# PALMER MASTER SWITCHES
# CONTACTOR TYPE
# REQUIREMENTS AND ADJUSTING PROCEDURES

## 1. GENERAL

1.01 This section covers contactor type master switches per KS-5078 and KS-5078-01. It is reissued to incorporate a brief description of the function and operation of the switch, to include information on contactor switches equipped with tripping and latch mechanism, to add information on voltage relays when used on 208 volt service, to modify the requirements on temperature rise and the values given in the table for lower closing range of the voltage relays, and to revise the procedures for adjusting the main contacts.

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

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

1.04 The a-c. line switch directly ahead of the master switch shall be opened before making any changes in connections or mechanical adjustments to the switch.

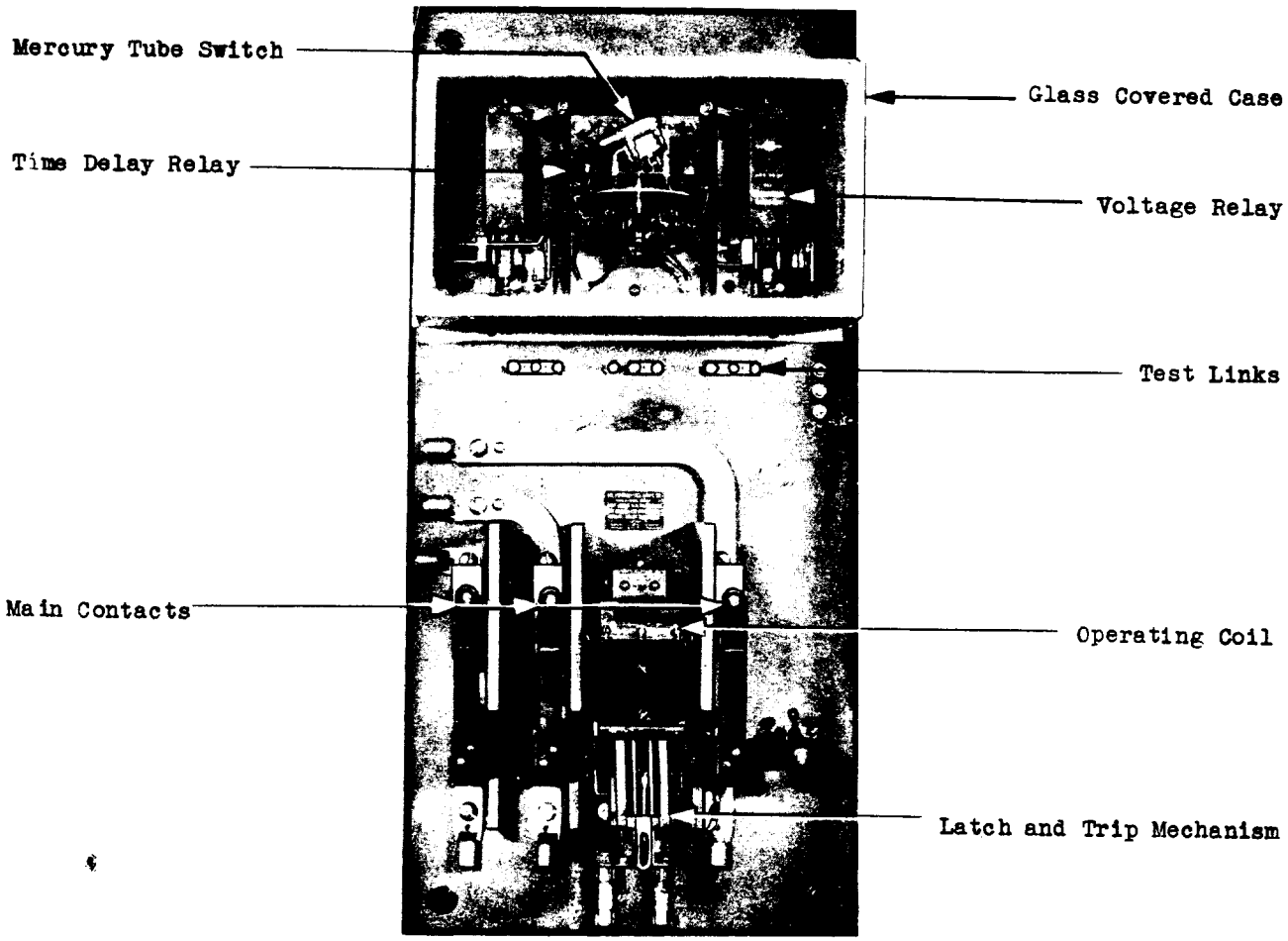



Fig. 1 – Master Switch (Without Cabinet)

1.05 The master switch automatically disconnects the a-c. supply from the duplex motors when the voltage is too high or too low and reconnects the supply when the voltage is within the proper range. The coil of each voltage relay is connected across one phase of the power service, either directly or through a transformer, while the relay contacts are in series with the time delay relay coil and a fuse directly across one phase of the power service. In Fig. 2 the contactor is shown open and the contacts on one voltage relay are open due to overvoltage on one phase. If proper voltage were restored, the voltage relay contacts would close and complete the circuit through the time delay relay element. After a few seconds the mercury tube switch would close and energize the operating coil to close the contactor. On switches not equipped with a tripping and latch mechanism, the operating coil remains energized to hold the contactor closed. On switches equipped with a tripping and latch mechanism, the tripping coil plunger pulls up and locks the contactor closed and deenergizes the operating coil. If the voltage should go out of range the associated voltage relay contact opens and deenergizes the mercury tube switch which after a short time delay deenergizes the tripping coil, causing the contactor to trip. The time delay relay introduces this delay in order that the contactor will not open or close on momentary fluctuations. On some switches an additional key is provided for manual instead of automatic reclosing after power failure.

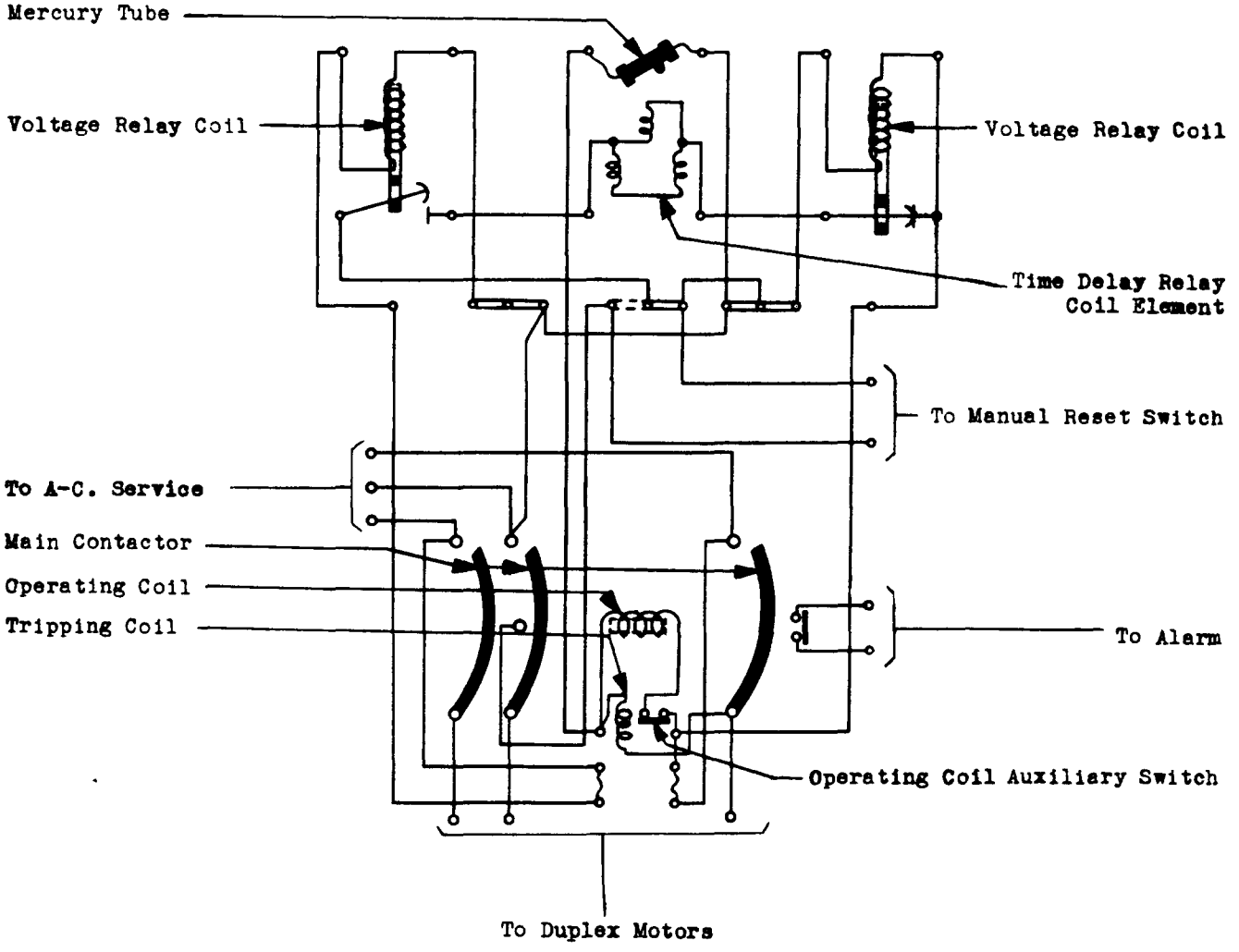



Fig. 2 – Circuit Schematic (Shown Without Transformers and Arranged for Manual Reclosing)

## 2. REQUIREMENTS

### Voltage Relays

**2.01** ***Operation***

(a) Voltage relay settings shall be with coils hot and shall be based on mean line voltage and mean coil voltage. ***Mean line voltage*** for the purpose of this section is the average of the high and the low over a typical 24-hour day. Where 200-volt motors and a transformer are used, select the transformer tap that gives the nearest to 230 volts at the relay coils when line voltage is at the mean value. This will be the ***mean coil voltage.*** Where 230-volt motors are used there is no transformer and mean line voltage and mean coil voltage are the same. Coils to be hot should be energized at normal voltage for at least 2 hours.

(b) Set ***upper contact opening*** at approximately 22 volts above mean coil voltage unless this setting corresponds to a line voltage in excess of 259 volts where 230-volt motors are used or in excess of 225 volts where 200-volt motors are used.

(c) The striker on the armature guide shall not engage the contact arm adjusting screw until after the armature has started its sudden upward movement.

(d) The upward movement of the armature shall be arrested by the contact arm stop screw.

(e) When the voltage on the solenoid coil is decreased slowly within the upper opening range, after the contacts have opened, there shall be no downward movement of the armature.

(f) Set ***upper contact closing*** at approximately 5 volts below the upper contact opening value.

(g) When the voltage on the solenoid coil is decreased slowly below the upper closing range, the armature shall descend slowly.

(h) Set ***lower contact opening*** at approximately 50 volts below the upper contact opening value.

(i) The striker on the armature guide shall not engage the lever adjusting screw until after the armature has started its sudden downward movement.

(j) The downward movement of the armature shall be arrested by the armature stop screw.

(k) When the voltage on the solenoid coil is slowly increased within the lower opening range after the contacts have opened, there shall be no upward movement of the armature.

(l) Set ***lower contact closing*** at approximately 8 volts above lower contact opening value.

(m) The ***intent*** of the above settings is to transfer to dc when ac is too high or too low and to avoid long periods of operation on dc. Voltage is usually considered excessive after 110 per cent of nameplate rating but in this case the high opening is allowed to go to 112-1/2 per cent since it is not expected to stay high over long periods of time. Variation from above settings to meet local conditions and the intent as explained herein are acceptable.

**2.02** ***Freedom of Moving Parts***

(a) The contact arm and associated lever shall move freely in their bearings and shall have little or no lateral motion.

(b) The armature shall not bind in its solenoid nor shall the armature guide bind on the guide rods.

**2.03** ***Position of Contact Arm and Contacts***

(a) The contact arm shall be approximately level when the contacts are closed.

(b) With the contacts closed the lower contact shall rest against its contact stop screw.

(c) When the contacts are open there shall be approximately 1/32″ clearance between the lower contact and its contact stop screw.

(d) The counterweight shall be approximately 1/8″ from the end of the contact arm.

**2.04** ***Position of Lever***

(a) With the armature raised the lever shall be approximately level and shall rest against its lever stop screw.

(b) With the contacts closed there shall be approximately 1/32″ clearance between the lever and the stud attached to the contact arm.

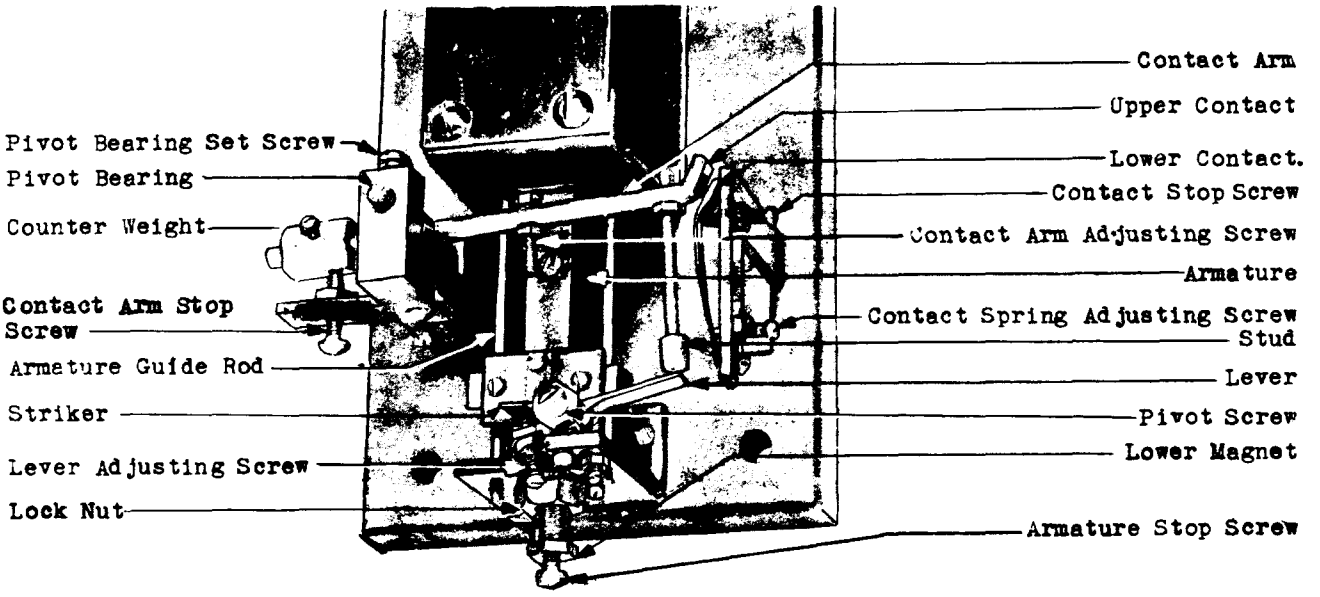



**Fig. 3 – Voltage Relay Details**

(c) With the armature against the armature stop screw and the contacts held open by the lever there shall be approximately 1/32" clearance between the counterweight and the contact arm stop screw.

2.05 ***Condition of Contacts:*** Relay contacts shall be clean, smooth and free from pits.

2.06 ***Condition of Magnet Face:*** The upper surface of the lower magnet and the guide rods shall be free from lint and dirt.

**Time Delay Relay**

2.07 ***Operation***

(a) When the following voltage is applied to the relay coil the aluminum disc shall rotate to the left and the mercury tube switch shall close with one unhesitating movement.

Without Transformer — 198 Volts
With " — 172 Volts

(b) When operating with or without transformers there shall be a time delay between the closing of the relay coil circuit and the closing of the mercury tube switch as follows.

Minimum — 5 seconds
Maximum — 7 "

Use ordinary watch with second hand.

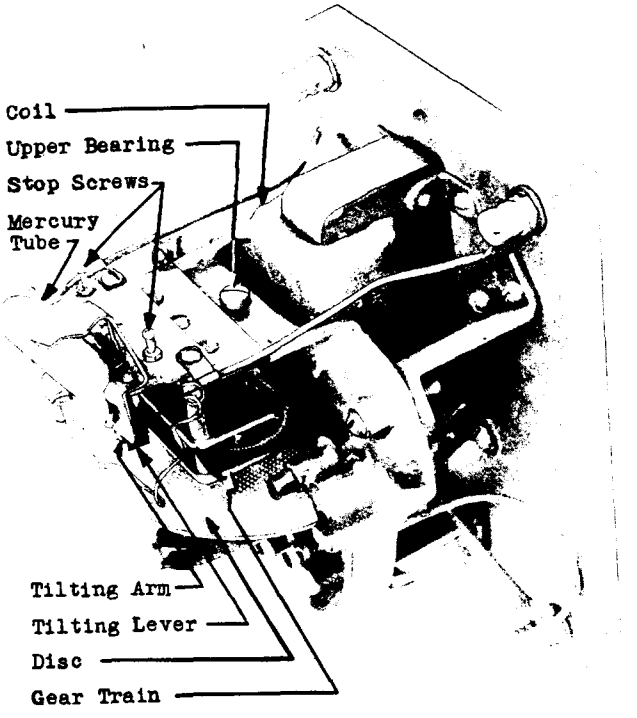



**Fig. 4 – Time Delay Relay**

(c) When operating with or without transformers upon the opening of the relay coil circuit, the mercury tube switch shall open with a time delay as follows.

Minimum — 3 seconds
Maximum — 5 "

Use ordinary watch with second hand.

**2.08** ***Location of Disc:*** The aluminum disc shall be approximately midway between the laminated pole-pieces. It shall not touch or bind on the pole-pieces in any position and it shall rotate easily and freely on its bearings.

**2.09** ***Freedom of Gears:*** All gears shall operate freely without binding.

**2.10** ***Freedom of Tilting Arm:*** The tilting arm of the gear train shall not bind on the tilting lever of the mercury tube switch nor shall there be more than 1/64" clearance between these two members. Gauge by sight.

**2.11** ***Mounting of Mercury Tube Switch:*** The mercury tube shall be mounted with its long end to the left as viewed from the front of the relay and the associated flexible leads shall not interfere with the operation of the relay.

**Contactor Switch**

**2.12** ***Condition and Adjustment of Main Contacts***

(a) Contacts shall be clean and free from burrs and the laminations shall not be discolored from overheating.

(b) On closing, the main contacts shall make in the following sequence: (1) carbon tip, (2) auxiliary metal tip, (3) laminated brush member. They shall open in the reverse sequence.

(c) On closing, the brushes of the main contacts of each pole shall begin to make contact at approximately the same time. The toe of the laminated member shall make contact on the angle part of the fixed contact first, followed by the laminations which shall flex perceptibly as shown in Figure 5. In the closed position, the contact surfaces of the laminations and the metal tip of the auxiliary main contact shall be parallel to the corresponding surface on the fixed contact so that they will make contact all the way across the surfaces.

**2.13** ***Clearances***

(a) When the contactor switch is in the open position, the crossbar shall rest against its associated stop screw and there shall be clearance between the bottom of the rollers and the bottom of their respective cam slots.

(b) When the contactor switch is in the closed position, there shall be clearance between the top of the rollers and the top of their respective cam slots.

**2.14** ***Freedom of Moving Parts:*** All moving parts shall operate freely without binding.

**2.15** ***Operation of Switches without Tripping and Latch Mechanism:*** The contactor shall close when the a-c. service is connected to the operating coil and shall remain closed until the coil is deenergized.

**2.16** ***Operation of Switches with Tripping and Latch Mechanism***

(a) When the a-c. service is connected the main contacts shall close, the tripping coil plunger shall rise and the mechanical latch shall lock the contactor switch closed. After the main contacts close, the final movement of the latch shall open the auxiliary switch and de-energize the operating coil.

(b) When the tripping coil is deenergized the plunger shall fall and by its own weight release the mechanical latch and allow the main contacts to open. The opening of the main contacts shall close the auxiliary switch so that when the a-c. supply is restored, the circuit through the operating coil will be completed.

**2.17** ***Contactor Noise:*** After the main switch closes there shall not be any excessive noise, such as chattering or humming.

**2.18** ***Routine Test:*** The operation of the switch shall be tested at least once a month.

**Temperature**

**2.19** After operation at full load for at least 2 hours with the cover closed, the ***temperature rise*** shall not exceed the following values above the room temperature of the surrounding air, either within the cabinet or in close proximity of the switch. Use a centigrade thermometer. The voltage may be that available within the operating range at the time of the

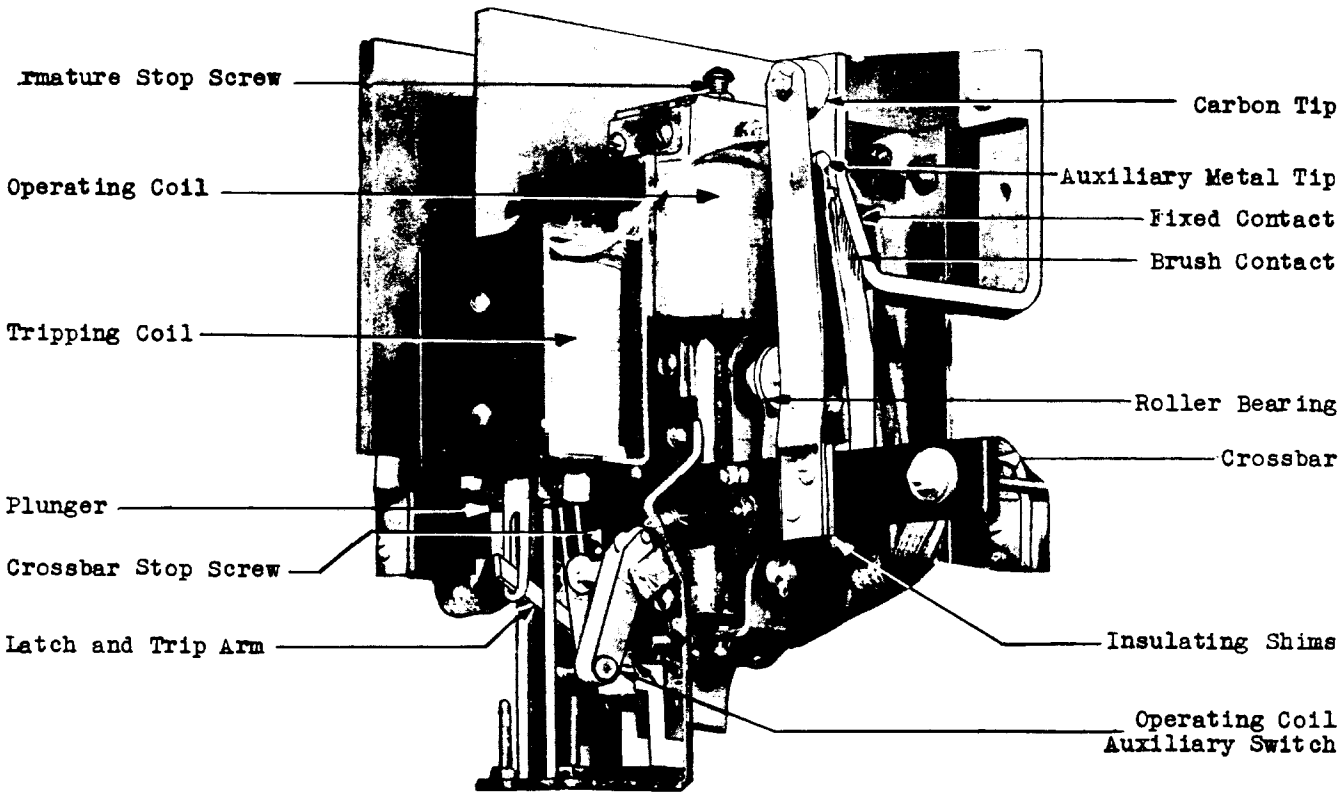



**Fig. 5 – Contactor, Trip and Latch Mechanism**

test except that for the voltage relay coils, the voltage should be the minimum within the range.

*Note:* The requirement need not be checked for unless heating trouble is experienced.

| | |
|---|---|
| Contactor, Tripping and Time Delay Relay Coils | 65° C. |
| Voltage Relay Coils | 90° C. |
| Main Contacts | 40° C. |
| Transformer Coils | 55° C. |

## 3. ADJUSTING PROCEDURES

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

| CODE OR SPEC NO. | DESCRIPTION |
|---|---|
| TOOLS | |
| 265C | Contact Burnisher Holder |
| 388A | 3/16- and 1/4-inch Open Double-end Offset Wrench |
| 417A | 1/4- and 3/8-inch Open Double-end Flat Wrench |
| 418A | 5/16- and 7/32-inch Open Double-end Flat Wrench |
| KS-6015 | Duck-bill Pliers |
| KS-6367 | 7/16- and 5/8-inch Open Double-end Flat Wrench |
| R-1005 | Jewelers Screwdriver |
| R-1051 | Pillar File |
| R-1102 | Fiber Spudger (for opening the voltage relay contacts while the voltage is on when checking the relay) |
| R-1770 | 1/2- and 9/16-inch Open Double-end Flat Wrench |

| CODE OR SPEC NO. | DESCRIPTION |
|---|---|
| **TOOLS** | |
| R-2652 | Thin Monkey-type Wrench |
| R-8210 | 1-1/2-inch Screwdriver |
| — | 5-inch Regular Screwdriver |
| **GAUGES** | |
| — | −20° to + 151C Thermometer, Kimble Co No. 43732 (or equivalent spirit-filled thermometer) |
| — | Ordinary Watch With Second Hand or Stop Watch |
| **MATERIALS** | |
| KS-2423 | Twill-jean Cloth or Equivalent |
| KS-7860 | Petroleum Spirits |
| — | Leads for Connections |
| — | Felt Pad |
| — | Abrasive Paper, Extra Fine Flint Paper or 4/0 Garnet Paper |
| **TEST APPARATUS** | |
| — | Voltmeter, AC, Weston Model 904, 300/150 Volts |
| — | Palmer Master Switch Test Set |

**3.002** The master switch cabinet covers which are fastened at the top are secured with two pins and not hinges. Consequently in removing the cover, it must be pulled out from the bottom of the cabinet and raised sufficiently to clear the pins.

**3.003** Since the voltage and time delay relays are delicate instruments which are affected by dust, etc, the glass covered case should not be left off longer than is necessary. Before putting on the case, note particularly that the leads from the mercury tube on the time delay relay are not touching anything. In putting on the case be careful that the gasket between the case and the panel is in place after which tighten the screws firmly.

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

**Voltage Relays**

**3.01** ***Operation*** (Rq 2.01)

(1) Connections to the master switch should be changed only after the line service switch directly ahead of the master switch has been opened to remove the line voltage from the switch. Connections should be made as shown in schematic form in Fig. 6, 7, 8, and 9. After connections are completed, energy for testing the voltage relays may be obtained by closing the line service switch.

***Note:*** In Fig. 6, 7, 8, and 9, frequency meter may be omitted since a check of frequency is seldom required.

(2) To adjust the upper range, slowly raise the voltage on the solenoid coil by turning the handle in the center of the panel on the test set in a clockwise direction. Smaller increments may be obtained by turning the small handle near the bottom edge of the panel. If the sudden upward movement of the armature occurs below the upper opening range, loosen the set screw at the top of the solenoid coil and slightly raise the top magnet. If the sudden upward movement occurs above the upper opening range, slightly lower the top magnet. Tighten the set screw. If the sudden upward movement of the armature cannot be obtained within the desired limits by adjusting the top magnet, the relay should be replaced. Set the contact arm adjusting screw so that the striker on the armature guide does not engage it until after the armature has started its sudden upward movement. Check readings should be taken on the operating voltage and its value noted.

(3) After the upper opening range is adjusted and the contacts open, adjust the upper closing range by slowly decreasing the voltage on the solenoid coil by turning the handles counterclockwise. If the sudden downward movement of the armature occurs above the upper closing range (or less than 3 volts be-

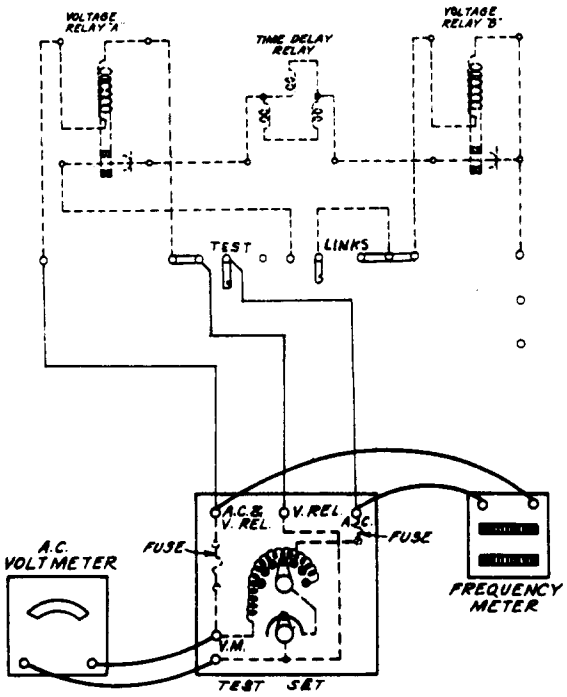



Fig. 6 – Test Connections for Relay "A" Without Transformer

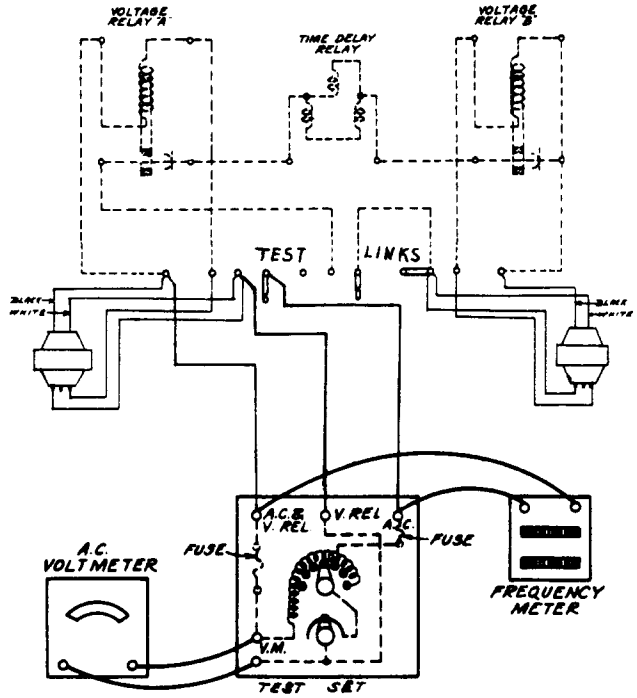



Fig. 8 – Test Connections for Relay "A" With Transformer

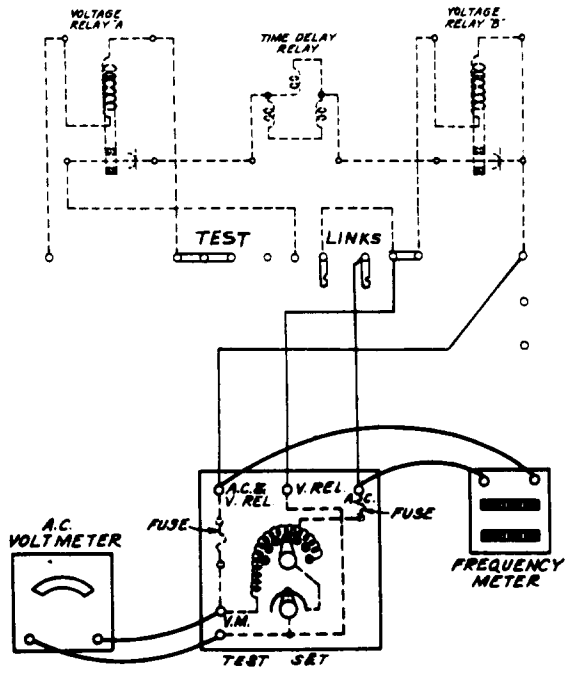



Fig. 7 – Test Connections for Relay "B" Without Transformer

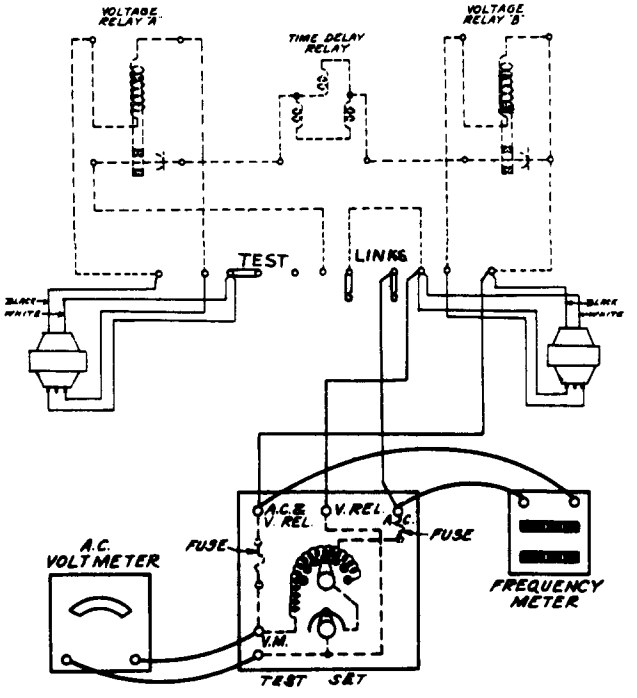



Fig. 9 – Test Connections for Relay "B" With Transformer

low the final operating voltage noted above under (2), slightly reduce the air-gap between the armature and the top magnet by turning the contact arm stop screw out (lowering it). If the sudden downward movement occurs below the upper closing range, slightly increase the air-gap between the armature and the top magnet by turning the contact arm stop screw in (raising it). Tighten the lock nut after an adjustment has been completed. If the contacts fail to close as the armature moves downward, turn the contact arm adjusting screw counterclockwise (raising it) slightly until they do close. Tighten the lock nut. After the adjustments are completed check readings should be taken and the operating value noted.

(4) If positive action of the contact arm is not obtained by these adjustments, a resetting of the contact arm adjusting screw may help. Raising the contact arm adjusting screw will help the action of the contact arm on its upper opening operation, while moving the contact arm adjusting screw down will help the action of the contact arm on its upper closing operation. In doing this, a gain in one operation is made at the expense of the other. The discretion of the adjustor sometimes is necessary to obtain a happy medium. If this adjustment is made to the contact arm adjusting screw it will be necessary to recheck the other adjustments.

(5) Recheck requirements (b), (c) and (d) of paragraph 2.01 and adjust if necessary.

(6) To adjust the lower opening range, decrease the voltage still further. If the sudden downward movement of the armature at the lower end of its travel occurs above the lower opening range, remove the armature stop screw, noting its position, turn the lower magnet out slightly (lowering it) and replace the armature stop screw in its original position. If the sudden downward movement occurs below the lower opening range, remove the armature stop screw, noting its position, turn the lower magnet in slightly (raising it) and replace the armature stop screw in its original position. Tighten the lock nuts after each adjustment. Set the lever adjusting screw so that the striker on the armature guide does not engage until after the armature has started its sudden downward movement. Check the final operating voltage and note the value.

(7) To adjust the lower closing range, slowly increase the voltage. If the sudden upward movement occurs below the lower closing range, turn the armature stop screw out slightly (lowering it). Tighten the lock nut. If the sudden upward movement occurs above the lower closing range, turn the armature stop screw in slightly (raising it). Tighten the lock nut. If the contacts fail to close when the armature moves upward, turn the lever adjusting screw out slightly (lowering it) until the contacts close. After these adjustments note the final operating voltage and recheck the requirements outlined in (g), (h), (i) and (j) of paragraph 2.01.

(8) Recheck the clearance between the counterweight and the contact arm stop screw. Adjust if necessary.

(9) Remove the test set connections and close the test links to their original positions.

**3.02** ***Freedom of Moving Parts*** (Rq. 2.02)

(1) Wipe any dust or dirt from the relay with a cloth. The armature guide rods and contact arm and lever pivots may be wiped with KS-2423 cloth or equivalent moistened with petroleum spirits.

(2) To adjust the pivot bearing of the contact arm, loosen the pivot bearing set screw and change the position of the pivot bearing. To adjust the lever loosen the lock nut and adjust its pivot screw. Tighten the lock nut after an adjustment has been made.

(3) If the relay armature binds after cleaning as outlined in (1) replace the complete relay.

**3.03** ***Position of Contact Arm and Contacts*** (Rq. 2.03)

(1) To adjust the level of the contact arm, loosen the lock nut associated with the contact stop screw and turn the stop screw in or out until the desired adjustment is reached. Raise the contact arm and adjust the clearance between the lower contact and its stop screw by loosening the lock nut on the contact spring adjusting screw and turning the adjusting screw. Tighten the lock nuts after the adjustments have been completed.

(2) To shift the position of the counterweight on the contact arm, loosen the set screw in the counterweight and shift the position of the weight on the contact arm. Tighten the set screw after any change.

**3.04** ***Position of Lever*** (Rq. 2.04)

(1) To adjust the position of the lever, loosen the lock nut on the lever stop screw and turn the lever stop screw in or out. Tighten the lock nut after any adjustment.

(2) To adjust the contact clearance, loosen the lock nut on the stud and turn the stud counterclockwise to increase the clearance, clockwise to decrease the clearance. Tighten the lock nut after each adjustment.

(3) If there is not the proper clearance between the counterweight and the contact arm stop screw, adjust the stud. Recheck the clearance between the lower contact and the associated stop screw and adjust as necessary.

**3.05** ***Condition of Contacts*** (Rq. 2.05)
**3.06** ***Condition of Magnet Face*** (Rq. 2.06)

(1) Wipe the guide rods and the top surface of the lower magnet with a piece of KS-2423 cloth or equivalent. Clean the contacts with a contact burnisher and wipe. Do not use an abrasive, such as sandpaper, on the contacts as this would remove the silver plating and increase the resistance of the contact.

**Time Delay Relay**

**3.07** ***Operation*** (Rq. 2.07)

(1) Connections to the time delay relay should be changed only after the line service switch directly ahead of the master switch has been opened. Connections should be made as shown in schematic form in Fig. 10. After connections are completed energy for testing the time delay relay may be obtained by closing the line service switch.

(2) Carefully, open one of the voltage relay contacts with a small wooden stick and allow the aluminum disc to come to rest. Next close the relay contact and note the time which elapses until the contactor switch closes. This test is made with the ac service connected to the master switch.

(3) If the delay in the closing of the mercury tube switch is too short, loosen the lock nut and turn the stop screw at the right end of the mercury tube switch counterclockwise (increasing the distance the switch must travel to close). If the closing time is too great, turn the stop screw clockwise (decreasing the distance the switch must travel to close). Tighten the lock nut after each adjustment.

(4) Open the voltage relay contacts and note the time which elapses until the contactor switch opens. If the delay in opening is too short, loosen the lock nut and turn the stop screw at the left end of the mercury switch counterclockwise (increasing the distance the switch must travel). If the delay in opening is too long, turn the stop screw clockwise (decreasing the distance the switch must travel). Tighten the lock nut after each adjustment.

(5) If the relay fails to operate mechanically, check the mechanical requirements. If the relay fails to operate electrically, note that the voltage relays operate and their contacts close. Test the coil circuits with a voltmeter by connecting it across the two lower terminals of the time delay relay. If there is no voltage the trouble is external to the time

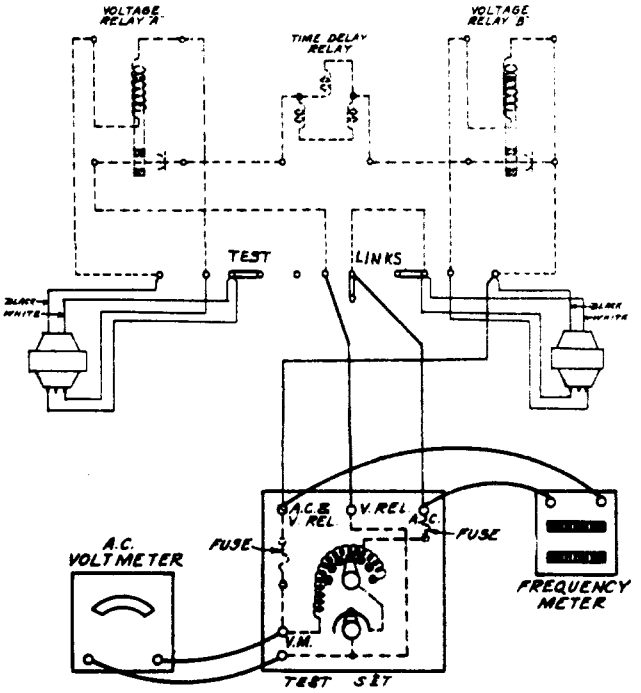



**Fig. 10 – Test Connections for Time Delay Relay With and Without Transformers**

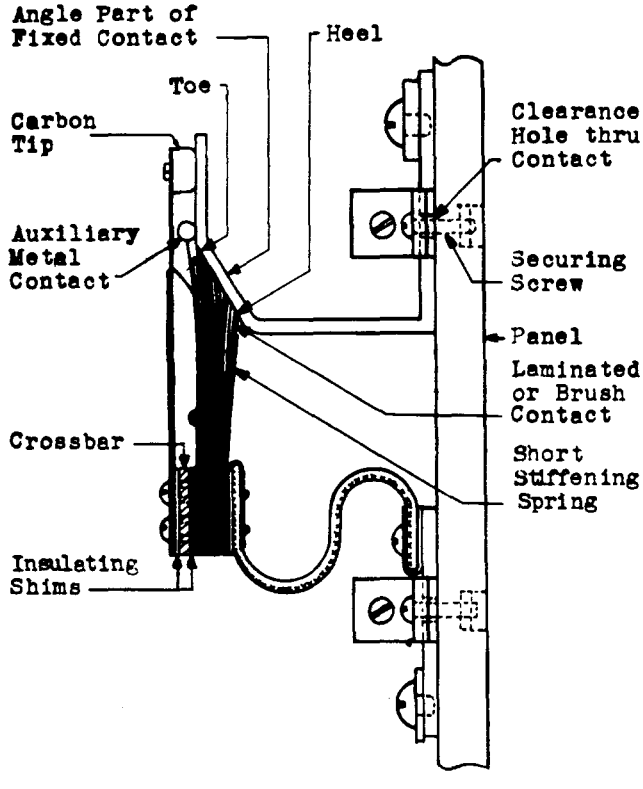
delay relay. If the voltage on the time delay relay is satisfactory, remove the two coil leads from one terminal and connect the meter in series with each lead separately. No reading indicates an open coil which should be replaced.

**3.08** ***Location of Disc*** (Rq. 2.08)

(1) If the disc is not about mid-way between the pole faces, remove both bearings and hold the disc shaft by hand. Loosen the small set screws in the hub of the disc with a jeweler's screwdriver and adjust the disc on the shaft. Tighten the set screws, put back the disc and bearings, being careful that the shaft slides up into the upper bearing without binding. Check the operation of the relay.

**3.09** ***Freedom of Gears*** (Rq. 2.09)

(1) No adjustment shall be made on the gear train. Replace it if defective.




Note:
The separation between leaves of the brush is shown exaggerated and is not usually obtainable in practice.

Fig. 11 – Main Contacts

**3.10** ***Freedom of Tilting Arm*** (Rq. 2.10)

(1) If necessary shape the prongs on the lower end of the tilting lever with the fingers or a pair of duck-bill pliers.

**3.11** ***Mounting of Mercury Tube Switch*** (Rq. 2.11)

(1) If necessary dress the leads so that they do not interfere with the operation.

**Contactor Switch**

**3.12** ***Condition and Adjustment of Main Contacts*** (Rq. 2.12)

(1) Disconnect the ac service to the switch and if the contacts are dirty wipe them with a piece of KS-2423 cloth or equivalent. If the contacts are burned or pitted, smooth with 4/0 Garnet paper or a fine file and wipe and adjust if necessary. Silvered contacts should not be sanded or filed unless they are giving trouble as this would remove the thin silver film. If the contacts are too badly pitted to be smoothed and adjusted or otherwise give evidence of overheating, such as discolored laminations, they must be replaced. However,

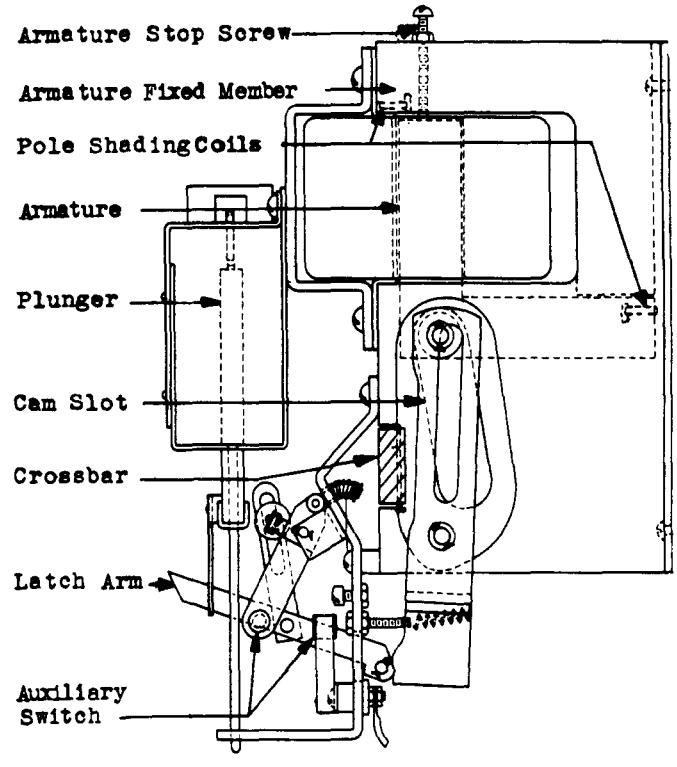



Fig. 12 – Operating, Tripping and Latch Mechanism

to avoid repetition of the trouble, first, ascertain the cause which might have been due to overloading or improper adjustment of the contacts or to other parts of the switch not being in good working condition. The alarm pole need not be replaced unless it is giving trouble. If one pole is used for ground connection for the floor alarm board it is suggested that the leads be disconnected or a piece of paper be folded over the fixed contact to avoid arcing across the contact while working on the switch. It is difficult to check and adjust the contacts with the baffles on and it is recommended that the baffles be removed.

(2) To check and adjust the main contacts, close the switch slowly by pushing up on the armature from underneath the switch. Note whether all laminations rest against the angle part of the fixed contact as shown in Fig. 11, whether the toe of the brush makes contact first followed by the other laminations and whether the carbon, auxiliary and brush contacts make contact in the proper sequence, etc. A check of the brush contact can be made with the switch closed by feeling whether a piece of paper can be inserted between the brush and fixed contact at any point. A further check may be had by opening the switch and placing a sheet of paper and pencil carbon back side to the brush and carbon side next to the paper between the contacts and then closing the switch. The imprint of the laminations may not be very distinct but it will give an indication, particularly whether the laminations are touching across the entire width. It is preferable to adjust the contacts in the following sequence.

(3) If all laminations do not rest against the angle part of the fixed contact, loosen the screws and move the fixed and movable contacts closer together or farther apart. If the clearance in the holes around the screws does not allow sufficient movement it will be necessary to remove the fixed contact and either elongate the clearance holes or drill them larger. After this adjustment tighten the screws.

(4) If the heel of the brush touches first and there are two insulating shims between the brush and the crossbar, remove one of the shims. If only one shim is present it will be necessary to shape the brush. To get the toe of the brush to touch first or to increase the pressure, grasp the brush with one hand approximately in the middle just above where the end attaches to the crossbar and hold the brush firmly. With the other hand push the toe of the brush toward the fixed contact. Repeat until the desired contact is obtained. In extreme cases it may be necessary to do considerable shaping, in which case it might be advantageous to remove the brush contact, place the riveted end in a vise and use a small thin monkeywrench in place of the fingers. Any shaping with a wrench should be done very carefully, however, not to injure the laminations.

(5) If the brush does not make contact all the way across, twist it slightly as required with a small monkeywrench. This may be done with the brush in place in the switch.

(6) Proper sequence of closing of the carbon tip, auxiliary contact and the brush contact may be obtained by shaping the carbon tip and auxiliary contact springs. The carbon tip spring may be shaped with flats or the fingers. The auxiliary metal contact spring should be given a short bend near the contact with flats to avoid interference with the adjustment of the carbon tip spring. To insure proper sequence of making contact after the switch has been in operation for a while, this adjustment should be made so that when the carbon tip makes contact in closing, for example, the auxiliary metal contact will be about 3/16 inch to 1/4 inch from making contact. When the auxiliary metal contact touches, the tip of the brush should be about 3/16 inch to 1/4 inch from touching. Too much clearance will unnecessarily add to the pressure required to close the switch. Be sure the carbon tip and auxiliary contacts make good contact all the way across. Due to the action of the switch mechanism it will be difficult to adjust the carbon tip for good contact both when it just makes contact and when the switch is fully closed. However, it is more important that the tip lie flat when it first makes contact than when the switch is fully closed.

(7) After all adjustments are completed check the operation of the switch electrically several times and if satisfactory reconnect the load, and be sure that all connections are tight, particularly the main contacts.

***Caution: Before operating the switch electrically disconnect the load from the switch so that, if the contacts do not close properly, there will not be any arcing at the contacts or possibility of blowing the dc fuses feeding the duplex motors and stopping the motors. Also, be sure the live parts of the switch do not touch the case, etc.***

(8) If the contactor fails to close completely, check the voltage across the operating coil. There are two taps on the operating coil which are usually tagged 230 volts and either 200 or 208 volts. Be sure the proper tap is connected. Any service voltage below 220 volts should use the 200- or 208-volt tap. Any service voltage of 220 volts or above should use the 230-volt tap. If the correct tap is being used, the clearances given in (6) above may be reduced to the minimum value for switches held closed magnetically in order to obtain satisfactory operation. If the contacts are held closed mechanically, it may be necessary to reduce these minimum values to a value such that they shall just not touch on account of the higher pressures employed.

(9) Check the pressure on the brush contacts with a gauge after removing the service voltage and closing the switch manually. Place a small cord under the laminated brush as near the point of contact as possible and pull the brush away from the fixed contact until it just ceases to make contact. Brushes held closed magnetically should show a pressure of 2 to 3 pounds on the gauge per brush contact as the brush ceases to make contact. Brushes held closed mechanically should show a pressure of from 4-1/2 to 5 pounds. If this pressure is too great for the switch to close magnetically it may be reduced slightly, but if the switch will not pull up against a brush pressure of at least 1-3/4 pounds per brush for contacts held closed magnetically or 4 pounds per brush for contacts held closed mechanically the contactor switch should be given a complete check. Adjustment is made by shaping the brush contacts individually. On switches which are held closed mechanically the auxiliary metal tip and carbon tip should be adjusted to have a pressure when in the closed position of between 3/4 to 1 pound each.

**3.13** ***Clearance*** (Rq. 2.13)

(1) With the ac service disconnected adjust the crossbar against its stop screw by loosening the lock nut and turning the screw in or out until the rollers are free in the cam slot. In case the bearings bind after adjusting the stop screw ascertain the cause and adjust or replace any defective parts.

(2) Close the contactor manually with a screwdriver held against the armature from underneath and hold the armature up as far as it will go. If there is no clearance between the roller bearing and the top of the cam slot, loosen the armature stop screw lock nut and turn the screw down slowly until the rollers are just free. Tighten the lock nut. If the rollers then do not turn freely ascertain the cause and adjust or replace defective parts.

**3.14** ***Freedom of Moving Parts*** (Rq. 2.14)

(1) With the ac service to the switch disconnected, slowly raise and lower the armature by hand with a screwdriver from underneath. Note that it does not bind, remembering that as the brush starts to make contact more effort will be required to raise the armature.

(2) For switches equipped with tripping and latch mechanism raise the armature slowly as before to close the switch. Hold it closed and raise the tripping coil plunger by hand to lockup the main contacts and open the operating coil auxiliary switch shown in Fig. 12. If pushing up the plunger does not cause the main switch to lock up, check the clearance requirements to be sure that the armature stop screw is not screwed down too much, which would prevent the armature shaft from rising sufficiently to engage the lock on the latch mechanism.

(3) With the armature locked up by the latch mechanism, slowly lower the plunger by hand and note that by its own weight, it releases the contactor and closes the auxiliary switch. In case the auxiliary switch does not

close, check that the crossbar stop screw is not in too far. Also note that the crossbar rests against its stop screw and is not held up by the binding of the curved pin which the crossbar pushes against to close the auxiliary switch. In case the pin binds, lubricate it slightly with oil or petrolatum.

**3.15** ***Operation of Switches Without Tripping and Latch Mechanism*** (Rq. 2.15)

(1) After checking the adjustment and clearance requirements, connect the ac service to the master switch. Note that after the time delay relay operates, the main contacts close. They should open when the ac supply is removed.

(2) If the contactor switch fails to operate electrically, test for an open in the operating coil or coil circuit by connecting a voltmeter in the circuit. Remove the ac supply while making connections. Place the voltmeter across the terminals of the coil. Note that the mercury tube in the time delay relay closes. No reading on the voltmeter indicates an open in the contactor operating coil circuit. Tighten the connections. If the coil circuit is satisfactory place the voltmeter in series with the contactor coil winding. No reading on the voltmeter with the mercury tube switch closed indicates an open in the coil. Replace a defective coil.

(3) If the switch starts to close but fails to close entirely, it may be that the wrong voltage tap is being used on the operating coil or that the pressure on the contacts is too great as covered under "Condition and Adjustment of Main Contacts".

**3.16** ***Operation of Switches with Tripping and Latch Mechanism*** (Rq. 2.16)

(1) This test should be made after the requirements on adjustments of contacts, clearance and freedom of moving parts have been checked. Connect the ac service to the switch. Note that after the time delay relay operates, the main contacts close, the tripping coil plunger rises, the contacts lock closed, and the operating coil auxiliary switch opens which deenergizes the operating coil. Disconnect the ac supply to release the tripping coil plunger and trip the main contacts and close the auxiliary switch. Repeat this process of opening and closing the main contacts in this manner several times.

(2) If the contactor switch fails to close, check the various connections and that the auxiliary switch is closed. Test the operating coil circuit with a voltmeter. Be sure to remove the ac supply while making connections. Place the voltmeter across the terminals of the coil and note that the mercury tube in the time delay relay closes the circuit. No reading on the voltmeter indicates an open in the operating coil circuit. Tighten the connections. If the coil circuit is satisfactory place the meter in series with the coil winding. No reading on the meter with the mercury tube switch closed indicates an open in the coil. Replace the coil.

(3) In case the contacts close but fail to lock up due to the tripping coil not operating check that the tripping coils and connections are satisfactory similar to checking the operating coil. If the plunger rises, check that the armature stop screw is not screwed down too far or that the brush contacts are adjusted for too great a pressure to allow the armature to close completely. Check also that the spring holds the lock against the latch as shown in Fig. 12.

**3.17** ***Contactor Noise*** (Rq. 2.17)

(1) This requirement applies particularly to the older type of master switches without latch mechanism of which the operating coil of the contactor is energized continually to hold the switch closed. With the later design the switch is locked up mechanically and the operating coil is deenergized.

(2) In case of excessive noise, after the switch is closed ascertain the cause. Replace any loose shafts or broken rollers on the contactor arm linkage. Any dirt or rust should be removed from the armature or pole faces with fine 4/0 garnet paper. To clean the pole faces, remove the guides and rollers for the contactor arm linkage and swing the contactor arm downward out of the way of the armature. Remove the armature and slide the contactor coil off by loosening the mounting screws above and below the coil. Smooth the armature and

pole faces with 4/0 garnet paper, wipe with clean KS-2423 cloth or equivalent and replace in the reverse order.

(3) If the pole shading short circuiting bands around the armature are loose replace the armature and the fixed laminated member if necessary. If the noise continues after the above procedure replace the contactor switch.

**3.18** ***Routine Test*** (Rq. 2.18)

(1) By simulating power failure conditions several times consecutively at least once a month, any joints in the linkage or other moving parts which might have a tendency to bind due to oxidation or accumulation of dust would be freed. Note that the main contacts are making good contact. Check, particularly, that the laminations of the moving contacts are not discolored due to overheating and that the contact screws are tightened firmly.

(2) Any troubles which are likely to develop either in the master switch or in the operation of the duplex motors on the battery should be noticed at the time of routine test and could be corrected so as to insure satisfactory operation when needed at the time of an actual power failure.

**Temperature**

**3.19** ***Temperature Rise*** (Rq. 2.19)

(1) Temperature measurements should be taken only after the master switch has been operated for at least two hours. The cover of the enclosing cabinet should be in place during this period, but the case over the voltage and time delay relays may be removed. Temperature measurements should be made with the switch connected to the power service.

***Caution: Care must be exercised while taking these measurements since with the a-c. supply connected the main contacts and other live parts have line voltage on them.***

(2) Measure the temperature of the coils and contacts by holding the bulb of a centigrade thermometer against the surface of the part being measured and observing the highest temperature indicated. That part of the bulb not in contact with the part whose temperature is being measured should be covered with a felt pad or equivalent material. The minimum voltage on the voltage relay coils, as covered in the requirements, may be obtained by connecting the test set as shown in Figs. 6, 7, 8 and 9.