

TemPower

INSTRUCTION MANUAL FOR AR-E AIR CIRCUIT BREAKERS (Fixed type and Type AGR-12B Overcurrent Protective Device)



**Types: AR206E
AR208E
AR210E
AR212E
AR216E**

Notice

- Be sure to read this manual before installing, operating, servicing, or inspecting the ACB.
- Please retain this manual for future reference.
- Electrical work must be done by competent persons.
- ACB maintenance, inspection, parts replacement, OCR field tests and setting changes must be performed by competent persons.

TERASAKI ELECTRIC CO., LTD.

TABLE OF CONTENTS

1. SAFETY NOTICES	5
2. RECEIVING AND HANDLING	7
2-1. Transportation Precautions	7
2-1-1. Transporting the ACB	7
2-2. Storage Precautions	8
2-3. Installation Precautions	8
3. GENERAL	10
3-1. Types and Descriptions	10
3-2. Parts and Functions	12
3-3. Circuits and Ratings	15
4. OPERATION	19
4-1. Charging and Opening operation	19
4-1-1. Charging operation	19
4-1-2. Closing operation	20
4-1-3. Opening operation	20
4-1-4. Motion of trip indication and spring charge indication switches	20
4-1-5. Motion of operation mechanisms	21
4-2. ON-OFF Button Cover Locking Procedure	23
4-3. Lock in OFF Procedure	23
4-4. OCR Cover Locking Procedure	24
5. OVERCURRENT RELEASE (OCR)	24
5-1. Specifications	24
5-2. Characteristics	25
5-2-1. L characteristic for general feeder	25
5-3. OCR Setting Procedure	27
5-4. Operation Indication	28
6. MAINTENANCE, INSPECTION AND PARTS REPLACEMENT	29
6-1. Inspection Procedures	30
6-2. Parts Replacement Procedure	33
6-2-1. Preparation	33
6-2-2. Arc chambers	36
6-2-3. Latch release coil (LRC)	37
6-2-4. Instantaneously-rated shunt trip device (SHT)	38
6-2-5. Control relay	39
6-2-6. Magnet hold trigger (MHT)	41
6-2-7. Auxiliary switches	42
7. TROUBLESHOOTING FLOWCHARTS	43

1. SAFETY NOTICES

Thank you for purchasing the TERASAKI AR-series Air Circuit Breaker (*TemPower2*).

This chapter contains important safety information.

Be sure to carefully read these safety notices, instruction in this manual, and other documents accompanying the Air Circuit Breaker (hereinafter referred to as the ACB) to familiarize yourself with safe and correct procedures or practices before installing, operating, or servicing the ACB.

In this manual, safety notices are divided into “DANGER” and “CAUTION” according to the hazard level:



: A danger notice with this symbol indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



: A caution notice with this symbol indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury and/or property damage.

Note that failure to observe a caution notice could result in serious injury/damage in some situations. Because safety notices contain important information, be sure to read and observe them.

■ Transportation Precaution



DANGER

- Never stand under the ACB that has been lifted or suspended by the lifting attachments. The weight of the ACB may cause serious injury.

■ Installation Precautions



CAUTION

- Electrical work must be done by competent persons.
- Do not place the ACB in such an area that is subject to high temperatures, high humidity, dusty air, corrosive gases, strong vibration and shock, or other unusual conditions. Mounting the ACB in such an area could cause a fire or malfunction.
- Be careful to prevent foreign objects (such as debris, concrete powder, dust, chippings, and iron powder) and oil or rainwater from entering the ACB. These materials inside the ACB could cause a fire or malfunction.
- Prior to commencing any work on the ACB, open an upstream circuit breaker or the like to isolate all sources of power/voltage. Otherwise, electric shock may result.
- Fix the ACB firmly on a flat, level surface using mounting screws. Otherwise, the ACB may cause to fall, resulting in damage to the ACB or personal injury.
- When terminating conductors to the ACB, tighten terminal screws to the torque specified in this manual. Otherwise, a fire could result.
- For 4-pole ACBs, be sure to connect a 3-phase, 4-wire neutral conductor to the N-phase pole (on the right end). Otherwise, an overcurrent may hinder the ACB from tripping, resulting in a fire.

■ Operation Precautions



DANGER

Never touch live terminal parts. Doing so will result in electric shock.



CAUTION

- Do not force down the charging handle after completion of manual charging operation. Doing so may cause a malfunction.
- The permissible operating voltage of the spring charging motor is 85 to 110% of the rated ac voltage or 75 to 110% of the rated dc voltage. Be sure to supply a voltage within the above ranges to the motor. Otherwise, a malfunction, burnout, or fire may result.

■ Operation Precautions (continued)

CAUTION

- Repeated open/close operation by the motor charging mechanism without pause should not exceed 15 times. If repeated continuous open/close operation is inevitable, a pause of at least 20 minutes should be provided after the repetitions of 15 times. Otherwise, a spring charging motor may be burnt out.
- Do not bring your hand or face close to arc gas vent of the arc chamber while the ACB is closed. Otherwise, a burn may result from high-temperature arc gas blowing out of the arc gas vent when the ACB trips open.
- If the ACB trips open automatically, remove the cause of tripping operation before re-closing the ACB. Otherwise, a fire could result.

■ OCR (Overcurrent Release) Handling Precautions

CAUTION

- OCR setting changes must be performed by competent persons.
- After setting changes are made, the settings be checked with e.g., a type ANS2S OCR test interface unit (optional).
- After completion of OCR tests, be sure to return the settings to the original values. Failure to do so may cause a fire or burnout.
- Before changing OCR settings, open the ACB and then lock the OFF button to prevent the ACB from being closed inadvertently.
- Use a small flatblade screwdriver with a torque of not more than 0.1 N·m or a force of not more than 0.1 N when adjusting the setting switches (rotary step switches or slide switches). An excessive torque or force may cause a malfunction.

■ Maintenance and Inspection Precautions

CAUTION

- ACB maintenance, inspection and parts replacement must be performed by competent persons.
- Do not touch ACB current carrying parts and ACB structural parts close to a current carrying part immediately after the ACB trips open. Remaining heat may cause a burn.
- Prior to commencing any work on the ACB, open an upstream circuit breaker or the like to isolate all sources of power/voltage from the main and control circuits. Otherwise, electric shock may result.
- Prior to commencing maintenance, inspection, or parts replacement, make sure that the closing springs are released and the ACB is open. Otherwise, unintentional open/close operation may lead to fingers or tools to be pinched by the open/close mechanism, resulting in injury.
- Retighten the terminal screws periodically to the specified torque. Otherwise, a fire could result.
- When grinding a contact tip, be careful to prevent grinding dust from entering the breaker operating mechanism. Wipe the tip clean after grinding. Otherwise, a malfunction or fire could result.
- Do not perform dielectric withstand tests under other conditions than specified. Doing so may cause a malfunction.
- Be sure to reinstall the arc chamber if removed. Failure to do so or incorrect installation of the arc chamber may result in a fire or burn.
- When charging the closing springs or performing open/close operation of the ACB with the arc chamber, front cover and/or side covers removed during maintenance or inspection work, do not touch parts other than those required for the above operation (charging handle, ON/OFF buttons, moving core and the like). Doing so may cause fingers or tools to be pinched, resulting in injury.
- When replacing an auxiliary, do not damage the control wire for the auxiliary or pinch the wire between the auxiliary and the breaker body. Doing so may cause a malfunction.

2. RECEIVING AND HANDLING

Upon receipt of your ACB, check the following. If you have any question or problem, contact us at the indicated on the back cover of this manual.

- Check that the ACB received is as ordered and that the accessories are as specified.
- Check that the ACB is not damaged during shipment.

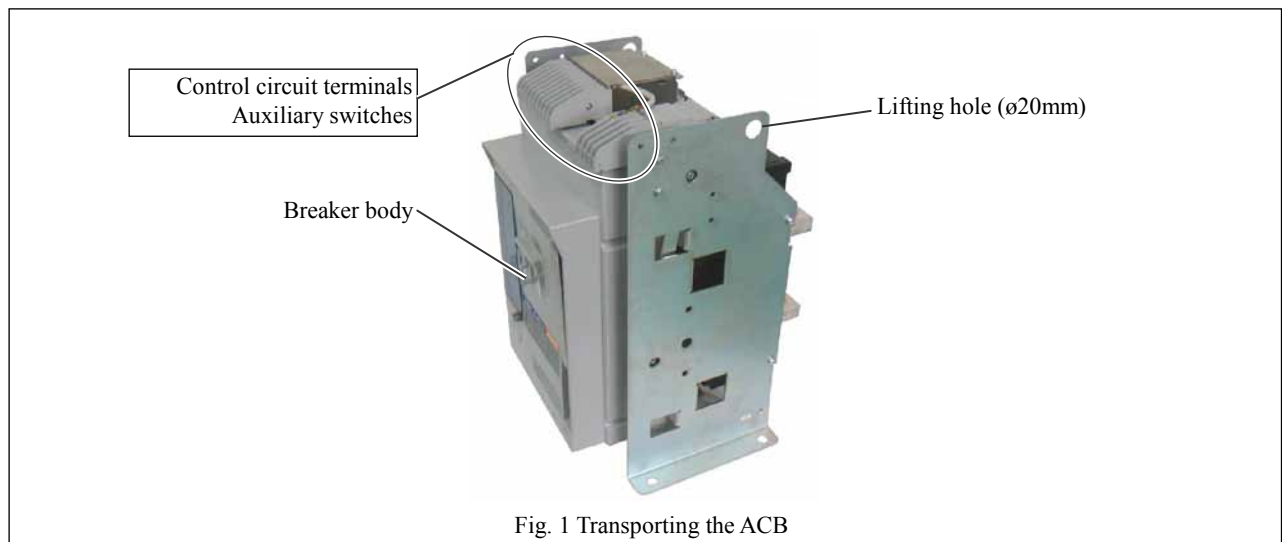
2-1. Transportation Precautions

DANGER

- Never stand under the ACB that has been lifted or suspended by a lifting attachments. If the ACB body is accidentally dropped, its weight may cause serious injury.

2-1-1. Transporting the ACB

- When lifting the ACB, hold it using lifting attachments or wire ropes through the lifting holes. Take care that the control circuit terminals, auxiliary switches, arc gas barrier and control terminal block cover which are shown in Fig. 1 are not damaged by the lifting rope. Lift the ACB carefully and gently. For transportation, place the ACB on a pallet and carry slowly and carefully.
- Avoid shock and vibration to the ACB during transportation.
- Do not lay the ACB during transportation.
- When transporting the ACB over great distances, crate it for protection against shock and vibration and secure the crate package with wood or ropes.
- Lower the ACB onto a flat, level surface.




2-2. Storage Precautions

It is recommended that the ACB be used as soon as you have received it. If it is necessary to store the ACB, note the following:

- Store the ACB in a dry indoor location to prevent condensation due to sudden changes in ambient temperature. Condensation has a harmful effect on the ACB insulation.
- Store the ACB in a clean place free of corrosive gases and dust. In particular, exposure to a mixture of moisture and cement dust may cause corrosion damage to metal parts of the ACB.
- Place the ACB on a flat, level surface in its normal position (Do not lay the ACB).
- Do not place the ACB directly on the floor. Do not stack the ACBs during storage.

2-3. Installation Precautions


CAUTION

- Electrical work must be done by competent persons.
- Do not place the ACB in such an area that is subject to high temperatures, high humidity, dusty air, corrosive gases, strong vibration and shock, or other unusual conditions. Mounting the ACB in such an area could cause a fire or malfunction.
- Be careful to prevent foreign objects (such as debris, concrete powder, dust, chippings, and iron powder) and oil or rainwater from entering the ACB. These materials inside the ACB could cause a fire or malfunction.
- Prior to commencing any work on the ACB, open an upstream circuit breaker or the like to isolate all sources of power/voltage. Otherwise, electric shock may result.
- When terminating conductors to the ACB, tighten terminal screws to the torque specified in this manual. Otherwise, a fire could result.
- For 4-pole ACBs, be sure to connect a 3-phase, 4-wire neutral conductor to the N-phase pole (on the right end). Otherwise, an overcurrent may hinder the ACB from tripping, resulting in a fire.

- Do not install the ACB in such an area that is exposed to direct sunlight.
- Make sure that the mounting base has a sufficient capacity of bearing the weight of the ACB (see Table 3). The mounting base must be protected against vibration. Take appropriate measures to provide a perfect protection to the mounting base against resonance. Otherwise, open/close operation of the ACB may cause a malfunction of other devices in the switchboard or vibrations of the switchboard may cause a malfunction of the ACB.
- Use the following screws with appropriate length for the main circuit terminals.

Main circuit terminal screws: Hex head M10, with flat washers (2), spring washer (1) and nut (1) per screw

Tightening torque: 22.5 - 37.2 N·m

Table 1 Number of main circuit terminal screws required

ACB type	AR206E - AR216E	
Number of main circuit terminal screws (3/4-pole)	Vertical, Horizontal, Front terminals	12/16

- Use the following screw for the ground terminal. The screw must have a length that allows it to be inserted 4 - 9 mm into the ground terminal M8 tapped hole.

Ground terminal screw: M8 (1) with spring washer and flat washer

Tightening torque: 11.8 - 14.7 N·m

- Use a support to hold conductors securely at distance L as shown in Fig. 2 and Table 2. Such a support will help preventing the conductors and main circuit terminals from being deformed or damaged due to a large electromagnetic force caused by any fault current.

Table 2 The maximum distance of the connection point of ACB to the first conductor support

		Short-circuit current (kA)		
		30	50	
L (mm)	AR206E - AR216E	Horizontal terminals	200	150
		Vertical terminals	150	100

The figure contains three diagrams illustrating support mounting. The first diagram shows 'Horizontal terminals' with an ACB on the left and three horizontal conductors extending to the right. A support is positioned at a distance L from the ACB. The second diagram shows 'Vertical terminals' with an ACB on the left and three vertical conductors extending upwards. A support is positioned at a distance L from the ACB. The third diagram shows 'Vertical terminals' with an ACB on the left and three vertical conductors extending upwards. A support is positioned at a distance L from the ACB. Labels include 'ACB', 'Conductor', 'Support', and 'L'.

Fig. 2 Support mounting

Tighten the terminal screw of control circuit terminals and auxiliary switches according to the Fig.3 torque.

The image shows a close-up of a terminal block on a device. A callout points to a wire connected to a terminal, labeled 'Wire for anti-burnout switch of instantaneously-rated Instantaneously-rated shunt trip device'. Another callout points to a terminal screw, labeled 'Auxiliary switch terminal screw (Control terminal screw) Pan head M4 x 8, with spring washer and terminal washer Tightening torque: 1.3 - 1.7 N·m'. The device has 'DANGER' and 'CAUTION' labels.

Fig. 3 Control terminal screw, Auxiliary switch terminal

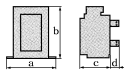
- If any work is done near the ACB that have been installed, protect the openings of the ACB with appropriate covers to prevent spatters, metal chips, wire cuttings or other foreign objects from entering the ACB.

3. GENERAL

3-1. Types and Descriptions

TemPower2 is available in types shown in Tables 3.

Table 3 Ratings

Frame size (A)		630		800		1000		1250		1600					
Type		AR206E		AR208E		AR210E		AR212E		AR216E					
Max. rated current [I_n] (A) *1, *2		JIS, IEC, EN, AS *5		630		800		1000		1250		1600			
N-phase rated current (A)		630		800		1000		1250		1600					
Number of poles *3, *4		3 4		3 4		3 4		3 4		3 4		3 4			
Dielectric withstand voltage [U_i] (50/60Hz)		1000		1000		1000		1000		1000					
Operating voltage [U_o] (50/60Hz)		690		690		690		690		690					
Rated breaking/making current [kA sym rms/kA peak]															
JIS, IEC, EN, AS [$I_{cs} = I_{cu}$]		AC690V *6										30/63			
		AC440V										50/105			
JEC		AC550V										30/63			
		AC460V										50/105			
		AC220V										50/105			
Rated short-time current [I_{cw}] [kA rms]		0.5 sec										50			
		1 sec										42			
Rated latching current (kA)												42			
Endurance in number of ON-OFF cycles *7		Mechanical		With maintenance								20000			
				Without maintenance								10000			
		Electrical		Without maintenance		AC460V		10000		5000					
						AC690V		7000		3500					
Installation												Fixed type			
Mass (kg)		35		42		35		42		38		45			
External dimensions (mm)															
Fixedtype *2 		a		356		441		356		441		356		441	
		b												460	
		c												272	
		d												63	
Connection method		Line side		Vertical, horizontal or front terminals											
		Load side		Vertical, horizontal or front terminals											
Control circuit terminal type												screw terminals			
Spring charging method												Manual or motor charging			
Overcurrent release (OCR)												No OCR, or L-characteristic for general feeder protection			
Operation indication												Group indication			
Tripping device		Tripping coil (MHT)										Standard equipment for OCR-equipped ACB			
		Instantaneously-rated Instantaneously-rated shunt trip device (SHT)										Optional			
		undervoltage trip device (UVT)										Optional			
Auxiliary switches		Number of switches		4C (standard), 7C or 10C; available for general feeder or microload											
		Terminal type		screw terminals											
Rated voltage		Operation power		AC100V, AC110V, AC120V, AC200V, AC220V, AC240V		DC24V, DC48V, DC100V, DC110V, DC125V, DC200V or DC220V									

*1: Ambient temperature: 40°C

*2: For both horizontal terminals

*3: For 2-pole applications, use two poles at both ends.

*4: 4-pole ACBs are not applicable to power distribution IT systems unless N-phase protection is provided.

*5: Comply with JIS C 8201-2-1 Ann.1 Ann.2

*6: Protection can not apply IT earthing system.

*7: Expected service life based on endurance test. The service life of ACB depends on the working and environmental conditions. Refer to chapter 6 "Maintenance, Inspection and Parts Replacement".

Use the ACBs in the environmental conditions specified in Table 4.

Table 4 Operating environment

Standard environment (Standard equipped ACBs)	Altitude	2000 m max.
	Ambient temperature	-5°C to +45°C
	Humidity	45 to 85% rel. max.
	Vibration	0.7G max.
	Shock	200 m/s ² (20G) max.
Special environment (Optional)	Atmosphere	No excessive water vapor, oil vapor, dust, or corrosive gases. No sudden change in temperature and no condensation. Ammonia (NH ₃): 0.5 ppm max, Hydrogen sulfide (H ₂ S)/sulfur dioxide (SO ₂)/hydrogen chloride (HCl): 0.1 ppm max., Chlorine (Cl ₂): 0.05 ppm max.
	Tropical environment package	Different from standard ACBs in that Ambient temperature: 60°C max. and Humidity: 95% rel. max. (no condensation)
	Cold environment package	Different from standard ACBs in that Ambient temperature: -25°C min. for use and -40°C min. for storage (no condensation)
	Corrosion-resistant package	Different from standard ACBs in that NH ₃ : 50 ppm max, H ₂ S: 10 ppm max., SO ₂ /HCl: 5 ppm max., and Cl ₂ : 1 ppm max.

Table 5 shows the dielectric withstand voltage and the insulation resistance of the ACBs.


 CAUTION
● Do not perform dielectric withstand/insulation resistance tests under other conditions than specified. Doing so may cause a malfunction.

Table 5 Dielectric withstand voltage and insulation resistance

Circuit		Dielectric withstand voltage (50/60Hz)			Impulse withstand voltage U_{imp}	Insulation resistance (DC500V Megger used)
Main circuit		Between poles, and terminal group and ground	AC3500V	1 minute	12kV	300MΩ
Control circuit	Auxiliary switches	For general feeder	AC2500V	1 minute	6kV	100MΩ
		For microload	AC2000V	1 minute	4kV	100MΩ
	Overcurrent release		AC2000V	1 minute	4kV	100MΩ
	Undervoltage trip device		AC2500V	1 minute	6kV	100MΩ
Other accessories		Between terminal group and ground	AC2000V	1 minute	4kV	100MΩ

The above data applies to new ACBs. Device terminals within ACBs are not covered. Use a DC500V Megger to measure the insulation resistance.

Table 6 shows the internal resistance and power consumption of the ACBs.

Table 6 Internal resistance and power consumption

Type	AR206E	AR208E	AR210E	AR212E	AR216E
Frame size (A)	630	800	1000	1250	1600
DC internal resistance (mΩ) (for 1-pole ACB)	0.027	0.027	0.027	0.024	0.024
AC power consumption (W) (for 3-pole ACB)	45	75	120	175	260

Table 7 shows applicable current of the ACBs. The applicable current varies depending on the ambient temperatures.

Table 7 Dependence of applicable current on ambient temperature

Type		AR206E	AR208E	AR210E	AR212E	AR216E
Standard	Conductor size	2 × 40 × 5t	2 × 50 × 5t	2 × 60 × 5t	2 × 80 × 5t	2 × 100 × 5t
	Ambient temperature (°C)					
IEC60947-2	40 (standard ambient temperature)	630	800	1000	1250	1600
EN60947-2	45	630	800	1000	1250	1530
AS3947-2	50	630	800	1000	1250	1470
JISC8201-2-1	55	630	800	1000	1250	1400
	60	630	800	970	1210	1330

Notes: Values with horizontal terminals.

Above figures are subject to the design of the enclosure and rating of conductor.

3-2. Parts and Functions

Fig. 4 provides a general views of the ACB.

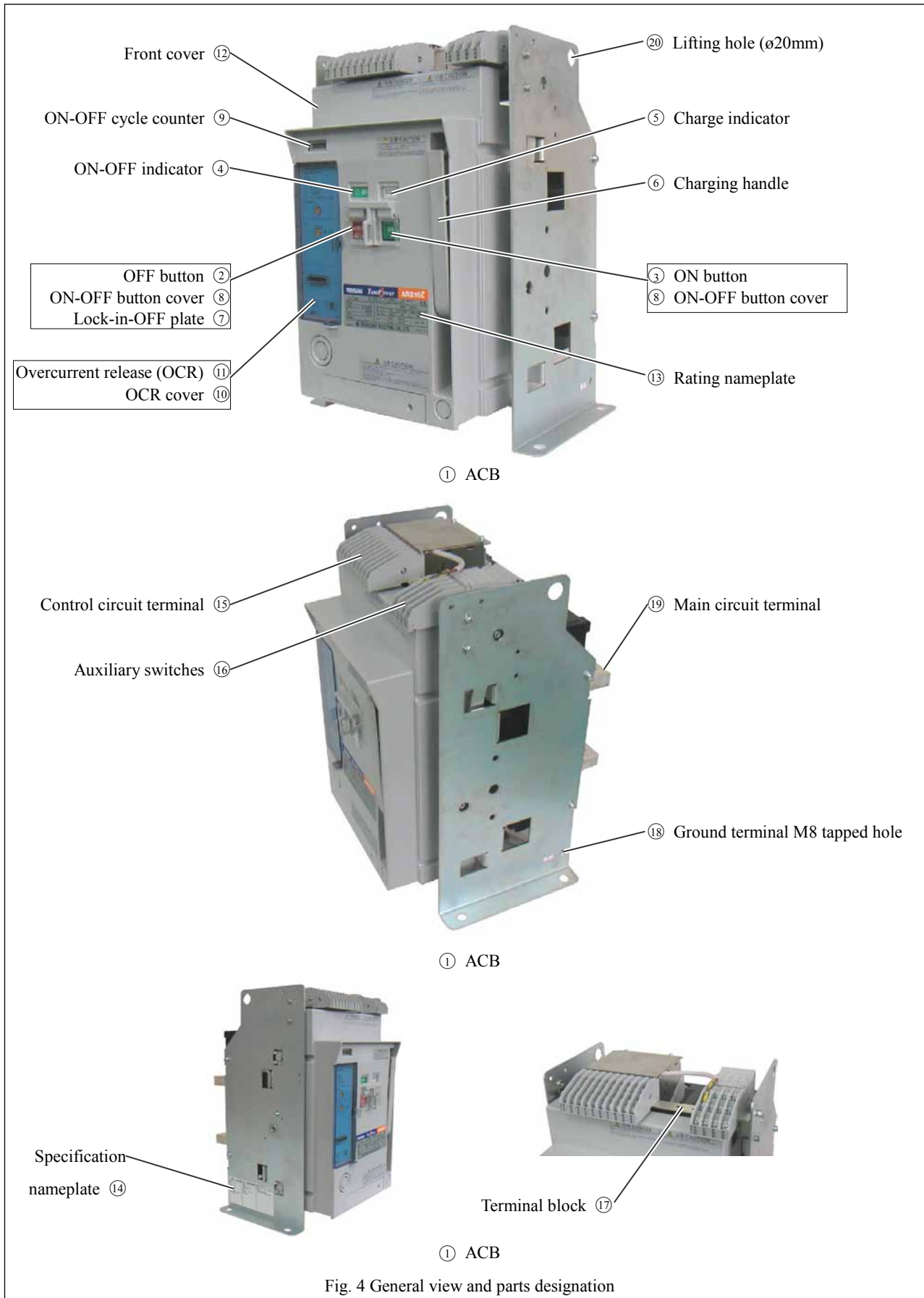


Fig. 4 General view and parts designation

①	ACB	ACB body
②	OFF button	Push to open the ACB.
③	ON button	Push to close the ACB.
④	ON-OFF indicator	Shows “OFF” when the ACB is open and “ON” when it is closed.
⑤	Charge indicator	Shows “CHARGED” when the closing springs are charged and “DISCHARGED” when it is released.
⑥	Charging handle	Pump to charge the closing springs.
⑦	Lock-in-OFF plate	Padlocking this plate allows the ACB to be locked in the open (OFF) state. (Padlocks are not supplied. Use padlocks with a 6 mm-diameter shackle.)
⑧	ON-OFF button cover	Provides protection against inadvertent button operation and can be padlocked. (Padlocks are not supplied. Use padlocks with a 6 mm-diameter shackle.) Up to three padlocks can be installed.
⑨	ON-OFF cycle counter (optional)	Reads the number of ON-OFF cycles. It counts a series of operations from close to open as one cycle.
⑩	OCR cover	Padlocking this plate prevents settings of overcurrent release ⑪ to be inadvertently changed. (Padlocks are not supplied. Use padlocks with a 6 mm-diameter shackle.)
⑪	Overcurrent release (OCR) (optional)	This protective device is supplied power via the CT for overcurrent installed in the ACB main circuit. When the CT detects an overcurrent in the main circuit, the OCR instructs the magnet hold trigger (MHT) to trip open the ACB.
⑫	Front cover	A plastic cover of the breaker body front panel.
⑬	Rating nameplate	Indicates the type, applicable standards and rated breaking capacity of the ACB.
⑭	Specification nameplate	Indicates the number of poles, operation method, accessories, and serial number of the ACB.
⑮	Control circuit terminals	Allow connections of external control wire to the control circuits. Wire connections are made through M4 screw terminals. Fig. 5 shows the control circuit terminals.



Fig. 5 Control circuit terminals

⑯	Auxiliary switches (optional)	Indicate the state of the ACB (ON or OFF). The auxiliary switches are available in 4C configuration (standard), or 7C or 10C configuration (optional). Connections to the switches are made through M4 screw terminals.
⑰	Terminal block	Contains control circuit terminals ⑮, and auxiliary switches.⑯
⑱	Ground terminal M8 tapped hole	Allows connection of a ground terminal.
⑲	Main circuit terminals	Allow connections of external conductors. These terminals are available in three configurations as shown in Fig. 6.



Vertical terminals



Horizontal terminals



Front terminals

Fig. 6 Main circuit terminals

⑳ Lifting hole (ø20mm)

Allows lifting attachments or wire ropes to be used for lifting the ACB.

3-3. Circuits and Ratings

Fig. 7 shows an ACB circuit diagram and Table 8 and Fig. 8 show the function of each terminal and the meaning of each sign in the diagram.

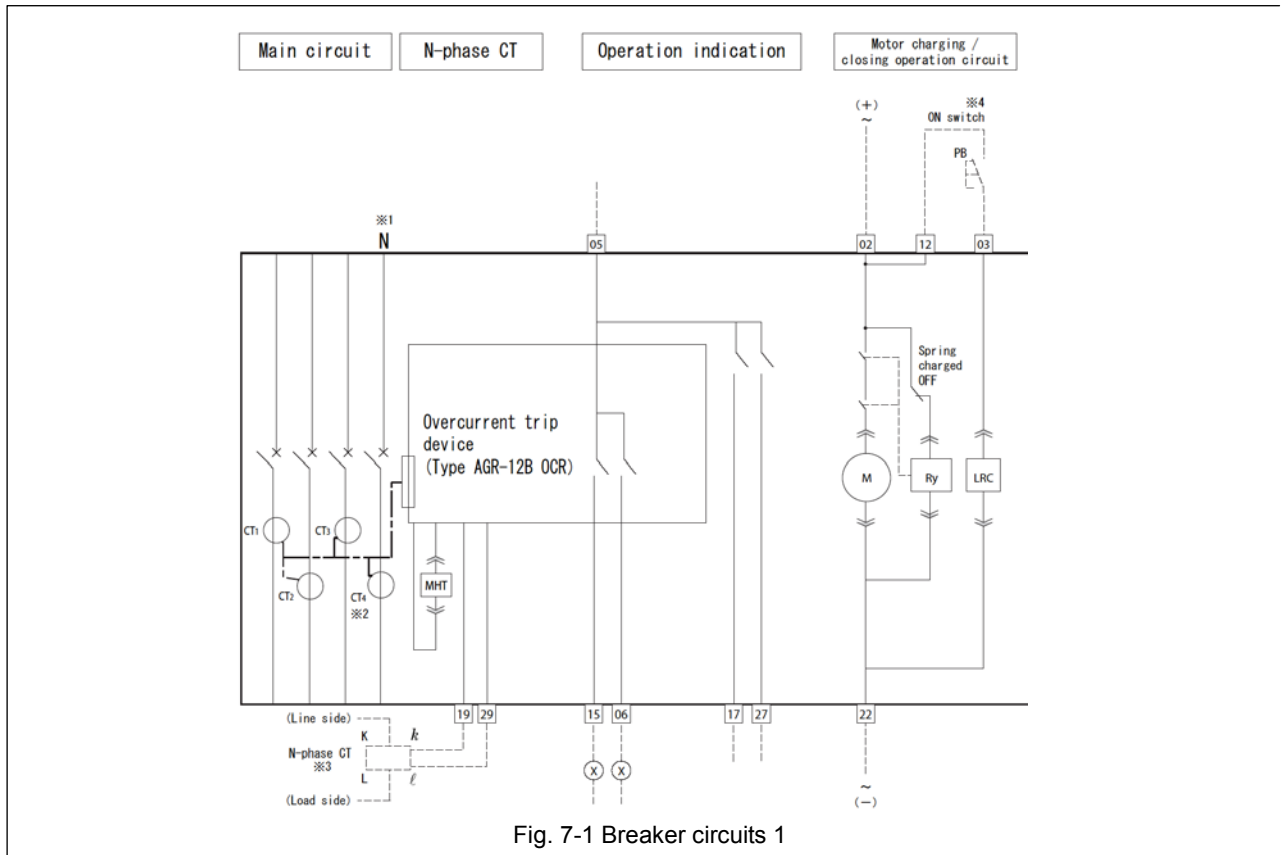


Fig. 7-1 Breaker circuits 1

Table 8-1 Terminal functions and circuit symbols 1 (Applicable to both 50 and 60Hz for AC. ⊕ and ⊖ mean the polarity for DC)

Terminal No.	Function	
02 ⊕ , 22 ⊖	AC100 - 120V, AC200 - 240V, DC100 - 125V, DC200 - 250V, DC24V or DC48V (To be stated when ordering)	Operation power input terminals
03 , 12	ON switch	Operation switch terminals
05 , 15	Group indication	Operation indication contact output terminals
05 , 17	Trip indication	
05 , 27	Spring charged indication	
10 , 20	AC100V, AC110V, AC120V, AC200V, AC220V, AC240V, DC24V, DC48V, DC100V, DC110V, DC125V, DC200V or DC220V (To be stated when ordering)	Instantaneously-rated shunt trip device power input terminals
08 , 09 , 18 , 28	AC100V, AC200V or AC400V unit (To be stated when ordering) Connect the unit to the applicable terminal Nos.	Undervoltage trip device power input terminals
	Terminal No. AC100V unit AC200V unit AC400V unit	
	08 , 09 AC100V AC200V AC380V	
	18 , 09 AC110V AC220V AC415V	
24 , 30	OFF switch	Undervoltage trip
19 , 29	Polarity: 19 k , 29 l	N-phase CT connection terminals *3
01 04 06 07 11 13 14 16 21 23 25 26	—	(Reserved)

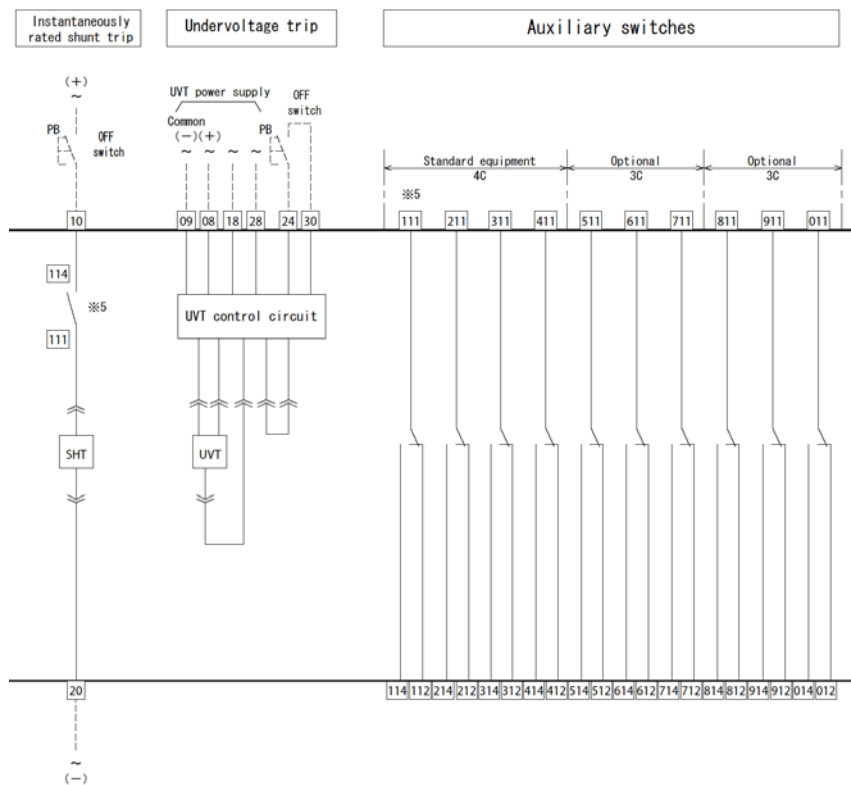


Fig. 7-2 Breaker circuits 2

Table 8-2 Terminal functions and circuit symbols 2

Symbol	Meaning	Symbol	Meaning
CT ₁ – CT ₄	CT for OCR *6	SHT	Instantaneously rated Instantaneously-rated shunt trip device *5
MHT	Magnet hold trigger	UVT	Undervoltage trip device
M	Spring charging motor	←←	Hand connector
Ry	Control relay	-----	User wiring
LRC	Latch release coil	-⊗-	Relay or LED

- *1: For 4-pole ACBs
- *2: For 4-pole ACBs equipped with N-phase protection and/or ground fault trip functions.
- *3: Used for 3-pole ACBs with ground fault trip functions to be installed in a 3-phase, 4-wire circuit.
- *4: Do not connect the ON switch with auxiliary switch b-contact in series. Doing so may cause pumping.
- *5: To be connected to auxiliary switch terminals 111 and 114 to prevent burnout.
- *6: Conversion ratio: CT rated primary current I_n (A)/100mA

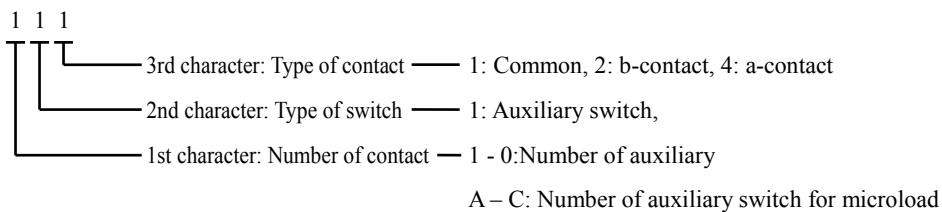


Fig. 8 Terminal number and function of auxiliary

Fig. 9 provides the terminal arrangement of the ACB.

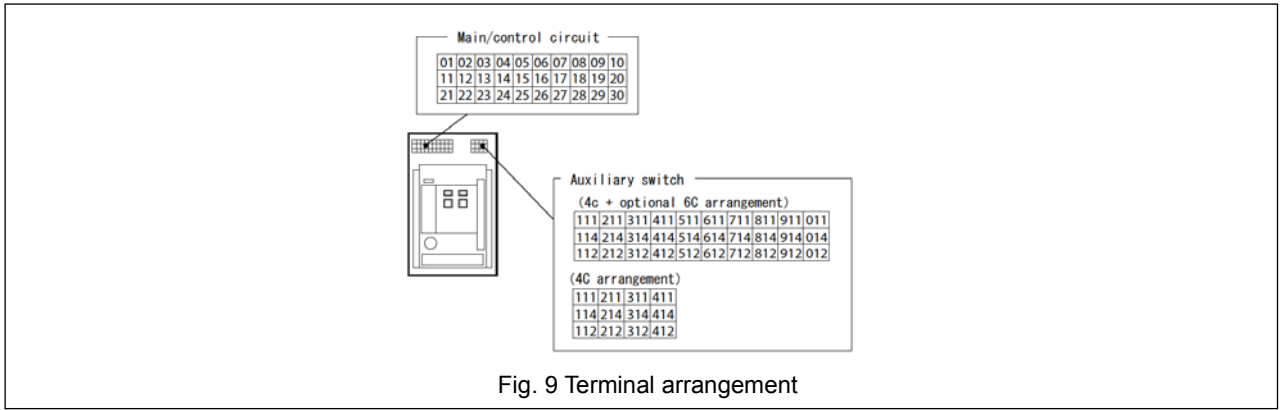


Fig. 9 Terminal arrangement

Tables 9 - 14 show the ratings of the operation power supply, the Instantaneously-rated shunt trip device (SHT), the undervoltage trip device (UVT), auxiliary switches, operation indication contacts, and the N-phase CT.

Table 9 Ratings of operation power supply

Rated voltage (V)	Permissible charging/closing voltage range	Ratings of operation power supply			
		Peak motor starting current (A)	Steady-state motor current (A)	Peak making current (A)	Latch release coil (LRC) resistance (ohm) *
AC100	85 - 110	7	1.1	0.29	300-380
AC110	94 - 121	7	1.1	0.25	350-440
AC120	102 - 132	7	1.1	0.22	440-540
AC200	170 - 220	4	0.7	0.15	1130-1390
AC220	187 - 242	4	0.7	0.13	1410-1740
AC240	204 - 264	4	0.7	0.11	1710-2090
DC24	18 - 26	14	4	1.04	20-26
DC48	36 - 53	10	1.6	0.51	85-105
DC100	75 - 110	6	0.8	0.25	350-440
DC110	82 - 121	6	0.8	0.22	440-540
DC125	93 - 138	6	0.8	0.21	540-680
DC200	150 - 220	4	0.5	0.13	1410-1740
DC220	165 - 242	4	0.5	0.12	1710-2090

* Ambient temperature: 20°C

Table 10 Ratings of Instantaneously-rated shunt trip device (SHT)

Rated voltage (V)	Permissible voltage range (V)	Peak exciting current (max.) (A)	Coil resistance (ohm) *	Max. contact parting time (ms)
AC100	70 - 110	1.6	32-40	50
AC110	77 - 121	1.8	32-40	
AC120	84 - 132	1.9	32-40	
AC200	140 - 220	0.63	135-170	
AC220	154 - 242	0.69	135-170	
AC240	168 - 264	0.76	135-170	
DC24	16.8 - 26.4	2.4	8.9-11	
DC48	33.6 - 52.8	1.3	32-40	
DC100	70 - 110	0.64	135-170	
DC110	77 - 121	0.70	135-170	
DC125	87.5 - 137.5	0.80	135-170	
DC200	140 - 220	0.33	540-670	
DC220	154 - 242	0.36	540-670	

* Ambient temperature: 20°C

Table 11 Ratings of undervoltage trip device (UVT)

Rated voltage (V)	Opening voltage range (V)	Attraction voltage (V)	Coil exciting current (A)	Power consumption (VA)		Coil resistance (ohm) *
				Normal	Attraction	
AC100	35 - 70	85	0.1	8	10	Holding coil: 410 – 510 Attraction coil: 5.6-6.8
AC110	38.5 - 77	93.5				
AC120	42 - 84	102				
AC200	70 - 140	170				
AC220	77 - 154	187				
AC240	84 - 168	204				
AC380	133 - 266	323				
AC415	145 - 290	352				
AC440	154 - 308	374				
DC24	8.4-16.8	20.4				
DC48	16.8-33.6	40.8				
DC100	35-70	85				

* Ambient temperature: 20°C

Table 12 Ratings of auxiliary switches

Voltage (V)	Auxiliary switches			
	For general feeder		For microload	
	Resistive load (A)	Inductive load (A) *1	Resistive load (A)	Inductive load (A) *2
AC100 - 250	5	5	0.1	0.1
AC251 - 500	5	5	-	-
DC30	1	1	0.1	0.1
DC125 - 250	1	1	-	-

*1: AC $\cos\phi \geq 0.3$, DC L/R ≤ 0.007

*2: AC $\cos\phi \geq 0.6$, DC L/R ≤ 0.01

*3: Min. applicable load: DC5V/1 mA

Table 13 Ratings of operation indication contacts

Voltage (V)	Rated contact current (A)			
	Group indication		Spring charging/tripping operation	
	Resistive load (A)	Inductive load (A) *1	Resistive load (A)	Inductive load (A) *2
AC250	3	3	3	3
DC30	3	3	3	2
DC125	0.5	0.25	0.5	0.5
DC250	0.3	0.15	0.1	0.1

*1: AC $\cos\phi \geq 0.3$, DC L/R ≤ 0.007

*2: AC $\cos\phi \geq 0.6$, DC L/R ≤ 0.01

*3: Min. applicable load: DC5V/1 mA

Table 14 Ratings of N-phase CT

Type of ACB	Type of N-phase CT	Ratings (A)
AR206E	T2GB40N06A	630A/100mA
AR208E	T2GB40N08A	800A/100mA
AR210E	T2GBX6N10A	1000A/100mA
AR212E	T2GBX6N12A	1250A/100mA
AR216E	T2GBX6N16A	1600A/100mA

4. OPERATION

4-1. Charging and Opening operation

DANGER

- Never touch live terminal parts. Otherwise, electric shock may result.

CAUTION

- Do not force down the charging handle after completion of manual charging operation. Doing so may cause a malfunction.
- The permissible operating voltage of the spring charging motor is 85 to 110% of the rated ac voltage or 75 to 110% of the rated dc voltage. Be sure to supply a voltage within the above ranges to the motor. Otherwise, burnout may result.
- Repeated open/close operation by the motor charging mechanism without pause should not exceed 15 times. If repeated continuous open/close operation is inevitable, a pause of at least 20 minutes should be provided after the repetitions of 15 times. Otherwise, a spring charging motor may be burnt out.
- Do not bring your hand or face close to arc gas vent of the arc chamber while the ACB is energized. Otherwise, a burn may result from high-temperature arc gas blowing out of the arc gas vent when the ACB trips open.
- If the ACB trips open automatically, remove the cause of tripping operation before re-closing the ACB. Otherwise, a fire could result.

The ACBs are available in two types in terms of the closing spring charging method and the remote operation capability: a manual charging type and a motor charging type. The manual charging type requires the charging and ON-OFF (close/open) operation to be done manually while the motor charging type allows the operation to be done either manually or by using a motor.

4-1-1. Charging operation

The ACB can be closed only when the closing springs have been charged. Be sure to charge the closing springs before closing the ACB. The charging operation is permitted, regardless of whether the ACB is ON (closed) or OFF (open). The procedure for charging the closing springs is as follows:

● Manual charging

Pump the charging handle (Fig. 10 ②) until the charge indicator (Fig. 10 ①) shows “CHARGED” Pumping the handle with the full stroke 6 - 8 times will fully charge the closing springs.

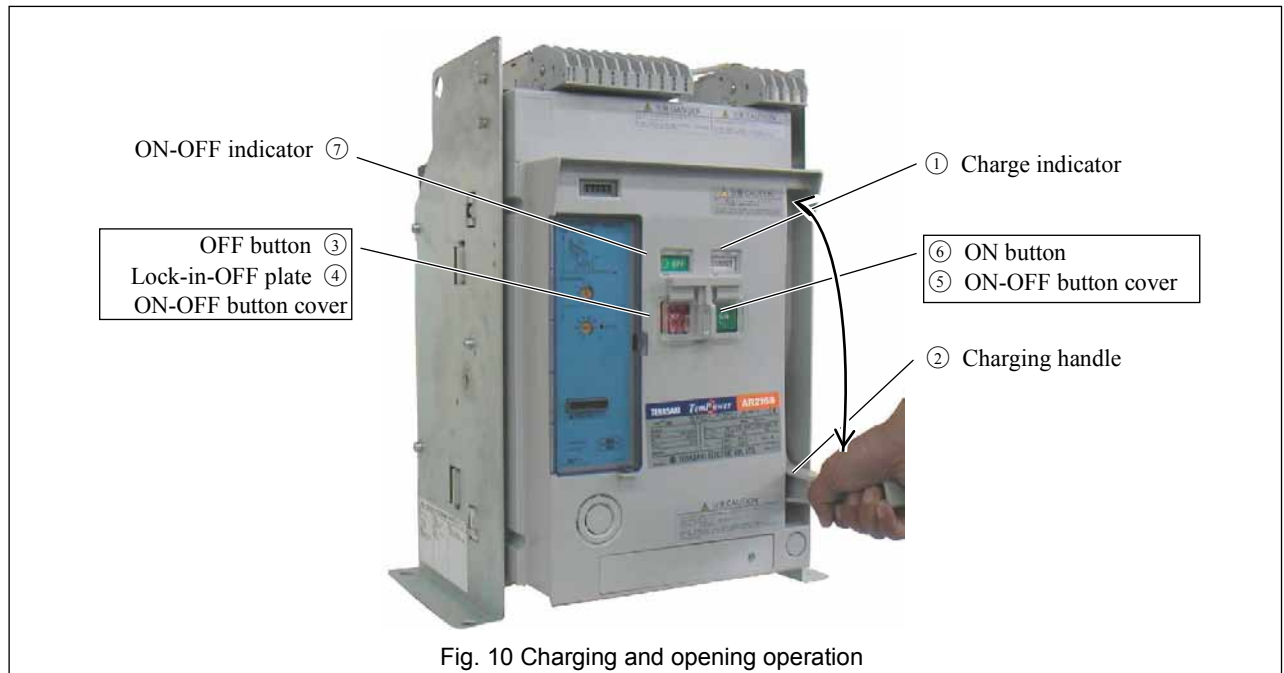


Fig. 10 Charging and opening operation

● **Motor charging**

When the charge indicator (Fig. 10 ①) changes to “DISCHARGED” while the specified operation voltage is applied to the control circuit terminals ② and ②, the charging motor is activated to start charging the closing springs. Upon completion of the charging operation, the charge indicator shows “CHARGED” and the charging motor is automatically deactivated. The time required for the motor charging operation depends on the operation voltage or the ACB types, but does not exceed 10 seconds.

4-1-2. Closing operation

The ACB closing operation is not permitted unless all of the following conditions are met.

- 1) The charge indicator (Fig. 10 ①) shows "CHARGED".
- 2) The OFF button (Fig. 10 ③) is not locked with the lock-in-OFF plate (Fig. 10 ④).
- 3) The specified voltage is supplied to the undervoltage trip device .

● **Manual closing**

Open the ON-OFF button cover (Fig. 10 ⑤) and press the ON button (Fig. 10 ⑥) The ACB will be closed with a sound. The ON-OFF indicator (Fig. 10 ⑦) shows "ON" and the charge indicator (Fig. 10 ①) shows "DISCHARGED".

● **Electrical closing**

Press the ON switch shown in Fig. 7. The latch release coil (LRC) (Fig. 7) will be excited and the ACB is closed with a sound. The ON-OFF indicator (Fig. 10 ⑦) shows "ON", the charge indicator (Fig. 10①) shows "DISCHARGED", and the charging motor starts charging the closing springs.

4-1-3. Opening operation

● **Manual opening**

Open the ON-OFF button cover (Fig. 10 ⑤) and press the OFF button (Fig. 10③). The ACB will trip open with a sound. The ON-OFF indicator (Fig. 10 ⑦) shows "OFF".

● **Electrical opening**

Press the OFF switch shown in Fig. 7. The Instantaneously-rated shunt trip device (SHT) or the undervoltage trip device (Fig. 7) will be excited so that the ACB trips open with a sound. The ON-OFF indicator (Fig. 10 ⑦) shows "OFF".

4-1-4. Motion of trip indication and spring charge indication switches

The trip indication and spring charge indication switches provide the breaker status as shown in Table 15.

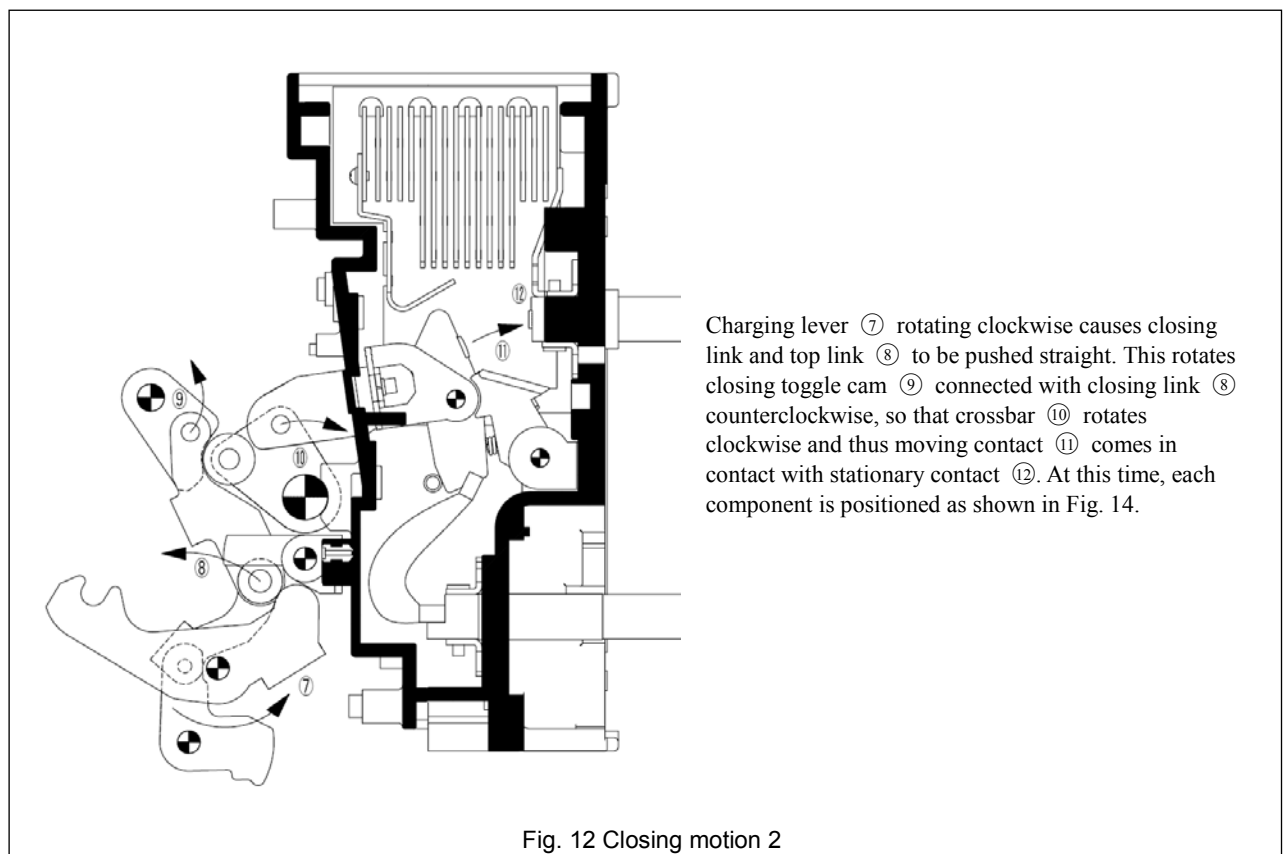
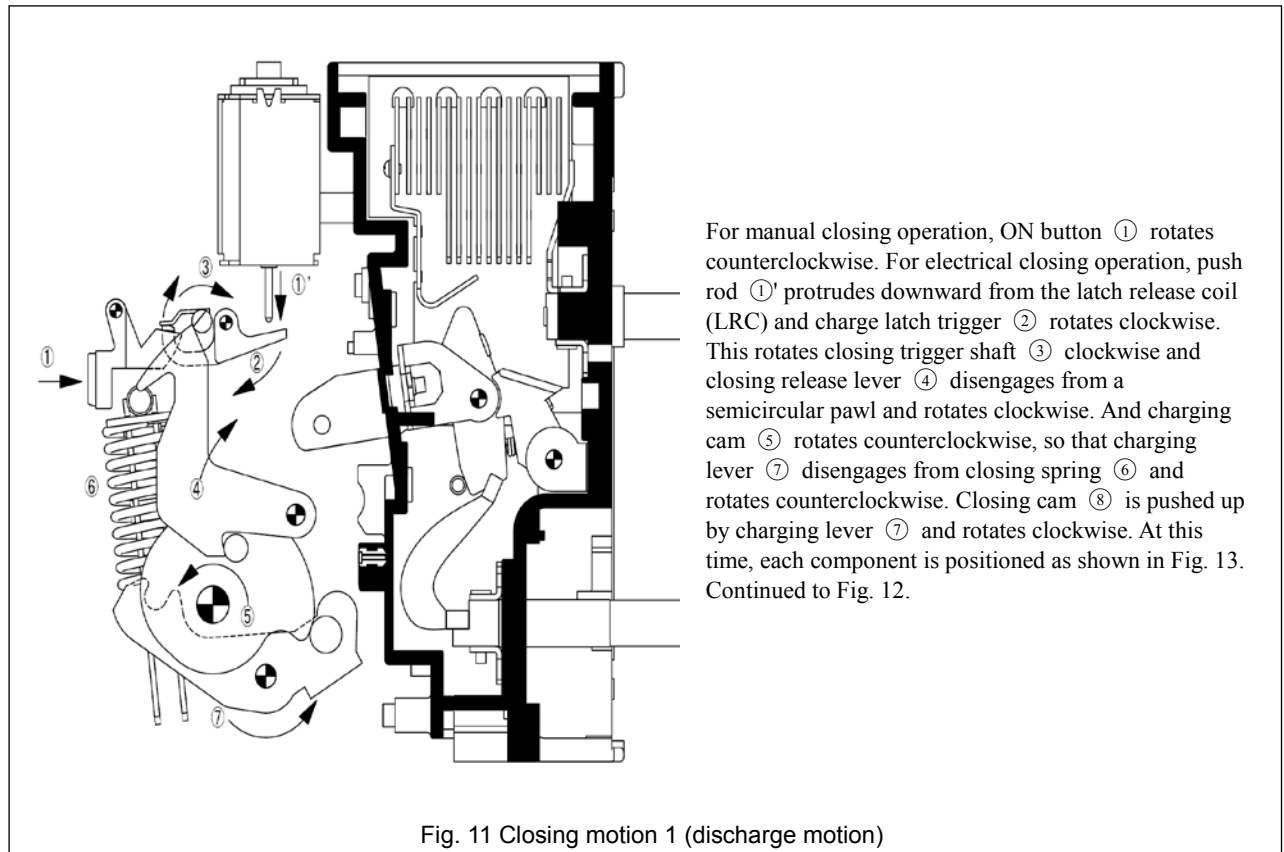
Table 15 Motion of trip indication and spring charge indication switches

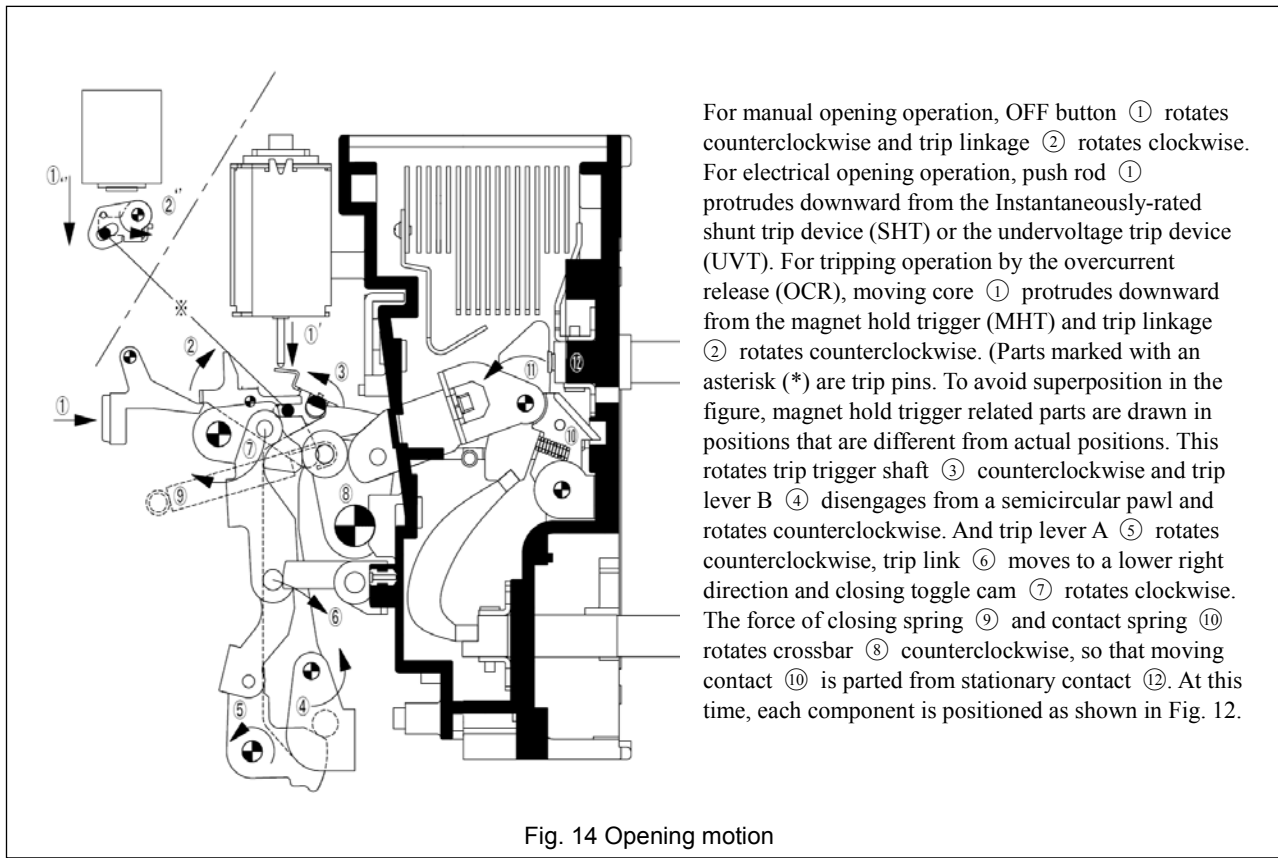
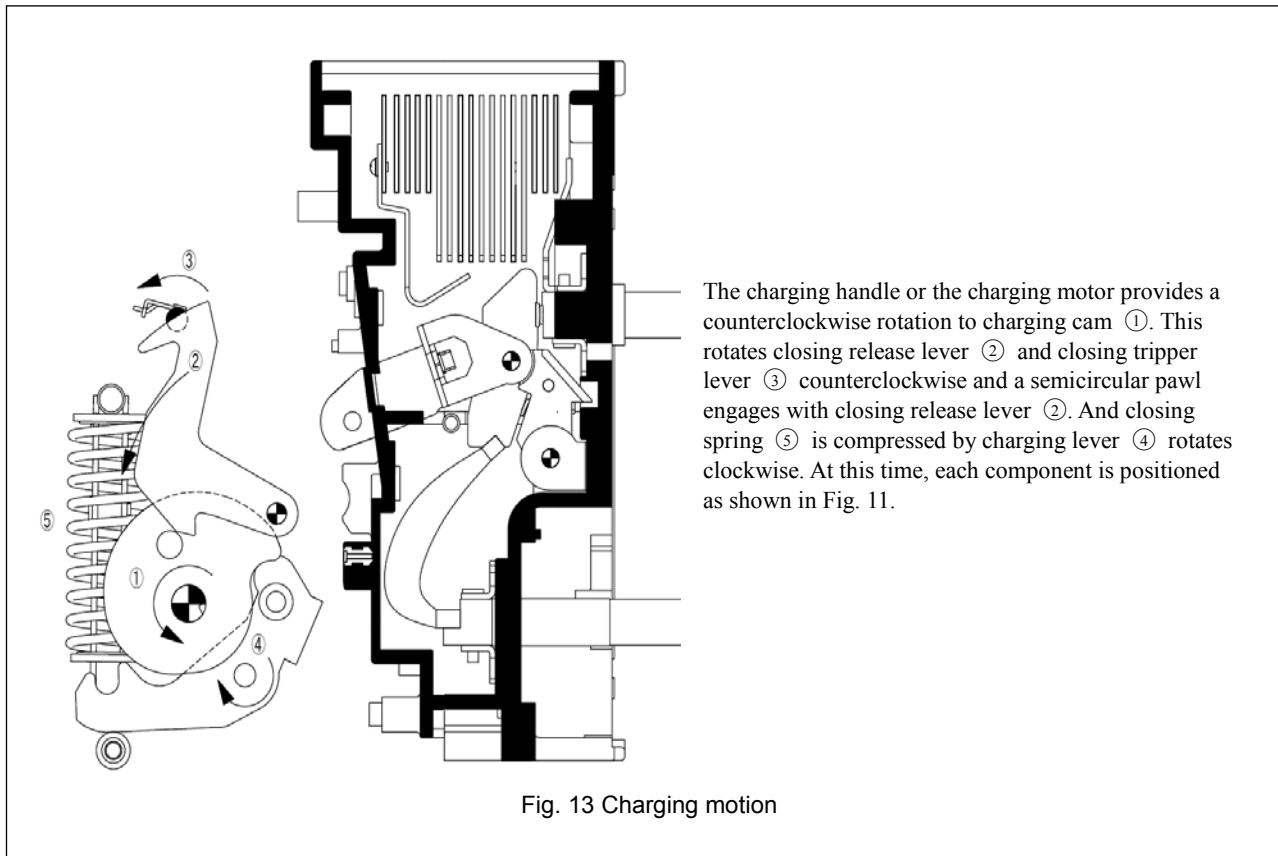
Type of OCR	Operation	Terminal No. See Fig. 16	Contact output				
			Closing spring		ACB closed	ACB open	
			Charged	Discharged		Not ready to close *	Ready to close *
All	Trip	⑤, ①⑦	No change	No change	OFF	ON	OFF
	Spring charge	⑤, ②⑦	ON	OFF	No change	No change	No change

* "Ready to close" means that all of the following conditions are met:
 1. The closing springs are charged.
 2. Opening operation is complete (At least 40 ms has elapsed after trip signal was produced).
 3. The OFF button is released.
 4. The specified voltage is applied to the undervoltage trip device (if equipped).

4-1-5. Motion of operation mechanisms

Figs. 11 - 14 illustrate the motion of the charging and ON-OFF mechanisms.





4-2. ON-OFF Button Cover Locking Procedure

Lock the button cover using a padlock with $\phi 6$ shackle (up to 3 padlocks can be used) as shown in Fig. 15. The ON-OFF button cover is locked and the ON and OFF buttons cannot be operated.



4-3. Lock in OFF Procedure

- 1) Open the OFF button cover shown in Fig. 16.
- 2) Raise the OFF-lock tab and close the button cover.
- 3) Lock the button cover using a padlock with $\phi 6$ shackle (up to 3 padlocks can be used) as shown in Fig. 16. The OFF button is locked depressed, which disables the ON button.



4-4. OCR Cover Locking Procedure

Lock the OCR cover using a padlock with $\phi 6$ shackle as shown in Fig. 17. The OCR cover cannot be opened, which prevents OCR settings from being changed.

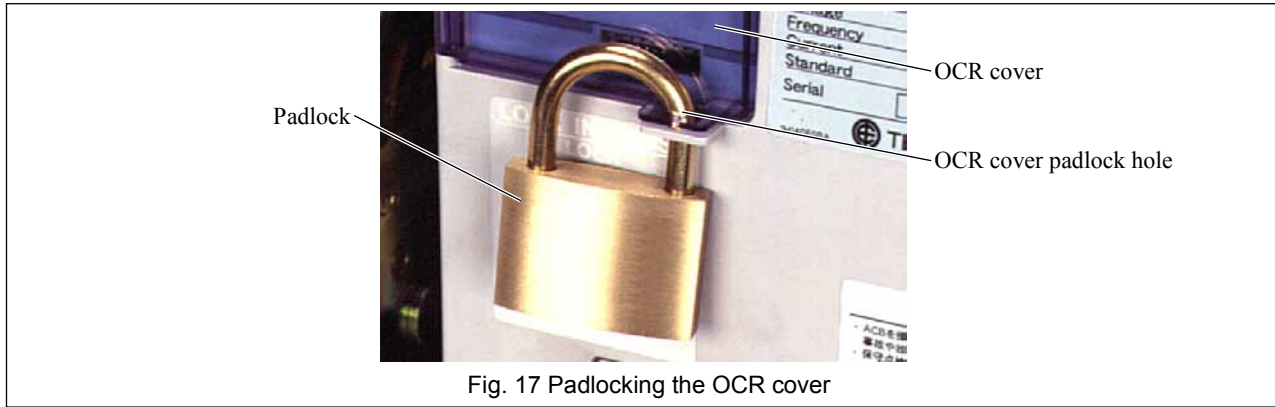


Fig. 17 Padlocking the OCR cover

5. OVERCURRENT RELEASE (OCR)

Options available for the type AR ACBs include a highly reliable overcurrent release (OCR) with a built-in 16-bit microprocessor. This OCR is supplied main circuit current signals from CT for OCR. When the OCR detects a fault, it sends a trip signal to the magnet hold trigger (MHT) or provides a trip indication or an alarm depending on the type of the fault.

The OCR uses the root mean square sensing for the long time delay (LTD), N-phase protection (NP) and Pre-trip alarm (PTA) functions. If a harmonic current flows through the ACB continuously, the root mean square sensing allows the ACB to operate normally.

The OCR is available in the type that follows:

- AGR-12BL L characteristic for general feeder (for works and transformer protection)

5-1. Specifications

Specifications of the OCR are shown in Table 16.

Table 16 Specifications of type AGR-12B OCR (●: Standard, ○: Optional, –: Not applicable)

Application		For general feeder		Reference section
Characteristic		L		
Type designation		AGR-12BL-AL	AGR-12BL-GL	
Protective function	Long time delay trip (LT)	●	●	5-2.
	Short time delay trip (ST)	●	●	
	Instantaneous trip (INST)	●	●	
Protection characteristic	Ground fault trip (GF)	–	●	5-2.
	N-phase protection (NP)	○	○	
	Pre-trip alarm (PTA)	○	○	
Trip indication	Group indication LED and contact output	●	●	5-4.
Test function		–	–	–
Control power supply		Not required	Not required	3-3.

5-2. Characteristics

5-2-1. L characteristic for general feeder

A general view, characteristic settings, and characteristic curves of the type AGR-12BL OCR (with L characteristic) are shown in Fig. 18, Table 17, and Fig. 19 respectively.

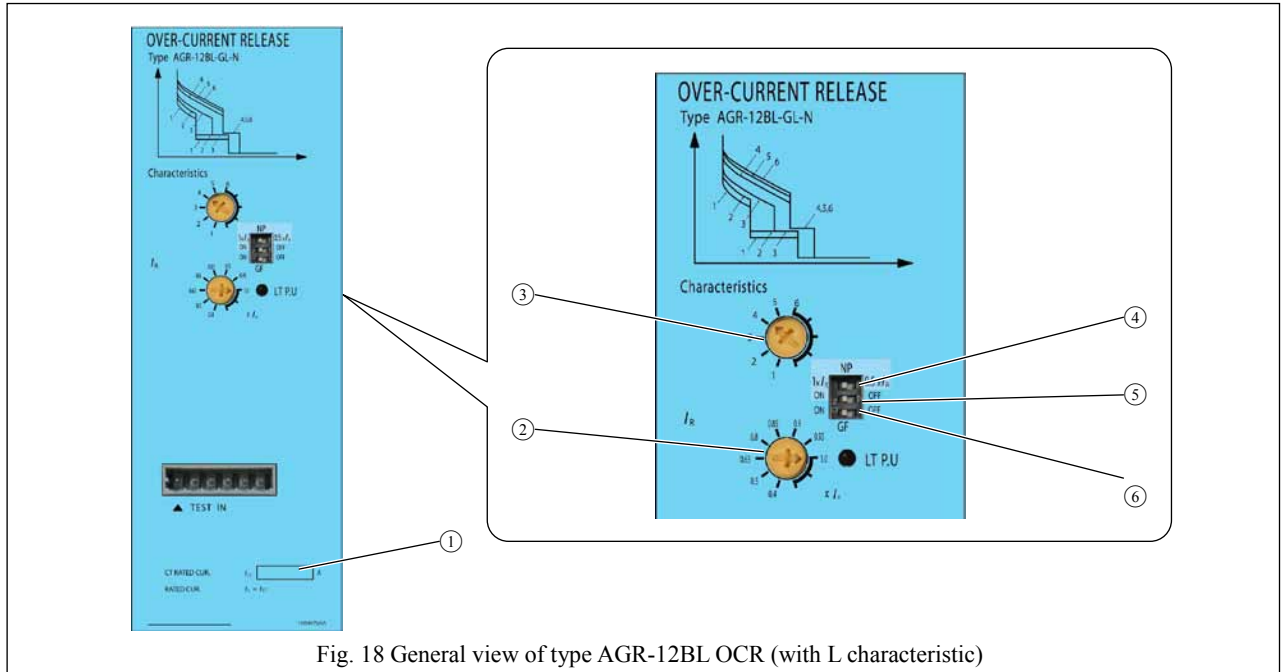


Fig. 18 General view of type AGR-12BL OCR (with L characteristic)

Table 17 Settings of type AGR-12BL OCR (with L characteristic)

No.	Setting item	Symbol									
①	Rated current (A)	I_n	$I_n = I_{CT}$ (630A, 800A, 1000A, 1250A, 1600A)								
②	Long time-delay trip pick-up current (A) $\times I_n$	I_R	Rated current [I_n] \times (0.4-0.5-0.63-0.8-0.85-0.9-0.95-1.0) (A)								
			<u>0.4</u>	<u>0.5</u>	<u>0.63</u>	<u>0.8</u>	<u>0.85</u>	<u>0.9</u>	<u>0.95</u>	<u>1.0</u>	
			AR206E	250	320	400	500	540	570	600	630
			AR208E	320	400	500	640	680	720	760	800
			AR210E	400	500	630	800	850	900	950	1000
			AR212E	500	630	800	1000	1050	1100	1200	1250
			AR216E	640	800	1000	1250	1350	1450	1500	1600
③	Characteristics	---	Non tripping when load current $\leq [I_R] \times 1.05$. Tripping when $[I_R] \times 1.05 < \text{load current} \leq [I_R] \times 1.2$								
	Long time-delay trip Time-delay (sec)	t_R	1	2	3	4	5	6			
			5.3	13.3	26.3	10	20	30			
			at 200% $\times [I_R]$		at 600% $\times [I_R]$						
			Tolerance: $\pm 20\% + 0.15\text{sec} - 0\text{sec}$								
	Shout time-delay trip pick-up current (A) $\times [I_R]$	I_{sd}	2.5	2.5	5	8	8	8			
			Tolerance: $\pm 15\%$								
	Shout time-delay trip Time-delay (msec)	t_{sd}	100	200	200	300	300	300			
			Resettable time	75	175	175	275	275	275		
			Max. total clearing time	170	270	270	370	370	370		
	Instantaneous trip pick-up current (A) $\times [I_R]$	I_I	10	10	10	16	16	16			
			Tolerance: $\pm 20\%$								
	Ground fault trip pick-up current (A)	I_g			$[I_n] \times 0.2$		Tolerance: $\pm 20\%$				
					⑥ ON / OFF						
	Ground fault trip Time-delay (msec)	t_g			200						
Resettable time					175						
Max. total clearing time					270						
N-phase protection pick-up current (A)	I_N			④ $0.5 \times I_R$ or $1 \times I_R$ selectable		Tolerance: $\pm 20\%$					
				⑤ ON / OFF							
		Non tripping when load current $\leq [I_N] \times 1.05$. Tripping when $[I_N] \times 1.05 < \text{load current} \leq [I_N] \times 1.2$									
N-phase protection Time-delay (sec)	t_N	$[t_R] = [t_N]$			$[t_R] = [t_N]$						
Pre-trip alarm pick-up current (A)	I_P			$[I_n] \times 0.8$							
				Non tripping when load current $\leq [I_P] \times 1.05$. Tripping when $[I_P] \times 1.05 < \text{load current} \leq [I_P] \times 1.2$							
Pre-trip alarm Time-delay (sec)	t_P			$0.5 \times [t_R] = [t_P]$							
				at 200% $\times [I_P]$		at 600% $\times [I_P]$					
		Tolerance: $\pm 20\% + 0.1\text{sec} - 0\text{sec}$									

● Underlined values are default settings.

● A pickup current means the threshold by which the OCR determines whether or not an overcurrent occurs. When the current flowing through the OCR exceeds the pickup current setting provided that $[I_R] \times 1.05 < \text{pickup current setting} \leq [I_R] \times 1.2$, the OCR starts counting the time for tripping. Once the current flowing through the OCR reduces to less than the pickup current setting, time count is reset.

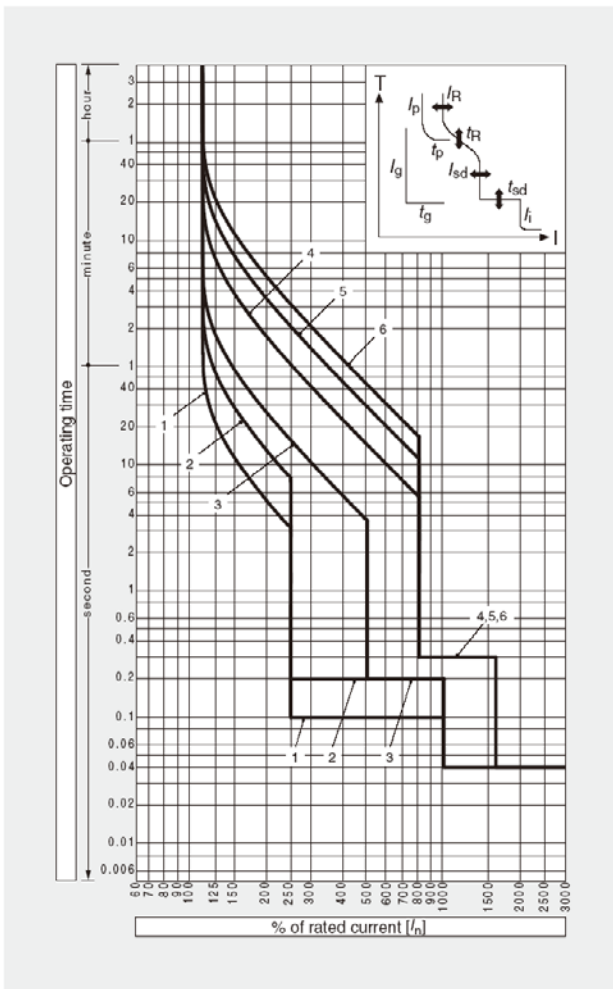
● ② A change in rated current setting results in changes in long time delay, short time delay, instantaneous, N-phase protection and Pre-trip alarm current settings accordingly.

● ③ A change in rated current setting results in changes in long time delay, short time delay, N-phase protection and Pre-trip alarm time delay settings accordingly.

● ④ Selectable from $0.5 \times I_R$ or $1 \times I_R$

● ⑤ "OFF" means the breaker is not tripped open.

● ⑥ "OFF" means the breaker is not tripped open.



Protection characteristic

Note 1: The operating time (t) at a long time delay, N-phase protection or Pre-trip alarm pickup current setting is given by

- Long time delay

$$t = -27.94 \times t_R \times \log_e \{ 1 - (1.125/I_R / i)^2 \} \pm 20\% + 0.15 - 0 \text{ [sec]}$$

I_R = Long time delay pickup current setting,
 i = Overcurrent, t_R = Time setting
- N-phase protection

$$t = -27.94 \times t_N \times \log_e \{ 1 - (1.125/I_N / i)^2 \} \pm 20\% + 0.15 - 0 \text{ [sec]}$$

I_N = N-phase protection pickup current setting,
 i = Overcurrent, t_N = Time setting
- Pre-trip alarm

$$t = -27.94 \times t_P \times \log_e \{ 1 - (1.125/I_P / i)^2 \} \pm 20\% + 0.1 - 0 \text{ [sec]}$$

I_P = Pre-trip alarm pickup current setting,
 i = Overcurrent, t_P = Time setting

Fig. 19 Characteristic curves of type AGR-12BL OCR (with L characteristic)

5-3. OCR Setting Procedure

CAUTION

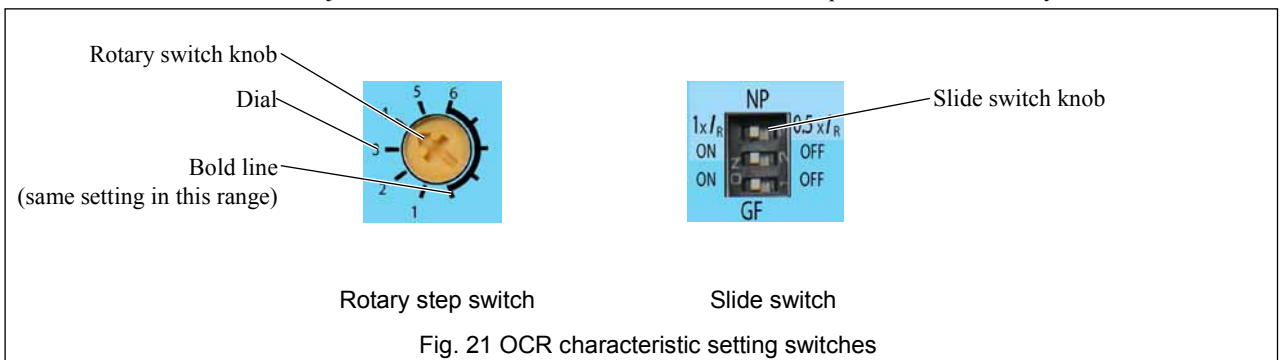
- OCR setting changes must be performed by competent persons.
- After setting changes are made, the settings be checked with e.g., a type ANS2S OCR test interface unit (optional).
- After completion of OCR tests, be sure to return the settings to the original values. Failure to do so may cause a fire or burnout.
- Before changing OCR settings, open the ACB and then lock the OFF button to prevent the ACB from being closed inadvertently.
- Use the cross slot screwdriver or small flatblade screwdriver with a torque of not more than 0.1 N·m or a force of not more than 0.1 N when adjusting the setting switches (rotary step switches or slide switches). An excessive torque or force may cause a malfunction.

The following describes how to set the OCR.

- 1) Open the ACB.
- 2) Push the right end of the OCR cover to the left at the hollow on the front cover to unlatch and open the OCR cover. See Fig. 20.
If the OCR cover is padlocked, first remove the padlock.



- 3) Use rotary step switches and slide switches to set the OCR. See Fig. 21.
 - Rotary step switches must be adjusted with a cross slot screwdriver. Turn switch knobs stepwise and do not stop the knobs halfway between calibration markings. A bold line on a switch dial means the same settings.
 - Slide switches must also be adjusted with a small flatblade screwdriver. Do not stop switch knobs halfway.



- 4) Close the OCR cover.
- 5) After setting changes are made, it is recommended that the settings be checked with e.g., a type ANS2S OCR test interface unit (optional).

5-4. Operation Indication

The OCR has LEDs on the front panel to provide operation indications as shown in Fig. 22 and Table 18. It also outputs operation signals to contacts.

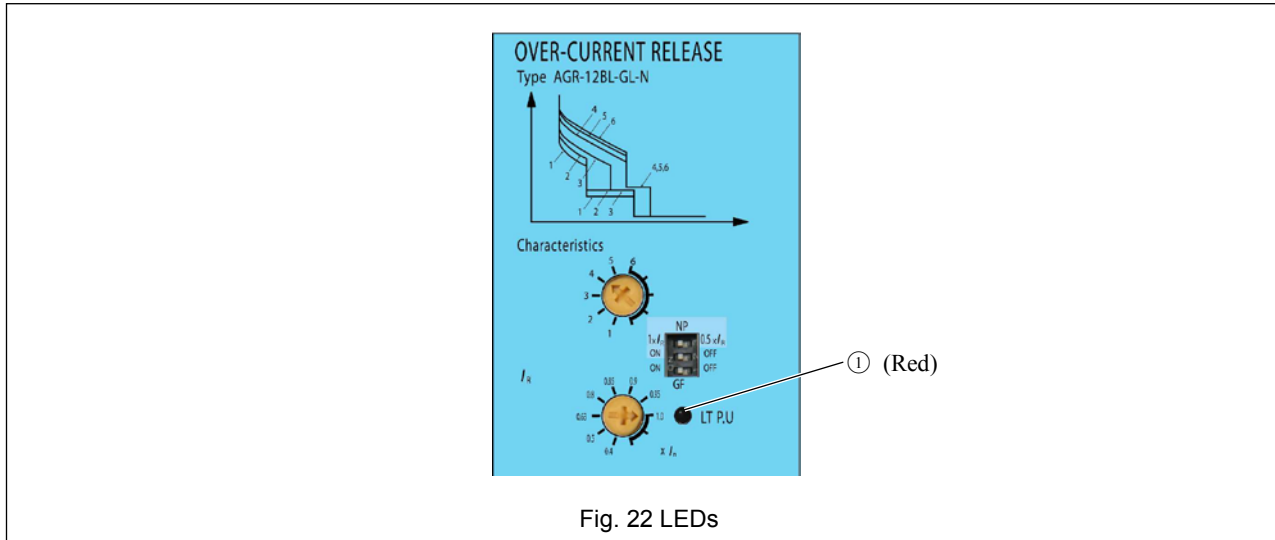


Fig. 22 LEDs

Table 18 Operation indication

Type of OCR	Control power supply	Operation	LED			Contact output			
			Position	State		Terminal No. See Fig. 16	State		
				Normal	pickup		Trip/Alarm	Normal	Trip/Alarm
AGR-12BL-AL AGR-12BL-GL	Not required	Long time delay trip (LT)	①	OFF	ON	OFF	05, 15	Turn OFF automatically after ON for 40 ms or more *1	
		N-phase protection (NP)			-				
		Short time delay trip (ST)			Flash	Flash	05, 06	OFF	ON
		Ground fault trip (GF)							
		Instantaneous trip (INST)							
		Pre-trip alarm (PTA)							

*1: A self-hold circuit is required.

6. MAINTENANCE, INSPECTION AND PARTS REPLACEMENT

This chapter describes the maintenance and inspection procedure for the AR series ACBs.

The service life of the ACB depends on the working and environmental conditions. The ACB is exposed to mechanical and electrical stresses and thus suffers gradual degradation during use, which will increase the possibility of malfunctions. Preventive maintenance and periodical inspection are very important to avoid any functional degradation, prevent malfunctions, extend the service life, and ensure safe operation.

The appropriate frequency of maintenance and inspection of the ACB varies depending on the installation conditions, the number of tripping operations, the magnitude of breaking current, and other factors that are to be considered empirically. As a guideline, Table 19 shows the recommended inspection frequency. See section 6-1 for detailed maintenance and inspection procedures.

Table 19 Frequency of maintenance and inspection

Category	Working and environmental conditions	Inspection level	Frequency in interval or number of open/close cycles			
			Interval	Number of open/close cycles		
Normal	<ul style="list-style-type: none"> Not so dusty, Not so much corrosive gases, Ambient temperature: 35°C or lower Not so humid, Number of open/close cycles per day: 2 or less Ex. Switchboards in electric installation rooms, Control rooms, Building installation	Normal/ Detailed	<ul style="list-style-type: none"> Every year or 2 years Every year after 3 years since installation Every half year after 6 years since installation 	Open/close condition	800AF or less	1000AF -1600AF
				Nearly no current level	Every 1000 cycles	
		Rated current level	Every 1000 cycles	Every 500 cycles		
		Thorough	<ul style="list-style-type: none"> Every 5 or 6 years Every 4 years after 6 years since installation Every year or 2 years after 10 years since installation 	Every 4000 cycles		
		Overhaul	When abnormality is found during normal or through inspection			
Harsh	<ul style="list-style-type: none"> Highly dusty, Much corrosive gases, Ambient temperature: 45°C or higher, Highly humid, Number of open/close cycles per day: 4 or more, Always exposed to vibrations Ex. Iron or chemical plants Engine rooms (without ventilation), Cogeneration installation, Ferryboats	Normal/ Detailed	<ul style="list-style-type: none"> Every year Every half year after 2 years since installation 	Open/close condition	800AF or less	1000AF -1600AF
				Nearly no current level	<ul style="list-style-type: none"> Every 1000 cycles Every 500 cycles after 1000 cycles 	
		Rated current level	<ul style="list-style-type: none"> Every 1000 cycles Every 500 cycles after 1000 cycles 	<ul style="list-style-type: none"> Every 500 cycles after 500 cycles 		
		Thorough	<ul style="list-style-type: none"> Every 2 or 3 years Every 2 years after 6 years since installation Every year after 10 years since installation 	<ul style="list-style-type: none"> Every 2500 - 3000 cycles Every 2000 cycles after 3000 cycles 		
		Overhaul	When abnormality is found during normal or through inspection			
Abnormal	<ul style="list-style-type: none"> Open/close operation due to overload, Tripping due to shortcircuit, Accidentally submerged 	Thorough	When abnormality occurs	Open/close condition	800AF or less	1000AF -1600AF
				Overcurrent level (approx. 6 times the rated current)	Every 25 cycles	Every 25 cycles
		Level exceeding overcurrent level	Every time	Every time		
		Overhaul	When ACB is deemed to be repairable at through inspection			

- Normal inspection includes inspection and actions that can be done only with removing the arc chamber, contacts, front cover and the like. Normal inspection can be performed by the user. Terasaki also provides normal inspection service.
- Detailed inspection includes inspection, actions, and parts replacement that will be done to prevent functional degradation caused by aging or the like when abnormality is found during normal inspection. You are recommended to use Terasaki's detailed inspection service.
- Thorough inspection must be left to Terasaki. Overhaul will be done in a Terasaki's factory.

● About the service life

The expected service life of AR series ACBs is shown in the "Endurance in number of ON-OFF cycles" rows in Tables 3. "With maintenance" in the tables means that appropriate inspection, maintenance, repair, and parts replacement are performed according to the instructions in this chapter. But, when an ACB performs three times of tripping operation nearly at the rated breaking current (three standard operating duty cycles), it is at the end of its safe service life even if thorough inspection is done every time it trips open. Such an ACB will be apt to suffer malfunctions and should be replaced without delay to avoid frequent inspection and parts replacement. See section 6-2 for detailed parts replacement procedures.

6-1. Inspection Procedures

CAUTION

- ACB maintenance, inspection and parts replacement must be performed by competent persons.
- Do not touch ACB current carrying parts and ACB structural parts close to a current carrying part immediately after the ACB trips open. Remaining heat may cause a burn.
- Prior to commencing any work on the ACB, open an upstream circuit breaker or the like to isolate all sources of power/voltage from the main and control circuits. Otherwise, electric shock may result.
- Prior to commencing maintenance, inspection, or parts replacement, make sure that the closing springs are released and the ACB is open. Otherwise, unintentional open/close operation may lead to fingers or tools to be pinched by the open/close mechanism, resulting in injury.
- Retighten the terminal screws periodically to the specified torque. Otherwise, a fire could result.
- When grinding a contact tip, be careful to prevent grinding dust from entering the breaker operating mechanism. Wipe the tip clean after grinding. Otherwise, a malfunction or fire could result.
- Do not perform dielectric withstand/insulation resistance tests under other conditions than specified. Doing so may cause a malfunction.
- Be sure to reinstall the arc chamber if removed. Failure to do so or incorrect installation of the arc chamber may result in a fire or burn.
- When charging the closing springs or performing open/close operation of the ACB with the arc chamber, front cover and/or side covers removed during maintenance or inspection work, do not touch parts other than those required for the above operation (charging handle, ON/OFF buttons, moving core and the like). Doing so may cause fingers or tools to be pinched, resulting in injury.
- When replacing an auxiliary, do not damage the control wire for the auxiliary or pinch the wire between the auxiliary and the breaker body. Doing so may cause a malfunction.

To ensure safety, be sure to perform the preparation work described in section 6-2-1 unless otherwise specified in the inspection procedures. The normal inspection procedure and the detailed inspection procedure are shown in Tables 21 and 22 respectively.

● Information you are requested to state

If you want us to take action against an abnormality, contact us while providing us the information shown in Table 20 below. Our contact is shown at the end of this manual.

Table 20 Information you are requested to state

Item	Description	Reference
Type	AR _____ poles Fixed type	Rating nameplate
Serial No.	_____ - _____	
Main circuit rated current	<input type="checkbox"/> AC <input type="checkbox"/> DC _____ V	Product Specifications
Rated voltage	_____ A	I_n
Spring charging method	<input type="checkbox"/> Manual charging <input type="checkbox"/> Motor charging Rated operation voltage: <input type="checkbox"/> AC <input type="checkbox"/> DC _____ V	CLOSING section on specification nameplate
Overcurrent release	<input type="checkbox"/> Non <input type="checkbox"/> Equipped Type: AGR-12BL - _____	OCR section on specification nameplate
Electrical tripping device	<input type="checkbox"/> Instantaneously-rated shunt trip device (SHT) Rated voltage: <input type="checkbox"/> AC <input type="checkbox"/> DC _____ V <input type="checkbox"/> Undervoltage trip device (UVT) Rated voltage: <input type="checkbox"/> AC <input type="checkbox"/> DC _____ V	TRIPPING section on specification nameplate
Special specification	SR: _____ SS: _____ SO: _____	OTHERS section on specification nameplate
Working conditions (Voltage, current, environment)		-
Symptom of abnormality (in detail): When, How, Where, etc.)		-
Inspection done/actions taken (if any)		6-1.
Status quo and schedule	Permissible power cut date and time: _____ Place where you want us to take action: _____	-

- The contents of the nameplate should be provided in detail.
- Related documents such as product specifications and inspection reports should be provided.
- If you have a desired inspection and maintenance schedule, let us know the schedule at your earliest convenience. Our service representative could not meet your last minute requirement.

Table 21 Normal inspection procedure

Check point	No.	Check item	Description		
General (*1)	1	Discoloration of conductors	Check connection conductors, main circuit terminals, and current carrying parts for heat discoloration. If such a symptom is found, contact us.		
	2	Parts missing	Check that screws, bolts, nuts, washers, springs, retainers and the like are not missing. If any parts are missing, contact us.		
	3	Damage to parts	Check for deformation, cracks, chips, rust, or other damage of parts. If damage is found, contact us.		
	4	Dust accumulation	Check that no dust is accumulated in ACB. If dust is accumulated, use vacuum cleaner to remove dust and wipe off with dry, clean cloth.		
Main/control circuit terminals See 2-3.	5	Connections	Check main circuit terminal screws, ground terminal screw, auxiliary switch terminal screws and control circuit terminal screws for looseness. If loose, tighten to specified torque.		
Arc chamber See 6-2-2.	6	Dust accumulation /Damage	Remove arc chamber and check it for foreign object or dust accumulation, deformation, cracks, chips and other damage. If foreign matter or dust is accumulated, use vacuum cleaner to remove foreign matter of dust and wipe off with dry, clean cloth. If metal spatters are adhered, use sandpaper to remove them. (*2) If arc chamber has stubborn adherents suffers damage, replace arc chamber.		
Contacts See 6-2-2	7	Surface condition	Remove arc chamber and check contact circumference, contacts, and contact tips for foreign object or dust accumulation, deformation, cracks, chips and other damage. If dust is accumulated, use vacuum cleaner to remove dust and wipe off with dry, clean cloth. If contact tips are badly discolored or roughened, polish with #200 sandpaper. (*2) If contact tip suffers damage or is less than 0.7 mm thick after polishing, replace both moving and stationary contacts. ●Blackening of contact tips is caused by oxidation or sulfuration and will be removed during closing operation. It has no harmful effect except in extreme causes. If heat discoloration is found, perform detailed inspection.		
Main circuit, Arc chamber See 6-2-2.	8	Insulation resistance	Close ACB and, using DC500V Megger, check that insulation resistance between main circuit terminals, between main circuit terminal group and ground, and between ends of adjacent grids exceeds 5M ohm. If resistance does not exceed 5M ohm, use sandpaper to remove carbonized portions of insulation around contacts or current carrying parts and/or spatters adhered to arc chambers and arc extinguishing grids. (*2) If problem persists, contact us.		
Operating mechanism See 6-2-5.	9	Internal mechanism	With OCR removed, check internal mechanism for missing parts, deformation, cracks, chips, foreign mater or dust accumulation, breakage of springs, and rust. If foreign matter or dust is accumulated, use vacuum cleaner to remove foreign matter of dust and wipe off with dry, clean cloth. If any parts are missing or damaged or springs are broken, contact us.		
Control circuit See 6-2-3.	10	Wiring	Remove side and front covers, check that wiring is properly connected, and not disconnected nor damaged. If incorrect connection is found, connect correctly. If disconnection or damage is found, contact us.		
Auxiliary switches See 6-2-7.	11	Operation	Check that auxiliary switches operate as shown to the right. If not so, replace switches.		
			State of operation lever	Current conducting between _11 and _12	Current conducting between _11 and _14
			Natural position	100 mΩ or less	Non
		Uppermost lift position	Non	100 mΩ or less	
	12	Auxiliary contacts	Remove auxiliary switches and check contacts for roughness. If roughened excessively, replace contacts.		
	13	Looseness of screws	Check screws of auxiliary switches for looseness. If loose, retighten.		
Operation related mechanism See 4-1 and 4-2.	14	UVT	Charge closing springs manually and attempt closing ACB to make sure ACB cannot be closed. If ACB can be closed, perform detailed inspection.		
	15	Operation mechanism, LRC, SHT and UVT	SHT and UVT supplied with power, perform closing spring charging operation and manual and electrical open/close operation several times to check that charge indicator, ON-OFF indicator and ON-OFF cycle counter provide correction indication and no abnormal sound is heard. If abnormality is found, perform detailed inspection.		

*1: Always check the "General" items during the inspection procedure shown in Table 21 above.

*2: Take care to avoid grinding dust from entering the ACB. Wipe contact surfaces clean of grinding dust.

Table 22 Detailed inspection procedure

Check point	No.	Check item	Description
Latch release coil (LRC) See 6-2-3.	1	Coil resistance	Disconnect hand connector (green) that is closer to coil than the other and, using tester, measure coil resistance between terminals and make sure it is within range specified in Table 9. (*3) If not so, replace LRC.
	2	Length and stroke of plunger	Remove LRC and, using vernier caliper, make sure plunger length is 24.2 - 24.8 mm in natural state and protrusion of plunger is 6.3 - 7 mm when moving core is pushed in. If not so, replace LRC.
	3	Hand connector	Check that hand connector (green) is connected to ACB hand connector (green) correctly. If incorrect, connect correctly.
	4	Looseness of screws	Check LRC mounting screws for looseness. If loose, retighten.
	5	Mechanical motion	With closing springs charged, check that pushing moving core results in ACB being closed slowly, and releasing moving core results in the core being restored smoothly. If not so, replace LRC. If it is useless to replace LRC, contact us. After inspection, open ACB and discharge closing springs.
Instantaneously rated shunt trip device (SHT) See 6-2-4.	6	Coil resistance	Disconnect hand connector (black) that is closer to coil than the other and, using tester, measure coil resistance between terminals and make sure it is within range specified in Table 10. (*3) If not so, replace SHT.
	7	Length and stroke of plunger	Remove SHT and, using vernier caliper, make sure plunger length is 24.7 - 25.3 mm in natural state and protrusion of plunger is 6.7 - 7.3 mm when moving core is pushed in. If not so, replace SHT.
	8	Hand connector	Check that hand connector (black) is connected to ACB hand connector (black) correctly. If incorrect, connect correctly.
	9	Looseness of screws	Check SHT mounting screws for looseness. If loose, retighten.
	10	Mechanical motion	With ACB closed, check that pushing moving core results in ACB being opened slowly, and releasing moving core results in the core being restored smoothly. If not so, replace SHT. If it is useless to replace SHT, contact us. After inspection, discharge closing springs.
Undervoltage trip device (UVT) See 6-2-1.	11	Coil resistance	Disconnect hand connector (red) and, using tester, measure coil resistance between terminals and make sure holding coil is rated at 330 - 420Ω. (*3) If not so, replace UVT.
	12	Operation	Remove UVT and press in plunger, and make sure releasing plunger causes plunger to be smoothly restored. If not so, replace UVT.
	13	Length and stroke of plunger	Remove UVT and, using vernier caliper, make sure plunger length is 32.7 - 33.3mm in natural state and plunger stroke is 6.7 - 7.3 mm. If not so, replace UVT.
	14	Hand connector	Check that hand connector (red) is connected to ACB hand connector (red) correctly. If incorrect, connect correctly.
	15	Looseness of screws	Check UVT mounting screws for looseness. If loose, retighten.
Magnet hold trigger (MHT) See 6-2-6.	16	Coil resistance	Disconnect hand connector (red) and, using tester, measure coil resistance between terminals and make sure it is 1.8 - 2.2 Ω. (*3) If not so, replace MHT.
	17	Operation	Remove MHT and pull out moving core slowly, and make sure pushing moving core allows core to be smoothly retracted and attracted If not so, replace MHT.
	18	Length and stroke of moving core	Remove MHT and, using vernier caliper, make sure protrusion of moving core is 6.7 - 7.3mm in pulled-out state. If not so, replace MHT.
	19	Hand connector	Check that hand connector (red) is connected to ACB hand connector (red) correctly. If incorrect, connect correctly.
	20	Looseness of screws	Check MHT mounting screws for looseness. If loose, retighten.
Charging motor and LRC	21	Electrical operation	With breaker body assembled to original state, supply ACB with operation power, and attempt to perform motor charging and electrical closing operation with max. and min. voltages within permissible charging/closing voltage range to make sure ACB operates normally. (See Table 9). If ACB does not operate normally, contact us.
SHT	22	Electrical operation	With breaker body assembled to original state, close ACB, supply SHT with power, and attempt to perform electrical opening operation with max. and min. voltages within permissible closing voltage range to make sure ACB trips open normally. (See Table 10). If ACB does not trip open, contact us.
UVT	23	Electrical operation	With breaker body assembled to original state, charge closing springs, and make sure that ACB closes when UVT is supplied with attraction power. And decrease UVT supply voltage to make sure ACB opening voltage is within specified opening voltage range. (See Table 11.) If ACB does not operate normally, contact us.
OCR and MHT	24	Operation	With breaker body assembled to original state, check OCR and MHT with type ANS2S OCR test interface unit (optional) to make sure ACB operates normally. If ACB does not operate normally, contact us.

● Always check the "General" items in Table 21 during the inspection procedure shown in Table 22 above.

*3 Take care to avoid damaging or deforming terminal pins when bringing tester lead into contact with them.

6-2. Parts Replacement Procedure

CAUTION

- ACB maintenance, inspection and parts replacement must be performed by competent persons.
- Do not touch ACB current carrying parts and ACB structural parts close to a current carrying part immediately after the ACB trips open. Remaining heat may cause a burn.
- Prior to commencing any work on the ACB, open an upstream circuit breaker or the like to isolate all sources of power/voltage from the main and control circuits. Otherwise, electric shock may result.
- Prior to commencing maintenance, inspection, or parts replacement, make sure that the closing springs are released and the ACB is open. Otherwise, unintentional open/close operation may lead to fingers or tools to be pinched by the open/close mechanism, resulting in injury.
- Be sure to reinstall the arc chamber if removed. Failure to do so or incorrect installation of the arc chamber may result in a fire or burn.
- When replacing an auxiliary, do not damage the control wire for the auxiliary or pinch the wire between the auxiliary and the breaker body. Doing so may cause a malfunction.

6-2-1. Preparation

Be sure to make the following preparations for parts replacement in order to ensure safety.

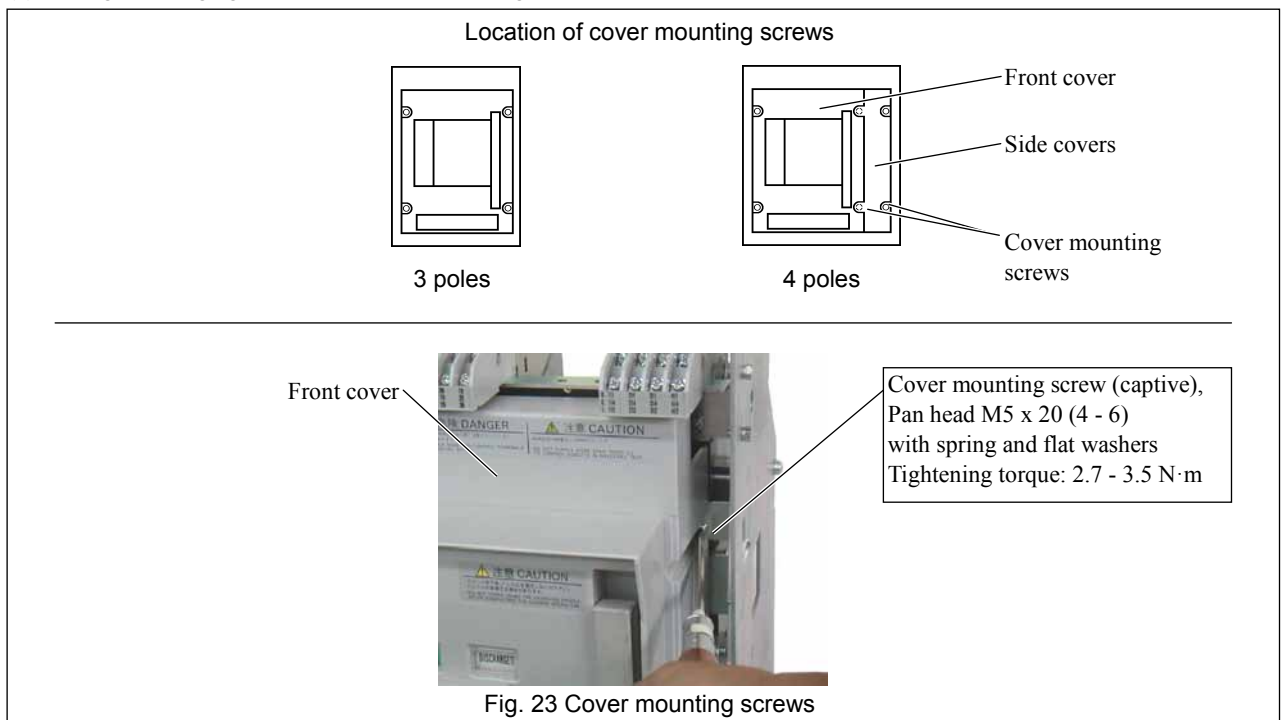
- 1) Open an upstream circuit breaker or the like to isolate all sources of power/voltage from the main and control circuits.
- 2) Discharge the closing springs and open the ACB. The procedure varies depending on whether or not the ACB is equipped with the undervoltage trip device (UVT).

- **When the ACB is not equipped with the undervoltage trip device (UVT):**

Perform manual closing/opening operation of the ACB. Refer to sections 4-1-2 and 4-1-3.

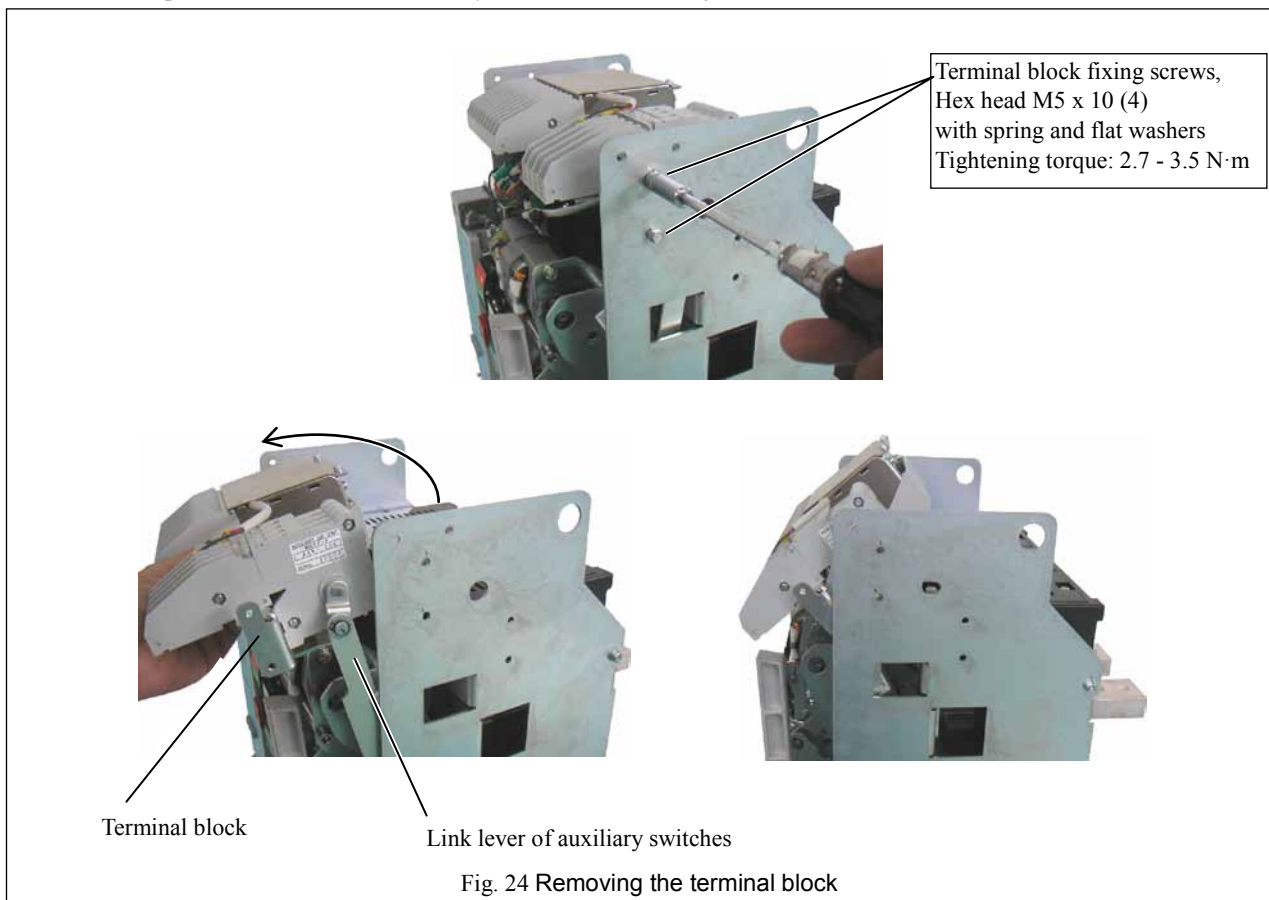
- **When the ACB is equipped with the undervoltage trip device (UVT):**

- (1) Turn the cover mounting screws five or six turns to loosen as shown in Fig. 23. If the ACB is equipped with side covers, first remove the side covers and then loosen the front cover mounting screws. (The cover mounting screws are of captive type and cannot be removed from the side and front covers.)
- (2) Pulling the charging handle down as shown in Fig. 10, remove the front cover.

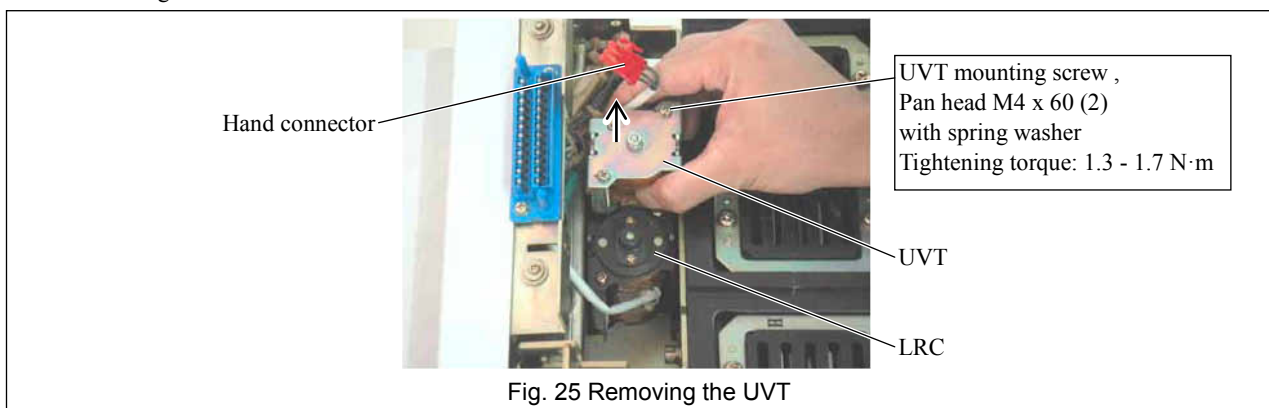


(3) Remove the terminal block fixing screws as shown in Fig. 24, and move the terminal block.

Take care to prevent the link lever of auxiliary switches from bending.



(4) Turn the UVT mounting screws eight or ten turns to loosen, disconnect the manual connector (red), and then remove the UVT as shown in Fig. 25.



(5) Reinstall each part or component in reverse order of removal after inspection. When installing the UVT, make sure the nameplate on the UVT can be viewed from the front of the ACB. and make sure the link lever pin of auxiliary switches is position specified in Fig.26.

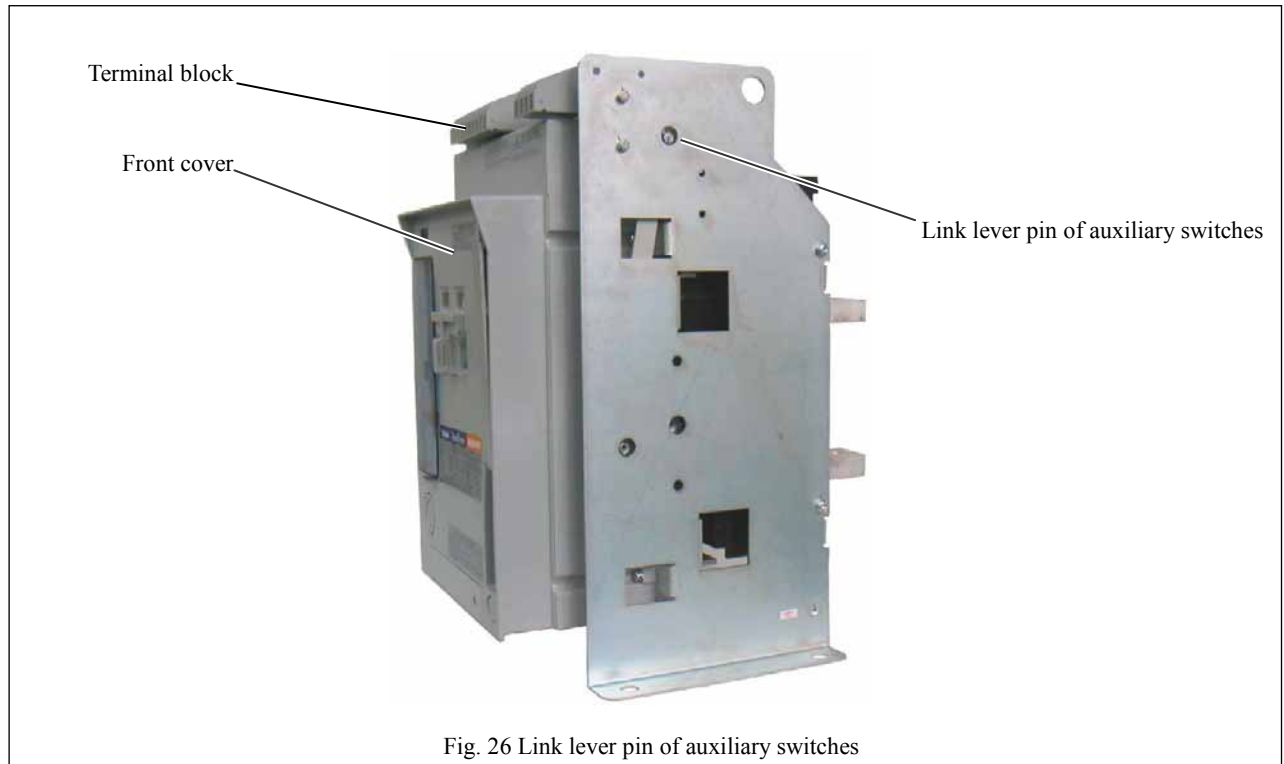


Fig. 26 Link lever pin of auxiliary switches

(6) Perform manual closing/opening operation of the ACB. Refer to sections 4-1-2 and 4-1-3.

● Fig. 27 provides the general view of the UVT.

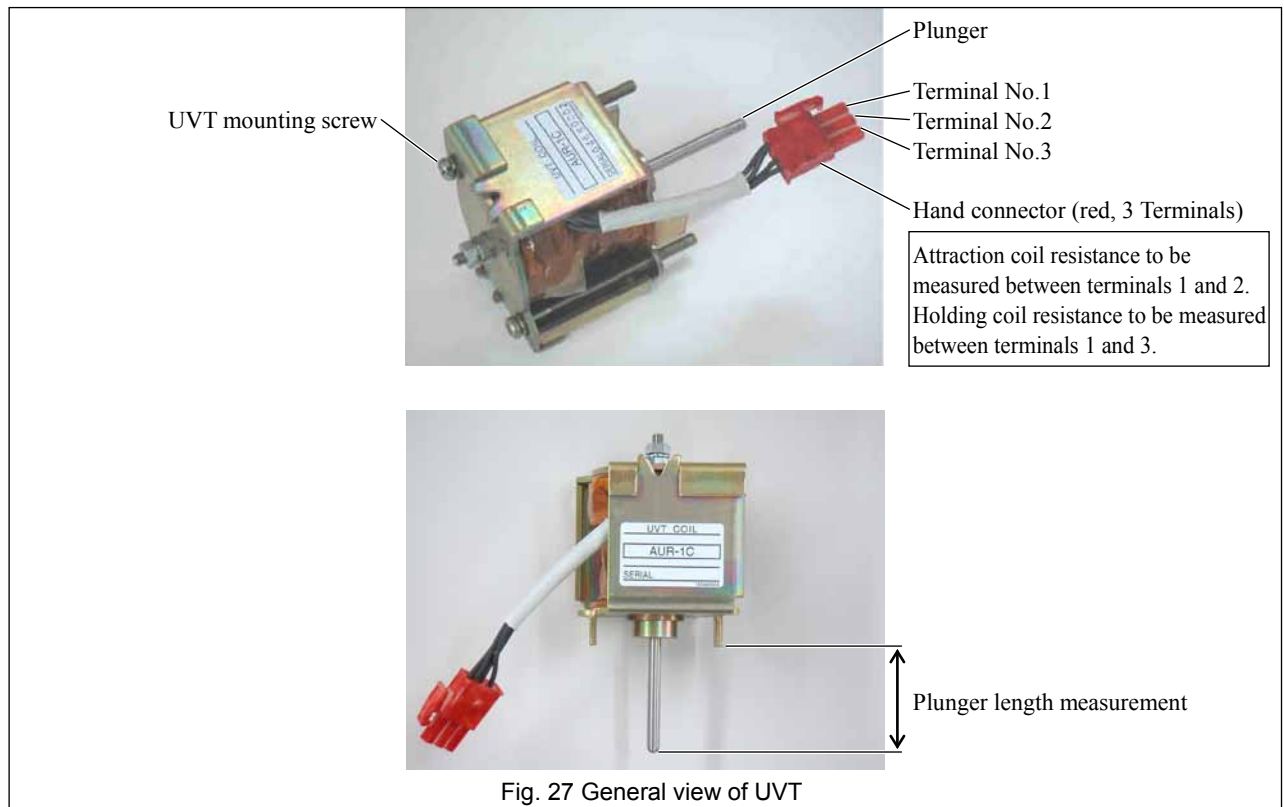
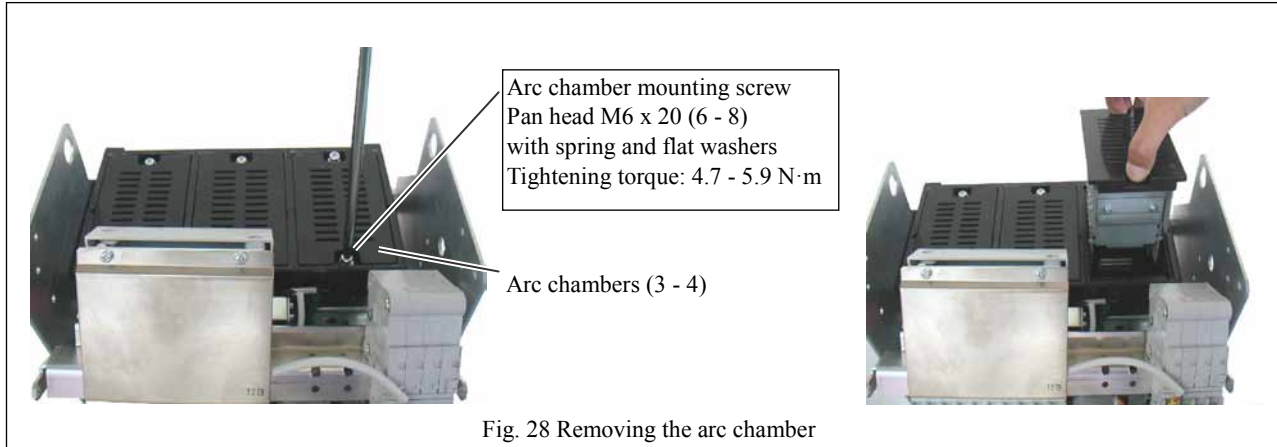


Fig. 27 General view of UVT

6-2-2. Arc chambers

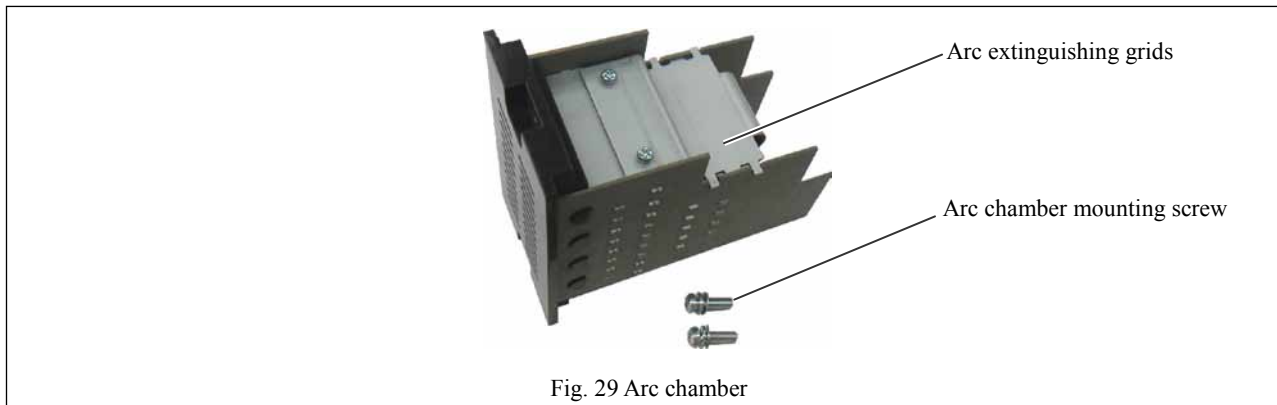
The following describes how to replace arc chambers.

- 1) Make preparations for parts replacement. Refer to section 6-2-1.
- 2) If the ACB is not equipped with the undervoltage trip device, turn the cover mounting screws five or six turns to loosen as shown in Fig. 23. If the ACB is equipped with side covers, first remove the side covers and then loosen the front cover mounting screws. (The cover mounting screws are of captive type and cannot be removed from the side and front covers.)
- 3) Pulling the charging handle down, remove the front cover.
- 4) Remove the terminal block fixing screws as shown in Fig. 24, and move the terminal block.
- 5) Remove the arc chamber mounting screw as shown in Fig. 28, and remove the arc chamber.

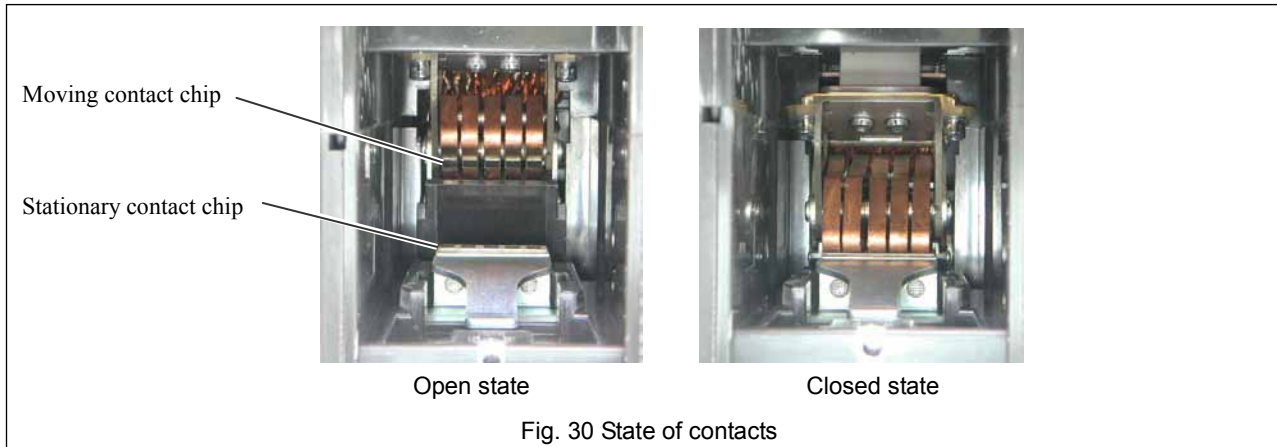


- 6) Reinstall each part or component in reverse order of removal after inspection.

● Fig. 29 shows a removed arc chamber.



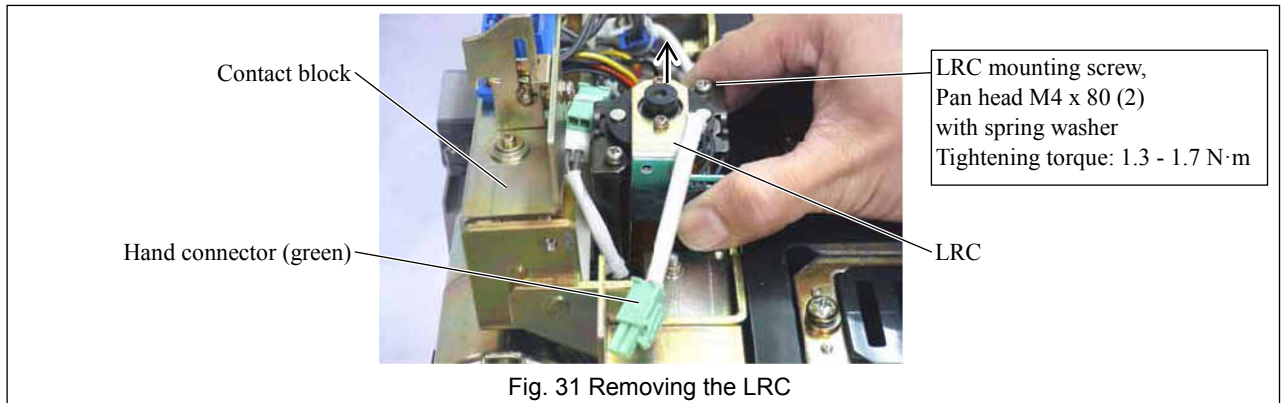
● Fig. 30 shows the contacts in closed and open state.



6-2-3 Latch release coil (LRC)

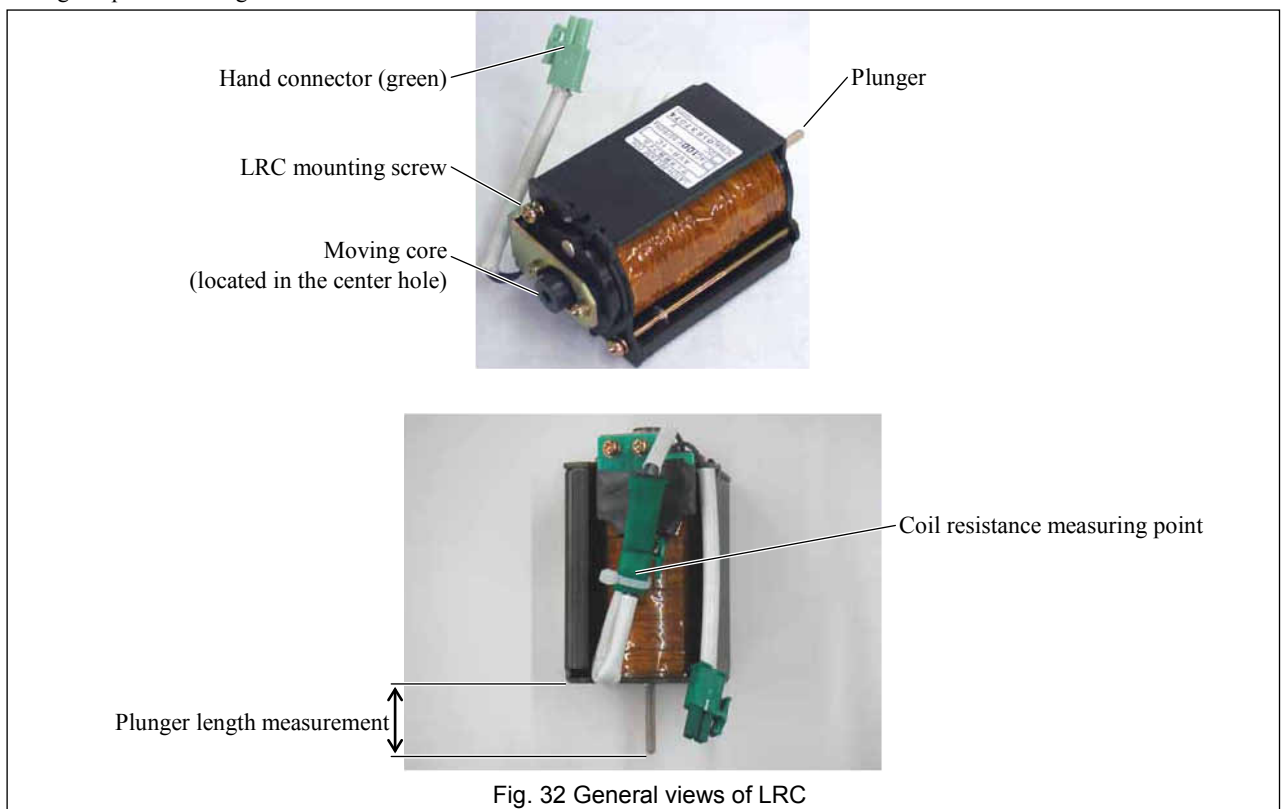
The following describes how to replace the latch release coil (LRC).

- 1) Make preparations for parts replacement. Refer to section 6-2-1.
- 2) If the ACB is not equipped with the undervoltage trip device, turn the cover mounting screws five or six turns to loosen as shown in Fig. 23. If the ACB is equipped with side covers, first remove the side covers and then loosen the front cover mounting screws. (The cover mounting screws are of captive type and cannot be removed from the side and front covers.)
- 3) Pulling the charging handle down, remove the front cover.
- 4) Remove the terminal block fixing screws as shown in Fig. 24, and move the terminal block.
- 5) Turn the LRC mounting screws eight or ten turns to loosen, disconnect the manual connector (green), and then remove the LRC. See Fig. 31.



- 5) Reinstall each part or component in reverse order of removal after inspection. When installing the LRC, make sure the nameplate on the LRC can be viewed from the front of the ACB.

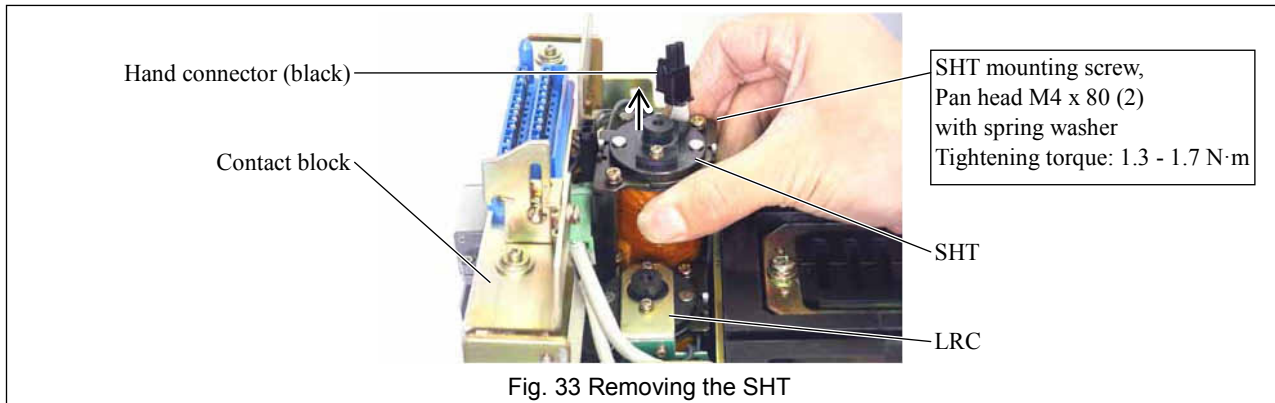
● Fig. 32 provides the general view of the LRC.



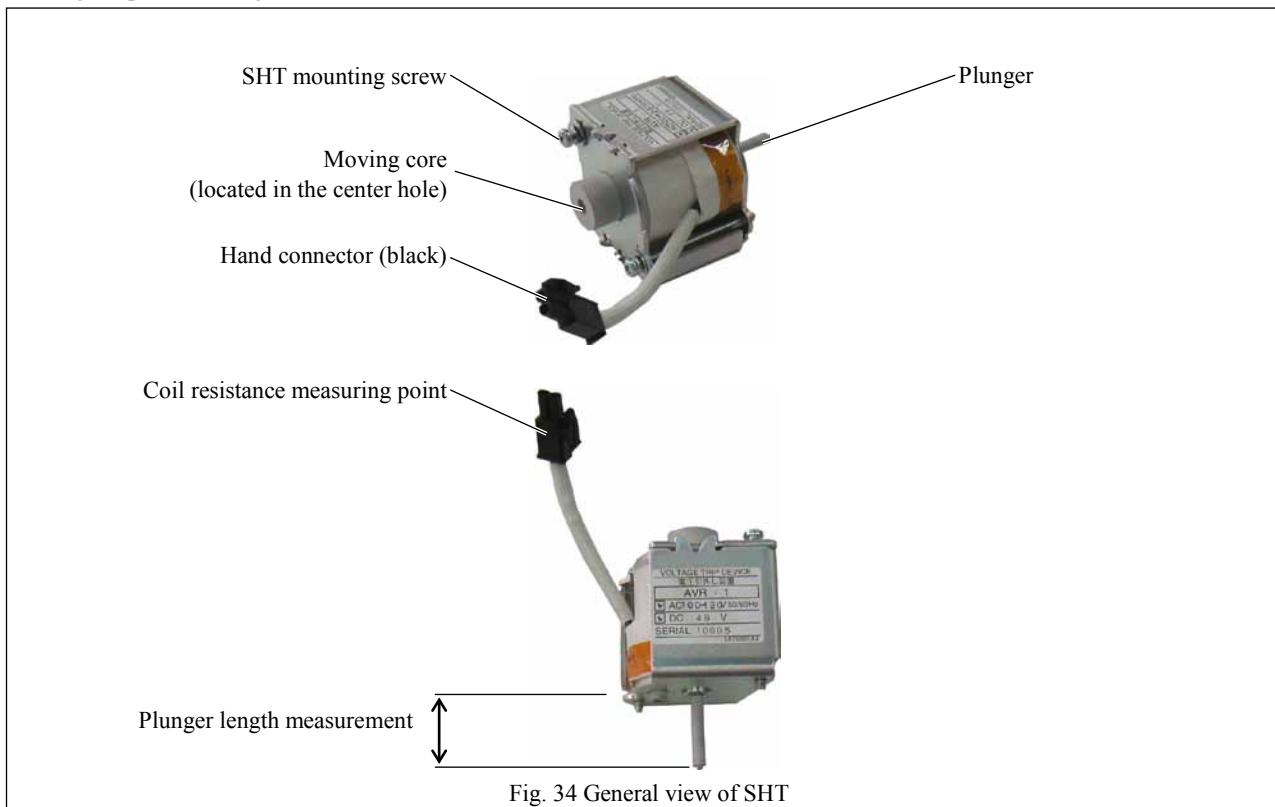
6-2-4. Instantaneously-rated shunt trip device (SHT)

The following describes how to replace the Instantaneously-rated shunt trip device(SHT).

- 1) Make preparations for parts replacement. Refer to section 6-2-1.
- 2) Turn the cover mounting screws five or six turns to loosen as shown in Fig. 23. If the ACB is equipped with side covers, first remove the side covers and then loosen the front cover mounting screws. (The cover mounting screws are of captive type and cannot be removed from the side and front covers.)
- 3) Pulling the charging handle down, remove the front cover.
- 4) Remove the terminal block fixing screws as shown in Fig. 24, and move the terminal block.
- 5) Turn the SHT mounting screws eight or ten turns to loosen, disconnect the manual connector (black), and then remove the SHT.
See Fig. 33.



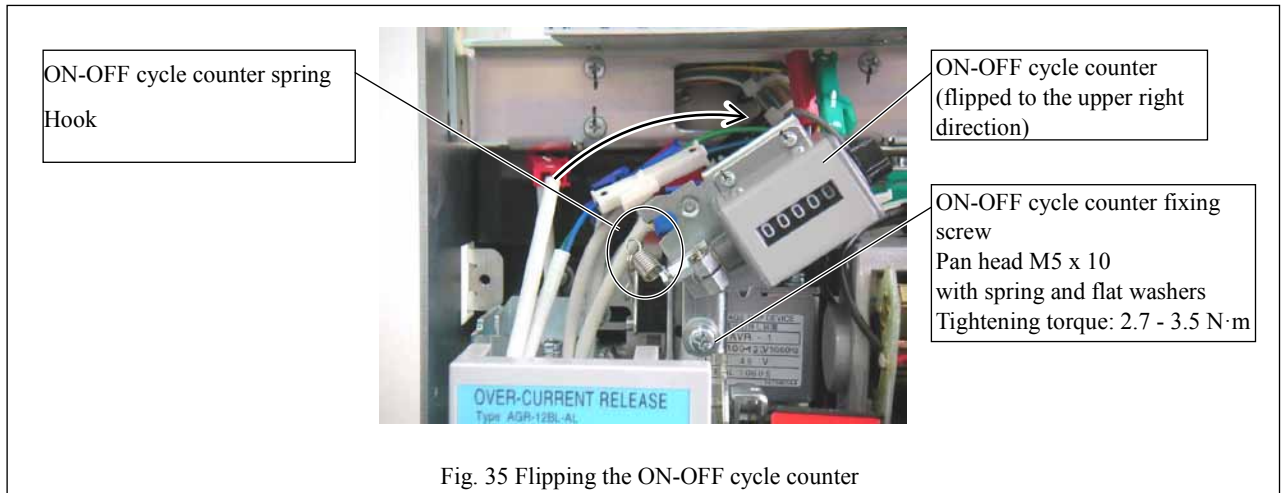
- 6) Reinstall each part or component in reverse order of removal after inspection. When installing the SHT, make sure the nameplate on the SHT can be viewed from the front of the ACB.
- Fig. 34 provides the general view of the SHT.



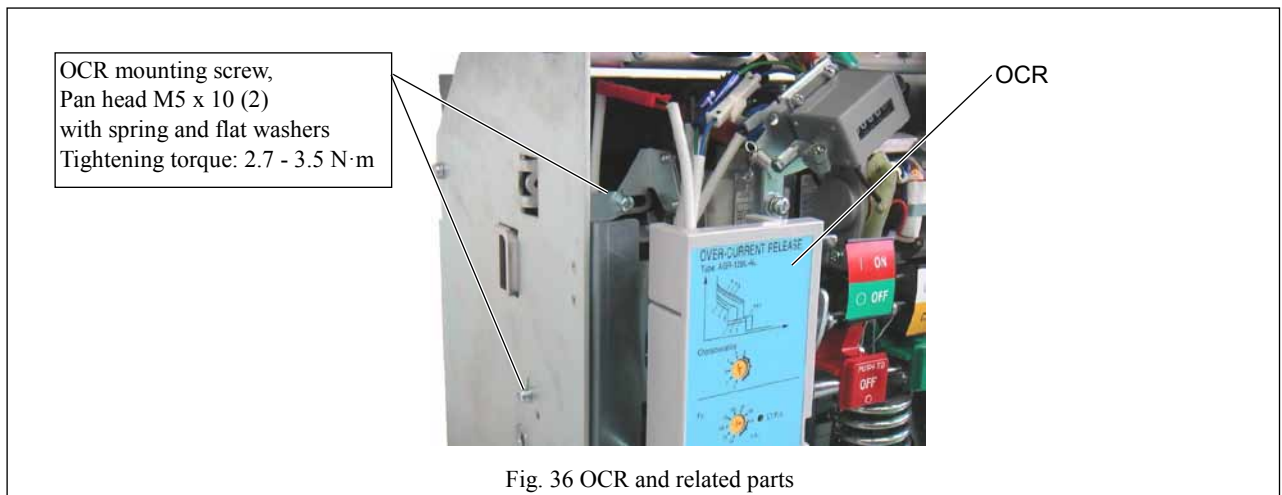
6-2-5. Control relay

The following describes how to replace the control relay.

- 1) Make preparations for parts replacement. Refer to section 6-2-1.
- 2) If the ACB is not equipped with the undervoltage trip device, turn the cover mounting screws five or six turns to loosen as shown in Fig. 23. If the ACB is equipped with side covers, first remove the side covers and then loosen the front cover mounting screws. (The cover mounting screws are of captive type and cannot be removed from the side and front covers.)
- 3) Pulling the charging handle down, remove the front cover.
- 4) If the ACB is equipped with the ON-OFF cycle counter, disengage the hook located under the cycle counter spring, turn the cycle counter fixing screw two or three turns to loosen (do not remove), and flip the cycle counter up to the upper right direction. See Fig. 35.



- 5) Remove the OCR mounting screw as shown in Fig. 36.



- 6) Raise the OCR to unlatch from other parts, remove the OCR and place it on the top of the breaker body. See Fig. 37.
- 7) Remove the OCR connector .

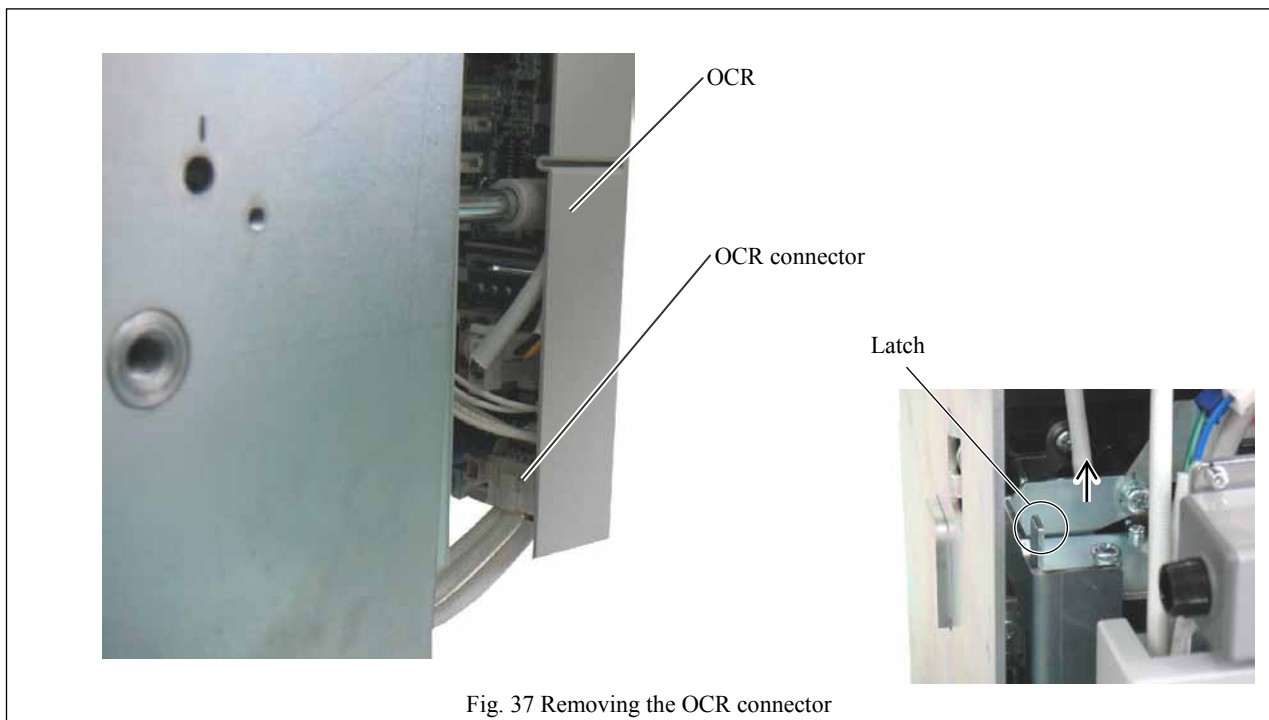


Fig. 37 Removing the OCR connector

- 8) Remove the relay retainer shown in Fig. 38 and remove the control relay from the relay base.

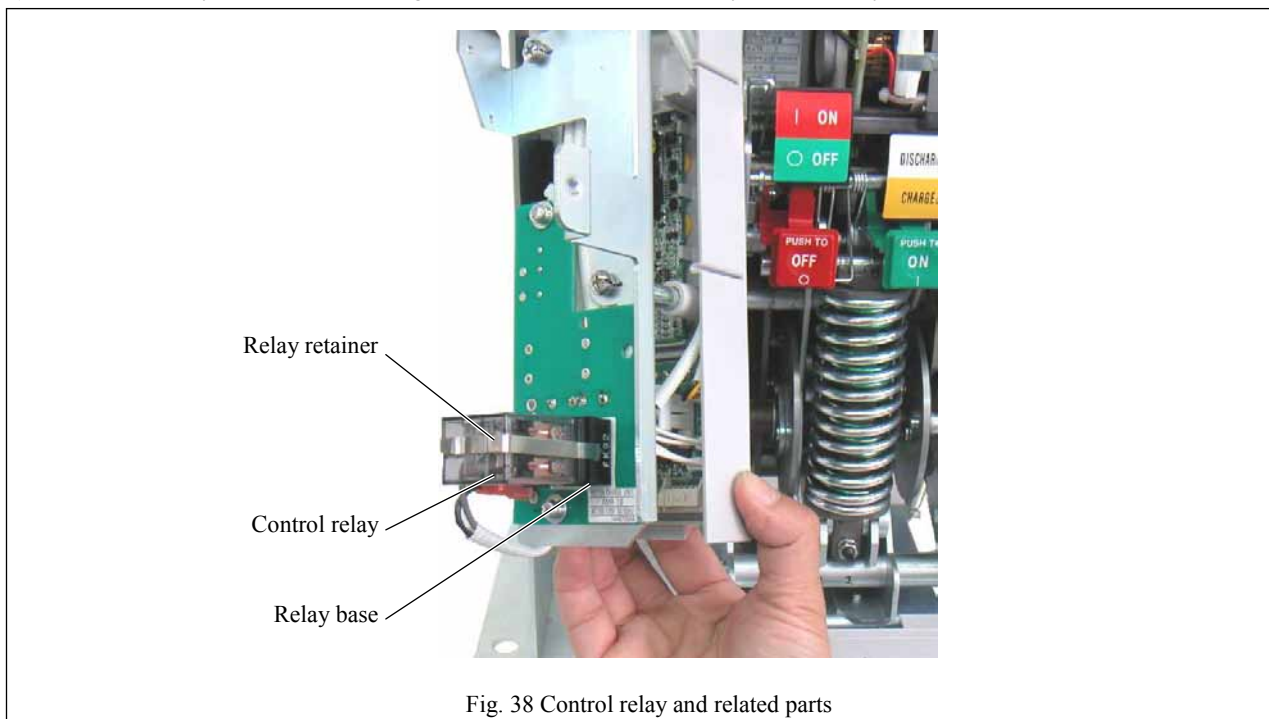


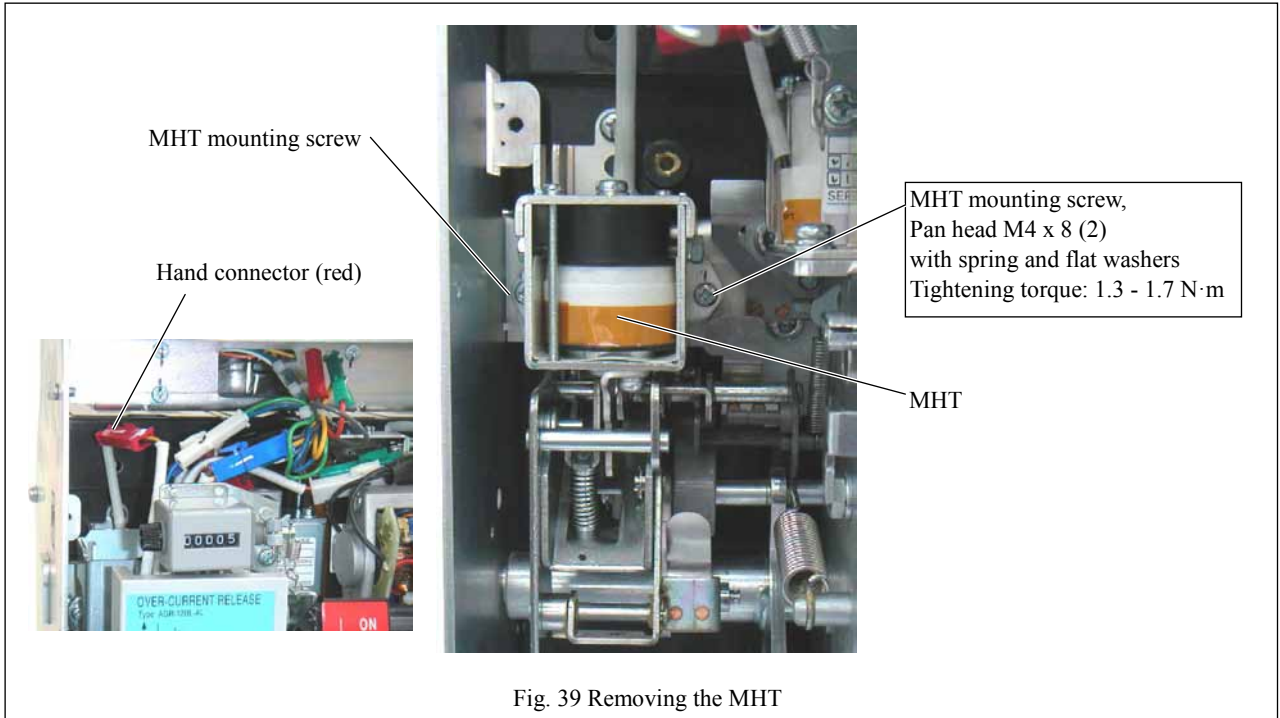
Fig. 38 Control relay and related parts

- 9) Reinstall each part or component in reverse order of removal after inspection.

6-2-6. Magnet hold trigger (MHT)

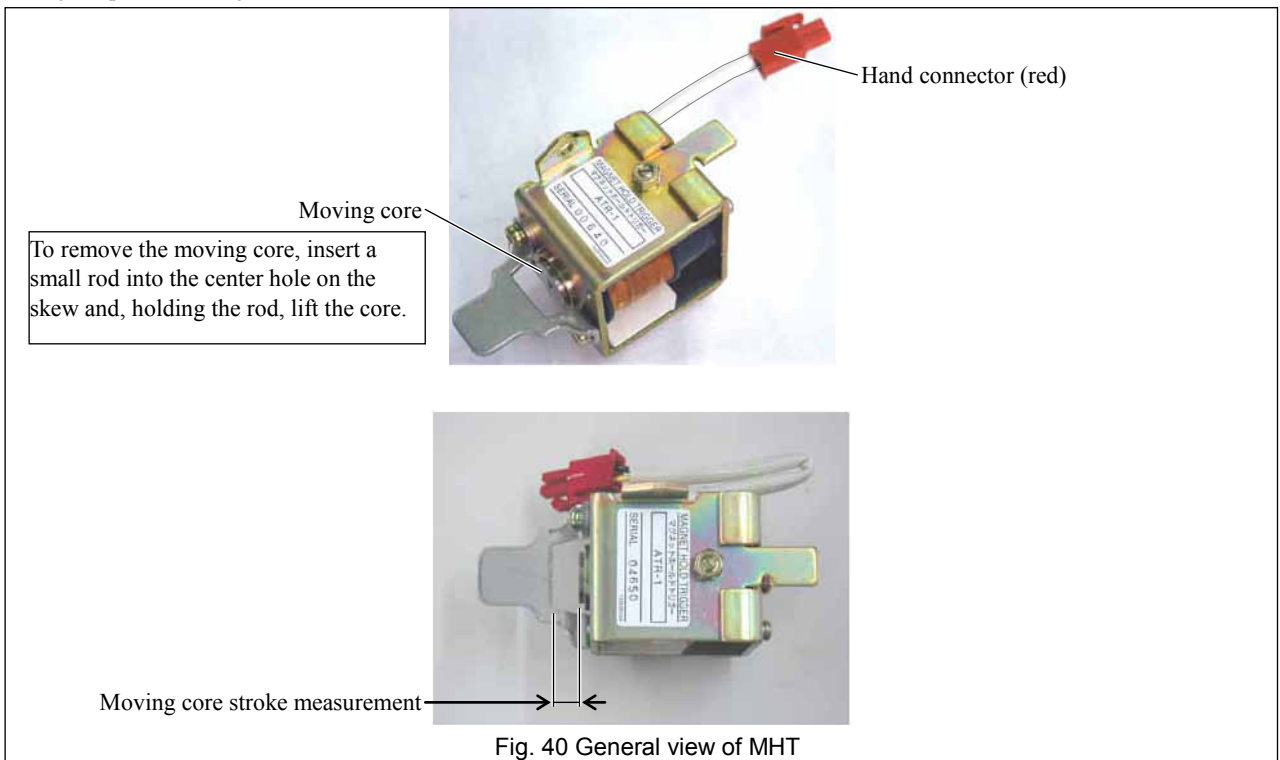
The following describes how to replace the magnet hold trigger (MHT).

- 1) Make preparations for parts replacement. Refer to section 6-2-1.
- 2) Remove the Hand connector (red) as shown in Fig. 39.
- 3) Remove the OCR. Refer to items 2) – 8), section 6-2-5.
- 4) Unscrew the MHT mounting screws shown in Fig. 39, disconnect the hand connector (red), and remove the MHT.



- 5) Reinstall each part or component in reverse order of removal after inspection.

● Fig. 40 provides the general view of the MHT.

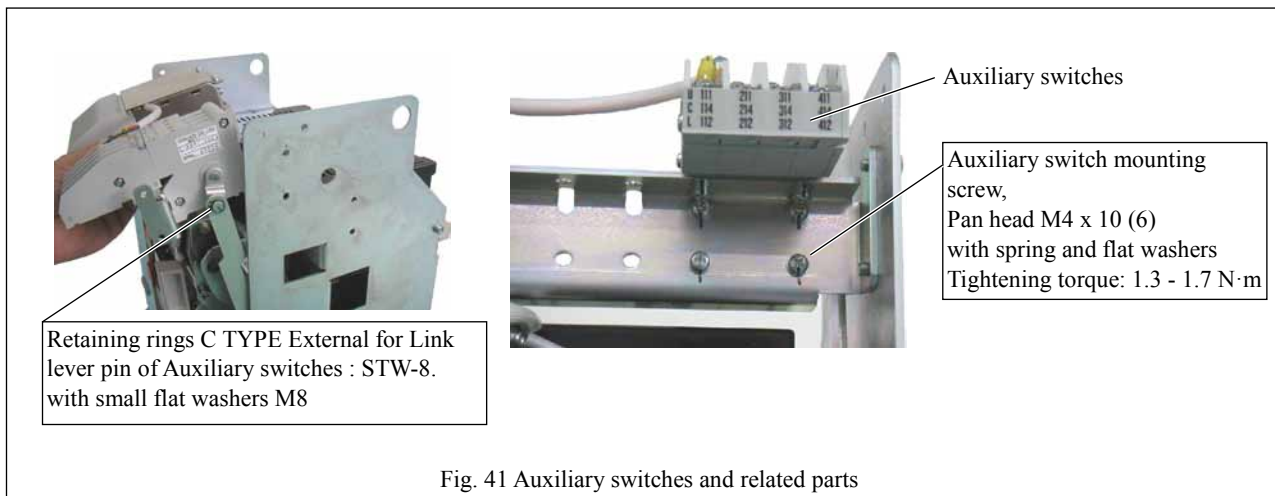


6-2-7. Auxiliary switches

The following describes how to replace auxiliary switches.

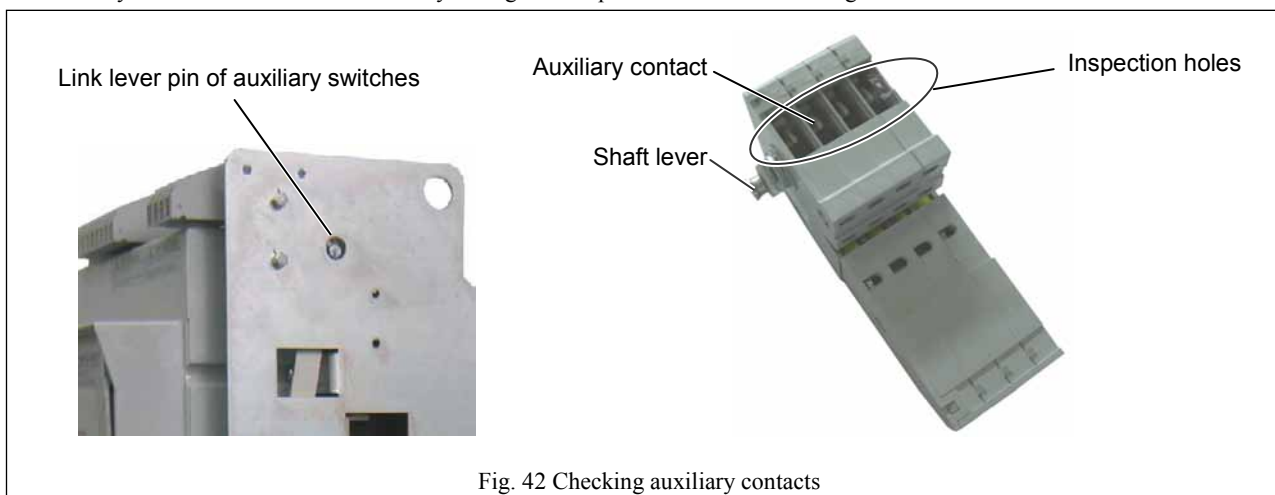
- 1) Make preparations for parts replacement. Refer to section 6-2-1.
- 2) If the ACB is not equipped with the undervoltage trip device, turn the cover mounting screws five or six turns to loosen as shown in Fig. 23. If the ACB is equipped with side covers, first remove the side covers and then loosen the front cover mounting screws. (The cover mounting screws are of captive type and cannot be removed from the side and front covers.)
- 3) Pulling the charging handle down, remove the front cover.
- 4) Remove the Auxiliary switch mounting screw as shown in Fig. 41.
- 5) Remove the terminal block fixing screws as shown in Fig. 24, and move the terminal block.
- 6) Remove the Retaining rings C TYPE External from the Link lever pin of Auxiliary switches by using the special tools as shown in Fig. 41, and remove the auxiliary switches.

(Do not reuse the Retaining rings C TYPE External. Be sure to use a new one.)



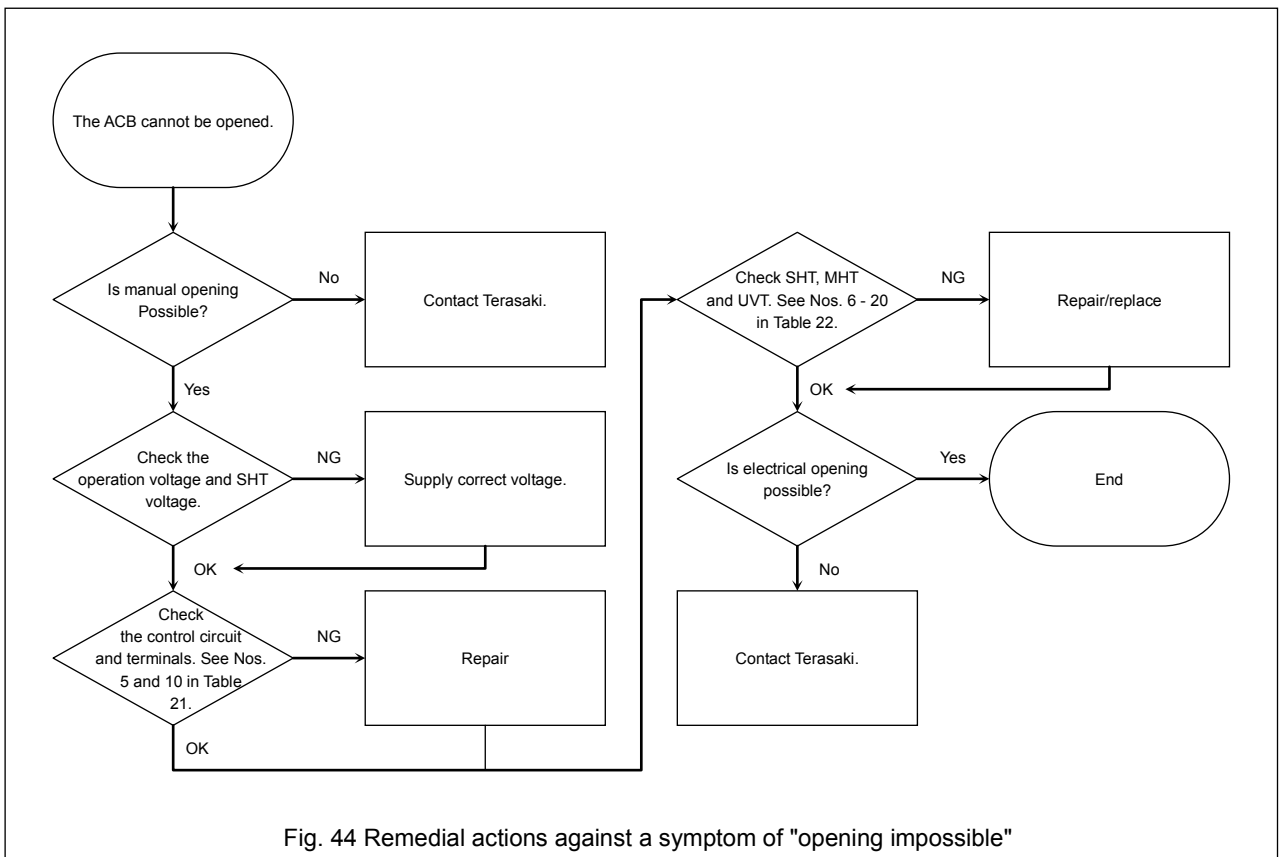
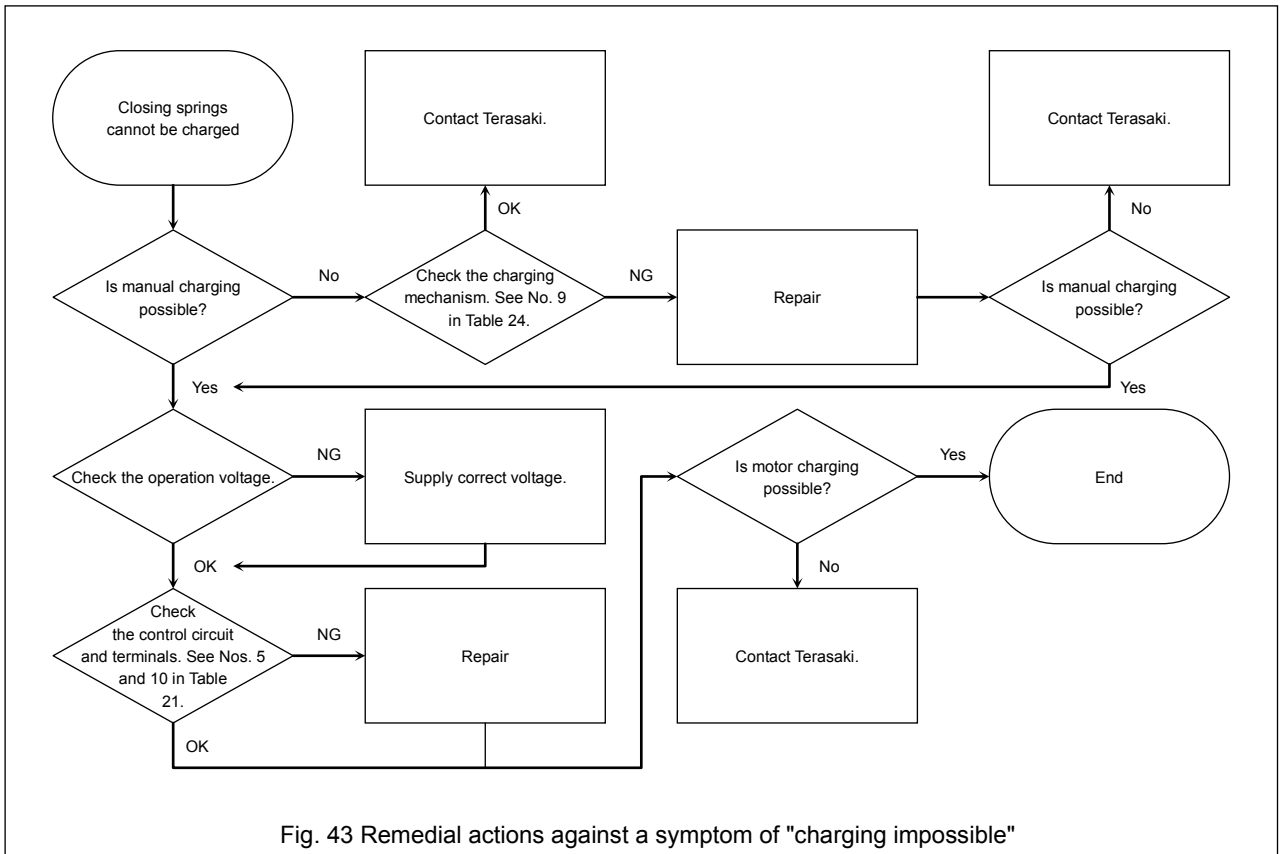
- 7) Reinstall each part or component in reverse order of removal after inspection, and make sure the link lever pin of auxiliary switches is position specified in Fig. 42.

● Auxiliary contacts can be checked visually through the inspection holes shown in Fig. 42.



7. TROUBLESHOOTING FLOWCHARTS

Figs. 43 - 46 are troubleshooting flowcharts where typical troubles and remedial actions are shown.



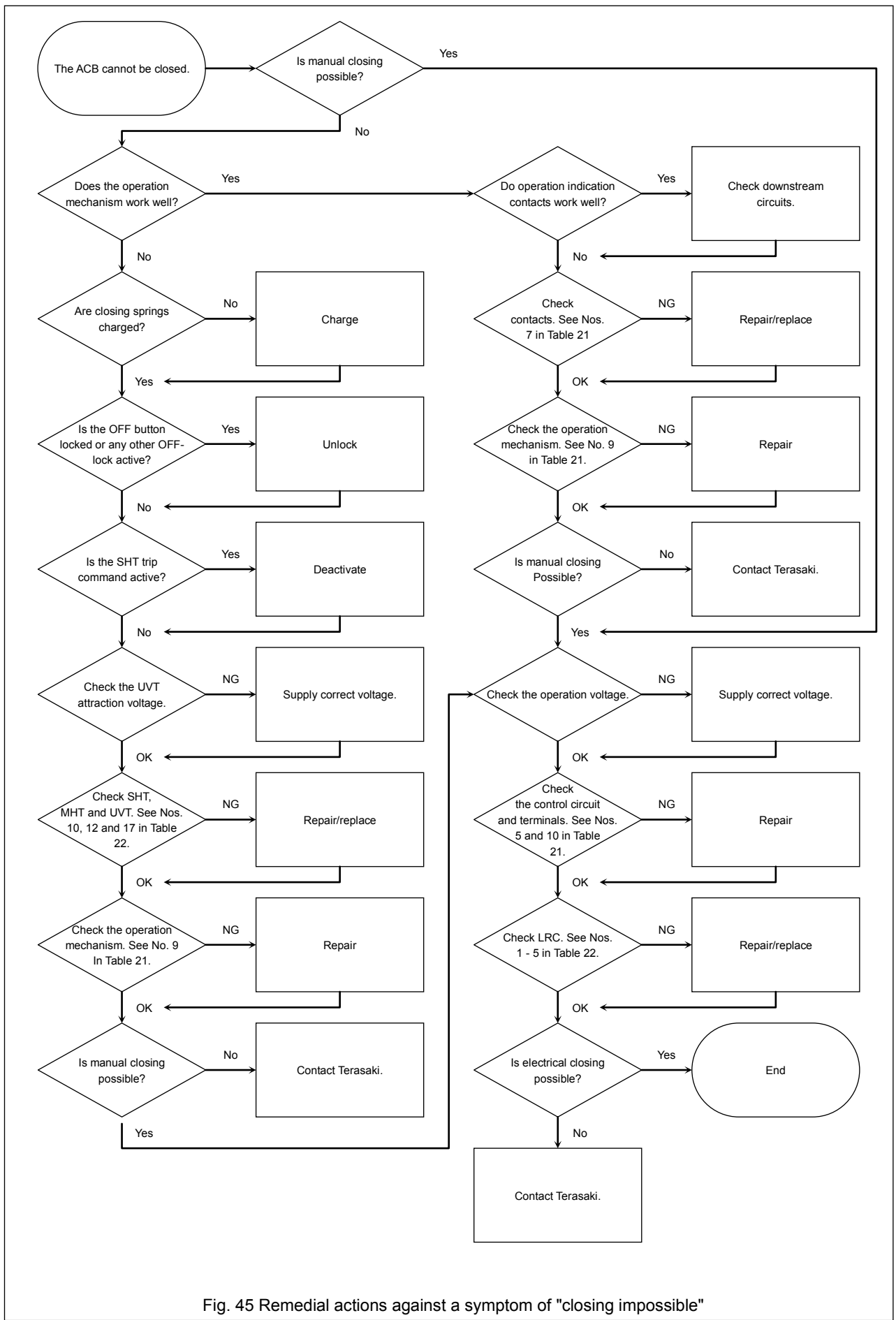


Fig. 45 Remedial actions against a symptom of "closing impossible"

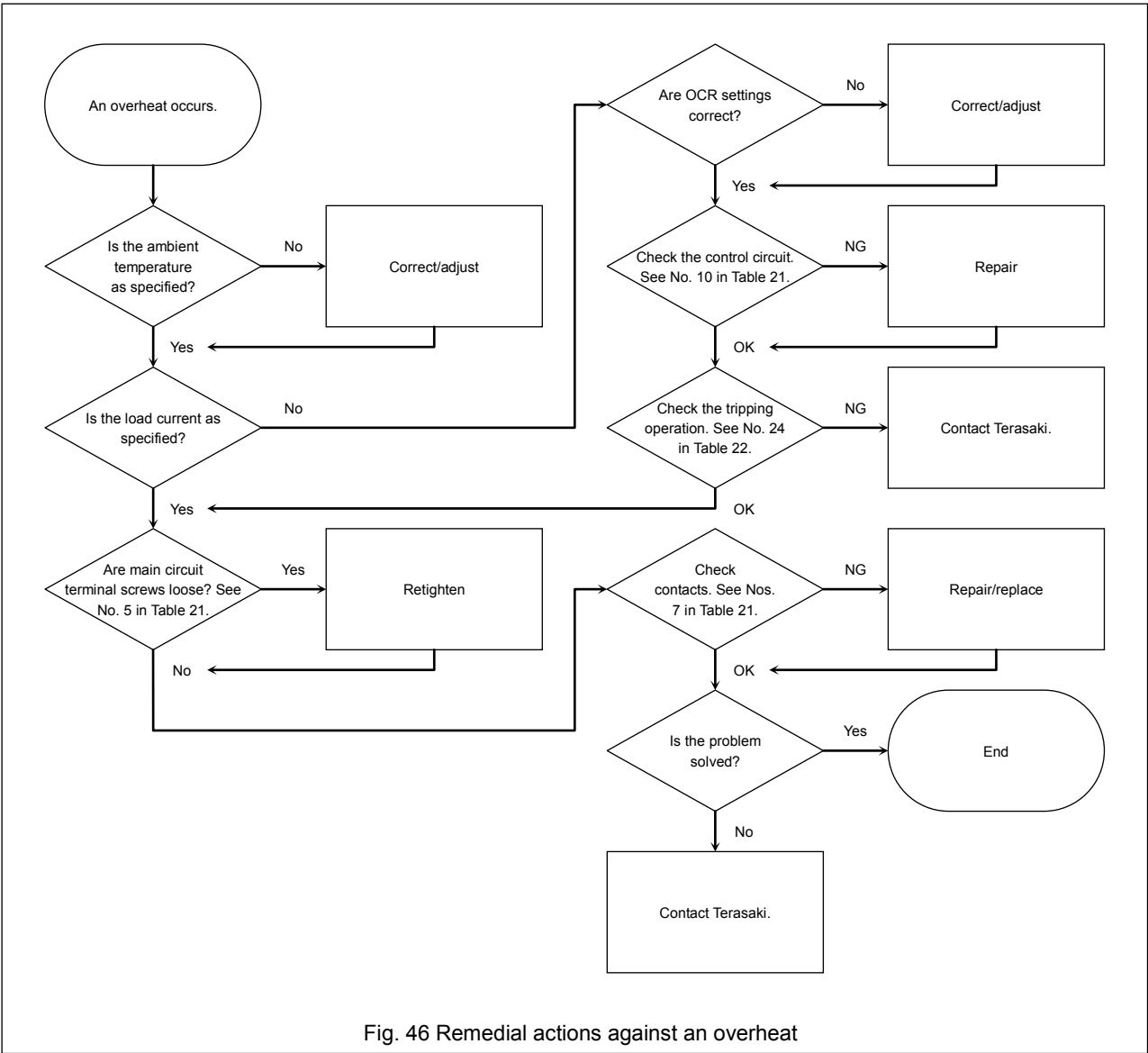


Fig. 46 Remedial actions against an overheat

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Published in January 2006

Revised in December 2008

Revised in February 2017

Revised in June 2018

The contents of this manual may be subject to change without notice.

Recycle paper used.

KRB-5368c