4. For the connections between a DC ammeter shunt and a remotely mounted ammeter, choose a wire size which will give the lead resistance specified on the dial of the ammeter. A remotely mounted ammeter may have a calibrating resistor to compensate for insufficient lead resistance. In this case choose an oversize wire and adjust the calibrating resistor to obtain the correct lead resistance.
5. Before making any connections, be certain that all leads to be handled are dead. Make no connections with live conductors.
6. Make connections to power leads last, applying proper lock-out tagout procedures.
7. A disconnecting means and short circuit protection must be installed ahead of the controller, unless they are included as a part of the controller.
8. With the power off, operate contactors, relays and interlocks by hand to see that they work freely. Mechanical interlocks should prevent the contacts of one contactor from touching while the other contactor is closed.
9. Turn the handles of rheostats, if provided, throughout their travel to see that the contact arm does not stub in passing over the contacts.
10. See that all terminals and current carrying joints are clean and tight. Refer to published torque requirements of the controller.
11. Before starting, disconnect the motor and check the operating sequence of the controller. Disconnect power and then reconnect the motor.
12. Close the circuit to the power supply. If a motor controller has separate switches for the power circuit and for the control circuit, always close the power circuit switch first and the control circuit switch last; this sequence will prevent picking up the contactors and then starting the motor with the disconnect switch.

If a DC motor has both a shunt field and a series field, their polarities should be the same. To check the relative polarities of these two fields, disconnect the shunt field and jog the motor with the series field alone; then reconnect the shunt field and jog the motor again; if the motor jogs in the same direction both times, the relative polarities of the shunt and series fields are correct.

If the controlled motor rotates in the wrong direction, check its field polarity and the power supply polarity or phase rotation to be sure they agree with the diagram. If so, for a DC motor interchange the armature connections A1 and A2. (Do not change the motor internal connection between the brush holder and the commutating field coil.) For a three-phase AC motor, interchange any two of the power connections to the motor. For other AC motors, refer to the instructions on the motor nameplate.

Preventive Maintenance

Preventive maintenance should be a program, a scheduled periodic action that begins with the installation of the equipment. At that time, specific manufacturer's instruction literature should be consulted, then stored for future reference. Follow-up maintenance should be at regular intervals, as frequently as the severity of duty justifies. Time intervals of one week, or one month, or one year may be appropriate, depending on the duty. It is also desirable to establish specific check lists for each control, as well as a logbook to record the history of incidents. A supply of renewal parts should be obtained and properly stored.

General guidelines

The whole purpose of maintaining electrical equipment can be summarized in two rules:

- Keep those portions conducting that are intended to be conducting.
- Keep those portions insulated that are intended to be insulated.

Good conduction requires clean tight joints free of contaminates such as dirt and oxides.

Good insulation requires the absence of carbon tracking and the absence of contaminants such as salt and dust that become hydroscopic and provide an unintended circuit between points of opposite polarity.

⚠ WARNING

MAINTENANCE OF CONTROL COMPONENTS REQUIRES THAT ALL POWER TO THESE COMPONENTS BE TURNED OFF BY OPENING AND LOCKING OPEN THE BRANCH CIRCUIT DISCONNECT DEVICE, USUALLY A SWITCH OR CIRCUIT BREAKER LOCATED IN THE SAME ENCLOSURE AS THE CONTROL COMPONENTS OR IN A PANEL BOARD OR SWITCHBOARD FEEDING THE CONTROL ENCLOSURE. SEPARATE CONTROL SOURCES OF POWER MUST ALSO BE DISCONECTED. IF CONTROL POWER IS USED DURING MAINTENANCE, CAUTION SHOULD BE USED TO PREVENT FEEDBACK OF A HAZARDOUS VOLTAGE THROUGH A CONTROL TRANSFORMER. BE ALERT TO POWER FACTOR CORRECTION CAPACITORS THAT MAY BE CHARGED. DISCHARGE THEM BEFORE WORKING ON ANY PART OF THE ASSOCIATED POWER CIRCUIT.

Cleaning

Soot, smoke, or stained areas (other than inside arc chutes), or other unusual deposits, should be investigated and the source determined before cleaning is undertaken. Vacuum or wipe clean all exposed surfaces of the control component (especially the pollution of the magnet pole surfaces) and the inside of its enclosure. Equipment may be vacuumed or blown clean with compressed air that is dry and free from oil. (Be alert to built-in oilers in factory compressed air lines!) If air blowing techniques are used, remove arc covers from contactors and seal openings to control circuit contacts that are present. It is essential that the foreign debris be removed from the control enclosure, not merely rearranged. Be careful not to force debris into other components such as circuit breakers. Control equipment should be clean and dry. Remove dust and dirt inside and outside the cabinet without using liquid cleaner. Remove foreign material from the outside top and inside bottom of the enclosure, including hardware and debris, so that future examination will reveal any parts that have fallen off or dropped onto the equipment. If there are liquids spread inside, determine the source and correct by sealing conduit, adding space heaters, or other action as applicable. It is advised that proper personal protection equipment be used while cleaning.

Mechanical checks

Tighten all electrical connections. Look for signs of overheated joints, charred insulation, discolored terminals, etc. Mechanically clean to a bright finish (don't use emery paper) or replace those terminations that have become discolored. Determine the cause of the loose joint and correct. Be particularly careful with aluminum wire connections. Aluminum wire is best terminated with a crimp type lug that is attached to the control component. When screw type lugs (marked CU/AL) are used with aluminum wire, joints should be checked for tightness every 200 operations of the device.

Wires and cables should be examined to eliminate any chafing against metal edges caused by vibration, that could progress to an insulation failure. Any temporary wiring should be removed, or permanently secured and diagramsmarked accordingly.

The intended movement of mechanical parts, such as the armature and contacts of electromechanical contactors, and mechanical interlocks should be checked for freedom of motion and functional operation.

Wrap-Up

Check all indicating lamps, mechanical flags, doors, latches, and similar auxiliaries and repair, if required.

Log changes and observations into record book before returning equipment into service. Do not remove any labels or nameplates. Restore any that are damaged.

Contact Wear and Replacement

Contactors are subject to both mechanical and electrical wear during their operation. In most cases mechanical wear is insignificant. The erosion of the contacts is due to electrical wear. During arcing, material from each contact is vaporized and blown away from the useful contacting surface.

A critical examination of the appearance of the contact surfaces and a measurement of the remaining contact overtravel will give the user the information required to get the maximum contact life.

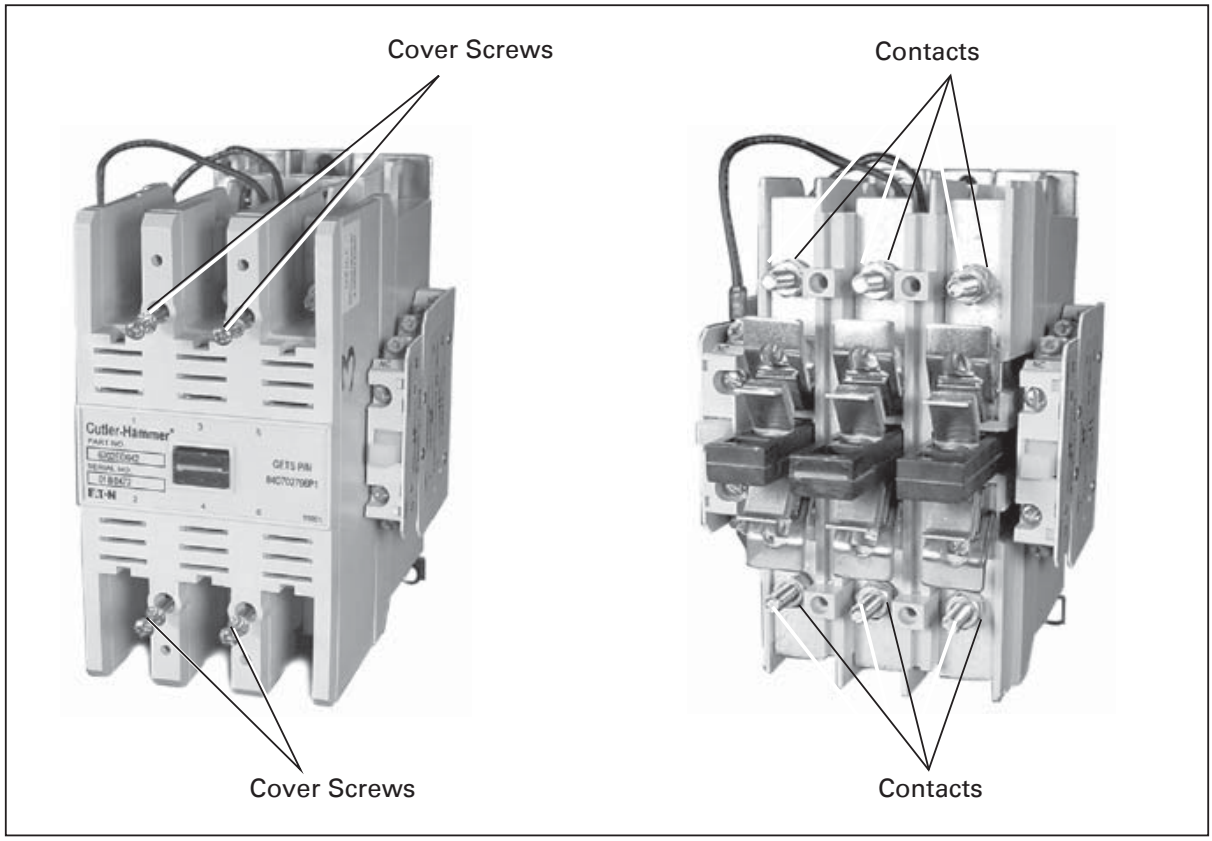

Figure 1. Example Contact Configuration