

Network Protector Instruction Manual

Type 137NP

800 to 3500 Amperes

 Richards

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SAFETY INFORMATION

This manual is intended for use by qualified individuals responsible for the installation, maintenance and operation of network protectors. Potentially unsafe conditions exist when installing, maintaining or operating network protectors.

All applicable safety procedures should be adhered to when installing, maintaining, or operating network protectors.

Only qualified electrical personnel should be permitted to work on 137NP Network Protectors.

De-energized and rack out the network protector mechanism before any maintenance procedure.

Never defeat safety interlocks on the network protector.

Never energize a partially assembled network protector.

Use extreme caution when installing or working on an energized protector.

Use insulated tools and gloves when working on energized network protectors.

Perform all appropriate electrical tests before any installation or operation of the network protectors.

WARNING

Before unpacking, installing, servicing, or operating 137NP network protectors read this manual thoroughly.

For additional information, contact Richards Mfg. Co. directly.

For application information, consult Richards Mfg. Co. or see appropriate ANSI Standards.

Do not operate 137NP network protectors under load except in appropriate enclosures.

The Richards 137NP Network Protectors are designed for secondary network application at 125/216 volt and 277/480 volt wye connected systems. Do not exceed design ratings.

Submersible Transformer Mounted

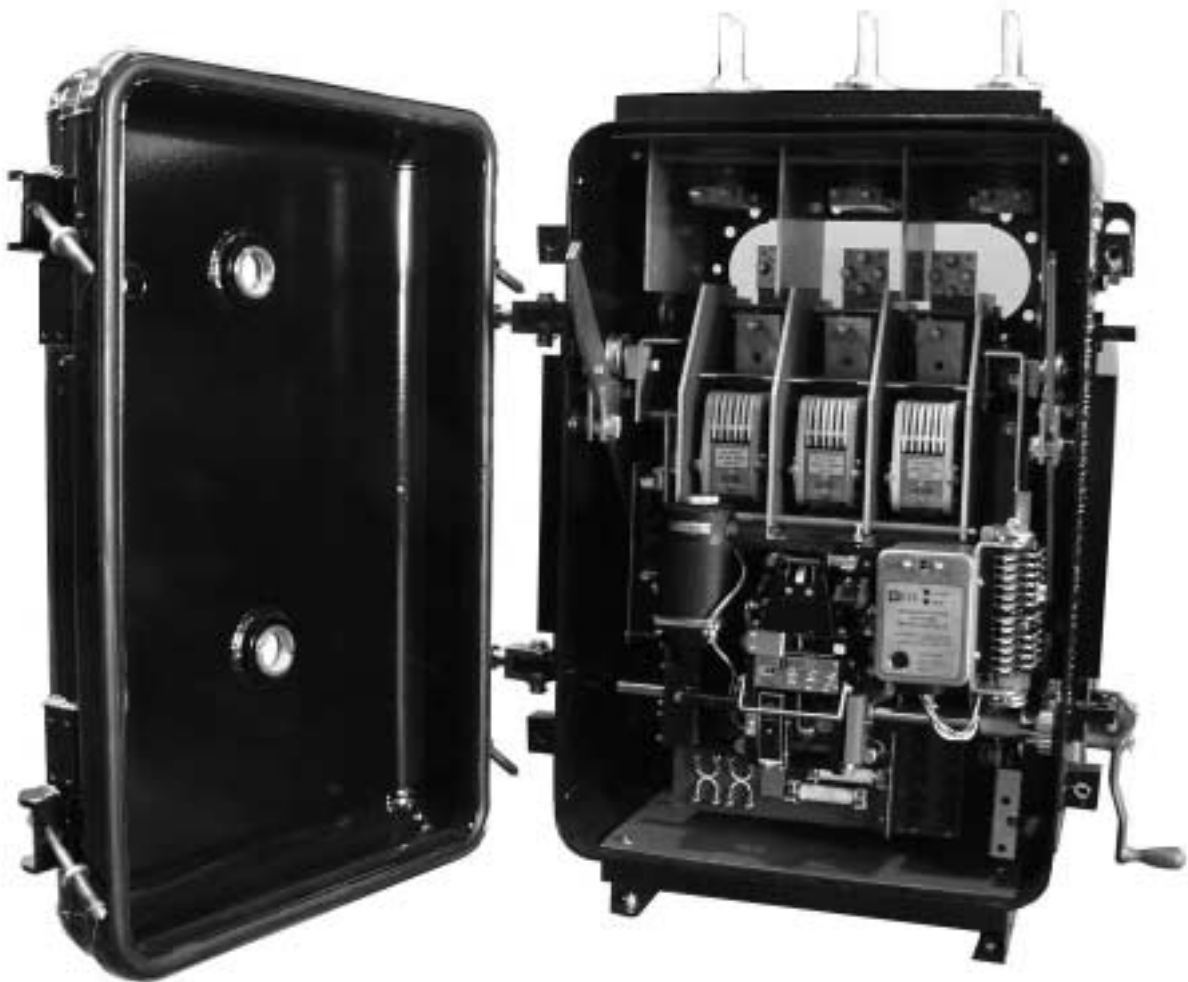


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I. OVERVIEW

A. Introduction

The automatic network protectors covered by this instruction book are of the heavy duty, motor-operated types for application in secondary AC network systems and are designated as submersible and non-submersible.

The Richards 137NP Network Protector consists of a circuit breaker, a motor operated mechanism, and an ETI Microprocessor Network Protector Relay that combines the functions of a network master relay, and a network-phasing relay. The ETI MNPR® provides all modes of operation, including sensitive, insensitive, time delay, instant, watt-var, and inverse watt-var.

B. 137NP Submersible Network Protector

The 137NP network protectors consist essentially of a circuit breaker, a motor operated mechanism, the necessary controlling relays, and auxiliary apparatus. These are all enclosed in a water-tight case, for use in locations subject to submersion.

The breaker unit is an integral unit which is removable from the enclosure. The breaker forms the rear portion of the unit with the operating mechanism and relay equipment in front.

The cover of the enclosure may be hinged from either side. Clear glass inspection windows permit reading the operation counter and inspection of the fuses without opening the cover. The enclosure is provided with an external handle for manual operation of the breaker unit. This handle may be mounted on either side of the case as desired. A pressure test valve is provided so that the enclosure may be tested for air tightness. Convenient pipe plugs are also located on the side of the enclosure to permit installation of external auxiliary circuits, if so desired. Lifting eyes are provided on all enclosures. Temporary and permanent mounting supports are additional provisions. The cover is sealed to the case with gaskets compressed by clamping strips and bolts.

There are two general styles of 137NP network protectors; one with the protector arranged for wall or framework mounting independently of the network transformer, "Separately Mounted", and the other for bolting on to a three phase network transformer, "Transformer Mounted". Separately mounted protectors are arranged for connection of the cables from the network transformers at the bottom of the enclosure and those to the network at the top. In the transformer mounted style the connection to the transformer is made by bolting the protector buses directly to the transformer secondary terminals.

Standard terminal facilities consist of various configurations of tangs, studs and quick disconnect terminals surrounded by an insulator. Limiter and non-limiter terminals are also available.

C. 137NP Non-Submersible Network Protectors

The non-submersible 137NP network protectors are generally similar to the submersible except that non-submersible enclosures are provided. These protector units are for applications in clear dry vaults. Equipment mounted enclosures (open framework) protectors are also available.

As in the case of submersible protectors the non-submersible type may be arranged for wall or framework mounting, or for bolting directly to the network transformers. Terminal facilities may be arranged for connection of one to four cables per phase, or for bus bar connections.

All protectors are arranged to permit the ready removal of the breaker unit without disturbing the cable connections.

II. INSTALLATION

CAUTION: ALL NETWORK PROTECTORS MUST BE MOUNTED VERTICALLY.

It may be well for original users of this device to set one up temporarily in a service shop, so as to become familiar with its characteristics and construction before installation on the system. See section on **Opening Enclosures**.

A. Receiving, Handling and Storage

Care should be exercised when unpacking a protector so that no damage is caused in any way, and a careful inspection made to see that no parts are damaged, missing or destroyed with the packing material. Mounting hardware (transformer mounted protectors) is shipped in separate cartons. Relays are shipped in separate cartons.

In handling or storing network protectors, always keep top up as marked on packaging.

Unsupported network protectors are unstable. Before removing shipping packaging, it is recommended that a protector be supported from a sling or other suitable means to keep it from falling over when the crating is removed.

Lift and handle the uncrated protector by the lifting eyes at the top of the case.

NOTE: Do not use the lifting eyes provided on the breaker unit for handling the complete equipment mounted protector. These lifting eyes are provided for handling the breaker unit only. Slings with spreaders are recommended to prevent damage to the upper terminals and barriers of the protectors.

Transformer-mounted, top-connected, submersible and non-submersible protectors are provided with permanent feet so that these protectors will rest upright on the floor. Separately mounted submersible protectors are provided with temporary feet to protect the

lower terminals when these protectors are set upright on the floor. These feet may be removed, when these protectors are bolted in position, to provide clearance for making cable connections.

Equipment-mounted protectors will not stand unsupported on the floor. When handling or resting these protectors on the floor, be careful not to damage the lower barriers or terminals and, if necessary, place a block under the channel framework

If the protectors are not to be used for some time, store in the packaging in which received.

B. Transformer Mounted Protectors

Submersible and Non-Submersible Units

Remove the breaker unit before mounting the enclosure of transformer mounted protectors on the transformer. Then remove the throat plate from the rear of the enclosure. The throat gasket is supplied with the network transformer. Mounting hardware is shipped in a separate bag including the lower supporting feet and the necessary hardware for securing the protector to the transformer.

The transformer throat gasket supplied with the network transformer should be treated with Glyptal and assembled to the clean surface of transformer throat flange. This gasket will be held in position by the dowel pins on this flange.

Lift the protector enclosure and guide it into position using the dowel pins provided on the transformer throat flange. Then tighten all throat bolts down evenly so that the throat gasket is compressed from about 40 percent to 50 percent of its thickness. Add the feet at the bottom of the enclosure using the proper number of spacers between the bottom of these feet and the transformer.

Just before placing the unit into the protector, clean the transformer terminals with the back of the bus bar of the protector. Use a brass wire brush and then wipe with a clean cloth.

C. Separately Mounted Protectors

Separately mounted network protectors may be mounted on a suitable framework or against the wall. The submersible protectors are secured in place by the two lugs at the bottom back of the enclosure. The non-submersible protectors are secured in place by mounting either in a pipe framework or placing bolts through the holes provided in the back of the channel framework

After submersible, separately mounted, protector enclosures are permanently mounted the feet at the bottom of the case may be removed for better access to the terminals.

D. Opening Enclosures

Before opening the enclosure, submersible and non-submersible protectors should be mounted in their final locations or if to be temporarily supported they must be securely anchored by the lifting eyes to a firm post or part of a building to keep the protector from tipping forward. To make inspection easier, the protector may be set up on some blocks, but if this is done, make sure the bottom of the protector cannot move when the breaker unit is rolled forward.

Most equipment mounted protectors may be rested upright on the floor without removing the lower barriers or lower terminals. However, when the lower barriers or terminals extend below the bottom of the channel frame the protector will have to be rested on blocks placed under the channels. Firmly secure these protectors to a post or a part of the building so that they will remain upright.

If the relays are to be tested on a temporarily mounted protector, the protector must be in a vertical position.

After temporarily supporting or permanently mounting the protector, the enclosure may be opened by unscrewing the cover bolts. If necessary, pry the cover open but do not damage the gasket with the instrument used to pry the cover loose.

E. Removing the Breaker Unit (see Figure 1 and 2)

Submersible and Non-Submersible Protectors

Remove the fuses and disconnects as outlined below for the different arrangements of protectors. Then lift the folding rails up and forward and lower them to the horizontal position so that they form a continuous surface with the rail in the enclosure. The unit may be rolled forward, after removing the four mounting screws.

WARNING: The manual operating handle must always be in the OPEN position before the breaker unit can be rolled forward or back into position for remounting in the enclosure.

1. Transformer Mounted Protectors

Top connected protectors. **Warning, the following sequence must be followed.** First remove the fuses without disturbing the fuse connecting blocks, then remove the fuse connecting blocks and the screws securing the protector unit to the low voltage transformer bushing. Reverse above procedure for replacing the protector unit.

2. Separately Mounted Protectors

Remove the fuses at the top of the protector and the disconnecting links at the bottom of the protector.

3. Equipment Mounted Protectors

The breaker units for the various arrangements of equipment mounted protectors may be removed in a manner similar to which the breaker units are removed from submersible and non-submersible protectors.

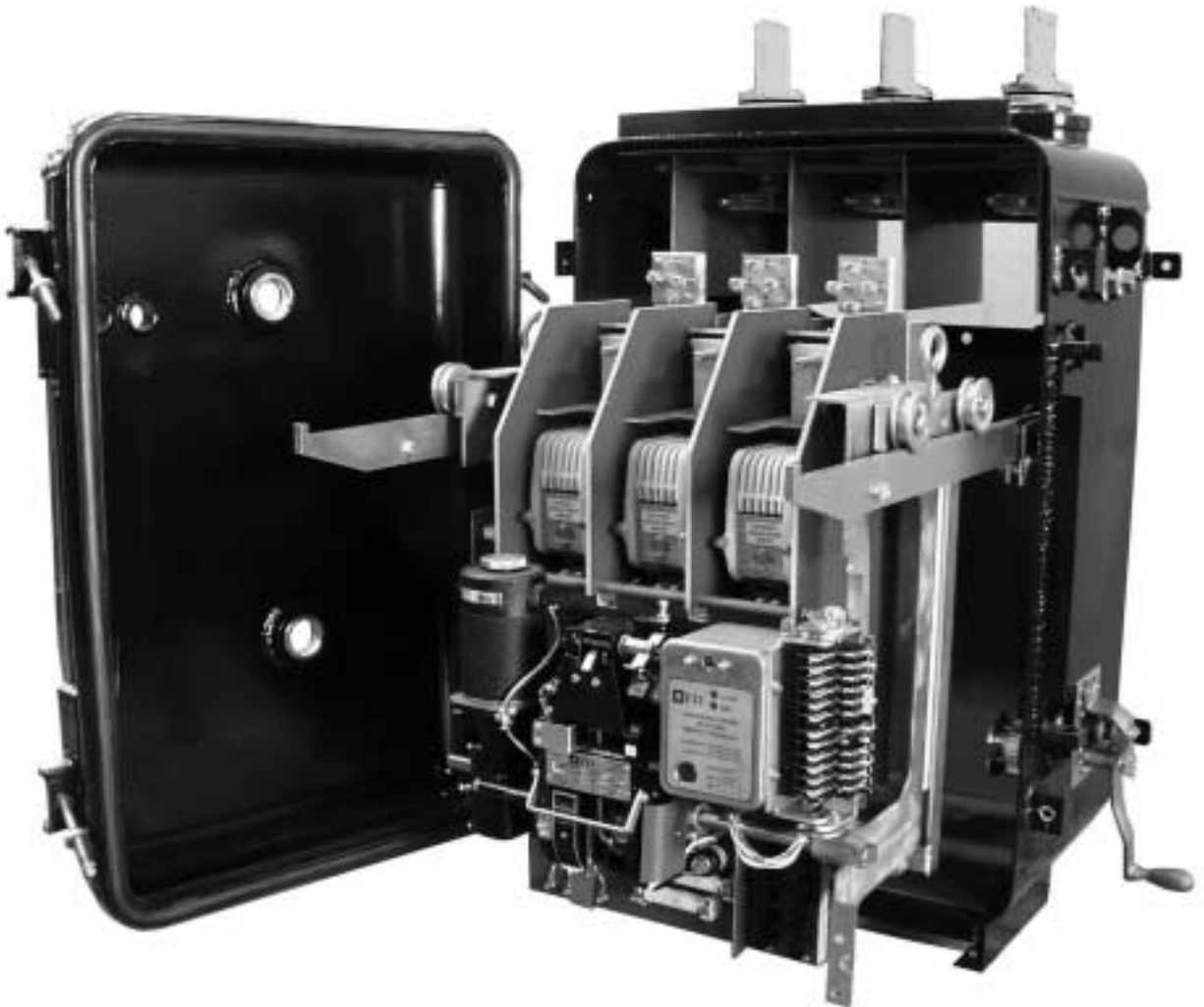


Figure 1 - Removable Unit Rolled Out On Rails



Figure 2 – Removable Unit Supported From Lifting Eyes

F. Connections

Cable connections should not be made until after fuses have been removed from protector. Do not replace fuses until all tests and checks outlined under **INSPECTION AND TESTING** have been made.

G. Relay Installation

After the protector has been installed either permanently or temporarily for testing, the network protector relay may be installed in the protector.

To install the relay, unscrew the knurled thumbscrew, move the claw-shaped cam counterclockwise and then place the relay in position, making sure that the contact blades on the relay line up with the stationary contacts. Move the cam clockwise to jack the relay into position. Screw knurled thumbscrews down to secure the relay. The relay is now free to swing through a large angle. To fasten the relay in its operating position, move the relay clockwise and pull latch forward.

New network protectors are wired for microprocessor type relays unless otherwise specified.

1. Closing In On Dead Networks

a. Electromechanical Relay

Network protectors with electromechanical relays may not close on a dead network to which there is no connected load. To be sure protectors will always pick up a dead network, particularly on a new system, or on spot networks for power only, it is recommended that a resistor load of 500 watts be connected between phase to which the phasing relay is connected and ground. Or on delta-connected systems, connected 250 watts between each phase (750 watts total). A 5.0uf capacitor may be used in place of the 500 watt resistor and 2.0uf capacitor in place of the 250 watt resistors. When the load on the secondary network grid reaches a point where all of the load will never be disconnected, the above mentioned resistors or capacitors may be removed from the grid.

b. ETI MNPR® Microprocessor Relay

Network protectors with ETI MNPR® microprocessor relays will close on a dead network with or without connected load.

III.MAINTENANCE

A regular inspection and maintenance schedule for network protectors is recommended. While experience will best indicate the frequency with which inspections should be made, the following routine is suggested.

In all cases open the protector manually and lock in the open position first, then remove fuses and the test caps before working on or inspecting or testing protector.

A. Schedule

1. At Installation

Complete inspection and test. See **INSPECTION AND TESTING**.

2. After First 24 Hours of Automatic operation

Read operation counter to make sure that the protector is not operating excessively. Twenty-five operations or less are not excessive for initial installations, and even fifty operations are not too many if the network load is to be increased soon. Additional load will eliminate a large percentage of the operations. If the number of operations during the first 24 hours is considered excessive, a check should be made to see that the mechanism operates positively. If it does, the protector is being operated by numerous power reversals. To correct this, the programming of the relay may need to be revised.

3. After First 48 Hours

Again read operation counter. If the number of operations is normal, daily reading may be discontinued.

4. After First Week

Read operation counter.

5. After First Month

Read operation counter.

6. After First Six Months

Complete inspection and test.

7. Yearly

Fully inspect and test protectors including relays and perform the following preventive maintenance.

- a. Remove breaker from the enclosure and inspect and clean the contacts.
- b. Check wiring terminals for tightness.
- c. Remove trip mechanism and inspect and clean mechanism if necessary. The protector mechanism is thoroughly lubricated at the factory and this lubrication should last for some time. However, if it appears that the mechanism requires lubrication, use SAE-30 machine oil on bearings. Wipe off all excess as the excess will collect dirt and nullify the effect of the lubricant.
- d. The bearings of the secondary latch shaft, Figure 15, should have just a drop of SAE-30 machine oil added if necessary and the latch surface should be coated very thinly with high grade petroleum jelly, to prevent rust.
- e. Check the level of the lubricant in the gearbox, Figure 17. If necessary add sufficient #4 hydraulic oil
- f. Remove one brush holder and brush from motor and inspect commutator surface with flashlight. If necessary, remove and disassemble motor and clean commutator.
- g. Lubrication of the motor bearings should not be necessary during the life of the motor. However, if lubrication is found necessary after a number of years, remove the motor, dismantle it, wash the bearings out thoroughly and repack them with a small quantity of grease.
- h. Clean torque brake when motor is removed.
- i. Check auxiliary switch contacts and clean if necessary.
- j. Check motor control device contacts and clean if necessary.
- k. Check mechanical indicator.

8. After Heavy Primary Short Circuits

Inspect protectors which have interrupted short circuits, cleaning the devices and resurfacing the breaker contacts.

9. De-energize Primary Feeders

Each feeder should clear completely, as indicated by the feeder voltmeter, if all the protectors are set to trip on transformer exciting current. On re-energizing the feeder, each protector should reclose as the load increases.

IV. INSPECTION AND TESTING

CAUTION: DO NOT OPERATE THE PROTECTOR, EITHER MANUALLY OR ELECTRICALLY, UNLESS IT IS IN A VERTICAL POSITION.

Before placing the protector in service it should be tested. Tests may be made with protector in its final location or with the protector in a temporary location in the service shop. If temporarily located be sure to secure the protector as described under **Receiving, Handling and Storage**. The breaker unit of submersible protectors may be either bolted in place in the housing or rolled out of the rails.

Always open the protector manually first; second, open the enclosure cover; third, remove fuses, and fourth remove all test caps before testing, working on, or inspecting the protector.

Test caps, Figure 3, located on the auxiliary panel below the breaker mechanism, provide a means of disconnecting control wiring from the main circuit. This is accomplished by removing insulated test caps to de-energize control wiring and tightening these test caps to energize control wiring. With the insulated test caps removed, provision is made on the projecting studs for the attachment of test clips so that control wiring may be energized from a separate source.

On new installations the fuses should be removed before the cables are connected and should not be replaced until the following tests are completed.

The protectors are shipped with the manual operating handle wired in the open position, the trip latch tied up and the folding rails wired down. Remove these ties before starting tests.

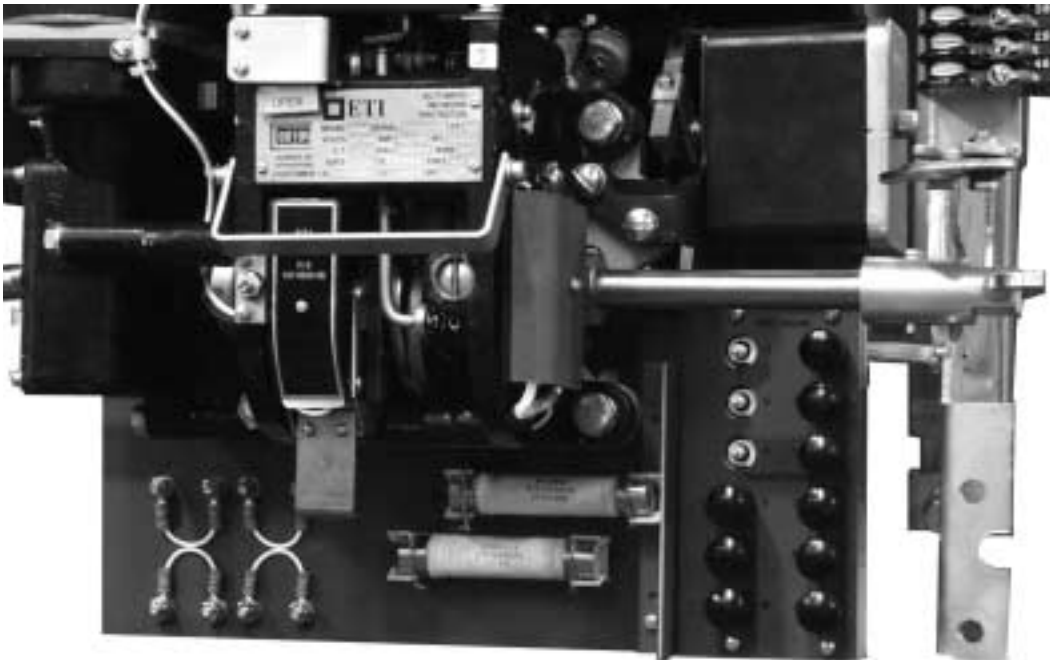


Figure 3 – Auxiliary Panel, Potential and Test Switches

A. Phasing

Phase out connections to protector to insure that “cross-phase” connection will not be made when the breaker is closed. Network voltage is available on network side of fuse mounting. Transformer voltage is available on opposite end of fuse mounting when the protector is closed.

B. Manual Operation

Close and open the breaker several times by hand. To do this swing the manual operating handle from the “open” to the “closed” position and when the breaker is closed return to the “open” position. The breaker should close with considerable pressure. If the hand-wheel of the motor is turned the motor cam may be advanced to a position where it will prevent the normal resetting of the mechanism after tripping. If this happens, turn the hand-wheel clockwise until the mechanism resets. Then turn two more revolutions. Now close the breaker manually and trip by lifting the extended lever above the trip coil. Repeat this operation, returning the manual handle to the “automatic” position. The trip mechanism and operating mechanism should reset.

C. Electro-mechanical Relays

The correct operation of the electromechanical type network master relay depends upon the application to the relay coils of currents and voltages of the proper phase sequence. For this reason the phase sequence of the network should be checked before putting a protector into service. This can be done by making a temporary reconnection of the phasing relay and observing its operation as follows:

1. Make the temporary change in the wiring of the phasing relay as indicated on the wiring diagram for the network protector.
2. Replace test caps B, C, and F only.
3. Trip protector open and move operating handle to “open” position. Do not close protector during this test.
4. Connect the network side of the protector to the network.
5. Observe the operation of the phasing relay contacts. If the relay contacts close with a strong torque toward the right, the phase sequence is 1, 2, 3. If the relay contacts open or move to the left, the phase sequence is 3, 2, 1.

The phase sequence of the protector is determined by the lead connections as shown on the wiring diagram. In general, network protectors are wired for 1, 2, 3 phase sequence at the factory. Protectors may be obtained which are wired 3, 2, 1 phase sequence if desired. (Note: Protectors wired for 1, 2, 3 phase sequence may be used with a 3, 2, 1

phase sequence provided four leads are interchanged in accordance with the wiring diagram).

6. Return the phasing relay connections to normal.
7. Remove test caps B, C, and F for the following tests.

D. ETI MNPR® Microprocessor Network Protector Relays

The relay will not close its contacts on a crossed phase system. It is, also, insensitive to phase sequence and will function accurately for protectors wired with phase sequence 1-2-3 and installed on systems wired 3-2-1.

E. Electrical Testing

When these observations have been completed the protector may be operated electrically to check the mechanism operation. These tests should be performed using a network protector test kit. Explicit instructions are included with these test kits. If a test kit is not available the following method can be used.

1. Remove the electromechanical or solid state relay and insert a jumper across terminals 1 and 2 (wire No. 6-6A) of the phasing relay plug (if provided).
 - a. On 120/216V units connect a 216V source to studs K and L to energize the operating circuits. Connect the closing contact of a control switch to terminals 2 and 3 (wire No. 6-11) of the master relay plus and a tripping contact to terminals 1 and 3 (wire No. 41-11). Activate the “closing contact” of the control switch. If the manual operating handle of the protector is in the automatic position the protector will close.

Activate the “tripping contact” of the control switch. The protector should now trip.

Turn the manual handle to the “open” position. Activation of the closed contact of the control switch should not close the protector.

- b. On 277/480V units connect a 480V source to studs 11 and 21 for trip circuit test, and studs 11 and 3A for motor and motor control circuit tests. Repeat test a. above.

If the mechanism over travels, and goes through a trip-free operation before closing, remove the motor and clean torque brake. If the breaker has been turned upside down or front side down, oil from the gearbox may run into the torque brake making it ineffective.

Figure 4 shows a test set up for obtaining the various voltages required for testing the protector mechanism. The variable auto-transformer should have inputs of 208 and 460 volts with a 16 amp current rating.

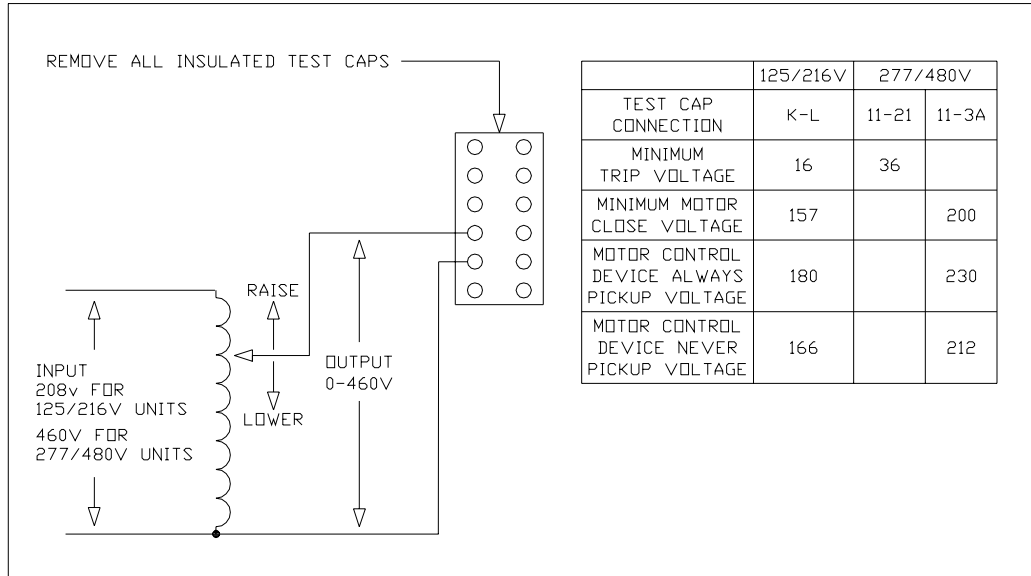


Figure 4 – Single Phase Test Circuit

F. Checking the Minimum Tripping Voltage

Using the auto-transformer test set up as described in Figure 4 apply 16 volts to studs K and L on 125/216V units and 36 volts to studs 11 and 21 on 277/480V units. Connect the tripping contact of a control switch across terminals 1 and 3 (wire No. 41-11) of the master relay plug. Activation of this contact should trip the protector.

G. Checking the Minimum Motor Closing Voltage

Using the auto-transformer test set up as described in Figure 4, apply 157 volts to studs K and L on 125/216V units and 200 volts to studs 11 and 3A on 277/480V units. Connect the closing contact of a control switch to terminals 2 and 3 (wire No. 6-11) of the master relay plug. Close the motor relay by hand by lifting up the plunger. Activate the closing contact of the control switch. The motor should close the protector. There is no adjustment for minimum closing voltage. This test merely shows that the motor has sufficient torque to close the protector.

H. Checking the Motor Control Device

Using the test set ups as previously described apply the following voltage levels to the protector control circuits.

1. For 125/216V units. The motor control device should never pick up at 166 volts and should always pick up at 180 volts. With the protector open apply 166 volts to studs K and L. Activate the closing contact of the control switch. The protector should not close. Repeat 10 times. If pickup occurs reset the motor control device by turning the calibrating nut (see Figure 13) up. Recheck.

Trip protector and apply 180 volts to studs K and L. Activation of the control switch closing contact should now close the protector. Repeat 10 times. If it does not, turn the calibrating nut of the motor control device down and recheck at 180 and 166 volts.

2. For 277/480V units the motor control device should never pick up at 212 volts and should always pick up at 230 volts. Apply these values to studs 11 and 3A and repeat test 1.

Where laboratory test facilities are not available or for other reasons it may be desirable to test the network relays in the field on the protector. These tests should be performed using a network protector test kit. Explicit instructions are included with these test kits.

I. Mechanical Checks

1. Check for resetting on trip-free operation. See instructions under **Trip Mechanism**.
2. Check the level of the oil in the gearbox. It should be up to the bottom of the ¼ inch plug on the side of the gearbox. If not, apply a sufficient amount of #4 hydraulic oil to bring the level to the proper point.
3. See that the polished part of the secondary latch shaft, Figure 15, is covered with a very thin coat of high grade petroleum jelly.

J. Return to Service

1. Replace all test caps.
2. Replace relays.
3. Replace fuses.
4. Close cover.

5. Move manual operating handle to automatic position. If voltage conditions are proper, the breaker will close.
6. Place air pressure test on enclosure to be sure it is tight. See instructions under **THE ENCLOSURE**.

During the mechanism tests, note the operation of the mechanical indicator and the operation counter. The indicator should read closed when the breaker is closed and open when the breaker is open. The operation counter should record each complete protector operation. Before energizing the control wiring make sure that the contacts of the motor control device are latched open.

It should be unnecessary to make high potential tests on protectors, because they are completely tested before leaving the factory. If, however, it is desired to make such tests a potential of 2000 volts AC may be applied for 60 seconds from each main conductor to ground and between any two main conductors.

Caution: During such tests see that the motor leads are disconnected and network relays, as well as the indicating lamps (if provided) are removed from the protector.

The motor may be tested at 900 volts AC 60 cycles, for 60 seconds, and the relays tested separately at 1500 volts AC for one second. Field hipot test values are 75 percent of factory test values.

V. THE REMOVABLE UNIT

Figure 5 shows a typical removable unit for the 137NP network protectors. The circuit breaker part of this unit is of the air-break type and it utilizes arc quenchers for restricting and extinguishing the arc.

The details and arrangement of the main conductors vary in accordance with the ampere ratings of the protectors, as well as with the different types of protector mountings. For the 800 through 1875 ampere ratings these main conductors or contact bars are made of solid copper, while for the 2000 through 3500 ampere ratings they are made of square hollow copper tubing

A. Arc Quenchers (see Figure 5 and 6)

The arc quenchers are held in place by two captive screws at the sides of the assembly. Loosening these two supporting screws permits tilting the arc quencher forward for examination of the arcing contacts of the breaker. For complete removal of the arc quencher it is also necessary to remove the four screws in the front of the assembly which secure the end of the flexible connection to the terminal plate of the magnetic blowout coil. On replacing the arc quencher, make sure that this flexible connection is properly connected and all screws are tight.

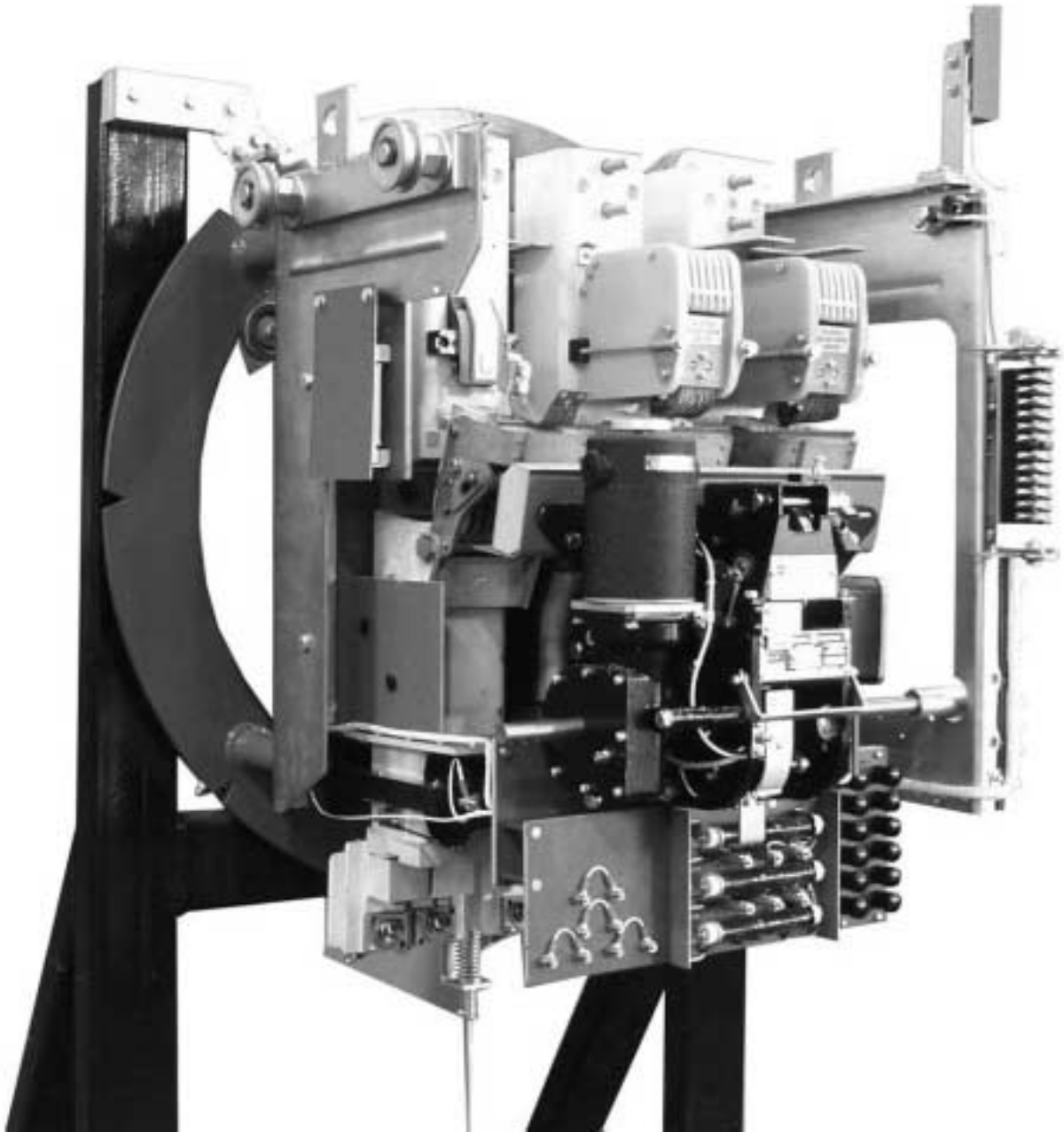


Figure 5 – Removable Unit On Network Protector Stand

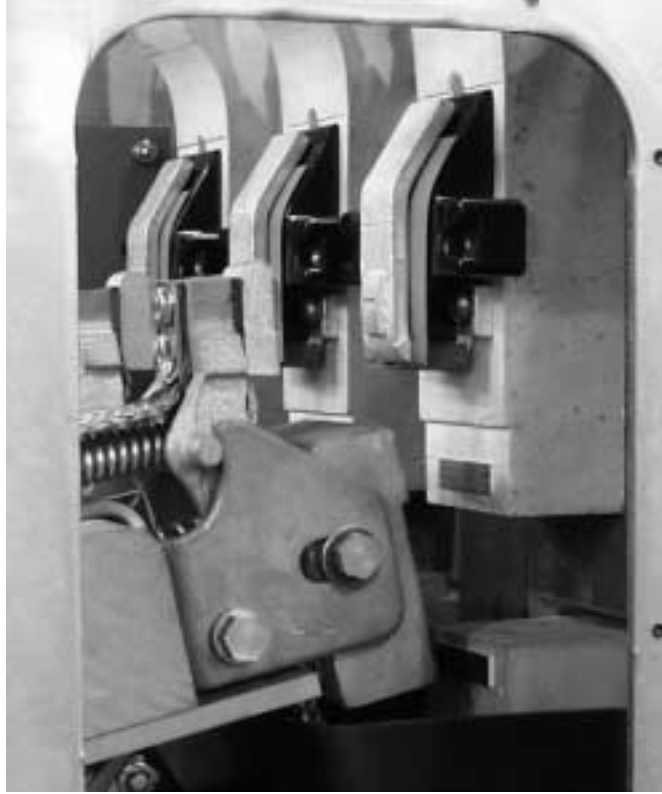


Figure 6 – Contact 800 to 1875 Amp Units

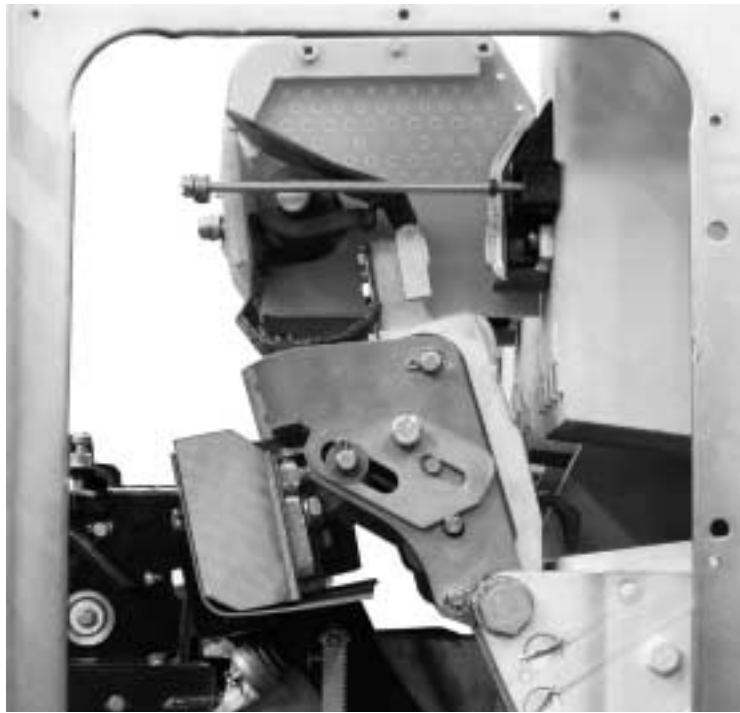


Figure 7 – Contact 2000 to 3500 Amp Units

B. Contact Construction for 800 through 1875 Ampere Protectors

Each breaker pole has a set of main current-carrying contacts and a set of arcing contacts (see Figure 6). The main current-carrying contacts consist of pieces of silver-alloy brazed to the contact bars and to a bridging block. The silver-alloy pieces on the contact bars are machined flat and the silver-alloy pieces on the ends of the bridging block are rounded slightly to obtain line contact. The main current-carrying contacts open first and the current is transferred to the arcing contacts which open last. In closing, the arcing contacts make first and the main current-carrying contacts last.

With the breaker open, the arcing contacts should be separated by a gap of one inch minimum. With the arcing contacts on one pole just touching, the maximum gap on the other two poles should not exceed 1/32 inch. With the arcing contacts just touching, the gap at the main current-carrying contacts should be 3/16 inch minimum and 3/8 inch maximum on the top, and 1/8 inch minimum and 5/16 inch maximum on the bottom. During the closing operation the crossbar and contact support should continue to move a minimum of 3/32 inch toward the closed position after the main contacts touch. This compresses the heavy springs behind the main bridging contact blocks to give the required contact pressure.

The contact surfaces should always be kept clean and smooth. After heavy short circuits they should be carefully inspected and, if necessary, any rough or high spots should be removed. Use a fine, clean file and wipe with a clean, dry cloth. When filing contacts remove the high spots only, do not file to the bottom of deep pits. Care should be taken to maintain a line contact as much as possible. To check the amount of contact obtained, take contact impressions by holding, between the contacts, a piece of thin carbon paper with tissue paper on the carbon side and closing the breaker. Open the breaker and examine the impressions on the paper. Good contact is indicated if a well defined impression shows for 75 percent or more of the length of the contact. Good contact is also indicated if a 0.001 inch feeler gage cannot be inserted between the main silver contacts for more than 25 percent of the length of the contact.

The movable arcing contacts are held in place by high-strength hexagon-head screws which are locked in position with locking plates (see Figure 6 and 7). When replacing the arcing contacts make sure that all screws are tight and that the locking plates are bent back around the screw heads.

The main current-carrying contacts have adequate capacity to carry full-load current even if the full line contact has been somewhat reduced, and replacement under normal circumstances is unnecessary. However, if it should be necessary to remove a main bridging contact, the following procedure is suggested (see Figure 6):

1. Remove the barriers and arc quenchers.
2. Close the breaker

3. Block the breaker in the closed position to prevent accidental tripping. This can be done by wedging a block of wood between the cross head and the trip mechanism frame.
4. Remove the two stop screws with lock washers on the sides of the contact bridging member.
5. Remove the blocking and trip the protector open.
6. The contact bridging member can now be lifted out.
7. To replace the contact, reverse the above procedure.

C. Contact Construction for the 2000 through 3500 Ampere Protectors

Each breaker pole has a movable-contact unit assembly consisting of several individually sprung bridging members in parallel. The bottom ends of these bridging members pivot around a bearing block welded to the lower main contact bar. Contact surfaces should be lubricated at the joint where they pivot on the bearing block welded to the lower main contact bar. The parts are silver plated and separate springs hold the bridging members in fixed-line contact with the bearing block. Contact buttons brazed to the top of the bridging members make point contact with other contacts brazed to the upper main contact bar. All these top contacts are low-resistance silver alloy and each bridge carries its share of the total current. Each pole-unit assembly is arranged such that one silver-alloy contact (the arcing contact) makes first and breaks last, and two silver-alloy contacts (intermediate contacts) make and break second. The remainder of the bridging members have silver-alloy contacts (main contacts) and these contacts make last and break first. There are four silver-alloy contacts in the 2000 through 3500 ampere assembly.

With the breaker open, the arcing contacts should be separated by a gap of 1-1/16 inches minimum. With the arcing contacts on one pole just touching, the maximum gap on the other two poles should not exceed 1/32 inch. With the arcing contacts just touching, the gap at the intermediate contacts should be 7/32 inch minimum and 9/32 inch maximum. With the intermediate contacts just touching, the gap at the main contacts should be 3/32 inch minimum and 5/32 inch maximum. During a closing operation the crossbar and contact support should continue to move a minimum of 3/32 inch toward the closed position after the main contacts touch. This compresses the contact springs to give the required contact pressure.

The surface of the contact buttons should be kept clean and smooth. Any pronounced rough or high spots resulting from a heavy short circuit should be removed by filing with a fine, clean file. After filing, wipe with a clean, dry cloth. When filing contacts, remove the high spots only, do not file to the bottom of deep pits.

The movable arcing contacts are held in place by high-strength hexagon-head screws which are locked in position with locking plates, (see Figure 6 and 7). When replacing the arcing

contacts make sure that all screws are tight and that the locking plates are bent back around the screw heads.

Replacement of the bridging contact members under normal circumstances should be unnecessary. However, if required, the following procedure is suggested (see Figure 7):

1. Remove the barriers and arc quenchers.
2. Close the breaker.
3. Block the breaker in the closed position to prevent accidental tripping. This can be done by wedging a block of wood between the cross head and the trip mechanism frame.
4. Remove the cam locking screws.
5. Remove the blocking and trip the protector open.
6. Remove the cotter pins and push out pivot pin "A".
7. Disconnect the small flexible connection at the bottom end of the arcing-contact bridging member.
8. Loosen pivot screws "B" and the entire contact assembly can be lifted out as a unit.
9. To replace the contact assembly, reverse the above procedure

D. Assembly of 2000 through 3500 Ampere Contact Head

Refer to Figure 8

1. Stack contacts and insulation with a 3/8 inch diameter pin in the location of Pin "A". This temporary pin should have a length less than the inside dimension of the contact carriage.
2. Assemble into carriage with Pin "B" and "C" using a 0.5 inch diameter rod in Pin "D" location.
3. Place assembly in a vise to clamp the surfaces indicated by "X".
4. Compress springs until Pin "A" can be used to push out the temporary 3/8 inch diameter pin.
5. Removal of Pin "D" makes unit ready for assembly into protector unit. Be sure and lubricate contact surfaces at the point where they pivot on bearing block welded to the lower main contact bar.

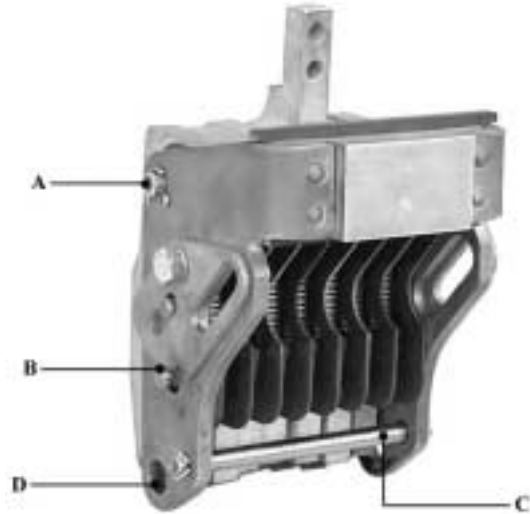


Figure 8 – Contact Head

Refer to Figure 9

1. The contact head is assembled to the cross bar with Pin “E” and to the stationary copper, hinge contact with pivot 6144209.
2. Add locking plate.
3. Force locking plate against Pin “B” with some suitable lever in contact with Pin “A” to establish spring pressure for the hinge contact.
4. Line up hole for 5/16 inch – 18 hexagonal screw with screw driver in slot used for Pin “E”.
5. A 5/16 inch – 18 hexagonal screw and locking plate are required on each side.

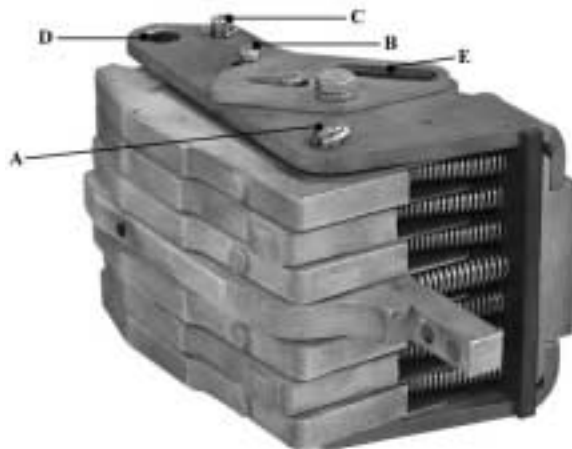


Figure 9 – Contact Head

E. Current Transformers

One current transformer, for use with the network relay, surrounds and is mounted on each pole of the breaker unit. Each current transformer has two windings; the phasing winding which is energized when the breaker contacts are open by the voltage across the breaker contacts and a secondary winding which is connected to the network relay current coils.

Current transformers are mounted directly on the main bus copper and may be removed by moving the protector unit forward, disconnecting the wiring at the current transformer coil terminals and removing the screws fastening the mounting brackets to the buses. When replacing current transformers, care should be exercised to insure that they are placed on the bus with the polarity mark H1 facing the network distribution transformer terminals. Also be sure that all connections are in exact accordance with original connections as designated on the wiring diagram for the particular protector involved.

F. Auxiliary Switch

Immediately below and to the right of the main breaker crosshead is mounted a unit assembly of auxiliary switches, which are operated by a rack and gear connected to the crosshead. These switches open and close the necessary control circuits as a function of breaker contact position.

After approximately every 5000 operations of the protector, the auxiliary switch contacts should be examined, and, if found to be pitted, they should be dressed with a fine file. It is not necessary to remove contacts to dress them, however, if necessary the movable contacts of this switch can easily be removed. Remove the stud above the wire connection. With the contact open, push it towards the stationary contact and lift up. The contact will lift out and can be repaired or replaced. This operation can be done with the auxiliary switch in position on the breaker unit.

The complete auxiliary switch assembly may be removed by disconnecting the driving link, and the control leads, and removing the two screws holding the mounting bracket to the breaker frame. The disassembly of the auxiliary switches is not recommended due to the many operating cams arranged in positions easily disturbed when dismantled.

After an auxiliary switch has been installed on the breaker unit, connect the rack and gear to crosshead, (see Figure 11). Manually operate breaker to insure proper operation before wiring. Removing screw "A" and slide will permit guide to drop down, so that rack can be raised to provide a close adjustment on gear for the following sequence of operation. Operate breaker manually. Contacts 1, 2, 3, and 9 should close when the arcing tips have between 3/16 inch and 1/16 inch gap. If contacts 1, 3 and 9 should operate oppositely, then rotate the gear approximately 180 degrees, so that these contacts will be positively closed at the same time in the above mentioned sequence. If the proper sequence cannot be obtained, the internal cams have been incorrectly assembled and the auxiliary switch must be removed and the cams relocated. After the auxiliary switch contacts have been properly adjusted, the

wired should be connected to their respective locations, circuits checked, and the protector electrically operated to make sure all circuits are completed by the auxiliary switch.



Figure 10 - Auxiliary Switch

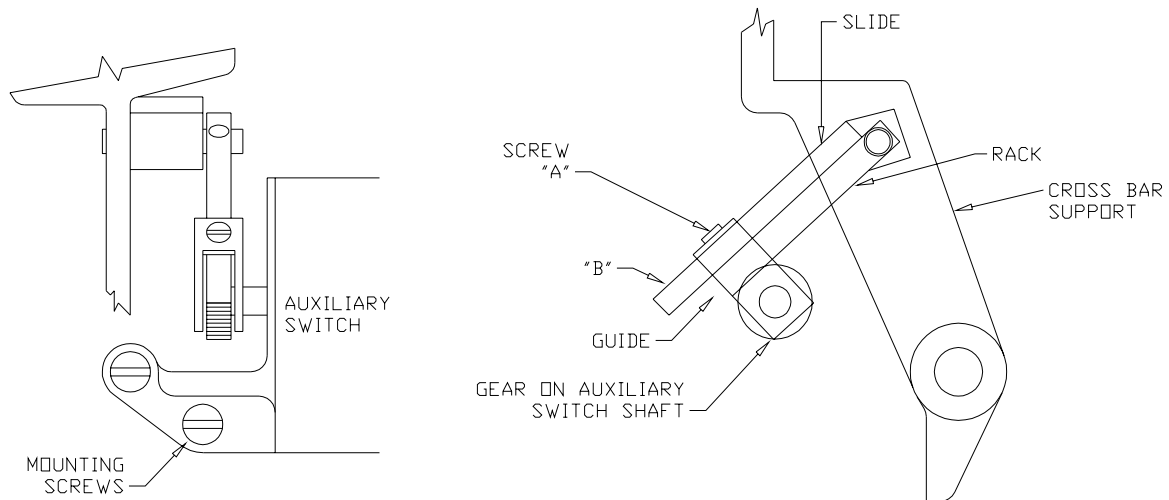


Figure 11 – Rack and Gear Mechanism

G. Mechanical Indicator

The protector is equipped with a mechanical indicator to tell whether the protector is “open” or “closed”. This mechanical indicator is operated by a linkage directly connected to the breaker crosshead. It exposes either the word “OPEN” or the word “CLOSED”, depending on the position of the breaker contacts. Provision is made for adjustment of the length of the operating link.

H. Operating Mechanism

The mechanism for closing the breaker of the 137NP network protectors is of the gear-driven cam, motor operated type. (see Figure 5). The operating motor is mounted on the worm and gear housing to the left of the closing linkage. The motor drives the worm through a torque brake which permits free running of the motor while torque is being transmitted from the motor to the worm, and serves to stop the motor’s rotation immediately when the motor is de-energized. The brake assembly serves as a coupling between the motor and worm shaft and is mounted on the lower end of the motor shaft in the upper part of the gear housing.

Sequence of Operation

The sequence of operation of the 137NP network protectors may be best explained by consideration of the simplified control diagram by Figure 12.

Assume that the breaker is open. The sequence on closure is as follows:

1. When the proper voltage conditions exist the relay will close its “closing contacts.
2. This action will energize the coil of the motor control device through the “b” and “c” switches (assuming that the manually operated handle is in the automatic position).
3. The motor device will then close its contacts and energize the operating motor.
4. As the breaker closes, two small cams on the main closing cam shaft will mechanically open the two contacts independently and the torque brake will stop its rotation.

If, when the protector closed, a primary feeder fault, or other conditions should occur which would cause sufficient power reversal to operate the network relay, tripping of the protector will occur as follows:

1. The network relay will close its tripping contacts, thus completing a circuit through the trip coil and series “a” switch.
2. The trip coil armature will then pick up (if the impressed voltage is 7-1/2 percent of normal or over) and release the trip mechanism latch, allowing the breaker to open.

- When this occurs, the “a” switch will open, de-energizing the trip coil, and the “b” switch will close, restoring the protector to its initial state.

When the breaker is closed or open, an “a” or “b” switch will indicate the breaker position for customer use. If the manual operating handle is moved to the “open” position, the “c” switch will open the closing circuit to prevent closure of the protector.

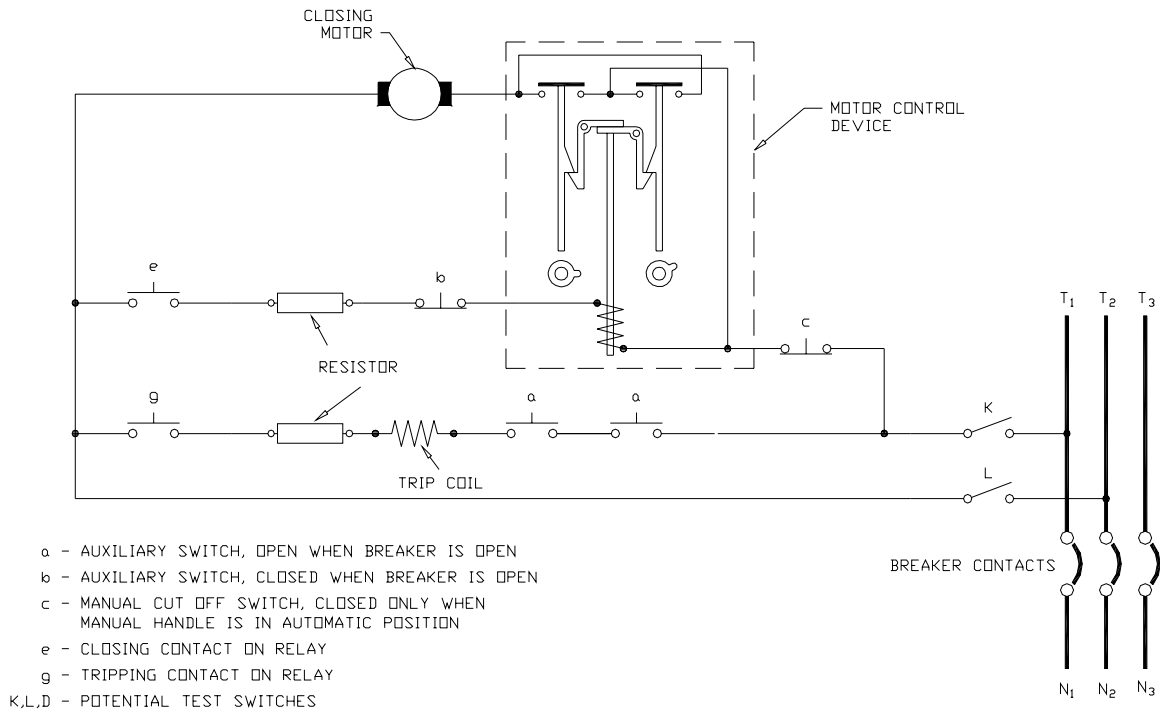


Figure 12 – Simplified Control Circuit

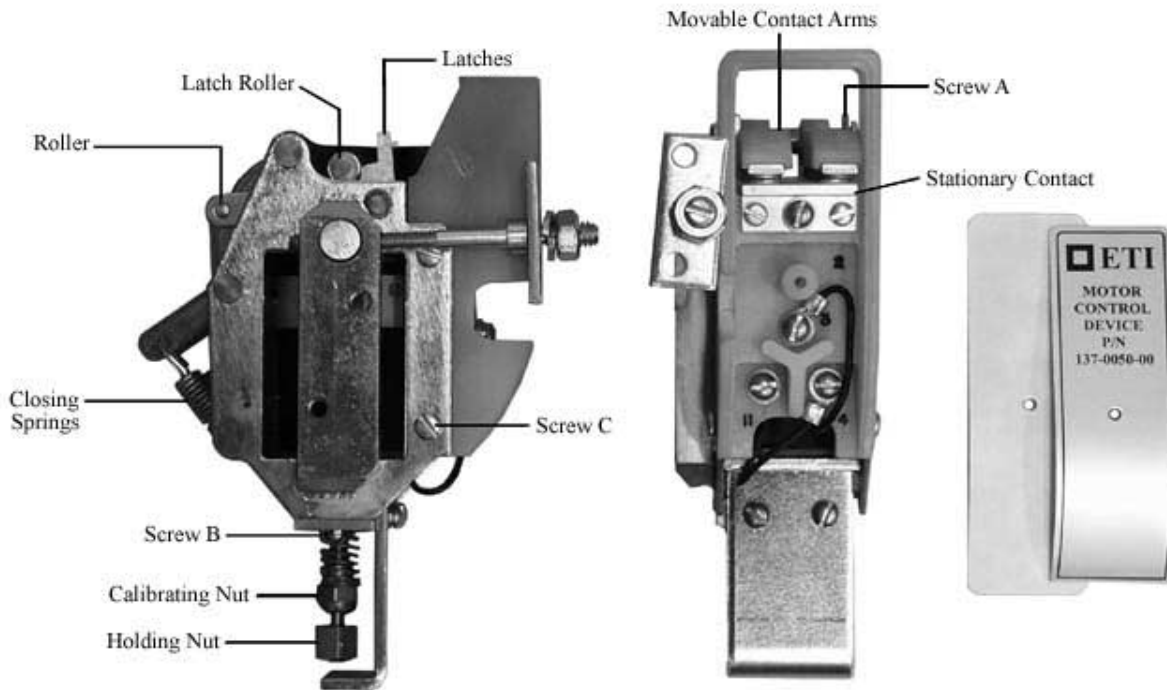


Figure 13 – Motor Control Device

I. Motor Control Device

The motor control device is mounted in the lower left-hand side of the closing mechanism assembly (see Figure 2). This device (see Figure 13) performs the necessary functions of energizing the motor when the closing contacts on the relays close, and of de-energizing the Omotor after the breaker is completely closed. The device consists essentially of two contacts connected in parallel, an individual latch for latching each contact in the open position, a coil and plunger for releasing both contact latches when energized, and a lever arrangement whereby two small cams on the main closing cam shaft will mechanically open the contacts independently. These two small cams for opening the contacts are staggered on the shaft such that either one or the other contact is always free to close. The location of these cams on the shaft is such that the second contact is not opened until after the breaker is latched in the closed position. Before either contact is opened during a closing operation the “b” switch has opened and has de-energized the coil of the control device.

This device should be adjusted to pick up electrically as approximately 80 percent of the normal motor circuit voltage (see **INSPECTION AND TESTING**). This must be checked with an instantaneously applied voltage. To adjust this pickup, secure holding nut and turn calibrating nut in a clockwise direction to decrease the voltage required to pick up armature. To increase the pickup voltage, reverse the above procedure. The contacts of this device must be latched open when in stalling protector in system.

No adjustment is required other than that necessary to maintain the pickup value desired. The contacts, however, should be examined after every 5000 operations; and, if necessary, dress contacts with a fine file on high spots only, do not file to bottom of pits.

Occasional renewal of contacts may be necessary. The stationary contact may be removed and replaced by removing the two screws located on front of contact. When replacing the movable contacts, remove screws "a" located on top and screw holding flexible connection to contact. When installing new contact make sure that all screws are tight and contact is lined up.

To replace coil, the motor control device must be removed from the breaker unit and wires disconnected. Disconnect coil leads from their terminals. Remove screws "b" (see Figure 13) and drop armature taking care not to misplace washer located on top of armature. Remove the tube and pole piece. The coil may now be removed from right side of device. To install, reverse the above procedure.

An adjustment has been provided which permits the position of the motor control device to be varied, thus controlling the point at which the motor is de-energized (see Figure 13). An adjusting screw fastened to the mechanism frame will advance the motor cutoff point if turned counterclockwise. If turned clockwise, the motor cutoff point is retarded. Before this adjustment can be changed, the lock screw of the device and the lock nut on the adjusting screw must be loosened. This adjustment will control the opening movement of the control device contacts. The contacts must open far enough to be latched in the open position, but must not open so far that they touch the upper member of the control device frame.

J. Trip Mechanism

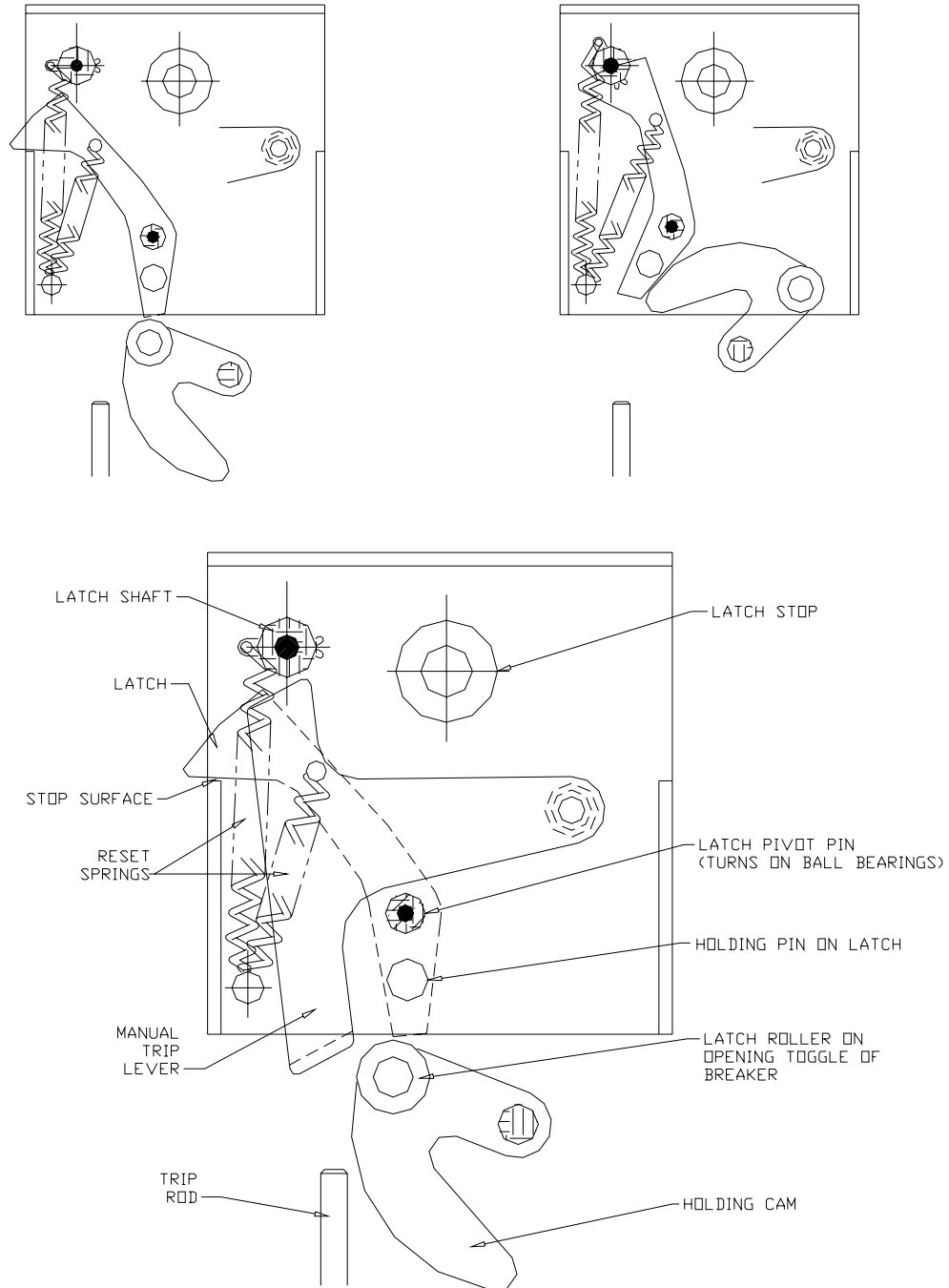
The trip mechanism in use on 137NP network protectors is self-resetting (see Figure 14A, B, C). Rotation of the latch shaft permits the latch to rotate about its pivot, releasing the latch roller and allowing the breaker toggle linkage to collapse. Both the breaker mechanism and the trip mechanism reset through the action of resetting springs. In order for the latch to reset properly, the breaker mechanism must reset before the trip mechanism. For this reason, the holding cam on the latch roller link holds the latch out of the reset position as shown in Figure 14B until the breaker mechanism is fully reset. Resetting of this trip mechanism is positive and no adjustments are required.

The trip coil should cause the breaker to be tripped open when any voltage from approximately 7-1/2 to 106 percent is applied to the tripping circuit.

1. Mechanism Adjustment

- a. Checking operation for resetting after trip-free operation.

It is essential that the breaker mechanism reset properly not only when tripped from the fully closed position but also after trip-free operation. Resetting of the latches after trip-free operation should be checked by the following method.



Figures 14A, B, C – Trip Mechanism

With the operating handle in the automatic position hold up the hand-trip finger (see Figure 15) such that the secondary latch is disengaged. Then energize the motor closing circuit at 230 volts (106 percent) and after two or three trip-free operations release the hand-trip finger. On the next operation the secondary latch should engage the latch shaft and the motor mechanism should then close the breaker and stop.

Should the above check show that the latch is not resetting properly, the following possible sources of trouble should be investigated.

- i. The motor closing cam may be in such a position that the lower roller on the bell crank strikes it before resetting. If such is found to be the case, turn the motor by hand until the cam goes past the roller and the bell crank drops into the reset position. The motor closing cam could get into such a position to prevent resetting either by excessive slipping of the motor brake or because of partial rotation of said cam be turning the motor by hand.
- ii. There may be a bind in the main closing mechanism which prevents the bell crank from dropping into the reset position. This could be caused by dirt or other foreign material getting into the mechanism, or by incorrect assembly if for any reason the breaker has been taken apart.
- iii. The torsion spring on the main latching toggle may not be turning the main latch arm back into the reset position. This again could be caused by binding or excessive friction resulting from dirt or other foreign material, or by incorrect assembly if for any reason the mechanism has been taken apart.

b. Adjustment of Tripping Solenoid

Automatic tripping of the breaker is accomplished by energization of the coil of the tripping solenoid which is mounted on the right-hand side of the trip mechanism. The plunger of this solenoid strikes an arm on the secondary latch shaft, thereby rotating the shaft and freeing the latch. There should be sufficient over travel of the trip plunger to insure position tripping at all times. To check this over travel, first loosen the locking nut (see Figure 15) on the latch adjustment screw and turn the screw down until it just trips the breaker. Then pick up the trip plunger by hand and measure the travel of this plunger between the point where it strikes the latch arm and the point where it can be raised no higher. This over travel should be approximately 1/16 to 3/32 inch. If the over travel is less than this the latch arm should be bent down to obtain the proper over travel. **After checking the over travel of the trip plunger, the latch adjustment screw must be reset.** To do this turn the screw down until it just trips the breaker and then back it off 1-3/4 minimum to 2 full turns. Lock the screw in this position with the locking nut.

Protectors have been carefully adjusted in the factory for low voltage tripping limits, and it should not be necessary to make any readjustments.

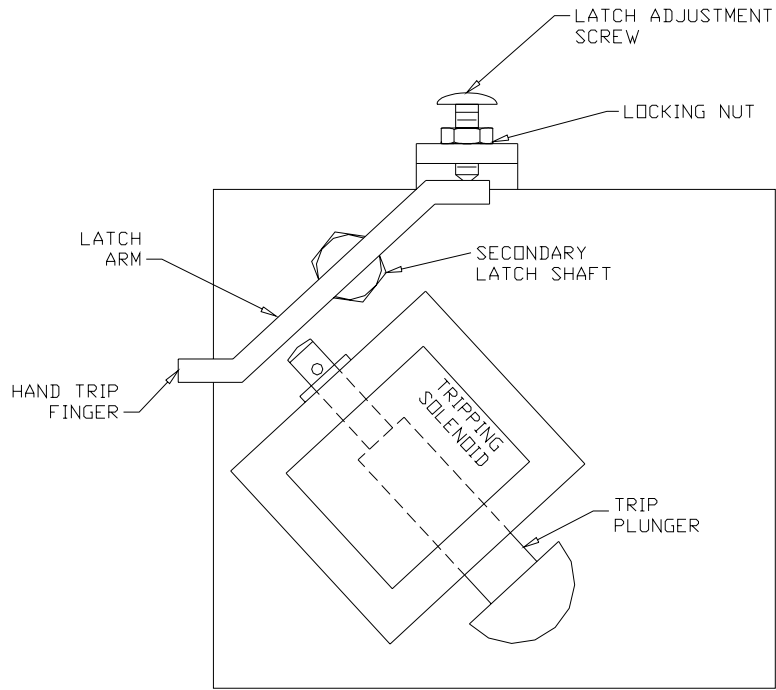


Figure 15 – Trip Solenoid

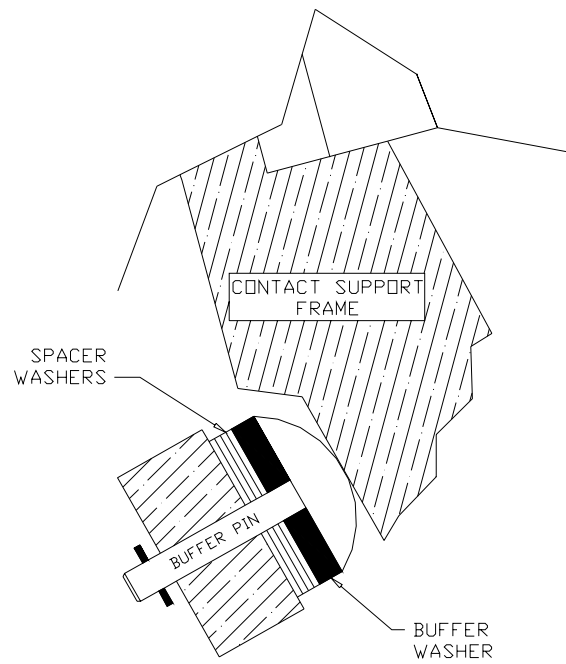


Figure 16 – Buffer Assembly

c. Replacement of Buffer Washers

The shock of the breaker opening is deadened by two buffer stops, one on either side of the mechanism assembly. The buffer washer used on these stops are made of a material which combines the necessary shock-absorbing qualities with long life and durability, and they should be replaced only by similar washers of the same material obtained from the factory. These buffer washers are 1/8 inch thick when new. If, after continued use, the thickness becomes less than 1/16 inch, they should be replaced with new ones. To replace the buffer washers proceed as follows:

Refer to Figure 16.

Close the protector and tie the latch, or block crosshead so that it cannot be tripped accidentally. Remove the cotter pins which hold the buffer pins in place and then remove the buffer pins. Replace the buffer washers with new ones and reassemble in the protector. Before putting the cotter pins back, trip the protector and check to see that the contact supporting frame strikes both buffer pins simultaneously. If not, add or remove spacer washers under the heads of the buffer pins until it does. The adjustment is correct when the following conditions exist.

When the breaker open and the contact supporting frame resting on the buffer stops, the trip resetting plunger should be bearing on the reset cam and holding the secondary latch in the reset position. When in this position the trip resetting plunger should be just starting to compress its spring and move relative to the crosshead frame. In no case should the spring behind the trip-resetting plunger be compressed solid.

The complete trip mechanism may be removed as a unit by disconnecting the trip coil leads, and removing the four screws holding the trip mechanism frame to the main mechanism frame. The trip mechanism may then be lifted and removed completely. **CAUTION: The breaker must be in the “open” position before the trip mechanism is unbolted from the mechanism.**

K. Operating Motor

The operating motor is of the totally enclosed, universal ball-bearing type which requires minimum maintenance. The motor should be inspected and cleaned periodically to insure perfect operation. This can best be accomplished by removing the motor from the protector, removing small hand wheel from the end of motor shaft by loosening the screws, removing the brushes located on side of motor frame and removing the two studs holding the motor frames together. This will permit complete dismantling of the motor for reconditioning and inspection.

The motor is rated for intermittent service, and reasonable care should be exercised when testing network protectors to avoid overheating of the motor by repeated operation.

Operating motors may be removed by disconnecting the leads from the terminals provided, removing the three bolts holding the motor to the gear housing, and lifting the motor vertically.

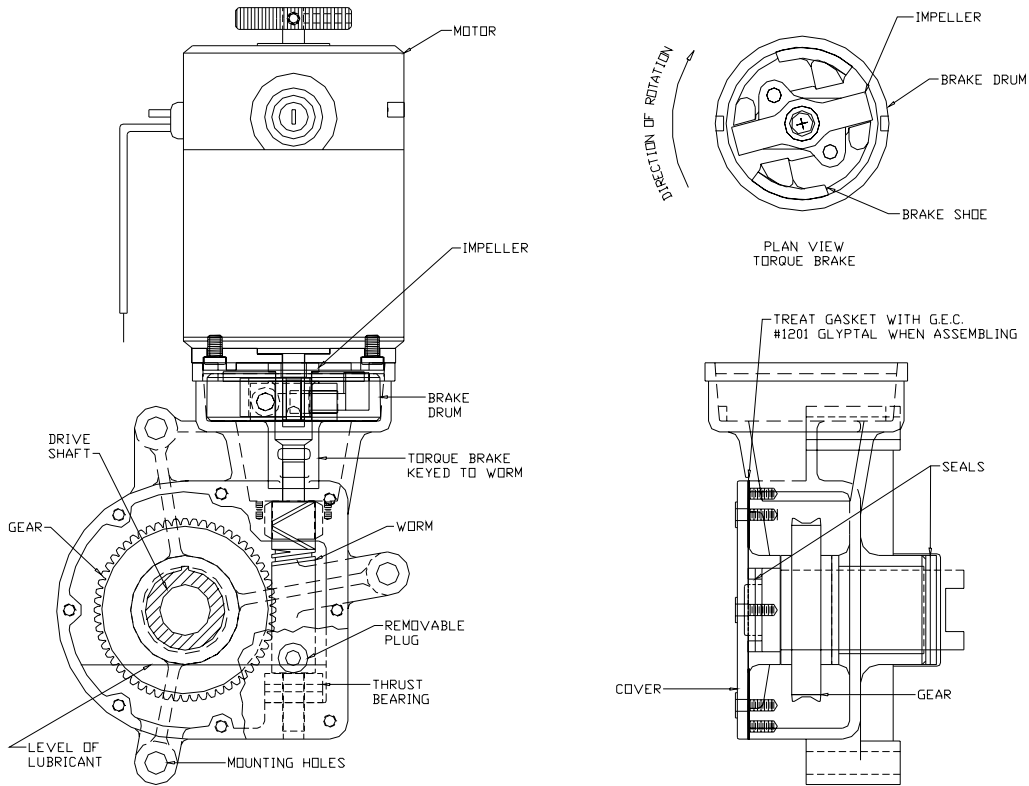


Figure 17 – Motor, Torque Brake and Gear Reducer

L. Torque Brake

The torque brake (see Figure 17) applied between the motor and the gear reducer unit serves as a coupling and controls the over travel of the motor closing cam when the motor is de-energized. This torque brake assembly consists of three units; (1) brake assembly keyed to gear reducer, (2) impeller keyed to motor shaft, and (3) brake drum keyed in the gear housing. When the motor is energized, the impeller releases brake shoe from the brake drum and transmits torque directly to the gear reducer. When the motor is de-energized, the motor torque on the impeller is released permitting the brake shoe to engage on brake drum and stop the mechanism.

The torque brake does not require adjustment other than an occasional inspection to insure that no oil or grease is present on the brake shoes or drum surfaces. When replacing brake be sure that the brake drum is in position. Before replacing motor make sure that impeller is

properly located on brake (see Figure 17) and spacing washers when used between the impeller and motor, should be replaced. Rotate hand wheel on motor to insure that no binding is present before operating.

M. Gear Assembly

The worm and gear are enclosed in a housing to form a unit assembly which is mounted to the side of the mechanism frame casting by three bolts.

The complete gear assembly, either with the motor removed or attached, can be removed by removing the three bolts holding the gear casing to the side of the mechanism frame and sliding the assembly off the end of the manual operating shaft.

N. Manual Operation

Manual operation of the breaker unit of the 137NP protectors is provided through a shaft concentric with the worm wheel and main closing cam shaft. This shaft carries a cam which is similar to the main closing cam and acts against the closing bell crank in the same manner to close the breaker, and is arranged to operate a push rod which lifts the primary latch to trip the breaker open.

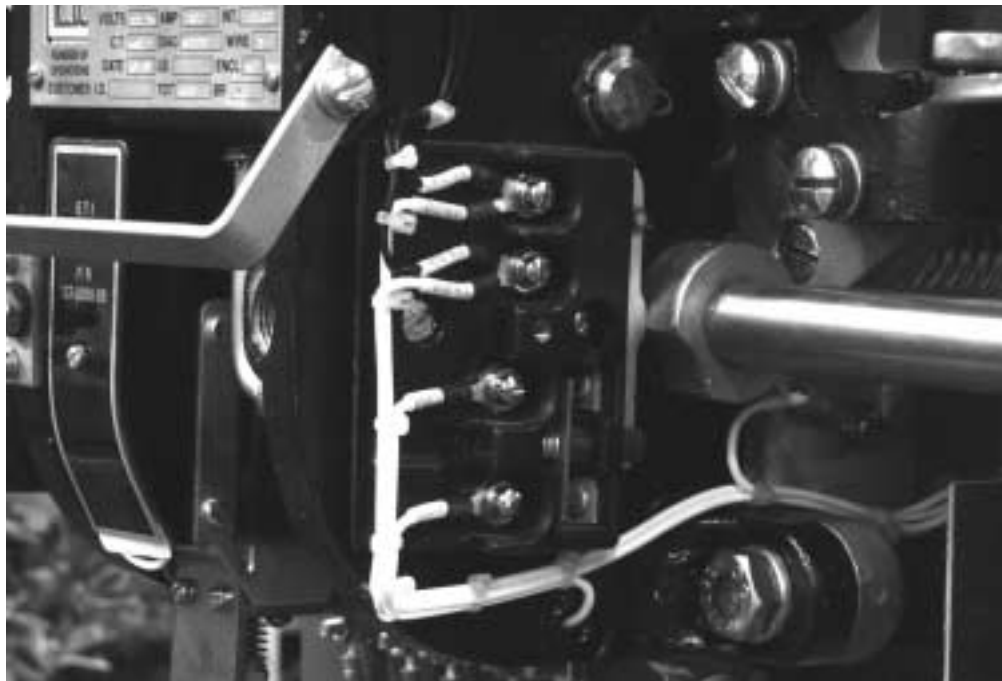


Figure 18 – Manual Cut Off Switch

O. Manual Cutoff Switch

The manual cutoff switch (see Figure 18), located on the right side of mechanism and actuated by a cam on manual operating shaft, opens the “closing” circuit when the manual handle is rotated to the “open” or “closed” position, thus preventing the protector from attempting to reclose with the handle in either of these positions. When the handle is rotated to the “closed” position, the breaker will be closed but will trip free from the manual handle if the trip coil is energized or the trip latch is released. When the handle is in the “automatic” position, the protector will perform its normal automatic functions.

The contacts of this switch should be examined periodically. If necessary, dress contacts with a fine file in high spots only, do not file to bottom of pits

P. Closing Linkage

The main closing linkage is contained in the main mechanism frame.

The complete operating mechanism can be removed from the breaker by disconnecting the control leads, and removing the two bolts on each side of the main mechanism frame, which hold this frame to the breaker frame. This operation may be performed either with the motor, gear assembly and trip mechanism in place, or with any of these parts removed.

CAUTION: Breaker must first be open.

VI. THE ENCLOSURE

The 137NP network protector (see page iii) is provided with a submersible enclosure. All cases are provided with a cover which may be hinged from either side and an external manual operating handle which should always be mounted on the side opposite the cover hinges so as to be accessible when the cover is open. If the enclosure is opened before the protector is mounted in its final location, be sure to secure the top of the enclosure to a solid support to prevent the protector from tipping forward when the unit is rolled forward.

The cover is provided with a gasket for making a watertight joint with the case. Gasket and case surfaces should be cleaned to insure a tight joint. Before closing the cover, it is advisable to cover the gasket surfaces with a thorough coating of flaked graphite or water pump grease for cork and flaked graphite or talc for Corprene. On quick opening boxes with rubber gaskets use talc. This procedure should be followed each time the cover is closed. The cover should be clamped against the case with the clamping arrangement provided by tightening the bolts gradually to insure an even distribution of pressure on the gasket.

All pipe thread fittings including pipe plugs, inspection window holders and pressure test valves, if removed, should be replaced by applying Glyptal or white lead to threads to insure a tight joint. All wiping sleeve cable bushing nuts, before being replaces, should be coated with a mixture of graphite and oil so that they can be removed or tightened easily.

After sealing the enclosure, all submersible protectors should be given an air pressure test. Any satisfactory air or nitrogen testing equipment may be used. Inflate the case with gas to not more than six pounds per square inch leave the pressure in the case for 24 hours. The pressure drop should not be more than two pounds. If it is, investigate for leaks; leaks may be found by painting the protector case with a thick solution of Ivory soap, glycerin and water.

The protector cases should be kept well painted in order to prevent corrosion. Particular attention should be taken to repaint any places where the paint may be marred or scratched off during or subsequent to installation. Recommendations for paint to be used will be furnished upon request.

A. Cover Gasket Replacement

1. Multi-bolt Enclosure

When replacing the gasket on the enclosure, remove the old gasket completely and clean flanges of all foreign material to insure a good bond when cementing new gasket in position. When gaskets are ordered as a supply part, complete installation instructions, together with an approved cement, will be shipped with the material.

2. Quick Opening Enclosure

- a. Remove cover from box. For flat-spring-type hinge remove four screws which secure hinge to front of cover. On boxes with sliding bolt-type hinge, remove cover by removing cotter pins and washers which hold cover to hinge bolt.
- b. Place cover in horizontal position with inside of cover facing upward.
- c. Remove old gasket material and clean all foreign material from gasket retainer.
- d. Select proper length gasket as follows:

Protector Description	Gasket Length in Inches
1600 Amp. Transf. Mounted (small box)	133
1600 Amp, Transf. Mounted (large box)	141
1600 Amp, Separate Mounted	139
2000 Amp	159
3000 Amp	162

- e. Place gasket in retainer. Start with the gasket ends near the center of one of the long sides of the cover. Place sections of the gasket in retainer as shown in Figure 19. Use wide nose pliers and soft mallet. Lubricating the gasket with hand cream will aid in positioning the gasket. Continue placing the gasket in the retainer. Work towards the gasket joint and be careful not to stretch, twist, or cut the gasket. When in its final position the gasket should be free from waves or tool

marks. Wipe the hand cream from the exposed gasket surface and apply talc to keep the gasket from sticking to the housing.

- f. Reassemble cover on the housing by following above procedure in the reverse order.



Figure 19 – Door with Gasket

B. Changing Location of Operating Handle

The manual operating handle is usually located on the right side of the enclosure when facing the protector, and will be supplied in this location unless otherwise specified. A bearing is furnished on both sides of the enclosure so that the location of the operating handle can be changed to suit requirements. It is the usual procedure to have the air pressure valve located on the opposite side of the operating handle.

The breaker unit coupling can also be located on either side of the manual shaft on the unit. This coupling is secured to the shaft by means of a taper pin which can be removed. The couplings on the case and breaker unit are so arranged that they will not engage when installing the breaker unit unless the breaker manual shaft and handle on case are in the open position.

When the handle is to be changed to the opposite side proceed as follows. Remove the handle and the indicator from the operating shaft, back out the locking screws in the packing nut, remove the packing nut, remove the coupling from the operating shaft, remove the operating shaft and remove the index plate.

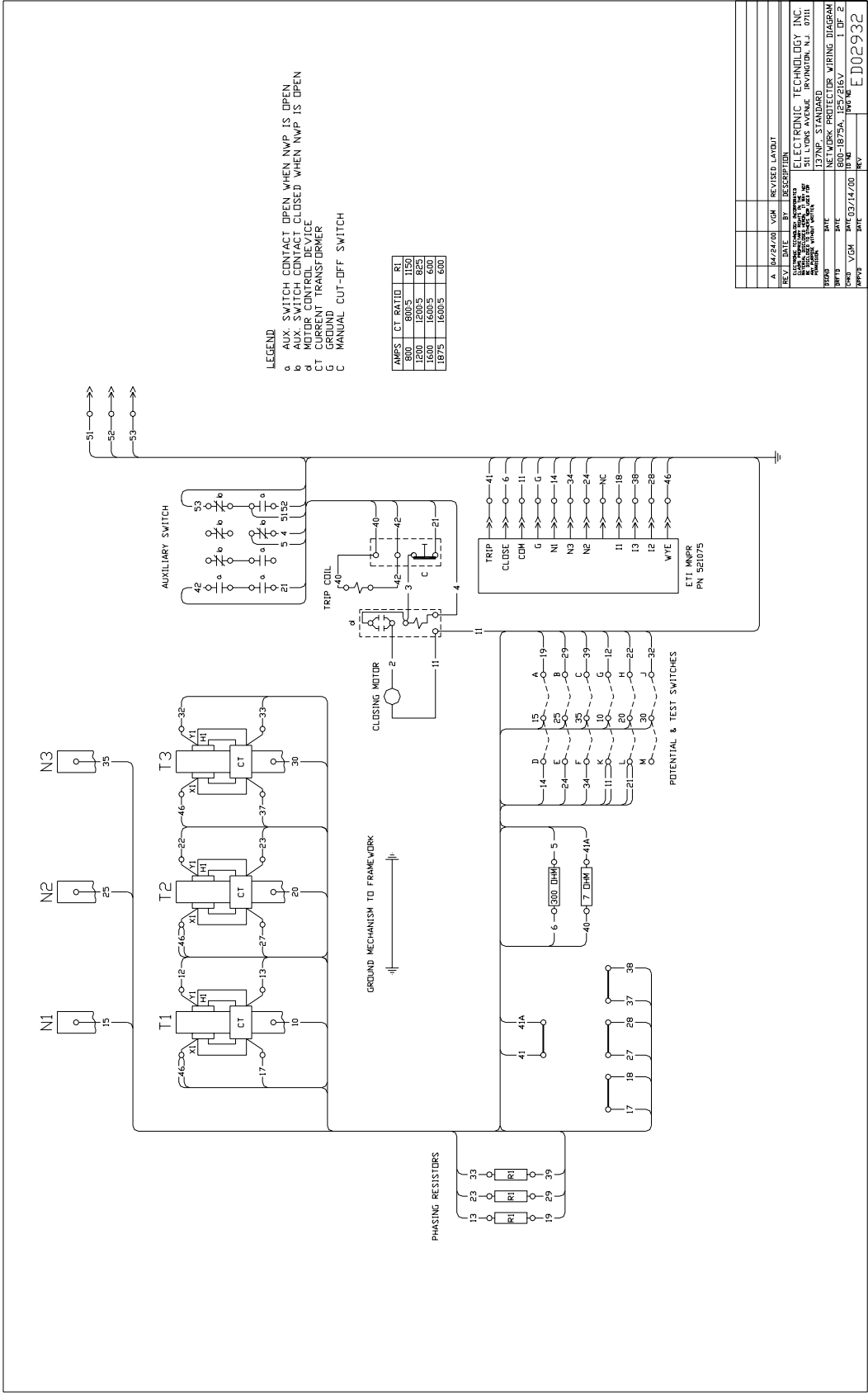
Remove the sealing nut from the bearing on opposite side of the enclosure and assemble to the bearing from which handle has been taken. Assemble the handle to the opposite side of the protector enclosure in opposite sequence to the above.

The pin holding coupling to the operating shaft is shown for right side of the enclosure mounting. When operating handle is mounted on left side of the enclosure the pin is inserted in the hole of the coupling opposite to that shown.

If the packing removed from original bearing is in good condition, assemble in the new bearing making sure that packing nut is drawn against the packing securely for proper pressure seal and that the locking screws are securely fastened to bearing to prevent packing nut from turning.

C. Packing

Packing nut is adjusted at the factory to provide an airtight seal, and further adjustment should not be necessary. If, however, it is found necessary to tighten packing nut, remove the handle and indicator, back out locking screws of packing nut and turn packing nut in clockwise direction to improve airtight seal. If packing nut is tightened to within 1/16 inch from bearing face, additional packing can be added or bearing repacked with recommended packing.



REV	DATE	BY	DESCRIPTION
1	03/14/00	WGM	REVISED LAYOUT
2	03/14/00	WGM	REVISED LAYOUT
3	03/14/00	WGM	REVISED LAYOUT
4	03/14/00	WGM	REVISED LAYOUT
5	03/14/00	WGM	REVISED LAYOUT
6	03/14/00	WGM	REVISED LAYOUT
7	03/14/00	WGM	REVISED LAYOUT
8	03/14/00	WGM	REVISED LAYOUT
9	03/14/00	WGM	REVISED LAYOUT
10	03/14/00	WGM	REVISED LAYOUT
11	03/14/00	WGM	REVISED LAYOUT
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13	03/14/00	WGM	REVISED LAYOUT
14	03/14/00	WGM	REVISED LAYOUT
15	03/14/00	WGM	REVISED LAYOUT
16	03/14/00	WGM	REVISED LAYOUT
17	03/14/00	WGM	REVISED LAYOUT
18	03/14/00	WGM	REVISED LAYOUT
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46	03/14/00	WGM	REVISED LAYOUT
47	03/14/00	WGM	REVISED LAYOUT
48	03/14/00	WGM	REVISED LAYOUT
49	03/14/00	WGM	REVISED LAYOUT
50	03/14/00	WGM	REVISED LAYOUT
51	03/14/00	WGM	REVISED LAYOUT
52	03/14/00	WGM	REVISED LAYOUT
53	03/14/00	WGM	REVISED LAYOUT

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