

CONTACTORS, EMERGENCY CELL SWITCHES,  
 RELAYS, AND STARTERS

1. GENERAL

1.01 This section covers contactors, emergency cell switches, relays, and starters produced by several manufacturers. Some have KS designations, the remainder having only the manufacturer's code number. The following table lists the equipment covered.

TABLE A

<u>Contactors</u>	<u>Starters</u>
Allen Bradley KS-5757 KS-15072 KS-15674 Bulletin 702	Allen Bradley KS-5309 KS-15584
Electric Products Type R	Cutler Hammer KS-5090 KS-5093 KS-5091
Ward Leonard K-40818 K-41059 K-40861 K-41060 K-40950 K-42506 K-42814 Bulletin 1901, Size 2 Bulletin 4401, Size 4	Ward Leonard KS-5505 KS-5543 KS-5770  K-40796 K-40908 K-40797 K-40910 K-40798 K-40923 K-40799 K-40947 K-40807 K-40985
<u>Emergency Cell Switches</u>	K-40808 K-40986 K-40809 K-40987
Palmer Electric KS-5312	K-40855 K-40988 K-40907
<u>Relays</u>	<u>Relays</u>
Ward Leonard Bulletin 106 Bulletin 130 Bulletin 131 Bulletin 132	Allen Bradley KS-15602

1.02 This section is reissued to add a test to check the operation of the overload relay, to add the KS-15674 dc contactor, the KS-15584 across the line starter, the Weston Model 931 voltmeter, to revise Fig. 10, and to add Fig. 11.

1.03 Reference shall be made to Section A400.001 covering general requirements and definitions for additional information necessary for the proper application of the requirements listed herein.

1.04 Requirements and associated procedures marked with a number sign (#) need not be checked by the installer, unless it is thought that the requirement is not being met or performance indicates that such a check is advisable.

1.05 Requirements and associated procedures marked with an asterisk (\*) need not be checked during maintenance, unless the apparatus or part is made accessible for other reasons, or performance indicates that such a check is advisable.

1.06 In the text, the word relay is used to denote contactor, emergency cell switch, relay, or starter unless a more specific reference is required.

1.07 For the purpose of this section, whether contacts of a relay are normally open (NO) or normally closed (NC) depends on the position of these contacts when no operating current is flowing in the coil and not on the position the contact may normally be in for a particular application. NO contacts and NC contacts are sometimes known as front and back contacts, respectively.

1.08 A relay is said to operate when the armature has moved sufficiently for NC contacts to open and NO contacts to close with reliable contact.

1.09 A relay is said to release when the armature has moved sufficiently for NO contacts to open and NC contacts to close with reliable contact.

1.10 When work is done on a relay in an operating circuit, see that service is maintained. When the voltage of the power supply is more than 150 volts to ground, disconnect the supply; when less, do not touch, at the same time, live terminals or parts which are at different potentials or otherwise short-circuit them.

1.11 Where the construction is such that adjustments are not practicable, failure of a relay to operate satisfactorily should be corrected by replacing the appropriate parts or the entire relay.

1.12 Requirements 2.01 to 2.06, inclusive, 2.09, and 2.10 have general application, except with respect to the Cutler Hammer starters, to which requirements 2.01, 2.02, and 2.10 only apply. The following requirements apply to particular apparatus and are to be considered in addition to the general requirements:

- 2.07 Overload Relays
- 2.08 KS-5309 and KS-15584 Starters

1.13 Orders for parts needed for replacement should give the nameplate date of the contactor, including the manufacturer's name, type or bulletin number, and serial number, KS and list numbers if any, together with a description of the part.

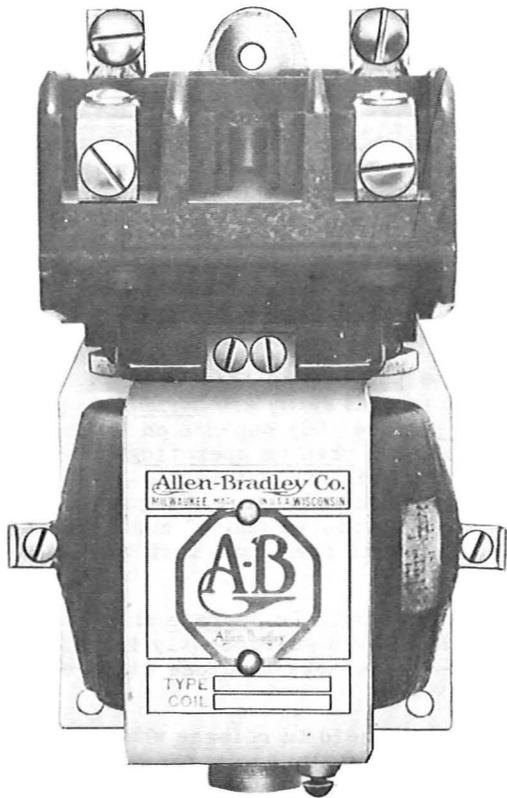


Fig. 1 - Contactor, KS-15072, 25-ampere Size



Fig. 2 - Contactor, KS-15072, 50-ampere Size

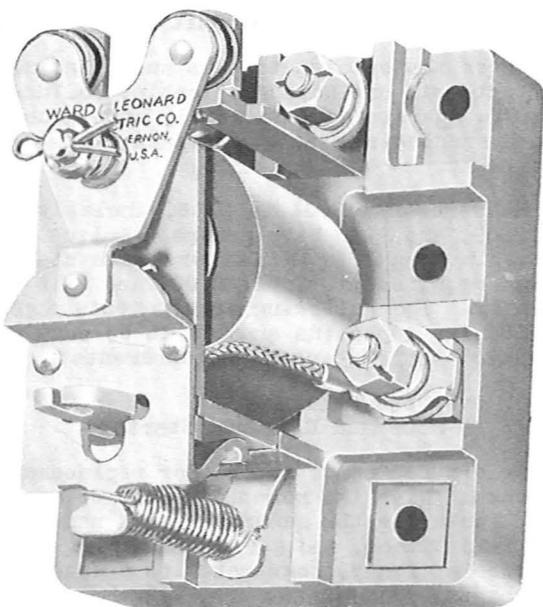


Fig. 3 - Relay, Ward Leonard, Bulletin 106

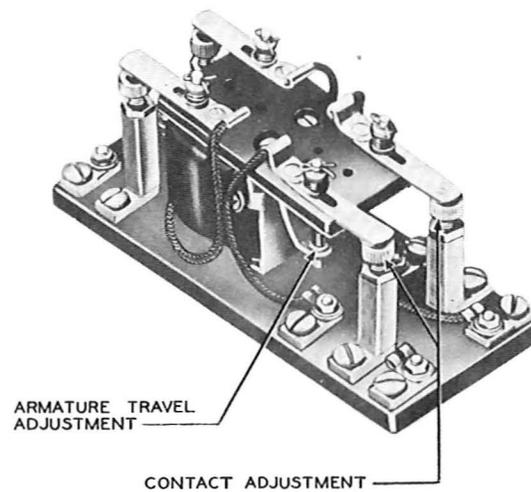


Fig. 4 - Relay, Ward Leonard, Bulletin 131

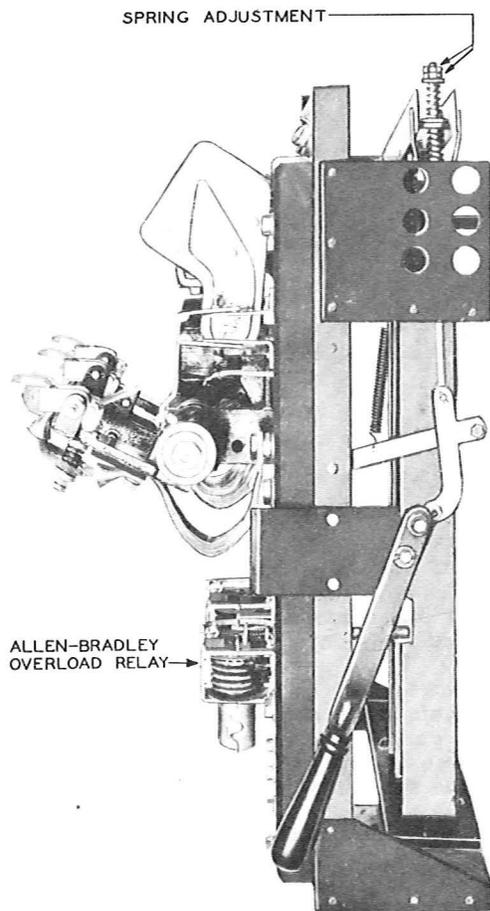


Fig. 5 - Starter, KS-5309

## 2. REQUIREMENTS

2.01 Mounting: All mounting bolts or screws shall be tight. Fastenings holding components together shall be secure.

Gauge by feel.

2.02 Contact surfaces shall be clean and free from build-ups which might interfere with reliable contact.

Gauge by eye.

2.03 Contact Alignment: Each pair of contacts shall be aligned so that, when the relay is operated, the outer edge of one contact does not overlap the outer edge of the other by more than 1/8 of its diameter or width at turn-over, and not more than 1/4 during life. In no case shall the overlap exceed 1/8 inch.

Gauge by eye.

### 2.04 Contact Sequence

(a) Unless otherwise specified, all NO main contacts on a relay shall make and break approximately simultaneously and all NC main

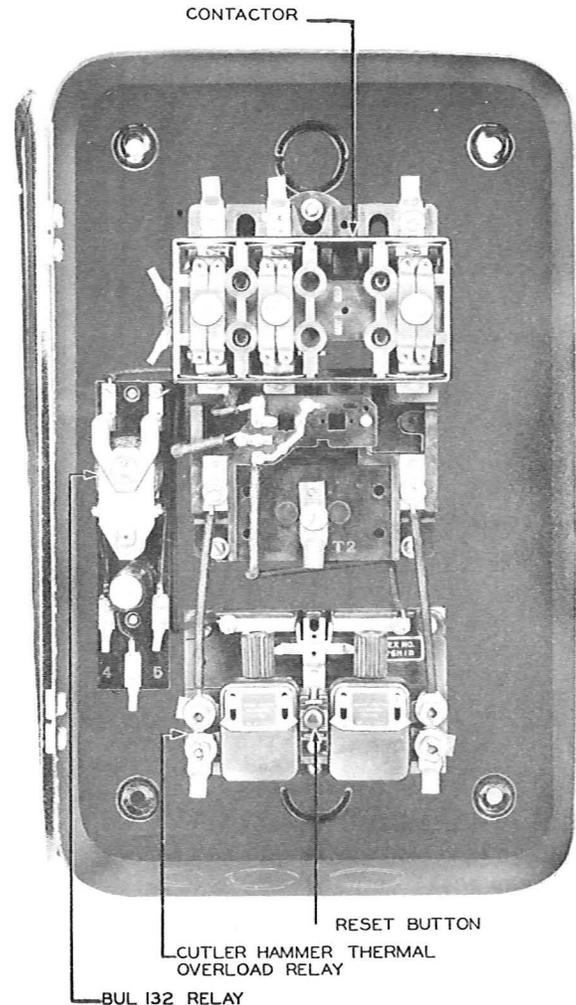


Fig. 6 - Starter, KS-5505

contacts shall break and make approximately simultaneously.

Gauge by eye.

(b) Auxiliary NO contacts, where present, shall make just before the main contacts make.

Gauge by eye or use 81A test set.

### KS-5312 Emergency Cell Switch

\*#(c) Contact sequence when operating shall be

Contacts 4 and 5	make
Contacts 2 and 3	break
Contacts 6 and 7	make
(Mechanical latch operates)	
Closing coil contacts	break
Tripping coil contacts	make

Gauge by eye.

### 2.05 Contact Gap

(a) The contact gap shall be as specified in the Circuit Requirements table.

Use scale.

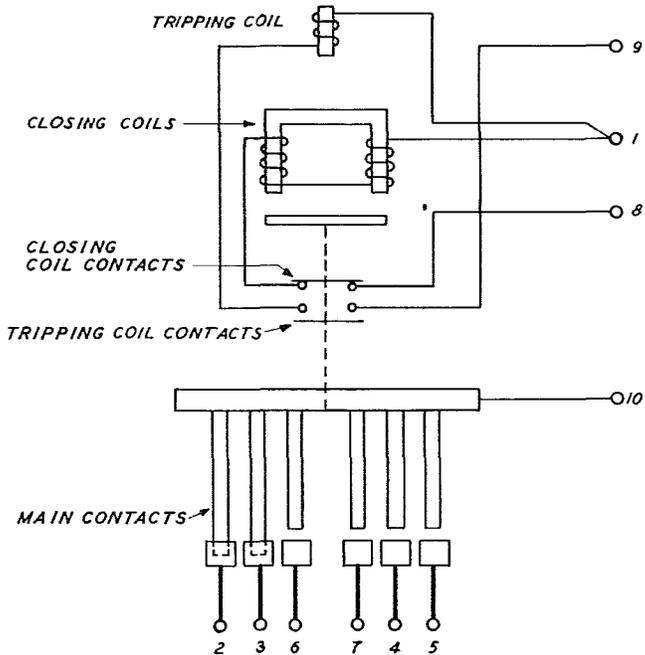


Fig. 7 - KS-5312 Emergency Cell Switch Schematic

Ward Leonard Equipment

(b) Unless otherwise specified, the contact gap shall be

Contactors (Main Contacts)

	Min
K-42506 and K-42814	3/4 In.
Bul 1901 Size 2	9/16 In.
Bul 4401 Size 4	3/4 In.

Use scale.

(c) If the contact gap is not specified, like contacts on the same relay shall have approximately the same gap. In no case shall the gap be so small that the arc formed at the opening of the circuit is not extinguished promptly.

Gauge by eye.

2.06 Contact Pressure and Follow

(a) Contact pressure, as measured with the contacts closed, shall be as specified in the Circuit Requirements table.

(b) When not specified in the Circuit Requirements table, the contact pressure shall be as specified in the following table.

Ward Leonard

<u>Contactors</u>	<u>Min</u>		
	<u>lbs</u>	<u>ozs</u>	<u>grams</u>
K-42506	5	8	2500
K-42814	2	0	925

<u>Contactors</u>	<u>Min</u>		
	<u>lbs</u>	<u>ozs</u>	<u>grams</u>
Bul 1901, Size 2, Main contacts	1	12	800
Bul 4401, Size 4, Main contacts	5	8	2500

Relays

<u>Bul 106</u>	<u>grams</u>	
	<u>NO contacts</u>	<u>NC contacts</u>
	20	10
<u>Bul 130, Bul 131, and Bul 132</u>	<u>grams</u>	
	<u>NO contacts</u>	<u>NC contacts</u>
	50	45

Use spring balance or gram gauge, as applicable.

(c) In general, there is an additional movement of the operating mechanism after the contacts touch. This usually results in the sliding of one contact on the other or in an increase in the contact pressure and is known as follow. It is necessary that the follow be checked where, due to the construction, contact pressure cannot be measured, or where specific values of contact pressure are not available. In such cases, contact follow shall be as specified in the following table.

<u>Allen Bradley Contactors</u>	<u>Min</u>
→ KS-5757, KS-15072, KS-15674, Bul 702	1/16 In.

Ward Leonard Starters

KS-5770	1/16 In.
Gauge by eye and feel.	

(d) The laminated main contacts of the KS-5312 emergency cell switch shall flex noticeably when making and breaking contact. When fully closed, all leaves of the laminated contact shall be separated one from the other. Gauge by eye.

(e) The contacts of the KS-15602 overcurrent relays are not adjustable.

\*#2.07 Overload Relays

(a) Overload relays, except KS-15602, where present and adjustable, shall be adjusted to operate at a value not exceeding 115 per cent of the full-load running current given on the motor nameplate.

Gauge by eye.

(b) KS-15602 overcurrent relays shall be adjusted to operate at the values of current listed below:

<u>List No.</u>	<u>Trip Current (Amps)</u>
1	65
2	105
3	135

2.08 KS-5309 and KS-15584 Starters

(a) The starter shall be capable of starting and smoothly accelerating its associated motor.

Gauge by sound.

2.09 Electrical Requirements

(a) The relay shall meet the electrical requirements specified in the Circuit Requirements table or other job information.

(b) Where electrical requirements are not specified in the Circuit Requirements table, operation of the relay shall be checked at any voltage available within the voltage range on the relay nameplate. Where a specific value of voltage is given, the range shall be taken as  $\pm 10$  per cent.

(c) Check of electrical requirements may be at the temperature at which the relay is found by the test man, unless H (hot) or C (cold) is specified in the Circuit Requirements table.

Note: Where electrical requirements are not specified in the Circuit Requirements table or other job information, normal operation of the relay is considered a satisfactory check, as indicated by (b) and (c), and this would also apply where no nameplate range or other operate values are available.

(d) Where H is specified in the Circuit Requirements table without heating instructions, the relay coil shall be energized for at least one hour prior to the test.

(e) Where C is specified in the Circuit Requirements table without cooling instructions, the relay shall be de-energized for at least 2 hours prior to the test.

#2.10 Temperature: The temperature of KS-15602 overcurrent relays shall not exceed

	<u>Max</u>
Current Coil	115C (239F)
Frame	95C (203F)

The temperature of other equipment covered in this section shall not exceed

	<u>Max</u>
Coils	105C (221F)
Solid Contacts	115C (239F)
Laminated Contacts	70C (158F)

If the temperature is thought to be excessive, measure by thermometer.

3. ADJUSTING PROCEDURES

3.001 List of Tools, Gauges, Materials, and Test Apparatus (Equivalents may be substituted)

Tools

Burnisher, contact, No. 265C  
File, pillar, 6 inches, R-1051  
Pliers, P-long-nose, 6-1/2 inches  
Pliers, combination

← Screwdriver, cabinet, 3 inches

Screwdriver, regular, 4 inches

Screwdriver, Stanley #2012

Spudger, fiber R-1102 ←

Test Set, 81A (Buzzer)

Wrench, adjustable, single end, 6 inches, R-1542

Wrench, 1/4 inch and 3/8 inch, hex., open double end, No. 417A tool

Gauges

Balance, spring, R-2771, 0-6 lbs ←

Gauge, push-pull tension, 79-B, 0-1000 grams

Gauge, push-pull tension, 79-C, 0-200 grams

Gauge, push-pull tension, 79-F, 0-6000 grams

Gauge, 70-D, 50-0-50 grams

Scale, steel, R-8550

Thermometer, 0-200C, R-1032

Voltmeter, ac, Weston model 528, ranges 300-150

Voltmeter, dc, Weston model 280 or 281, ranges 150-60-30 or preferred Weston model 931, ranges 300-150-75-30 ↴

Materials (See Sections A710.011 and A710.012)

Cloth, cleaning, KS-14666 ←

Cloth, abrasive, 150 grade

Oil, dashpot

Pad, felt

Spirits, petroleum

Test Apparatus ↴

Autotransformer, continuously tapped (Variac, 8-amp, 230-volt input, type V-20HM or equivalent, General Radio Co, Cambridge, Mass., suggested)

Fuse, 10 amps, 250 volts

Test Set, 35D or F type

Transformer, current, type JKR-2, cat. No. 7930, 5:800 amperes, General Electric Co. ↴

3.002 General Procedure

(1) It is recommended that requirements be checked and any required adjustments be made in the order outlined in the following paragraphs.

3.01 Mounting (Rq 2.01)

(1) Tighten loose screws and bolts with a screwdriver or an appropriate wrench.

3.02 Contact Surfaces (Rq 2.02)

(1) The purpose of cleaning contacts is to remove any gummy or dirty substance that would interfere with reliable contact. It is not necessary or desirable to keep the contacts polished or shining. Clean them by wiping with a cloth moistened with petroleum spirits, fol-

lowed by a dry cloth. The contacts should be disconnected from the power supply during the cleaning operation.

↳ **Note:** Silver contacts should not be filed. They should be cleaned as in (1) and if the build-up is excessive, should be replaced.

(2) There shall be as little smoothing of contacts as is consistent with satisfactory operation. Contacts should be smoothed while closed, when practicable. For contacts disconnected from the power supply, insert a burnishing tool or a strip of abrasive cloth (for contacts connected to power, abrasive cloth only) between the contacts to be smoothed, if the construction permits, and draw it back and forth until the build-ups are reduced enough to insure reliable contact. For larger copper contacts, a file may be used, if necessary. Clean the contacts as outlined in (1) after smoothing.

(3) Contacts which are badly worn should be replaced, together with their associated springs, if they are attached by riveting, as in the case of the Ward Leonard relays.

Allen Bradley Contactors

(4) Access to the main contacts can be had by removing the arc chamber. Use the 3-inch cabinet screwdriver for the smaller contactor and the 6-inch adjustable wrench for the larger. The instruction relative to the contacts, "Never clean, etc." which appears on some nameplates refers to the use of a file. If the contacts fail to meet the requirements for freedom from build-ups, they may be smoothed with the burnisher or with abrasive cloth

while the arc chamber is removed. If any of the contacts should require replacement, replace the entire set. The stationary contacts are replaced by replacing the entire arc chamber in which they are mounted. To replace the movable contacts, press down with the fingers, rotate the contact bar 90 degrees, and lift it off the stud. Install the new contacts by a reverse operation.

(5) Where auxiliary contacts are present, they may be cleaned as outlined above. To replace them, it will be necessary to dismantle the contactor.

Ward Leonard Contactors

(6) Access to the main contacts in the type of contactors shown in Fig. 8 can be had by removing one screw from each side of the contactor, thus releasing the head. One screw is located close to the auxiliary switch and the other in a corresponding position on the other side of the contactor.

(7) The movable contacts can be released for replacement by removing the slotted collars. The stationary contacts can be removed with a screwdriver.

(8) The contacts in totally enclosed auxiliary switches are not accessible. If they fail to make reliable contact, or if oil or grease is observed in the mechanism, remove the switch and place it in some convenient vessel containing petroleum spirits until the oil or grease is removed. Operate the switch manually while wet with the spirits to clean the contacts. Allow the switch to become completely dry before replacing it in the circuit.

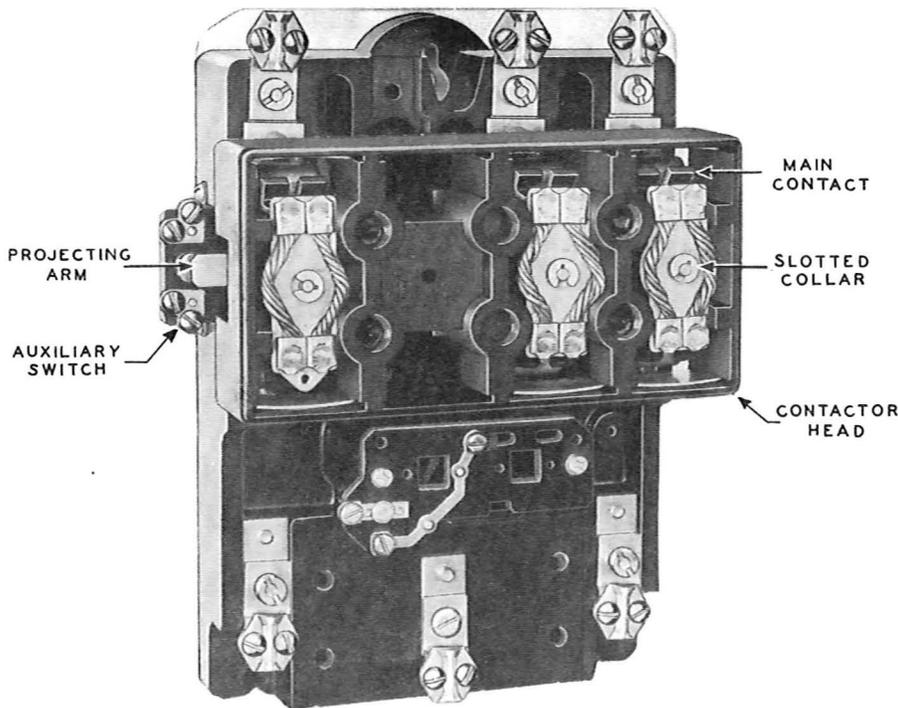


Fig. 8 - Ward Leonard Contactor, K-40818

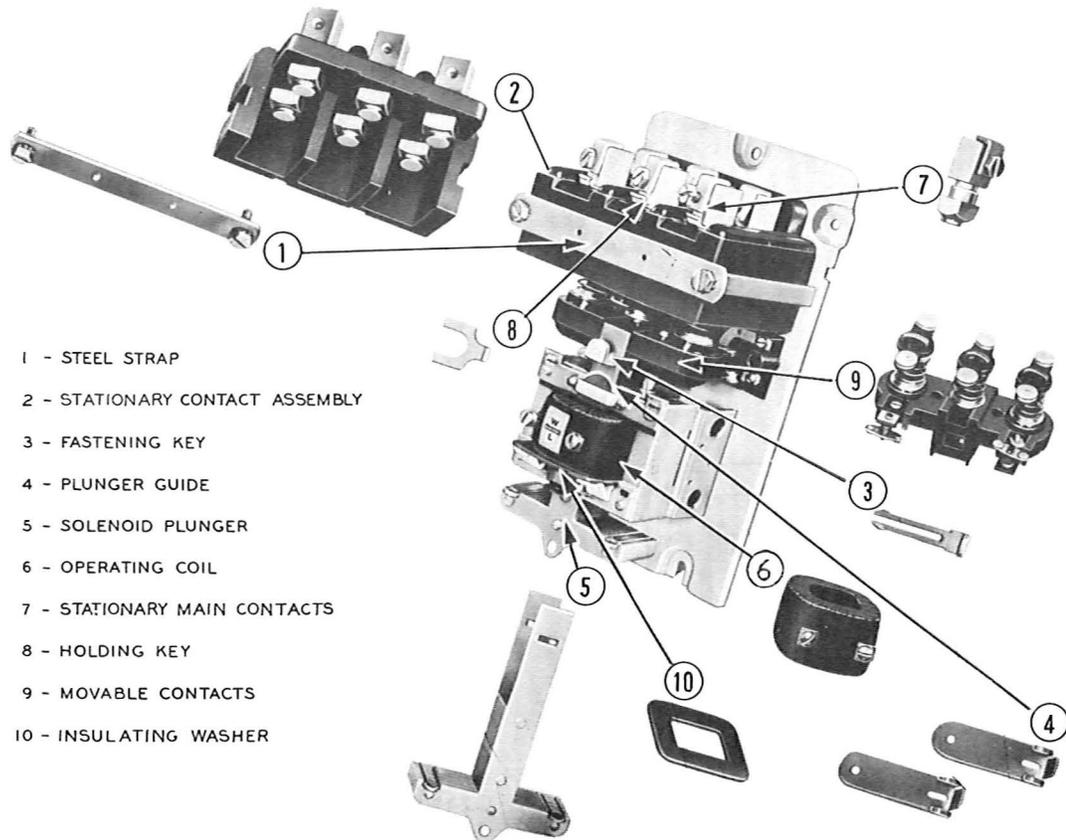


Fig. 9 - KS-5770 Starter

KS-5770 Starter

(9) To obtain access to the main contacts, remove the steel strap (1) and slide out the contact assembly. The stationary main contacts (7) can be removed individually for replacement by removing the associated key (8) and rotating the contact. To remove movable contacts, press down, rotate 90 degrees, and withdraw. If the contacts fail to meet the requirements for freedom of build-ups, they may be smoothed with the burnisher or with abrasive cloth while the contact assembly is removed from the starter. See Fig. 9.

3.03 Contact Alignment (Rq 2.03)

(1) Where feasible, correct by making necessary adjustments with pliers. In other cases, correct by loosening the bolts which hold the contact carrying arm on the shaft to obtain play, and moving the arm as required. Tighten the bolts before leaving.

(2) If alignment cannot be obtained, make replacements as required.

3.04 Contact Sequence (Rq 2.04)

(1) If associated contacts do not make or break approximately simultaneously, inspect the group for any that are out of alignment with

the others. Correct by shaping the contact springs with the pliers or raising or lowering stationary contact assemblies, as required, to bring them into alignment with the others of the group. When the contacts are supported by heavy members not susceptible to shaping with the pliers, check for mechanical trouble which may require the replacement of parts. Check 2.03, 2.05, 2.06, and 2.08 after any change.

3.05 Contact Gap (2.05)

(1) When a metal scale is used for checking contact gaps, the contacts must be disconnected from the power supply.

(2) For relays having contacts on but one end of the spring, measure the contact gap of NC contacts with the relay operated and of NO contacts with the relay released.

(3) For relays having NC and NO contacts on opposite ends of the same spring, the contact gap of each should be measured while its associated contact is just made, without any follow or flexing of the contact pressure spring. The armature should be moved by hand.

(4) To change the contact gap of relays having both NO and NC contacts, or NC contacts only, raise or lower the stationary NC contacts, as required, by rotating them on their supporting screws, or by shaping with pliers, if the contact is mounted on a flat strip. Where only NO contacts are present, the work should be done in a similar manner on the stationary contacts.

(5) For contactors of the general type of the Ward Leonard Bulletin 4401, measure contact gap in accordance with (2), as applicable. Adjust by shaping the movable contact support.

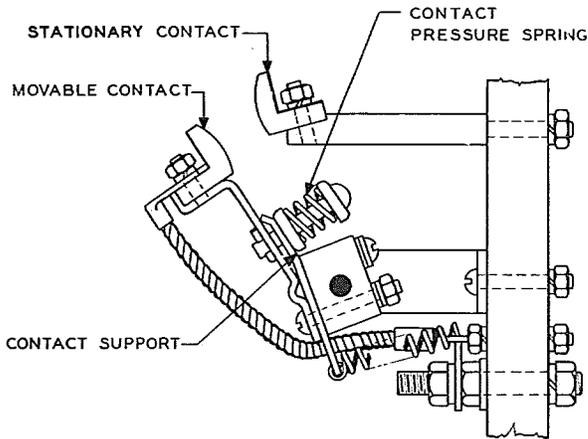


Fig. 10 - Contactor, Ward Leonard, Bulletin 4401

### 3.06 Contact Pressure and Follow (Rq 2.06)

(1) To measure the contact pressure of NO contacts, operate the relay electrically by a temporary circuit or hold the armature securely against the pole face with a screwdriver, taking care not to press on any part of the contact spring which supports the moving contact nor to force the armature out of alignment. Place the gauge against the contact spring as near to the moving contact as possible and exert a pressure with the gauge away from the stationary contact. Read the gauge as the moving contact leaves the stationary contact. With the larger contacts, it may be necessary to pass a loop of cord between the contact and the hook of the spring balance.

(2) To measure the contact pressure of the NC contacts, proceed in a manner similar to that outlined in (1), but allow the armature to be held in its nonoperated position by the pull of its spring.

(3) In readjusting, it is desirable to have as much tension on the various springs as is consistent with meeting other requirements. Either the fan-type gauge or the push-pull tension gauge may be used for measuring contact pressures. When access to the contact springs is impossible with the fan-type gauge, the push-pull gauge must be used. When one

contact spring has been shaped or otherwise changed, or when the position of a stationary contact is changed, recheck the contact pressure on all the contacts on the relay.

(4) Contact pressure may be adjusted by raising or lowering the stationary contacts (see 3.04). This should be resorted to in the case of NC contacts only after getting whatever adjustment is available by changing the tension of the armature spring. The details of this procedure are different, depending upon the design of the relay and can be determined by inspection. In some designs, the spring is terminated on a screw which can be turned to increase or decrease the tension as required, and finally locked in position by a nut or other means. In others, the spring is terminated on a tang which is adjustable by the use of pliers.

(5) In cases where the construction does not permit adjustment of contact pressure, low pressure should be corrected by the replacement of the appropriate parts, such as springs or badly worn contacts.

(6) When checking contacts for follow, close the contactor or starter slowly by hand observing the distance the support can move after the contact is first made.

(7) In general, correction for the lack of follow involves either the adjustment of contacts to increase the contact pressure or, if this is not feasible, the replacement of weakened springs or other appropriate parts.

(8) If the laminated contacts of KS-5312 emergency cell switches fail to meet the requirement for flexing, look for softening of the metal and replace as required.

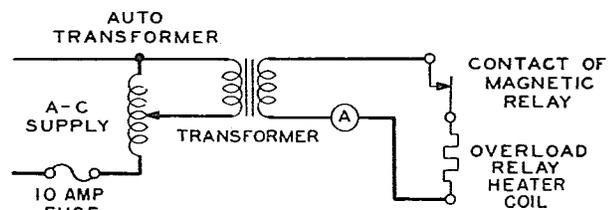


Fig. 11 - Test Circuit For Overload Relays

### \*#3.07 Overload Relays (Rq 2.07)

(1) To check the overload relay on a single-phase starter or a 3-phase starter, open the ac supply at the switch and fuse unit by removing fuses or opening the motor circuit disconnect switch. Connect the test circuit (see Fig. 11) across the heater coil of the overload relay. When connected across the L and T terminals, block the magnetic contactor of the starter operated. With the test auto-transformer, adjust the current to 250 per cent of the rated motor full-load current. Observe visually the operation of the relay. If the relay does not operate within 5 minutes, replace the entire relay. If no current flows

when voltage is raised with autotransformer,  $\uparrow$  replace heater coil only. Reset overload relay after test. For 3-phase starters, repeat for the other heater coils.

**Note:** For adjustable-type overload relays, the current applied to the heater coil should be twice the relay rating times its percentage setting.  $\downarrow$

(2) To adjust the Cutler Hammer relay (see Fig. 12), loosen the screws which hold the cover in place and raise or lower it to bring the indicator opposite the desired graduation on the calibration plate. Adjust both elements of the relay to the same graduation.

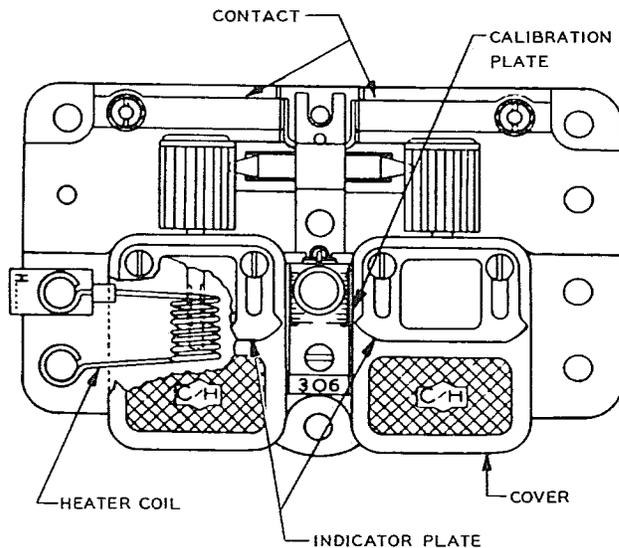
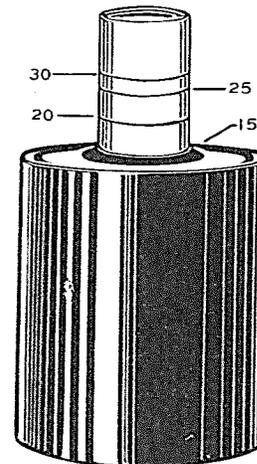
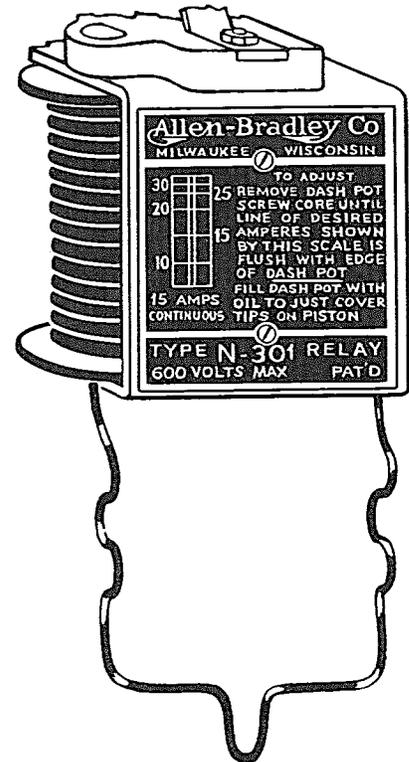


Fig. 12 - Thermal Overload Relay, Cutler Hammer

(3) To adjust the Allen Bradley relay which is shown in Fig. 13, remove the dashpot. Turn the core until the desired calibration line is flush with the top edge of the dashpot. Use care to avoid spilling oil out of the dashpot. If there is reason to believe that the oil in the dashpot has become gummy or dirty, it may be replaced, first removing the piston which is carried by the core. To remove, gently knock the coverplate loose from the top of the dashpot by pulling upward on the core. Clean out the old oil and refill with dashpot oil, if readily available, or with light mineral oil, and fill until the projections on the top of the piston are just covered.

(4) To adjust the KS-15602 overcurrent relays (see Fig. 14), loosen the locknut, and screw the plunger core until the line corresponding to the required trip current rating is flush with the inside edge of the cup washer. Lock the plunger in position with the locknut.



**NOTE:** THE LINES ON THE CORE CORRESPOND TO THE AMPERE SCALE ON THE NAMEPLATE

Fig. 13 - Overload Relay, Allen Bradley

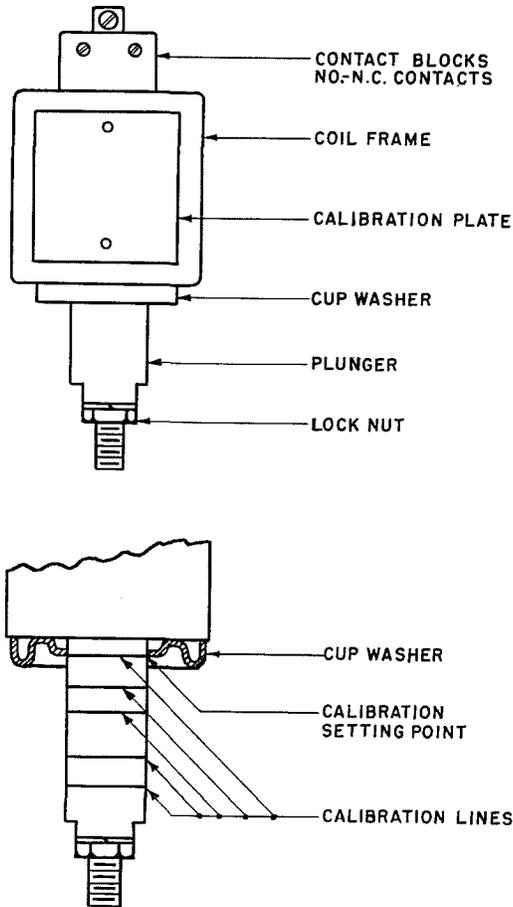


Fig. 14 - KS-15602 Relay

test set is without one. Where test set preparation has not been specified on the Circuit Requirements table, disconnect both coil terminals and furnish battery and ground through the test set with B/G or B/G/V preparation.

(3) Where requirements are specified in volts, ac, an ac voltmeter should be used, together with a continuously tapped autotransformer, protected by a 10-ampere fuse. Connect the relay and the voltmeter across the output of the autotransformer and adjust to specified values.

(4) Operate and release adjustments may be made by making changes in the contact pressure or the tension of the armature spring, as applicable. Whenever any changes are made, care should be taken that the other requirements continue to be met.

(5) If the armature moves toward the core, as the operate current is applied, but fails to pull all the way up to the core or to the stop pin, it is an indication of excessive contact pressure, a bind in the moving parts, an obstruction in the armature gap, or excessive armature spring tension. Remove obstructions and binding or make adjustments as outlined in 3.05.

(6) If the relay does not release, check the armature for binding, and clean or replace it. Check the armature spring to see that it has sufficient tension to return the armature to the nonoperated position. Replace the spring if sufficient tension cannot be obtained by adjustment. In a dc relay, if the stop pin or washer, which is in the face of the armature, fails to prevent the armature coming into direct contact with the pole face and permits it to stay there after the voltage is removed from the coil, replace the armature if feasible, otherwise replace the relay.

(7) In some cases, the armature or pole face may require cleaning. Use petroleum spirits on a cloth wrapped around the flat end of the fiber spudger.

(8) When any change is made in mechanical settings during the adjustment for electrical requirements, recheck requirements 2.03 to 2.06.

### →\*#3.08 KS-5309 and KS-15584 Starters (Rq 2.08)

(1) If the motor experiences a heavy surge when the RUN contactor closes, change the spring adjustment to increase the compression on the spring. Loosen the nuts, turn them down on the rod, and retighten. See Fig. 5.

### 3.09 Electrical Requirements (Rq 2.09)

(1) If a relay fails to operate when required, connect a voltmeter across the coil terminals. If there is no reading on the voltmeter, check the associated circuit for the cause. Failure to operate with rated voltage at the coil terminals may sometimes be corrected by readjustment, but, in some cases, may be due to an open coil. To check for an open coil, connect the voltmeter in series with the operating voltage and the coil. The absence of an indication on the voltmeter when so connected shows that the coil is open and should be replaced.

(2) Where requirements are given in volts, direct current is meant, unless otherwise specified, and a 35-type test set should be used, supplemented by a dc voltmeter if the

### \*#3.10 Temperature (Rq 2.10)

(1) If the temperature is thought to be excessive, hold the bulb of the thermometer against the hottest spot in question, covering that part of the bulb not in contact with the relay by a piece of felt or the equivalent.

(2) If the temperature exceeds the specified limits, see that the other requirements are met. If these requirements are met and the temperature is still above the specified limit, with nameplate rated voltage not exceeded, refer the matter to the supervisor as the coil or contact assembly may have to be replaced.

Caution: Various parts reach temperatures at which it is dangerous to touch them.