TERASAKI
Innovators in Protection Technology

TemPower2

INSTRUCTION MANUAL FOR AIR CIRCUIT BREAKERS

(With Draw-out Cradle and Type AGR-11B Overcurrent Protective Device)

Types: AR208S
AR212S
AR216S
AR220S
AR325S
AR332S
AR440S
AR440SB
AR212H
AR216H
AR220H
AR316H
AR320H
AR325H
AR332H
AR420H
AR440H

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.

KRB-5258c

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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:

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

⚠CAUTION : 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 a lifter or 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 draw-out cradle of the ACB firmly on a flat, level surface using mounting screws. Otherwise, the draw-out operation may cause the breaker body or the draw-out cradle to fall, resulting in damage to the ACB or personal injury.
- Take care not to deform or bend protrusions in the bottom face of the draw-out cradle when fixing the draw-out cradle with mounting screws. Deformation of the protrusions may cause a malfunction.
- Connect conductors (including screws) to the main circuit terminals in the specified area. Otherwise, a short-circuit 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.

■ Operation Precautions

⚠ DANGER

- Never touch live terminal parts. Doing so will result in electric shock.
- Do not leave the ACB body in the draw-out position. If the ACB body is accidentally dropped, its weight may cause serious injury.

⚠ 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.
- If the ACB has the breaker fixing bolts, be sure to loose the fixing bolts before draw-out operation. Otherwise, damage to the ACB may result.
- Make sure the draw-out cradle is secured with mounting screws before inserting or drawing out the breaker body. Otherwise, the insertion or draw-out operation may cause the breaker body or the draw-out cradle to fall, resulting in damage to the ACB or personal injury.
- When retracting the draw-out rail into the draw-out cradle, be sure to push the rail end. Do not hold the hook pin, body stopper, or body stopper shaft. Doing so may cause your fingers to be pinched, resulting in injury.
- Do not forcedly turn the draw-out handle clockwise when the breaker body is in the “CONN.” position. Doing so may cause a malfunction.
- If the ACB has the breaker fixing bolts, make sure the bolts on both sides are securely tightened before using the ACB. Loosened fixing bolts may cause a malfunction of the ACB, in particular when it is installed in such an area that is subject to strong vibrations.

■ 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 ANU-1 OCR checker (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.
- Take care to avoid adhesion of dust to main and control circuit contacts. Dust on the contacts may result in a fire.
- 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 lifter or lifting attachments. If the ACB body is accidentally dropped, its weight may cause serious injury.

2-1-1. Transporting the ACB

- Before transporting the ACB, make sure the breaker body is in the CONN. position. If the ACB has breaker fixing bolts, make sure the breaker body is secured to the draw-out cradle with the fixing bolts.
- When lifting the ACB, hold it using lifting attachments or wire ropes through the lifting holes. Take care that the position switches, 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.
- When transporting the ACB while it is installed in a switchboard, you should fix the breaker body in the draw-out cradle with the breaker fixing bolts (optional).
- Lower the ACB onto a flat, level surface.

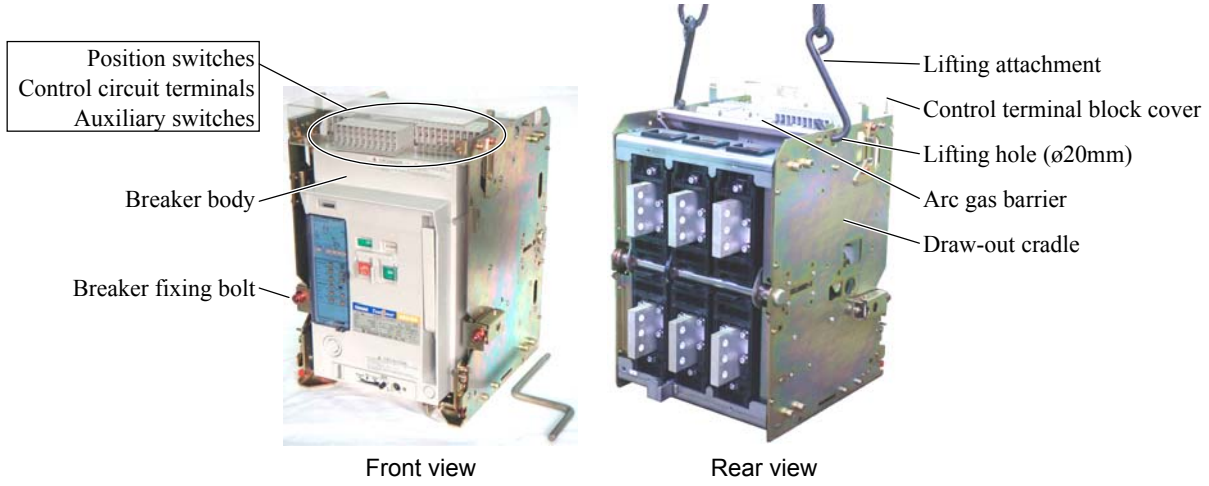


Fig. 1 Transporting the ACB

2-1-2. Transporting the breaker body

- Use an optional lifter or lifting plate to transfer the breaker body.
- When transporting the breaker body on a lifter, move the lifter with the lifter fork held at the lowest possible position.
- Take care not to exert forces on the front cover and the control circuit contacts shown in Fig. 2 . Otherwise, a deformation or damage may result.

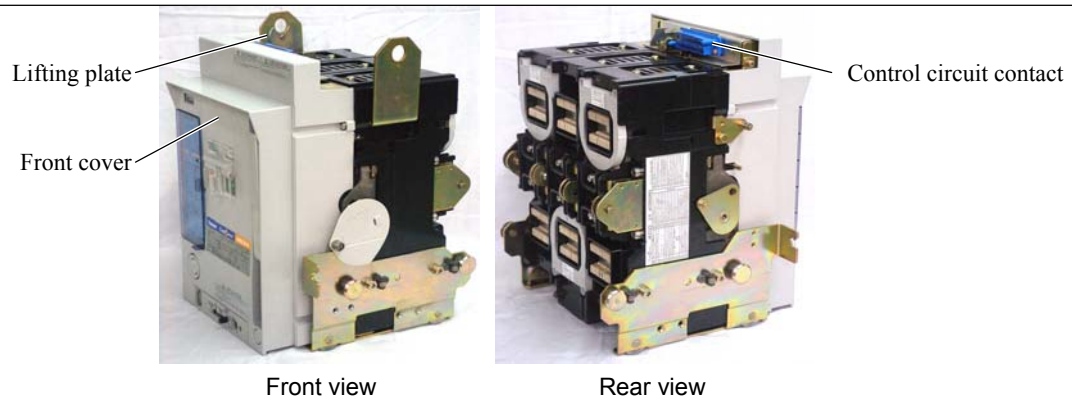


Fig. 2 Transporting the breaker body

2-1-3. Transporting the draw-out cradle

- When transporting the draw-out cradle, hold it using lifting attachments or wire ropes through the lifting holes or carry it by the portions (4 points) marked with the arrows shown in Fig 3. When carrying the draw-out cradle, take care not to exert forces on the arc gas barrier, the draw-out arm, the position switches, the auxiliary switches, the control circuit terminals, the control terminal block cover, and the control circuit contacts.

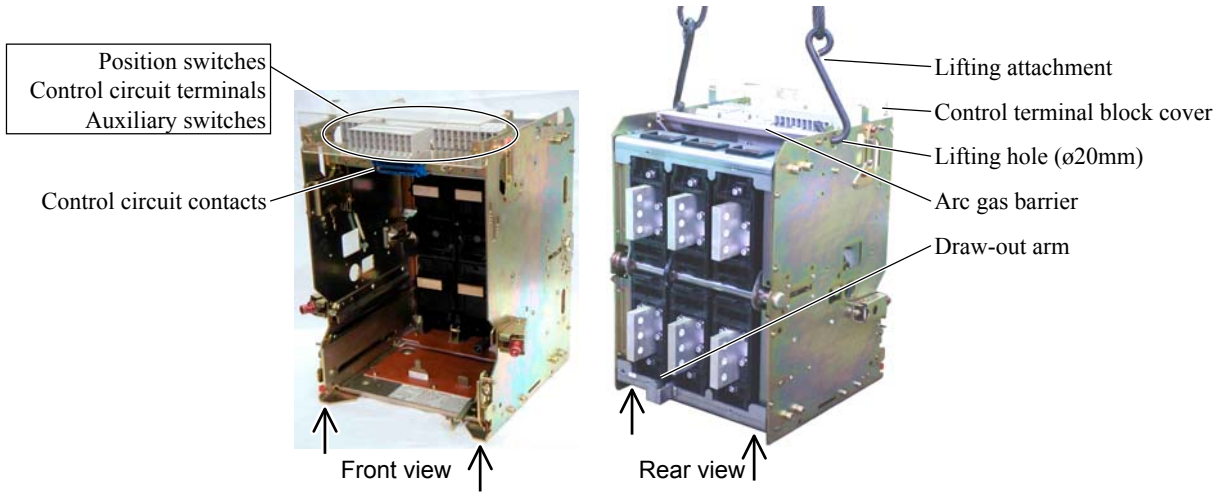


Fig. 3 Transporting the draw-out cradle

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.
- Fix the draw-out cradle of the ACB firmly on a flat, level surface using mounting screws. Otherwise, the draw-out operation may cause the breaker body or the draw-out cradle to fall, resulting in damage to the ACB or personal injury.
  Take care not to deform or bend protrusions in the bottom face of the draw-out cradle when fixing the draw-out cradle with mounting screws. Deformation of the protrusions may cause a malfunction (see Fig. 4).
- Connect conductors (including screws) to the main circuit terminals in the specified area. Otherwise, a short-circuit 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.

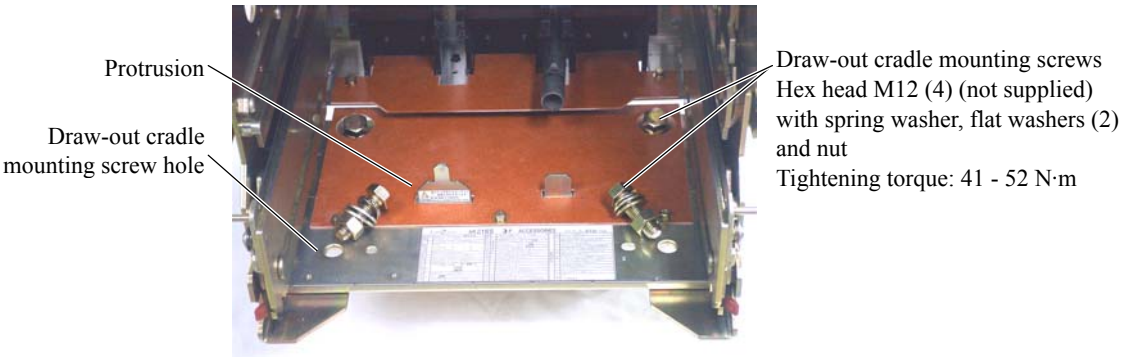


Fig. 4 Protrusion on the bottom of the draw-out cradle

- For AR440SB, the mounting screw protection covers are installed on two of four mounting screw holes. When fixing the draw-out cradle, insert the draw-out cradle mounting screws into these two holes while lifting open the covers.

  Do not lift open the cover too high. Failure to do so may result in damage to the cover.

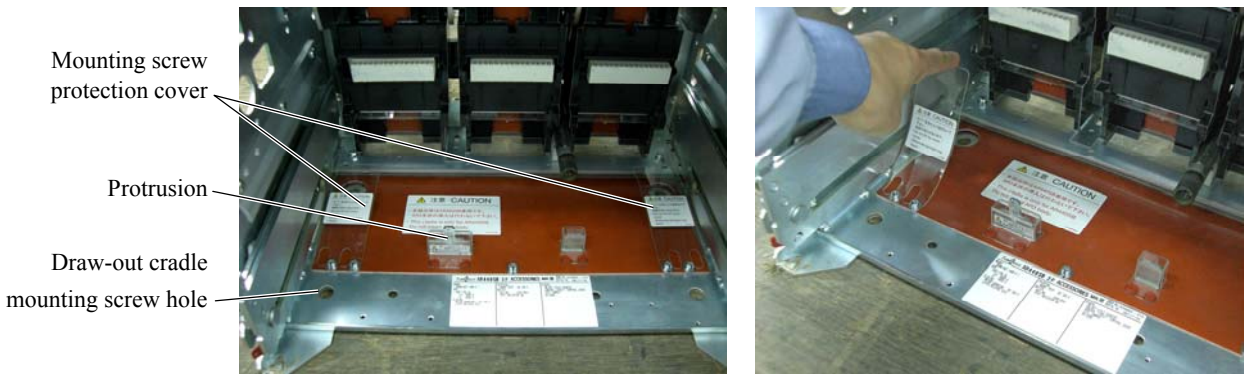


Fig. 5 Mounting screw protection cover

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 and Table 4). 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		AR208S, AR212S, AR216S	AR220S, AR212H, AR216H, AR220H	AR325S, AR332S AR316H, AR320H, AR325H, AR332H	AR440S**B**	AR440S, AR420H, AR440H
Number of main circuit terminal screws (3/4-pole)	Vertical terminals	12/16	18/24	24/32	24/32	48/64
	Horizontal/front terminals*	12/16		18/24	-	-

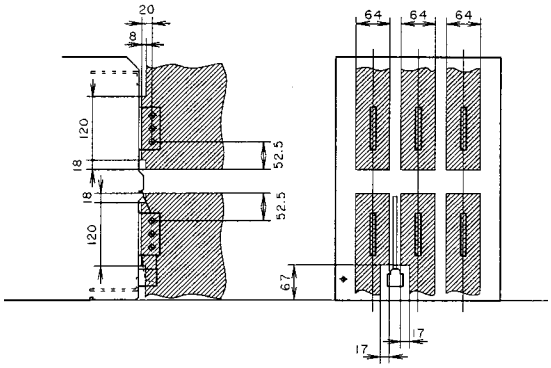
* Front terminals are not applicable for high-performance ARxxxH types.

- 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

● Connect conductors to the main circuit terminals in the conductor connection area as shown in Figs. 6 - 9.

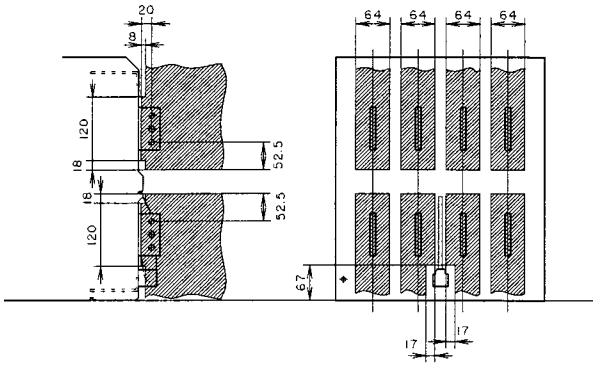
●Vertical terminals, 3 Poles

Right side view　　Back view



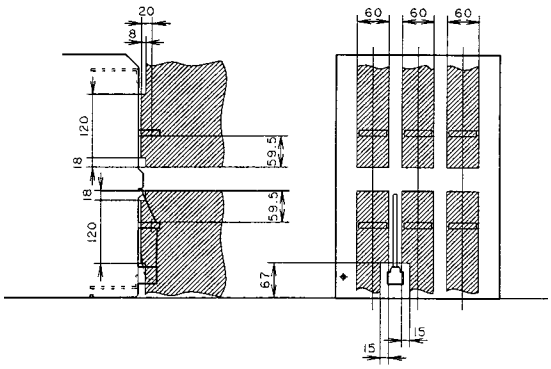
●Vertical terminals, 4 Poles

Right side view　　Back view



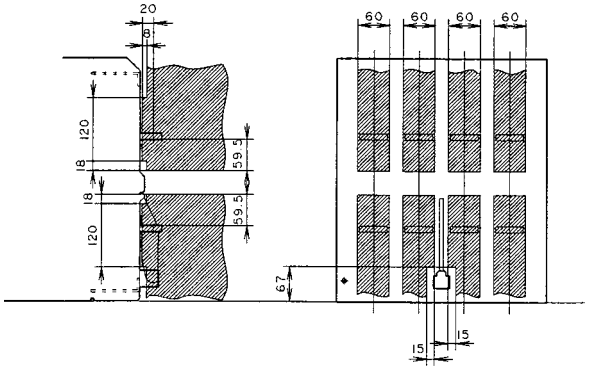
●Horizontal terminals, 3 Poles

Right side view　　Back view



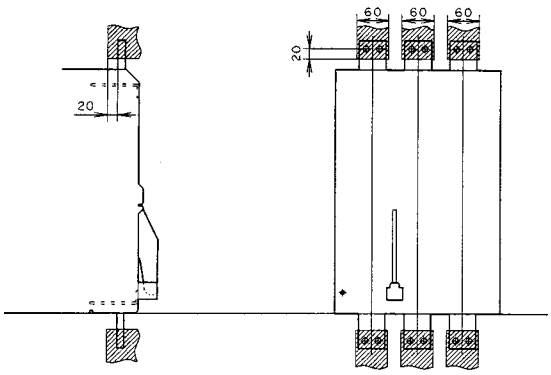
●Horizontal terminals, 4 Poles

Right side view　　Back view



●Front terminals, 3 Poles

Right side view　　Back view



●Front terminals, 4 Poles

Right side view　　Back view

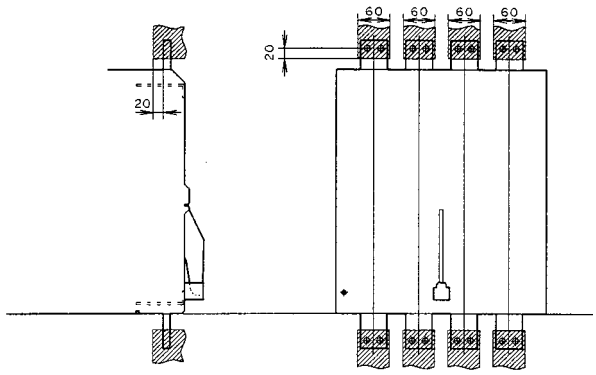
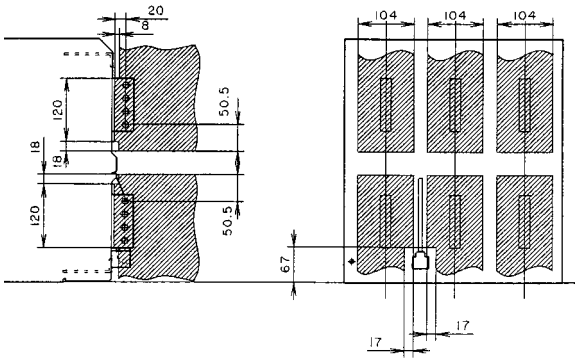


Fig. 6 Conductor (include screw) connection area (AR208S, AR212S, AR216S, AR220S, AR212H, AR220H)

*Insulation distance of conductor connection area and earth metal is more than 12.5mm.

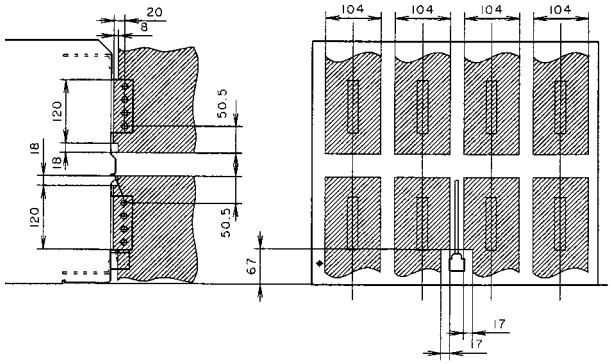
●Vertical terminals, 3 Poles

Right side view　　Back view



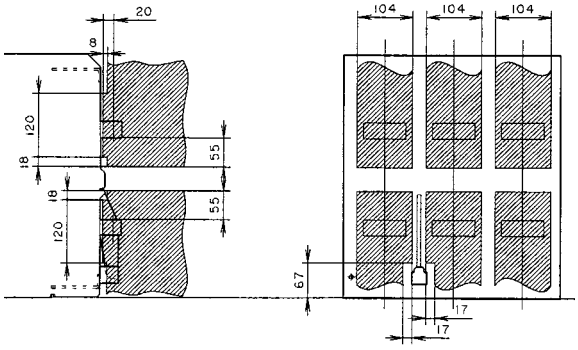
●Vertical terminals, 4 Poles

Right side view　　Back view



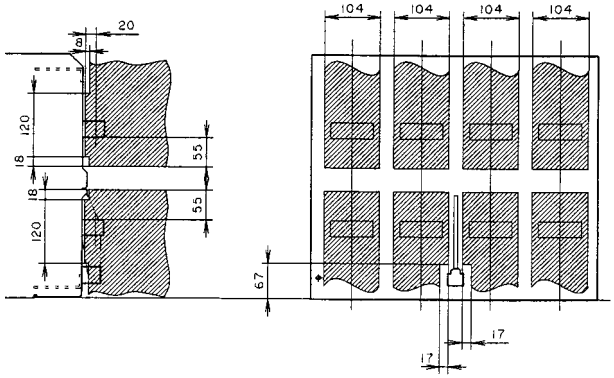
●Horizontal terminals, 3 Poles

Right side view　　Back view



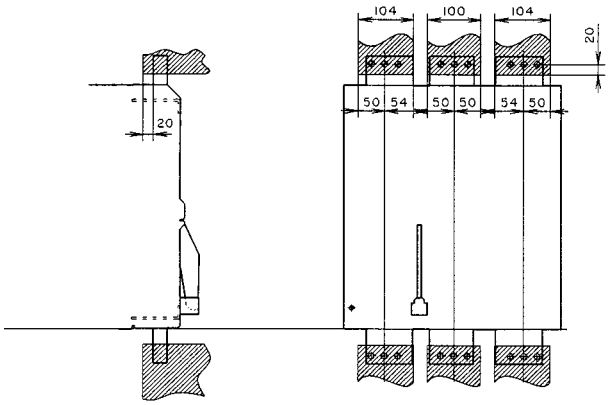
●Horizontal terminals, 4 Poles

Right side view　　Back view



●Front terminals, 3 Poles

Right side view　　Back view



●Front terminals, 4 Poles

Right side view　　Back view

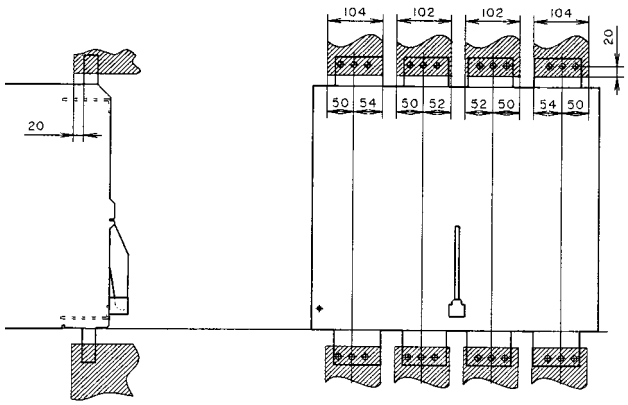
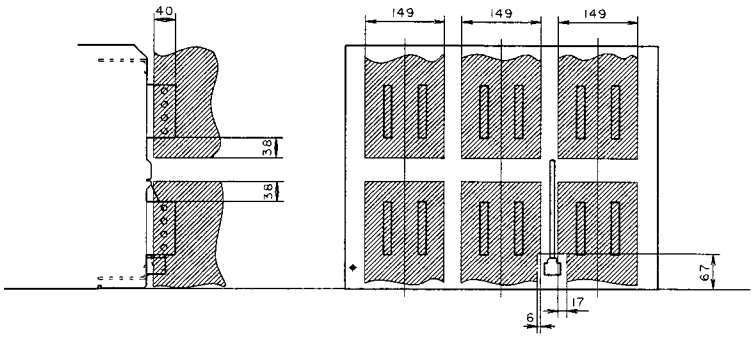


Fig. 7 Conductor (include screw) connection area (AR325S, AR332S, AR316H, AR320H, AR325H, AR332H)

*Insulation distance of conductor connection area and earth metal is more than 12.5mm.

●Vertical terminals, 3 Poles

Right side view　　Back view



●Vertical terminals, 4 Poles

Right side view　　Back view

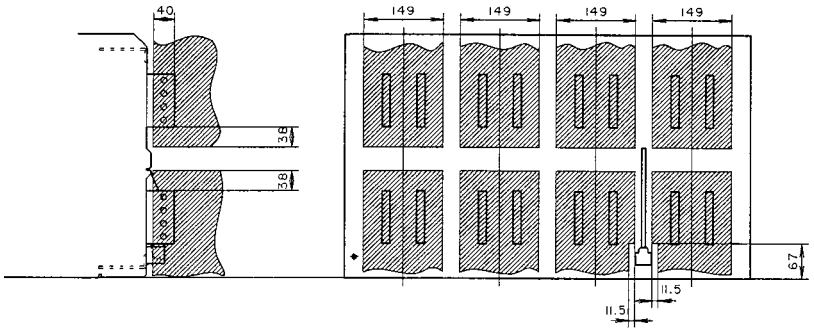
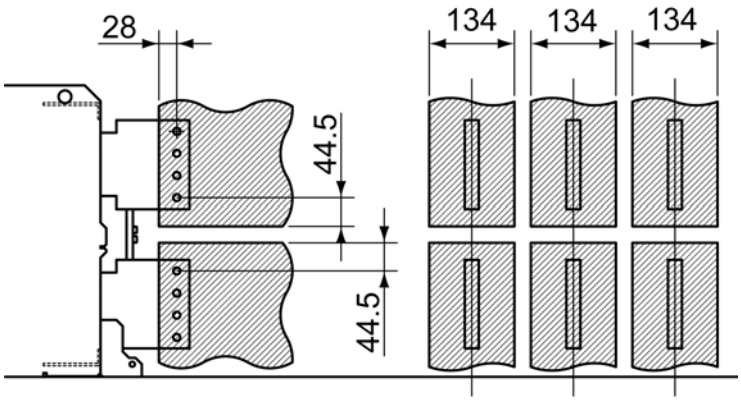


Fig. 8 Conductor (include screw) connection area (AR440S)

*Insulation distance of conductor connection area and earth metal is more than 12.5mm.

●Vertical terminals, 3 Poles

Right side view　　Back view



●Vertical terminals, 4 Poles

Right side view　　Back view

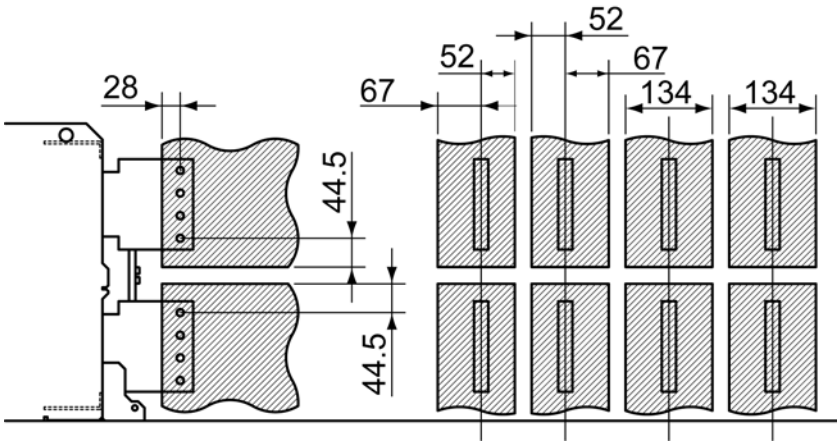


Fig. 9 Conductor (include screw) connection area (AR440SB)

*Insulation distance of conductor connection area and earth metal is more than 12.5mm.

● Use a support to hold conductors securely at distance L as shown in Fig. 10 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.

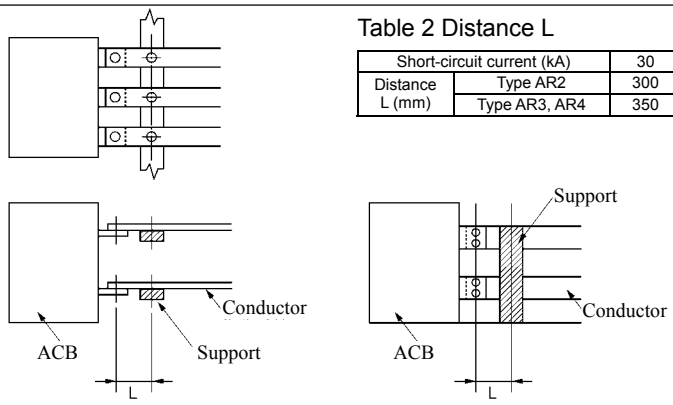


Table 2 Distance L

Short-circuit current (kA)		30	50	65	80	100
Distance L (mm)	Type AR2	300	250	150	150	-
	Type AR3, AR4	350	300	250	150	150

Fig. 10 Support mounting

● The following procedure makes it easy to make connections with plug-in tab terminals (#187) of position switches, control circuit terminals, and auxiliary switches.

(1) Draw out the breaker body to the removed position, and remove it using an optional lifter or lifting plate. Refer to sections 4-2-2 and 2-1-2.

(2) If the ACB is equipped with the control terminal block cover, loosen both the cover fixing screws and remove the cover.

(3) Remove the terminal block fixing screws shown in Fig. 11.

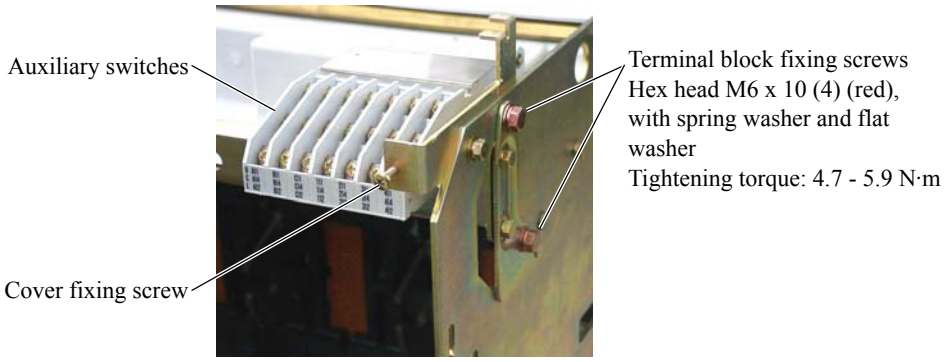


Fig. 11 Terminal block fixing screws

(4) Tilt the terminal block down as shown in Fig. 12. After connecting wires, tilt the terminal block up again and fix it with the terminal block fixing screws.

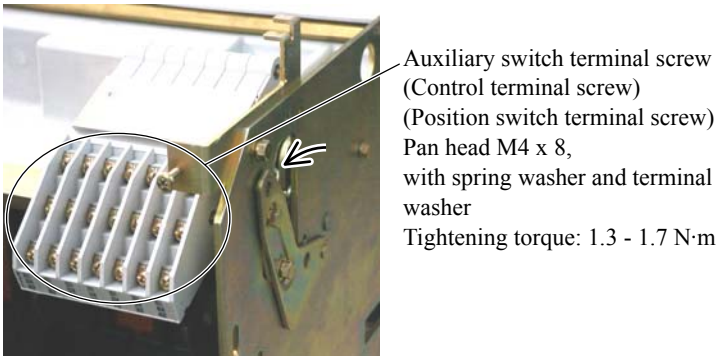


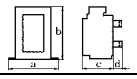
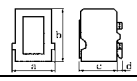
Fig. 12 Terminal block tilted down

● 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

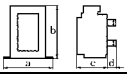
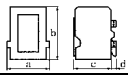
TemPower2 is available in types shown in Tables 3 and 4.

Table 3 Standard types

Frame size (A)			800	1250	1600	2000	2500	3200	4000	4000
Type			AR208S	AR212S	AR216S	AR220S	AR325S	AR332S	AR440SB	AR440S
Max. rated current [I_n] (A) *1, *2	IEC, EN, AS JIS Marine use		800	1250	1600	2000	2500	3200	4000	4000
N-phase rated current (A)			800	1250	1600	2000	2500	3200	4000	4000
Number of poles *3, *4			3 | 4	3 | 4	3 | 4	3 | 4	3 | 4	3 | 4	3 | 4	3 | 4
Dielectric withstand voltage [U_i] (50/60Hz) *5			1000	1000	1000	1000	1000	1000	1000	1000
Operating voltage [U_e] (50/60Hz) *6			690	690	690	690	690	690	690	690
Rated breaking/making current [kA sym rms/kA peak]										
IEC ,EN, AS [$I_{cs} = I_{cu}$] JIS C 8201-2-1 Ann.1 Ann.2	AC 690V *8		50/105				65/143		85/187	75/165
	AC 440V		65/143 *10				85/187 *10		100/220	100/220
NK *7	AC 690V		50/115				65/153		*14	75/179
	AC 450V		65/153 *10				85/201 *10		*14	100/245
For DC	DC 600V *9 DC 250V		40/40							
Rated short-time current [I_{cw}] [kA rms] (1 sec.)			65				85		100	100
Rated latching current (kA)			65				85		85	100
Endurance in number of ON-OFF cycles *11	Mechanical	With maintenance	30000	30000	30000	25000	20000	20000	15000	15000
		Without maintenance	15000	15000	15000	12000	10000	10000	8000	8000
	Electrical	Without maintenance AC 460V	12000	12000	12000	10000	7000	7000	3000	3000
		Without maintenance AC 690V	10000	10000	10000	7000	5000	5000	2500	2500
Installation			Draw-out or fixed type							
Mass (kg) for draw-out type			73 | 86	73 | 86	76 | 90	79 | 94	105 | 125	105 | 125	126 | 158	139 | 176
External dimensions (mm)										
Fixed type *12 	a		360 | 445	360 | 445	360 | 445	360 | 445	466 | 586	466 | 586	- | -	- | -
	b		460						-	-
	c		290						-	-
	d		75						-	-
Draw-out type *13 	a		354 | 439	354 | 439	354 | 439	354 | 439	460 | 580	460 | 580	460 | 580	631 | 801
	b		460						460	460
	c		345						345	375
	d		40						140	53
Connection method	Line side		Vertical, horizontal or front terminals						Vertical terminals	Vertical terminals
	Load side		Vertical, horizontal or front terminals						Vertical terminals	Vertical 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 (TC)		Standard equipment for OCR-equipped ACB							
	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		AC100 - 120V, AC200 - 240V, DC100 - 125V, DC200 - 250V, DC24V or DC48V							

*1: Ambient temperature: 40°C (45°C for marine used))
*2: With horizontal terminals for AR208S - 216S and vertical terminals for AR220S - 440S
*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: Varies depending on applicable standards. AC1000V applies to ACBs conforming to IEC60947-2 and JIS C8201-2.
*6: Varies depending on applicable standards. AC690V applies to ACBs conforming to IEC60947-2 and JIS C8201-2.
*7: Applicable to 3-pole ACBs with INST or MCR.
*8: For applicability to power distribution IT systems, consult us
*9: Applicable under 3-pole serial connection scheme.
*10: For AC500V
*11: 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”.
*12: For both vertical and horizontal terminals
*13: This manual covers draw-out type ACBs.
*14: In applying or going to apply.

Table 4 High-performance types

Frame size (A)			1250	1600	2000	1600	2000	2000	2500	3200	4000
Type			AR212H	AR216H	AR220H	AR316H	AR320H	AR420H	AR325H	AR332H	AR440H
Max. rated current [I_n] (A) *1, *2	IEC, EN, AS JIS Marine use		1250	1600	2000	1600	2000	2000	2500	3200	4000
N-phase rated current (A)			1250	1600	2000	1600	2000	2000	2500	3200	4000
Number of poles *3, *4			3 / 4	3 / 4	3 / 4	3 / 4	3 / 4	3	3 / 4	3 / 4	3
Dielectric withstand voltage [U_i] (50/60Hz) *5			1000	1000	1000	1000	1000	1000	1000	1000	1000
Operating voltage [U_e] (50/60Hz) *6			690	690	690	690	690	690	690	690	690
Rated breaking/making current [kA sym rms/kA peak] *7											
IEC ,EN, AS [$I_{CS} = I_{CU}$] JIS C 8201-2-1 Ann.1 Ann.2	AC 690V *9		55/121			85/187		75/165	85/187		75/165
	AC 440V		80/176			100/220		120/264	100/220		120/264
NK *8	AC 690V		55/128			85/201		*14	85/201		*14
	AC 450V		80/186			100/233		*14	100/233		*14
For DC	DC 600V *10		40/40								
	DC 250V										
Rated short-time current [I_{CW}] [kA rms] (1 sec.)			80			100		100	100		100
Rated latching current (kA)			65			85		100	85		85
Endurance in number of ON-OFF cycles *11	Mechanical	With maintenance	30000	30000	25000	30000	25000	15000	20000	20000	15000
		Without maintenance	15000	15000	12000	15000	12000	8000	10000	10000	8000
	Electrical	Without maintenance AC 460V	12000	12000	10000	12000	10000	3000	7000	7000	3000
		Without maintenance AC 690V	10000	10000	7000	10000	7000	2500	5000	5000	2500
Installation			Draw-out or fixed type								
Mass (kg) for draw-out type			79 / 94	79 / 94	79 / 94	105 / 125	105 / 125	139	105 / 125	105 / 125	139
External dimensions (mm)											
Fixed type *12 	a		360 / 445	360 / 445	360 / 445	466 / 586	466 / 586	-	466 / 586	466 / 586	-
	b		460					-	460		-
	c		290					-	290		-
	d		75					-	75		-
Draw-out type *13 	a		354 / 439	354 / 439	354 / 439	460 / 580	460 / 580	631	460 / 580	460 / 580	631
	b		460					460	460		460
	c		345					375	345		380
	d		40					53	40		60
Connection method	Line side		Vertical terminals (Horizontal terminals can be specified as an option)					Vertical terminals	Vertical terminals (Horizontal terminals can be specified as an option)		Vertical terminals
	Load side		Vertical terminals (Horizontal terminals can be specified as an option)					Vertical terminals	Vertical terminals (Horizontal terminals can be specified as an option)		Vertical 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 (TC)		Standard equipment for OCR-equipped ACB								
	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		AC100 - 120V, AC200 - 240V, DC100 - 125V, DC200 - 250V, DC24V or DC48V								

*1: Ambient temperature: 40°C (45°C for marine used)
*2: For vertical 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: Varies depending on applicable standards. AC1000V applies to ACBs conforming to IEC60947-2 and JIS C8201-2.
*6: Varies depending on applicable standards. AC690V applies to ACBs conforming to IEC60947-2 and JIS C8201-2.
*7: Setting the instantaneous trip function to NON reduces the rated breaking current to the rated latching current.
*8: Applicable to 3-pole ACBs with INST or MCR.
*9: For applicability to power distribution IT systems, consult us
*10: Applicable under 3-pole serial connection scheme.
*11: 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”.
*12: For vertical terminals
*13: This manual covers draw-out type ACBs.
*14: In applying or going to apply.

Use the ACBs in the environmental conditions specified in Table 5.

Table 5 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.
	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_2S)/sulfur dioxide (SO_2)/hydrogen chloride (HCl): 0.1 ppm max., Chlorine (Cl_2): 0.05 ppm max.
Special environment (Optional)	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_2S: 10 ppm max., SO_2/HCl: 5 ppm max., and Cl_2 : 1 ppm max.

Table 6 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 6 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	Between terminal group and ground	AC2500V	1 minute	6kV	100MΩ
		For microload	Between terminal group and ground	AC2000V	1 minute	4kV	100MΩ
	Position switches		Between terminal group and ground	AC2000V	1 minute	4kV	100MΩ
	Overcurrent release		Between terminal group and ground	AC2000V	1 minute	4kV	100MΩ
	Undervoltage trip device, Reverse power trip device		Between terminal group and ground	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 7 shows the internal resistance and power consumption of the ACBs.

Table 7 Internal resistance and power consumption

Type	AR208S	AR212S	AR216S	AR220S	AR325S	AR332S	AR440SB	AR440S	
Frame size (A)	800	1250	1600	2000	2500	3200	4000	4000	
DC internal resistance (mΩ) (for 1-pole ACB)	0.033	0.033	0.028	0.024	0.014	0.014	0.017	0.014	
AC power consumption (W) (for 3-pole ACB)	200	350	350	490	600	780	1650	1060	
Type	AR212H	AR216H	AR220H	AR316H	AR320H	AR325H	AR332H	AR420H	AR440H
Frame size (A)	1250	1600	2000	1600	2000	2500	3200	2000	4000
DC internal resistance (mΩ) (for 1-pole ACB)	0.024	0.024	0.024	0.014	0.014	0.014	0.014	0.014	0.014
AC power consumption (W) (for 3-pole ACB)	260	350	490	310	430	600	780	*1	1060

*1:Contact us.

Table 8 shows applicable current of the ACBs. The applicable current varies depending on the ambient temperatures.

Table 8 Dependence of applicable current on ambient temperature

Type		AR208S	AR212S	AR216S	AR220S	AR325S	AR332S	AR440SB	AR440S
Standard	Conductor size / Ambient temperature (°C)	2 × 50 × 5t	2 × 80 × 5t	2 × 100 × 5t	3 × 100 × 5t	2 × 100 × 10t	3 × 100 × 10t	4 × 150 × 10t	4 × 150 × 6t
IEC60947-2 EN60947-2 AS3947-2 JIS C8201-2-1 Ann.1 Ann.2	40 (standard ambient temperature)	800	1250	1600	2000	2500	3200	4000	4000
	45	800	1250	1600	2000	2500	3200	4000	4000
	50	800	1250	1600	2000	2500	3200	3940	4000
	55	800	1200	1540	1820	2500	2990	3820	3940
	60	800	1150	1460	1740	2400	2850	3690	3760
NEMA,SG-3 ANSI C37.13	40 (standard ambient temperature)	800	1250	1540	2000	2500	3200	3310	3700
	45	800	1190	1470	1960	2500	3010	3200	3580
	50	800	1130	1390	1860	2440	2860	3100	3470
	55	790	1070	1310	1750	2300	2690	2980	3350
	60	740	1000	1230	1640	2150	2520	2870	3140
JEC-160	40 (standard ambient temperature)	800	1100	1460	1740	2370	2610	2870	3230
	45	800	1060	1400	1680	2280	2510	2750	3100
	50	800	1010	1340	1600	2180	2400	2620	2970
	55	770	960	1280	1530	2080	2290	2490	2830
	60	730	920	1220	1450	1970	2170	2360	2690

Type		AR212H	AR216H	AR220H	AR316H	AR320H	AR325H	AR332H	AR420H	AR440H
Standard	Conductor size / Ambient temperature (°C)	2 × 80 × 5t	2 × 100 × 5t	3 × 100 × 5t	2 × 100 × 5t	3 × 100 × 5t	2 × 100 × 10t	3 × 100 × 10t	2 × 150 × 6t	4 × 150 × 6t
IEC60947-2 EN60947-2 AS3947-2 JIS C8201-2-1 Ann.1 Ann.2	40 (standard ambient temperature)	1250	1600	2000	1600	2000	2500	3200	2000	4000
	45	1250	1600	2000	1600	2000	2500	3200	2000	4000
	50	1250	1600	2000	1600	2000	2500	3200	2000	4000
	55	1250	1600	1820	1600	2000	2500	2990	2000	3940
	60	1250	1550	1740	1600	2000	2400	2850	2000	3760
NEMA,SG-3 ANSI C37.13	40 (standard ambient temperature)	1250	1600	2000	1600	2000	2500	3200	*1	3700
	45	1250	1600	1960	1600	2000	2500	3010	*1	3580
	50	1250	1600	1860	1600	2000	2440	2860	*1	3470
	55	1250	1510	1750	1600	1950	2300	2690	*1	3350
	60	1240	1420	1640	1550	1830	2150	2520	*1	3140
JEC-160	40 (standard ambient temperature)	1250	1500	1740	1600	2000	2370	2610	*1	3230
	45	1250	1440	1680	1600	2000	2280	2510	*1	3100
	50	1250	1380	1600	1600	2000	2180	2400	*1	2970
	55	1250	1310	1530	1600	1920	2080	2290	*1	2830
	60	1230	1250	1450	1600	1820	1970	2170	*1	2690

Notes: For AR208S, AR212S and AR216S, it is assumed that main circuit terminals are of horizontal type at both the line and load sides. For other types, it is assumed that main circuit terminals are of vertical type at both the line and load sides. The above values may vary depending on the switchboard configuration.

3-2. Parts and Functions

Fig. 13 provides a general views of the ACB.

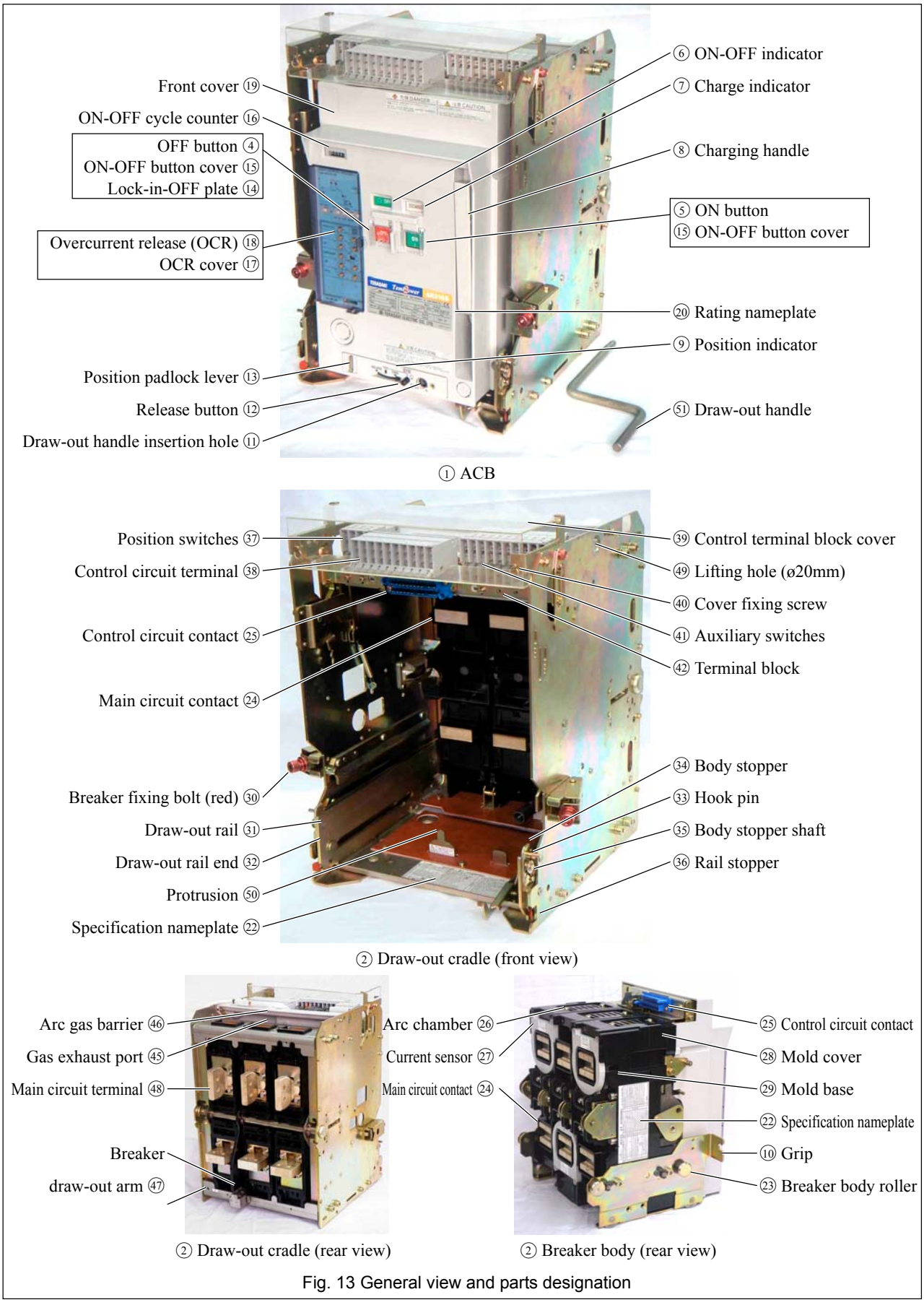


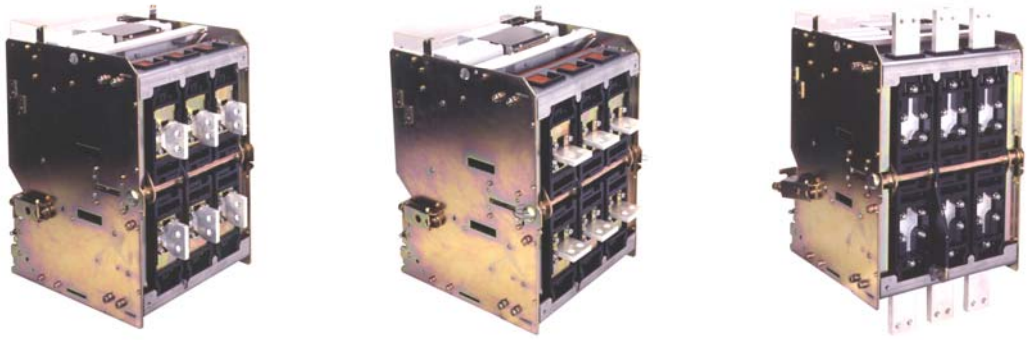
Fig. 13 General view and parts designation

①	ACB	Consists of breaker body ③ and draw-out cradle ②.
②	Draw-out cradle	Comes with main circuit terminals ㊽, control circuit terminals ㊳, auxiliary switches ㊶, and position switches ㊲.
③	Breaker body	Contains the ON-OFF mechanism, the closing coil， the tripping device, and overcurrent release ⑲.
④	OFF button	Push to open the ACB.
⑤	ON button	Push to close the ACB.
⑥	ON-OFF indicator	Shows “OFF” when the ACB is open and “ON” when it is closed.
⑦	Charge indicator	Shows “CHARGED” when the closing springs are charged and “DISCHARGED” when it is released.
⑧	Charging handle	Pump to charge the closing springs.
⑨	Position indicator	Indicates the present breaker body position: CONN., TEST, or ISOLATED.
⑩	Grip	Hold to draw out the breaker body.
⑪	Draw-out handle insertion hole	Insert the draw-out handle into this hole to move the breaker body.
⑫	Release button	Push to move the breaker body from the TEST position.
⑬	Position padlock lever (optional)	Accommodates up to three padlocks to lock the breaker body in the CONN., TEST or ISOLATED position. (Padlocks are not supplied. Use padlocks with a 6 mm-diameter shackle.)
⑭	Lock-in-OFF plate (optional)	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.)
⑮	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.
⑯	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.
⑰	OCR cover	Padlocking this plate prevents settings of overcurrent release ⑱ to be inadvertently changed. (Padlocks are not supplied. Use padlocks with a 6 mm-diameter shackle.)
⑱	Overcurrent release (OCR)	This protective device is supplied power via the power CT installed in the ACB main circuit. When the current sensor detects an overcurrent in the main circuit, the OCR instructs the magnet hold trigger (MHT) to trip open the ACB.
⑲	Front cover	A plastic cover of the breaker body front panel.
⑳	Rating nameplate	Indicates the type, applicable standards and rated breaking capacity of the ACB.
㉒	Specification nameplate	Indicates the number of poles, operation method, accessories, and serial number of the ACB.
㉓	Breaker body roller	Allows breaker body ③ to be moved on draw-out rail ㉛.
㉔	Main circuit contact	Closes when the breaker body is in the CONN. position.
㉕	Control circuit contact	Closes when the breaker body is in the CONN. or TEST position.
㉖	Arc chamber	Extinguishes the arc that occurs in the breaking operation. Two arc chambers are fitted per pole. See 6-2-2. "Arc chambers".
㉗	Current sensor	Converts the current in the main circuit into a voltage signal in proportion to the magnitude of the current and sends the signal to overcurrent release ⑱.
㉘	Mold cover	A plastic cover of the breaker body side face.
㉙	Mold base	A plastic cover of the breaker body rear face.
㉚	Breaker fixing bolt (red) (optional)	Allows the breaker body to be locked in the CONN. position even if the ACB is subject to strong vibrations.
㉛	Draw-out rail	Use to draw out the breaker body from the draw-out cradle.
㉜	Draw-out rail end	Refer to chapter 1 “Operation Precautions”.
㉝	Hook pin	Refer to chapter 1 “Operation Precautions”.
㉞	Body stopper	Prevents the breaker body from falling when the body is drawn out from the draw-out cradle.
㉟	Body stopper shaft	Refer to chapter 1 “Operation Precautions”.
㊱	Rail stopper (red)	Allows the draw-out rail to be locked in the drawn-out or retracted state.
㊲	Position switches (optional)	Indicate the present breaker body position: CONN., TEST, ISOLATED or INSERTED. The position switches are available in 2C or 4C configuration. Connections to the position switches are made through M4 screws.

㊳	Control circuit terminals	Allow connections of external control wire to the control circuits. Wire connections are made through M4 screw terminals. Fig. 14 shows the control circuit terminals.

Fig. 14 Control circuit terminals

㊴	Control terminal block cover (optional)	Protects the position switches, the control circuit terminals and the auxiliary switches from damage.
㊵	Cover fixing screw	Secures the control terminal block cover.
㊶	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.
㊷	Terminal block	Contains position switches ㊱, control circuit terminals ㊲, and auxiliary switches ㊳.
㊹	Ground terminal M8 tapped hole	Allows connection of a ground terminal.
㊺	Gas exhaust port	Allows the arc gas to be discharged from arc chamber ㉕ in a horizontal direction when the ACB trips open.
㊻	Arc gas barrier	Prevents the arc gas from being discharged upwards from arc chamber ㉕ when the ACB trips open.
㊼	Breaker draw-out arm	Is retracted in the draw-out cradle when the breaker body is in the CONN. position.
㊽	Main circuit terminals	Allow connections of external conductors. These terminals are available in three configurations as shown in Fig. 15.



Vertical terminals　　Horizontal terminals　　Front terminals

Fig. 15 Main circuit terminals

㊾	Lifting hole (ø20mm)	Allows lifting attachments or wire ropes to be used for lifting the ACB.
㊿	Protrusion	Refer to section 2-3. “Installation Precautions”.
(51)	Draw-out handle (removable)	Use to draw out /insert the breaker body from/into the draw-out cradle.

3-3. Circuits and Ratings

Fig. 16 shows an ACB circuit diagram and Table 9 and Fig. 17 show the function of each terminal and the meaning of each sign in the diagram.

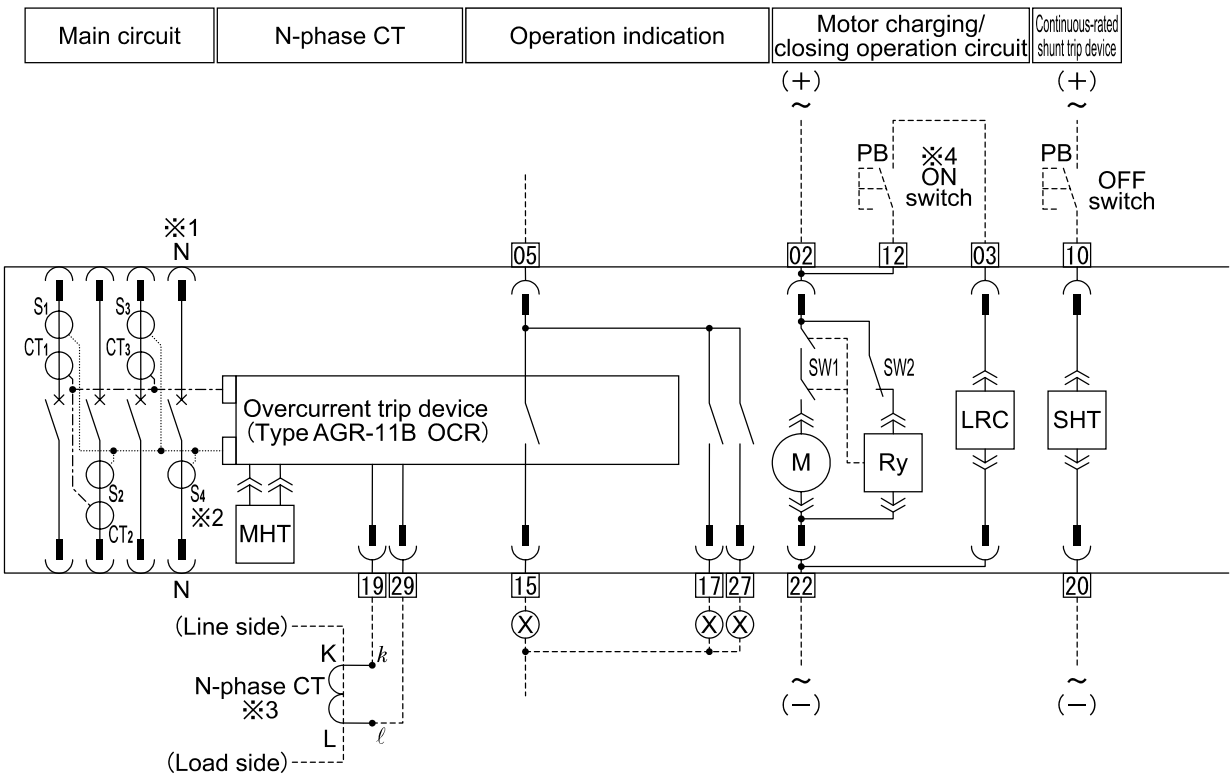


Fig. 16-1 Breaker circuits 1

Table 9-1 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)	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
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)

Terminal No.	AC100V unit	AC200V unit	AC400V unit
08, 09	AC100V	AC200V	AC380V
18, 09	AC110V	AC220V	AC415V
28, 09	AC120V	AC240V	AC440V

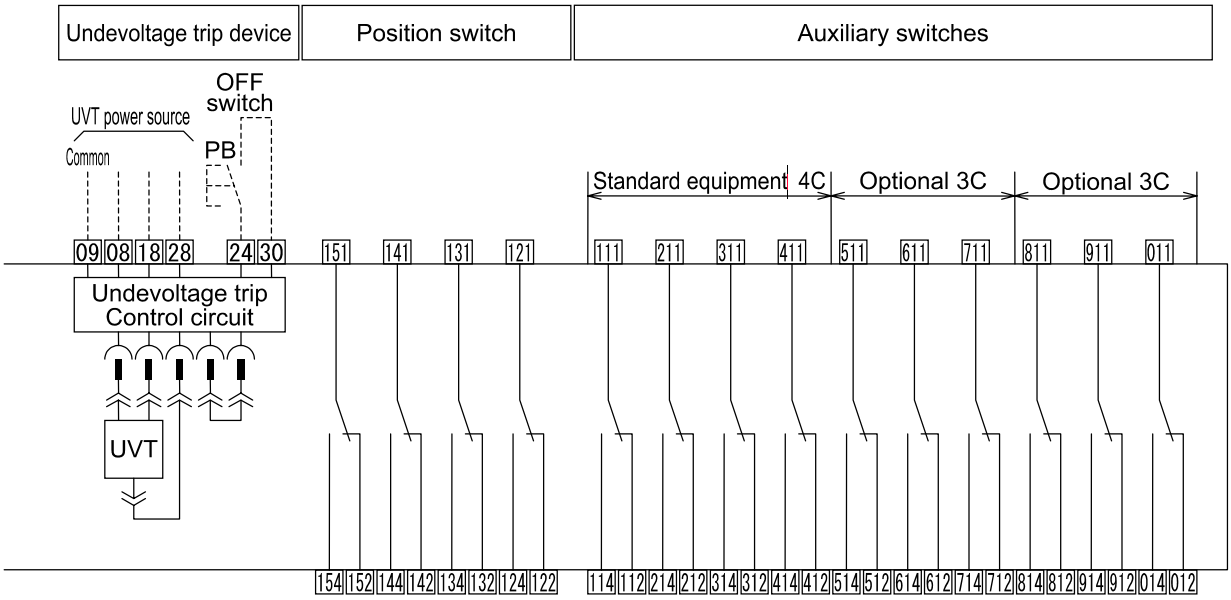


Fig. 16-2 Breaker circuits 2

Table 9-2 Terminal functions and circuit symbols 2

Symbol	Meaning	Symbol	Meaning
S_1 - S_4	Current sensors *5	LRC	Latch release coil
CT_1 - CT_3	Power supply CT *6	SHT	Shunt trip device
MHT	Magnet hold trigger	UVT	Undervoltage trip device
M	Spring charging motor	—◖	Main/control circuit contact
Ry	Control relay	—≪	Hand connector
SW1	Spring charged “OFF” switch	-----	User wiring
SW2	Control relay a contact	-⊗-	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: Conversion ratio: CT rated primary current I_{CT} (A)/150 mV
*6: Provide power to the overcurrent trip device.

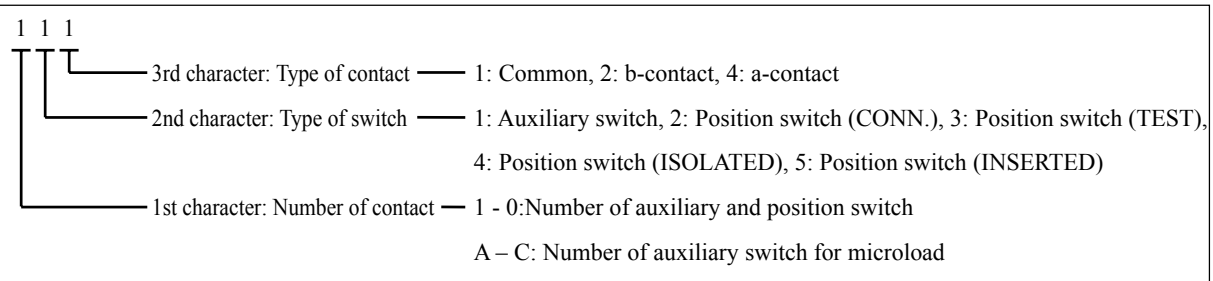


Fig. 17 Terminal number and function of auxiliary and position switches

Fig. 18 provides the terminal arrangement of the ACB.

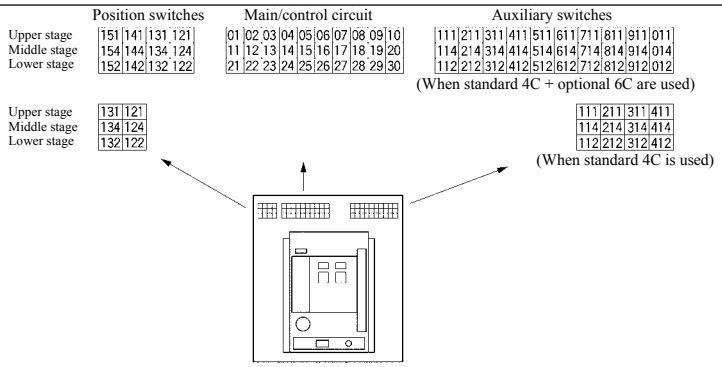


Fig. 18 Terminal arrangement

Tables 10 - 15 show the ratings of the operation power supply, the shunt trip device (SHT), the undervoltage trip device (UVT), auxiliary switches, position switches, operation indication contacts, and the N-phase CT.

Table 10 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	0.48	180-230
AC110	94 - 121	7	1.1	0.39	220-280
AC120	102 - 132	7	1.1	0.37	260-330
AC200	170 - 220	4	0.7	0.24	750-920
AC220	187 - 242	4	0.7	0.19	910-1120
AC240	204 - 264	4	0.7	0.18	1060-1300
DC24	20 - 26	14	4	1.65	13-16
DC48	41 - 53	10	1.6	0.86	49-61
DC100	85 - 110	6	0.8	0.39	220-280
DC110	94 - 121	6	0.8	0.37	260-330
DC125	106 - 138	6	0.8	0.31	350-440
DC200	170 - 220	4	0.5	0.19	910-1120
DC220	187 - 242	4	0.5	0.18	1060-1300

* Ambient temperature: 20°C

Table 11 Ratings of shunt trip device (SHT)

Rated voltage (V)	Permissible voltage range (V)	Peak exciting current (max.) (A)	Steady-state current (reference value) (A)	Coil resistance (ohm) *	Max. contact parting time (ms)
AC100	70 - 110	0.48	0.32	180-230	40
AC110	77 - 121	0.39	0.26	220-280	
AC120	84 - 132	0.37	0.24	260-330	
AC200	140 - 220	0.24	0.16	750-920	
AC220	154 - 242	0.19	0.13	910-1120	
AC240	168 - 264	0.18	0.12	1060-1300	
DC24	16.8 - 26.4	1.65	1.1	13-16	
DC48	33.6 - 5.28	0.86	0.57	49-61	
DC100	70 - 110	0.39	0.26	220-280	
DC110	77 - 121	0.37	0.25	260-330	
DC125	87.5 - 137.5	0.31	0.21	350-440	
DC200	140 - 220	0.19	0.13	910-1120	
DC220	154 - 242	0.18	0.12	1060-1300	

* Ambient temperature: 20°C

Table 12 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 13 Ratings of auxiliary and position switches

Voltage (V)	Auxiliary switches				Position switches	
	For general feeder		For microload			
	Resistive load (A)	Inductive load (A) *1	Resistive load (A)	Inductive load (A) *2	Resistive load (A)	Inductive load (A) *2
AC100 - 250	5	5	0.1	0.1	11	6
AC251 - 500	5	5	-	-	-	-
DC8	-	-	-	-	10	6
DC30	1	1	0.1	0.1	6	5
DC125	-	-	-	-	0.6	0.6
DC250	-	-	-	-	0.3	0.3
DC125 - 250	1	1	-	-	-	-

*1: AC cosø ≥ 0.3, DC L/R ≤ 0.007
*2: AC cosø ≥ 0.6, DC L/R ≤ 0.01
*3: Min. applicable load: DC5V/1 mA

Table 14 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 cosø ≥ 0.3, DC L/R ≤ 0.007
*2: AC cosø ≥ 0.6, DC L/R ≤ 0.01
*3: Min. applicable load: DC5V/1 mA

Table 15 Ratings of N-phase CT

Type of ACB	Type of N-phase CT	Ratings (A)		
AR208S, AR212S, AR216S AR212H, AR216H, AR316H	CW80-40LS	200/5A	400/5A	800/5A
		1250/5A	1600/5A	
AR220S, AR325S, AR332S, AR440S AR220H, AR320H, AR325H, AR332H AR440SB,AR420H,AR440H	EC160-40LS	1600/5A	2000/5A	2500/5A
		3200/5A	4000/5A	

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.
- If the ACB has the breaker fixing bolts, make sure the bolts on both sides are securely tightened before using the ACB. Loosened fixing bolts may cause a malfunction of the ACB, in particular when it is installed in such an area that is subject to strong vibrations.

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. 19 ②) until the charge indicator (Fig. 19 ①) shows “CHARGED” Pumping the handle with the full stroke 10 - 13 times will fully charge the closing springs.

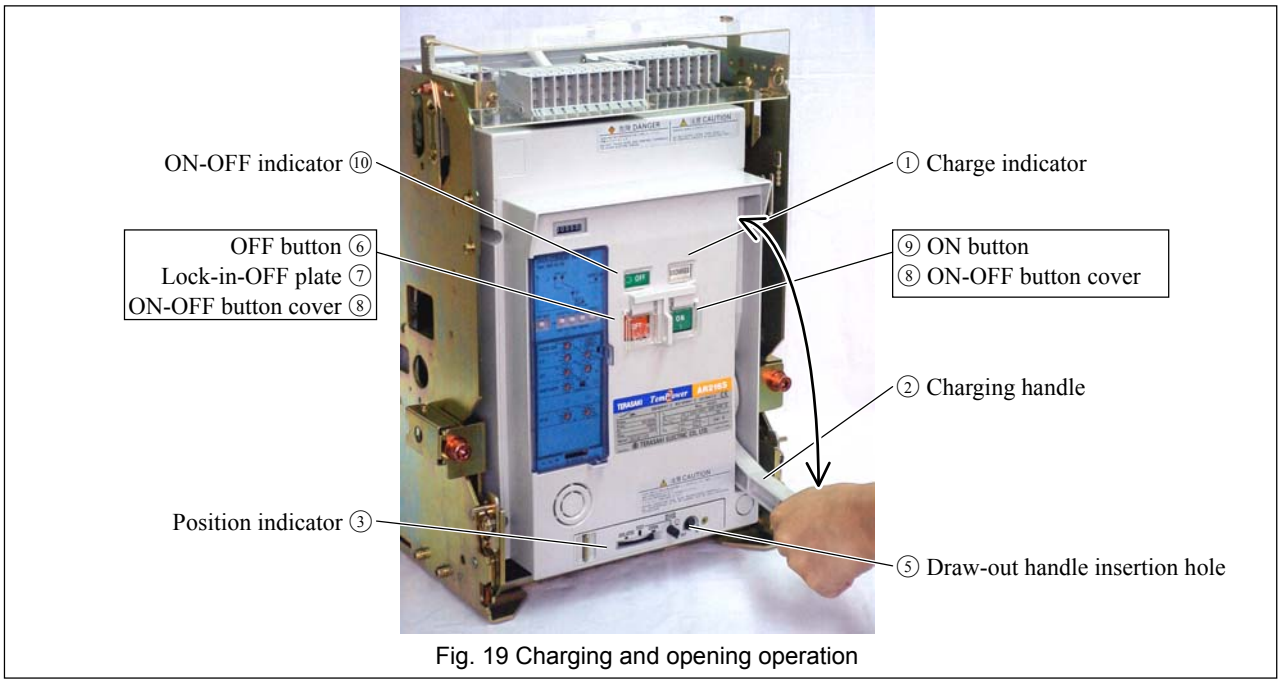


Fig. 19 Charging and opening operation

- Motor charging

When the charge indicator (Fig. 19 ①) changes to “DISCHARGED” while the specified operation voltage is applied to the control circuit terminals 02 and 22, 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. 19 ①) shows "CHARGED".
2) The position indicator (Fig. 19 ③) shows "CONN.", "TEST" or "ISOLATED" (a halfway position not permitted).
3) The draw-out handle is not inserted in the draw-out handle insertion hole(Fig. 19 ⑤) .
4) The OFF button (Fig. 19 ⑥) is not locked with the lock-in-OFF plate (Fig. 19 ⑦).
5) The specified voltage is supplied to the undervoltage trip device .

- Manual closing

Open the ON-OFF button cover (Fig. 19 ⑧) and press the ON button (Fig. 19 ⑨). The ACB will be closed with a sound. The ON-OFF indicator (Fig. 19 ⑩) shows "ON" and the charge indicator (Fig. 19 ①) shows "DISCHARGED".

- Electrical closing

Press the ON switch shown in Fig. 16. The latch release coil (LRC) (Fig. 16) will be excited and the ACB is closed with a sound. The ON-OFF indicator (Fig. 19 ⑩) shows "ON", the charge indicator (Fig. 19 ①) 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. 19 ⑧) and press the OFF button (Fig. 19 ⑯). The ACB will trip open with a sound. The ON-OFF indicator (Fig. 19 ⑩) shows "OFF".

- Electrical opening

Press the OFF switch shown in Fig. 15. The shunt trip device (SHT) or the fixed type undervoltage trip device (Fig. 15) will be excited so that the ACB trips open with a sound. The ON-OFF indicator (Fig. 19 ⑩) 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 16.

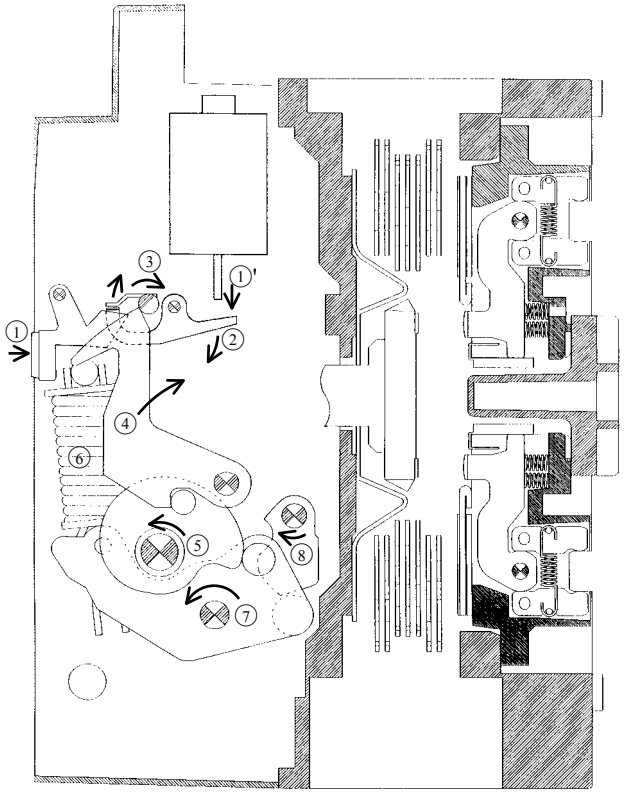
Table 16 Motion of trip indication and spring charge indication switches

Type of OCR	Operation	Contact output					
		Terminal No. See Fig. 16	State				
			Closing spring		ACB closed	ACB open	
			Charged	Discharged		Not ready to close *	Ready to close *
All	Trip	05, 17	No change	No change	OFF	ON	OFF
	Spring charge	05, 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).

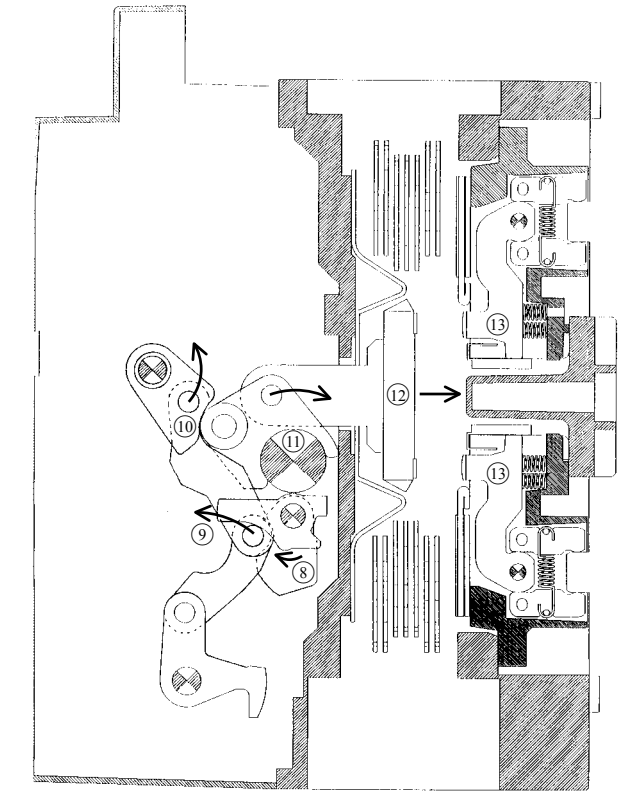
4-1-5. Motion of operation mechanisms

Figs. 20 - 23 illustrate the motion of the charging and ON-OFF mechanisms.



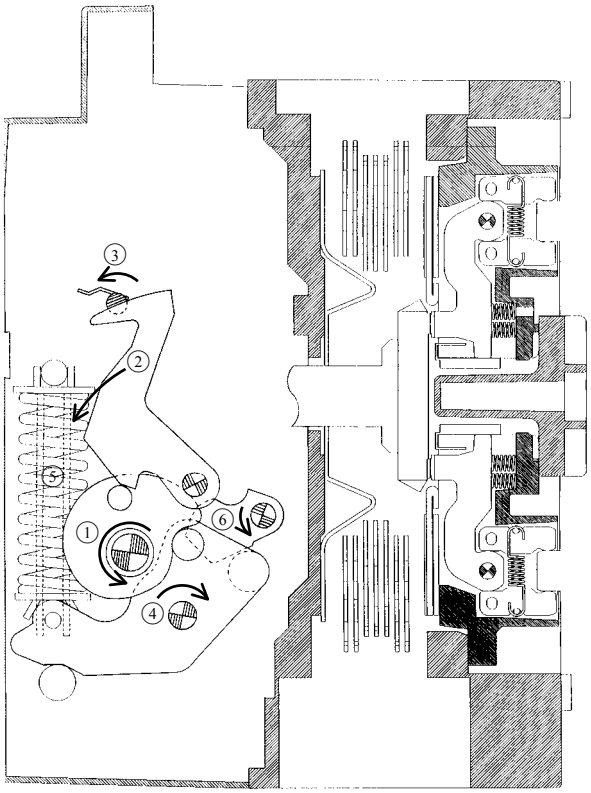
For manual closing operation, ON button ① rotates counterclockwise. For electrical closing operation, push rod ①' protrudes downward from the latch release coil (LRC) and charge latch trigger ② rotates clockwise. This rotates closing trigger shaft ③ clockwise and closing release lever ④ disengages from a semicircular pawl and rotates clockwise. And charging cam ⑤ rotates counterclockwise, so that charging lever ⑦ disengages from closing spring ⑥ and rotates counterclockwise. Closing cam ⑧ is pushed up by charging lever ⑦ and rotates clockwise. At this time, each component is positioned as shown in Fig. 22. Continued to Fig. 21.

Fig. 20 Closing motion 1 (discharge motion)



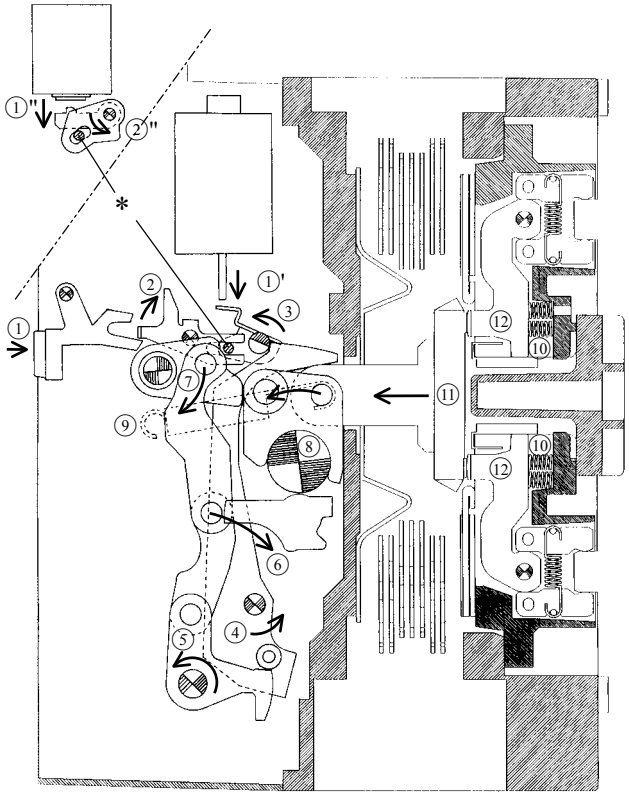
Closing cam ⑧ rotating clockwise causes closing link and top link ⑨ to be pushed straight. This rotates closing toggle cam ⑩ connected with closing link ⑨ counterclockwise, so that crossbar ⑪ rotates clockwise and thus moving contact ⑫ comes in contact with stationary contact ⑬. At this time, each component is positioned as shown in Fig. 23.

Fig. 21 Closing motion 2



The charging handle or the charging motor provides a counterclockwise rotation to charging cam ①. This rotates closing release lever ② and closing tripper lever ③ counterclockwise and a semicircular pawl engages with closing release lever ②. And charging lever ④ rotates clockwise so that closing spring ⑤ is compressed and closing cam 5 rotates counterclockwise. At this time, each component is positioned as shown in Fig. 20.

Fig. 22 Charging motion



For manual opening operation, OFF button ① rotates counterclockwise and trip linkage ② rotates clockwise. For electrical opening operation, push rod ① protrudes downward from the shunt trip device (SHT) or the undervoltage trip device (UVT). For tripping operation by the overcurrent release (OCR), moving core ① protrudes downward from the magnet hold trigger (MHT) and trip linkage ② rotates counterclockwise. (Parts marked with an asterisk (*) are trip pins. To avoid superposition in the figure, magnet hold trigger related parts are drawn in positions that are different from actual positions. This rotates trip trigger shaft ③ counterclockwise and trip lever B ④ disengages from a semicircular pawl and rotates counterclockwise. And trip lever A ⑤ rotates counterclockwise, trip link ⑥ moves to a lower right direction and closing toggle cam ⑦ rotates clockwise. The force of closing spring ⑨ and contact spring ⑩ rotates crossbar ⑧ counterclockwise, so that moving contact ⑩ is parted from stationary contact ⑫. At this time, each component is positioned as shown in Fig. 21.

Fig. 23 Opening motion

4-2. Draw-out and Insertion Operation

4-2-1. General

The draw-out type ACB consists of the breaker body and the draw-out cradle. The main and control circuit terminals are installed on the draw-out cradle, which permits you to draw out and inspect or service the breaker body without the need for removing wiring from the terminals.

The draw-out mechanism allows you to move the breaker body to any of the four positions as shown in Fig. 24. The switchboard panel door can be shut with the breaker body drawn out to the CONN., TEST or ISOLATED position.

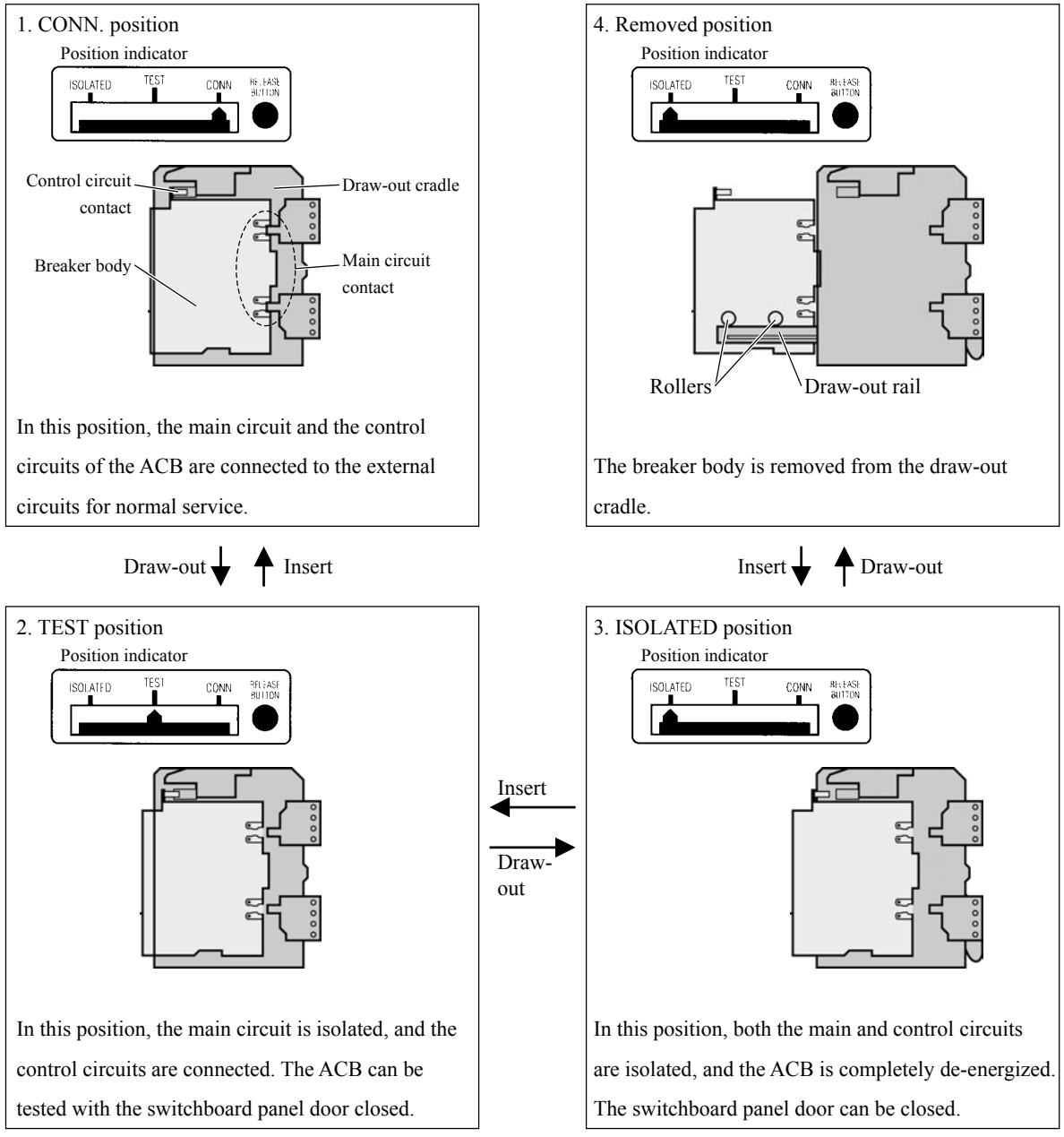


Fig. 24 Positions of breaker body in draw-out cradle

● Operation Durability

The AR series ACBs are designed to ensure the operation durability of 100 draw-out and insertion cycles in conformance to IEC 60947-1 and JIS C8201-2 (one cycle means that the breaker body is drawn out from the CONN. position to the Removed position and inserted back to the CONN. position). Draw-out and insertion operation of more than 100 cycles could abrade the main circuit contacts, resulting in an overheat of the contacts during energization.

4-2-2. Draw-out operation

⚠ DANGER

- Never touch live terminal parts. Otherwise, electric shock may result.
- Do not leave the ACB body in the removed position. The weight of the ACB may cause serious injury.

⚠ CAUTION

- If the ACB has the breaker fixing bolts, be sure to loosen the bolts on both sides before draw-out operation. Otherwise, damage to the ACB may result.
- Make sure the draw-out cradle is secured with mounting screws before drawing out the breaker body. Otherwise, the draw-out operation may cause the breaker body or the draw-out cradle to fall, resulting in damage to the ACB or personal injury.
- When retracting the draw-out rail into the draw-out cradle, be sure to push the rail end. Do not hold the hook pin, body stopper, or body stopper shaft. Doing so may cause your fingers to be pinched, resulting in injury.

Use the separate draw-out handle to draw-out the breaker body.

4-2-2-1. Moving the breaker body from the CONN. position to the TEST position

1) Open the ACB. (If the ACB remains closed, the draw-out handle (Fig. 25 ①) cannot be inserted).
2) Loosen the breaker fixing bolts (Fig. 25 ②), if used, to unlock the breaker body (Fig. 25 ③).
3) Unlock the position lock lever (Fig. 25 ⑭) if locked. See section 4-5.
4) Insert the draw-out handle into the draw-out handle insertion hole (Fig. 25 ④) and slowly turn counterclockwise until the position indicator (Fig. 25 ⑤) shows “TEST”.

- When the main circuit is disconnected at the disconnect contacts, the breaker body will be slightly pushed forward by the spring action of the main circuit disconnect contacts. At this moment, a bang sound will be heard. This sound does not mean a malfunction.
- The ACB cannot be closed as long as the draw-out handle is in the draw-out handle insertion hole. To close the ACB e.g., for ON-OFF testing, remove the draw-out handle.

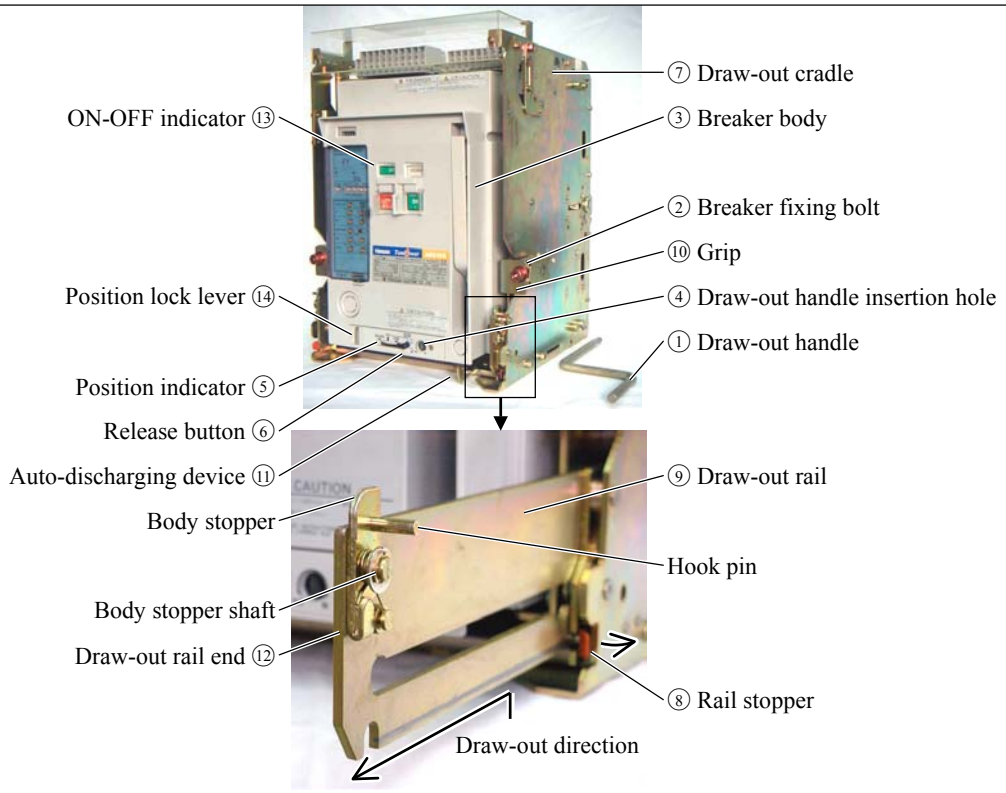


Fig. 25 Draw-out and insertion operation

4-2-2-2. Moving the breaker body from the TEST position to the ISOLATED position

1) Open the ACB. (If the ACB remains closed, the draw-out handle (Fig. 25 ①) cannot be inserted).
2) Press the release button (Fig. 25 ⑥). The release button will be locked depressed.
3) Unlock the position lock lever (Fig. 25 ⑭) if locked. See section 4-5.
4) Insert the draw-out handle into the draw-out handle insertion hole (Fig. 25 ④) and slowly turn counterclockwise until the position indicator (Fig. 25 ⑤) shows "ISOLATED" and a freewheeling sound is heard. Turning the draw-out handle will unlock the release button.
5) Remove the draw-out handle.

4-2-2-3. Moving the breaker body from the ISOLATED position to the removed position

1) Make sure the draw-out cradle (Fig. 25 ⑦) is secured with mounting screws.
2) Unlock the position lock lever (Fig. 25 ⑭) if locked. See section 4-5.
3) Push the rail stoppers (Fig. 25 ⑧) outward on both sides of the draw-out cradle to unlock the draw-out rail (Fig. 25 ⑨), and then uphold and pull out the rail until it stops. The draw-out rail will be locked again by the stoppers. (The breaker body cannot be drawn out unless the rail is locked).
4) Holding both the grips (Fig. 25 ⑩), draw out the breaker body until it stops.

- If the ACB is equipped with an optional auto-discharging device (Fig. 25 ⑪), the closing springs of the ACB will be automatically discharged with a mechanical sound. This sound does not mean a malfunction.
- Do not leave the ACB body on the draw-out rail pulled out.

5) Use an optional lifter or lifting plate to transfer the breaker body (Fig. 25 ③) to a safe place. Refer to section 2-1-2.

4-2-3. Putting the breaker body back into the draw-out cradle

⚠ DANGER

- Never touch live terminal parts. Otherwise, electric shock may result.
- Do not leave the ACB body in the removed position. The weight of the ACB may cause serious injury.

⚠ CAUTION

- Make sure the draw-out cradle is secured with mounting screws before inserting the breaker body into the draw-out cradle. Otherwise, the insertion operation may cause the breaker body or the draw-out cradle to fall, resulting in damage to the ACB or personal injury.
- When retracting the draw-out rail into the draw-out cradle, be sure to push the rail end. Do not hold the hook pin, body stopper, or body stopper shaft. Doing so may cause your fingers to be pinched, resulting in injury.
- Do not forcedly turn the draw-out handle clockwise when the breaker body is in the CONN. Position. Doing so may cause a malfunction.
- If the ACB has the breaker fixing bolts, make sure the bolts on both sides are securely tightened before using the ACB. Loosened fixing bolts may cause a malfunction of the ACB, in particular when it is installed in such an area that is subject to strong vibrations.

Use the separate draw-out handle to insert the breaker body.

4-2-3-1. Putting the breaker body back to the ISOLATED position

1) Make sure the draw-out cradle (Fig. 25 ⑦) is secured with mounting screws.
2) Push the rail stoppers (Fig. 25 ⑧) outward on both sides of the draw-out cradle to unlock the draw-out rail (Fig. 25 ⑨), and then uphold and pull out the rail until it stops. The draw-out rail will be locked again by the stoppers. (The breaker body (Fig. 25 ③) cannot be inserted unless the rail is locked).
3) Use an optional lifter or lifting plate to place the breaker body rollers (Fig. 26) on the draw-out rail (Fig. 26).
   - Do not leave the ACB body on the draw-out rail pulled out.

4) If the ACB has the breaker fixing bolts (Fig. 25 ②), make sure the bolts are loosened and, holding both the grips (Fig. 25 ⑩), firmly push the breaker body into the draw-out cradle.

5) Push the rail stoppers (Fig. 25 ⑧) outward on both sides of the draw-out cradle (Fig. 25 ⑫) to unlock the draw-out rail, and then push the rail ends to insert the rail until it stops. The draw-out rail will be locked again by the stoppers.

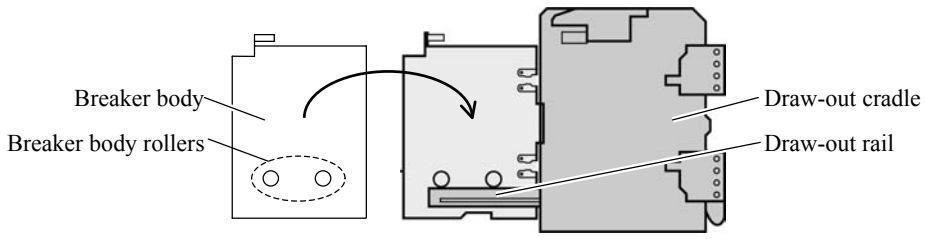


Fig. 26 Placing the breaker body on the draw-out rail

4-2-3-2. Moving the breaker body from the ISOLATED position to the TEST position

1) Make sure the ON-OFF indicator (Fig. 25 ⑬) shows "OFF". (If the ACB remains closed, the draw-out handle (Fig. 25 ①) cannot be inserted).

2) Unlock the position lock lever (Fig. 25 ⑭) if locked. See section 4-5.

3) Insert the draw-out handle into the draw-out handle insertion hole (Fig. 25 ④) and slowly turn clockwise until the position indicator (Fig. 25 ⑤) shows "TEST".

- The ACB cannot be closed as long as the draw-out handle is in the draw-out handle insertion hole. To close the ACB e.g., for ON-OFF testing, remove the draw-out handle.

4-2-3-3. Moving the breaker body from the TEST position to the CONN. position

1) Open the ACB. (If the ACB remains closed, the draw-out handle (Fig. 25 ①) cannot be inserted).

2) Unlock the position lock lever (Fig. 25 ⑭) if locked. See section 4-5.

3) Press the release button (Fig. 25 ⑥). The release button will be locked depressed.

4) Insert the draw-out handle into the draw-out handle insertion hole (Fig. 25 ④) and turn clockwise until the position indicator (Fig. 25 ⑤) shows "CONN." and the handle cannot be turned with its max. operating torque (14.7 N-m).
Turning the draw-out handle will unlock the release button.

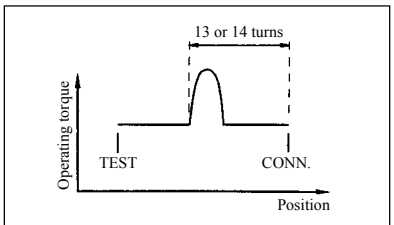


Fig. 27 Handle operating torque

- When the main contact starts engaging, the force required to turn the handle will increase as shown in Fig. 27. This symptom does not mean a malfunction. Continue to turn the handle. Rotating the handle more 13 or 14 turns moves the breaker body to the CONN. position, where the handle cannot be turned with its max. operating torque.

5) Remove the draw-out handle.

6) Tighten the breaker fixing bolts (Fig. 25 ②), if used, to lock the breaker body.

4-2-4. Contact status of auxiliary and position switches

Tables 17 and 18 show the contact status of auxiliary switches and position switches respectively.

Table 17 Contact statues of auxiliary switches

ACB state / Breaker body position	ON	OFF	Status of a-contact	Status of b-contact
CONN.			ON	OFF
			OFF	ON
TEST			ON	OFF
			OFF	ON
ISOLATED			ON	OFF
			OFF	ON
Removed			ON	OFF
			OFF	ON

Table 18 Contact statues of position switches

Position indication / Switch	ISOLATED	TEST	CONN.	Status of a-contact	Status of b-contact
CONN. position indication				ON	OFF
				OFF	ON
TEST position indication				ON	OFF
				OFF	ON
ISOLATED position indication				ON	OFF
				OFF	ON
Inserted position indication *				ON	OFF
				OFF	ON

* "Inserted" means that the breaker body is in the CONN., TEST, or ISOLATED position.

4-3. ON-OFF Button Cover Locking Procedure

Lock the button cover using a padlock with ø6 shackle (up to 3 padlocks can be used) as shown in Fig. 28. The ON-OFF button cover is locked and the ON and OFF buttons cannot be operated.

Fig. 28 Locking the ON-OFF button cover

4-4. Lock in OFF Procedure

1) Open the OFF button cover shown in Fig. 29.
2) Raise the OFF-lock tab and close the button cover.
3) Lock the button cover using a padlock with ø6 shackle (up to 3 padlocks can be used) as shown in Fig. 29. The OFF button is locked depressed, which disables the ON button.

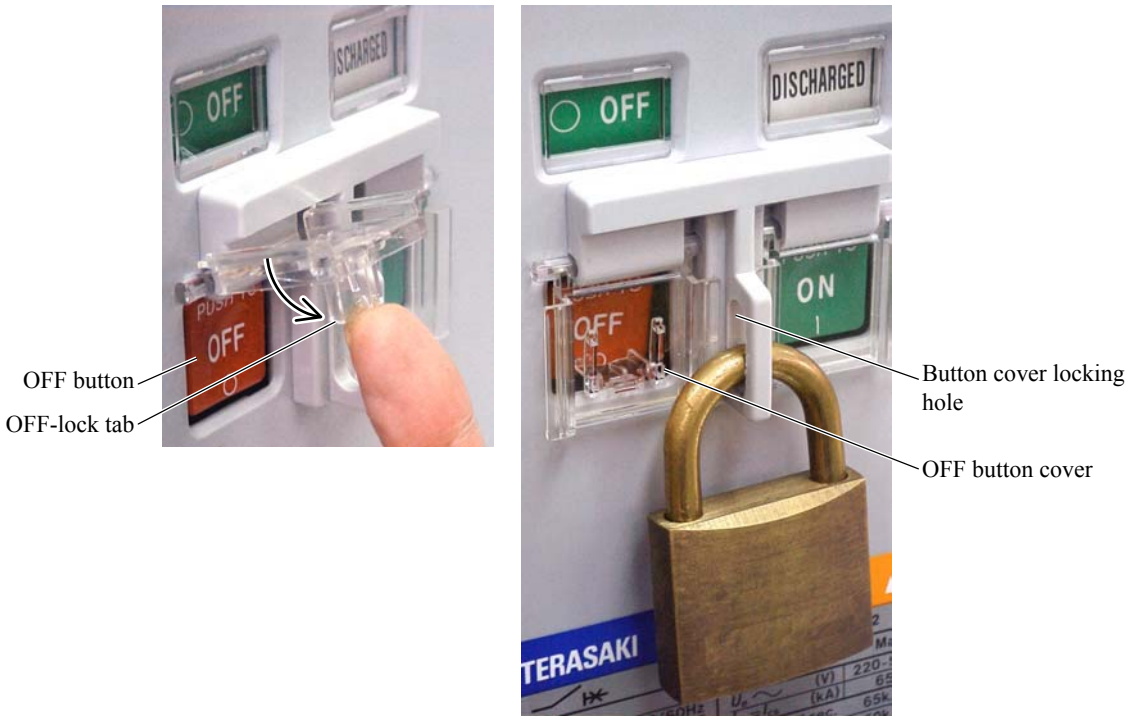


Fig. 29 Locking the OFF button

4-5. Position Lock Lever Locking Procedure

1) Move the breaker body to the desired position (CONN, TEST or ISOLATED).
2) Pull out the position lock lever shown in Fig. 30.
3) Lock the position padlock lever using a padlock with ø6 shackle (up to 3 padlocks can be used) as shown in Fig. 30. This prevents the draw-out handle from being inserted into the draw-out handle insertion hole, i.e., the breaker position cannot be changed.

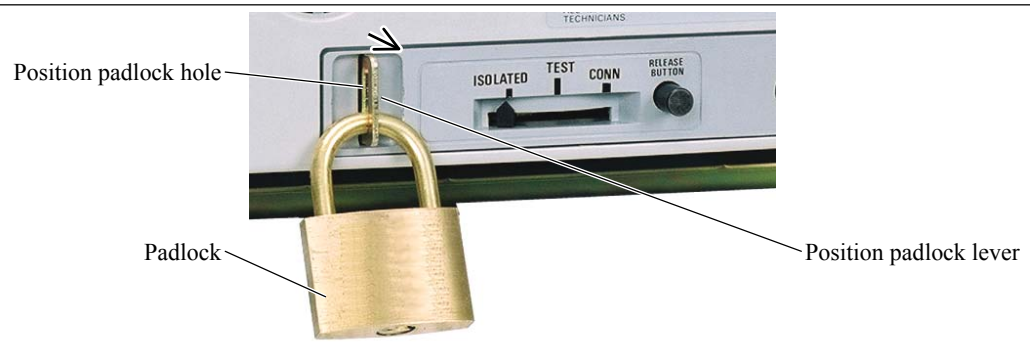


Fig. 30 Locking the position padlock lever

4-6. Breaker Fixing Bolt Securing Procedure

1) Move the breaker body to the CONN. position.
2) Loosen the breaker fixing bolt shown in Fig. 31, move the spring and flat washers close to the bolt head and push the bolt into the U-notch of the grip.
3) Tighten the breaker fixing bolt using the draw-out handle. This procedure is required for both the sides of the ACB.

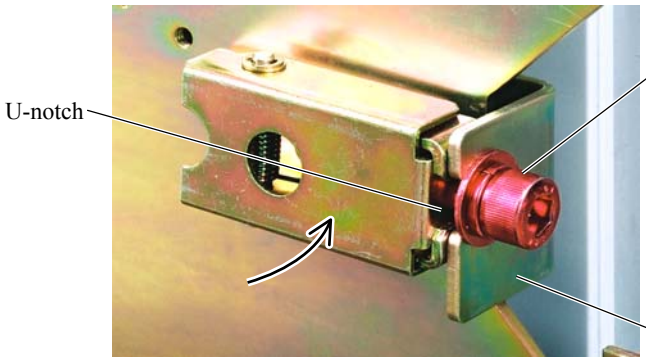


Fig. 31 Securing the breaker fixing bolts

4-7. OCR Cover Locking Procedure

Lock the OCR cover using a padlock with ø6 shackle as shown in Fig. 32. The OCR cover cannot be opened, which prevents OCR settings from being changed.

Fig. 32 Padlocking the OCR cover

5. OVERCURRENT RELEASE (OCR)

Options available for the type AR ACBs include a highly reliable, multi-functional overcurrent release (OCR) with a built-in 16-bit microprocessor.

This OCR is supplied with power through a CT and main circuit current signals from current sensors. 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), and N-phase protection (NP) functions. (When six times the CT rated primary current is exceeded, the peak value sensing is used instead.) 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-11BL L characteristic for general feeder (for works and transformer protection)

5-1. Specifications

Specifications of the OCR are shown in Table 19.

Table 19 Specifications of type AGR-11B OCR (●: Standard, ○: Optional, –: Not applicable)

Application		For general feeder		Reference section
Characteristic		L		
Type designation		AGR-11BL-AL	AGR-11BL-GL	
Protective function	Long time delay trip (LT) Short time delay trip (ST) Instantaneous trip (INST)	●	●	5-2.
	Ground fault trip (GF)	–	●	
	N-phase protection	○	○	
Protection characteristic	I^2t ON/OFF (ST)	●	●	
	I^2t ON/OFF (GF)	–	●	
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-11BL OCR (with L characteristic) are shown in Fig. 33, Table 20, and Fig. 34 respectively.

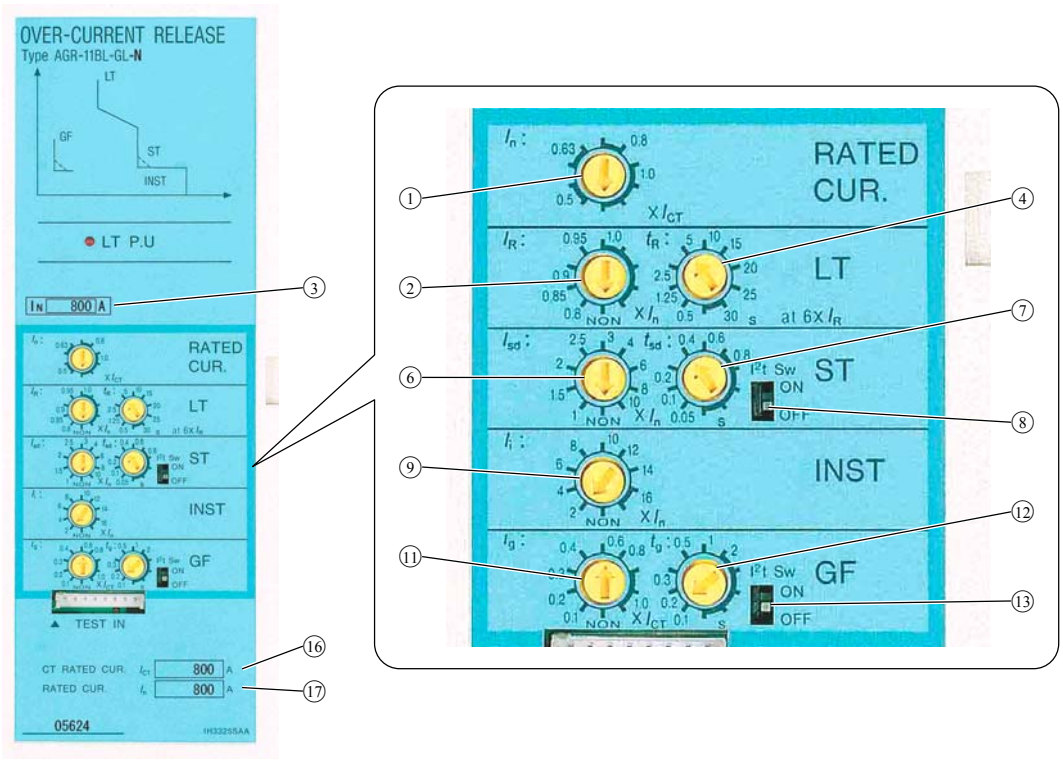


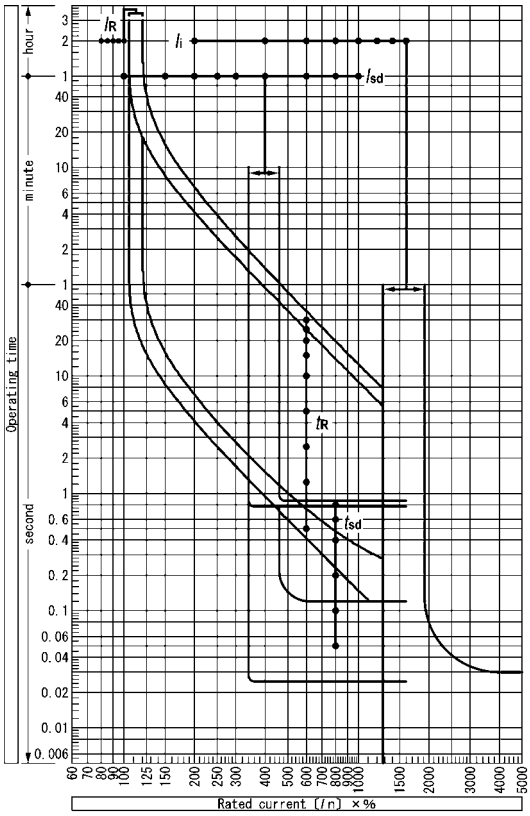
Fig. 33 General view of type AGR-11BL OCR (with L characteristic)

Table 20 Settings of type AGR-11L OCR (with L characteristic)

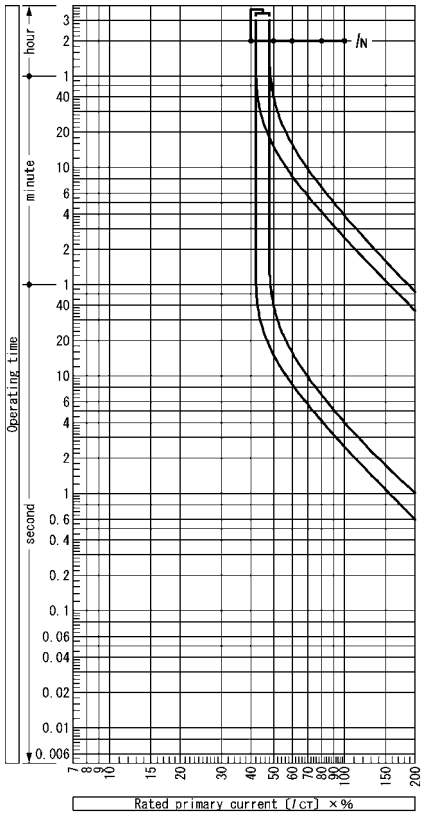
No.	Setting item	Symbol	Setting range								
①	Rated current*1	I_n	CT rated primary current [I_{CT}] × (0.5-0.63-0.8-1.0) (A)								
			Applied [I_{CT}] (A)		200	400	800	1250	1600	2000	2500	3200	4000
			Rated current [I_n] (A)	[I_{CT}] × 0.5	100	200	400	630	800	1000	1250	1600	2000
				[I_{CT}] × 0.63	125	250	500	800	1000	1250	1600	2000	2500
				[I_{CT}] × 0.8	160	320	630	1000	1250	1600	2000	2500	3200
				[I_{CT}] × 1.0	200	400	800	1250	1600	2000	2500	3200	4000
②	Long time delay trip pickup current (continuous)	I_R	[I_n] × (0.8-0.85-0.9-0.95-1.0-NON) (A) • Non tripping at not more than [I_R] x 1.05, Tripping at more than [I_R × 1.05 and not more than [I_R] × 1.2								
③	N-phase protection trip pickup current (continuous)	I_N	[I_{CT}] × (0.4-0.5-0.63-0.8-1.0): Fixed to a single point • Non tripping at not more than [I_N] × 1.05, Tripping at more than [I_N] x 1.05 and not more than [I_R] × 1.2								
④	Long time delay/N-phase protection trip timing	t_R	Long time delay: (0.5-1.25-2.5-5-10-15-20-25-30) (sec) at 600% of [I_R], Tolerance: ±15%, +0.15s –0s N-phase protection: (0.5-1.25-2.5-5-10-15-20-25-30) (sec) at 600% of [I_N], Tolerance: ±15%, +0.15s –0s								
⑥	Short time delay trip pickup current	I_{sd}	[I_n] × (1-1.5-2-2.5-3-4-6-8-10-NON) (A), Tolerance: ±15%								
⑦	Short time delay trip timing	t_{sd}	Relaying time (ms.)		50	100	200	400	600	800	
			Resettable time (ms.)		25	75	175	375	575	775	
			Max. total clearing time (ms.)		120	170	270	470	670	870	
⑧	Short time delay trip I²t mode	I²t t_{sd}	ON/OFF								
⑨	Instantaneous trip pickup current	I_i	[I_n] × (2-4-6-8-10-12-14-16-NON) (A), Tolerance: ±20%								
⑪	Ground fault trip pickup current *2	I_g	[I_{CT}] × (0.1-0.2-0.3-0.4-0.6-0.8-1.0-NON) (A), Tolerance: ±20%								
⑫	Ground fault trip timing	t_g	Relaying time (ms.)		100	200	300	500	1000	2000	
			Resettable time (ms.)		75	175	275	475	975	1975	
			Max. total clearing time (ms.)		170	270	370	570	1070	2070	
⑬	Ground fault trip I²t mode	I²t t_g	ON/OFF								
⑯	CT rated primary current display-only field										
⑰	Factory-set rated current display-only field										

- Underlined values are default settings.
- NON setting disables protective functions. If the short time delay trip function and the instantaneous trip function are set to NON, however, the fail-safe operates so that:
  • The instantaneous trip function is activated at [I_n] × 16 or more if the short time delay trip function and the instantaneous trip function are set to NON.
- 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] x 1.05 < pickup current setting ≤ [I_R × 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.

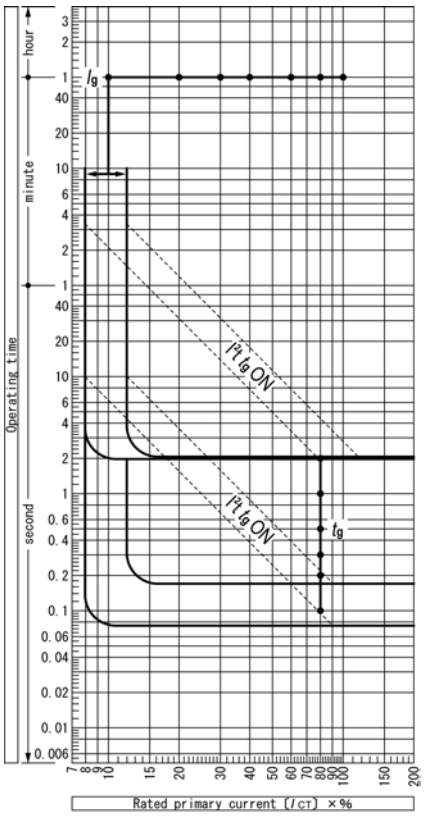
*1: A change in rated current setting results in changes in long time delay, short time delay, and instantaneous current settings accordingly.
*2: The ground fault trip pickup current setting should not exceed 1200A.



Long time delay trip, Short time delay trip and Instantaneous trip



N-phase protection trip



Ground fault trip

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

$$t = -27.94 \times t_R \times \log_e \{ 1 - (1.125 I_R / i)^2 \} \quad \pm 15\% \ +0.15 \ -0 \ [\text{sec}]$$

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

Note 2: The short time delay trip function has precedence over the long time delay trip function. The OCR operates at the short time delay trip timing even in those current ranges in which the long time delay trip time setting is shorter than the short time delay time setting.

Fig. 34 Characteristic curves of type AGR-11BL 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 ANU-1 OCR checker (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.

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. 35. If the OCR cover is padlocked, first remove the padlock.

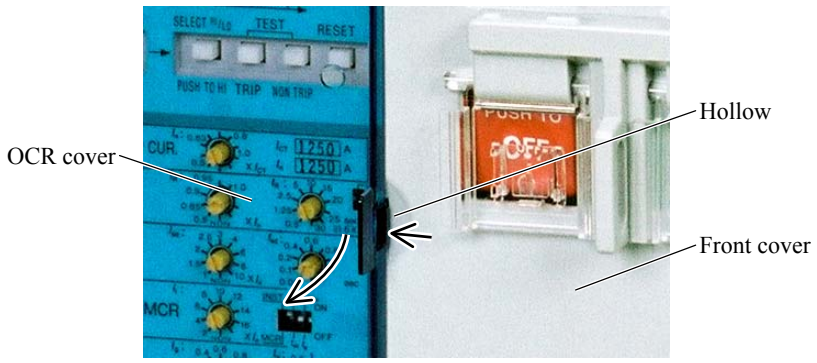
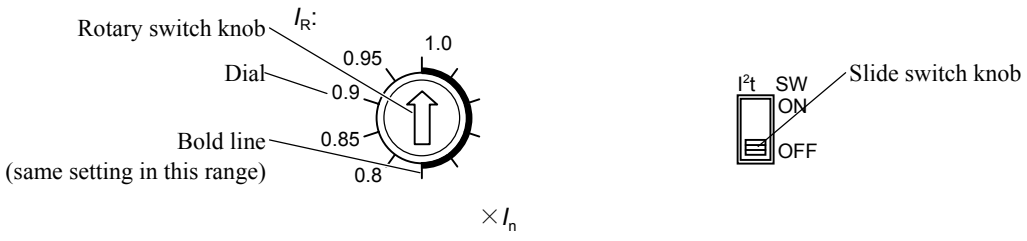


Fig. 35 OCR cover

3) Use rotary step switches and slide switches to set the OCR. See Fig. 36.

- Rotary step switches must be adjusted with a small flatblade 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.



Rotary step switch Slide switch

Fig. 36 OCR characteristic setting switches

4) Close the OCR cover.

5) After setting changes are made, it is recommended that the settings be checked with e.g., a type ANU-1 OCR checker (optional).

5-4. Operation Indication

The OCR has LEDs on the front panel to provide operation indications as shown in Fig. 37 and Table 21. It also outputs operation signals to contacts.

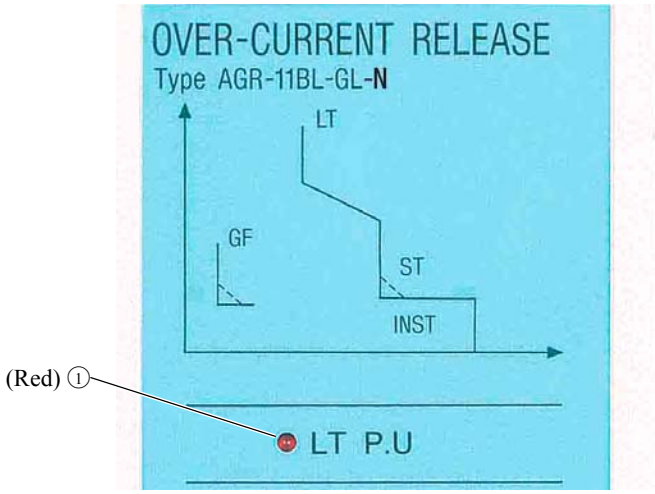


Fig. 37 LEDs

Table 21 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-11BL-AL AGR-11BL-GL	Not required	Long time delay trip (LT) N-phase protection (NP)	①	OFF	Flash	OFF	05, 15	OFF	Turn OFF automatically after ON for 40 ms or more *1
		Short time delay trip (ST) Ground fault trip (GF)							
		Instantaneous trip (INST)			OFF				

*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 22 shows the recommended inspection frequency. See section 6-1 for detailed maintenance and inspection procedures.

Table 22 Frequency of maintenance and inspection

<table>
<tr><th rowspan="2">Category</th><th rowspan="2">Working and environmental conditions</th><th rowspan="2">Inspection level</th><th colspan="2">Frequency in interval or number of open/close cycles</th></tr>
<tr><th>Interval</th><th>Number of open/close cycles</th></tr>
<tr><td rowspan="4">Normal</td><td rowspan="4">• 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</td><td rowspan="2">Normal/ Detailed</td><td rowspan="2">• Every year or 2 years
• Every year after 3 years since installation
• Every half year after 6 years since installation</td><td><table><tr><td>Open/close condition</td><td>800AF or less</td><td>1250AF - 2500AF</td><td>3200AF or more</td></tr><tr><td>Nearly no current level</td><td colspan="3">Every 1000 cycles</td></tr><tr><td>Rated current level</td><td>Every 1000 cycles</td><td>Every 500 cycles</td><td>Every 100 cycles</td></tr></table></td></tr>
<tr><td>Thorough</td><td>• Every 5 or 6 years
• Every 4 years after 6 years since installation
• Every year or 2 years after 10 years since installation</td><td>Every 4000 cycles</td></tr>
<tr><td>Overhaul</td><td colspan="2">When abnormality is found during normal or through inspection</td></tr>
<tr><td rowspan="3">Harsh</td><td rowspan="3">• 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</td><td rowspan="2">Normal/ Detailed</td><td rowspan="2">• Every year
• Every half year after 2 years since installation</td><td><table><tr><td>Open/close condition</td><td>800AF or less</td><td>1250AF - 2500AF</td><td>3200AF or more</td></tr><tr><td>Nearly no current level</td><td colspan="3">• Every 1000 cycles
• Every 500 cycles after 1000 cycles</td></tr><tr><td>Rated current level</td><td>• Every 1000 cycles
• Every 500 cycles after 1000 cycles</td><td>• Every 500 cycles
• Every 250 cycles after 500 cycles</td><td>• Every 100 cycles
• Every 50 cycles after 100 cycles</td></tr></table></td></tr>
<tr><td>Thorough</td><td>• Every 2 or 3 years
• Every 2 years after 6 years since installation
• Every year after 10 years since installation</td><td>• Every 2500 - 3000 cycles
• Every 2000 cycles after 3000 cycles</td></tr>
<tr><td>Overhaul</td><td colspan="2">When abnormality is found during normal or through inspection</td></tr>
<tr><td rowspan="2">Abnormal</td><td rowspan="2">• Open/close operation due to overload,
• Tripping due to shortcircuit,
• Accidentally submerged</td><td rowspan="2">Thorough</td><td rowspan="2">When abnormality occurs</td><td><table><tr><td>Open/close condition</td><td>800AF or less</td><td>1250AF - 2500AF</td><td>3200AF or more</td></tr><tr><td>Overcurrent level (approx. 6 times the rated current)</td><td>Every 25 cycles</td><td>Every 25 cycles</td><td>Every 25 cycles</td></tr><tr><td>Level exceeding overcurrent level</td><td>Every time</td><td>Every time</td><td>Every time</td></tr></table></td></tr>
<tr><td>Overhaul</td><td colspan="2">When ACB is deemed to be repairable at through inspection</td></tr>
</table>

- 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 and 4. "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.
- Take care to avoid adhesion of dust to main and control circuit contacts. Dust on the contacts may result in a fire.
- 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 24 and 25 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 23 below. Our contact is shown at the end of this manual.

Table 23 Information you are requested to state

Item	Description	Reference
Type	AR_____ __ __ poles with draw-out cradle	Rating nameplate
Serial No.	_____ – _____	
Main circuit rated current	☐ AC ☐ DC _____V	Product Specifications
Rated voltage	_____A	I_n
Spring charging method	☐ Manual charging ☐ Motor charging Rated operation voltage: ☐ AC ☐ DC _____V	CLOSING section on specification nameplate
Overcurrent release	☐ Non ☐ Equipped Type: AGR-11__ – _____ Rated control voltage: ☐ AC ☐ DC _____V	OCR section on specification nameplate
Electrical tripping device	☐ Shunt trip device (SHT) Rated voltage: ☐ AC ☐ DC _____V ☐ Undervoltage trip device (UVT) Rated voltage: ☐ AC ☐ 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 24 Normal inspection procedure

<table>
<tr><th>Check point</th><th>No.</th><th>Check item</th><th>Description</th></tr>
<tr><td rowspan="4">General
(*1)</td><td>1</td><td>Discoloration of conductors</td><td>Check connection conductors, main circuit terminals, and current carrying parts for heat discoloration. If such a symptom is found, contact us.</td></tr>
<tr><td>2</td><td>Parts missing</td><td>Check that screws, bolts, nuts, washers, springs, retainers and the like are not missing. If any parts are missing, contact us.</td></tr>
<tr><td>3</td><td>Damage to parts</td><td>Check for deformation, cracks, chips, rust, or other damage of parts. If damage is found, contact us.</td></tr>
<tr><td>4</td><td>Dust accumulation</td><td>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.</td></tr>
<tr><td>Main/control circuit terminals
See 2-3.</td><td>5</td><td>Connections</td><td>Check main circuit terminal screws, ground terminal screw, auxiliary switch terminal screws, control circuit terminal screws, and position switch terminal screws for looseness. If loose, tighten to specified torque.</td></tr>
<tr><td>Main/control circuit contacts
See 4-2.</td><td>6</td><td>Surface condition</td><td>Draw out the breaker body from draw-out cradle and check that contacts have no dust accumulation and discoloration. If dust is accumulated, use vacuum cleaner to remove dust and wipe off with dry, clean cloth. If surface is discolored badly, polish it with #200 sandpaper. (*2) For main circuit contacts, apply contact grease (SS grease, No. F-5G, FUJI KAGAKU SANGYO) to contact surface after cleaning.
● Excessive grease may foster dust accumulation. Grease should be applied lightly.
● Blackening of contacts is caused by oxidation or sulfuration and has no harmful effect except in extreme cases. If heat discoloration, arc marks, roughness, or peeling of plating layer is found, contact us.</td></tr>
<tr><td>Arc chamber
See 6-2-2.</td><td>7</td><td>Dust accumulation /Damage</td><td>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.</td></tr>
<tr><td>Main circuit, Arc chamber
See 6-2-2.</td><td>8</td><td>Insulation resistance</td><td>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.</td></tr>
<tr><td rowspan="2">Contacts
See 6-2-2, 6-2-3 and 6-2-4.</td><td>9</td><td>Surface condition</td><td>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.</td></tr>
<tr><td>10</td><td>Looseness of screws</td><td>Check moving and stationary contact mounting screws A and B for looseness. If loose, retighten.</td></tr>
<tr><td>Control circuit
See 6-2-5.</td><td>11</td><td>Wiring</td><td>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.</td></tr>
<tr><td>Operating mechanism
See 6-2-7.</td><td>12</td><td>Internal mechanism</td><td>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.</td></tr>
<tr><td rowspan="3">Auxiliary switches
See 6-2-9.</td><td>13</td><td>Operation</td><td>Check that auxiliary switches operate as shown to the right. If not so, replace switches.
<table>
<tr><th>State of operation lever</th><th>Current conducting between _11 and _12</th><th>Current conducting between _11 and _14</th></tr>
<tr><td>Natural position</td><td>100 mΩ or less</td><td>Non</td></tr>
<tr><td>Uppermost lift position</td><td>Non</td><td>100 mΩ or less</td></tr>
</table></td></tr>
<tr><td>14</td><td>Auxiliary contacts</td><td>Remove auxiliary switches and check contacts for roughness. If roughened excessively, replace contacts.</td></tr>
<tr><td>15</td><td>Looseness of screws</td><td>Check screws of auxiliary switches for looseness. If loose, retighten.</td></tr>
<tr><td rowspan="3">Operation related mechanism
See 4-1 and 4-2.</td><td>16</td><td>Draw-out/insertion mechanism</td><td>Draw out and insert breaker body to check that draw-out handle can be turned with max. operating torque or less, position indictor provides correct indication, release button operates normally, and no abnormal sound is heard during handle operation. If abnormality is found, contact us.</td></tr>
<tr><td>17</td><td>UVT</td><td>With breaker body in ISOLATED position, charge closing springs manually and attempt closing ACB to make sure ACB cannot be closed. If ACB can be closed, perform detailed inspection.</td></tr>
<tr><td>18</td><td>Operation mechanism, LRC, SHT and UVT</td><td>With breaker body in TEST position and operation mechanism, 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.</td></tr>
</table>

*1: Always check the "General" items during the inspection procedure shown in Table 24 above.

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

Table 25 Detailed inspection procedure

<table>
<tr><th>Check point</th><th>No.</th><th>Check item</th><th>Description</th></tr>
<tr><td rowspan="5">Undervoltage trip device (UVT)
See 6-2-1.</td><td>1</td><td>Coil resistance</td><td>Disconnect hand connector (red) and, using tester, measure coil resistance between terminals and make sure holding coil is rated at 410 - 510 Ω and attraction coil at 5.6 - 6.8Ω. (*) If not so, replace UVT.</td></tr>
<tr><td>2</td><td>Operation</td><td>Remove UVT and press in plunger, and make sure releasing plunger causes plunger to be smoothly restored. If not so, replace UVT.</td></tr>
<tr><td>3</td><td>Length and stroke of plunger</td><td>Remove UVT and, using vernier caliper, make sure plunger length is 32.5 - 33.5mm in natural state and plunger stroke is 6.5 - 7.5 mm. If not so, replace UVT.</td></tr>
<tr><td>4</td><td>Hand connector</td><td>Check that hand connector (red) is connected to ACB hand connector (red) correctly. If incorrect , connect correctly.</td></tr>
<tr><td>5</td><td>Looseness of screws</td><td>Check UVT mounting screws for looseness. If loose, retighten.</td></tr>
<tr><td rowspan="4">Contacts
See 6-2-2, 6-2-3 and 6-2-4</td><td rowspan="3">6</td><td rowspan="3">Parting distance</td><td>With ACB open, remove arc chamber and, using compass and vernier caliper, make sure distance between moving and stationary contact tips falls within the following ranges. If not so, replace both moving and stationary contacts. If it is useless to replace contacts, contact us.
<table>
<tr><th rowspan="2">Distances between moving and stationary contact tips(mm)
Types</th><th colspan="2">Line side</th><th colspan="2">Load side</th></tr>
<tr><th>phase A-C</th><th>phase N</th><th>phase A-C</th><th>phase N</th></tr>
<tr><td>AR208S, AR212S, AR216S, AR220S, AR325S, AR332S, AR440S(3P), AR440SB(3P)</td><td>17-20.5</td><td>16-20</td><td>17-20.5</td><td>16-20</td></tr>
<tr><td>AR440S(4P), AR440SB(4P)</td><td>17-21.5</td><td>17-21.5</td><td>17-21.5</td><td>17-21.5</td></tr>
<tr><td>AR212H, AR216H, AR220H, AR316H, AR320H, AR325H, AR332H, AR420H, AR440H</td><td>17-20.5</td><td>16-20</td><td>16-20</td><td>16-20</td></tr>
</table></td></tr>
<tr><td>7</td><td>Engagement</td><td>Insert 3.5 - 4.0-mm-dia x 50-mm-length rod into engagement measuring hole vertically until it stops, and measure protrusion of rod when ACB is open and closed. Make sure difference in protrusion is following: line side; 2.7-3.4mm, load side; 2.7-4.0mm. (The difference of the value of line side and load side must not exceed 1.0mm.) If not so, replace both moving and stationary contacts. If it is useless to replace contacts, contact us.</td></tr>
<tr><td>Current sensors
See 6-2-3.</td><td>8</td><td>Looseness of screws</td><td>Check current sensor mounting screws for looseness. If loose, retighten.</td></tr>
<tr><td rowspan="5">Latch release coil (LRC)
See 6-2-5.</td><td>9</td><td>Coil resistance</td><td>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 10. (*) If not so, replace LRC.</td></tr>
<tr><td>10</td><td>Length and stroke of plunger</td><td>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.</td></tr>
<tr><td>11</td><td>Hand connector</td><td>Check that hand connector (green) is connected to ACB hand connector (green) correctly. If incorrect, connect correctly.</td></tr>
<tr><td>12</td><td>Looseness of screws</td><td>Check LRC mounting screws for looseness. If loose, retighten.</td></tr>
<tr><td>13</td><td>Mechanical motion</td><td>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.</td></tr>
<tr><td rowspan="5">Shunt trip device (SHT)
See 6-2-6.</td><td>14</td><td>Coil resistance</td><td>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 11. (*) If not so, replace SHT.</td></tr>
<tr><td>15</td><td>Length and stroke of plunger</td><td>Remove SHT 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 SHT.</td></tr>
<tr><td>16</td><td>Hand connector</td><td>Check that hand connector (black) is connected to ACB hand connector (black) correctly. If incorrect, connect correctly.</td></tr>
<tr><td>17</td><td>Looseness of screws</td><td>Check SHT mounting screws for looseness. If loose, retighten.</td></tr>
<tr><td>18</td><td>Mechanical motion</td><td>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.</td></tr>
<tr><td rowspan="5">Magnet hold trigger (MHT)
See 6-2-8.</td><td>19</td><td>Coil resistance</td><td>Disconnect hand connector (red) and, using tester, measure coil resistance between terminals and make sure it is 1.8 - 2.2 Ω. (*) If not so, replace MHT.</td></tr>
<tr><td>20</td><td>Operation</td><td>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.</td></tr>
<tr><td>21</td><td>Length and stroke of moving core</td><td>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.</td></tr>
<tr><td>22</td><td>Hand connector</td><td>Check that hand connector (red) is connected to ACB hand connector (red) correctly. If incorrect , connect correctly.</td></tr>
<tr><td>23</td><td>Looseness of screws</td><td>Check MHT mounting screws for looseness. If loose, retighten.</td></tr>
<tr><td>Charging motor and LRC</td><td>24</td><td>Electrical operation</td><td>With breaker body assembled to original state, move breaker body to TEST position, 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 10). If ACB does not operate normally, contact us.</td></tr>
<tr><td>SHT</td><td>25</td><td>Electrical operation</td><td>With breaker body assembled to original state, move breaker body to TEST position, 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 11). If ACB does not trip open, contact us.</td></tr>
<tr><td>UVT</td><td>26</td><td>Electrical operation</td><td>With breaker body assembled to original state, move breaker body to TEST position, 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 12.) If ACB does not operate normally, contact us.</td></tr>
<tr><td>OCR and MHT</td><td>27</td><td>Operation</td><td>With breaker body assembled to original state, check OCR and MHT with type ANU-1 OCR checker (optional) to make sure ACB operates normally. If ACB does not operate normally, contact us.</td></tr>
</table>

● Always check the "General" items in Table 24 during the inspection procedure shown in Table 25 above.

* 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.
- Take care to avoid adhesion of dust to main and control circuit contacts. Dust on the contacts may result in a fire.
- 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) Draw out the breaker body to the removed position, and remove it using an optional lifter or lifting plate. Refer to sections 4-2-2 and 2-1-2.
3) 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. 38. 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.)

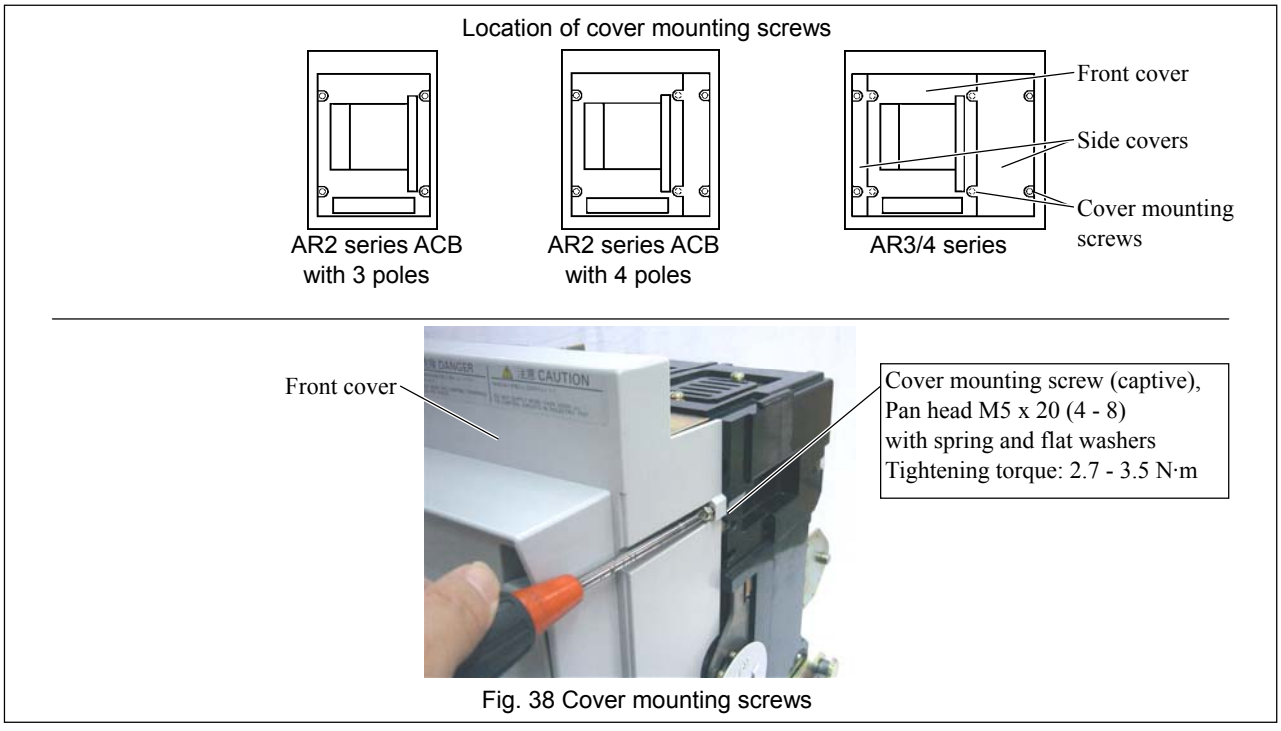


Fig. 38 Cover mounting screws

(2) Remove the contact block fixing screws as shown in Fig. 39.

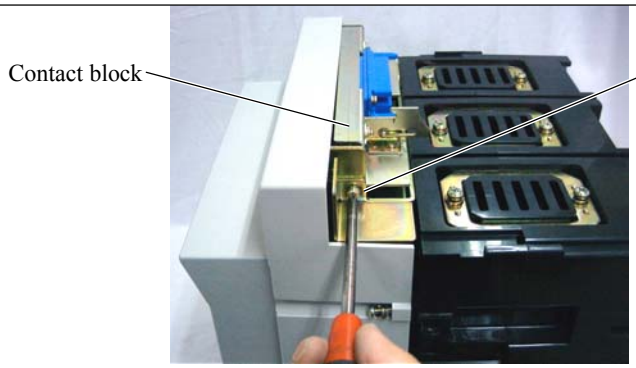


Fig. 39 Contact block fixing screws

(3) Slide the front cover to the left and flip the contact block up as shown in Fig. 40.

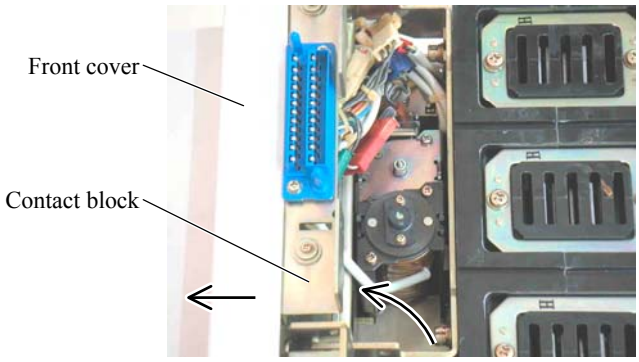


Fig. 40 Flipping the contact block

(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. 41.

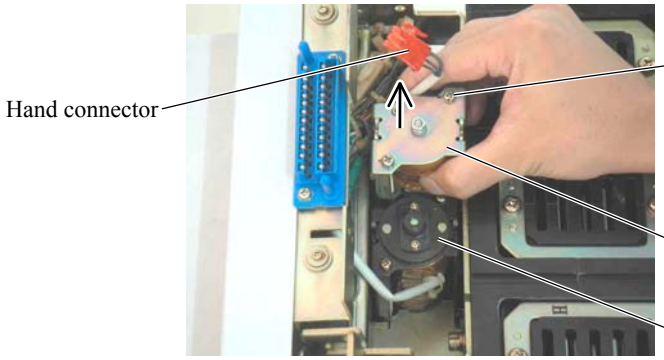


Fig. 41 Removing the UVT

(5) Flip the contact block down and slide the front cover to the original position as shown in Fig. 42.

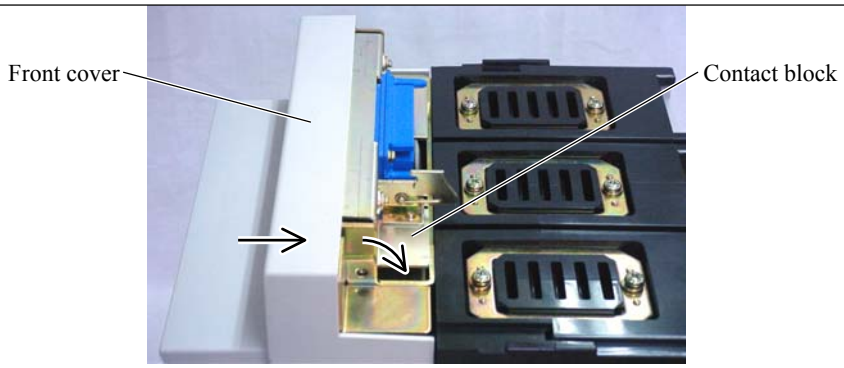


Fig. 42 Sliding the front cover to the original position

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

(7) 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.

● Fig. 43 provides the general view of the UVT.

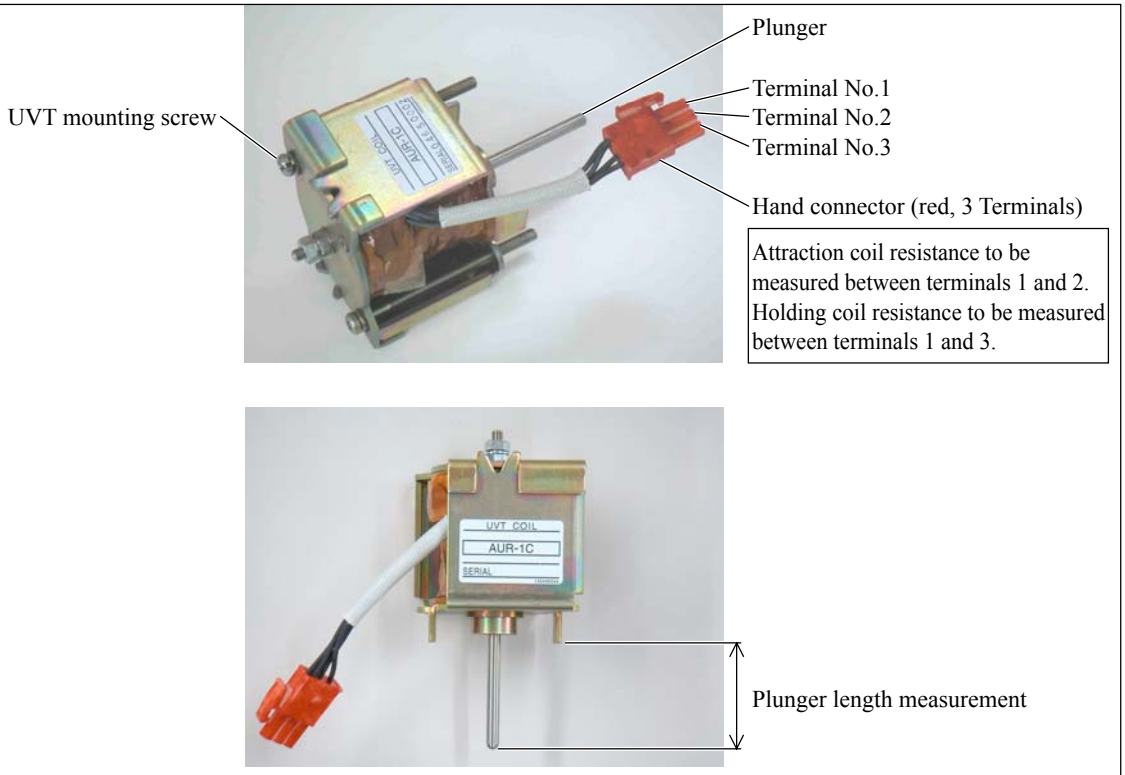


Fig. 43 General view of UVT

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) Carefully lay the breaker body on spacers with the backside down as shown in Fig. 44. The spacers must be at least 7-cm high to prevent deformation of protrusions on the breaker body backside, and have the size and strength that allow the breaker body to be safely laid on them. Take care to keep the main circuit contacts clean of dust.

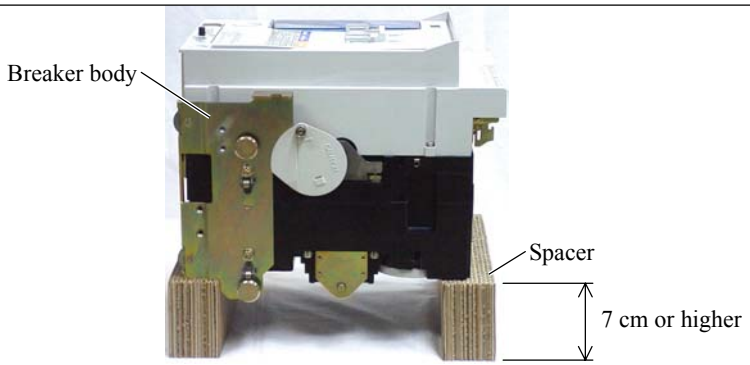


Fig. 44 Laying the breaker body on spacers

3) Turn the arc chamber mounting screw eight or ten turns to loosen as shown in Fig. 45. (The arc chamber mounting screws are of captive type and cannot be removed from the arc chamber.)

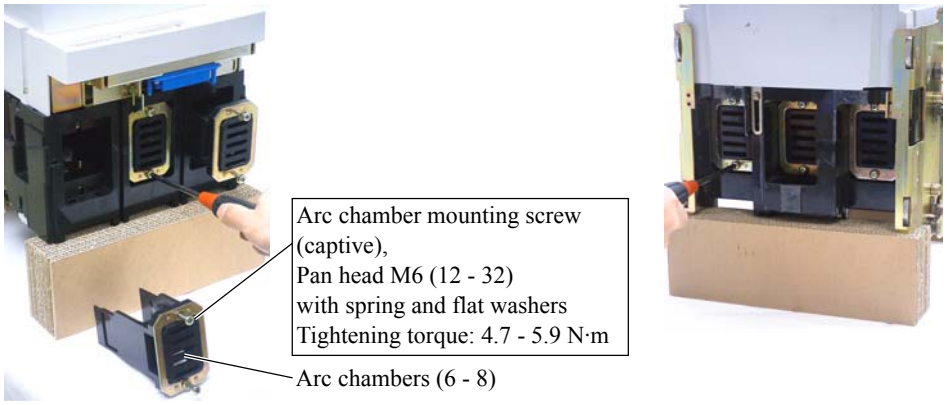


Fig. 45 Arc chamber mounting screws

4) Holding the arc chamber mounting screw, remove the arc chamber.

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

● Fig. 46 shows a removed arc chamber.

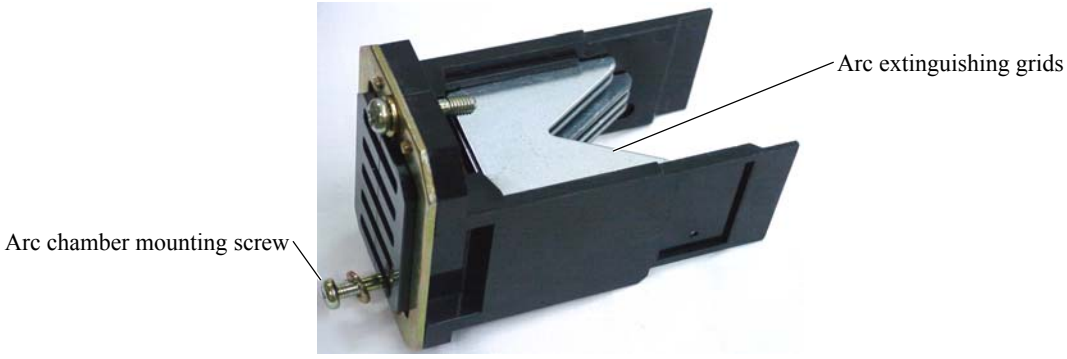


Fig. 46 Arc chamber

6-2-3. Stationary contact

The following describes how to replace the stationary contact. Fig. 47 shows the general view around the stationary contact.

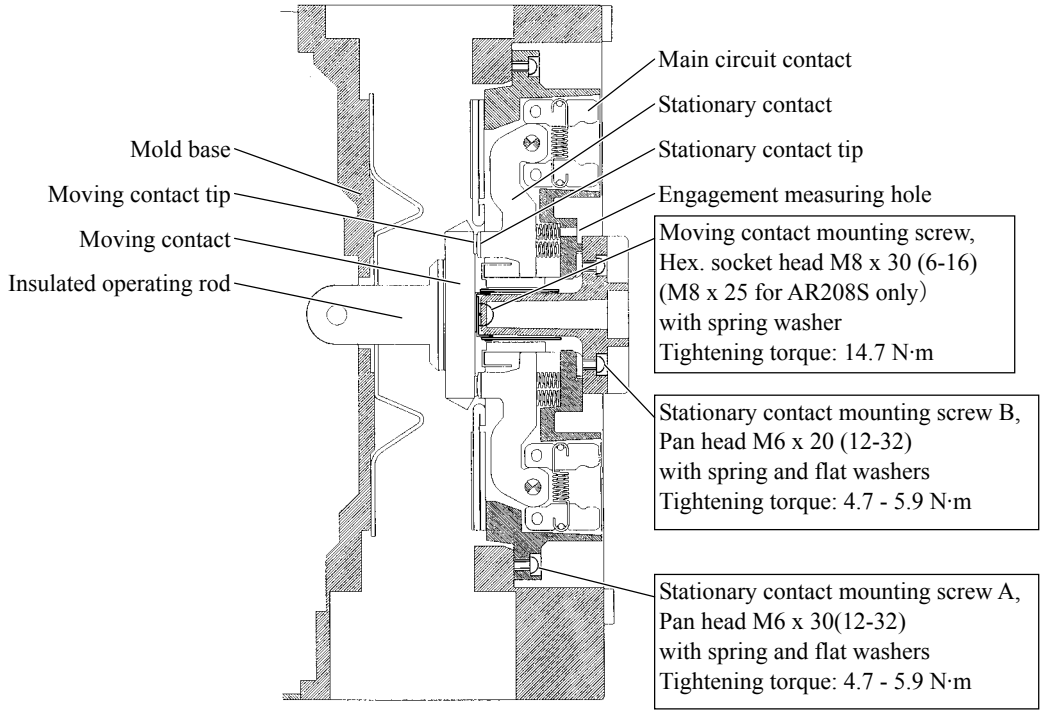


Fig. 47 General view around the stationary contact

1) Make preparations for parts replacement. Refer to section 6-2-1.
2) Unscrew the current sensor mounting screws and remove the current sensor and the power supply CT located behind the sensor. Take care not to exert undue force on the control wire between the current sensor and the power supply CT. To remove the current sensor, hold the top of the sensor, then tilt and pull it out in a slanting direction as shown in Fig. 48.

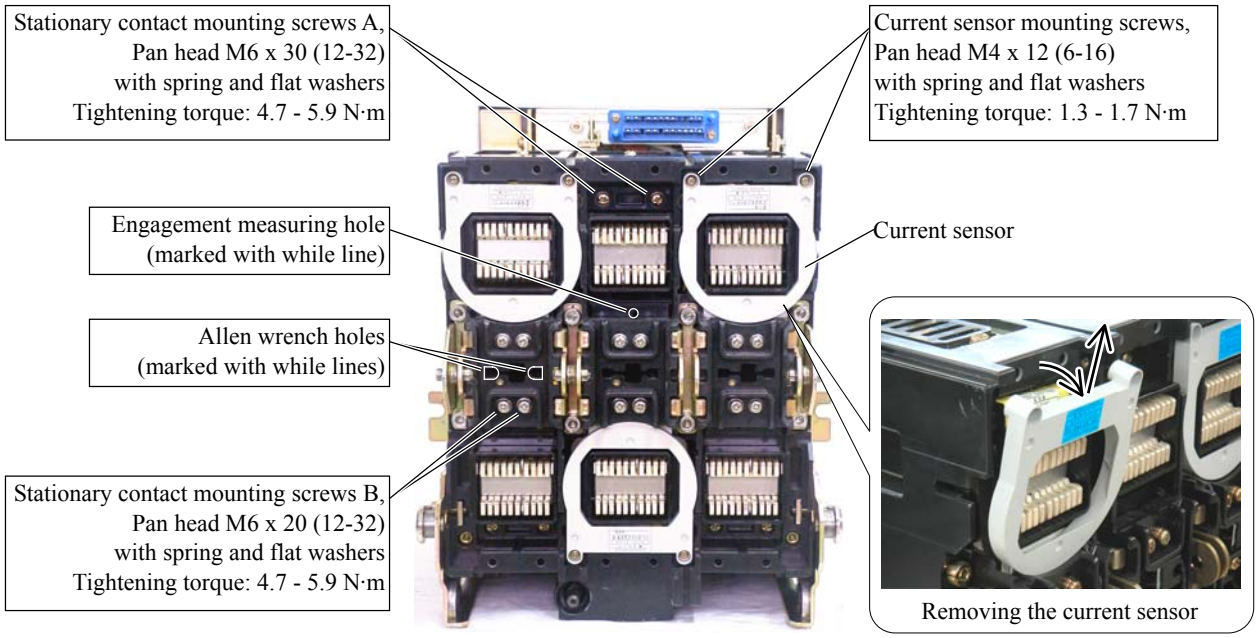


Fig. 48 Stationary contact

3) Unscrew stationary contact mounting screws A and B.

4) Tilt and remove the stationary contact as shown in Fig. 49. (The insulation sheet will be removed at the same time.) If the current sensor and power supply CT hinder the removal of the stationary contact, make a record of the ties for control wires between the current sensor and power supply CT (position/number of ties and type of control wires) using a digital camera, then cut the ties and remove the stationary contact. Restore the ties after replacing the stationary contact.

Ties: TYTON Insulok T18RHS (heat resistance grade: HS, 100 mm long x 2.5 mm wide) or equivalent (2 or 3 pcs per pole)

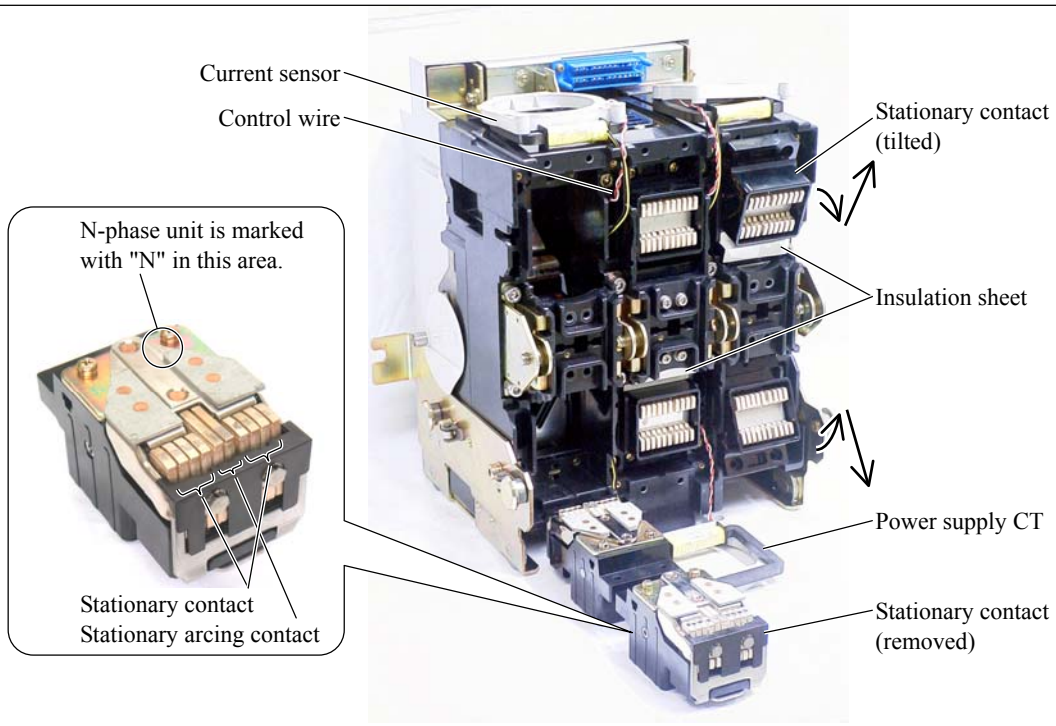


Fig. 49 Removing the stationary contact

5) Reinstall each part or component in reverse order of removal after inspection. Make sure the insulation sheet is installed. Be sure to restore the ties if they have been cut during removal of the stationary contact.

6) After installing the moving and/or stationary contact, be sure to perform 10 - 20 cycles of open/close operation and then retighten the contact mounting screws to the specified torque.

● Fig. 50 shows the contacts in closed and open state.

Fig. 50 State of contacts

6-2-4. Moving contact

The following describes how to replace the moving contact.

1) Make preparations for parts replacement. Refer to section 6-2-1.
2) Remove the arc chambers and stationary contact. Refer to sections 6-2-2 and 6-2-3.
3) Insert an Allen wrench of a nominal diameter of 5 into each of the Allen wrench holes shown in Fig. 48, turn each moving contact mounting screw two or three turns to loosen, and raise and remove the upper separator shown in Fig. 51.

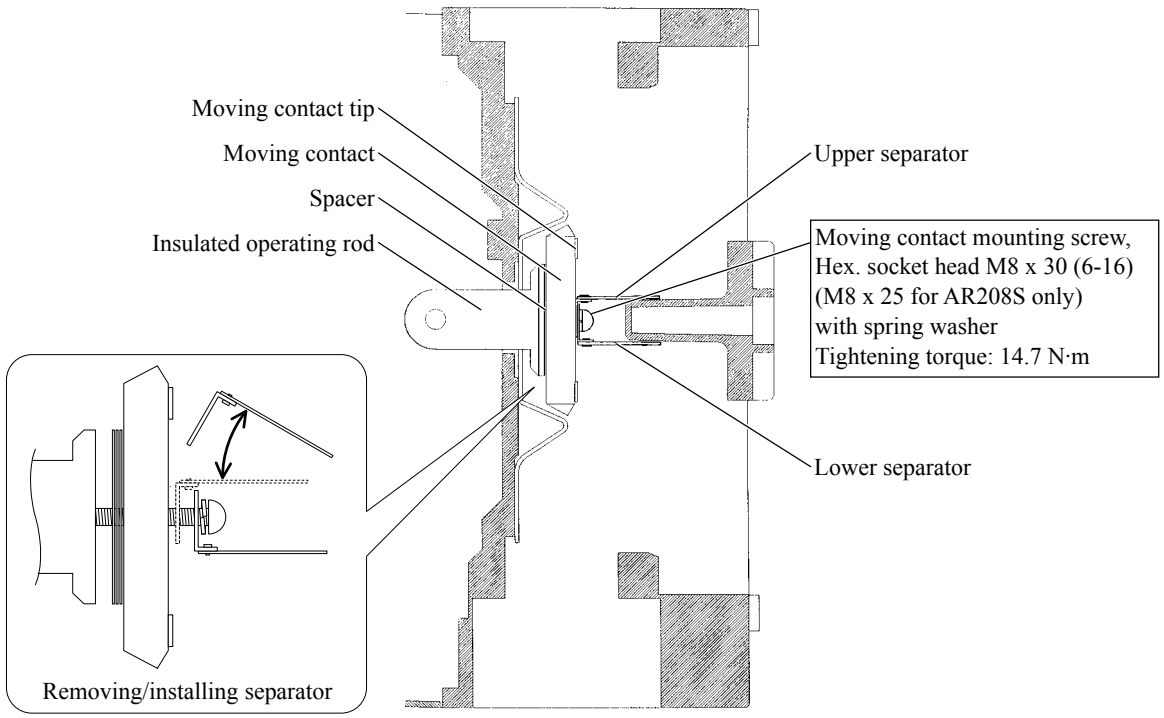


Fig. 51 Moving contact

4) Supporting the spacers (the number of which varies depending on the poles), the moving contact, the lower separator, and the moving contact mounting screws by hand, turn the moving contact mounting screws additional two or three turns to remove these parts. Fig. 52 shows the moving contact-related parts.

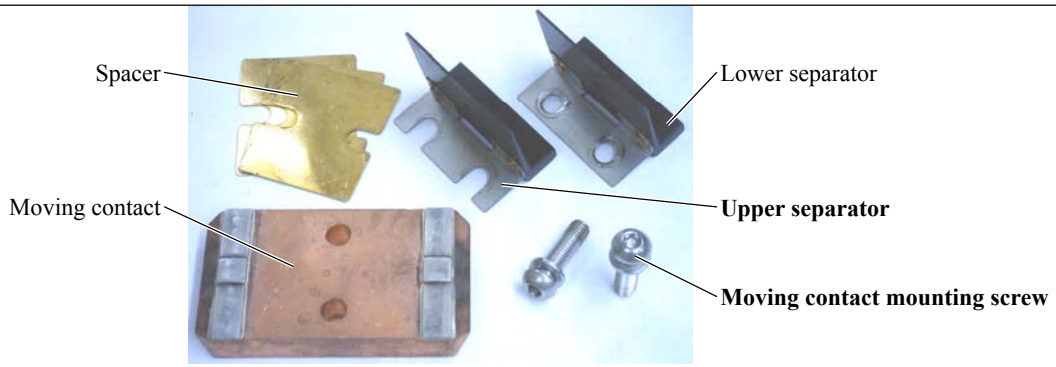


Fig. 52 Moving contact-related parts

5) Reinstall each part or component in reverse order of removal after inspection. As to the moving contact-related parts, however, install the spacer, moving contact, upper separator, lower separator, spring washer and moving contact mounting screw in this order, beginning wit the side of insulated operation rod. See Fig. 51.
6) After installing the moving and/or stationary contact, be sure to perform 10 - 20 cycles of open/close operation and then retighten the contact mounting screws to the specified torque.

6-2-5 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 fixed type undervoltage trip device, turn the cover mounting screws five or six turns to loosen as shown in Fig. 38. 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 contact block fixing screws as shown in Fig. 39.
5) Flip the contact block up as shown in Fig. 40.
6) Turn the LRC mounting screws eight or ten turns to loosen, disconnect the manual connector (green), and then remove the LRC. See Fig. 53.

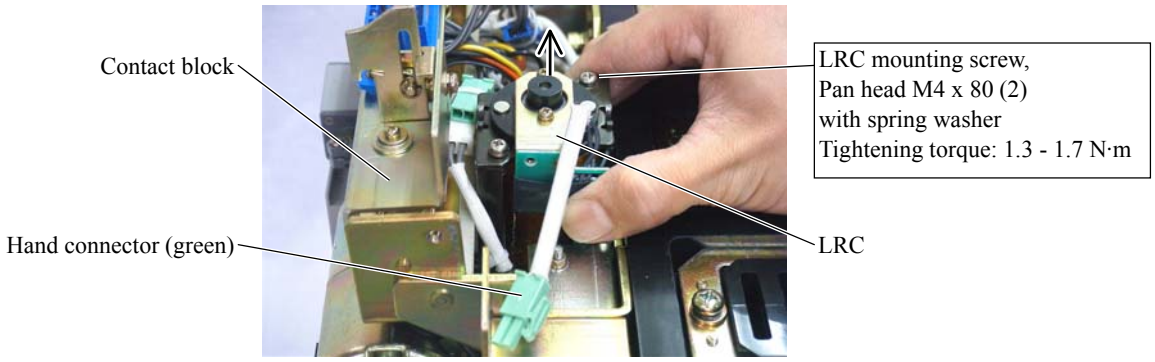


Fig. 53 Removing the LRC

7) 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. 54 provides the general view of the LRC.

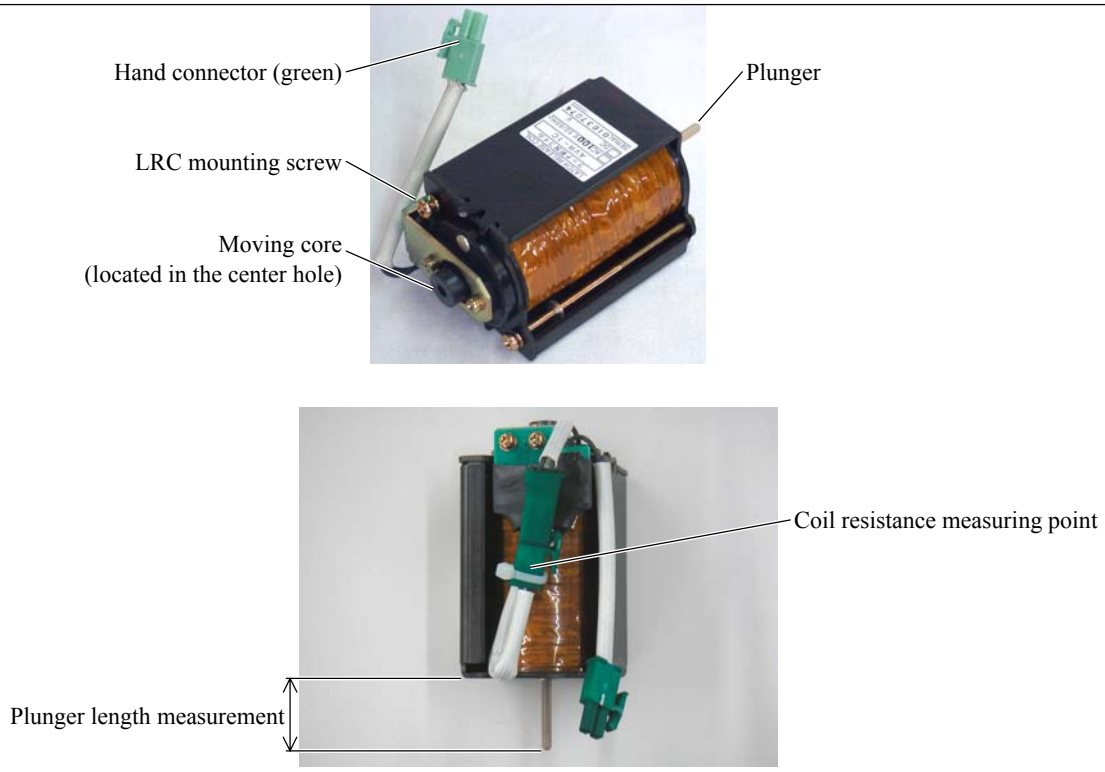


Fig. 54 General views of LRC

6-2-6. Shunt trip device (SHT)

The following describes how to replace the 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. 38. 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 contact block fixing screws as shown in Fig. 39.
5) Flip the contact block up as shown in Fig. 40.
6) Turn the SHT mounting screws eight or ten turns to loosen, disconnect the manual connector (black), and then remove the SHT. See Fig. 55.

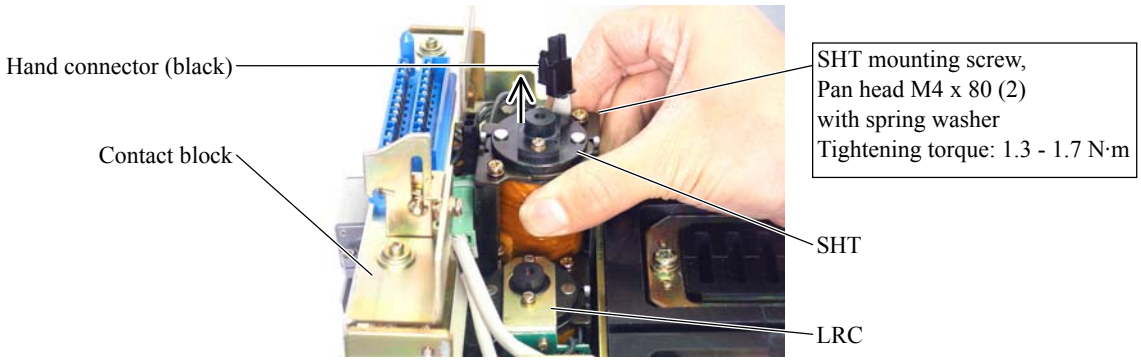


Fig. 55 Removing the SHT

7) 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. 56 provides the general view of the SHT.

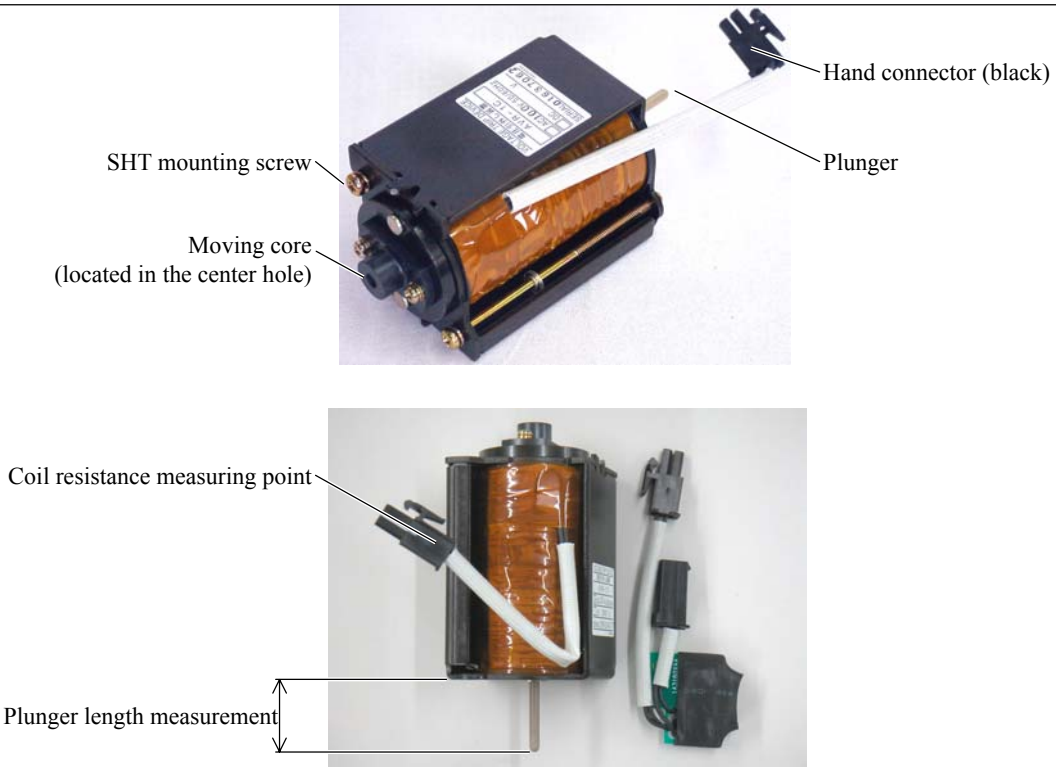


Fig. 56 General view of SHT

6-2-7. 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 fixed type undervoltage trip device, turn the cover mounting screws five or six turns to loosen as shown in Fig. 38. 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. 57.

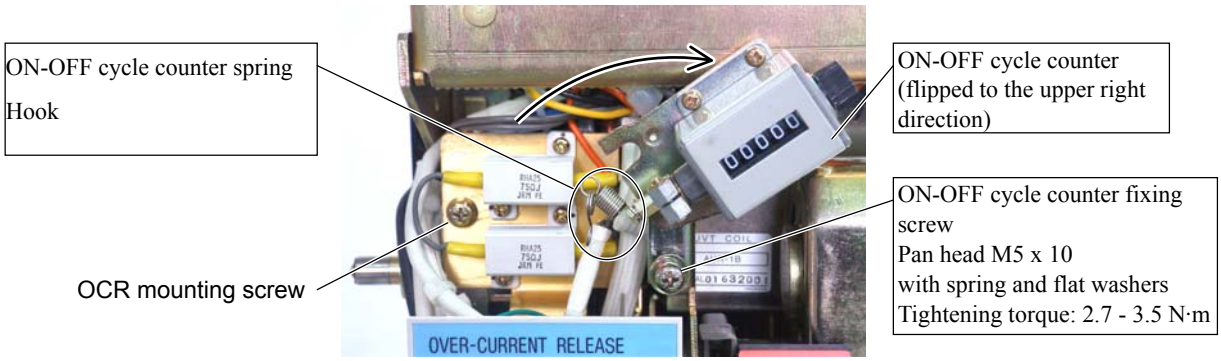


Fig. 57 Flipping the ON-OFF cycle counter

5) Unscrew the OCR mounting screws and remove the wiring from the wire tie. See Fig. 58.

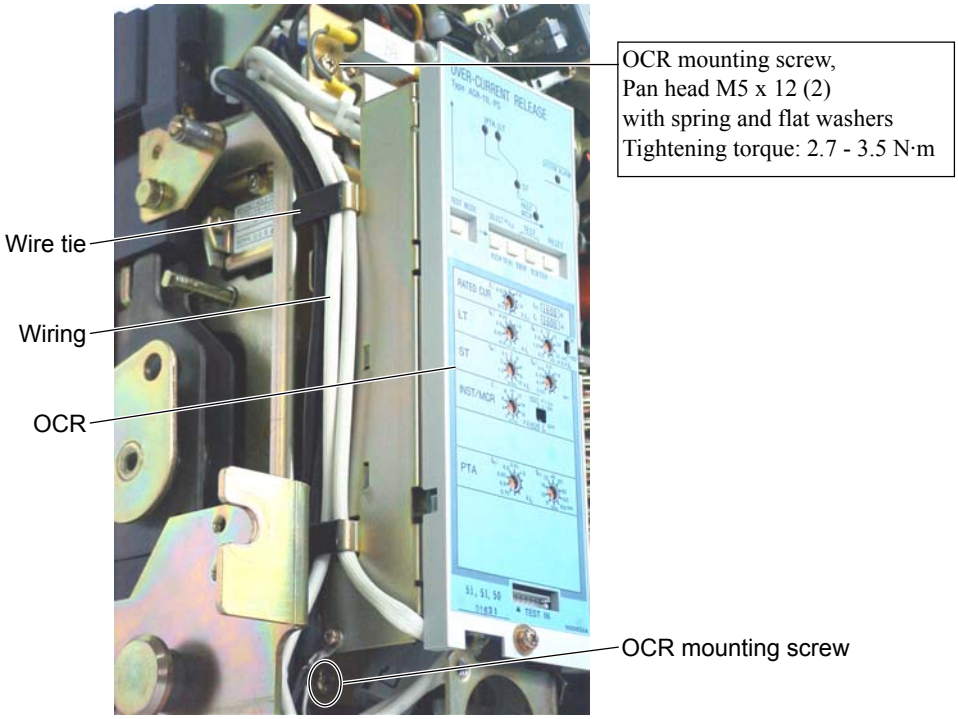


Fig. 58 OCR and related parts

6) Pull out the OCR as shown in Fig. 59, remove the hand connector(s) above the OCR and place it on the floor. The hand connector(s) below the OCR does not require to be removed. The type and quantity of the hand connectors vary depending on the specification of the ACB.

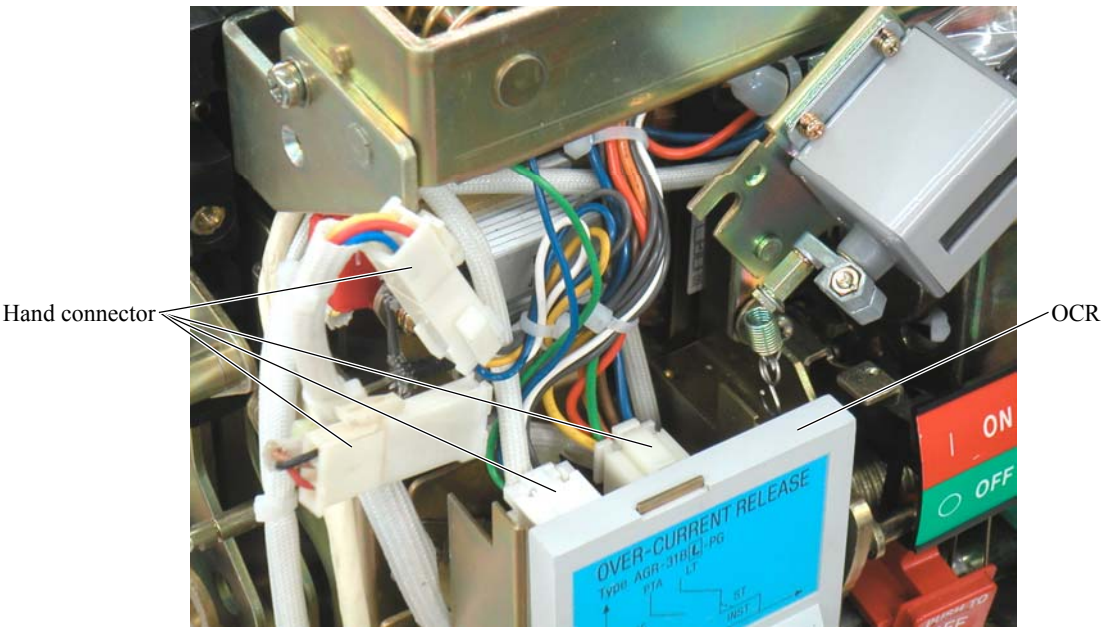


Fig. 59 Removing hand connectors

7) Unscrew the contact block mounting screws as shown in Fig. 39 and flip the contact clock up as shown in Fig. 40.

8) Unscrew relay base mounting screws A and B, raise the relay base to unlatch from other parts, remove the base and place it on the top of the breaker body. To remove relay base mounting screw B, use a ball end type 4-mm Allen wrench. See Fig. 60.

● When relay base mounting screw A, the relay base ground terminal will also be removed.

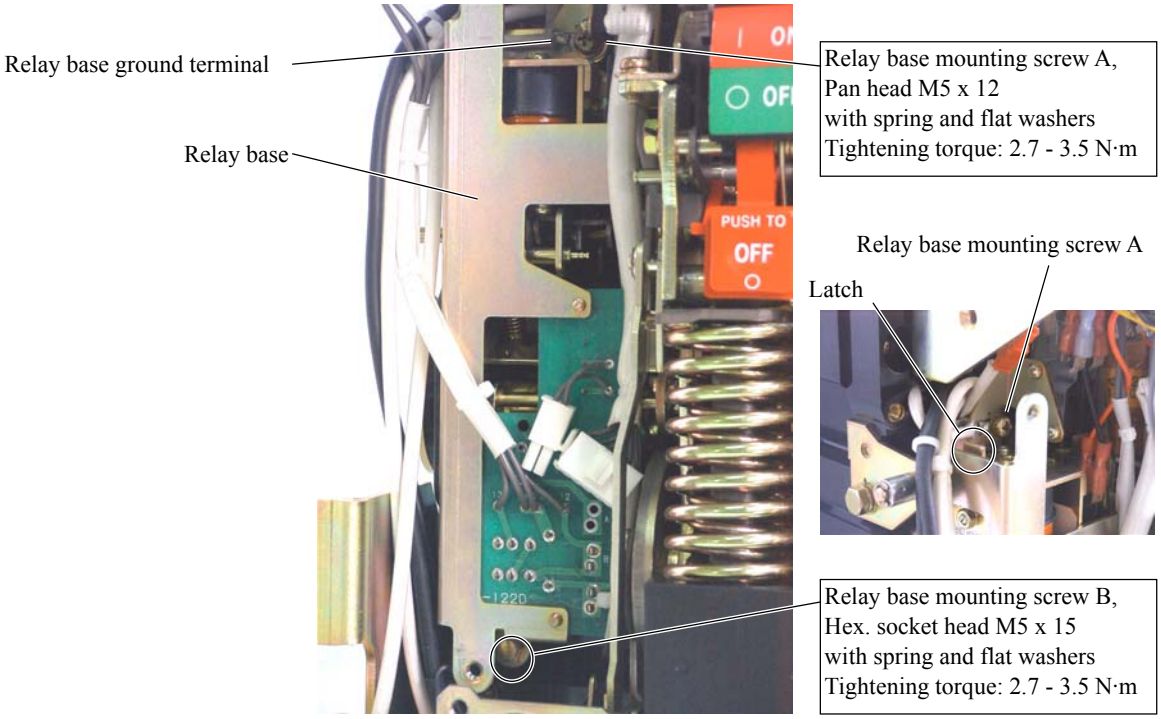


Fig. 60 Relay base and related parts

9) Remove the relay retainer shown in Fig. 61 and remove the control relay from the relay base.

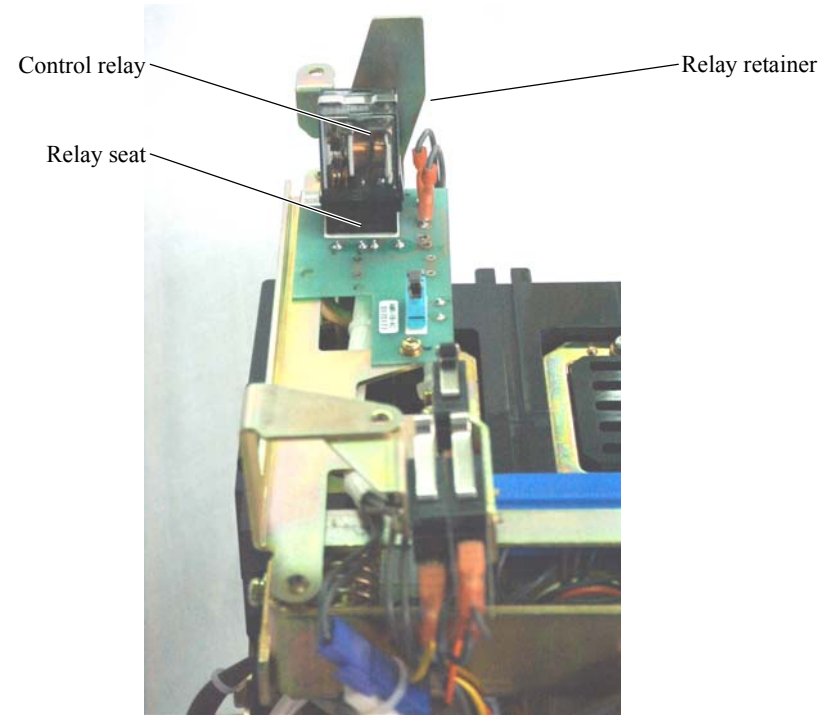


Fig. 61 Control relay and related parts

10) Reinstall each part or component in reverse order of removal after inspection. Do not forget to install the OCR ground terminal and the relay base ground terminal.

6-2-8. 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 OCR and the relay base. Refer to items 2 - 8, section 6-2-7.

3) Unscrew the MHT mounting screws shown in Fig. 62, disconnect the hand connector (red), and remove the MHT.

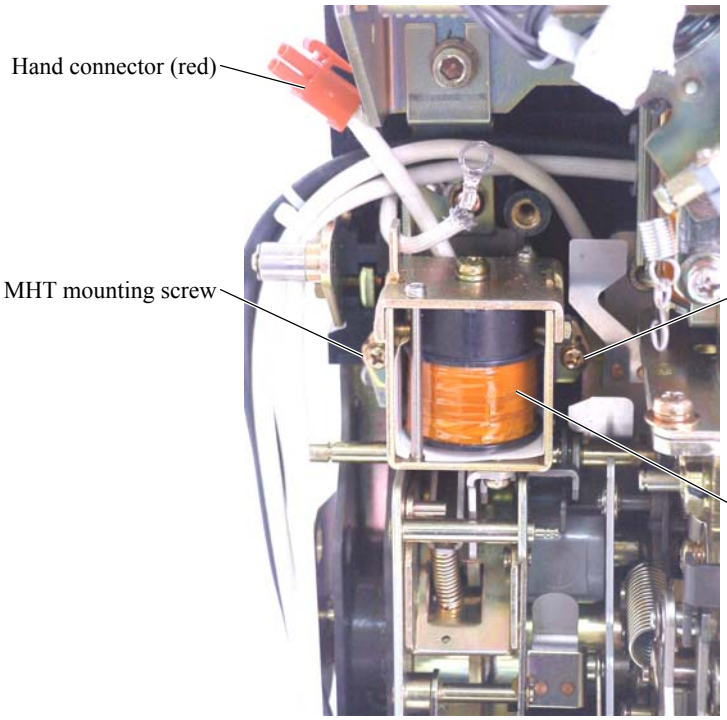
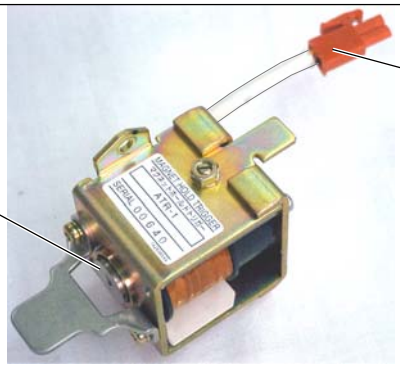


Fig. 62 Removing the MHT

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

● Fig. 63 provides the general view of the MHT.



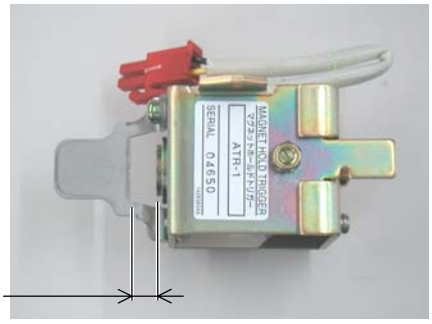


Fig. 63 General view of MHT

6-2-9. Auxiliary switches

The following describes how to replace auxiliary switches.

1) Make preparations for parts replacement. Refer to section 6-2-1, 1) and 2).

2) If the ACB is equipped with the control terminal block cover, loosen both the cover fixing screws and remove the cover.

3) Remove the auxiliary switch mounting screws shown in Fig. 64.

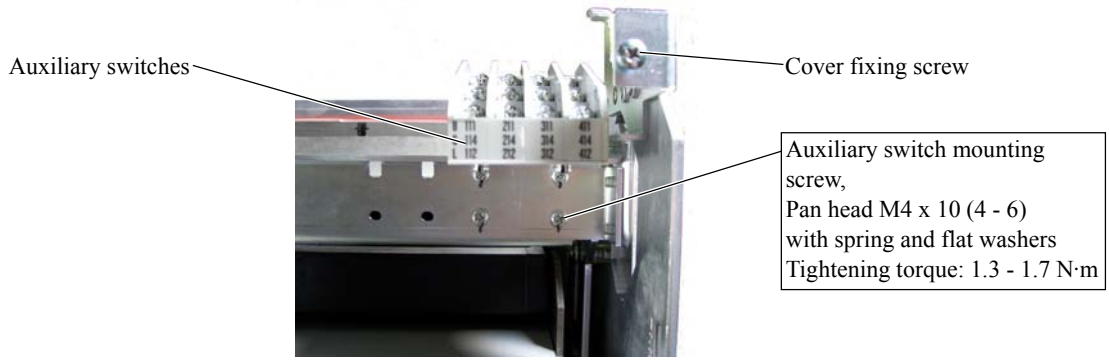


Fig. 64 Auxiliary switches and related parts

4) Depressing the AUX lock lever shown in Fig. 65, raise the operation lever till a shaft lever (see Fig. 66) appears in the top of draw-out cradle.

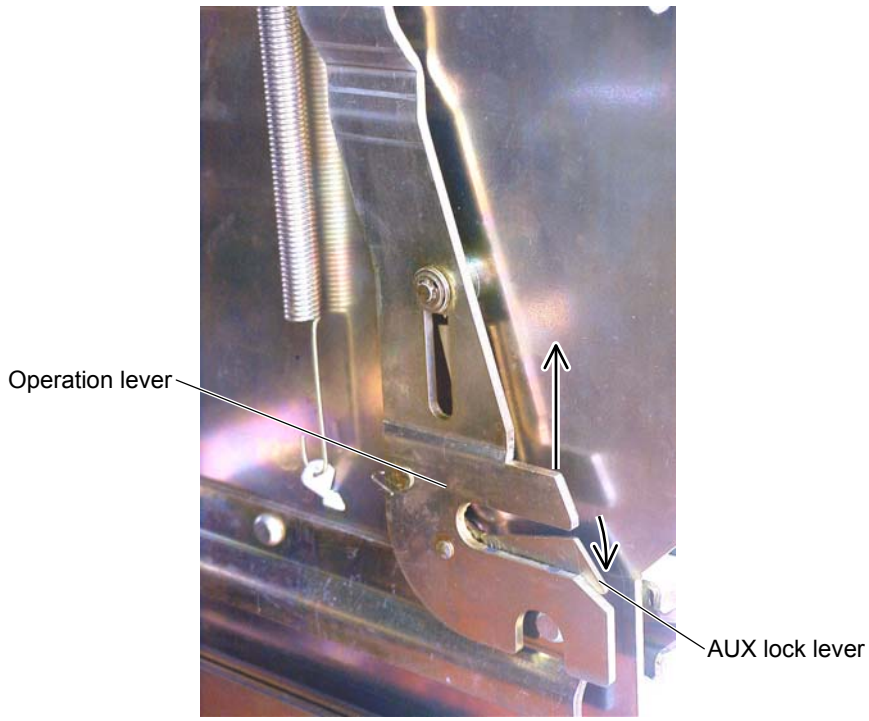


Fig. 65 AUX lock lever and operation lever

5) With the operation lever raised, uplift the auxiliary switch unit, pull the shaft lever through the U-notch, and remove the auxiliary switch unit. See Fig. 66.

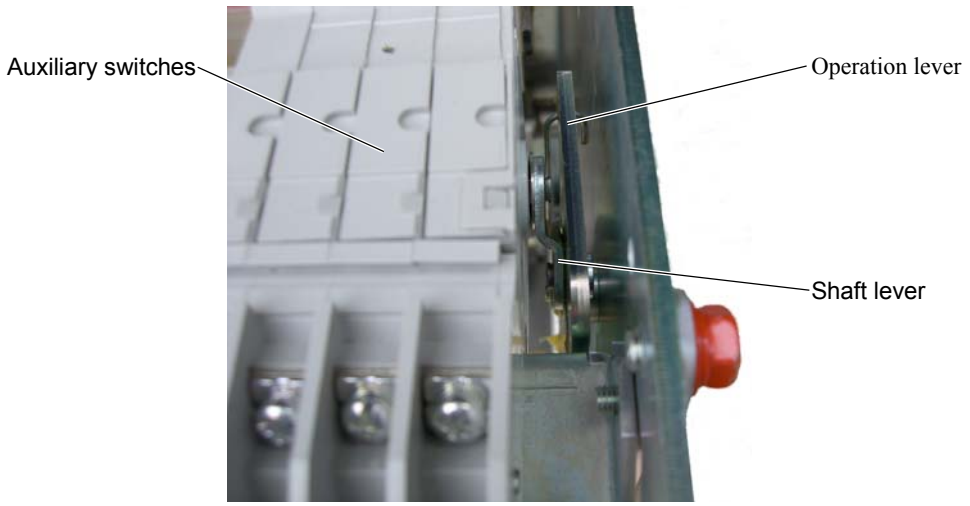


Fig. 66 Removing the auxiliary switches

6) Reinstall each part or component in reverse order of removal after inspection. When installing the auxiliary switch unit, apply molybdenum grease to the engagement of the operation lever and the shaft lever.

● Auxiliary contacts can be checked visually through the inspection holes shown in Fig. 67.

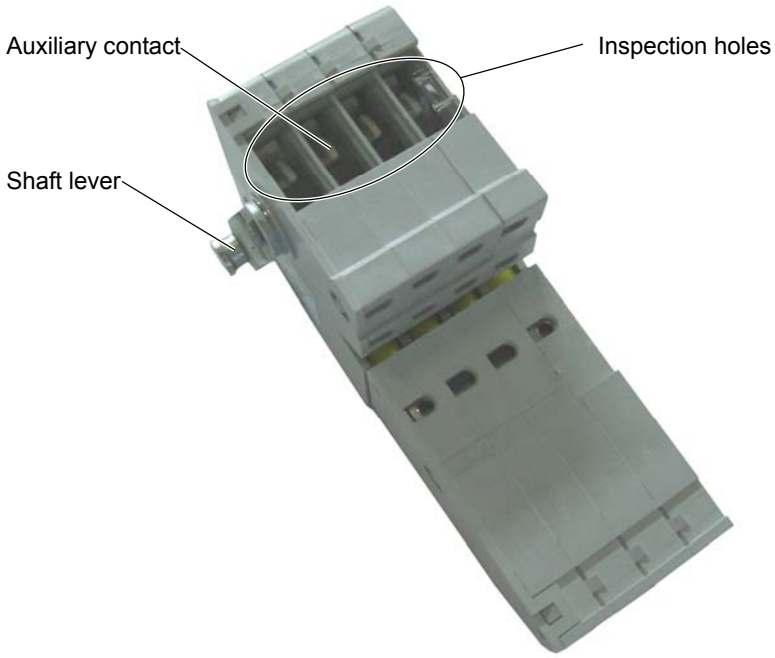


Fig. 67 Checking auxiliary contacts

7. TROUBLESHOOTING FLOWCHARTS

Figs. 68 - 71 are troubleshooting flowcharts where typical troubles and remedial actions are shown.

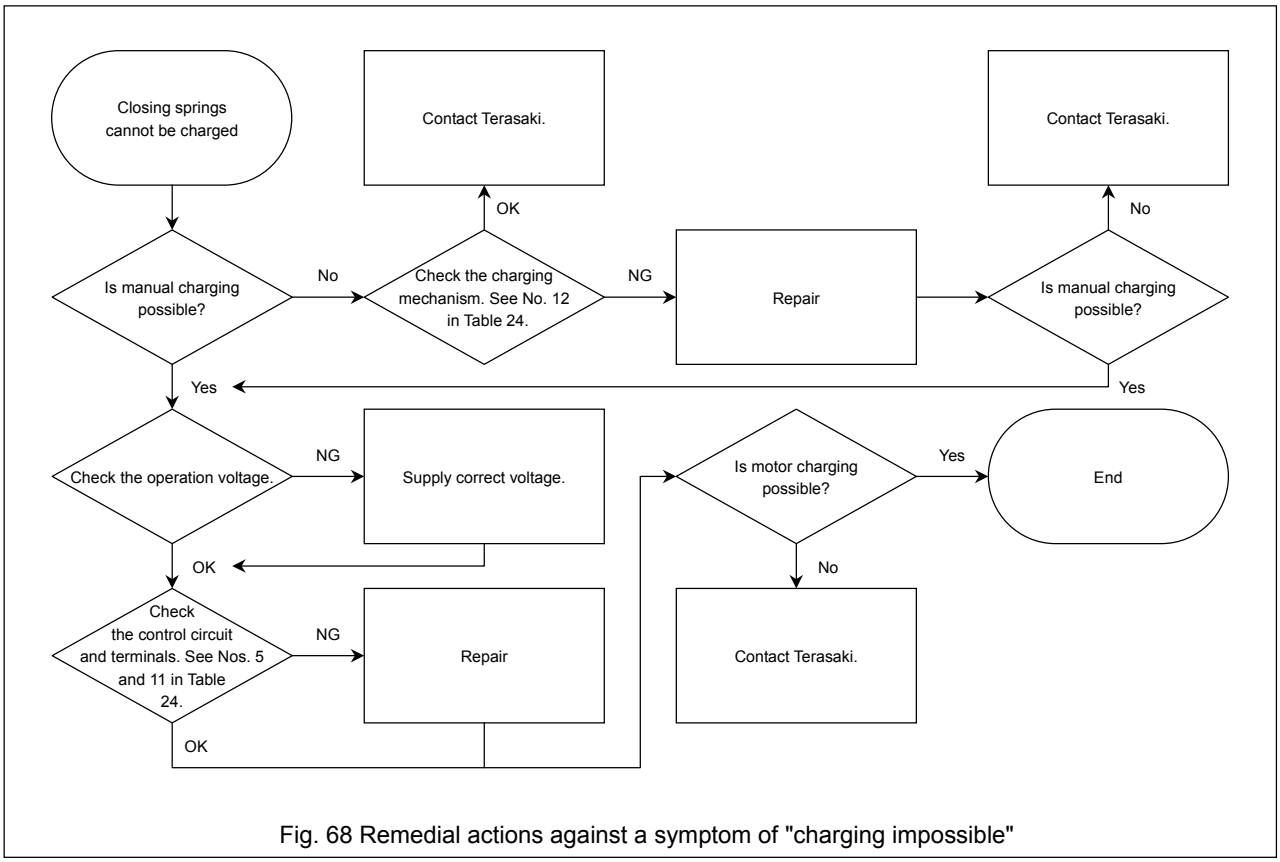


Fig. 68 Remedial actions against a symptom of "charging impossible"

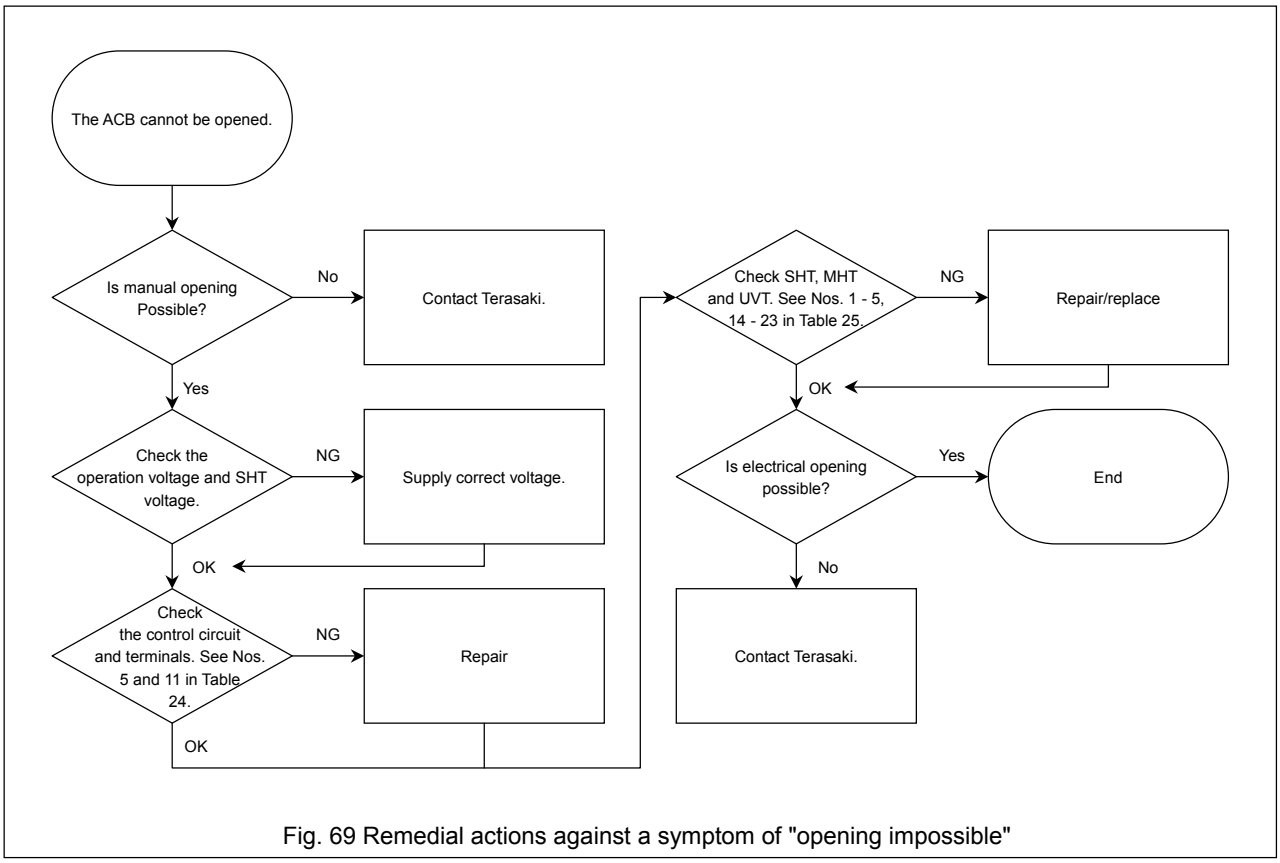


Fig. 69 Remedial actions against a symptom of "opening impossible"

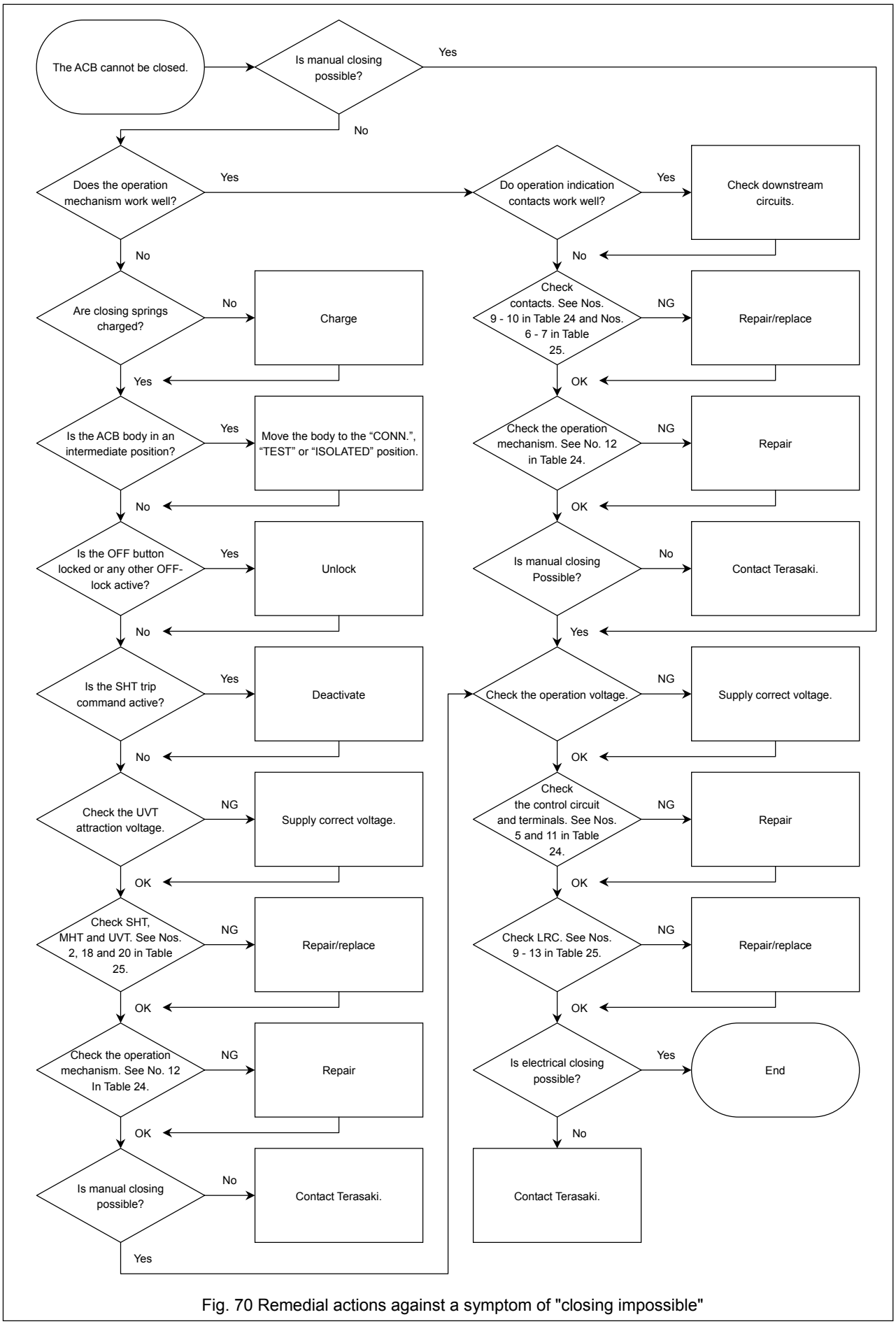


Fig. 70 Remedial actions against a symptom of "closing impossible"

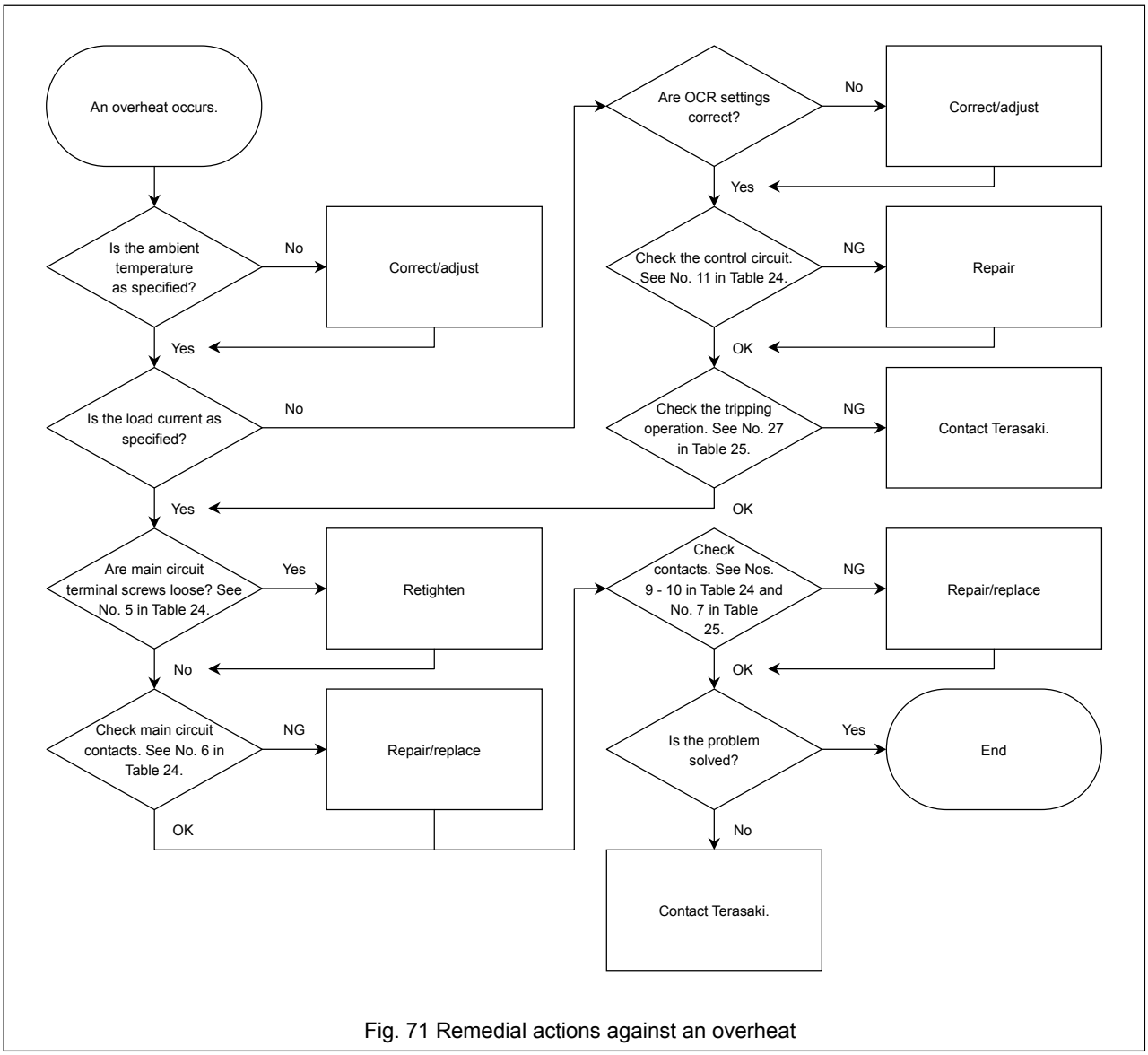


Fig. 71 Remedial actions against an overheat

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