AUTOMATIC STARTERS AND COMPENSATORS HAVING NO KS DESIGNATIONS CUTLER-HAMMER, INC., SQUARE D COMPANY, AND WARD LEONARD ELECTRIC COMPANY REQUIREMENTS AND ADJUSTING PROCEDURES

1. GENERAL

1.01 This section covers automatic starters and compensators of the following commercial types, modified by the manufacturers as required.

Cutler-Hammer	Bul 9586 H296	Starter
Square D	Class 8606 Type GG-2Y	Compensator
Ward Leonard	Special Bul 4051	Compensator

1.02 This section is reissued to incorporate material from the addendum in its proper location. In this process marginal arrows have been omitted.

1.03 Reference shall be made to Section 020-010-711 covering General Requirements and Definitions for additional information necessary for the proper application of the requirements listed herein.

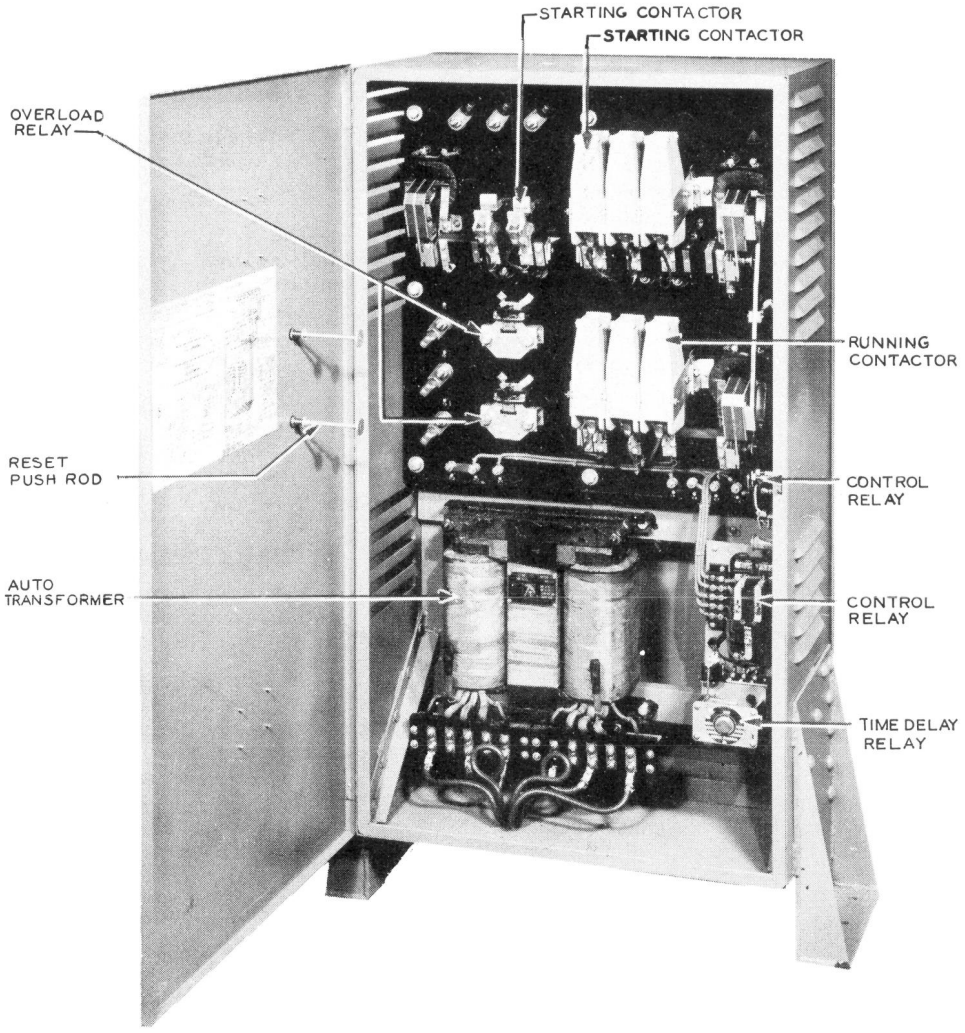

Fig. 1 - Ward Leonard Compensator

1.04 Phi (*): Requirements are marked with a phi when they are not required to be checked before turnover.

1.05 Asterisk (*): Requirements are marked with an asterisk when to check for them would necessitate dismantling or dismounting of apparatus, or would affect the adjustment involved, or other adjustments. No check need be made for these requirements unless the apparatus or part is made accessible for other reasons, or its performance indicates that such a check is advisable.

1.06 In the text, the word relay is used to denote contactor or control relay unless specific mention of either 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.

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 Before doing any work on this equipment, see that the service is maintained and disconnect the equipment from the power supply.

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

1.12 Orders for parts needed for replacement should give the manufacturer's name, the type, or bulletin number, nameplate data if available, and a full description of the part.

2. REQUIREMENTS

2.01 Mounting: All mounting bolts and the fastenings which hold the component parts together shall be secure. Gauge by feel.

2.02 Contact surfaces shall be clean and free from buildups which might interfere with reliable contact. Gauge by eye.

Caution: To avoid shock, do not touch the contacts with the hands nor do any work on them with tools, while connected to the power service.

2.03 Contact Alignment: Each pair of contacts shall be aligned so that when the contactor is operated, the outer edge of one contact does not extend beyond the outer edge of the other by more than 1/8 of its diameter or width, at turnover, and by not more than 1/4 of its diameter or width, during life. Gauge by eye.

2.04 Contact Sequence

(a) Unless otherwise specified, all main contacts of a contactor shall make contact simultaneously.

(b) Auxiliary contacts (NO) on a contactor shall make contact before the main contacts. Gauge by eye.

(c) In Ward Leonard compensators, the right-hand NO contact of the control relay associated with the time delay relay shall make contact before the NC contact breaks.

2.05 Contact Separation

(a) Contact separation shall be as specified in the Circuit Requirements Table. Use scale.

(b) Unless otherwise specified, the contact separation for Ward Leonard equipment shall be

	Min.	Max.
Control relays	1/8"	3/16"
Contactors	11/16"	13/16"

Use scale.

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

2.06 Contact Pressure and Follow

(a) Contact pressure, 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 or follow shall be as specified in the following table.

	Contact Pressure or Follow	
Cutler-Hammer Contactors		
Main and Aux. Contacts	Appreciable follow	
Square D Contactors	Min.	Max.
Main Contacts	14 lbs.	17 lbs.
Auxiliary Contacts	Appreciable follow	
Square D Control Relays		
All contacts	Appreciable follow	

	Contact Pressure or Follow	
Ward Leonard Contactors	Min.	Max.
Main Contacts	4 lbs.	5 lbs.
Auxiliary Contacts	Appreciable follow	
Ward Leonard Control Relays		
NO contacts	Min. 50 grams	
NC contacts	Min. 45 grams	

Use fan-type or push-pull tension gauge, or spring balance, as applicable for pressure measurements. Gauge follow by eye.

(c) Where no specific values of contact pressure are available there shall be additional movement of the operating mechanism after the contacts touch. This usually results in sliding of one contact on the other or an increase in the contact pressure and is known as follow. Gauge by eye and use an 81A test set if necessary.

2.07 Autotransformers: The voltage applied to the motor shall be such as to bring it to approximately full speed within approximately the following interval

Motor Rating	Seconds
30 hp	10
40 hp	15
50 hp	15
75 hp	20

The starting current shall not blow the motor fuses.

Note: The Cutler-Hammer starter is not equipped with autotransformers.

2.08 Time delay relays in the compensators shall be adjusted to transfer the motor smoothly, but without excessive delay, from the starting taps on the autotransformers to the line. Gauge by sound.

*2.09 Thermal Relays

(a) The thermal relay used for overload protection in the Cutler-Hammer starter 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) The thermal overload relay used in the Square D and Ward Leonard compensators is not adjustable.

2.10 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.

(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). 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 deenergized for at least 2 hours prior to the test.

*2.11 The temperature shall not exceed

	Max.
Coils	95C-(203F)
Contacts	115C-(239F)

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

3. ADJUSTING PROCEDURES

3.001 List of Tools, Gauges, Materials, and Test Apparatus

Code or Spec No.	Description
Tools	
265C	Contact Burnisher Holder (includes No. 266C and 266E tools)
417A	1/4- and 3/8-inch Open Double-end Flat Wrench
KS-2662	File, No. 6 Straight Cut
KS-6854	3-1/2-inch Screwdriver
R-2512	8-inch Single-end Adjustable Wrench
-	6-1/2-inch P-Long-nose Pliers
Gauges	
70D	50-0-50 Gram Gauge or
79C	0-200 Gram Push-Pull Tension Gauge
R-2771	0-6 lbs Balance Spring
R-2481	0-30 lbs Balance Spring
R-8550	6-inch Steel Scale
R-1032, Detail 1	Thermometer
-	Volt-Ammeter, DC, Weston Model 281 Range 150/60/3V

Code or Spec No.	Description
Gauges	
-	Voltmeter, AC, Weston Model 528 Range 300/150V
Materials	
KS-7860	Petroleum Spirits
KS-14666	Cloth
-	Felt Pad
-	150 Grade Abrasive Cloth
Test Apparatus	
35 Type	Test Set
81A	Test Set
-	Autotransformer, Continuously Tapped, (Variac, 2.5-ampere, 230-volt input, Type V-5, HMT or equivalent: General Radio Co, Cambridge, Mass. suggested.)

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.

(2) The lamp signal in the 35-type test set can be used to indicate contact closure.

3.003 Care should be exercised when using petroleum spirits in power rooms where there are dc machines, since commutation may be adversely affected by softening of commutator film by the fumes. To avoid the need for burnishing the commutators of dc machines, after doing any cleaning called for in this section, provide adequate ventilation, use the absolute minimum amount of petroleum spirits required for the cleaning operation, and keep the container closed when not in use.

3.01 Mounting (Rq. 2.01)

(1) Tighten loose screws and bolts with the screwdriver or 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, followed by a dry cloth. The contacts should be disconnected from the power supply during the cleaning operation.

(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, and draw it back and forth until the buildups are reduced enough to insure reliable contact. Clean the contacts as outlined in (1) above after smoothing.

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

(4) When the tubes which constitute the movable auxiliary contacts of the Cutler-Hammer contactor become worn, loosen the retaining nuts and turn the tubes to present a new surface.

(5) For access to the contacts of Square D control relays, remove the two screws which project through the nameplate, and remove the entire movable contact assembly. Reduce any buildups by the use of abrasive cloth.

3.03 Contact Alignment (Rq. 2.03)

(1) Correct by making necessary adjustments with pliers where this is practicable. In other cases, correct by loosening the clamping bolts which hold the contact carrying arm on the shaft to obtain play and moving the arm as required. Retighten the bolts before leaving.

(2) If the above procedures are ineffective, make replacements as required.

3.04 Contact Sequence (Rq. 2.04)

(1) The main contacts of contactors can be adjusted to make contact simultaneously by one or the other of the following procedures. Where the contact arm is attached to the shaft by means of a clamp, see Fig. 2, slightly loosen one of the two clamping screws and tighten the other by a similar amount, repeating as required. The selection of which screw to loosen depends upon the direction in which it is desired to move the contact. Where attachment is made by means other than clamping, as in the Ward Leonard contactors, see Fig. 3, adjust the associated contact support with the pliers as required.

(2) Adjust auxiliary contacts with the pliers. On Cutler-Hammer contactors, the adjustment is made on the

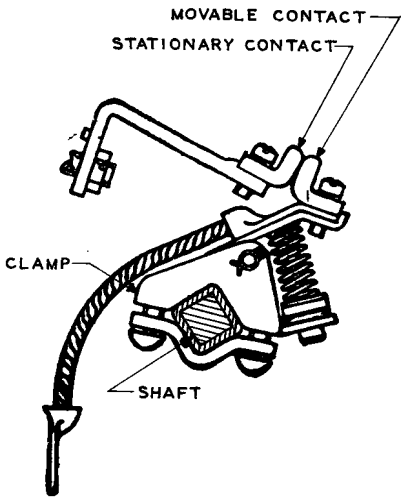

Fig. 2 - Cutler-Hammer

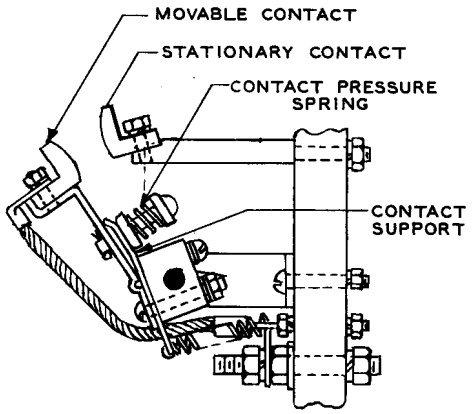

Fig. 3 - Ward Leonard

Main Contacts of Contactors

stationary contact fingers and on Square D and Ward Leonard contactors, on the movable contact fingers.

(3) The sequence of Ward Leonard control relays is adjusted by raising or lowering the stationary contacts as required. Loosen the locking nut before making the adjustment and tighten it after the adjustment has been made.

(4) The contacts of Square D control relays are not adjustable.

3.05 Contact Separation (Rq. 2.05)

(1) When a scale is used, the contacts must be dead while checking.

(2) To change the contact separation of a Ward Leonard control relay having both NO and NC contacts, raise or lower the stationary NC contacts as required, by rotating them on their supports.

(3) To change the main contact separation of a Ward Leonard contactor, proceed according to 3.04 (1).

(4) The contact separation of other equipments is not adjustable.

3.06 Contact Pressure and Follow (Rq. 2.06)

(1) Contacts having inadequate pressure may become roughened or burned. Where this condition is observed, hold the relay closed manually and try the pressure of each contact by pulling the movable contact away from the stationary contact with the fingers. Replace contact pressure springs which have become weakened.

(2) In readjusting Ward Leonard control relays, it is desirable to have as much contact pressure as is consistent with meeting other requirements. Adjust so that pressures on the contacts on both sides of the armature are approximately equal, unless difference is necessary to meet other requirements. Either the fan-type gauge or the push-pull tension gauge may be used for measuring contact pressures of relays. When access to the contact springs is impossible with the fan-type gauge, the push-pull gauge must be used. When the position of a stationary contact has been changed, recheck the pressure on all contacts of the relay.

(3) To measure the contact pressure of the NO contacts, energize the operating coil 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 springbalance.

(4) To measure the contact pressure of the NC contacts, proceed in a manner similar to that outlined in (3), but allow the armature to be held in its nonoperated position by the pull of its spring.

(5) Contact pressure of Ward Leonard control relays may be adjusted by relocating 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. To accomplish this, loosen the locknuts on the retaining screw and adjust as required.

(6) 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.

(7) To check follow, operate the relay by hand, observing the travel of the operating mechanism after the contacts under check make contact. An 81A test set connected across the contacts will be helpful in determining the point at which they make.

(8) 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, including the contacts, themselves.

3.07 Autotransformers (Rq. 2.07)

(1) Raise the starting voltage to reduce the starting time or lower the voltage to decrease the starting current, as required, by changing the tap connections at the autotransformers.

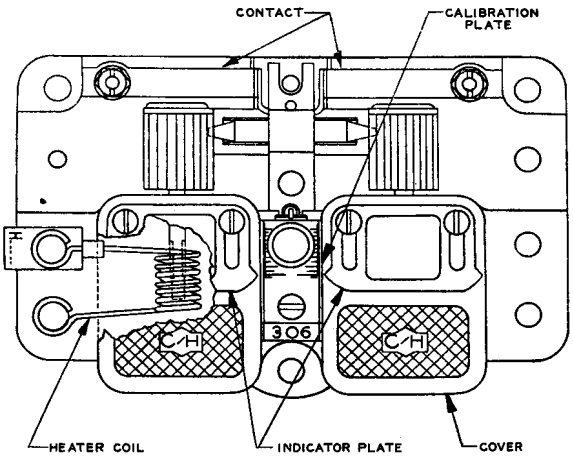

Fig. 4 - Cutler-Hammer Starter - Thermal Overload Relay

3.08 Time Delay Relays (Rq. 2.08)

(1) The time delay relay in Square D compensators is of the pneumatic type. See that the mechanism operates without binding and remove dirt as required. Adjustment is accomplished by rotating, as indicated, the knurled knob which is located near the top of the relay at the front.

(2) In the time delay relay in Ward Leonard compensators, (see Fig. 5) a synchronous motor drives a differential gear train, one gear of which is held by means of its associated knurled wheel and a magnet operated brake, causing a contact arm to rotate and close a pair of NO contacts and to open a pair of NC contacts. When released by the brake, the contact arm is returned to its released position by a spring. See that the mechanism operates freely and remove dirt. To adjust the time delay, loosen the lock screw, designated LOCK on the face of the dial, and rotate the hexagonal knob until the arrow points to the desired time setting marked on the dial. Retighten LOCK.

(3) To adjust the brake, with the armature of the brake magnet in its released position, loosen the lock nuts, using two 417A tools, and turn the lower nut up or down on the push rod as required. Tighten by turning the upper nut down on the lower. To adjust the return spring on the contact arm, remove the screw pin located in the shaft in front of the knurled wheel. The serrated wheel, which is normally held by the pin, may be turned clockwise to increase or counter clockwise to decrease the tension, as required and the pin replaced, locking the serrated wheel in the new position with respect to the shaft.

3.09 Thermal Relays (Rq. 2.09)

(1) To adjust the Cutler-Hammer relay, (see Fig. 4) loosen the screws which hold the cover in plate 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.

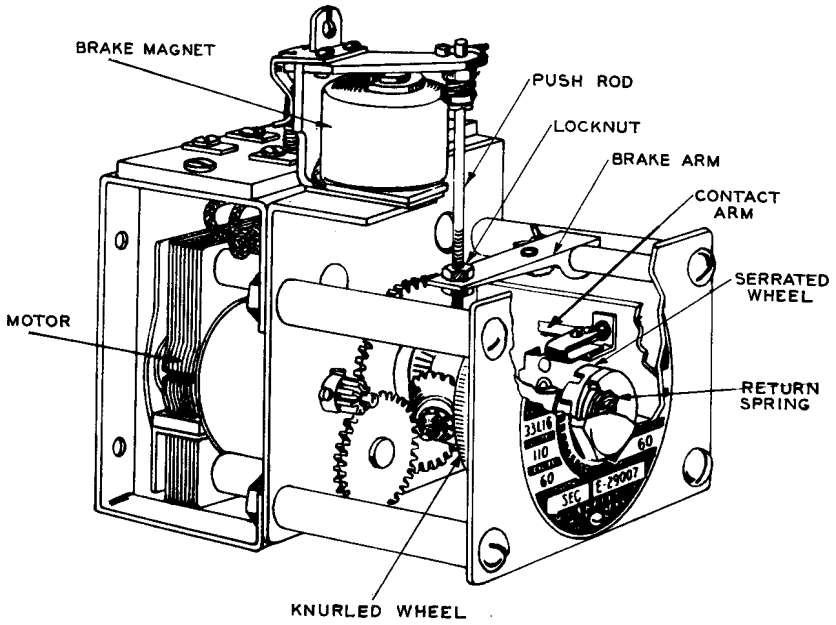

Fig. 5 - Ward Leonard Time Delay Relay

3.10 Electrical Requirements (Rq. 2.10)

(1) A check of the operation of a voltage-rated relay is made by connecting a voltmeter across the coil terminals. If there is no reading on the voltmeter, a study of the associated circuit is necessary to find whether the absence of voltage indicates a circuit fault, or is a condition to be overcome by blocking a relay or otherwise changing circuit conditions. Failure to operate with rated voltage at the coil terminals may sometimes be corrected by readjustment, but in some cases, it 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. If no indication appears on the voltmeter, 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 d-c voltmeter if the 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, a-c, an a-c voltmeter should be used, together with a continuously tapped autotransformer, protected by a 2-1/2- or 3-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 3.04.

(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 d-c relay, if the stop pin or washer which is in the face of the armature, fails to prevent the

armature coming in 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 rare cases, the armature or pole face may require cleaning with petroleum spirits on a cloth wrapped around the blade of a screwdriver.

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

3.11 Temperature (Rq. 2.11)

(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.