TERASAKI
Ensuring Service, Maintaining Quality

TemPower (with PRQ)

INSTRUCTION MANUAL

TYPES: AT 06

AT 12

AT 16

AT 20

AT 25

AT 32

AT 40

TERASAKI ELECTRIC CO., LTD.

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I. RECEIVING AND HANDLING

The TemPower AT Series Air Circuit Breakers are completely assembled, inspected and tested both electrically and mechanically at the factory, then shipped in fully guaranteed conditions in construction and operation. Upon receipt of your breaker, check the following. If you have any question or any problem, contact our agent nearest you.

◎ Check that the breaker received is as ordered, and also that the accessories are as specified.

◎ Check that the breaker is not damaged during shipment.

1. Storage

While it is recommended that the breaker be used as soon as you have received it, if it is necessary to store the breaker for some time before its installation, please note the following for proper storage:

◎ Store the breaker in a dry indoor location to prevent the condensation due to sudden change in temperature, which is quite harmful to the breaker insulation.

◎ Store the breaker in a clean place free of corrosive gases, dirt and dust. In particular, a mixture of cement dust and moisture can cause corrosion in the various metal parts of the breaker, and fully protect the breaker from such mixtures.

◎ Place the breaker on a flat, level surface in its normal position.

◎ Do not place the breaker directly on the floor.

2. Directions for Transportation

When transporting the breaker from one place to another, note the following:

◎ When lifting up the breaker, apply wire ropes to the lifting plates (Fig. 1 (6)). Take the necessary care so that the tightened wire ropes will not touch the arc chutes (Fig. 1 (23)) and multi-protective device (Fig. 1 (25)). When lifting up the breaker, be sure to lift up it slowly.

For transportation, place the breaker on a pallet and carry slowly and carefully.

◎ Lower the breaker onto a flat, level surface.

◎ Avoid impacts and shocks to the breaker during the transportation.

II. DESCRIPTION OF VARIOUS PARTS

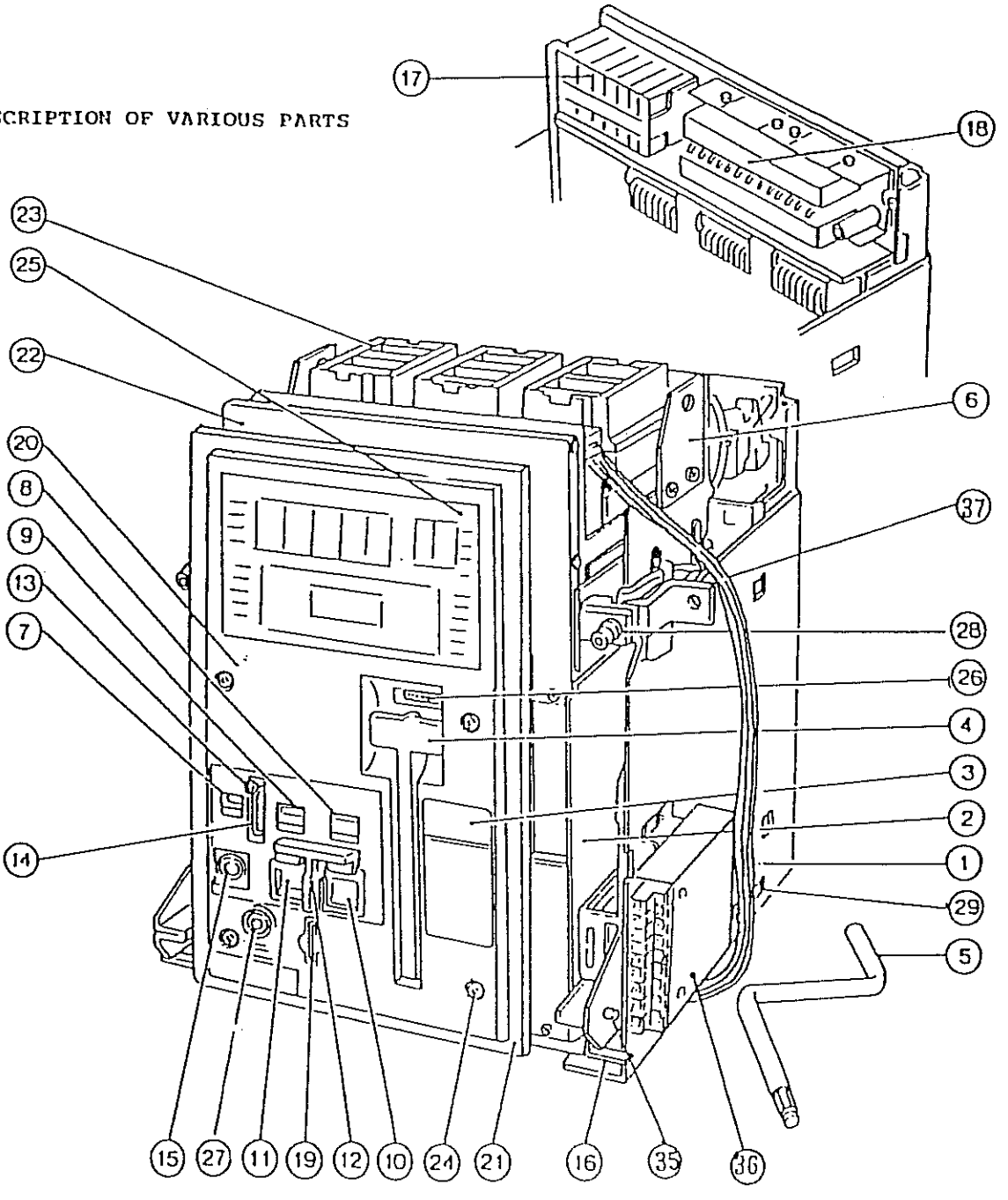


Fig. 1. General view of TemPower AT series air circuit breaker.

Numbers in ( ) correspond to the locator numbers in Fig. 1.

(1) Draw-out cradle.

(2) Breaker body.

(3) Nameplate.

(4) Charging handle.
This handle is pumped to manually charge the closing springs. It is also used for slow closing operation.

(5) Draw-out handle. (Handle grip removable)
Used to move the breaker body from one position to another in the draw-out cradle. There are three positions: CONN., TEST and ISOLATED.

(6) Lifting plate.
Used to transport the breaker and install the breaker into the switchboard.

(7) Position indicator.
Shows the word "CONN.", "TEST" or "ISOLATED" according to the position of the breaker body in the cradle.

(8) OPEN-CLOSED indicator.
Shows the word "OPEN" when the breaker is open. and "CLOSED" when the breaker is closed.

(9) Spring charged indicator.
Shows the word "CHARGED" when the closing springs are fully charged and "DISCHARGED" when they are released.

(10) PUSH TO CLOSE button.
Pressing this button closes the breaker.

(11) PUSH TO OPEN button.
Pressing this button trips open the breaker.

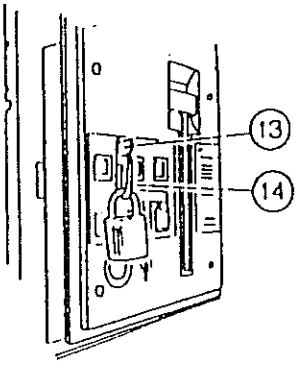
(12) Manual operation button cover. (Optional)
The cover for push-to-close and push-to-open buttons to protect careless close-open operation.
Padlocks are available.

o Padlocks themselves are not supplied (6 to 8 shackle diameter).

(13) Position stopper release lever.
When this lever is in the up position, the breaker is locked in each of the CONN., TEST and ISOLATED positions. This lever can be turned down only only when the breaker is OPEN. Turning down this lever unlocks the position stopper.

(14) Position padlock lever. (Optional)
Up to three padlocks may be applied to this lever to keep the breaker body locked in the CONN., TEST or ISOLATED position.

o Padlocks themselves are not supplied (6 to 8 shackle diameter).



(13) Position stopper release lever

(14) Position padlock lever

Fig. 2

(15) Draw-out handle insertion hole.
The draw-out handle (5) is inserted here. This hole is fitted with a shutter, which opens when the position stopper release lever (13) is turned down.

(16) Draw-out stopper.
These stoppers lock the breaker body in the ISOLATED position, and remove position.

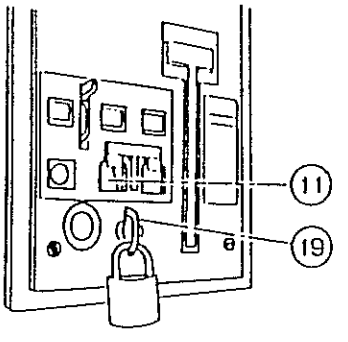
(17) Auxiliary switch assembly. (Optional)
The auxiliary switch assembly has five a-contacts and five b-contacts, and wiring is made directly to the switch terminals.
M3.5mm terminal screws are to be used.

(18) Disconnect device for control circuits.

(19) Open position padlock lever. (Optional)
The breaker may be padlocked in the OPEN position. To padlock the breaker in the OPEN position, press the PUSH TO OPEN button (11) and pull out the lever (19), then apply up to three padlocks to the lever. Under this padlocked condition, the breaker is prevented from being closed manually or electrically.

To return the lever (19) to the withdrawn position, unpadlock and press the PUSH TO OPEN button (11) again.

o Padlocks themselves are not supplied (6 to 8mm shackle diameter).



(11) PUSH TO OPEN button

(19) Open position padlock lever

Fig. 3

(20) Front panel

(21) Dust plate (Optional)

(22) OCR Front protective cover

(23) Arc chute

(24) Front panel mounting screw

(25) Type PRQ multi-function protective device (8-bit CPU). (Optional)
This is a 3-pole unit and operates on the secondary current from current transformers mounted on the main circuits of the breaker body.

(26) Close-open counter. (Optional)
Counts and indicates the number of close-open cycles of the breaker.

(27) Keylock device. (Optional)
This will be fitted when a key lock or key interlock system is specified in the order.

(28) Fixing block. (Optional)
These blocks are standard equipment when the breaker is subject to the ship classification society's rules. These are to be secured to the switchboard framework. The breaker body (2) is secured to the draw-out cradle (1) by the screws only when it is in the CONN. position.

(29) Wiring hole for position switch.
The terminals are fitted with the position switches in the draw-out cradle.

(35) Lifter position pim:

(36) RS-interface.

(37) Cable (with connector)

III. OPERATION

The TemPower AT series air circuit breakers are available either in manual charging type or in motor charging type.

1. Manual Charging Type

In the manual charging type, charging the closing springs and open-close control of the breaker are all done manually. The breaker is closable only when the closing springs are charged.

1.1 Spring Charging Operation

Follow the procedure given below to charge the closing springs:

1) Pump the charging handle (Fig. 4b (4)). The maximum stroke of the charging handle is about 105° in angle.

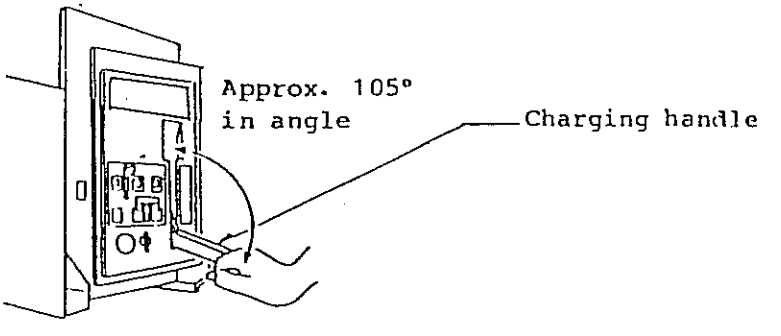
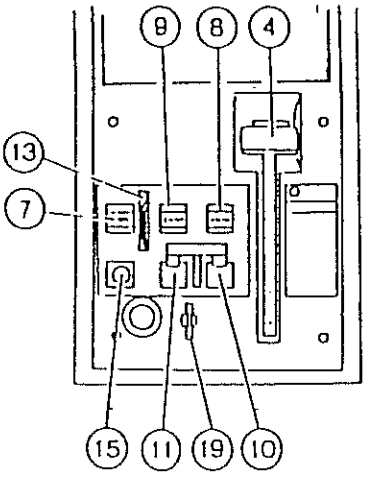


Fig. 4a

2) When the closing springs are fully charged, a metallic "click" will be heard and no further pumping of the charging handle will be possible. When the charging handle is pumped with its maximum stroke (approx. 105°), about four pumping cycles will complete the charging. Check that the spring charged indicator (Fig. 4b (9)) now shows "CHARGED".



(4) Charging handle
(7) Position indicator
(8) OPEN-CLOSED indicator
(9) Spring charged indicator
(10) PUSH TO CLOSE button
(11) PUSH TO OPEN button
(13) Position stopper release lever
(15) Draw-out handle insertion hole
(19) Open position padlock lever

Fig. 4b. Manual operation section.

1.2 Closing Operation

Before closing the breaker, check the following items:

1) The closing springs are charged.

2) The position stopper release lever (Fig. 4b (13)) is in the up position.

3) The shutter of the draw-out handle insertion hole (Fig. 4b (15)) is completely closed.

4) The open position padlock lever (Fig. 4b (19)) is not pulled out.

5) The specified voltage is applied to the undervoltage trip device (option) or the function of the undervoltage trip device is locked. (See the description of the undervoltage trip device for the procedure described in page 29.)

Upon satisfactory confirmation of the above items, open manual operation button cover (Fig. 1 (12)) upward if provided and press the PUSH TO CLOSE button (Fig. 4b (10)). The breaker is closed.
The OPEN-CLOSED indicator (Fig. 4b (8)) shows "CLOSED", and the spring charged indicator (Fig. 4b (9)) shows "DISCHARGED".

NOTE: Even when the items 2) to 5) are not satisfied, the charged closing springs are released by pressing the PUSH TO CLOSE button, but the breaker will not be placed in closed state. Be sure to perform closing operation according to each check item in 2) to 5).

1.3 Opening Operation

Open the manual operation button cover upward if provided and press the PUSH TO OPEN button (Fig. 4b (11)). This trips open the breaker, and the OPEN-CLOSED indicator (Fig. 4b (8)) shows "OPEN".

2. Motor Charging Type

In this type, a motor-operated mechanism automatically charges the closing springs. Means for remote electrical open-close control of the breaker are also fitted. See Fig. 5 for control circuit diagram. Complete manual operations are also possible, for which the same procedures as described in Section 1. above apply.

2.1 Spring Charging Operation

1) Supply the specified control power voltage to the charging motor circuit. As soon as the closing springs are discharged, the charging motor is turned on to charge the closing springs.

2) The charging motor is automatically stopped when the closing springs are fully charged, and the spring charged indicator (Fig. 4b (9)) shows "CHARGED". While the charging time varies depending on the the rated control voltage and the type of breaker, it is normally within a range from 2.4 to 10 seconds.

NOTE: The permissible control voltage range for the charging motor is 85 to 110% of the rated voltage when AC rated, or 75 to 110% when DC rated. It is strongly recommended to supply the control power at the rated voltage.

2.2 Closing Operation

Before closing the breaker, check the following items:

1) The closing springs are charged.

2) The position stopper release lever (Fig. 4b (13)) is in the up position.

3) The shutter of the draw-out handle insertion hole (Fig. 4b (15)) is completely closed.

4) The open position padlock lever (Fig. 4b (19)) is not pulled out.

5) The specified voltage is applied to the undervoltage trip device (option) or the function of the undervoltage trip device is locked (see the description of the undervoltage trip device for the procedure described in page 29).

Upon satisfactory confirmation of the above items, press the CLOSE button (PB "CLOSE", Fig. 5). This energizes the latch release coil (LRC, Fig. 5), which, in turn, releases the charged closing springs and the breaker is immediately closed.

The spring charged indicator shows "DISCHARGED". With the closing springs discharged, the charging motor is immediately turned to charge the closing springs.

NOTE: Even when the items 2) to 5) are not satisfied, the charged closing springs are released by pressing the PUSH TO CLOSE button, but the breaker will not be placed in closed state. Be sure to perform closing operation according to each check item 2) to 5).

2.3 Opening Operation

The shunt trip device (SHT) or undervoltage trip device (UVT) is used for remote electrical opening operation.

Press the OPEN button (PB "OPEN", Fig. 5). This trips open the breaker via the SHT or UVT.

NOTE: When open-close operations are repeated with the charging motor ON, limit the number of successive open-close cycles to 15 times. If the open-close cycle is repeated more than 15 times, allow a cooling period of at least 20 minutes between the 15th cycle and the 16th cycle.

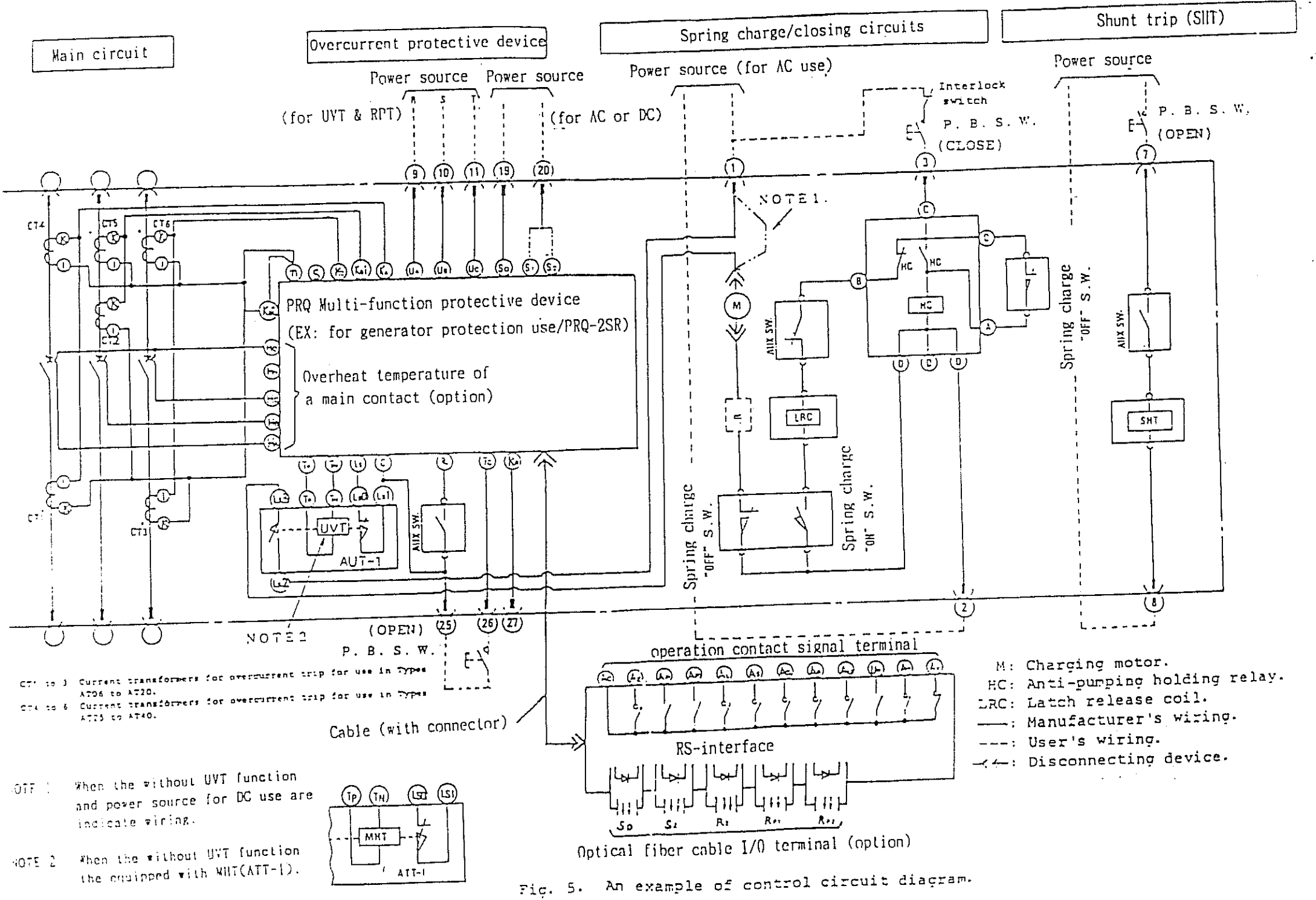


Fig. 5. An example of control circuit diagram.

3. Slow Closing Operation

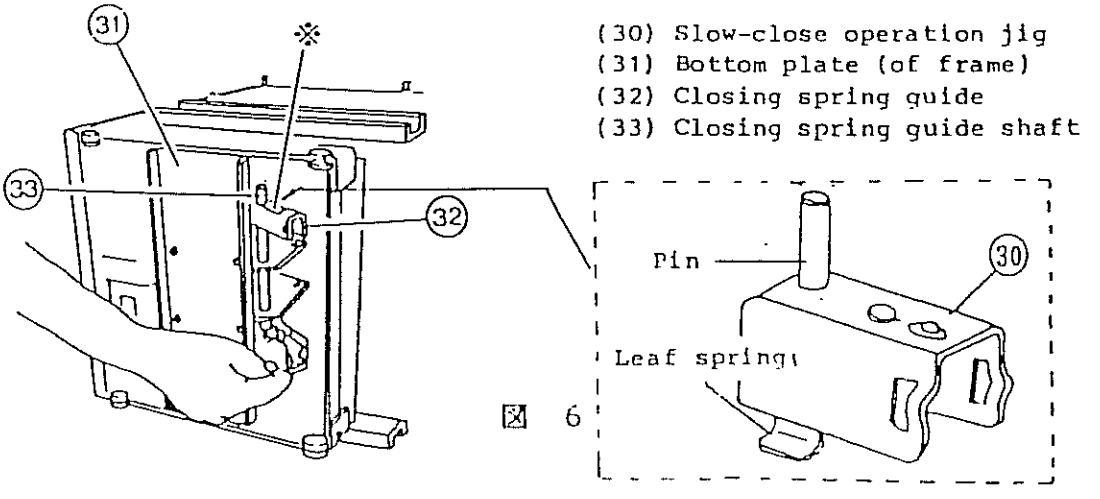
Avoid slow closing operation for purposes other than inspection and maintenance for the breaker. Check that 3 poles of arcing contact are touched at the same time or the main contact is touched after the arcing contact has touched, using an optional slow-close operation jig pair (2 jigs/set).

3.1 Slow closing procedure

1) Remove the breaker body (Fig. 1 (2)) from the draw-out cradle. See IV for how to remove the breaker body.

2) Place the removed breaker body on a workbench in such a position that its bottom is readily visible and accessible, turning it sideways or backward. Take every precaution to avoid the damage to the breaker.

3) Pump the charging handle (Fig. 4b (4)) to fully charge the closing springs. When the springs are fully charged, a wider gap (shown *-marked in Fig. 6) develops between each closing spring guide (Fig. 6 (32)) and the closing spring guide shaft (Fig. 6 (33)). Insert the jigs leaf springs into each gap (square hole), with their pins extending to the inner side of the breaker. Make sure that both the closing spring guides are now jig inserted.



(30) Slow-close operation jig
(31) Bottom plate (of frame)
(32) Closing spring guide
(33) Closing spring guide shaft

図 6

Fig. 6

4) Check that the conditions to close the breaker are satisfied. See items 2) to 5), 2.2 of III.

5) Press the PUSH TO CLOSE button (Fig. 4b (10)).
Although the closing mechanism moves slightly, the breaker remains open. The breaker is now ready for slow closing operation.

6) Pump the charging handle (Fig. 4b (4)). The moving contacts move toward the stationary contacts in unison with down strokes of the charging handle, and the breaker is closed with 3 or 4 pumping cycles. When the breaker is closed, the indicators show "CLOSED" and "DISCHARGED" respectively.

7) Press the PUSH TO OPEN button (Fig. 4b (11)) to open the breaker. When performing further slow closing operation, repeat the procedure from 5) above.

3.2 Restoring the Slow-Close Condition to Normal

1) Press the PUSH TO OPEN button (Fig. 4b (11)) to open the breaker.

2) Pump the charging handle (Fig. 4b (4)) to charge the closing springs. The spring charged indicator (Fig. 4 (9)) shows "CHARGED".

3) Compress the jig's leaf springs to remove the jigs from the respective closing spring guides (Fig. 6 (32)).

o The jigs cannot be removed after the PUSH TO CLOSE button is pressed, in which case repeat the procedure from 6) in 3-1.

The jigs (Fig. 6 (30)) are stored external to the breaker.

IV. DRAW-OUT MECHANISM

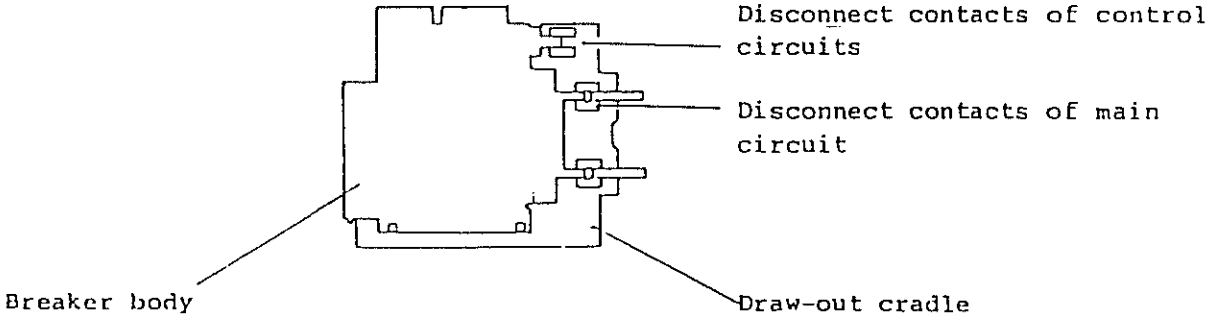
The draw-out mechanism permits to draw out and remove the breaker body from the draw-out cradle and to put the breaker body back into the cradle, thereby facilitating the inspection and parts replacement.

The draw-out mechanism permits to move the breaker body to any of the following three positions in the draw-out cradle. The switchboard panel door can be shut with the breaker body drawn out to the TEST or ISOLATED position.

The auxiliary switch assembly (Fig. 1 (17)) mounted on the draw-out cradle works in the CONN. and TEST positions (the CONN. position only when the breaker is subject to the ship classification society rules).

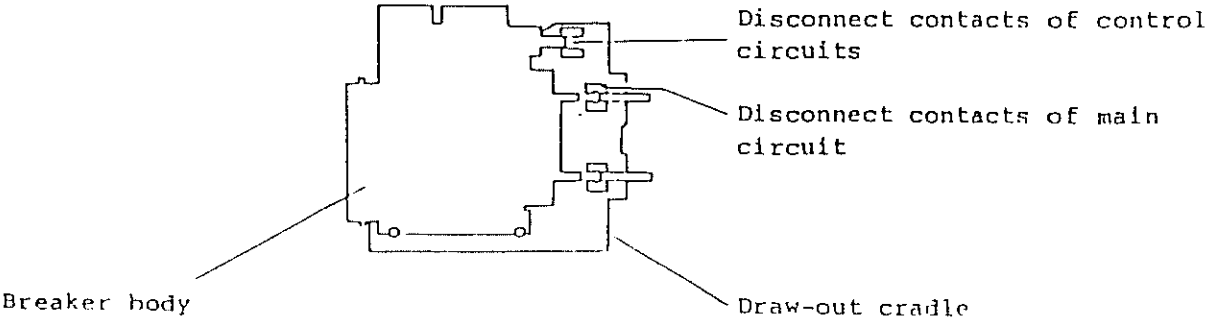
o CONN. position

In this position, the main circuit and the control circuits (of the breaker) are connected to the external circuits for normal service.



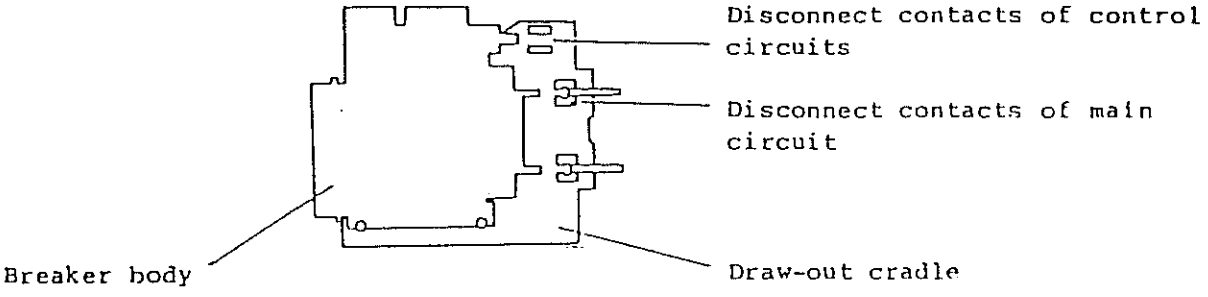
o TEST position

In this position, the main circuit is isolated, and the control circuits are connected. This position permits such as close-open test, control circuit function test, etc.



o ISOLATED position

In this position, the main circuit and the control circuits are isolated. The breaker is completely de-energized in this position.



1. Moving the Breaker Body Within Draw-out Cradle

The draw-out handle (Fig. 1 (5)) is used to move the breaker body to one of the three positions (CONN., TEST, and ISOLATED) in the draw-out cradle. Attached draw-out handle (installed external to the breaker) is to be used.

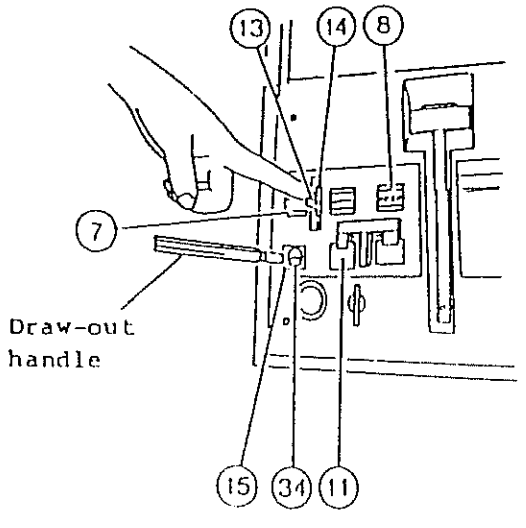
NOTE: When the fixing blocks (Fig. 1 (28))(option) are fitted, loosen the right and left screws, using the draw-out handle.

1.1 Moving to TEST Position

1) Check that the breaker is OPEN. If it is CLOSED, press the PUSH TO OPEN button (Fig. 7 (11)) to open the breaker.

2) When the fixing blocks (Fig. 1 (28)) are fitted, loosen and free the right and left screws.

3) Turn down the position stopper release lever (Fig. 7 (13)) to open the shutter of the draw-out handle insertion hole (Fig. 7 (15)).



(7) Position indicator
(8) OPEN-CLOSED indicator
(11) PUSH TO OPEN button
(13) Position stopper release lever
(14) Position padlock lever
(15) Draw-out handle insertion hole
(34) Draw-out mechanism shaft (hex socketed)

Fig. 7

4) Engage the draw-out handle with the draw-out mechanism shaft (Fig. 7 (34)) and turn the handle counter-clockwise to move the breaker body. As the breaker body is drawn out the position stopper release lever (Fig. 7 (13)) automatically returns to the up position, but leave it as it is.

NOTE: At the time when the main circuit is disconnected as the breaker body is being drawn out, the breaker body will be slightly pushed forward by the spring action of the primary disconnect contacts with a "bang". While the loudness of this bang may vary from one breaker type to another, the bang itself is perfectly normal and does not affect the breaker performance.

When the breaker is drawn out to the TEST position, a metallic click will be heard, the breaker will be locked in this position, and a further turning effort on the draw-out handle will be stopped. The position indicator (Fig. 7 (7)) now shows "TEST". Do not attempt to force-turn the draw-out handle under this condition.

NOTE: When the draw-out handle is inserted in the draw-out mechanism shaft, the breaker is prevented from being closed. For close-open test, remove the draw-out handle.

1.2 Moving to ISOLATED Position

1) After the breaker body has been drawn out to the TEST position, turn down the position stopper release lever (Fig. 7 (13)) again.

2) Turn the draw-out handle counter-clockwise to move the breaker body. As the breaker body is drawn out the position stopper release lever (Fig. 7 (13)) automatically returns to the up position, but leave it as it is. When the breaker is drawn out to the ISOLATED position, a metallic click will be heard, the breaker will be locked in this position, and a further turning effort on the draw-out handle will be stopped. The position indicator (Fig. 7 (7)) now shows "ISOLATED". Do not attempt to force-turn the draw-out handle under this condition, but remove it.

3) For inspection or maintenance in the ISOLATED position, if the breaker is in charged condition, perform close-open operation once, and release the closing springs.

NOTE: If the automatic closing spring release mechanism (option) is fitted, the charged closing springs will be automatically discharged as the breaker body is moved from the TEST position to the ISOLATED position. Although this may be felt as a light shock, just continue the draw-out operation.

1.3 Further Withdrawal and Removal of Breaker Body from ISOLATED Position

The breaker body may be further drawn out from the ISOLATED position to remove it from the draw-out cradle for inspection, maintenance or parts replacement purposes. If the breaker is in charged condition, perform close-open operation once, and release the closing spring.

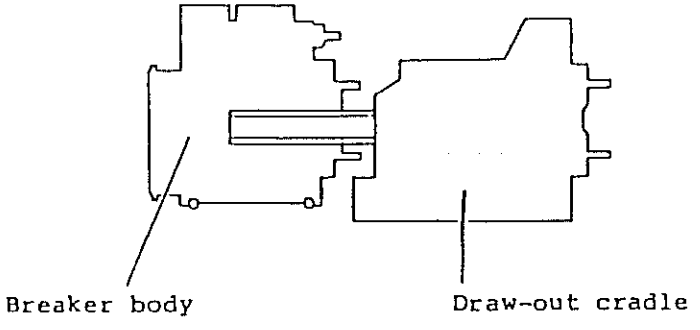


Fig. 8

1) Lower the left and right draw-out stoppers to unlock the breaker body, and slowly draw out the breaker body from the draw-out cradle until the draw-out stoppers are locked.

CAUTION: Do not leave the breaker body as it is.
When the above operation is made in as-received condition to separate the breaker body from the cradle, take necessary measures to prevent the possible turnover due to a change of the center of gravity.

2) Apply wire ropes to the lifting plate (Fig. 1 (6)) and lift the breaker body upward after unlocking the left and right draw-out stoppers.

Alternatively, a lifter (available as option) may be used to remove the breaker body from the draw-out cradle.

2. Putting the Breaker Body Back into Draw-out Cradle

Follow the procedure given below to put the removed breaker body back into the draw-out cradle.

1) Check that the breaker is OPEN, then check that the position indicator (Fig. 1 (7)) is showing "ISOLATED".

2) Check that the jigs for slow-closing operation (Fig. 6 (30)) are not fitted in the closing spring guides (Fig. 6 (32)).

3) Check that the spring charged indicator (Fig. 1 (10)) is showing "DISCHARGED", indicating the closing springs are discharged.

NOTE: If automatic closing spring release mechanism (option) is fitted, the charged closing springs will be automatically discharged as the breaker body is moved from the ISOLATED position to the TEST position. Although this may be felt as a light shock, just continue the insertion operation.

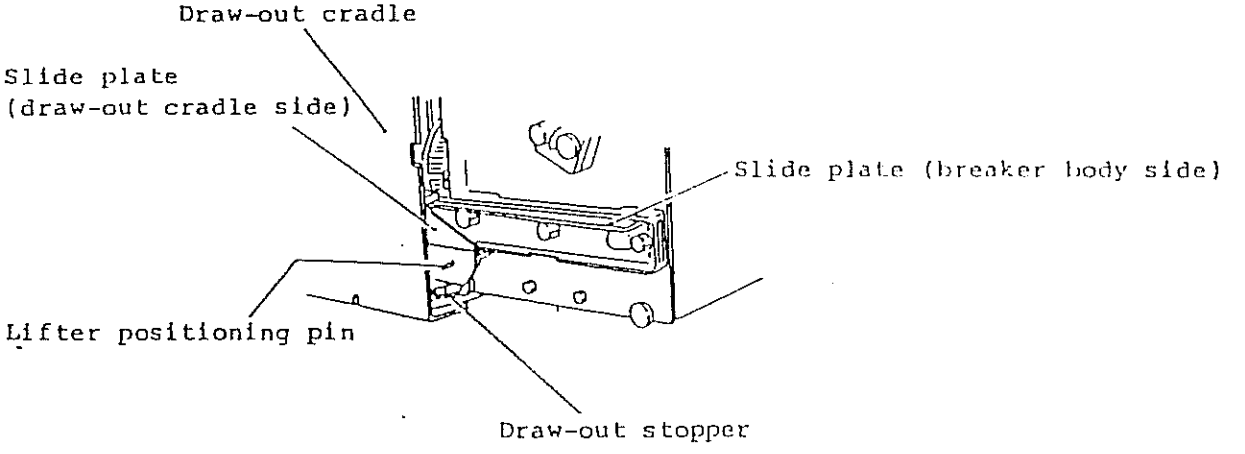
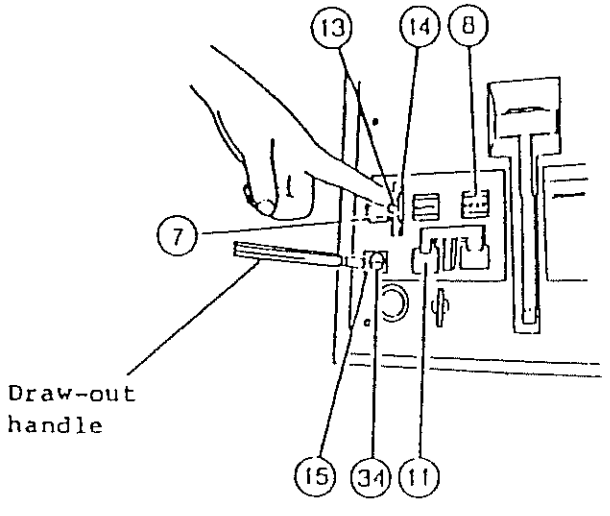


Fig. 9

4) Lift up the breaker body or push in the breaker body until the draw-out stoppers are locked so that the slide plate of the breaker body side will be engaged with the slide plate of the draw-out cradle side, using a special lifter.

5) Further push in the breaker body again until the draw-out stopper are locked.

6) Turn down the position stopper release lever (Fig. 10 (13)) to open the shutter of the draw-out handle insertion hole (Fig. 10 (15)), and engage the draw-out handle with the draw-out mechanism shaft (Fig. 10 (34)).



(7) Position indicator
(8) OPEN-CLOSED indicator
(11) PUSH TO OPEN button
(13) Position stopper release lever
(14) Position padlock lever
(15) Draw-out handle insertion hole
(34) Draw-out mechanism shaft (hex socketed)

Fig. 10

7) Turn the draw-out handle clockwise to send the breaker body into the draw-out cradle. As the breaker body is moved the position stopper release lever (Fig. 10 (13)) automatically returns to the up position, but leave it as it is. When the breaker is sent into the TEST position, a metallic click will be heard, the breaker will be locked in this position, and a further turning effort on the draw-out handle will be stopped. The position indicator (Fig. 10 (7)) now shows "TEST".

   Turn down the position stopper release lever again, and turn the draw-out handle clockwise to send the breaker into the CONN. position. The position stopper release lever automatically returns to the original position (up position), but continue the insertion operation.

   Mating of the primary disconnect device starts just before the CONN. position, and the draw-out handle will become heavy, but continue to turn the handle. When the breaker is sent into the CONN. position, a metallic click will be heard, the breaker will be locked in this position, and a further turning effort on the draw-out handle will be stopped. The position indicator now shows "CONN.". Remove the draw-out handle (Fig. 10 (6)).

8) When the fixing blocks (Fig. 1 (28)) are fitted, fully tighten the right and left fixing screws using the draw-out handle.

9) The draw-out handle is stored external to the breaker.

V. PERIODIC INSPECTION AND PARTS REPLACEMENT

Frequency of Periodic Inspection

While it is most appropriate that the user works out his own inspection plan for his breakers according to the switching frequency, the values of normal making and breaking currents, the magnitude of fault current interrupted, service conditions and environmental conditions, it is recommended to perform a simplified inspection once every 6 months and a full inspection once a year.

Be sure to draw out the breaker to the ISOLATED position or to remove the breaker body from the draw-out cradle for inspection or parts replacement purposes.

1. Arc Chutes

Check each arc chute during the periodic inspection and also after a fault current was interrupted.

A cracked arc chute cover or de-ion grid side plate, or a heavy, hard-to-remove deposition of molten contact or de-ion grid pieces inside of the arc chute requires replacement of the arc chute.

1.1 Periodic Inspection

INSPECTION ITEM	METHOD/CRITERIA/DISPOSITION
Dirt, dust, foreign matters	Check visually. Inside must be clean, free of foreign matters and dust. Blow off foreign matters and dust with a jet of compressed air.
Cracks	Check visually. There should be no cracks or other damages. Replace arc chute if cracked or damaged.

1.2 Removal and Mounting

Loosen the two mounting screws captivated on an arc chute until they are free, then remove the arc chute. To mount the arc chute, set it in position and tighten the two mounting screws.

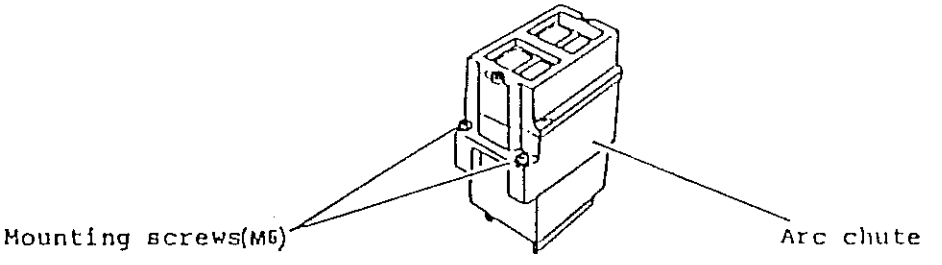
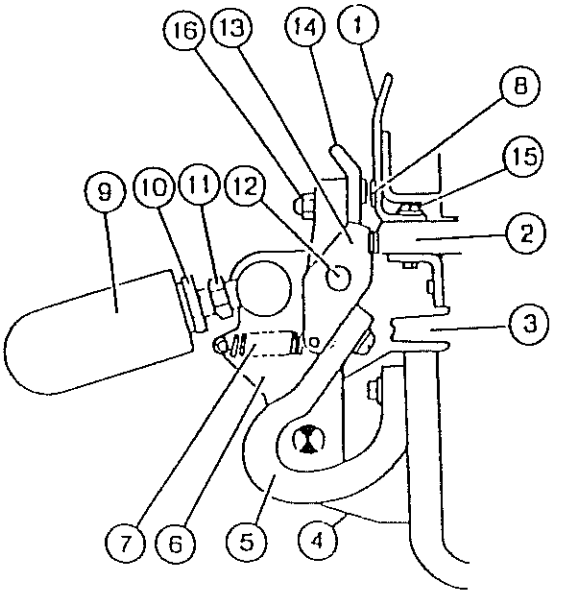


Fig. 11. Arc chute.

2. Contacts

The pole contact assemblies are visible and accessible when the arc chutes are removed. Check them during a periodic inspection and after a short-circuit fault current was interrupted.



(1) Stationary arcing contact
(2) Stationary main contact
(3) Molded base
(4) Contact bearing
(5) Ribbon lead
(6) Contact holder
(7) Contact spring
(8) Contact tip
(9) Operating rod
(10) Locknut
(11) Adjusting screw
(12) Moving contact pin
(13) Main moving contact
(14) Moving arcing contact
(15) Stationary arcing contact mounting screw
(16) Moving arcing contact mounting nut

Fig. 12. Side view of contact assembly.

2.1 Periodic Inspection

1) Arcing Contacts

INSPECTION ITEM	METHOD/CRITERIA/DISPOSITION
Contact tip surfaces	o Check visually. o Blackening of contact tip surfaces is due to oxidation and sulfuration, but should not constitute a problem since it is wiped off in closing operation. o Remove deposition of dirt, dust, grease, etc. o Dress roughened surfaces with a fine emery paper (#200). If thickness of contact tip is reduced to 1/3 of original value after a number of dressing operations, replace both the moving and stationary arcing contacts.
Mounting conditions	o Check each moving arcing contact for loosening of mounting nut (M5) (Fig. 12 (16)). Retighten nuts as necessary. o Check each stationary arcing contact for loosening of mounting screws (two pan head M5) (Fig. 12 (15)). Tighten screws as necessary. o Check each contact tip pair for proper alignment in the closed position.

CAUTION: When dressing contact tips, exercise care so as not to let cutting dust fall into the breaker mechanism. After dressing, be sure to wipe and clean the tips.

2) Main Contacts

While the main contacts are almost free of roughening or wear, clean their surfaces at the time of a periodic inspection.

2.2 Replacement

1) Stationary Arcing Contact (see Fig. 12)

(1) Remove the two mounting screws (Fig. 12 (15)) and remove the stationary arcing contact (Fig. 12 (1)).

(2) Set a new stationary arcing contact in position and firmly tighten the two mounting screws.

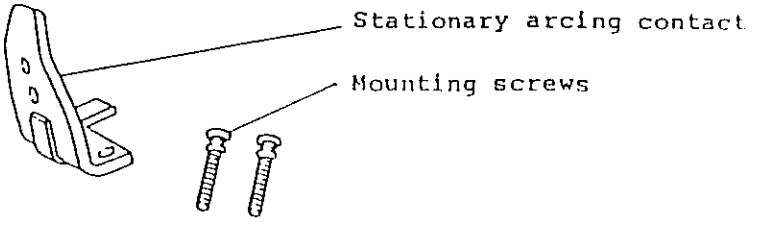


Fig. 13. Stationary arcing contact.

2) Moving Arcing Contact (see Fig. 12)

Breaker Type	No. of Moving Arcing Contacts per Pole
AT 06	Two pieces (with left and right side pieces paired)
AT 12	Two pieces (" ")
AT 16	Two pieces (" ")
AT 20	Two pieces (" ")
AT 25	Two pieces (" ")
AT 32	Two pieces (" ")
AT 40	Three pieces (with left, center and right side pieces paired)

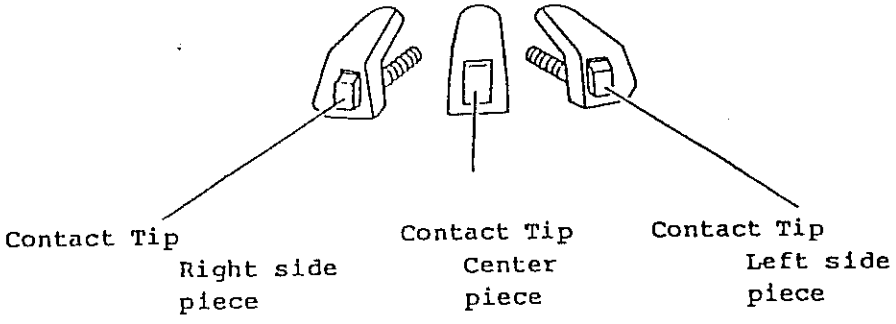


Fig. 14a

- Remove the mounting nut (Fig. 12 (16)) and remove the moving arcing contact (Fig. 12 (14)). Exercise care so as not to drop the spring washer.
- Set a new moving arcing contact in position and firmly tighten the mounting nut.

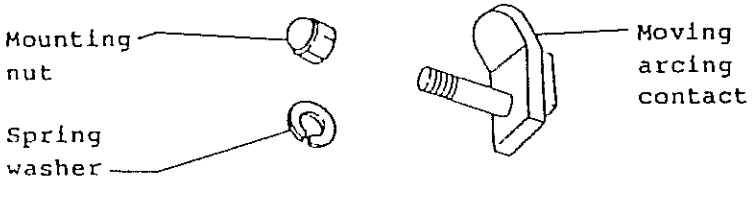
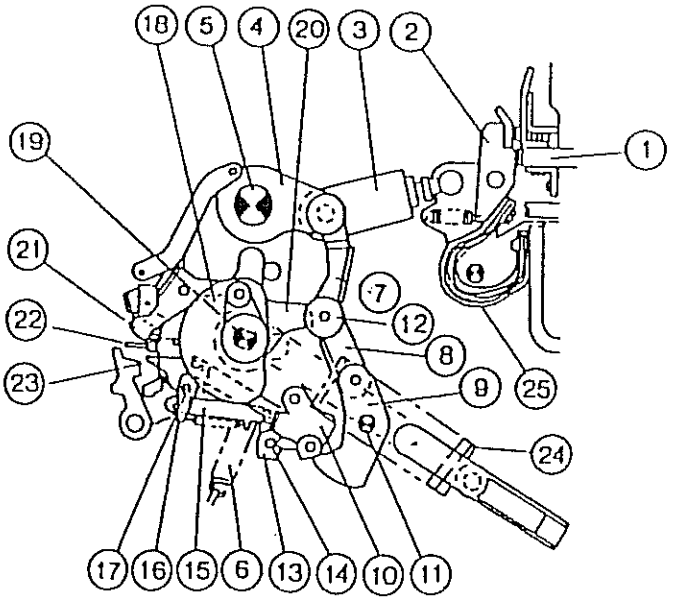


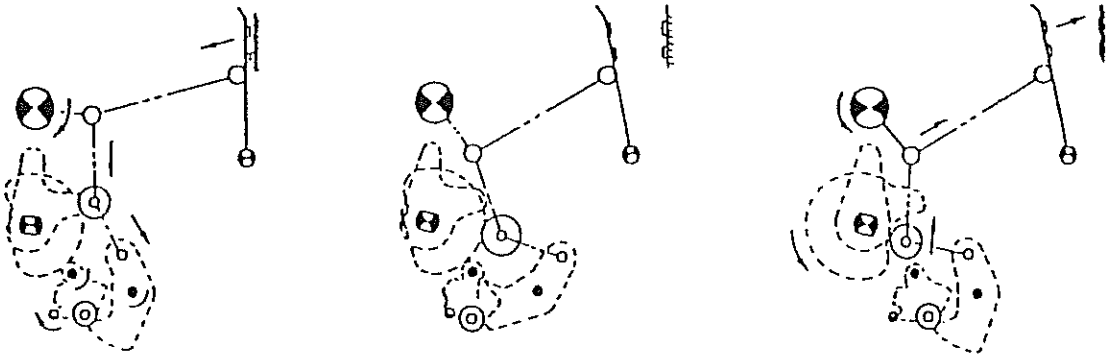
Fig. 14b. Moving arcing contact.

3. Operating Mechanism



(1) Stationary contact assembly
(2) Moving contact assembly
(3) Operating rod
(4) Connector lever
(5) Crossbar
(6) Trip spring
(7) Closing link
(8) Trip link
(9) Trip lever A
(10) Trip lever B
(11) Trip lever pin
(12) Closing roller
(13) Trigger lever
(14) Trigger pawl
(15) Trigger link
(16) Trigger actuating lever
(17) Trigger actuating lever shaft
(18) Closing cam
(19) Closing cam shaft
(20) Closing latch
(21) Closing release lever
(22) Closing release pawl
(23) Closing release plate
(24) Closing springs
(25) Ribbon lead

Fig. 15a. Operating mechanism in closed position.



Closed Position (Closing springs "Discharged")

Tripped Position (Closing springs "Discharged")

Open Position (Closing springs "Charged")

Fig. 15b

3.1 Periodic Maintenance

Check the operating mechanism in detail to a possible extent. If there are detail parts that seem to require a check but are hard to check, please contact TERASAKI.

INSPECTION ITEM	METHOD/CRITERIA/DISPOSITION
Operation	o Open and close the breaker through manual control to check the mechanical parts for normal operartion.
Lubrication	o Add a small amount of grease to each of the pins, shafts and their bearings. Avoid excessive oiling as such will result in accumulation of dirt and dust.
Screws, Bolts and Springs	o Check tightening screws and bolts of each part for loosening. Tighten them if loose. o Check each spring for proper engagement and damage. Correct problem by repair or replacement.
Dirt and dust	o Latching parts should be free of dirt and dust. Wipe them with a clean cloth.

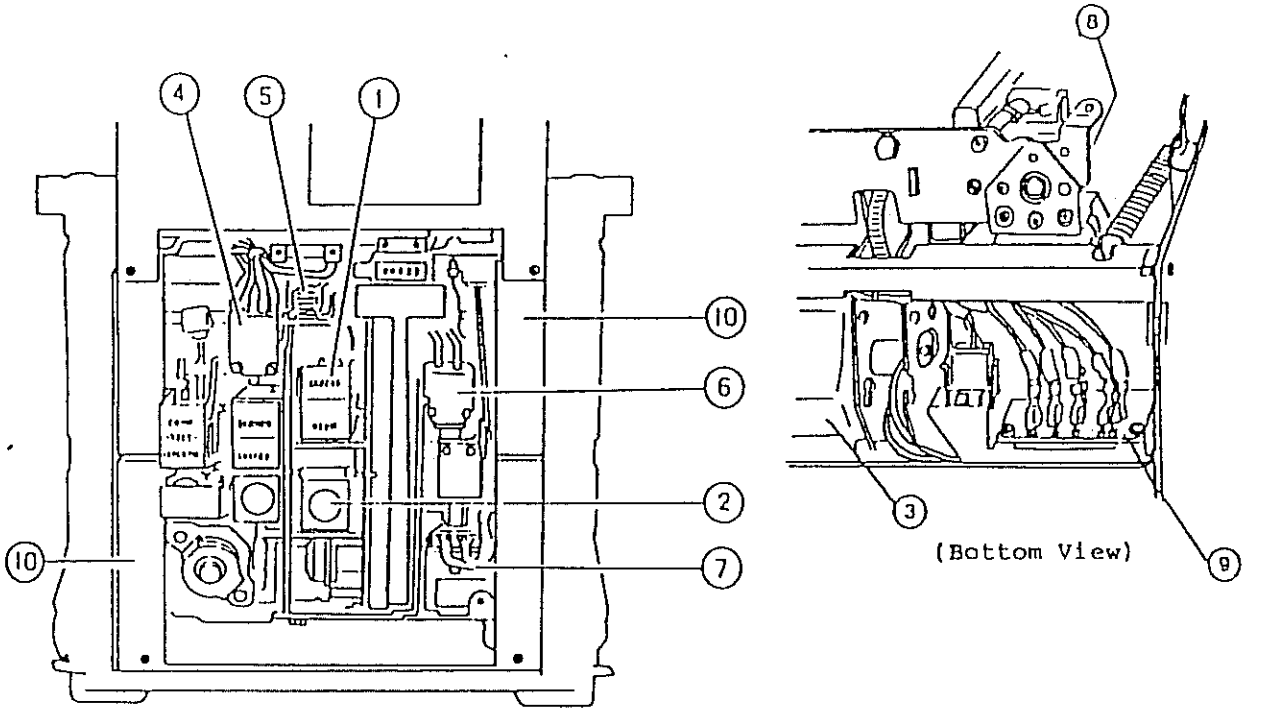
4. Internal Accessories

Remove the front panel (Fig. 1 (20)) to gain access to the internal accessories. Also remove the OCR front protective cover (Fig. 1 (22)) and the mechanical part protective cover (Fig. 16 (10)) if necessary. To remove the front panel, remove the four front panel mounting screws (Fig. 1 (24)).

Safety Precautions:

- o Do not place your finger or a tool in the gap between the PUSH TO CLOSE button and the OPEN-CLOSED indicator (Fig. 1 (8)) since this gap is closed when the breaker is closed.

- o Never attempt to put your hand or a tool into the breaker when the closing springs are charged.
  Be sure to discharge the closing springs prior to internal inspection.



(1) OPEN-CLOSED indicator
(2) PUSH TO CLOSE button
(3) Charging motor
(4) Charged indicator switch
(5) Latch release device (LRC)
(6) Auxiliary micro switch
(7) Magnet hold trigger (MHT)
(8) Shunt trip device (SHT)
(9) Anti-pumping hold relay (HC)
(10) Mechanical part protective cover

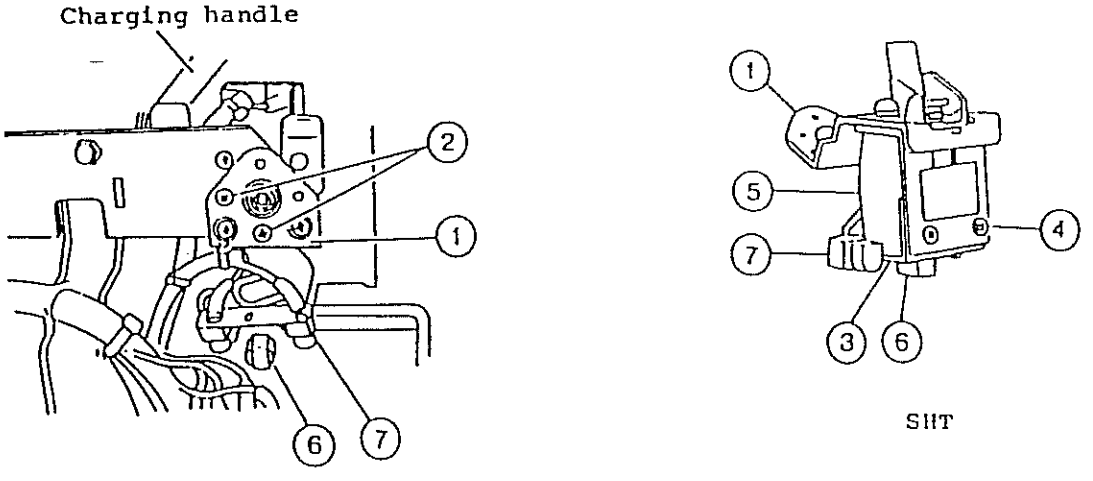
Fig. 16. Location of internal accessories, motor charging type.

4.1 Shunt-Trip Device (SHT)

Table I. Coil Resistance Values (Reference values).

Rated Voltage, V		Coil Resistance, Ohms
AC	421 to 480	472
	380 to 420	352
	180 to 250	101
	100 to 150	25
DC	150 to 230	161
	90 to 125	36
	48	9.7
	24	2.7

4.1.1 General View of Shunt Trip Device (SHT)



(1) Support
(2) Support mounting screws
(3) Yoke
(4) Yoke mounting screw
(5) Coil
(6) Moving core
(7) Terminal

Fig. 17. Shunt trip device as mounted, bottom view.

4.1.2 Periodic Inspection

INSPECTION ITEM	METHOD/CRITERIA/DISPOSITION
Operation	o Push the moving core of SHT with a pointed tool, such as screwdriver tip, then slowly release the core. The result is acceptable if the core returns lightly. o Slowly push in the moving core after closing the breaker. The result is acceptable if breaker trips open. o If the breaker trips open at less than 70% of the rated voltage after closing the breaker, the result is acceptable.
Coil	o Measure the coil resistance with an ohm-meter. o If it is much lower than the value shown in Table 1 or there is no continuity, replace the SHT.
Terminals and Mounting Screws	o Check terminals and mounting screws for loosening. Tighten them if loose.

4.1.3 Replacement of SHT

1) Take out the breaker body from the draw-out cradle.

2) Set the breaker body so that the bottom surface is visible (see Fig. 17).

3) Remove the two wires from the SHT terminals (Fig. 17 (7)).

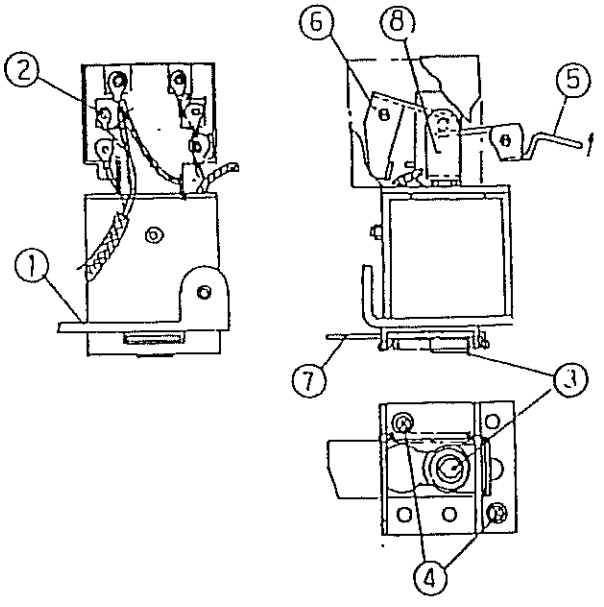
4) Remove the two support mounting screws (M5 and M4, one each) (Fig. 17 (2)), and take out the SHT.

5) After checking the light movement of the moving core (Fig. 17 (6)) of new SHT, mount it in the breaker as it was.

6) Connect the two wires to the SHT terminals (Fig. 17 (7)).

7) Test the SHT both electrically and mechanically for normal operation.

4.2 Undervoltage Trip Device (UVT)



(1) Support bracket (from breaker frame).

(2) Terminal.

(3) Moving core.

(4) Unit mounting screws.

(5) Trip piece.

(6) Switch actuator.

(7) Slide plate.

(8) Core holder.

Fig. 18. UVT coil unit (de-energized, operate state).

4.2.1 Periodic Inspection

INSPECTION ITEM	METHOD/CRITERIA/DISPOSITION
Operation	. The breaker is trip-free when the UVT is de-energized. Because of this, when the PUSH TO CLOSE button is depressed, the closing springs are discharged, but if the breaker is not closed, the result is acceptable. . If the breaker can be closed at more than 85 of the rated voltage, the result is acceptable. . If the breaker can be tripped at 70 to 35% of the rated voltage after closing breaker, the result is acceptable.
Coil Resistance	. Measure the coil resistance with an ohm-meter. If the ohm-meter indicator 160 ohms, it is normal. If it is much lower than this value or there is no continuity, replace the UVT.
Terminals and Mounting Screws	. Check terminals and mounting screws for loosening. Retighten them if loose.

4.2.2 Replacement of UVT Coil Unit (Fig. 18)

When it is necessary to replace the UVT coil, replace the whole coil unit.

1) Remove the six wires from the unit terminals (2).

2) Push up the moving core (3) and remove the two M4 unit mounting screws (4).

3) Lightly push up the trip piece (5) and take out the unit.

4) Mount the new unit in the reverse order of the removal, and connect the removed wires to the new unit's terminals.

5) Pull down the moving core (3) to the original position by holding the end with pliers.

6) Test the undervoltage trip device both electrically and mechanically for normal operation.

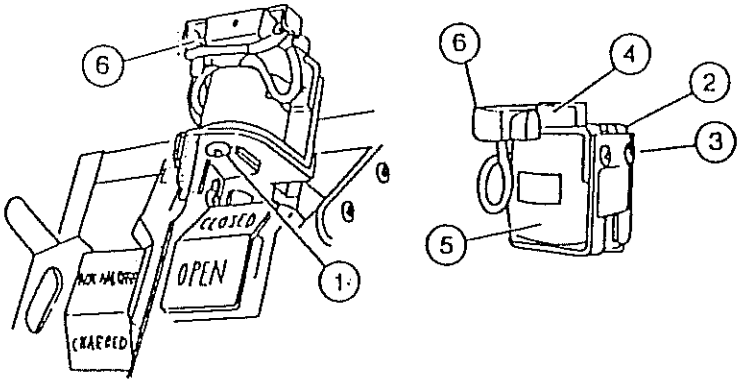
4.2.3 Function Lock

During the inspection and maintenance, the breaker can be closed without resetting the UVT, i.e., without supplying the voltage to the UVT.
To lock the UVT in RESET state, push up the moving core (Fig. 18 (3)) until it is caught in position. With the UVT mechanically locked in RESET state, the breaker can be closed. To unlock, force down the tip of the switch actuator (Fig. 18 (6)). This returns the moving core to the original position. If the moving core is left locked, the slide plate (Fig. 18 (7)) will be kept in the out position by the moving core to interfere with mounting of the front panel (Fig. 1 (21)).

4.3 Latch Release Device (LRC)

See Table 1 given in 4.1 Shunt Trip Device for the coil resistance values.

4.3.1 General View of Latch Release Device (LRC)



(1) LRC mounting screw

(2) Yoke

(3) Yoke mounting screw

(4) Moving core

(5) Coil

(6) Terminal

LRC

Latch release device as mounted.

Fig.19

4.3.2 Periodic Inspection

INSPECTION ITEM	METHOD/CRITERIA/DISPOSITION
Operation	o Push the moving core with a pointed tool, such as screwdriver tip, then slowly release the core. The result is acceptable if the core returns lightly. o Charge the closing springs and push the moving core. The result is acceptable if the closing springs are discharged o If the breaker can be closed at 85% of the rated voltage, the result is acceptable.
Coil Resistance	o Measure the coil resistance with an ohm-meter. o If it is much lower than the value shown in Table 1 or there is no continuity, replace the LRC.
Terminals and Mounting Screws	o Check terminals and mounting screws for loosening. Tighten them if loose.

4.3.3 Replacement of LRC

1) Remove the wires from the LRC terminals (Fig.19 (6)).

2) Remove one M5 LRC mounting screw (Fig.19 (1)), and take out the LRC from the breaker body.

3) After checking the light movement of the new LRC moving core (Fig.19 (4)), mount it in the breaker as it was.

4) Connect the wires to the LRC terminals (Fig.19 (6)).

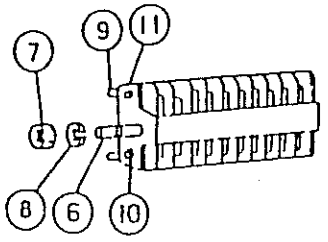
5) Test the device both electrically and mechanically for normal operation in the same manner described in 4.3.2.

4.4 Auxiliary Switch Unit

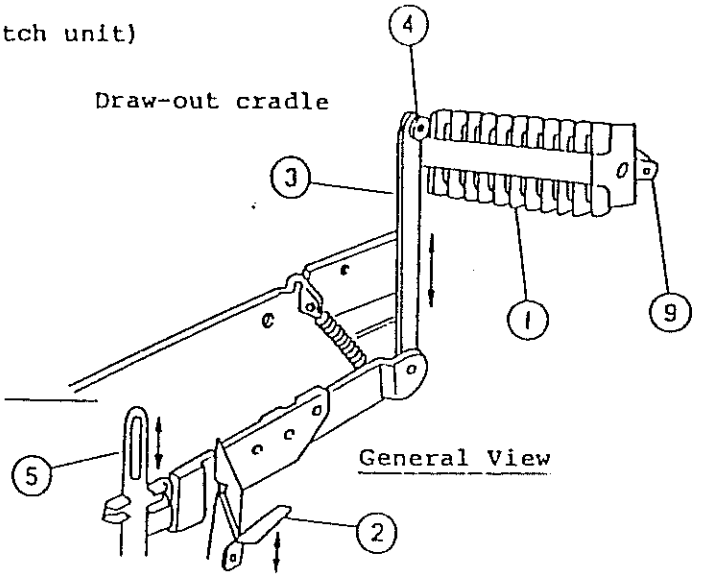
In the case of draw-out type, auxiliary switches operate only when the breaker body is in the CONN. or TEST position. Further, where the ship classification society's rules apply, they operate only in the CONN. position.

The auxiliay switch unit itself is mounted on the draw-out cradle and mechanically linked to the breaker switching mechanism.

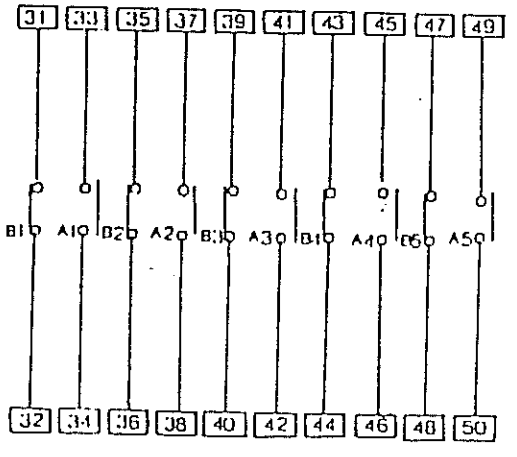
4.4.1 General View of Auxiliary Switch Unit and Contact Arrangement



(Switch unit)



General View



Contact Circuit Diagram

(1) Auxiliary switch unit
(2) Lock lever
(3) Operating lever
(4) Operating arm
(5) Actuator slide plate
(6) Shaft
(7) Shaft connecting nut
(8) S washer
(9) Support mounting screw
(10) Switch mounting screw
(11) Support

Fig.20

4.4.2 Periodic Inspection

INSPECTION ITEM	METHOD/CRITERIA/DISPOSITION
Operation	1. Take the breaker body out of the draw-out cradle. 2. Connect the ohm-meter or alarm (buzzer) to each switch element. 3. Lower the lock lever (Fig.20 (2)) for unlocking, and move the operating slide plate (Fig.20 (5)) up and down to check each switch element for continuity. . When actuator slide plate is up position, breaker is CLOSED. . When actuator slide plate is down position, breaker is OPEN. 4. Check that a-contact is ON and b-contact is OFF when breaker is CLOSED, and that a-contact is OFF and b-contact is ON when breaker is OPEN.
Contact Surface	o Check each contact for surface roughness (removing laminated phenolic plate from unit permits visual check of contacts). o If contact is excessively worn or rough, replace whole switch unit.
Terminals and Mounting Screws	o Check terminals and mounting screws for loosening. Tighten them if loose.

4.4.3 Replacement of Auxiliary Switch Unit (see Fig.20)

The auxiliary switch unit is an assembly of 10 switch elements (5 a-contacts and 5 b-contacts). Replace the whole switch unit even if a defect is partial.

1) Remove the one M4 shaft connecting nut (Fig.20 (7)).

2) Remove the three M5 support mounting screws (Fig.20 (9)).

3) Pull out the shaft (Fig.20 (6)) from the operating arm (Fig. (4)), and remove the auxiliary switch unit.

4) Fit the shaft (Fig.20. (6)) of the new auxiliary switch unit into the square hole in the operating arm (Fig.20 (4)).

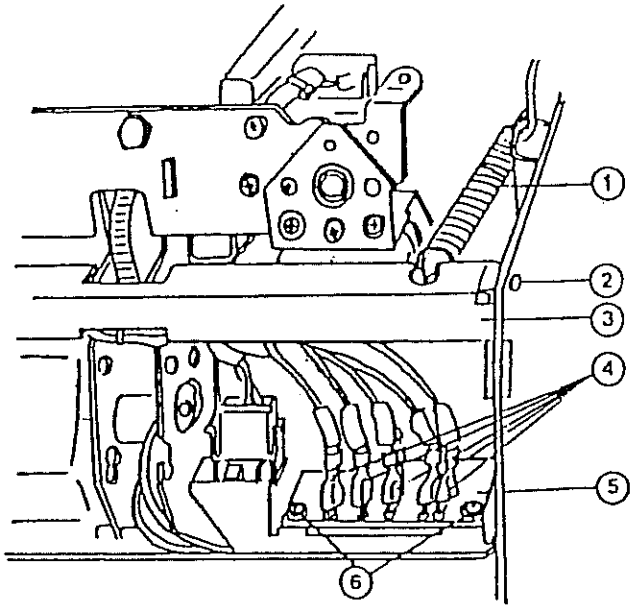
5) Tighten the three M5 support mounting screws (Fig.20 . (9)).

6) Tighten the one M4 shaft connecting nut (Fig.20 . (7)).

7) Check the switch unit for normal operation in the method described in 4.4.2.

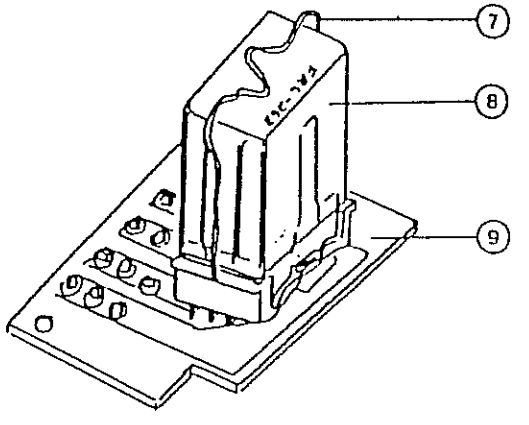
4.5 Anti-pumping Hold Relay (HC)

4.5.1 General View of Anti-pumping Hold Relay (HC)



(1) Close-open spring
(2) Side-plate support mounting tap screws (one each for left and right, 5mm nom. dia.)
(3) Side-plate support
(4) Wire terminals (Fasten terminal)
(5) Motor control unit PC board
(6) Two M4 mounting screws for PC board

Fig.21 . Motor control unit PC board as mounted (Bottom View).



(7) Clip
(8) Relay (HC)
(9) PC board

Fig.22 Relay (HC).

4.5.2 Operation Check

Open and close the breaker through electrical control to check the relay for normal operation.
Do this in the following procedure.

1) With the pushbutton switch (Fig. 5 PB "Close") ON, close the breaker.

2) Immediately place the closed breaker in open condition.
Even when the closing springs are "charged", if the breaker is not placed in re-closed condition, the result is acceptable.
For resetting, turn the pushbutton switch (Fig. 5 PB "Close" OFF.

4.5.3 Replacement of HC

1) Take the breaker body out of the draw-out cradle.

2) Place the breaker in OPEN condition.

3) Set the breaker body so that the bottom surface is visible.
(See Fig.21)

4) Remove the close-open spring (Fig.21 -(1)).
Do this with utmost care.

5) Remove the side-plate support mounting screws (one each for right and left)(Fig.21 (2)) to take out the side plate support (Fig. 21 (3)).

6) Remove the two M4 mounting screws for PC board (Fig. 21 (6)).

7) Take out the clip fixing the relay (HC)(Fig. 22 (6)), and remove the relay (HC)(Fig. 22 (8)) from PC board.

NOTE: It is not necessary to remove the connected wire terminals (Fasten terminal)(Fig.21 (4)).

8) Insert a new relay (HC) into PC board (Fig.21 (5), Fig.22 (9)), and fix it with a clip.

9) Check that the connected wire terminals (Fasten terminal) are inserted securely. If required, remove them once, and insert them securely once again.

10) Install PC board in the original place of the breaker with two M4 mounting screws for PC board.

11) Install the side-plate support in the original position with the right and left side-plate support tapping screws.

12) Install the close-open spring.

13) Check the relay for normal operation in the method described in 4.5.2.

VI. OVERCURRENT PROTECTIVE DEVICE

Type PRQ Multi-Function Protective Device

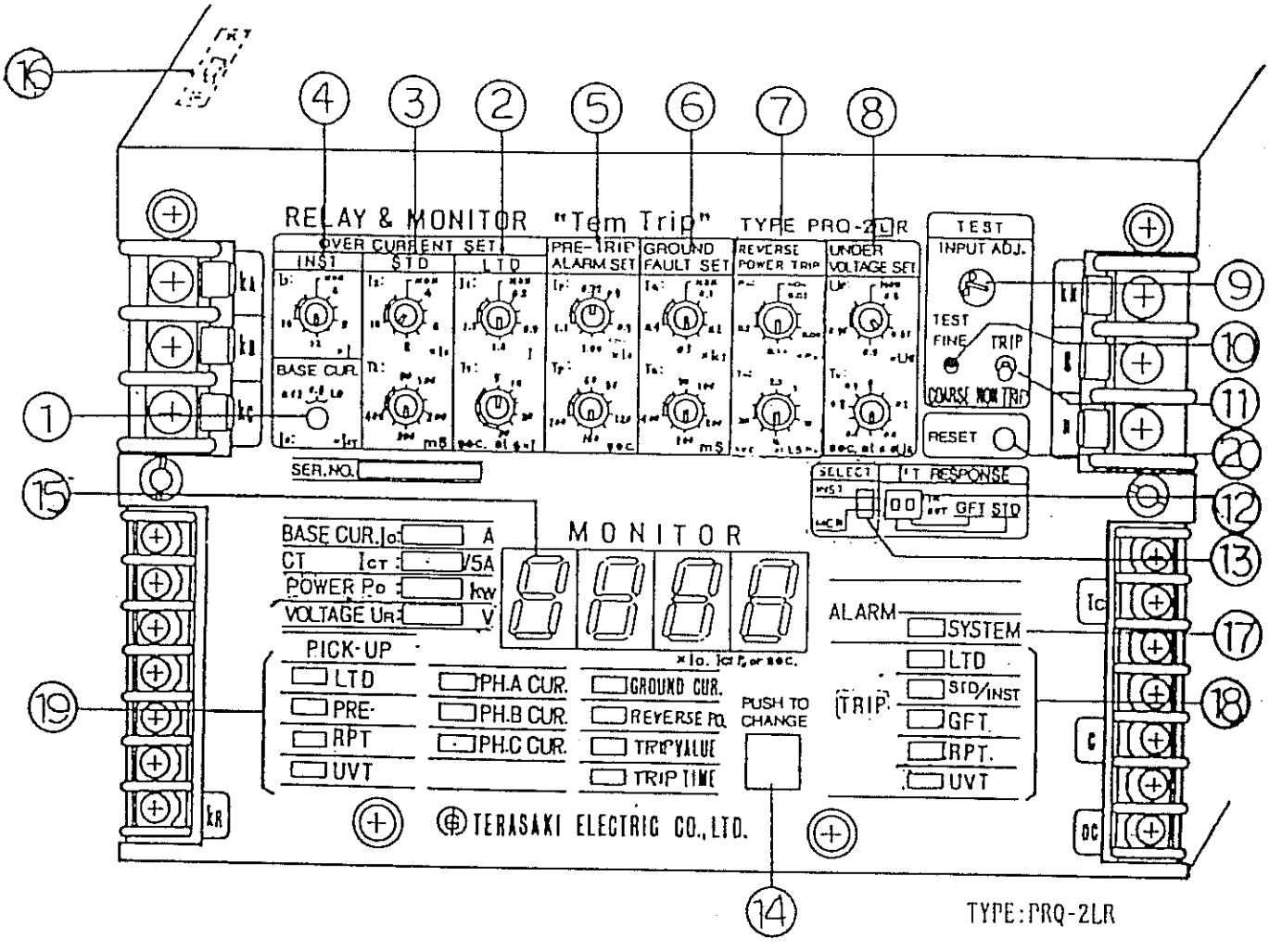
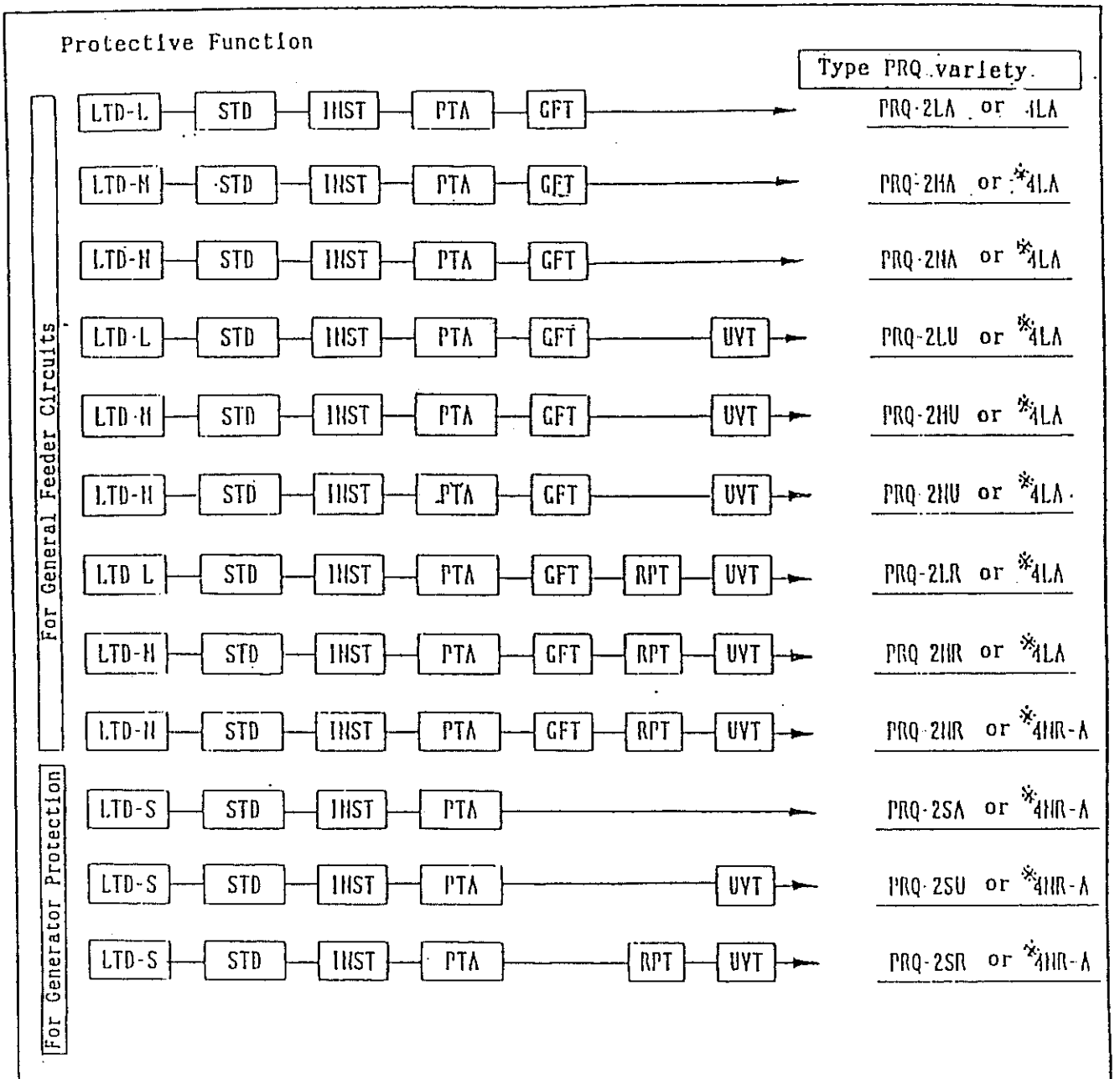


Fig. 23

(1) Base current select dial
(2) Long time delay trip pickup current/time setting dials
(3) Short time delay trip pickup current/time setting dials
(4) Instantaneous trip pickup current setting dial
(5) Pretrip alarm pickup current/time setting dial
(6) Ground fault trip pickup current/time setting dials
(7) Reverse power trip pickup power/time setting dials
(8) Undervoltage trip pickup voltage/time setting dials
(9) "INPUT ADJ." volume
(10) TEST switch
(11) "TRIP" "NON TRIP" select switch
(12) "I^2T RESPONSE" switch
(13) INST-MCR select switch
(14) PUSH TO CHANGE button
(15) Monitor
(16) Polarity reversing switch
(17) ALARM indicator light (LED)
(18) TRIP indicator light (LED)
(19) PICKUP indicator light
(20) RESET button

Type PRQ multi-function protective device is a 8-bit CPU loaded, high-reliability, multi-functional protective device. This device is classified into the types for general feeder circuits and the types for generator protection. Refer to the following protective function combination table. Also check the type of the purchased Type PRQ multi-function protective device, and read the required items carefully.



LTD(L, M, N, S) : Long Time Delay Trip (r.m.s. value control) STD : Short Time Delay Trip

INST : Instantaneous Trip PTA : Pretrip Alarm (r.m.s. value control) GFT : Ground Fault Trip

RPT : Reverse Power Trip UVT : Undervoltage Trip

* Applicable to AT40 only. GFT pickup current setting range differs.

1. Base Current[I_0] Setting of Type PRQ Multi-function Protective Device

Base current[I_0]

For General Feeder Circuits

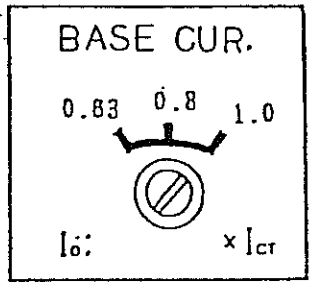
- Base current is a basic current necessary for various kinds of settings of Type PRQ protective device. The base current is set to the position you specified, and indicated on the nameplate as follows:

BASE CUR. I_0 : A

Base current[I_0] can be adjusted to 63%, 80% and 100% of the rated primary CT current[I_{CT}]. When you change the setting position of[I_0], refer to Table 1 for the corresponding base current.

Table1: Base current[I_0]

適用 I_{cT}	ダイヤル位置 0.63	0.8	1.0
80	50	63	80
160	100	125	160
250	160	200	250
320	200	250	320
500	320	400	500
630	400	500	630
1000	630	800	1000
1250	800	1000	1250
1600	1000	1250	1600
2000	1250	1600	2000
2500	1600	2000	2500
3200	2000	2500	3200
4000	2500	3200	4000



- Base current can be selected by turning the base current select dial (Fig. 23-(1) to the desired scale with a flat-bladed screwdriver.

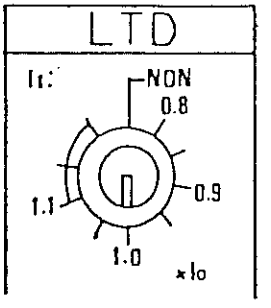
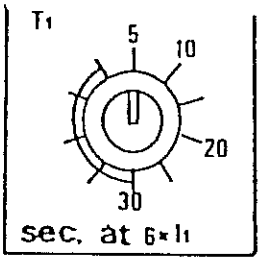
For Generator Protection

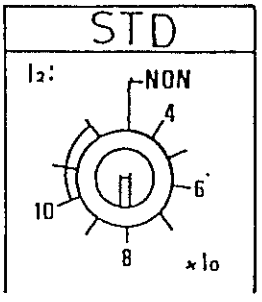
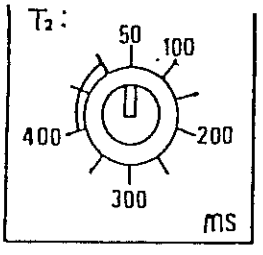
- Base current [I_0] is equal to the rated current of the generator. A proper CT is selected according to the rated current. However, the base current is adjusted so as to be fixed at the rated current level by the internal input match, thus making it impossible to change the rated current (base current [I_0]).
  It is indicated on the nameplate as follows:

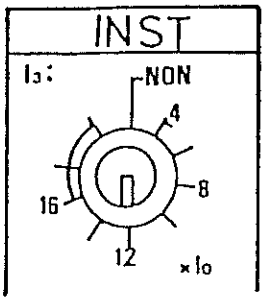
BASE CUR. I_0 : A

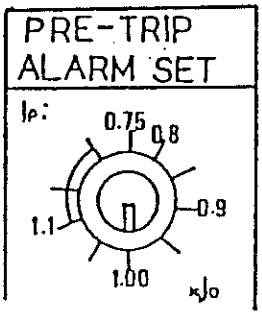
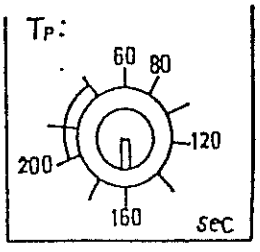
2. Protective Functions and Setting Ranges of Type PRQ Multi-function Protective Device

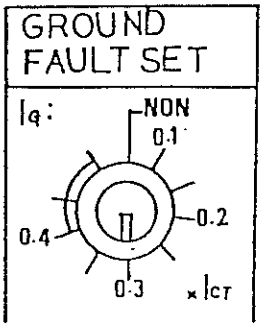
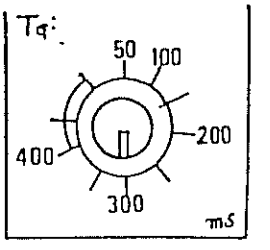
When you change the settings, read "Method of Changing Protective Function Settings" to be explained in Item VI-6 first.

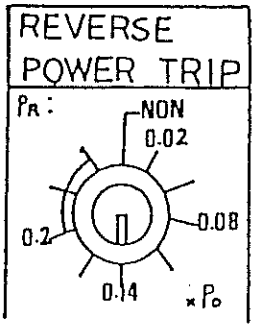
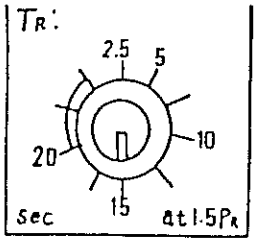
Protective Function	Long Time Delay Trip	
	Pickup Current[I_1] Setting Range	Time[T_1] Setting Range
		
	(Ex.) General Feed Circuits	(Ex.) General Feed Circuits
For General Feeder Circuits	◦ Setting dial is scaled in multiples of [I_0]. There are 8 discrete setting positions: NON, 0.8, 0.85, 0.9, 0.95, 1.0, 1.05 and 1.1 times I_0. ◦ The breaker is not tripped at less than 105%, and tripped at more than 120% of [I_1] setting. NOTE: At NON setting, the protective function does not operate.	◦ Setting dial is scaled in seconds, indicating the operating time at current flow of 600% x [I_1]. (300% in case of M, N characteristics) ◦ With L characteristic, there are 6 discrete setting positions: 5, 10, 15, 20, 25, and 30 seconds. With M, N characteristics, there are 9 setting positions: 1. 1.5, 2, 2.5, 3, 3.5, 4, 4.5 and 5 seconds.(Tolerance: Setting±15%, with M, N characteristics: ±20%)
For Generator Protection	◦ Setting dial is scaled in multiples of [I_0]. There are 8 discrete setting positions: NON, 0.8, 1.0, 1.05, 1.1, 1.15, 1.2, and 1.25 times [I_0] setting. ◦ The breaker is tripped at 95% to 105% of [I_1] setting. (Operation tolerance : Setting±5%) NOTE: At NON, the protective function does not operate.	◦ Setting dial is scaled in seconds, indicating the operating time at current flow of 120% x [I_1]. ◦ There are 10 discrete positions: 15, 20, 25, 30, 35, 40, 45, 50, 55 and 60 seconds. (Tolerance: Setting±15%)

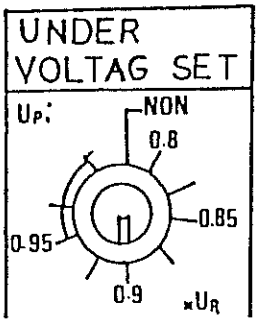
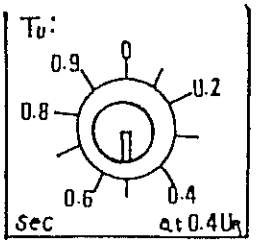
Protective Function	Short Time Delay Trip	
	Pickup Current[I_2] Setting Range	Time[T_2] Setting Range
	 (Ex.) General Feed Circuits	 (Ex.) General Feed Circuits)
For General Feeder Circuits	◦ Setting dial is scaled in multiples of [I_0]. There are 8 discrete setting positions: NON, 4, 5, 6, 7, 8, 9 and 10 times [I_0]. (Tolerance: Setting±15%) NOTE: At NON, the protective function does not operate. However, when INST is also set at NON, the STD protective function operates at 1000% of [I_0] setting.	◦ Setting dial is scaled in milliseconds, indicating the operating time at current flow higher than [I_2] setting. ◦ There are 8 discrete setting positions: 50, 100, 150, 200, 250, 300, 350 and 400 milliseconds. Tolerance: (T_2±20ms)◦10% NOTE: Either definite-time or inverse-time can be selected. Definite-time characteristic is normal, which is given by OUT position of I^2t RESPONSE switch. When inverse-time characteristic is required, set the I^2t RESPONSE switch (Fig. 23-(12)) to IN position.
For Generator Protection	◦ Setting dial is scaled in multiples of [I_0]. There are 8 setting positions: NON, 2, 2.5, 3, 3.5, 4, 4.5 and 5 times [I_0]. (Tolerance: Setting±10%) NOTE: At NON, the protective function does not operate. However, when INST is also set at NON, the STD protective function operates at 500% of [I_0] setting.	◦ Setting dial is scaled in milliseconds, indicating the operating time at current flow higher than [I_2] setting. ◦ There are 8 setting positions: 50, 100, 150, 200, 250, 300, 350 and 400 milliseconds. Tolerance: ±10% of(T^2±20ms)

Protective Function	Instantaneous Trip Pickup
	Pickup Current [I_3] Setting Range
	 (Ex.): General Feed Circuits
For General Feeder Circuits	• Setting dial is scaled in multiples of [I_0]. • There are 8 discrete setting positions: NON, 4, 6, 8, 10, 12, 14 and 16 times [I_0]. Tolerance: Setting±20% NOTE 1: At NON setting, the protective function does not operate. In this case, the rated breaking capacity of the breaker may be decreased. Prior to setting to NON, compare the short-circuit pickup current setting of the circuit and the breaker's rated breaking capacity and make sure there is no problem. NOTE 2: When STD is set at NON, the INST protective function operates at 1000% of [I_0], even when the setting is at more than 1000%. NOTE 3: When the INST-MCR select switch (Fig. 23-(13)) is set to MCR, the INST protective function operates only at the time of close operation of the breaker. In this case, the rated breaking capacity of the breaker may be decreased. Prior to setting to MCR, compare the short-circuit pickup current setting of the circuit and the breaker's rated breaking capacity and make sure there is no problem.
For Generator Protection	Same as above

Protective Function	Pretrip Alarm	
	Pickup Current [I_P] Setting Range	Time [T_P] Setting Range
	 (Ex.) General Feed Circuits	 (Ex.) General Feed Circuits
For General Feeder Circuits	◦ Setting dial is scaled in multiples of [I_0]. ◦ There are 8 discrete setting positions: NON, 0.75, 0.8, 0.85, 0.9, 0.95, 1, 10.5 and 1.1 times [I_0]. Tolerance: Setting±5%	◦ Setting dial is scaled in seconds, indicating the operating time at current flow higher than [I_P] setting. ◦ There are 8 setting positions: 60, 80, 100, 120, 140, 160, 180 and 200 seconds. Tolerance: Setting±15% NOTE: Two kinds of operation signals are output: Alarm signal at 50% of the time setting, and alarm signal at the time setting.
For Generator Protection	Same as above	◦ Setting dial is scaled in seconds, indicating the operating time at current flow of 120% x [I_P] setting. ◦ There are 8 setting positions: 10, 15, 20, 25, 30, 35, 40 and 45 seconds. Tolerance: Setting±15% NOTE: Two kinds of operation signals are output: Signal which sends alarm at 50% of the time setting, and signal which sends alarm at the time setting.

Protective Function	Ground Fault Trip	
	Pickup Current [I_G] Setting Range	Time [T_G] Setting Range
		
For General Feeder Circuits	◦ Setting dial is scaled in multiples of the CT rated primary current [I_{CT}]. ◦ There are 8 discrete setting positions: NON, 0.1, 0.15, 0.2, 0.25, 0.3, 0.35 and 0.4 times [I_{CT}]. (For Type AT40 ACB, 4 positions are provided: NON, 0.1, 0.15 and 0.2 times [I_{CT}]) Tolerance: Setting±20% NOTE: At NON setting, the protective function does not operate. The 3-pole ACB must be applied to the 3-phase, 4-wire circuit, and the neutral CT must be applied to the N-phase for protection purpose. If not, make sure to set [I_G] to NON, and short between g-h terminals of Type PRQ device, using wire, etc. to prevent erroneous operation. Refer to Item VI-5 for the CT for the neutral.	◦ Setting dial is scaled in milliseconds, indicating the operating time at current flow higher than [I_G] setting. ◦ There are 8 discrete setting positions: 50, 100, 150, 200, 250, 300, 350 and 400 milliseconds. Tolerance: ±10% of(T_G±20ms) NOTE: Either definite-time or inverse-time can be selected. Definite-time characteristic is normal, which is given by OUT position of I^2t RESPONSE switch. When inverse-time characteristic is required, set I^2t RESPONSE switch (Fig. 23-(12)) to IN position.
For Generator Protection	---	---

Protective Function	Reverse Power Trip	
	Pickup Power [P_R] Setting Range	Time [T_R] Setting Range
		
For General Feeder Circuits	◦ Setting dial is scaled in multiples of [P_0]. ◦ There are 8 discrete setting positions: NON, 0.02, 0.05, 0.08, 0.11, 0.14, 0.17 and 0.2 times [P_0]. Tolerance: Setting±10% NOTE 1: Regarding the polarity of the reverse power detection circuit, normal connection is achieved by supplying power to the upper terminal of the ACB main circuit. For the reverse connection (power supplied to the lower terminal), change the polarity reversing switch (Fig. 23-(16)) setting to REV from NOR. NOTE 2: At NON setting, the protective function does not operate. When the control circuit terminals No.25 to No.27 are shorted (see Fig. 5), the function does not operate, either.	◦ Setting dial is scaled in seconds, indicating the operating time at power of 150% of [P_R] setting. ◦ There are 8 discrete setting positions: 2.5, 5, 7.5, 10, 12.5, 15, 17.5 and 20 seconds. Tolerance: Setting±20%
For Generator Protection	Same as above	Same as above

Protective Function	Undervoltage Trip	
	Pickup Voltage [U_P] Setting Range	Time [T_U] Setting Range
		
For General Feeder Circuits	◦ The protective function operates when the rated voltage [U_R] decreases to less than 65%. ◦ Setting dial is scaled in multiples of [U_R], which indicates the trip (reset)voltage (?). ◦ There are 8 discrete setting positions: NON, 0.8, 0.825, 0.85, 0.875, 0.9 and 0.95 times [U_R]. Tolerance: Setting±5% NOTE: When the specified voltage is applied between the control circuit terminals No.19 and 20 (Fig. 5), and NON is set, the protective function does not operate even at the time of undervoltage (no-voltage).	◦ Setting dial is scaled in seconds, indicating the operating time at 40% of [U_R]. ◦ There are 10 setting positions: 0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8 and 0.9 seconds. Tolerance: (T_U+70ms)◦5%
For Generator Protection	Same as above	Same as above

3. Measurement and Operation Indication

Control power is required for measurement and operation indication. Supply the specified power between terminals No.19 and No.20 (Fig. 5 : Control Circuit Diagram) of the control circuit disconnecting device (Fig. 1-(18)).

- Control power is also required for ground fault trip, reverse power trip, pretrip alarm, MCR trip and field test functions.
- For DC rating, connect No.19 to positive (+) pole, and No. 20 to negative (-) pole.

3-1. Measurement

Current, ground fault current and reverse power of each phase (excluding the N-phase) in an electric circuit in operation can be measured.

1) Current of each phase

Select the phase to be measured with PUSH TO CHANGE button (Fig. 23-(14)). The green LED on the selected phase lights up. The value displayed on the monitor (Fig. 23-(15)) for the selected phase indicates the ratio to base current [I_0].

Current in electric circuit = Displayed value x BASE CUR. [I_0] ☐ A (mean value)

2) Ground fault current

Select "GROUND CUR." with PUSH TO CHANGE button, which turns on the green LED. The displayed value indicates the ratio to the CT rated primary current [I_{CT}]. In case of no ground fault, the monitor displays "00.00".

Ground fault current = Displayed value x CT [I_{CT}] ☐ /5A

3) Reverse power

Select "REVERSE PO." with PUSH TO CHANGE button, which turns on the green LED. The displayed value indicates the ratio to the generator rated power [P_0].

Reverse power = Displayed value x POWER [P_0] ☐ KW

3-2. Operation indication

There are 3 kinds of operation indications:

* PICK-UP indication to tell that the breaker has not been tripped yet, but has already exceeded the pickup current.

* TRIP indication to tell the cause of tripping operation.

* ALARM indication.

1) PICKUP Indication

(1) LTD (overcurrent)

When the electric circuit current has exceeded the LTD trip pickup current, the orange LED for LTD in the PICK-UP indication section lights up. This indicates that the breaker will be tripped if overcurrent continues in the circuit. Measuring each phase current in this state by using PUSH TO CHANGE button allows overcurrent of each phase to be indicated.

(2) PRETRIP

When the circuit current has exceeded the PRETRIP ALARM pickup current, the orange LED for PRETRIP in the section lights up. This indicates that the alarm signal will soon be output between the terminals (AC-AP_1 at 50% x time setting · AC-AP_2 at time setting) of the RS interface (Fig. 1-(36), Fig. 5), if overcurrent continues in the circuit. Please note that PRETRIP pickup indication LED lights up prior to the LTD pickup indication LED in the above (1), and that the PRETRIP LED is also lit up when the LTD LED lights up.

(3) RPT (Reverse Power trip)

When reverse power has exceeded the REVERSE POWER trip pickup current, the orange LED for RPT in the section lights up. This indicates that the breaker will soon be tripped if the exceeded reverse power continues.

(4) UVT (Undervoltage trip)

When voltage of power of terminals No.9-No.10 (Fig. 5 : Control Circuit Diagram) has become less than UVT pickup voltage, the orange LED for UVT in the section lights up to indicate that power has been stabllized. Also, the contact signal is output between terminals AC-UP of the RS interface.(Fig. 1-(36) and Fig. 5)

2) TRIP Indication

When the breaker has been tripped due to the tripping operation of Type PRQ protective device, the cause of trip, trip current (power, voltage) and tripping time can be indicated.

(1) Trip cause indication is done by turning on the corresponding red LED in the TRIP indication section, and by performing the contact output at the RS interface. (Fig. 1-(36))

Trip Cause Indication

Trip cause	Red LED lit up	Contact Output Terminal No.
Overcurrent	"LTD"	Between AC-AL
Short-circuit	"STD/INST"	Between AC-AS ◦ With Type PRQ-2S, contact output is ON for 50ms only. (automatically reset)
Ground fault	"GFT"	Between AC-AG
Reverse power	"RPT"	Between AC-AR
Undervoltage	"UVT"	Between AC-AU

(2) The values are displayed on the monitor (Fig. 23-(15)).

Select TRIP VALUE with PUSH TO CHANGE button (Fig. 23-(20)). Trip current (power, voltage) is displayed on the monitor as the ratio to the rated current (power, voltage). When selecting TRIP TIME, the operating time is displayed.

◦ Reset

When RESET button (Fig. 23-(20)) is depressed, the LED goes out, the contact output is OFF and trip data stored in CPU is deleted.
Before closing the breaker again, be sure to depress RESET button in order to ensure that trip cause indication (LED, contact output and monitor indication) is cleared.

3) ALARM indication

The following abnormality is supervised:

(1) Overheat of the breaker main contacts (Option)

The temperature detection sensor is provided in the vicinity of the breaker main contacts. In case of the overheat, the red HEAT LED in the ALARM indication section lights up, and the contact signal is output between terminals A_C-A_F of the RS interface (Fig. 1-(36) and Fig. 5)

(2) SYSTEM abnormality

When abnormality occurs in Type PRQ protective device and the breaker trip circuit, the red SYSTEM LED in the ALARM indication section lights up, and at the same time, the contact signal is output between

terminals A_C-A_E of the RS interface. Also, the following error message is displayed on the monitor.

Error Message

0001 ... Short-circuit detection (CPU) failure

0002 ... UVT coil attraction failure

0003 ... Breaker not tripped

0004 ... Tripping coil (MHT or UVT) disconnected

- Reset

When RESET button is depressed, normally the LED goes out, the contact output is OFF and the monitor displays "00.00". If some abnormality occurs, immediately contact TERASAKI.

4. RS interface type and rating

Type PRQ protective device (Fig. 1-(25) and RS interface (Fig. 1-(36)) are connected via the dedicated connector-attached multiconductor cable (Fig. 1-(37)), thus converting various kinds of indications signals to contact output.
Four types of interface are available, and the instructions given here are applicable to each type.
For the fire alarm, zone interlock and data output employing optical fiber cables (option), refer to the corresponding separate manual.

Type	Contact output for operation indication	Fire alarm	Zone interlock	Data output
RS-20	O	□	□	□
RS-21	O			
RS-22	O	□		
RS-23	O		□	□

□ : Optical fiber cable required

O : Standard feature

Rating of Contacts for Operation Indication

	Resistive load	Inductive load
250 V AC	125 VA	20 W (2A max.)
250 V DC	60 W	10 W (2A max.)

5. CT for the neutral (N-phase) and its connection

When the 3-pole ACB provided with the ground fault protection function is applied to the 3-phase, 4-wire circuit, it is necessary to provide the CT for ground fault tripping in the N-phase busbar. Please use the CT supplied separately as the accessary of Type PRQ protective device.

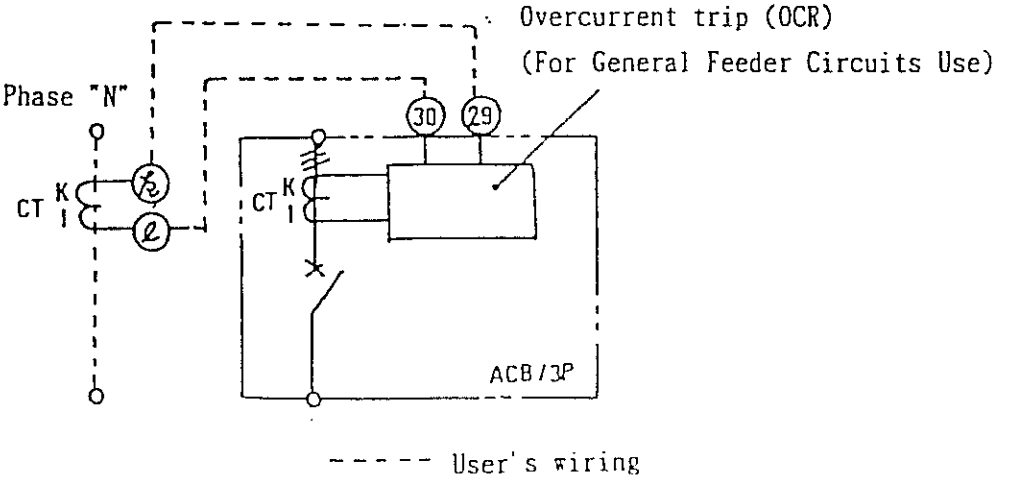
5-1. ACB type and applicable CT for the neutral

ACB type	Applicable CT type	CT rating [A]
AT06 AT12 AT16	CW80-40LS	320/5 630/5 1250/5 1600/5
AT20 AT25 AT32 AT40	EC160-40LS	500/5 1000/5 1600/5 2000/5 2500/5 3200/5 4000/5

NOTE: Use the CT having the same rating as [I_{CT}] indicated on the nameplate of Type PRQ protective device.

5-2. Wiring

Wiring between the control circuit terminals of the breaker and the CT for the N-phase is shown in the diagram. Pay attention to the polarity at the time of wiring.



6. Method of Changing Protective Function Settings

Type PRQ protective device is set to the setting positions you specified and supplied to you (the specified setting positions are not marked).
The setting positions can be readily changed by dial operation.

1) For removing the transparent cover on the protective device front, remove the screw on either end with a flat-bladed screwdriver.

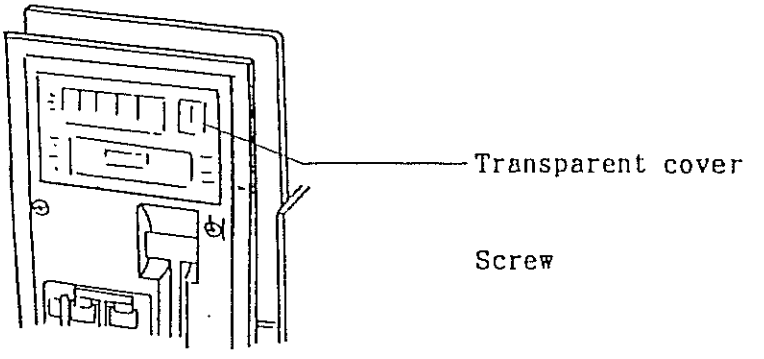
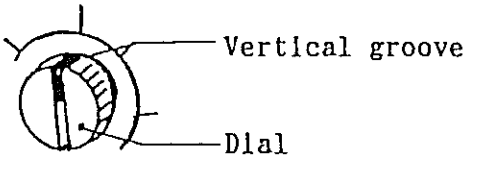


Fig. 24

2) For setting change, turn the dial with a flat-bladed screwdriver, and align the vertical groove on the dial with the scale graduation.



NOTE 1 : The click step dial is employed. However, if the dial is set to an intermediate position between scale graduations inadvertently, it will be set to not the intermediate value but either scale set value, resulting in unclear setting. Be sure to set the dial to the position where the vertical groove and scale graduation are aligned with each other.

NOTE 2 : The dial can be lightly turned with a screwdriver. Do not push it strongly or turn it forcedly.

3) Return the transparent cover to its original place.

7. Field Test Method of Type PRQ Multi-Function Protective Device

Two kinds of the field test method are provided: the function check and secondary current check. In the former method, the test function switch (INPUT ADJ. volume (Fig. 23-(9)) and TEST switch (Fig. 23-(10)) are used. In the latter method, the testing equipment is used.

7-1. Function check method

1) Use INPUT ADJ. volume for test input adjustment. The input value can be adjusted regardless of if the breaker is closed or not, and if the TRIP indication LED is lit up or not.

2) The test can be conducted either by tripping the breaker or without tripping the breaker. Select either method with "TRIP" "NON TRIP" select switch (Fig.23-(11)), according to the test purpose.
With "TRIP" position, when the breaker is tripped, the TRIP indication LED will be simultaneously lit up, and contact output of the RS interface be simultaneously ON.
With "NON TRIP" position, the LED will light up, but contact output will remain OFF.
The check method to be described here includes the confirmation of tripping operation.
Be sure to confirm the following items prior to the check.

- Draw out the breaker to the TEST position or to the ISOLATED position, or in case of the draw-out type breaker, take it out from the draw-out cradle.
  If making function check in the TEST position, ensure that there is no influence on the sequence. When taking the breaker out from the draw-out cradle for check, the charging terminal will be exposed, so be careful not to receive electric shock by touching it inadvertently.

- Control power

  Control power is required for the check. Make sure that the specified power is supplied between terminals No.19 and No.20 of the control circuit (Fig. 5).
  If making the check in the ISOLATE position or taking the breaker out from the draw-out cradle, make sure that the control power specified on the nameplate is supplied between power input terminals of Type PRQ protective device, S_0 and S_1, or between S_0 and S_2.

Function Check Method for Each Protective Function

1. Long Time Delay Trip Function Check

	For General Feeder Circuits and Generator Protection
Verification of Pickup Current Setting	1. Turn INPUT ADJ. volume back to the left (Min. side) with a flat-bladed screwdriver. 2. Select the phase for measurement with the green PUSH TO CHANGE button. Select "PH. A CUR." for A-phase, "PH. B CUR." for B-phase, and "PH. C CUR" for C-phase. The LED for the selected phase will light up. 3. Set TEST switch (Fig. 24-(10)) to FINE, and hold it there with your hand. The monitor displays "00.00". 4. Still holding TEST switch in the position, gradually turn INPUT ADJ. volume to the right with a screwdriver until the LTD pickup indication LED lights up. Read the value displayed on the monitor when the LED lights up, which is the pickup current level for the selected phase. If the value is within the following range, it is normal. ◦ General feed circuits: 1.05 to 1.2 times [I_1] (long time delay pickup current setting) ◦ Generator protection: 0.95 to 1.05 times [I_1] NOTE: The PRETRIP pickup indication LED lights up before the LTD pickup indication LED lights up. 5. Release TEST switch when the pickup current has been confirmed. The switch automatically returns to the neutral position, the monitor displays "00.00", and the LTD LED goes out. * Follow the same procedure as above for measuring other phases.

Long Time Delay Trip Function Check

	For General Feeder Circuits and Generator Protection
Verification of Tripping Operation and Time Delay	1. Turn INPUT ADJ. volume back to the left (Min. side) with a screwdriver. 2. Select the phase for measurement with PUSH TO CHANGE button. In case of the type for general feed circuits, if the STD and INST pickup current settings are less than 6 times of base current [I_0] (less than 3 times [I_0] with M, N characteristics), set the respective pickup current setting dial to NON. 3. Calculate test input value. ◦ General feed circuits: 6 times [I_1] setting (3 times in case of M, N characteristics) ◦ Generator protection: 1.2 times [I_1] setting 4. Set TEST switch to COARSE and hold it there. The monitor displays "00.00". 5. Still holding the switch in the position, gradually turn INPUT ADJ. volume to the right with a screwdriver until the monitor reads the test input value. 6. When the value on the monitor has become substantially equal to the test input value (+ side recommended), release TEST switch to turn OFF test input. The monitor displays "00.00". 7. Close the breaker. ◦ If the LTD trip indication LED is lit up, press RESET button to turn off the LED. 8. Again, set TEST switch to COARSE and hold it there. When the breaker is tripped and the LTD trip indication LED is lit up, release the switch. The switch automatically returns to the neutral position, and at the same time the monitor displays "00.00". The LTD LED remains ON. 9. Select TRIP VALUE with PUSH TO CHANGE button, and select TIP TIME to confirm the tripping time. If the trip current is substantially equal to the test input value, and the tripping time is within the range of time setting [T_1]±15% (in case of M, N characteristics ±20% tolerance), it is normal. 10. After the check completion, press RESET button. The LTD LED for TRIP indication goes out. 11. If you have taken the above Step 2, return the dials to the original setting positions.

2. Short Time Delay Trip Function Check

	For General Feeder Circuits and Generator Protection
Verification of Pickup Current Setting	1. Turn INPUT ADJ. volume back to the left (Min. side) with a flat-bladed screwdriver. 2. Select the phase for measurement with PUSH TO CHANGE button. 3. Set TEST switch to COARSE and hold it there. The monitor reads "00.00". 4. Still holding the switch in the position, gradually turn INPUT ADJ. volume to the right with a screwdriver until the STD/INST trip indication LED lights up. 5. When the LED has lit up, release the switch. The switch automatically returns to the neutral position, and at the same time the monitor returns to "00.00". The STD/INST LED remains ON. 6. Select TRIP VALUE with PUSH TO CHANGE button to confirm the trip current. If the trip current is within the range of the trip pickup current setting $[I_2]\pm15\%$ (for generator protection, $\pm10\%$), it is normal. The TRIP TIME value is a reference value. 7. After the check completion, press RESET button. The STD/INS LED goes out.

Short Time Delay Trip Function Check

	For General Feeder Circuits and Generator Protection
Verification of Tripping Operation and Time Delay	1. Turn INPUT ADJ. volume back to the left (Min. side) with a flat-bladed screwdriver. 2. Select the phase for measurement with PUSH TO CHANGE button. 3. Calculate the test input value. ◦ Approx. 1.2 to 1.5 times [I_2] (short time delay trip pickup current setting) 4. Set TEST switch to COARSE and hold it there. The monitor reads "00.00". 5. Still holding the switch in the position, gradually turn INPUT ADJ. volume to the right with a screwdriver until the monitor reads the test input value. 6. After confirming that the value on the monitor is equal to the test input value, release TEST switch to turn OFF the test input. The monitor returns to "00.00". 7. Close the breaker. Press RESET button to turn off the STD/INST trip indication LED. 8. Again, set TEST switch to COARSE. When the breaker is tripped and the STD/INST LED is lit up, release the switch. The switch automatically returns to the neutral position, and at the same time the monitor returns to "00.00". The STD/INST LED remains ON. 9. Select TRIP TIME with PUSH TO CHANGE button to confirm the tripping time. If the tripping time is within the range of ((time setting [T_2]±20ms) x ±10%), it is normal. NOTE: In case that reverse-time is selected, the breaker is tripped in a time delay corresponding to the characteristic. 10. After the check completion, press RESET button. The STD/INST LED goes out.

3. Instantaneous Trip Function Check

	For General Feeder Circuits and Generator Protection
Verification of Pickup Current Setting and Tripping Operation	1. Close the breaker. 2. Set the short time delay(?) trip pickup current setting dial to NON position. 3. Turn back INPUT ADJ. volume to the left (Min. side) with a flat-bladed screwdriver. 4. Select the phase for measurement with PUSH TO CHANGE button. 5. Set TEST switch to COARSE and hold it there. The monitor reads "00.00". 6. Still holding the switch in the position, gradually turn INPUT ADJ. volume to the right until the breaker is tripped and the STD/INST trip indication LED lights up. The max. test input on the monitor is approx. 10.2 times. 7. When the breaker is tripped and the LED has lit up, release the switch. The switch automatically returns to the neutral position, and at the same time the monitor returns to "00.00". The STD/INST LED remains ON. 8. Select TRIP VALUE with PUSH TO CHANGE button to confirm the trip current. If the trip current is within the range of the pickup current setting [I_3]±20%, it is normal. As the check is conducted with STD trip pickup current dial set to NON, the INST protective function will operate at 1000% of [I_0] setting as a fail-safe function, even if the setting is at more than 1000%. Ignore TRIP TIME. 9. After the check completion, press RESET button. The STD/INST LED goes out. 10. Return the dial to its original setting position.

4. Pretrip Alarm Function Check

	For General Feeder Circuits and Generator Protection
Verification of Pickup Current Setting	1. Turn INPUT ADJ. volume back to the left (Min. side) with a flat-bladed screwdriver. 2. Select the phase for measurement with PUSH TO CHANGE button. 3. Set TEST switch to FINE, and hold it there. The monitor reads "00.00". 4. Still holding the switch in the position, gradually turn INPUT ADJ. volume to the right with a screwdriver until the PRETRIP pickup indication LED lights up. Read the value displayed on the monitor when the LED lights up, which is the pickup current for the selected phase. If it is within the range of the pretrip alarm pickup current setting [I_p]±5%, it is normal. 5. After the check, release the switch. The switch automatically returns to the neutral, the monitor returns to "00.00", and the PRETRIP LED goes out.
Verification of Operating Time	1. Turn INPUT ADJ. volume back to the left (Min. side) with a flat-bladed screwdriver. 2. Select the phase for measurement with PUSH TO CHANGE button. 3. Calculate the test input value. • 1.2 times [I_p](pretrip alarm pickup current setting) 4. Set TEST switch to FINE, and hold it there. The monitor reads "00.00". 5. Still holding the switch in the position, gradually turn INPUT ADJ. volume with a screwdriver until the monitor reads the test input value. 6. After confirming that the value on the monitor is substantially equal to the test input value, release the switch to turn OFF test input. The monitor returns to "00.00". 7. Again, set TEST switch to FINE, and hold it there. The PRETRIP pickup indication LED remains ON. If current flows between terminals [AC] and [AP1] of the RS interface at 50% of pretrip alarm setting time [T_p], and between terminals [AC] and [AP2] at [T_p], it is normal. 8. If the respective operating time is within the range of [T_p]±15%, it is normal. After the check completion, release the switch. The switch automatically returns to the neutral, and at the same time the monitor returns to "00.00", and the PRETRIP LED goes out.

5. Ground Fault Trip Function Check

	For General Feeder Circuits and Generator Protection
Verification of Pickup Current Setting	1. Turn INPUT ADJ. volume back to the left (Min. side) with a flat-bladed screwdriver. 2. Select GROUND CUR with PUSH TO CHANGE button. 3. Set TEST switch to FINE, and hold it there. The monitor reads "00.00". 4. Still holding the switch in the position, gradually turn INPUT ADJ. volume to the right until the GFT trip indication LED lights up. 5. After confirming that the LED has lit up, release the switch. The switch automatically returns to the neutral position, and at the same time the monitor returns to "00.00". The GFT LED remains ON. 6. Select TRIP VALUE with PUSH TO CHANGE button to confirm the trip current. If the value on the monitor is within the range of the pickup current setting [I_G]±20%, it is normal. The TRIP TIME value is a reference value. 7. After the check completion, press RESET button. The GFT LED goes out.

Ground Fault Trip Function Check

	For General Feeder Circuits and Generator Protection
Verification of Tripping Operation and Trip Time Delay	1. Turn INPUT ADJ. volume back to the left (Min. side) with a flat-bladed screwdriver. 2. Select GROUND CUR with PUSH TO CHANGE button Calculate the test input value. ∘ Approx. 1.5 times [I_G] (trip pickup current setting) 3. Set TEST switch to FINE, and hold it there. The monitor reads "00.00". 4. Still holding the switch in the position, gradually turn INPUT ADJ. volume to the right with a screwdriver until the monitor reads the test input value. 5. After confirming that the value on the monitor is equal to the test input value, release TEST switch to turn OFF the test input. The monitor returns to "00.00". Press RESET button to turn OFF the GFT trip indication LED. 6. Close the breaker. 7. Again, set TEST switch to FINE. When the breaker is tripped and the GFT LED lights up, release the switch. The switch automatically returns to the neutral position, and at the same time the monitor returns to "00.00". The GFT LED remains ON. 8. Select TRIP TIME with PUSH TO CHANGE button to confirm the tripping time. If the value on the monitor is within the range of{([T_G]±20ms) x ±10%}, it is normal. NOTE: In case that the inverse-time characteristic is selected, the breaker is tripped in a time delay corresponding to the characteristic. 9. After the check completion, press RESET button. The GFT LED goes out.

6. Reverse Power Trip Function Check

	For General Feeder Circuits and Generator Protection
Verification of Pickup Current Setting	1. Supply the specified control power to terminals No.9, No.10 and No.11 of the control circuit (Fig. 5). (when the check is conducted with regard to 3-phases.) Or, supply the single-phase current source between terminals U_A·U_C-U_S provided on the left side wall of Type PRQ protective device. 2. Turn INPUT ADJ. volume back to the left (Min. side) with a flat-bladed screwdriver. 3. Select REVERSE POWER with PUSH TO CHANGE button. 4. Set TEST switch to FINE, and hold it there. The monitor reads "00.00". 5. Still holding the switch in the position, gradually turn INPUT ADJ. volume to the right with a screwdriver until the RPT pickup indication LED lights up. If the value displayed on the monitor when the LED is lit up is within the range of the pickup power setting $[P_R]$∘10%, it is normal. 6. After the check completion, release the switch. The switch automatically returns to the neutral position, and at the same time, the monitor returns to "00.00", and the RPT LED goes out.

Reverse Power Trip Function Check

	For General Feeder Circuits and Generator Protection
Verification of Tripping Operation and Time Delay	1. Supply the specified control power to terminals No.9, No.10 and No.11 of the control circuit(Fig. 5). (when the check is conducted with regard to 3-phases) Or, supply the single-phase current source between terminals U_A·U_C-U_B provided on the left side wall of Type PRQ protective device. 2. Turn INPUT ADJ. volume back to the left (Min. side) with a flat-bladed screwdriver. 3. Calculate the test input value. • 1.5 times [P_R] (trip pickup power setting) 5. Set TEST switch to FINE, and hold it there. The monitor reads "00.00". 6. Still holding the switch in the position, gradually turn INPUT ADJ. volume to the right with a screwdriver until the monitor reads the test input value. 7. After confirming that the monitor value is substantially equal to the test input value (+ side recommended), release the switch to turn OFF the test input. The monitor returns to "00.00". 8. Close the breaker. 9. Again, set TEST switch to FINE, and hold it there. When the breaker is tripped and the RPT trip indication LED is lit up, release the switch. The switch automatically returns to the neutral position, and at the same time the monitor returns to "00.00". The RPT LED remains ON. 10. Select TRIP VALUE with PUSH TO CHANGE button, and select TRIP TIME to confirm the tripping time. If the trip power is substantially equal to the test input value, and the tripping time is within the range of the time setting [T_R]±20%, it is normal. 11. After the check completion, press RESET button. The RPT LED goes out.

7-2. Secondary Current Check Method

- Switches for testing provided on Type PRQ protective device cannot be used. The tripping operation, trip current and time-delay characteristics can be checked with secondary current levels converted from the primary current settings supplied to the CT secondary side from a test current source.

- Test current

  The reference test current value can be obtained from the conversion formula shown below:

  I_T (A) = (I/I_{CT}) x 5

  where, I : Set value ($[I_1]$, $[I_2]$, $[I_3]$, $[I_P]$, or $[I_G]$, etc.)
  I_{CT} : Rated primary current of CT
  (Indicated on the nameplate)
  5 : Secondary current value of CT

  Example : I = 900A, I_{CT} = 1250A, I_r = (900/1250) x 5 = 3.6A

- Draw-out position of the breaker

  For each check, draw out the breaker to the TEST or ISOLATE position, or take it out from the draw-out cradle.

> If making the characteristic check in the TEST position, make sure that there is no influence on the sequence. If taking out the breaker from the draw-out cradle for check, charging terminal will be exposed, so be careful not to receive electric shock by touching it inadvertently.

Test equipment and control power to be prepared.

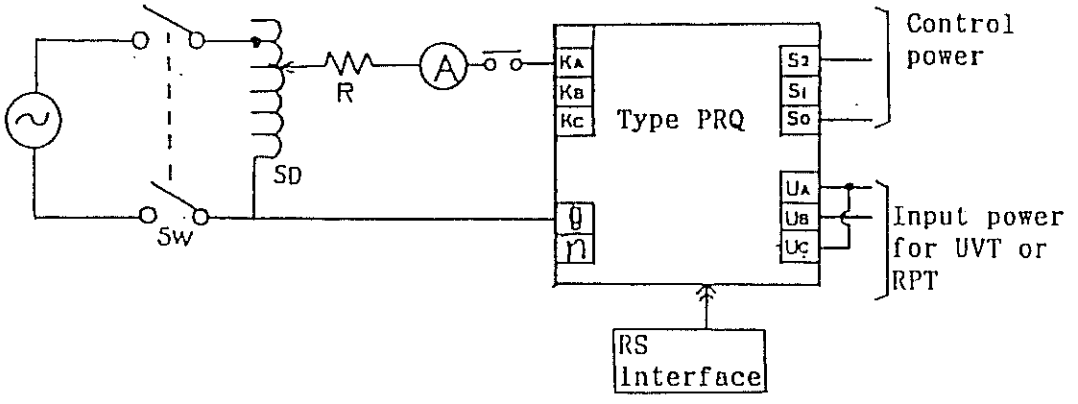
- Watch (TRIP VALUE and TRIP TIME indication on the monitor can also be used.)
- Flat-bladed screwdriver
- Tester
- Control power

  Apply the specified voltage to the control circuit of Type PRQ protective device.

  Make sure that the specified control power is applied between terminals No 19 and No.20 of the control circuit (Fig. 5). If making the check by drawing out the breaker to the ISOLATED position or taking it out from the draw-out cradle, supply the power specified on the nameplate between the power input terminals No.S_0 and S_1, or between No. S_0 and S_2 provided on the right side wall of Type PRQ protective device.

- Test equipment

  Prepare an adjustable constant current unit which can output a distortionless sinusoidal current. A sample test equipment circuit is shown below:



CAUTION: 1. Do not apply the test current more than the instantaneous trip pickup current setting[I_{3J} x 1.2. 2. Turn the test current OFF immediately when the breaker is tripped.

- Connect the test equipment outputs to the fasten terminals (K_A, K_B, K_C, g, n) of Type PRQ protective device as shown in the Table below. If fasten terminals are to be used, prepare the fasten terminals for Type 250 tab as connecting terminals. If solderless terminals are to be used, disconnect the connected fasten terminals (K_A, K_B, K_C, g, n), and connect the solderless terminals to the same positions.

Protective Function	
Long time delay trip, Short time delay trip, Instantaneous trip, Pretrip alarm	One of K_A, K_B, K_C and n
Ground fault trip,	g - n
Reverse power trip,	KB1-n (Pay attention to the polarity) Apply voltage to UA·UC-UB.
Undervoltage trip,	Apply voltage to UA-UB.

Characteristic Check Method for Each Protective Function

1. Long Time Delay Trip Characteristic Check

	For General Feeder Circuits and Generator Protection
Verification of Pickup Current Setting	1. Close the breaker. Apply test current [I_T]. 2. Increase the current gradually from zero, and read the current value at the time when the LTD pickup indication LED lights up. If the current value is within the following range, it is normal: • For general feeder circuits : 1.05 to 1.2 times [I_T] • For generator protection : 0.95 to 1.05 times [I_T] 3. Reduce the test current output to zero.
Verification of Tripping Operation and Time Delay	1. Close the breaker. 2. In case of the type for general feeder circuits, if the STD/INST pickup current settings are less than 6 times of the base current [I_0] (3 times [I_0] with M, N characteristics), set the respective current setting dial to NON with a flat-bladed screwdriver. 3. Apply the current corresponding to 6 times [I_T] in case of the type for general feed circuits, and 1.2 times [I_T] in case of the type for generator protection. 4. At the same time, start the trip time delay measurement with a watch. The breaker will be tripped and the LTD trip indication LED be lit up. If the tripping time is within the range of the time setting [T_1]±15% (±20% in case of M, N characteristics), it is normal. 5. Reduce the test current output to zero. 6. Press RESET button to turn off the LTD LED. 7. If you have taken the above Step 2, return the STD/INST pickup current setting dials to the original setting positions with a screwdriver.

2. Short Time Delay Trip Characteristic Check

	For General Feeder Circuits and Generator Protection
Verification of Pickup Current Setting	1. Close the breaker. 2. Rapidly apply the current in the range of the test current [I_T]±15%(±10% in case of the type for generator protection). If the breaker is tripped, and the STD/INST trip indication LED is lit up, it is normal. NOTE: The test current should be applied for 50ms with 3 seconds or more intervals in between. 3. Reduce the test current output to zero. 4. Press RESET button to turn off the LED.
Verification of Tripping Operation and Trip Time Delay	1. Close the breaker. 2. Apply the test current equal to approx. 1.5 times [I_T]. At the same time, start the trip time delay measurement with a watch. 3. The breaker will be tripped and the STD/INST trip indication LED be lit up. If the tripping time is within the range of {(trip time setting [T_2]±20ms) x ±10%} plus the breaker opening time delay (20ms), it is normal. NOTE: In case that the inverse-time characteristic(I^2t=c) is selected, the breaker is tripped in a time delay corresponding to the characteristic. (In case of the type for general feed circuits) 4. Reduce the test current output to zero. 5. Press RESET button to turn off the LED.

3. Instantaneous Trip Characteristic Check

	For General Feeder Circuits and Generator Protection
Verification of Pickup Current Setting	1. Close the breaker. 2. Set the short time delay time setting dial [T_2] to the maximum setting position. Also, set the long time delay pickup current setting dial [I_1] to NON. Apply the current in the range of the test current [I_T]±20%. If the breaker is tripped, and the STD/INST trip indication LED is lit up within this range, it is normal. NOTE: The test current should be applied for 50ms. 3. Apply the test current. 4. Reduce the test current output to zero. 5. Press RESET button to turn off the LED. 6. Return the setting dials (positions of which were changed in the above Step 2) to the original setting positions.

4. Pretrip Alarm Characteristic Check

	For General Feeder Circuits and Generator Protection
Verification of Pickup Current Setting	1. Close the breaker. 2. Apply the test current. Increase the test current [I_T] gradually from zero, and read the current value at the time when the PRETRIP pickup indication LED is lit up. If the value is within the range of [I_T]±5%, it is normal. 3. Reduce the test current output to zero.
Verification of Operating Time	1. Close the breaker. 2. The tripping time can be confirmed only when the RS interface is connected by the connector-attached multiconductor cable. Apply the current equal to 1.2 times [I_T]. At the same time, start the time measurement with a watch until the ON signal is output at the RS interface. It is to be output at terminals AC-AP1 at the 50% of the time setting [T_p], and at AC-AP2 at [T_p]. If the respective output is done at the time in the range of [T_p]±15%, it is normal. 3. Reduce the test current output to zero.

5. Ground Fault Trip Characteristic Check

	For General Feeder Circuits and Generator Protection
Verification of Pickup Current Setting	1. Close the breaker. 2. Apply the test current. Increase the test current [I_T] gradually from zero. If the breaker is tripped and the GFT trip indication LED is lit up by applying the current in the range of [I_T]±20% , it is normal. 3. Reduce the test current output to zero. 4. Press RESET to turn off the LED.
Verification of Tripping Operation and Trip Time Delay	1. Close the breaker. 2. Apply the current equal to approx. 1.5 times [I_T]. At the same time, start the tripping time measurement with a watch. 3. The breaker will be tripped and the GFT trip indication LED be lit up. if the tripping time is within the range of {(T_G trip time setting±20ms) x ±10%} plus the breaker opening time delay (20ms), it is normal. NOTE: In case the inverse-time characteristic (I^2t=c) is selected, the breaker is tripped in a time delay corresponding to the characteristic. 4. Reduce the test current output to zero. 5. Press RESET button to turn off the LED.

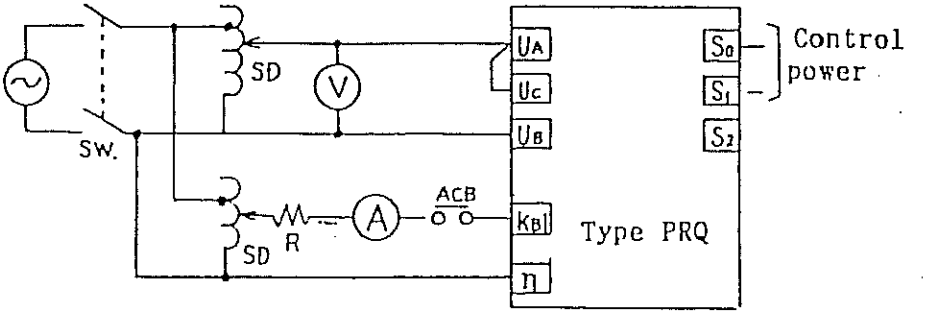
6. Reverse Power Trip Characteristic Check

Verification of Trip Pickup Power Setting and Trip Time Delay

For General Feeder Circuits and Generator Protection

The single-phase test circuit and the test method is explained below:

1. Prepare the test circuits as shown below, using a voltmeter and an ammeter.



- The terminals in the circuit indicate "Normal connection". In case of "Reverse connection" (when the polarity reversing switch (Fig. 23-(16)) is set to REV), reverse the positions of K_B1 and n for connection.

2. Draw out the breaker (ACB) to the ISOLATED position, or take it out from the draw-out cradle, and close the breaker.

3. Supply the specified control power between Terminals S_0 and S_1 or between S_0 and S_2.

4. Supply the voltage $\sqrt{3}/2$ times [U_R](Type PRQ voltage rating) between $U_A \cdot U_C - U_B$.

5. The test current [I_T] can be obtained from the conversion formula shown below:

- For confirmation of pickup power

$$I_T\ (A) = \frac{P_R \times 10^3}{\sqrt{3} \cdot V \cdot \cos\phi} \times \frac{5}{I_{CT}}$$

Wherein, P_R: Reverse power (KW)pickup setting
V: Primary side rated voltage
$\cos\phi$: Test equip. power factor
I_{CT}: Rated primary (A) current of CT

- For confirmation of tripping time

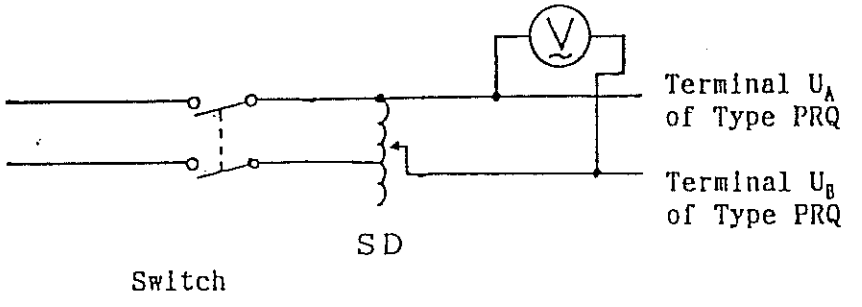
1.5 times [I_T]

6. Apply the test current. Increase the current gradually from zero to [I_T]±10%. If the RPT pickup indication LED is lit up in this range, the trip pickup current setting [P_R] is normal.

(to be continued)

	For General Feeder Circuits and Generator Protection
Verification of Pickup Power Setting and Trip Time Delay	7. Apply the test current to confirm the tripping time. At the same time, start the tripping time measurement with a watch. 8. The breaker is tripped, and the RPT trip indication LED is lit up. If the tripping time is within the range of the time setting [T_R]±20%, it is normal. 9. Press RESET button to turn off the LED.

7. Undervoltage Trip Characteristic Check

	For General Feeder Circuits and Generator Protection
Verification of Trip Pickup Voltage Setting and Tripping Voltage	• Prepare the test circuit. A sample is shown below.  • Connect the test circuit to U_A and U_B of Type PRQ. The connection to the control circuit is the same as that for other checks. 1. Draw out the breaker to the ISOLATED position or take it out from the draw-out cradle. 2. Increase the test voltage gradually from nonvoltage, and read the voltage when the UVT pickup indication LED lights up. If the voltage is within the range of the trip pickup voltage setting [U_P]±5%, it is normal. 3. Close the breaker. 4. Apply the rated voltage [U_R]. 5. Lower the voltage gradually until the breaker is tripped and the UVT trip indication LED is lit up. (If a time delay is set, lower the voltage by every 5V with a slight interval in between as the operating point approaches.) If the voltage when the LED lights up is within the range of less than [U_R] x 65%±5%, it is normal. 6. Return the voltage to nonvoltage. 7. Press RESET to turn off the LED.

Undervoltage Trip Characteristic Check

	For General Feeder Circuits and Generator Protection
Verification of Tripping Time	1. Apply the rated voltage and close the breaker. 2. Rapidly reduce the rated voltage to less than 40% of the rated voltage, and at the same time, start the tripping time measurement with a watch. If the time when the breaker is tripped and the UVT trip indication LED is lit up is within the range of{(the time setting [T_U] + 70ms) x ±5%}, it is normal. 3. Press RESET button to turn off the LED.

VII. INSULATION RESISTANCE TEST AND DIELECTRIC WITHSTAND TEST

The insulation resistance test and dielectric withstand test for the main circuit and control circuit are performed as follows:

1. Main circuit

   1) Dielectric withstand voltage characteristic should be 2500V AC for one minute.

   2) Use a 500V DC insulation resistance tester (Megger)

2. Control circuit

   1) Dielectric withstand voltage characteristic should be 1500V AC for one minute.
   If the motor charging and closing operation circuits are rated at 24V DC, the characteristic should be 500V AC for one minute.

      ∘ (Control circuit terminals [1] , [2] , [3] , [4])

      If control power of Type PRQ protective device is 24V DC, the characteristic should be 500V AC for one minute.

      ∘ (Control circuit terminals [19] [20])

   2) Use a 500V DC insulation resistance tester (Megger) for the insulation resistance test.