STARTERS, CIRCUIT BREAKERS, CONTACTORS, FIELD CONTROL PANELS, AND MAGNETIC SWITCHES GENERAL ELECTRIC COMPANY REQUIREMENTS AND ADJUSTING PROCEDURES

1. GENERAL

1.01 This section covers starters, circuit breakers, contactors, field control panels, and magnetic switches manufactured by the General Electric Company. The starters and other apparatus included in this section are shown in Table A. The apparatus consists essentially of CR2800 dc or CR2810 ac contactors of various forms in combination with components listed in Table B. Apparatus without KS- designation is identified by its CR- designation.

1.02 Information contained in this section was formerly a part of Section 026-305-701, Issue 8-D.

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 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.

1.11 ***Caution: If a relay is in a circuit where 150 volts or more are applied across terminals on the relay, the voltage should be removed from the terminals before performing any work on the relay or checking requirements other than electrical requirements. In circuits where less than 150 volts are applied across terminals, service may be maintained while working on the relay by bridging and insulating the contacts as covered in 3.002. In some cases, it may be necessary to disconnect leads to maintain service.***

TABLE A

APPARATUS	KS- DESIGNATION	GENERAL ELECTRIC CO CODE	REQT	FIG.
Part of Motor Generator Ckt	KS-5030, KS-5030-01, & KS-5030-02,	—	2.10	—
	KS-5550 & KS-5550-01	(Ckt Breakers)	2.16	—
Field Control Panel	KS-5150	CR7003 & CR7006	2.11	4
Contactor	KS-5422	CR2800	2.10	3
Magnetic Switch	KS-5414	CR7002	2.13	6
Starters	KS-5152	CR1038	2.12	—
	KS-5153	CR7006	2.13	—
	KS-5236	CR7006	2.13	—
	KS-5290 & KS-5290-01	CR4012	2.10	2
	KS-5345 & KS-5345-01	CR7006	2.13	5
	KS-5429	CR4012	2.10	—
	KS-5432	CR7006	2.13	—
	KS-5486	CR7006	2.14	—
	KS-5487	CR4065	2.15	—
	KS-5791	CR1062	2.12	—
	KS-15537	CR1062N	2.12	—
	KS-15540	CR7006	2.14	—

TABLE B

COMPONENTS	KS- DESIGNATION	GENERAL ELECTRIC CO CODE	REQT	FIG.
Contactors	—	CR2800 Type	2.10	1
	—	CR2810 Type	2.17	7
Control Relays	—	HG101	2.18	—
Overload Relays	—	CR2824-TC221C	2.19	8
	—	CR2824-TC121C	2.19	9
Time-Delay Relays	—	CR2820-1051	2.20	10
	—	CR2820-1099	2.21	11

1.12 ***Caution: 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.***

1.13 Relays should not be handled by the contact springs.

1.14 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.

1.15 Requirements 2.01 through 2.09 have general application, except as otherwise specified. The other requirements apply to particular apparatus and are to be considered in connection with the general requirements.

2. REQUIREMENTS

ϕ2.01 ***Mounting:*** The mounting bolts and the fastenings which hold the component parts together shall be secure.

Gauge by feel.

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

ϕ2.02 ***Cleaning Contacts and Removing Buildups:*** Contacts shall be clean and free from buildups which might interfere with reliable contact.

Gauge by eye.

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, relays, or manually operated switches shall make or break approximately at the same time.

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

(b) For specific information, see the paragraph pertaining to the apparatus under consideration.

2.05 ***Contact Separation***

(a) Contact separation shall be as specified in the circuit requirements table.

Use the R-8550 scale.

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

Gauge by eye.

(c) Contact separation information, as available, is specified in paragraphs pertaining to specific apparatus.

2.06 ***Contact Pressure***

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

Use gram gauge or spring balance, as applicable.

(b) Contact pressures, as available, are specified in paragraphs pertaining to specific apparatus.

(c) Where no specific values of contact pressure are available, there shall be additional movement of the operating mechanism after the contacts touch. This results in the sliding of one contact on the other or in an

increase in the contact pressure and is known as follow.

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

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

2.08 ***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 per cent of that value or, if no nameplate value is available, at the minimum experienced in the office.

2.09** ***Temperature: The temperature shall not exceed:

	MAX	
Operating and blow-out coils	105 C	(221 F)
Resistors (exposed conductors)	390 C	(734 F)
Resistors (imbedded conductors)	290 C	(554 F)
Other parts	90 C	(194 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.

2.10 ***Contactors in KS-5030, KS-5030-01, and KS-5030-02 Ringing Motor Control — KS-5290, KS-5290-01, and KS-5429 Starters — KS-5422 and CR2800 Contactors***

*(a) Where the line contactor is equipped with contacts for connecting the motor field and armature separately to the supply, the field contacts shall close before the armature contacts.

Gauge by eye.

*(b) The CEMF contactor shall operate to short circuit the starting resistance in the motor armature circuit, bringing the motor up to speed without undue delay or excessive inrush of current in the motor or blowing of fuses.

Gauge by sound of the motor or by the blowing of fuses.

(c) Contact pressure of NC main contacts, except KS-5290, KS-5429, and KS-5290-01, unless otherwise specified, shall be per Table C.

Use gram gauge or spring balance, as applicable.

TABLE C — CONTACT PRESSURES (see 2.10)

AMPERE RATING	TYPE	POUNDS				GRAMS			
		INITIAL		FINAL		INITIAL		FINAL	
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
80	1126	7/8	1	1-3/4	2	400	450	800	900
150	1163	2	3	2-1/4	3-1/4	900	1350	1050	1450
150	1116	2	2-1/2	3-1/2	4	900	1150	1600	1800
150	1173	3	4-3/4	6	10-1/2	1350	2150	2700	4750
300	1175	6-3/4	9	13-1/2	17	3075	4050	—	—

Note: Type 1163 final pressure shall be at least 1/4 pound (115 grams) greater than initial pressure.

(d) Contact pressure of NO main contacts specified as Low or High in the circuit requirements table shall be:

	POUNDS		GRAMS	
	MIN	MAX	MIN	MAX
Low (L)	3/8	7/8	170	400
High (H)	1-1/2	2-1/2	675	1150

Use gram gauge or spring balance.

(e) If not otherwise specified, contact pressure shall be:

	PRESSURE
KS-5290, Lists 1, 3, 5, & 8	High
KS-5290, Lists 2, 4, 6, & 7	Low
KS-5290-01, All Lists	High
KS-5429, List 05	High
KS-5429, All Other Lists	Low

Note: Some old list numbers 02, 04, and 06 were furnished with high pressure. Such cases can be recognized by measurement and should be maintained on the original basis.

(f) The HG101 control relay found in KS-5429 starters shall meet requirement 2.18.

(g) CR2800-type contactors in non-KS applications shall have contact pressures in accordance with (d). Where the contactor rating or the full-load current rating of its associated motor is 44 amperes or more, use high pressure. For ratings below 44 amperes, use low pressure.

2.11 *KS-5150 Field Control Panel*

(a) The main contactor shall meet requirement 2.17. Use contact pressure requirements applying to ratings of less than 100 amperes.

*(b) When the contactor is in the released position, there shall be clearance between each operating lever and its associated NC contact arm.

Gauge by eye.

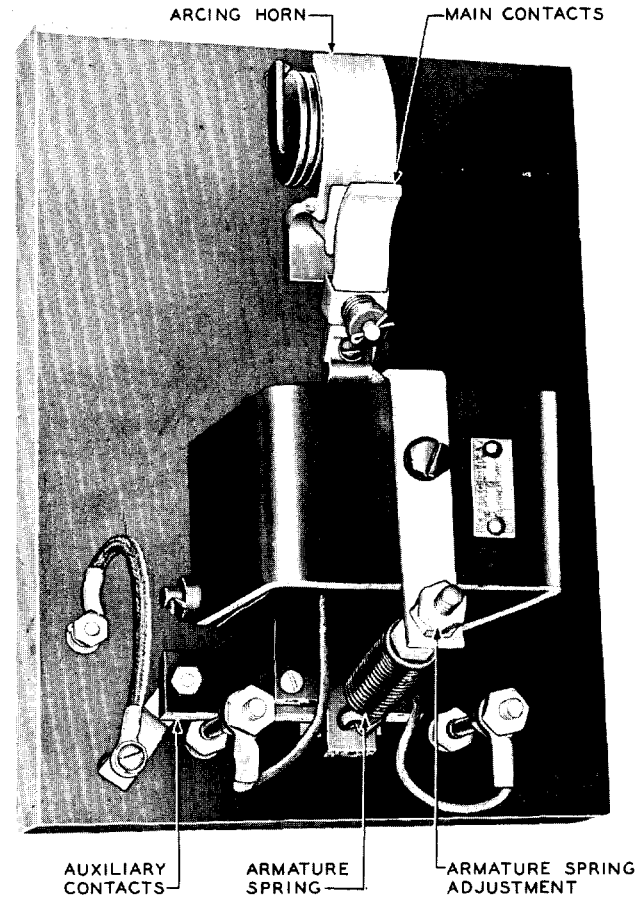

Fig. 1 – CR2800-1126 Contactor

(c) The time-delay relay shall meet the following requirement.

	REQUIREMENT
CR2820-1051	2.20
CR2820-1099	2.21

2.12 *KS-5152, KS-5791, and KS-15537 Manual Starters*

(a) There are no specific requirements for this apparatus; however, the general requirements shall be met.

2.13 *KS-5153, KS-5236, KS-5345, KS-5345-01, and KS-5432 Automatic Starters, and KS-5414 Magnetic Switch*

(a) Maintain the components in accordance with the following.

	REQUIREMENT
Main contactor	2.17
Overload relay	2.19
Control relay	2.18

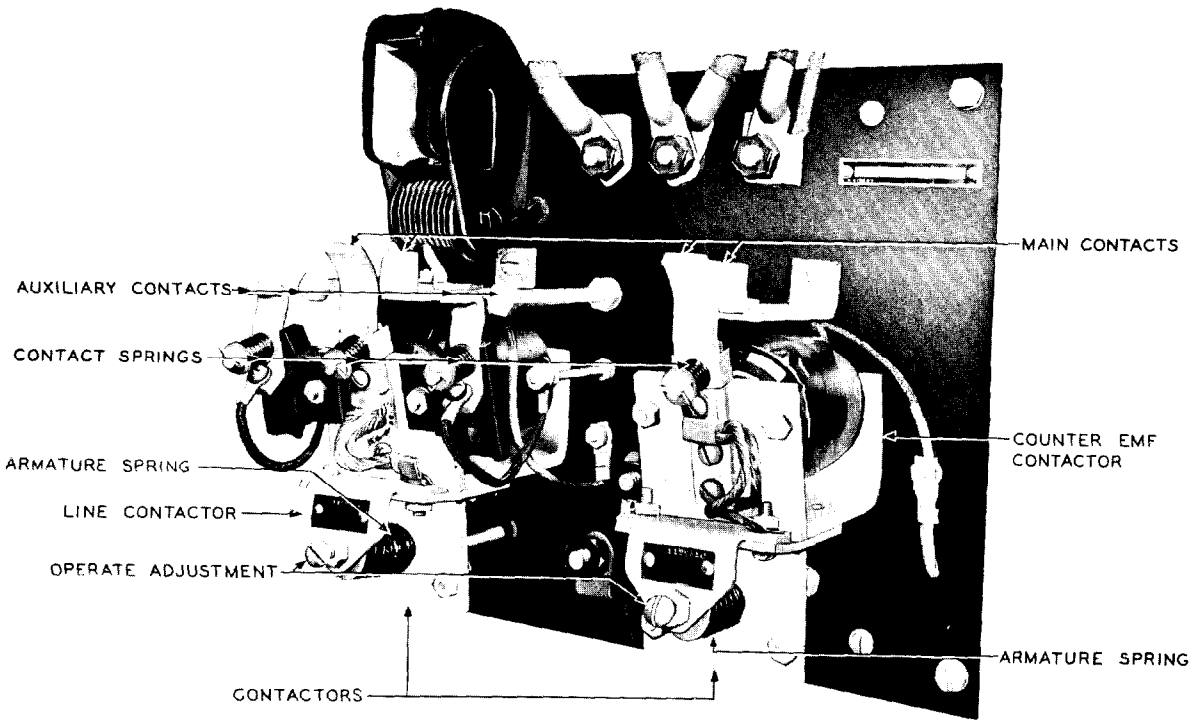

Fig. 2 – KS-5290 Counter EMF Starter

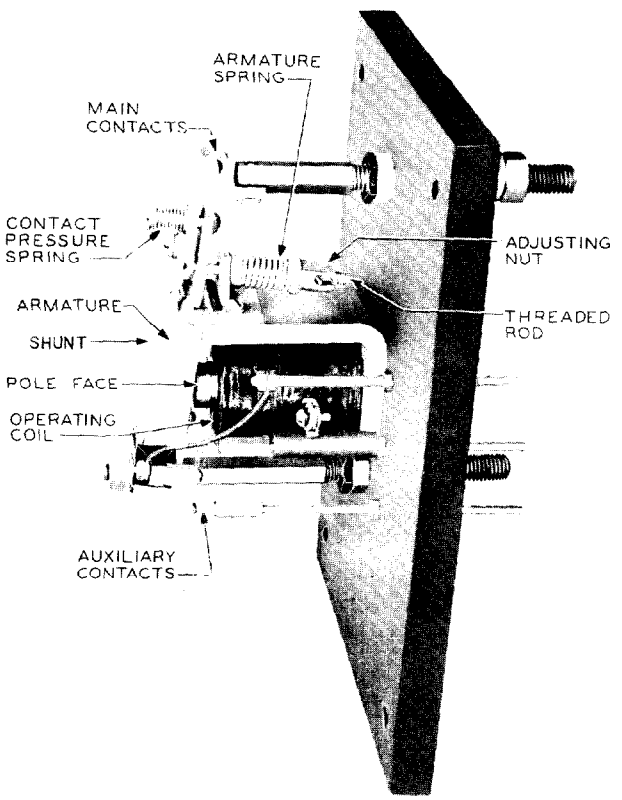

Fig. 3 – KS-5422, List 07 and 17 Contactors

(b) In the KS-5414 magnetic switch, the contacts in the ac circuits shall make contact before and break after the dc contacts.

Gauge by eye.

2.14 *KS-5486 and KS-15540 Automatic Starters*

*(a) ***Overload Relays:*** 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.

(b) There are no other specific requirements; however, the general requirements shall apply.

*2.15 *KS-5487 Starter*

(a) The solenoid shall operate to close the motor starting contacts and start the escapement-type delay mechanism. After delays, the first and second accelerating contacts shall close, short circuiting the starting resistance in steps, finally connecting the motor to the line.

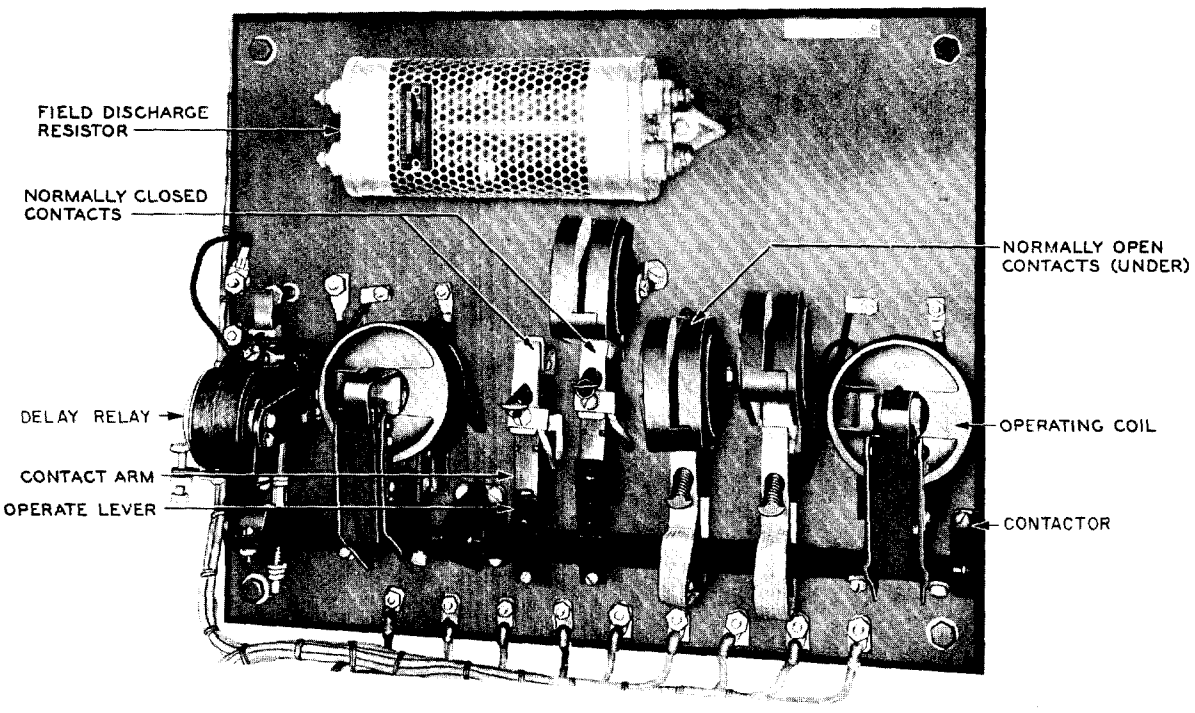

Fig. 4 – KS-5150 Field Control Panel

(b) The delay shall be such as to hold the motor current to values that will not blow the supply fuses.

ϕ2.16 *Circuit Breakers in KS-5550 and KS-5550-01 Circuits*

(a) The type AE-1 circuit breaker, associated with dc generators, shall trip on reverse current when the generator stops and on overload, at approximately 125 per cent of rated load.

(b) The dashpot shall be cleaned and refilled with fresh oil (KS-8321) every 3 years.

(c) The type AF-1 circuit breaker, associated with alternators, shall trip on overload at approximately 125 per cent of the full-load rating.

2.17 *CR2810-Type Contactors*

(a) Contact pressure of main NO contacts, based on nameplate rating if shown (otherwise on the ampere rating of the associated overload relay when present), or of the starter shall be per Table D.

Use gram gauge or spring balance as applicable.

(b) Contact pressure of NC contacts, with contacts fully closed, shall be

Min 200 grams
Max 300 grams

Use the 79B gauge.

*2.18 *HG101 Control Relays*

(a) Contact pressure, with the contacts fully closed shall be

Min 70 grams
Max 200 grams

Use the 79C gauge.

(b) Contact separation shall be

Min 1/4 inch

Use the R-8550 scale.

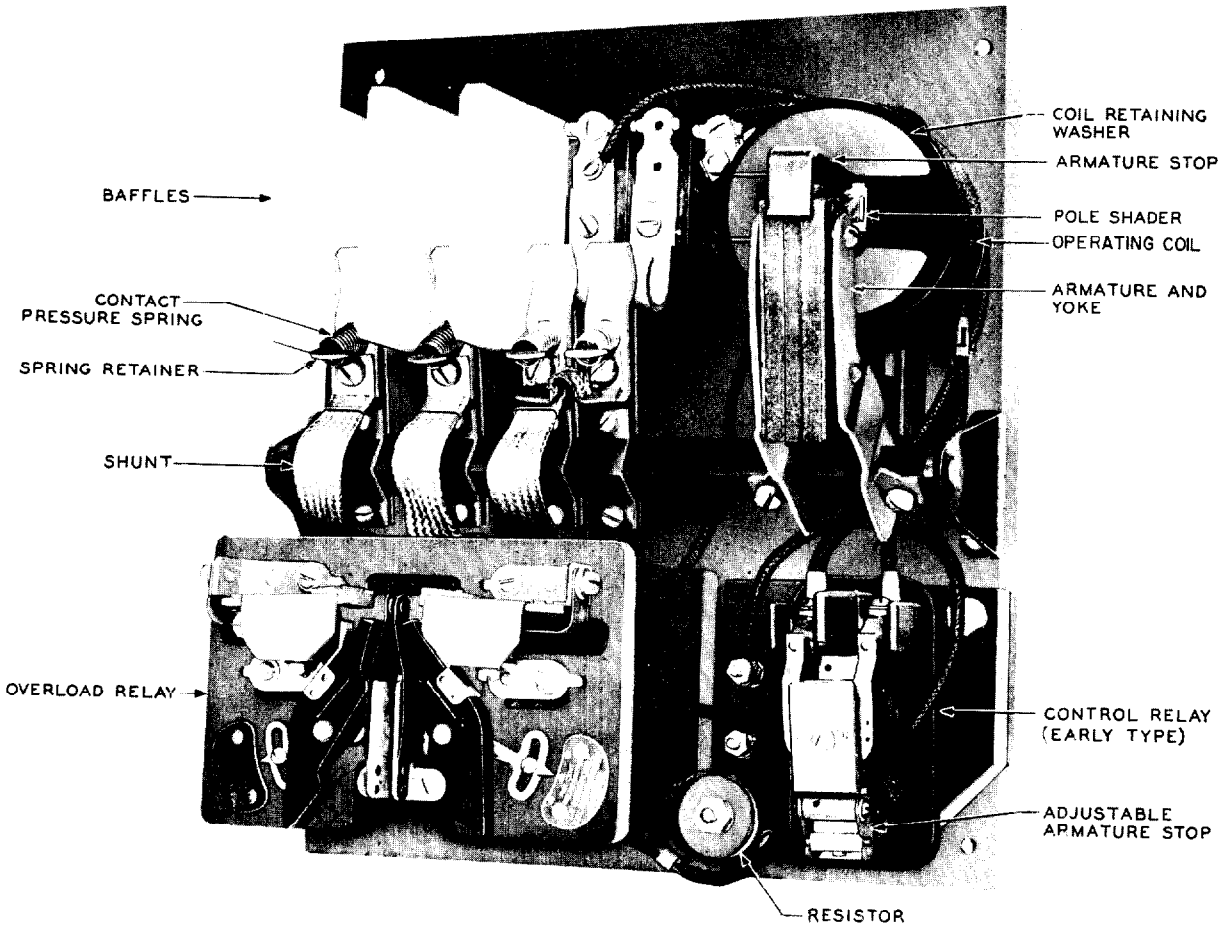

Fig. 5 – KS-5345 Starter

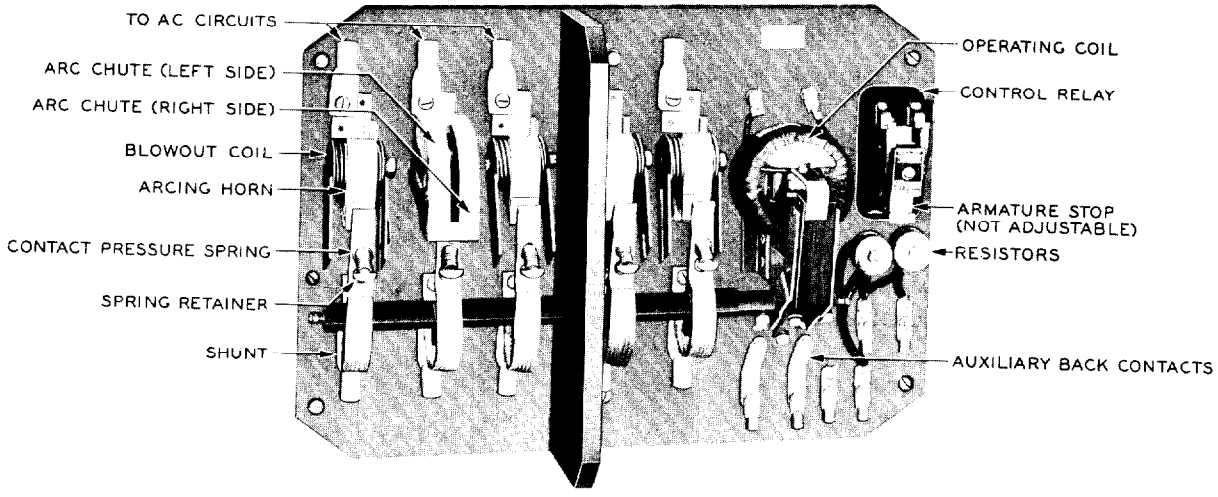

Fig.6 – KS-5414 Magnetic Switch

TABLE D — CONTACT PRESSURES (see 2.17)

AMPERE RATING	POUNDS				GRAMS			
	INITIAL		FINAL		INITIAL		FINAL	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Below 100	1-1/2	2	2	2-1/2	675	900	900	1150
100-199	3-1/4	4-1/4	7	9	1450	1900	3200	4050
200-299	7-1/2	8-1/2	15	17	3400	3850	—	—

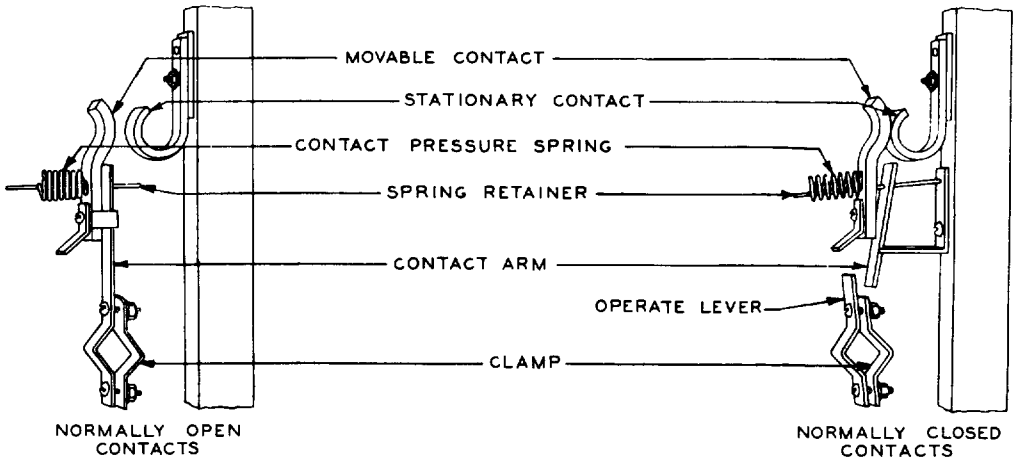

Fig. 7 – Contacts of the CR2810 Hinged-Armature Type Contactors

2.19** ***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 per cent 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 per cent.

(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.

2.20 ***CR2820-1051 Time-Delay Relay***

(a) When the operating coil is energized, its armature shall close and tend to close the contact under control of the retarding coil. When the motor being started is approximately up to speed, the retarding coil armature shall release the contact allowing it to close.

(b) When de-energized, there shall be clearance between the armature and core of the retarding coil of

Min 1/32 inch

Gauge by eye.

(c) The contact separations shall be

Min 1/8 inch

Gauge by eye.

2.21** ***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

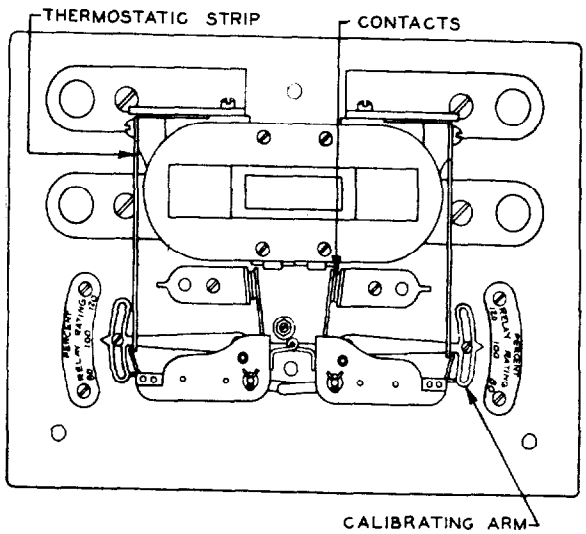

Fig. 8 – CR2824-TC221C Overload Relay

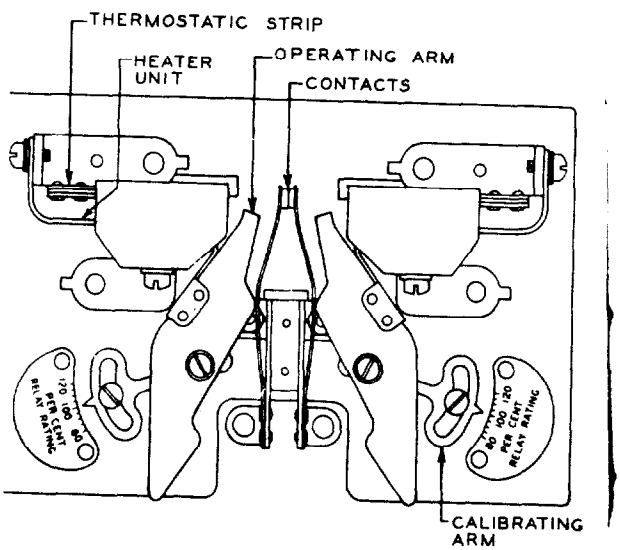

Fig. 9 – CR2824-TC121C Overload Relay

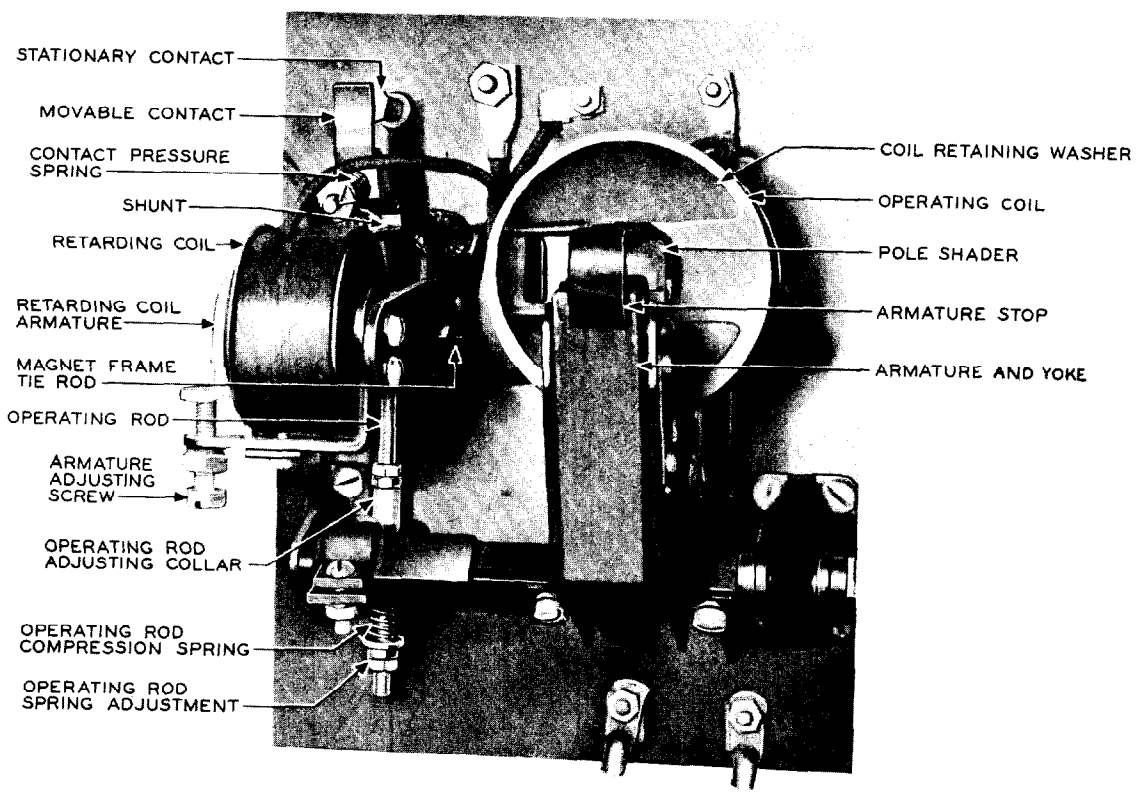

Fig. 10 – CR2820-1051 Time-Delay Relay

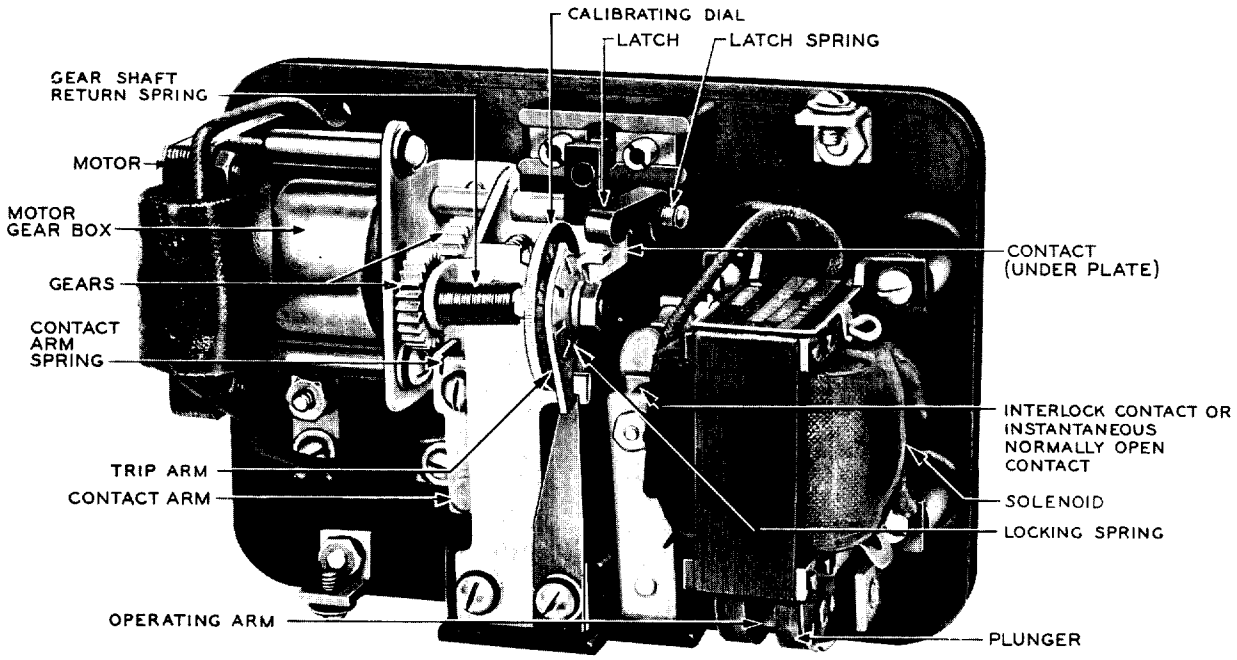

Fig. 11 – CR2820-1099 Time-Delay Relay

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 disk until it trips the latch: (1) closing 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. 11 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) When used in a KS-5150 field control panel, the time delay shall be adjusted to close the field circuit of the associated motor as soon as it reaches approximately full speed.

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)

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
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
—	Long-Nose Pliers
—	3-Inch 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
—	−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)

CODE OR SPEC NO.	DESCRIPTION
MATERIALS	
KS-6232	Light Mineral Oil
KS-7187	Bond Paper
KS-8321	Dashpot Oil
KS-8372	Stabilized Trichloroethylene
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)
—	Fuse, 3 Amperes, 240 Volts
—	No. 14 Gauge AM Wire

3.002 ***Maintaining Service While Working on Relay***

(1) ***General:*** If less than 150 volts is applied across terminals and it is not practicable to disconnect the relay from the power supply (see 1.11 and 1.12), bridge the current-carrying contacts and insulate live parts as covered in (2) and (3), respectively.

Caution: Use care when working in close quarters with live parts.

(2) ***Bridging Contacts:*** To maintain service while work is being done affecting closed contacts carrying current in working circuits, bridge the contacts at the most convenient points in the circuit other than at the relay if practicable. No. 839 cords (3 or 6 feet long), each end equipped with a 360A tool and a KS-6278 connecting clip (jaws insulated with a 108 cord tip), are satisfactory for strapping purposes. Lengths of No. 14 gauge insulated wire or flexible cord such as is commonly used in lighting circuits with KS-6780 connecting clips (jaws insulated with No. 108 cord tips) are equally satisfactory.

(3) ***Insulating Contacts and Parts:*** KS-7187 bond paper should be used for insulating live parts and should be shaped or bent as necessary to provide protection with minimum interference to the work being done. To prevent closure of open contacts in a live circuit, place bond paper, as required, around the fixed contact or disconnect the lead to the contact spring.

3.003 ***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)

(1) Tighten loose mounting screws and terminal nuts.

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

(1) ***General:*** The purpose of cleaning contacts is to remove any gummy or dirty substances that would interfere with reliable contact. It is not necessary or desirable to keep contacts polished or shining.

Note: Silver contacts require no attention but 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).

(a) 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.

(b) Before cleaning contacts or removing buildups, disconnect the power supply from the contacts if practicable (refer to 1.11 and 1.12).

(2) ***Cleaning Contacts:*** To remove dirt and gummy substances, clean the contacts with KS-8372 trichloroethylene 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 trichloroethylene into a 1-ounce bottle. It is important to avoid the use of contaminated trichloroethylene in cleaning the contacts. Therefore, discard the trichloroethylene as soon as it appears slightly dirty.

(b) Dip the hairs of a clean KS-14208 brush their full length in the trichloroethylene. 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. If necessary, burnish the contacts with the 374A burnisher blade as covered in (d).

(d) To burnish the contacts, insert the 374A burnisher blade held in the 374D contact burnisher holder between the contacts. Do not burnish live contacts. If the contacts are normally open, press them together by holding the armature firmly against the pole face with the KS-6320 orange stick. Draw the burnisher blade back and forth until the contacts are clean as determined by visual inspection. After burnishing, brush the contacts with a dry, clean KS-14208 brush.

(3) ***Removing Buildups:*** There shall be as little smoothing of contacts as is consistent with satisfactory operation. Contacts should be smoothed while closed. If the contacts are normally open, hold the armature firmly against the pole face with the KS-6320 orange stick, taking care not to touch the contact springs. Care ***must*** be taken that the contacts are not forced out of their normal position while being held closed manually during burnishing.

(a) For contacts in live circuits of 150 volts or more to ground, remove the voltage from the terminals as outlined in 1.11 and 1.12 before removing buildups.

(b) To remove buildups in dead circuits, use a strip of 150 grade abrasive cloth, the KS-2662 file, or the 374A burnisher blade held in the 373D contact burnisher holder. For contacts in live circuits of less than 150 volts to ground, use abrasive cloth only.

(c) Insert the abrasive cloth, file, or blade between the contacts. Draw the cloth, file, or blade back and forth until the buildups are reduced enough to insure reliable contact. Filling of large copper contacts disconnected from the power supply should be done so as to keep contact surfaces parallel and of original contour. After burnishing, brush the contacts with a dry KS-14208 brush.

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. 7.

(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. 7. 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.

(2) Shape the contacts of HG101 control relays with pliers as required.

3.05 ***Contact Separation*** (Reqt 2.05)

(1) The contacts must be disconnected from the power supply while checking the separation with the scale or thickness gauge.

(2) To adjust contact separation, follow the applicable procedure given above for contact sequence.

3.06 ***Contact Pressure*** (Reqt 2.06)

(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. 12. 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 that the contactor should be operated when checking initial pressure and released when checking final pressure.

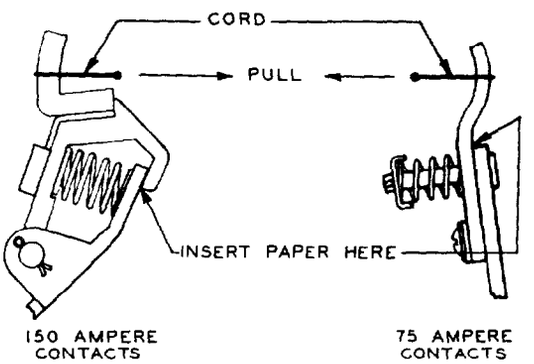

Fig. 12 – Measurement of Initial Contact Pressure

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

(5) Replace weak springs.

(6) 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.

3.07 ***Freedom of Operation*** (Reqt 2.07)

(1) 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-8372 trichloroethylene on a KS-14666 cloth wrapped around the KS-6320 orange stick, as required.

3.08 ***Electrical Requirements*** (Reqt 2.08)

(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, 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 and 1.12.)

(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. When checking a contactor, the test set and cords are satisfactory unless the current in the coil exceeds 0.750 ampere. This will occur in the larger contactors only. In doubtful cases, measure the resistance of the operating coil with an ohmmeter and calculate the current. When necessary, set up a test circuit with the rheostat connected in series with battery supply and the coil and the voltmeter connected across the coil. The cords and clips mentioned in the following paragraph will be 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.

(5) ***Operate adjustments*** are made by changing airgap between the armature and the pole face or by changing the tension in the armature spring. The airgap in CR2810-type contactors can be changed by shaping the armature stop. In other types look for a screw, the position of which is adjustable. The tension of the armature spring is, in some cases, adjustable by means of a nut running on a threaded rod. Determine the procedure by inspection. Where there are no adjustments, it will be necessary to replace the spring.

3.09 ***Temperature*** (Reqt 2.09)

(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

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

3.10 ***Contactors in KS-5030, KS-5030-01, and KS-5030-02 Ringing Motor Control — KS-5290, KS-5290-01, and KS-5429 Starters — KS-5422 and CR2800 Contactors*** (Reqt 2.10)

(1) To check the sequence of operation of field and armature contacts, operate the contactor manually. Adjust the height of the stationary field contact stud by changing the positions of the nuts which hold it in the panel.

(2) To cause the CEMF contactor to operate earlier, decrease the pressure of the armature spring. See Fig. 2.

3.11 ***KS-5150 Field Control Panel*** (Reqt 2.11)

(1) To obtain clearance between the operating lever and its associated NC contact arm, proceed as covered in 3.04(1).

3.12 ***KS-5152, KS-5791, and KS-15537 Manual Starters*** (Reqt 2.12)

(1) To obtain access to the contacts, remove the molded head which carries the movable contacts.

3.13 ***KS-5153, KS-5236, KS-5345, KS-5345-01, and KS-5432 Automatic Starters, and KS-5414 Magnetic Switch*** (Reqt 2.13)

(1) To check the contact sequence of a KS-5414 magnetic switch, operate it by hand. When the contacts in the ac circuits are just making, the dc contact gap should be 1/32 inch. To adjust, change the position of the contact arms on the shaft as covered in 3.04(1).

3.14 ***KS-5486 and KS-15540 Automatic Starters*** (Reqt 2.14)

(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.

(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. 13. 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 the adjustable relay does not operate within 5 minutes, readjust the relay as covered in 3.19. Reset the relay after test. For 3-phase starters, repeat for the other heater coils.

3.15 ***KS-5487 Starter*** (Reqt 2.15)

(1) To check the starter, operate it electrically, observing the action of the several components and of the associated motor.

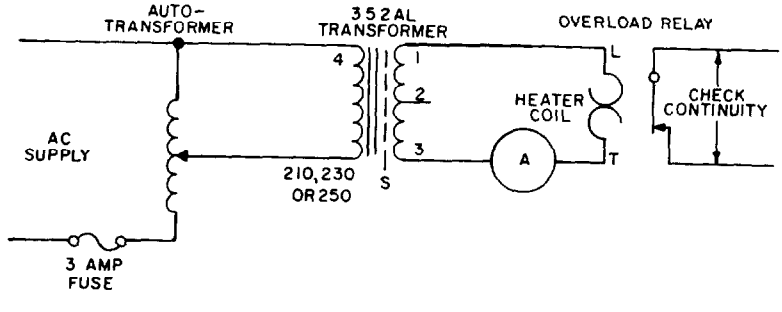

Fig. 13 – Test Circuit for Checking Overload Relays

(2) To adjust the timing, remove the cover from the gear box at the left side of the starter and lengthen the pendulum to increase the time by turning the nut which holds the weight on the pendulum rod.

3.16 ***Circuit Breakers in KS-5550 and KS-5550-01 Circuits*** (Reqt 2.16)

(1) If the AE-1 breaker does not trip on reverse current when the associated generator stops, loosen the reverse current adjusting knob and raise it as required. To adjust the overload trip, loosen the overload adjusting knob and move it upward to lower the trip value. The current may be read on the ammeter associated with the generator.

(2) To remove the dashpot for re-oiling, turn it counterclockwise. Wipe clean with a cleaning cloth and refill to the marked Oil Line and replace.

(3) If the AF-1 breaker fails, it should be replaced.

3.17 ***CR2810 Type Contactors*** (Reqt 2.17)

(1) To check contact pressure, proceed as outlined in 3.06. Replace weak springs as indicated.

3.18 ***HG101 Control Relay*** (Reqt 2.18)

(1) To measure contact pressure, hold the armature securely against the pole face with a screwdriver, taking care not to press on any part of the contact spring which supports the moving contact. Place the gauge against the contact spring near to the moving contact on the side of the contact nearer the hinge, and exert a pressure with the gauge away from the stationary contact. Read the gauge as the moving contact leaves the stationary contact.

(2) Maintain the contacts in accordance with 3.02, 3.03, 3.04, 3.05, and 3.06.

3.19 ***C2824-TC221C and CR2824-TC121C Adjustable Overload Relays*** (Reqt 2.19)

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

(c) Desired per cent of full-load current of the motor.

(d) Use the following formula to determine the setting of the calibrating arms.

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

Example:

If (a) = 4.3, (b) = 5, and (c) = 115, then (d) 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 (d) by 3- or 4-point steps until the nuisance tripping is eliminated but, in no case, shall this result in (c) being over 125 per cent of motor rating.

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

(2) After the relay has been readjusted, it shall again be checked for test requirement 2.14 and, if the relay fails to meet the requirement, it shall be replaced.

(3) Maintain the contacts in accordance with 3.02, 3.03, 3.04, 3.05, and 3.06.

3.20 ***CR2820-1051 Time-Delay Relay*** (see Fig. 10) (Reqt 2.20)

(1) If the retarding coil armature fails to release, look for the leaf spring and its adjusting screw and increase the tension of the spring.

(2) If the contacts close before the motor is up to speed, correct by a combination of the following procedures. Adjust the armature adjusting screw to lower the retarding coil armature (but not beyond the point at which the centers of the armature and the core correspond), and lower the nut located on the operating rod below the spring to decrease the pressure of the spring. Final adjustment should be made with the armature adjusting screw. Avoid weakening the operat-

ing rod spring so much that the contacts fail to follow when closing.

(3) If the delay is too long, correct by raising the armature and increasing the pressure of the operating rod spring, making the final adjustment with the armature adjusting screw. Avoid raising the armature so much that the contact separation is reduced below the minimum.

(4) The clearance between the armature and the core of the retarding coil is adjusted by means of the nut on the magnet frame tie rod.

(5) The contact separation is adjusted by changing the position of the armature as covered in (2). Recheck the delay after making any adjustment of the contact separation.

3.21 *CR2820-1099 Time-Delay Relay* (see Fig. 11) (Reqt 2.21)

(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. 11) 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.