

MULTI-STEP STARTERS

GENERAL ELECTRIC COMPANY

REQUIREMENTS AND ADJUSTING PROCEDURES

1. GENERAL

- 1.01 This section covers the KS-5162 and KS-5365 multi-step starters for a-c motors.
- 1.02 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.
- 1.03 These starters limit the initial inrush current to polyphase a-c. motors and cause a time delay before the next increment of current. This process continues in steps until the motor is up to full speed on the line. The starter also provides under-voltage and overload protection. The maximum current increments and the minimum time intervals depend on local service regulations. Once the proper delay is set on the delay devices to meet the specified values, it would not ordinarily be necessary to change these adjustments.
- 1.04 The starters furnished prior to January 1926 were equipped with a CR2823-MC-4A type definite time delay relay and the time interlocks were held closed electrically. Starters furnished thereafter were equipped with a definite time delay relay of the CR2823-MC-9A type and the time interlocks were combined with the associated contactor and were held closed mechanically.
- 1.05 The a-c. service shall be opened ahead of the switch before making tests or adjustments not requiring service voltage.

2. REQUIREMENTS

2.01 Operation

Note: Fig. 1 shows the circuit of a typical starter of four steps. Although other starters may have more steps or fewer steps and different wire service, the operation is similar. For reference in giving the following operating requirements for the Fig. 1 arrangement, the individual pieces of apparatus are designated numerically in their sequence of operation in starting the motor.

- (a) The start switch, when closed, shall first close contactor (1) which connects the neutral points of the auto-transformer. The closing of this contactor shall close line contactor (2).

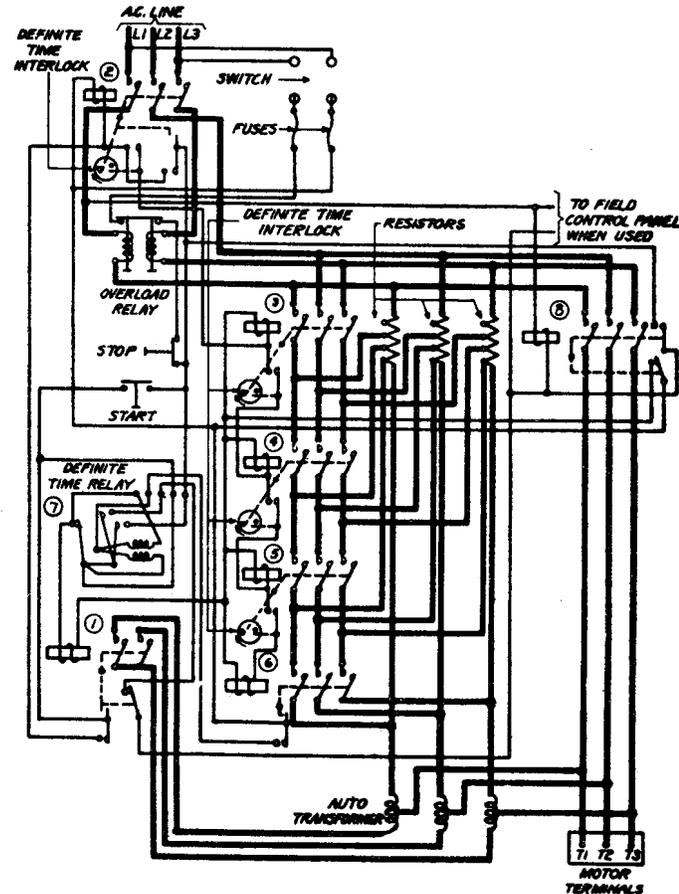


Fig. 1 - Circuit of a Multi-Step Starter

This operation shall energize the line side of the auto-transformer in series with resistances. With the proper tap connected on the transformer, the resistance shall be of such value that the initial current inrush shall not be greater than that allowed for the particular installation.

- (b) At the end of not less than the time increment specified, the definite time interlock associated with the line contactor (2) shall operate and close the first accelerating contactor (3) which by-passes a sufficient amount of series resistance to permit an additional current inrush of not more than the allowed increment. After contactor (3) closes, its interlock shall operate

2.01 (Continued)

after a delay and close the circuit to energize the operating coil of the next contactor (4), by-passing another section of the starting resistance and allowing an additional inrush of current. This process shall continue in steps until the last interlock contactor operates at which time the motor will then be operating on the full starting tap voltage of the auto transformer.

(c) The operation of the last interlock contactor, (6), will energize definite time relay (7). This relay shall be set for the time delay required for the motor to reach approximately full speed on the tap voltage of the auto-transformer. When this relay operates, it shall cause the contactor (1) to release which opens the connections to the neutral of the auto-transformer. The auto-transformer coils will then remain in the circuit to the motor as series

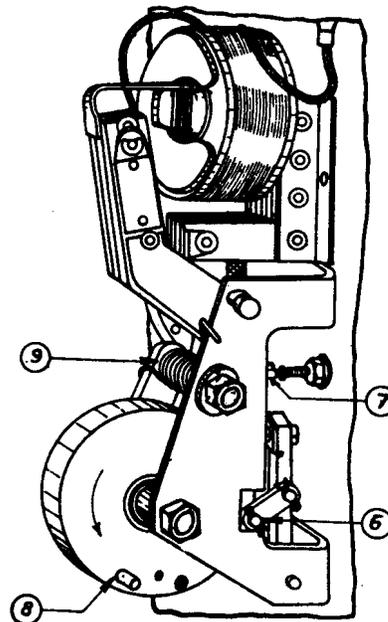
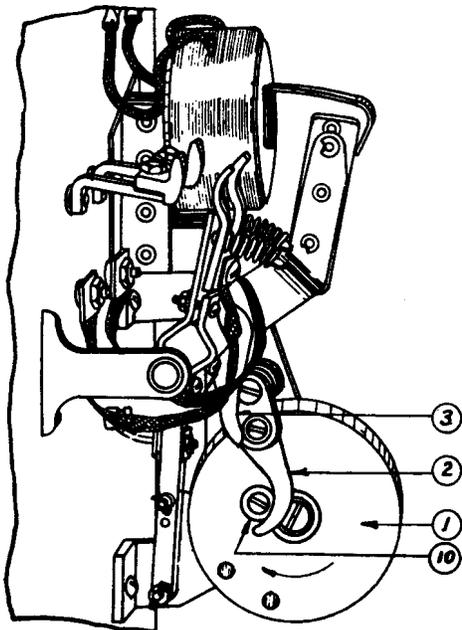
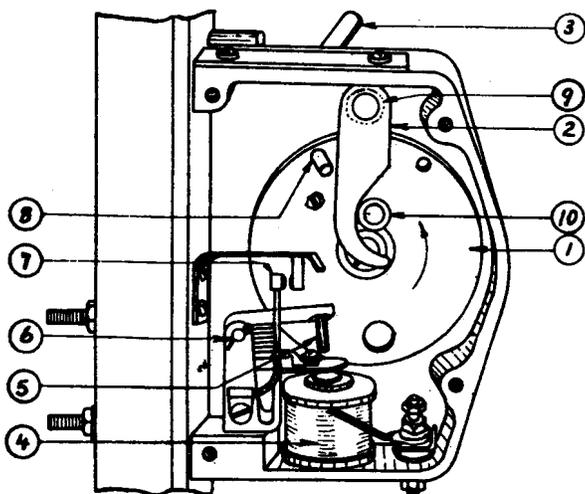


Fig. 2B Interlock Contactor
(After January 1926)



1. Flywheel
2. Operating Finger
3. Trigger Arm
4. Coil
5. Finger
6. Arm
7. Contact
8. Pin
9. Operating Finger Spring
10. Collar

Fig. 2A Interlock (Prior to January 1926)

Fig. 2 - Definite Time Interlock

2.01 (Continued)

reactances. The running contactor (8) shall then close immediately and by-pass the auto-transformer coils and connect the motor directly on the line. The change over from the starting to the running side of the auto-transformer shall not cause a greater current inrush than the increment allowed.

(d) When the running contactor (8) closes, its auxiliary normally closed contact shall open the circuit through the contactor coil (3) thus releasing this and in turn all other contactors except the line (2) and running (8) contactors.

(e) Pulling out the stop switch or operation of the overload relay shall open the circuit through the line contactor coil and open all contactors.

2.02 The contact surfaces shall be clean, smooth, and free from pits.

Pull Button Switches

2.03 The handle and arm carrying the contact disc shall move freely.

2.04 The movement of the handle and associated contact disc shall be opposed by the action of the spring which shall return the handle and disc to its normal position when released.

2.05 The contact fingers shall move freely, engage with a wiping action, and shall seat firmly so as to make good contact with the disc.

Contactors

2.06 Contact fingers shall close with sufficient compression to insure a wiping action and to make good electrical contact when the armature is closed against the pole-faces.

2.07 Contactor noise such as humming shall be a minimum.

Overload Relay

2.08 The plungers of the overload relay shall move freely in the solenoids.

2.09 The adjustments shall be such that the relay will operate to open the contact when the current in either solenoid exceeds 125 per cent of the normal full load current of the motor unless the local instructions specify otherwise.

Definite Time Interlock (See Fig. 2)

2.10 The operating finger shall hold the flywheel in its normal position until moved from that position by the closing of the associated contactor. The movement of

the operating finger shall release the flywheel and permit it to rotate. When the associated contactor opens, the operating finger spring shall return the flywheel to its unoperated position.

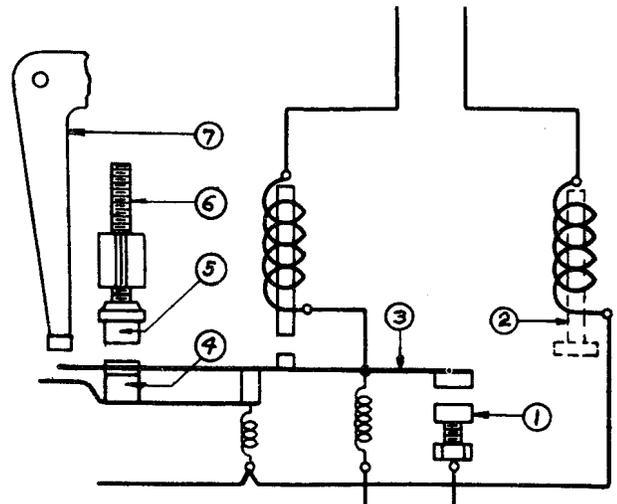
2.11 The auxiliary contacts shall normally be open with a clearance of approximately 1/8" to 3/16". Gauge by sight.

2.12 The flywheel shall rotate freely when released. The degree of movement of the flywheel shall be limited by the stop pin. The stop pin shall be screwed into the hole which permits a specified time delay, usually approximately 1/2 second, before the movement of the flywheel closes the auxiliary contacts.

Definite Time Relay (See Fig. 3)

2.13 The motor disc shall rotate freely and shall not touch or bind on the pole-pieces in any position.

2.14 The relay armature shall pull up at the same time that the disc starts to rotate. After a movement of approximately 1/32" (visual check) the armature shall mesh the gear train moved by the motor disc and close the contact. Gears shall operate freely.



1. Contact
2. Rotating Motor Element
3. Armature
4. Contact
5. Contact
6. Contact Adjusting Screw
7. Latch

Fig. 3 - Schematic of CR-2823-MC-4A Time Relay (Furnished on Starters Prior to January 1926)

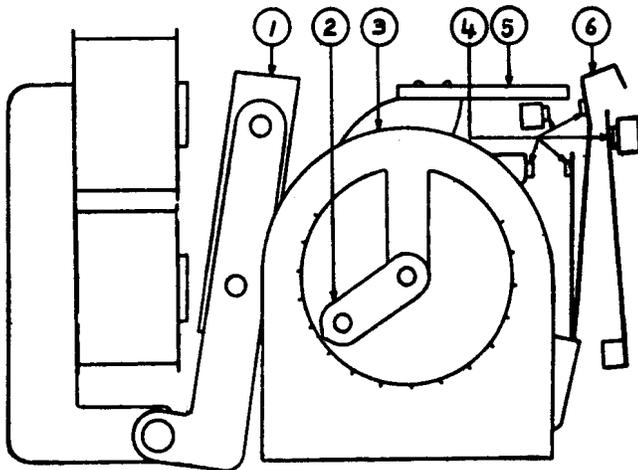
2.15 The time delay shall be sufficient to permit the associated motor to come up to approximately full speed. The latch shall then be released permitting the relay armature to break the circuit at (4) and make contact at (5). With the opening of contact (4) the relay motor coil shall be disconnected and the disc shall stop rotating. When the relay is deenergized the gear train and the relay armature with its associated contacts and latch shall return to their original position. Gauge by sight.

2.16 The air-gaps shall have approximately the following clearances. Gauge by sight.

	<u>Gap</u>	<u>Clearance</u>
(a)	Between contact (1) and armature	1/16" to 3/32"
(b)	Between contact (5) and armature	1/8" to 5/32"
(c)	Between latch (7) and armature	3/32" to 1/8"

Definite Time Relay (See Fig. 4)

2.17 The latch and magnet armature shall move freely.



1. Armature
2. Pointer
3. Dial Plate
4. Three sets of contacts
5. Latch
6. Contact Arm

Fig. 4 - Definite Time Relay CR-2823-MC-9A (Furnished on equipments after January 1926)

2.18 Gaps

(a) When the relay is completely deenergized the gap between the latch and the arm shall be approximately 1/8". Gauge by sight.

(b) With the magnet coils energized and the armature closed and the latch down, the gap between the upper contacts shall be approximately 3/16". Gauge by sight.

2.19 The time delay shall be adjusted to allow the motor generator to come up to approximately full speed.

Note: Once the relay is correctly adjusted for a particular machine, it should not be necessary to change the adjustment.

2.20 Operation of Relay

(a) With the relay in the off position (deenergized) the right hand contact shall be closed and the other two open. The magnet armature shall be open and the latch shall be down.

(b) When the relay is energized, the motor shall start to rotate and the magnet armature shall close and mesh the pawl in the gear and pull the arm against the latch. The right hand contact shall remain closed and the left hand contact shall make contact.

(c) After a definite time, depending on the setting of the relay, the latch shall be raised and allow the right contact to open and the middle contact to close. This shall stop the motor but shall leave the magnet armature closed with the relay in the running position.

(d) When the magnet coils are deenergized the parts shall return to the off position.

3. ADJUSTING PROCEDURES

3.001 Tools, Gauges and Materials

Tools

- File, Pillar, 6", R-1051
- Hammer, Ball Peen, 1 lb. AT&TCo. Spec. 6258N
- Screwdriver, Regular 4", AT&TCo. Dwg. 46-X-34
- Pliers, P - Long Nose, 6-1/2" AT&TCo. Spec. 6267
- Wrench, Adjustable, 6", R-1542
- Wrenches, Open End, with openings 3/8", 7/16", 1/2", 9/16", 5/8", and 3/4".

Gauges

- Voltmeter, AC, Weston Model 155, Range 0-150-300 volts or equivalent.

3.001 (Continued)Materials

Cloth, Cleaning, Twill Jean, D-98063
 Kerosene
 Oil, Dashpot, G.E.
 Sandpaper, 4/0

3.002 Equipment covered by this section is adjusted and tested before it leaves the factory and should only require adjustment if injured in transit, unpacking or installing. Adjustment should only be made by persons familiar with the equipment who understand what may be expected from each change.

3.01 Operation (Rq. 2.01)

(1) If the starter does not operate satisfactorily, locate the piece of apparatus not functioning properly by noting the position of all contactors. In general, the trouble will be due to either a blown fuse or poor condition of the auxiliary contacts on the various contactors or the contacts of the start switch or overload relay. Adjust the individual pieces of apparatus as covered under their respective headings.

3.02 Contact Surfaces (Rq. 2.02)

(1) Contacts shall be smoothed when necessary with sandpaper and wiped with a dry cloth and any foreign material removed. Metal contacts when slightly pitted may be filed before being given the above treatment. Replace any badly pitted contacts.

Pull Button Switches3.03 Handle and Arm (Rq. 2.03)

(1) Remove any foreign matter which may interfere with the movement of the arm in its guide. If the arm is bent the switch and the arm should be straightened or the switch replaced.

3.04 Movement of the Handle (Rq. 2.04)

(1) If the spring is so weak that return to the normal position is not positive, the switch shall be removed and the spring stretched or replaced.

3.05 Contact Fingers (Rq. 2.05)

(1) When the contact fingers bind or fail to make good contact they should be adjusted with a pair of long nose pliers or the switch replaced.

Contactors3.06 Contact Fingers (Rq. 2.06)

(1) If the armature fails to close, look for binding and, if none,

check the coil. Connect a voltmeter across the terminals of the contactor coil. If the voltmeter shows no reading when voltage is applied, the circuit is open ahead of the coil. If the circuit is not open, connect the voltmeter in series with the contactor coil. No reading on the voltmeter indicates that the coil is open. Replace any open coil.

(2) If the pressure of the contacts is weak, the springs should be stretched or replaced. Only sufficient pressure to insure positive contact with wiping action between the contact surfaces should be maintained.

3.07 Noise (Rq. 2.07)

(1) If a contactor is noisy, see that the movable armature fits closely against the face of the pole-pieces; that the short-circuiting band or wire fits tightly; that the laminations of the pole-pieces are clamped rigidly; that the faces of the pole-pieces and the armature are free from rust and dirt and that the shaft carrying the fingers fits snugly in the bearings. Any loose parts should be tightened or replaced and any rust or dirt on the faces of the armature or pole-piece should be removed with sandpaper and the parts should then be wiped with a dry cloth.

Overload Relay3.08 Plungers (Rq. 2.08)

(1) Move plungers up and down by hand and if they bind or stick see that no dust or dirt is in the solenoids and that the oil in the dash-pots has not become gummed or thick. The dash-pot may be removed by unscrewing the oil well. Empty the old oil, clean the by-pass, rinse with kerosene and wipe dry, removing lint. Refill with dash-pot oil to the level marked on the well.

3.09 Adjustment (Rq. 2.09)

(1) The overload relay may be adjusted to open the contacts at a lower current value in the following manner. Loosen the set screw in the upper knurled nut on the plunger. Turn the plunger (while holding the piston) part of a revolution in a counter-clockwise direction, thereby raising the plunger in the solenoid. To open the contacts at a higher current value, the plunger should be turned in a clockwise direction, lowering the plunger in the coil. The time element setting may be increased by loosening the set screw in the lower knurled nut, holding the plunger firmly so that it does not turn, and turning the nut at the bottom

3.09 (Continued)

in a clockwise direction. The time element setting may be decreased by turning the nut in the opposite direction. Tighten all set screws after each adjustment.

Definite Time Interlock (Fig. 2)**3.10 Operating Finger (Rq. 2.10)**

(1) Move the finger by hand to check its operation. If the shaft binds clean or replace it. If the spring is weak replace it. Note that the collar (10) is free to rotate on its pin.

3.11 Auxiliary Contacts (Rq. 2.11)

(1) The required opening between contacts in the open position may be obtained either by shaping the thin copper strap which holds the contact point or by adjusting the stationary contact.

3.12 Flywheel (Rq. 2.12)

(1) The stop pin (8) shall be screwed into the small hole near the periphery which will permit the specified delay after operation of the associated contactor before the trigger arm is released, and closes the auxiliary contact. More time delay may be obtained if desired, by placing the stop in one of the other holes which allows a greater rotation of the flywheel before the trigger arm is released.

Note: In some cases using the interlock shown in Fig. 2A the pin shown below pin (8) in the figure is used if pin (8) gives more delay than necessary.

Definite Time Relay (See Fig. 3)**3.13 Motor Disc (Rq. 2.13)**

(1) If necessary remove the disc and clean the bearings. If the disc becomes damaged it should be replaced.

When replacing adjust the bearings carefully to allow a little end play in the shaft and avoid tightening too firmly as this would bend the shaft or injure the bearings.

3.14 Armature (Rq. 2.14)

(1) No adjustment shall be made on the gear train. If it becomes damaged or fails to operate properly the relay shall be replaced.

3.15 Time Delay (Rq. 2.15)

(1) To adjust the time element, loosen the screw locking the pointer. Move the pointer to the desired setting as indicated on the calibration plate and tighten the locking screw.

3.16 Air-gap (Rq. 2.16)

(1) The air-gap may be adjusted with the associated contact screws, except for the gap between the armature and latch which should be adjusted by shaping the relay armature.

Definite Time Relay (See Fig. 4)**3.17 Latch and Magnet Armature (Rq. 2.17)****3.18 Gaps (Rq. 2.18)****3.19 Time Delay (Rq. 2.19)****3.20 Operation of Relay (Rq. 2.20)**

(1) Clean, adjust or replace parts as necessary. Coarse adjustments are made by inserting the pawl in one of the three notches in back of the dial. It is preferable to have the pointer nearer the center of the scale. This can be done by placing the pointer in the middle and shifting the pawl to give approximately the desired time. The outer notch gives the maximum delay, the middle notch less and the inner notch least. Fine adjustments are made by moving the pointer on the dial. Depress the small button catch on the pointer while moving the pointer. Releasing the catch allows it to hold the pointer in place.