

AUTOTRANSFORMER-TYPE MANUAL AC STARTERS
GENERAL ELECTRIC COMPANY
REQUIREMENTS AND ADJUSTING PROCEDURES

1. GENERAL

1.01 This section covers the following manual-type ac motor starters, manufactured by the General Electric Company.

KS-5092	KS-5292
KS-5140	KS-5292-01
KS-5140-01	KS-5310

1.02 This section is reissued to revise the title, to add operate requirements and test procedures for overload relays, to add the form G150 starters, to add the CR2824-41M and -42G relays, to remove information covering the selection and replacement of heater elements on nonadjustable relays, to revise the list of tools, gauges, and materials, and to add Fig. 2, 3, 8, and 13. In addition, the phi (ϕ) sign and the asterisk (*) sign have been added.

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.

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 The ac service shall be disconnected directly ahead of the starter before removal of the case covers or the oil tank. The service may be reconnected while electrical tests are being made.

1.07 Since the oil tank on the form K22 starter weighs approximately 180 pounds when filled with oil, it is recommended that at least three men be used to handle it, one on each side and the third to release it. Drain and fill plugs may be provided to facilitate handling the tanks.

2. REQUIREMENTS

2.01 *Oil Level*

(a) The oil shall be maintained at the level indicated by the line on the outside of the tank as observed with the tank removed, or where drain and fill plugs are provided, at the level determined by the fill plug opening.

ϕ (b) The oil shall be changed at least every 5 years unless operating experience indicates a different interval is desirable. Use General Electric Company No. 10C switch oil.

2.02 *Autotransformer*: Suitable taps shall be used so that the motor will come up to speed in reasonable time (5 to 10 seconds on the smaller sets and up to 20 to 30 seconds on the larger sets), but the starting current shall not be high enough to blow the motor line fuses, rated at 125 per cent of the full load running current of the motor.

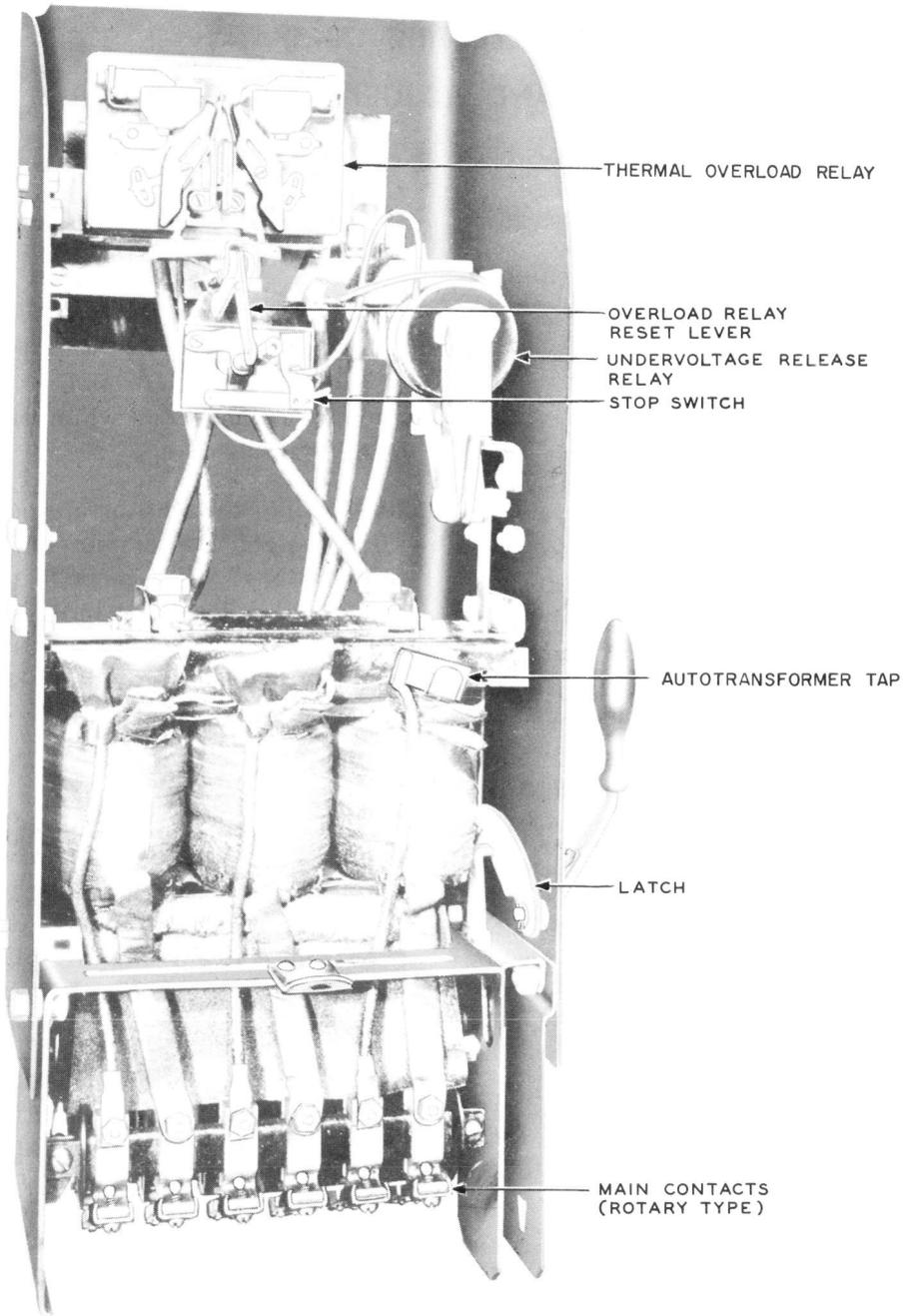


Fig. 1 – KS-5140 Manual-type AC Starter — Form K1 (With Cover and Oil Tank Removed and Insulation Off One Transformer Tap)

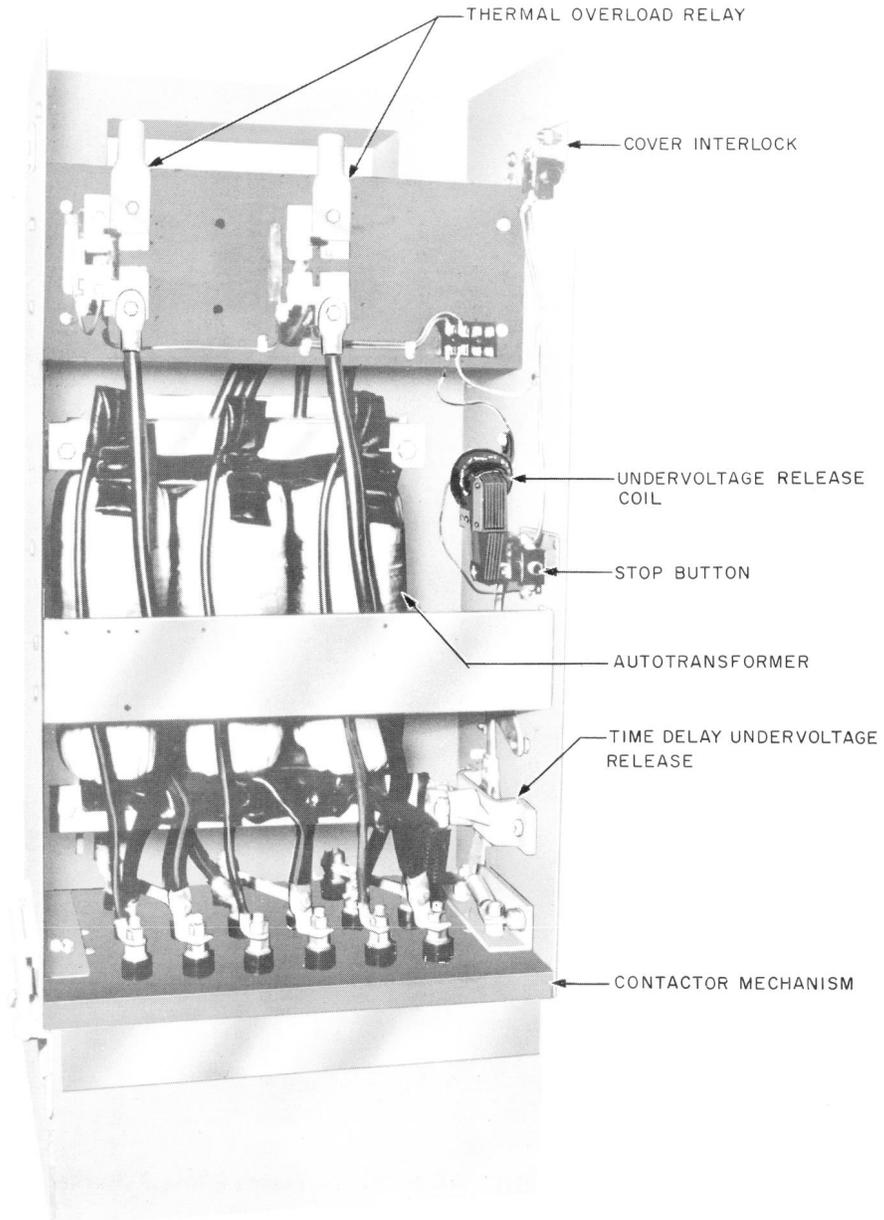


Fig. 2 – KS-5140-01 Manual-type AC Starter — Forms K33 and G150
(Form G150 Shown With Cover Removed)

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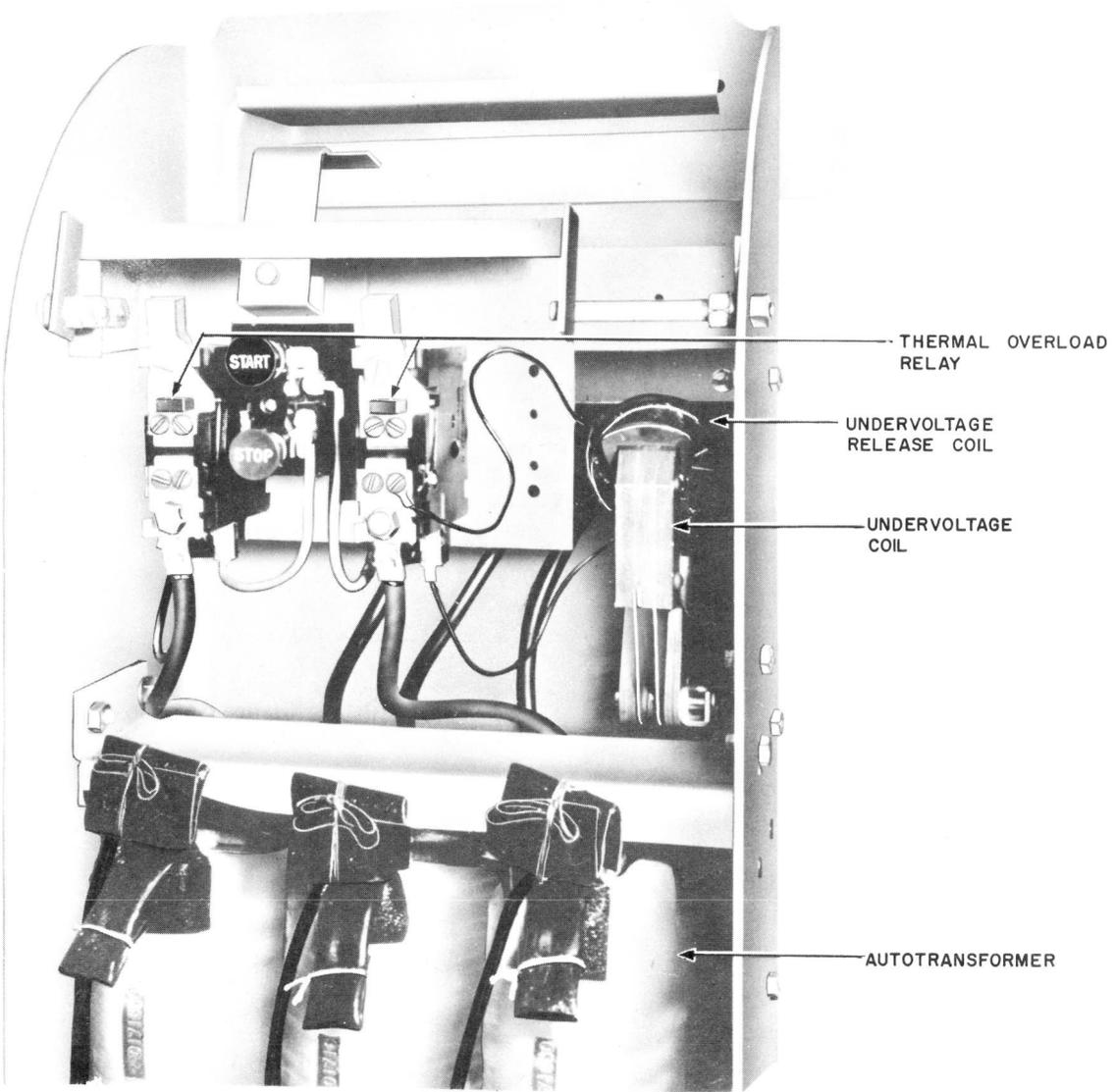


Fig. 3 — KS-5140-01 Manual-type AC Starter — Forms E and F (Partial Front View of Form E Shown With Cover Removed)

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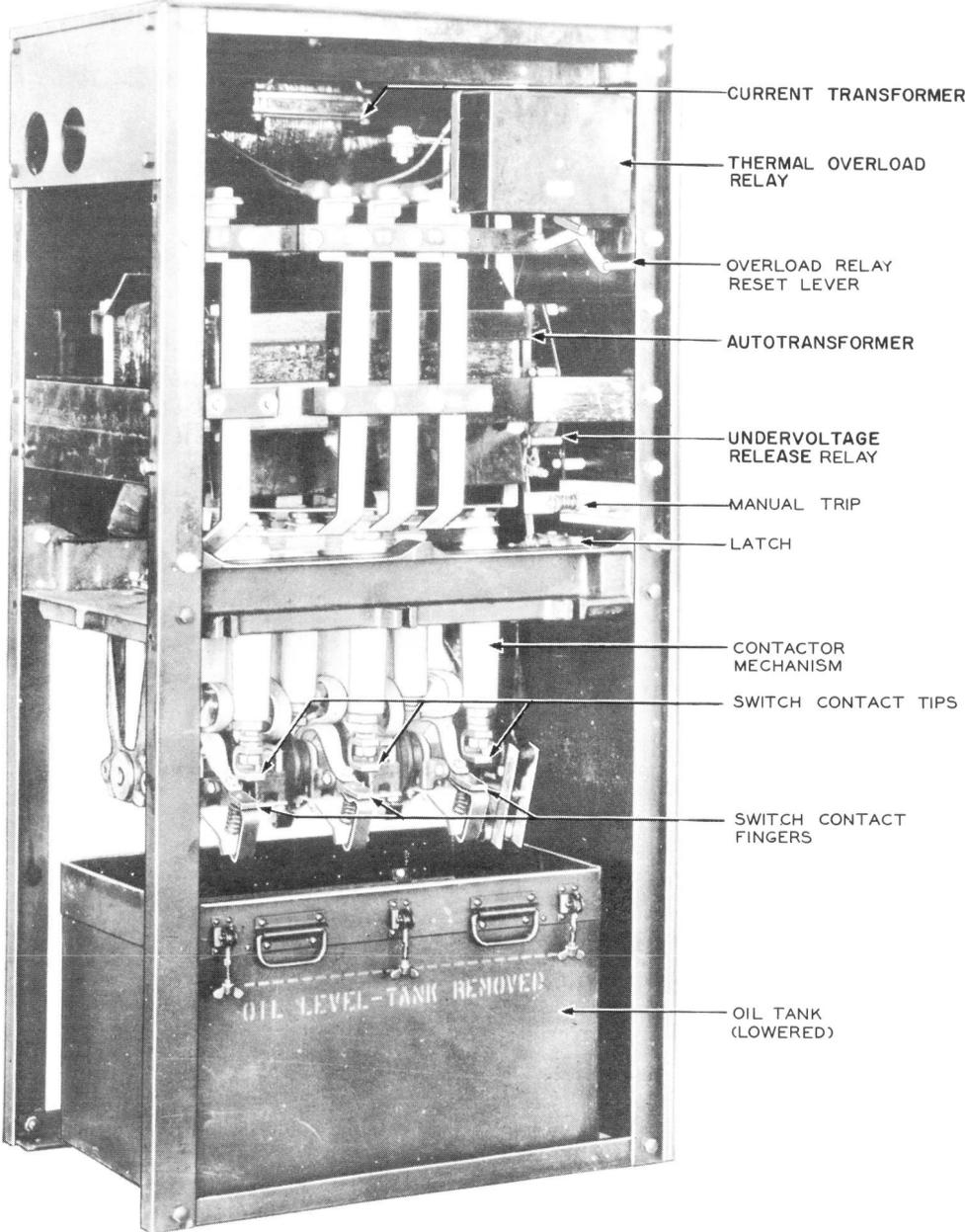


Fig. 4 – KS-5310 Manual-type AC Starter — Form K22 (With Covers Removed)

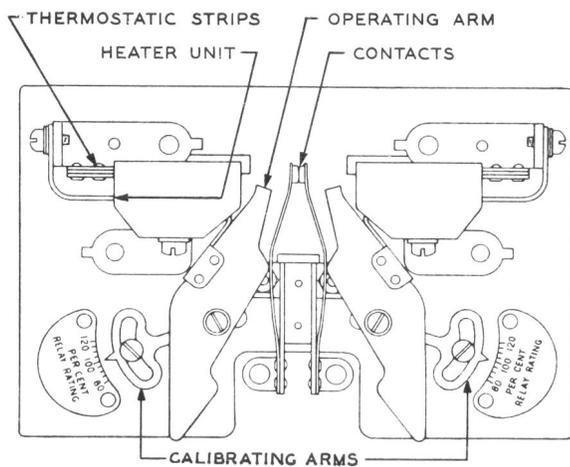


Fig. 5 – CR2824-TC121C Thermal Overload Relay

2.03 Overload Relays

(a) Test

* (1) **Adjustable Types:** With 250 per cent 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.

* (2) **Nonadjustable Types:** With 250 per cent 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, flowing in the heater coil of the overload relay, the relay shall operate within 5 minutes.

φ(3) The operate requirements of all overload relays shall be checked annually.

(b) CR2824-TC221C and CR2824-TC121C Adjustable Overload Relays

(1) **Readjust:** The calibrating arms shall be set to operate at a value not exceeding 115 per cent of the full-load running current given on the motor nameplate.

(2) The thermostatic strips shall latch with the pivoted levers to hold the relay contacts closed during normal operation. The relay contacts, in series with the coil in the undervoltage retaining magnet coil circuit, shall open on overload, thereby de-energizing the coil. See 2.09 (b).

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

φ(c) CR2824-2D, -41M, -42A, -42C, -42F, and -42G Nonadjustable Overload Relays

(1) 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.

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

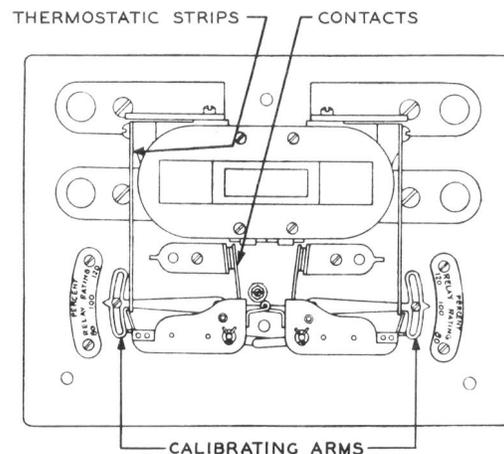


Fig. 6 – TC2824-TC221C Thermal Overload Relay

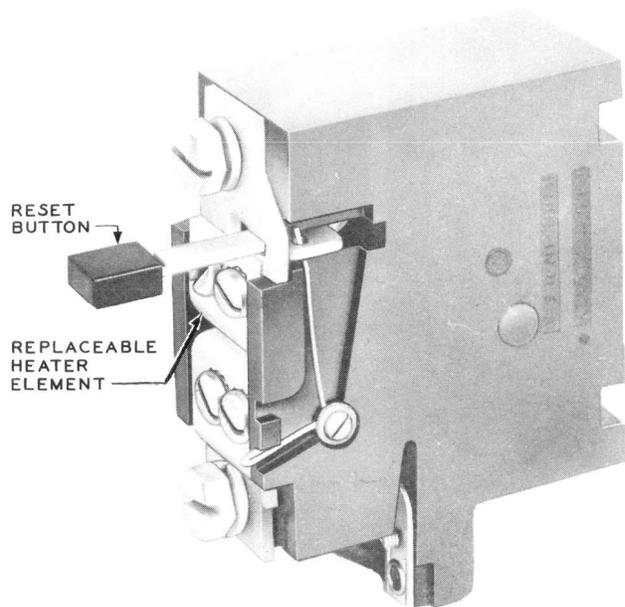
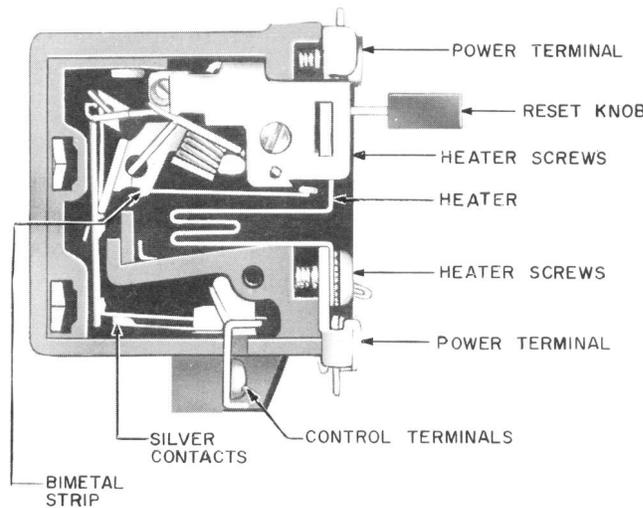


Fig. 7 – CR2824-42F Thermal Overload Relay



**Fig. 8 – Typical CR2824-41 Type Overload Relay
With Cover Removed and Heater Mounted**

φ2.04 Main Contacts

- (a) The switch contacts shall be clean and smooth.
- (b) The contacts shall be secured firmly and shall make firm contact, and the opposing surfaces shall be parallel.

Gauge by eye.

***2.05 Form K22 Starter Contactor Mechanism**

- (a) With the starter handle in the RUN position and held there manually, there shall be a clearance of approximately 1/32 inch between the notch in the latch lever and the associated pin, and approximately 1/4 inch between the compression spring support and the arcing horn on the RUN side. The latter is shown in Fig. 11.

Gauge by eye or use the R-8550 scale.

- (b) With the handle in the START position, there shall be approximately 2-3/4 inches between the tips of the stationary and movable RUN contacts and 1/4 inch between the compression spring support and the arcing horn, as shown in Fig. 12.

Use the R-8550 scale.

***2.06 Forms E, F, K1, K19, K33, and G150 Starter Contactor Mechanisms:** The gaps between the stationary and movable contacts with the starter handle in the OFF position should be as follows.

Starter Size (HP)	SIDE	
	START	RUN
1 (20 to 25)	5/8 ±1/16	5/8 ±1/16
2 (30 to 50)	5/8 ±1/16	5/8 ±1/16
3 (75)	7/8 ±1/16	19/32 ±1/16

2.07 Switch Handle: The switch handle shall return to OFF position when released from the START position manually or the RUN position electrically.

2.08 Latch: The latch shall prevent the switch handle from being thrown slowly from the START to the RUN position or directly from the OFF to the RUN position.

2.09 Undervoltage Release

- (a) At any normal voltage available within ±10 per cent of the value stamped on the nameplate, the release shall hold up magnetically so that the latch holds the starter switch in the RUN position. Use voltmeter to check that the release is functioning within limits.

- (b) When the voltage fails across the coil, the release shall trip the latch and allow the switch handle, when in the RUN position, to return to the OFF position.

- (c) When provided, the delay feature in the undervoltage release shall provide a delay of

Min 1-1/2 seconds
Max 5 seconds

in the release of the starter after the removal of line voltage.

Use a stop watch or equivalent.

2.10 Stop Switch

- (a) When the STOP button is pushed in on any starter or the cover is removed on the forms E, F, K1, and K19 starters, the

stop switch shall trip the undervoltage release and allow the starter to open.

Caution: When operating the stop-switch button to release the starter, push it only far enough for the purpose, to avoid catching the finger between the button and the edge of the hole in the cover.

(b) When the cover is in place on the forms E, F, K1, and K19 starters, the stop switch shall be closed and make good contact.

→ (c) Except on the forms K22, K33, and G150 starters, lowering the oil tank shall cause the cover to open far enough to open the contacts of the stop switch, thereby allowing the starter switch contacts to open.

(d) On some starters, pushing in the STOP button also resets the thermal overload relay after the starter has been opened by an overload. On other starters, a second pushbutton is provided for this purpose.

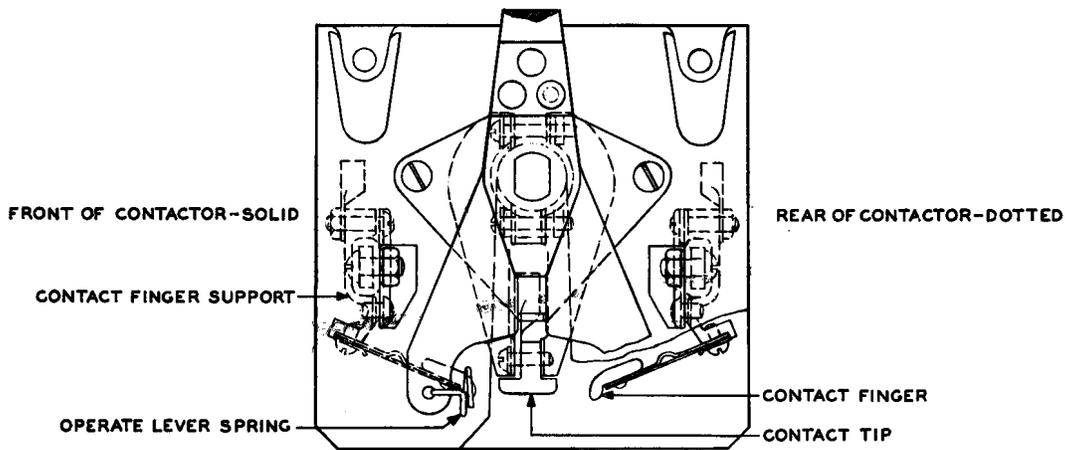


Fig. 9 - Rotary-type Contactor Mechanism on Form K1 Starter

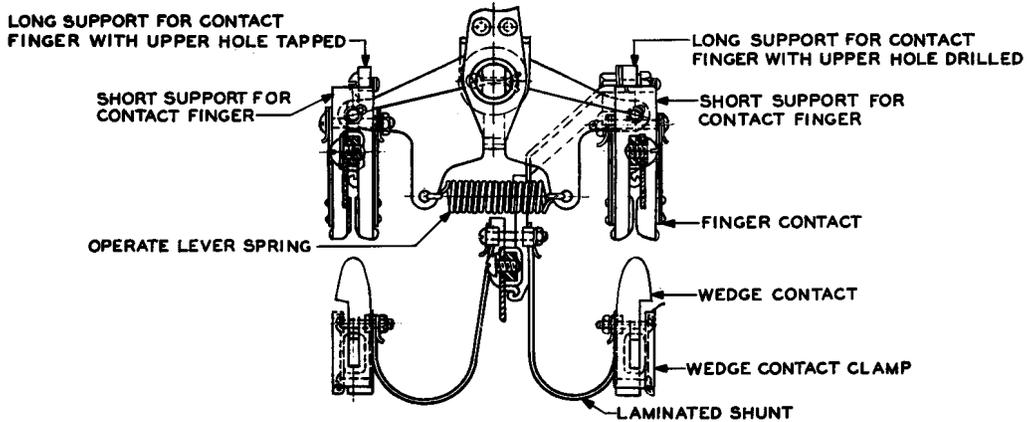


Fig. 10 - Parallel-type Contactor Mechanism on Form K19 Starter

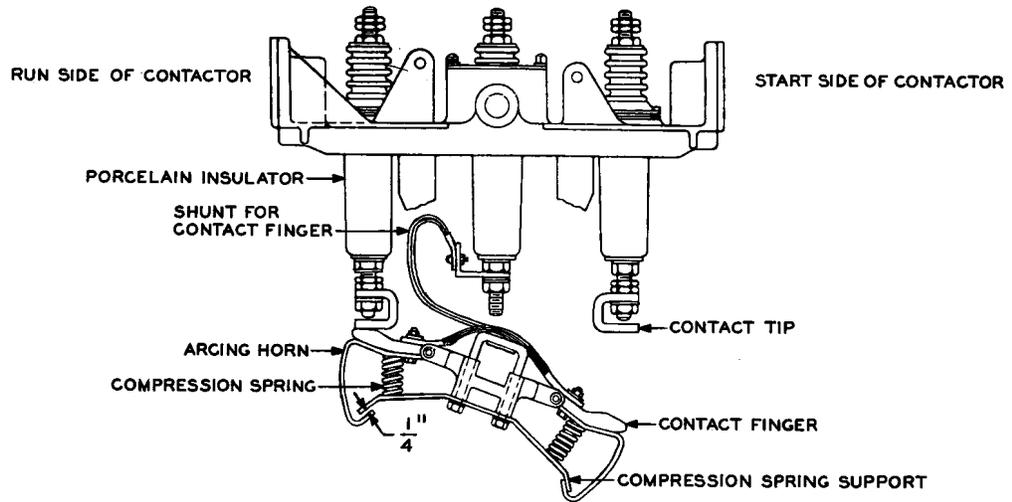


Fig. 11 – Contactor Mechanism on Form K22 Starter (in RUN Position)

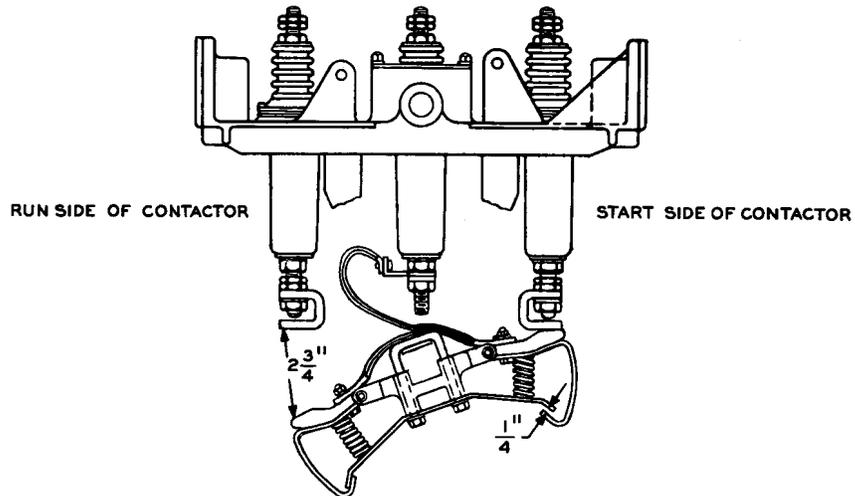


Fig. 12 – Contactor Mechanism on Form K22 Starter (in START Position)

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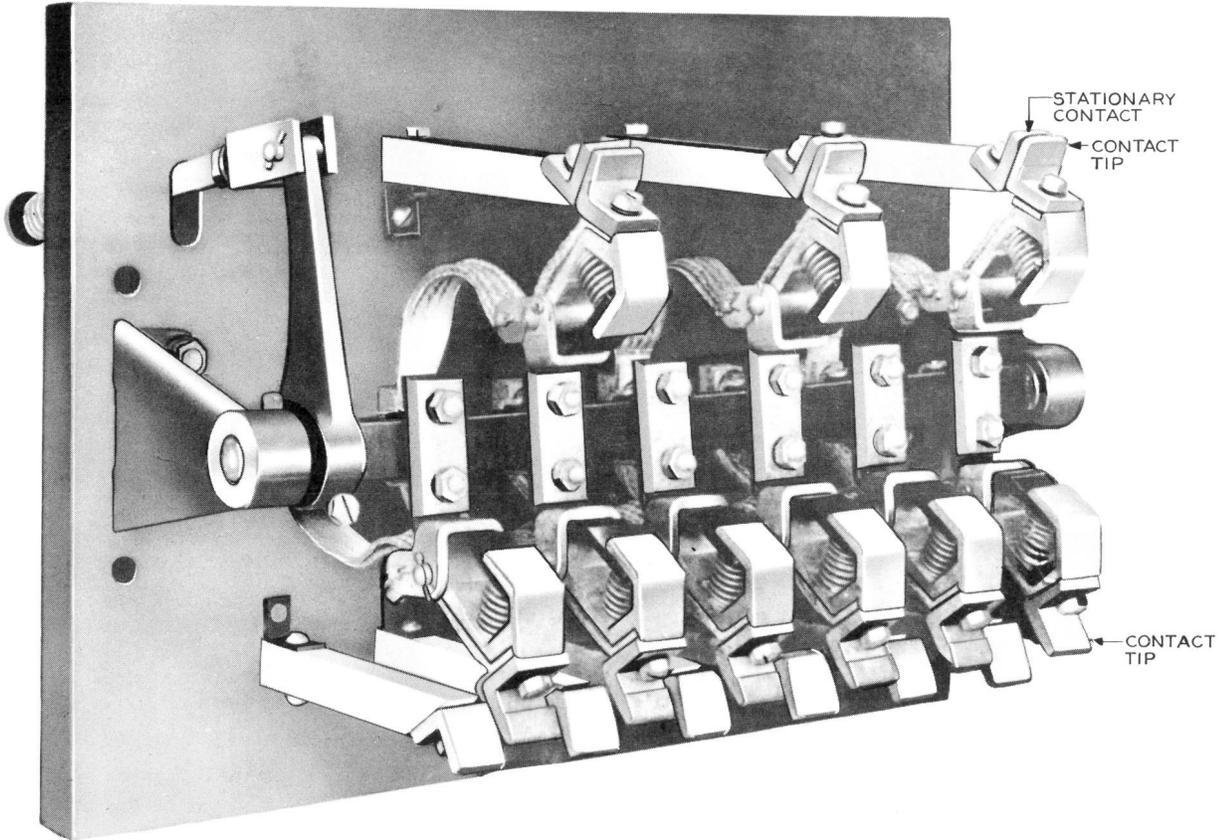


Fig. 13 – Contactor Mechanism on Form K33 and G150 Starters

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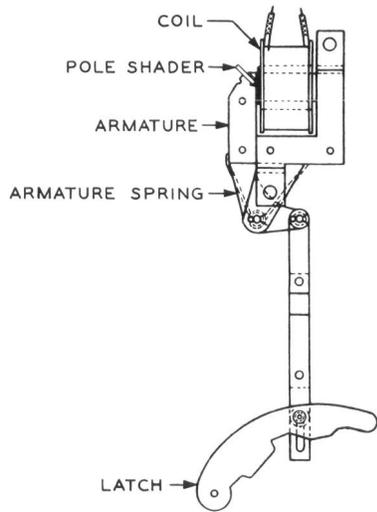


Fig. 14 – Contactor-type Undervoltage Release — Without Time-delay Feature

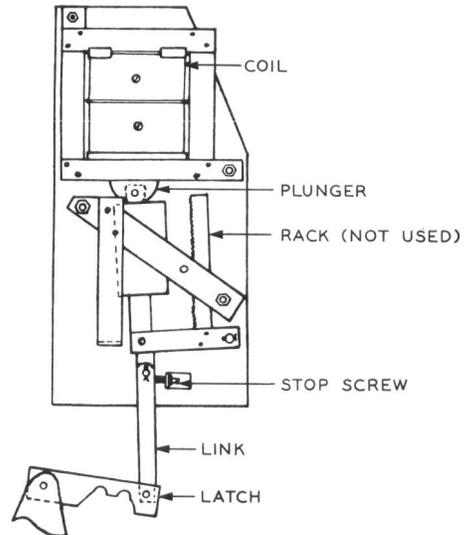


Fig. 15 – Solenoid-type Undervoltage Release — Without Time-delay Feature

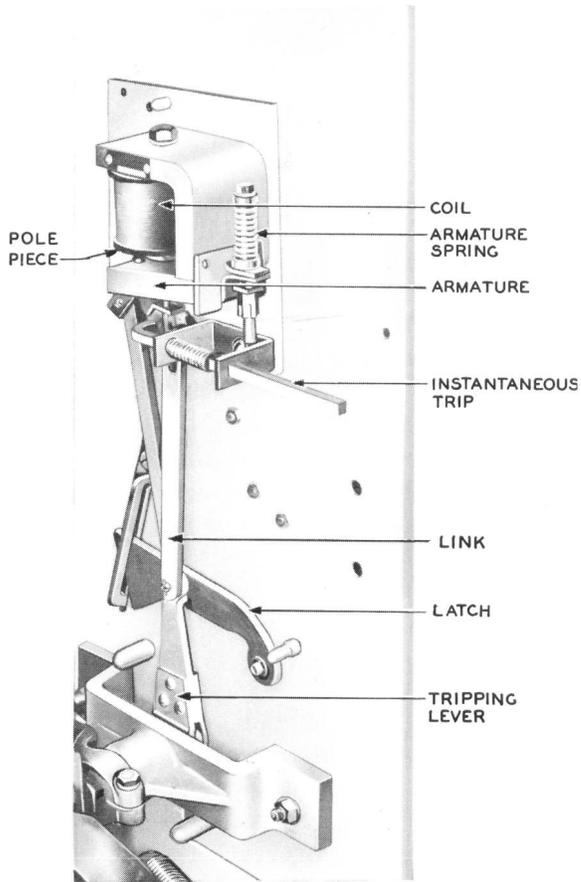


Fig. 16 – Contactor-type Undervoltage Release — With Time-delay Feature

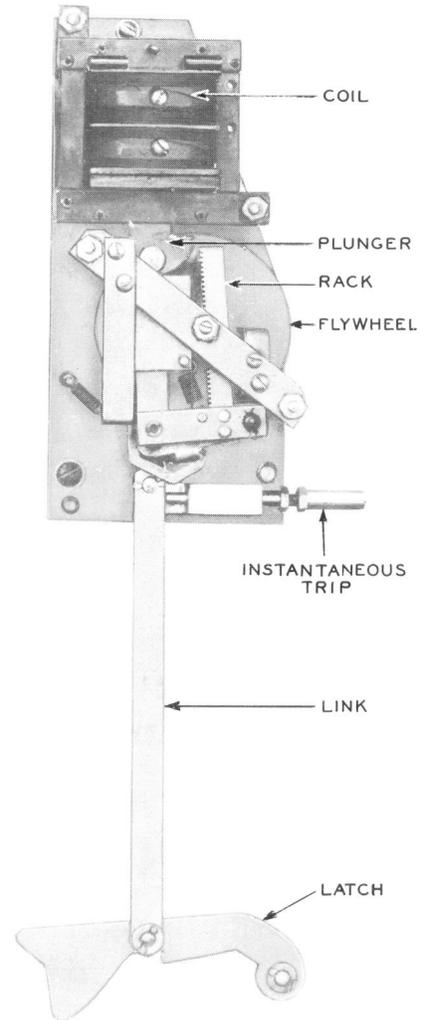


Fig. 17 – Solenoid-type Undervoltage Release — With Time-delay Feature

3. ADJUSTING PROCEDURES

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

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
265C	Contact Burnisher
KS-2662	File
KS-6780 (as reqd)	Connecting Clips
R-1542	6-inch Single-end Adjustable Wrench
—	6-1/2 inch P-Long-nose Pliers
—	Combination Pliers
GAUGES	
KS-3008	Stop Watch
R-8550	6-inch Steel Scale
—	Voltmeter, AC, Weston Model No. 528, Ranges 300-150
MATERIALS	
KS-14666	Cleaning Cloth
—	Abrasive Cloth, 150 Grade
—	Lamp Cord
(as reqd)	
—	Switch Oil, General Electric Company No. 10C (1.5 gal., 2 gal., 3 gal., 5 gal., or 55 gal.)
TEST APPARATUS	
352AL	Transformer
—	Ammeter, AC, Weston Model No. 528, Range 50 Amperes
—	Autotransformer, Continuously Tapped (Variac, 2-ampere, 230-volt input, type W-5, HMT, provided with overload protector, or equivalent; General Radio Company, Cambridge, Mass. suggested)

3.01 *Oil Level* (Reqt 2.01)

(1) The frequency of adding to or replacing the oil is dependent upon the amount of carbonization of the oil, suspended particles of contact metal in the oil, etc, conditions

which vary with the usage for the particular office and must be considered accordingly. The case size capacities are as follows.

STARTER	CASE SIZE	GALLONS
KS-5092, KS-5140, KS-5140-01, and KS-5292	1	1-1/2
KS-5092, KS-5140, and KS-5140-01	2	6
KS-5092	3	6
KS-5140-01	3	8-1/2
KS-5310	—	18

(2) *Oil Tanks on All Starters, Except Form K22:*

To release the oil tank, squeeze the two handles together at each end of the tank. Except on forms K33 and G150 starters, the oil tanks may be lowered and suspended in an intermediate position during switch inspection. The oil tanks on forms K33 and G150 starters must be set on the floor under the starter where it can catch the oil drip; the oil tanks on other forms may be set on the floor when necessary. Because of the handles which protrude from the oil tanks, the tanks cannot be dropped vertically to the floor. To set the tank on the floor, remove the tank, turn it 90 degrees, and place it on the floor between the braces to catch the oil drip. If it is desirable to place the tank on the floor in the same relative position it had when installed, remove the tank, put one handle under one brace, and turn the tank to get the other handle under the brace on its side. When restoring the tank, be sure that the upper handles are raised in position sufficiently to engage the slots in the sides of the case.

(3) *The oil tank on the form K22 starter* may

be provided with drain and fill plugs on the left side of the tank as viewed from the operating handle end of the starter. The plugs facilitate lowering and raising the tank when necessary for inspection of the switch. Where plugs are provided, drain the tank before lowering it. When the tank is restored, refill it with oil up to the level determined by the fill plug opening. Since the tank is held by three thumbscrews on each side, it is suggested that the thumbscrews in the middle

be unscrewed last when the tank is to be lowered, and tightened first when the tank is to be restored. See 1.07.

Caution: *When it is necessary to change the oil on tanks provided with fill and drain plugs, do not fill the tank with new oil without removing and cleaning the tank to avoid contamination of the new oil by residual oil and deposits at the bottom of the tank.*

3.02 Autotransformer (Reqt 2.02)

Note: Once the proper taps on the autotransformers are connected, it will not be necessary to change them unless the nominal line voltage changes appreciably. Any subsequent failure of the motor to start properly would probably be due to blown line fuses in one or more phases, poor condition of the main contacts, loose connections, etc, rather than improper tap connections on the autotransformer. The taps on the form K22 starter are inaccessible after installation unless the panel on the motor side is removed, and this is not practicable because of the terminating conduits.

(1) If the motor fails to start, check for blown fuses or loose connections and correct as required. If it fails to come up to approximately its normal speed while connected to the autotransformers through the starting contacts, it will be necessary to change the taps to increase the voltage. On the other hand, if the motor starts and accelerates rapidly but blows its fuses at starting, it will be necessary to reduce the voltage.

(2) When it is necessary to change the taps, measure with a voltmeter the voltage between any two of the terminals T-1, T-2, and T-3 while the starter is in the start position. (See the circuit label pasted inside the starter.) This will give the voltage of the taps to which the starting leads are connected. Make similar measurements between corresponding taps on the autotransformers to determine which taps will give the required change in voltage. For the voltmeter connections, use lengths of ordinary lamp cord with a KS-6780 connecting clip at one end of each, and remove sufficient insulation from the taps to give access to them. Move the starting leads to the new taps, check

the starting of the motor, and restore the insulation which has been disturbed.

(3) As found, the autotransformers will be arranged to apply voltages beginning at 50 per cent of line voltage and progressing in 5 per cent steps either to 65 per cent or to 35 per cent. If the required voltage is within the range not immediately available, the autotransformers must be reversed electrically. To do this, it will be necessary to interchange the line and common connections of each coil. Before undertaking this work, refer it to the supervisor, who may prefer to use the services of the manufacturer's repair organization.

Caution: *To avoid shock, do not touch, at the same time, live parts which are at different potentials, and do not work with tools while the starter is connected to the power service.*

3.03 Overload Relays (Reqt 2.03)

(1) **Test Procedure:** This procedure applies for the test requirement of 2- 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.

(a) 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. 18. If the 352AL transformer is used, terminals 1 and 3 are connected to the L and T terminals of the overload relay and 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.

(b) 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 in (2) below. Reset the overload relay after test. Repeat procedure for 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.

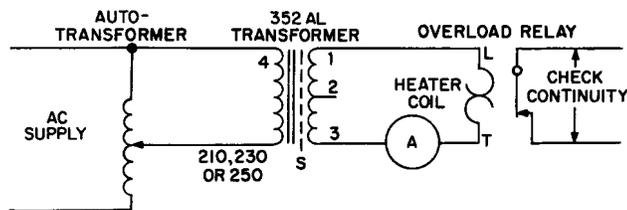


Fig. 18 – Test Circuit for Checking Overload Relays

(2) **CR2824-TC121C and CR2824-TC221C Adjustable Overload Relays**

(a) **Readjust:** To determine the position of the calibrating arms, note the full-load current of the motor as given on the nameplate, and the rating of the relay as shown on its nameplate. Except for the form K22 starter, no current transformers are used, the full-motor current going through the relay. In these cases, divide 115 per cent of the motor nameplate current by the relay rating. For example, assume the motor nameplate current is 100 amperes and the relay rating is 120 amperes. Then $\frac{1.15 \times 100}{120} = 96$ per cent, which is the setting for the calibrating arms.

(b) Current transformers with a ratio of 20 to 1 (500 amperes to 25 amperes) are used with the form K22 starter and are involved in the calculations as follows. Assume the motor nameplate current is 376 amperes and the relay rating is 20 amperes. With the transformer ratio of 20 to 1, the current with the relay full load of 20 amperes on the secondary would be $20 \times 20 =$

400 amperes on the primary. Dividing 115 per cent of the motor nameplate current by the comparable relay rating gives $\frac{1.15 \times 376}{400} = 108$ per cent as the setting of the calibrating arms.

Note: If the setting, as determined in (a) or (b), results in too frequent operation of the relay in service and the relay is found to be operating at less than 110 per cent of the motor nameplate current, possibly because of a high ambient temperature, readjust the relay upward in steps of 1 per cent until it holds in under existing operating conditions, but do not exceed 115 per cent of the motor nameplate current.

(c) After the relay has been readjusted, it shall again be checked for the test requirement 2.03, and if the relay fails to meet the requirement, it shall be replaced. Refer to Section 026-380-801 for replacement information.

(d) If the thermostatic strips are damaged, the overload relay should be replaced as a unit or returned to manufacturer for repair.

(e) If the contacts are rough, open them by tripping the thermostatic strips carefully and smooth the contacts with a burnisher. If they are burned excessively, replace them. If necessary, shape the contact springs with the aid of long-nose pliers to increase the contact pressure. Push in on the reset lever to reset the strips.

(3) **CR2824-2D, CR2824-41M, and CR-2824-42-type Nonadjustable Overload Relays**

(a) 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.

3.04 **Main Contacts** (Req't 2.04)

(1) Examine the contacts for roughness and pits. If they are burred, smooth them with a strip of 150 grade abrasive cloth or the KS-2662 file and wipe with a KS-14666 cloth. If the flat part of the contacts is ex-

cessively rough or pitted, the contacts must be replaced. If the contacts do not have sufficient pressure or do not make even contact, the flat spring on which they are mounted, except on the form K22 starter, may be shaped as required. Check that each contact is firmly secured to its support. Take care that abrasive or contact particles do not contaminate oil.

3.05 *Form K22 Starter Contactor Mechanism* (Reqt 2.05)

(1) Hold the handle as far in the RUN position as it will go and adjust the setscrew on the RUN side to provide the 1/32-inch clearance between the notch in the latch and the associated pin. This setscrew is underneath the casting that supports the contactor mechanism. Then adjust the pressure of the RUN contacts by setting the stationary RUN contacts to provide the 1/4-inch clearance between the compression spring support and arcing horn shown in Fig. 11.

(2) Move the handle to the START position and adjust the setscrew on the START side to give the clearance of 2-3/4 inches between the tips shown in Fig. 12. Then adjust the pressure on the START contacts by setting the stationary contact to give the 1/4-inch clearance between the compression spring support and arcing horn.

3.06 *Forms E, F, K1, K19, K33, and G150 Starter Contactor Mechanisms* (Reqt 2.06)

(1) Do not attempt to adjust the contact gaps. Replace the contacts when they are excessively burned or worn or the gaps are out of limits.

3.07 *Switch Handle* (Reqt 2.07)

(1) Operate the handle manually and, if it does not return to the OFF position from both the RUN and START positions with a positive movement, check for binding, or if necessary, replace the spring.

3.08 *Latch* (Reqt 2.08)

(1) Determine whether the switch handle can be moved directly from the OFF to the RUN position or slowly from the START to the RUN position. If either of these operations is possible, check to see whether the latch or linkage binds and adjust or replace parts as necessary.

3.09 *Undervoltage Release* (Reqt 2.09)

(1) If the undervoltage release of the contactor type does not hold closed firmly at the line voltage, be sure the circuit through the stop button switch and overload relay contacts in series with the coil is complete. (See circuit on inside of starter cover.) Check that the spring holds the armature against the pole piece even when there is no voltage on the coil. Check the voltage across the coil with a voltmeter. If the voltage is satisfactory, connect the meter in series with the coil. A reading of no voltage indicates an open-circuited coil which should be replaced.

(2) If the plunger on the solenoid type of release does not pull up, check the coil with a voltmeter across it and in series with it as above. If the coil is satisfactory, check for binding of the mechanism. If the plunger pulls up but the latch does not hold in, check for worn latch mechanism. Then note the action of the two links between the latch and the release mechanism shown in Fig. 15. These links are pinned together and have a toggle action so that the rising of the solenoid holds them against the adjustable stopscrew and holds the latch engaged. If the stopscrew is adjusted inward so far that the links can not be brought up to center (in line), the latch will not be held engaged. The latch also will not be held engaged if the screw is outward so far that the links go much beyond center on the stop side. The best adjustment is for the links to be on center when the solenoid is pulled up. If necessary, adjust the stopscrew accordingly and check the action of the release mechanism for holding on line voltage and for releasing on no voltage.

(3) If the release of either the contactor or solenoid type does not allow the starter to trip when the voltage across the coil decreases, check for binding of the armature, solenoid, linkage, etc.

(4) If the delay in the release of a starter equipped with a delay feature is outside the limits, examine the mechanism and remove foreign material, grease, or dirt as required. The form K33 starter may be provided with a dc time-delay release of the contactor type. The time delay on this type can be varied by using nonmagnetic shunts of different

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thicknesses between the armature and pole piece, but it is factory set at 2-1/2 seconds and should not require readjustment (see Fig. 16). A time-delay feature, which is dependent upon the rotation of a flywheel by a rack and is not adjustable, may also be provided on solenoid-type release mechanisms (see Fig. 17).

3.10 Stop Switch (Reqt 2.10)

(1) If necessary, except on the form K22 starter, adjust the nuts on the STOP switch rod so that when the STOP button is

→ pushed in its contacts will open. Note that except on the forms K22, K33, and G150 starters, the contacts close when the cover is on, and open when it is removed. If the contacts are rough, smooth them with the KS-2662 file or the 265C contact burnisher. If the contacts are burned excessively, replace them. If necessary, shape the contact springs carefully to increase the contact pressure.

(2) The STOP button on the K22 starter operates mechanically to trip the under-voltage release, and therefore it is not likely that the stop switch will get out of order.