MITSUBISHI ELECTRIC

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Magnetic Contactors and Magnetic Starters
MAINTENANCE AND INSPECTION MANUAL MS-T Series

16
A

Safety Precautions

Please read this instruction manual and enclosed documents before starting mounting, operation, maintenance and inspections to ensure correct usage. Thoroughly understand the equipment and device, safety information and precautions before starting operation.
The safety precautions are ranked as "WARNING" and "CAUTION" in this instruction manual.

⚠ **WARNING**	When a dangerous situation may occur if handling is mistaken leading to fatal or major injuries.
⚠ **CAUTION**	When a dangerous situation may occur if handling is mistaken leading to medium or minor injuries, or physical damage.

Note that some items described as CAUTION may lead to serious results depending on the situation.
In any case, important information that must be observed is described.

- ○The contents of this instruction manual are subject to change without notice.
- ○Mitsubishi Electric will not be held responsible for any damage caused by repairs, disassembly or modifications by a party other than Mitsubishi or a Mitsubishi Electric Service Center.
- ○For the use in high-reliability-requiring applications such as nuclear energy control, moving objects including vehicles, traffic light control, medical purposes, etc., please contact Mitsubishi.
- ○An effort has been made to improve the quality and reliability of the product, but the product may fail. Vibration, shocks, improper wiring to the magnetic contactor may also cause a failure and may also lead to a serious consequence such as a machine malfunction and power supply short-circuit. Take care to prevent secondary damage, such as personal injuries or fires because of this product's failure.
- ○Store the "Instruction manual" and "Precautions for Use" enclosed with the product in a place that is easily accessible.

⚠ WARNING

- Always disconnect the product from the power source before starting installation, maintenance or inspections. There is a risk of electric shock or machine malfunctions.
  Vibration, shocks, improper wiring to the product may also cause a failure, leading to a serious consequence such as a machine malfunction and power supply short-circuit.
- Do not touch or go near the product (especially live sections such as terminals) while the power is ON. Failure to observe this could lead to electric shocks or burns.

⚠ CAUTION

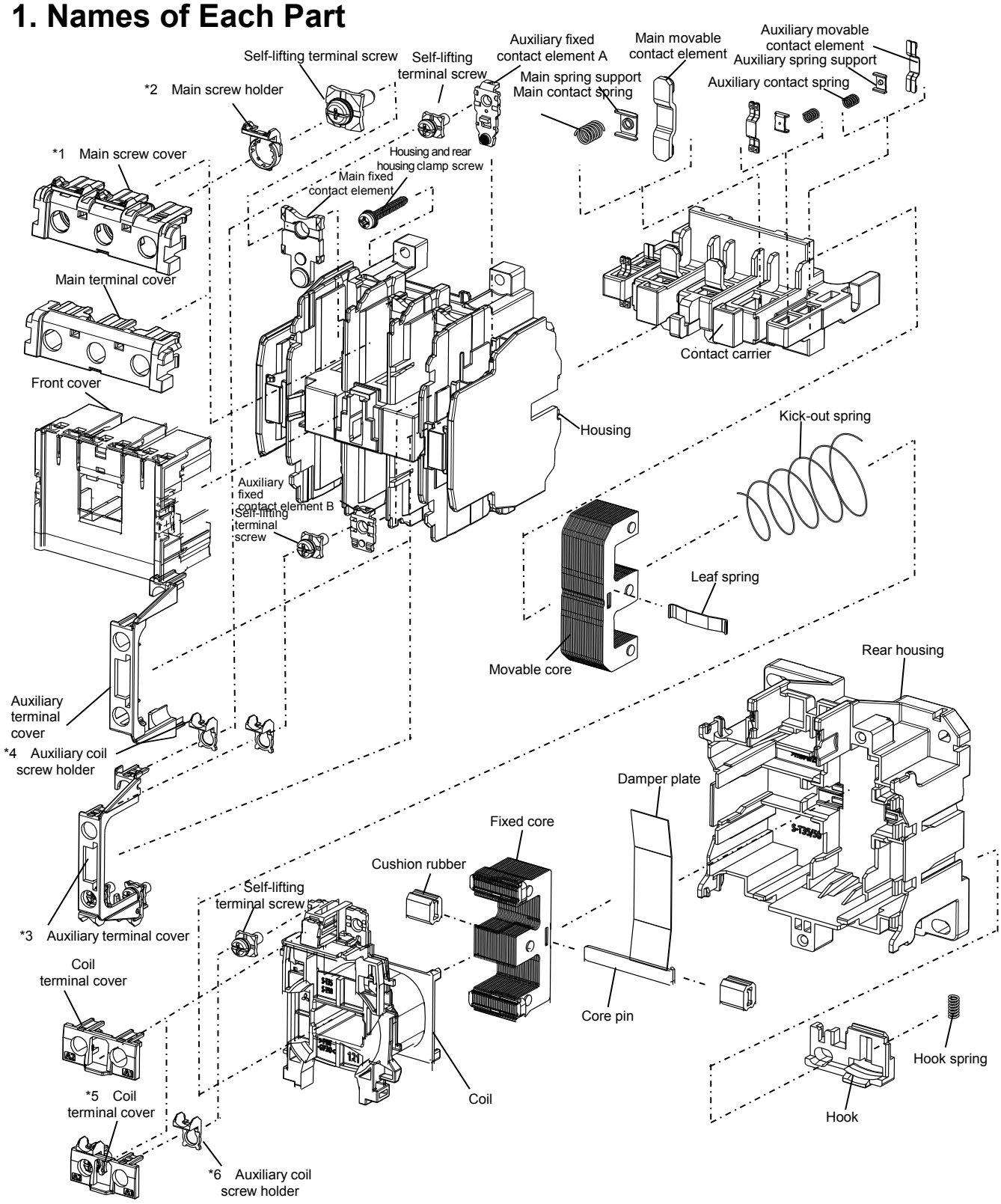
- Mounting, wiring, and maintenance/inspection should be performed only by individuals with specialized expertise in electrical work, electrical wiring, etc.
- Do not modify or disassemble the product. In addition, even when performing maintenance and inspection, be sure to stay within the bounds of this manual. For MS-T series magnetic contactors (10 to 32 A models), electromagnetic relays, and thermal overload relays, it is not possible to perform contact replacement, coil replacement, and other types of individual part replacement, so do not modify or disassemble the product. Failure to observe this could result in faults.
- Secure a space larger than that specified in the Instruction Manual when mounting the product. Failure to do so could lead to burns or fires.
- During installation and wiring, do not allow foreign matter such as pollutants, dust, and wire shavings enter the product. Failure to do so could lead to burns or fires due to contact failure or malfunction.

⚠ CAUTION

- If the mounting screw size is changed or an insufficient number is used, or if the mounting onto the mounting rail (IEC35mm width) is incomplete, the product may fall off.
- Use wire sizes that meet the applied voltage, flowing current and inrush current, and tighten them with the torque specified in the Instruction Manual. Faulty wiring could cause fires, accidents or product failures.
- Tighten terminal screws and mounting screws with the mounting torque specified by Mitsubishi, and retighten them periodically. If the mounting torque is too large, the terminal screws and mounting screws may break. If the terminal or mounting screws become loose or are broken, fires may occur due to overheating, which could result in the product falling and causing a serious accident.
- Always confirm the ratings and specifications, and use the product within the specified ratings and specifications.
  Use in an environment that exceeds the ratings or specifications could lead to ground faults or short circuit accidents due to destruction of the insulation, to fires due to overheating, and damage due to incorrect shut off.
- The areas around the terminals and coils become hot while the power is ON. Do not touch these without proper care.
- Never manually operate the product in the live state.
- If contacts are by switched excessive currents, or if contacts are welded and do not open due to abnormal wear, deterioration of the contacts, or the end of product life, the machine device could become uncontrollable. Ensure safety by predicting such mechanical constraints and inhibited closing and releasing caused by contact welding.
- If chattering occurs in the operation command contacts, the contacts may become welded and lead to malfunction or fires.
- If smoke is generated due to a short circuit accident, etc., toxic gas may be generated. Make sure not to inhale the toxic gas.
- If the contacts are welded because of wear, there is a risk of fire. Always use this product together with a suitable protection device such as a wiring breaker or fuse.
- The voltage fluctuation range of the coil is 85 to 110%, however if a voltage exceeding 100% is applied for a long time, deterioration of the coil insulation will increase, and the mechanical durability will drop. Always use the coil within an average rated voltage of 95 to 100%.
- If a voltage too low in operating a magnetic contactor is applied, a current exceeding the rating may flow to the coil and could soon burn the coil or start a fire.
- If the wiring for the operation circuit is long, the wiring impedance could lower the coil voltage and inhibit contacts from closing when an instantaneous current flows through the coil.
  Depending on the stray capacitance in the wiring, the contacts may not open even when the coil is de-excited.
- Use in a circuit that contains harmonics or surges could result in coil burning or fires.
- If the arc cover and arc box are removed for inspections and the like, be sure to remount them to their original positions.
  There is a remote possibility that a serious accident could be caused by a short circuit or breaker failure when the arc cover and arc box are not in place.

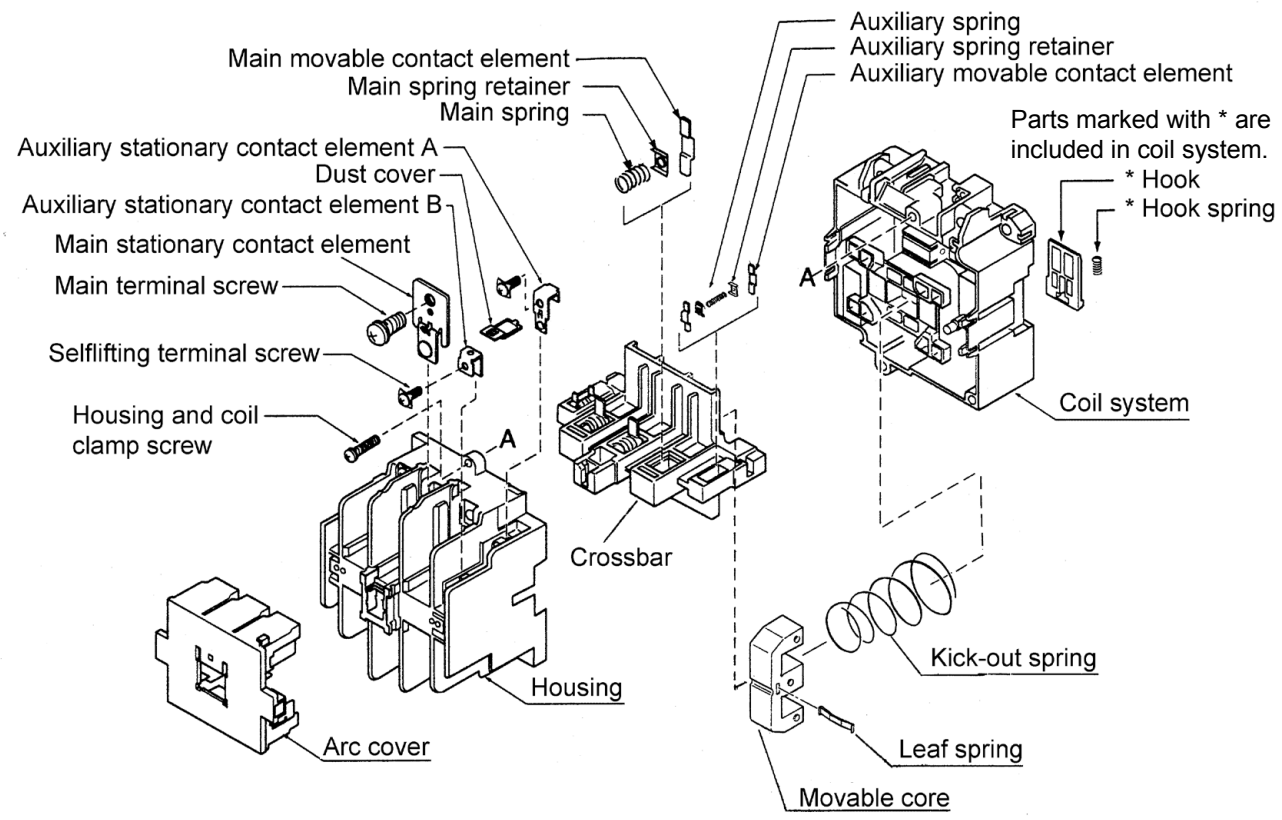
Contents

1. Names of Each Part



Note) Parts *1 to *6 are exclusive for the S-T50BC.

(1) S-T50(BC) Magnetic contactor



(2) S-T65 Magnetic contactor

2. Maintenance and Inspection of Contacts

⚠ WARNING

- Turn the power off before starting maintenance or inspections. Failure to do so could lead to electric shocks or machine malfunctions.

⚠ CAUTION

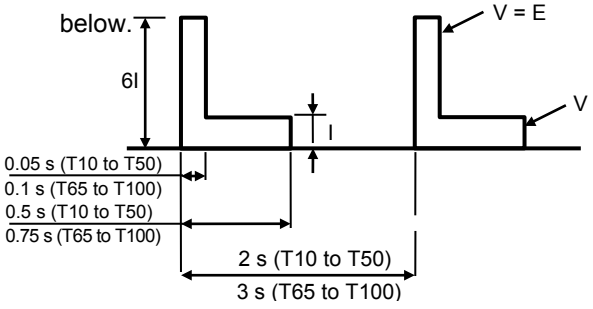
- Maintenance and inspection should be performed only by individuals with specialized electrical knowledge.
- The areas around the terminals will become hot while the power is ON. Do not touch these without proper care.
- Contacts and mechanical parts have switching lifespans, so be sure to inspect them periodically for wear.
- Contacts may become welded and fail to open due to switching of excessive currents, abnormal wear or deterioration of the contacts, or due to the life. In addition, contacts may fail to open due to unanticipated mechanical restraints other than contact welding. There is a danger that the machine device could become uncontrollable as a result of a contact failing to open. Ensure safety by predicting such mechanical constraints and inhibited closing and releasing caused by contact welding.
- Be sure to return the arc cover and arc box to their original positions after removing them. Otherwise, a serious accident could be caused by a short circuit or breaker failure when the arc cover and arc box are not in place.
- During maintenance, inspection, or replacement of contacts, only remove or modify the necessary parts. Failure to observe this could lead to performance degradation.
- If chattering occurs in the operation command contacts, the contacts may become welded and lead to malfunction or fires.
- If smoke is generated due to a short circuit accident, etc., toxic gas may be generated. Make sure not to inhale the toxic gas.
- It is possible to perform contact replacement as an emergency repair in response to a contact inspection, and the replacement method is described in this manual. However, this may lead to short circuits and fires due to a reduction in insulation. Perform replacement of the product as a whole.
- If parts are removed or replaced during inspections, repair work, and the like, confirm that there are no additional problems, and then ensure that these parts are positioned and fastened in their original locations.
- If the product is disassembled and reassembled during inspections, repair work, and the like, be sure that foreign matter does not enter the product.
- Magnetic contactors and magnetic relays with 10 to 32A frames cannot be disassembled.

2.1 Mechanism of Contact Wear

Wear to contacts involves electrical wear, in which contact material scatters in fine particles by the switching of currents, and mechanical wear, in which contacts become deformed as a result of striking, friction, etc. Wear to contacts is for the most part due to electrical wear.

(1) Normal usage Category AC-3

Normal usage refers to usage in which the starting current is applied to the 3-phase squirrel-cage motor, and the current decreases after the full-speed state is reached, and then the contact opens. In JIS, this is called Category AC-3. More specifically, this is the operation in which a current that is six times the rated usage current closes the circuit, and a current that is equal to the rated usage current opens the circuit, as shown below.



Category AC-3 electrical endurance test operation
I: Rated working current
E: Rated working voltage

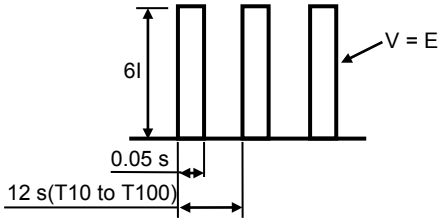
=

The unevenness of the contact surface in this case is relatively low, and the wear deformation is very low as well. In a silver alloy contact, it is typical for the surface to be covered with fine black particles, and for there to be marks on parts of the contact. In this case, there is no need to service the contact while it is in use.
The wear on the respective contacts on the three poles is not uniform, and it is normal for two of the poles to exhibit most of the wear. This is because the three pole contacts do not switch exactly simultaneously, and because there is a 120° phase difference in the current.

(2) Inching and plugging Category AC-4

Inching refers to shutting off the starting current before the motor reaches the full speed by frequently repeating the motor's start and stop operation.

Plugging is a method to generate a reverse run torque when braking the motor, and involves switching a large current which is comprised of the reverse phase current added to the starting current.



Category AC-4 electrical endurance test operation

In JIS, these usage methods are called Category AC-4, which prescribes testing based on operations such as that shown on the left. This operation switches the motor's starting current, and is a severe operation on the magnetic contactor. During inching, a current that is six times the rated operational current is shut off, causing the contact wear to be extremely large. The unevenness of the contact surface is significant, and the contact material scatters in fine particles.

For the silver alloy contact, the black section extends to the surface and periphery of the base, and large white marks appear on the contact surface.

(3) Abnormal switching caused by chattering

The phenomenon in which switching is occurs repeatedly at an extremely high frequency due to a drop in the circuit voltage, or due to bouncing of the operation contact, is called chattering. During chattering, the motor's starting current will repeatedly switch, and the contact temperature will rapidly rise due to the arc generated between the contacts. This will cause the contact life to be shortened significantly, so take measures immediately to prevent it.

(4) Switching of abnormal currents

Switching that reaches or exceeds 13 times the rated operational current, caused by for instance a short circuit accident, constitutes usage that exceeds the capacity of the magnetic contractor. The contact looks as though extreme inching has been performed, and the contact surface may be significantly deformed as though lashed by arcs.

The insulator around the contacts also blacken, the insulation deterioration accelerates, and if switching is carried out many times, reuse becomes impossible.

The contact becomes welded if the current reaches or exceeds 20 times the rated operational current. This type of welding is often seen when the current is abnormal.

(5) When oil gets on contact

If switching is carried out when there is oil on the contact surface, such as when using the contact in a machine tool, contact wear accelerates significantly. In such cases, the oil is decomposed by the switching arc, a large amount of hydrogen gas is discharged, wear accelerates, and the one-digit or two-digit lifespan when in a normal atmosphere is shortened.

The contact surface is blackened by oil and carbon, and the peripheral insulator becomes extremely dirty, so take measures to prevent this by, for example, changing the mounting position or using a protective structure.

2.2 Maintenance of Contacts

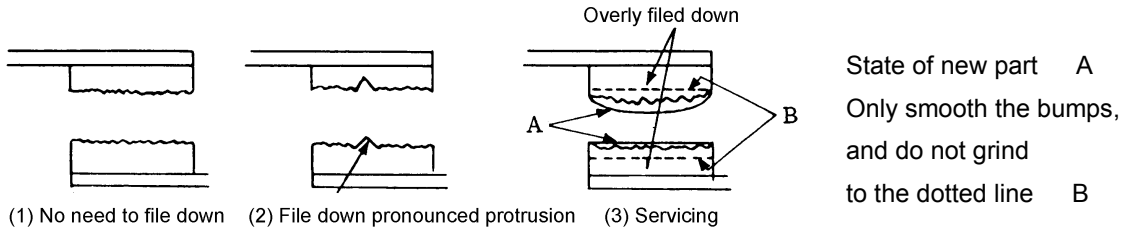
(1) Contact maintenance period and method

When the contact becomes discolored or uneven, there is a tendency to file and polish the contact surface. This is a method used to service contacts that use easily oxidized copper, silver tungsten, and the like. For the magnetic contactors that use a silver alloy contact, shaving the contact with a file can shorten the life.

Blackening of the contact and slight unevenness of the contact surface caused by normal switching operation does not require servicing, and in fact not servicing the contact can lead to favorable wear conditions and a longer life.

However, if localized unevenness is significant or if burrs appear due to extremely severe switching, voltage fluctuation, large current shut-off, or other forms of abnormal switching, the contact should be serviced.

When the contact has reached its end-of-life and its wear limit (see section 2.3), the contacts for all of the poles must be replaced. To service the contact, the significant unevenness shown below should be smoothed. The entire contact does not need to be filed down or polished.



Servicing of contacts

(2) Discoloration of contacts

Black discoloration of the electrical contact is caused by sulfurization and the adherence of foreign matter. The sulfurization of the contact is silver sulfide caused by gas in the air. The color will change from brown to brownish to black depending on the film thickness. Sulfurization of silver alloys is caused mainly by hydrogen sulfide generated from sewage, contaminated waterways, human beings, and waste gas. Silver sulfide is used on semiconductors films, and does not cause a problem in a normal environment or at normal switching frequencies. However, it can cause contact defects when the current or voltage is low, and switching is infrequent.

The discoloration that arises when contact switching is performed with foreign matter adhered to the contact is the result of a complicated reaction. It cannot be determined which compound causes which color, but the black color is carbon generated when molded items, airborne carbon compounds, and the like are decomposed by arcs.

Yellow in bands is the color of oxidants, and will be dispersed partially.

Silver oxidants do not have a strong insulation film such as copper oxide, and readily decompose at approximately 250°C due to thermal and mechanical weakness. These oxidants break down at low voltage, so the contact resistance in a circuit with a voltage of 24 V or higher does not pose a major problem.

(3) Rise in contact temperature

As per the specifications, the temperature rise in a magnetic contactor's contacts "must not impede usage," but a general guideline for contact temperature rise is 100°C [K] or less. The temperature rise at the terminal section is specified as 65°C [K] or less (ambient temperature 40°C).

(4) Abnormal wear causes and measures

(a) For inching and plugging

The amount of contact wear will differ depending on the proportion of inching and plugging relative to the full operation count. However, this usage method is fundamentally quite severe so, referring to the catalog and the like, select a magnetic contactor with a large rated capacity.

(b) For chattering

The causes of wear can be broadly divided into the following two causes.

(i) Excessive voltage drop

If the circuit voltage drop is excessive (a level exceeding 15%) when the magnetic contactor is closed and the motor's starting current flows, the magnetic contactor repeatedly undergoes a process of closing, voltage drop, opening, voltage recovery, closing again, voltage drop, and so on, resulting chattering at a high frequency of approximately once every 20 to 50 milliseconds. The following are conceivable causes, so ameliorate them as necessary. This type of voltage drop cannot be measured with a tester. An oscilloscope is the appropriate device to use to record it.

- Insufficient power supply capacity.
- Insufficient wire size.
- Mounting too far from power source.
- Incorrect starting method (for example, during simultaneous starting of multiple motors).

(ii) Bouncing of control circuit system

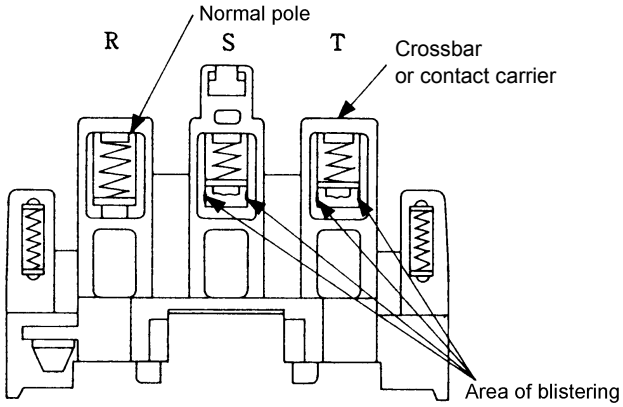
If the contact in the control circuit bounces due to a mechanical or electrical shock or vibration from an external source, the excitation of the magnetic contactor's operating coil is cut off, and chattering occurs. The following causes are conceivable. Investigate the cause and make modifications accordingly.

- The relay is mounted near magnetic contactor, and the relay contact bounces due to the impact of the contactor closing.
- The contact of the pressure switch, float switch, limit switch, or the like bounces. Alternatively, the relay operates intermittently due to unstable fluctuation of the switches.
- The contact bounces due to an incorrect control panel structure or installation.
- Terminal connection is insufficient. (Screw tightening or soldering is incorrect.)
- The coil voltage is too high, causing a large impact when the switch is closed.

(5) Discerning the cause based on the burn damage

The current is turned on and shut off at a high frequency due to chattering, so the amount of arc heat accumulated becomes higher than that dispersed. This causes the contact section to reach a high temperature of approximately 800°C in a short time (3 to 20 seconds with starting current, or 20 to 120 seconds with rated current). In cases such as this, the contact could follow the process below and ultimately burn.

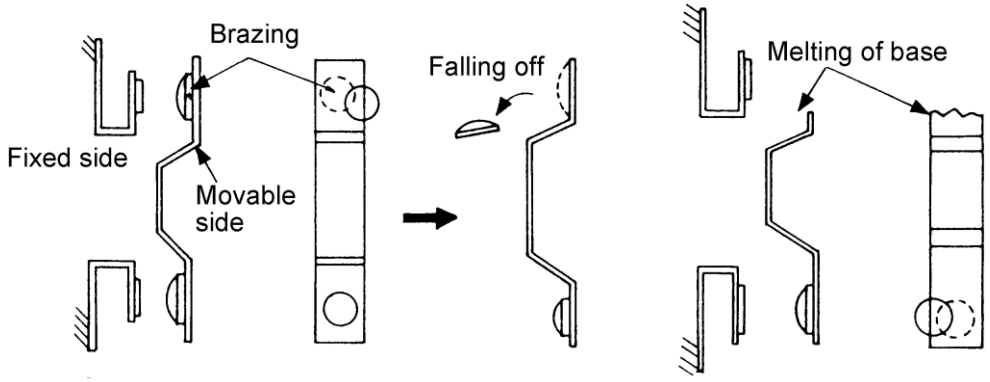
1. There are cases in which blistering deformation occurs in the sliding section of the crossbar or contact carrier that supports the movable contact element, resulting in poor movement of the movable contact element.



As shown by poles S and T in the figure, the spring retainer catches on this section due to blistering, which prevents the movable contact element from being pushed completely.
(Note) Pole R represents a normal pole.

1. Blistering of mold (sliding section) occurs during the early stage of chattering.

2. Next the brazed section of the contact melts, causing the brazed section to deviate or the contact to fall off.



3. If chattering continues, the current will be switched at the base section where the contact has fallen off, and the base will melt. In addition, the sliding section of the contact carrier blisters due to the heat, causing carbonization to progress.
   In some cases, the heat may be conveyed to the connected wire, causing the insulator sheath to discolor or melt.
4. In most cases, if the two-pole contact element melts, the current is shut off, and the accident is closed out.
   In some cases, the carbonization of the insulator parts around the contact element may progress due to arc heat, and cause a short circuit between poles.

The above is a description of the burning state of the contact caused by chattering. Burn damage caused by abnormal current is somewhat different.

• Discerning contact burn damage caused by abnormal current

If an excessive current is turned on due for instance to a short circuit, in most cases contact welding will occur. However, if the protective coordination in respect to short circuit accidents in the circuit is insufficient, the contact element may melt.

2.3 Contact Replacement Reference and Method

⚠ CAUTION

- Maintenance and inspection should be performed only by individuals with specialized electrical knowledge.
- It is possible to perform contact replacement as an emergency repair in response to a contact inspection, and the replacement method is described in this manual. However, this may lead to short circuits and fires due to a reduction in insulation. Perform replacement of the product as a whole.
- After contact replacement, mount the arc cover and arc box securely. There is a remote possibility that a serious accident could be caused by a short circuit or breaker failure when the arc cover and arc box are not in place.
- If the contacts are welded because of wear, there is a risk of fire. When performing the inspection described below, use this product together with a suitable protection device such as a wiring breaker or fuse.
- Magnetic contactors and magnetic relays with 10 to 32A frames cannot be disassembled.

Generally, with normal operation, the replacement period can be determined by the rated capacity, the switching count (as derived from the usage count), and by the number of days used. However, with actual motor operation, various conditions such as inching operation and the abnormal wear described earlier must also be considered. The contact replacement period must therefore be decided based on the degree of wear deformation.

(1) Electrical lifespan limits

(a) When the contact thickness wears to 50% of that of a new part.

(b) When contact has extreme deformation or peeling, or the insulator is burned and deteriorated.

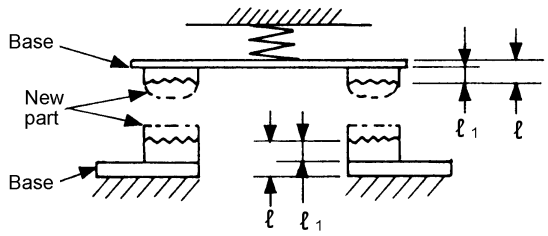
(c) When the insulation resistance between each pole, between grounds, or between the power load sides deteriorates to 1 MΩ or less.

(d) If a withstand voltage test can be done, when 2,500 V for one minute cannot be withstood at the locations listed in (c).

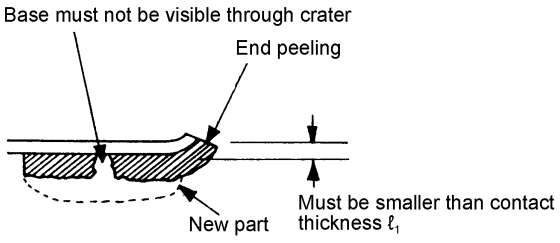
(2) Determination based on changes in contact shape

Changes in contact shape due to wear are often not uniform, so when making a determination, look at the average of the contact surfaces. When the thickness ℓ_1 of the contact having the most wear reaches 50% or less of that of a new part, replace the parts for all three poles. In actuality, it is easier to look at the ℓ dimensions, including the base. These dimensions are shown inside ▭ in Appendix 1 Spare Parts Table.

For extreme unevenness or wear of a tip caused by abnormal wear, you may choose to replace it when the degree of end peeling or unevenness approaches the thickness of the contact.

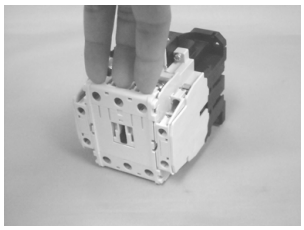
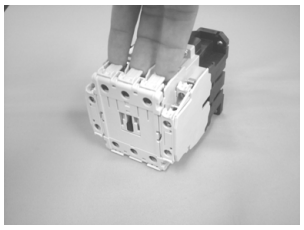
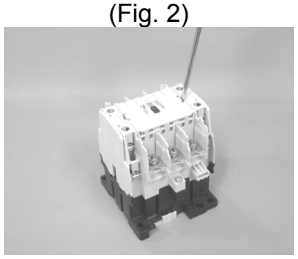
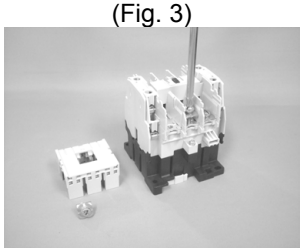
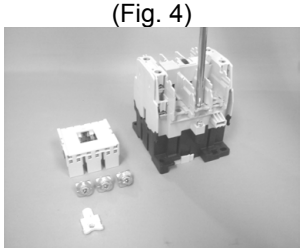
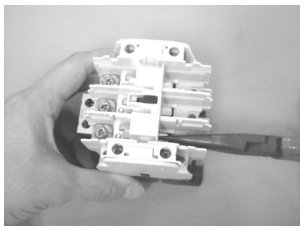


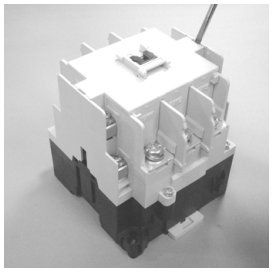
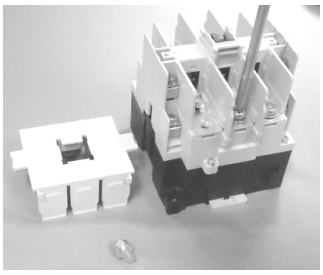
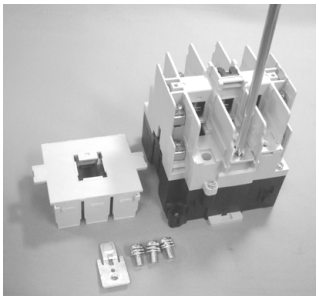
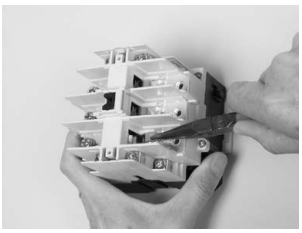
Contact wear dimensions

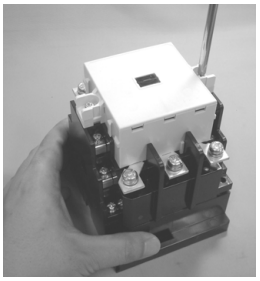
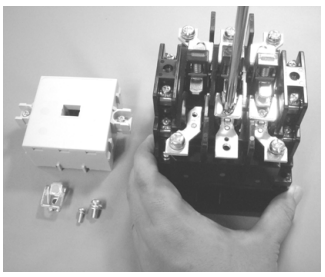
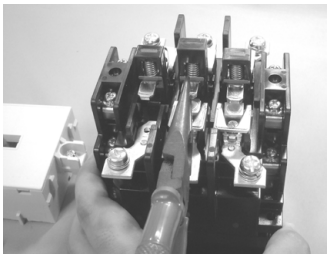


During abnormal usage

2.4 Contact Replacement Procedures

<table>
<tr><td colspan="3">S-T35 and T50</td></tr>
<tr><td rowspan="4">Contact</td><td>Main fixed contact element</td><td>(1) Remove the terminal cover. (Fig. 1)
(For the S-T35BC and T50BC, see Fig. 2)
 
(Fig. 1)
 
(Fig. 2)
(2) Insert a flat-tip screwdriver into the end of the front cover, and remove the front cover. (Fig. 3)
 
(Fig. 3)
(3) Remove the terminal screw on the fixed contact element. (Fig. 4)
 
(Fig. 4)
(4) Catch a Phillips screwdriver on the hole for tightening the terminal screw, and remove the fixed contact element. (Fig. 5)
 
(Fig. 5)
(Note 1) After inspections, be sure to securely mount the front cover on the unit, and confirm that the fixed contact element (terminal) has not come out.</td></tr>
<tr><td>Main movable contact element</td><td>(1) Same as (1) to (3) above.
(2) Pull out with tweezers. (Fig. 6)
 
(Fig. 6)</td></tr>
<tr><td>Built-in auxiliary contact</td><td>Remove the terminal cover.
(1) Remove the terminal screw, and pull out the fixed contact element with a screwdriver.
(2) Pull out the movable contact element with tweezers.
(3) Mount the new movable contact element onto the movable carrier or crossbar.
(4) Insert the new fixed contact element into the housing or base. (See the insertion procedures on page 15.)</td></tr>
<tr><td>Unit-mounted auxiliary contact</td><td>(1) While lifting up the unit-mounting stopper, slide the unit toward the power supply side.
(2) Mount the new unit.
(Refer to the catalog for information regarding compatibility.)</td></tr>
</table>

<table>
<tr><th colspan="3">S-T65 and T80</th></tr>
<tr><td rowspan="4">Contact</td><td rowspan="3">Main fixed contact element</td><td>(1) As shown to the right, insert a flat-tip screwdriver into the end of the arc cover, and remove the arc cover.
  </td></tr>
<tr><td>(2) Remove the terminal screw on the fixed contact element.
  </td></tr>
<tr><td>(3) Catch a Phillips screwdriver on the hole for tightening the terminal screw, and remove the fixed contact element.
  </td></tr>
<tr><td>Main movable contact element</td><td>(1) Same as (1) above.
(2) Pull out the movable contact element with long-nose pliers.
  </td></tr>
<tr><td>Built-in auxiliary contact</td><td colspan="2">(1) Remove the terminal screw, and pull out the fixed contact element with a screwdriver.
(2) Pull out the movable contact element with tweezers.
(3) Mount the new movable contact element onto the movable carrier or crossbar.
(4) Insert the new fixed contact element into the housing or base. (See the insertion procedures on page 15.)</td></tr>
<tr><td>Unit-mounted auxiliary contact</td><td colspan="2">(1) While lifting up the unit-mounting stopper, slide the unit toward the power supply side.
(2) Mount the new unit.
(Refer to the catalog for information regarding compatibility.)</td></tr>
</table>

<table>
<tr><th colspan="3">S-T100</th></tr>
<tr><td rowspan="3">Contact</td><td>Main fixed contact element</td><td>(1) Loosen the screws on the ends of the arc box, and remove the arc box.
 
(2) Loosen the screw fastening the fixed contact element, and remove the fixed contact element.
  </td></tr>
<tr><td>Main movable contact element</td><td>(1) Same as (1) above.
(2) Pull out the movable contact element with long-nose pliers.
  </td></tr>
<tr><td>Built-in auxiliary contact</td><td>(1) Remove the terminal screw, and pull out the fixed contact element with a screwdriver.
(2) Pull out the movable contact element with tweezers.
(3) Mount the new movable contact element onto the movable carrier or crossbar.
(4) Insert the new fixed contact element into the housing or base. (See the insertion procedures on page 15.)</td></tr>
<tr><td>Unit-mounted auxiliary contact</td><td>(1) Remove the unit mounting screws, and remove the unit.
(2) Mount the new unit.
(See the mounting procedures in the catalog.)</td></tr>
</table>

Auxiliary fixed contact element　Insertion procedure

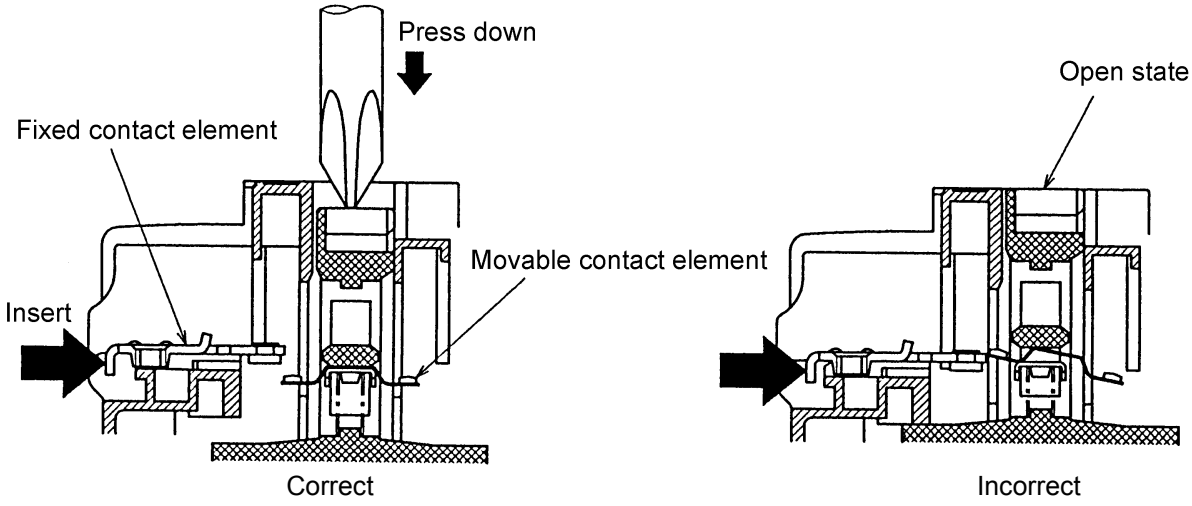
●Application

If the fixed contact element is removed for replacement, experimentation, or the like, and is then reinserted carelessly, the movable contact element may be pushed out by the end of the fixed contact element. The proper insertion procedures are described below.

●Insertion procedures

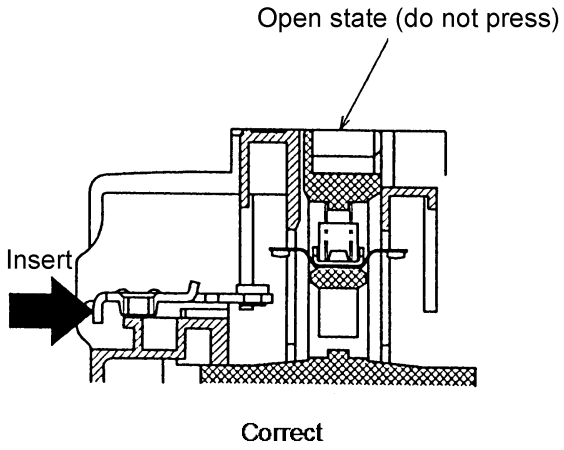
(1) For b (NC) contact

As shown below, press the end of the movable section with a screwdriver or the like to enter the closed state, or for the mechanically latched type, to enter the latched state, and then insert the fixed contact element. If the element is inserted in the open state, the movable contact element will be pressed down, and will fall off, as shown to the right.



(2) For a (NO) contact

For a (NO) contact, insert the element with the movable section in the open state. If the element is inserted while the movable section is pressed in the same manner as for b (NC) contact, the movable contact element will be pushed out and will fall off.



For the mechanically latched type, release the latch (a (NO) contact in OFF state) before insertion.

2.5 Contact Welding

If the contact is welded due to a short-circuit current or chattering, take the following measures.

(a) Light welding

If the welding is light and the contact can be opened easily and has uneven portions, the contact surface can be filed down with a file and reused. File the surface down such that the surface is still slightly uneven, and make sure not to file too far.

(b) Heavy welding

If the welding is heavy and the contact cannot be opened even when pulled, replace the contactor with a new part. In cases such as this, there may be a large amount of arc heat, so insulator around the contact must also be inspected. The contact cannot be reused.

2.6 Maintenance of Arc Box

- Highly heat-resistant and arc-resistant material is used for the MS-T Series front cover, arc cover, and arc box insulator material, so even if the material discolors or peels, the breaking performance and contact life will not be affected.
- The arc runner and grid may melt, scatter, and thin out due to the arcs, but replacement of these parts is not necessary. (This is not wear that will affect performance during normal use, including inching operation.)
- During inspections, remove any foreign matter (for example, metal chips that have scattered), accumulated friction debris, and dust.
- In cases such as the following, damage may occur during excessive current shut-off or other sorts of abnormal use, so replace the magnetic contactor (using a magnetic contactor with a large rated current).
  (1) When the arc runner or the like is abnormally worn and breaks.
  (2) When a hole opens in the partition wall of the housing, arc box, etc.

2.7 Precautions after Inspections

(a) Mount the front cover, arc cover, and arc box.

After removing them, be sure to reinstall the front cover, arc cover, and arc box to their original positions. When operating with an operation coil, mount the front cover, arc cover, and arc box even if the current is not switched using a contact.

(b) Do not press the operation display on the surface to switch the current.

During inspections and sequence checks, the current is switched by pressing the operation display. This operation is used only for checking. Never do this while a current is flowing to the main contact. Doing so will cause contact welding.

(c) Cleaning

When replacing a contact, remove stains on the front cover, arc cover, the inside of the arc box, insulation barrier, and the like with a soft cloth.

3. Maintenance and Inspection of Core and Coil

⚠ **WARNING**	• Turn the power off before starting maintenance or inspections. Failure to do so could lead to electric shocks or machine malfunctions.

⚠ **CAUTION**	• Maintenance and inspection should be performed only by individuals with specialized electrical knowledge. • The areas around the terminals and coils will become hot while the power is ON. Do not touch these areas without proper care. Failure to observe this could lead to burns. • Coils have thermic lifespans, so be sure to inspect them periodically for discoloration. • Never manually operate the product in the live state. Failure to observe this could lead to electric shocks or burns. • If parts are removed or replaced during inspections, repair work, and the like, confirm that there are no additional problems, and then ensure that these parts are positioned and fastened in their original locations. • If the product is disassembled and reassembled during inspections, repair work, and the like, be sure that foreign matter does not enter the product. Failure to do so could lead to burns or fires due to contact failure or malfunction. • Magnetic contactors and magnetic relays with 10 to 32A frames cannot be disassembled.

3.1 AC Magnet (S-T35, T50)

(1) Magnet stroke and reaction force

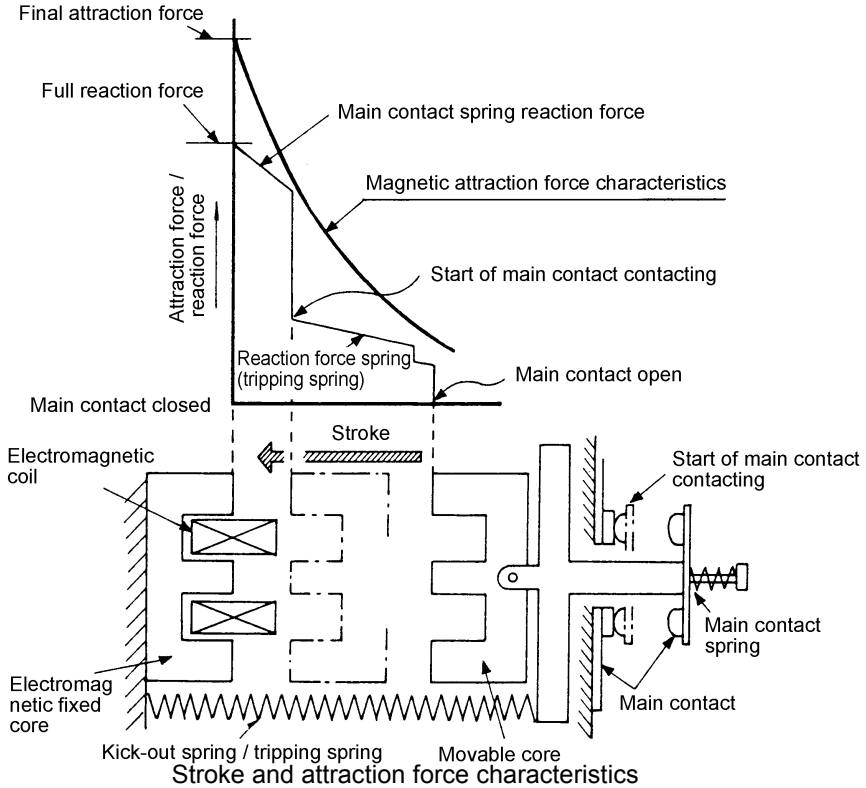
The magnetic contactor and magnetic relay operate their contacts using the attraction force of magnets. When the movable core is open, the excitation current in the coil is large, and the attraction force is at its weakest. After attraction, the attraction force is at its strongest.

The main contact begins to contact during that stroke, and the reaction force increases rapidly. The reaction force becomes the largest after the attraction, and the excitation in the coil current becomes constant. Full conduction of electricity is achieved for the first time at this point.

During this interim process and during the full stroke, the attraction force overcomes the reaction force and operates.

If this relationship does not continue after attraction as well, various problems will occur.

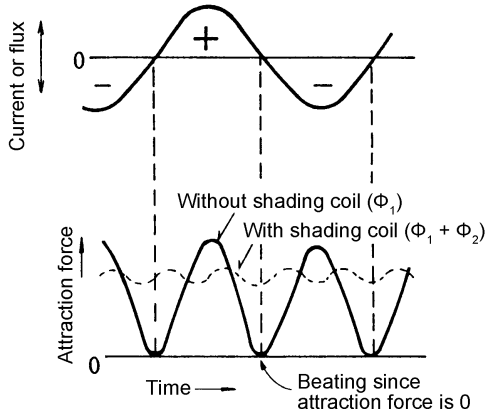
In addition, the instant that the main contact contacts, an inrush current flows to the motor. As a result, voltage drops occur more readily and, since the contact force is weak, contact welding occurs more readily as well.



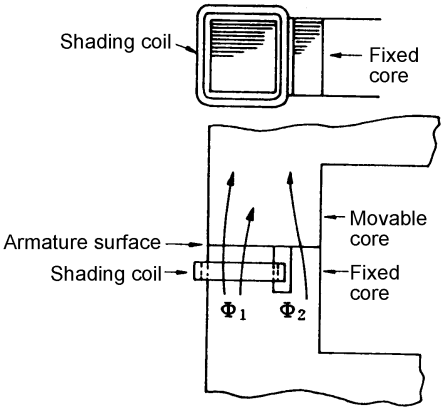
Stroke and attraction force characteristics

(2) Shading coil

The attraction force created by the alternating current will change over time along with the frequency of the circuit. The attraction force will thus be overtaken by the reaction force of the contact, causing beating and making the contact unusable. To reduce this beating, a shading coil is provided on the core.



Attraction force of AC magnet



Shading coil

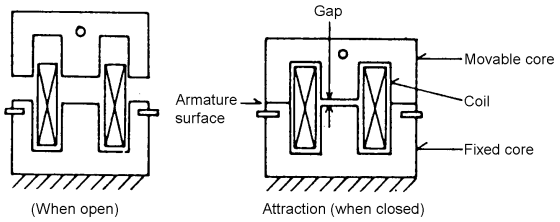
Through the use of a shading coil, the flux $\phi 2$ created by the shading coil is combined with the original flux $\phi 1$, and the beating is decreased significantly. Even if the beating is decreased in this manner, an AC magnet fundamentally cannot prevent beating completely. To completely eliminate beating, the contactor must be replaced with a DC-operated type or a mechanically latched type.

(3) Rust and dirt on core armature surface

The AC magnet prevents beating by using a shading coil, but if there is a gap between this movable core and the fixed core's armature surface, the effect of the shading coil will be cut in half. Thus, the armature surface is given a smooth finish, and is treated for rust prevention.

However, since the core is an electric steel sheet, depending on the environment in which the magnetic contactor is used, rust may form on the armature surface, or dirt may enter during switching, resulting in beating.

In particular, if the dirt is a type that contains water or oil, it will exert adhesive force and can cause core dropping (motor runaway), resulting in hazardous conditions.



S-T35 and T50 (E-E type core)

(4) Gap for residual magnetism prevention

An electric steel plate is used for the AC magnet, but a gap is provided to prevent core dropping, in which, due to residual magnetism, the movable core does not separate, even when the coil current is turned off after attraction. The size of the gap differs depending on the size of the magnetic contactor, but is approximately 0.1 mm for the T35 and T50 types.

3.1.1 Maintenance of Core

(1) Beating size guidelines

●Non-obstructive beating

Beating that can be heard slightly when a magnetic contactor is placed in a quiet room and is listened to from approximately 60 cm away is normal. Even if the beating is larger, the excitation current in the coil is for the most part not increasing, so the coil will not burn.

●Beating requiring caution

If beating is as loud as a buzzer accompanied by vibration, the excitation current in the coil is increasing. In this case, some measures must be taken.

(2) Prevention of beating

During normal use, beating that causes a problem is a rare event. However, depending on the usage environment and conditions, if for example high humidity, dust, or corrosive gas is present, beating may occur.

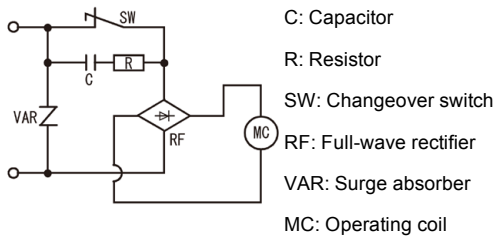
If beating occurs readily, use of a DC operated type or mechanically latched contactor is optimal. Consider changing or replacing the contactor.

Cause of beating	Measures
• Infiltration of foreign matter onto core attraction surface Dust and other foreign matter from outside; rust	• Use an outer box to prevent foreign matter and moisture from outside. • Enclose rust inhibiting and moisture absorbing agents. • If the temperature fluctuation is large, heat with a heater when operation is halted.
• Decrease in attractive force Drop in power supply voltage Inadequate rating of coil being used	• Use a coil that is appropriate to the voltage, and lower voltage fluctuations. (Pick-up voltage: 85 to 110%; continuous operation voltage: 95 to 100%)
• Disconnection of shading coil • Decrease in gap between core center poles • Roughening or uneven wear on core attraction surface	The mechanical switching endurance limit of the magnetic contactor has been reached. Replace it.
• Resonance of devices mounted in same panel	Reevaluate the panel structure.

3.2 AC Operated DC Exciting Magnet

For the S-T65 to T100 (AC-operated types), a voltage drop method using the capacitor shown below is incorporated. The AC-operated power source is converted to DC internally.

When the magnetic contactor is closing, the changeover switch (SW) still ON, so the current flows and is attracted to the coil (MC). During continuous operation, the changeover switch turns OFF, and the current that flows to the operating coil (MC) is limited by the capacitor (C). This allows the holding state to be maintained with little power consumption. The magnet is a DC magnet, so there is no beating sound from the magnet. In addition, in contrast to an AC magnet that uses a shading coil, since there is no hysteresis loss or shading coil loss, power consumption can be lowered significantly.



Typical DC holding type coil circuit diagram

3.3 Maintenance of Coil

⚠ CAUTION

- Maintenance and inspection should be performed only by individuals with specialized electrical knowledge.
- The voltage fluctuation range of the coil is 85 to 110%, but if a voltage not in that range is applied for an extended period of time, burning or fires could occur due to an increase in current and a drop in insulation.
  Taking endurance life into consideration, use the coil at 95 to 100% of the rated voltage.
- Even if a voltage too low in operating a magnetic contactor is applied, a current exceeding the rating may flow to the coil and could soon burn the coil or start a fire.
- Use in a circuit that contains harmonics or surges could result in coil burning or fires.
- If smoke is generated due to a short circuit accident, etc., toxic gas may be generated. Make sure not to inhale the toxic gas.

(1) Coil voltage fluctuation range

The operating range with respect to the voltage fluctuation is 85 to 110%. For example, for a standard 200 V AC coil:

50Hz 170 to 264V
60Hz 170 to 264V

However, if at all possible, use at a voltage of 95 to 100% is recommended. If the voltage exceeds 100%, the insulation endurance of the coil will drop. Particularly for applications in which continuous conductance usage is frequent, be careful not to allow the voltage to exceed 100%.

(2) Rise in coil temperature

Class E insulation or higher is used for the coil insulation.

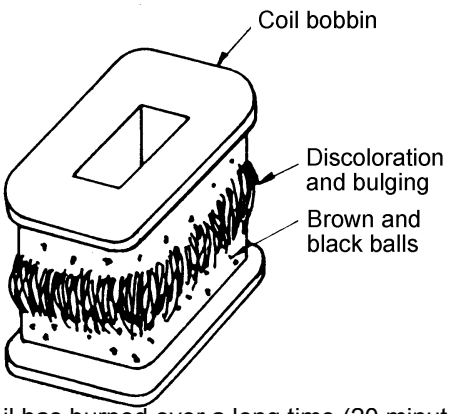
Temperature rise standard: JIS C8201-4-1 Class E 100°C [K] (Based on resistance method at ambient temperature of 40°C.)

Consequently, the coil will feel hot to the touch, but if the temperature is within the aforementioned temperature rise, this does not represent an anomaly.

(3) Discernment based on coil burn damage

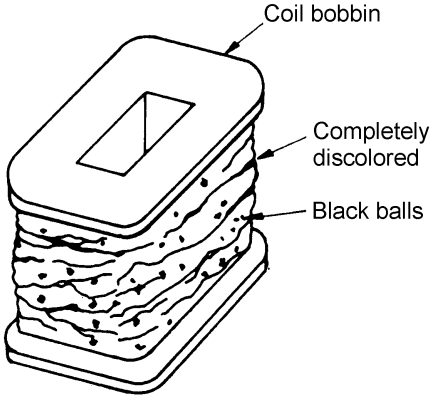
In addition to simple coil burning causes, there are cases when many causes overlap. Thus, discerning the causes by looking at the coil after it has burned is difficult. Often the actual status records and site must be investigated. However, some general guidelines are described below.

●Coil that has burned in a short time (several minutes or less) [S-T65 to T100]



The center area of the coil is bulging out. Small brown and black balls have formed on the surface. Part of the insulation tape on the surface has burned, and the edges appear to be normal.
A layer short circuit in the coil generally does not cause discoloration to the exterior.

●Coil has burned over a long time (20 minutes or more) [S-T65 to T100]



The entire surface of the coil is swollen and black. All of the insulation tape is burnt and has shrunk. Many of the small balls on the surface are black. The entire surface of a coil that has burned over a long time is swollen and discolored. Since a coil that has burned in a short time is only partially discolored, the situation can be differentiated based on this.

●Burnt coil (S-T35 and T50)

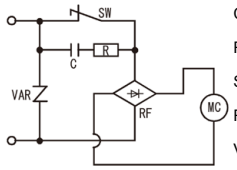
In some cases, blistering deformation occurs on the interior of the coil bobbin, and the movable core does not move smoothly.

●The mechanically latched magnetic contactor and magnetic relay coils have short time ratings.

The magnetic contactor coil and magnetic relay coil both have a rating of 15 seconds. Consequently, if they are subjected to continuous conduction of electricity, they will burn in a short time. Note that, particularly when the voltage drop is large and the operation has become inhibited, the electrical conductivity time in the coil tends to increase.

(4) S-T65 to T100 coil electronic part failure

⚠ CAUTION	• The varistor (used in the coil, surge absorber, etc.) may emit smoke as a result of deterioration. Make sure not to go near the product during operation. Also, always use a short-circuit protection device such as a fuse on the operating circuit.



C: Capacitor
R: Resistor
SW: Changeover switch
RF: Full-wave rectifier
VAR: Surge absorber
MC: Operating coil

■Varistor (VAR) damage

The varistor may in some cases be damaged due to application of a voltage that is twice the rated voltage, or of an extremely large surge voltage.

Cracks will form on the epoxy filler and varistor surface, and often the resistance between the coil terminals will be zero.

■Full wave rectifier (RF) damage

The rectifier may in some cases be damaged due to an external lightning surge or thermal stress after the surge absorber (varistor) is damaged.

The resistance between the coil terminals will be zero, so detection is possible.

■Changeover switch (SW) contact defect

Contact defects rarely occur because of the cleaning function of C and R, but in some cases defects can occur if foreign matter enters the contact surface or if sulfur gas gets in.

The resistance value between the coil terminals will be 1 KΩ or higher, so detection is possible.

Table 1 Coil burning causes and countermeasures

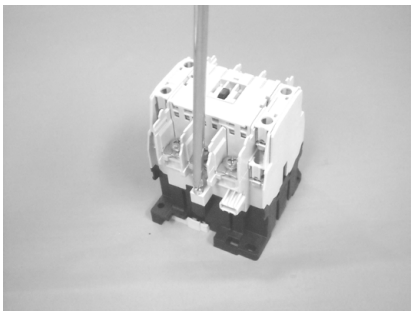
Cause	State	Measures
• Excessive voltage A 100 V coil was used with a 200 V circuit	<S-T35 and T50 types> Burned in short time	Replace the coil.
	<S-T65 to T100 types> Varistor burned in several seconds	Replace the coil.
• Attraction not possible due to voltage drop The voltage is 85% or less, or a 200 V coil was used with a 100 V circuit	Burned in short time Beating is significant	• Voltage of 100% is preferable. • Use a DC-operated type (as the DC coil has no rush current, and does not burn easily).
• Chattering Insufficient power capacity, bouncing of operating contact	• Burned in short time (differs depending on situation) • Incidence of contact burning	• Increase the power capacity. • Prevent bouncing.
• Entry of large foreign matter to core armature surface.	Beating is significant (Burning time varies depending on the size of the foreign matter.)	Prevent foreign matter by providing an outer box
• Layer short circuit caused by entry of machine oil etc.	Use of alkaline machine oil for machine tools.	Prevent entry of machine oil.

Note 1. For SL and SRL type mechanically latched magnetic contactors and magnetic relays, do not replace the coil or disassemble the latched section.

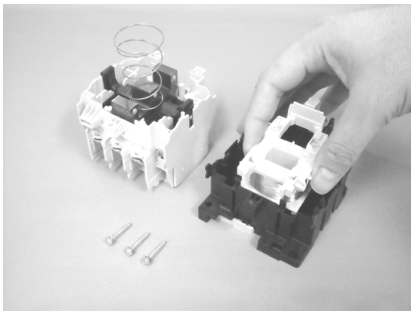
3.4 Coil Replacement Procedures

3.4.1 S-T35 and T50

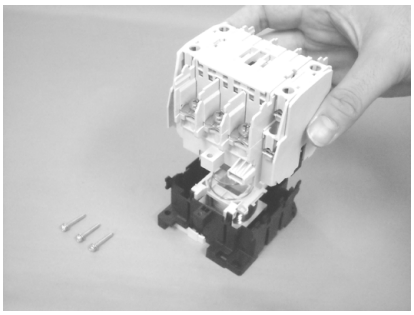
(1) Remove the three screws fastening the housing and the rear housing.



(2) Separate these housings and remove the coil.

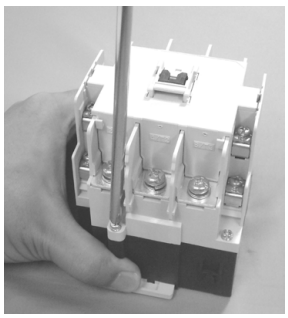


(3) Place the new coil in the center of the fixed core.



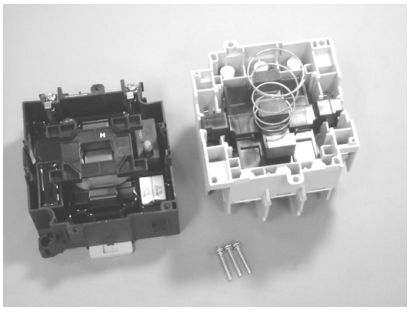
(4) While setting the conical spring on the housing side onto the top of the coil, assemble the housing and the rear housing.
(The side of the conical spring that is in contact with the coil spool is the side with the larger diameter.)

(5) Fasten the housing and the rear housing with the screws.



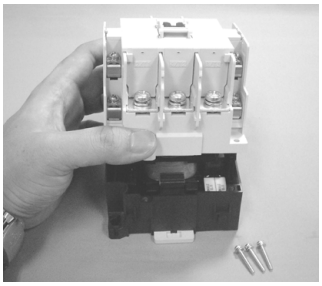
3.4.2 S-T65 and T80

(1) Remove the three screws fastening the housing and the coil, as shown on the right.



(2) The coil is comprised of the mounting frame, coil, and fixed core in an integrated unit. Replace this unit as a whole.

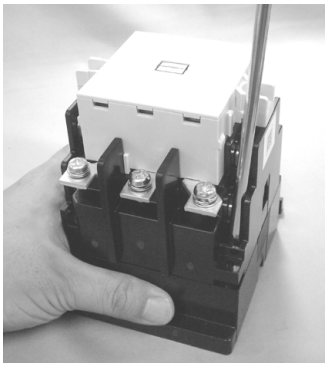
(3) While setting the conical spring on the housing side onto the top of the coil (a unit comprised of the mounting frame, coil, and fixed core), assemble the housing and the coil. (The side of the conical spring that is in contact with the coil spool is the side with the larger diameter.)



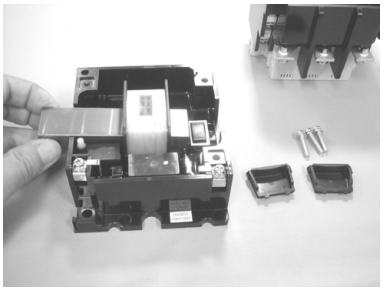
(4) Tighten the housing and the mounting frame with the screws.

3.4.3 S-T100

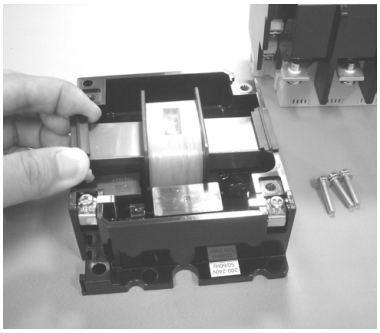
(1) Remove the three screws fastening the base and coil (the mounting frame and coil are integrated), as shown on the right.



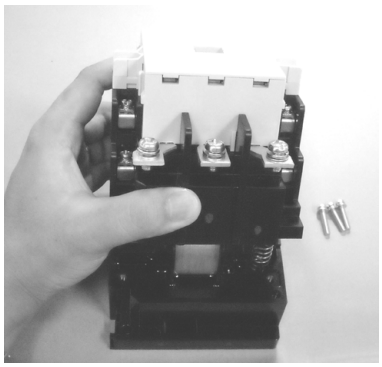
(2) Remove the stoppers from the coil, and remove the fixed core. (One stopper each on the left and right.)



(3) Insert the fixed core into the coil to be replaced, and fit the stoppers. (Both sides.)



(4) Fit the spring on the base side into the spring retainer, assemble the base and coil, and tighten the screws.

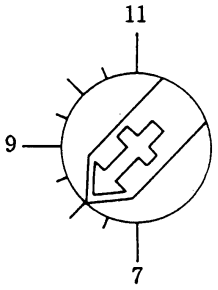


4. Maintenance and Inspection of Thermal Overload Relay

(1) Heater rating and adjustment

For the settling current of the thermal overload relay, select one that matches the motor's full load current. Make fine adjustments by rotating the knob. For example, if the motor's full load current is 8 A, use a 9 A thermal overload relay, and turn the knob as shown below to set it to the 8 A scale position.

Note that a mistaken trip could occur due to the ambient temperature, wire size, set value error, time transition changes, and the like. Turn the knob to adjust the set position.



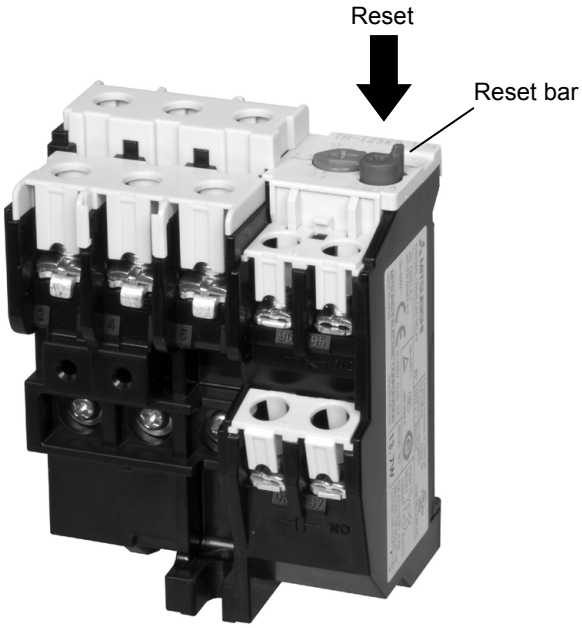
Knob adjustment (for 8 A)

[Reset]

If an overcurrent flows to the motor, the thermal overload relay will trip. Check the cause of the overcurrent, take measures to remedy it, and then press the reset bar to reset the relay. There may be cases in which the relay cannot be reset immediately after a trip, but it is possible to reset it after the bimetal cools. For the automatically reset type, the relay will be reset automatically after a short time (roughly 10 seconds to 10 minutes, depending on the temperature to which the bimetal has been heated).

[Do not disassemble.]

Never touch the inside of the thermal overload relay. The thermal overload relay has been precisely adjusted and shipped from Mitsubishi.



(2) Melting of the thermal overload relay

The thermal overload relay is used to protect the motor from burning. It cannot be used as protection against short circuits, so if a short circuit occurs, replace the thermal overload relay.

The thermal overload relay heater will melt if a large current exceeding the heater's fuse I^2t passes through it due to a short or the like. To prevent melting of the heater, take coordinated protective action by for example using the correct capacity for the non-fuse breaker connected on the power side of the magnetic starter, or using a thermal overload relay that has a saturation reactor.

If the heater melts, the bimetal in the thermal overload relay may curve in the opposite of the correct direction. This is because the bimetal is abnormally heated and the internal stress is exceeded due to a large heating amount caused by the heater melting, and is deformed permanently.

5. Recommended Update Interval

The recommended update interval for each device is either 10 years or the prescribed switching count noted in the catalog or the like.

Note that this recommended update interval is not a value that is guaranteed with respect to the functions or performance. Instead, it is an interval after which it is generally believed that the part should be replaced due to deterioration of the constituent materials, taking economic factors into account as well, and assuming that the part is used under normal working conditions and that the maintenance and inspections described below are carried out.

6. Maintenance and Inspection Check List

Date:

Magnetic starter, magnetic relay

Fill in after inspection

Class		Inspection item		Purpose	Details of inspections	Remarks	Results
	Daily inspection	Abnormal noise	Listen	Abnormality	Generation of abnormal noise (Abnormal noise caused by electromagnet fault or damage, etc.)	Per panel (all)	
		Abnormal odor	Smell	Abnormality	Generation of abnormal odor	Per panel (all)	
		Appearance	Visual	Contamination	Existence of water or oil adherence or fault caused by dust	Per panel (all)	
				Breakage	Existence of mold breakage, discoloration or deformation	Per panel (all)	
Periodic inspection (reference: every six months)		Clamp screw	Visual	Loosening	Are any of the clamp screws loose?	All	
		Metal sections	Visual	Rusting, corrosion	Is there any rust or corrosion?	All	
		Movement of movable sections	Manual or electric	Movement fault	Do movable sections move smoothly when operated manually or electromagnetically?	All	
Detailed inspection		Life and function deterioration	Test (Test at Mitsubishi)	The following section indicates the overview of the sampling tests for the items requiring further inspection during the life margin estimation, daily inspection and periodic inspection.			
				Contact contamination	(1) Contact resistance measurement – Existence of contact resistance abnormality		
				Mechanism friction	(2) Operation test – Existence of operating voltage abnormality		
				Layer short circuit	(3) Coil characteristics test – resistance value, current value, and existence of abnormality	Sampling	
				Contact wear	(4) Main dimension measurement – Is value within tolerable value?		
				Contact operation	(5) Contact reliability test – Is value within tolerable value? (reliability test)	Sampling	
				Life margin	(6) Coil life margin test (high-temperature electrical conductivity, surge test, BDV pin hole test)	Sampling	

7. Troubleshooting List

7.1 Magnetic Contactor (T10 to T32) and Magnetic Relay

Trouble	State	Cause	Measures
Contacts do not close	A beating sound (loud or quiet) is heard, but contacts do not close.	The coil rating voltage is incorrect.	Replace the correct entire unit.
		The terminal voltage is low (85% or less).	Modify to the specified voltage.
		The voltage drop is large { Power supply capacity is insufficient. / Wiring capacity is insufficient.	Increase the power supply capacity. Use thicker wires.
		Layer short circuit in coil.	Replace the entire unit.
		The unit is damaged.	Replace the entire unit.
	There is no sound.	The wiring is faulty.	Repair the faulty section.
		Operating switch is faulty.	Replace the switch.
		The fuse is blown.	Replace the fuse.
		Wire breakage in operating coil or short circuit in operating circuit.	Replace the entire unit.
Contacts do not open. (Does not return.)	It does not get de-excited.	A voltage is applied on the coil.	Check and modify the circuit.
		Capacitance between wires for long-distance wiring.	Use a DC operated type.
		Induction voltage from other wires.	Separate from the other wires.
		Operating switch is faulty. { Welding / Breakage	Check that the capacity is correct, and replace if necessary. Replace the switch (relay).
	There is no excitation.	The contact is welded.	Replace the entire unit, check the cause, and take measures.
		Dew has condensed on the core surface.	Decrease the temperature difference.
		Attraction due to residual magnetism.	The unit is worn. Replace the entire unit.
		The unit has deformed due to heat or mounting stress.	Replace the entire unit.
		The unit is damaged.	Replace the entire unit.
Coil burning	Burned in short time	The coil rating voltage is incorrect.	Replace with the unit having the correct rating.
		The applied voltage is incorrect (high).	Replace the entire unit, and modify the voltage.
		Operating voltage is low, thereby inhibiting attraction.	Replace the entire unit, and modify the voltage.
		Layer short circuit	Replace the entire unit, check the cause, and take measures.
	Burned after a while	Attraction is not possible occasionally (when voltage is 85% or less, etc.)	Replace the entire unit, check the cause, and take measures.
		Layer short circuit caused by environmental deterioration.	Replace the entire unit, check the cause of deterioration, and take measures.
		The applied voltage is too high.	Replace the entire unit, and modify the voltage.
		The in-panel temperature is too high. (55°C or more)	Replace the entire unit, and lower the in-panel temperature.
Contact welding	No-fuse breaker or fuse blew	Short circuit on load side { Insulation deterioration / Wiring failure / Handling mistake. Simultaneously closing when using reversing or Y-Δ starter.	Check the cause and make modifications. If there is a fault with the unit, replace the unit.
	Light welding occurred during use	Chattering occurs.	Check the cause and make modifications.
		The switching frequency is too high.	Lower the frequency or increase the capacity.
		A semi-attraction state is caused by a drop in voltage.	Check and remove the cause of the voltage drop.
		Electrical life	If there is a fault in the unit, replace the entire unit.
		The load is too large.	Replace with a magnetic contactor and motor having the correct capacity.

Continued

Trouble	State	Cause	Measures
Abnormal wear of contact	Arc during switching is large.	The load is too large.	Replace with a magnetic contactor having a large capacity.
		The switching frequency is high.	Select a capacity that matches the frequency.
		The bounce at closing is large.	Check the cause and make modifications.
	The contact's brazed section has fallen off.	The contact chattering is large.	Check the cause and make modifications.
		The switching frequency is too high.	Lower the frequency, or replace with a part having a large capacity.
	The wear is fast.	There is corrosive gas.	Modify the housing or installation position.
		Simultaneous contact does not take place.	Replace the entire unit.
Contact failure		Low voltage, low current	Set to 100V 50mA or more if possible. Connect the contacts in parallel (redundancy).
		The mechanism section is damaged.	Replace the entire unit.
Terminal burn damage	Terminal or wire burn damage	The terminal screws were not tightened.	Replace the entire unit. Correctly tighten the screws.
		The terminal screws were not tightened sufficiently.	
		The screws were loosened by vibration or impact.	Prevent vibration and impact.
		The wires are thin.	Replace the wires and entire unit.
		Contact welding or wear (life).	Replace the entire unit.
A beating sound is heard.	The sound is heard occasionally	The core is worn. (The life is up.)	Replace the entire unit.
		The power supply voltage is low.	Check the cause and make modifications.
		There are high levels of corrosive gas or humidity.	Use a DC operated or mechanical latch that prevents entry from external sources.
	The sound is always heard.	The shading coil has a breakage (life).	Replace the entire unit.
		Incorrect mounting or distortion of mounting surface.	Change to correct mounting.
		The coil voltage is incorrect. (Low voltage)	Replace with the unit having the correct rating.
		The core is worn. (The life is up.)	Replace the entire unit.
		Resonance during panel mounting.	Change the mounting structure.
		Mechanical interlock	Readjust or replace the mechanical interlock.
	Sound is heard at main circuit section.	A large current is flowing.	Measure the current and remove the cause.
		The wiring in the housing has been separated.	Pass the input and output wiring through the same hole when wiring.

7.2 Magnetic Contactor (T35 to T100)

Trouble	State	Cause	Measures
Contacts do not close	A beating sound (loud or quiet) is heard, but contacts do not close.	The coil rating voltage is incorrect.	Replace the correct entire unit.
		The terminal voltage is low (85% or less).	Modify to the specified voltage.
		The voltage drop is large { Power supply capacity is insufficient. / Wiring capacity is insufficient. }	Increase the power supply capacity. Use thicker wires.
		Foreign matter is in movable area	Disassemble and clean the area.
		Layer short circuit in coil.	Replace the coil.
		The unit is damaged.	Replace the entire unit.
	There is no sound.	The wiring is faulty.	Repair the faulty section.
		Operating switch is faulty.	Replace the switch.
		The fuse is blown.	Replace the fuse.
		Wire breakage in operating coil or short circuit in operating circuit.	Replace the coil.
Contacts do not open. (Does not return.)	It does not get de-excited.	A voltage is applied on the coil.	Check and modify the circuit.
		Capacitance between wires for long-distance wiring.	Use a DC operated type.
		Induction voltage from other wires.	Separate from the other wires.
		Operating switch is faulty. { Welding / Breakage }	Check that the capacity is correct, and replace if necessary. Replace the switch (relay).
	There is no excitation.	The contact is welded.	Replace the contact, check the cause, and take measures.
		Oil, dust, or the like has adhered to the core surface	Replace the entire unit and prevent adhesion
		Dew has condensed on the core surface.	Decrease the temperature difference.
		Attraction due to residual magnetism.	The unit is worn. Replace the entire unit.
		Foreign matter is in movable area	Disassemble and clean the area.
		The unit has deformed due to heat or mounting stress.	Replace the entire unit.
		The unit is damaged.	Replace the entire unit.
Coil burning	Burned in short time	The coil rating voltage is incorrect.	Replace with a coil having the correct rating.
		The applied voltage is incorrect (high).	Replace the coil, and modify the voltage.
		Operating voltage is low, thereby inhibiting attraction.	Replace the coil, and modify the voltage.
		Layer short circuit	If there is no problem with the unit, replace the coil, check the cause, and take measures.
	Burned after a while	Attraction is not possible occasionally (when voltage is 85% or less, etc.)	Replace the coil, check the cause, and take measures.
		Layer short circuit caused by environmental deterioration.	Replace the coil, check the cause of deterioration, and take measures.
		The applied voltage is too high.	Replace the coil, and modify the voltage.
		The in-panel temperature is too high. (55°C or more)	Replace the coil, and lower the in-panel temperature.
Contact welding	No-fuse breaker or fuse blew	Short circuit on load side { Insulation deterioration / Wiring failure / Handling mistake } Simultaneously closing when using reversing or Y-Δ starter.	Check the cause and make modifications. If there is no problem with the unit, replace the contact. If there is a problem with the unit, replace the unit.
	Light welding occurred during use	Chattering occurs.	Check the cause and make modifications.
		The switching frequency is too high.	Lower the frequency or increase the capacity.
		A semi-attraction state is caused by a drop in voltage.	Check and remove the cause of the voltage drop.
		Electrical life	If there is no problem with the unit, replace the contact.
		The load is too large.	Replace with a magnetic contactor and motor having the correct capacity.

Continued

Trouble	State	Cause	Measures
Abnormal wear of contact	Arc during switching is large.	The load is too large.	Replace with a magnetic contactor having a large capacity.
		The switching frequency is high.	Select a capacity that matches the frequency.
		The bounce at closing is large.	Check the cause and make modifications.
	The contact's brazed section has fallen off.	The contact chattering is large.	Check the cause and make modifications.
		The switching frequency is too high.	Lower the frequency, or replace with a part having a large capacity.
	The wear is fast.	Oil has adhered to contact surface.	Clean the contact and prevent adherence.
		There is corrosive gas.	Modify the housing or installation position.
		Simultaneous contact does not take place.	Set the difference in the dimensions of the contact locations of the main contact to no more than approx. 0.5mm.
Contact failure	Occurs occasionally	There is a lot of dust.	Clean the area and implement dustproofing measures.
		The contact surface is sulfurized.	Polish the contact surface, and take sulfurization prevention measures.
		Foreign matter is on contact surface.	Clean the contact surface.
		Foreign matter is in movable area	Disassemble and clean the area.
	Occurs continually	Oil or dust has adhered to contact surface.	Disassemble and clean it, and take measures to prevent adherence.
		Contact surface is extremely sulfurized.	Replace the contact, and modify the location where it is attached to the housing.
		Low voltage, low current	Set to 100V 50mA or more if possible.
		Foreign matter has contaminated the contact surface	Disassemble and clean the area.
		The contact has fallen off.	Repair the contact, remove the cause of the contact falling, take measures to prevent adherence, and check the unit.
		The mechanism section is damaged.	Replace the entire unit.
Terminal burn damage	Terminal or wire burn damage	The terminal screws were not tightened.	Replace the entire unit. Correctly tighten the screws.
		The terminal screws were not tightened sufficiently.	
		The screws were loosened by vibration or impact.	Prevent vibration and impact. Periodically retighten the screws.
		The wires are thin.	Replace the wires and entire unit.
		Contact welding or wear (life).	Replace the entire unit.
A beating sound is heard.	The sound is heard occasionally	Foreign matter infiltrated between cores.	Replace the entire unit.
		There is rust on the cores.	Replace the entire unit.
		The core is worn. (The life is up.)	Replace the entire unit.
		The power supply voltage is low.	Check the cause and make modifications.
		There are high levels of corrosive gas or humidity.	Use a DC operated or mechanical latch that prevents entry from external sources.
	The sound is always heard.	Foreign matter infiltrated between cores.	Replace the entire unit.
		The cores have become rusty.	Replace the entire unit.
		The shading coil has a breakage (life).	Replace the entire unit.
		Incorrect mounting or distortion of mounting surface.	Change to correct mounting.
		The coil voltage is incorrect. (Low voltage)	Replace with the correct coil.
		The core is worn. (The life is up.)	Replace the entire unit.
		Resonance during panel mounting.	Change the mounting structure.
		Mechanical interlock	Readjust or replace the mechanical interlock.
	Sound is heard at main circuit section.	A large current is flowing.	Measure the current and remove the cause.
		The wiring in the housing has been separated.	Pass the input and output wiring through the same hole when wiring.

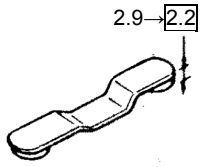
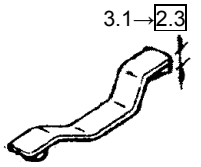
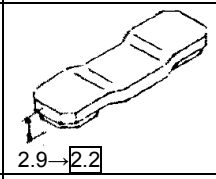
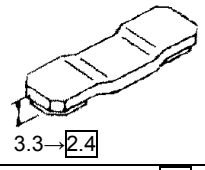
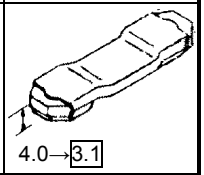
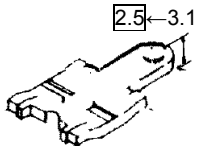
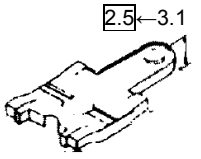
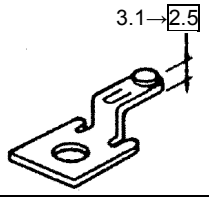
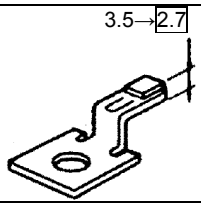
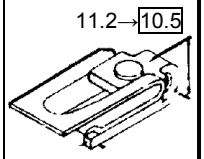
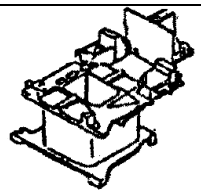
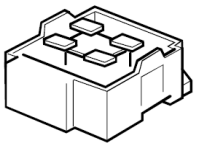
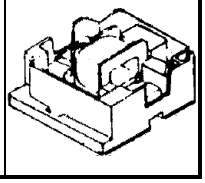
7.3 Thermal Overload Relay

Trouble	State	Cause	Measures
Thermal overload relay operates	Occurs frequently	The load is large.	Correct the load.
		The switching frequency is too high.	Reselect a capacity that matches the frequency.
		Shocks and vibrations during use are large.	Change the mounting method and location.
		Error in setting the relay scale position.	Set the relay scale position correctly.
		Error in selecting the relay current capacity.	Switch to a correct current capacity.
	Occurs during start-up	The start-up time is long (over 10 seconds).	Reselect the relay, and install a saturation reactor.
		The start-up current is large.	
		Application error (⅄-Δ, pole change, etc.)	Reselect a correct application.
		The ambient temperature rises.	Perform temperature compensation or change the mounting location.
		There is variation in the load.	Normalize the load or reselect the motor.
Thermal overload relay does not operate	-	Error in selecting the relay capacity.	Reselect a correct one.
		Error in setting the relay scale position.	Set it correctly.
		Relay damage	Replace the relay.
		The motor has a specialized structure.	Replace the thermal overload relay with a specialized one.
		The reset bar is being pressed.	Remove the item causing the problem.
		Reset repeats in quick succession.	Reevaluate the motor capacity.
		Contact welding (short-circuit in circuit)	Replace the relay.
		Magnetic contactor is faulty.	Replace the magnetic contactor.
		Erroneous wiring or wiring failure	Repair the faulty section.
	Heater melting	Short-circuit current flowed.	Replace the relay, and modify the protection coordination.
		Wiring failure or erroneous wiring	Replace the relay, and repair the faulty section.
Thermal overload relay cannot reset	-	Reset is too fast.	Reset it after it cools down.
		Poor contact with the contact	Replace the relay.
		Wiring failure	Repair the faulty section.

Appendix 1. Spare Parts List

S-T Magnetic Contactor Main Contact Element, Spring, and Coil List (Unit: mm)

* For the S-T10 to T32 and the SD-T12 to T32, contacts cannot be replaced.

Type		S-T35	S-T50	S-T65	S-T80	S-T100
Main movable contact element						
Main fixed contact element						
Main contact kit no.		BHA49N300	BHA49N301	BH759N300	BHA59N300	BH769N300
Qty. in kit	Movable contact element	3	3	3	3	3
	fixed contact element	6	6	6	6	6
	Hook spring	3	3	3	3	3
Coil			Same as S-T35		Same as S-T65	

Note 1. The dimensions given in →□ for the main movable contact element and fixed contact element are the life limit dimensions for when the contact is worn evenly. (Unit: mm)

Note 2. The kit numbers for the SD-T35 to T100, which differ from those for the S-T35 to T100, are as follows.

Type	Main contact kit no.
SD-T35	HA49N302
SD-T50	HA49N303
SD-T65	HA59N301
SD-T80	HA59N302
SD-T100	BH769N303

S-T Magnetic Contactor Auxiliary Contact Element

* For the S-T10 to T32 and the SD-T12 to T32, contacts cannot be replaced.

Type		S-T35 and T50	S-T65 to T100
Kit no.		BHA49N304	BH539N315
Qty. in kit	Movable contact element	4	4
	a fixed contact element	4	4
	b fixed contact element	4	4
	Hook spring	4	2

Appendix 2. Measures when Unit has been Submerged

If the controller has been submerged due to flooding, fire, or the like, in most cases it will not be possible to use the controller again. If due to unavoidable circumstances the controller must be used, its characteristics and performance cannot be guaranteed. Replace the unit with a new one as soon as possible.

Magnetic Contactors and Magnetic Starters
MAINTENANCE AND INSPECTION MANUAL

Mitsubishi Electric Corporation Nagoya Works is a factory certified for ISO14001 (standards for environmental management systems)and ISO9001(standards for quality assurance management systems)

⚠Safety Warning

To ensure proper use of the products listed in this catalog, please be sure to read the instruction manual prior to use.

ISO 14001 JACO EC97J1113 UKAS MANAGEMENT SYSTEMS 051

ISO 9001 BUREAU VERITAS Certification UKAS MANAGEMENT SYSTEMS 008

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