Document: GF077601-B

TOSHIBA

INSTRUCTIONS

INSTALLATION - OPERATION - MAINTENANCE

Type VK & HVK Series Vacuum Circuit Breakers 5-15kV

APPLICABLE TYPE FORMS

(1200A)	(2000A)	(3000A)
VK-6M32A	VK-6P32A	
HVK-6M32A	HVK-6P32A	
VK-6M40A	VK-6P40A	
HVK-6M40A	HVK-6P40A	
VK-8M40A	VK-8P40A	VK-8Q40
HVK-8M40A	HVK-8P40A	
VK-10M25A2	VK-10P25A2	
HVK-10M25A2	HVK-10P25A2	
VK-10M40A	VK-10P40A	VK-10Q40
HVK-10M40A	HVK-10P40A	
VK-6M50	VK-6P50	VK-6Q50
VK-10M50	VK-10P50	VK-10Q50

NOTES:

1) The designation of H before VK (ie. HVK) denotes that the circuit breaker unit was assembled in the USA using domestic and foreign components. All references to model numbers in this manual will be by the numbers following the VK- and HVK-.

2) This manual was written for the Toshiba type form circuit breakers listed on this page used in conjunction with Toshiba cells. For circuit breakers utilized in the conversion of other equipment, a supplemental instruction manual should be obtained from the conversion manufacturer.

Issued 2/95. Supersedes GF077601-A Dated 12/94.

INTRODUCTION

READ THIS MANUAL carefully for important information about safety, handling, installation, operation, maintenance, and parts replacements for spring-operation-type, VK and HVK series vacuum circuit breakers.

This manual and all accompanying drawings should be considered a permanent part of the equipment. They should be readily available for review and reference at all times.

DIMENSIONS shown in the manual are metric and/or their U.S. equivalent.

INQUIRIES should be addressed to:

Field Service Department
Toshiba International Corporation
13131 West Little York Road
Houston, Texas 77041 USA
Telephone: (713) 466-0277
(800) 231-1412
(800) 527-1204 (Canada)
Fax: (713) 466-8773

⚠WARNING **Use only Toshiba-authorized replacement parts.**

⚠WARNING **This equipment is designed and built in accordance with applicable safety standards in effect on the date of manufacture. Unauthorized modifications will void warranty and can result in severe injury, death and property damage. Do not make any modifications to this equipment without the written approval of Toshiba.**

TABLE OF CONTENTS

SAFETY

IMPORTANT MESSAGES

Read this manual and follow its instructions. Signal words such as DANGER, WARNING and CAUTION will be followed by important safety information that must be carefully reviewed.

⚠ DANGER Indicates a situation which will result in death, serious injury, and severe property damage if you do not follow instructions.

⚠WARNING Means that you might be seriously injured or killed if you do not follow instructions. Severe property damage might also occur.

⚠ CAUTION : Means that you might be injured if you do not follow instructions. Equipment damage might also occur.

NOTE: Gives you helpful information.

SAFETY CODES

Comply with all applicable state and local codes. Unless superseded by state and local codes, adhere to all applicable ANSI, OSHA, IEEE, NEMA and National Electrical Code (NFPA 70) and Maintenance Procedures in NFPA 70B standards. This includes standards pertaining to the manufacture, assembly, installation, grounding, maintenance, conversion, rating and operation of:

1) Metal-clad switchgear
2) Power switchgear
3) Metal-clad and station type cubicle switchgear
4) AC high voltage circuit breakers

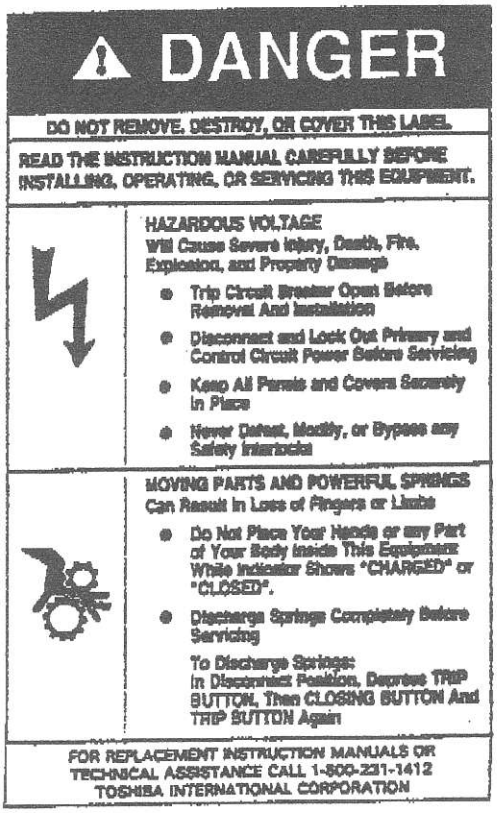
READ ALL SAFETY SIGNS

Safety signs are placed on the circuit breaker for your safety and instruction.

Read and follow the instructions in this manual and on the safety signs located on the equipment.

Keep the safety sign visible and in good shape.

Never remove, damage, or cover any safety sign.



SAFETY INSTRUCTIONS

READ INSTRUCTION MANUAL BEFORE ATTEMPTING THE FOLLOWING PROCEDURES

MANUAL OPERATING PROCEDURE:

TO CHARGE SPRINGS:	Remove Charging Handle Socket Cover and Insert Charging Handle Into Socket Opening. Rachet Handle Up and Down Until A Click Is Heard And Spring Indicator Reads CHARGED (Yellow). Ratchet Handle No Further. Remove Handle and Replace Socket Cover.
TO CLOSE BREAKER:	Push the CLOSING BUTTON. Circuit Breaker Indicator Will Then Read CLOSED (Red) and DISCHARGED (White).
TO OPEN BREAKER:	Push the TRIP BUTTON. Circuit Breaker Indicator Will Then Read OPEN (Green) and DISCHARGED (White).

NOTE: The Following Can Result in Equipment Damage.
Depression Of The CLOSING BUTTON With The Circuit Breaker CLOSED.
Depression Of The CLOSING BUTTON With The INTERLOCK LEVER Raised.
Depression Of The CLOSING BUTTON With The TRIP BUTTON Depressed.

INSTALLATION Or REMOVAL:

INDICATORS Must Read DISCHARGED (White) And OPEN (Green) Before The Breaker Can Be Installed Into Or Removed From The Cell (Cradle).

QUALIFIED OPERATORS ONLY

Only qualified persons are to install, operate or service this equipment according to all applicable codes and established safety practices.

A **qualified person must**:

1) **Carefully read the entire instruction manual.**
2) Be skilled in the installation, construction or operation of the equipment and aware of the hazards involved.
3) Be trained and authorized to safely energize, de-energize, clear, ground, lockout and tag circuits in accordance with established safety practice.
4) Be trained and authorized to perform the service, maintenance or repair of this equipment.
5) Be trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses, face shield, flash clothing, etc. in accordance with established practices.
6) Be trained in rendering first aid.

RECEIVING AND UNPACKING

The circuit breaker units are subjected to factory production testing prior to being packed and shipped.

ACCEPTANCE INSPECTION

Confirm that the circuit breaker unit is complete, correct as specified and undamaged from shipment and handling.

Upon receipt of the equipment, do the following:

1) Make an immediate inspection for damage which might have occurred during shipment (Fig. 1). If damage is discovered, it should be noted with the carrier prior to accepting the shipment, if possible.

2) Carefully unpack the equipment sufficiently to check for missing parts or concealed damage.

3) Keep the equipment upright (Fig. 2).

⚠ CAUTION : Never lay the equipment on its side or upside down. This may cause equipment damage to occur.

4) File a claim with the carrier for any damaged or missing items and immediately notify the nearest Toshiba International Corporation representative.

⚠WARNING Do not install or energize equipment that has been damaged. Damaged equipment can fail during operation, resulting in fire and explosion.

5) If the circuit breaker has been utilized for the conversion of other equipment, see the CONVERSIONS Section of this manual. Confirm that your conversion manufacturer is in compliance with this section.

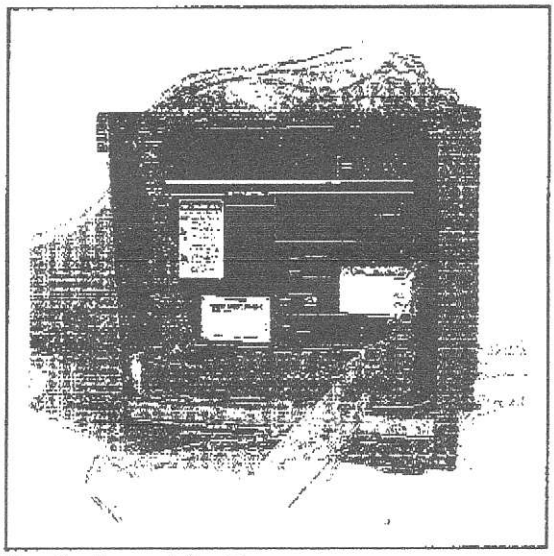


Fig. 1 Inspect for Damage

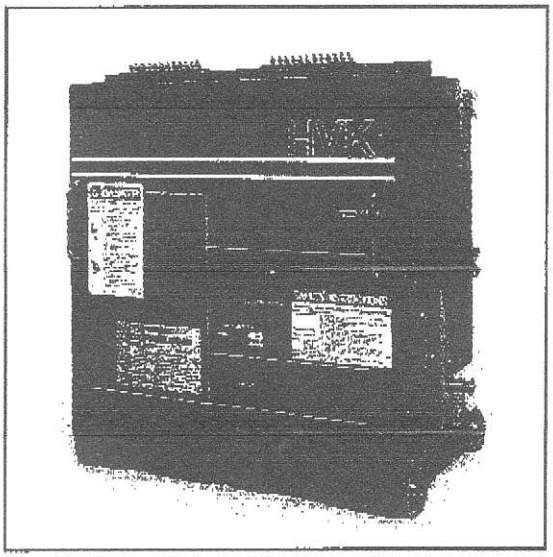


Fig. 2 The Circuit Breaker should be kept Upright

LIFTING FOR HANDLING AND MOVING

When handling and moving the circuit breaker, the suspension techniques shown in this section may be used. When installing or removing the circuit breaker from the cell above floor level, refer to the "Lifting For Installation" instructions in the INSTALLATION Section of this manual.

⚠WARNING Do not attempt installation of the circuit breaker above floor level using the lifting methods described in this section. Always use a Toshiba Portable Lifter for installation.

Care and caution should be used when handling the circuit breaker units to avoid damage to the equipment and personal injury.

Always keep the circuit breaker in a generally upright position.

⚠CAUTION : When lifting, the circuit breaker will tilt slightly backwards. Stand clear of the breaker when lifting or you may be injured.

Always use lifting equipment suitable for handling the weight of the unit. The capability of the lifting equipment to handle the size and weight of the circuit breaker should be confirmed prior to lifting.

⚠CAUTION : Attempting to manually lift the circuit breaker can cause serious injury or equipment damage. Always use suitable lifting equipment.

WHEN LIFTING:

6M32A	10M25A2
6P32A	10P25A2
6M40A	10M40A
6P40A	10P40A
8M40A	
8P40A	

Lift the circuit breaker as shown in Fig. 3 and Fig. 4.

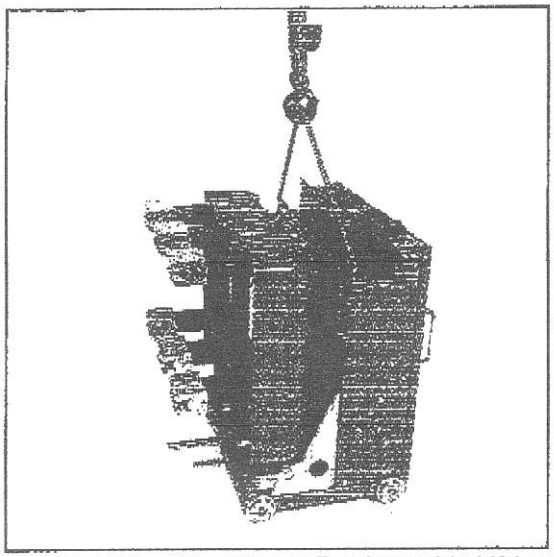


Fig. 3 Lifting the Circuit Breaker with Lifting Hooks.

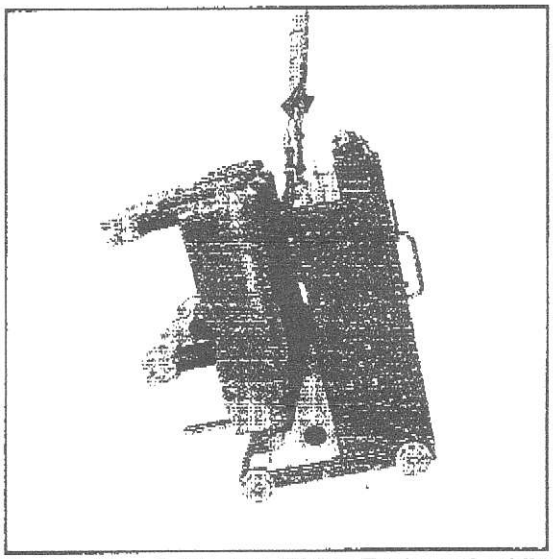


Fig. 4 Circuit Breaker Tilting Backward while Lifting.

WHEN LIFTING:

6M50	10Q40
6P50	10M50
6Q50	10P50
8Q40	10Q50

Lift the circuit breaker as shown in Fig. 5.

NOTE: The circuit breaker has a set of lifting plates as accessories. Lifting plates must be removed before attempting to install into cell.

WHEN LIFTING FOR INSTALLATION:

The VK & HVK Circuit Breaker Types listed in this manual use the procedure described in the INSTALLATION section.

STORAGE

If the circuit breaker is to be stored for any length of time prior to installation, the following precautions should be taken:

1) The original packing should be restored, if possible.

2) Do not subject the equipment to moisture or sun rays. Store in cool, clean, and dry location.

3) Place a dust cover over the circuit breaker packaging to protect against dirt and moisture.

4) Store in an upright position.

INSPECTION DURING STORAGE

Routine scheduled inspection is necessary if storage is for an extended period. The unit should be checked for condensation, moisture, corrosion, and vermin.

Prior to installation, the circuit breaker should be carefully examined for evidence of physical damage, corrosion, or other deterioration. Refer to the PRE-ENERGIZATION section of this manual.

The MAINTENANCE section of this manual describes various types of inspections recommended for this circuit breaker during the operation period.

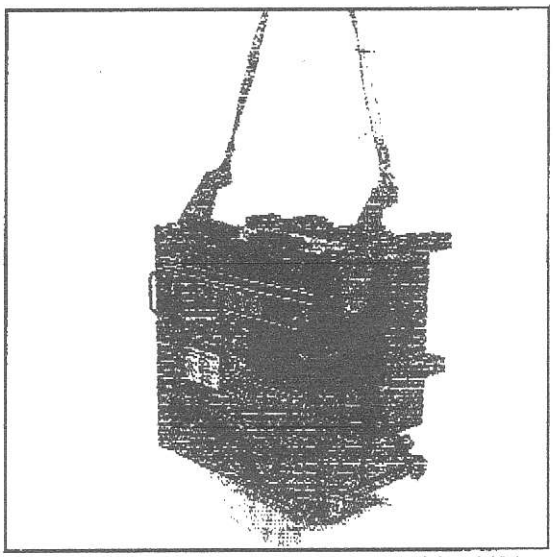


Fig. 5 Lifting Circuit Breaker with Lifting Plates.

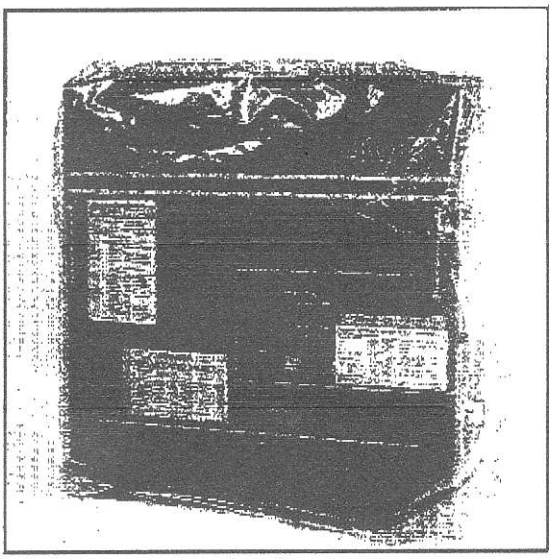


Fig. 6 Circuit Breaker Storage

GENERAL DESCRIPTION

The Toshiba VK & HVK Series medium voltage circuit breakers in this manual are designed for applications at utilization voltages ranging from 5 kV to 15 kV and interrupting ratings ranging from 250 MVA to 1000 MVA. The circuit breakers are intended for use only in metal-clad distribution switchgear and other limited applications.

Fig. 7, Fig. 8, and Fig. 9 illustrate and identify various components of the circuit breaker.

COMPONENTS LEGEND:

1) Handle for moving circuit breaker
2) Secondary disconnects
3) Rating interlock pin
   - 6M/P/Q50
   - 8Q40
   - 10Q40
   - 10M/P/Q50
4) Interlock lever
5) Wheel
6) Primary disconnects
7) Barrier
8) Racking screw
9) Vacuum interrupter
10) Flexible conductor
11) Insulated operation rod
12) Rating interlock plate
   - 6M/P32A
   - 6M/P40A
   - 10M/P25A2
   - 10M/P40A
   - 8M/P40A

⚠WARNING **Use only genuine Toshiba replacement parts and accessories. Improper components could cause the circuit breaker to malfunction.**

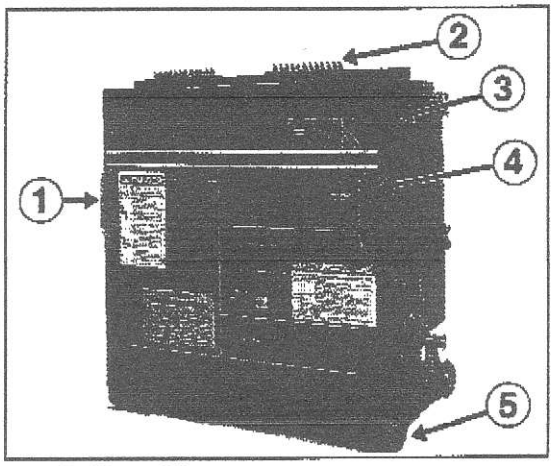


Fig. 7 Front View

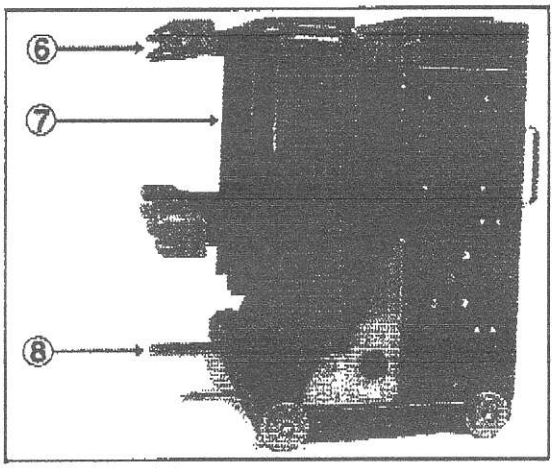


Fig. 8 Side View

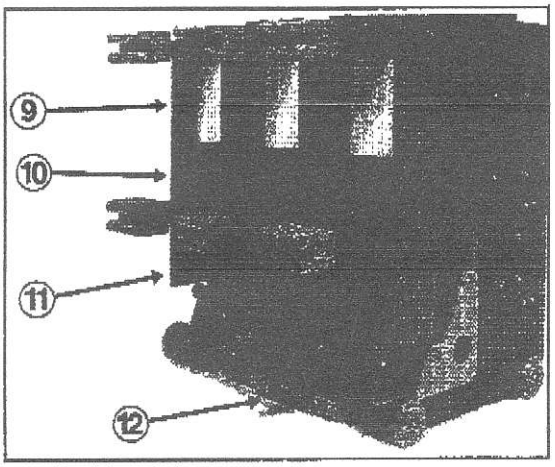


Fig. 9 Rear View

SAFETY DEVICES

Safety interlocks and guards are provided as an integral part of the equipment design. These devices are provided for your safety.

⚠ DANGER **Never Defeat, Modify or Bypass any Safety Devices, Interlocks, or operating mechanism. This would make the equipment unsafe. Fire, explosion, severe injury, death, and property damage could occur.**

⚠WARNING **Do not operate this equipment unless all covers and panels are in place.**

A. SPRING CHARGE INTERLOCK

With the closing springs charged, the circuit breaker cannot be moved into or out of the cell.

A steel plunger (Fig. 10) mechanically prevents the breaker unit from being withdrawn until the closing springs are completely discharged.

B. CLOSE PIN INTERLOCK

With the circuit breaker closed, it cannot be moved between the connected, test and disconnected positions. Also, it cannot be moved into or out of the cubicle.

The close pin interlock (Fig. 11) is mechanically held down, thus locking the unit in place.

Additionally, a safety plate blocks the racking handle opening to prevent insertion of the handle.

C. RATING INTERLOCK PIN / PLATE

The circuit breaker has an interlock to prevent the breaker from connecting to a cell that has a continuous current rating different from the circuit breaker.

This interlock is accomplished by the rating interlock pin (Fig. 12) on the 6M/P/Q50, 8Q40, 10Q40, and 10M/P/Q50.

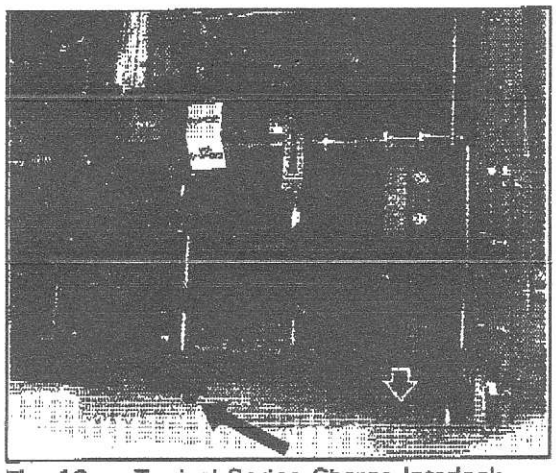


Fig. 10 Typical Spring Charge Interlock

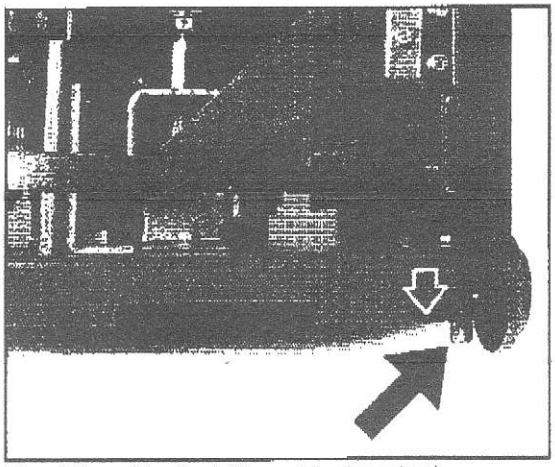


Fig. 11 Typical Close Pin Interlock

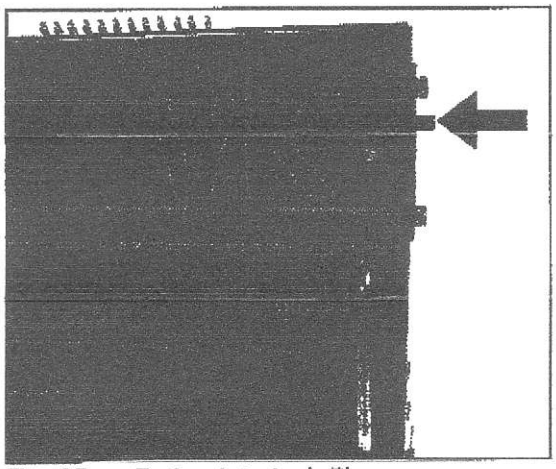


Fig. 12 Rating Interlock Pin

The interlock is accomplished by a rating interlock plate (Fig. 13) on the 6M/P32A, 6M/P40A, 10M/P25A2, 8M/P40A and 10M/P40A.

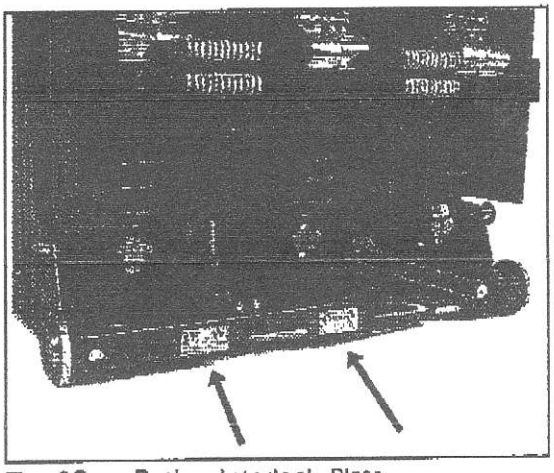


Fig. 13 Rating Interlock Plate

INTERLOCK LEVER

The interlock lever (Fig. 14) on the right side of the circuit breaker front panel cannot be lifted when the circuit breaker is closed.

Before lifting the interlock lever, verify that the open-closed indicator reads "OPEN" (green).

When the interlock lever is lifted, the closing action is blocked both electrically and mechanically.

With the interlock lever up, the microswitch (Fig. 15) is open, thus electrically preventing the circuit breaker from being closed.

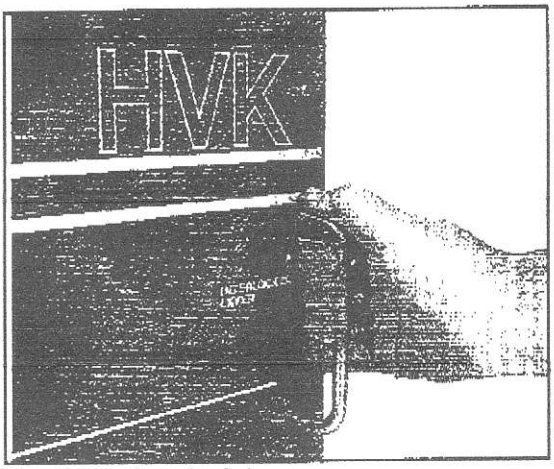


Fig. 14 Interlock Lever

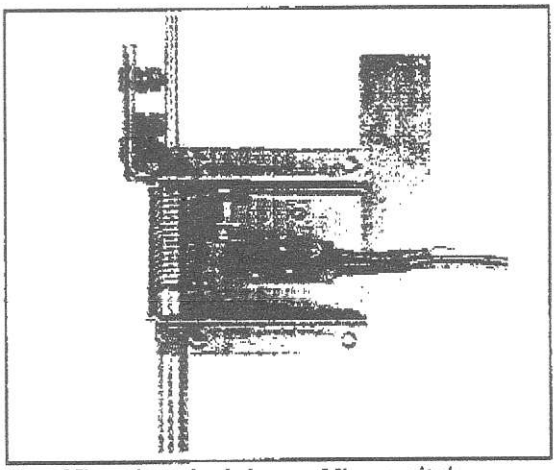


Fig. 15 Interlock Lever Microswitch

SELF COUPLING TYPE SECONDARY (CONTROL CIRCUIT) DISCONNECTS

Self coupling type secondary (Control Circuit) disconnects are mounted on the top of the circuit breaker (Fig. 16). The control circuit is connected to the appropriate stationary contacts (Fig. 17) when the circuit breaker is in the connected or test position.

⚠WARNING Hazardous Voltage. Turn Off and Lock Out Primary and Control Circuit Power Before Servicing.

To ensure smooth connection of the self coupling contacts, apply a thin film of TOSHIBA B8 grease to the stationary contacts before inserting the circuit breaker into the cell (cradle).

⚠WARNING Do not allow grease or any other substances to contaminate insulating materials. Contaminated insulators can allow a short circuit or ground fault to occur.

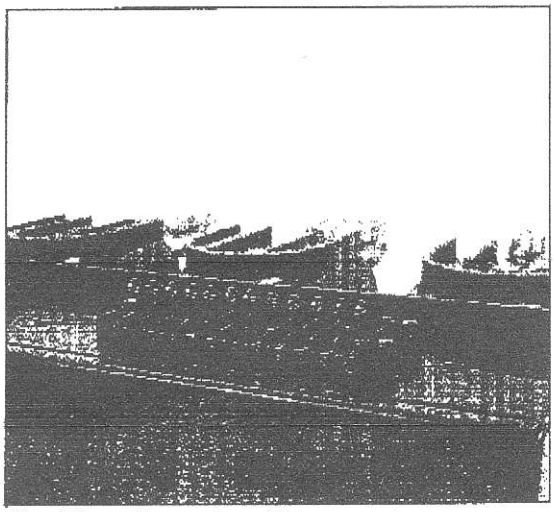


Fig. 16 Secondary Disconnects

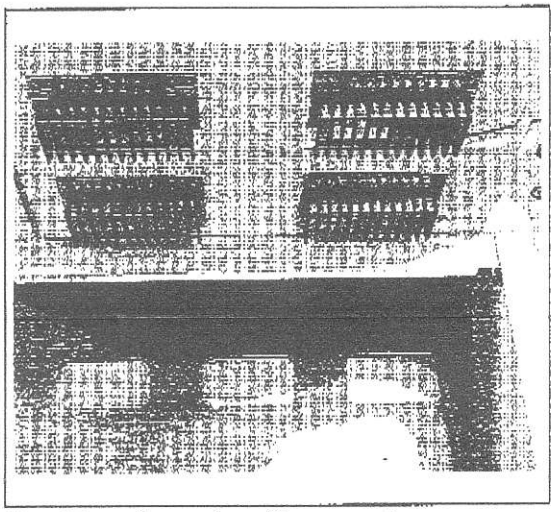


Fig. 17 Secondary Disconnects

SERVICE CONDITIONS

⚠WARNING **Do not install this equipment in areas where unusual service conditions exist. Using this equipment in other than usual service conditions can result in equipment failure.**

Toshiba VK & HVK Series Circuit Breakers are intended for use in usual service conditions as defined by ANSI. The temperature of the air (ambient air temperature) surrounding the switchgear should be between the limits of -30°C (-22°F) and +40°C (104°F). The altitude of the equipment installation should not exceed 3300 ft (1000 m).

NOTE: Temperature, altitude or other conditions outside of the usual limits may require derating or other special equipment. Contact Toshiba International Corporation for additional information.

RATING

Prior to Installation:

The maximum fault current capacity of the power system at the point of installation should be verified. This value must not exceed the symmetrical interrupting capability of the circuit breaker. Fig. 18 illustrates a typical circuit breaker nameplate and ratings.

⚠ DANGER **Do not exceed the ratings specified on the circuit breaker nameplate or system accessories. Underrated equipment can fail during operation causing fire, explosion, severe injury, death, and property damage.**

To calculate the required Symmetrical Interrupting Capability, use the formula in Note 4 and 5 of Table 1. All system accessories such as surge suppressors, lightning arrestors, etc. should be checked to verify their ratings capacity.

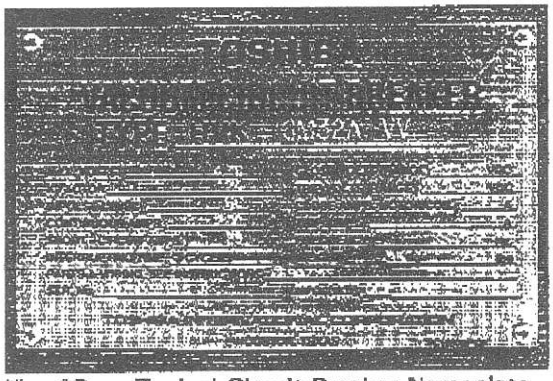


Fig. 18 Typical Circuit Breaker Nameplate

Table 1. RATINGS (Symmetrical Rating Basis, ANSI C37.06)

Identification			Rated Values								Related Required Capabilities			
			Voltage		Insulation Level		Current					Current Values		
Type Form of Breaker	Nominal rms Voltage Class (kV)	Nominal 3-phase Class (MVA)	Vmax Rated Maximum rms Voltage (kV) (2)*	Rated Voltage Range Factor K (3)*	Rated Withstand Test Voltage		Continous rms Current Rating at 60Hz (A)	SCA Short circuit rms Current Rating (at Rated Max. kV) (kA) (4)*	Rated Interrupting Time (Cycles)	Rated Permissable Tripping Delay, Y (Seconds)	Rated Maximum rms Voltage Divided by K (kV)	Maximum Symmetrical Interrupting Capability (5)	3 Sec Short-time Current Carrying Capability	Closing and Latching Capability 1.6K Times Rated Short-circuit rms Current (kA)
					Low Frequency rms Voltage (kV)	Crest Impulse Voltage (kV)						K Times Rated Short-circuit rms Current		
												(kA)	(kA)	
6M32A	4.16	250	4.76	1.24	19	60	1200	29	3	2	3.85	36	36	58
6P32A	4.16	250	4.76	1.24	19	60	2000	28	3	2	3.85	36	36	58
6M40A (1)*	4.16	350	4.76	1.0	19	60	1200	41	3	2	4.76	41	41	66
6P40A (1)*	4.16	350	4.76	1.0	19	60	2000	41	3	2	4.76	41	41	66
6M50	4.16	350	4.76	1.19	19	60	1200	41	3	2	4.0	49	49	78
6P50	4.16	350	4.76	1.19	19	60	2000	41	3	2	4.0	49	49	78
6Q50	4.16	350	4.76	1.19	19	60	3000	41	3	2	4.0	49	49	78
8M40A	7.2	500	8.25	1.25	36	95	1200	33	3	2	6.6	41	41	66
8P40A	7.2	500	8.25	1.25	36	95	2000	33	3	2	6.6	41	41	66
8Q40 (1)*	7.2	500	8.25	1.25	36	95	3000	33	3	2	6.6	41	41	66
10M25A2	13.8	500	15	1.30	36	95	1200	18	3	2	11.5	23	23	37
10P25A2	13.8	500	15	1.30	36	95	2000	18	3	2	11.5	23	23	37
10M40A	13.8	750	15	1.30	36	95	1200	28	3	2	11.5	36	36	58
10P40A	13.8	750	15	1.30	36	95	2000	28	3	2	11.5	36	36	58
10Q40 (1)*	13.8	750	15	1.30	36	95	3000	28	3	2	11.5	36	36	58
10P40A (1)*	13.8	1000	15	1.0	36	95	2000	37	3	2	15	37	37	59
10Q40 (1)*	13.8	1000	15	1.0	36	95	3000	37	3	2	15	37	37	59
10M50	13.8	1000	15	1.30	36	95	1200	37	3	2	11.5	48	48	77
10P50	13.8	1000	15	1.30	36	95	2000	37	3	2	11.5	48	48	77
10Q50	13.8	1000	15	1.30	36	95	3000	37	3	2	11.5	48	48	77

* Numbers in parenthesis refer to the NOTES, below.

NOTES:

1) ANSI C37.06 does not define these ratings.

2) Maximum voltage for which the circuit breaker is designed and the upper limit for operation.

3) K is the ratio of rated maximum voltage to the lower limit of the range of operating voltage in which the required symmetrical and asymmetrical interrupting capabilities vary in inverse proportion to the operating voltage.

4) To obtain the required symmetrical interrupting capability of circuit breaker at an operating voltage between 1/K times rated maximum voltage and rated maximum voltage, the following formula shall be used:

$$\text{Required Symmetrical Interrupting Capability} = (\text{SCA}) \times \frac{(\text{Vmax})}{(\text{Vop})}$$

Where:

SCA = Short-Circuit rms Current Rating from Table (kA)

Vmax = Rated Maximum rms Voltage (kV) from Table

Vop = Measured operating voltage (kV)

5) Current values in this column are not to be exceeded even for operating voltages below 1/K times rated maximum voltage. For voltages between the rated maximum voltage and 1/K times rated maximum voltage, follow (4) above.

LIFTING FOR INSTALLATION

Unlike the lifting procedures recommended in the RECEIVING, STORAGE AND HANDLING section, Lifting for Installation purposes requires a different technique.

A Portable lifter as shown in Fig. 19 should be used for the insertion or removal of a circuit breaker to the switchgear compartment above floor level.

The portable lifter may also be used to transport the circuit breaker to and from the switchgear.

⚠WARNING **Do not attempt to install or remove a circuit breaker above floor level from a compartment by using the lifting eyes or plates. Use a Toshiba portable lifter.**

⚠WARNING **Discharge springs completely before installation.**

⚠CAUTION : Always insure the portable lifter is operated on a firm and level surface.

USING THE PORTABLE LIFTER

1) Set wheel stops to the locked position.
2) Place the circuit breaker on the lifter bucket and lock in place with the interlock pin (Fig. 20).

⚠WARNING **Do not transport the circuit breaker without the interlock pin locked in place.**

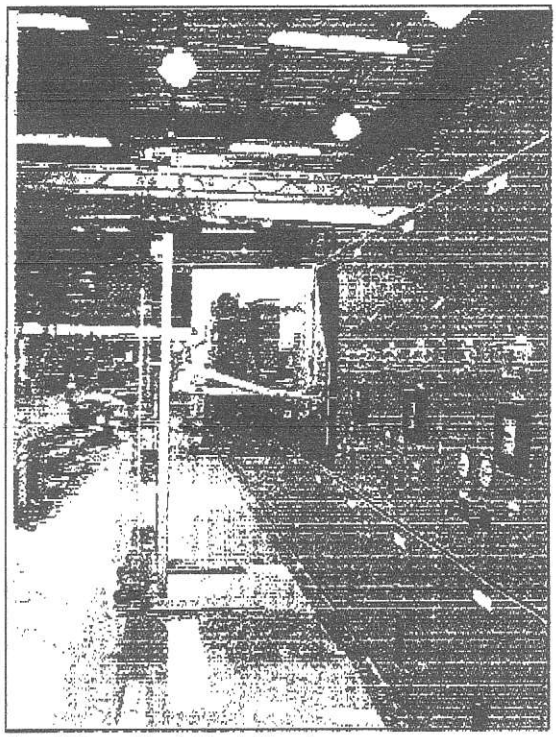


Fig. 19 Portable Lifter in use

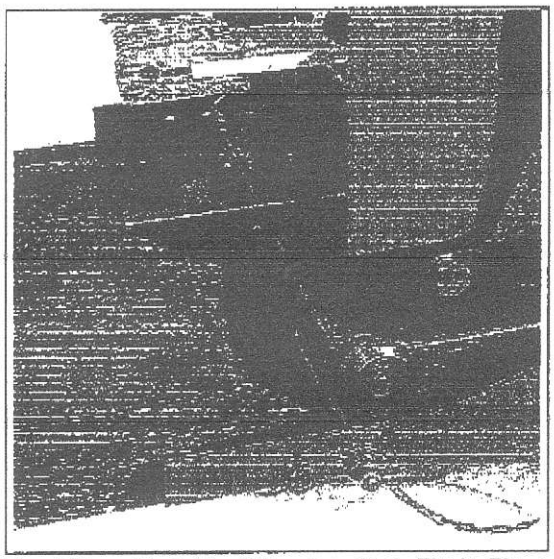


Fig. 20 Portable Lifter Interlock Pin in Place

⚠WARNING Do not transport the Vacuum Circuit Breaker in the elevated position while using portable lifter.

3) Unlock the wheel stops and move the lifter into position in front of the cell.

4) Before moving the circuit breaker on or off the lifter bucket, make sure that:

   a) The bucket tab is lowered over the cell stud to insure the lifter does not move (Fig. 21).

   b) The wheel stops are again locked.

⚠WARNING The portable lifter must be securely fixed to the circuit breaker cell before transferring the circuit breaker to or from the cell.

5) Remove the circuit breaker interlock pin.

6) Follow the procedure "MOVING THE CIRCUIT BREAKER IN THE CELL" for insertion into the equipment cell.

MOUNTING PADS

Some installations utilize elevated equipment mounting pads. This type of installation will increase the overall height of the equipment. Pads should not increase the equipment height more than 6 inches, or the portable lifter may not work. Additionally, mounting pads should extend no more than 6 inches forward of the switchgear.

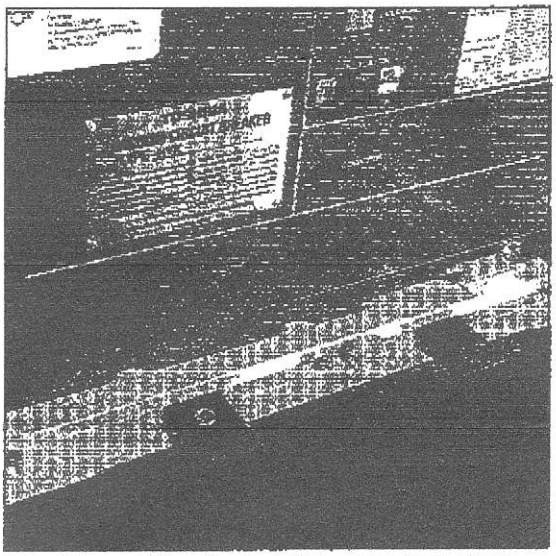


Fig. 21 Lifter Bucket Tab over Cell Stud

MOVING THE CIRCUIT BREAKER IN THE CELL

⚠ DANGER **Fire and explosion hazard. Trip circuit breaker open and discharge springs before attempting removal or installation.**

⚠WARNING **Unit contains powerful springs. Discharge springs completely before servicing.**

To Discharge Springs:

In either Disconnect or out of cell position, Depress **Trip Button**, then **Closing Button**, and **Trip Button** again (Fig. 22).

Disconnect Position - The circuit breaker is first placed into this position when installed into the cell (Fig. 23).

NOTE: 1) With the closing spring charged, the circuit breaker cannot be moved into or out of the cell.

2) With the circuit breaker closed, it cannot be moved between the Connected, Test and Disconnect Positions and it cannot be moved into or out of the cell.

Test Position - This position is between the Disconnected Position and the Connected Position (Fig. 24).

To Move the Circuit Breaker from the **Disconnect Position to Test Position:**

1) Lift and hold the interlock lever on the right side as shown in Fig. 25.

2) Hold both grip handles (Fig. 26) and push the circuit breaker into the cell.

NOTE: When the interlock lever is released at the predetermined position, make sure that the interlock lever has dropped completely.

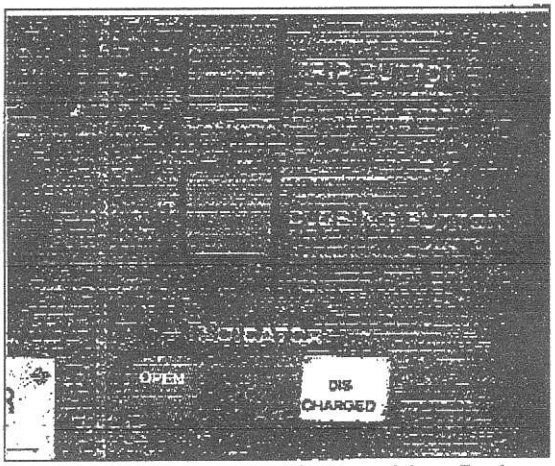


Fig. 22 Circuit Breaker with Springs Discharged

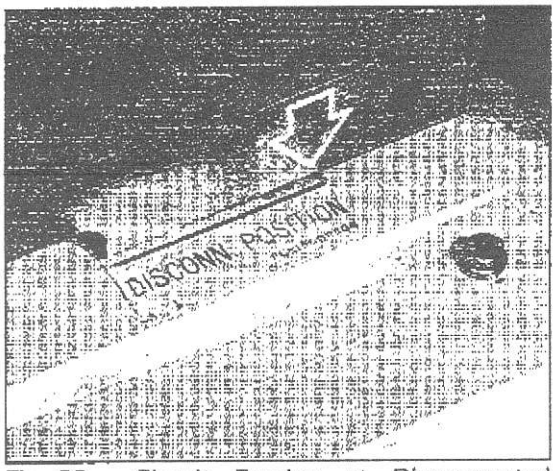


Fig. 23 Circuit Breaker at Disconnected Position

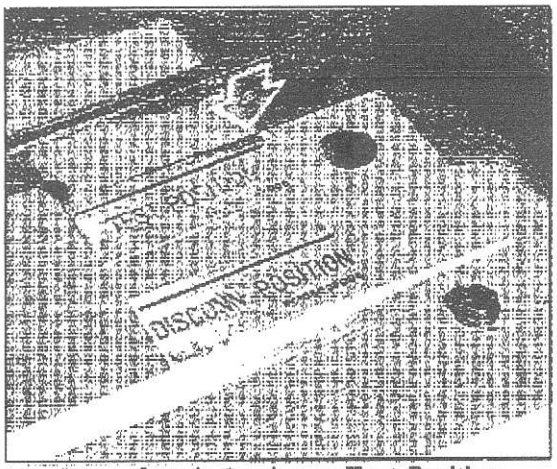


Fig. 24 Circuit Breaker at Test Position

Connected Position - In this position, the circuit breaker primary disconnect bus stabs are connected to the switchgear bus bars.

In moving the circuit breaker from the **Test Position to the Connected Position:**

1) First check to make sure the open-closed indicator reads **"OPEN"** (green).

⚠ DANGER **Fire and explosion hazard. Trip circuit breaker open before attempting to rack the circuit breaker into the Connected Position.**

2) Lift the interlock lever.

3) Insert the racking handle as shown in Fig. 27.

4) Turn the handle clockwise (Fig. 28). The circuit breaker will move inward.

5) Stop rotating the racking handle when the racking screw thread has cleared the racking nut. You will hear a click sound as the arrow at the lower part of the circuit breaker comes in line with the red line of the **Connected Position** indicating plate on the cell floor (Fig. 29).

6) Remove the racking handle.

7) Check to verify the interlock lever has dropped completely.

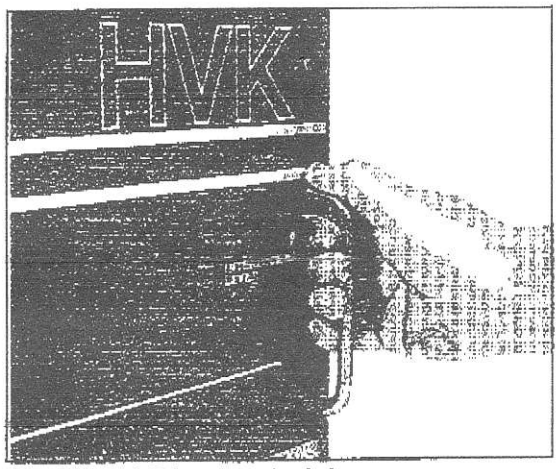


Fig. 25 Lifting Interlock Lever

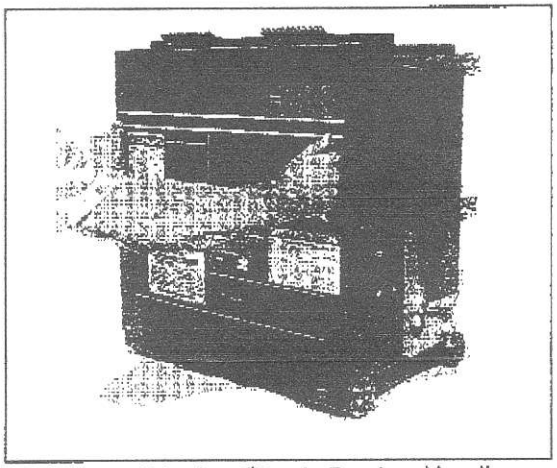


Fig. 26 Gripping Circuit Breaker Handles

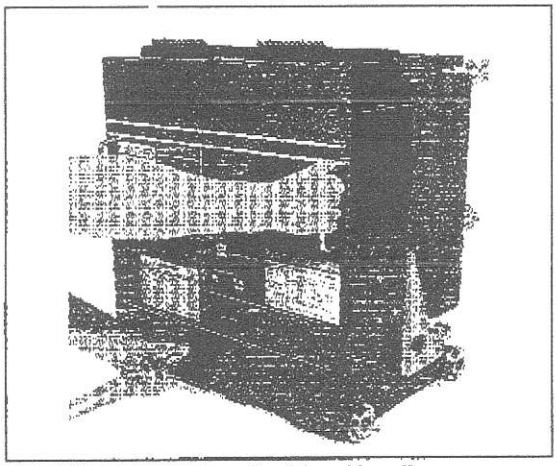


Fig. 27 Inserting Racking Handle

When drawing out the circuit breaker from the **Connected Position to the Test Position:**

1) First check to make sure the open-closed indicator reads **"OPEN"** (green).

⚠ DANGER **Fire and explosion hazard. Trip circuit breaker open before attempting to rack the circuit breaker out of the Connected Position.**

2) Lift the interlock lever.

⚠ CAUTION : To avoid equipment damage, do not push the closing button (green) while the Interlock Lever is lifted.

3) Insert the racking handle (Fig. 27).

4) Turn the racking handle counterclockwise to move the circuit breaker to the **Test Position.**

5) Stop rotating the racking handle when the racking screw thread has cleared the racking nut. You will hear a click sound as the arrow at the lower part of the circuit breaker is aligned with the red line of the **Test Position** indicating line.

6) Remove the racking handle.

7) Check to verify the interlock lever has dropped completely.

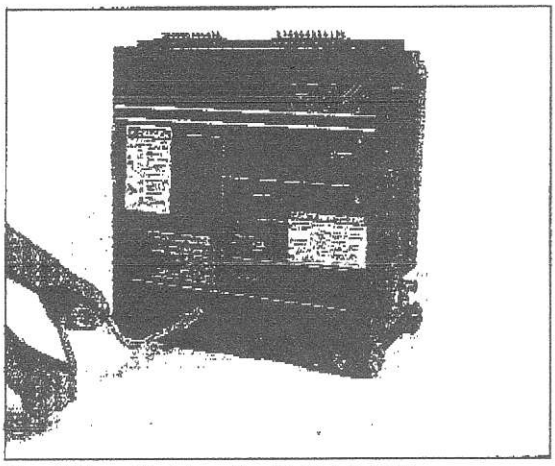


Fig. 28 Turning Racking Handle

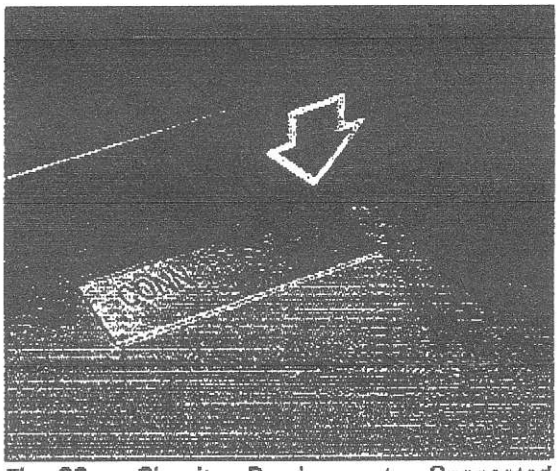


Fig. 29 Circuit Breaker at Connected Position

GENERAL

BEFORE ENERGIZING THE CIRCUIT BREAKER for the first time, follow the procedure below to verify that the equipment is properly installed and functional.

⚠ DANGER Hazardous Voltage. Turn off and lock out all primary and control circuit power sources prior to performing this pre-energization check.

⚠WARNING Do not operate this equipment until a complete safety inspection has been made.

⚠WARNING Do not energize damaged equipment that has not been repaired or verified.

⚠WARNING Do not remove, cover or destroy any safety signs.

⚠WARNING Do not operate this equipment until all panels and covers have been replaced.

- ☐ Prior to operating the circuit breaker, be sure that the circuit breaker unit is installed in the correct cell.
- ☐ All blocks or other temporary braces used for shipment must be removed.
- ☐ Before closing the enclosure, all metal chips, scrap wire and other debris left over from installation must be cleaned out.
- ☐ Cover all unused openings in the cell surrounding the circuit breaker. Replace all panels and covers.
- ☐ A supply of spare parts, fuses, etc. should be established.
- ☐ Instruction manuals and diagrams should be collected and filed.
- ☐ Replace all parts, guards and barriers that may have been removed during wiring and installation.

ELECTRICAL CHECKS

⚠WARNING Electrical shock hazard. Do not touch energized components during a test using auxiliary power.

- ☐ An electrical insulation resistance test should be performed to verify that the circuit breaker and associated field wiring are free from short circuits and grounds. Refer to the MAINTENANCE Section of this manual for additional information.

⚠WARNING Hazardous voltages are present during dielectric testing which can result in serious injury or death. High potential tests should be performed only by qualified personnel.

- ☐ All switches and circuit breakers must be set to the OFF and/or OPEN position before energizing incoming power.

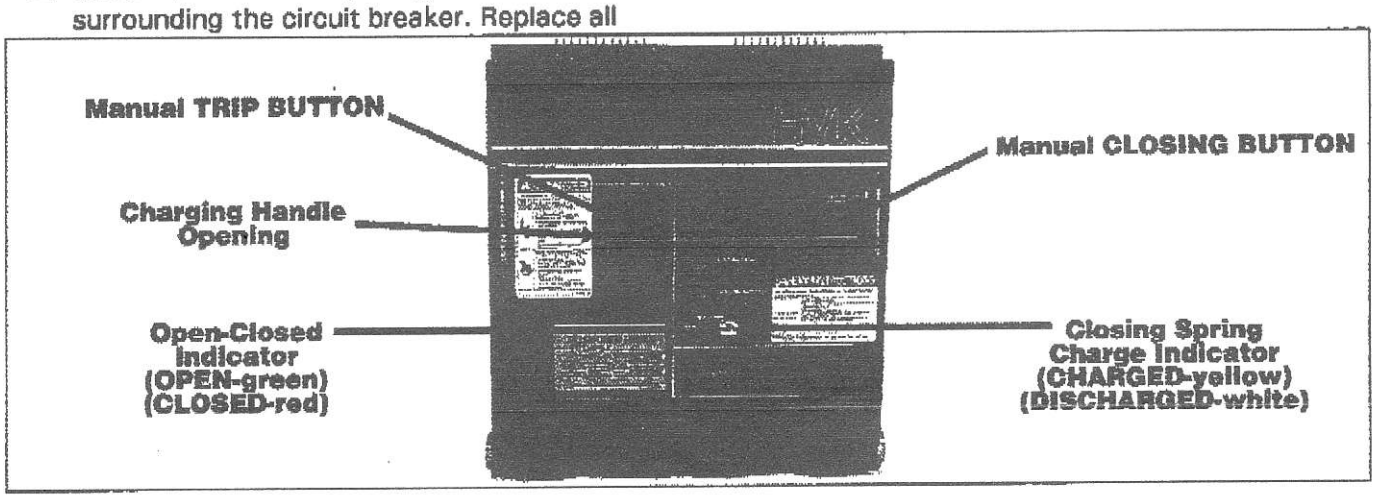


Fig. 30 Typical Front Circuit Breaker Layout

MANUAL OPERATION

⚠WARNING Powerful Springs. Do not place your hands or any part of your body inside this equipment while any indicator shows "CHARGED" (yellow) or "CLOSED" (red).

A. Manual Charging of Closing Spring (Fig. 31)

1) Remove the charging handle cover. Insert the charging handle into the opening for the manual charging handle.

2) Ratchet the handle up and down several times (usually 7 times) until a click (latch) sound is heard and the closing spring charging indicator changes from "DISCHARGED" (white) to "CHARGED" (yellow). This is the position where the closing spring is charged and no further movement of the handle is required.

3) Remove the charging handle and replace the cover plate to the opening.

NOTE: The number of times the handle must be operated depends on the angle of handle operation.

B. Manual Closing Operation

Push the manual closing button (green) and the circuit breaker will close (Fig. 32). At this time the open-closed indicator reads "CLOSED" (red) and the spring charging indicator turns to "DISCHARGED" (white).

⚠CAUTION : To avoid equipment damage do not push the closing button (green) while the circuit breaker is closed.

⚠CAUTION : To avoid equipment damage do not push the closing button (green) while the trip button (red) is depressed.

C. Manual Opening (Tripping) Operation

Push the trip button (red) and the circuit breaker will open. The open-closed indicator (Fig. 33) will read "OPEN" (green).

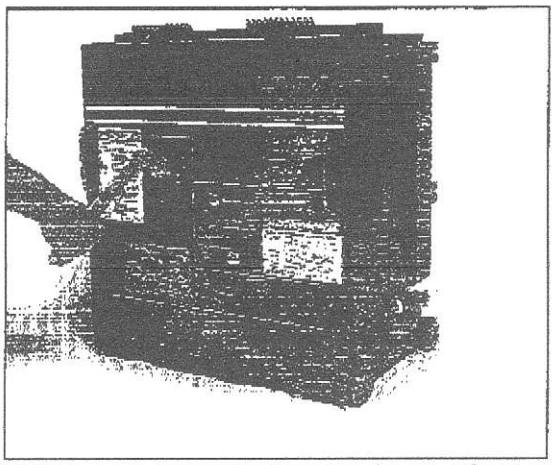


Fig. 31 Manual Charging of Closing Spring

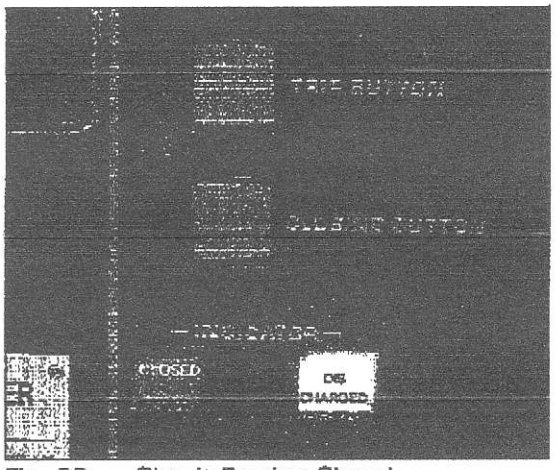


Fig. 32 Circuit Breaker Closed

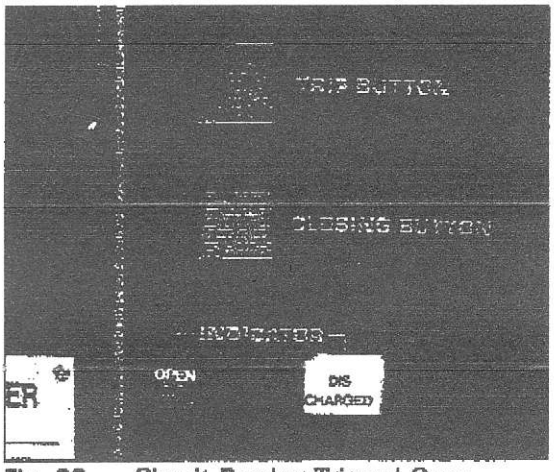


Fig. 33 Circuit Breaker Tripped Open

ELECTRICAL OPERATION

Electrical operation can be carried out at the Test or Connected Position. When the circuit breaker is outside of the cell, it can be operated electrically by using Toshiba International Corporation's accessory test cabinet.

⚠WARNING Powerful Springs. Do not place your hands or any part of your body inside the equipment while indicator shows "CHARGED" (yellow) or "CLOSED" (red).

⚠WARNING Check circuit breaker nameplate for verification of proper operating voltages.

A. Electrical Charging of Closing Spring

Upon applying power to the control circuit, the charging motor will immediately start. When the spring is charged, the closing spring charging indicator turns from "DISCHARGED" (white) to "CHARGED" (yellow), and the motor stops. The spring charging is now completed.

B. Electrical Closing Operation

When the closing switch is turned to "CLOSE" position, the closing coil will be immediately energized and the circuit breaker will close. The open-close indicator will then read "CLOSED" (red). After the closing of the breaker, the charging motor will immediately begin to charge the closing springs. Upon the completion of charging, the closing spring charging indicator will read "CHARGED" (yellow).

C. Electrical Opening (Tripping) Operation

When the trip switch is turned to "TRIP" position, the trip coil will be immediately energized and the circuit breaker will open, with the open-closed indicator reading "OPEN" (green).

CONTROL CIRCUIT OPERATION

A. Closing Sequence

The schematics shown in Fig. 34 thru Fig. 36 reflects the condition where:

1) Charging is complete, and
2) The circuit breaker is open.

NOTE: The closing spring immediately begins charging when the control circuit is energized.

⚠WARNING Powerful springs and moving gears. Do not place your hands or any part of your body inside the equipment while the circuit breaker is charging.

In this condition, the external operation switch CS(1) is turned to the "CLOSE" position causing:

1) Circuit IL, b1, LCS, Y-b, X-b, CC to energize the closing coil CC, instantly, and
2) **The circuit breaker closing time is 30-40 msec.**, at which time,
3) Auxillary switch b1 opens,
4) Closing coil CC, de-energizes,
5) Auxiliary relay Y, energizes, completing the anti-pumping circuit.

B. Charging Sequence

At the same time the circuit breaker is closed:

1) Limit switch, LS, closes
2) Control Relay X, energizes
3) Circuit LS, LS, X-a, M, X-a, F is completed, and
4) Charging motor runs (for about 4 sec)

When closing spring is charged:

1) Limit switch, LS, opens.
2) Control relay X, de-energizes.

C. Tripping (Opening) Sequence

The tripping of the circuit breaker involves only the a1, TC circuit. When the external operation switch CS(2) is turned to the "TRIP" position:

1) Trip coil, TC, energizes, and
2) **Circuit breaker opening or tripping time is 15-20 msec.**

At which time:

1) Auxiliary switch A1, opens
2) Trip coil, TC, de-energizes

NOTE: For circuit breakers with different voltage combinations for closing, tripping or charging, consult Toshiba International Corporation for the particular schematic.

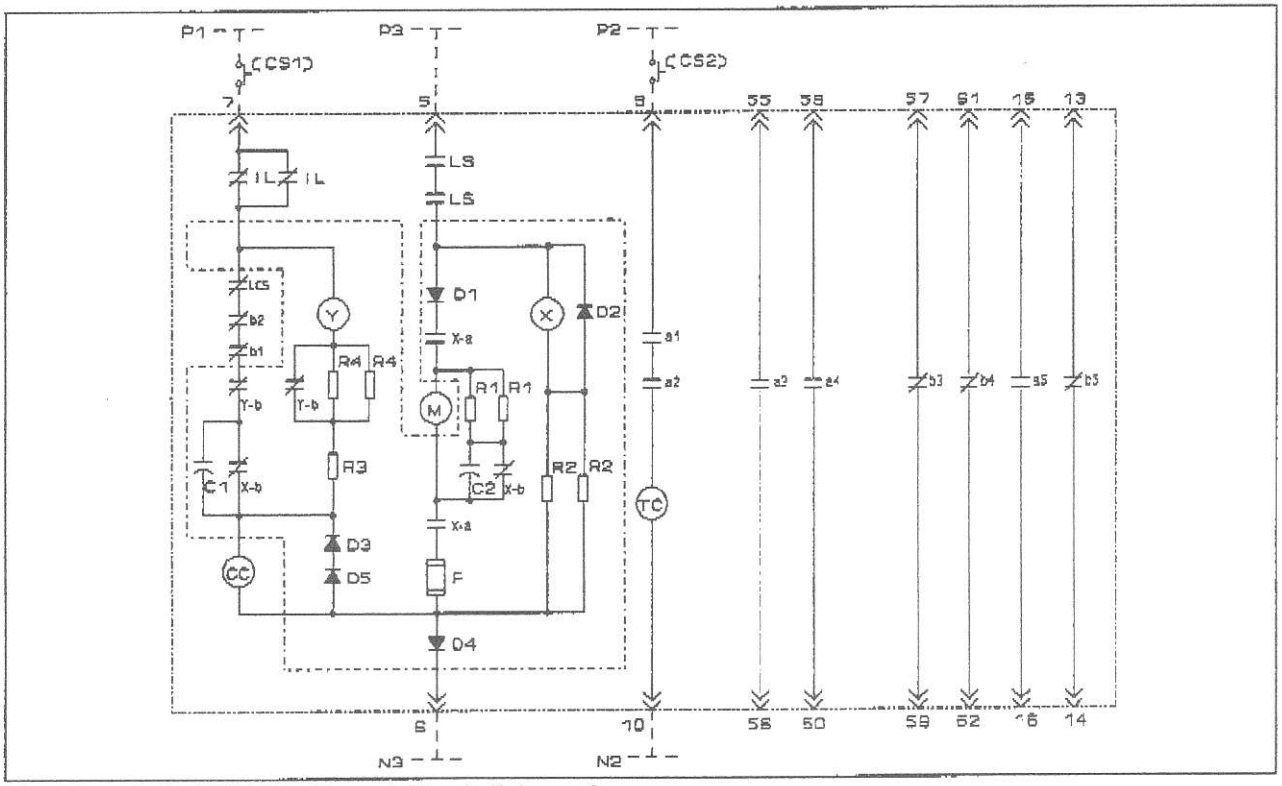


Fig. 36 200-250 VDC Control Circuit Schematic

SYMBOL	DESCRIPTION
Y	Auxiliary relay coil
Y-b	Auxiliary relay contacts (N.O.)
X	Control relay coil
X-a	Control relay contacts (N.O.)
X-b	Control relay contacts (N.C.)
CC	Closing coil
TC	Trip coil
a1-a5	Auxiliary contacts (N.O.)
b1-b5	Auxiliary contacts (N.C.)
M	Charging motor
LS	Limit switches
D1-D5	Diodes
R1-R4	Resistors
IL	Interlock switches
C	Capacitor
F	Fuse
LCS	Latch Checking Switch

Fig. 37 Legend for Control Circuit Schematics

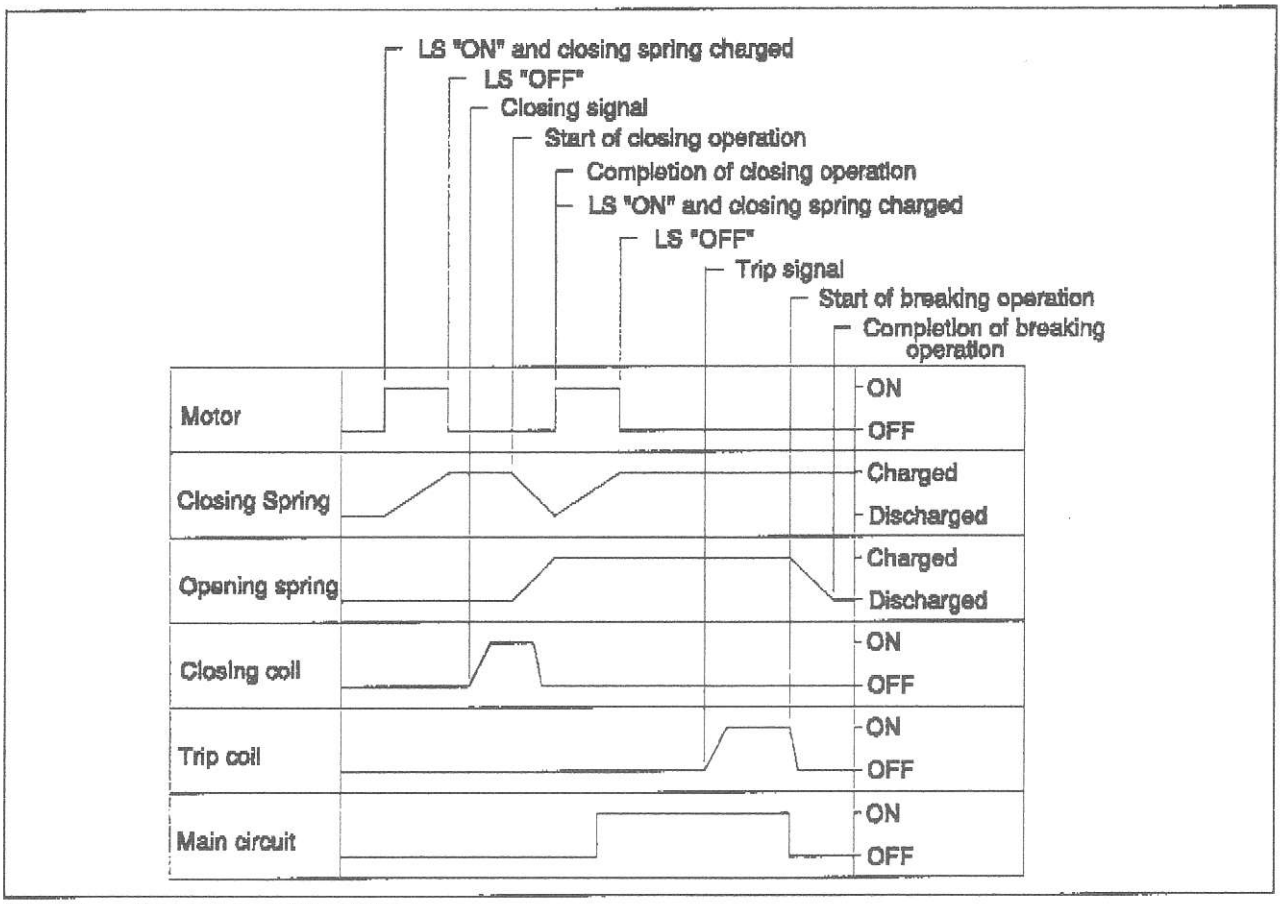


Fig. 38 Sequence of Operation

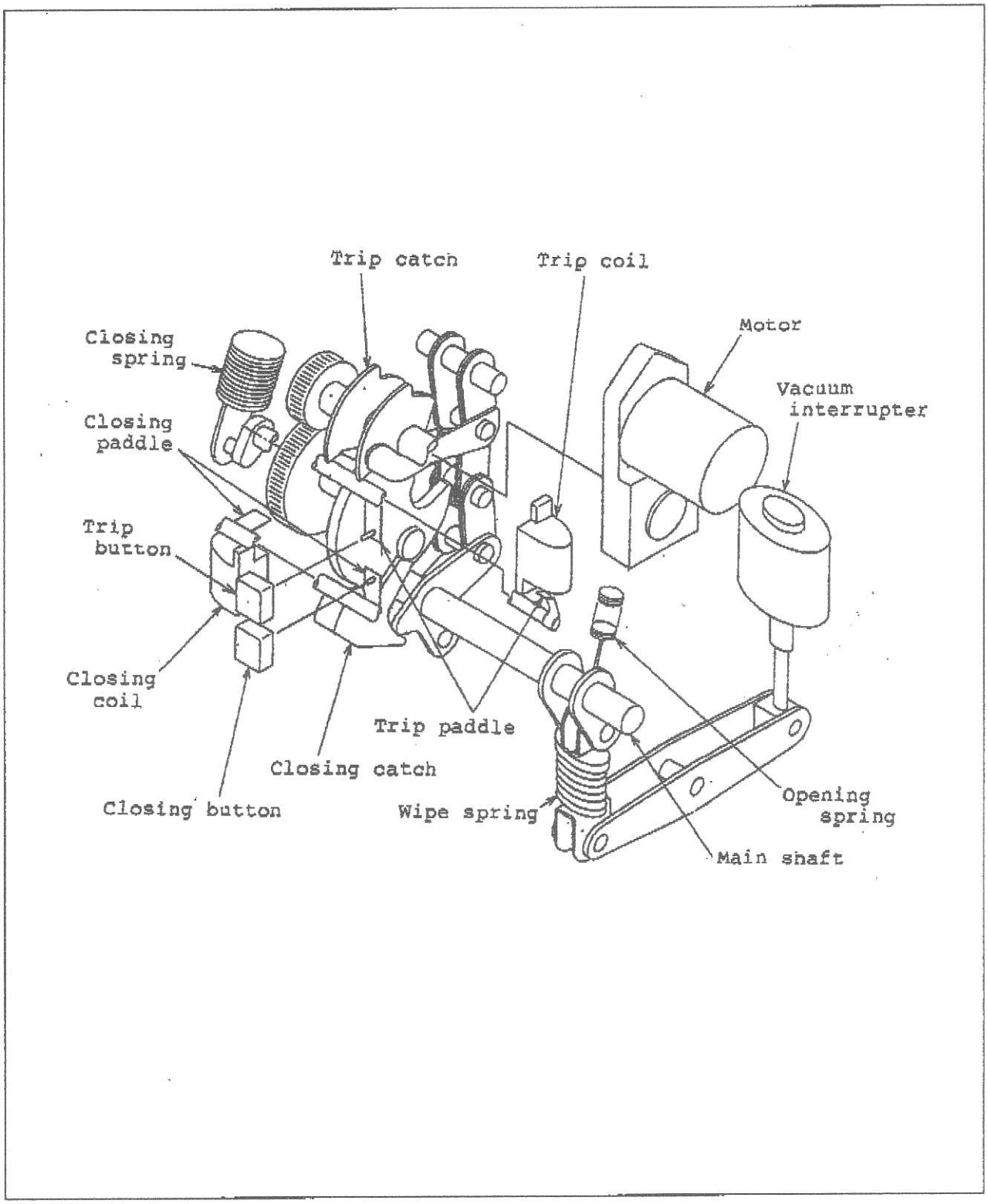


Fig. 39 Mechanism

MECHANISM OPERATION

⚠WARNING Do not modify or overload the circuit breaker operating mechanism. Slow closure of the breaker could result in fire and explosion.

A. Closing

The condition shown in Fig. 40 represents the condition where the circuit breaker is open and the closing spring is charged (ready for closing). In this condition, the closing catch is released by the closing button or the closing coil, the closing spring causes the cam to rotate quickly into the condition shown in Fig. 41 in which the circuit breaker is closed.

B. Charging

From the closed condition of Fig. 41 only the closing cam is rotated by the motor, with the circuit breaker kept closed, until the roller on the cam engages with the catch.

C. Tripping

When the trip shaft is released by the trip button or the trip coil, all the links return to the original open condition shown in Fig. 40.

D. Trip Free

When the trip catch is released, the link will move to the trip free condition shown in Fig. 42. When the charging operation is completed, the link will assume the open condition.

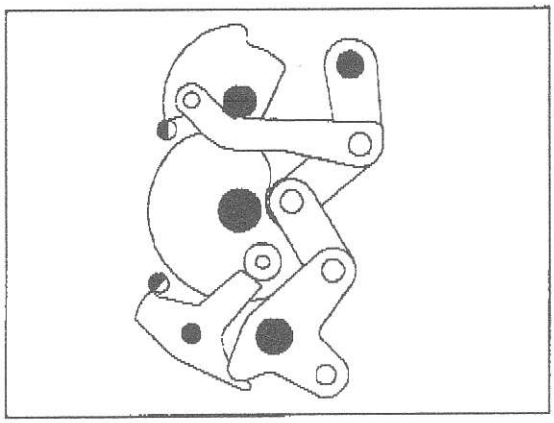


Fig. 40 Mechanism Opened

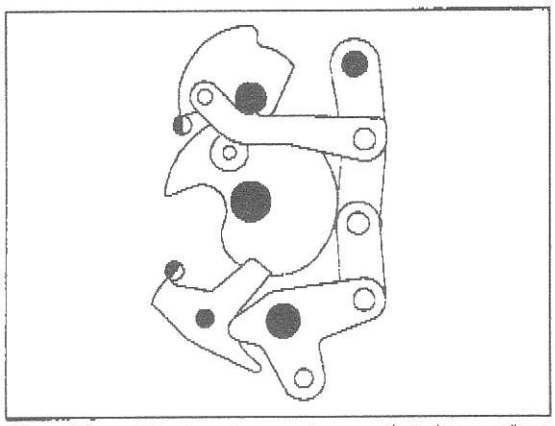


Fig. 41 Mechanism Immediately after Closing by Signal

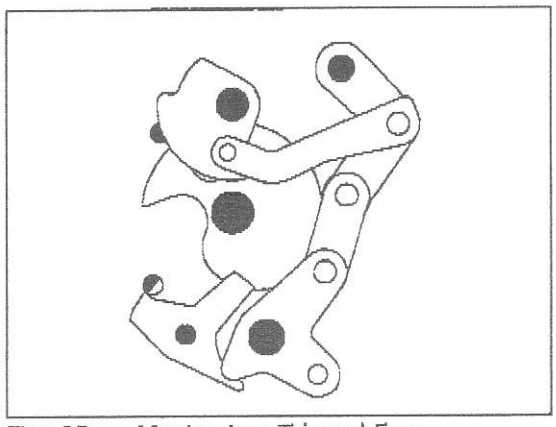


Fig. 42 Mechanism Tripped Free

MAINTENANCE PROGRAM

In order to ensure continued reliable and safe operation of the equipment, a program of routine maintenance must be established. Operating and environmental conditions will usually dictate the frequency of inspection required. NFPA Publication 70B "Electrical Equipment Maintenance" may be used as a guide for setting up the maintenance program.

⚠ DANGER Contact with energized components can cause severe injury, death and property damage. Turn-off and lock out Primary and Control Circuit Power before servicing.

⚠WARNING Improper maintenance can cause severe injury, death, and property damage. Only qualified and authorized persons are to install, operate, or service this equipment.

⚠WARNING Do not allow grease or any other substances to contaminate any insulating materials. Contaminated insulators can allow a short circuit or ground fault to occur.

NOTE: Refer to the SAFETY section of this manual for important information.

MAINTENANCE RECORD

Keep a permanent record of all maintenance work. At a minimum, this record should include information on:

1) Items inspection
2) Reports of any testing
3) Equipment condition
4) Corrective actions or adjustments
5) Date of work
6) Comments

The degree of detail of the record will depend somewhat on the operating conditions.

Table 2. Circuit Breaker Recommended Torque Values

Hardware Size	Recommended Torque	
	(kgf-cm)	(ft-lb)
M3	10	0.7
M4	20	1.4
M5	40	2.9
M6	80	5.8
M8	200	15.5
M10	350	25.0
M12	450	33.0

Table 3. Switchgear Recommended Torque Values

Hardware Size	Recommended Torque	
	(kgf-cm)	(ft-lb)
1/4-20	55-83	4-6
5/16-18	138-207	10-15
3/8-16	276-415	20-30
1/2-13	553-691	40-50

SERVICING EQUIPMENT

For your safety, turn off and lock out main and control circuit power before servicing the circuit breaker.

Should service to the circuit breaker be required while the system remains energized, extreme caution must be exercised. Also, certain minimum safety procedures must be followed:

1) Only **qualified personnel** should attempt this service.
2) **Do not service** a circuit breaker unit while connected to the line terminals. Withdraw the de-energized circuit breaker from the energized main bus before servicing.

⚠WARNING **Never service the circuit breaker while in the Connected Position.**

3) Verify that the automatic line terminal shutters are closed. **Never** service a unit unless these shutters are fully closed.
4) **Never** perform service on or next to exposed components energized with line voltage.

⚠WARNING **Failure to adhere to these safety procedures can result in severe injury, death and severe property damage.**

INSPECTION AND MAINTENANCE TYPES

NOTE: Refer to the SAFETY section of this manual for important information.

For points and types of lubrication refer to Fig. 43

A. Acceptance Inspection

This inspection confirms that the circuit breaker unit is complete, correct as specified, and undamaged from shipment. The procedure for this inspection is outlined in the RECEIVING section of this manual.

B. Patrol Inspection

Inspection of the condition of the circuit breaker while energized.

1) Check that no unusual sounds or smells exists externally.

C. Visual Inspection

Inspection performed with the circuit breaker withdrawn from the switchgear compartment.

1) With front cover removed, inspect entire circuit breaker for deformation, rust or any other types of abnormalities.

D. Periodical Inspection

Inspection performed with the circuit breaker withdrawn from the switchgear compartment.

1) Perform Visual Inspection.
2) Clean and lightly coat the contacting surfaces of the main conductive parts with Toshiba B8 grease.
3) Close and trip circuit breaker manually and electrically to insure proper operation of mechanism. Check wipe measurement (Pg. 36).
4) Inspect to insure lubrication of sliding and rotating parts.
5) Lubricate sliding and rotating parts with machine oil as required.
6) Test the circuit breaker to insure that primary and secondary circuit insulation resistances are within Toshiba International Corporation specifications (Pg. 35).

E. Detail Inspection

Inspection performed with the circuit breaker drawn outside of the switchgear compartment.

1) Perform Periodical Inspection.
2) Re-grease sliding and rotating parts. Replace cotter pins and E-rings that are removed with new ones.
3) Perform dielectric test (see Vacuum Check on Pg. 37).
4) Test the circuit breaker to insure that closing time (Pg. 20), opening time (Pg. 20) and minimum operating voltages (Pg. 48) of both the close and trip coils are within Toshiba International Corporation specifications.

F. Overhaul

Complete disassembly of circuit breaker to replace worn parts as required. Clean and re-grease all parts. To be performed only by Toshiba International Corporation.

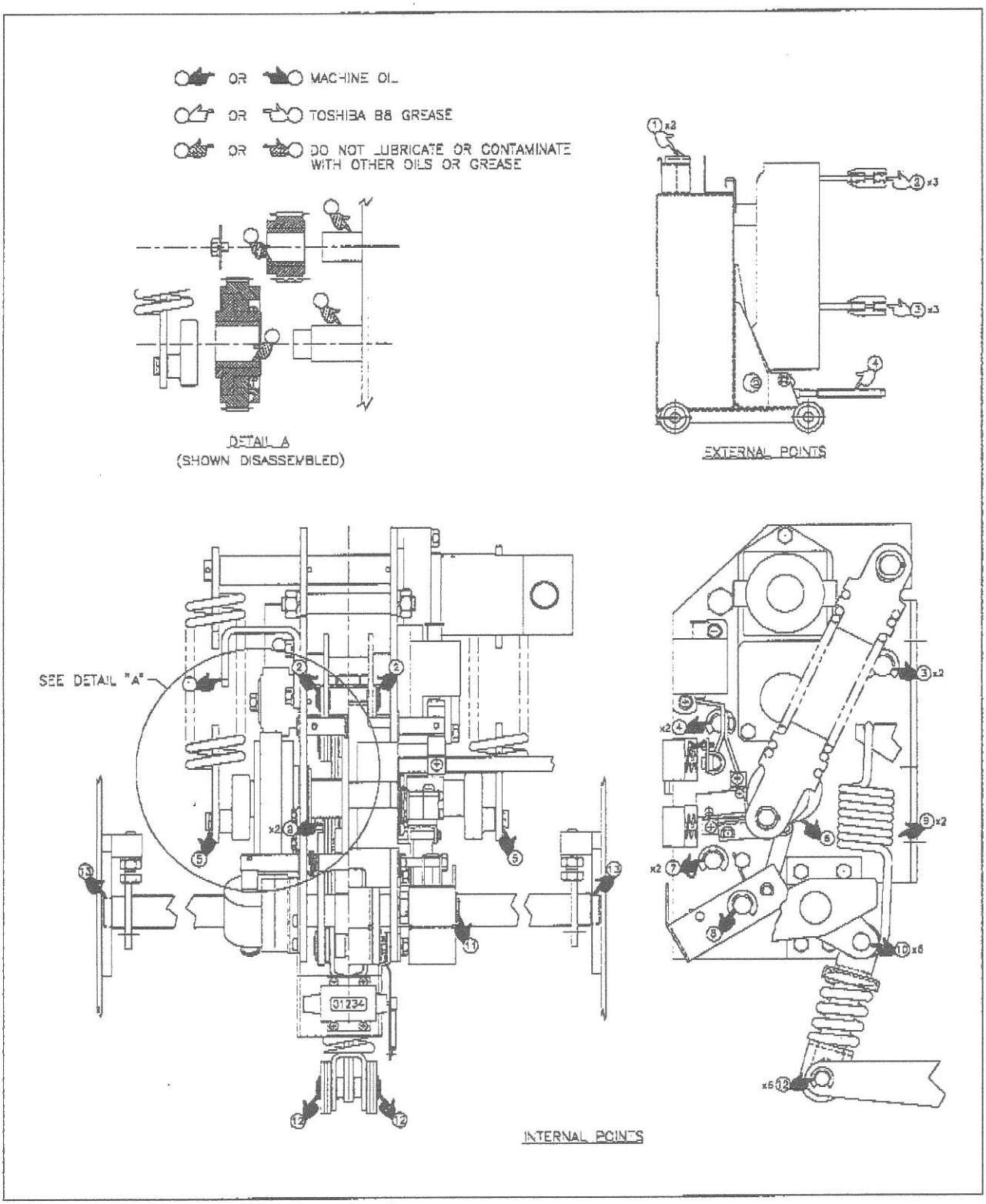


Fig. 43 Points and Types of Lubrication

INSPECTION AND MAINTENANCE INTERVALS

The frequency and detail of the required inspections will vary depending on the environment of service and type of inspection to be performed. Using Fig. 44 select between the charts of operating years and operating cycles which will require the most frequent inspections and maintenance.

In addition, when applying circuit breakers in severe atmospheric sites such as outdoor compartments, dusty environments, high temperatures and/or high humidity the inspection and maintenance frequency should be, at a minimum, twice as often.

If the 12th year overhaul is not carried out, the Detail Inspection should be applied in the cycles of the Periodical Inspection (every 3 years).

Should the circuit breaker be subjected to a severe condition such as drop, collision, earthquake or fire contact Toshiba International Corporation for a complete inspection.

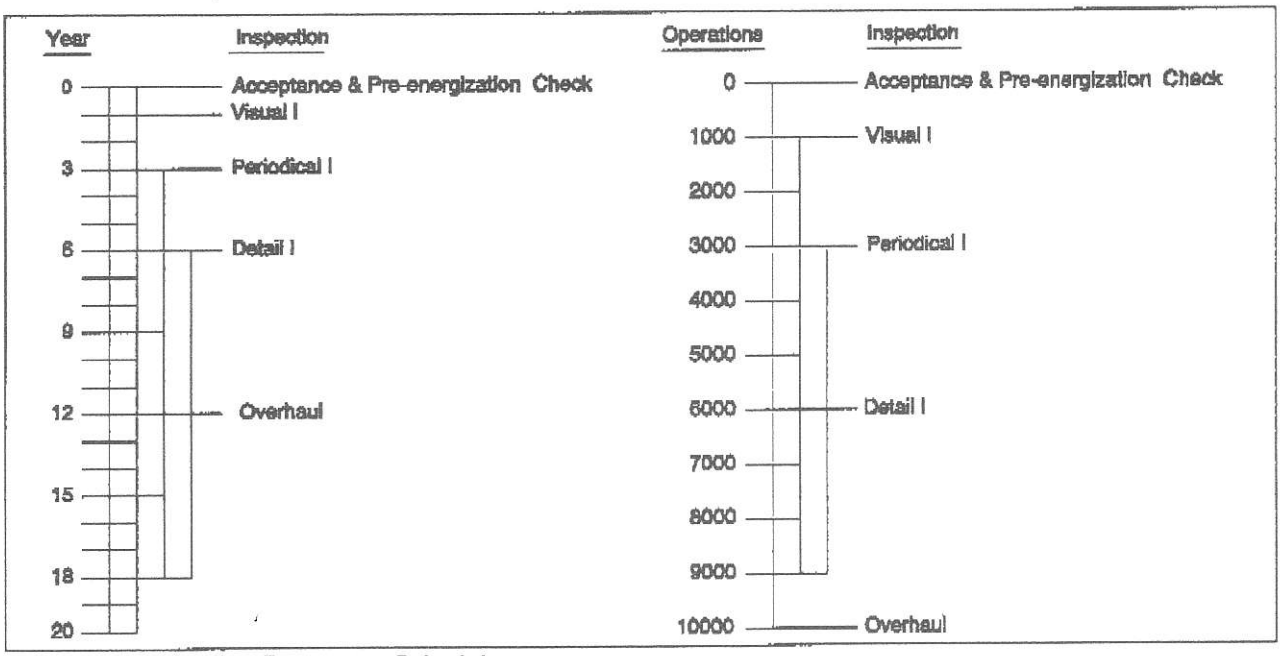


Fig. 44 Inspection Frequency Schedules

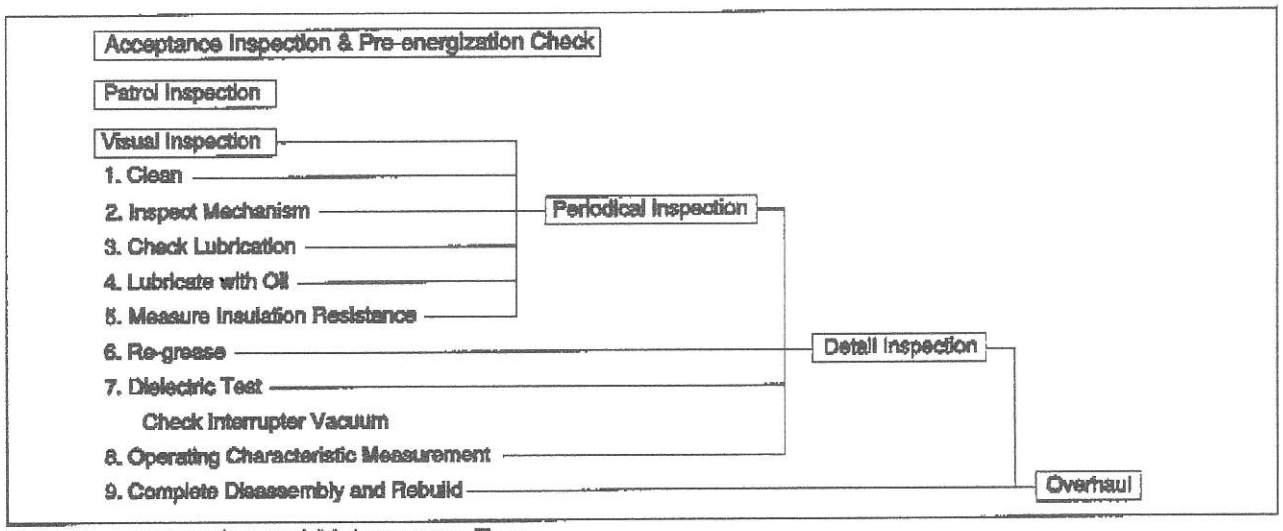


Fig. 45 Inspection and Maintenance Tree

Table 4. Check Points for Inspection

Checks should be done in accordance with INSPECTION AND MAINTENANCE INTERVALS.

No.	Check Point	Check Item	Check Method	Criteria	What to do	Remarks
1	Entire Circuit Breaker/ Switchgear	Tightness of hardware	Visual check, check tightness with tools.	There should be no loose hardware.	Retighten loose hardware.	Table 2, Table 3 (Pg. 26)
		Dust and foreign matter	Visual check.	The circuit breaker should be clean and contain no foreign matter.	Wipe with a clean dry cloth, use a brush or vacuum cleaner.	
		Deformation, excessive wear and damage	Visual check.	There should be no deformation, excessive wear or damage.	Remove cause and replace parts.	
		Lost or missing parts	Visual check.	There should be no missing parts.	Reinstate to the normal condition.	
		Bus supports	Visual check, check tightness with tools.	Bus supports must be secure and undamaged.	Replace damaged parts and tighten unsecured supports.	Table 3 (Pg. 26)
		Enclosure damage	Visual check.	Enclosures should exhibit no damage as to reduce electrical spacing.	Repair as necessary.	
		Field wiring	Visual check.	Field wiring should have proper clearance to live buses.	Provide adequate clearance where necessary, physically secure.	

Table 4. Check Points for Inspection (cont.)

No.	Check Point	Check Item	Check Method	Criteria	What to do	Remarks
1	Entire Circuit Breaker/ Switchgear	All wiring	Visual check.	There should be no covers pinching wiring or wiring against sharp or abrasive surfaces.	Secure and protect wiring as necessary.	
		Grounding connection	Visual check, check tightness with tools.	All grounding connections should be properly made and tight.	Tighten as necessary	Table 2, Table 3 (Pg. 26)
		Covers, guards, and barriers	Visual check.	All covers, guards, and barriers must be securely in place. All unused openings must be covered.	Replace or repair as needed	
		Safety Signs	Visual check.	Safety signs, labels, nameplates, etc. should not be covered or obscured by paint. They must be securely affixed.	Repair or replace as needed	
2	Operating Mechanism and Safety Devices	Dust and foreign matter	Visual check.	There should be no dust and foreign matter.	Remove foreign matter by wiping clean	
		Smooth operation	Manual operation.	Operation should be smooth.	Determine cause of mis-operation.	
		Lubrication of bearing pins	Check by feel and sight.		Apply a small amount of machine oil.	
		Closing and tripping shaft	Visual check.	Must rotate smoothly.		

Table 4. Check Points for Inspection (cont.)

No	Check Point	Check Item	Check Method	Criteria	What to do	Remarks
2	Operating Mechanism and Safety Devices	Closing and tripping shaft	Visual check.	Must rotate smoothly.	Apply a small amount of machine oil.	
		Interlock, key-switches, etc.	Functional check.	Must operate smoothly, securely, and properly.	Reinstate to proper operating condition.	
3	Vacuum Interrupter	Contact wear	Measurement of wipe length.	Wipe length should be greater than 1 mm (.039 in.)	Factory service is required if the wipe length is 1 mm. (.039 in.) or less.	Pg. 36
		Vacuum pressure	See Vacuum Check section		Factory service required when vacuum pressure is not sufficient.	Pg. 37
		Number of open-close operations	Counter.	When the counter reading reaches 6,000 or 6 years of service has been reached (for the rated current interruption), check the internal pressure. Follow up checks should be made every 3 years of service thereafter or until the counter reading reaches 10,000. For the method of checking the vacuum pressure see the Vacuum Check section.	Factory service is required if the internal pressure is not sufficient or when the counter reaches 10,000.	Pg. 37
		Contamination	Visual check.	There should be no dust or foreign matter on the interrupter surface.	Wipe with a clean cloth dampened with alcohol.	

Table 4. Check Points for Inspection (cont.)

No.	Check Point	Check Item	Check Method	Criteria	What to do	Remarks
4	Auxiliary Switch	Terminals	Tighten with screw driver.	There should be no loose screws.	Retighten.	
		Case and contacts	Visual check.	There should be no damage nor deformation.	Replace when damaged.	Pg. 45
5	Primary Disconnects	Discoloration of contact surfaces by heat	Visual check.	There should be a thin film of Toshiba B8 grease on the contact surface. There must be no discoloration.	If the contact surface has no grease on it, apply a small amount of Toshiba B8 grease. Replace if the contact is discolored.	
6	Control Circuit	Closing and tripping electrically	Check at the Test Position or out of cell using a Toshiba auxiliary test cabinet.	The closing and tripping operations can be done smoothly.	Check circuits and the closing and tripping devices, also check the microswitches and fuses.	
7	Secondary (Control Circuit) Disconnects	Insulation portion	Visual check.	There should be no damage.	Replace if there is any damage.	
		Contact surface	Visual check.	There should be a thin film of Toshiba B8 grease on the contact surface.	If the contact surface has no grease on it, apply a small amount of B8 grease.	Pg. 10

Table 4. Check Points for Inspection (cont.)

<table>
<tr><th>No.</th><th>Check Point</th><th>Check Item</th><th>Check Method</th><th>Criteria</th><th>What to do</th><th>Remarks</th></tr>
<tr><td rowspan="2">8</td><td rowspan="2">Barrier (Vacuum Interrupter Support)</td><td rowspan="2">Contamination, discoloration, and damage.</td><td rowspan="2">Visual check.</td><td>There should be no dust and foreign matter.</td><td>Wipe with a clean cloth.</td><td rowspan="2"></td></tr>
<tr><td>There should be no cracks or damages.</td><td>Factory service required if cracked or damaged.</td></tr>
<tr><td>9</td><td>Measurement of Insulation Resistance</td><td colspan="3"><table><tr><th>Measuring location</th><th>Insulation resistance</th><th>Megger</th></tr><tr><td>Main circuit-Ground</td><td>500 Mohm or more</td><td>1000V</td></tr><tr><td>Control circuit-Ground</td><td>2 Mohm or more</td><td>500V</td></tr><tr><td>Between main circuit</td><td>500 Mohm or more</td><td>1000V</td></tr></table></td><td>When the insulation resistance between the main circuit is low, clean the surface of the vacuum interrupter with a dry cloth and then take measurements again.</td><td></td></tr>
</table>

WIPE MEASUREMENT

When the circuit breaker is closed, pressure on the main contacts inside the vacuum interrupter is maintained by a set of springs. As the main contacts inside the vacuum interrupter wear, the amount of wipe on the springs decreases. Wipe is used to measure contact wear and maintain contact pressure. The decrease in wipe is also used to determine when to replace the vacuum bottle due to wear of the contacts.

⚠WARNING **Never use a circuit breaker with insufficient wipe. Insufficient wipe will cause poor contact pressure and can result in fire, explosion, severe injury, death and property damage.**

⚠WARNING **Never adjust the wipe of a vacuum interrupter. Improper adjustment of the wipe can result in fire, explosion, severe injury, death and property damage.**

For:		
	6M32A	10M25A2
	6P32A	10P25A2
	6M40A	10M40A
	6P40A	10P40A
	8M40A	
	8P40A	

With the circuit breaker closed, visually check the wipe mark (red) as shown in Fig. 46. The interrupter **must** be replaced when the wipe mark is no longer visible.

For:		
	6M50	10Q40
	6P50	10M50
	6Q50	10P50
	8Q40	10Q50

With the circuit breaker closed, measure the wipe as shown in Fig. 47. The interrupter **must** be replaced when the block extends 1mm below the plate.

All servicing and replacement of vacuum interrupters should be done by Toshiba International Corporation. Consult the factory for further details.

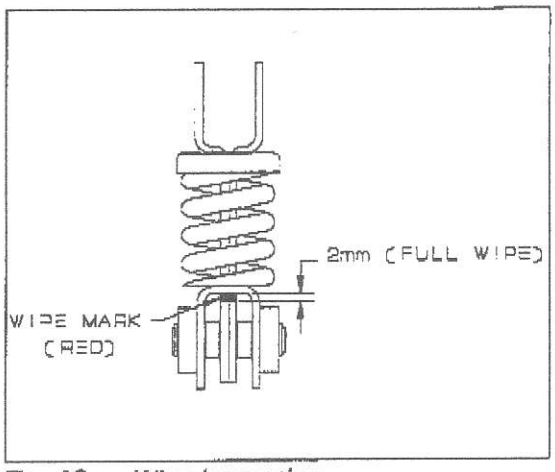


Fig. 46 Wipe Inspection

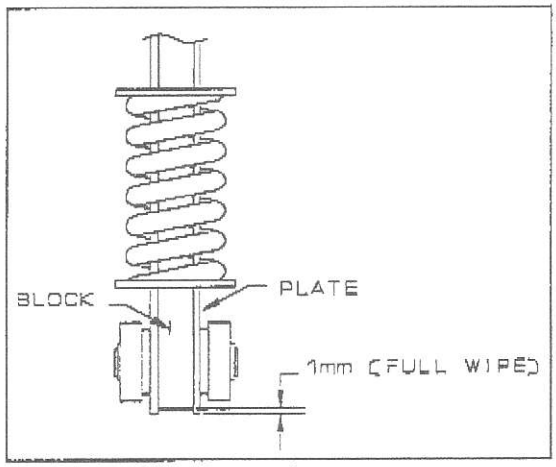


Fig. 47 Wipe Inspection

VACUUM CHECK

This test procedure is provided to evaluate the dielectric integrity of the vacuum interrupter. The relationship between the dielectric breakdown voltage and internal vacuum interrupter pressure has been found to be generally predictable.

NOTE: Applying abnormally high voltage across a pair of contacts in vacuum may produce X-rays. The radiation may increase with the increase in voltage and/or decrease in contact spacing. X-rays produced during this test with recommended voltage and normal contact spacing is extremely low and well below maximum permitted by standards.

⚠WARNING Radiation Exposure Hazard. X-rays may cause illness or injury. Stay at least 1 meter (3.3 ft) away from circuit breaker during this test.

⚠WARNING Hazardous voltages are present during dielectric testing which can result in severe injury or death. Only qualified personnel should conduct this testing.

For Vacuum Check Procedures see pages 39 and 40.

Fig. 49 is an example of a test circuit that can be used to check the dielectric integrity.

NOTE: As an option, a compact vacuum checker (Type CI35-1D) is available, which enables a quick and easy check on the vacuum interrupter internal pressure.

Defective vacuum interrupters will consistently fail with little delay therefore, 10 seconds of voltage application is sufficient.

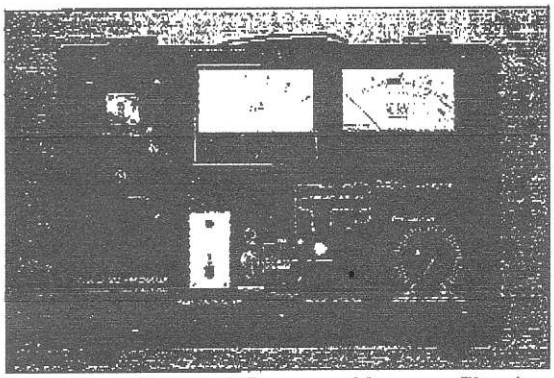


Fig. 48 Optional Compact Vacuum Checker

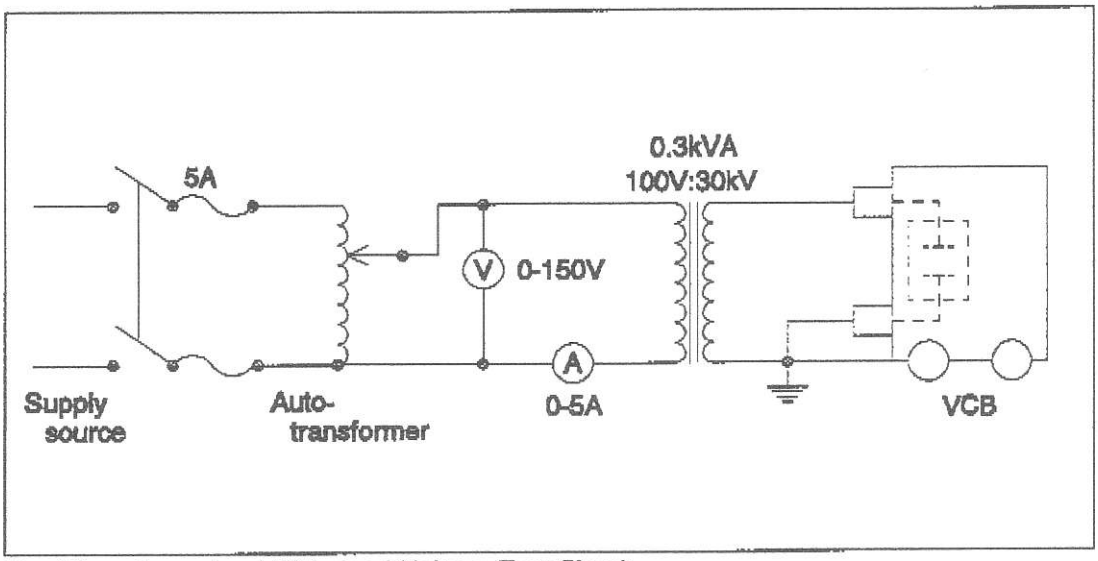


Fig. 49 Example of Withstand Voltage Test Circuit

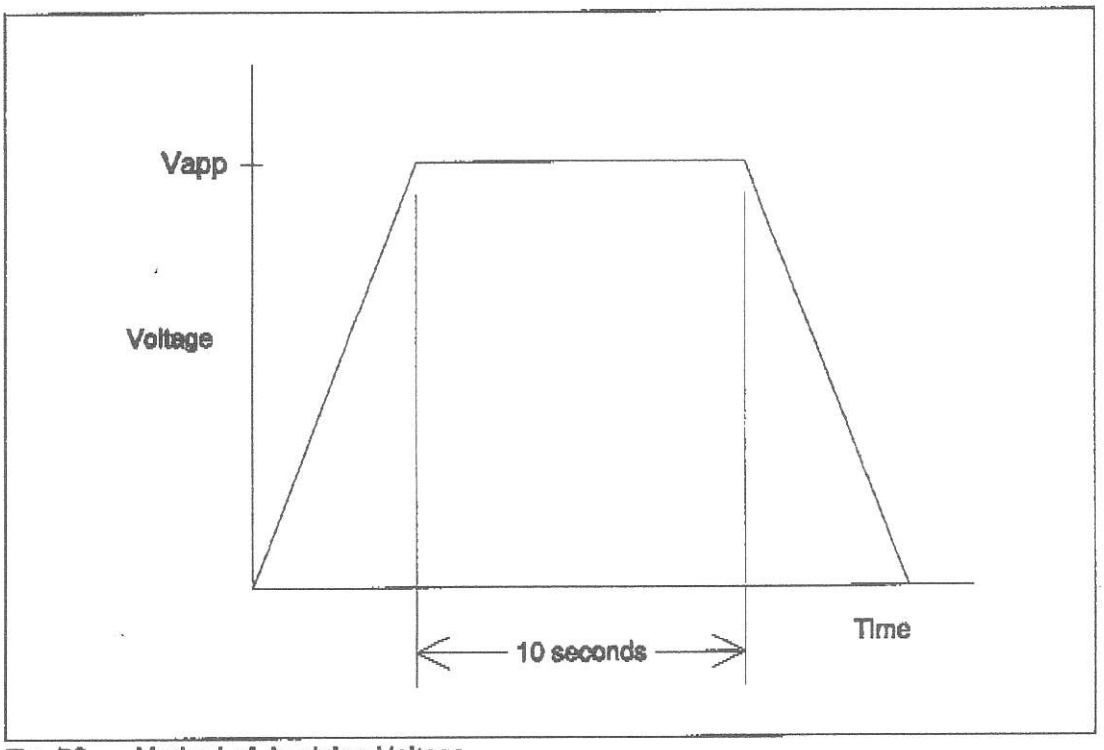


Fig. 50 Method of Applying Voltage

VACUUM CHECK PROCEDURE FOR:

6M/P32A	8M/P40A
10M/P25A2	6M/P40A
10M/P40A	

The relationship between the dielectric breakdown voltage and the vacuum internal pressure is shown in Fig. 52.

⚠WARNING **Radiation Exposure Hazard. X-rays may cause illness or injury. Stay at least 1 meter (3.3 ft) away from circuit breaker during this test.**

⚠WARNING **Hazardous voltages are present during dielectric testing which can result in severe injury or death. Only qualified personnel should conduct this testing.**

Set Up:

1) Test circuit: Fig. 49
2) Circuit Breaker: Test in open "tripped" position
3) Expected Failure Voltage Range: 17-19 kVac
4) Applied Test Voltage (Vapp): 22 kVac
5) Time of applied voltage: 10 sec. maximum.

NOTE: Apply voltage at a rate of approximately 2kV per second until Vapp is reached. Decrease at the same rate.

Procedure:

1) Voltage is to be applied between the terminals of the vacuum interrupter
2) Start at zero and increase voltage gradually
3) If ammeter shows current flow, reduce voltage to zero and again increase.
4) Repeat steps (2) and (3) a few times.

Criteria:

1) If the current increases with a voltage increase, the interrupter is defective.
2) If zero, or negligible (less than 0.5 A) current is found with a voltage increase, the interrupter is good.

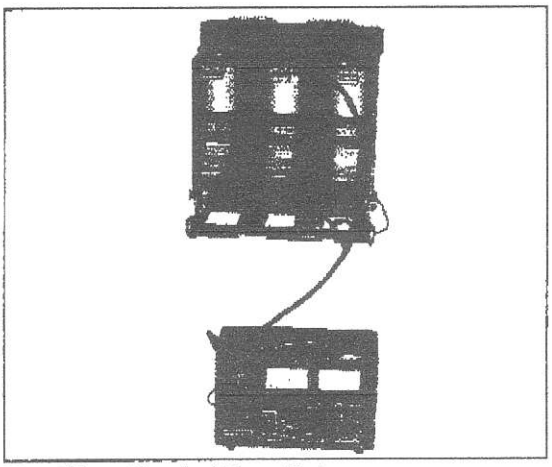


Fig. 51 Typical Test Setup

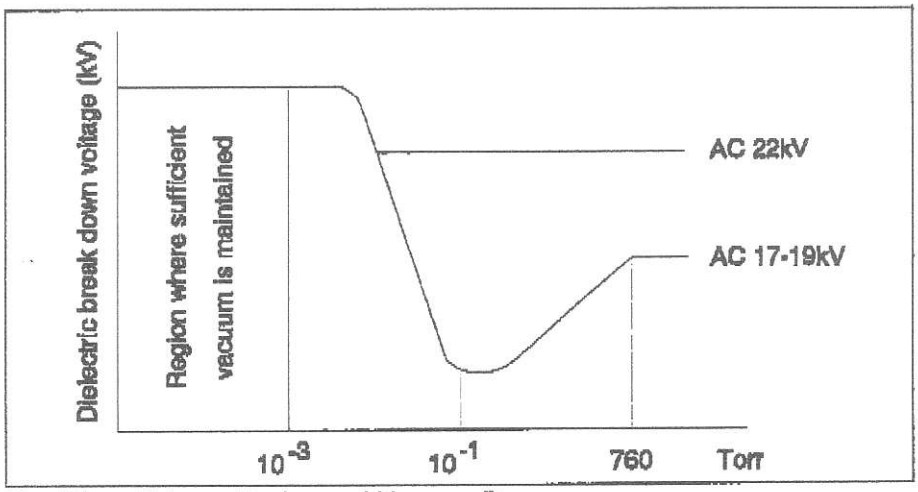


Fig. 52 Voltage Vs. Internal Vacuum Pressure

VACUUM CHECK PROCEDURE FOR:

10Q40 6M/P/Q50
10M/P/Q50

The relationship between the dielectric breakdown voltage and the vacuum internal pressure is shown in Fig. 54.

⚠WARNING Radiation Exposure Hazard. X-rays may cause illness or injury. Stay at least 1 meter (3.3 ft) away from circuit breaker during this test.

⚠WARNING Hazardous voltages are present during dielectric testing which can result in severe injury or death. Only qualified personnel should conduct this testing.

Set Up:

1) Test circuit: Fig. 49
2) Circuit Breaker: Test in open "tripped" position
3) Expected Failure Voltage Range: 17-21 kVac
4) Applied Test Voltage (Vapp): 25 kVac
5) Time of applied voltage: 10 sec. maximum.

NOTE: Apply voltage at a rate of approximately 2kV per second until Vapp is reached. Decrease at the same rate.

Procedure:

1) Voltage is to be applied between the terminals of the vacuum interrupter
2) Start at zero and increase voltage gradually
3) If ammeter shows current flow, reduce voltage to zero and again increase.
4) Repeat steps (2) and (3) a few times.

Criteria:

1) If the current increases with a voltage increase, the interrupter is defective.
2) If zero, or negligible (less than 0.5 A) current is found with a voltage increase, the interrupter is good.

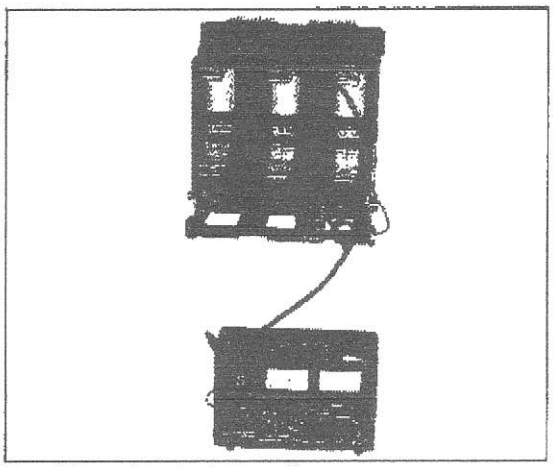


Fig. 53 Typical Test Setup

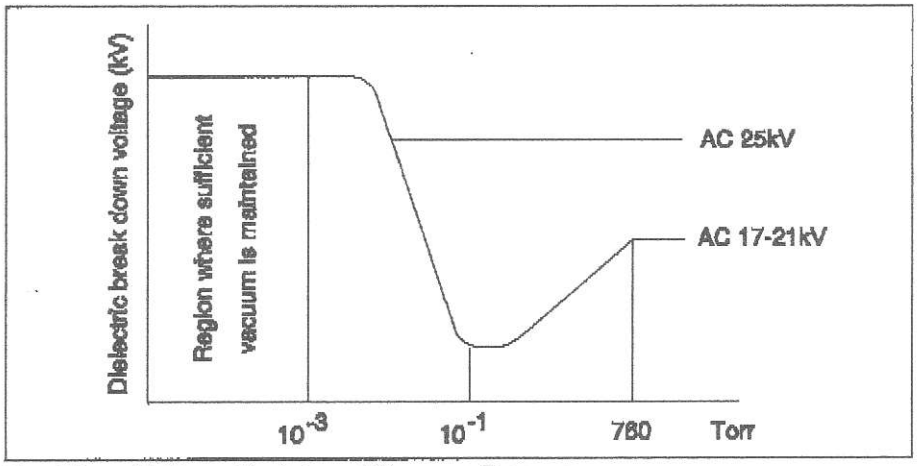


Fig. 54 Voltage Vs. Internal Vacuum Pressure

TROUBLESHOOTING GUIDELINES

Table 5. Troubleshooting Guidlines

SYMPTOM	SOURCE OF TROUBLE	PROBLEM	SOLUTION	REFERENCE FIG.
Circuit Breaker does not close at all - Closing signal is supplied	Mechanical	Closing spring damaged or dislocated	*	Fig. 55
		Closing catch seized or galled	*	Fig. 39
		Closing paddle dislocated	Reposition or Replace	Fig. 39
		Closing coil (burned, armature damaged, galled)	Replace	Fig. 55 Fig. 60- Fig. 64
		Motor (burned)	*	
	Mechanical (Unit has been utilized for a Conversion)	Binding due to MOC or other problem	Requires factory service, contact your conversion manufacturer	
	Control Circuit	Aux. Switch (poor contact or burned)	Replace	Fig. 55 Fig. 56- Fig. 59
		Control relay (poor contact or burned)	Replace entire control circuit board	Fig. 55 Fig. 66- Fig. 68
		Aux. Relay (poor contact or burned)	Replace entire control circuit board	Fig. 55 Fig. 66- Fig. 68
		Motor (poor contact or burned)	*	
		Terminal or connector (poor contact or burned)	Check or Replace	
		Microswitch (poor contact or burned)	*	
		Fuse blown	Replace	

* Item Requires Factory Service - Consult Toshiba International Corporation

Table 5. Troubleshooting Guidelines (cont.)

SYMPTOM	SOURCE OF TROUBLE	PROBLEM	SOLUTION	REF. FIG.
There is a closing sound but circuit breaker did not close.	Mechanism	Resetting spring and links (fails to reset)	*	Fig. 39
		Trip catch (fails to reset)	*	Fig. 39
		Trip shaft (fails to reset)	*	Fig. 39
		Interlock (fails to catch)	*	Fig. 14-Fig. 15
		Trip coil burned, armature damaged, galled	Replace coil. Otherwise *	Fig. 55 Fig. 60-Fig. 64
		Main shaft (galled)	*	Fig. 39
	Breaking portion	Insulated operation rod (damaged)	*	
Undesirably closes (without a closing signal)	Mechanism	Closing catch (unable to reset)	*	Fig. 39
		Closing shaft (unable to reset	*	Fig. 39
	Control circuit	Short circuit of the closing circuit and the power supply circuit	Identify and correct	Fig. 34-Fig. 37
Does not trip at all (when a tripping signal is supplied)	Mechanism	Trip coil (burned or galled)	Replace	Fig. 55 Fig. 60-Fig. 64
		Trip shaft and trip catch (galled)	*	Fig. 39
		Trip paddle (dislocated)	Readjust	Fig. 39
		Main shaft (galled)	*	Fig. 39
	Vacuum Interrupter	Contacts Welded	*	
	Control circuit	Auxiliary switch (poor contact or burned)	Replace	Fig. 55 Fig. 66-Fig. 68

* Item Requires Factory Service - Consult Toshiba International Corporation

Table 5. Troubleshooting Guidelines (cont.)

SYMPTOM	SOURCE OF TROUBLE	PROBLEM	SOLUTION	REF. FIG.
Does not trip at all (when a tripping signal is supplied) (cont)	Control circuit (cont)	Trip coil (burned, armature damaged, or galled)	Replace	Fig. 55 Fig. 60- Fig. 64
		Terminal and connector (poor contact or burned)	Replace	
There is a tripping sound but it actually did not trip	Mechanism	Link (galled)	*	Fig. 39
Undesirably trip (without a tripping signal)	Mechanism	Trip catch (damaged)	*	Fig. 39
	Control circuit	Short circuit of the tripping circuit and the power supply circuit.	Identify and correct	Fig. 34- Fig. 37

* Item Requires Factory Service - Consult Toshiba International Corporation

REPLACEMENT OF PARTS

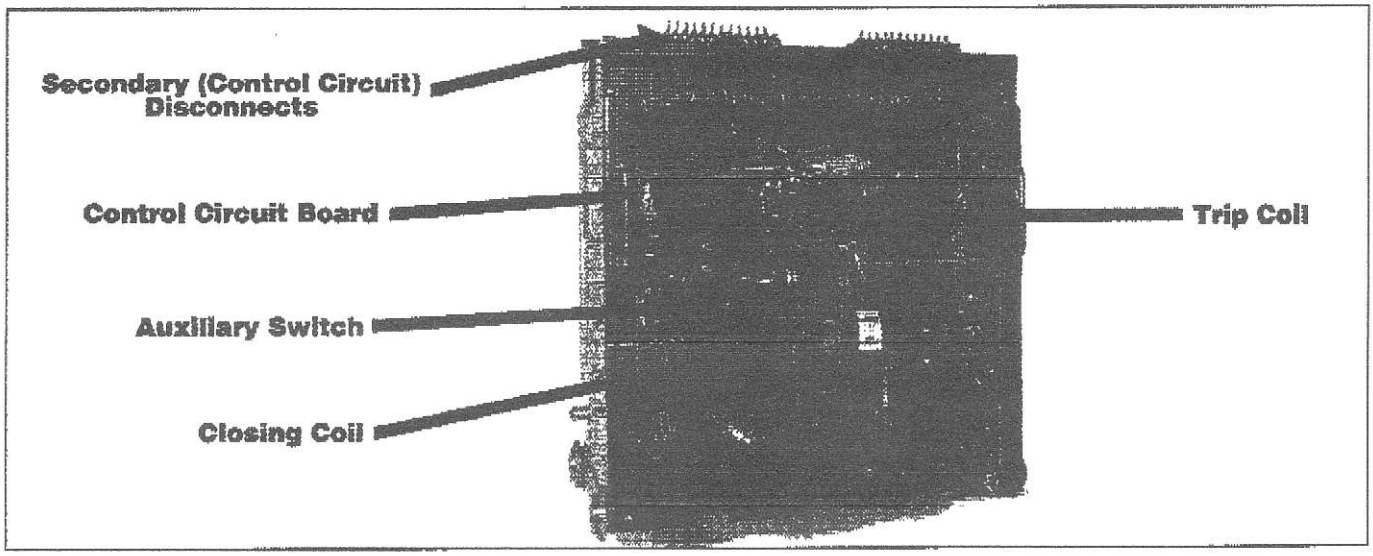


Fig. 55 Component Part Location

⚠WARNING **Use only genuine Toshiba parts. Use of non-Toshiba parts can result in severe injury, death, and property damage. Only qualified personnel should replace parts within this circuit breaker.**

REPLACEMENT OF AUXILIARY SWITCH

⚠WARNING **Do not replace the Auxiliary Switch with the circuit breaker in the Connected or Test Position. Turn off and lock out Main and Control Circuit Power before servicing.**

⚠WARNING **Confirm that the circuit breaker indicators show "DISCHARGED" (white) and "OPEN" (green) before servicing.**

Tools Required: Ohm meter
Phillips Screwdriver

PROCEDURE:

1) Before beginning replacement, confirm the number of contacts on the replacement auxiliary switch are correct (5 NO, 5 NC).

2) Remove the front cover of the circuit breaker.

3) Disconnect the link from the main shaft of the operating mechanism by removing the screw (Fig. 56).

4) Remove the four screws which attach the auxiliary switch to the circuit breaker (Fig. 57).

5) Remove wires connected to the auxiliary switch.

NOTE: Mark the auxiliary switch terminal numbers on the wire terminals to prevent mis-wiring.

6) Re-attach the wires to the new auxiliary switch.

NOTE: When rotated to the proper position, the auxiliary terminal numbers (1,2,5,6...) will be on the front side.

7) Mount the switch in the circuit breaker and tighten the four screws that hold the switch in place.

8) Connect the link to the main shaft of the mechanism and tighten the screw to secure in place.

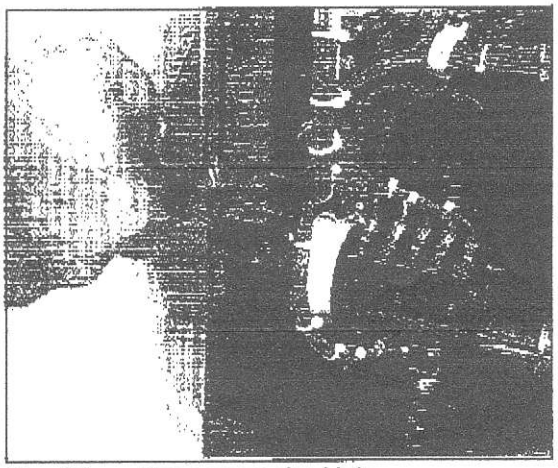


Fig. 56 Disconnect the Link

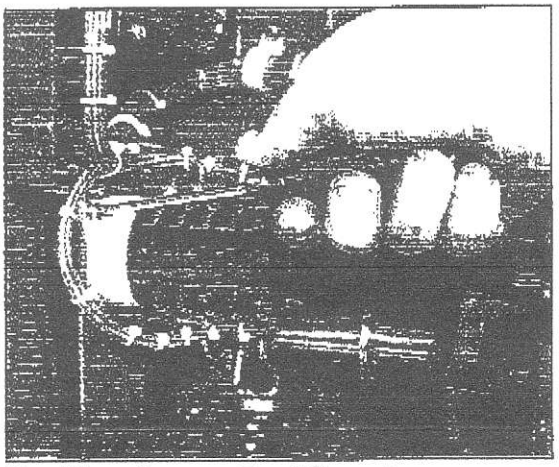


Fig. 57 Remove the 4 Screws

9) Confirm the continuity of the "NC" (b) contacts with a tester (Terminals No. 1-2, 5-6, 9-10, 13-14 and 17-18). Confirm the non-continuity of the "NO" (a) contacts with a tester (Terminals No. 3-4, 7-8, 11-12, 15-16 and 19-20).

10) Manually charge the closing springs.

⚠WARNING Unit contains powerful springs. Do not place your hands or any part of your body inside the circuit breaker or near the mechanism while the springs are CHARGED or the circuit breaker is CLOSED.

11) Manually close the circuit breaker by pressing the Closing Button.

12) Confirm the non-continuity of the "NC" (b) contacts with a tester (Terminals No. 1-2, 5-6, 9-10, 13-14 and 17-18). Confirm the continuity of the "NO" (a) contacts (Terminal No. 3-4, 7-8, 11-12, 15-16 and 19-20).

13) Manually trip the circuit breaker by pressing the Trip Button.

14) Confirm that the circuit breaker can be electrically operated (Close, Charge and Trip).

15) Confirm than no parts or tools are left in the circuit breaker.

17) Replace the front cover (Fig. 59).

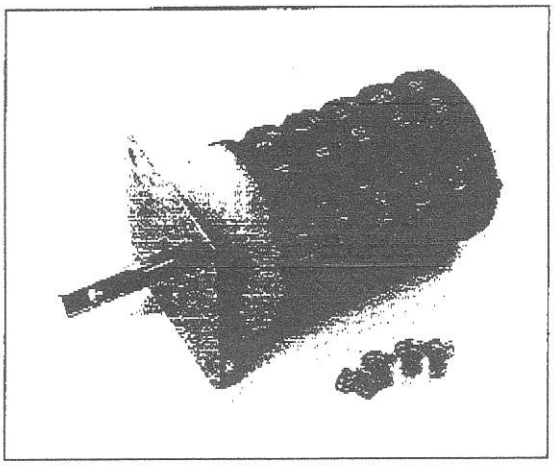


Fig. 58 Removed Auxiliary Switch

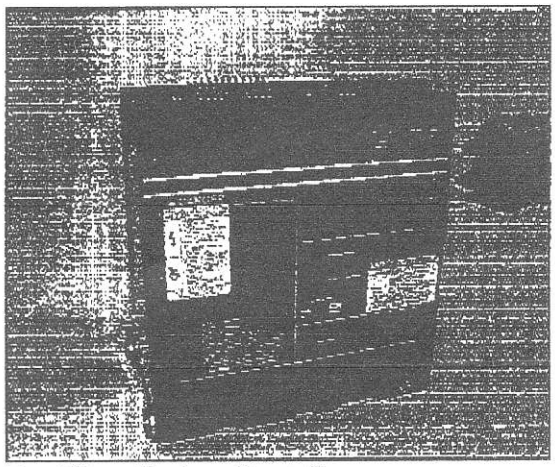


Fig. 59 Replace Front Cover

REPLACEMENT OF CLOSING AND TRIP COILS

⚠WARNING **Do not replace the Close or Trip Coil with the circuit breaker in the Connected or Test position. Turn off and lock out Main and Control Circuit Power before servicing.**

⚠WARNING **Confirm that the circuit breaker indicators show "DISCHARGED" (white) and "OPEN" (green) before servicing.**

Tools Required: Ohm meter
Phillips Screwdriver
Sandpaper

PROCEDURE:

NOTE: Replacement of the close and trip coil is by the same procedure.

1) Before beginning replacement of the coil, confirm the resistance and armature stroke of the new coil is correct by using Table 6. If a measured value is different from that listed in the table, contact Toshiba International Corp. for assistance.

Table 6. Coil Resistance and Armature Stroke

VOLTAGE (DC)	RESISTANCE	STROKE
30	3.78Ω ± 5%	7mm ± 0.5mm
48/50	7.75Ω ± 5%	
100/110	27.70Ω ± 5%	
125	38.50Ω ± 5%	
200/220	126.20Ω ± 5%	
250	187.60Ω ± 5%	

2) Remove the front panel of the circuit breaker.

3) Remove the screws holding the coil in place (Fig. 62).

4) Confirm that there is no debris in the threaded holes of the coil base.

5) Lightly rub off any oxidation film (Fig. 63) on the terminals of the coil and coil base with a fine grit sandpaper. Do not rub excessively.

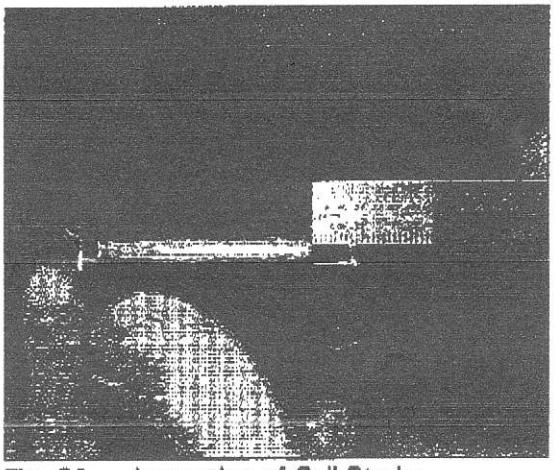


Fig. 61 Inspection of Coil Stroke

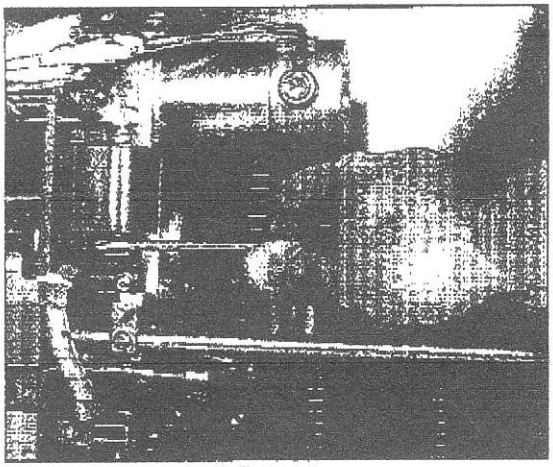


Fig. 62 Remove Screws

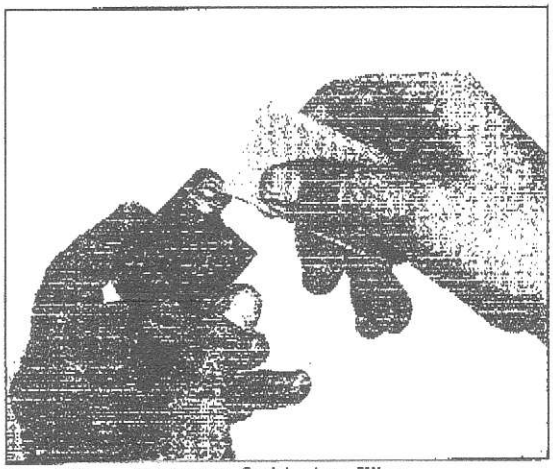


Fig. 63 Remove Oxidation Film

6) Position the new coil on the base with the coil end containing the screw head facing the paddle. Maintain a wipe measurement of 1-1.5mm (Fig. 64). Alternate the tightening of the coil mounting screws until a torque of 20kg-cm (1.4ft-lb) is reached.

7) Confirm that the coil electrically operates the circuit breaker.

⚠WARNING **Unit contains powerful springs. Do not place your hands or any part of your body inside the circuit breaker or near the mechanism while the springs are CHARGED or the circuit breaker is CLOSED.**

8) Confirm that the coil operates the circuit breaker by the voltage range in Table 7. If the circuit breaker does not operate within the specified range, contact Toshiba International Corporation.

Table 7. Coil Voltage Operating Range

RATED VOLTAGE (DC)	CLOSE VOLTAGE RANGE (DC)	TRIP VOLTAGE RANGE (DC)
24	*	14-28
30	24-36	18-36
48/50	38-56	28-56
100/110	80-124	56-124
125	100-140	70-140
200/220	160-248	112-248
250	200-280	140-280

* Not Recommended by ANSI

9) Confirm that no parts or tools are left inside the circuit breaker.

10) Replace the front cover (Fig. 65).

NOTE: Close and trip coil of the same voltage ratings are identical.

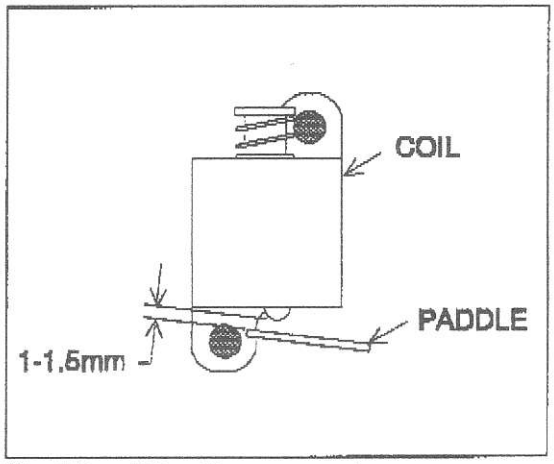


Fig. 64 Wipe Measurement

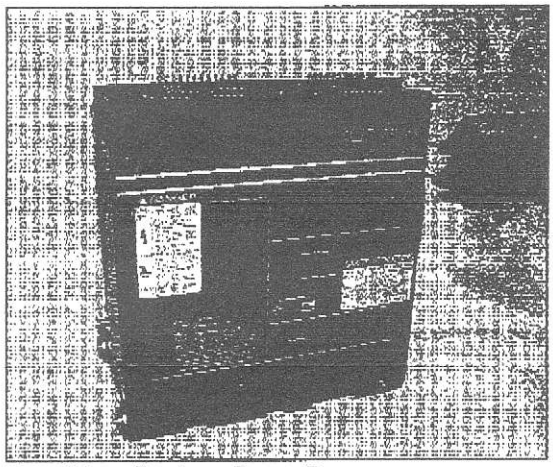


Fig. 65 Replace Front Cover

REPLACEMENT OF CONTROL CIRCUIT BOARD

⚠WARNING Do not replace the Control Circuit Board with the circuit breaker in the Connected or Test Position. Turn off and lock out Main and Control Circuit Power before servicing.

⚠WARNING Confirm that the circuit breaker indicators show "DISCHARGED" (white) and "OPEN" (green) before servicing.

Tool Required: Phillips Screwdriver

Procedure:

1) Using Table 8 and Fig. 66 below, confirm the rated operating voltage of control circuit board before replacement.

NOTE: For information concerning Circuit Boards other than 3N9A0007-A contact Toshiba International Corporation.

Table 8. Control Circuit Board Voltage

Circuit Board	3N9A0007-A					
Check Point	R3 in Fig. 66					
Control Voltage	30 DC	48 DC	100/110 DC	125 DC	200/220 DC	250 DC
Resistance and Capacity	100ohm 2W	240ohm 2W	750 ohm 2W	1kohm 2W	3kohm 2W	7.5kohm 2W
1st Color Code	BROWN	RED	PURPLE	BROWN	ORANGE	PURPLE
2nd Color Code	BLACK	YELLOW	GREEN	BLACK	BLACK	GREEN
3rd Color Code	BROWN	BROWN	BROWN	RED	RED	RED
4th Color Code	GOLD	GOLD	GOLD	GOLD	GOLD	GOLD

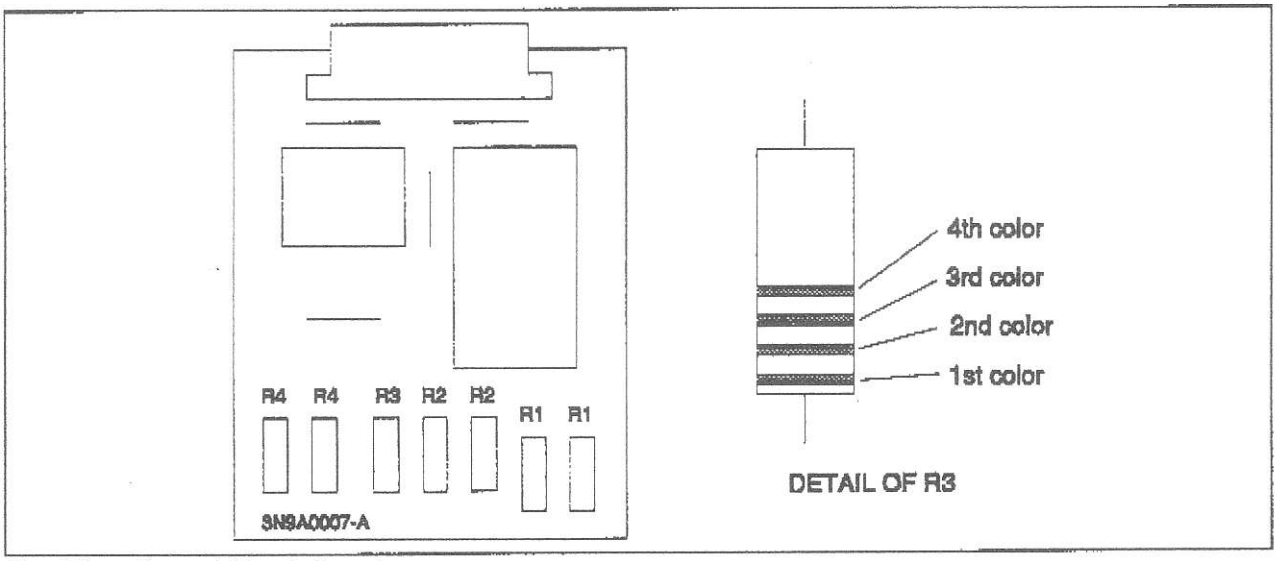


Fig. 66 Control Circuit Board

2) Remove the front cover of the circuit breaker.

3) Disconnect the wire harness connector from the control circuit board socket by pulling the connector straight out while depressing the connector tab to unlock it (Fig. 66).

⚠ CAUTION : Turning or rotating connector case or pulling on connector wires can cause contact failure.

4) Remove the thumbscrew (Fig. 67) and rotate the retaining spring downward.

5) Draw out the Control Circuit Board (Fig. 68) and replace it with the new one.

6) Rotate the retaining spring back into position and tighten the thumbscrew.

7) Push the connector into the control circuit board socket until locked in place.

8) Confirm that the circuit breaker properly operates electrically.

⚠ WARNING Unit contains powerful springs. Do not place your hands or any part of your body inside the circuit breaker or near the mechanism while the springs are CHARGED or the circuit breaker is CLOSED.

9) Confirm that the circuit breaker operates within the voltage ranges of Table 7 (Pg. 48). If the circuit breaker does not operate within the specified range, contact Toshiba International Corporation.

10) Confirm that no parts or tools are left inside the circuit breaker.

11) Replace the front cover.

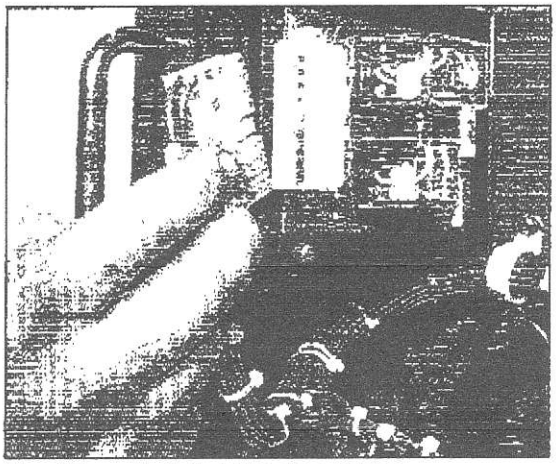


Fig. 66 Pull Out the Connector

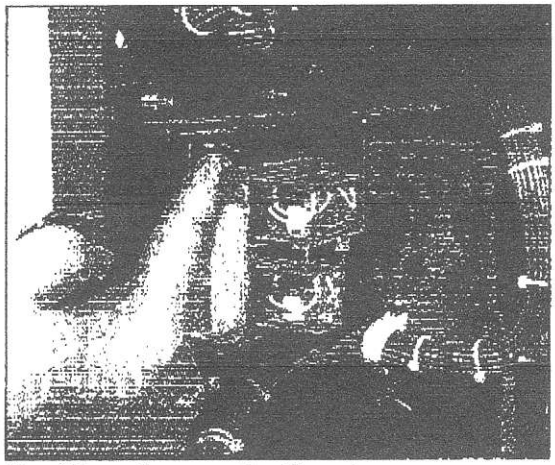


Fig. 67 Remove the Thumbscrew

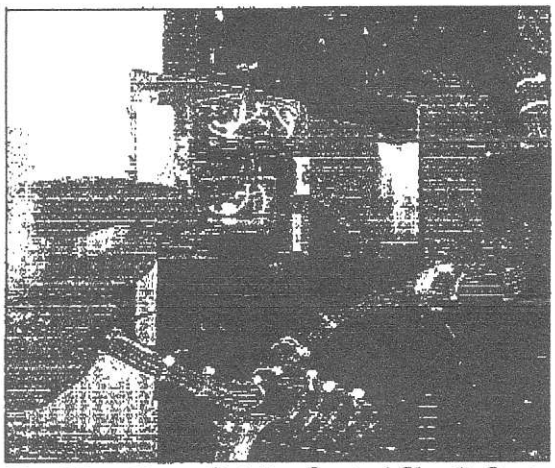


Fig. 68 Draw Out the Control Circuit Card

REPLACEMENT OF THE CONTROL CIRCUIT BOARD FUSE

⚠WARNING Do not replace the Control Circuit Board Fuse with the circuit breaker in the Connected or Test Position. Turn off and lock out Main and Control Circuit Power before servicing.

⚠WARNING Confirm that the circuit breaker indicators show "DISCHARGED" (white) and "OPEN" (red) before servicing.

PROCEDURE:

1) Confirm the rated operating voltage and rated current of fuse using Table 9 before the replacement.

Table 9. Fuse Ratings

Operating Voltage	Rated Fuse Current
30 VDC	4 Amp
48 VDC	2 Amp
100/110 VDC	1.5 Amp
125 VDC	1.5 Amp
200/220 VDC	3/4 Amp
250 VDC	3/4 Amp

2) Remove the front cover of the circuit breaker.

3) Disconnect the wire harness connector from the control circuit board socket by pulling the connector straight out while depressing the connector tab to unlock it (Fig. 69).

⚠CAUTION : Turning or rotating connector case or pulling on connector wires can cause contact failure.

4) Remove the thumbscrew (Fig. 70), rotate the retaining spring downward and draw out the Control Circuit Board (Fig. 71).

5) Replace the fuse (Fig. 72) and slide the card back into place.

6) Rotate the retaining spring back into position and tighten the thumbscrew.

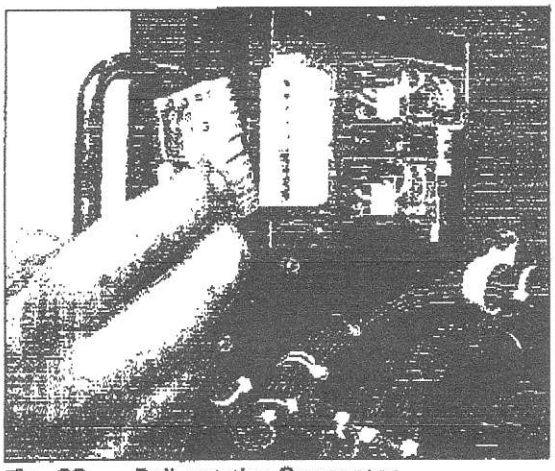


Fig. 69 Pull out the Connector

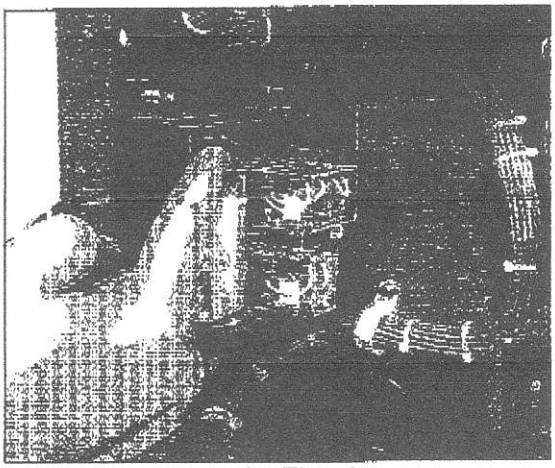


Fig. 70 Remove the Thumbscrew

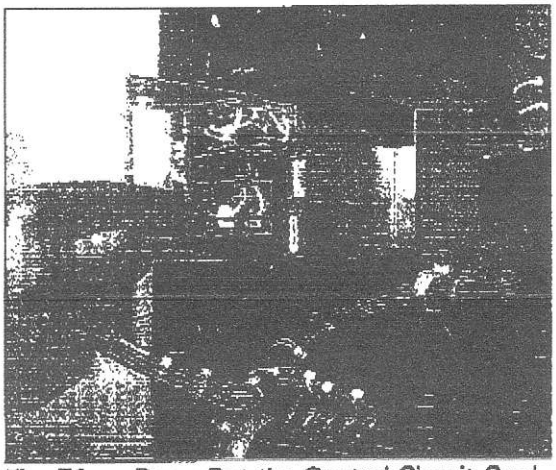


Fig. 71 Draw Out the Control Circuit Card

7) Push the connector into the control circuit board socket until locked in place.

8) Confirm that the circuit breaker properly operates electrically.

⚠WARNING : Unit contains powerful springs. Do not place your hands or any part of your body inside the circuit breaker or near the mechanism while the springs are CHARGED or the circuit breaker is CLOSED.

10) Confirm that no parts or tools are left inside the circuit breaker.

11) Replace the front cover.

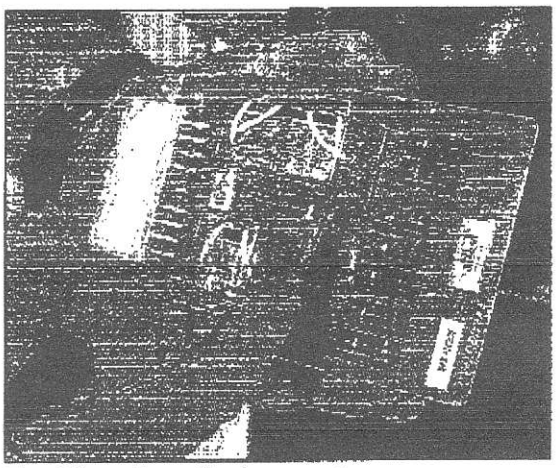
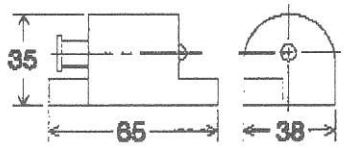
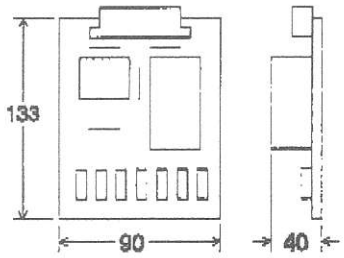
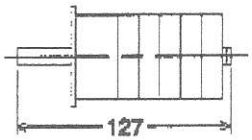
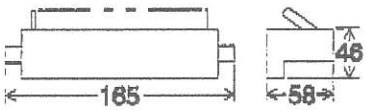
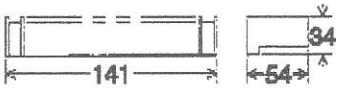


Fig. 73 Fuse Replacement

REPLACEMENT PARTS LIST

Table 10. Replacement Parts List for Common Use

NO.	Name of part	Outline (Dimensions in mm.)	QTY	Ordering Code No.	
1	Closing and Trip coil		2	250VDC	4D9A2174G001
				220/ 200VDC	4D9A2174G002
				125VDC	4D9A2174G003
				110/ 100VDC	4D9A2174G004
				50/ 48VDC	4D9A2174G005
				30VDC	4D9A2174G006
				24VDC	4D9A2174G007
2	Auxiliary relay unit		1	250VDC	4D9A2176G001
				220/ 200VDC	4D9A2176G002
				125VDC	4D9A2176G003
				110/ 100VDC	4D9A2176G004
				50/ 48VDC	4D9A2176G005
				30VDC	4D9A2176G006
3	Auxiliary switch		1	4D9A2177G004	
4	Secondary disconnects (VCB side)		2	4D9A2179G001	
5	Secondary disconnects (Cell side)		4	4D9A2179G002	

CONVERSIONS

A "conversion" is the altering of existing switchgear equipment or the components of, including the replacement of parts or materials other than the original design.

It is the responsibility of each person engaged in utilizing Toshiba vacuum circuit breaker components in conversions to determine the suitability of those components for incorporation in any particular application based upon the following considerations:

A. The electrical characteristic and design of the system in which the breaker component will operate.

B. The ratings of the Toshiba breaker component and the original breaker equipment in which it is to be installed.

C. The design and operation of all safety interlocks incorporated in the Toshiba breaker component and in the chassis or truck of the original circuit breaker.

D. The design of the cubicles in which the Toshiba breaker component and truck are to be operated.

E. The design and operation characteristics of all external switches which are to be operated by the Toshiba breaker component and truck.

In addition, all of the following safety procedures must be satisfied when Toshiba vacuum circuit breaker components are utilized in the conversions of other equipment:

1. All applicable ANSI, IEEE and NEMA standards must be adhered to. This includes, without limitation, all standards which pertain to the manufacture, assembly, installation, conversion, testing and operation of metal-clad switchgear, power switchgear, metal-clad and station-type cubicle switchgear and alternating current-high voltage circuit breakers; and
2. The mechanical and electrical designs and operation of the Toshiba vacuum circuit breaker component and the original circuit breaker to be converted must be analyzed to utilize the safest combination of interlocks incorporated in the breaker component and in the truck on which it is installed - **DO NOT REMOVE, DEFEAT, OR BYPASS ANY SAFETY INTERLOCK.**
3. Heavy gauge steel (11 gauge or heavier) must be used in all covers and barriers to envelop the unused space above and around the Toshiba vacuum circuit breaker component which was formerly occupied by the original breaker. These covers and barriers must be properly grounded, braced and affixed and must enclose the unused space as required by ANSI.
4. The ratings specified in the Toshiba vacuum circuit breaker component nameplate or system accessories such as surge suppressors or lighting arresters, etc., must never be exceeded. A short circuit analysis should be performed to insure equipment is appropriate for the available fault current.
5. All mechanically operated external switches installed on the original circuit breaker and in the cubicles in which it was used should be replaced with mechanically operated switches supplied by Toshiba International Corporation or by electronically operated external switches. The Toshiba vacuum circuit breaker component and the breaker truck on which it is installed must be properly aligned, adjusted and tested. Such alignment, adjustment and tests should be performed in the cubicles in which the Toshiba vacuum circuit breaker and breaker truck will be operated to make certain that:

(a) The breaker truck's components and all of the safety interlocks on the truck and the Toshiba vacuum circuit breaker component functions properly as originally designed; and

(b) The opening and closing of the Toshiba vacuum circuit breaker component results in proper operation of all external switches installed on the breaker component, truck and cubicle; and

(c) The operation of external switches and mechanical interlocks does not affect the opening and closing of the Toshiba vacuum circuit breaker component. Breaker opening and closing times must be in accordance with the specifications described in this manual (Pg. 20).

6. Toshiba vacuum circuit breakers must be operated only in accordance with the written instructions contained in this manual.

⚠WARNING **Failure to comply with these safety procedures can cause fire and explosion, resulting in severe injury, death and property damage.**

AUTOMATIC SPRING DISCHARGE

Automatic Spring Discharge is the discharging of the closing spring without first closing the circuit breaker. The Toshiba circuit breakers in this manual are designed and intended for **only Manual Spring Discharge,** and **only** by the following procedure.

1) Disconnect the control circuit power.

2) Depress the **"Trip Button"** (red), followed by the **"Closing Button"** (green) and then depress the **"Trip Button"** (red) once again.

If the circuit breaker that is being converted utilizes the automatic spring discharge to discharge the closing spring upon, either the insertion or withdrawal of the circuit breaker into or out of the cell, the Disconnect Position, the Test Position or the Connected Position, it is recommended that the design of the circuit breaker truck and cell be modified in a manner that will require **Manual Spring Discharge only.**

If Automatic Spring Discharge cannot be avoided, the following is strongly recommended:

(a) A counter be installed to monitor the number of Automatic Spring Discharge operations; or

A record be maintained as to the number of Automatic Spring Discharge operations that have been performed; and

(b) Maintenance should be performed on the closing spring charging gears after every 100 Automatic Spring Discharge operations.

Note: Failure to perform maintenance on the closing spring charging gears can result in the inability to charge the closing springs. This will render the circuit breaker inoperable (unable to close).

Maintenance of the closing spring charging gears should be performed only by Toshiba International Corporation only. Consult Toshiba International Corporation for further information.

VMD

The VMD (Vacuum Circuit Breaker Monitoring Device) is a device used to monitor the circuit breaker during a closing operation initiated by an electrical signal and will trip the circuit breaker open should a slow or incomplete closing operation occur. **This safety device should be installed on any Toshiba circuit breaker utilized in a conversion that uses the main opening-closing shaft for any purposes other than the normal open-close operation or the operation of a Toshiba MOC.**

⚠WARNING Do not overload the circuit breaker operating mechanism. Slow or incomplete closing of the circuit breaker can cause fire and explosion, resulting in severe injury, death and property damage.

The VMD monitors the performance of the circuit breaker during the closing operation from an electrical signal. If the circuit breaker fails to close within 100msec after an electrical closing signal has been sent, the VMD will send an electrical signal to a secondary trip coil. This coil will trip the circuit breaker open at any physical point of the closing operation and release any energy stored in the closing springs, thus reducing the chances of a serious electrical failure.

Once the VMD has performed a tripping operation, it will cut the control circuit power to the charging motor thus preventing the closing springs from being recharged. This will render the circuit breaker temporarily inoperable. The VMD will reset automatically only after the control circuit power has been interrupted.

An indicating light that protrudes slightly through the circuit breaker front cover will be illuminated if the VMD has performed a tripping operation.

Should the VMD trip the circuit breaker open, the circuit breaker must be removed from service and a thorough inspection made to determine the cause of the slow or incomplete closing of the circuit breaker. The cause of the slow or incomplete closing must be corrected before placing the circuit breaker back in service.

⚠WARNING Do not reset the VMD or attempt circuit breaker operation until the cause of slow or incomplete closing has been determined and corrected. Failure to do so can cause fire and explosion, resulting in severe injury, death and property damage.

Refer to the VMD manual GF077680 for more information regarding operation and maintenance.

WARRANTY AND LIMITATION OF LIABILITY

Toshiba International Corporation ("Company") warrants that all equipment and parts described herein will be free from defects in materials and workmanship. THIS WARRANTY WILL EXPIRE EIGHTEEN (18) MONTHS AFTER THE DATE ON WHICH SUCH EQUIPMENT AND PARTS (EXCLUDING REPAIRED OR REPLACEMENT EQUIPMENT AND PARTS FURNISHED PURSUANT TO THIS WARRANTY) ARE SHIPPED BY THE COMPANY TO THE INITIAL PURCHASER OR TWELVE (12) MONTHS AFTER SUCH EQUIPMENT AND PARTS (EXCLUDING REPAIRED OR REPLACEMENT EQUIPMENT AND PARTS FURNISHED PURSUANT TO THIS WARRANTY) ARE FIRST PLACED IN OPERATION, WHICHEVER PERIOD FIRST EXPIRES.

The Company will, at its option, repair or replace any such equipment or part which is defective under the terms of the foregoing warranty, free of charge; provided the purchaser (1) promptly notifies the Company in writing of such defect, and (2) furnishes the Company satisfactory proof thereof, and (3) establishes that the equipment or part has been properly installed, maintained and operated within the limits of rated capacity and normal usage and in accordance with this manual, and (4) if requested by the Company, returns the defective equipment or part to the Company and pays all expenses incurred in connection with such return. The repaired or replacement equipment or part will be delivered, free of charge, to the purchaser F.O.B. the Company's warehouse or, at the Company's option, F.O.B. a Company authorized service shop, not loaded on truck or other carrier. The purchaser will pay the costs applicable to the equipment or part following such delivery, including, without limitation, all handling, transportation, assembly, insurance, testing and inspection charges.

THE FOREGOING OBLIGATION TO REPAIR OR REPLACE EQUIPMENT AND PARTS SHALL BE THE SOLE AND EXCLUSIVE REMEDY OF THE PURCHASER, ITS CUSTOMERS AND USERS OF THE EQUIPMENT AND PARTS FOR BREACH OF THE FOREGOING WARRANTY. THE COMPANY SHALL HAVE NO OBLIGATIONS TO DISASSEMBLE ANY EQUIPMENT OR PART WHICH IS DEFECTIVE WITHIN THE TERMS OF THE ABOVE WARRANTY OR TO INSTALL ANY REPAIRED OR REPLACEMENT PART OR EQUIPMENT OR TO PAY ANY COSTS INCURRED IN CONNECTION WITH SUCH DISASSEMBLY OR INSTALLATION. THE COMPANY, TOSHIBA CORPORATION AND THEIR SUPPLIERS AND SUBCONTRACTORS HEREBY DISCLAIM ALL OTHER EXPRESS, STATUTORY AND IMPLIED WARRANTIES, INCLUDING, WITHOUT LIMITATION, ALL EXPRESS, STATUTORY AND IMPLIED WARRANTIES APPLICABLE TO REPAIRED OR REPLACED EQUIPMENT AND PARTS FURNISHED PURSUANT TO THE FOREGOING WARRANTY AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY.

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