



Instructions for 36" Wide Vacuum-Break Starters Rated 360 Amperes, 7200 Volts, Slide-Out Type



DANGER

HAZARDOUS VOLTAGE.

READ AND UNDERSTAND THIS BOOKLET IN ITS ENTIRETY BEFORE INSTALLING OR OPERATING CONTROLLER. INSTALLATION, ADJUSTMENT, REPAIR AND MAINTENANCE OF THESE CONTROLLERS MUST BE PERFORMED BY QUALIFIED PERSONNEL. A QUALIFIED PERSON IS ONE WHO IS FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZARDS INVOLVED.

THE CONTROLLER

Each Ampgard® motor starter (controller) consists of one nonload-break isolating switch, one or more Type SJS, NEMA Size H6, vacuum-break contactors, current-limiting fuses, a set of current transformers, and some form of overload protection. The isolating switch has a limited make and break rating, suitable only for closing and opening limited magnetizing current loads. The controller is designed to start, stop and protect a three-phase medium-voltage motor within the ratings shown in Table I. The controller may also be used to switch transformer windings or capacitor banks. Each Ampgard® controller occupies all or a portion of a steel structure that may also enclose a horizontal bus system to distribute power to two or more sections and a vertical bus system in each section connected to the horizontal main bus system. The controllers are configured for full-voltage or reduced-voltage starting, reversing or nonreversing, single-speed or two-speed applications.

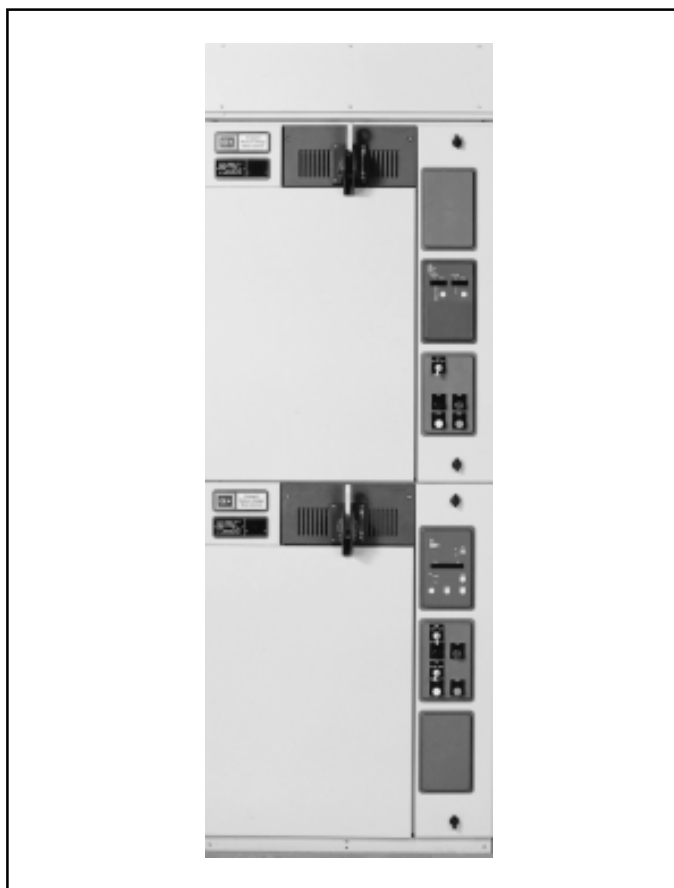


Fig. 1 Ampgard® Motor Controller, 36" Wide

TABLE I. AMPGARD® EQUIPMENT RATINGS

TABLE I. AMPGARD® EQUIPMENT RATINGS								
Range Of System Voltage	Normal Utilization Voltage	Continuous Current Rating Enclosed	50 or 60 Hertz Horsepower Rating		Induction Motor	Interrupting Capacity, 50-60 Hz (rms) Symmetrical At Nominal Utilization Voltage		Isolating Switch Make/Break Ratings
			Synchronous Motor			Fuses	Controller	
			80% P.F.	100% P.F.	Motor			
2200-2500	2300	360A	1500	1750	1500	50,000 Amp	200,000 kVA	750 VA
3800-5000	4000	360A	2500	3000	2500	50,000 Amp	350,000 kVA	600 VA
6200-7200	6600	360A	4000	5000	4000	50,000 Amp	570,000 kVA	600 VA
Nonmotor Applications at: >>>>>>>>			2200 - 2500 Volts		3800 - 5000 Volts		6200 - 7200 Volts	
Transformer Switching Rating =			1250 kVA		2250 kVA		3000 kVA	
Capacitor Switching Rating =			1200 kVAR		2100 kVAR		2400 kVAR	

THE CONTROLLER (Cont.)

While this instruction booklet is dedicated to full-voltage starting, the other applications listed are an expansion of the same principles shown.

MEDIUM-VOLTAGE COMPONENTS

The flow of current through a vacuum-break controller (starter) can be traced by referring to the upper portion of Figure 4, where the controller is shown in the energized position. The line stab assembly mounted at the back of the enclosure also serves as the controller line terminals (1). The stabs themselves are engaged by the fuse jaws (2) of the isolating switch which is mounted on rails above the contactor. The ferrules (3) of the current-limiting motor-starting power circuit fuses (4) clip into the fuse jaws, and the load ferrules (5) fit into the fuse holders (6) which are part of the contactor line terminals. Current flows through the contactor from the load ferrules of the power circuit fuses, through the shunts (7), and the vacuum interrupters (bottles) of the contactor (8), to the contactor load terminals (9). Cables (10) pass through current transformers and connect the contactor load terminals to the controller load (motor) terminals mounted on the enclosure wall to the left of the isolating switch. See Figure 2. Connect the conductors from the motor to these latter terminals.

LOW-VOLTAGE CONTROL COMPONENTS

The low-voltage components consisting of an interposing relay, protective relays, and optional equipment are generally mounted on a slide-out panel. The single-phase control power transformer is bolted to the contactor frame. The capacity of this transformer ranges from 600 VA to 2 kVA, depending upon requirements. The primary winding of the control power transformer is connected to the line through the power circuit fuse assembly, and is protected by two additional low rating current-limiting fuses mounted on the contactor. See Figure 6. The secondary of the control power transformer supplies power to the 120 (or 240) volt grounded control circuit through secondary fuses mounted next to the test-run plug.

The slide-out panel and attached door constitute the low-voltage compartment for most Ampgard motor controls. This panel and door combination may be removed from the base enclosure by first removing four machine screws from the top and bottom rail bayonets on the back side of the panel and lifting the panel up until the bayonets clear their slots. These screws must be replaced when the panel is reinstalled to maintain stability. Pull-apart terminal blocks permit mechanical and electrical separation from the contactor. See Figure 6.

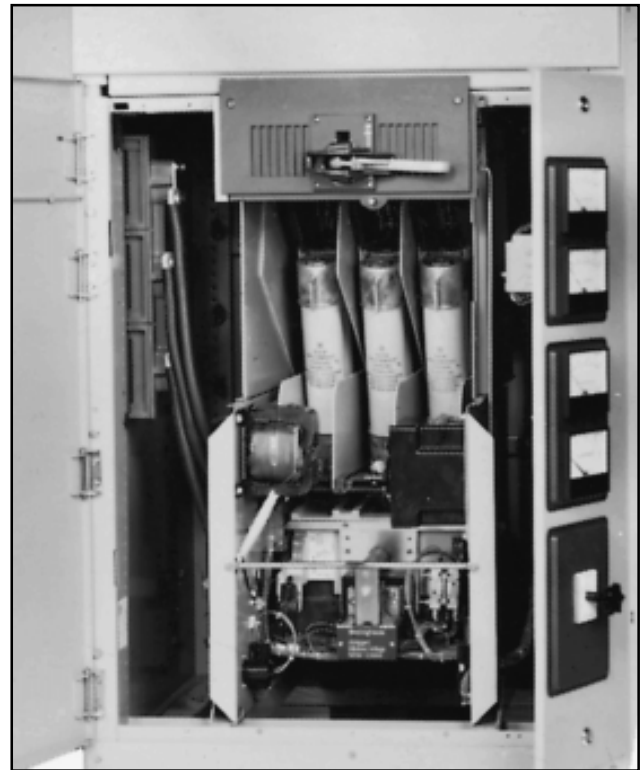


Fig. 2 SJS Contactor & Isolating Switch

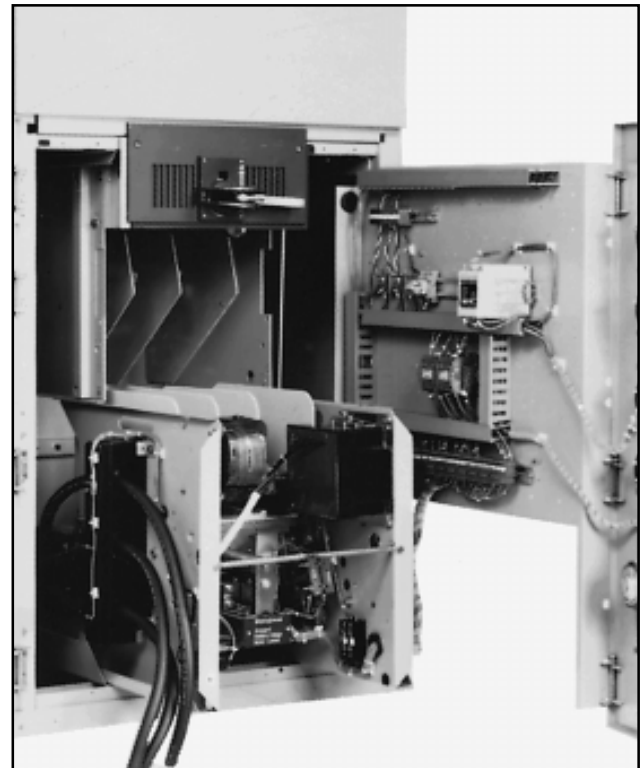


Fig. 3 Low-Voltage Compartment

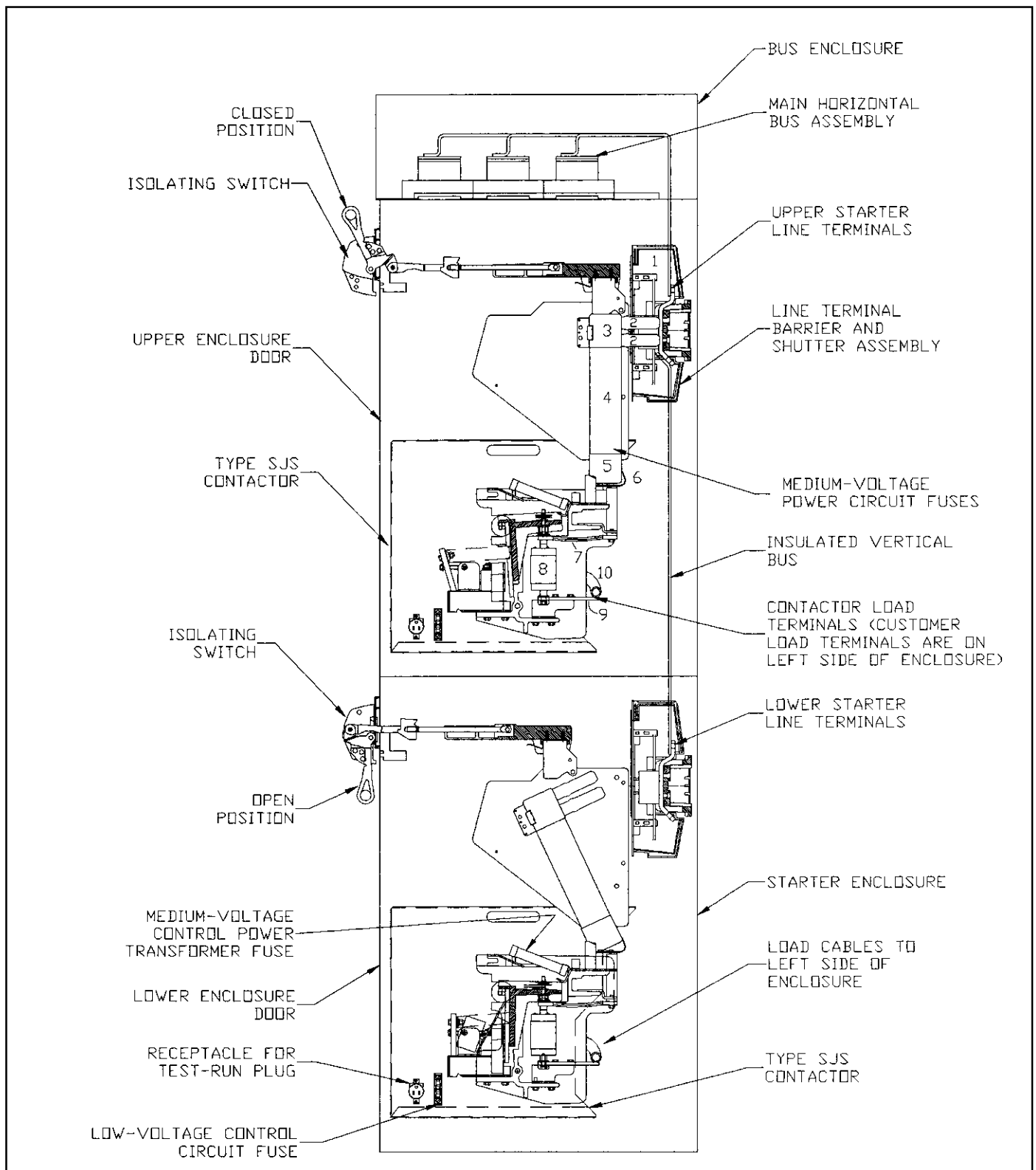


Fig. 4 Ampgard® Components, Two Starters (Controllers) Shown

LOW-VOLTAGE CONTROL COMPONENTS (Cont.)

To energize the primary of the control power transformer, the contactor must be inserted into the enclosure, the power circuit fuses must be installed, and the isolating switch must be closed.

For convenience during maintenance, when it may be desirable to energize the contactor or the control circuit, a test-run plug is provided. **WITH THE ISOLATING SWITCH OPEN**, disconnect the plug from the socket and plug it into a 120 volt single-phase polarized extension cord (or 240 volt when specified). See Figure 6.

Disconnect this temporary circuit and restore the plug to its socket on the contactor before returning the unit to service.

LOW-VOLTAGE CUTOFF SWITCH

Two auxiliary switches are installed behind the operating handle housing of the isolating switch and used to disconnect the load of a control power transformer, space heaters, or other auxiliary circuits. Each of these auxiliary switches has an inductive load rating of 20 amperes at not greater than 250 VAC. These auxiliary contacts operate within the first five degrees of movement of the isolating switch handle. At least one of the normally-open contacts of these switches disconnects the control power transformer from its load.

ISOLATING SWITCH

Each Ampgard® isolating switch is a medium-voltage, three-pole, manually operated device. It consists of an operating mechanism and a sliding tray mounted between two steel end plates. The sliding tray is molded insulating material and carries three sets of fuse jaw finger assemblies. One end of the fuse jaw finger assembly grips the upper ferrule of the power fuse while the other end engages the line stab. In the switch open position, the three fuse jaw fingers are grounded.

Arc resistant and flame retarding insulating barriers are mounted between phases and also between the two outside poles and the isolating switch end plates.

This isolating switch is a nonload-break device. It must never close or interrupt a power load. However, it does have a limited capacity for interrupting the single-phase control power and potential transformers exciting current. In terms of transformer ratings, the maximum load is the equivalent of an unloaded (exciting current only) 6 kVA transformer.

An Ampgard® starter is shipped with the isolating switch in the ON position (Figure 5, View A). The isolating switch handle is operated by moving it through a vertical

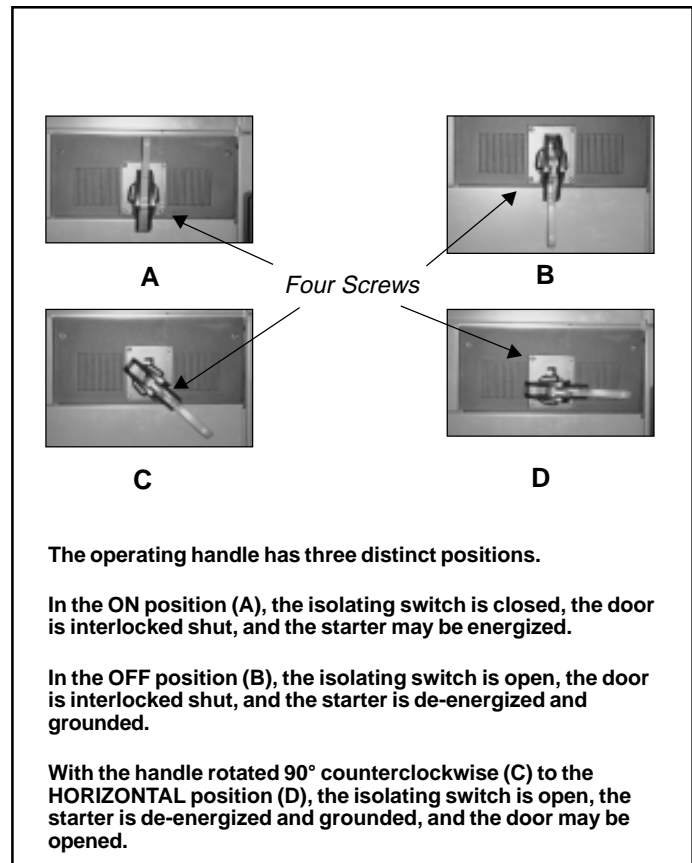


Fig. 5 Isolating Switch Handle Positions

arc from the ON to the OFF position. From the OFF position, it can be rotated 90° counterclockwise to the HORIZONTAL position, the door-open position (Figure 5, View D).

In both the ON and OFF positions, a portion of the handle housing extends over the door to the medium-voltage compartment, preventing this door from being opened. To open this door, the handle must be moved to the HORIZONTAL position.

With the handle in the OFF position, up to three padlocks can be used to lock out the switch, preventing the handle from being moved to either the ON or the HORIZONTAL position. This locked position prevents both unauthorized entry into the medium-voltage compartment and accidental closing of the isolating switch while maintenance work is being done. From the HORIZONTAL position, the handle cannot be moved to the ON position without first moving to the OFF position.

SHORT-CIRCUIT AND OVERLOAD PROTECTION

Overcurrent protection is provided by the current-limiting power circuit fuses and by the overload sensor supplied from the current transformers. The power circuit fuses have a special time/current characteristic for motor service that is coordinated with the characteristic of the overload protection. Currents greater than full-load motor current, up through locked-rotor current, will operate the overload protection and trip the contactor before the fuses open. This coordination prevents unnecessary fuse blowing. Since the interrupting capacity of the contactor is limited, the power circuit fuses must operate faster than the overload protector and contactor when the overcurrent is greater than the current corresponding to the contactor interrupting rating in order to limit damage to the starter or motor. In all faults above interrupting rating and within the rating of the equipment, the current-limiting "R" rated fuses will operate first. The interrupting rating of the vacuum bottles used in this contactor is 7600 amperes, r.m.s. symmetrical. The current transformers, overload protector, and power circuit fuses are

coordinated with the motor characteristics, so that the controller must be used with the motor for which it was designed. Motors with special characteristics often require additional protective relays. Consult the instruction leaflet for that particular protective relay before attempting any adjustment or service. Protective relays are **not** set at the factory.

ENCLOSURE

These Ampgard® motor controllers are supplied in cells assembled into floor-mounted enclosures. These enclosures are 36 inches wide x 30 inches deep x 90-inches high (92 cm wide, 76 cm deep, and 229 cm high). Each 90-inch high enclosure accommodates one or two Ampgard® starters depending upon the requirements. Complex controllers such as reduced-voltage starting require more than one 36" wide section. A 10-inch (25cm) high horizontal bus enclosure can be added at the top which increases the total enclosure height to 100 inches (254 cm).

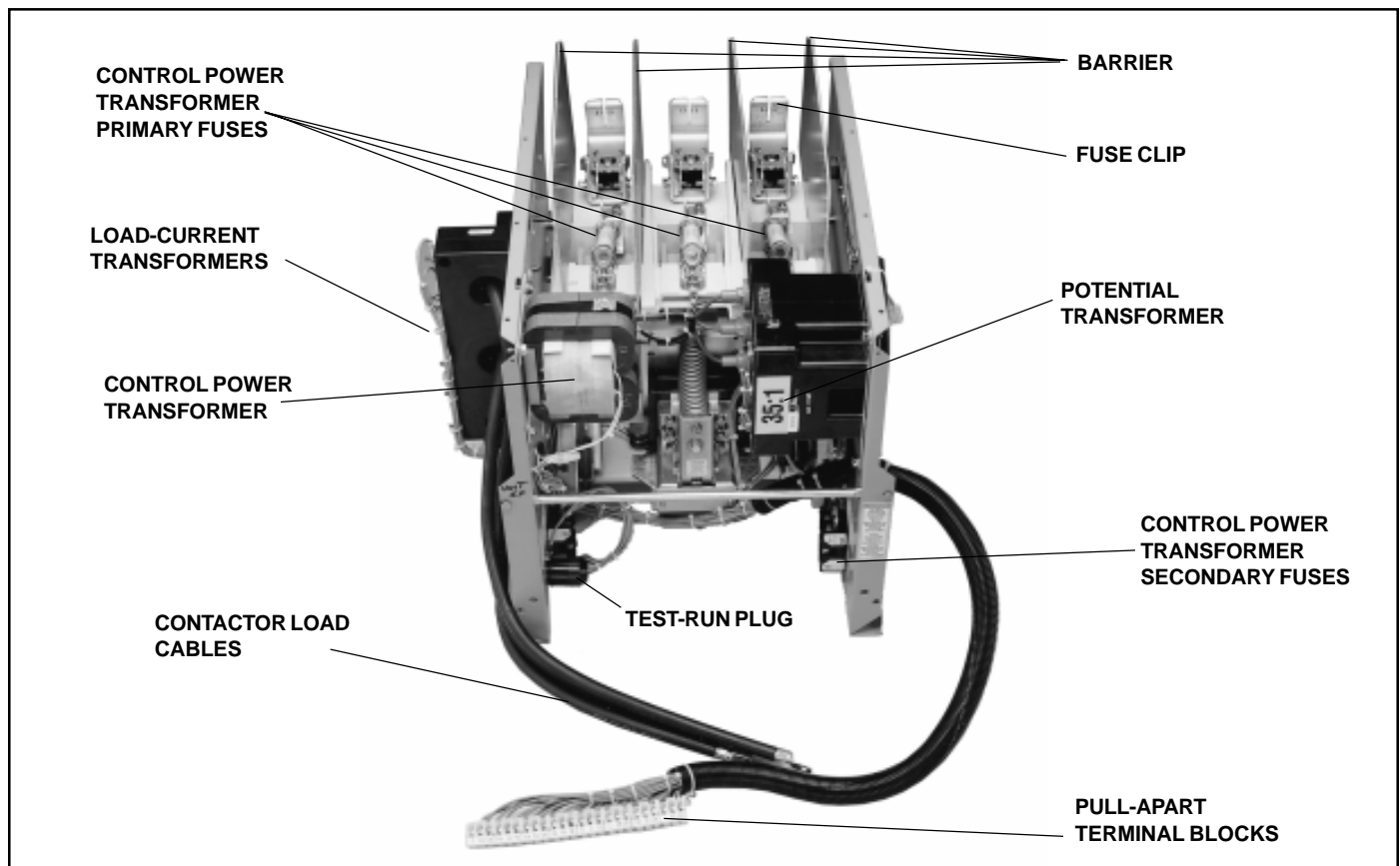


Fig. 6 Type SJS Contactor, Front View

MECHANICAL INTERLOCKS

Before putting an Ampgard® controller into service, become familiar with the mechanical interlocks.

Door Interlock.

With the isolating switch handle in the HORIZONTAL position, the door to the medium-voltage compartment can be opened. As soon as the door opens, a mechanical interlock becomes effective. It is designed to prevent the user from accidentally operating the isolating switch handle and closing the starter on to the line with the door open.

This interlock is a spring-loaded plunger located just below the handle housing (Figure 5, View D). This prevents the handle from being accidentally returned to the OFF position. This interlock may be deliberately bypassed by depressing the plunger with a screwdriver so that the handle can be moved to the OFF position to observe the operation of the isolating switch during installation or maintenance. To do this, it is necessary to deliberately bypass the interlock. The handle must be returned to the HORIZONTAL position by again depressing the interlock plunger before the door can be closed. The operator must be aware of what he is doing and take appropriate safety precautions.

Contactor-to-Isolating-Switch Interlock.

There is also a mechanical interlock that is designed to prevent the isolating switch from closing with the contactor already closed, and to prevent the contactor from closing while the isolating switch is being opened. This latter state (the transition phase) is shown in Figure 7. With the isolating switch fully open or fully closed the contactor may be opened or closed. See Figure 8. If the clevis is not connected to the interlock arm, the contactor cannot be closed electrically. This is a positive interlock, it cannot be bypassed without disassembly of the interlocking parts. **DO NOT DISTURB THE FACTORY ADJUSTMENTS OF THESE INTERLOCKS!**

Line Stab Insulating Shutter.

When an Ampgard® isolating switch is installed, both a shutter and a rear line stab barrier are in place in the controller structure and are intended to prevent accidental access to the line bus. As the isolating switch is opened, the sliding tray (Figure 9) mechanically drives the insulating shutter closed across the three line stab openings in the rear barrier. As the shutter closes the openings, green and white striped labels are uncovered to visually indicate that the shutter is closed. With the isolating switch in the fully open position, the fuse jaw finger assemblies and the line side of the main fuses are connected to the ground bar.

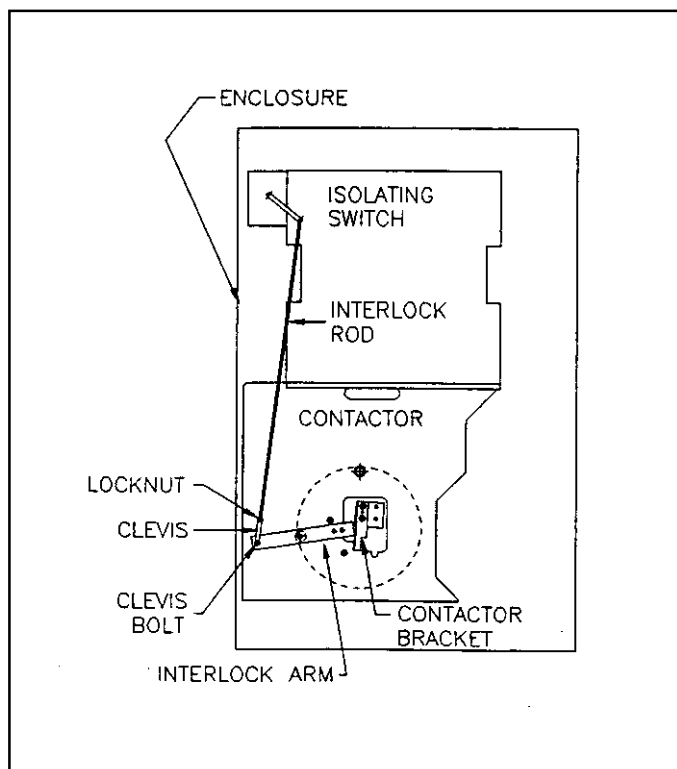


Fig. 7 Switch and Contactor Interlocked Closed

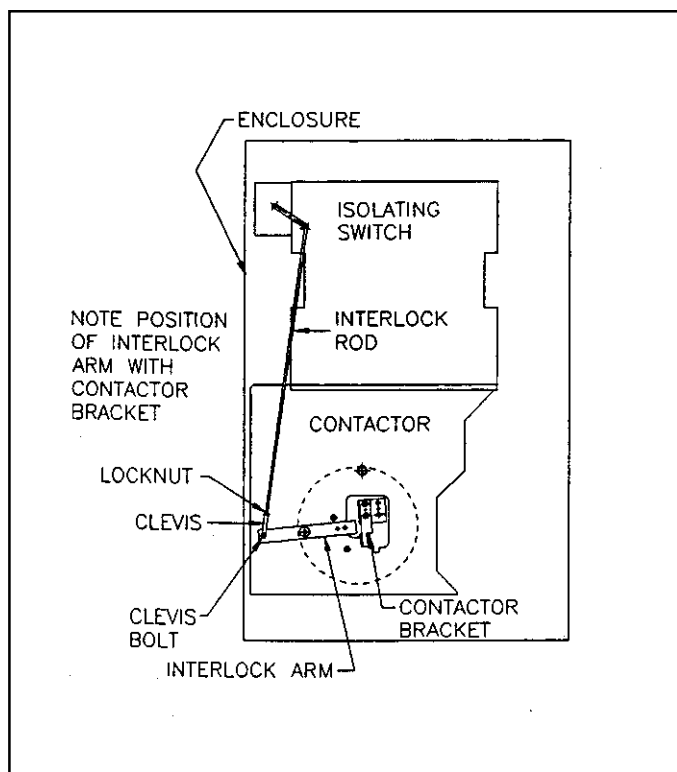


Fig. 8 Contactor Open, Interlock Neutral

As a final precaution before touching any of the electrical parts of the starter, visually check to make certain that the shutter is closed, the green and white striped labels are visible, the grounding fingers are in contact with the ground bar, and the tips of the fuse fingers are visible.

When the isolating switch is removed from the starter structure, a latch lever (32, Figure 10) on the shutter assembly is activated. It is designed to hold the insulating shutter closed. This latch may be deliberately bypassed and the shutter moved to the open position. **CAUTION! Under these conditions the exposed line terminal stabs of the starter may be energized at line potential.**

When the isolating switch is replaced in the structure, the latch member is automatically released to allow the shutter to operate normally.

THE CONTACTOR

The Type SJS contactor has its main contacts sealed inside ceramic tubes from which all air has been evacuated, i.e., the contacts are in vacuum. No arc boxes are required, because any arc formed between opening contacts in a vacuum has no ionized air to sustain it. The arc simply stops when the current goes

through zero as it alternates at line frequency. The arc usually does not survive beyond the first half cycle after the contacts begin to separate. The ceramic tube with the moving and stationary contacts enclosed is called a vacuum interrupter or a bottle, and there is one such bottle for each pole of the contactor. A three-pole contactor has three vacuum bottles. A metal bellows (like a small, circular accordion) allows the moving contact to be closed and pulled open from the outside without letting air into the vacuum chamber of the bottle. Both the bellows and the metal-to-ceramic seals of modern bottles have been improved to the point that loss of vacuum is no longer cause for undue concern. The moving contacts are driven by a molded glass polyester crossbar (see Figure 11) rotating with a square steel shaft supported by two shielded, pre-lubricated ball bearings that are clamped in alignment for long life and free motion. Only the end edges of the square shaft are rounded to fit the bearings, so that portions of the four shaft flats provide positive indexing of mechanical safety interlocks.

The contacts in an unmounted bottle (vacuum interrupter) are normally-closed, because the outside air pressure pushes against the flexible bellows. For contactor duty, the contacts must be open when the operating magnet is not energized. Therefore, the contacts of the vacuum bottles must be held apart mechanically against the air pressure when used in a contactor. In the Type SJS contactor, all of the bottles are held open by a single kickout spring on the front of the contactor. (See Figure 11.) The kickout spring presses against the moving armature and crossbar and thereby forces the bottles into the open contact position. Note that in the open position, the crossbar is pulling the moving contacts to hold them open.

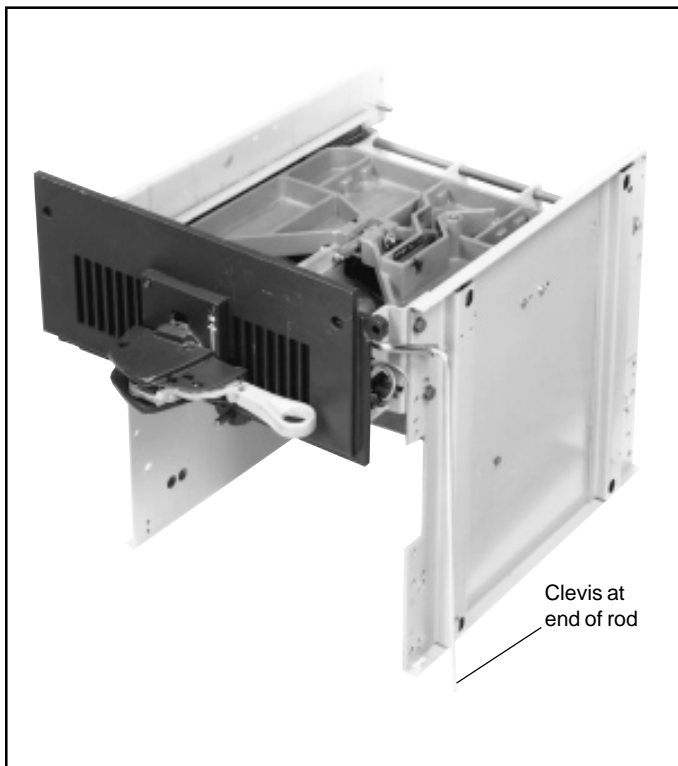


Fig. 9 Sliding Tray Mechanism of 360 Ampere Isolating Switch

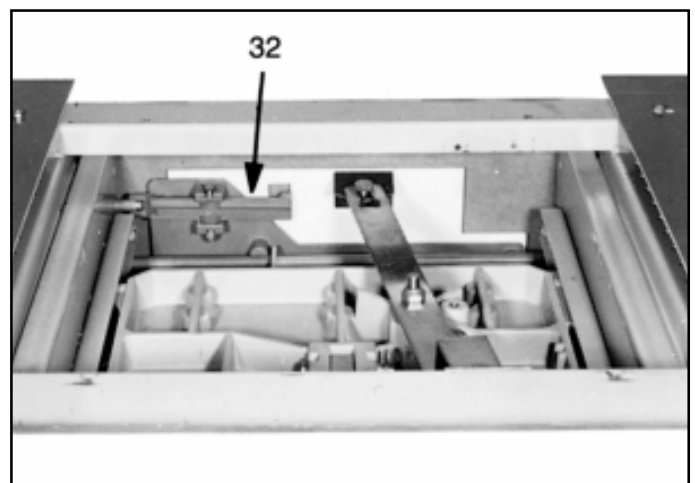


Fig. 10 Shutter Operating Mechanism

THE CONTACTOR (Continued)

The kickout spring is adjustable and occupies the space above the operating magnet. The kickout spring must be removed before the magnet coil can be changed if that becomes necessary. The normal position of the kickout spring lever is vertical. The lever can be loosened to unload the kickout spring (after loosening the set screw that locks the adjusting screw). Unscrew the 0.313-inch adjusting screw immediately below the kickout spring itself. Although it can be loosened, the lever is captive. As the screw is loosened, the kickout spring will reach its relaxed, free length and can be removed easily. To re-install it, reverse the procedure. Insert the uncompressed, free spring into position; then apply load by tightening the adjusting screw on the lever until the lever is approximately vertical. See specific instructions later. Because the spring forces exceed 100 pounds (45 kilograms), place a free hand over the kickout spring as a precaution while turning the adjusting screw in either direction. Tighten the set screw to lock the adjusting screw.

The operating magnet (see Figure 11) is on the front of the contactor. The coil has a "figure-eight" shape and is really two coils in series, with a connection to their common point. Both coils are encapsulated in one environmentally-immune coil shell, which also contains a full-wave silicon diode rectifier. An AC or DC source can be connected to terminals A and B on the coil shell. When an AC source is applied, the rectifier converts the AC to unfiltered DC to excite the magnet. When a DC source is applied, only two legs of the full-wave rectifier are active and pass DC current for magnet excitation. The magnet will not chatter as AC magnets sometimes do but at less than rated voltage, it may hum slightly. A normally-closed auxiliary contact, set to open slightly before the armature fully closes, is connected to terminals C and D on the coil shell. When adjusted correctly, this auxiliary contact allows a relatively high current through the pick-up winding, and as the contactor closes, the auxiliary contact inserts the holding winding, which reduces the coil current to a low value, sufficient to hold the magnet closed without overheating.

In the description of the bottles, it was mentioned that no arc boxes are required. However, because of electrical clearance requirements, **four phase barriers must be installed before the contactor is energized. Where no fuses are mounted directly above the contactor, as, for example, in the case of one contactor in a reversing controller, no barriers are required or furnished.**

CONTACTOR-MOUNTED COMPONENTS

To simplify installation and servicing, a number of related components are mounted on the Type SJS contactor

chassis: a control power transformer with test plug and fuses, instrument-quality potential transformers with secondary fuses (when furnished), primary fuses for the control power and potential transformers, and load side fuse clips for the power circuit fuses. See Figures 6 and 12. The test-run plug is used to connect to an auxiliary source of control voltage when it is not inserted into the receptacle that is the output from the secondary of the control power transformer. This male test plug can be plugged into a standard polarized 120-volt (or 240-volt, depending on coil voltage rating) extension cord socket for testing the control circuit and any sequence without energizing the medium-voltage controller at power circuit voltage. When the male plug is transferred to the extension cord, it automatically disconnects from the control power transformer to prevent feedback of high voltage into the power circuits. Check to be sure no inadvertent bypass of this arrangement has been made in the wiring before relying on this safety feature.

CONTACTOR HANDLING

Each contactor weighs about 160 pounds (73 kilograms). An oblong hole is provided in each sidesheet for lifting if desired.

A horizontal bar is provided at the front for pulling the contactor out of its cell, or for pushing it back into place.

When a type SJS contactor is installed in a medium-voltage controller it can be moved to a drawout position or removed from the enclosure as follows:

WARNING: ALL WORK ON THIS CONTACTOR SHOULD BE DONE WITH THE MAIN DISCONNECT DEVICE OPEN. AS WITH ANY CONTACTOR OF THIS VOLTAGE, THERE IS DANGER OF ELECTROCUTION AND/OR SEVERE BURNS. MAKE CERTAIN THAT POWER IS OFF. CHECK FOR VOLTAGE WITH VOLTAGE SENSOR OR A METER OF THE APPROPRIATE RANGE.

1. If removal is planned, provide a lift truck or suitable platform to receive the contactor as it comes out.
2. **Make sure all circuits are deenergized.**
3. Remove the three power circuit fuses using the fuse puller supplied with the starter.
4. Disconnect the control plug and stow it so that the cable will not be damaged. Disconnect the two 3-point separable terminal blocks on the right front of the isolating switch.
5. Disconnect the isolating switch auxiliary contact pull-apart terminal blocks located on the lower right-hand side of the isolating switch.
6. Disconnect the contactor load-side cables from the controller load terminals.

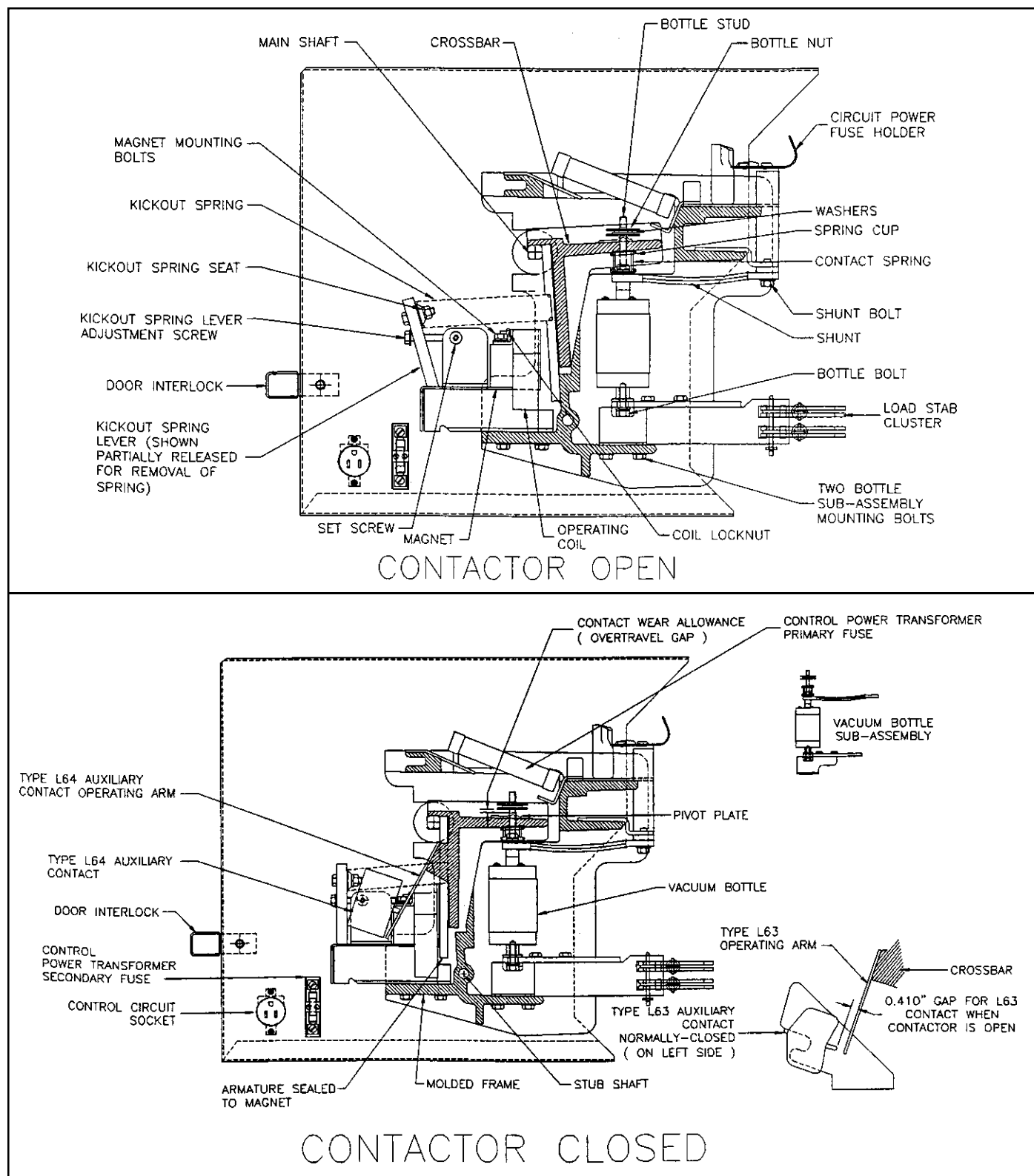


Fig. 11 Type SJS Contactor Positions

CONTACTOR HANDLING (Cont.)

7. Loosen the hex-head bolt attaching the clevis at the end of the isolating switch interlock rod to the contactor mechanical interlock sufficiently far to free the clevis and rod. See Figures 7 and 8. Access to this bolt is from the low-voltage compartment. Where two contactors are bolted together by the factory and mechanically interlocked, (e.g., reversing or reduced voltage) the two are removed as a single package. The mechanical interlock and bus bar connections between them need not be removed. However, where three contactors are behind a single door and mechanically interlocked, (e.g., for a single-winding two-speed motor) the two mechanical interlocks between the top and center contactors must also be disconnected to withdraw any contactor. Loosen the clevis bolts on each interlock arm of the top and center contactors sufficiently far to free the two interlock rods between them before attempting to withdraw a contactor. Remove the interlock rods, but mark them "front" and "rear" to insure correct reinstallation. **DO NOT DISTURB ANY FACTORY-SET INTERLOCK ADJUSTMENTS.**
8. Use a 0.50-inch socket wrench to remove the two horizontally-mounted positioning bolts located at the bottom front edge of the contactor sidesheets.
9. Carefully slide the contactor out to a balanced drawout position or onto the fork truck or platform. All routine inspection and maintenance can be done with the contactor in the drawout position. Lift off the phase barriers for easier access.

To reinstall, reverse the procedure.

INSTALLATION

This industrial type control is designed to be installed by adequately trained and qualified personnel with appropriate supervision. These instructions do not cover all details, variations, or combinations of the equipment, its storage, delivery, installation, check-out, safe operation, or maintenance. Care must be exercised to comply with local, state, and national regulations, as well as safety practices, for this class of equipment. See **START-UP PRECAUTIONS.**

For site preparation and general information regarding receiving, storage, and installation see I.B. 48001.

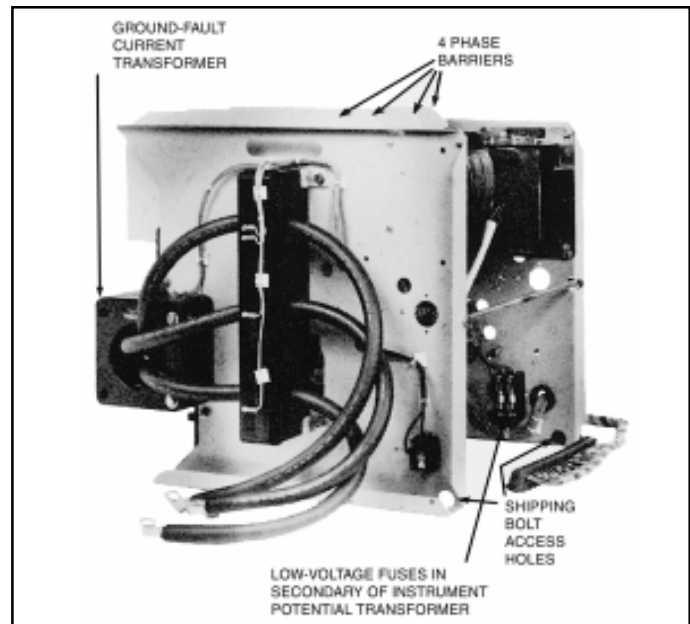


Fig. 12 Type SJS Contactor Side View



CAUTION

TALL STRUCTURE — MAY TIP OVER IF MISHANDLED.

MAY CAUSE BODILY INJURY OR EQUIPMENT DAMAGE.

DO NOT REMOVE FROM SKID UNTIL READY TO SECURE IN PLACE. READ THE HANDLING INSTRUCTIONS IN I.B. 48001 BEFORE MOVING.

Medium-voltage motor controllers are extremely heavy and the moving equipment used in handling must be capable of handling the weight of the motor controller. Confirm this capability prior to starting any handling operations with the controller.

The motor controller should be kept in an upright position unless specific instructions to the contrary are provided with the controller.

After a level installation site has been prepared, the Ampgard® assemblies positioned and fastened in place, and protective packaging removed, the individual controllers can be disassembled to permit access to conduit and complete wiring. Step-by-step disassembly procedures are shown on Pages 12, 13, and 14. Following the recommended procedures will save time. All cable connections can be made by access through the front of the enclosure.

When there is access space behind the installation, the rear panel of the enclosure can be removed to facilitate wiring. Adequate space has been provided at the rear of

the enclosure for medium-voltage line and load cables, while low-voltage cables may be conveniently arranged near the right-hand enclosure wall. See Figure 3.

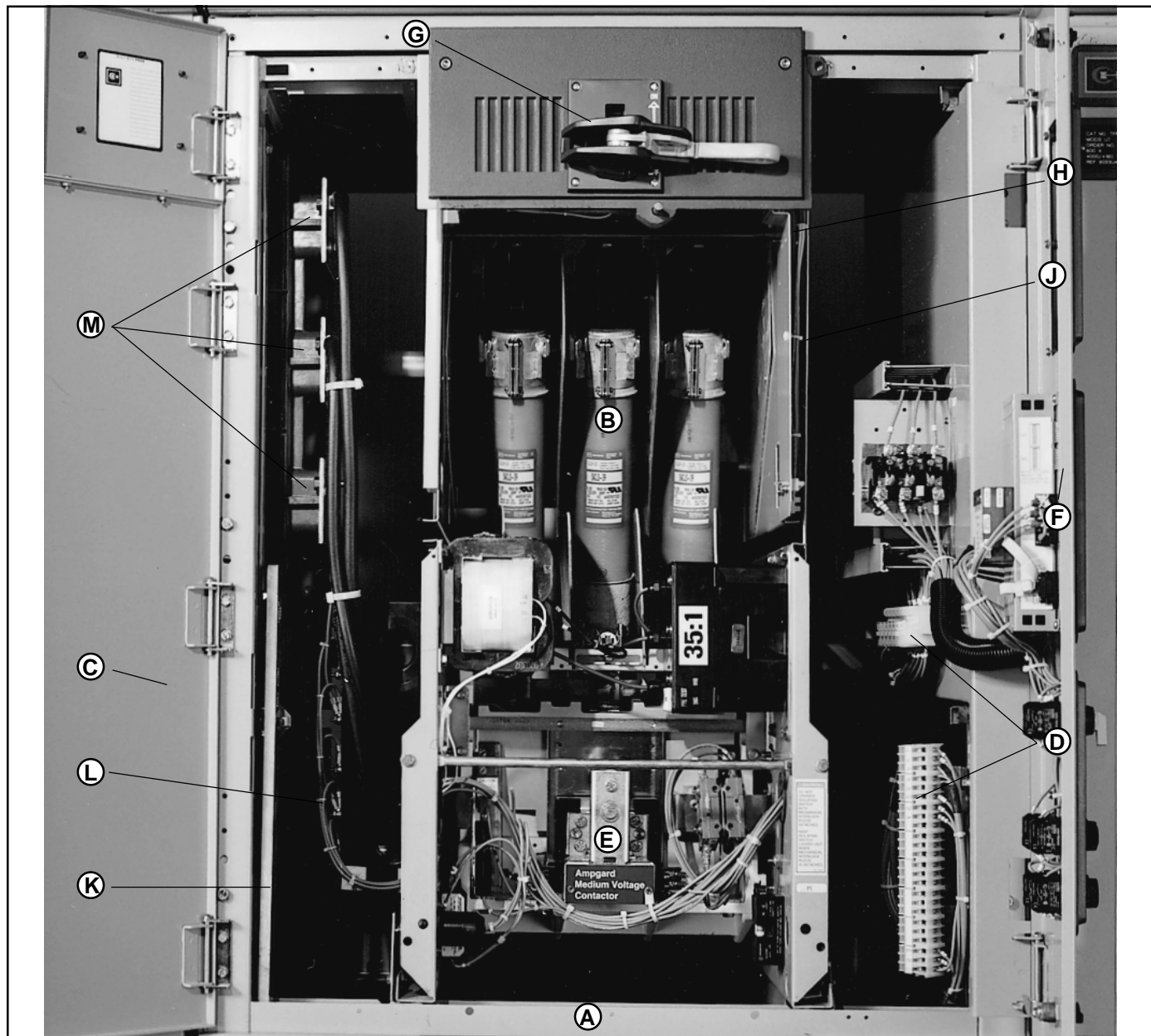


Fig. 13 Key Points In Disassembly

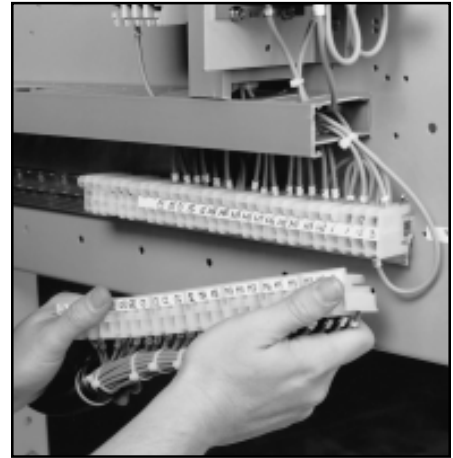
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|------------------------------------|---|
| A. POSITIONING BOLTS | G. ISOLATING SWITCH |
| B. POWER CIRCUIT FUSES | H. ISOLATING SWITCH AUXILIARY CONTACT TERMINAL BLOCKS |
| C. MEDIUM-VOLTAGE COMPARTMENT DOOR | J. ISOLATING SWITCH MECHANICAL INTERLOCK |
| D. CONTROL TERMINAL BLOCKS | K. FUSE PULLER |
| E. VACUUM CONTACTOR | L. LOAD CABLES |
| F. LOW-VOLTAGE COMPARTMENT DOOR | M. MOTOR TERMINALS |



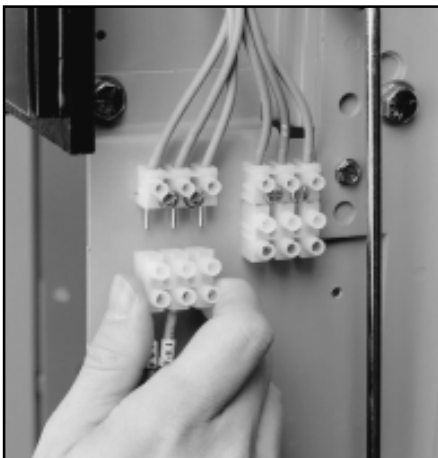
- 1** Remove the two positioning bolts (A). Free the clevis attached to the mechanical interlock arm. See Figure 8 on Page 6. Save all hardware.



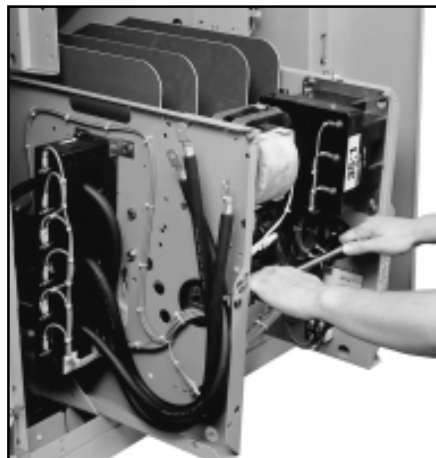
- 2** Remove three power circuit fuses (B) using the fuse puller (K) supplied. See operating instructions inside medium-voltage door (C).



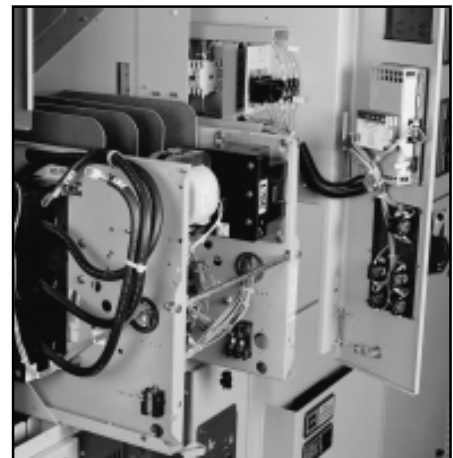
- 3** Separate the contactor side of the control wires from the terminal block (D).



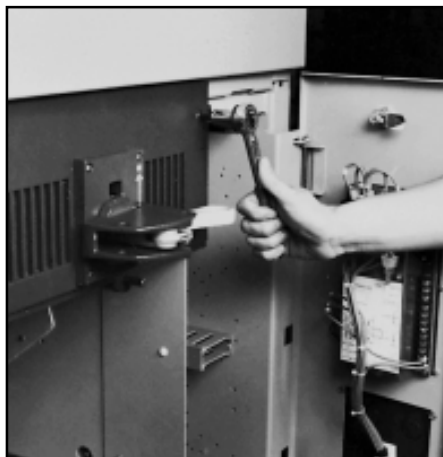
- 4** Disconnect the auxiliary contact terminal blocks (H) on the isolating switch.



- 5** Remove contactor (E) with a sharp pull forward.



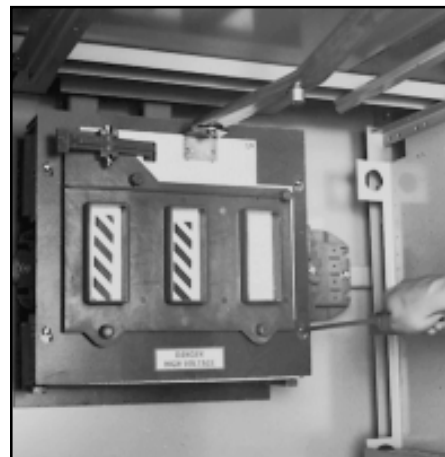
- 6** Part way out the contactor will reach a balanced position. Lower the contactor to the floor and slide it out of the way. The contactor weighs approximately 160 lbs. (73 kilograms). If a contactor is installed in an upper compartment, an industrial lift with a platform is necessary.



- 7** Free the isolating switch (H), by removing two hex head bolts as shown.



- 8** Pull the isolating switch forward. **CAUTION:** It has no latch and will pull completely out. However, it weighs only 75 lbs. (34 kilograms) and can usually be handled without a crane or lift.



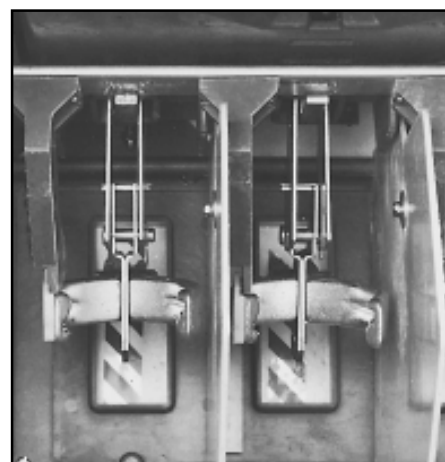
- 9** If no vertical bus bars are present and cable is used to connect power to the line stabs, loosen four pan head screws holding the barrier and shutter assembly approximately three turns. Lift the assembly up and off the screws. Disconnect the shutter drive lever using the keyhole in the lever.



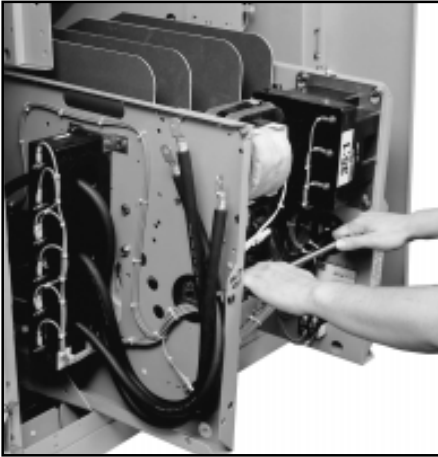
- 10** Refer to load cable instruction tag located at motor terminals (M) for load wiring instructions. Controller is now ready to wire, both line and load.



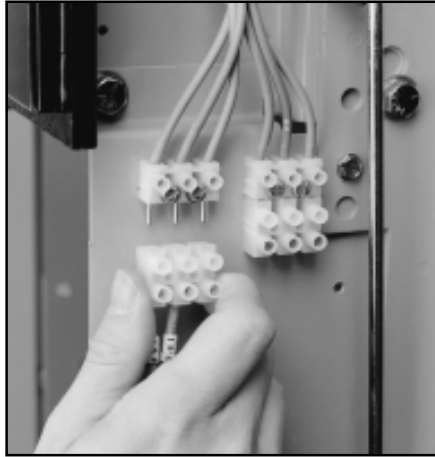
- 11** After wiring, reverse the procedure to reassemble. Slide the isolating switch in place and secure with two bolts. **Refer to Steps 7 and 8.**



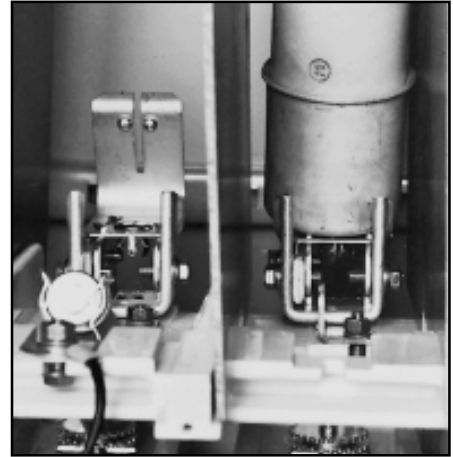
- 12** Check to make sure each fuse clamp is in correct position in fuse locator. Refer to instructions on the lower door.



- 13** Return the contactor to its compartment. Reattach the two positioning bolts.



- 14** Reconnect the clevis attached to the mechanical interlock arm. Reconnect the isolating switch auxiliary contact terminal blocks. Reconnect the contactor control wire terminal blocks. **Refer to Steps 3 and 4.**



- 15** Install the three power circuit fuses. Make sure each fuse is fully seated on the bottom fuse holder located on the contactor.

START-UP PRECAUTIONS

Before attempting to put a newly installed motor controller into service, study the wiring diagram and instruction literature.

General Precautions. Be sure that:

1. The corresponding controller and motor are connected as shown on the Cutler-Hammer drawings. This is particularly essential in this class of motor controller as the fuse ratings, current transformers, and overload protection are based on the characteristics of the particular motor to be controlled.
2. The controller is connected to a suitable power supply with characteristics agreeing with motor and starter nameplate markings.
3. The motor and the machine it drives are properly lined up, bolted down, lubricated, free of obstructions, and ready to go.
4. Connections are neat, tight, of proper capacity and in agreement with the diagram.
5. Equipment has been cleaned of dirt, scraps of wire, tools, and all other foreign material.
6. THE INSULATION LEVEL OF THE STARTER IS CHECKED AND RECORDED BEFORE THE STARTER IS ENERGIZED. See **GENERAL MAINTENANCE**.

7. Enclosure door closes easily. Do not force the door closed but rather look for improperly positioned contactor, fuses, or isolating switch.
8. All safety precautions have been taken and the installation conforms with applicable regulations and safety practices.

For Isolating Switch. Be sure that:

1. The current-limiting motor-starting power circuit fuses have been properly installed. See the permanent operating instructions on the inside of the medium-voltage door.
2. The mechanical interlocking system operates freely to provide the intended protection.



DANGER

OPERATE THE ISOLATING SWITCH ONLY WITH ALL DOORS CLOSED AND COMPLETELY LATCHED. THE ISOLATING SWITCH MAY FAIL TO INTERRUPT IF ITS RATING HAS BEEN EXCEEDED BY AN UNDETECTED INTERNAL FAULT.

For Contactor. Be sure that:

1. THE FOUR PHASE BARRIERS ARE INSTALLED WHEN PROVIDED.
2. The contactor coil is electrically isolated, to prevent feedback into a control power transformer and a hazardous situation.
3. There has been a check, using an extension cord and a separate source of AC control circuit power, of the control circuit functions.

Operate the appropriate pushbuttons to close and open the contactor. If the contactor does not close fully or does not drop out fully, refer to the **CONTACTOR MAINTENANCE** section below.

While the contactor is **closed**, observe the overtravel gap between the pivot plates on the cross bar and the underside of the lower bottle nut on each pole. This overtravel gap should be no less than .075 inch (1.91 mm) when the contactor is new. If less, refer to **Contact Wear Allowance**.

While the contactor is **open**, push the armature rearward with a long screwdriver or other rod applied to the lower end of the armature above the coil terminals. The armature should not move because it should be firmly against the glass polyester main frame. See Figure 11. To correct a problem, see **Changing Operating Coil** under **CONTACTOR MAINTENANCE**.

Disconnect the extension cord and restore the plug into its socket on the contactor chassis.

CHECK-OUT, VACUUM INTERRUPTERS

The dielectric strength of the interrupters should be checked before the contactor is energized for the first time and regularly thereafter to detect at the earliest possible date any deterioration in the dielectric strength of the contact gap since this may result in an interruption failure. Although an AC dielectric test is recommended, a DC test may be performed if only a DC test unit is available. A good vacuum interrupter will withstand a 16kV-60-Hz test or a 23kV-DC test across a .156-inch (4-mm) contact gap. This is the nominal contact gap for a new contactor. When performing DC tests, the voltage should be raised to test value in discrete steps and held for a period of one minute. When tested with an AC high potential tester, expect a capacitance leakage current of approximately 1.3 milliamperes. For a DC tester expect 5 microamperes. Any spark across the contact gap indicates failure.

**CAUTION**

SOME DC HIGH POTENTIAL UNITS, OPERATING AS UNFILTERED HALF-WAVE RECTIFIERS, ARE NOT SUITABLE FOR TESTING VACUUM INTERRUPTERS, BECAUSE THE PEAK VOLTAGE APPEARING ACROSS THE INTERRUPTERS CAN BE SUBSTANTIALLY GREATER THAN THE VALUE INDICATED.

When a vacuum bottle is tested with voltage over 5000 volts across its open gap, there is some possibility of generating X-rays. Test time should be minimized, and personnel should not be closer than 10 feet (3 meters) and preferably located behind some barrier. This is a precaution until such time as the possible hazard is better understood and standards are published.

Periodic dielectric tests across open contacts should not be omitted on the basis of satisfactory contactor performance since under certain operating conditions, the contactor may perform satisfactorily even though one vacuum interrupter has become defective.

The interval between periodic tests depends on the number of operations per day, environmental factors, and experience. It is a matter of operator judgment.

CHECK-OUT, MECHANICAL

One of the features of Ampgard® motor control is the interlocking of the contactor and isolating switch which prevents **opening** the isolating switch when the contactor is closed, and prevents **closing** the isolating switch if the contactor is already closed due to some malfunction. Neither closing nor opening of the isolating switch under load is permissible. The isolating switch interlock arm does not move, except when the isolating switch is being opened or closed.

Similarly, **during the opening or closing** of the isolating switch, the interlock rod on the isolating switch drives the interlock arm of the SJS contactor clockwise so that the heavy end moves down to keep the contactor from closing. If the isolating switch interlock rod is not attached to the interlock arm of the contactor by the clevis shown in Figures 7 and 8, the natural weight of the interlock arm moves the arm to a position which prevents the contactor from closing.

All these interlocks are intended to protect against malfunction. But they should be tested with main POWER OFF prior to start-up (and at intervals thereafter) by simulating improper operation and sequencing of the contactor and isolating switch. Failure to interlock must be corrected before power is applied.

**DANGER**

OPERATE THE ISOLATING SWITCH ONLY WITH ALL DOORS CLOSED AND COMPLETELY LATCHED. THE ISOLATING SWITCH MAY FAIL TO INTERRUPT IF ITS RATING HAS BEEN EXCEEDED BY AN UNDETECTED INTERNAL FAULT.

GENERAL MAINTENANCE

Ampgard® motor controllers should be operated and maintained by authorized and qualified personnel only. Personnel authorized to operate the isolation switch and those authorized to inspect, adjust, or replace equipment inside the enclosure should have a complete understanding of the operation of the controller, and must have thorough training in the safety precautions to be followed when working with medium-voltage equipment.

MAINTENANCE PRECAUTIONS

There is a hazard of electric shock whenever working on or near electrical equipment. Turn off all power supplying the equipment before starting work. Lock out the disconnecting means in accordance with NFPA 70E, "Electrical Safety Requirements for Employee Safety In the Workplace." Where it is not feasible to de-energize the system, take the following precautions:

- a) Instruct persons working near exposed parts that are or may be energized to use practices (including appropriate apparel, equipment and tools) in accordance with NFPA 70E.
- b) Require persons working on exposed parts that are or may be energized to be qualified persons who have been trained to work on energized circuits.

For the purpose of these instructions, a qualified person is one who is familiar with the installation, construction, or operation of the equipment and the hazards involved. In addition, this person should have the following qualifications:

- a) Be trained and authorized to energize, de-energize, clear, ground, and tag circuits and equipment in accordance with established safety practices.
- b) Be trained in the proper care and use of protective equipment, such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established practices.

- c) Be trained in rendering first aid.
- d) Be knowledgeable with respect to electrical installation codes and standards, for example, the National Electrical Code (NEC).

MAINTENANCE PROGRAM

A maintenance program should be established as soon as the controller has been installed and put into operation. After the controller has been inspected a number of times at monthly intervals and the conditions noted, the frequency of inspection can be increased or decreased to suit the conditions found.

Before attempting maintenance, consult the specific circuit diagrams supplied with the controller.

Insulation Level

After installation, and before energizing the controller for the first time, the insulation resistance between poles, and from each pole to ground should be measured and recorded. It is not practical to specify an absolute value for this reading since it is dependent on other connected apparatus and conditions of service. However, any unusually low reading or abrupt reduction in a reading would indicate a possible source of trouble, and the cause should be investigated and corrected.

Fuses

Inspect the current-limiting fuses after each fault-clearing operation, since this is the most severe service to which they will be subjected. Check the fuse resistance, and compare this value with a new fuse. A visual sign of an open fuse is provided by a colored indicator in the top of the fuse. This indicator pops up and is visible when the fuse is blown.

Use the fuse puller to remove and replace blown fuses. The fuse puller is stored alongside the contactor rail. The correct procedure for replacing fuses is described on the operating instruction panel which is permanently fastened inside the door to the medium-voltage compartment. This instruction panel also lists the correct fuse rating and fuse part number for that particular starter. The same type, rating and part number of power circuit fuses must be used for replacement in all cases. If preferred, fuses may be removed and replaced by hand.

If for any reason, there is doubt about the condition of a fuse, a simple test is to check its electrical continuity and resistance.

CONTACTOR MAINTENANCE

All work on this contactor should be done with the main circuit disconnect device open, and using a separate source of control power to operate the magnet. Before applying external control circuit power, make certain that the contactor coil circuit is electrically isolated, to prevent feedback into a control power transformer that could be hazardous. Disconnect power from any other external circuits. Also, discharge any hazardous capacitors.

The basic principles to be followed in the maintenance of all electrical equipment are: (1) keep conducting parts as good conductors and (2) keep insulating parts as good insulators, i.e., tighten and clean.

Much routine maintenance on the low-voltage portion can be done with the contactor partially withdrawn to the balanced position, rather than completely removed. However, the contactor can also be completely removed and taken to a bench.

A bottle wrench and a .020-inch (.51mm) feeler gauge are screw-mounted to the right-hand sidesheet of the contactor when the Ampgard® controller is shipped. The feeler gauge is used to determine the vacuum bottle end-of-life by virtue of contact erosion. One end of the bottle wrench is used to adjust the operating arm associated with the Type L64 auxiliary contacts (see **Auxiliary Contact Adjustment** below) and the other end of the wrench is for use with pre-1983 vintage vacuum bottles.

Insulation Level

Refer to the insulation resistance measurements between contactor poles and from each pole to ground that were recorded at start-up and subsequent intervals. Measure the same points in the same manner and record. Investigate any abrupt reduction in resistance or any unusually low reading.

Dust and moisture are detrimental to electrical equipment and industrial equipment is designed to tolerate a less-than-perfect environment. However, excessive dust can cause trouble, and should be wiped or blown off at appropriate intervals. If the contactor is wet for any reason, dry it until the insulation resistance between poles and from each pole to ground has returned to normal.

The contacts inside the interrupters are immune to dust and moisture and require no attention of this type.

Vacuum Interrupters

Gross loss of vacuum is highly unlikely, but it can be checked easily. With the contactor open, pull upward on the bottle nuts, one pole at a time, using an effort of about 20 pounds (9 kilograms). If the bottle nuts move easily away



Fig. 14 Controller With Doors Open

from their pivot, the vacuum has probably failed and the bottle sub-assemblies must be replaced.

It is also unlikely, but possible, to have a very slight leak that does not change the bottle force appreciably, but which might seriously damage the ability of the bottle to interrupt. In this regard, it must be remembered that in a three-phase circuit, it is possible for any two good interrupters to successfully interrupt the circuit even if the third interrupter is weak. But this condition should not be allowed to continue. It can be detected only by a dielectric test.

Check the dielectric strength of the interrupters before the contactor is energized for the first time and regularly thereafter to detect, at the earliest possible date, any deterioration in the dielectric strength of the contact gap since this may result in an interruption failure. The vacuum interrupters should be tested as specified in the section **CHECK-OUT, VACUUM INTERRUPTERS**.

CONTACTOR MAINTENANCE (Continued)

Contact Wear Allowance

Contact material vaporizes from the contact faces during every interruption and condenses elsewhere inside the bottle. This is normal, and is provided for by overtravel, or wear allowance. When the contactor is fully closed, there is a gap between the lower bottle nut and a pivot plate. See Figure 12. As the contacts wear, this gap decreases. When the gap goes below .020 inch (.51 mm) on any pole, all the bottle subassemblies should be replaced. Use the .020-inch (.51-mm) thick fork-shaped overtravel feeler gauge supplied for this measurement, part no. 5259C11. **DO NOT RE-ADJUST THE BOTTLE NUTS TO RESET OVERTRAVEL AS THE CONTACTS WEAR.** Once placed into service, overtravel should be checked but not adjusted.

Inspection After Short Circuit Or Overload

The Type SJD contactor is intended to be protected by power circuit fuses in accordance with the NEC. However, the magnitude of a short circuit may exceed the damage threshold of the vacuum bottles. After the interruption of any short circuit, particularly after a major one that might have been near the maximum MVA rating of the controller, examine the unit for any apparent physical damage, or deformation of conductor bars and cables. If there is any evidence of severe stress, all bottle subassemblies must be replaced. If the overtravel has changed significantly (from the last inspection) on one or more bottles, replace all bottle subassemblies.

A dielectric test does not by itself confirm that the bottles should be returned to service after a fault. However, if there is no physical evidence of stress, and if the overtravel exceeds the .020-inch (.51-mm) minimum, the bottles can then be dielectrically tested as outlined previously. If physical stress, overtravel, and dielectric test results are within acceptable limits, it is reasonable to return the contactor to service after a fault.

Magnet Operating Range

When properly adjusted as described in previous sections, the contactor should operate within the ranges shown in Table II.

Operating Coil

The standard operating coils are shown in Table III. They should be supplied directly from an AC or DC source with sufficient volt-ampere capacity to maintain coil voltage during inrush while closing. No external resistors are required.

TABLE II. COIL PERFORMANCE

Rated Coil Voltage	Pick-Up-To-Seal Voltage		Drop-Out-To-Full-Open Voltage	
	Above	Below	Below	Above
110-120 VAC	50	96	75	10
125 VDC	55	100	82	11
220-240 VAC	100	192	150	20
250 VDC	110	200	164	22

TABLE III. OPERATING COILS

Coil Part No.	7860A34G02	7860A34G04
AC Rating	110-120 VAC 50-60Hz	220-240 VAC 50-60Hz
AC Inrush AC Sealed	1300 VA 25 VA	1400 VA 26 VA
DC Rating	125 VDC	250 VDC
DC Inrush DC Sealed	1500 VA 28 VA	1600 VA 29 VA
Replacement Coil Kit Part No.	2147A48G11	2147A48G21

Changing Operating Coil

The contactor operating coil has a pick-up winding which is intermittently rated. It may burn out in only minutes if continuously energized at rated voltage and the L63 auxiliary contact does not open correctly.

The coil contains its own rectifier to convert applied AC into unfiltered full-wave rectified DC. When parts are in alignment and the coil is at rated voltage, the magnet will be silent. At reduced voltage, a slight hum is acceptable. However, the magnet must not chatter.

If for some reason a coil must be changed, proceed as follows:

1. Deenergize **all** circuits.
2. Loosen the set screw holding the kickout spring adjusting screw. See Figure 6.
Loosen the kickout spring adjusting screw until the kickout spring can be removed easily.
NOTE: Whenever adjusting the kickout spring lever, put a free hand over the kickout spring as a precaution.
3. Remove leads to coil terminals, noting their position for later reconnection.
4. Remove the two 0.313-inch magnet mounting bolts. Remove the bolts completely and set aside until later.
5. Lift magnet and coil upward and out.
6. Remove the coil clip from old coil and install on the new coil. Note that the coil clip is **THREADED**. Remove the coil lock nut before removing the screw. When installing the clip on the new coil, tighten the screw only to snug. Then lock the screw into the coil clip with the lock nut. Note that the head of the screw must be toward the armature.
7. Re-install the magnet into the coil, and lower both into position. Do not force. Sometimes it is necessary to jiggle the coil slightly into its sealed position.
8. Install the two magnet mounting bolts, but do not tighten.
9. Re-connect the coil circuit.
10. After checking for safe operation, energize the coil and close the contactor. While the magnet is sealed, tighten the two magnet mounting bolts, using continuing care against shock. Then de-energize the coil.
11. Re-install the kickout spring, making sure to put the two ends of the spring wire downward, so that the spring will take a natural bow. Tighten the adjusting screw until the kickout spring lever is approximately vertical, and the armature is solidly against its stop on the molded frame. See Figure 12. When a screwdriver is pushed against the bottom end of the armature in the open position, the armature must not move. If it does, the kickout spring should be tightened further to push the armature to a solid position. Tighten the set screw to lock the kickout spring adjusting screw.

If the magnet chatters, look for mechanical interference that prevents the magnet from sealing. If there is no interference, then the magnet itself may be misaligned. The magnet gap can be seen from the left and the right sides with the help of a flashlight. The stationary magnet can be aligned with a 0.50-inch (12.7mm) diameter steel rod inserted into the two holes in the core of the magnet

and used as a lever to put a corrective set into the magnet frame. It should not be necessary to do this unless the contactor has been damaged and it can be seen that the armature does not fit against the magnet. A poor magnet-to-armature fit usually produces a high dropout voltage and/or chatter.

Mechanical interference can be produced by various incorrect adjustments. Two specific points to check are:

- A. Armature travel incorrect, causing the contact springs to be compressed into a solid, non-resilient "tube" that stops the crossbar rigidly. Call Cutler-Hammer Service for assistance.
- B. The auxiliary contact assemblies operating arms are misadjusted, so that a contact plunger bottoms solidly before the magnet seals. When the contactor is fully sealed closed, there should still be a small amount of travel remaining for these plungers. Adjust as described below.

Contactor Auxiliary Contacts

Two Type L64 auxiliary contact assemblies are mounted on the contactor front (right side) to provide four isolated auxiliary, 600 VAC, 10 ampere, double-break contacts for use in control circuits. Any combination of normally-open or normally-closed circuits is available by selection of the appropriate assembly from Table IV.

The normally-open (NO) L64 auxiliary contacts close just after the main contacts of the contactor close. The normally-closed (NC) L64 auxiliary contacts open just before the main contacts close.

In addition, a single-circuit Type L63 auxiliary contact (normally-closed) is mounted on the front (left side) and is connected to coil terminals C and D. This auxiliary contact (578D461G03) is equipped with permanent magnet blowouts on the contacts.

TABLE IV. TYPE L64 AUXILIARY CONTACTS

Part Number	Circuit Combination Provided By One Auxiliary Contact Assembly
843D943G21	One Normally-Open and One Normally-Closed
843D943G22	Two Normally-Open
843D943G23	Two Normally-Closed

CONTACTOR MAINTENANCE (Continued)

Auxiliary Contact Adjustment

The $0.410 \pm .010$ -inch ($10.4 \pm .25$ -mm) gap shown for the normally-closed Type L63 auxiliary contact in the insert picture in the lower portion of Figure 12 is factory set. The 0.410-inch (10.4-mm) gap is important and must be held. If the gap is too large, the hold-in winding of the operating coil will not be inserted as the contactor closes, causing the pick-up winding in the coil to burn out. The pick-up winding is intermittent-duty rated. If the 0.410-inch (10.4-mm) gap is too small, the hold winding will be inserted too soon, reducing the pull force before the contactor is closed, producing an oscillation of the armature similar to an old doorbell.

The Type L64 auxiliary contact adjustment is not as critical. In the open-contactor position, the L64 plunger should rest lightly against the operating arm. Neither the L63 or L64 assemblies should bottom solidly in the closed contactor position, as discussed under **Magnet Operating Range**.

A bottle wrench and a .020-inch (.51-mm) feeler gauge are screw mounted to the right-hand sidesheet of the contactor when the Ampgard® controller is shipped.

After an L64 auxiliary contact is added or replaced, adjustment can be made by bending the operating arm with the forked end of the bottle wrench. See Figure 15.

After an L63 auxiliary contact is replaced, gap adjustment may be made by first loosening the jam nut on the operating arm with a 0.438-inch open-end wrench. The gap size is changed by rotating the 0.25"-20 bolt. Clockwise rotation will increase the gap distance. Counterclockwise rotation will decrease the gap distance. Use a Vernier calipers or a 0.410-inch (10.4-mm) feeler gauge to measure the gap size. After the gap has been set, tighten the jam nut against the interlock operating arm. A heavy-duty contactor closing tool which can be used as a manual operator is available. Order Part No. 2147A47G17.

Vacuum Bottle Subassembly Replacement

If it becomes necessary to replace vacuum bottles, obtain Vacuum Bottle Subassembly Replacement Kit part number 2147A47G13, and follow the enclosed instructions. This kit includes three bottle subassemblies, as all bottle subassemblies must be replaced at the same time.

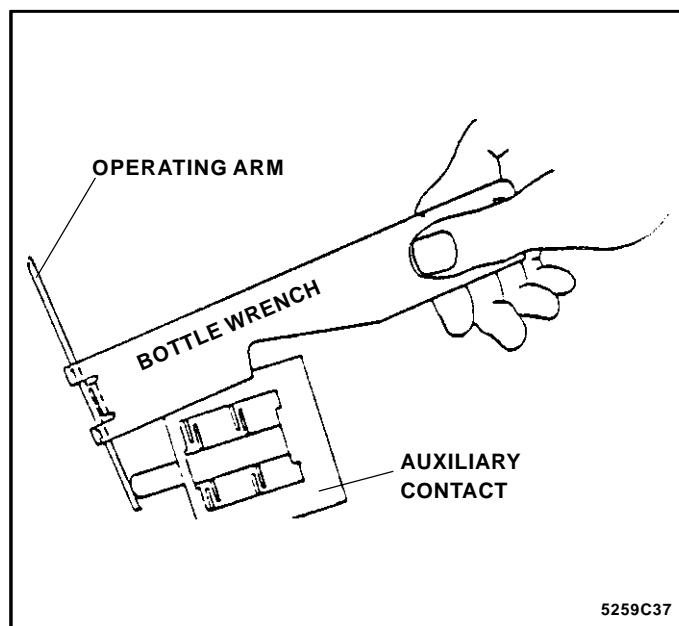


Fig. 15 Adjustment of Type L64 Operator

TABLE V - RENEWAL PARTS

Item	Replacement Kit No.
Vacuum Bottle (3) Subassemblies	2147A47G13
Feeler Gauge and Bottle Wrench	2147A47G15

CONNECTION DIAGRAM

Figure 17 shows the routing of the conductors and connection points to the internal portion of the SJS control circuit. The conductor cable pattern shown in Figure 17 is used for both two-pole and three-pole contactors. For interconnections with other Ampgard® components, see the wiring diagram furnished with the order.

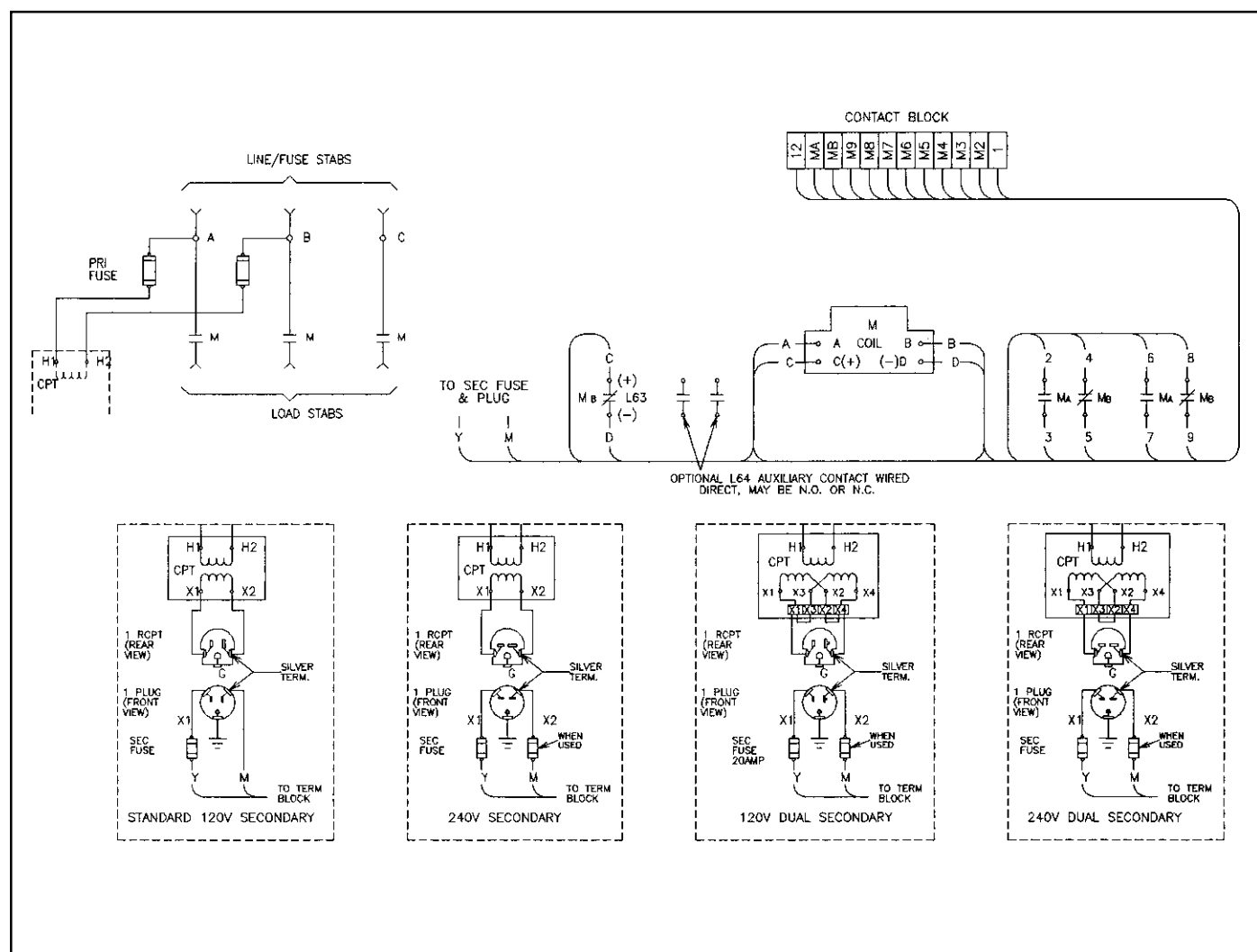


Fig. 16 Cable and Connection Diagram

ISOLATING SWITCH MAINTENANCE



DANGER

OPERATE THE ISOLATING SWITCH ONLY WITH ALL DOORS CLOSED AND COMPLETELY LATCHED. THE ISOLATING SWITCH MAY FAIL TO INTERRUPT IF ITS RATING HAS BEEN EXCEEDED BY AN UNDETECTED INTERNAL FAULT.

When the isolating switch is removed from the starter structure, a latch lever on the shutter assembly is activated. It is designed to hold the insulating shutter closed. This latch may be deliberately by-passed and the shutter moved to the open position. Caution should be observed since the exposed line terminal stabs of the starter may be energized at line potential.

When the isolating switch is replaced in the structure, the latch lever is automatically released to allow the shutter to operate normally.

Lubrication

Periodically, apply a light coating of Dow Corning DC-4 high temperature silicone grease (or equivalent) to the tips of the fuse jaw fingers where they engage the line terminal stabs. Also clean and lubricate the tray guide rails of the isolating switch. See Figure 10.

Welded Jaws or Contacts

In the unlikely event that either the isolating switch fuse jaws or the contactor contacts should weld closed, or if an event should occur such that the isolating switch handle cannot be moved from the ON to the OFF position, provision has been made so that the door to the medium-voltage compartment can be opened in an emergency. The door can be opened by using the following procedure:

1. Make sure that the main incoming power line is de-energized, to avoid a hazardous situation when the door is opened.
2. Remove the four screws holding the rectangular handle housing of the isolating switch to the front casting. (See Figure 6.)
3. Disconnect the leads between the isolating switch auxiliary switches and their pull-apart terminal blocks.
4. The complete handle housing can now be pushed up far enough to provide clearance for opening the door and any maintenance to be carried out.

As a final precaution before touching any of the electrical parts of the starter with the isolating switch removed, visually check to make certain that the shutter is closed, the green and white striped labels are visible, the grounding fingers are in contact with the ground bar, and the tips of the fuse fingers are visible.

Auxiliary Contact Replacement

The auxiliary switch kit, part number 2147A01G01, consisting of two auxiliary contact switches mounted to a spring plate and leads, is designed for replacing auxiliary switches used with Ampgard® isolating switches. The kit includes two switch mechanisms, each with an inductive-load rating of 20 amperes at not more than 250 VAC. These switches serve as the low-voltage cutoff switch.

Assemble the auxiliary switches as shown in Figure 17. Carefully remove the old switches from the rear of the door interlock spring housing. Do not remove the spring or door interlock pin. Discard the old spring plate. Use spring plate mounting hardware to mount the auxiliary switch assembly to the spring housing.

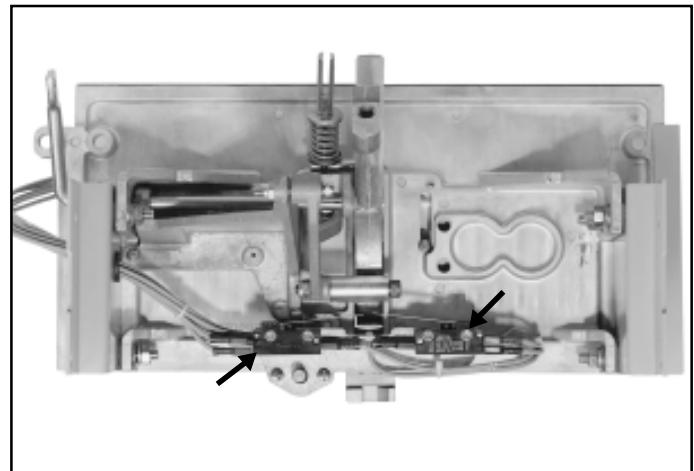


Fig. 17 Auxiliary Switch Installation

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