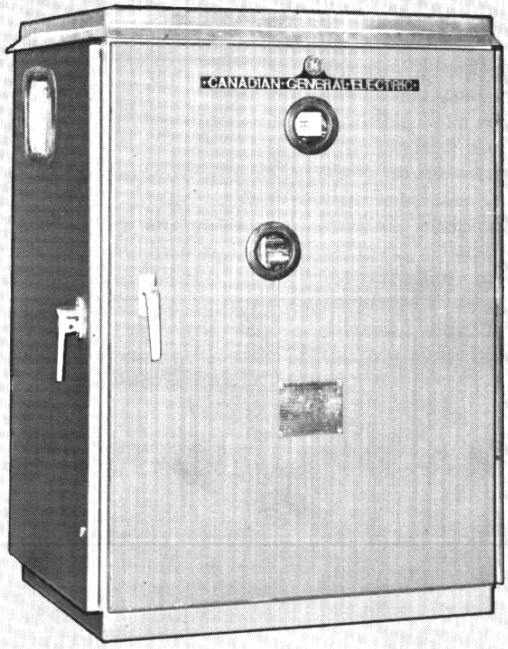
INSTRUCTIONS

PGEI - 1315A

SPRING - CHARGED OPERATING MECHANISM



TYPE ML-14

FOR OIL - BLAST CIRCUIT BREAKERS

SPRING - CHARGED OPERATING MECHANISM TYPE ML-14

INTRODUCTION

The Type ML-14 mechanism is a spring operated mechanism for outdoor oil-blast circuit breakers. It is designed for high speed operation during the circuit breaker interruption of faults and high speed reclosing. It is mechanically trip-free and non-pumping when closed on short circuits. Its high speed characteristic is the result of a simple, rugged linkage design having low-friction bearings.

The mechanism and associated operating equipment are enclosed in a weatherproof housing designed for mounting on the front end of the breaker. DC voltage is required for the control circuit. AC voltage is recommended for the spring charging motor and required for the heater circuits. Since the control circuit requires very low operating currents, the necessity for large storage batteries or rectifiers is eliminated. Batteries are recommended for the DC source. The mechanism and its accessories will operate at the standard ASA voltage ratings. The breaker nameplate is mounted on the outside of the front door of the mechanism housing.

Proper installation and maintenance are necessary for continued satisfactory operation. The following instructions will provide information for placing the mechanism and breaker in service and for the necessary maintenance. It should be kept in mind that the illustrations in the instruction book are for illustrative purposes and may not always be an actual picture of the equipment being furnished. For final information always refer to the drawings that are furnished separately with the equipment. For additional instructions on the circuit breaker, refer to the breaker instruction book.

RECEIVING, HANDLING AND STORAGE

Each mechanism is carefully inspected and packed by workmen experienced in the proper handling and packing of electrical equipment. Immediately upon receipt of a mechanism, an examination should be made for any damage sustained during shipment. If injury or rough handling is evident, a damage claim should be filed with the transportation company, and the nearest Canadian General Electric Apparatus Sales Office should be promptly notified.

The crating or boxing must be removed carefully using a nail puller.

Check all parts against the packing list to make certain that no parts have been overlooked while unpacking. Always search the packing material for hardware that may have loosened in transit.

If the mechanism cannot be installed in the proper location immediately, and it is necessary to store the equipment, it should be kept in a clean, dry place protected from mechanical injury. Machined parts should be coated heavily with grease to prevent rusting. If stored for any length of time, periodic inspections should be made to see that corrosion has not taken place and to insure good mechanical condition. If possible, the space heater should be energized to prevent moisture condensation inside the mechanism housing.

Should the mechanism be stored under unfavorable atmospheric conditions, steps should be taken to dry out the mechanism before it is placed in service.

DESCRIPTION

The ML-14 spring-charged operator consists of motor-operated closing springs with the associated mechanism and control equipment. The unit is designed to operate large outdoor oil circuit breakers with provision for closing, opening, trip-free and reclosing operations.

The control house for this mechanism is a steel weatherproof house which contains a strip as a sealant around the doors. Inside this housing are located a

motor for charging the closing springs, closing springs operating mechanism, auxiliary switch and the control panel with its relaying, operating and control switches and BCT terminal boards.

Control voltages are given on the nameplate. The motor operating voltage is either AC or DC, but preferably AC.

Also provided on the equipment is a manual trip device. This consists of a mechanism for manually tripping the breaker and a lock-out switch for opening the closing circuit, to prevent the breaker from closing from a remote source when it is tripped by this mechanism locally.

WARNING

THERE IS A DEGREE OF HAZARD TO MANUAL CLOSING OF ANY POWER BREAKER INTO A LIVE SYSTEM. MANUAL CLOSING WITH THE BREAKER IN SERVICE MUST BE AVOIDED EXCEPT IN EXTREME EMERGENCY. OPERATE MANUALLY ONLY WHEN THE BREAKER HAS BEEN COMPLETELY DE-ENERGIZED AND ISOLATED.

INSTALLATION

During the installation of the mechanism, it is necessary to make reference to the instruction book for the oil circuit breaker that it operates.

The mechanism and housing are normally shipped fastened directly to the frame of the oil circuit breaker. The mechanism is installed and properly adjusted when received. The trip latches are fastened during shipment and this fastening should be removed after the breaker has been moved into position.

CONNECTIONS

After the mechanism has been mounted, electrical connections can be made. Before making these, precautions should be taken to see that all leads to be connected to the mechanism are de-energized.

Run control wires in conduit insofar as it is practicable. Control wires must be run separately and remote from high tension leads and not in the same duct or parallel to high tension leads unless the distance separating the two sets of wiring is sufficient to prevent possible communication between them as a result of short circuits.

Use control wiring of adequate size so that, with full operating current flowing to the operating mechanism, the voltage across the terminals of the mechanism will be within the limits specified as standard for the range of control voltage.

Use the proper connection diagram for each individual job for testing and making connections. The mechanism is wired completely at the factory to terminal boards mounted on the bottom of the control panel. Incoming conduits can be terminated in a removable plate in the housing floor directly under the terminal boards. This plate can be drilled to suit any conduit requirements. It is recommended that all conduits entering the mechanism housing be sealed off at their entrances to the housing.

ADJUSTMENTS

Although the mechanism has been adjusted and tested at the factory, it is advisable to check all the following points as well as those listed under FINAL INSPECTION to be sure that no change has occurred during shipment and installation. No adjustments should be altered unless this inspection indicates it is necessary.

Use manual operation for all preliminary inspection. After the mechanism is connected to the breaker, operate it slowly to see that the operation is smooth throughout the closing stroke, that no binding occurs, and that no excessive play is noticeable between parts. Electrical operation should be attempted only after it is certain that all mechanism adjustments are made correctly and that the oil circuit breaker is correctly adjusted according to its instructions.

The breaker and mechanism adjustments must be checked when the mechanism is being manually closed since the mechanism can only be operated slowly in the closing direction.

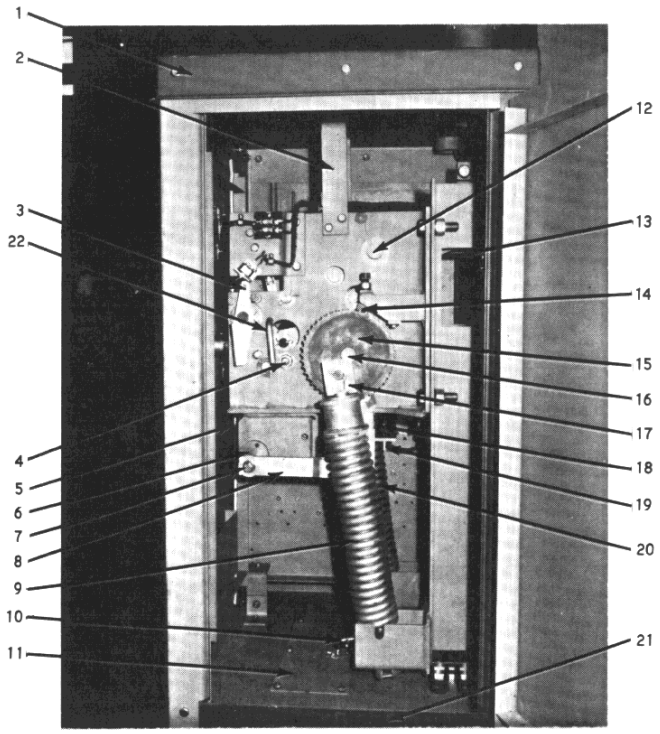
CAUTION

Under no circumstances should the breaker be tripped manually or electrically without oil in the tanks until the breaker instruction book has been referred to for the proper procedure of opening the breaker without oil in the tanks.

Manual operation of the mechanism should not be attempted until the bearing surfaces of the mechanism have been checked for lubrication. Refer to the section on lubrication for the proper oils and greases.

MANUAL OPENING

The breaker can be tripped manually by operating the manual trip lever (4, figure 1). This will give an opening operation very similar to that obtained when the breaker is tripped electrically. The breaker cannot be opened slowly.



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1. Mechanism House
2. House Support Bracket
3. Manual Trip Lever
4. Trip Latch Clearance Adjustment Eccentric
5. Manual Close Push Rod
6. Eccentric
7. Manual Charging Stud (5/8 inch hex)
8. Driving Link
9. Right Closing Spring
10. Right Closing Spring Blocking Device
11. Access Plate (Customer's Wiring)
12. Output Crank Main Shaft
13. Output Crank
14. Latching And Safety Pawls
15. Ratchet Wheel
16. Cam Shaft
17. Guide Block
18. Closing Coil (52CC)
19. Closing Coil Plunger
20. Left Closing Spring
21. Weatherstrip
22. Trip Latch Blocking Pin

Figure 1 Right Side View Of Mechanism

MANUAL CLOSING

To operate the mechanism manually, charge the breaker closing springs manually using a 5/8 inch ratchet wrench on the manual charging stud (see figure 2) to turn the driving eccentric (6). Turning the driving eccentric counter clockwise will advance the ratchet wheel (3) and compress the closing springs.

When the springs have reached the fully charged position the indicator will read "CHARGED", and the driving pawl (4, figure 2) will be raised from the ratchet wheel teeth. Additional turning of the eccentric will not advance the ratchet wheel. The latching and safety pawls (16, figure 1) work in conjunction with the driving pawl to prevent the ratchet wheel (3, figure 2) from turning backwards due to the force of the closing springs as the ratchet wrench is operated.

Insert the spring blocking device and manually discharge the springs against the pins by pushing the manual close button (1, figure 2). The springs are now blocked and slow closing of the breaker contacts can be accomplished by again turning the driving eccentric with a 5/8 ratchet wrench.

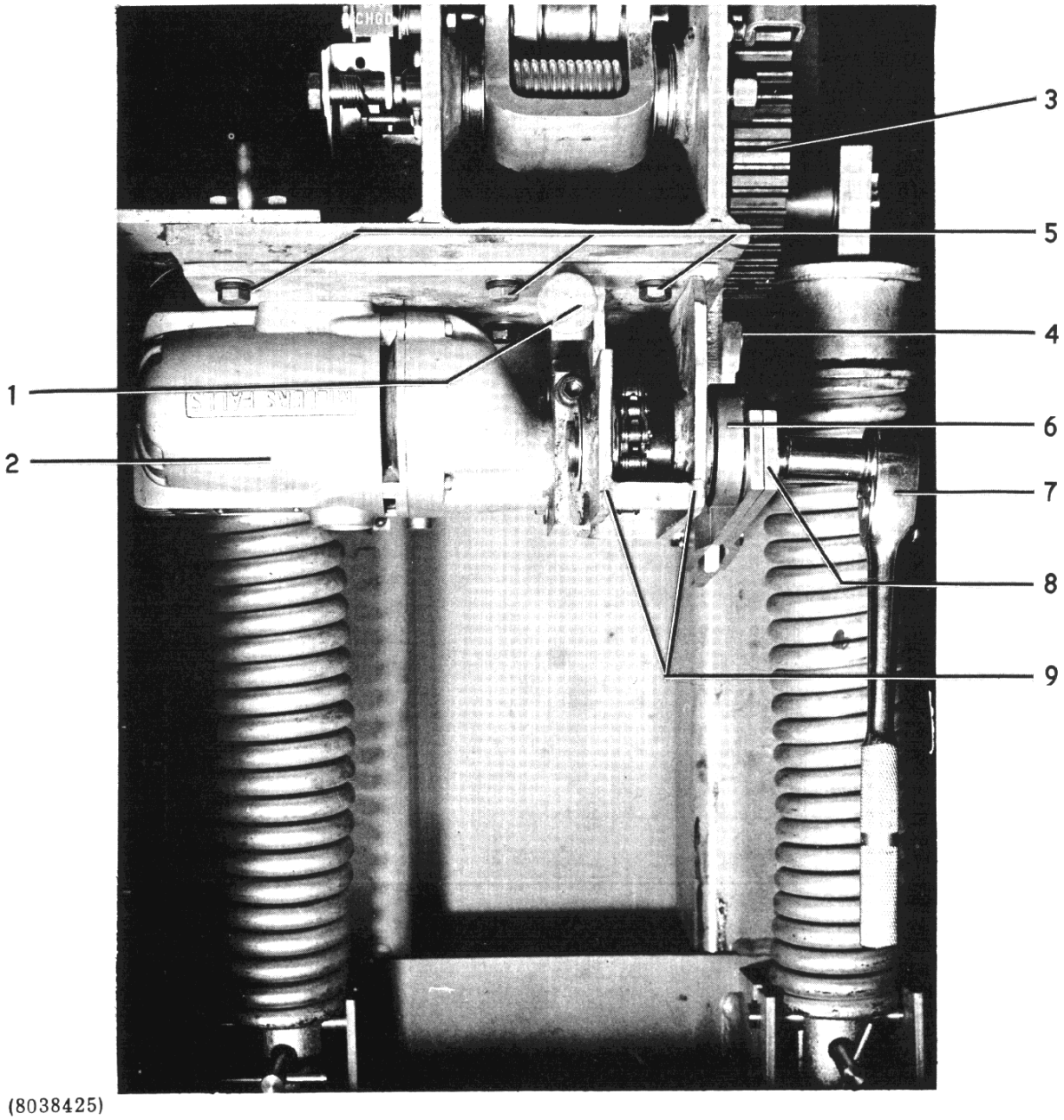
During the slow closing operation, check to insure that the mechanism does not stick or bind during the entire stroke, that it latches securely in the closed position, and that it trips freely when the manual trip lever (4, figure 1) is operated. The breaker should not be operated electrically until it has been operated several times manually to insure freedom of action. At this time, also check the breaker adjustments as given in the breaker instruction book.

WARNING

DO NOT WORK ON EITHER THE BREAKER OR MECHANISM UNLESS THE CLOSING SPRINGS AND TRIP-LATCH ARE BLOCKED. THIS PRECAUTION IS REQUIRED TO PREVENT ACCIDENTAL CLOSING OR TRIPPING.

After the adjustments have been checked, the springs can be unblocked. Rotate the driving eccentric until the indicator reads "CHARGED" and the ratchet wheel no longer is advanced. The closing spring blocking devices can now be removed. Do not operate the manual close button while the breaker is in the closed position as damage to the linkage, ratchet wheel and pawls might occur. This damage would be caused by the energy of the springs not being absorbed by the mechanism linkage and breaker in the spring hitting a stationary linkage instead of pushing a movable linkage.

Operate the circuit breaker electrically several times. Check the control voltage as described under CONTROL POWER CHECK.



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1. Manual Close Push Rod Button
2. Spring Charging Motor
3. Ratchet Wheel
4. Driving Pawl
5. Motor Mounting Bolts
6. Eccentric
7. Manual Spring-charging Ratchet Wrench - 5/8''
8. Driving Link
9. Motor Support and Bearing Housing

Figure 2 Driving Elements

CAUTION

If the breaker secondary wiring is to be given a hi-potential test at 1500 volts AC, remove both the motor leads from the terminal connection. Failure to disconnect the motor from the circuit may cause damage to the winding insulation.

TRIP LATCH WIPE

Refer to figure 3. The wipe (U) of the trip latch (23) on the trip latch roller (26) should be from 0.18 inch to 0.26 inch. This can be measured by putting a film of grease on the latch closing the breaker part way and tripping. The mechanism has the proper trip latch wipe when the latch rests against the stop pin (25). No adjustment is provided and a visual inspection is usually all that is required. If this setting is not correct, look for insufficient travel of the trip shaft.

WARNING

WHEN WORKING ON THE MECHANISM IN THE CLOSED POSITION, KEEP FINGERS CLEAR OF THE LINKAGE, AS ACCIDENTAL TRIPPING CAN CAUSE SEVERE INJURY.

Use the trip latch blocking pin tool which is inserted in the trip latch blocking pin hole (24, figure 1) until it extends beyond the opposite frame.

TRIP LATCH CLEARANCE

With the breaker in the tripped position and the closing springs charged, check the clearance (R, figure 3) between the trip latch (23, figure 3) and the trip latch roller (26). It should measure 0.03 inch to 0.06 inch.

To change the adjustment, (N, figure 4) loosen the locknut (26, figure 4) at the trip latch clearance adjustment eccentric and the set screw (25) with the breaker in the tripped position. Adjust the eccentric as necessary. Adjust the trip latch clearance by turning the eccentric in a clockwise direction while decreasing the clearance. This will lock the eccentric. Tighten the locknuts on the eccentric after adjusting the eccentric.

PROP CLEARANCE

With the breaker closed as far as possible, that is, with the springs blocked and the cam (12, figure 3) rotated so that the cam follower roller shaft (10) is at its maximum height over the prop (7), the clearance (V) between the prop and prop pin should be 0.06 inch to 0.16 inch. No adjustment is provided and a visual inspection is usually all that is required.

PROP WIPE

With the breaker closed and the linkage resting on the closing prop (7, figure 3) the prop wipe (K) should be 0.18 inch to 0.38 inch from the cam follower roller shaft (10) to the edge of the prop. No adjustment is provided and a visual inspection is usually all that is required.

CLOSING LATCH WIPE

The wipe (X, figure 5) between the closing latch (6, figure 5) and the closing latch roller (30) should be 0.18 inch to 0.26 inch. If resetting is required, loosen, set and retighten the adjustment screw (8) then tighten the locking nut (9).

CLOSING LATCH MONITORING SWITCH

The closing latch (6, figure 5) must be fully reset and the closing latch monitoring switch (14) operated before the motor (37) will start. The closing latch monitoring switch should be wiped by the operating lever (20, figure 6) so that the clearance (T, figure 3) between the operating lever and the switch mounting bracket is 0.03 inch or less. To obtain this adjustment, bend the monitoring switch operating lever as necessary. Be sure the latch is fully reset before making any adjustments.

MOTOR LIMIT SWITCHES

With the closing springs blocked, rotate the switch cam (4, figure 5) until the motor limit switch striker (26) has traveled the maximum amount (about 180 degrees rotation of the cam). Loosen the support bolt (29) and rotate the switch support until the gap (Z, figure 5) between the motor limit switch striker (26, figure 5) and the switch support is 0.03 inch or less.

AUXILIARY SWITCH - TYPE SB-1

The auxiliary switch (1, figure 6) is mounted on the left side of the operating mechanism frame (11). The linkage (2) attached to the pin (2, figure 3) of the output crank (4) operates the auxiliary switch shaft which opens and closes the 'a' and 'b' contacts. The 'a' contacts are open when the breaker is open and the 'b' contacts are open when the breaker is closed. The 'a' contacts need only to be checked to make certain they are open when the breaker is open. The 'b' contacts need only to be checked to see that they are open when the breaker is closed. No adjustment is provided and a visual inspection is usually all that is required.

DRIVING AND LATCHING PAWL ADJUSTMENT

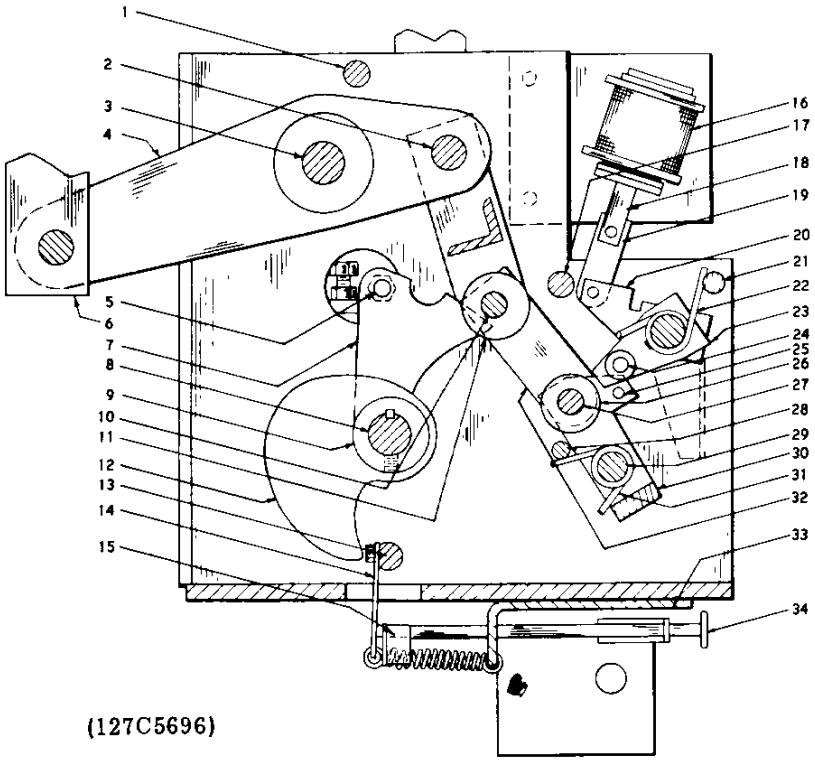
The driving pawl must advance the ratchet wheel sufficiently on each stroke to allow the latching pawl to fall into the ratchet teeth of the ratchet wheel. This should be checked with the major portion of the closing spring load against the driving members. With the mechanism unblocked, manually charge the closing springs with the manual charging wrench until they are slightly more than half charged.

NOTE

The position referred to above is (9) teeth counter clockwise from the 0.161 diameter hole in ratchet wheel. This is when the major load is on the mechanism.

Slowly rotate the charging wrench until the driving pawl has advanced the ratchet tooth to its maximum

1. Mechanism Frame Tie Rod
2. Output Crankshaft Pin
3. Output Crank Main Shaft
4. Output Crank
5. Spacer and Spring Pin
6. Rod Lower Coupling
7. Closing Prop
8. Cam Shaft
9. Cam Shaft Bearing
10. Cam Follower Roller Shaft
11. Cam Follower Roller
12. Cam
13. Closing Latch Shaft
14. Monitoring Switch Operating Lever
15. Monitoring Switch
16. Trip Coil
17. Stop Pin
18. Trip Coil Plunger
19. Trip Coil Linkage
20. Trip Crank
21. Mechanism Frame Tie Rod
22. Trip Latch Spring
23. Trip Latch
24. Trip Latch Guide Roller
25. Stop Pin
26. Trip Latch Roller
27. Trip Latch Roller Shaft
28. Clearance Adjustment Eccentric Shaft
29. Link Shaft
30. Support Link
31. Support Link Spring
32. Link
33. Motor Support Bracket
34. Manual Close Push Rod Button



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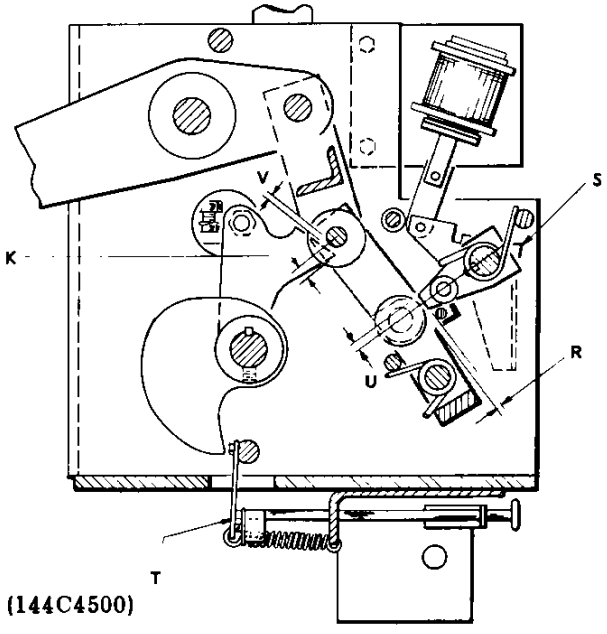
Linkage In Latch Closed Position



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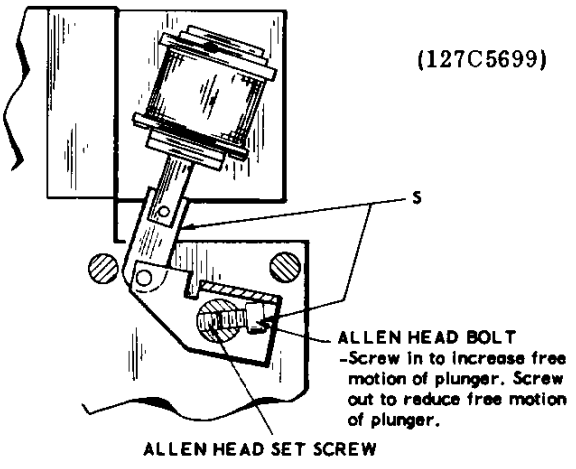
Adjustments And Final Clearance Checks



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Section Showing Adjustment Of Trip Coil Plunger (S)

Figure 3 Left Side Section Of Mechanism (Section A-A)

travel as shown in figure 4(b) of this instruction. Now check the latching clearance between the ratchet tooth and the outboard latching pawl 'P' dimension should equal approx. 0.06". Adjust motor support bracket if necessary to obtain 'P' dimension, then tighten jacking screw and lock in position with locking nut as shown on drawing 161B4560.

To check the 'Q' dimension shown in figure 4(c) of this instruction, slowly rotate the charging wrench counter clockwise thus allowing the outboard latching pawl to rest on the ratchet tooth and the driving pawl to travel to its maximum clockwise position. 'Q' dimension should equal approx. 0.02".

CAUTION

If adjustment is required for either pawl, the closing springs must first be fully charged and blocked before loosening the motor support bracket mounting bolts. When the adjustment is made, the right-hand side motor support bracket mounting bolts are to be tightened first, to assure proper alignment. After tightening the remaining bolts and the jacking screw, the springs should be released and the clearances checked again as described above.

LATCHING PAWL TO RATCHET WHEEL CLEARANCE

The latching pawl (23, figure 4) (which is the outboard pawl at this location) must have a 0.015 to 0.030 inch clearance above the teeth of the ratchet wheel (29) when the closing springs are completely charged (H, figure 4). This is checked with the closing springs completely closed and blocked by measuring the distance between the outboard latching pawl and the ratchet tooth with the pawl raised as high as possible. This is adjusted by loosening the locknut (22, figure 4) and adjusting the latching and safety pawls' adjustment screw (21) as necessary. The safety pawl, (inboard of the latching pawl) will then have up to a 0.060 inch clearance.

This can also be checked by measuring the distance between the bottom of the latching and safety adjustment screw and the top surface of the latching pawl when the closing springs are completely charged.

TRIP LATCH CHECKING SWITCH

Rotate the trip latch (23, figure 3) clockwise (looking at the left side of the mechnism) by pressing the manual trip lever (42, figure 6) to open the latch checking switch operating lever (23, figure 5). Allow the trip latch to reset slowly and determine the point at which the contacts of the trip latch checking switch (22) make by using a circut continuity tester, such as a light indicator or bell set. The contacts of the trip latch checking switch should just make (see W and Y, figure 5) when there is a 0.06 inch gap between the trip latch (23, figure 3) and the stop pin (25) located on the trip latch assembly support link (30). There should be a minimum of 0.015 inch between the operating lever and the trip latch checking switch (22, figure 5). Bend the trip latch checking switch operating lever as necessary to adjust.

TRIP COIL PLUNGER

Refer to S, figure 3. The plunger (18, figure 3) of the trip coil (16) must have 0.12 inch free travel before the trip latch (23) starts to move to provide proper tripping at reduced voltages. This is adjusted by loosening the Allen set screw which is located in the trip latch shaft (24). This set screw bears against the Allen head bolt (40, figure 6) securing the bolt in place and is inserted into the trip latch shaft from the front of the trip latch shaft. The Allen head bolt must be removed from the trip latch shaft before the Allen set screw can be moved. Rotate the trip crank about the trip latch shaft until the correct free travel of the trip coil plunger is obtained. Adjust the Allen head bolt to contact the trip crank at this point. Install the Allen screw from the front side of the trip latch shaft then tighten the Allen head adjusting bolt. This free travel must be sufficient so that the breaker is able to trip at its minimum trip voltage. The values are in a chart under FINAL INSPECTION.

CLOSING COIL PLUNGER

The closing coil plunger (13, figure 5) of the closing coil (11) must have a minimum of 0.12 inch free travel (see F, figure 5) before the tang of the closing latch is contacted. If this free travel is less than 0.12 inch, remove the coil and file the plunger until it has 0.12 inch free travel.

MANUAL TRIP LEVER

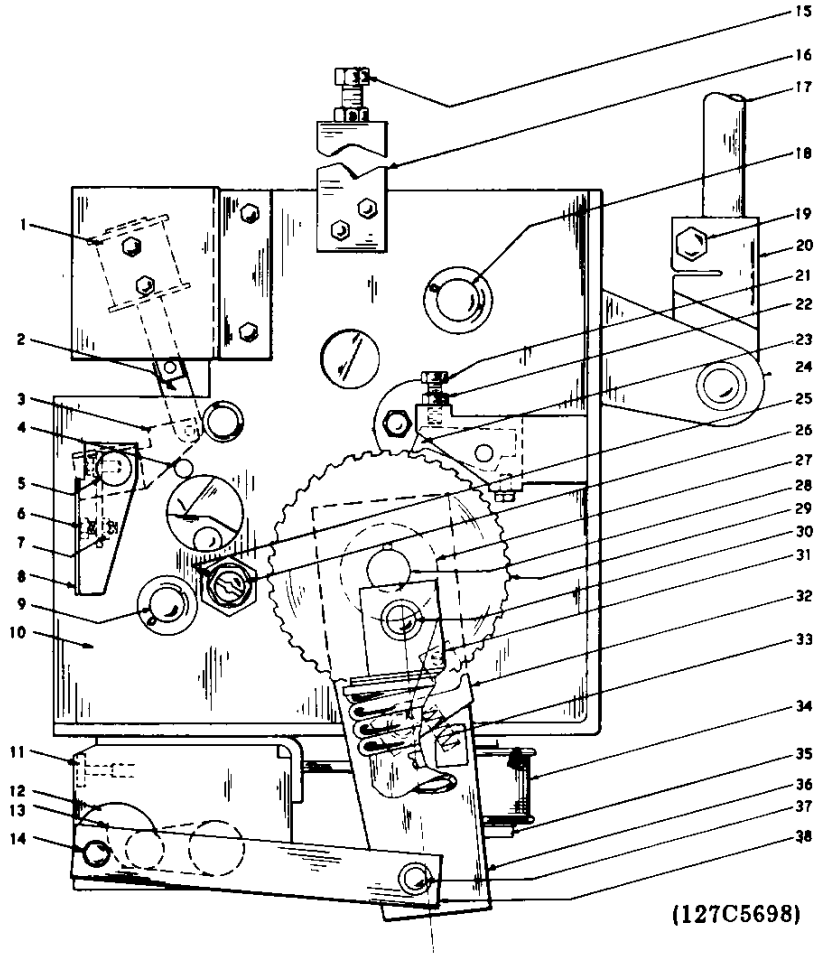
The manual trip lever (8, figure 4) is adjusted to hang vertically, or forward of vertical so that the trip latch is pushed clear of the trip roller, by adjusting the manual trip adjusting bolt (6, figure 4) as required.

FINAL INSPECTION

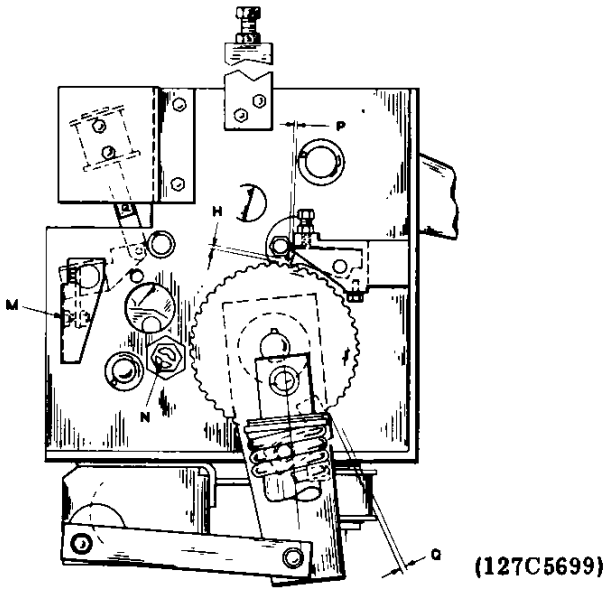
After the mechanism has been installed with all mechanical and electrical connections completed, make the following inspection and test:

1. See that the mechanism is properly set up and securely fastened to the breaker framework.
2. Review the adjustments shown in table 1.
3. Check that all bolts, nuts and screws are properly tightened and that all washers and cotter pins are in place with cotter pin ends effectively bent over.
4. Inspect all wiring for damage during installation work, check terminal connections for loose screws, and test for possible grounds or short circuits.

1. Trip Coil
2. Trip Coil Linkage
3. Trip Crank
4. Trip Latch Blocking Pin Hole
5. Trip Latch Shaft
6. Manual Trip Adjusting Bolt
7. Manual Trip Lock Nut
8. Manual Trip Lever
9. Link Shaft
10. Mechanical Frame
11. Manual Close Push Rod Button
12. Driving Eccentric
13. Spring Charging Motor
14. Driving Eccentric Bearing
15. Mechanism House Adjusting Bolt
16. Mechanism House Support Bracket
17. Breaker Operating Rod
18. Output Crank Main Shaft
19. Rod Locking Bolt
20. Rod Lower Coupling
21. Latching Pawls Adjusting Screw
22. Latching Pawls Adjusting Locknut
23. Latching Pawl
24. Output Crank
25. Set Screw
26. Trip Latch Clearance Locknut
27. Driving Crank Bushing
28. Cam Shaft
29. Ratchet Wheel
30. Sprocket
31. Guide Block
32. Driving Pawl
33. Driving Pawl Return Spring
34. Closing Coil
35. Closing Coil Support Bracket
36. Driving Crank
37. Driving Link Bushing
38. Driving Link

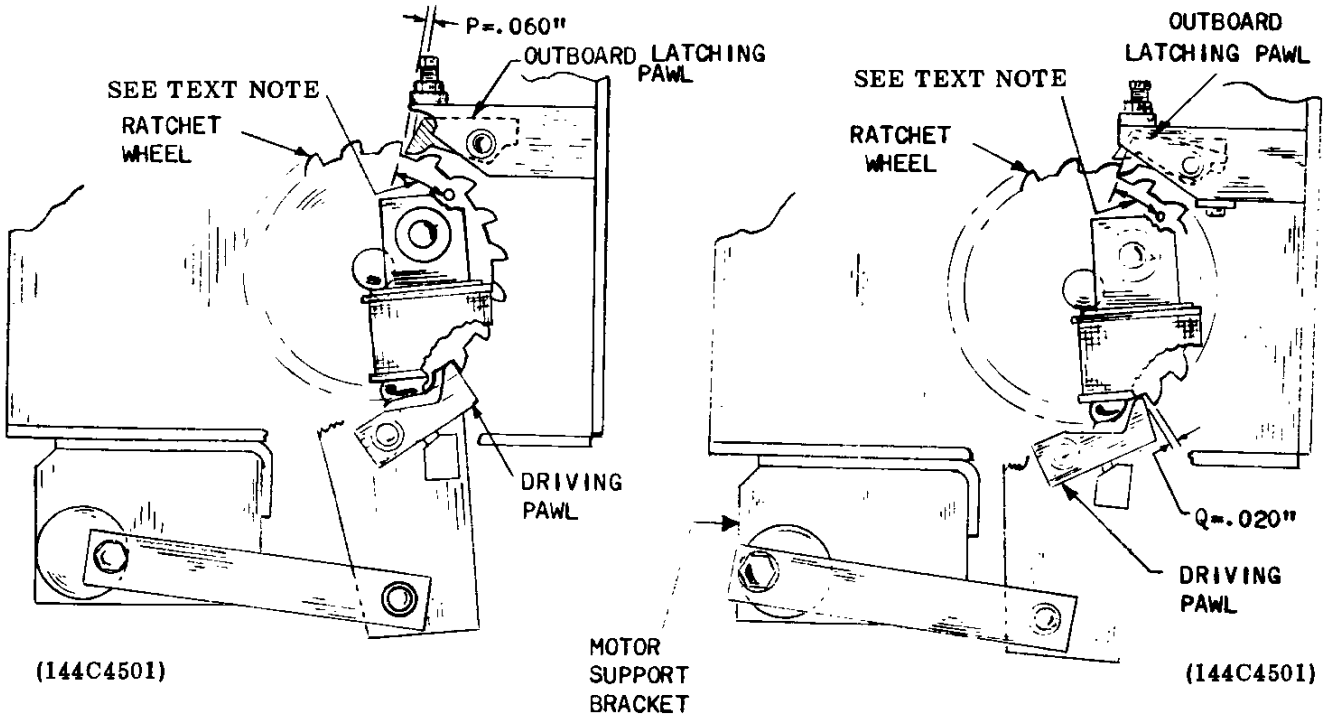


Right Side View Of Mechanism In Latch Closed Position



(a) Adjustments And Final Clearance Checks

Figure 4 Right Side View Of Mechanism



(b) Latching Pawl Adjustment

(c) Driving Pawl Adjustment

Figure 4(Cont'd) Right Side View Of Mechanism

1.	Trip latch wipe (with trip latch resting against stop pin)	(U, Fig. 3)	0.18 inch to 0.26 inch
2.	Trip latch clearance	(R, Fig. 3)	0.03 inch to 0.06 inch
3.	Trip latch nominal clearance	(R, Fig. 3)	0.045 inch
4.	Closing prop clearance	(V, Fig. 3)	0.06 inch to 0.16 inch
5.	Closing prop wipe	(K, Fig. 3)	0.18 inch to 0.38 inch
6.	Closing latch wipe	(X, Fig. 5)	0.18 inch to 0.26 inch
7.	Closing latch monitoring switch LC(C) maximum clearance	(T, Fig. 3)	0.03 inch
8.	Motor limit switches (44 and SCO) maximum clearance	(Z, Fig. 5)	0.03 inch
9.	Driving pawl minimum driving clearance	(Q, Fig. 4)	0.020 inch
10.	Latching pawl minimum latching clearance	(P, Fig. 4)	0.060 inch
11.	Latching pawl-ratchet wheel clearance	(H, Fig. 4)	0.015 inch to 0.030 inch
	The driving pawl and latching pawl clearance should be approximately equal.		
12.	Trip latch checking switch ("1c") minimum clearance	(Y, Fig. 5)	0.015 inch
13.	Trip latch checking switch ("1c") contacts just make when the gap between the trip latch and the stop pin is	(25, Fig. 3)	0.06 inch
14.	Trip coil plunger free travel minimum	(S, Fig. 3)	0.12 inch
15.	Closing coil plunger free travel minimum	(F, Fig. 5)	0.12 inch
16.	Space heater		functioning

Table 1 Summary of Adjustments

5. See that all bearing surfaces and the cylinder are properly lubricated. (Refer to OPERATION AND MAINTENANCE.)

6. Operate the breaker slowly with the manual charging wrench and note that there is no excessive binding or friction and that the breaker can be moved to the fully opened and fully closed positions.

7. Operate the mechanism electrically and check the following points:

   a) Closing, opening, reclosing and trip-free times.

   b) Minimum trip and closing voltage.

8. See that all points where the surface of the paint has been damaged during installation are repainted immediately.

9. Make a final check that the breaker is securely fastened to its foundation and properly leveled.

10. Check that the ground connections are properly made and tightened.

11. Make certain that all pipe plugs and bolted connections are properly tightened and that all covers and gaskets are properly installed to prevent entrance of moisture.

CONTROL POWER CHECK

After the mechanism has been closed slowly and opened several times with the maintenance closing wrench and the mechanism adjustments are checked as described, the closed circuit operating voltages should be checked at the release coil, trip coil, and motor terminals. For electrical operation of the mechanism, the control power may be either an alternating or direct current source. The operating ranges for the closing and tripping voltages are given on the breaker nameplate. The following ranges are standard:

Nominal Voltage	Closing Range		Tripping Range	
	Minimum	Maximum	Minimum	Maximum
48V DC	36 -	52V DC	28 -	60V DC
125V DC	90 -	130V DC	70 -	140V DC
250V DC	180 -	260V DC	140 -	280V DC
115V AC	95 -	125V AC	95 -	125V AC
230V AC	190 -	250V AC	190 -	250V AC

If the closed circuit voltage at the terminals of the coil or motor does not fall in the specified range, check the voltage at the source of power and line drop between the power source and breaker.

When two or more breakers operating from the same control power source are required to close simultaneously, the closed circuit voltage at the closing coil or motor of each breaker must fall within the specified limits.

Electrical closing or opening is accomplished by energizing the closing or trip coil circuit. It is also possible to trip or close the breaker manually by pressing the manual trip lever or the manual close button.

OPERATION

The ML-14 operating mechanism is of the stored-energy type designed to give high speed closing and opening. The mechanism will operate on AC or DC voltage. The operating voltage is indicated on the breaker nameplate. Closing and opening operations are controlled electrically by the remote relaying, and mechanically by the manual close and trip levers located behind the front door of the mechanism house.

SPRING CHARGING

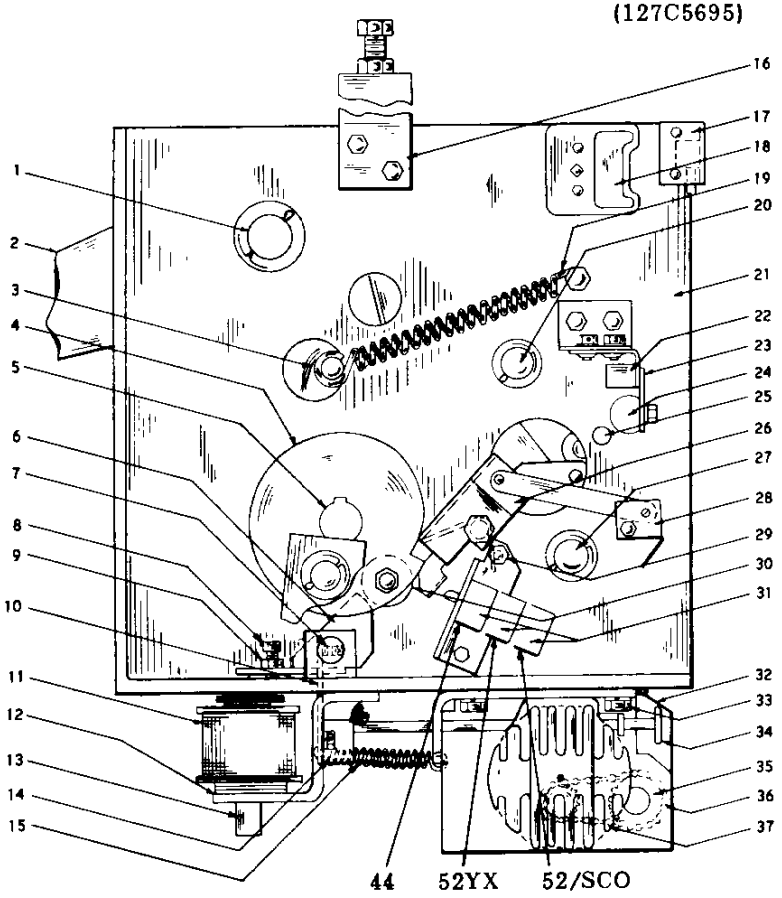
The mechanism consists of a high speed gear motor (21, figure 6) that compresses a set of closing springs (22 and 57) through the action of a simple eccentric (51), a ratchet wheel (43), and pawl (49), assembly. The rotary action of the motor is converted to a short straight stroke pumping action through the eccentric and a driving link (54) that carries a spring-loaded driving pawl.

The driving pawl advances the ratchet wheel (29, figure 4) only a few degrees each stroke where it is held in position by the latching and safety pawls. When the ratchet wheel has been rotated approximately 180 degrees, the closing springs will be fully compressed. As the ratchet wheel continues to rotate, the spring load will shift overcenter and attempt to discharge, but will be prevented from discharging by the closing latch (6, figure 5). After only a few degrees of rotation, the closing latch roller (30) will engage the closing latch and the compressed springs will be held in repose until a closing operation is required. During the last few degrees of the ratchet wheel rotation, the motor limit switches are released and the driving pawl is raised from the ratchet wheel surface. This allows the motor and driving mechanism to coast to a natural stop expending all residual energy.

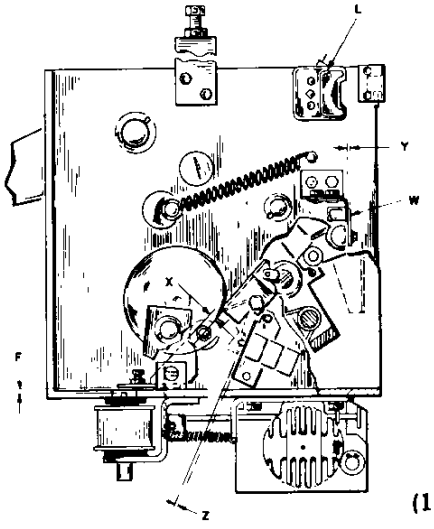
During the time the springs are being compressed, the cutoff and anti-pump relay 52Y locks the closing power circuits open. The 52Y relay will remain energized until the springs are fully charged and the control and motor limit switch contacts are reset.

1. Output Crank Main Shaft
2. Output Crank
3. Prop
4. Limit Switch Cam
5. Cam Shaft
6. Closing Latch
7. Closing Latch Shaft
8. Closing Latch Wipe Adjusting Screw
9. Closing Latch Wipe Adjusting Screw Locknut
10. Closing Latch Monitoring Switch Operating Lever
11. Closing Coil
12. Closing Coil Support Bracket
13. Closing Coil Plunger
14. Closing Latch Monitoring Switch 52/LC(C)
15. Closing Latch Spring
16. Mechanism House Support Bracket
17. Operation Counter
18. Auxiliary Switch
19. Prop Reset Spring
20. Stop Pin
21. Mechanism Frame
22. Trip Latch Checking Switch 52/LC(T)
23. Trip Latch Checking Switch Operating Lever
24. Trip Latch Shaft
25. Trip Latch Blocking Pin Hole
26. Motor Limit Switch Striker
27. Link Shaft
28. Charged-discharged Indicator
29. Motor Limit Switch Support Bolts
30. Closing Latch Roller
31. Motor Limit Switches
32. Motor Support Bracket
33. Motor Support Bracket Bolts
34. Manual Close Push Rod Button
35. Sprocket
36. Driving Chain
37. Spring-charging Motor

(127C5695)



Left Side View Of Mechanism In Latch Closed Position



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Adjustments And Final Clearance Checks

Figure 5 Left Side View Of Mechanism

The closing springs may be charged manually if control voltage is lost. A standard 5/8 inch ratchet wrench should be used to rotate the eccentric in a counterclockwise direction until the indicator reads "CHARGED" and the driving pawl no longer engages the ratchet wheel. The use of the ratchet wrench provides for maximum safety in the event that control power is suddenly restored without warning. In this event, the motor drive will take over again and continue to charge the springs while the ratchet wrench harmlessly turns in the unloaded direction. Opening the circuit will prevent the power from being applied when it is not required.

CLOSING OPERATION

Closing the breaker is accomplished by energizing the closing coil or by manually pressing the close button. In either case, the closing latch is rotated away from the closing latch roller, permitting the springs to discharge. The energy of the springs is applied to the rotation of a cam which closes the breaker through a simple linkage that remains trip free at all times. A monitoring switch operated by the closing latch will start the spring-charging motor after it is fully reset.

When the breaker is closed without power to the spring-charging motor, the cam (12, figure 3) is in the position of the dotted cam shown in figure 7. This is due to the motor not forcing the cam into the undotted cam position shown in figure 7 since the motor did not start charging the springs immediately upon closing the breaker as it does during a normal closing operation when the motor is energized.

OPENING OPERATION

An electrical opening operation is initiated by energizing the trip coil. This is accomplished either by actuating a remote trip circuit or by a combination of relays and current devices used to detect a fault on the load side of the breaker. When energizing the trip coil, the trip plunger rotates the trip latch causing the operating mechanism linkage to collapse. The energy stored in the breaker opening springs is thus released, opening the breaker. During this operation, the trip coil circuit is de-energized, and upon completion of the opening operation, the operating mechanism is returned to its normal position, ready for closing.

Manual tripping follows the same procedure except that instead of energizing the trip circuit, the manual trip lever is used. The mechanism cannot be operated slowly while opening.

When the breaker is opened after being closed without charging the closing springs, the cam is in the position of the dotted cam shown in figure 9. This is due to the motor not forcing the cam into the undotted position shown in figure 9 since the motor did not start charging the closing springs immediately upon closing the breaker as it does during a normal closing operation when the motor is energized.

TRIP-FREE OPERATION

If the trip coil circuit is energized while the breaker is closing, the trip coil plunger will force the trip latch away from the trip roller causing the mechanism linkage to collapse and the breaker to reopen. The closing cam will complete its closing stroke and the springs will recharge as in a normal closing operation. The position of the mechanism linkage during its operation is shown in figures 7, 8 and 9.

MAINTENANCE

PERIODIC INSPECTION

The operating mechanism of an oil circuit breaker must have regular systematic inspection during which every part is looked over carefully. The frequency of inspections should be determined by each operating company on the basis of the service to which the operating mechanism is subjected. Operating experience will soon establish a maintenance schedule that will give assurance of proper mechanism condition. An annual inspection and maintenance program is desirable in addition to a visual inspection at more frequent intervals. These inspections should be coordinated with an inspection of the breaker parts for maximum convenience.

PRECAUTIONS

Be sure that all primary and secondary circuits have been opened and grounded before any inspection or maintenance is attempted.

After any adjustment is made in the mechanism, operate manually to check the adjustment before operating electrically.

Use the connection diagram accompanying the operating mechanism in all cases when testing and connecting the mechanism.

When making adjustments in the mechanism or breaker, make certain that the closing springs are blocked as described under NORMAL CLOSING.

WARNING

DO NOT WORK ON THE BREAKER OR MECHANISM WHILE IN THE CLOSED POSITION UNLESS THE PROP AND TRIP LATCH HAVE BEEN SECURELY WIRED OR BLOCKED TO PREVENT ACCIDENTAL TRIPPING. DO NOT WORK ON THE BREAKER OR MECHANISM WHILE THE SPRINGS ARE CHARGED UNLESS THEY ARE SECURED IN THAT POSITION BY THE MAINTENANCE SPRING BLOCKING DEVICE.

1. Auxiliary Switch
2. Switch Operating Linkage
3. Prop Reset Spring
4. Trip Latch Checking Switch Support
5. Switch Operating Lever
6. Trip Latch Roller Shaft Bearing
7. Trip Latch Spring
8. Trip Latch
9. Trip Latch Stop Pin
10. Charged-Discharged Indicator
11. Mechanism Frame
12. Motor Limit Switches
13. Left Guide Block Bearing
14. Limit Switch Cam
15. Guide Block
16. Closing Latch Bearing
17. Closing Latch Shaft
18. Closing Latch
19. Motor Support Bracket Bolts
20. Monitoring Switch Operating Lever
21. Spring-Charging Motor
22. Left Closing Spring
23. Closing Spring Support
24. Spring Blocking Device
25. Mechanism House Adjusting Bolt
26. Mechanism House Support Bracket
27. Breaker Operating Rod
28. Operating Counter
29. Trip Coil Support
30. Trip Coil Shims
31. Trip Coil
32. Output Crank
33. Link
34. Trip Coil Plunger
35. Trip Coil Linkage
36. Latching Pawls Adjustment Screw
37. Latching Pawl
38. Trip Latch Shaft
39. Trip Crank
40. Trip Coil Linkage Adjustment
41. Trip Latch Roller
42. Manual Trip Lever
43. Ratchet Wheel
44. Right Guide Block Bearing
45. Driving Crank
46. Guide Block
47. Support Link Spring
48. Manual Close Push Rod Button
49. Driving Pawl
50. Sprocket Shaft Bushing
51. Driving Eccentric
52. Driving Chain
53. Manual Charging Stud
54. Driving Link
55. Sprocket
56. Motor Support Bracket
57. Right Closing Spring

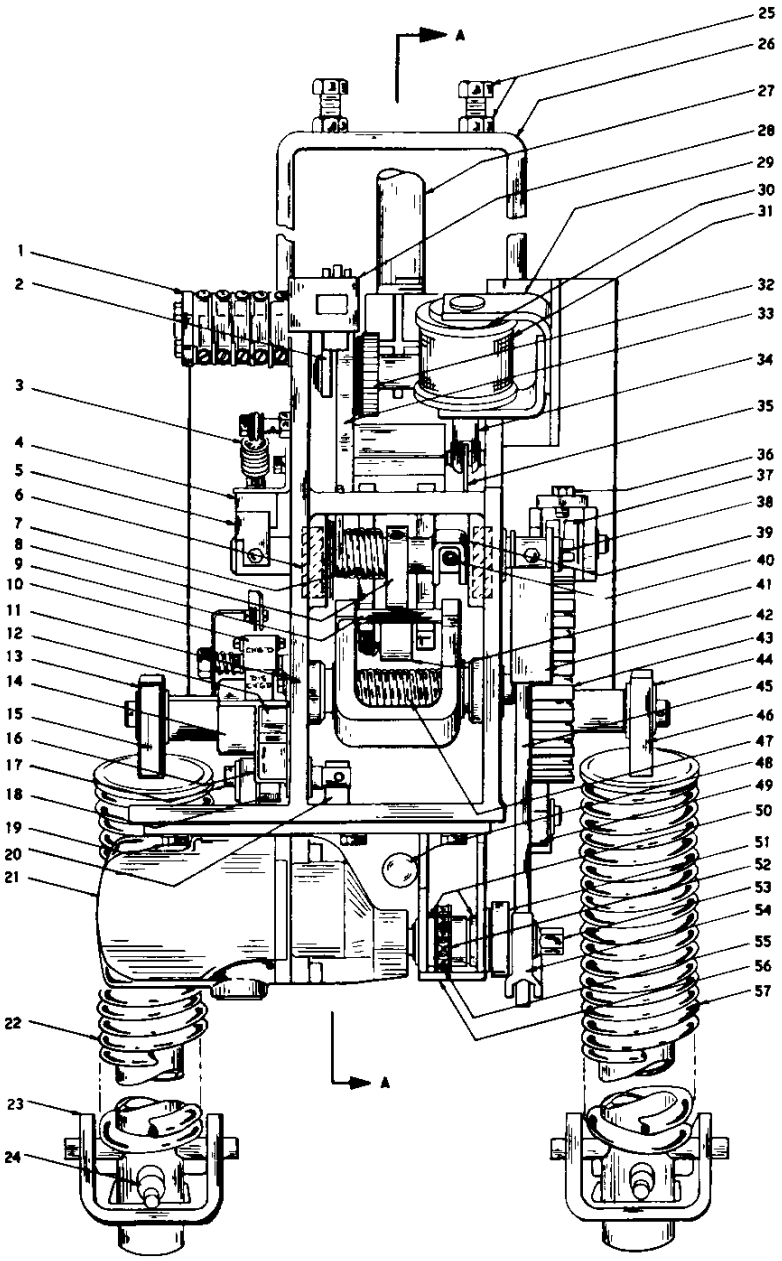

Figure 6 Front View Of Mechanism In Latch Closed Position

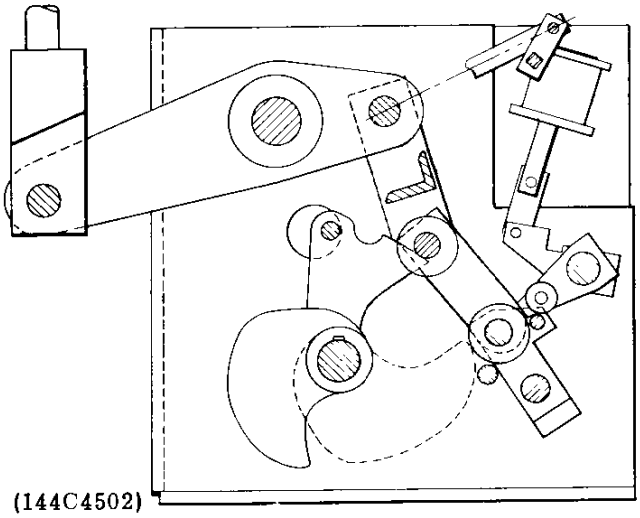

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Figure 7 Position of Linkage - Mechanism Closed

Solid Cam indicates closing spring charged.
Dotted Cam indicates closing spring discharged.

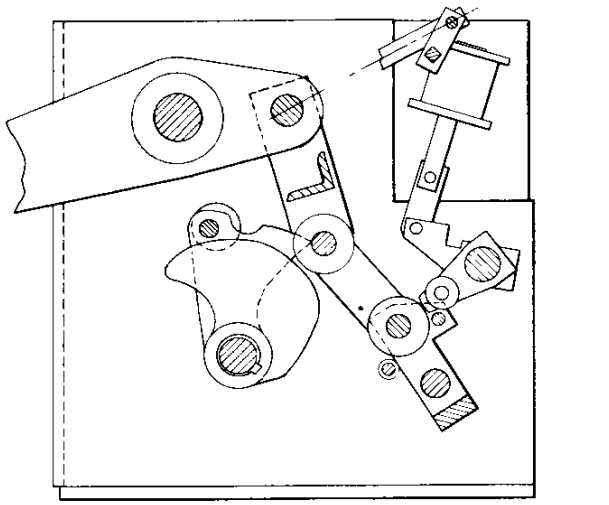

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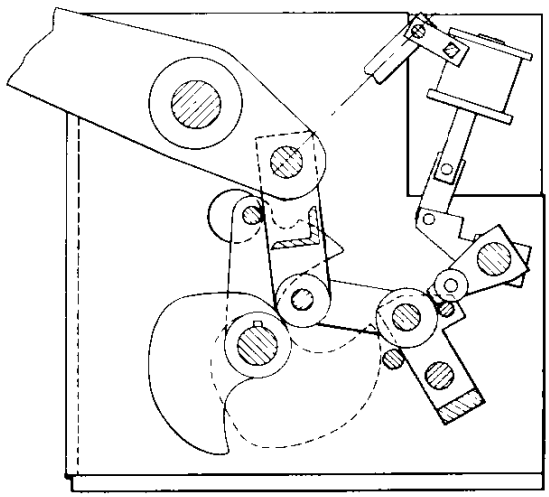
Figure 8 Position of Linkage - Mechanism Going Closed



(144C4504)

Figure 9 Position of Linkage - Mechanism Open

Solid Cam indicates closing spring charged.
Dotted Cam indicates closing spring discharged.

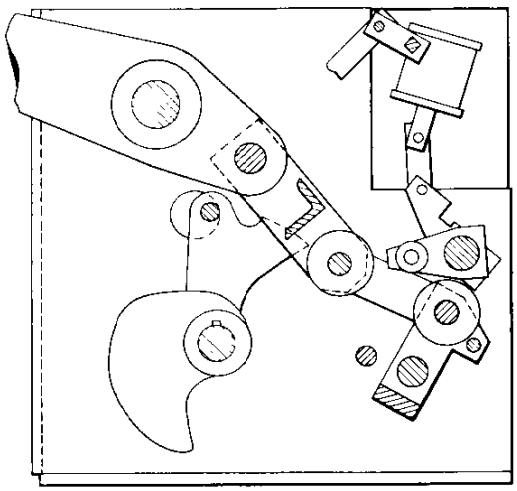


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Figure 10 Position of Linkage - Mechanism Going Open

A careful inspection should be made to check for loose nuts or bolts and broken retaining rings. All cam, roller, and latch surfaces should be inspected for any evidence of damage or excessive wear. Lubricate the mechanism as outlined under LUBRICATION, then, using the manual charging wrench, open and close the breaker several times to make certain that the mechanism operates freely throughout its entire stroke. Check the mechanism adjustments as specified under ADJUSTMENTS. Check all terminal connections.

INSULATION TEST

If the breaker secondary wiring is to be given a hipotential test at 1500 volts AC, remove both the motor leads from the terminal boards.

CAUTION

Failure to disconnect the motor from the circuit may cause damage to the winding insulation.

LUBRICATION

In order to maintain reliable operation, it is important that all mechanisms be properly lubricated at all times.

Even the finest oils and greases have a tendency to oxidize with age, as evidenced by hardening and darkening in color. Elimination of the hardened lubricant is essential for the proper operation of circuit breakers. Also, frequent operation of the mechanism causes the lubricant to be forced out from between the bearing surfaces. A simple lubrication will often clear up minor disturbances which might be mistaken for more serious trouble.

A definite lubrication schedule should be set up taking into consideration the frequency of operation of the mechanism and local conditions. Until such a schedule is worked out, the mechanism should be lubricated at each periodic inspection and also whenever it is overhauled, in accordance with the lubrication chart. It is also recommended that all circuit breakers and their associated operating mechanisms be operated at regular intervals to insure the user that the equipment is operating freely.

The lubrication chart is divided into two methods of lubrication. The first method outlines the maintenance lubrication which should be performed at the time of periodic maintenance, and requires no disassembly. The second method outlines a lubrication procedure similar to that performed on the breaker at the factory, but should be used only in case of a general overhaul or disassembly for other reasons, or if the operation of the breaker becomes slower.

CLEANING BEARINGS

ROLLER AND NEEDLE BEARINGS

The cam follower bearings (11, figure 3), trip latch roller bearing (26), and the cam shaft bearings (9), should first be removed from the mechanism and the inner race disassembled. They should then be placed in a container of clean petroleum solvent or similar cleaner.

PART	LUBRICATION AT MAINTENANCE PERIOD	ALTERNATE LUBRICATION (REQUIRES DISASSEMBLY)
Sleeve Bearings - Textolite Bearings - driving pawl - closing prop, etc.	Light application of machine oil SAE 20 or SAE 30.	Film of grease. *
Sleeve Bearings - Bronze Bearings - latching pawls - driving eccentric, driving crank, driving link.	Light application of machine oil SAE 20 or SAE 30.	Remove bearings or links, clean per instructions and lubricate liberally. *
Roller and Needle Bearings - Guide block, cam shaft, closing latch shaft.	Light application of machine oil SAE 20 or SAE 30.	Clean per instructions and repack with lubricant. *
Ground surfaces such as cams, ratchet teeth, etc. (Surfaces coated with M_oS_2).	No lubrication required	No lubrication required.
Ground surfaces such as latches, rollers, prop, etc.	Wipe clean and apply lubricant *	Wipe clean and apply lubricant. *
Sealed Bearings - trip latch roller shaft.	Cannot be lubricated	Replace when they become sluggish.
Motor Gear Box	Not normally required. Lubricate when motor becomes sluggish	Clean and apply Texaco 'All Temp' or a similar lubricant.

* Beacon 325 grease or equivalent.

Table 2 Lubrication Chart

WARNING

DO NOT USE CARBON TETRACHLORIDE.

If the grease in the bearings has become badly oxidized, it may be necessary to use alcohol (the type used for thinning shellac) to remove it. Ordinarily, by agitating the bearings in the cleaning solution, and using a stiff brush to remove the solid particles, the bearings can be satisfactorily cleaned. Do not handle the bearings with bare hands as deposits from the skin onto the bearings are inductive to corrosion. If the bearings are touched, the contamination can be removed by washing in alcohol. After the bearings have been thoroughly cleaned, spin them in clean new light machine oil until the cleaner or solvent is entirely removed. Allow this oil to drain off and then repack the bearings immediately with lubricant, being sure all metal parts are greased. Any removable seals should then be replaced.

CAUTION

If it becomes necessary to clean the bearings in alcohol (shellac thinner), be sure the alcohol is perfectly clean, and do not allow the bearings to remain in the alcohol more than a few hours. If it is desirable to leave the bearings in the alcohol for a longer time, an inhibited alcohol such as is used for anti-freeze should be used. Even then the bearings should be removed from the alcohol within twenty-four hours. Esso Anti-Freeze and Du Pont Zerone are satisfactory for this purpose. Precautions against the toxic effects of the alcohol must be exercised by wearing rubber gloves and by using the alcohol in a well ventilated room; excessive exposure to the fumes can be unpleasant to personnel. Washing the bearings in the light oil and draining should follow immediately, then apply the lubricant.

Bearings that are pressed into the frame or other members, such as the eccentric drive bearings contained in the motor support, should not be removed. After removing the shaft and inner race, the bearing can usually be cleaned satisfactorily with petroleum solvent or a similar cleaner and a stiff brush. Follow the procedure outlined above using a light machine oil and lubricant before reassembling the inner race and shaft.

ROLLING SURFACES

A number of rolling and rubbing surfaces in the mechanism have been lubricated with a baked-on, dry, molybdenum disulfide coating. This requires no maintenance and should last the life of the breaker.

TROUBLESHOOTING

Failure of a mechanism to operate properly will generally fall within three general classes; failure to trip, failure to close or latch closed, and failure of closing springs to recharge. The Troubleshooting Table shows particular types of problems that might be encountered, together with suggestions for remedying the trouble.

REPAIR AND REPLACEMENT

The following information covers in detail the proper method of removing various parts of the mechanism in order to make any necessary repairs. This section includes only those repairs that can be made at the installation on parts of the mechanism that are most subject to damage or wear.

CAUTION

Upon completion of any repair work, all mechanism adjustments must be checked. Refer to the section on INSTALLATION, paying particular attention to ADJUSTMENTS and FINAL INSPECTION.

MOTOR LIMIT SWITCHES

1. Remove the two mounting bolts (29, figure 5) from the switch support.
2. Remove the two mounting screws of the switches.
3. Disconnect the lead wires of the switch which is to be replaced.
4. Reassemble in the reverse order and check the switch adjustment as explained under ADJUSTMENTS.

TRIP LATCH CHECKING SWITCH

To remove the trip latch checking switch (22, figure 5) remove the two mounting screws and disconnect the lead wires. Reassemble in the reverse order and check the switch adjustments as explained under ADJUSTMENTS.

TRIP SHAFT AND LATCH

1. Remove the trip latch checking switch operating lever (5, figure 6).
2. Remove the cotter pins on both ends of the shaft.
3. Remove the set screw which is in the latch shaft.
4. Remove the trip crank adjustment bolt (40).
5. Place a block between the latch and the frame (either side) and drive the shaft until the latch is free of the key.
6. Remove the key and all burrs that may be raised around the keyway on the shaft.

7. Reassemble the parts in the reverse order. Be sure the trip latch spring (7, figure 6) is properly installed and the trip latch (8) is aligned in the center of the trip latch roller (41). Check the trip latch adjustment as described under ADJUSTMENTS.

TRIP LATCH ROLLER BEARING

1. Remove the two cotter pins at the ends of the shaft (27, figure 3).
2. Partially remove the shaft out the right side of the frame until the trip latch roller (26) is free.
3. Reassemble in the reverse order with the proper spacing of washers. Be sure the trip latch roller rotates freely.

TRIP COIL (TC)

To replace the potential trip coil (31, figure 6), proceed as follows:

1. With the breaker in the open position, remove the two mounting bolts which support the coil support bracket (29).
2. Remove the upper portion of the support bracket and remove the shims (30).

FAULT	CAUSE	REMEDY
Failure to trip.	Mechanism binding or sticking caused by lack of lubrication.	Lubricate complete mechanism.
	Mechanism binding or sticking caused by being out of adjustment.	Check all mechanism adjustments, latches, stops, auxiliary devices, etc., in accordance with section on ADJUSTMENTS. Examine latch and roller surfaces for corrosion. Clean as necessary.
	Damaged trip coil.	Replace coil after determining cause of failure.
	Blown fuse in trip circuit.	Replace blown fuse after determining cause of failure.
	Faulty connections in trip circuit.	Repair broken or loose wires and see that all binding screws are tight.
	Damaged or dirty contacts in trip circuit.	Recondition or replace contacts.
Failure to close or latch closed.	Mechanism binding or sticking caused by lack of lubrication.	Lubricate complete mechanism.
	Damaged or dirty contacts in control circuit.	Recondition or replace contacts.
	Blown fuse in closing circuit.	Replace blown fuse after determining cause of failure.
	Faulty connection in charging circuit.	Repair broken or loose wires and see that all binding screws are tight.
Failure of closing springs to recharge.	Driving motor inoperative due to lack of power	Check and replace fuses after determining cause of blown fuses.
	Driving motor inoperative due to an opened or shorted winding.	Replace motor after checking motor limit switches for proper setting and ratchet wheel and linkage for possible foreign objects causing jamming.

Table 3 Troubleshooting Table

3. Cut the trip coil wires at the butt connectors and remove the trip coil.

4. When replacing the trip coil, be sure to assemble the correct fiber spacers at the ends before securing the support bracket.

5. Adjust the trip coil location to allow 0.12 inch of trip coil plunger (34) free travel before the trip latch (8) starts to move.

6. Butt connect the wires and check the operation of the trip coil electrically and mechanically.

CLOSING COIL (CC)

To remove the closing coil (11, figure 5), proceed as follows:

1. Block the closing springs (22 and 57, figure 6) as described under INSTALLATION.

2. Remove the left-hand closing spring (22) as described in CLOSING SPRINGS.

3. Remove the two mounting bolts which fasten the closing coil support bracket (12, figure 5) to the mechanism frame and remove the shims above and below the closing coil.

4. Cut the closing coil wires at the butt connectors and remove the closing coil.

5. Replace the closing coil and the correct number of fiber spacers before fastening the support bracket to the mechanism frame.

6. Butt connect the wires and check that the closing coil plunger (13) is not binding. Check the closing coil for electrical operation.

CLOSING LATCH

1. Remove the cotter pins at both ends of the closing latch shaft (7, figure 5).

2. Remove the closing latch spring (15), and the closing latch monitoring switch operating lever (10).

3. Remove the set screws from the closing latch (6).

4. Move the closing latch shaft to the left (away from the frame) by tapping lightly on the inside end of the shaft. Rotate the shaft and continue tapping until the shaft is free. The shaft will push the outside needle bearing from its housing.

5. Reassemble in the reverse order putting the bearing into the frame last. Use a small piece of tubing or pipe when inserting the bearing to assure proper alignment of the bearing with its hole.

6. Check the latch adjustments as described under ADJUSTMENTS.

MOTOR SUPPORT

1. To remove the motor support (56, figure 6), first remove the closing latch spring (15, figure 5).

2. Remove the retaining ring which prevents the driving link from falling off the manual charging stud (53, figure 6).

3. Remove the driving link.

4. Remove the motor leads from the terminal board.

5. Remove the six 3/8 inch bolts (19, figure 6), from the bottom of the frame and three 3/8 inch bolts from right hand side of frame.

6. Remove the four mounting bolts from the motor (not shown).

7. Remove the retaining ring from between the motor and the motor support.

8. Remove the motor.

9. Reassemble all parts of the motor support in the reverse order and re-align it properly as described under DRIVING PAWL ADJUSTMENTS.

CAM

1. Remove the two set screws from the ratchet wheel (43, figure 6) and remove the wheel from the main shaft.

2. Remove the two set screws from the cam (4, figure 5).

3. Remove the prop reset spring (19).

4. Remove the two set screws (12, figure 3) from the cam and move the cam to the right on the shaft as far as it will go. Slide the cam shaft to the left until the key is fully exposed. Remove the key and check the shaft for burrs before removing the shaft from the frame.

5. Remove the shaft out the left side of the mechanism frame.

6. Reassemble in the reverse order using the correct number of washers and spacers to properly locate the parts.

7. Rotate the mechanism through a closing operation using the manual charging wrench. Check the location of the cam follower roller (11, figure 3), on the cam. If necessary, adjust the cam on the cam shaft to correct the alignment. Complete the closing operation and check the location of the cam follower roller shaft (10) on the prop (7). It should be approximately centered.

CLOSING SPRINGS

The closing springs (22 and 57, figure 6) can be removed as follows:

1. Charge the springs with the manual charging wrench and insert the spring blocking device pins (24) as described in INSTALLATION.

2. Discharge the springs by pushing the manual close button (48).

3. Rotate the cam shaft by using the manual charging wrench until the gap between the springs and the guide block is two inches or more.

4. Lift both springs until they clear the lower supports, then pull forward and down until the top supports are free.

5. Either open the operating mechanism by pushing the manual trip lever or block the breaker in the closed position with a suitable blocking device.

6. After reassembling the springs check the breaker stroke as described in the breaker instruction book.

REPLACEMENT PARTS

It is recommended that sufficient renewal parts be carried in stock to enable prompt replacement of worn, damaged or broken parts. A stock of such parts minimizes the service interruptions caused by breakdowns, and saves time and expense. When continuous operation is a primary consideration, more renewal parts should be carried, the amount depending upon the severity of the service and the time required to secure replacements.

Renewal parts may not always be identical to the original parts, since improvements are made from time to time. The parts which are furnished, however, will be interchangeable.

When ordering renewal parts, address the nearest Sales Office of Canadian General Electric Company Limited giving the complete data shown on the breaker nameplate, such as the serial number, type and rating of the breaker. The breaker nameplate is mounted on the inside of the front door of the operating mechanism compartment. Also furnish a complete description of each part, the quantity required, and, if possible, the number of the requisition on which the breaker was originally furnished.

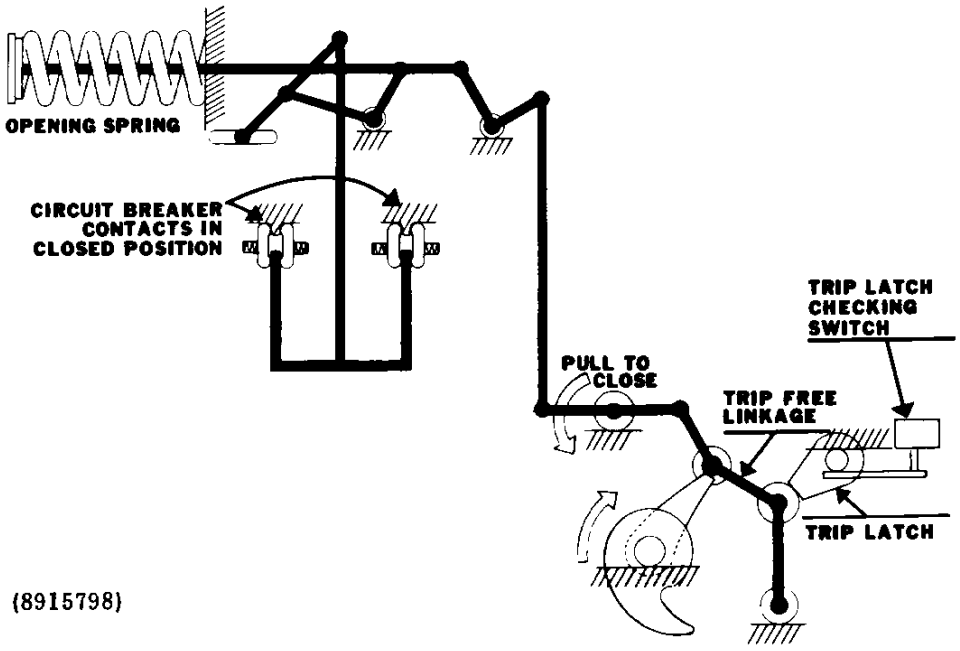

Figure 11 Linkage With Breaker In Closed Position

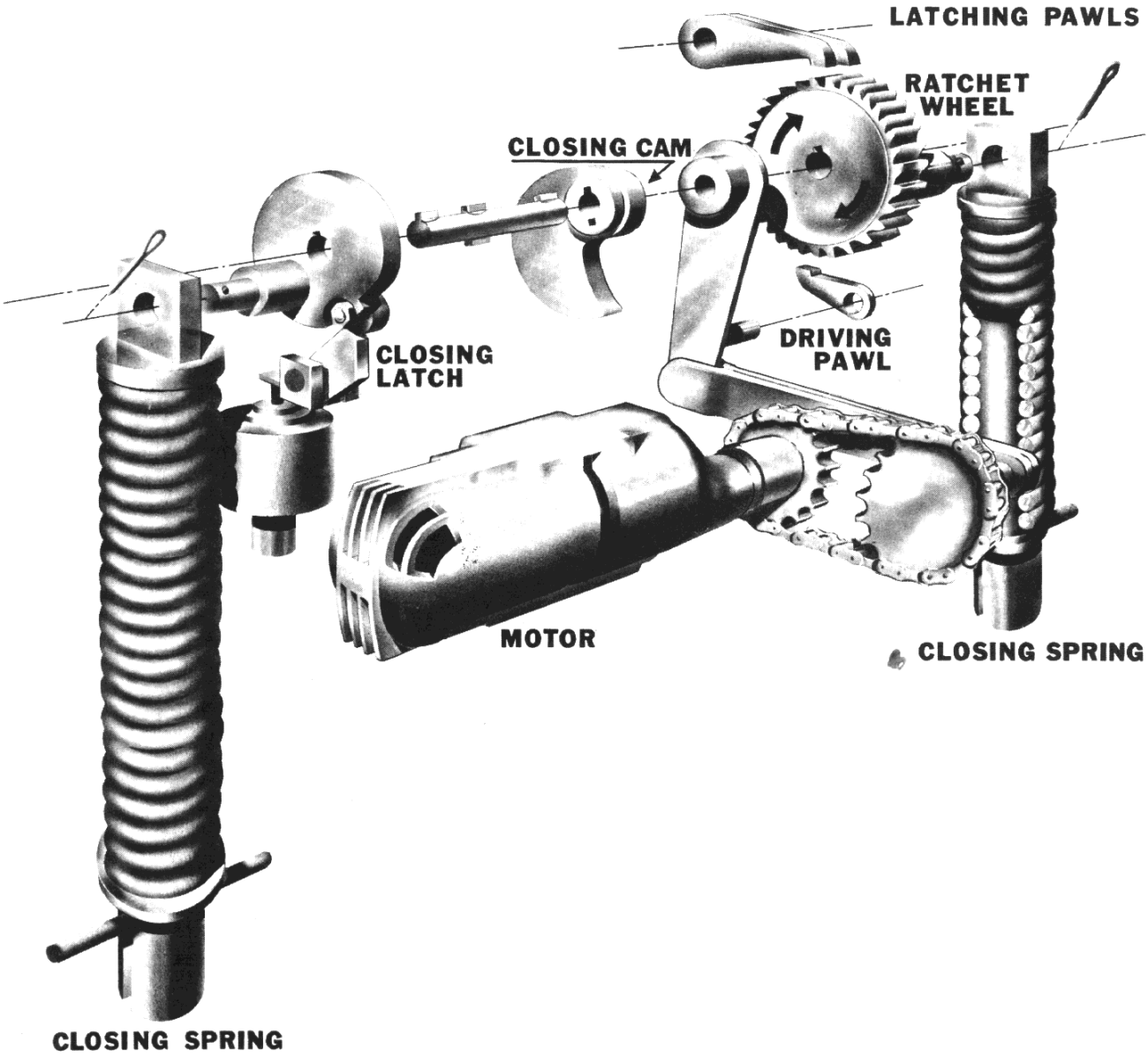

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Figure 12 Pictorial Diagram Of ML-14 Mechanism

		ML-14 MECHANISM			
POSITION OF BREAKER	POSITION OF SPRING	MOTOR LIMIT SWITCHES	TRIP LATCH CHECKING SWITCH	CLOSING LATCH MONITORING SWITCH	MOTOR POSITION
CLOSED	CHARGED	⊣⊢ ⊣⊢ ⫽	⫽	⫽	STOPPED
GOING OPEN	CHARGED	⊣⊢ ⊣⊢ ⫽	⊣⊢	⫽	STOPPED
OPEN	CHARGED	⊣⊢ ⊣⊢ ⫽	⫽	⫽	STOPPED
GOING CLOSED	DIS-CHARGING	⫽ ⫽ ⊣⊢	⫽	⊣⊢	STOPPED
CLOSED	DIS-CHARGED	⫽ ⫽ ⊣⊢	⫽	⫽	RUNNING
GOING OPEN	DIS-CHARGED	⫽ ⫽ ⊣⊢	⊣⊢	⫽	RUNNING
* OPEN	DIS-CHARGED	⫽ ⫽ ⊣⊢	⫽	⫽	RUNNING
OPEN	CHARGING	7 ⫽ 8 9 ⫽ 10 11 ⊣⊢ 12	⫽	⫽	RUNNING
C.G.E. DESIGNATION		52YX 44 52/SCO	52/LC(T)	52/LC(C)	
G.E. DESIGNATION		SM/LS	LC	CL/MS	

44 - Motor cut-off switch, opens when spring is charged.

52YX - 52Y time delay switch,closes when spring discharges, opens when spring is charged.

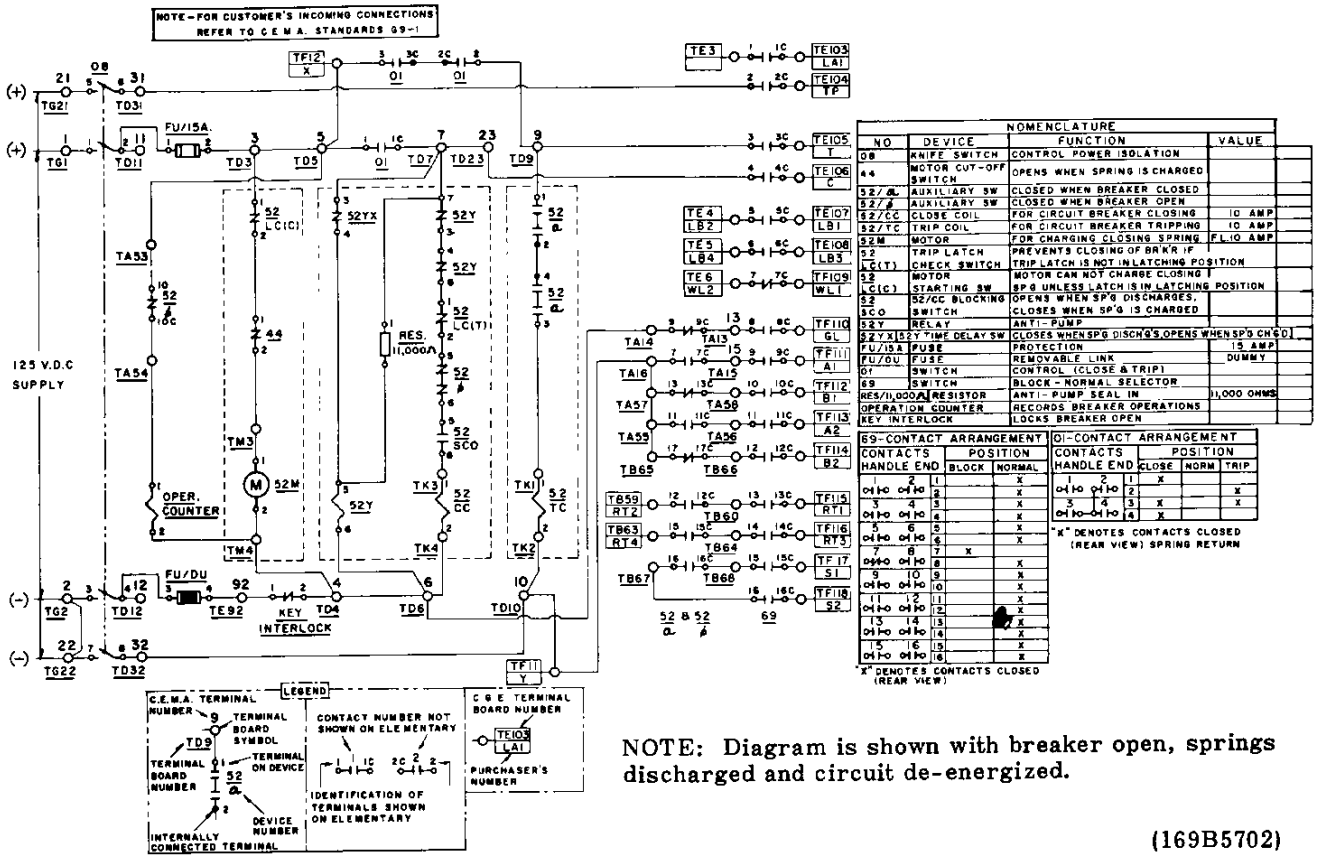
52/SCO - 52/CC blocking switch, opens when spring discharges, closes when spring is charged.

52/LC(T) - Prevents closing of breaker if trip latch is not in latching position.

52/LC(C) - Motor starting switch,motor cannot charge closing spring unless latch is in latching position.

* Electrical Diagrams drawn in this position.

Table 4 Mechanical Position Of Switches



NOTE: Diagram is shown with breaker open, springs discharged and circuit de-energized.

(169B5702)

Figure 13 Schematic Diagram Of ML-14 Mechanism

POWER DELIVERY
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CANADIAN GENERAL ELECTRIC