AUTOTRANSFORMER-TYPE STARTERS AND COMPENSATORS GENERAL ELECTRIC COMPANY REQUIREMENTS AND ADJUSTING PROCEDURES

1. GENERAL

1.01 This section covers the following compensators and starters manufactured by the General Electric Company.

Compensators	KS-5311
Starters	
KS-15635	KS-15853
KS-15663	KS-15854
KS-15781	KS-15941

1.02 This section is reissued to:

- Add information covering the CR2820-B130AA pneumatic time-delay auxiliary contact.
- Incorporate material from the addendum into the section.

1.03 Reference shall be made to Section 020-010-711 covering general requirements and definitions for additional information necessary for the proper applications of the requirements listed herein.

1.04 ***Phi (ϕ):*** 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, contacts are normally open (NO) or normally closed (NC) depending on their position when no operating current is flowing through the coil and they are not on their normal position for a particular application which may involve continuous operating current through the coil under normal circuit conditions. NO and NC contacts are sometimes referred to as front and back contacts, respectively.

1.08 ***Operate:*** A relay is said to operate if, when current is connected to its winding, the armature moves sufficiently to meet the following conditions:

(a) All normally open contacts close and all normally closed contacts open.

(b) The armature rests against the core.

1.09 ***Release:*** 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 ***Nonoperate:*** A relay is said to nonoperate when, with current flowing through the coil, the armature has not moved sufficiently for NO contacts to close or to reduce the pressure of NC contacts enough to cause unreliable contact.

Caution: The voltage should be removed from the terminals before performing any work on the relay or checking requirements

other than electrical or temperature requirements. Before work is started on a relay which operates in an automatic-control circuit, make the automatic control inoperative as described in the appropriate section covering the apparatus.

1.11 Relays should not be handled by the contact springs.

1.12 Where the construction is such that adjustments or other procedures are not practicable, failure to operate satisfactorily should be corrected by replacing the appropriate parts or the entire unit.

1.13 The starters and compensators consist essentially of ac contactors of various forms in combination with components listed in Table A.

TABLE A

COMPONENTS	REQT	NOTES
CONTACTORS — GE CO		
Solenoid-Type		
CR105D		
CR109D		
CR2810E	2.08	1
CR2810F		
CR7107E		
CR7107F		
Hinged-Armature Type		
CR2810-1000 series	2.09	1
CR2810G		
CONTROL RELAYS — STRUTHERS-DUNN INC		
8HXX222		
8HXX285		
8BXX325		2
8BXX338		

COMPONENTS	REQT	NOTES
OVERLOAD RELAYS — GE CO		
CR2824-TC121C	2.10	3
CR2824-TC221C	2.10	3
CR2824-2D		
CR2824-42B		
CR2824-42C		
CR2824-42H	2.11	3
CR2824-42J		
CR2824-42M		
CR124F012		
TIME DELAY RELAYS — GE CO		
CR2820-1099	2.14	5
CR2820-1740A	2.15	5
CR2820-A111AA	2.16	5
CR2820-B110AA	2.16	5
CR2820-B111AA	2.16	5
→ **TIME DELAY CONTACT-GE CO**		
→ CR2820-B130AA	2.18	5

Note 1: The contact pressure of the contactors is not adjustable.

Note 2: The Struthers-Dunn relays shall meet the requirements of Section 040-810-701.

Note 3: Operate requirements of overload relays — see reqt 2.12.

Note 4: Output voltage of selenium rectifiers — see reqt 2.13.

Note 5: Time-delay interval adjustment and setting taps on autotransformer — see reqt 2.17.

2. REQUIREMENTS

ϕ**2.01** ***Mounting:*** The mounting bolts and the fastenings which hold the component parts together shall be secure.

Gauge by feel.

ϕ**2.02** ***Cleaning Contacts and Removing Buildups:*** Contacts shall be clean and free from buildups which might interfere with reliable contact.

Gauge by eye.

Caution: To avoid shock, do not touch or allow metallic tools to come into contact at the same time with exposed terminals or other parts which are at different potentials.

2.03 ***Contact Alignment***

(a) The alignment of each pair of contacts having equal diameter or width shall be such that, when they are completely closed, the edge of one contact of the pair does not extend beyond the edge of its mating contact by more than one-eighth of its diameter or width at turnover and by not more than one-quarter during life.

(b) The alignment of contacts of unequal diameter or width shall be such that, when they are completely closed, the edge of the smaller contact does not extend beyond the edge of the larger.

Gauge by eye.

2.04 ***Contact Sequence***

(a) All main contacts of multipole contactors shall make or break approximately at the same time.

Gauge by eye or use an 81A test set (buzzer) as necessary.

2.05 ***Freedom of Operation:*** The apparatus shall operate and release without sticking or binding. Hum or chatter shall not be excessive.

Note: Some of the larger size KS-5311 starters have oil holes on the contactor shaft bearings. Where so equipped, lubricate periodically with a few drops of KS-6232 light mineral oil.

2.06 ***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 so specified, operation of a relay shall be checked at the minimum coil voltage specified on the nameplate, or if the nominal value is specified at 90 percent of that value, or if no nameplate value is available, at the minimum experienced in the office.

2.07** ***Temperature: The rise in temperature above an ambient temperature between the limits of 10 to 40° C shall not exceed the following:

	MAXIMUM RISE ABOVE AMBIENT
Operating and blow-out coils	65° C (149° F)
Resistors (exposed conductors)	350° C (662° F)
Resistors (imbedded conductors)	250 °C (482° F)
Autotransformer windings	
Class A	65° C (149° F)
Class B or H	85° C (185° F)

Use a thermometer.

If the temperature is thought to be excessive, check as follows: Hold the bulb of the thermometer against the hottest spot in question, covering the part of the bulb not in contact with the part being measured by a pad of asbestos. Observe the highest temperature indicated after it has stabilized.

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

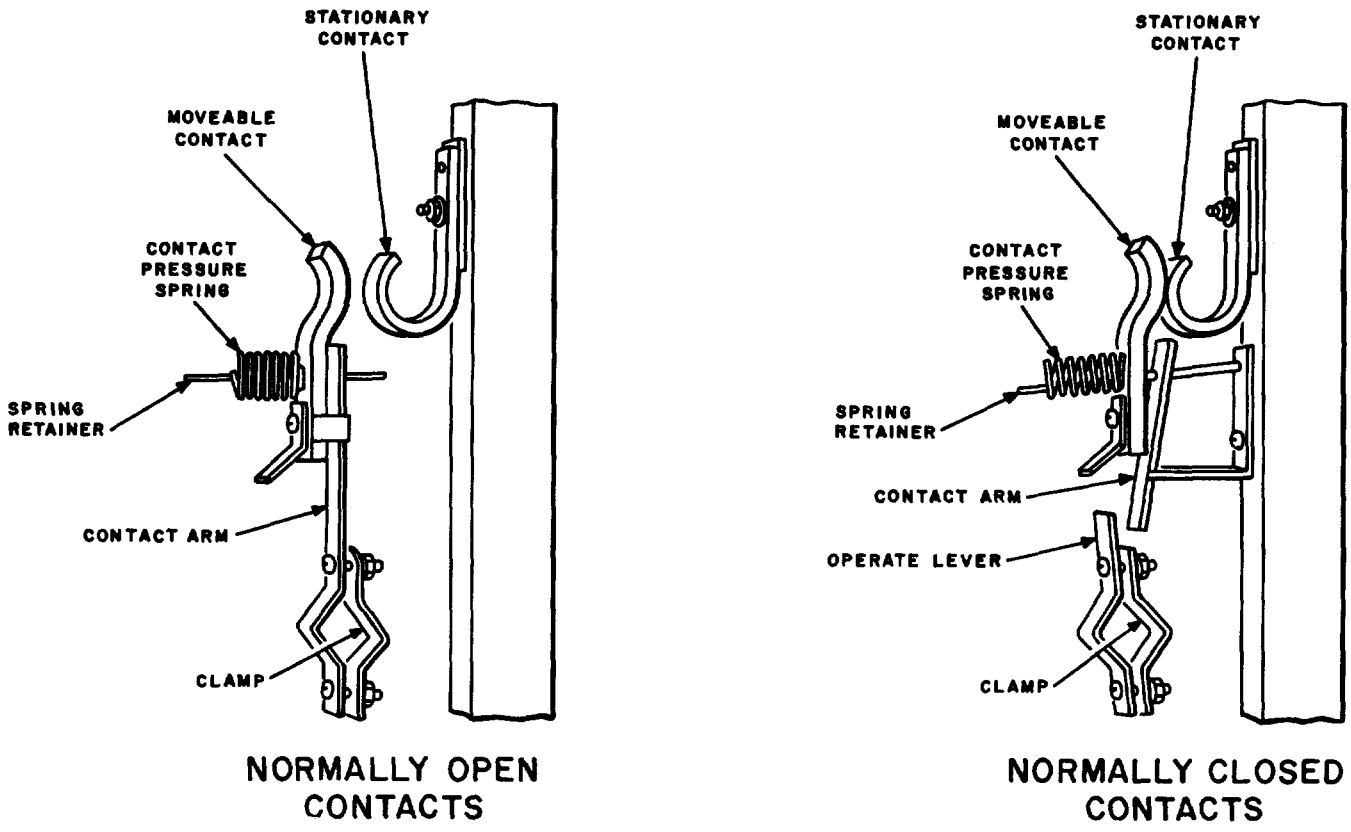

Fig. 1 — Contacts of the Hinged-Armature Type Contactors

2.08** ***Contactors — Solenoid Type

(a) ***Contact Pressure and Follow:*** For the main contacts, the contact pressure shall be adequate if the movable contact support moves appreciably after the contacts make.

Gauge by feel.

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

2.09** ***Contactors — Hinged-Armature Type

(a) ***Contact Pressure:*** The contact pressures for the hinged-armature type contactors, when measured at the center of the contact, shall be as specified in the following Tables B, C, D, and E.

Use gram gauge or spring balance as applicable.

Note: Since the R-2481 spring balance is calibrated up to 30 pounds only, it is suggested that when it is used the difference be estimated.

TABLE B — CONTACT PRESSURES FOR CONTACTORS OF KS-5311

POUNDS					GRAMS			
COMPENSATOR FORM	STARTING		RUNNING		STARTING		RUNNING	
	INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL
A1A	1-1/2-2	2-2-1/2	1-1/2-2	2-2-1/2	679-900	900-1150	679-900	900-1150
B1A	3-1/4-4-1/4	7-9	3-1/4-4-1/4	7-9	1450-1900	3200-4050	1450-1900	3200-4050
C1A	7-1/2-8-1/2	15-17	7-1/2-8-1/2	15-17	3400-3850	6800-7700	3400-3850	6800-7700
E1F	7-1/2-8-1/2	15-17	12-1/2-14-1/2	30-34	3400-3850	6800-7700	5650-6575	13600-15400

TABLE C — CONTACT PRESSURES FOR CONTACTORS OF KS-15663

POUNDS					GRAMS			
LIST NO.	STARTING		RUNNING		STARTING		RUNNING	
	INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL
1,2,3,4	3-3/4-5	5-1/2-7-1/2	3-3/4-5	5-1/2 7-1/2	1700-2275	2500-3400	1700-2275	2500-3400
5,6	7-1/2-8-1/2	15-17	7-1/2-8-1/2	15-17	3400-3850	6800-7700	3400-3850	6800-7700
7,8	7-1/2-8-1/2	15-17	12-1/2-14-1/2	30-34	3400-3850	6800-7700	5650-6575	13600-15400

TABLE D — CONTACT PRESSURES FOR CONTACTORS OF KS-15781 AND KS-15854

POUNDS					GRAMS			
LIST NO.	STARTING		RUNNING		STARTING		RUNNING	
	INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL
5,6			7-1/2-8-1/2	15-17			3400-3850	6800-7700
7,8	7-1/2-8-1/2	15-17	12-1/2-14-1/2	30-34	3400-3850	6800-7700	5650-6575	13600-15400

TABLE E — CONTACT PRESSURES FOR CONTACTORS OF KS-15941

POUNDS			GRAMS	
LIST NO.	RUNNING		RUNNING	
	INITIAL	FINAL	INITIAL	FINAL
6,7	7-1/2-8-1/2	15-17	3400-3850	6800-7700

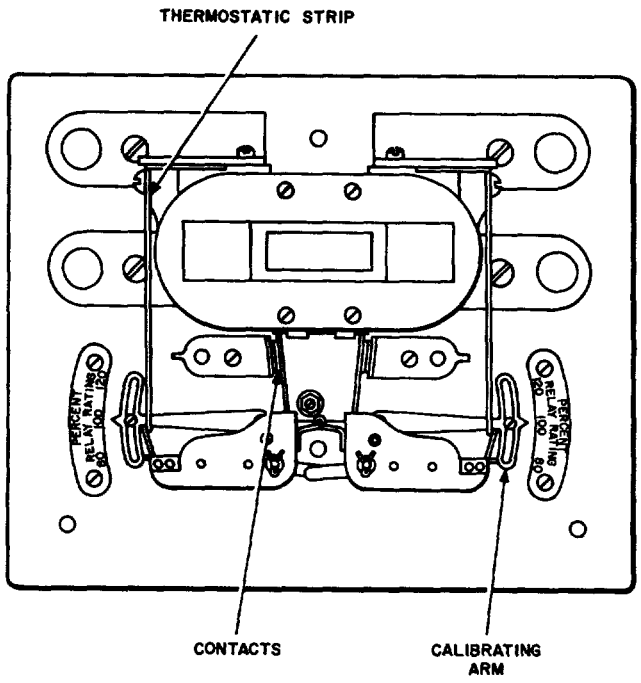

Fig. 2 — CR2824-TC221C Overload Relay

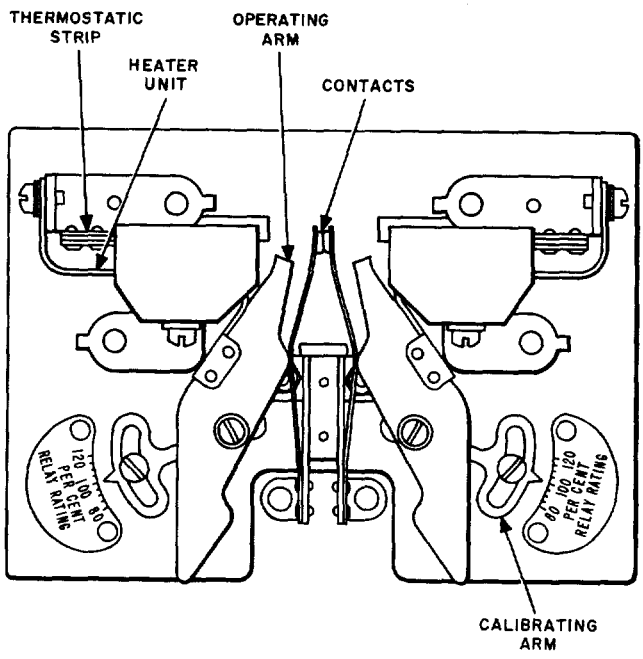

Fig. 3 — CR2824-TC121C Overload Relay

2.10** ***CR2824-TC221C and CR2824-TC121C Adjustable Overload Relays

(a) Unless otherwise specified in local job information, the relay shall be adjusted to operate at 110 to 115 percent of the rated full-load ampere of associated motor (see motor nameplate) where there is an overload circuit breaker in the output circuit of the associated generator. In other cases, the adjustment shall be at 105 percent.

(b) The thermostatic strips shall latch the operating arms to hold the contacts closed for normal operation and shall trip the arms to remove an overload.

2.11 ***CR2824-2D and CR2824-42B, -42C, -42H, -42J, and -42M and CR124F012 Nonadjustable Overload Relays***

(a) The relay contacts shall remain closed during normal operation. A manual reset button is provided which shall reclose the contacts after the relay has been tripped.

(b) The contact surfaces shall be clean and smooth and make firm contact.

(c) The arrow on the adjustable trip knob of the CR124F012 relay shall be in alignment with the markings on the side of the relay housing.

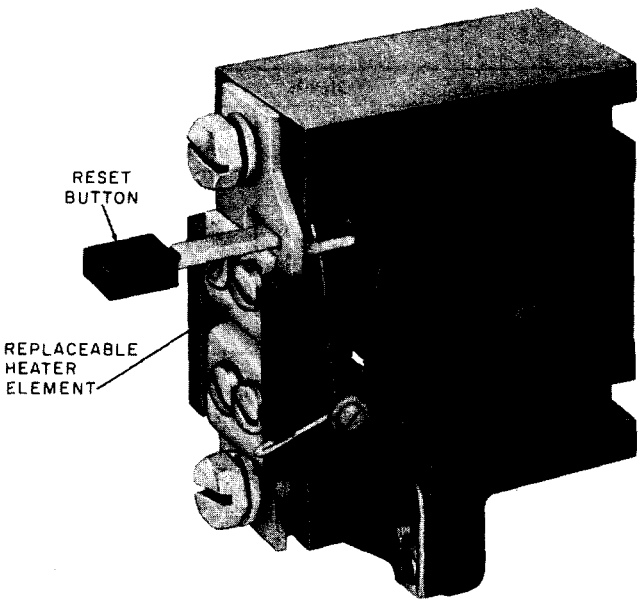

Fig. 4 — CR2824-42 Type Thermal Overload Relay

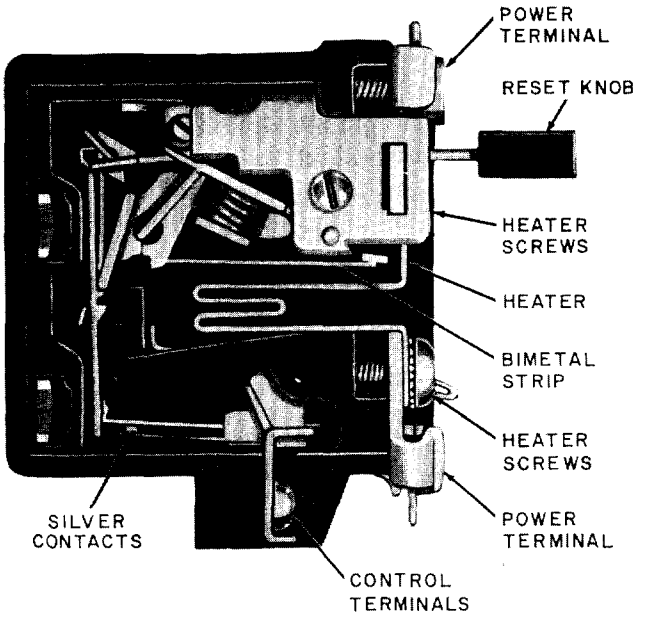

Fig. 5 — Typical CR2824-42 Type Overload Relay with Cover Removed and Heater Mounted

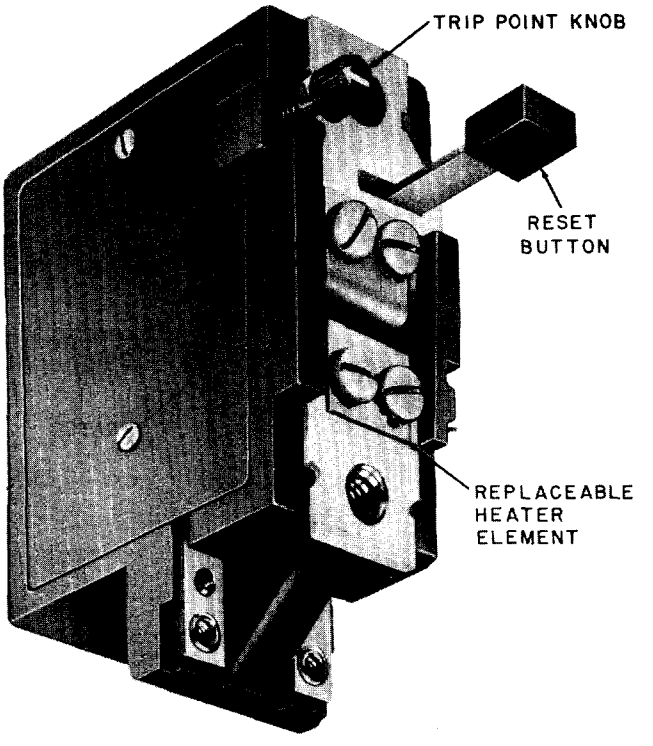

Fig. 6 — CR124F012 Thermal Overload Relay

2.12 *Starters With Overload Relays*

*(a) ***Adjustable Types:*** With 250 percent of the full-load current of the motor (as given on the motor nameplate multiplied by the percentage settings as read on the scale plate of the relay) flowing in the heater coil of the overload relay, the relay shall operate within 5 minutes.

*(b) ***Nonadjustable Types:*** With 250 percent of the full-load current of the motor [as given on the motor nameplate divided by the current step-down ratio of the current transformer if used (see note below)] flowing in the heater coil of the overload relay, the relay shall operate within 5 minutes.

Note: Current transformer as shown on schematics of:

KS-15663 Lists 7 and 8 (Fig. 21)
KS-15781 Lists 7 and 8 (Fig. 25 and 27)
KS-15854 Lists 7 and 8 (Fig. 32)

ϕ(c) The operate requirements of all overload relays shall be checked annually.

2.13 *Selenium Rectifier in KS-15663 Lists 7 and 8, KS-15781 Lists 7 and 8, and KS-15854 Lists 7 and 8*

(a) The selenium rectifier output voltage measured across the energized run contactor coils will be:

STARTER VOLTAGE AC	VOLTAGE DC
200	21
230	23

*2.14 *CR2820-1099 Time-Delay Relay*

(a) With the operating coil de-energized, the plunger shall be down, the gears out of mesh, and the contact arm latched with its upper contact open and its lower contact closed. The cut-out switch for the timing motor shall be closed.

(b) When the operating coil is energized, the plunger shall pull up and mesh the gears, and the timing motor shall turn the calibration disc until it trips the latch: (1) closing

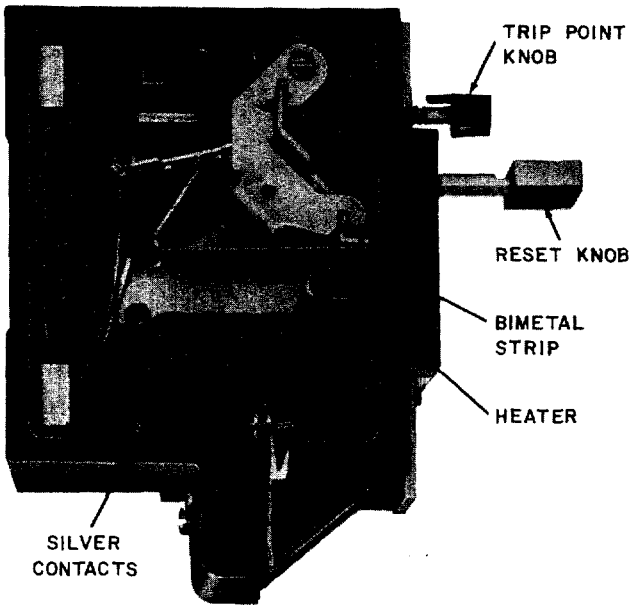

Fig. 7 — CR123F012 Thermal Overload Relay With Cover Removed and Heater Mounted

the upper contact on the contact arm, (2) opening the lower contact, and (3) opening the timing motor cut-out switch.

(c) Some models of these delay relays have a rubber disc in place of the gear shown in Fig. 8 on the motor shaft. The rubber disc engages a brass gear mounted on the shaft with the calibration disc and gear shaft spring. Contact pressure between the rubber disc and brass gear is maintained by a spring and pin directly below the gear shaft spring. The spring and pin are associated with two brackets, the gap between which becomes smaller as the rubber disc is worn. This gap should be more than 1/32 inch at the upper end of the brackets. Timing motors with rubber disc drive shall turn the gear shaft and calibrating unit until the latch is tripped, a downward pressure of 2 ounces (57 grams) being applied near the outer end of the latch.

Use the 70J gauge.

(d) The time-delay interval shall be adjusted in accordance with requirement 2.17.

2.15 ***CR2820-1740A Time-Delay Relay***

(a) With the relay de-energized, the relay motor start contact shall be open, the motor stop contact shall be closed, the clutch disengaged, and gear train reset.

(b) When the relay is energized, the relay motor start contact, operated by the magnet, shall close to start the motor, the clutch shall be engaged, and the motor shall drive the gear train.

(c) At the expiration of the delay interval, the gear train shall open the relay motor stop contact and operate the switchette (snap-action type switch).

(d) The auxiliary contacts (motor control contacts) shall be clean and free from buildups which might interfere with reliable contact.

(e) The time-delay interval shall be adjusted in accordance with requirement 2.17.

2.16 ***CR2820-A111AA, -B110AA, and -B111AA Pneumatic Time-Delay Relays***

The time-delay interval shall be adjusted in accordance with requirement 2.17.

2.17 ***Time-Delay Interval Adjustment***

(a) With the line voltage at its average value, the voltage supplied by the ***autotransformers*** to the motor which is being started shall be such as to bring the motor to approximately full speed, within approximately the following interval without blowing the supply fuses:

MOTOR RATING HP	SECONDS
15 to 30	10
31 to 40	15
41 to 75	20
76 to 125	25

Use watch or clock.

(b) The delay interval shall be adjusted so the motor which is being started is transferred smoothly but without excessive delay from the starting taps on the auto-transformer in the starters or compensators, to the line, at any line voltage within the office range.

Gauge by sound.

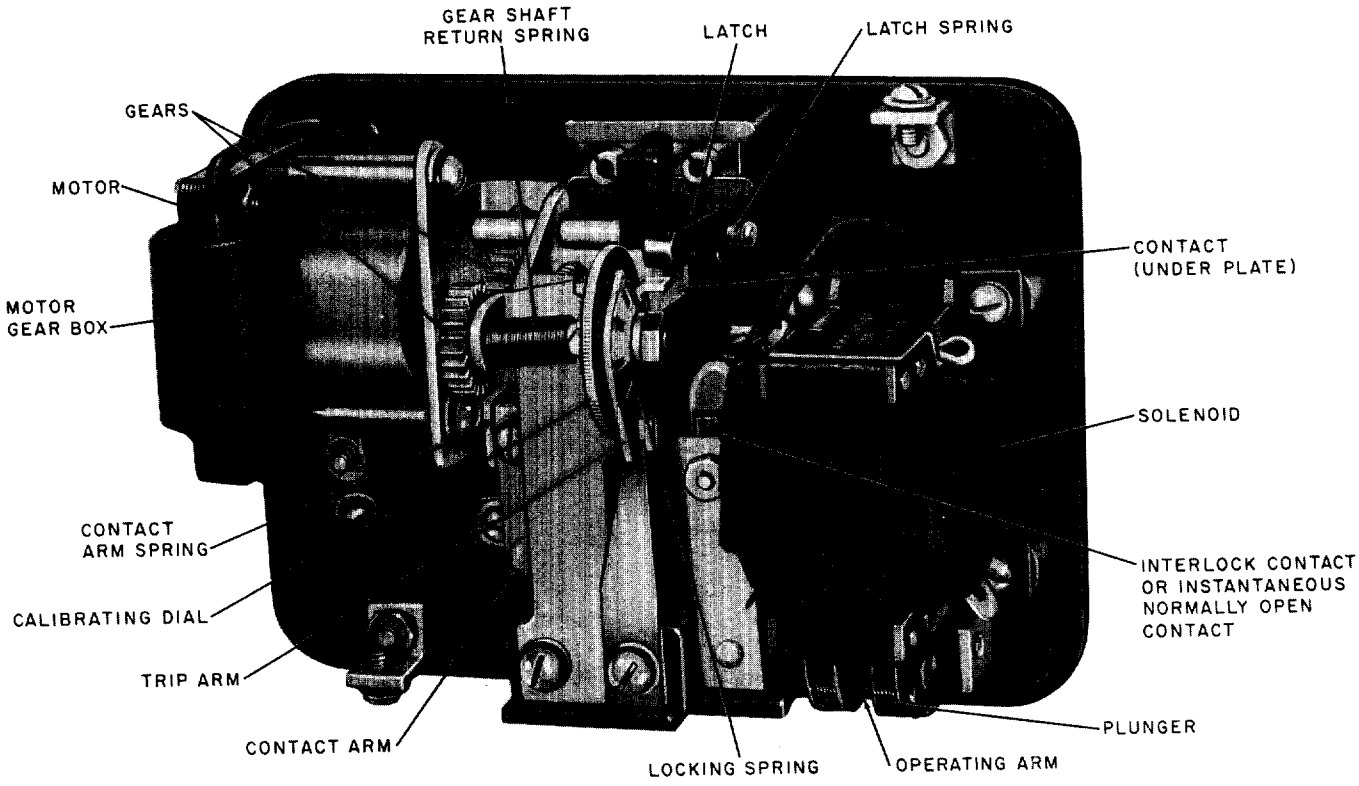

Fig. 8 — CR2820-1099 Time-Delay Relay

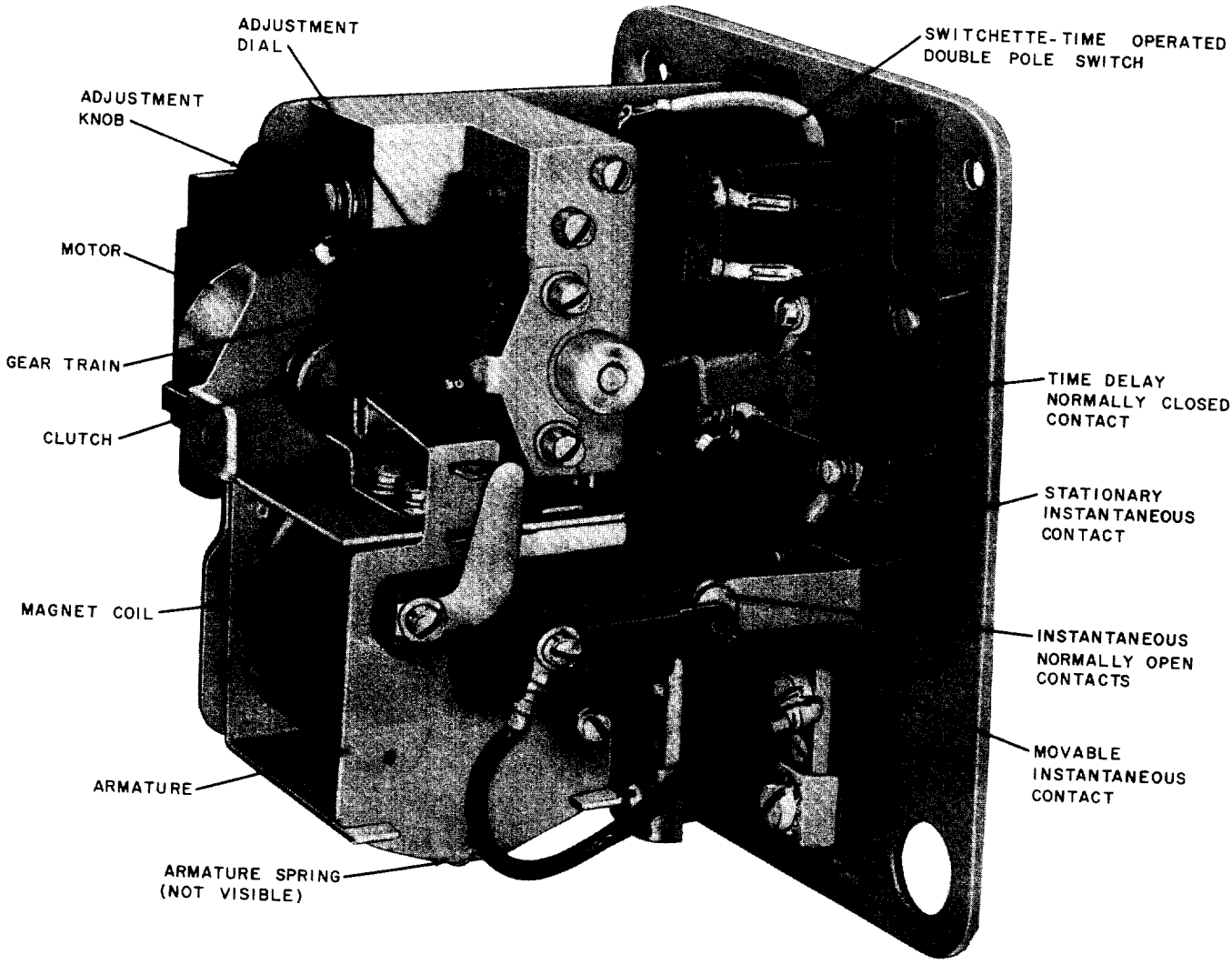

Fig. 9 — CR2820-1740A Time-Delay Relay

2.18 ***CR2820-B130AA Pneumatic Time-Delay Auxiliary Contact***

(a) The pneumatic time-delay auxiliary contact is similar to the lower half of the relay shown in Fig. 11 consisting of a timing stem, timing contact unit, pneumatic head and frame.

(b) The time-delay interval shall be adjusted to operate at 20 seconds.

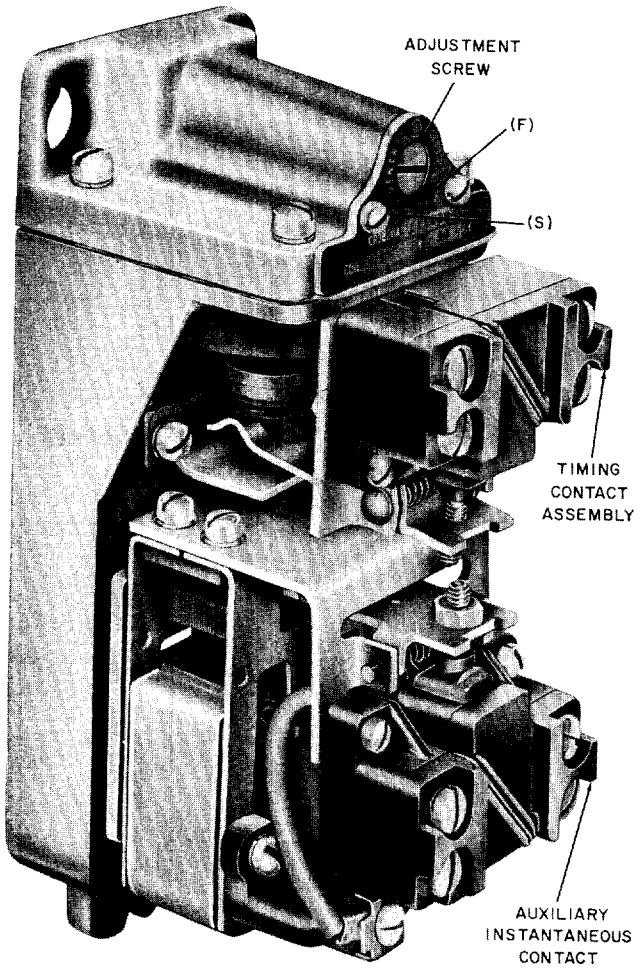

Fig. 10 — CR2820-A111AA Pneumatic Time-Delay Relay

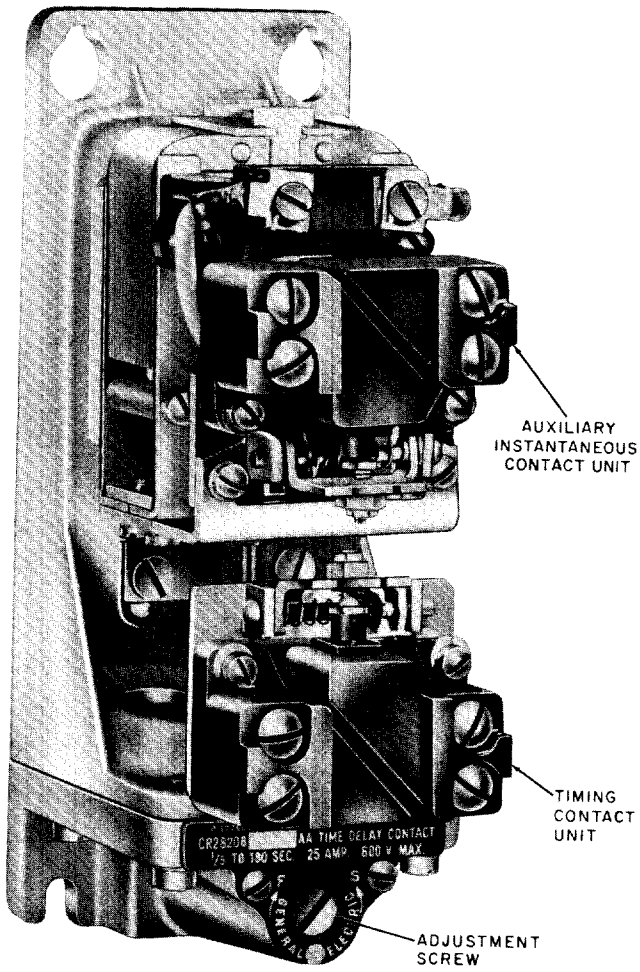

Fig. 11 — CR2820-B111AA Pneumatic Time-Delay (also general design of CR2820-B110AA Relay)

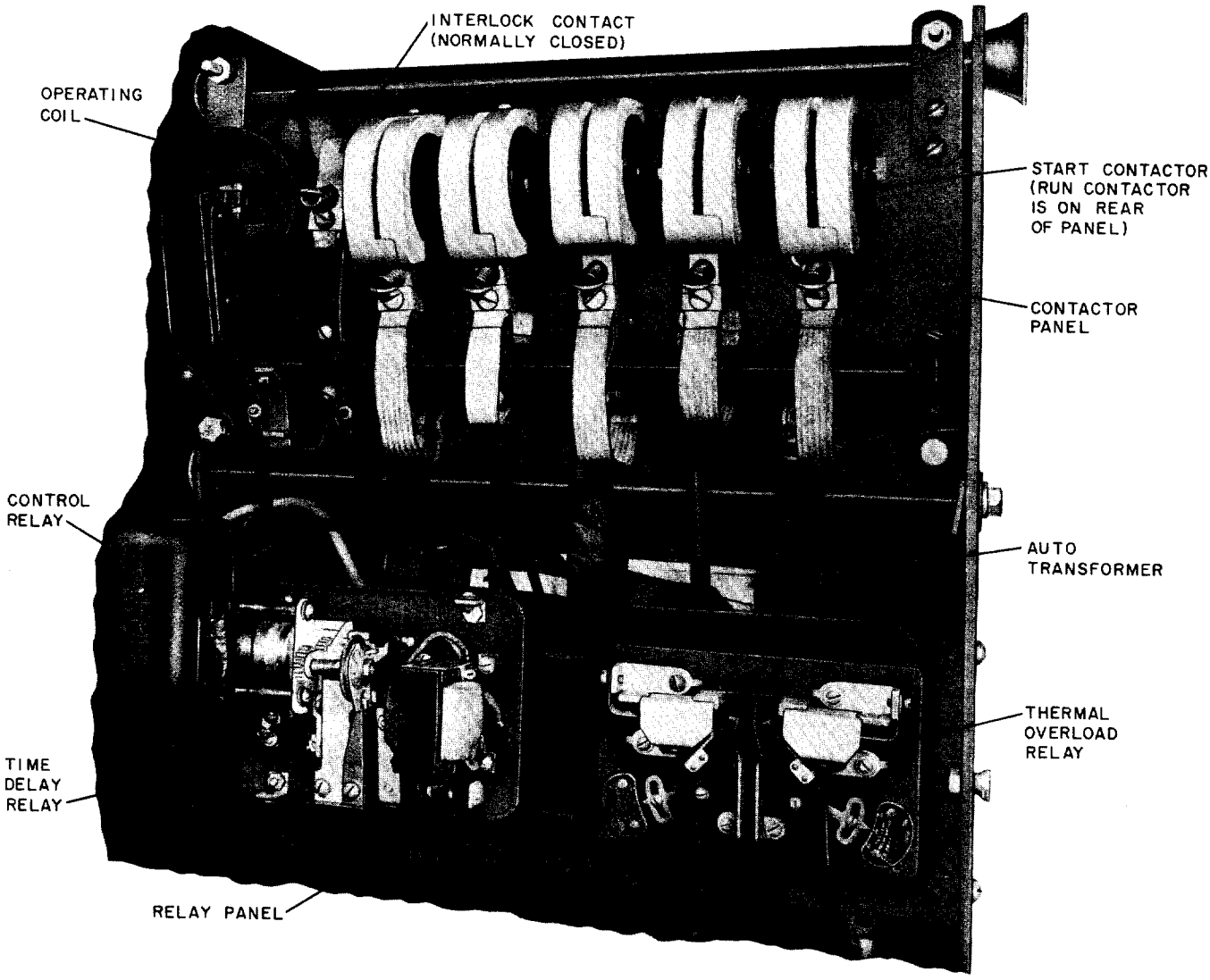

Fig. 12 — KS-5311 Automatic Starting Compensator (Small Size)

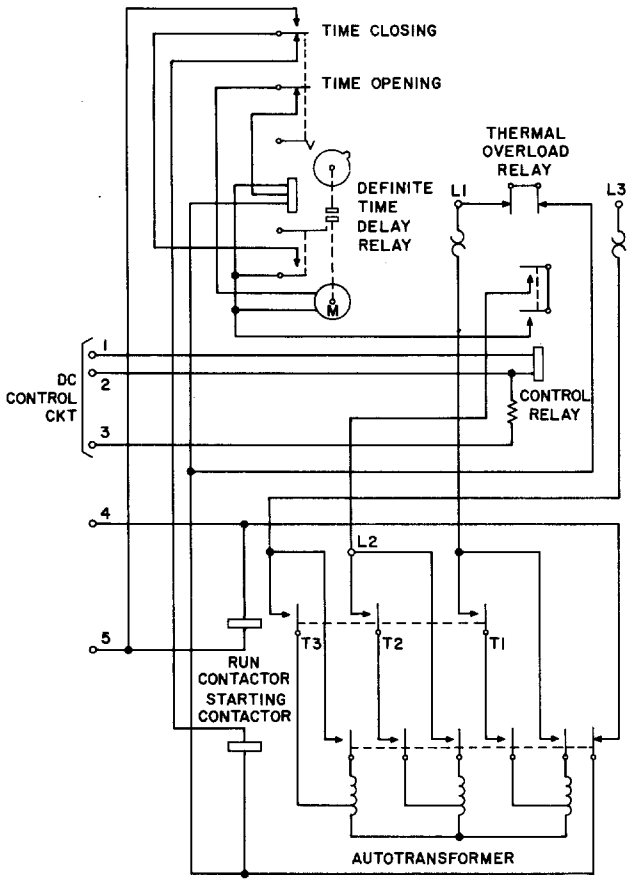

Fig. 13 — KS-5311 List 10, 11, 15, 16, 17, 20, 25, 26, and 27 Compensator Schematic

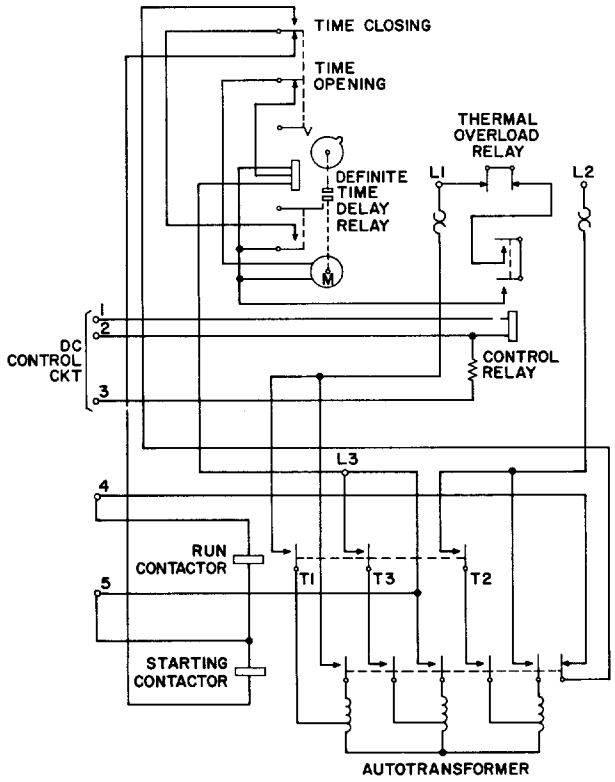

Fig. 14 — KS-5311 List 12, 13, 21, 22, 23, and 28 Compensator Schematic

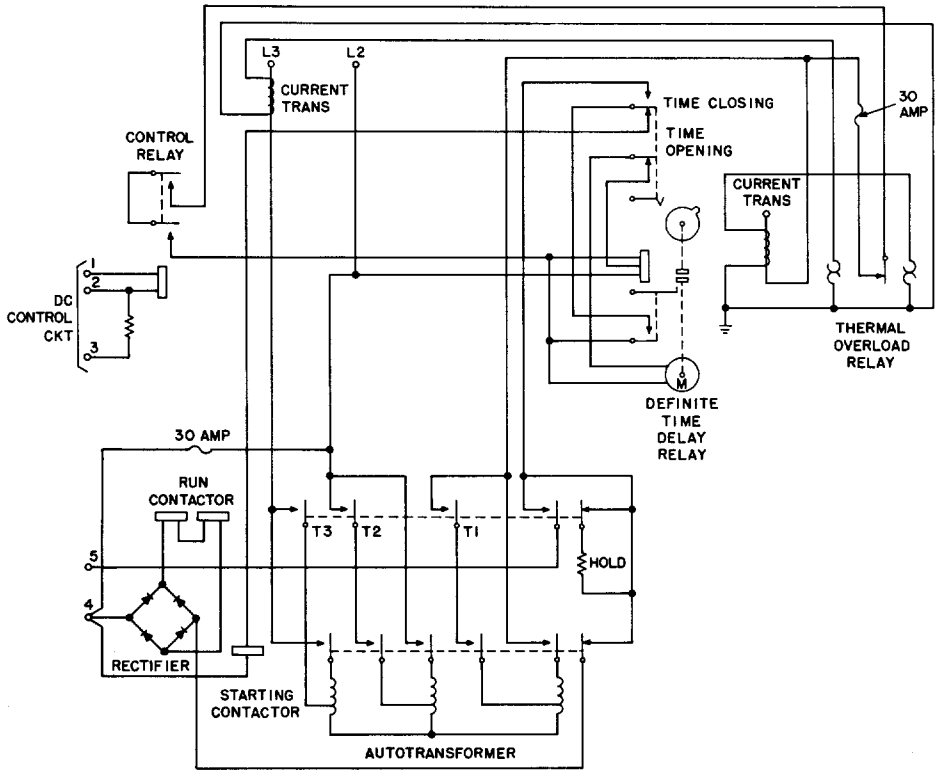

Fig. 15 — KS-5311 List 19 and 29 Compensator Schematic

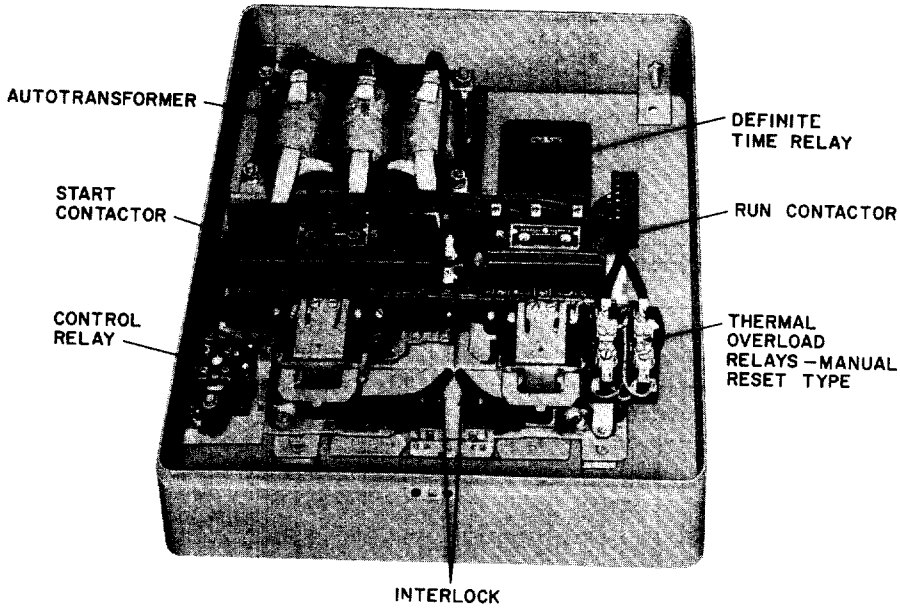

Fig. 16 — KS-15635 List 11 AC Starter

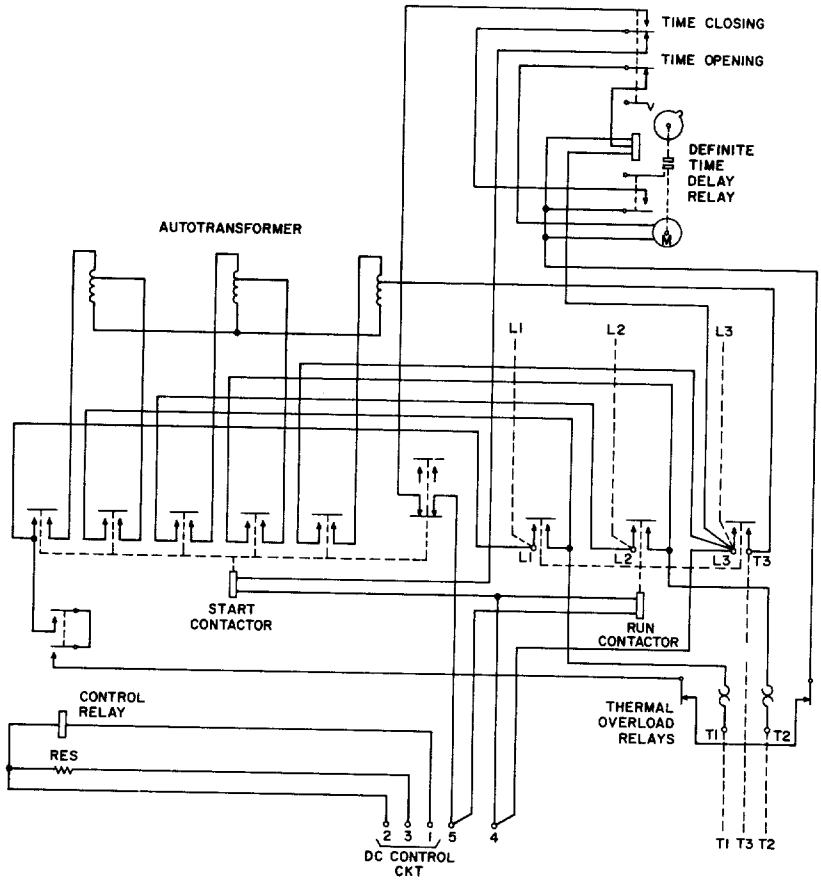

Fig. 17 — KS-15635 List 1, 2, 3, 11, 12, and 13 AC Starter Schematic

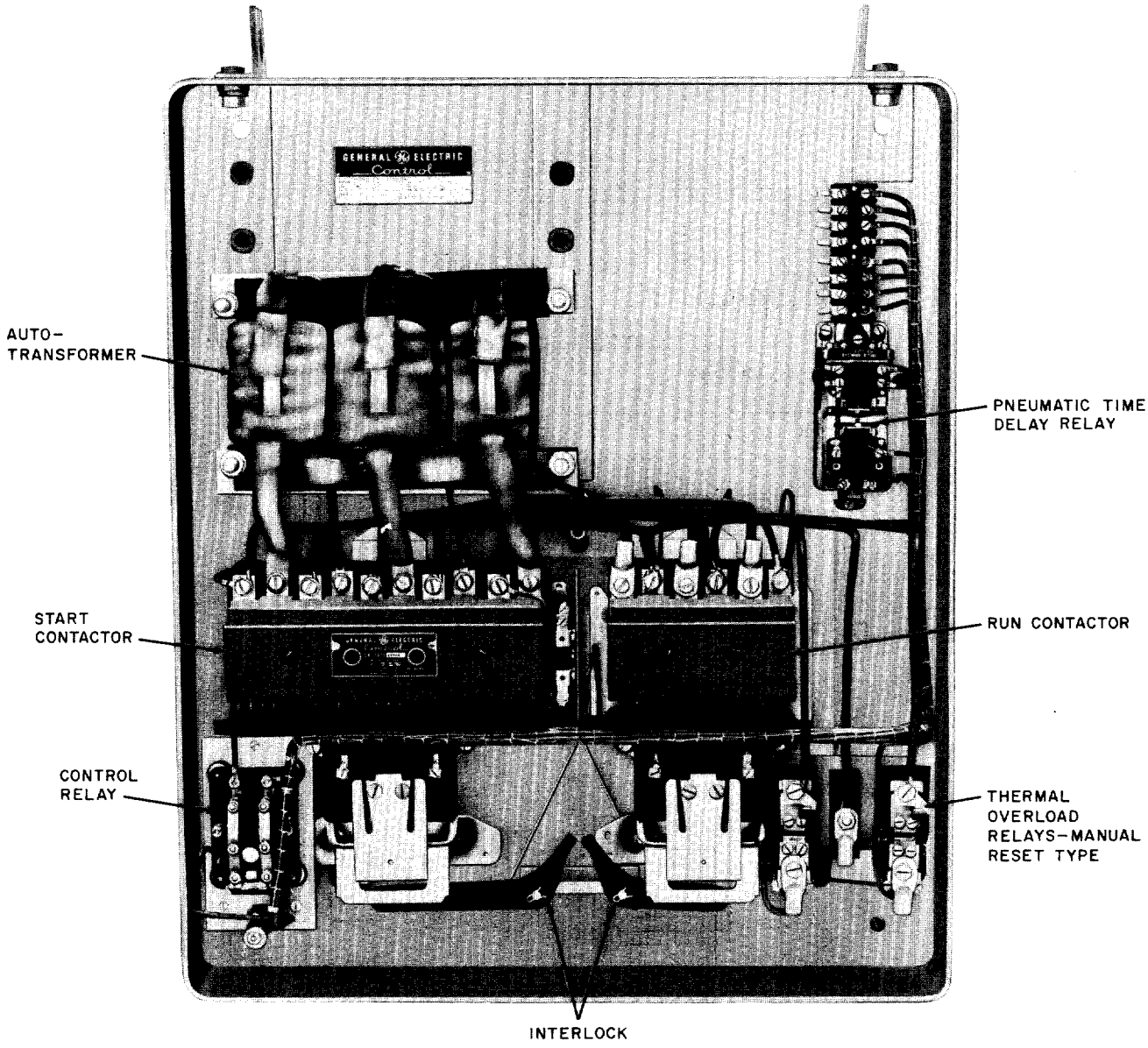

Fig. 18 — KS-15635 List 21 to 26 AC Starters

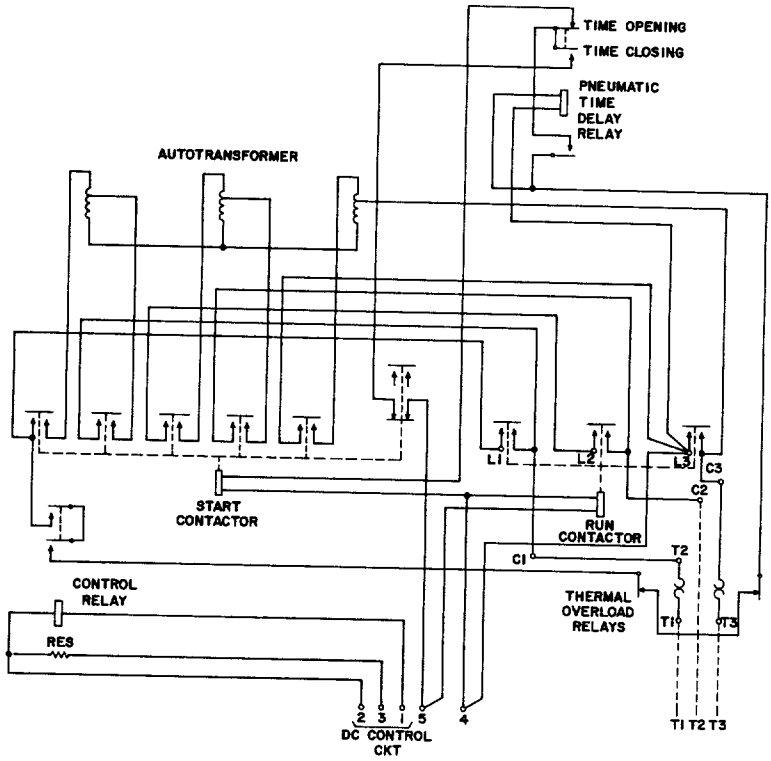

Fig. 19 — KS-15635 List 21 to 26 AC Starter Schematic

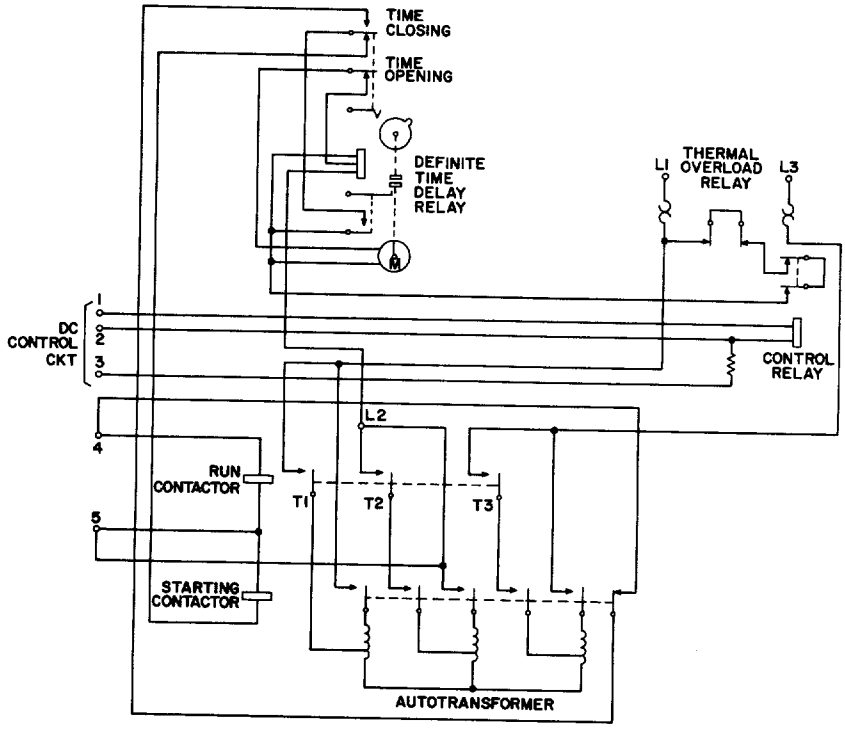

Fig. 20 — KS-15663 List 1 to 6 AC Starter Schematic

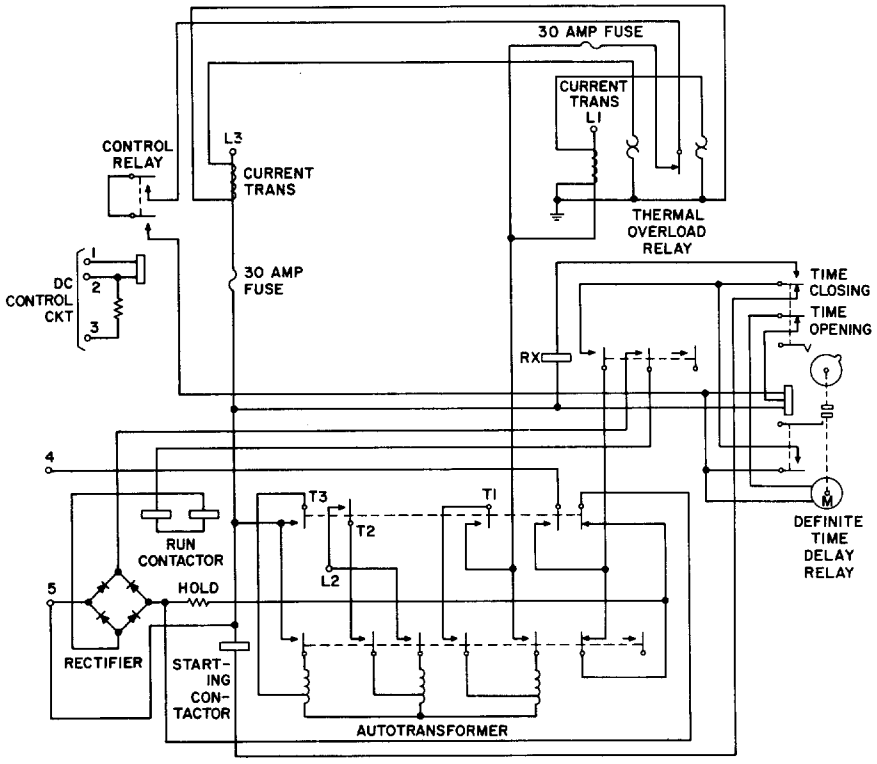

Fig. 21 — KS-15663 List 7 and 8 AC Starter Schematic

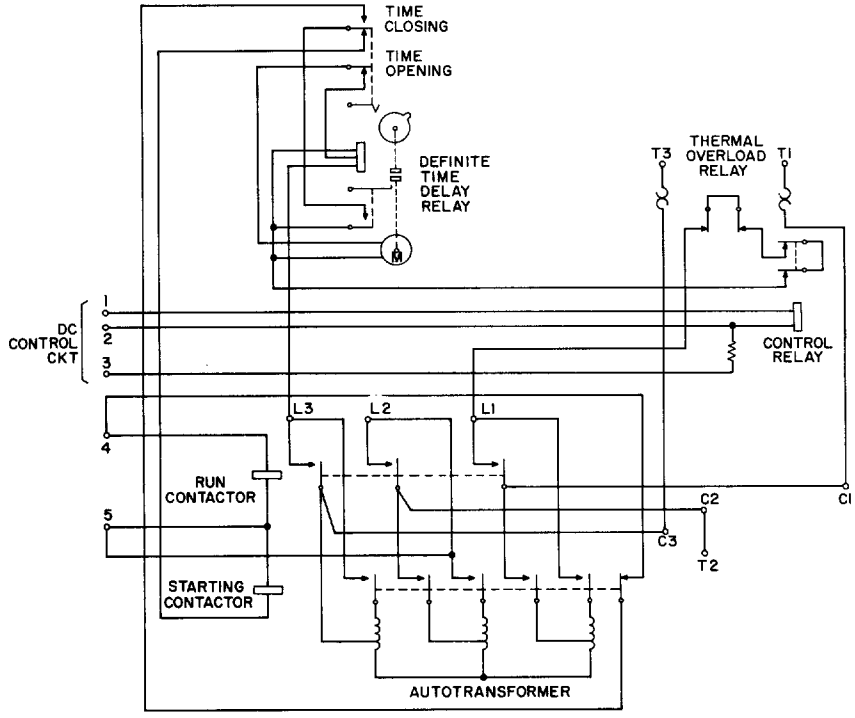

Fig. 22 — KS-15781 List 1 to 6 AC Starter Schematic (Older Type Using CR2820-1740A Time-Delay Relay)

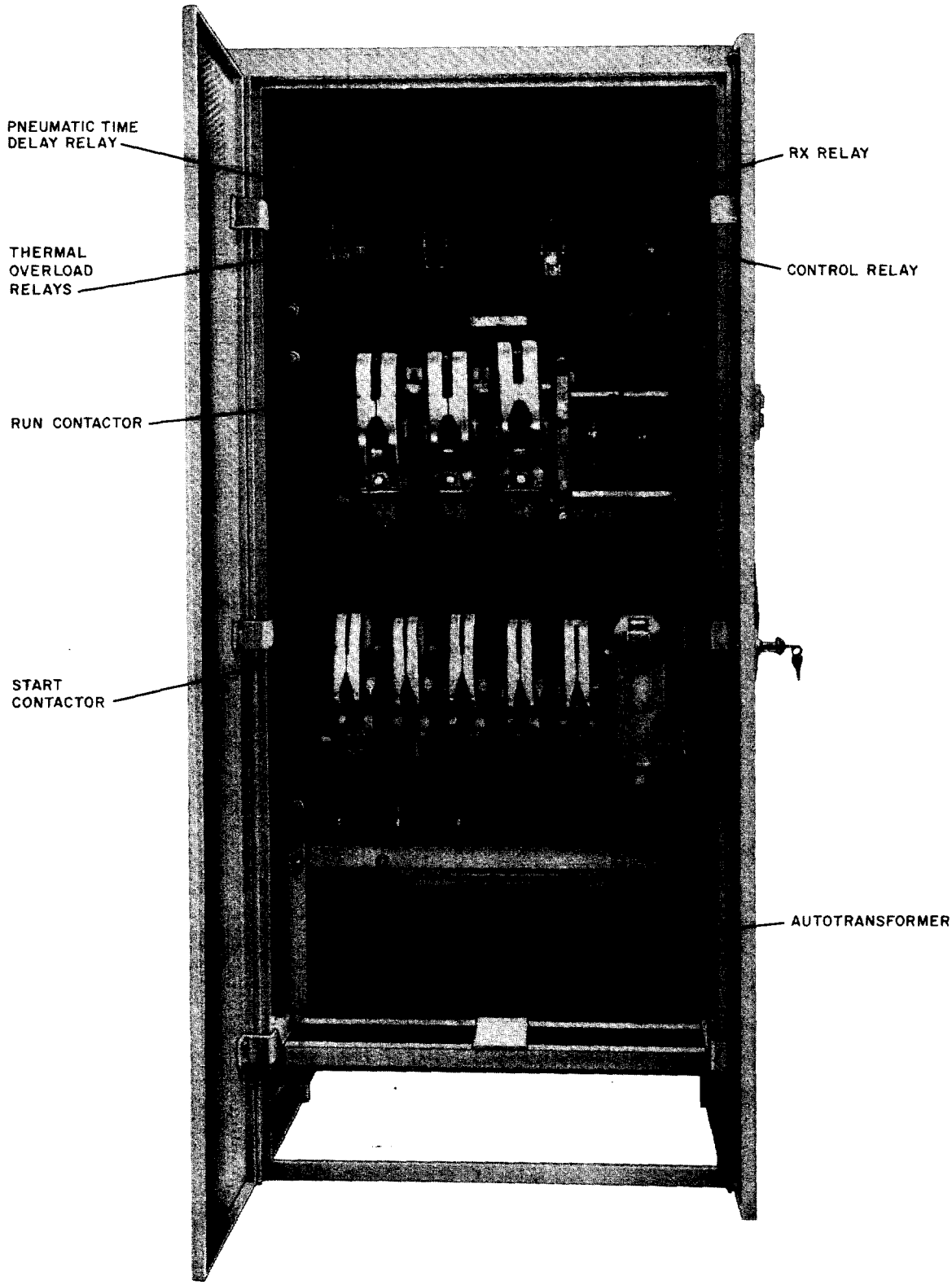

Fig. 23 — KS-15781 List 7 and 8 AC Starters

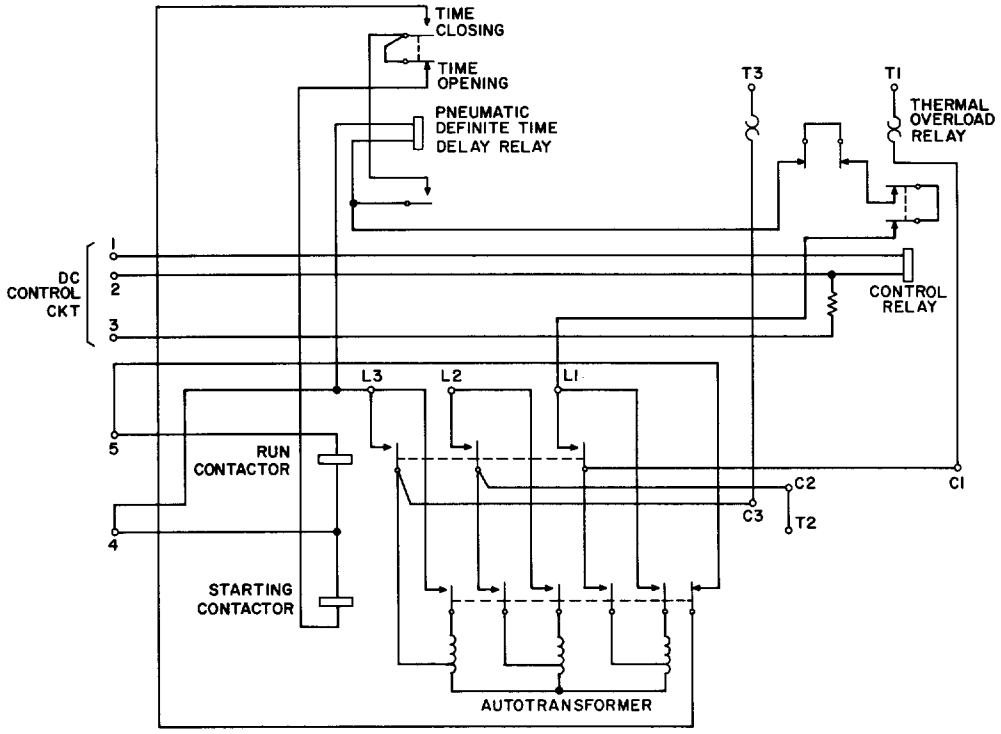

Fig. 24 — KS-15781 List 1 to 6 Starter Schematic (Newer Type Using CR2820-A111AA Time-Delay Relay)

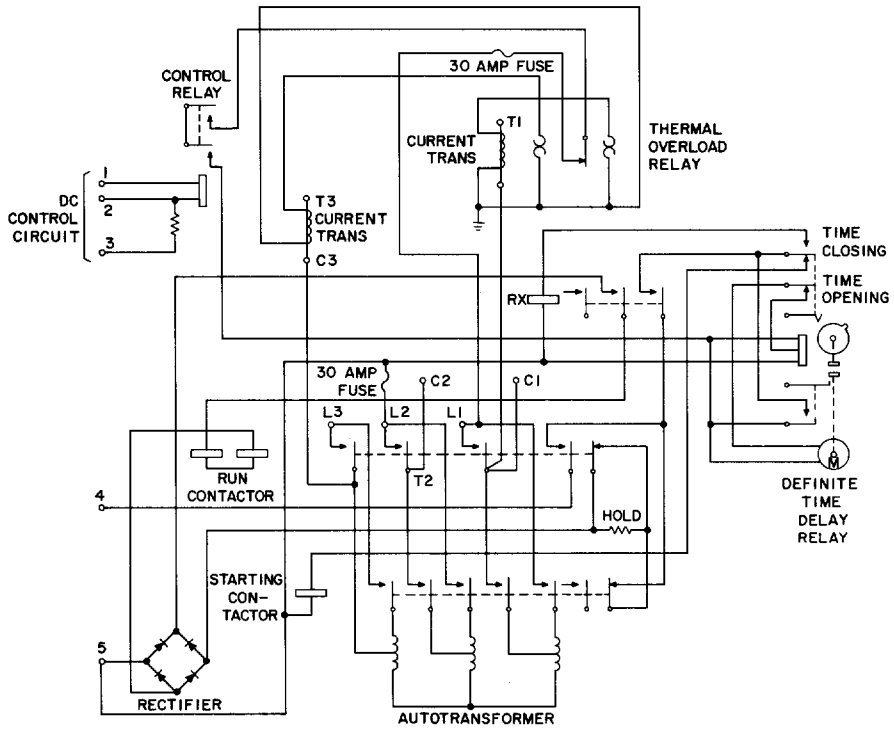

Fig. 25 — KS-15781 List 7 and 8 AC Starter Schematic (Older Type Using CR2820-1740A Time-Delay Relay)

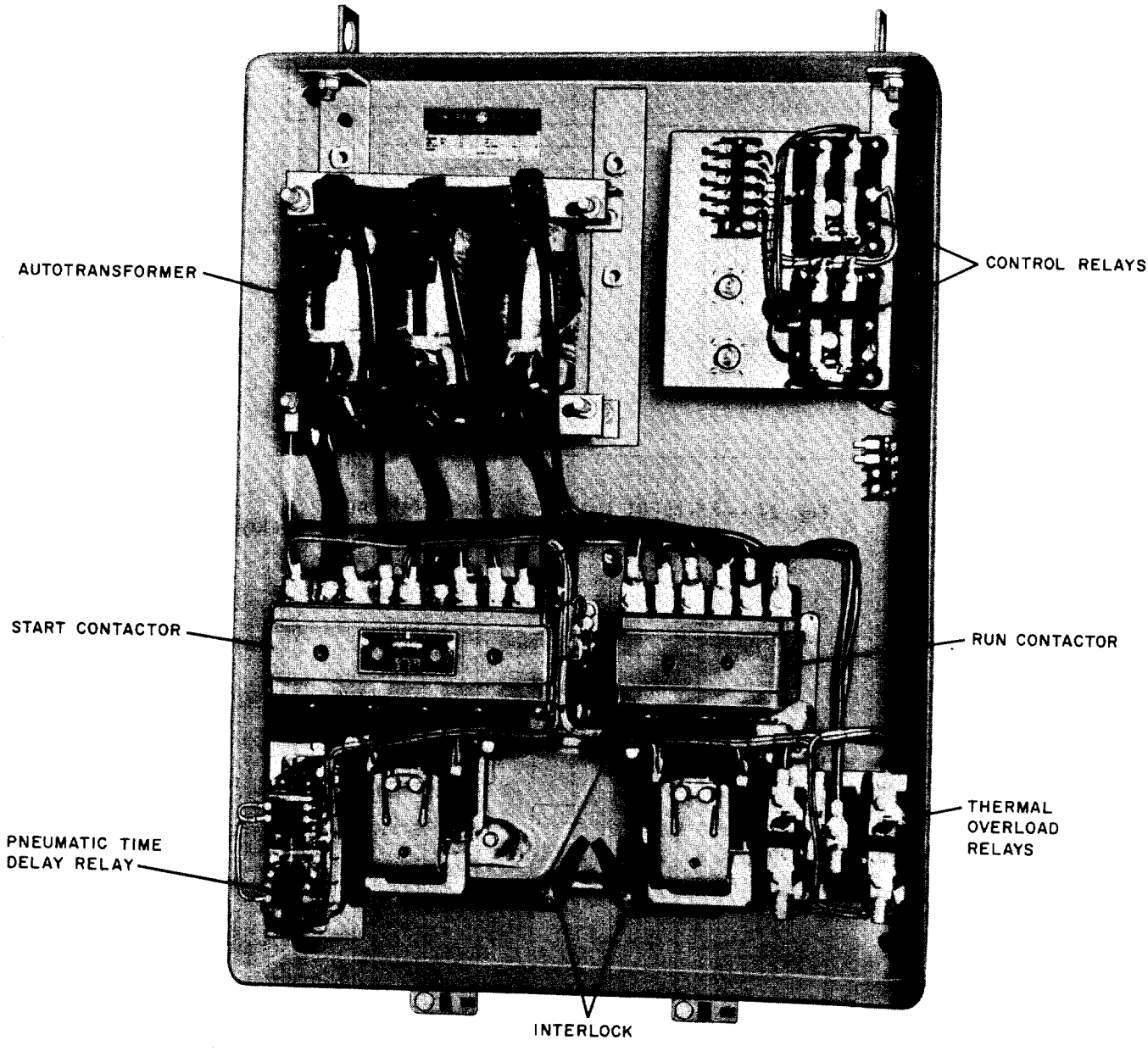

Fig. 26 — KS-15853 List 1 to 6 Starters

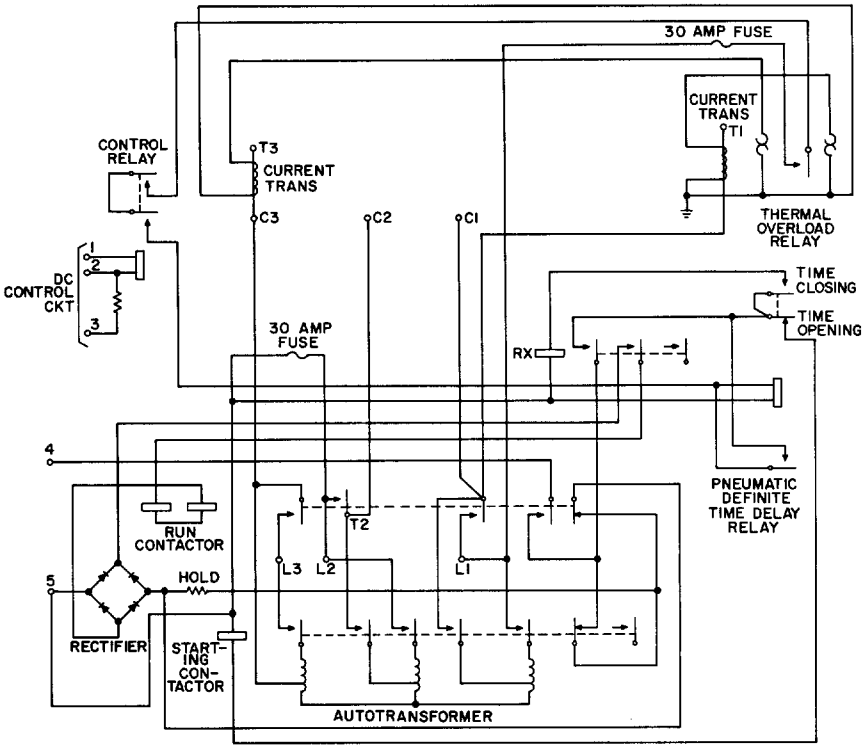

Fig. 27 — KS-15781 List 7 and 8 AC Starter Schematic (Newer Type Using CR2820-A111AA Time-Delay Relay)

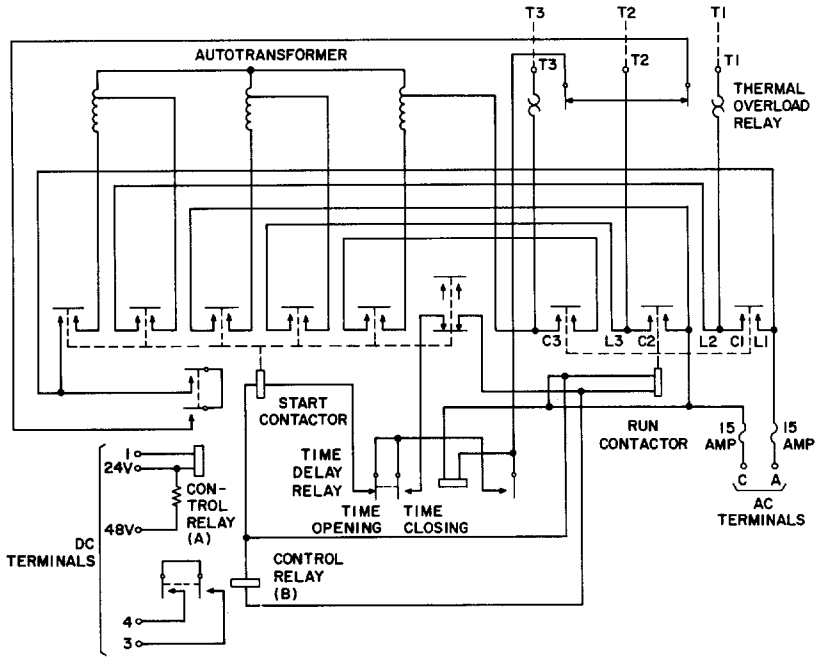

Fig. 28 — KS-15853 List 1 to 6 Starter Schematic

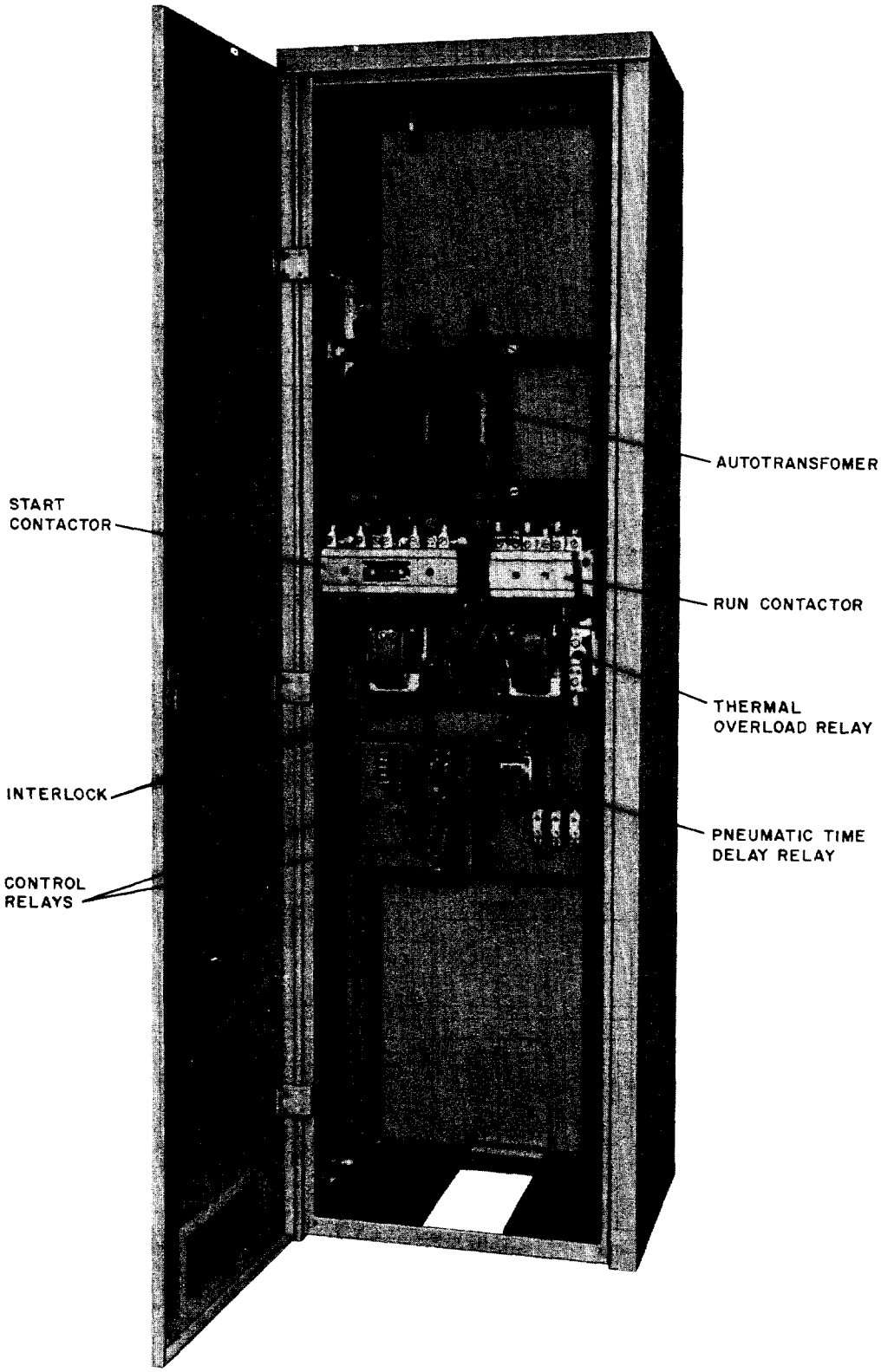

Fig. 29 — KS-15854 List 1 to 4 Starters

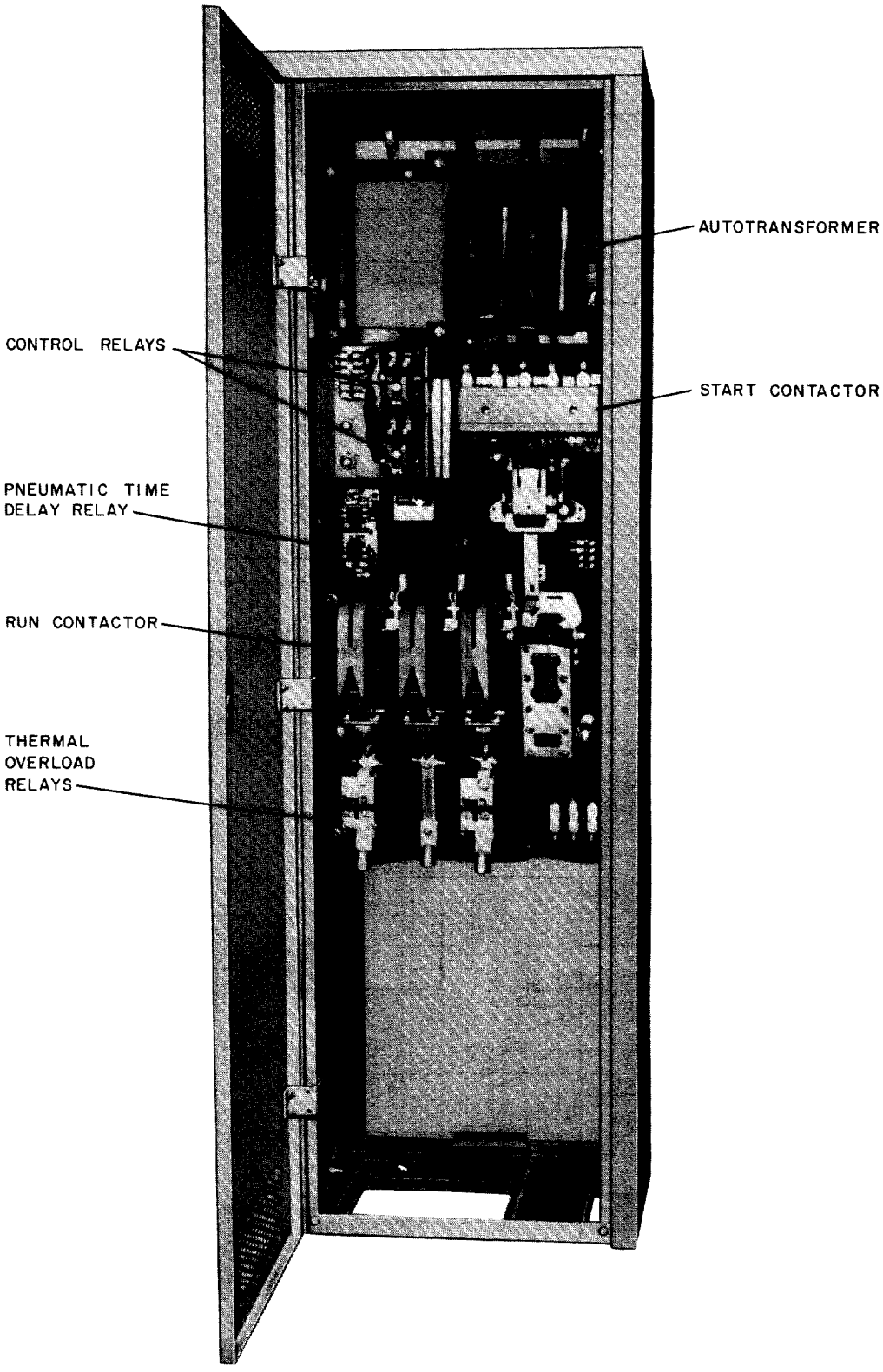

Fig. 30 — KS-15854 List 5 and 6 Starters

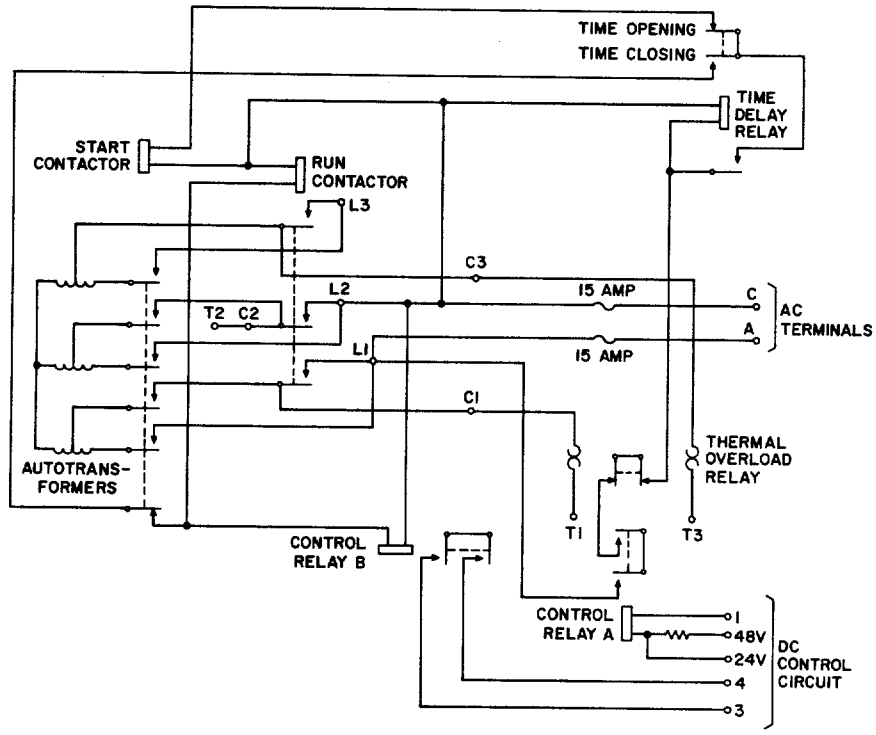

Fig. 31 — KS-15854 List 1 to 6 Starter Schematic

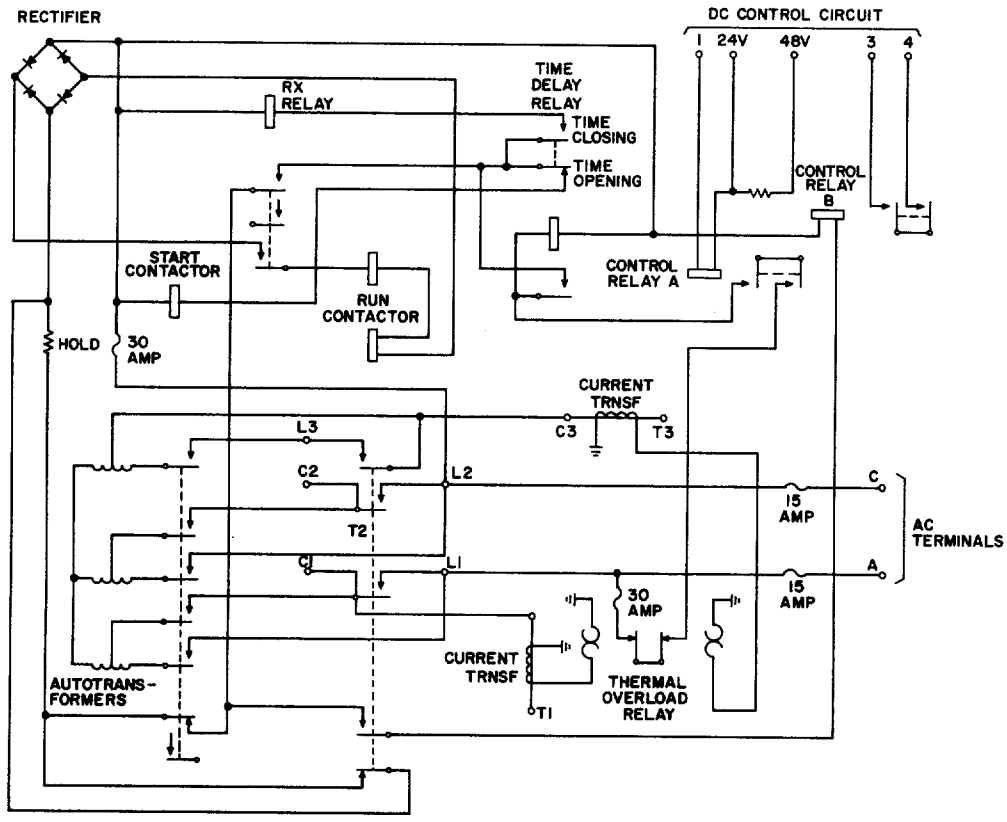

Fig. 32 — KS-15854 List 7 and 8 Starter Schematic

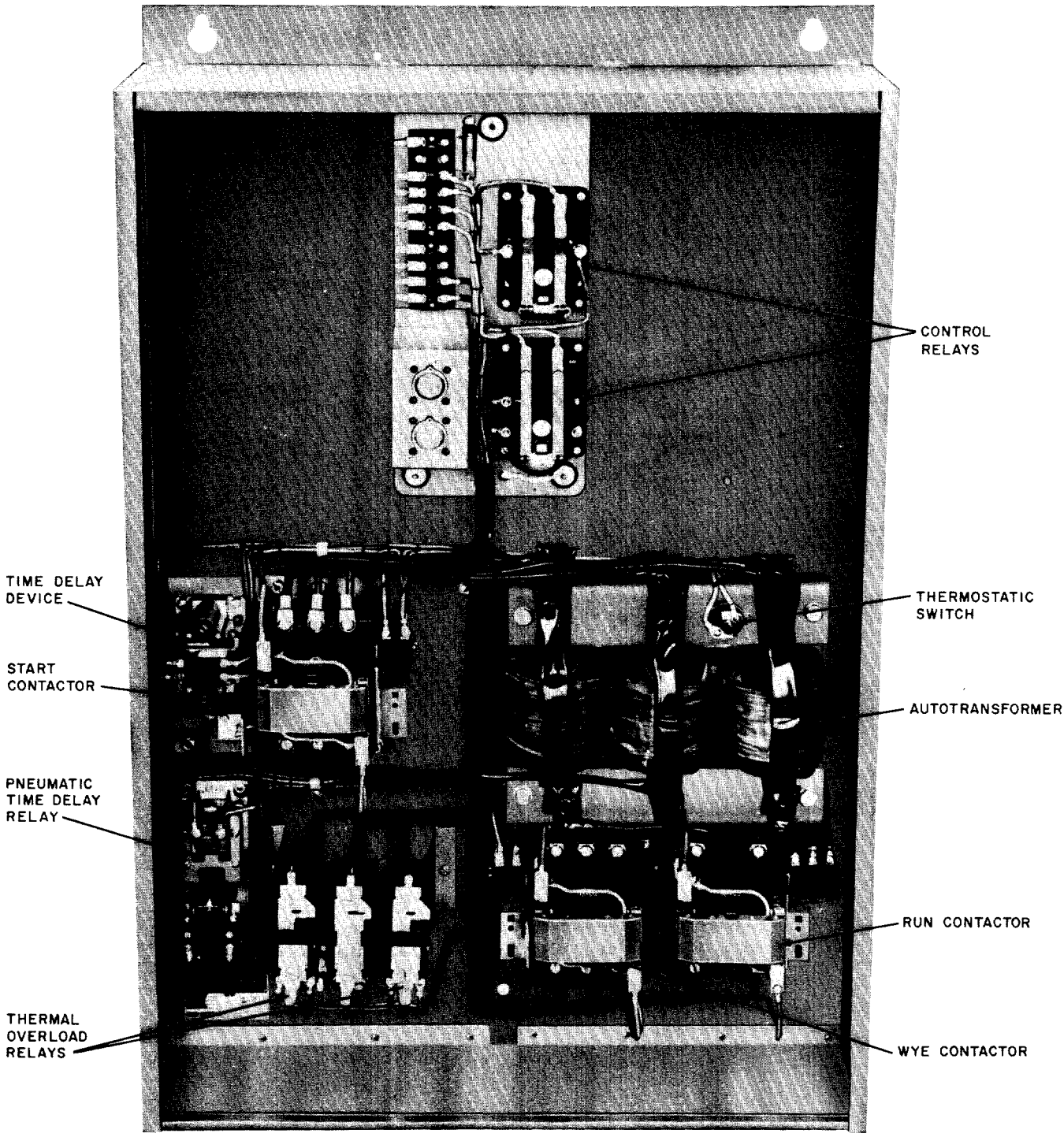

Fig. 33 — KS-15941 List 11 and 12 AC Starters (Size 2)

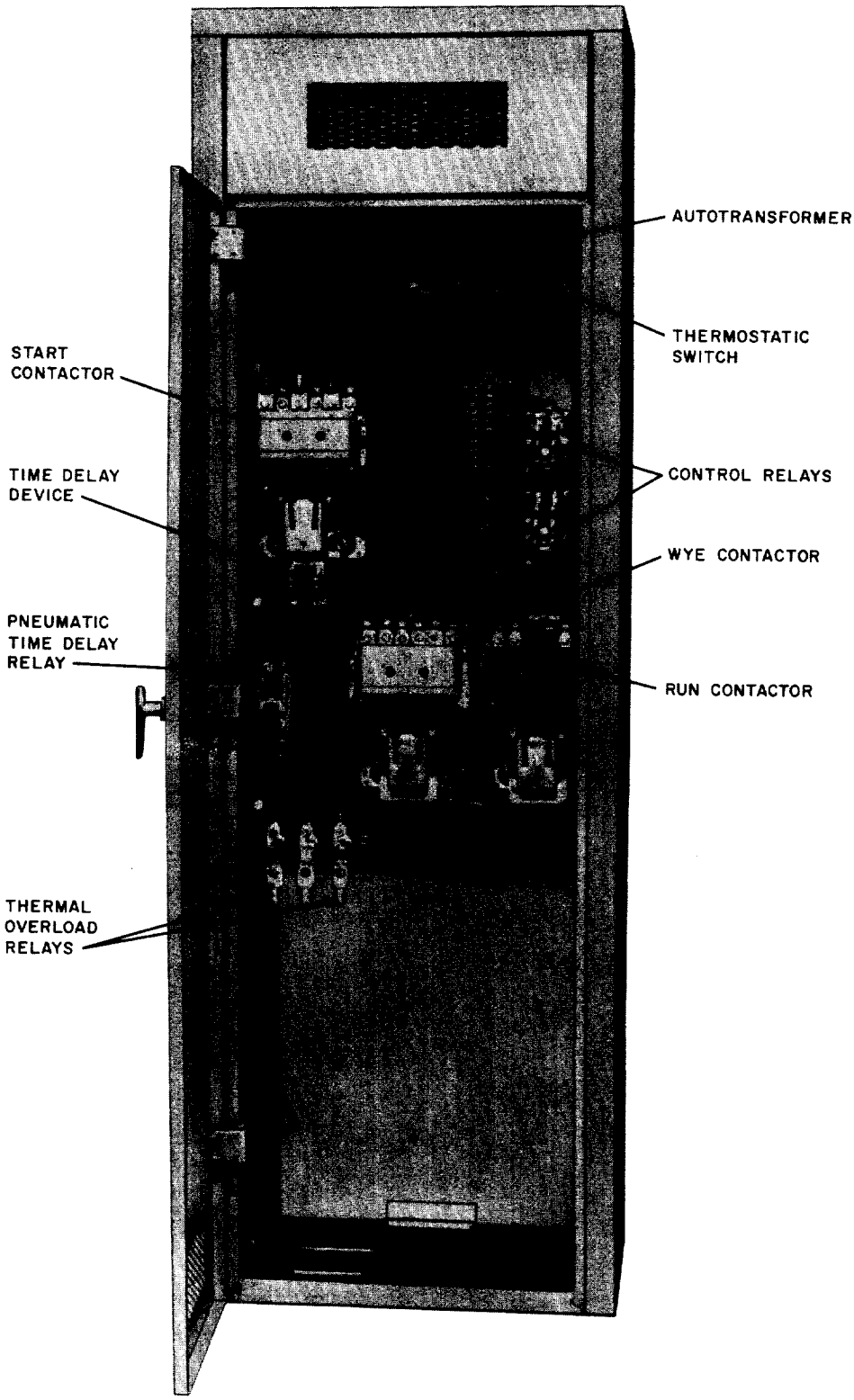

Fig. 34 — KS-15941 List 4, 5, 16, and 17 AC Starters (Size 4)

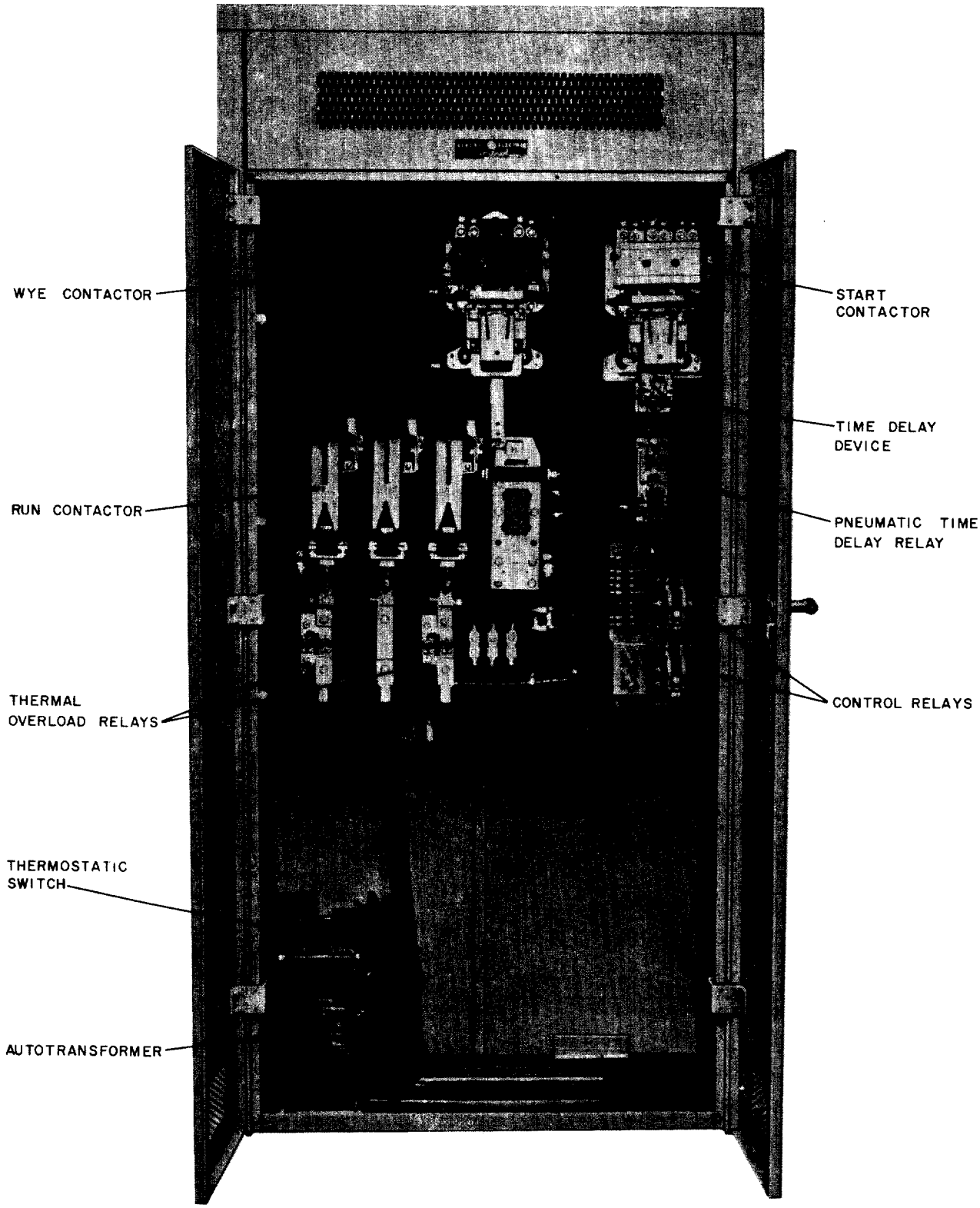

Fig. 35 — KS-15941 L6 and L7 AC Starters (Size 5)

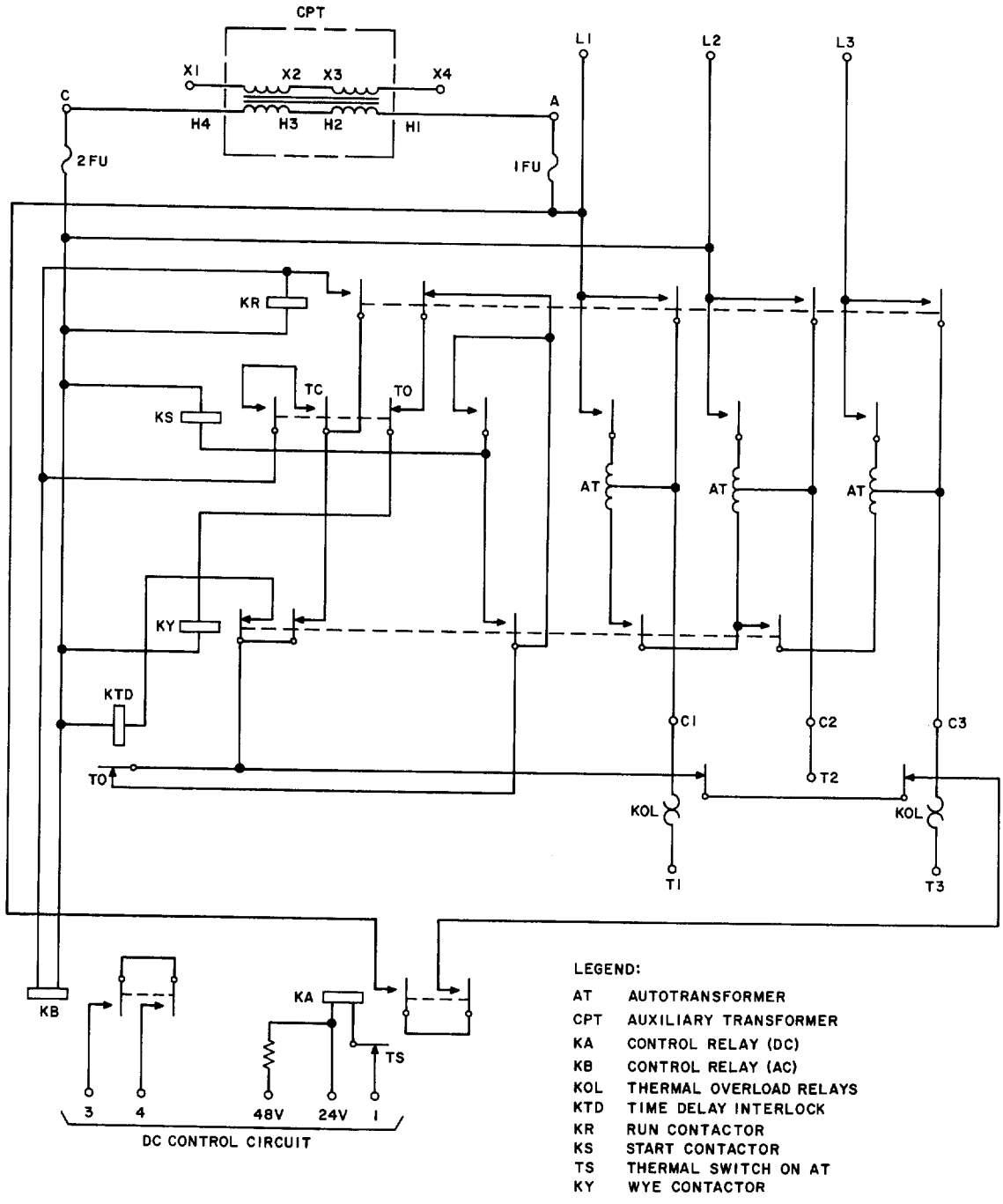

Fig. 36 — KS-15941 Starter Schematic — L1 to L7 (220 Volt) and L11 to L17 (440 Volt)

3. ADJUSTING PROCEDURES

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

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
365 (as reqd)	Connecting Clip
373D	Contact Burnisher Holder
374A	Burnisher Blade
417A	1/4- by 3/8-Inch Hex. Open Double-End Flat Wrench
418A	5/16- by 7/32-Inch Hex. Open Double-End Flat Wrench
KS-2662	File
KS-6278 (as reqd)	Connecting Clip (jaws insulated with 108 cord tips)
KS-6320	Orange Stick
KS-6780 (as reqd)	Connecting Clip (jaws insulated with 108 cord tips)
KS-14208 (2 reqd)	Brush
R-1542	6-Inch Single-End Adjustable Wrench
—	P Long-Nose Pliers
—	3-Inch C Screwdriver
—	4-Inch E Screwdriver
—	5-Inch E Screwdriver
—	Stanley No. 2012 Screwdriver
GAUGES	
70J	0-150 Gram Gauge
79B	0-1000 Gram Push-Pull Tension Gauge
79C	0-200 Gram Push-Pull Tension Gauge
79F	0-6000 Gram Push-Pull Tension Gauge
R-2481	0- to 30-Pound Spring Balance
R-2771	0- to 6-Pound Spring Balance
R-8550	6-Inch Steel Scale

CODE OR SPEC NO.	DESCRIPTION
GAUGES	
—	−10 to +400°C Thermometer, Fisher Scientific Co No. 14-985
—	Ammeter, AC, Weston Model No. 528, Range 50 Amperes
—	Ammeter, AC, Weston Model No. 528, Range 1 Ampere
—	Voltmeter, DC, Weston Model No. 931, Ranges 300-150-75-30
—	Voltmeter, AC, Weston Model No. 528, Ranges 300-150
—	Current Transformer, Weston Model No. 539 (used with Weston Model No. 528 AC Ammeter, 1 ampere, for measuring current values higher than 50 amperes)
MATERIALS	
KS-6232	Light Mineral Oil
KS-7187	Bond Paper
KS-19578 L1	Trichloroethane ←
KS-14666	Cleaning Cloth
—	Abrasive Cloth, 150 Grade
—	Asbestos Pad
—	1-Ounce Bottle
TEST APPARATUS	
35-Type	Test Set
81A	Test Set (buzzer)
352AL	Transformer
—	893 Cord, 3 Feet Long, Each End Equipped with a 360A Tool (1W13A cord) and a 365 or KS-6278 Connecting Clip
—	893 Cord, 6 Feet Long, Each End Equipped With a 360A Tool (1W13B cord) and a 365 or KS-6278 Connecting Clip
—	Autotransformer, Continuous Tap (Variac, 2.5-ampere, 230-volt input, type V-5HMT, General Radio Co, or equivalent)

CODE OR SPEC NO.	DESCRIPTION
TEST APPARATUS	
—	Fuse, 3 Amperes, 240 Volts
—	No. 14 Gauge AM Wire

Caution: Unless otherwise stated in the procedures, do not make adjustments or perform work on live contacts or parts.

3.01 ***Mounting*** (Reqt 2.01)

Tighten loose mounting screws and terminal nuts.

3.02 ***Cleaning Contacts and Removing Buildups*** (Reqt 2.02)

(1) ***General***

(a) Before cleaning contacts or removing buildups, disconnect the power supply from the contacts. (Refer to 1.11.)

Caution: Be sure to disconnect the power supply before removing the arc hood covers of the contactors. Never operate starters with covers removed.

(b) Silver contacts of the relays and solenoid-type contactors must be replaced before the silver is completely gone. Do not file or use sandpaper on the contacts as it only results in a loss of silver and a reduction of life. Clean as in (2) or smooth with a burnisher as in (3). If buildups are excessive, the contacts should be replaced.

(c) Replace contacts which are badly worn. When replacing worn movable contacts of a control relay, or elsewhere when necessitated by the construction, install a complete contact spring.

(2) ***Cleaning Contacts:*** To remove dirt and gummy substance, clean the contacts with → KS-19578 L1 trichloroethane as covered in (a) and (b) and then brush them with a dry, clean KS-14208 brush as covered in (c).

→ (a) Pour a small quantity of the trichloro→ ethane into a 1-ounce bottle. It is important to avoid the use of contaminated → trichloroethane in cleaning the contacts. Therefore, discard the trichloroethane as soon as it appears slightly dirty.

→ (b) Dip the hairs of a clean KS-14208 brush their full length in the trichloroethane. Remove excess fluid by wiping the brush on the edge of the bottle. Then, with the pair of contacts open, brush the entire surface of the contact to be cleaned with the moist brush.

(c) Brush the contacts with a dry, clean KS-14208 brush.

(3) ***Removing Buildups:***

(a) There shall be as little smoothing of contacts as is consistent with satisfactory operation. Contacts should be smoothed while closed, where practicable. To remove buildups, use the 374A burnisher blade held in the 373D contact burnisher holder. Insert the blade between the contacts and move it back and forth until the buildups are reduced enough to insure reliable contact. Exercise care to avoid reducing the height of the contact. After burnishing, brush the contacts with a dry KS-14208 brush.

(b) In general, the contacts of the clapper or hinged-armature type contactor will not need attention during their normal life but, if prominent beads form on the surface or if the contacts turn a dark color due to overheating, the contact faces should be dressed with the KS-2662 file. Filing the contacts should be done so as to keep contact surfaces parallel and of original contour.

3.03 ***Contact Alignment*** (Reqt 2.03)

(1) Where feasible, shape with the pliers a movable contact spring that is slightly bent or out of alignment. Any contact spring that becomes badly bent out of shape should be removed and reshaped or replaced with a new contact spring. Straighten stationary contact supports with the pliers as required.

(2) Where adjustment of alignment by the use of pliers is not feasible, loosen the clamping bolts which hold the contact arm

to the shaft to obtain play and move the arm as required. See Fig. 1.

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

3.04 ***Contact Sequence*** (Reqt 2.04)

(1) Contacts which are carried on contact arms clamped to the shaft may be adjusted by the following procedure: See Fig. 1. 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.

3.05 ***Freedom of Operation*** (Reqt 2.05)

Operate the apparatus manually, after disconnecting it from the power service. Look for sticking or binding and remove the cause. If the contactor is noisy, see that the faces of the core of the operating coil and of the armature are clean and free from rust. Clean with KS-19578 L1 trichloroethane on a ← KS-14666 cloth wrapped around the KS-6320 orange stick, as required.

3.06 ***Electrical Requirements*** (Reqt 2.06)

(1) A check of the operation of a relay may be made by connecting a voltmeter across the coil terminals. If there is no indication on the voltmeter, a study of the associated circuit is necessary to determine 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.

Caution: In the case of a coil rated 190 to 253 volts or 380 to 500 volts, make the connections with the circuit disconnected from the power supply.

(2) When readjusting or when checking for any electrical requirement except the check of operation discussed in (1), the relay should be disconnected from the working circuit if practicable. (Refer to 1.11.)

(3) Where requirements are expressed in volts, direct current is meant unless otherwise specified, and a 35-type test set having a voltmeter or supplemented by a voltmeter should be used when checking a control relay. For the connections, 893 cords (3 feet long), each end equipped with a 360A tool and a 365 clip are satisfactory.

(4) Where electrical requirements are expressed in volts alternating current, connect the ac supply to the input of a continuously tapped autotransformer protected by a 2-1/2 or 3-ampere fuse. Connect the relay coil and a voltmeter across the output of the autotransformer and adjust to the specified value. For the test connections, use lengths of flexible cord of the type used with small electrical appliances with KS-6780 clips at each end.

3.07 ***Temperature*** (Reqt 2.07)

(1) If the temperature exceeds the specified limit, see that:

For blow-out coils	Ampere rating is not exceeded.
For operating coils	Maximum voltage is not exceeded.
For resistors	Rated watts are not exceeded.
For autotransformer windings	Frequency of starting not exceeded.

(2) If the temperature still exceeds the specified limits and the other requirements are met, refer the matter to the supervisor.

3.08 ***Contactors — Solenoid Type***

(1) In general, correction for lack of contact pressure and follow involves the replacement of badly worn contacts and weak contact springs. If any of the contacts require replacement, replace the entire set.

(2) The contacts of the contactors may be cleaned as covered in 3.02. Do not use abrasive cloth or a file.

3.09 ***Contactors — Hinged-Armature Type*** (Reqt 2.09)

(1) To check the ***initial pressure*** of NO contacts of a contactor with the contactor in the released position, attach a short loop of cord around the movable contact and insert a small piece of KS-7187 bond paper in the contact assembly between the contact finger and support. See Fig. 37. Hook the gauge in the loop and pull away from the stationary contact. Observe the indication of the gauge at the instant the paper can be moved.

(2) To check the ***final pressure*** of NO contacts of a contactor, proceed as above with the contactor operated and the paper inserted between the contact surfaces. The contactor may be operated manually or electrically by means of a temporary connection to the operating coil. See that the contacts are not connected to the service voltage while being handled.

(3) To check initial and final pressure of NC contacts, proceed as above except the contactor should be operated when checking initial pressure and released when checking final pressure.

(4) Where no separate requirements are given for initial and final pressure, final pressure is meant.

(5) Replace weak springs.

3.10 ***CR2824-TC221C and CR2824-TC121C Adjustable Overload Relays*** (Reqt 2.10)

(1) The scale for setting the calibrating arms is marked 80 to 120, which is in percentage of the relay heating element rating. To determine the proper value for the setting of the calibrating arms, determine the following:

(a) Full-load current of the motor as given on the motor nameplate.

(b) Current step-down ratio of current transformer if used.

(c) Rating of relay heating elements as shown on the relay nameplate.

(d) Desired percent of full-load current of the motor.

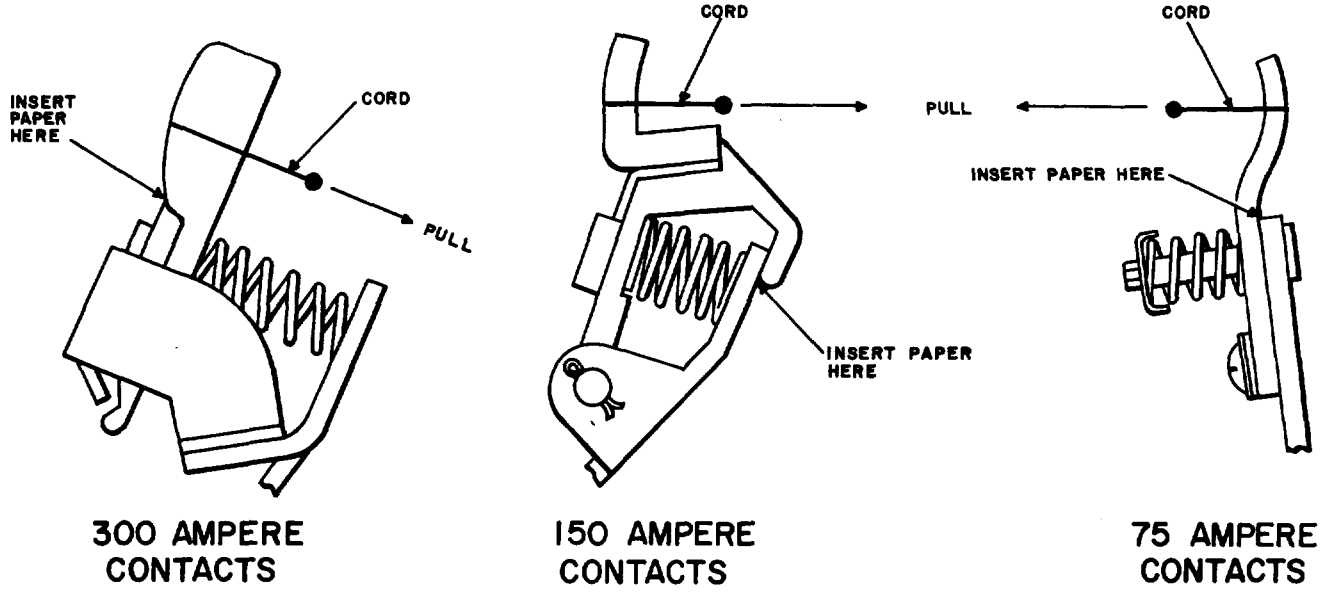

Fig. 37 — Measurement of Initial Contact Pressure

(e) Use the following formula to determine the setting of the calibrating arms:

$$(e) = \frac{(a) \times (d)}{(b) \times (c)}$$ setting of the calibrating arms (see note)

Example, where current transformer is used. If (a) = 334, (b) = 80 (as for example 400 to 5 amperes), (c) = 5, and (d) = 105, then (e) will be 88.

Example, where current transformer is not used. Use the above formula except omit the current step-down ratio of the transformer. If (a) = 4.3, (c) = 5, and (d) = 115, then (e) will be 99.

Note: In case of too frequent relay operation (nuisance tripping) where the relay ambient is 5°C or higher than the motor ambient, increase (e) by 3- or 4-point steps until the nuisance tripping is eliminated but, in no case, shall this result in (d) being over 125 percent of motor rating.

$$(d) = \frac{(e) \times (b) \times (c)}{(a)}$$ shall not exceed 125 percent

Omit (b) from this formula if a current transformer is not used.

(2) After the relay has been readjusted, it shall again be checked for test requirement 2.12 and, if the relay fails to meet the requirement, it shall be replaced.

(3) Maintain the contacts in accordance with 3.02, 3.03, and 3.05.

3.11 ***CR2824-2D and CR2824-42B, -42C, -42H, -42J, and -42M and CR124F012 Nonadjustable Overload Relays*** (Reqt 2.11)

To inspect the contacts, remove the relay side panels which are held by screws. If the contacts are rough, open them by tripping the relay mechanism and smooth with a burnisher. If necessary, shape the contact springs with long-nose pliers to increase the contact pressure. Push in the reset button to reclose the contacts.

3.12 ***Starters with Overload Relays*** (Reqt 2.12)

(1) This procedure applies for the test requirement of single-phase starters and 3-phase starters having a full-load motor current of 25 amperes or less, or a full-load motor current greater than 25 amperes but employing a current transformer in association with the overload relay.

(2) Open the ac supply at the switch and fuse unit by removing fuses or opening the motor circuit disconnect switch. Where current in excess of the output rating of the autotransformer is required, a transformer should be added as shown in Fig. 38. If the 352AL transformer is used, terminals 1 and 3 are connected to the L and T terminals of the overload relay; terminals 4 and 210, 230, or 250, depending on line voltage, are connected to the output of the autotransformer. With the above arrangement, current up to 62-1/2 amperes at 2.5 volts ac can be obtained by manipulation of the autotransformer. With the test autotransformer, adjust the current to the required value.

(3) If no current flows when voltage is applied with the autotransformer, replace the heater coil. If a nonadjustable relay does not operate within 5 minutes, replace the relay. If an adjustable relay does not operate within 5 minutes, readjust the relay as covered

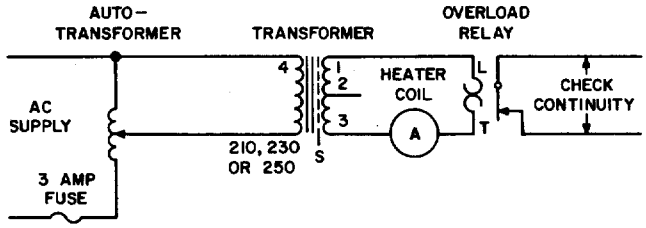

Fig. 38 — Test Circuit for Checking Overload Relays

in 3.10. Reset the relay after test. For 3-phase starters, repeat for the other heater coils.

Note: If the overload relay is thought to be at fault on starters having a full-load motor current of 25 amperes or more and which do not have a current transformer associated with the overload relay, it is suggested that a new overload relay be installed and the defective relay be sent to the supplier for repair.

3.13 ***Selenium Rectifier in KS-15663 Lists 7 and 8, KS-15781 Lists 7 and 8, and KS-15854 Lists 7 and 8*** (Reqt 2.13)

If the output voltage is below the specified limit, refer the matter to the supervisor as the rectifier may have to be replaced.

3.14 ***CR2820-1099 Time-Delay Relay*** (Reqt 2.14)

(1) The delay, extending from the time the relay is energized until the contact arm is released by the latch, is controlled by the setting of the calibration disc which is marked in 2- or 5-second steps. The disc is set by holding the locking spring to one side and rotating the disc until the desired value is opposite the pointer.

Note: The nut which fastens the calibration disc is subject to loosening. Tighten periodically.

(2) If the disc fails to return to its stop when the relay is released, the gear shaft spring should be strengthened. Proceed by pulling one end around the spindle and returning it to its resting place against the frame.

(3) The check of the timing motor drive with 2-ounce (57 grams) pressure on the latch is to avoid slippage of the rubber disc drive. If slippage occurs, clean the rubber disc and brass gear thoroughly with a dry cloth. This disc should be checked at routine inspections to insure that it is free from oil. If persistent slippage or wear of the rubber disc is encountered or if the gap between the brackets associated with the rubber disc drive ever becomes as small as 1/32 inch, the matter should be referred to the supervisor who may wish to replace the relay.

(4) If the gears do not mesh, it is an indication that the operating arm is bent or that the pivot points for the gear rocket arm assembly are worn. The operating arm which engages the plunger (see Fig. 8) may be straightened as required. If parts are worn, refer the matter to the supervisor who may wish to replace the relay.

(5) If the relay fails to function properly because of defective or broken parts or if coil burn outs have been experienced, replace the relay as covered in Section 026-305-801.

3.15 ***CR2820-1740A Time-Delay Relay*** (Reqt 2.15)

(1) When the gear train is reset, the adjustment dial will indicate the delay interval which is adjustable by means of the adjustment knob. During timing, the unexpired time will be indicated with operation of the switchette occurring at zero. (See Fig. 9.)

(2) When checking the relay, look for dirt or binding and clean with a dry cloth as required. Do not oil any part of this relay. If the relay fails to function properly because of a defective switchette, magnet coil, or motor, replace these parts as covered in Section 026-305-801.

(3) In those areas where high voltage is prevalent and coil burn outs have been experienced, the relay should be replaced as covered in Section 026-305-801.

3.16 ***CR2820-A111AA, -B110AA, and -B111AA Pneumatic Time-Delay Relays*** (Reqt 2.16)

(1) To adjust the relay (see Fig. 10 and 11), start with the adjustment screw turned clockwise to the extreme "F" (FAST) position, turn the adjustment screw counterclockwise toward "S" (SLOW), checking occasionally until the desired setting is approached. Always make the final adjustment in small increments from "F" to "S." In the event the desired setting is accidentally passed, turn the adjustment screw one full turn back toward

"F"; then proceed as above until the desired setting is reached.

Note: The rate of change of timing in relationship to the adjustment screw position is greater for long-time delays than for short-time delays. It will be noted that a considerably greater adjustment is required at the "F" (FAST) end than is required at the "S" (SLOW) end to produce an equal effect.

(2) Refer to Section 026-305-801 for replacement parts and procedures.

3.17 ***Time-Delay Interval Adjustment*** (Reqt 2.17)

(1) If the motor which is connected to the starter is in satisfactory condition but fails to start or comes up to speed too slowly, change the taps on the autotransformers to increase the starting voltage. If the fuses blow or there is other evidence of excessive starting current, change the taps to decrease the voltage.

(2) The taps in the newer starters are marked in percent of line voltage. See that taps are properly insulated with tape after any work has been done on them.

(3) If in an old starter the taps are found unmarked, refer to the table below for tap voltages or use an ac voltmeter.

TAP LOCATION	PERCENT
Nearest the core	65
Next outward	60
Next outward	55
Nearest surface of coil	50

(4) When determining the setting of the delay relay, it is necessary first to obtain an initial value which meets the requirement at the line voltage existing at the time and then to increase this to obtain a final value such as will insure that, when started at the lowest voltage likely to be encountered at the office, the motor will attain the required speed before being transferred to the line.

(5) When determining the initial setting, start with a value which may prove to be longer than required and reduce it in steps of 1, 2, or 5 seconds, depending upon the particular model of relay involved. Start the motor on each setting observing the voltage until the motor shows a tendency to jump when transferred from the starting taps to the line. Then increase the relay until the motor transfers smoothly. This gives the initial setting.

(6) To obtain the final setting in an office having power service voltage limits not exceeding ±5 percent, increase the setting by an amount depending upon the voltage observed during the foregoing procedure as follows:

OBSERVED VOLTAGE	PERCENT INCREASE
Near low limit	None
Near average	20
Near high limit	40

In an office having power service voltage limits of ±10 percent, proceed as outlined below:

OBSERVED VOLTAGE	PERCENT INCREASE
Near low limit	None
About 5 percent low	20
Near average	40
About 5 percent high	60
Near high limit	80

For example, if the initial setting is found to be 10 seconds at 250 or 480 volts as applicable and the office limits are 230 ±10 percent or 440 ±10 percent, the setting should be increased by 80 percent of 10 seconds, namely 8 seconds. The final setting then becomes 18 seconds.

3.18 ***CR2820-B130AA Pneumatic Time-Delay Auxiliary Contact*** (Reqt 2.18)

The adjusting procedure is the same as 3.16.