Network Protector Instruction Manual

Type 416NP
800-2250 Ampere

Richards MANUFACTURING CO.

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IM 1241-001A

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 416NP Network Protectors.

De-energize 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 protector.

WARNING

Before unpacking, installing, servicing, or operating 416NP network protectors read this manual thoroughly.

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

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

Do not operate 416NP network protectors under load except in appropriate enclosures.

The 416NP Network Protectors are designed for secondary network application at 125/216 volt through 277/480 volt wye connected systems. Do not exceed design ratings.

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I. OVERVIEW

A. Introduction

The Richards 416NP Network Protector consists of a circuit breaker, a motor operated stored energy closing 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.

The circuit breaker has contacts fashioned from a weld resistant alloy. In addition, the breaker has arcing contacts to protect the main contacts from the initial arc generated when the protector is closed. When the protector is closed, the contact pressure is significant so as to create a solid electrical contact. In the event that the protector fails to open at the time of a severe fault, fuses are present as a final safety precaution. Current Transformers, located above the lower disconnect contacts on each phase, are used to send current readings to the relay. The mechanism is mechanically trip free. The mechanism will not close if it receives a trip instruction at any point in the closing cycle. A shunt trip device, designed to trip at very low voltages when necessary retains the latch. The breaker unit includes accelerating springs so that the breaker contacts may be opened quickly.

B. 416NP Ratings

Network protectors are furnished with a current rating of up to 2250 amperes. The voltage ratings are 125/216 (phase to ground/phase to phase) through 277/480, 3 phase, 4-wire wye or other special voltages per customer request. All units have an interrupting and fault close and latch rating of 30,000 amperes.

C. 416NP Housings

All Network Protector housings are designed to allow the removable breaker to be rolled out on rails for easy maintenance. The 416NP is equipped with a new system that allows for an automatic rack in or out of the protector mechanism. Rack out distance is limited to 2" when the housing door is closed. After an automatic rack-out, the door of the housing can be safely opened. At this time, the rail extensions can be installed and the removable breaker is able to be rolled out to the point where it can be vertically lifted out of the housing. Many different types of terminals are available. The type of terminals is tailored to each customer's needs. The submersible housing is manufactured from copper bearing steel. An external operating handle can be locked in two different positions "AUTOMATIC" and "OPEN". In addition, the handle can be moved to a third, momentary location "CLOSE" only if the Operating Handle Blocking Device is removed (Figure 1). The door contains a window so that the operations counter and position indicator can be inspected without opening the protector's door.

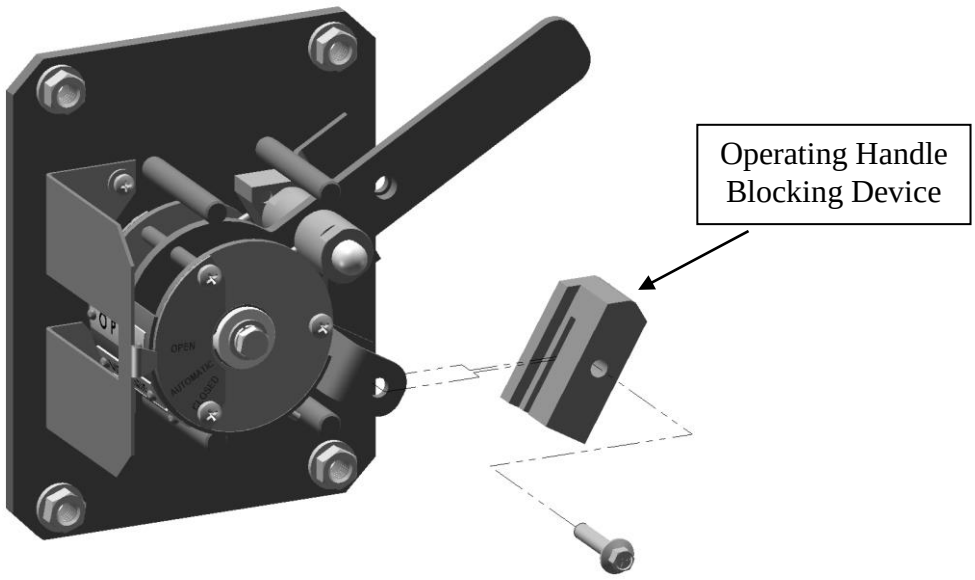

Figure 1

II. INSTALLATION

A. Receipt of the 416NP

The 416NP Network Protector should be removed from its packaging in a careful manner such that no parts are damaged. The protector should be immediately inspected to ensure that no damage has occurred during shipment. If the unit has been damaged, the common carrier should be contacted immediately. Any dust that has accumulated during shipment should be removed from the unit. All 416NP protectors should be stored upright in a clean, dry location. Submersible units should be stored with their doors sealed.

All 416NP Network Protectors are equipped with holes for lifting the unit into place. The lifting eyes are welded to each side of the housing, near the top. A nylon sling should be used to lift the protector so not to scratch the housing. The sling should be used in conjunction with a spreader so that the cable terminals are not damaged. For a submersible housing, care should be taken to ensure that the housing is supported before the door is opened and the protector mechanism rolled out. The feet of the protector cannot support the weight of both the door and the mechanism in the rolled out position.

416NP Weight Chart	
Mechanism Only	**Pounds (lbs)**
800 – 2250 Amperes	525
Housing Only	
800 – 2250 Amperes	1075

B. Preliminary Testing

The 416NP Network Protector should be tested before it is installed on a network system. The protector should be firmly mounted and secured.

C. Mounting the 416NP – Mechanical Connection to Transformer

Transformer Mounting Protectors

Before mounting the housing to the transformer the operator should ensure that the transformer is not energized. The housing for the transformer mounted submersible protector is attached to the network transformer at two points, at the low voltage throat and by means of pads located near the bottom of the protector. The protector housing should first be supported on the transformer throat using two dowel pins. The pins are located on the transformer and line up with holes at the back of the protector housing. After the pins are in place on the housing, the back of the housing should be bolted to the transformer throat using the bolts provided. When the housing to throat connection is secure, the bottom of the housing is connected to the bottom of the transformer using the provided mounting brackets.

D. Mounting the 416NP – Testing and Electrical Connection to Transformer

When the housing has been secured to the transformer, the housing bus bars should be connected to the transformer outlet bushings on the transformer throat using a flexible connector designed to join the threaded stud emerging from the throat area to the housing bus bars. The removable breaker is then ready to be installed in the housing. In order to install the breaker, the handle must be locked in the open position. Then the removable breaker is placed on the housing rails. Before closing the protector into a network, every breaker should be opened and closed at least five times under control of the ETI MNPR® (See the wiring diagrams located at the end of this manual). The operator should ensure that the relay is programmed to the desired specifications. The appropriate voltage for conducting automatic tests should then be applied across the protector using a three-phase test set. If the ETI MNPR® is not fully operational, the protector may still be operated by applying rated voltage across the outside poles of the circuit breaker and then issuing commands through the ETI Commander Software using the handheld Android device. The trip-free action of the breaker may be tried by immediately tripping the protector after the circuit breaker arcing contacts have touched, during a closing cycle. Once the removable breaker has been tested and displays the desired performance, it is ready to be connected to the transformer.

The removable breaker must be rolled inside the housing as per instructions below:

1. Manually push the breaker inside the housing and align it with locating sticker (Figure 2).

2. Push the engagement handle down (Figure 3) in order to engage fingers (Figure 4) to the contact plate mounted on the enclosure and consequently provide power to the racking circuit. When the fingers fully engage on the contact plate, a white indicator light on the Racking Pendant will turn on (Figure 5).

3. Use the Racking Pendant, to rack in the removable breaker. After the motor finishes the cycle and stops, the unit will be fully connected to network and to transformer side.

Figure 2

Figure 3

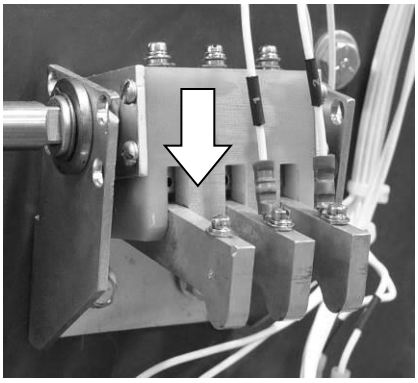

Figure 4

Figure 5

E. Energizing the Feeder

Once the protector is mechanically and electrically connected to the transformer and the breaker has been tested, the main cables leading to the secondary network should be connected to the protector terminals and the protector housing to the ground. The protector should still be physically locked open using the handle and a locking block. The primary feeder is now ready to be energized. Once it is energized, follow your standard protocol, or use the optional Phase Test Box and Cable to measure the voltage differential and phase relations.

To use the Phase Test Box, first plug the Phase Test Cable into the 8-pin connector located on the test box, followed by connecting it to either the inside of the housing or through a 1" NPT on the exterior side of the housing. Then, a suitable voltmeter shall be used to measure differential and phase relations across the test box. If the phase relations are correct and the transformer voltage is higher than the network voltage by the right amount, the removable breaker can be racked in and the handle should be moved to the "AUTOMATIC" position, in order to close the protector.

F. Checking a Submersible Housing for Water-Tightness

Although every 416NP submersible housing is tested for water-tightness at the factory, the user may wish to retest once the protector is installed. With the protector closed and operating properly, the housing door should be closed and tightened to the case. The seals on the gasket can then be tested by attaching a pressure gauge together with bottled nitrogen to the sampling valve and charging the housing with a pressure of six (6) psi. Leaks can then be detected placing soapy water over the gasket seal and checking for air bubbles.

III. 416NP DESIGN

A. 416NP Circuit Breaker

The circuit breaker on the 416NP consists of three independent bus bars (each representing a phase) mounted on an insulating panel along with control wiring. Five fingers make up the main stationary contact assembly. Individual springs provide pressure against the main moving contacts when the protector is closed. Above the main contacts is the arcing contact. The stationary arcing contacts oppose each other and are spring biased together. When the protector closes the moving arcing contact wedges in between the opposing stationary contacts.

A gap with a range from 0.050 to 0.100 inches is maintained on the main stationary contacts to be certain that contact pressure is uniform (Reference Figures 6 & 7). A contact resistance of less than 20 micro ohms should also be verified.

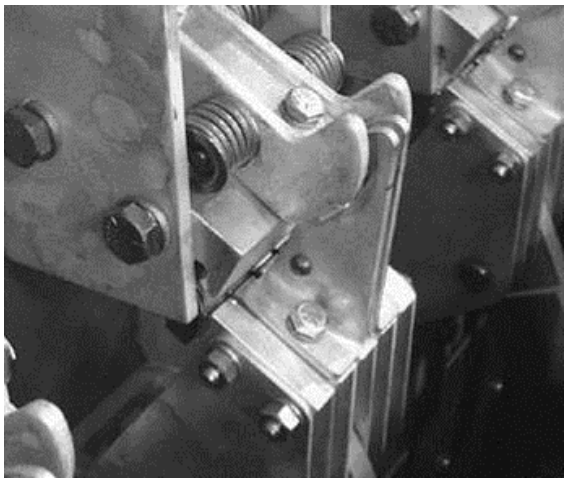

Figure 6

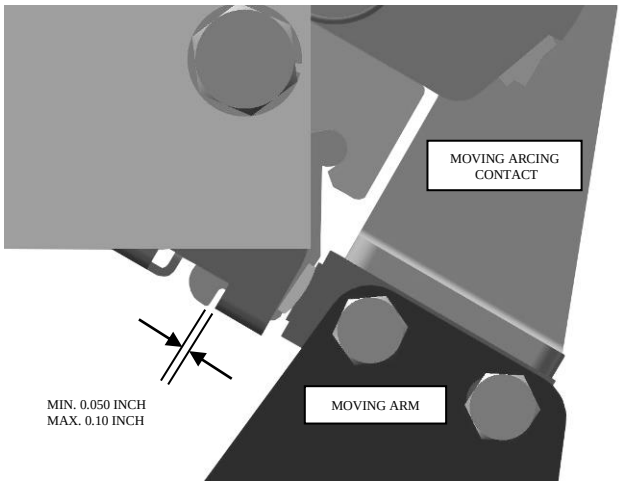

Figure 7

The five main moving contacts are bolted between six contact blades that pivot on a pin through the lower bus assembly. Bellville washers maintain contact pressure between coined silver plated rings and the lower bus assembly.

The moving contact assemblies are connected by individual adjustable linkages to the main operating shaft. Contact gap is adjusted by changing the threaded linkage length. The main operating shaft has three levers for the three phases, an opening spring lever, an auxiliary switch and indicator lever, and a main actuation linkage attachment point at the center phase lever. Bearings support the main shaft in four locations. Bumper stops of neoprene rubber washers and steel washers absorb the shock of stopping the opening motion.

The main contacts of the circuit breaker are made of a weld resistant alloy. The arcing contacts described above, part shortly after the main contacts have opened, reducing stress to the main contacts.

Fuses are provided internal (Figure 8) or external (Figure 9) of the network protector. In order to isolate the removable breaker for test or repairs, simply rack the breaker out, install the rail extensions and then the removable breaker can be rolled out on its rails.

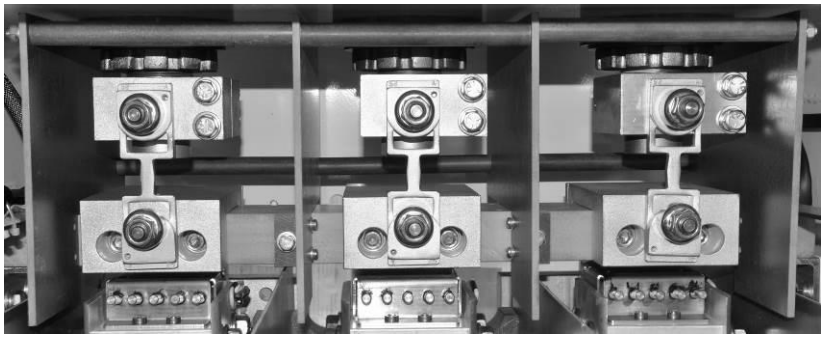

Figure 8: Internal Fuses

Figure 9: External Fuses

Figure 10: Lower Network Protector Contacts

Current transformers (Figure 10) on each bus bar work in conjunction with the ETI MNPR® to trip the protector on reverse current.

B. 416NP Mechanism

The 416NP Network Protector mechanism is a stored energy design. A closing motor first charges a spring which then provides the closing force for the contacts. A cam and clutch arrangement is used to provide this function. A trip free linkage assembly is used to provide breaker opening anytime a trip command is issued. The shunt trip coil releases the trip free lever allowing the toggle link to move upward thus opening the breaker very rapidly. After opening, the linkage resets itself to be ready for the next closing cycle.

C. The Operating Handle

On the submersible housing an external handle mates with the internal trip linkage that provides three positions "OPEN" (Figure 11), "AUTOMATIC" (Figure 12) and "CLOSE" (Figure 13). A lever at the shaft engages with a lever of the mechanism toggle so that the movement of the handle from the "AUTOMATIC" to the "OPEN" position will actuate the trip linkage. Both, electrical and mechanical interlock prevent the breaker from closing when the handle is in the "OPEN" position. When the handle is returned to the "AUTOMATIC" position the MNPR® is able to reclose the protector if system's conditions are met. When the handle is moved to the "CLOSE" position the electrical closing circuit is completed and the network protector will close. The handle must be put in the "OPEN" position in order to rack in or rack out the network protector.

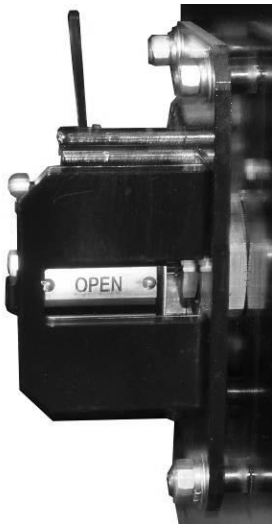

Figure 11

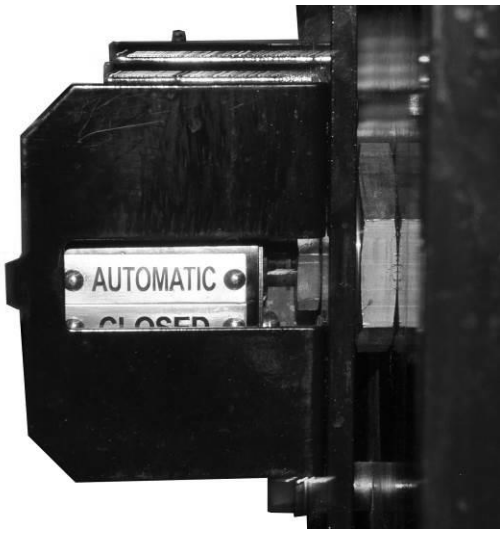

Figure 12

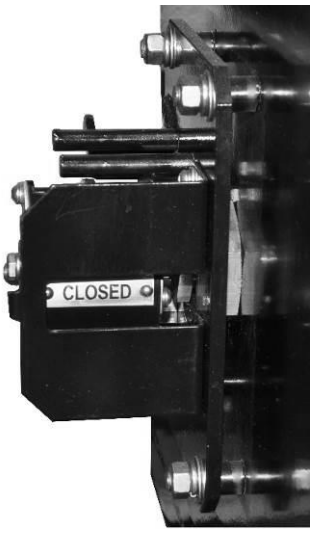

Figure 13

D. Relay Panel

The ETI MNPR® and required devices for controlling the operation of the protector are pre-wired on the relay panel. The relay plugs into the front of the panel so that no adjustment needs to be made to the permanent wiring when installing or removing the MNPR®.

E. Closing Motor

The closing motor (Figure 10) is a single-phase universal wound motor with an integral gear reduction. Additional external gears further reduce the speed between motor and closing cam. The rotation of the closing cam charges the closing spring to provide a stored energy source for rapid closing of the protector contacts. The stored energy design provides high amperage make and latch ratings for closing into fault conditions. The motor shall have enough torque to close the protector at 73% of the motor's rated voltage. The motor can be removed through the left side of the assembly.

Figure 10

F. Shunt Trip Assembly

The shunt trip assembly unit (Figure 11), comprising the trip magnet with its coil, is mounted on a frame that also carries a trip plunger, and the latch check contacts. The shunt trip is designed to operate down to 7.5% voltage. There should be a small gap between the plunger and strike lever, but it should never exceed 3/32 inch. The latch check switch prevents energizing the close circuit if the shunt trip is actuated electrically or manually.

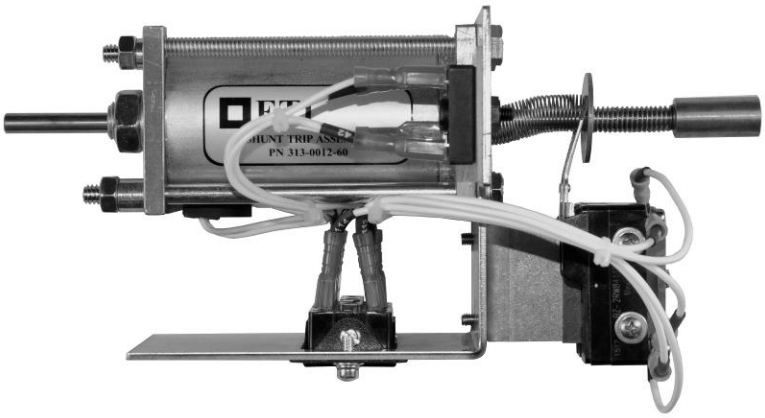

Figure 11

A tripping cycle consists of the following sequence of operations:

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

2. The opening of the circuit breaker returns the auxiliary switches to their original position, thereby opening the circuit of the shunt trip coil and closing the circuit of the motor control relay, in preparation for the next closing operation.

G. Motor Circuit Control

The closing motor is energized by the motor control relay that is controlled by the ETI MNPR®, the auxiliary switch and by the latch check switch of the removable breaker. A signal from the MNPR® energizes the coil of the motor control relay, which then closes its contacts. The closing of these contacts serves to energize the circuit of the motor. The motor control relay seals in the energized position independent of the MNPR® contacts. The motor charges the closing spring and spring energy closes the protector. After the breaker latches, the auxiliary switch opens, and de-energizes the motor control relay. At 73% nominal voltage, the motor control relay shall not pick up to energize the closing motor. However, at that voltage the closing motor must generate enough torque to energize the closing spring to complete a close sequence. The motor control relay must pick up at 80% nominal voltage.

A closing cycle consists of the following sequence of operation:

1. The MNPR® contacts close, thereby completing the circuit to the coil of the motor control relay.

2. The motor control relay energizes and seals in.

3. The motor, being energized by the relay, then rotates the closing cam charging the closing spring.

4. When the spring is fully charged its energy is released to close the network protector.

5. The closing of the protector opens the auxiliary switch contacts, de-energizing the motor control relay and stopping the motor. At the same time the auxiliary switch contacts in the shunt trip circuit are closed.

H. Internal Position Indicator and Operations Counter

A position indicator identifies the "OPEN" or "CLOSED" mechanical status of the breaker. Depending on the breaker position, only one word: "OPEN" or "CLOSED" is visible from the front of the protector, on a semaphore flag (See Figures 12 & 13). A non-resettable mechanical operations counter is mounted at the front of the protector and it is visible through the window located on the housing.

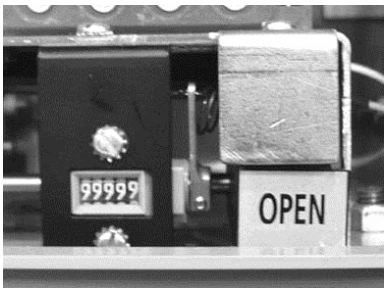

Figure 12

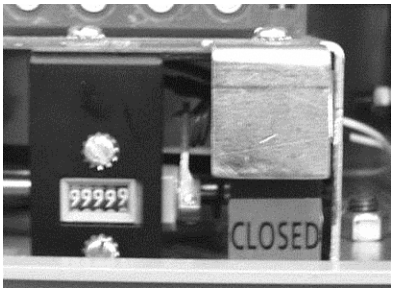

Figure 13

I. Auxiliary Switch

The main auxiliary switch consists of a rotary control switch. There are twelve contacts provided, although not all of them are used in the standard wiring arrangement. Contacts are made and opened by metal segments rotated between stationary fingers. The switch contacts are controlled through a mechanical connection with the operating mechanism.

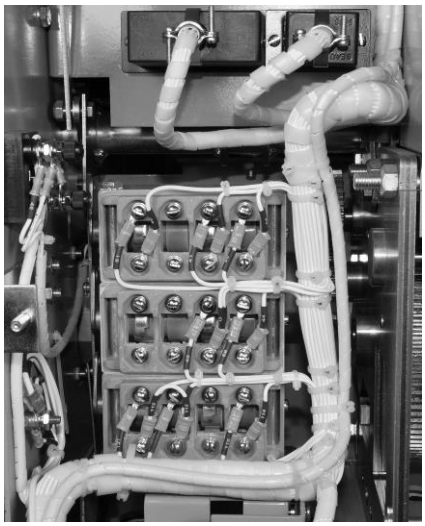

Figure 14

J. Racking Pendant

The 416NP uses a Racking Pendant to control the automatic racking in and out of the removable breaker. This Racking Pendant is equipped with four (4) Indicator Lights, a Selector Switch and a Push Button. The White LED indicates whether the racking circuit has 'POWER ON'; the Red and Green LEDs indicate whether the protector main contacts are 'CLOSED' or 'OPEN'; and the Amber LED indicates that the removable breaker is fully 'RACKED IN' when illuminated. The Selector Switch is used to choose the direction the mechanism is going to travel, whether it be 'IN' or "OUT', while the momentary Push Button initiates the racking circuit, 'RUN'. (See Figure 15)

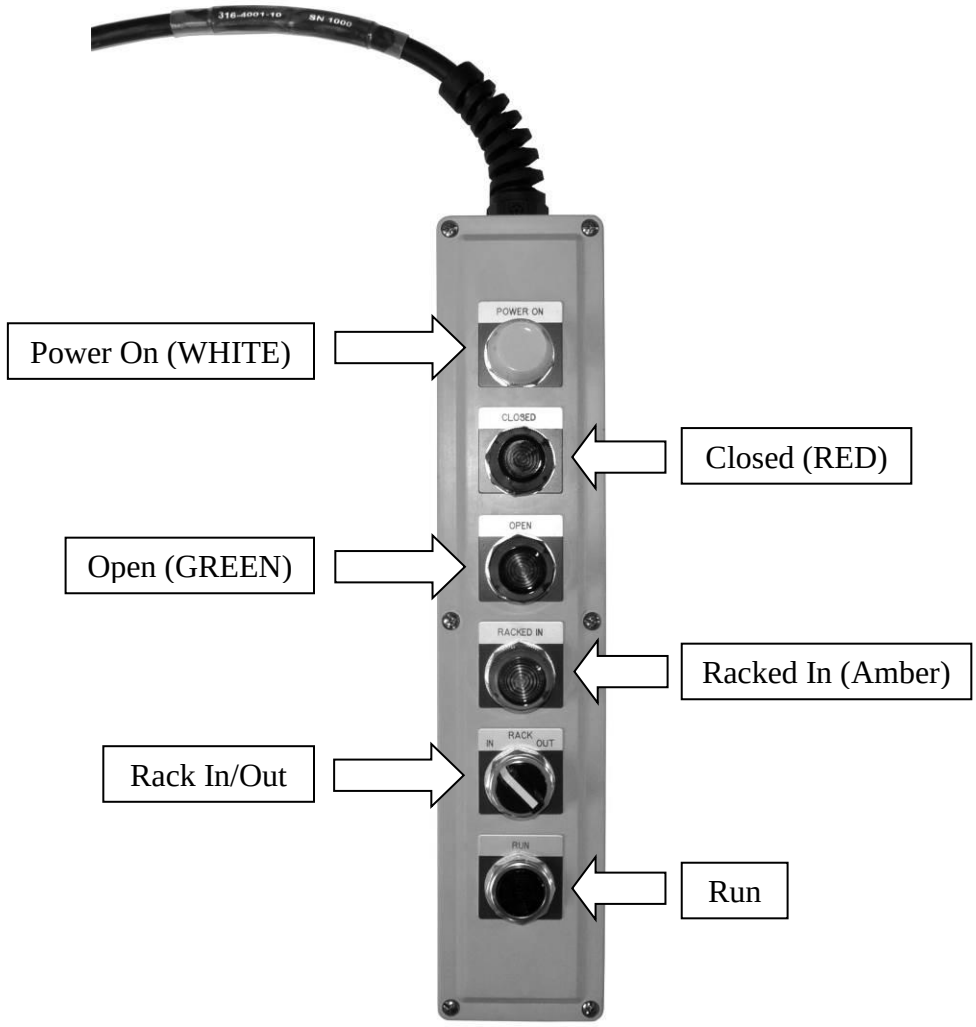

Figure 15

K. Racking system - Rack In/ Rack Out

The 416NP is equipped with a racking system that has two main functions:

1. Locks the unit inside the housing, which automatically connects it to network/transformer side.

2. Disconnects the unit from the network/transformer side and enables it to be removed for service.

Both steps can be performed by using either automatic (Figure 16, Item 1) or manual gearboxes (Figure 16, Item 2). Manual gearbox is driven with an L-shaped wrench supplied with each unit (Figure 18). An interlock system (Figure 17) installed on the center panel prevents protector from racking in or out when main contacts are closed.

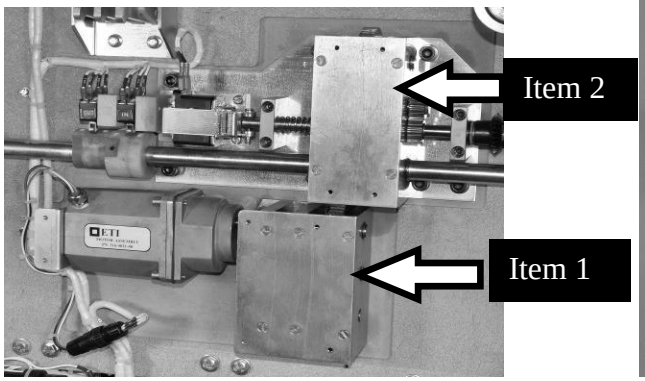

Figure 16

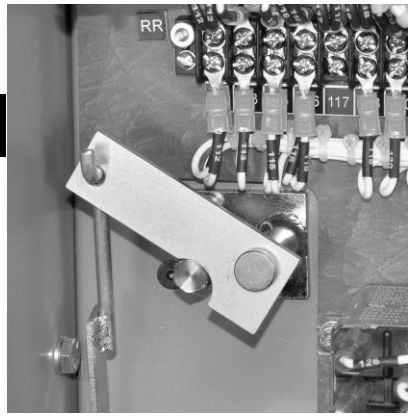

Figure 17

Figure 18

L. Racking circuit contact system

The 416NP is equipped with a Racking Circuit Contact System (Figure 19) composed of spring loaded contacts that are engaged by the operator thru a lever in front of the removable breaker and are disengaged automatically when the breaker is moved to the racked out position. Using the Racking Pendant, for visual confirmation, an **amber light on** will indicate that the system is engaged, **no lights** will indicate that the system is disengaged and a **white light on** will indicate that the racking circuit has power.

The Racking Circuit Contact System has two main functions:

1. Isolates the removable breaker from all power after a rack out sequence.

2. Re-establishes power to the racking circuit.

Figure 19: Racking Circuit Contact System

M. Racking motor

The racking motor is a single-phase universal wound motor with reversing capability. The rotation direction of the motor moves the cams to rack in, or rack out the removable breaker.

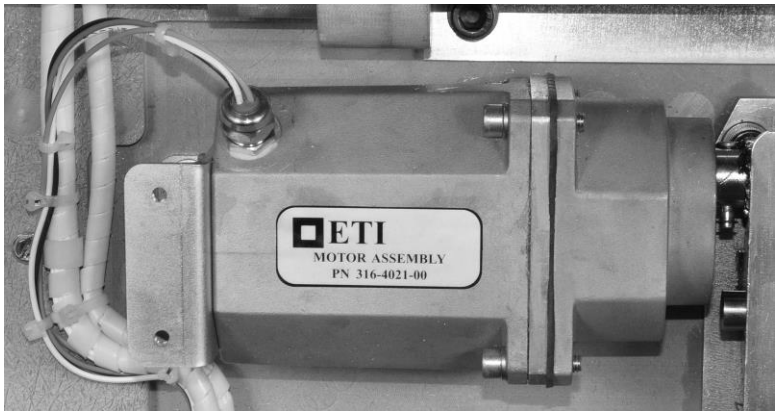

Figure 20: Racking Motor

N. Racking Solenoid

The electromechanical solenoid controls the manual and automatic racking system. Energizing the solenoid pulls the fork, and connects the automatic gearbox to enable the unit to be racked in or out via the motor. Once the solenoid is de-energized, the spring pressure returns the fork back into the manual gearbox and allows the user to rack the unit in or out manually.

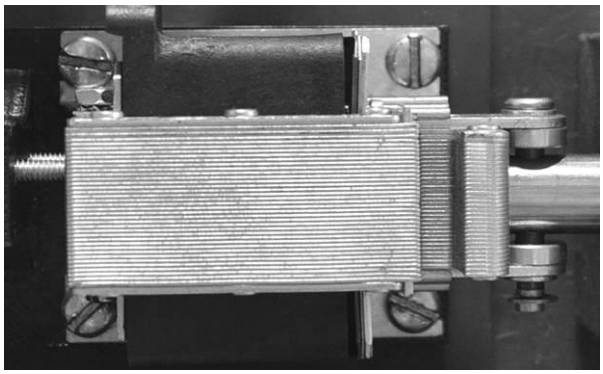

Figure 21: Racking Solenoid

IV. MAINTENANCE

416NP protectors should be inspected on a scheduled basis. The inspection should consist of both a mechanical checkup followed by a test of the electrical operations of the protector.

Caution: Before making any inspection of the protector or the relay, it is crucial to isolate the unit from both the transformer and the network. Isolation is accomplished by locking the protector in the open position using the handle and the locking block. The fuses should then be removed, isolating the unit from the network, as well as the disconnect links, which isolates the unit from the transformer. Before performing any work, an appropriate voltmeter, or continuity meter should be used to ensure that the unit is not energized.

A. Inspection

1. The Circuit Breaker Unit

The following regular maintenance should be performed:

a. All electrical connections should be tightened.
b. All springs should be properly placed and in working order.
c. All nuts, pins, cotters, and screws should be properly placed and tightened.
d. All current carrying elements should be checked for damage due to overheating.
e. All contacts should be cleaned and checked to see that they form good electrical connections.
f. All fiberglass barriers should be checked to ensure that they are not broken.
g. All connections on the terminal blocks should be checked and tightened.
h. The control circuits should be tested.

2. The Housing

The following regular maintenance should be performed:

a. All electrical connections should be tightened.
b. The fuses, disconnect links and terminals should be examined for damage associated with overheating.
c. The housing itself should be checked for corrosion.
d. All fiberglass barriers should be examined to make sure that none are broken.
e. The housing itself should be checked to ensure that it is watertight.
f. The handle should be checked to ensure that it operates properly.

B. Automatic racking operation

1. Automatic removable breaker Rack Out

Caution: If not attached to the transformer the housing must be supported to prevent tipping over when the door is opened and the mechanism racked out.

a) Connect the Racking Pendant into the mating bulkhead connector on the side of the housing (Figure 22).

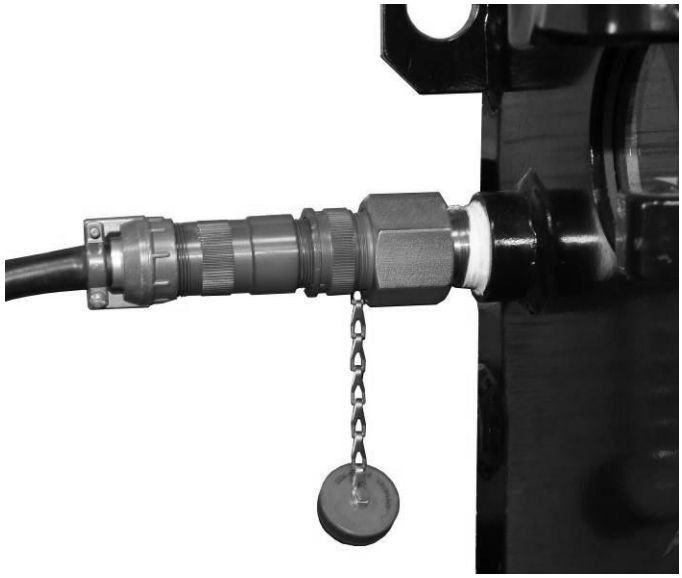

Figure 22

b) Place the handle in "OPEN" position.

c) Use the racking pendant to rack out the mechanism.

d) Auto transmission will push the removable breaker out by approximately 1.5 inches.

e) Verify position of the breaker through indicator window on the side of enclosure. Indicator must be in "FREE" position. (Figure 23)

f) Open the door after the removable breaker stops and all indicator lights on the pendant turn off.

g) Install the extension rails.

h) Installation of extension rails will automatically lift up the safety bracket (Figure 24)

i) At this point, pull the removable breaker outside of the housing for service.

Figure 23

Figure 24

2. Automatic removable breaker Rack In

   a) Verify that the position of the cams are facing the front of the breaker. If the cams are not facing the front of the breaker, install the insulated 7/16 inches L-shaped wrench provided, onto the crankshaft and rotate the cams until they point towards the front. (See Figure 25)

   b) Manually push the removable breaker in and align it with the location stickers on inside the housing.

   c) Push the engagement handle down in order to engage fingers and power-on the protector.

   d) After actuating engagement lever, watch for the safety light. If the safety light is off, the motor is not seeing power and will not work. System needs troubleshooting. When the safety light is on, continue to step e.

   e) Close the housing door.

   f) Use the racking pendant, located on the outside of housing to rack-in the breaker and connect it to the transformer side. After the motor finishes full cycle and stops, the unit will be fully connected to network and transformer side.

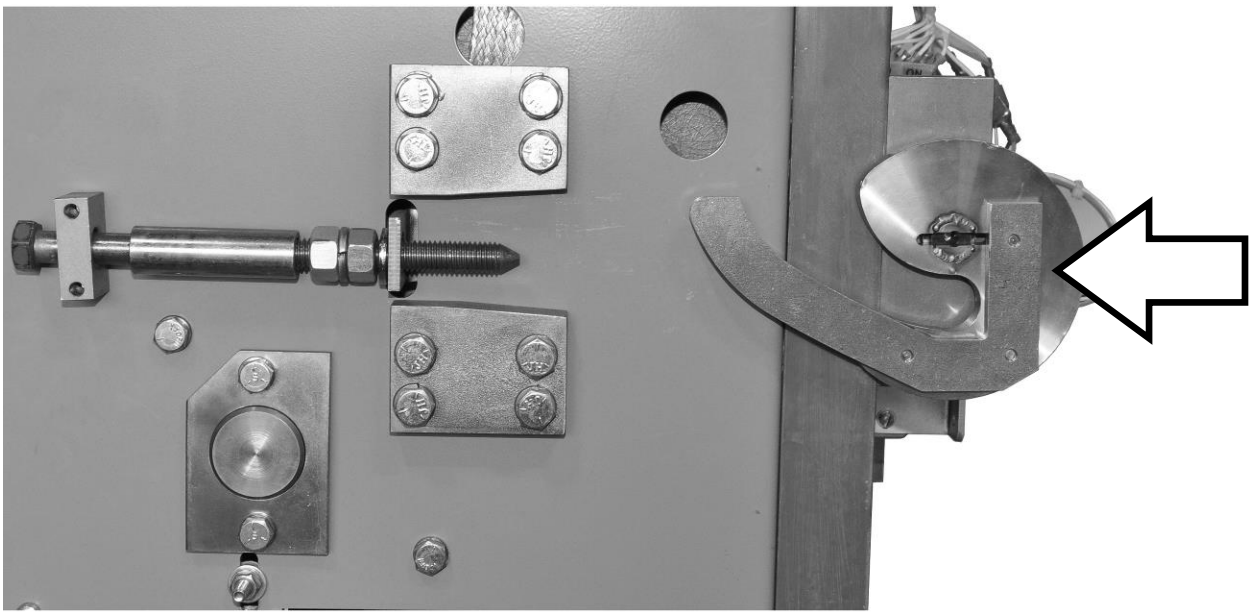

Figure 25

C. Manual racking operation

Note: This method should be used in instances when the motor can not be powered and needs troubleshooting.

1. Manual breaker Rack Out

    a) Place the handle in "OPEN" position.

    b) Open the housing door.

    c) Install the supplied 7/16 inches L-shaped wrench onto the crankshaft (look on the left hand side on the center panel) and turn it clockwise to rack out the protector.

    d) Installation of extension rails will automatically lift up the safety bracket allowing the removable breaker to be pulled all the way out of the housing (Figure 24).

2. Manual breaker Rack In

    a) Verify that the position of the racking cams are facing the front of the removable breaker. If the racking cams are not facing the front of the breaker, install the insulated 7/16 inches L-shaped wrench provided, onto the crankshaft and rotate the cams until the cams are pointing towards the front. (See Figure 25)

    b) Manually push the removable breaker in and align it with the wheel location stickers on inside the housing.

    c) Re-engage power to the Racking Pendant by pushing down on the engagement handle.

    d) Install the pre-supplied 7/16 inches L-shaped wrench onto the crankshaft (look on the left hand side on the center panel) and turn it counter-clockwise to rack in the protector. (Figure 26).

    e) When the unit is fully racked in, remove wrench, both rails and close the door.

    f) At this point the unit will be connected to transformer and network side.

Figure 26

D. Contact Inspection

1. Rack out removable breaker.
2. Remove arc chutes.
3. Remove phase barriers.
4. Manually close the network protector by setting the handle position to "AUTO" and pumping the ratchet handle to charge the closing spring until the protector closes.
5. Inspect main contact gaps through side plate access holes. When the protector is closed the gap should be in 0.050 to 0.100 inch. (See Figure 7)

E. Replacing Racking Circuit Fuse

1. Trip mechanism open by moving the network protector external handle to the "OPEN" position.
2. De-energize the Transformer.
3. Isolate the Network Protector from Secondary Network, if possible.
    a. If protector has external fuses or links – removal of these fuses or links is acceptable.
    b. If the protector does not have external fuses or links, be aware that the fuse holder is still live.
4. Set up rail extensions and manually rack out mechanism.
5. Locate and replace the blown racking circuit fuse (Figure 27).
6. Re-secure fuse holder as shown in Figure 27.
7. Manually rack the mechanism into the enclosure (See Manual mechanism Rack In under Manual Transmission Operation).
8. Close enclosure door.
9. Re-establish connections to Secondary Network (if applicable).
10. Energize the Transformer.
11. Return the Network Protector external handle to the "AUTO" position.

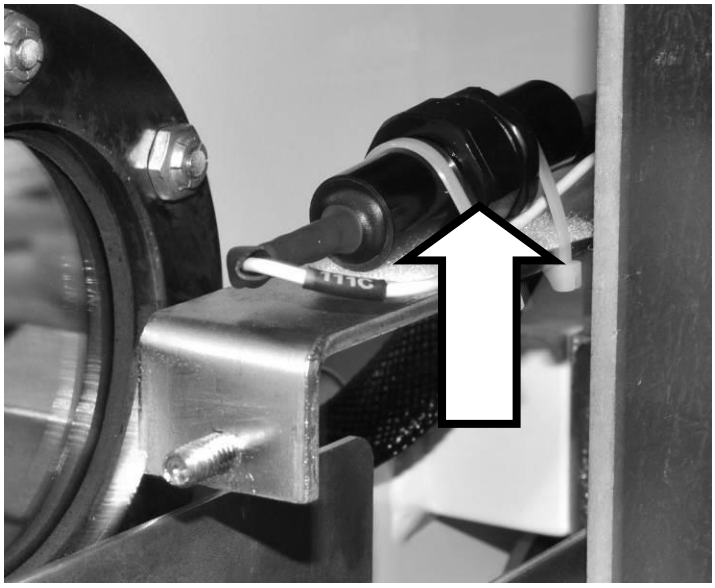

Figure 27

F. Replacing Phasing Test Fuses (Optional)

1. Trip mechanism open by moving the network protector external handle to the "OPEN" position.
2. De-energize the Transformer.
3. Isolate the Network Protector from Secondary Network, if possible.
    a. If protector has external fuses or links – removal of these fuses or links is acceptable.
    b. If the protector does not have external fuses or links, be aware that the fuse holders are still live.
4. Set up rail extensions and manually rack out mechanism.
5. Hoist mechanism off the rail extensions and place mechanism safely aside.
6. Locate and replace the respective blown fuse.
7. Secure fuses and wiring to walls of enclosure before re-installing mechanism.
8. Place mechanism on back onto rail extensions.
9. Manually rack the mechanism into the enclosure (See Manual mechanism Rack In under Manual Transmission Operation).
10. Close enclosure door.
11. Re-establish connections to Secondary Network (if applicable).
12. Energize the Transformer.
13. Return the Network Protector external handle to the "AUTO" position.

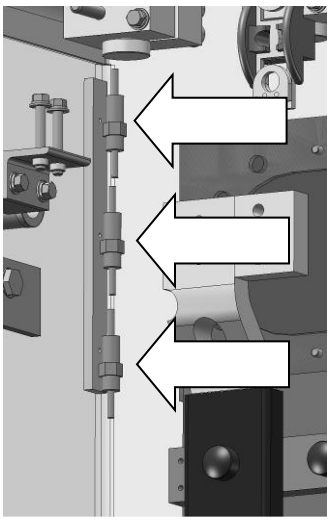

Figure 28