cloth, but extreme care must be exercised to see that the surfaces are left smooth and straight. After the protector has opened a severe fault, it is recommended that all contact surfaces be inspected and repaired as found necessary. Dirty contacts must be cleaned so that burning does not result.

3. *Arcing Contacts.* The circuit-breaker arcing contacts are of an arc-resisting metal and should last the life of the protector. These contacts must have a substantial initial spring tension. When the breaker is opening, the arcing contacts must remain in contact until the main contacts of the circuit breaker are approximately 3/16 inch apart; when closing, they must make contact at the same point. This clearance distance is affected by the adjustment of the contact adjusting nuts, which produce the initial spring deflection of the spring behind the alloy contacts. After a severe interruption, the arcing contacts may require dressing up.

4.2.2 Stationary and Moving Contacts 2500 and 3500 Ampere

1. *Blades.* The 2500 and 3500 ampere units have moving contacts of the hinged blade construction. The contact surfaces on the blades are serrated in the direction of motion and should require no maintenance. The contact surfaces on the stationary contact which match up with the blades should be kept perfectly flat and smooth at all times. Minor pitting may be repaired using a very fine file or crocus cloth.

2. *Graphite Grease.* A light coating of graphite grease is applied to the upper and lower end of the blades to reduce friction. The coating of grease applied at the factory should last the life of the protector. If grease is applied, use sparingly, since it is a conducting material and may be harmful if splattered around the moving contact assembly.

3. *Arcing Tips.* The arcing tips are made of a special arc resistant metal. After a severe interruption the arcing contacts may require dressing up.

4.2.3 Fuses.

1. Whenever the links or fuses are replaced in a protector, care should be taken that all contact surfaces are in good condition and that good electrical contacts are made. The surfaces must be smooth and clean and securely clamped. The clamping hardware for fuses is captive, consisting of a steel nut, washer and lockwasher as a unit assembly. Make certain that all connections are tight. Torque to 50 ft-lbs. for all ½ inch studs and hardware.

2. In case a fuse has blown, any deposits from the fuse must be removed. The deposits left by the melting of an alloy or copper fuse are conducting, and must be removed, and the circuit breaker parts cleaned as found necessary.

3. The fuses at the upper end and the line-contact disconnect links at the lower end connect the breaker unit to the protector terminals. The contact surfaces to which these links and fuses bolt should be lined up to assure a good contact and to prevent undue stress in the fuses. The fuse mounting surfaces should be parallel and displaced from each other by not more than 1/32 inch. Check tension of alloy fuses per Para. 5.5.3.

4. The "De-ion" arc chamber requires no maintenance beyond periodic inspection to see that the path between the splitter plates is kept open, particularly on non-submersible protectors.

5. A switch which is in the motor closing circuit is located on the hand operating shaft near the lower left hand corner of the main panel. The switch should make contact only when the handle is placed in the AUTO position. No adjustment is required on the switch but it should be inspected periodically to see that the contacts are in good condition.

4.2.4 Main Barrier

The main barriers of the circuit-breaker, which segregate the poles in the vicinity of the fuses and "De-ion" arc chutes are built in units and may be removed by removing two retaining bolts. AN ENERGIZED PROTECTOR SHOULD NOT BE OPENED OR CLOSED WHILE THE BARRIERS ARE REMOVED. Fixed barriers are located at other points for the purpose of protection to workmen while working on or around the protector, or for protecting vulnerable parts of the protector at times of severe circuit interruption.

4.2.5 Current Transformers

The current trransformers on the pole units operate in conjunction with the master relay to trip the protector on reverse power flow. The secondary current of these

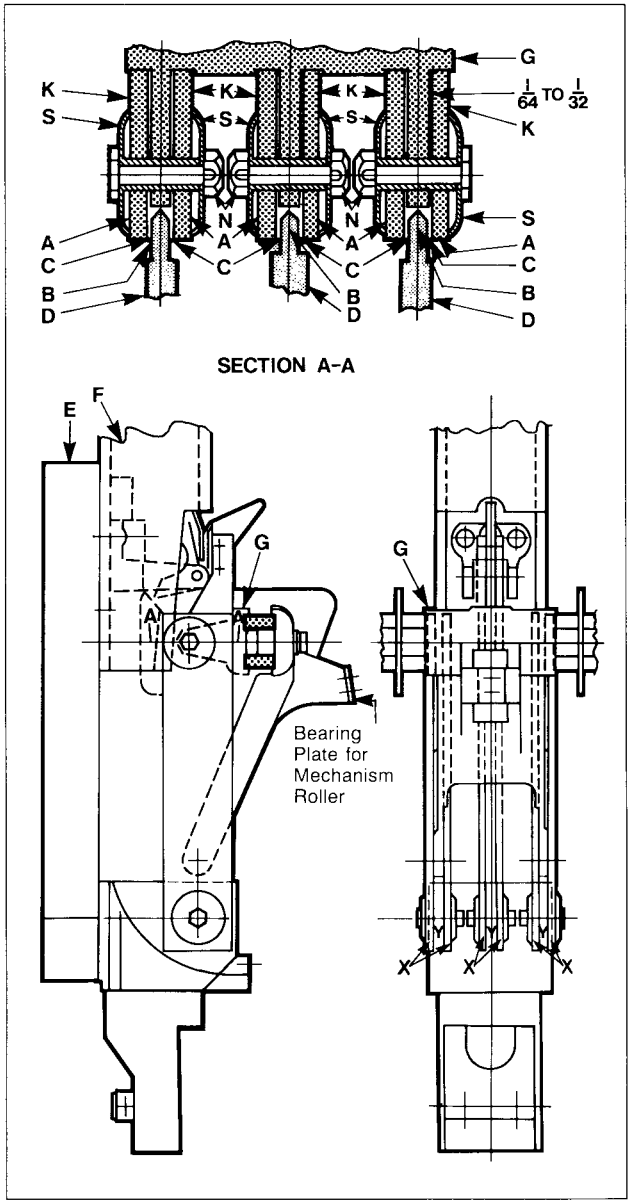


FIG. 15 *2500 and 3500 Ampere Moving and Stationary Contact Assembly*

current transformers at normal full load of the protector is 5 amperes. For a given type of relay the current transformers for the various ratings of protectors are so designed that a relay with a given setting will have the same setting (in percent of CT primary) for any ampere rating protector on which it may be mounted.

It is essential that the current transformers be connected with proper polarity in all cases. The current transformers carry a white mark on one face adjacent to one of the secondary terminals. This mark indicates the polarity terminal for both the primary and the secondary. The mounting of the current transformer in the protector is always with this white mark toward the top of the protector.

For the proper connection of the secondary terminals of the current transformer, reference should be made to the diagram received with the order, since the particular connection will vary depending on whether the top or the bottom terminals of the protector will be connected to the network. With electro-mechanical relays, one side of the current transformer secondary is usually connected to the copper conductor on which the transformer is mounted, and this portion of the circuit then becomes common to the current and phasing circuit of the master relay.

4.2.6 Miscellaneous

On protectors where an air dashpot is used to decelerate the moving contact assembly during the opening stroke of the breaker, the dashpot should be inspected annually to see that it is working properly. A light oiling and cleaning may be required to keep the dashpot in correct working order.

There is no part of the operating mechanism which should require lubrication other than the original lubrication given at the factory.

The motor brushes have long life and should require renewal or attention only after extended periods of service. Annual inspection is recommended.

The shunt trip and two lead closing motor assembly units are arranged very much alike. To remove either unit, first unscrew the two captive hexagon head bolts which have their heads projecting below the edge of the frame of the unit. The unit can be withdrawn downward and the electrical connections will part automatically at the double pole butt-contact connector. On three lead motors, a separate polarized 4 pole connector must be first disconnected from the base located on the mechanism frame before removing the motor.

When replacing the shunt trip, make certain that the trip lever on the shunt trip unit assembly is seated properly beneath the trip lever on the mechanism assembly. This assembly is made easiest when the relay

panel is swung away from the circuit breaker unit and the manual trip lever in the front of the mechanism is depressed.

When replacing the closing motor unit see that the half of the coupling which is at the end of the motor shaft is turned to a position in which it will enter the half on the worm shaft. If either the motor or the shaft to which it is coupled is rotated manually, be sure the direction of rotation is as shown on the motor. Reverse rotation of the motor will cause the mechanism to jam and break the key which fastens the worm gear to the worm gear shaft.

Located inside the motor mechanism and mounted on the worm gear shaft is the motor cut-off switch. This switch requires no adjustment but should be inspected periodically to make certain that the contacts are in good working order. Failure of this switch to maintain good contact during a closing stroke can cause the protector to stall in the partly closed position and thus be damaged due to over-heating caused by lack of contact pressure.

The auxiliary switch located in the upper right hand corner of the relay panel should require no maintenance during the life of the protector. A wiping action between contacts during the operation of the switch tends to keep these contacts clean and in good working order.

The auxiliary motor control contactor should require little care beyond periodic checking of the contact surfaces to see that adequate contact is maintained.

In general, the circuit breaker and relay panel parts should require less attention on submersible units than on non-submersible units. On submersible units, dust and dirt particles are less likely to get into the working parts of the protector and consequently longer life will result.

4.3 SUBMERSIBLE HOUSING

The paint finish on the housing should at all times be kept in good condition to prevent corrosion. In case the finish becomes noticeably marred or removed it should be suitably repaired with rust resisting paint.

4.3.1 Leak Testing

It is recommended that each submersible protector be inspected regularly for leaks. For the usual installation a yearly inspection is recommended, with more frequent inspections for those locations subjected to frequent submersion.

On new installations or after a gasket has been replaced, a retightening of door bolts should be made in about six or eight weeks, followed immediately by a test for leaks. Further tightening of gasket joints should be made as required.

1. The test for leaks is an internal air pressure test from three to seven pounds per square inch, depending on the method of procedure. A test pressure of three pounds may be placed in a cold protector and allowed to stand for twenty-four hours with the protector placed in service during the test period. The twenty-four hour load-cycle may generate sufficient heat to raise the internal pressure another three pounds, making the total pressure approximately six pounds per square inch. **Pressures greater than seven pounds should not be allowed to remain in the housing for any appreciable length of time.** Leaks are evidenced by drops in pressure during the twenty-four hour period. However, air may escape from the protector through the strands of connected cables and this fact must always be considered in making the twenty-four hour test. The short time test at seven pounds pressure, using soap-water as a leak indicator at all joints, is satisfactory for determining the location of any leaks.

2. The usual pressure testing outfit consists of the following:
   Bottled nitrogen.
   Pressure reducers, gauges and connections.
   Soap-water and brush.

3. Each submersible housing is equipped with either an air test device or a tapped hole to receive a pressure test connection. There are three types of test valves which can be supplied with the protector namely; Schrader, Belknap 994 and Waterbury 325. The Belknap 994 test valve is operated by a Belknap 994-0 valve which automatically opens the valve as it is screwed in place. The 994 valve is equipped with a fine screw thread and remains locked in place automatically. The Belknap 994-0 connector is equipped with an outlet for rubber hose connection.

   The Waterbury 325 value is sealed by means of two tapered surfaces, one in the plug cap and one in the main body of the valve. To unseal, unscrew the large hexagonal nut until it backs up tightly onto the underside of the small hexagonal cap nut. A further careful backward turn will then release the tapered seal and remove the plug cap assembly. When

reassembling the cap nut assembly to the main body of the valve, all threads must be clean and the tapered sealing surfaces must be clean and well lubricated. The plug cap is then hand tightened onto the main valve and a further one-eighth to one-quarter turn with a wrench will then seal the valve. The operating device for the Waterbury 325 test value is the Waterbury 315 valve which is screwed on to the 325 test valve.

4.3.2 Gasket Materials

In general, three different gasket materials are used at various places on the housing as follows:

Material	Application
1. Neoprene	Housing Cover Inspection Windows Hand Operating Flange
2. Molded Composition Packing	Operating Handle Shaft Gland
3. Nitrile Rubber	Entrance Bushing Flanges

The Neoprene cover gasket is an extruded round synthetic rubber tubing, which is oil and solvent resistant, colour black, 3/8 inch I.D. and 1 1/4 inch O.D. It is intended that the housing cover may be opened and closed a large number of times before Neoprene gasket renewal is required. Lubriplate 130A should be used between the gasket surface on the housing and the Neoprene gasket to prevent sticking.

The Nitrile rubber bushing gasket is a black heat-resistant synthetic rubber, shore hardness 65, in 3/8 x 3/8 inch cross-section, retained in a slot on the base of the bushing flange inside the perimeter.

4.3.3 Threaded Plugs

It is usually desired to have threaded plugs easily removable and hence it is recommended that such plugs be screwed in place with Teflon tape. This procedure makes a tight seal, and the plugs are easily removed.

4.4 REPLACEMENT OF COVER GASKET AND REVERSAL OF HANDLE

(Replacement of cover gasket and adjustment of cover on a quick opening housing with sliding hinge centers.)

4.4.1 Gasket Replacement

1. The cover may be removed from the housing so that the work may be done more readily since no centering adjustments are disturbed by removing the cover. Referring to Fig. 17, take out the cotter pins and the stop nuts "A" on the bolts "C" on the hinged side. The hinge bolts should be loosened first about ½-inch so that when the bolts "D" on the opening side are loosened, all gasket pressure is released before any bolts are completely removed. The removal of the clamping and hinge bolts from the blocks "E" will then free the cover from the housing.

2. Remove the old gasket and clean the steel bearing surfaces on the cover and housing so that these surfaces are free from dirt, lumps of paint and particles of old gasket.

3. Cut the gasket length 8 to 10 inches oversize. Cut the ends of the gasket in a smooth plane at right angle to the axis of the gasket. Start by applying a light coating of lubriplate 130A to the gasket retainer channel. The gasket is initially tacked into position at about 10 points on the 4 corners and 4 sides with some excess between each point. Each loop should be about the same length. The two ends of the gasket should be located near the center of one of the long sides of the cover and are inserted last. The gasket is inserted at each tacking point preferably with the aid of a tool such as wide nosed pliers.

   Take care when inserting the gasket so that in its final position the gasket is free from twist, waves or tool marks. Continue by inserting the center points only of each loop around the circumference of the door. Repeat this procedure 2 or 3 times as necessary to completely insert the gasket into the retainer. The ends of the gasket are inserted last. Take about 8 to 10 inches at each end of the gasket so the flat ends can be butted together and inserted into the retainer. No cement or seal is necessary on the ends. The gasket length is 8 to 10 inches in excess of the door circumference and is in compression to ensure a reliable seal. After the gasket is completely inserted as described above, pound it around the entire circumference with a heavy rubber mallet to ensure it is securely in place in the retainer channel.

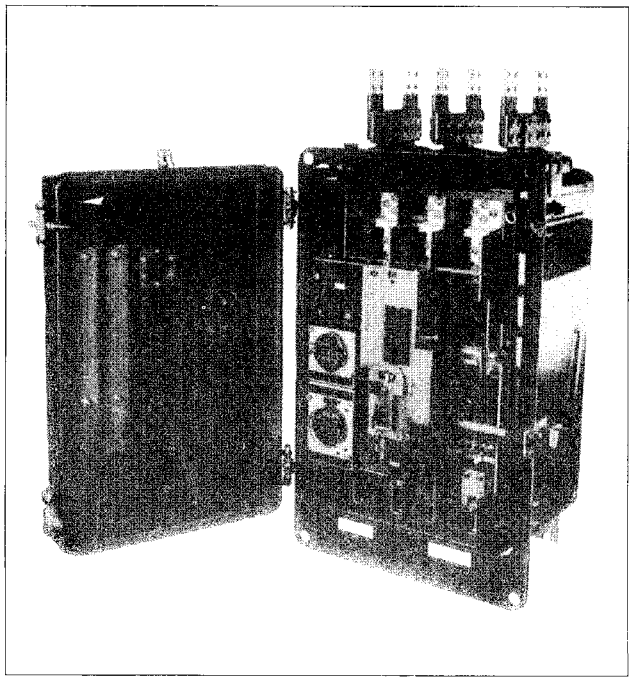


FIG. 16 *2500-Ampere Submersible Housing with Sliding Hinge Centers.*

4. Cover the exposed portion of the gasket with Lubriplate 130A to keep the gasket from sticking to the housing.

5. Reassemble the cover on the housing and tighten bolts "C" and "D" until the housing is watertight. Take the bolts down evenly to obtain a uniform deflection of the gasket. A torque of 300 pound inches on the bolts should be sufficient to obtain a watertight seal on the cover gasket.

6. On the hinged and opening sides of the housing, stop nuts "B" are run against the support block "E" on the housing and the two nuts are jammed together to act as a stop for the bolts. Stop nuts "A" are now assembled on the hinge bolts "C" allowing space between nuts and block "E" so that there is sufficient bolt movement available to release the gasket pressure on the hinged side.

7. Replace the cotter pins on hinge bolts "C" to prevent accidental removal of these bolts.

4.4.2 Adjustment of Gasket

When a cover needs additional tightening for watertightness, loosen the stop nuts "A" and "B" and proceed as in 5 and 6 above.

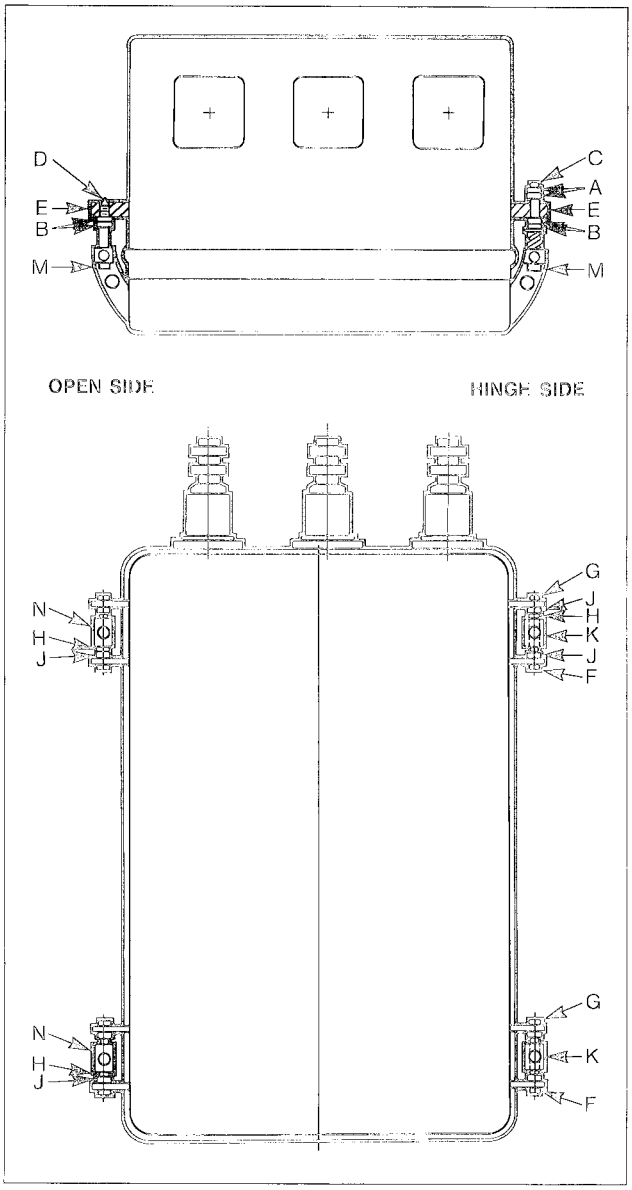


FIG. 17 *Sliding Hinge Details*

4.4.3 Centering the Cover on the Housing

If for any reason it becomes necessary to center the cover on the housing proceed as follows:

1. Set the cover guides inside the housing so they will support the cover in the correct vertical position.

2. Slide the cover horizontally until it is in the correct position.

3. On the hinged side of the housing the subassemblies, each consisting of the hinge bolt "C", the hinge

block "K", the spring and the two stop nuts "B", are threaded into support blocks "E" on the housing until lower pivot pins "F" can be inserted. The upper pivot pin "G" must have the correct number of spacing washers "H" between nut "J" and hinge block "K" to support the cover in the correct position vertically. The pivot pins "F" and "G" are now clamped in place by tightening nuts "J". With all pivot pin assemblies on the hinged side in place and securely tightened, the cover may be swung several times to see that its location is correct on the housing. If necessary the pivot pins "F" and "G" can be moved horizontally by sliding these pins in the slot in the hinged bracket "M". Vertical adjustment is provided by the spacing washers "H".

4. The clamping bolts on the opening side of the housing may now be assembled in a manner similar to the one used on the hinged side. The bolt should be positioned to enter the tapped hole in the housing support block "E" as freely as possible. Vertical adjustment of these bolts is obtained by means of washers inserted at the lower end of swivel block "N".

5. The stop nuts may now be set as previously described.

4.4.4 Reversal of Hinged Side of Cover

To reverse the hinged side of the cover, the detachable assemblies mounted on hinge brackets are interchanged from one side to the other. Remove the cover from the housing and the pivot pin assemblies from the cover and proceed as described in "Centering the cover on the housing", Para 4.4.3.

4.4.5 Operating Handle

The packing gland for the shaft of the hand operating mechanism should require little attention since it is seldom used. Occasional tightening of this gland to compensate for compression set in the gaskets may be required to keep a watertight seal.

4.4.6 Reversal of Handle

To change the operating handle of the housing from one side to the other, proceed as follows:

1. Remove the operating handle from the housing auxiliary shaft by removing the bolt which fastens the two members together. See FIG. 18.

2. The circuit breaker unit is then dismounted from the housing and the housing auxiliary shaft removed from the housing.

3. Change the tongue end of the shaft from one side to the other on the circuit breaker.

4. The handle packing gland details consisting of the locking piece, gland, bearing, packing, and auxiliary shaft are removed from the operating handle side and the dummy plate is removed from the plug side.

5. The operating handle details and dummy plate are interchanged from one side of the housing to the other and re-assembled.

6. Assemble the operating handle to the housing.

7. Make certain that all gasket and gland connections on the operating handle and dummy side are watertight.

4.5 NON-SUBMERSIBLE HOUSING

Non-submersible enclosures require little attention except to see that the finish on the enclosure remains in good condition and that none of the barrier material is broken or damaged.

4.6 ADJUSTMENTS

Note: Review SAFETY INFORMATION on pages 3 and 4 before any adjustments are performed.

4.6.1 Circuit Breaker, 800 to 1875 Amperes Inclusive

1. For satisfactory operation of the circuit breaker, all contacts must be in good contact and be under full pressure. To be sure of these conditions, it is necessary that the circuit breaker be closed to the proper point, which condition exists when the main contact spring is compressed 1/16 inch after the main contacts first touch. At the same time the transfer contact springs should be compressed 3/16 inch beyond the position where the tips first touch. See Fig. 14. It is important that these contact adjustments be maintained, not only in order that

there shall be suitable pressure, and freedom of contacts to seat properly, but also to assure correct sequence of parting of main and arcing contacts. It is necessary that the adjusting nut for the main contact spring be so set as to have 1/16 inch clearance when the circuit breaker is latched closed (in which position the contact spring should be compressed 1/16 inch beyond its initial compression).

4.6.2 Circuit Breaker, 2500 and 3500 Amperes.

1. The 2500 and 3500 ampere CM-22 network protectors have a blade type contact construction as shown in FIG. 15.

   There are three pairs of moving blades for each phase that engage three contact members "D" on the stationary conductor "F" when the contacts are closed.

2. The contact pressure is provided by means of spring washers "S", one on the outside of each moving blade. Adjustments in this pressure are made by tightening or loosening a nut and bolt on the outside pairs of blades and two nuts on the center blades. A castellated nut or elastic stop nut is used which can be locked to the bolt or stud with a cotter pin after final adjustments have been made.

3. After the contacts have been aligned properly, and have been set at the proper pressure, the stationary and moving conductors "F" and "H" are doweled to the panel "E" to prevent any subsequent movement. In view of this, no adjustment of these conductors should be necessary in the field.

4. If for any reason the contact pressure must be set in the field, it is necessary first to make sure that the three castings "G", are properly located and securely fastened to the cross-bar. Proper location of these castings on the cross-bar consists of maintaining the 1/64 to 1/32 dimension between the blades "K" and the casting "G" shown in section "AA". After this has been done, the contacts should be checked with .0015 feeler gauge. If this feeler is inserted between the moving and stationary blades at point "C", it must not enter for a length more than ½ inch. This still leaves approximately 1½ inch contact. A slight increase in contact pressure will close this gap when necessary.

   Following this, the contact pressure on each individual blade can be adjusted. With 1000 amperes d-c on each phase, the milli-volts drops "AB" across the moving and stationary blades must be between two and three milli-volts. All the drops on one phase should be checked, after which, adjustment can be made on those contacts that show the greatest variation above these limits. This should provide for a minimum number of adjustments before a nearly equal current distribution is obtained between the various contacts of one phase.

   Any necessary adjustments can then be made by loosening or tightening the nuts "N" depending upon whether the drop across the contacts needs to be increased or decreased. Be sure to open and close the protector a few times to seat the contacts properly after each change in contact adjustment and before taking a milli-volt drop reading. To guard against excessive pressure on the contacts, the milli-volt drop should not be permitted to go below one milli-volt on any one contact with the average on all eighteen contacts of the three phases maintained at approximately 2 milli-volts.

5. When all these adjustments have been made, the contact nuts should be locked in place by means of cotter pins.

6. Although no field adjustment should be necessary at the blade hinged point, the milli-volt drop "XY" should be maintained at approximately one to two milli-volts if there should ever be need for adjustment at this point.

7. As a final check, the protector should be operated electrically a number of times at the minimum closing voltage per Table 3 to make sure that the motor is strong enough to close the contacts fully at all times, and that the contacts do not stick in the closed position due to excessive pressure when the protector is opened by means of the shunt trip. Finally, the protector should be partially closed manually several times to make sure that it does not stick in a closed or partially closed position due to excessive contact pressure at any point of its travel.

8. On each pole, the outer two sets of blades act as the main contacts and the middle set on the serrated portion as the secondary contacts. The arcing con-

tacts are located on the middle set of blades above the secondary contacts. When the protector is closed, when the arcing contacts just touch, there should be a minimum of 3/32 inch gap at the secondary contacts to assure proper operation of the protector when carrying rated current or interrupting fault currents.

9. The contact opening is adjusted by means of the two air dashpots located on the ends of the cross-bar. When the protector is in the open postion, the contact opening at the arcing tips should be between ¾ and $^{7}/_{8}$ inch. The setting is made by loosening the nut on the rod of the dashpot assembly and rotating the piston to the correct position. This adjustment must be made with the circuit breaker open and the mechanism securely fastened to the circuit breaker unit. Care must be used to see that a minimum of 1/64-inch clearance remains between the mechanism roller and the hardened plate on the cross-bar assembly on which the roller bears when closing the protector. After the piston has been placed in the correct position, the nut is jammed up tight against the piston, locking the assembly in place. Two holes are in the piston so that it may be held in place during the locking operation.

4.6.3 Operating Mechanism Adjustments

The shunt trip adjusting screw is shown at the bottom of FIG. 11. Adjustment of the screw fixes the position of the trip lever, which acts as a stop for the latch toggle. Final adjustment of the set screw is made while the shunt trip is in place on the mechanism. Latch toggle loads, which the trip magnet must overcome when tripping the breaker, are reduced by turning the screw clockwise, or increased by the reverse movement.

In general, a light load is desirable, which means that the screw should be so adjusted as to allow the latch toggle to pass only slightly over center. Too light an adjustment is to be avoided, since it may allow the breaker to trip due to mechanical shock or vibration. Installations which are subject to vibration require a latch toggle setting farther over center than that required under steadier conditions.

A good adjustment for average conditions can be made by removing the latch spring and setting the latch toggle so that it will just barely hold the breaker closed during a closing operation. When the spring is restored to its position the additional holding-in force which it provides will be sufficient for the majority of cases.

The resistor associated with the motor closing contactor should be so adjusted that the contactor will be picked up at 80% of normal voltage as described in detailed tests of the operating mechanism. Since the operating motor will close the protector at 70% of rated voltage, a pick-up adjustment of 80% of normal voltage on the relay assures that the motor will always receive enough energy to close the breaker positively.

The operating arm of the operation counter may be adjusted as follows:

The clamping screw in the arm of the counter should be loosened until the arm may be moved on its shaft, but still has sufficient friction to operate the counter. With the clamp screw so set, place the arm in approximately the correct position. Operate the protector several times to see if it counts correctly. If it has counted correctly, the arm is set properly and the clamp screw may be tightened in place. If it has failed to count, shift the arm on the shaft a slight amount in the proper direction and repeat.

4.6.4 Enclosures

Should a quick opening housing require additional tightening of the cover to obtain a water-tight seal, the adjustment may readily be made in the field. If a torque wrench is available, a torque of 300 pound-inches applied to each of the clamping and hinge bolts as described in Para. 4.4.1 should produce a watertight seal. In case a torque wrench is not available, the stop nuts at all the clamping points should be backed off a uniform amount and the cover tightened to the new stop position. This procedure should be done in about 1/16 inch steps.

Note: Non-submersible enclosures require no adjustment.

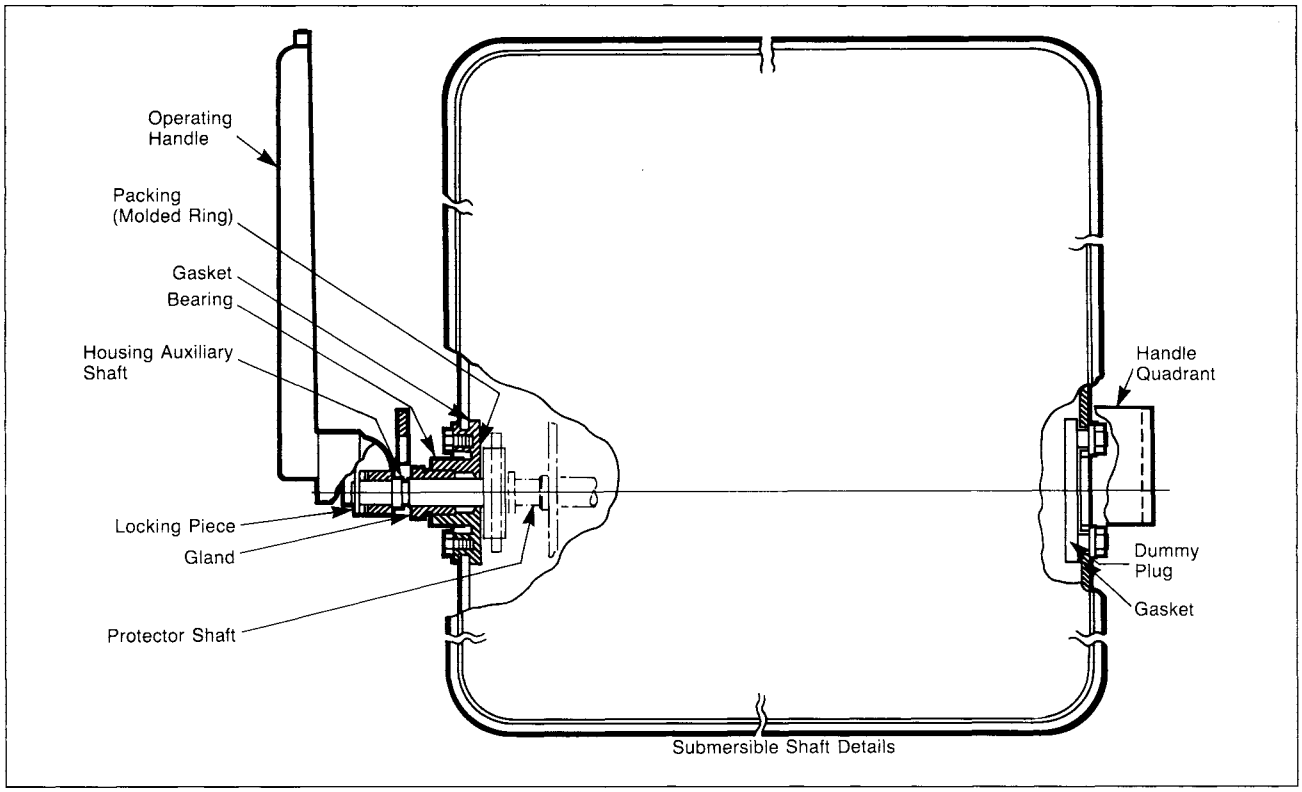


FIG. 18 *Shaft Details for Submersible Housings*

4.7 ELECTRICAL TESTS

WARNING

ANY MECHANICAL OR ELECTRICAL MODIFICATION TO ANY NETWORK PROTECTOR REQUIRES THAT THE NETWORK PROTECTOR BE GIVEN APPROPRIATE ELECTRICAL TESTS, USING PROPERLY MAINTAINED TESTING DEVICES, BEFORE PLACING INTO SERVICE. FAILURE TO PERFORM SUCH ELECTRICAL TESTS CREATES CONDITIONS LEADING TO THE POSSIBILITY OF DEATH, SEVERE PERSONAL INJURY OR PROPERTY DAMAGE.

The purpose of electrical tests in the field is to determine whether the protector and relays are in proper working condition. Such tests will be most effective and reliable and will be facilitated by employing the simplest practicable test methods and connections. It is desirable to check, by means of electrical tests, as many as possible of the electrical and mechanical functions of the protector. Electrical tests should be conducted on all new units after receipt, during periodic inspection and maintenance procedures, and after any mechanical or electrical modification to the network protector.

4.7.1 Electrical Test Procedures

All electrical tests should be performed with a three-phase network protector test kit and multimeter, with the breaker rolled out on its rails, as described in Para. 3.1.

A complete description of the electrical test procedure at system operating voltage is provided in I.B. 35-556A for electro-mechanical relays and I.B. 35-581A for solid-state relays.

When re-energizing the network protector after satisfactory completion of electrical tests, follow procedures described in Para. 4.7.4, Safety Probe Procedure.

4.7.2 Maintenance Electrical Test

Periodically, two tests should be performed on the CM-22 network protectors, particulary if the unit has been re-wired or re-built in any manner. These tests are the dielectric and ductor tests. If these tests are performed at the same time as the operations tests referred to in Para. 4.7.1 it is preferable to do these tests first and then the operation tests.

Dielectric Tests - Rollout Unit

The network relay(s) must not be installed. Remove all other test connections. Disconnect motor, rectifier, lighting transformer, remove light bulb, and lift all ground connections. With grounding wire, tie the relay socket terminals and all wiring terminals together, but avoid touching any grounded area with the shooting wire.

With breaker closed, apply 2200 volts, 60 Hz, for 1 minute between the following parts:

A. Three phases interconnected and ground
B. Two outside phases and ground, center phase grounded
C. Control wiring terminals and ground
D. Trip coil leads and ground.

NOTE: The above value of 2200 Vac is meant to be applied to breakers of new manufacture. All other breakers, regardless of age, apply 75 percent of that value, which is 1650 Vac.

Lighting Transformer - see sheet

Motor - see sheet

Dielectric Test - Enclosure (Transformer bus only)

Disconnect all other test connections. Apply 5000 volts, 60 Hz, for 1 minute between:

A. Three phases interconnected
B. Two outside phases and ground, center phase grounded.

Note: The above value of 5000 Vac is meant to be applied to enclosures of new manufacture. All other enclosures, regardless of age, apply 75 percent of that value, which is 3750 Vac.

Ductor Test - Rollout Unit Only

Measure and record the resistance of each phase of the rollout unit, excluding disconnects. The maximum value per phase is:

800/1875 Amp.	15 Microhms
2500/3000 Amp.	11 Microhms
3500 Amp.	13 Microhms

Note: Ductor readings may be affected by amperage output of ductor as well as atmospheric relative humidity.

4.7.3 Safety During the Installation and Maintenance of 480 Volt Network Protectors

NOTE: Reference to 480 volt is typical only. The same instructions will apply to 400, 433 and 600 volt network protectors.

While proper safety practices on a 216 volt network system are extremely important, at 480 volts extraordinary care must be taken.

There is a basic difference between a 216 volt network and 480 volt network. There is the likelihood that a 480 volt arc will be self-sustaining, while a 216 volt arc will probably burn clear.

The following is a suggested outline procedure for installation and maintenance of <u>all</u> network protectors:

1. On submersible units, vent the unit by loosening the hinge bolts on side of protector opposite operating handle. Move network protector handle to TRIP position and open door of protector housing.
2. Remove disconnect links at bottom of rollout unit, using insulated wrench and insulated gloves.
3. Remove fuses. Use insulated socket wrench and insulated gloves.
4. Loosen bolts that fasten rollout unit to housing.
5. Install rail extensions and move rollout unit from housing.
6. Remove barriers as required, make a thorough inspection and clean all parts.

7. Check for:

   a. Frayed or damaged insulation on control wiring.

   b. Loose bolts or hardware. Pay particular attention to bolts and wiring at rear of main panel.

   c. Broken barriers.

   d. Shifting or movement of parts. Make certain there is proper spacing between phases and from phase to ground.

   e. Carefully check for cracked or damaged cross bar insulation.

   f. Search for indications of overheating and determine cause.

   g. Remove arc chutes and inspect contacts. Smooth contacts, if necessary.

   h. Adjust contacts, if necessary, to assure positive pressure.

   i. Inspect fuses to make certain they are not partially melted, damaged, or loose.

   j. Replace all parts and tighten relay panel. Operate protector manually.

   k. Connect test kit to rollout unit and perform operational tests as outlined in test kit instruction book. See Para. 4.7.1 herein.

8. Before connecting lower links or fuses, test between network connections and rollout unit with a fused test lead, as described in Para. 4.7.4.

9. Close housing door of protector and move handle to AUTO position.

The procedure for installing new protectors should be the same as for maintanance. Although protectors are thoroughly inspected and tested before leaving the factory, it should not be assumed that they will not suffer damage in transit. Also, in installation itself, considerable handling is required to move the protector to the job site and install it on the transformer.

THE NEED FOR STRICT SAFETY PRECAUTIONS IS IMPERATIVE.

4.7.4 Safety Probe Procedure

This procedure requires the use of a fused "Safety Probe" comprising two insulated leads with an in-line current limiting cartridge fuse holder located in the center and insulated test probes mounted at each end. The cartridge fuse should be rated at 1 ampere at 600 volts and be of the current limiting type suitable for use on systems with 100 kA fault capacity, similar to the BUSSMAN TYPE KTK-1.

After satisfactory test and relay calibration and before replacing any fuses or disconnect links, the following "Safety Probe Procedure" must be followed for all ratings of CM-22 network protectors. This ensures that no fault exists between the breaker main contacts, both transformer and network side, and the control wiring connected to the main contact bus.

Step 1 – Roll unit back into housing to installed position.

Step 2 – With insulated wrench, insert and tighten four captive bolts on main breaker back panel.

Step 3 – Swing relay panel closed and with insulated wrench tighten bolts securely on relay panel.

Step 4 – Replace rollout rails to stored position.

Step 5 – With protector breaker in tripped position, place one insulated test probe at breaker network fuse mounting position for Phase A and the other probe on network terminal bushing fuse mounting position Phase A.

Step 6 – Using light tester, bell tester or ohmmeter, check test fuse continuity across test probes.

Step 7 – If test fuse has not blown, install network fuse Phase A with insulated wrench and insulated gloves.

Step 8 – If test fuse has blown, roll unit back out and check protector and relays for phase-to-ground fault. (Repeat from Step 1.)

Step 9 – Place one insulated test probe on breaker network fuse mounting position Phase B and the other probe on network terminal bushing fuse mounting position Phase B.

Step 10 – Repeat Step 6.

Step 11 – If test fuse has not blown, intall network fuse Phase B with insulated wrench and insulated gloves.

Step 12 – If test fuse has blown, remove Phase A Network fuse and roll unit back out and check protector for phase-to-phase and/or phase-to-ground fault. (Repeat from Step 1.)

Step 13 – Place one insulated test probe on breaker network fuse mounting position Phase C and the other probe on network terminal bushing fuse mounting position Phase C.

Step 14 – Repeat Step 6.

Step 15 – If test fuse has not blown install Network fuse Phase C with insulated wrench and insulated gloves.

Step 16 – If test fuse has blown, remove Network fuses Phase A and Phase B and roll unit back out and check protector for phase-to-phase and phase-to-ground fault. (Repeat from Step 1.)

Step 17 – Use same procedure for testing transformer side of protector at disconnect link mounting positions. Starting with Phase A, etc. Use insulated wrench and insulated gloves.

Step 18 – Close protector door and latch in non-submersible unit, or tighten clamp bolts on operating handle side only, if submersible units.

Step 19 – Place operating handle in AUTO position.

Step 20 – Tighten hinge bolts on submersible units.

Step 21 – Pressure test submersible units.

SECTION 5 - OVERHAUL AND REPAIR

WARNING

REVIEW AND UNDERSTAND SAFETY INFORTION ON PAGES 3 AND 4 BEFORE ANY OVERHAUL OR REPAIR IS PERFORMED. FAILURE TO FOLLOW INSTRUCTIONS CONTAINED HEREIN COULD RESULT IN SEVERE PERSONAL INJURY, DEATH AND/OR PRODUCT OR PROPERTY DAMAGE.

5.1 SAFETY INSTRUCTIONS

1. When working on an energized protector, always use insulated tools and insulated gloves.
2. The protector should be in the OPEN position before the cover is fully opened.
3. Roll the protector out of the enclosure before checking or testing parts.
4. Work only on a de-energized protector, rolled out onto the extension rails.
5. Always move the operating handle to the OPEN position before the disconnecting links or fuses are removed.
6. Check to ensure that the breaker contacts have opened. Refer to Para. 3.4.
7. Any modification to any network protector, whether it be a complete wiring harness replacement or a motor replacement, requires that the network protector be electrically and mechanically retested, including tests referred to in Para. 4.7.1 and 4.7.2.
8. Use only the schematic and wiring diagram applicable to the specific network protector being worked on.

5.2 CHECK LIST OF EQUIPMENT TROUBLES

Note: This list may not be complete. The user should perform any inspection appropriate to the situation

5.2.1 Circuit Breaker

1. Failure of the circuit-breaker to close may be due to:
   a. Mechanism trouble.
   b. Obstruction in the circuit breaker.
   c. Poor connections to terminal blocks or relays.
2. Failure of the circuit breaker to open may be due to:
   a. Mechanism trouble.
   b. Friction in the circuit breaker.
   c. Contact welding.
   d. A broken accelerating spring on the circuit breaker.
   e. Poor connections to terminal blocks or relays.
3. Overheating of the circuit breaker may be due to:
   a. Overload.
   b. Low spring pressure on contacts.
   c. Circuit breaker not completely closed.
   d. Contacts in bad condition
4. Burning of the main contacts may be due to:
   a. Poor contact on the transfer contacts or in the circuit of the transfer contacts.
   b. Too light spring pressure on the transfer contacts.
   c. The main contacts of the circuit breaker closing ahead of the transfer contacts.
   d. Dirt or obstruction between contact surfaces.
   e. Circuit breaker opening too slowly (due to friction or broken accelerating spring).
   f. Light pressure on main contacts.

5.2.2 Mechanism and Relay Panel

1. Failure of the mechanism to close the protector may be due to:
   a. An open-circuit in the motor.
   b. A short-circuit or open-circuit in the control circuit of the motor.
   c. Worn-out motor brushes.
   d. Mechanical obstruction preventing the motor from rotating.
   e. Mechanical obstruction in the toggle mechanism.
   f. An open-circuit to the coil of the motor closing contactor.
2. Failure of mechanism to latch may be due to:
   a. Incorrect adjustment of the latch toggle.
   b. Friction in shunt trip rod or in latch toggle.
3. Failure of the protector to trip may be due to:
   a. An open-circuited shunt trip coil
   b. Friction or mechanical obstruction which prevents the tripping of the toggle.
   c. Improper operation of the auxiliary switch in the shunt trip circuit.
   d. An open control circuit through the master relay.

5.3 TOOLS FOR OVERHAULING AND REPAIR

In addition to the standard set of tools required normally for working on protectors such as wrench sets, pliers, screwdrivers, etc., the following special tools are necessary for safety and convenience.

1. Insulated Wrench, 3/4-in. Hex, short S_I718A212-G02 for small frame, and long S_I5765A20 G02 for large frame.This wrench is used to remove the fuses and disconnect links, open the housing and loosen the relay panel and main panel mounting bolts. Since the network side of the protector may always be energized, the insulated wrench should be used at all times when removing the fuses or links from the protector.

2. Wrench, 9/16-in. for 3/8 inch bolt head, used to remove the motor and shunt trip.

3. A pair of wide nosed pliers will be very helpful if it is necessary to replace the circular Neoprene gasket on the cover of submersible housings.

5.4 DISASSEMBLING INSTRUCTIONS

WARNING

ALL PROCEDURES IN SECTION 5.4 BELOW MUST BE PERFORMED ONLY ON A DE-ENERGIZED NETWORK PROTECTOR.

5.4.1 Removal of Rollout Unit from Enclosure

(Refer also to Section 3.1)

1. Place the operating handle in the OPEN position.

2. Remove the disconnect links and fuses in this order.

3. Loosen the panel mounting bolts located near each corner of the main panel. During this operation it is necessary to open the relay panel by loosening the two bolts which fasten the relay panel to the circuit breaker.

4. Place the extension rails in position.

5. Roll breaker out onto entension rails until front roller meets the rail stop.

5.4.2 Removing the Upper Stationary Contact

1. Remove the protector rollout unit from the enclosure.

2. Remove the main circuit breaker unit barriers.

3. Remove the arc chute and wiring from the stationary contact.

4. The stationary contact can now be removed by removing the two bolts from the rear of the main panel which fasten the stationary contact to the main panel.

5. On 2500 and 3500 ampere protectors the stationary contact is doweled to the main panel to prevent movement between the two members. If the stationary contact can be reused, it should be assembled on the same pole from which it was removed. If a new stationary contact is used, the contact should be doweled to the main panel after blade and fuse alignment has been made by using the dowel holes in the main panel as templates.

5.4.3 Removing a Current Transformer

1. Roll the rollout unit out on the rails.

2. Disconnect the current transformer leads.

3. On protectors rated 1875 amperes and below, remove the link stud located at the lower end of the moving contact assembly.

4. Withdraw the bolt at the lower end of the transformer and slide the transformer off the moving contact assembly.

5. See Para. 5.5.5 for current transformer style numbers.

5.4.4 Removing a Moving Contact Outer Pole 1875 Amperes and Below

1. Remove the protector rollout unit from the enclosure.

2. Remove the wiring from the moving contact. The current transformer may also be removed if so desired but this is not necessary.

3. Remove the main circuit breaker barrier and the arc chute.

4. Remove the screws which fasten the crossbar clamps to the crossbar and withdraw the contact springs for the main and secondary contacts by removing the two nuts used to adjust the contact pressure on the main and scondary contacts.

5. Remove the nut used to adjust the contact pressure on the arcing tip and withdraw the contact spring for the arcing tip.

6. Loosen the two bolts on the rear of the main panel near the bottom. These bolts are tapped into the block on the moving contact assembly. When loose, the moving contact may be drawn downward and completely removed from the circuit breaker.

5.4.5 Removing a Moving Contact Middle Pole 1875 Amperes and Below

Proceed as described under removing an outer pole except that the following additional steps are necessary:

1. The current transformer and the cross-bar must be completely removed by loosening up the cross-bar clamps on each pole and removing the two cross-bars. In order to remove the cross-bar clamp on the centerpole, it is necessary first to remove the insulated bumper on the moving contact assembly. This bumper covers up the head of the bolt used to fasten the cross-bar castings on the centerpole.

2. When the two bolts which fasten the moving contact assembly to the main panel are removed, the moving contact may be withdrawn by sliding it upward until it is free from the circuit breaker.

5.4.6 Removing a Complete Relay Panel and Mechanism

Note: Use only the wiring diagram applicable to the specific protector being worked on.

The swinging assembly consisting of the relay panel and mechanism can be removed as a unit from the circuit breaker. To do this, isolate the protector from the system and leave the operating handle in the OPEN position. Remove the wiring from the 8 point terminal blocks which runs over to the relay panel. Loosen the bolts which fasten the mechanism and the relay panel to the circuit breaker and swing the assembly outward. The assembly can now be lifted off the hinge frame on the circuit breaker unit.

The relay panel is mounted to the operating mechanism by means of four bolts. Two of the mounting bolts are located on the top front of the mechanism casting and two are located at the bottom of the casting below the motor. When separating the relay panel from the mechanism, the two wires running from the motor cut-off switch on the mechanism to the two terminal posts below the phasing resistor must be disconnected, the motor closing contactor must be removed, and the link which actuates the auxiliary switch must be removed.

5.4.7 To Remove Motor Closing Contactor

Note: Use only the wiring diagram applicable to the specific protector being worked on.

1. Disconnect all wiring from the contactor and mark their location for reconnecting.

2. Remove the screw located just above the contactor which fastens the contactor mounting bracket to the mechanism casting.

3. Remove the three screws from the front of the relay panel which fasten the contactor mounting bracket to the relay panel.

5.4.8 To Remove the Auxiliary Switches

Note: Use only the wiring diagram applicable to the specific protector being worked on.

1. With the rollout unit removed from the enclosure, remove the arc chutes and main barriers from the circuit breaker unit, open the relay panel and mechanism, and remove sufficient insulating barriers from the relay panel to provide complete access to the switch.

2. Remove all wiring from the terminals of the switches.

3. Remove the clevis on the lever end of the switch assembly which actuates the switch rotors.

4. Remove the flag link on top of the auxiliary switch assembly which operates the mechanical indicator.

5. Remove the two long ¼ inch pan head screws which secure the auxiliary switch assembly to the relay panel.

5.4.9 Terminator Assembly

To remove the top terminator assembly from the housing, the unit must be isolated from the line and the protector locked open. The fuses and disconnect links must be removed from the protector. The protector must be in the rolled out position. Then remove the upper barrier assembly to gain access to the terminator hold-down bolts. Remove the six ½ inch bolts for each single phase terminator from the top inside of the protector. The terminator bushing is now free from the top of the housing.

To reinstall the terminator bushing it is recommended that a new gasket be used, especially if the existing one is several years old or has become damaged during removal. The gasket material is Nitrile Rubber, Shore Hardness 65, ⅜ x ⅜ inch cross-section. The terminator is then secured to the top of the protector with six 1/2 inch bolts 1.0 inch long threaded into inserts molded into the bottom of the flange. The hardware including standard flat and lockwashers should be grade 5, plated with yellow zinc dichromate. The bolts should be torqued to 30 to 35 ft-lb. **maximum.**

5.5 RETRO-BUILD

We suggest that once every five years, a complete re-check of all network protectors be undertaken, paying particular attention to those units built prior to 1978, to ensure complete integrity of the protector insulation system. The minimum checks suggested are described below.

5.5.1 Dielectric Test on Transformer Bus

1. Test transformer bus at 3750 volts for one minute. Refer to Para. 4.7.2.

   If the bus bar insulators fail — replace with retro-build kit:
   S/N8310A07G01 for 800-1875A
   S/N8310A08G01 for 2500-3000A
   S/N8310A09G01 for 3500A.

These apply only to transformer mounted units.

5.5.2 Dielectric Test on Rollout Unit

Test rollout unit at 1650 volts for one minute. Refer to Para. 4.7.2.

A. If the breaker wiring harness fails, replace with new wiring harness. Contact nearest Cutler-Hammer sales representative for ordering information, and provide nameplate information from the unit.

DANGER

IF THE BREAKER HAS A WIRING HARNESS MANUFACTURED FROM THE BRAIDEDCOTTON, CLASS A, TYPE SIS WIRE OR THE SILICON-RUBBER CONTROL WIRE IT WOULD BE NECESSARY TO DRILL MOUNTING HOLES IN THE ASBESTOS BACK PANEL FOR THE ADDITION OF WIRING CLIPS, TO FIT THE MODERN TEFLON WIRE HARNESS. THIS ACTION SHOULD NEVER BE CONSIDERED AS FREE ASBESTOS WILL BE RELEASED INTO THE ATMOSPHERE. THE ONLY COURSE OF ACTION IS TO REPLACE THE COMPLETE BREAKER ELEMENT.

B. If the breaker is equipped with the older type W auxiliary switch and this happens to fail electrically or mechanically, it can be replaced with the modern RC type of auxiliary switch assembly using S/N 310C626-GO3.

5.5.3 Lead Alloy Fuse Tension

If lead-alloy fuses are utilized they should be checked every inspection period to ensure that proper tension exists at the alloy element when installed. This is accomplished by placing the fuse on a flat surface and attempting to rock the fuse back and forth. A minimum of 1/32 inch clearance should be found under both mounting legs. (See **FIG. 26**). If the proper offset is not detected, replace the fuse with one that will exhibit the correct tension.

5.5.4 Gasket Leaks

Inspect all gaskets for leaks. Refer to Para. 4.3.1. Replace any that leak.

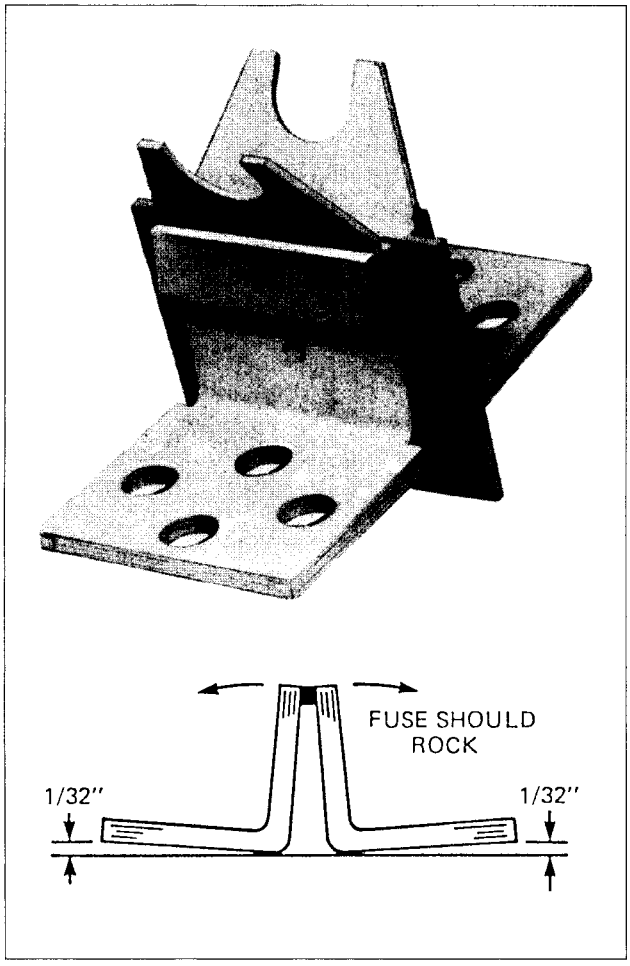


FIG. 26 *Lead-Alloy Fuse Configuration*

5.5.5 Current Transformer Style Numbers and Insulation

For optimum reliability, components with Class H insulation system are recommended. See information below.

A. Current transformers. Present S/N for Class H units are:

Ratio	Style Number
800-5A.	*745C148G01* *Multi-Ratio 1600 / 1200 / 800-5A.*
1200-5A.	*2713C37G01* *Multi-Ratio 1600 / 1200-5A.*
1600-5A.	*592C554G01*
2000-5A.	*6109C13G01*
2500-5A.	*592C556G01*
3000-5A.	*592C557G01*

B. Interphase barriers for breaker and enclosure. Refer to Cutler-Hammer for correct ordering information. The shop order number and/or style number and/or serial number of the network protector in question should be known.

OTHER REFERENCES

DB 35-550	CM-22 Descriptive Bulletin
RPD 35-550	CM-22 Renewal Parts Data
I.B. 35-556-A	Portable Test Kit Instruction Book
Supplement to I.L. 35-555.1	Portable Test Kit Instruction Book
I.B. 35-581A	Network Relays Instruction Book

Notes

Notes

Type CM-22 Network Protectors
800 to 3500 Amperes

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