ALLIS-CHALMERS CONTROLS

INSTRUCTIONS

TYPE FC-1000A, 15-KV

AIR MAGNETIC CIRCUIT BREAKERS

With

SOLENOID OR STORED

ENERGY OPERATORS

BWX-6734

18X3089

PRINTED IN U.S.A. SGM & CO. INC.

ILLUSTRATIONS

This instruction manual contains installation, operation and maintenance information for Type FC-1000A solenoid or stored energy operated, 15-kv air magnetic circuit breakers.

Warranty

The sales contract carries all information on warranty coverage.

Receiving

Circuit breakers are shipped from the factory completely assembled and bolted to a pallet for handling with fork lift truck. Observe weight markings on crates and ensure that capable handling equipment is used.

Follow the breaker handling instructions attached to the breaker's front panel.

When handling breaker with a crane or hoist, hooks should be attached only as instructed. Use a spreader to prevent frame distortion. Do not attach lifting hooks, rope, etc., to bushings, insulating parts, fittings, etc.

Remove crating or other protective covering carefully with the correct tools. Check each item with the shipping manifest. If any shortage or damage is found, immediately call it to the attention of the local freight agent handling the shipment. Proper notation should be made by him on the freight bill. This prevents any controversy when claim is made and facilitates adjustment.

Storage

Indoor — The circuit breaker should be installed as soon as possible. If storage is necessary, it should be kept in a clean, dry place where it will not be exposed to dirt, corrosive atmospheres or mechanical abuse.

Outdoor — Outdoor storage of circuit breakers is not recommended. If breakers must be stored outdoors, they must be completely covered and a heat source provided to prevent condensation and subsequent corrosion.

Circuit Breaker Preparation

Prepare the circuit breaker for insertion into its cubicle as follows:

NOTE

Breakers are shipped in closed position with the trip latch blocked or tied to prevent tripping during shipment. Tie or blocking must be removed.

1. Free trip latch.
2. Push manual trip rod to open breaker.
3. Remove phase barriers and unfasten coil connections as described in Adjustments Section under "Phase Barrier Assemblies."
4. Expose the contact area by tilting the arc chutes as described in Adjustments Section under "Tilting Arc Chutes."
5. Remove dust, foreign particles, etc., from breaker.
6. Check for simultaneous closing of arcing contacts (within 1/16 inch) by slowly closing the breaker. To slowly close a solenoid operated breaker, insert the manual closing device into the angle bracket mounted at the rear of the breaker. With the device rolls against the solenoid armature, lever the armature in to close the breaker. Refer to Adjustments Section under "Type SE-3 Stored Energy Operator" for procedure to slowly close that type of breaker.
7. Trip out breaker by depressing trip rod.
8. Return arc chutes to upright position, fasten coil connections and replace phase barriers. Be sure screws on all phases are tightened securely.
9. Install plug jumper and energize control. (Springs should charge on stored energy breakers.)
10. Close breaker — } with control switch on cubicle panel.
11. Trip breaker — } with control switch on cubicle panel.
12. Push depress lever and close electrically (*).
13. Release depress lever and repeat steps 10 (#) and 11.
14. Lock out Kirk interlock (if provided, mounted on cubicle floor plate and repeat step 10 (*).
15. Open interlock and repeat steps 10 (#) and 11.
16. De-energize control power and remove plug jumper.
17. Coat movable primary disconnects with a light film of lubricant supplied by A-C. Refer to page 52, "Circuit Breaker Insertion," of Switchgear instruction book (18X9587-03) for breaker insertion instructions.
18. Insert breaker into its cubicle to the "disconnect" position and close manually (stored energy operated breakers only) (*).

    Step 18 does not apply to solenoid operated breakers.
19. Complete movement of breaker to "test" position and repeat steps 10 (#) and 11.
20. Check for proper alignment between stationary and movable secondary contacts. Also between breaker fork and auxiliary switch.

(*) Breaker is trip free.
(#) Breaker will close.

NOTE

If bus or line are energized, get clearance to de-energize before beginning this step.

21. With line and bus de-energized, rack breaker into fully connected position. Close and trip breaker from main control panel.

22. Breaker is now ready for normal operation.

DESCRIPTION

A typical circuit breaker consists of primary disconnect, arc chute, and operator sections. The primary disconnect section contains the main contacts, which supply power to the load. The arc chute section dissipates the power arc drawn during the opening of the main contacts. The operator section contains the mechanism used to close and open the main contacts. This mechanism consists of either a solenoid or a stored energy operator with its associated control circuitry.

Arc Interruption

Arc interruption is accomplished in free air at atmospheric pressure with the aid of a self-induced, magnetic blowout field and forced air draft. When the trip solenoid is energized, load current is being carried by the main contacts. As the contacts open, the main contacts part first and the current is carried by the arcing contacts.

The arc between the arcing contacts is transferred to the arc runners as the arcing contacts open. This transfer establishes full current flow through the blowout coils, setting up a strong magnetic field. The magnetic field, accompanied by the natural thermal effects of the heated arc, tends to force the arc upward into the barrier stack. The cool surfaces of the barrier stack cool and de-ionize the arc, while the V-shaped slots in the stack reduce its cross-section and elongate it, leading to rapid extinction. The arc runners are made of wide, heavy material for maximum heat dissipation and minimized metal vaporization.

A puffer mechanism provides a forced air draft through the main contact area. This aids the magnetic blowout field and natural thermal effect in forcing the arc into the barrier stack for easy extinction.

Operators

The breaker is closed by the action of an operator straightening a toggle in a four-bar linkage arrangement. The operator is powered by either a solenoid or pre-charged stored energy springs.

Solenoid Operator — Type SO-45F

A large dc solenoid operator is used to drive two links of the four-bar linkage to an in-line position, allowing a prop latch to drop behind a toggle roll in the linkage system and hold the breaker closed. Control can be from either direct or alternating current sources.

DC Control

This control consists of two relays which may be mounted on a common base. Solenoid operator current is handled by the main control or X relay, while the second (Y) relay provides auxiliary control.

AC Control

For alternating current applications, an ac control relay is used to switch the ac to the input of a silicon rectifier for control of the solenoid operator. The dc output of the silicon rectifier is connected directly to the operator. This control consists of two relays which may be mounted on a common base. Alternating current to the rectifier is handled by the main control or X relay, while the second (Y) relay provides auxiliary control.

Silicon Rectifier

A full wave rectifier is used to convert alternating current to direct for the dc solenoid operator.

CAUTION

This rectifier is designed for intermittent duty and should not be used for any other purpose.

The four rectifiers (diodes) are mounted on heat sinks which are assembled together with a terminal block on a chassis. The diodes are connected to form a full wave, single-phase, bridge. Direction of current flow does not affect solenoid operation. Nominal operating voltage for the rectifier is up to 300 volts ac.

The junctions of these rectifiers can be damaged by over-voltage or heating due to excessive current flowing through them. Protection against switching transients is provided by a suppressor.

Rectifier junctions will be destroyed if the full E/R closing current flows for more than a second or two as might occur if the breaker fails to close normally due to mechanical difficulty. To protect the rectifier, a fuse is provided in the closing circuit capable of blowing under such conditions. The blown fuse must be replaced only with another of the same type and rating. As a safety measure, the fuse should always be in series with the rectifier during any test operations. Limit such operations to not more than two a minute.

Stored Energy Operator — Type SE-3

The stored energy operator uses charged springs to power the closing operation. Opening is spring-powered also, but not with the same springs used for closing. A stored energy operator consists of three systems: driving, spring linkage and four-bar toggle linkage. These systems are disengaged from each other except while performing their specific functions. For example — the driving and spring linkage systems are completely free of each other except when the spring linkage is being charged. Similarly, the spring linkage and four-bar toggle linkage systems are free of each other except during a closing operation.

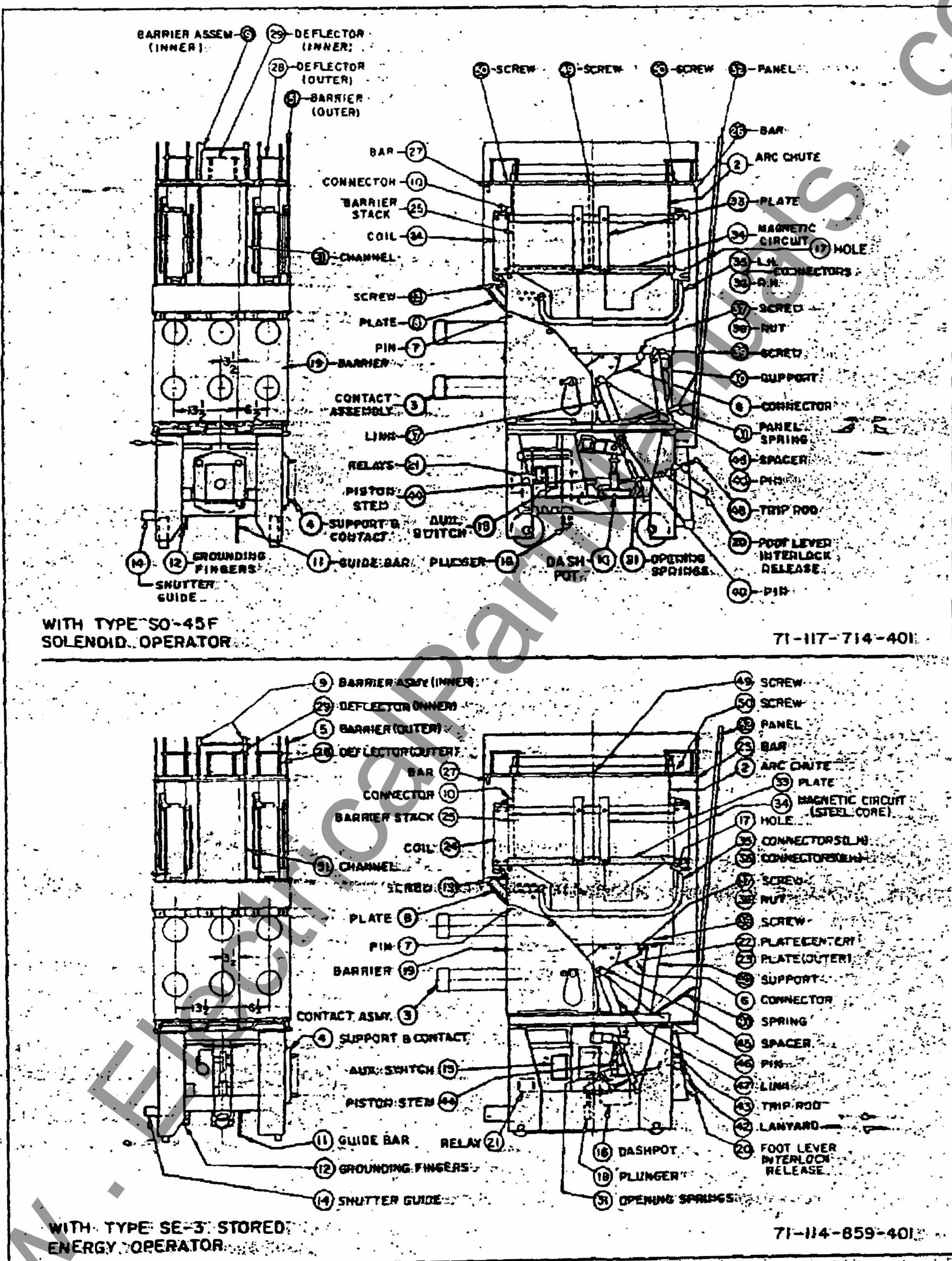


Figure 1. — Typical Type FC-1000A Circuit Breaker Assemblies

Stored energy operated breakers normally require only a single commercial relay for auxiliary control. This relay is furnished to match the control voltage.

Reset Relay

The reset relay is used for instantaneous reclosure service on stored energy operated breakers instead of a latch check switch. The relay is electro-mechanical. It's controlled by a solid state device consisting of a voltage regulator and timing circuits mounted on a printed circuit board and encapsulated in a resilient material for shock resistance. Closing time is not affected by voltage or current variances well beyond the standard circuit breaker control limits.

Auxiliary Equipment

Auxiliary Switch

Mounted on the breaker, the auxiliary switch is normally used to open the trip circuit when the circuit breaker is opened. As this multi-stage switch operates from the breaker disconnect blades, circuitry dependent on the position of the breaker, such as indicator lights, etc., is wired through this switch. The individual stages are easily converted to "a" or "b" without disassembling the switch. (See page26, Figure 16.)

Capacitor Trip Device

A capacitor trip device is commonly used with circuit breakers that are alternating current supplied and installed in remote locations or unattached substations where battery cost and maintenance are undesirable.

In these cases, the capacitor trip device may be charged from the same stepdown transformer that is used to energize the breaker control. This stepdown transformer should be connected to the line side of the breaker.

To add the capacitor trip device to existing breakers originally shipped with dc trip coils, contact your Allis-Chalmers sales representative.

Arc Chute Assembly (Figure 2)

Each arc chute consists of a flame retardent envelope which provides phase isolation for interruption and venting of the by-product gases of interruption. The arc chute contains —

1. The stationary end arc runner (4) and moving end arc runner (3) to which the arc terminals transfer from the arcing contacts. The arc runners from paths for the arc terminals to travel up the arc chute. Transfer to the stationary end runner (4) is aided by transfer stack (5).
2. The barrier stack (23) consisting of a number of refractory plates, with "v-shaped" slots, cemented together. The barrier stack cools, squeezes and stretches the arc to force a quick interruption.
3. The barrier plate (27) containing coolers (20) through which the by-product gases of interruption pass, completes the cooling and deionizing of the arc products. Tube (18) encloses the barrier stacks and runners and supports the deflector plates (28 and 29) which also help break up and disperse the arc products.

OPERATION

Type SO-45F Solenoid Operator (Figure 3)

The primary closing force of this operator is supplied by a dc solenoid. The iron circuit housing the solenoid consists of the main operator frame — to which the pole head is welded — a helically wound tube and a back plate held in place by four screws (68). The armature (4), with plunger (6) and cap (19) attached, slides in a non-magnetic tube (5). When the coil (8) is energized, the armature moves toward the pole head. The non-magnetic washer (21) keeps the armature from actual contact with the pole head so that the armature will release rapidly when the coil is de-energized by reducing the effect of the residual magnetism. The armature is returned by a spring around the plunger.

4-Bar Linkage (Figure 4)

The operator, through the use of a 4-bar linkage, may be electrically and mechanically trip-free by the release of the trip latch mechanically or by energizing the trip solenoid electrically at any time during the closing stroke or after the breaker is closed.

The 4-bar linkage consists of links (70, 101, 102 and 73). In normal closing operation, point E is held fixed between stop bolt (75) and trip latch (27). When the closing solenoid is energized, plunger (6) moves forward to rotate link (101) about center E. This forces link (102) to move, rotating arm (73) about its fixed center B. The forward travel of point D carries it past prop latch (97) which holds point D as plunger (6) retracts. The rotation of arm (73) closes the breaker blades and extends the opening springs.

To open the breaker, trip latch (27) is rotated about its center G either electrically — by energizing the trip solenoid coil which moves the trip pin down to strike and rotate the latch — or mechanically — by depressing the tail of the latch. This releases point E, allowing link (70) to rotate about its fixed center F. Links (101 and 102) drop allowing arm (73) to rotate, pulled down by spring (7). As point D drops, it is freed from the prop latch (97). Reset spring (91) pulls D back, lifting point E back of trip latch (27) and resetting the linkage. If the trip latch (27) is rotated at any time during the closing stroke, the linkage will collapse.

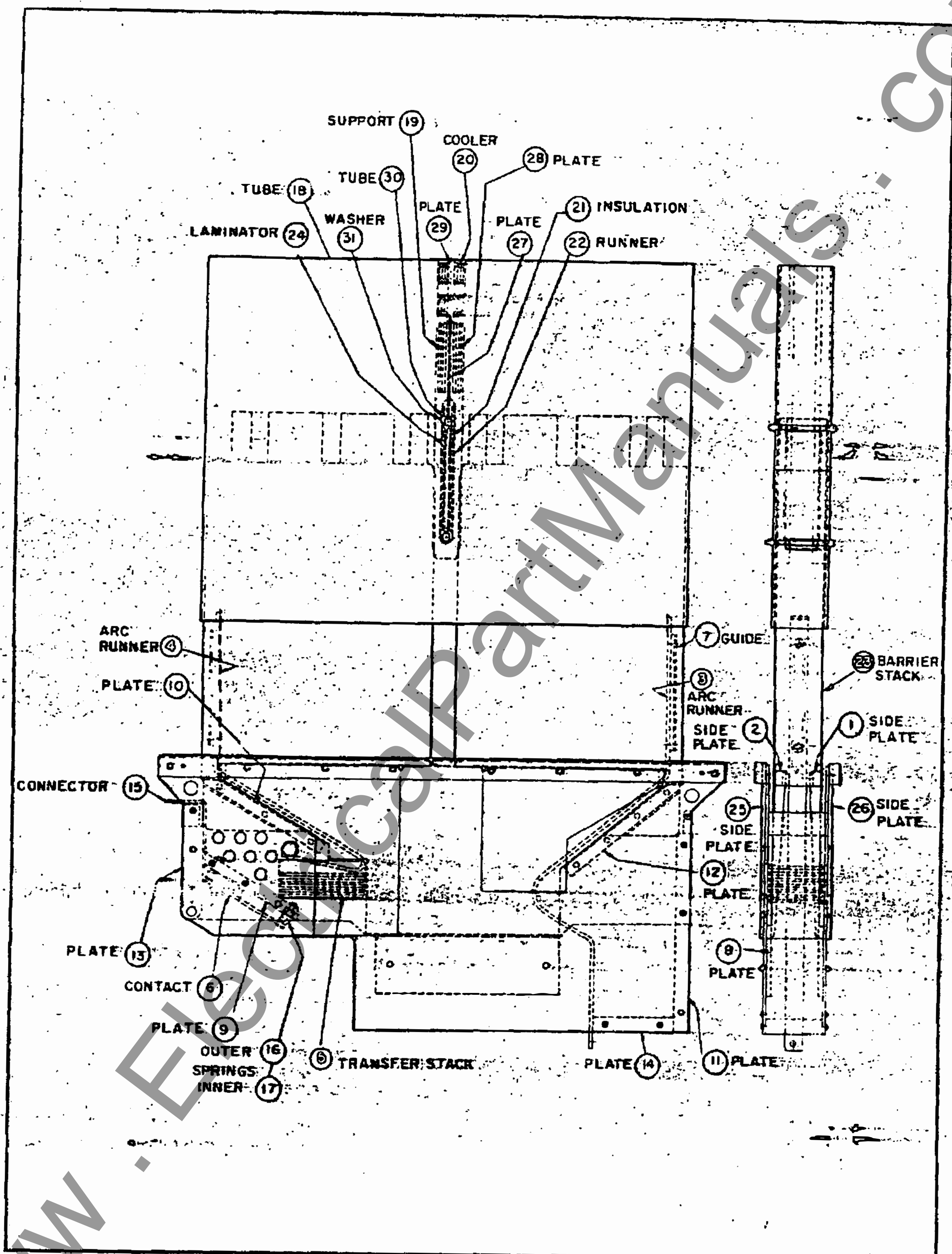


Figure 2. —Arc Chute

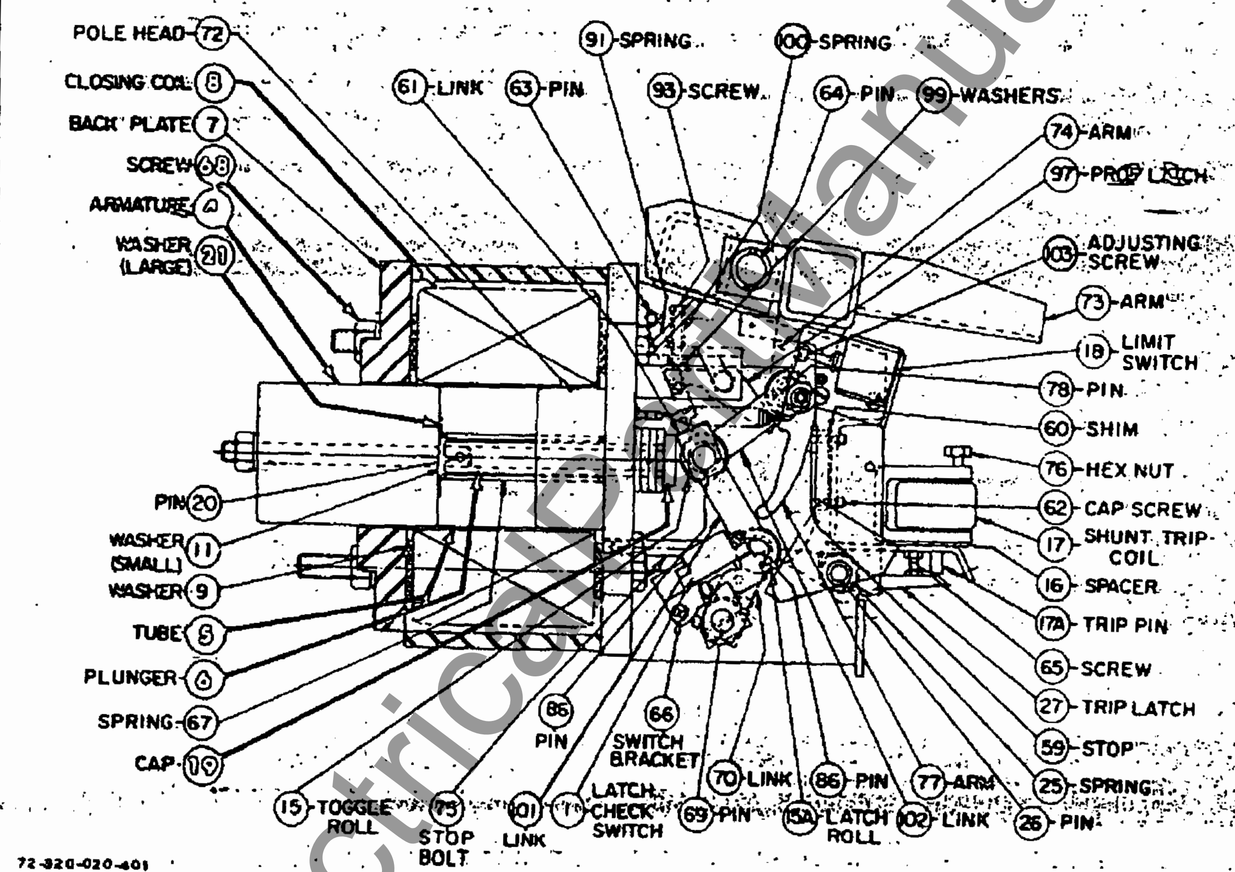


Figure 3. — Type SO-45F Solenoid Operator Assembly

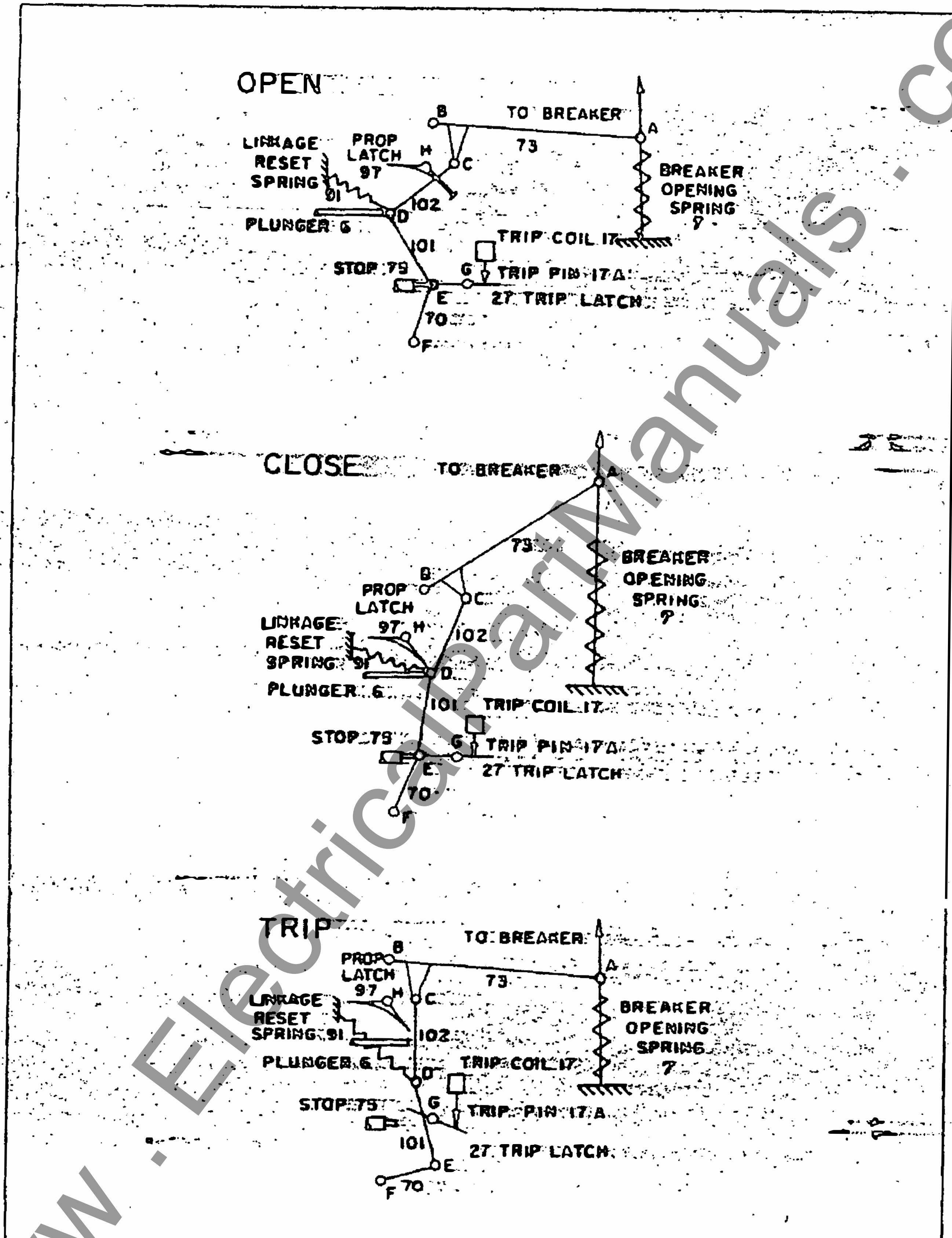
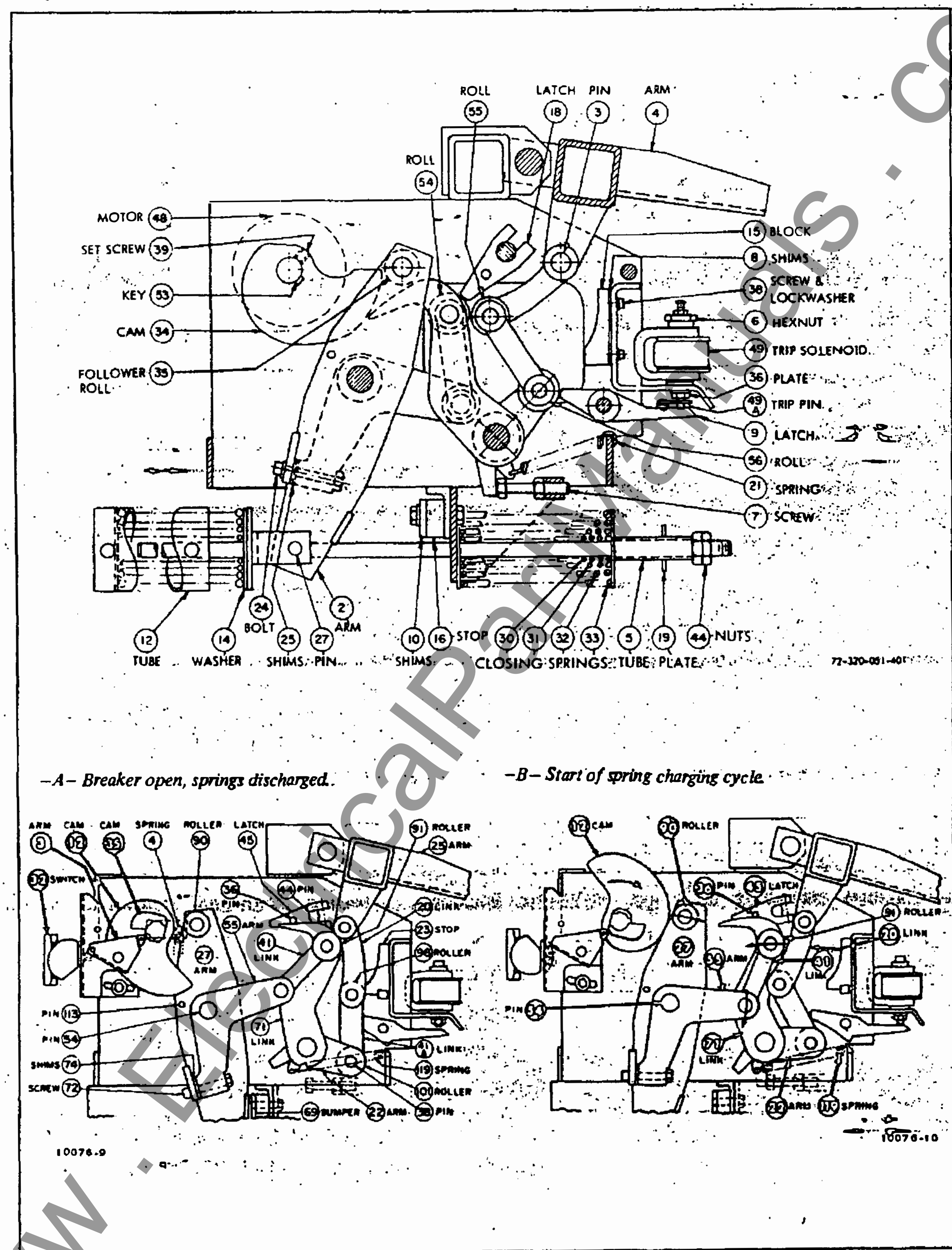


Figure 4. — Four-bar Linkage



–A– Breaker open, springs discharged.

–B– Start of spring charging cycle.

Figure 5.—Type SE-3 Stored Energy Operator Assembly

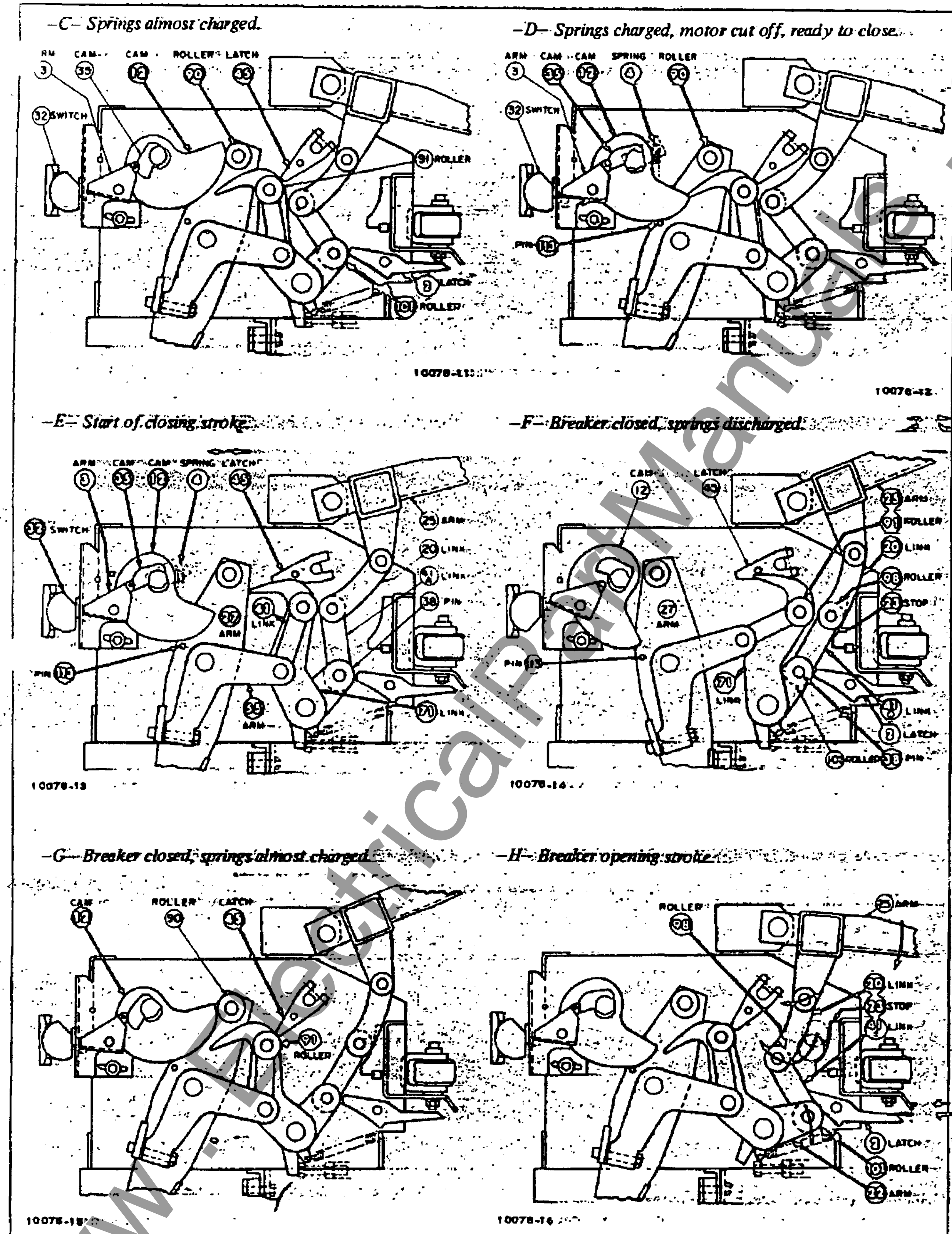


Figure 5 — Type SE-3 Stored Energy Operator Assembly (cont.)

Type SE-3 Stored Energy Operator — (Figure 5 A-H)

Fig. A — Breaker open, springs discharged. Switches (32) released as arm (3) has been released by cam (35). Switch (32) closes motor circuit and cam (12) rotates clockwise.

Fig. B — Cam (12) has rotated against roller (90) forcing arm (27) and (55), which are fastened together, to rotate clockwise about pin (54). This compresses the closing springs which are fastened to the lower end of arm (27). The rotation of arm (55) pulls link (71) to the left thru link (41). Spring (119) rotates arm (22), attempting to recouple the 4-bar linkage but is retarded by link (20) riding on roll (91) until link (71) moves to the left. Note: Latch (45) is held from resetting by pin (36) riding on crown of horn of link (71).

Fig. C — Roller (90) is at crown of cam (12). Latch roll (91) is past latch (45), allowing latch to drop in place and the 4-bar linkage has reset with trip latch (2) reset back of roll (101).

Fig. D — There are teeth cut from the driving gear train so that when cam (12) clears roller (90), the motor drive is disconnected and cam (12) is free. Reset spring (4) continues the rotation of cam (12) until it rests against pin (113). Cam (35) rotates with cam (12). When cam (12) rests against pin (113), cam (35) holds the switches (32) in thrown position.

Fig. E — Latch (45) has been rotated to close the breaker. This releases link (71). Arm (27) rotates counterclockwise as the closing springs force its lower end to the right. Arm (55) thru link (41) forces link (71) to the right. As arm (27) rotates, pin (113) drops away, freeing cam (12) which is rotated by spring (4) allowing cam (35) to release arm (3) and switches (32) which throw over closing motor circuit to recharge springs.

Fig. F — Roller (91), by the swing of link (71), forces roller (98) ahead of it. Link (41A) rotates about pin (38) held by latch (2). Straightening of the toggle framed by links (41A) and (20) raises (25), closing the breaker. Links (41A) and (20) go over toggle against stop (23).

Fig. G — Shows the breaker closed and the springs almost charged. The cam (12) has gone by its crown and is easing roller (91) onto latch (45).

Fig. H — Trip latch (2) has been rotated to release roller (101). Arm (22) rotates about its fixed center, allowing links (41A) and (20) to drop. Shape of stop (23) forces roller (98) back to break the overtoggle between links (41A) and (20), allowing the 4-bar linkage to reset.

Operator Control

Type SO-45F Solenoid Operator (Figure 6)

The normal control for this operator has the close and control power from a common source. The solenoid has dc coils designed to give maximum efficiency over the desired control voltage range.

For dc control the normal method is as shown in Fig. 6A. When the close contact (CS-C) is closed, current flow through 52LC and 52Y1 energizes the 52X relay coil. This closes contacts (52X3 and 52X4) to energize the closing coil (52cc). Contact (52X1) closes to lock in the 52X relay coil. Late in the solenoid stroke, the limit switch contact (52aa) closes, energizing the 52Y relay. The closing of the 52Y2 relay and the opening of the 52Y1 contacts cuts off the 52X3 and 52X4 contacts and the lock-in circuit (X1) of the 52X relay. If the close control remains closed, the 52Y relay is still locked in through contact 52Y2 and must be opened to reset the control for another close. This forms the anti-pump circuit so that on a trip-free operation the close control has to be opened before the breaker will attempt another close action.

For ac control, a full-wave bridge rectifier is used to supply dc to the closing coil. An ac control similar to the dc control scheme is shown in Fig. 6B. The control function is the same as for the dc control. A surge suppressor is furnished across the rectifier to protect against high voltage surges which may destroy the rectifier elements.

The more commonly used ac control method (Fig. 6C) requires a close control with a normally closed contact and a normally open contact. When the supply is energized, relay (52Y) is energized and locks in through contact (52Y2) to terminal (5). Contact (52Y4) also closes so that when the close control switch operates, current flow through terminal (7) and 52Y4 energizes the 52X relay which locks in through 52X1 and terminal (5). Relay (52X) energizes the close coil circuit through 52X2 and 52X3. Late in the solenoid stroke, limit switch contacts (52bb) open de-energizing the 52Y relay. Opening of contacts (52Y2 and 52Y4) de-energizes the 52X relay, opening contacts (52X1, 52X2 and 52X3) and de-energizes the entire circuit. To re-energize the circuit, relay (52Y) must be energized by releasing the close control to re-energize terminal (19). If the breaker is closed, contact (52b) will be open and relay (52Y) will energize when the breaker is tripped open.

Type SE-3 Stored Energy Operator (Figure 7)

The normal control for this operator has been incorporated in one switch assembly located at the rear of the unit. It consists of two heavy-duty toggle switches (6) operated by common linkage (4) from the motor switch cam (1) on the main charging cam shaft.

The main spring charging motor power is supplied through terminals 3 and 4. The mechanical interlock is a switch operated by the breaker release lever which opens the motor circuit when the lever is depressed. The 88-1 and 88-2 switches are shown with the main closing springs discharged. The 88-1-bb contact is in the drive motor circuit and is used to start the motor when the springs are discharged and stop the motor when the springs are fully

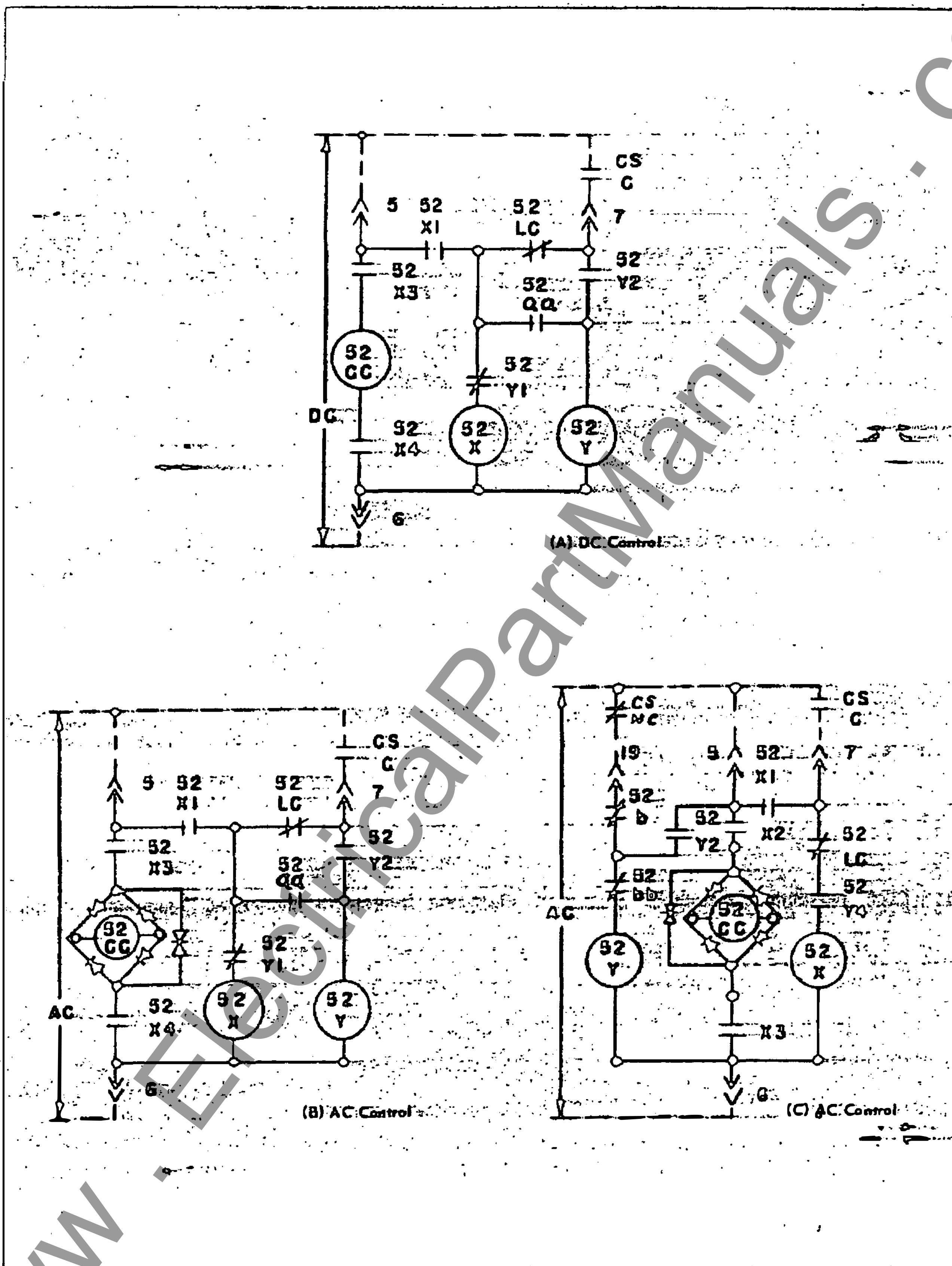


Figure 6 — Closing Control Schemes, Type SO-45 Solenoid Operator

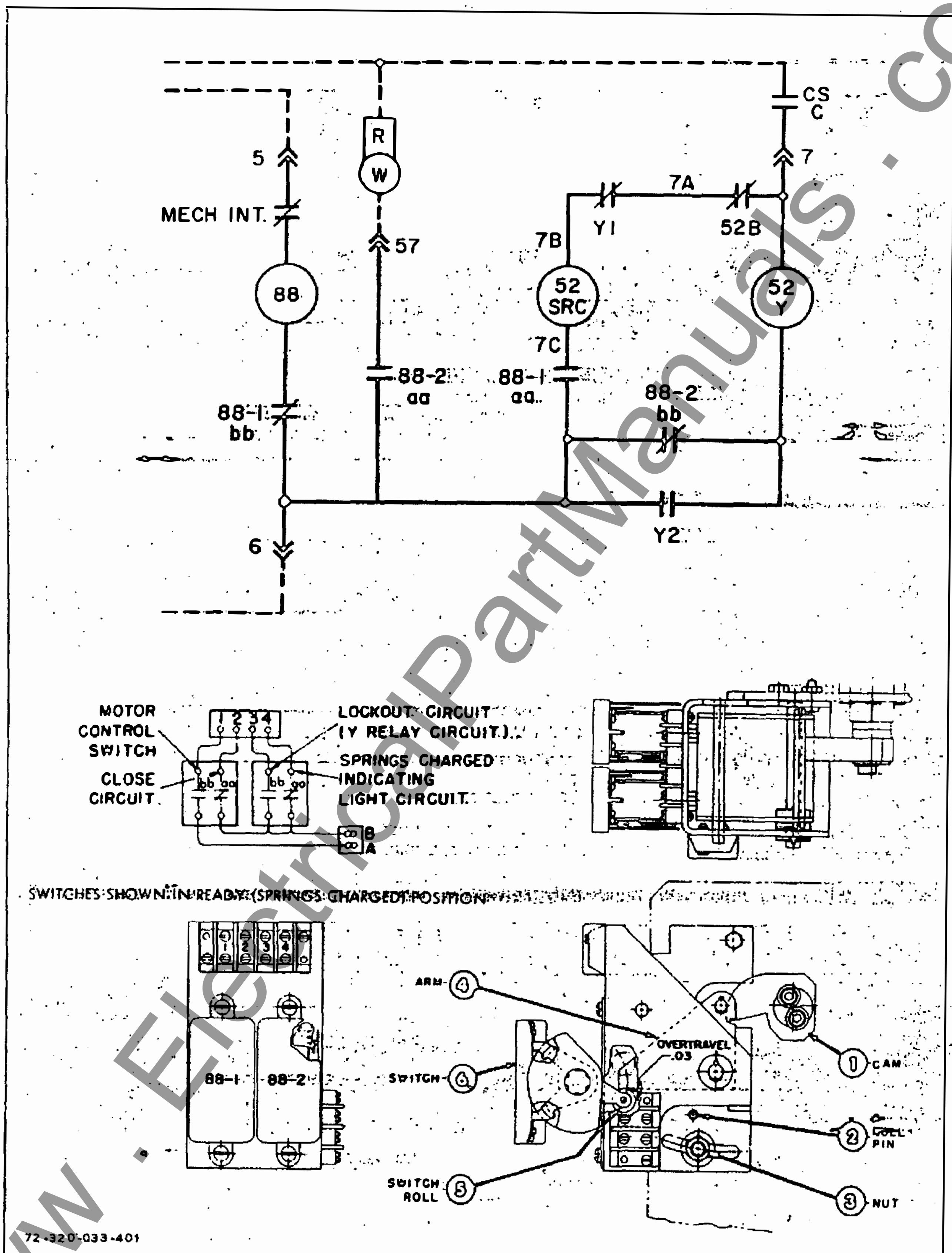


Figure 7. — Closing Control Scheme and Assembly Type SE-3 Stored Energy Operator

charged. The 88-1-aa contact is in the close control circuit and keeps the circuit open until the springs have been fully charged.

The 88-2-bb contact is in the close control lockout circuit. The 88-2-aa contact is used to energize an indicating light which shows that the springs are fully charged. When the control is energized, the motor starts to charge the springs. When the closing springs are charged, the driving motor disengages because of the cutout teeth in the main driving gear. The 88-1-bb switch opens when the springs are fully charged. As the charging linkage charges the main closing springs, the motor switch cam rotates with the spring charging cam. When the drive disengages, the cam snaps over and the 88-1 and 88-2 switches are thrown, cutting off the motor circuit.

When the closing springs are discharged, the cam is freed and the reset spring rotates the cam shaft to release the switch. Release of the switch closes the motor circuit and starts the spring charge.

Closing Circuit (Figure 7)

When the close control switch (CSC) is closed, the circuit from terminal 7 through 52B and Y1 to 52SRC, through 88-1 to terminal 6 energizes the spring release coil (SRC), closing the breaker. As soon as the closing springs are discharged, 88-2 (bb) closes to energize 52Y relay. If the close control switch remains closed, the 52Y relay remains locked in through contact 52T2. Control switch (CSC) has to be released to reset control for another closing operation.

Reset Relay (Figure 8)

The reset relay is an electronic solid state time delay which operates an electro-mechanical relay (R). The relay's normally open contacts, in turn, energize the spring release coil (SRC) to close the breaker. The relay contacts are rated 15 amperes.

The relay closing time is not affected by broad variance of voltage and current well beyond the standard circuit breaker control limits. The time delay error caused by temperature is minor, being less than 3% from -20 to +80C and not over 5% to -40C.

The voltage regulator and timing circuits are mounted on a printed circuit board and encapsulated in a resilient material for shock resistance.

The controlled supply voltage charges the capacitor (C_1) through the time rate determining resistor (R_1) to the triggering voltage of the unijunction transistor (UJT) which activates the SCR, energizing the relay coil.

Variable resistor (R_1) is preset at the factory for a delay of ten cycles and locked in place by the stem locking nut. A 5-degree change in resistor setting would mean a change in delay of approximately 1/2 cycle. The unit is adjustable from an approximately instantaneous to a 60-cycle delay. Any readjustment should be made using a cycle counter or equivalent for timing.

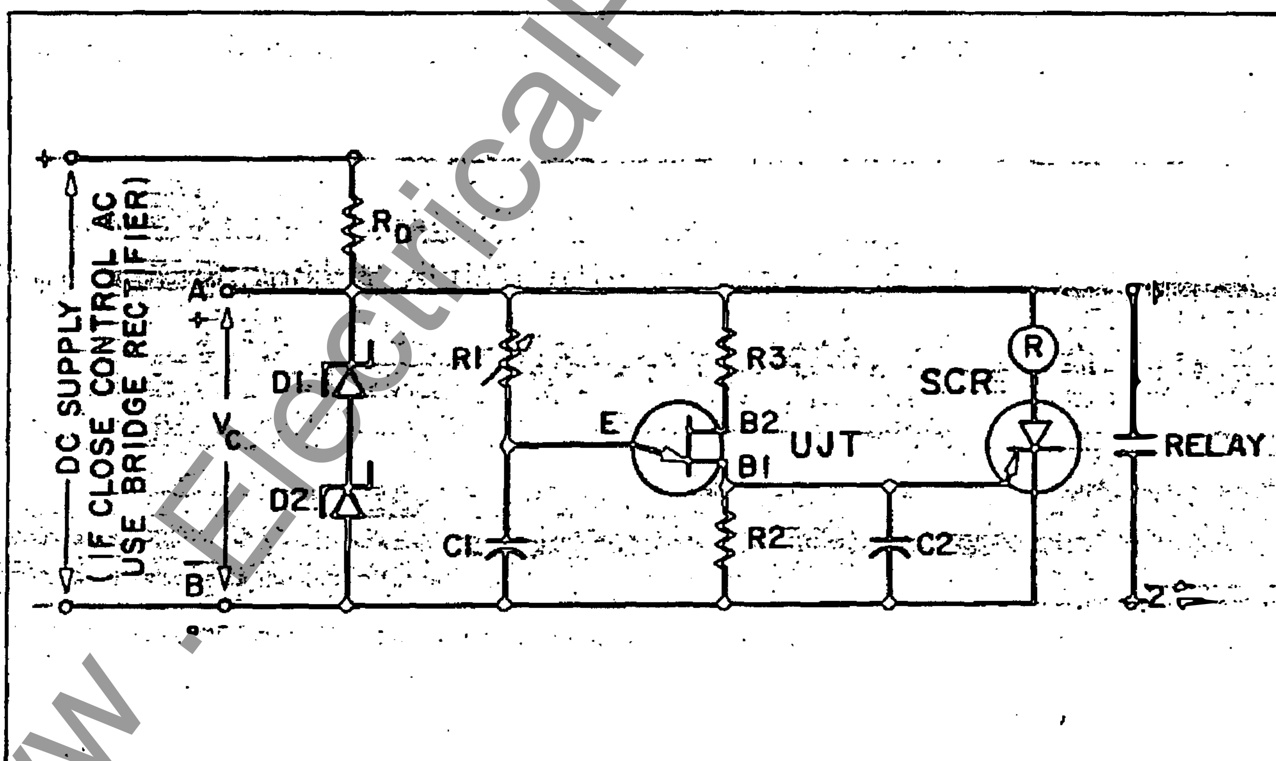


Figure 8 — Reset Relay Circuit

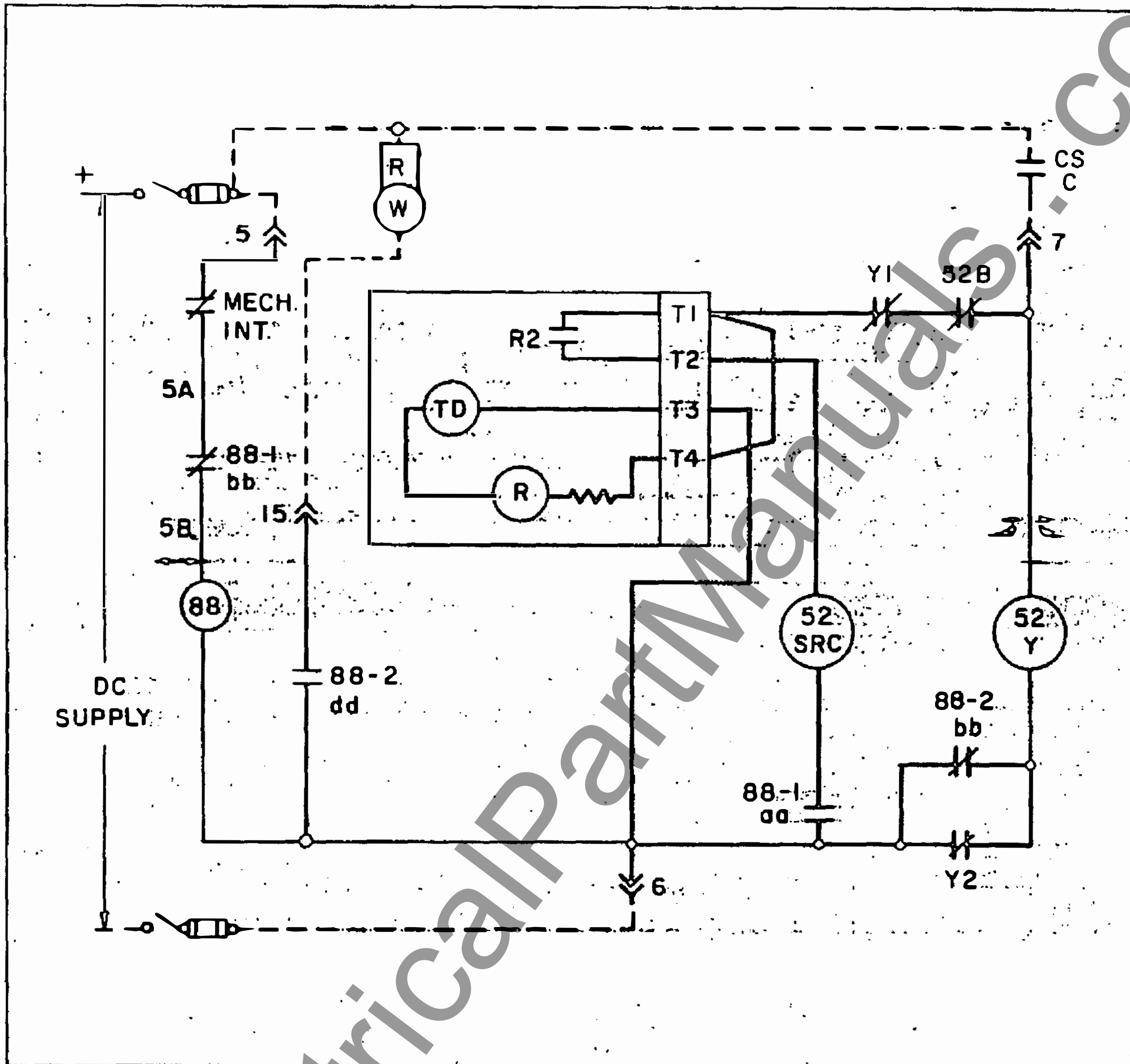


Figure 9. – DC Closing Control Scheme, Reset Relay

Reset Relay DC Control (Figure 9)

The delay circuit in the reset relay is a closely controlled capacitor relaxation circuit, direct current operated. When the close control switch is closed, the circuit from 7 through 52B and Y1 to terminal T4 and from terminal T3 to 6 energizes the time delay circuit. After the specified delay, normally ten cycles, the relay coil is energized, closing the relay contact (R_2), tieing terminal T1 to terminal T2, completing the circuit to the spring release coil and closing the breaker.

Reset Relay AC Control (Figure 10)

When used with an ac closing circuit, a full-wave, bridge rectifier is used to supply dc to the delay circuit. The input to the rectifier is T1 and T2. The dc output through terminals T3 and T4 supply the time delay circuit of the reset relay.

Spring Release Latch

Fig. 11a shows the sp ing release latch in the hold position and locked in place by links (W and X) which are over toggle against screw (A). To release the latch, link (X) must be moved upward to invert the toggle.

When the spring release solenoid is energized (Fig. 11b), the armature moves up with the ram, forcing link (X) up, to break the over toggle condition of links (W and X). Link (X) is rotated to the right, removing the latch from the latch roll to release the closing mechanism.

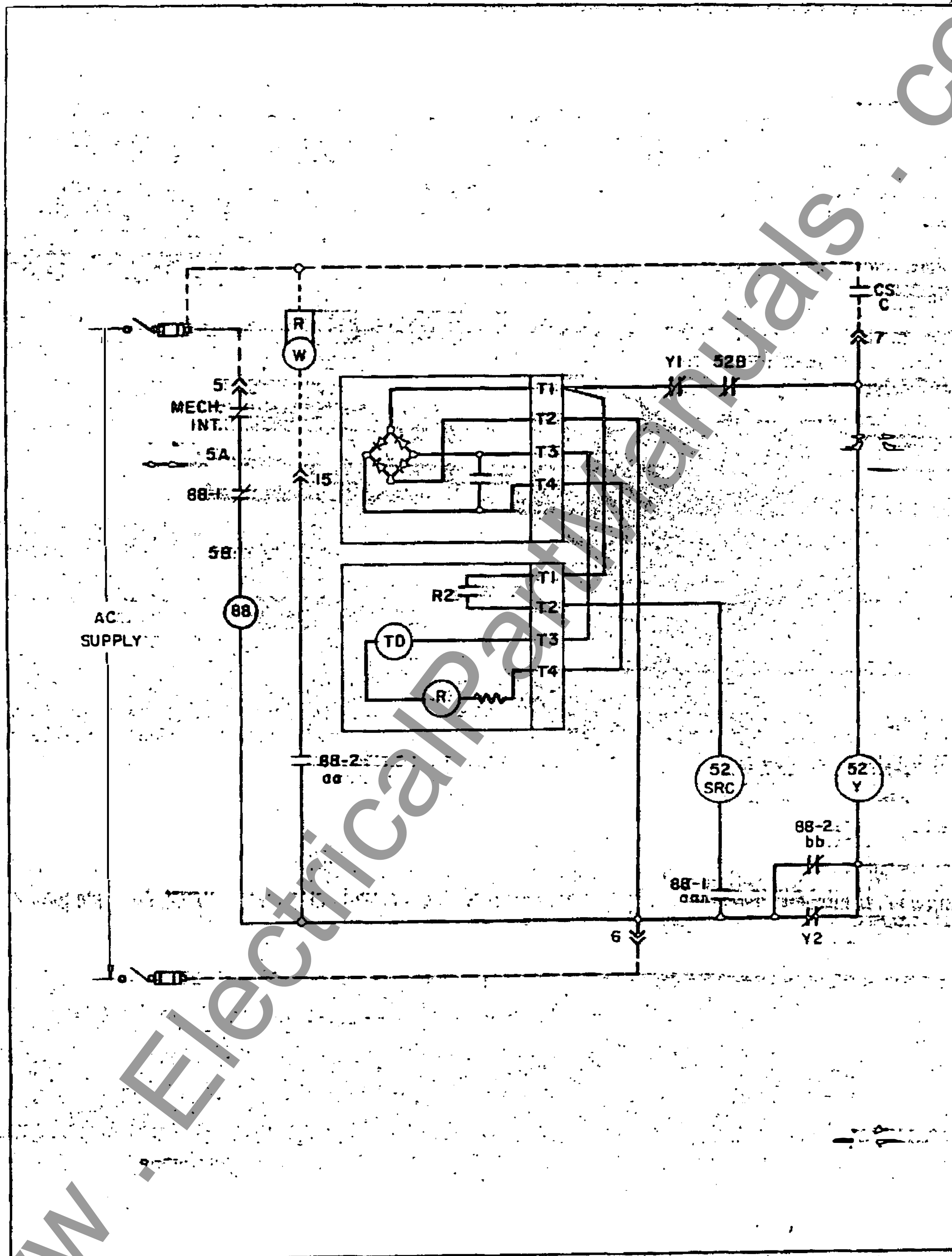


Figure 10: — AC Control Scheme; Reset Relay.

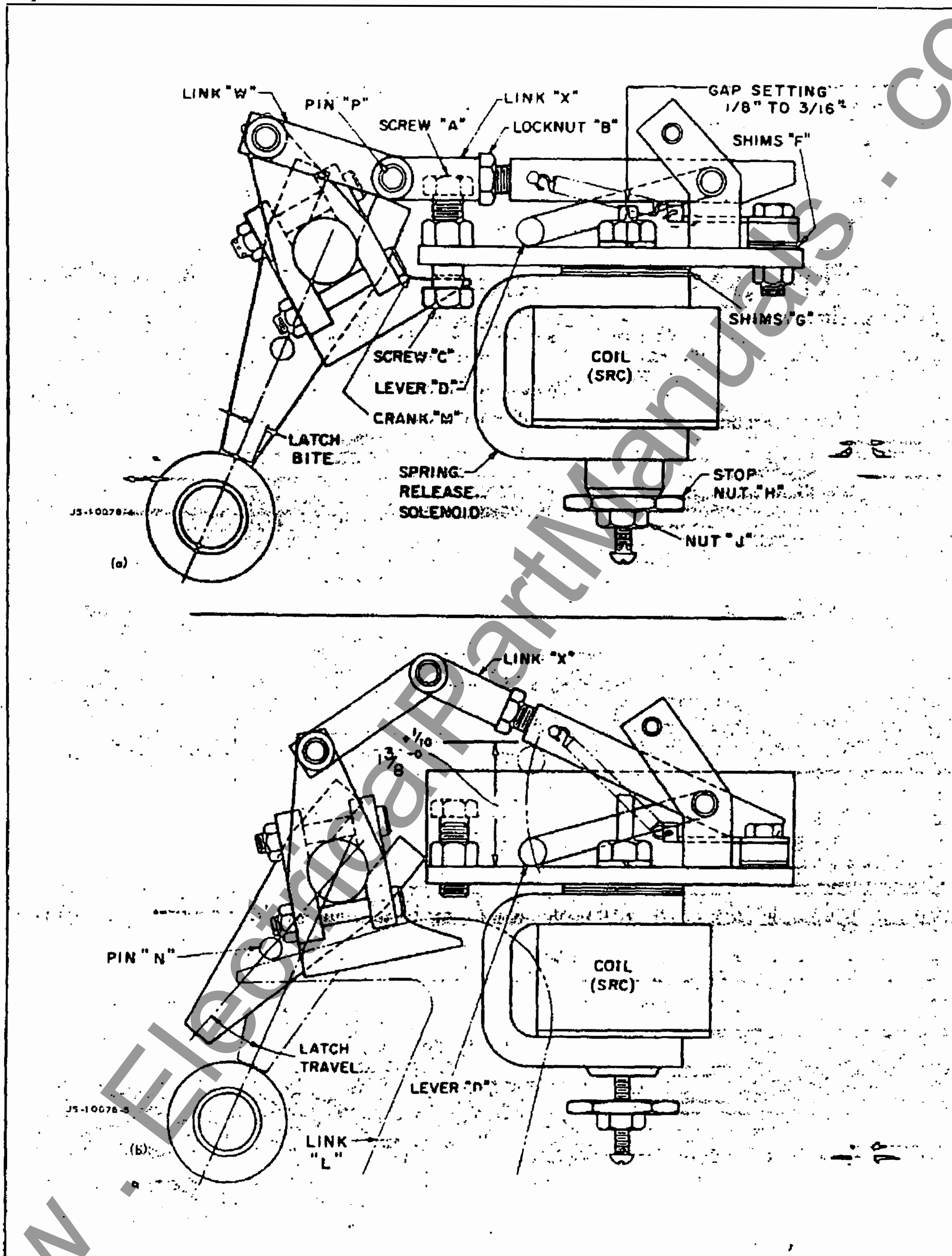


Figure 11. – Spring Release Latch, Type SE-3 Stored Energy Operator

ADJUSTMENTS

Adjustments are factory set and checked before and after numerous mechanical operations on every breaker to insure correctness. No adjustment checking should be necessary on new breakers. If a malfunction occurs, check for hidden shipping damage.

The following will help you get the correct adjustments when replacing a broken or worn part.

Circuit Breaker Timing (Figure 12)

A comparison of circuit breaker timing at any period of maintenance with that taken when the breaker was new will indicate the operational condition of the breaker mechanism. A time variance of more than 1/2 cycle on opening and 2 cycles on closing indicates a maladjustment or friction buildup. Remove screw (18) in the movable contact arm for connection of a speed analyzer.

Phase Barrier Assemblies (Figure 1)

Full size barriers of high dielectric flame retardent material isolate each phase.

To remove the phase barriers disconnect springs (41) and lower panel (32) to floor. Remove bar (26) and then two outer phase barriers (5). Next remove two screws (13), plate (8), bar (27) and channel (51) in order as listed. Slide out inner phase barrier assembly (9). Replace parts in reverse order making certain that barriers are properly seated in their locating slots.

Tilting Arc Chutes (Figure 1)

Remove steel panel (32) by removing panel springs (41) and bolts holding panel hinges to breaker frame. Leave dowel pins in place. Then lift out the steel horizontal shield. Remove screws (37) to disconnect arc runner and screws (39) to detach arc chute from rear support (40).

Place arc chute lifter on breaker as shown in Figures 13A-G and raise arc chutes.

Upon lowering arc chutes, replace screws (37) and (39) and replace steel panel.

Barrier Stacks (Figure 1 unless otherwise indicated)

The barrier stacks are fragile and should be handled carefully. They should be inspected for erosion of the plates in the areas of the slots. The stacks should be replaced when a milky glaze is observed on the full length of the edges of most of the slots. They should be replaced if plates are broken or cracked. When cleaning the breaker and cubicle, inspect for pieces of barrier stack refractory material which would obviously indicate breakage.

To remove barrier stacks, remove phase barriers and tilt arc chutes as just described. Referring to Fig. 1, next loosen two screws (50) and one screw (49) permitting tube (Fig. 2, 18) and deflector (28) or (29) to be removed as a unit. Note that the difference between inner and outer deflectors is the block to which bar (26) is fastened. This block extends beyond the rest of the deflector on the two outer phases.

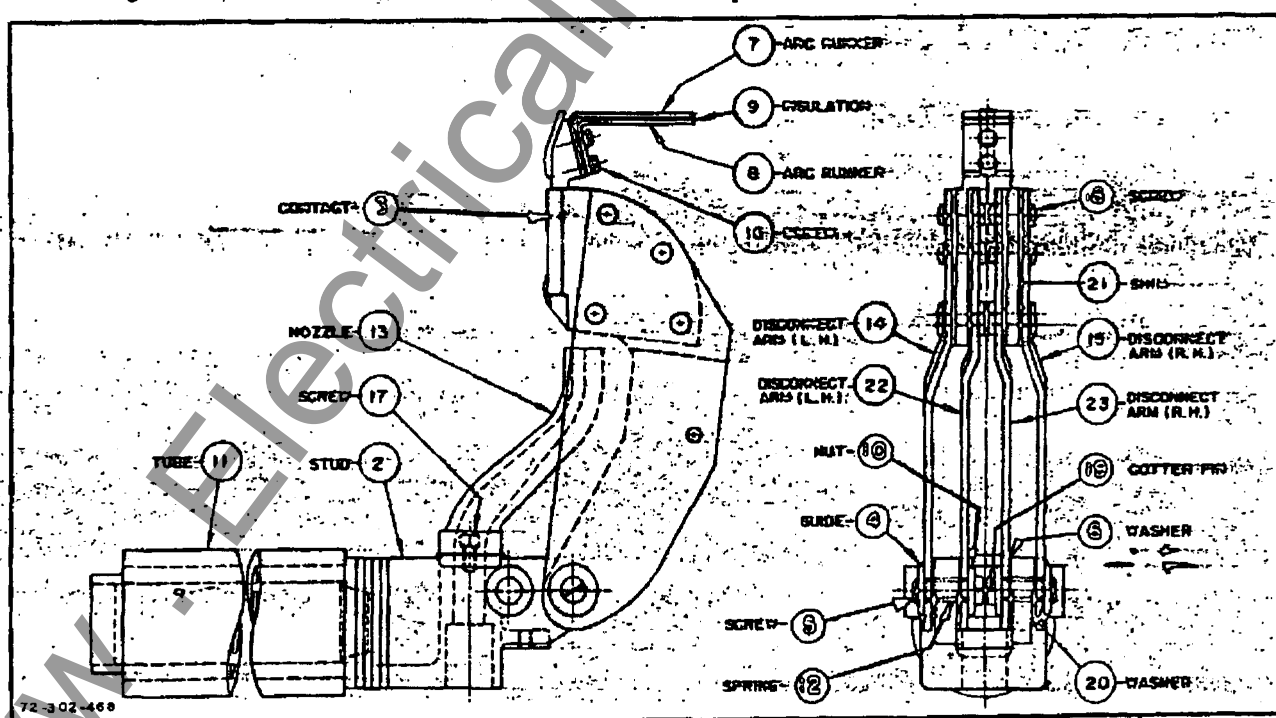


Figure 12 — Lower Bushing Assembly

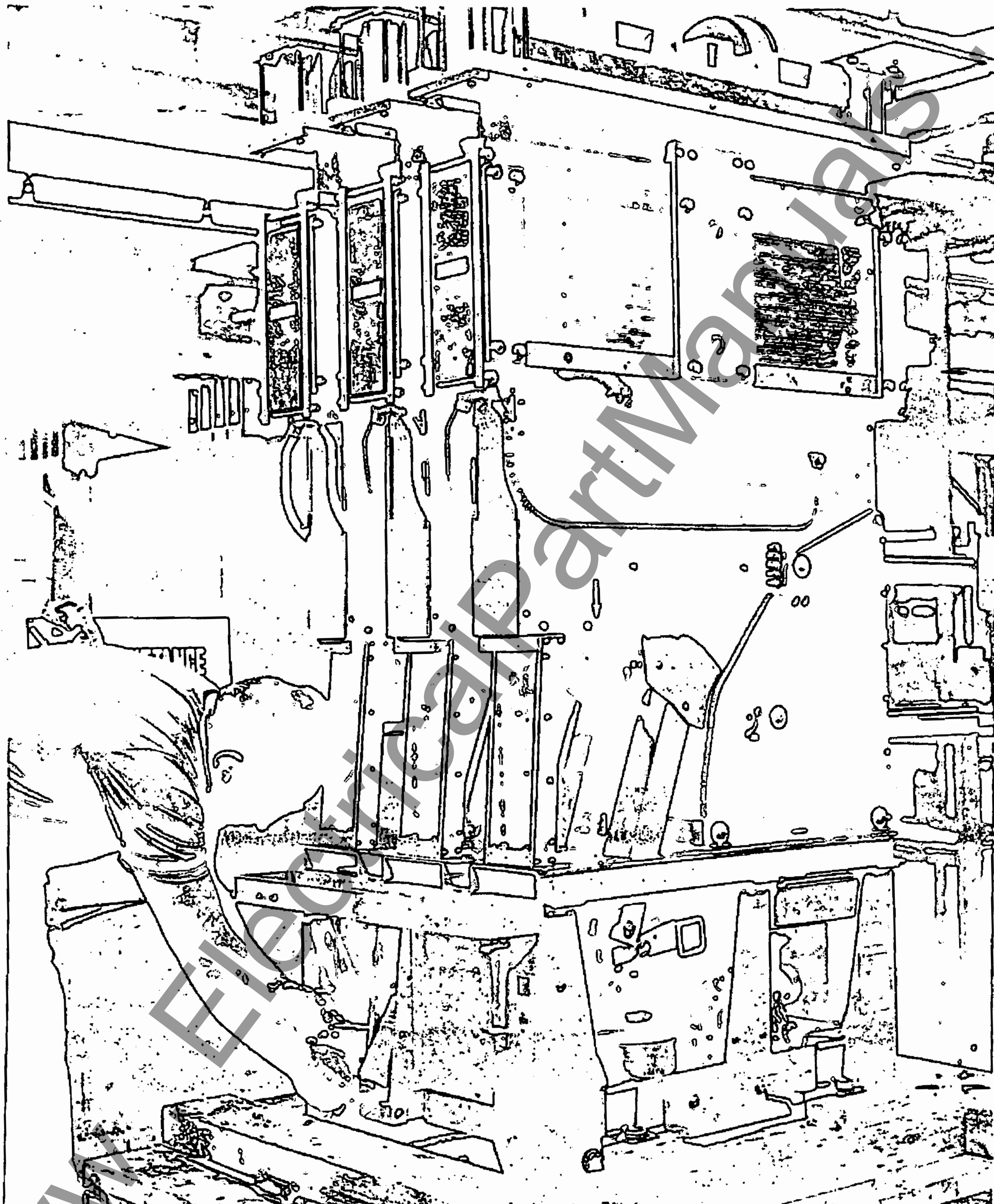


Figure. 13A. — Arc Chute Lifter Installation. Remove bolt from foot pedal, allow pedal to hang between lugs of channel.

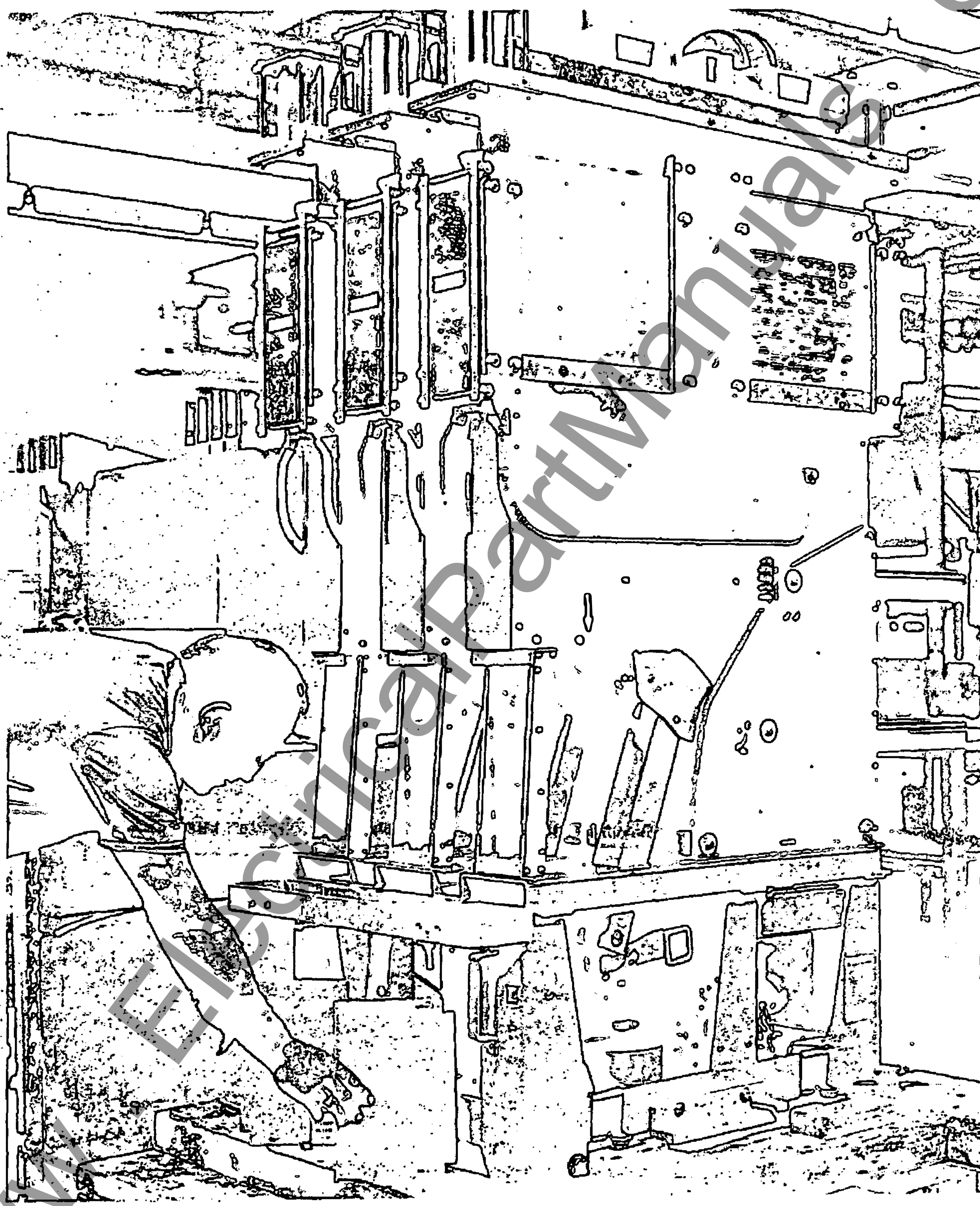


Figure 13B — Arc Chute Lifter Installation: Remove lower panels.

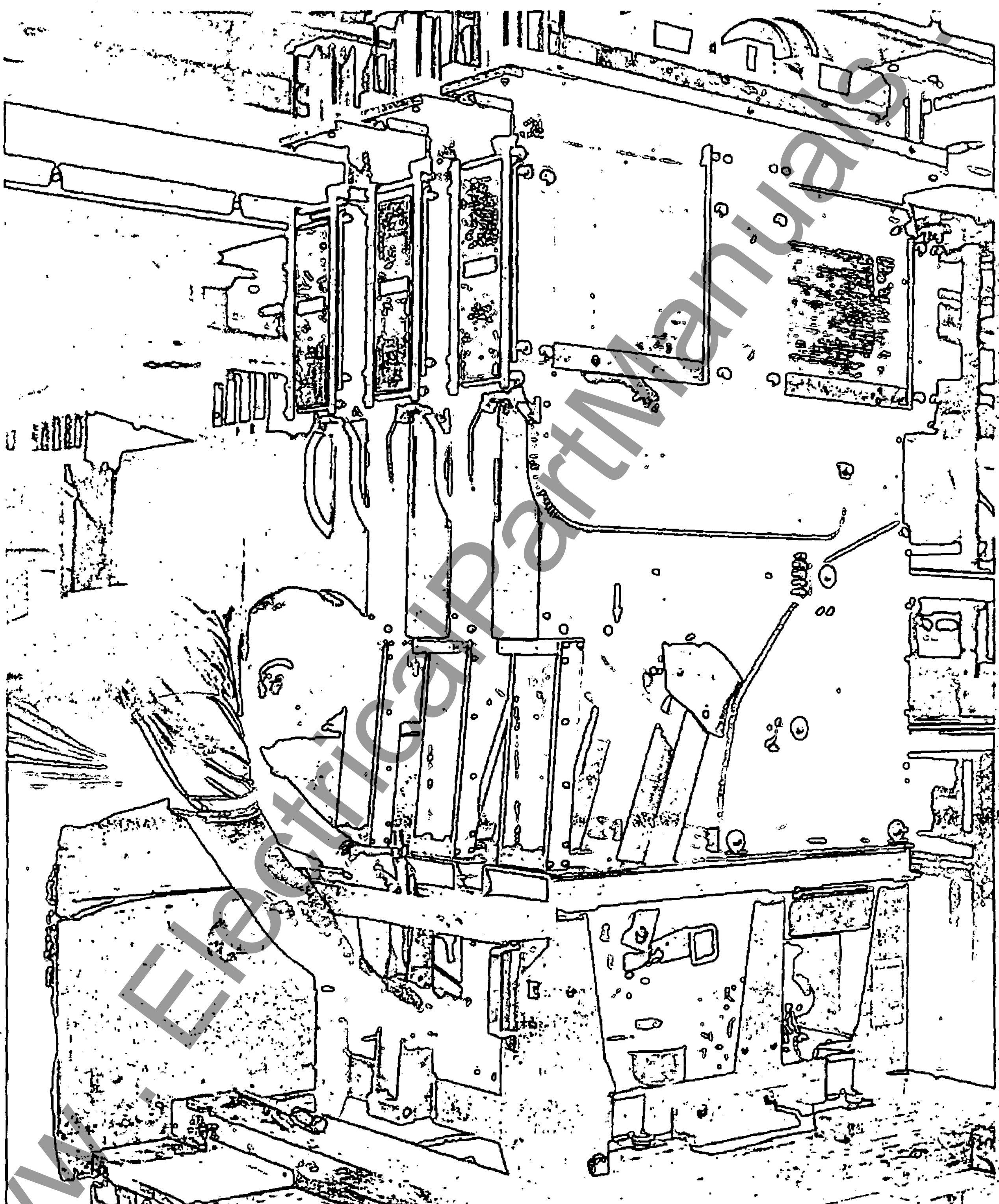


Figure 13C. — Arc Chute Lifter Installation. Install support rod with pin thru holes in channel above foot pedal.

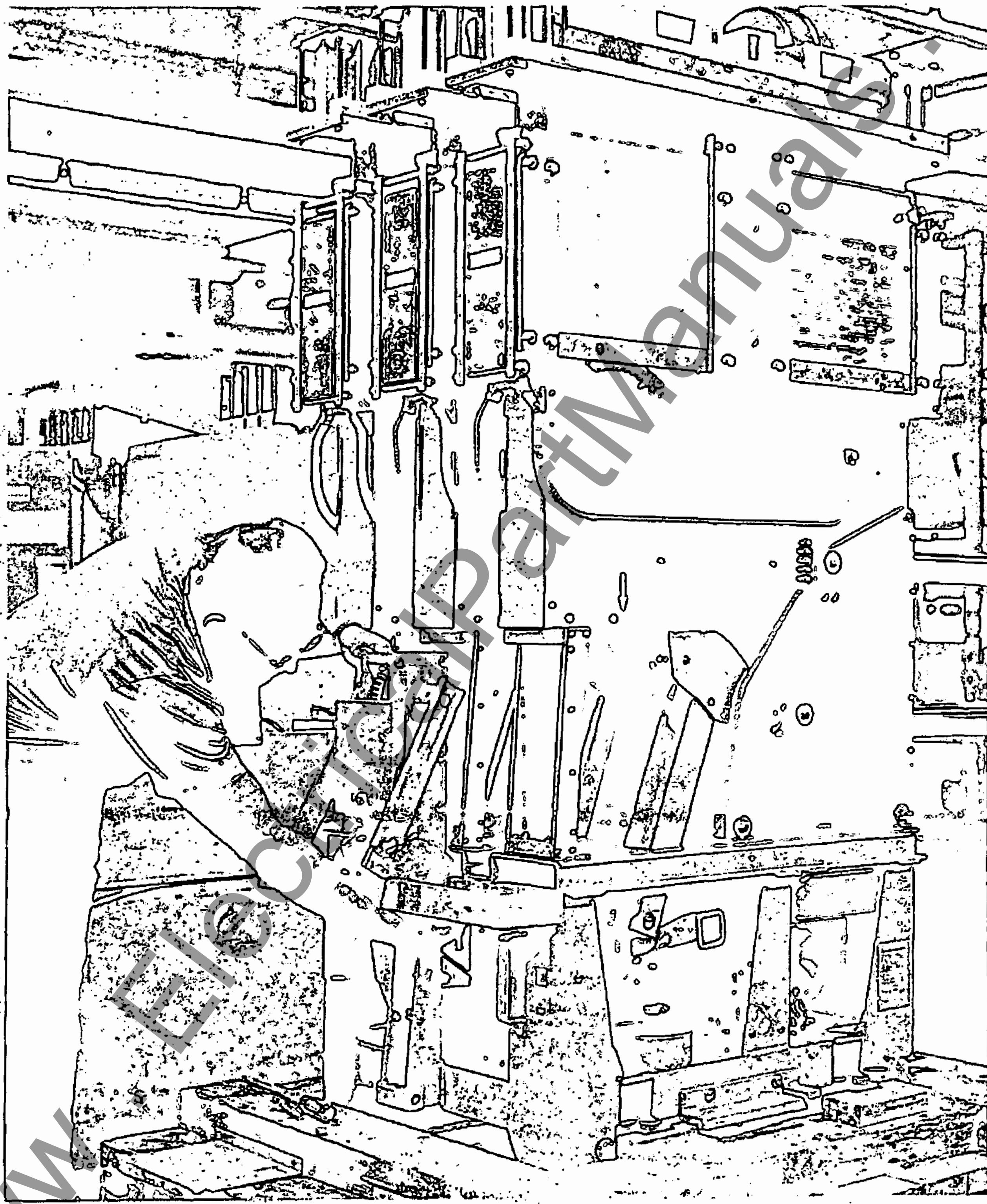


Figure. 13D. — Arc Chute Lifter Installation. Set arc chute lifter gear box on breaker and support rod and insert pin thru gear box and breaker using top holes in channel. Level gear box by turning nut on support rod.

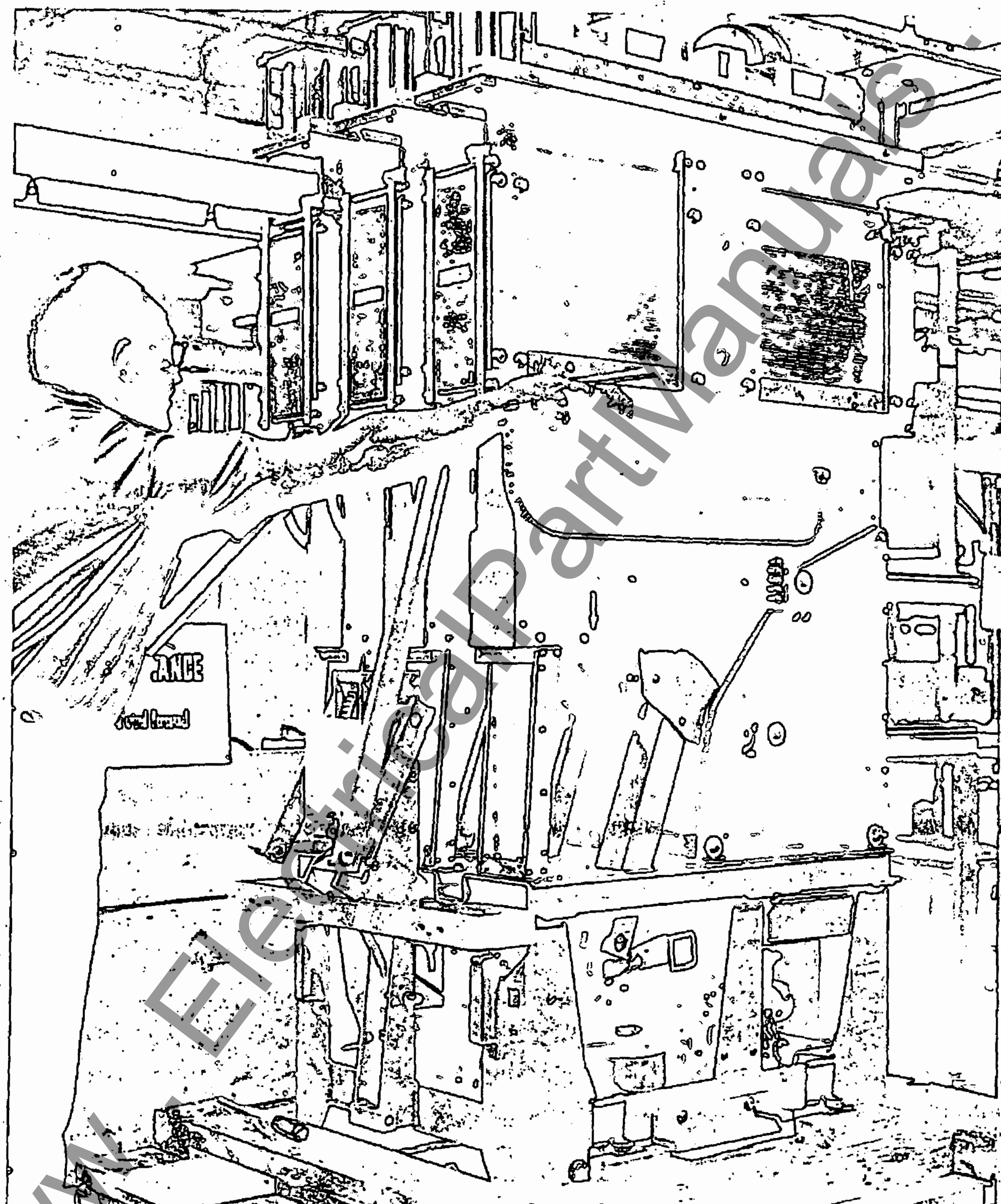


Figure 13E. — Arc Chute Lifter Installation. Install long rod thru holes in arc chute with lifting arms between the phases. (channel portion faces outward).

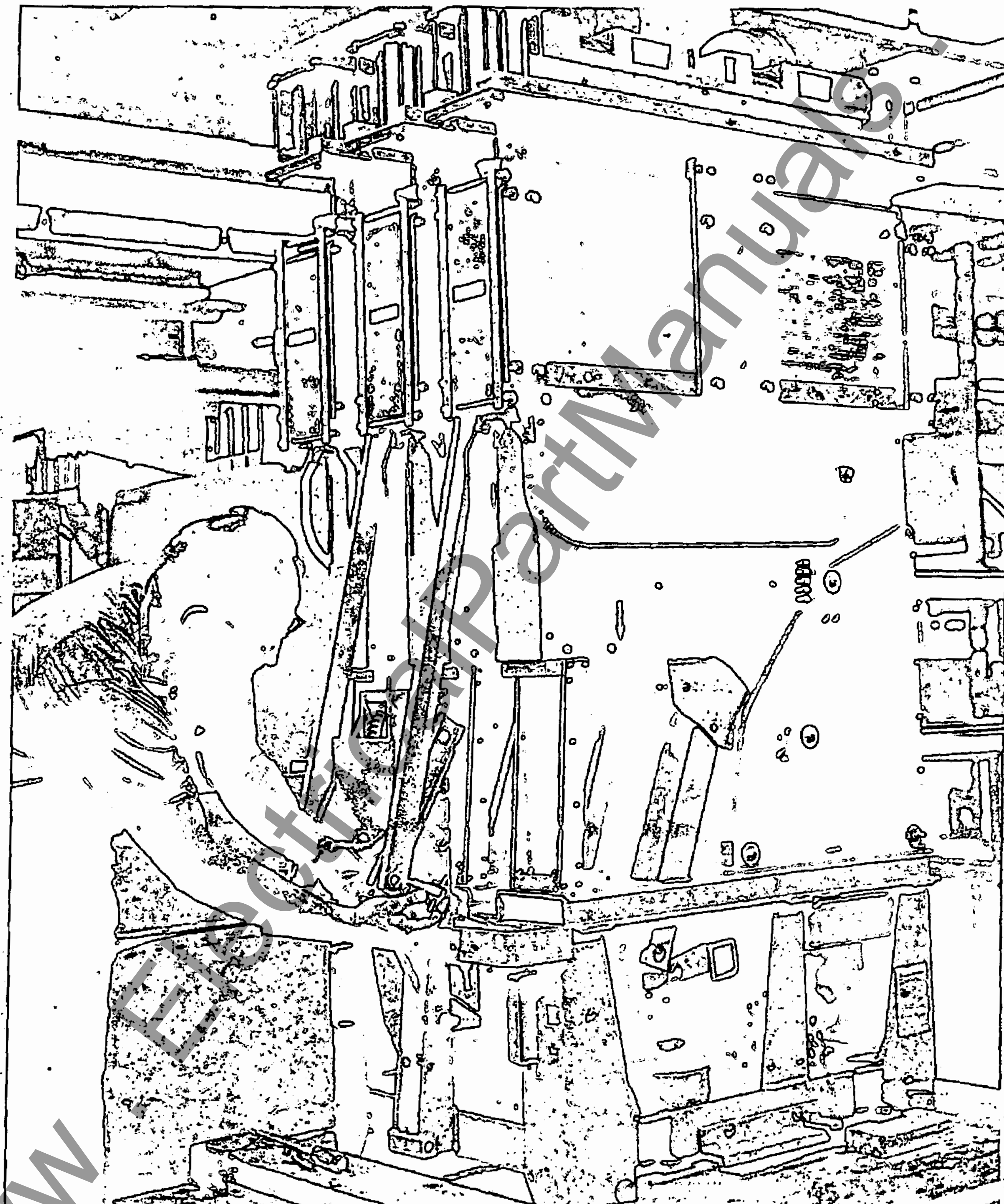


Figure 13F. – Arc Chute Lifter Installation: Attach lifting arms to crank arms on gear box with shoulder screws.

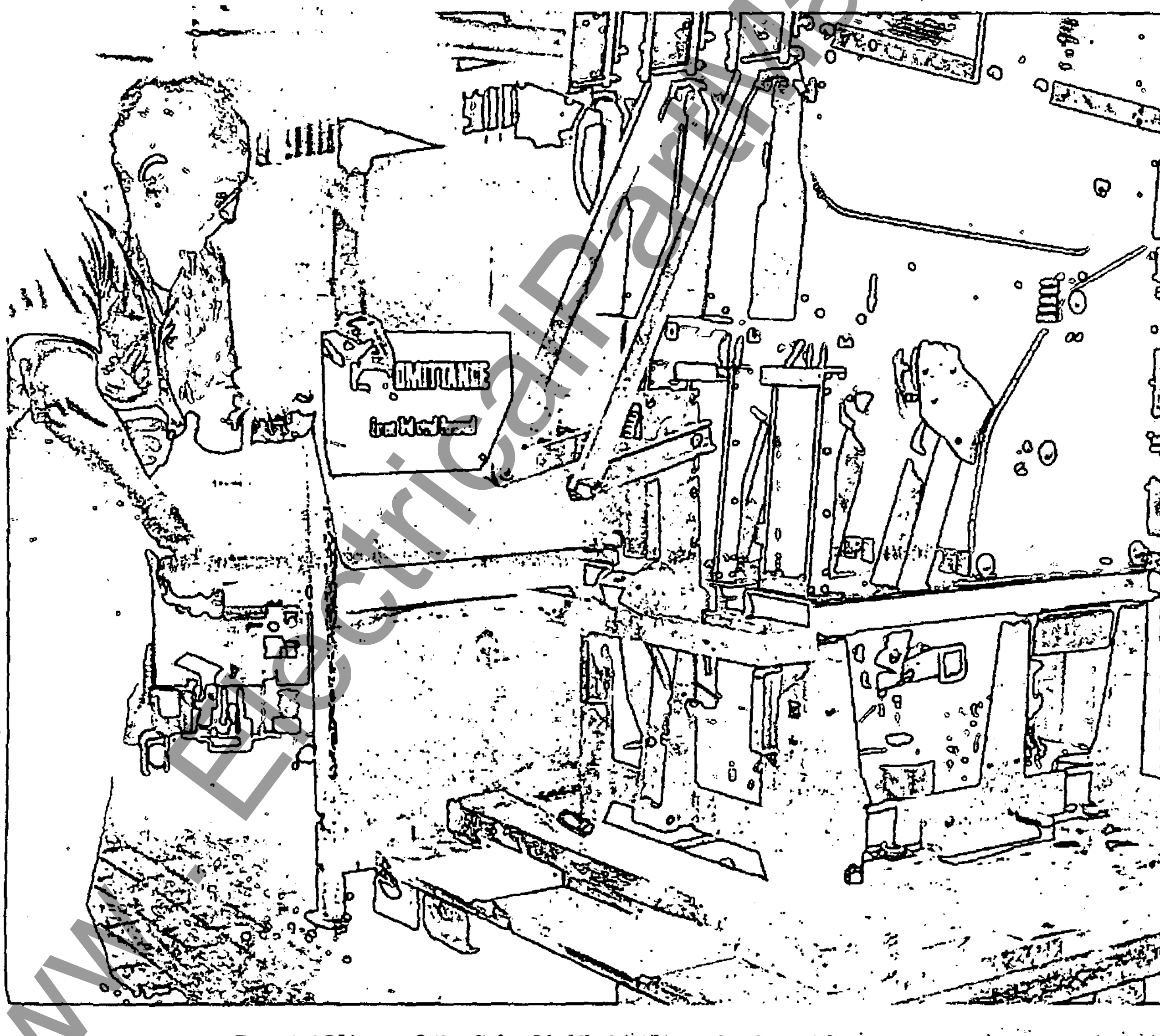


Figure 13G — Arc Chute Lifter Installation. Rotate handle to lift arc chutes.

The barrier stacks (Fig. 2, 23) can next be removed. Care must be taken as a slotted refractory plate fits between each guide (Fig. 2, 7) and arc runner (Fig. 2, 3 and 4).

On installation make certain the "vee" slots of the barrier stack are downward and that the slotted refractory plate slips between the arc runner and its guide.

On replacing the tube (Fig. 2, 18) avoid any twisting which could damage parts of the barrier stack. Tighten screws (49) and (50).

Lower arc chutes and replace phase barriers.

Servicing Contacts (Figure 12)

The frequency of contact inspection depends on severity of service. Remove disconnect arms as a unit by removing screw (5), nut (10) and spring (12). Carefully inspect all contact surfaces in hinge joint. Silver washer (6) and adjacent surfaces should be clean and free of roughness or galling. Lubricate silver washer and mating surfaces by rubbing in microfine dry graphite sparingly. Reassemble hinge joint. Tighten screw (5) and nut (10) so that cotter pin (19) can be re-installed. Spring (12) and washer (6) must be assembled in their original position to assure proper adjustment. Replace badly pitted or burned contacts before they are damaged to such an extent to cause improper operation of breaker.

Contact Alignment and Stroke

The contacts are an integral part of the bushing assemblies and are carefully aligned with the upper and lower bushings before shipment. Normally, no further adjustment is necessary. Check for proper contact alignment and, at the same time, for moving contact stroke by checking dimensions "c" (view "AA," Fig. 14) between contact finger (8) and plate (7), Fig. 14, on each side of bushing top and bottom of each phase separately. It is not necessary that contacts touch simultaneously on all three phases.

If this dimension is 3/64 to 5/64 of an inch at all four points in a phase, both the alignment of the contacts and the stroke of the moving contact of that phase are correct. If this dimension is not 3/64 to 5/64 of an inch, but all four points in any phase measure within 1/32 inch of each other, the moving contact stroke of that phase must be adjusted (see "Adjustment for Stroke"). If this dimension is not within tolerance and there is a difference of over 1/32 of an inch among the four measurements in a phase, it is necessary to first adjust the contact alignment (see "Adjustment for Contact Alignment") and then the stroke of the moving contact.

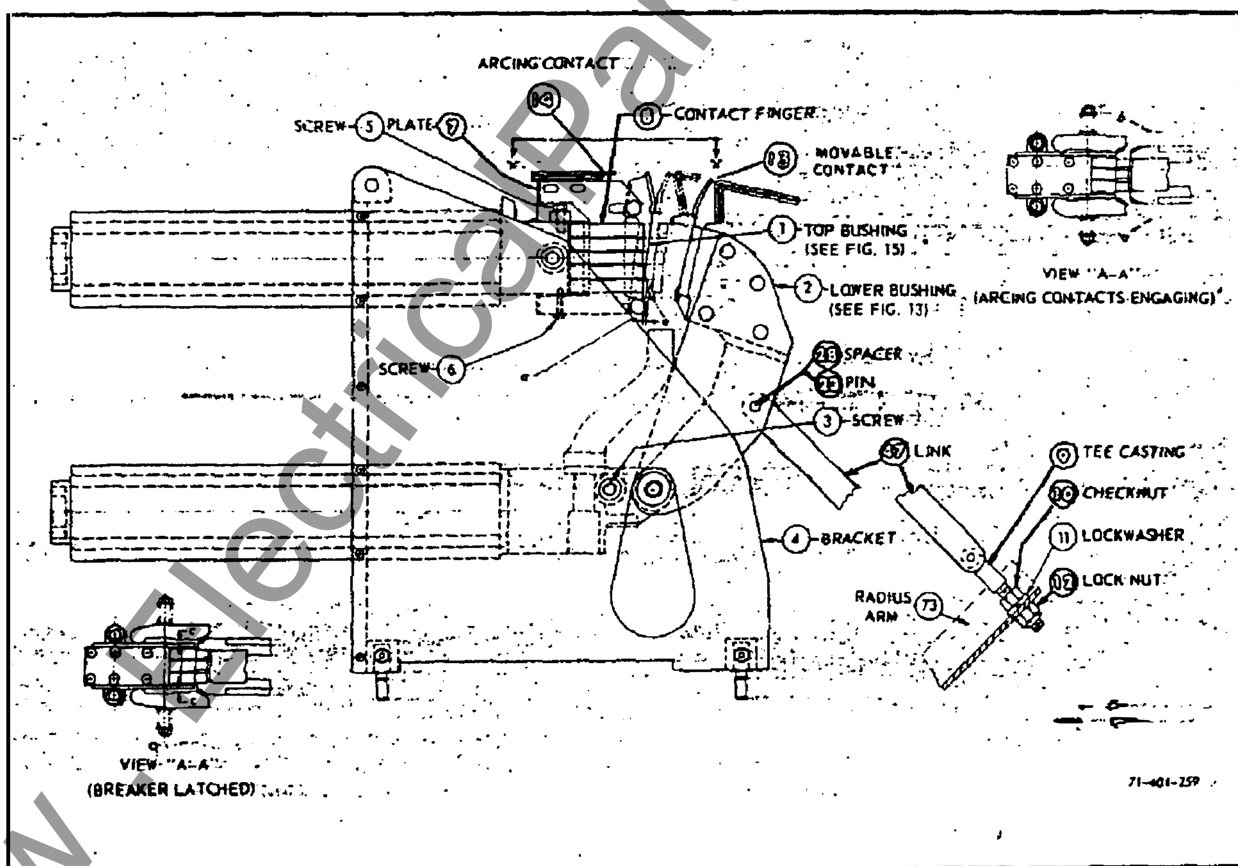


Figure 14. – Stud and Support Assembly

Adjustment for Contact Alignment

To adjust contact alignment, manually slow close the breaker until main contact fingers (fig. 15) touch. With main contact fingers on one side touching, no more than .020 inch* gap should exist to fingers on the other side. To adjust, release four screws (24, 25) and move blocks (8, 13) sideways until contacts are aligned. Tighten screws (24, 25).

When making this adjustment, make sure that block (8) is held firmly against stop on top of stud.

* If this exact dimension and tolerance cannot be met, move blocks (8, 13) so that on a power closure all four dimensions "c", Fig. 14 (top and bottom of both sides) in a phase are within .031 inch of one another. Contact alignment in this phase will then be in proper adjustment.

Adjustment for Stroke

This adjustment is accomplished by lengthening or shortening link (47), Fig. 1, between operator mechanism and interrupter moving blade to bring dimension "c" (view "AA," Fig. 14) to 3/64 to 5/64 of an inch. Open breaker. Referring to Fig. 14, adjust length of link (47) by turning checknut (10) and locknut (12) that hold tee casting (9) to radius arm (73). Fill space with washers. Make sure this adjustment brings dimensions "c" within tolerance in each phase. After reaching correct contact engagement, make sure that checknut (10) and locknut (12) are tightened securely (a compound, such as Locktite, may be used to insure against slipping). The stroke should be adjusted in each phase individually.

Contact Lead

Contact lead is adjusted at the factory and, normally, no further adjustment is necessary. However, it should be checked on each phase separately and only with contact alignment on the phase in correct adjustment.

Make sure breaker is open before checking for contact lead adjustment. Referring to Fig. 14, disconnect the movable contact from operator link (47) by removing pin (23) and two spacers (28). Bring movable arcing contact (13), so that it just touches the stationary arcing contact (14), as shown in view AA — "Arcing Contacts Engaging". Measure dimension "a," the shortest gap between the two tertiary contacts, and dimension "b", view AA, the shortest gap between the main contacts. Dimension "a" should be 1/8 to 5/32 inch and dimension "b" 9/32 to 3/8 inch.

If dimensions "a" and "b" are incorrect, remove one roll pin from each plate (10) and loosen eight screws (22), Fig. 15. Insert a spacer as thick as correct dimension "a" between the tertiary contacts, and apply a C-clamp bearing on rear of block (8), Fig. 15, and front of movable contact (13), Fig. 14. Tighten C-clamp to dimension "b." With contacts held in this position, move two plates (10), Fig. 15, back so that pins (16) are touching leading end of plate slots. Tighten eight screws (22), drill and insert pin to retain adjustment. Remove spacer, remove C-clamp and reconnect movable contact (Fig. 14, 13) to link (Fig. 14, 47).

Auxiliary Switch (Figure 16)

The type Q-10 auxiliary switch has been tested and adjusted at the factory. Contacts used in the breaker control circuit should not require further adjustment.

The switch is designed so that the individual contacts may be repositioned in fifteen degree steps without disassembling the switch.

Using long-nosed pliers, move the rotor contact (16) in the slot of the shell (14), compressing spring (15). This will free the rotor from the retainer (17). Rotate the rotor to the desired position and release. Be sure the rotor springs solidly back against the retainer to fully engage the rotor and retainer teeth.

Type SO-45F Solenoid Operator (Figure 17)

Latch Roll Clearance — With the breaker open and latch roll (15A) resting against stop bolt (75), the latch roll should clear the trip latch (27) by 1/64 to 3/64 of an inch. Adjustment is made by stop bolt (75).

Trip Latch — The trip latch (27) should engage the latch roll (15A) 1/8 to 3/16 of an inch above the lower edge of the latch face with the breaker closed. This adjustment offsets the clearance between the trip pin and trip latch. Refer to "trip solenoid" adjustment.

Trip Solenoid — The trip solenoid is adjusted by shims so that when the armature (4) is against the pole head (72) there is 1/32 to 3/32 of an inch travel after the breaker trips.

The trip pin (17A) clears the trip latch (27) when relaxed by 3/32 to 5/32 of an inch. Adjustment is by hex nut (76).

Prop Latch — The prop latch (97) is adjusted by shims so that it engages the toggle roll (15) 1/8 to 3/16 of an inch above the lower face of the latch.

Limit Switch — The limit switch (18) is located on the front of the operator frame and is contacted by an extension of the toggle roll (15) pin within the 4-bar toggle linkage.

Adjust by screw (103). Contact action required by circuit breaker should be at 3/4 to 7/8 of an inch stroke of ram cap (19).

Latch Check Switch — The latch check switch (1) is mounted on the bottom of the operator frame. The switch makes contact near the end of the reset travel of the lower link (70) of the 4-bar toggle linkage.

Adjust by moving switch bracket (66). The latch check switch may be jumper wired out or omitted if not used for instantaneous reclose.

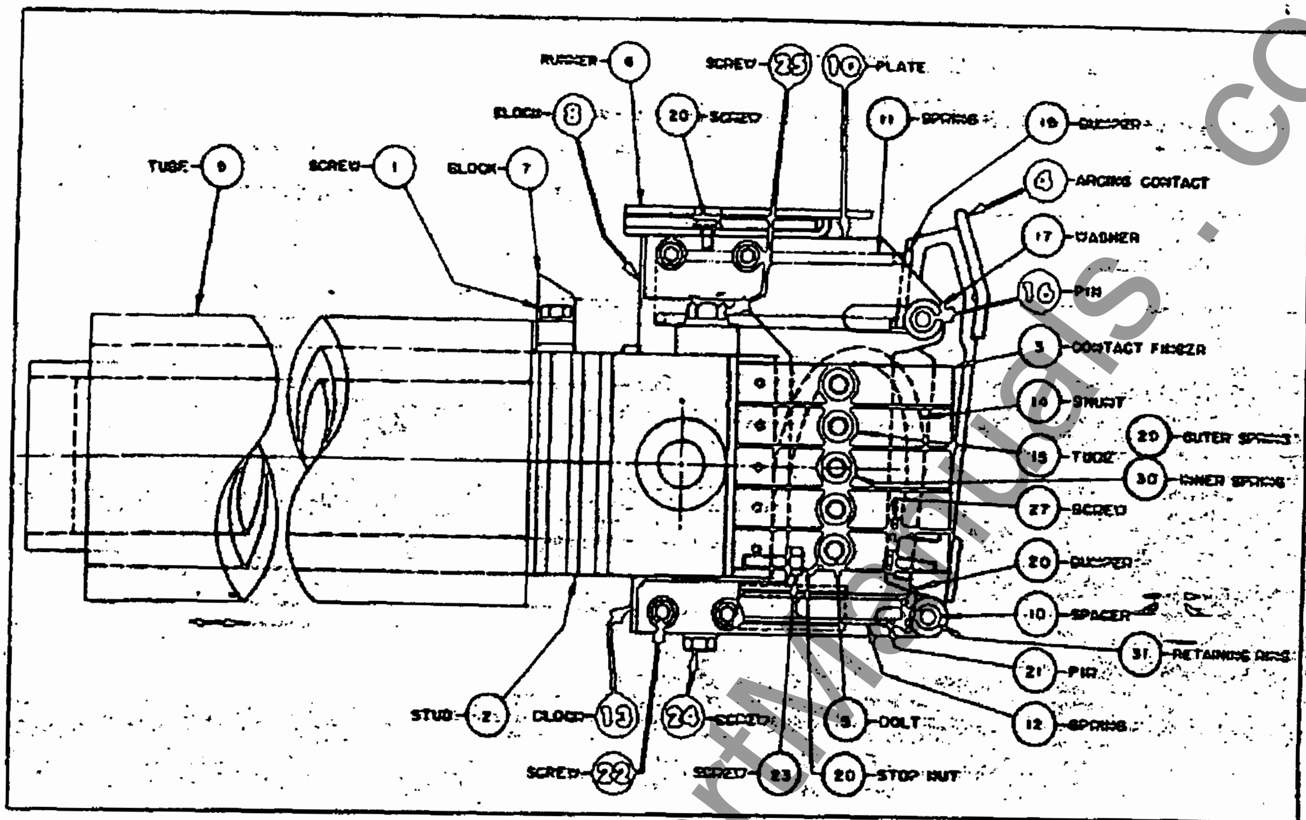


Figure 15. —Top Bushing Assembly.

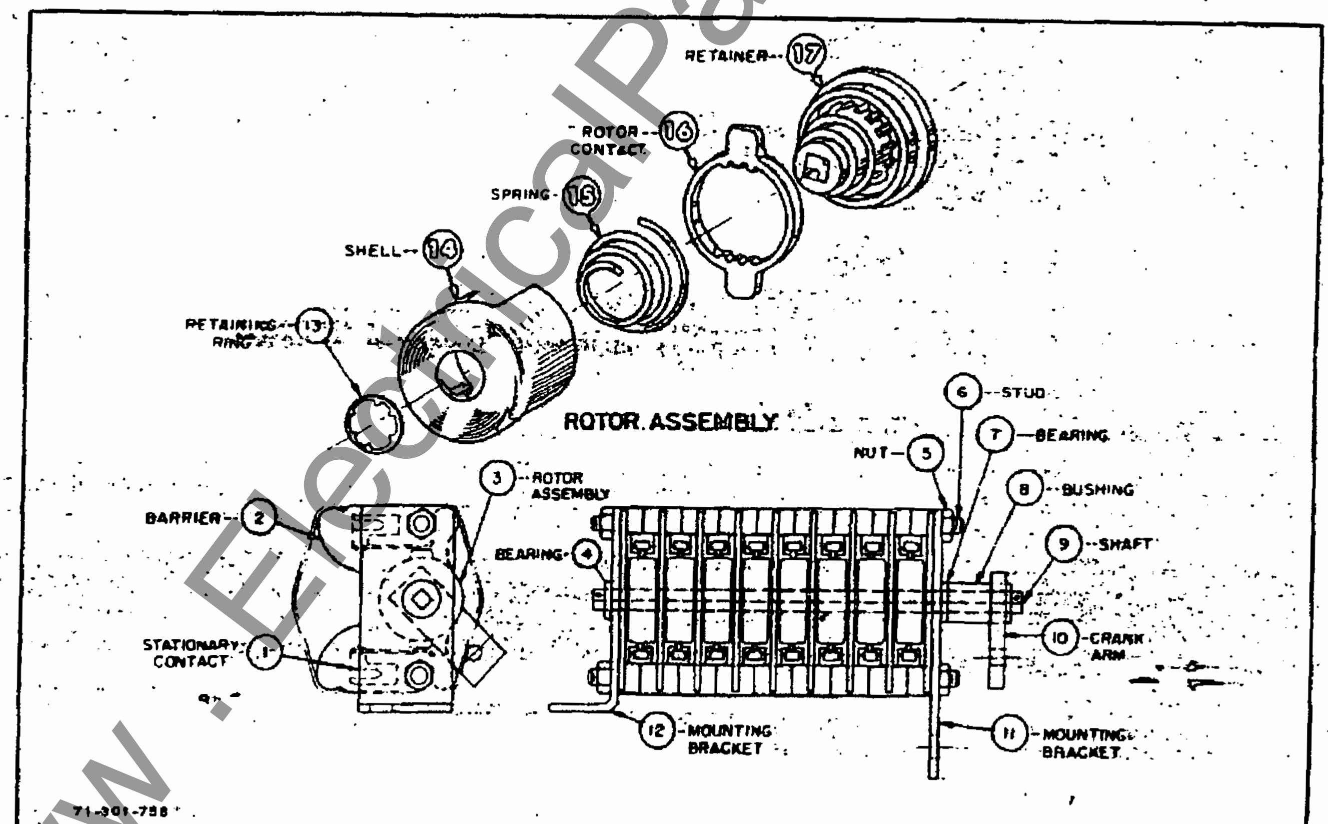


Figure 16. —Type Q-10 Auxiliary Switch

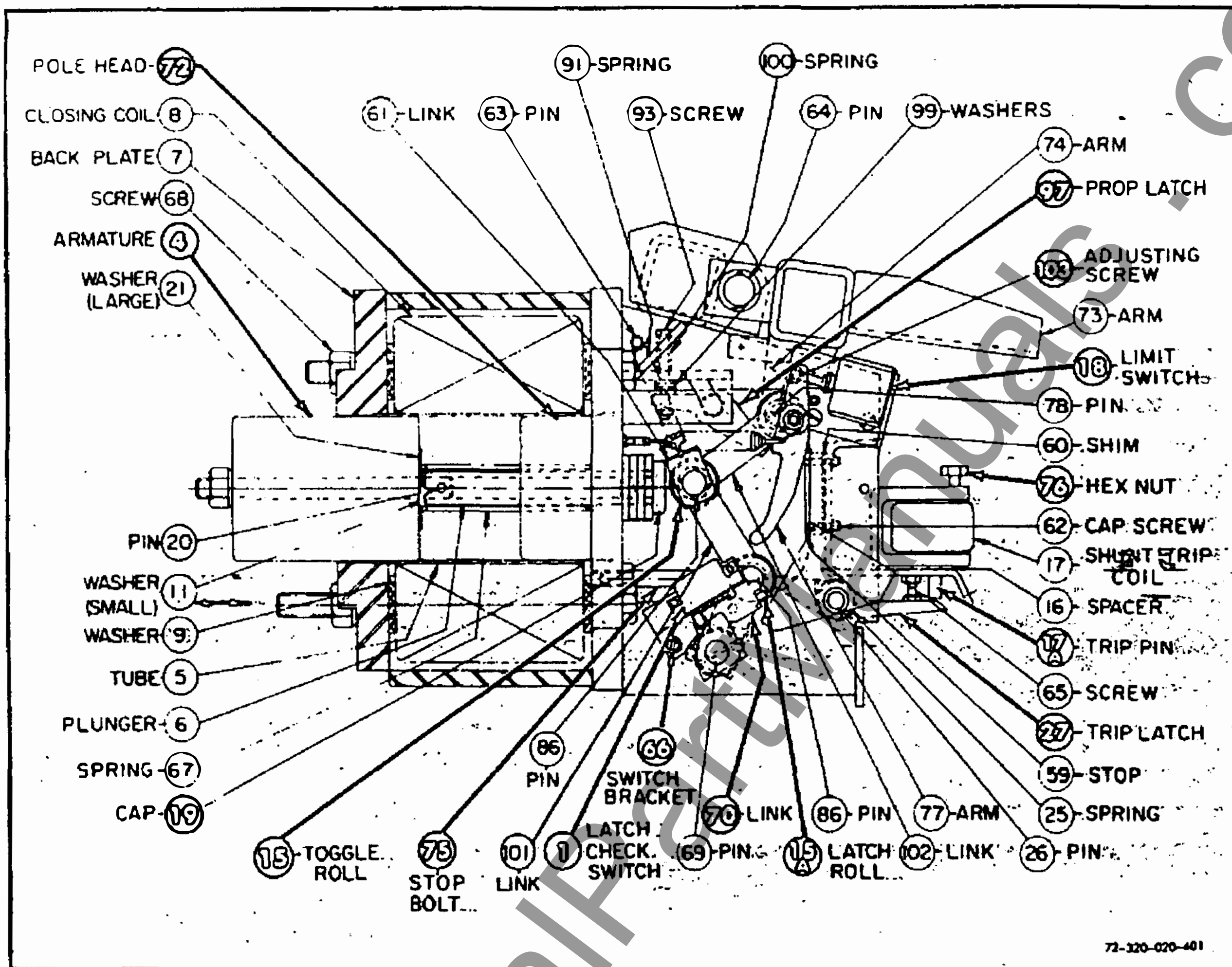


Figure 17. – Type SO-45F Solenoid Operator Assembly

Type SE-3 Stored Energy Operator (Figure 18–19)

Main Toggle Roll – When the breaker is in closed position with roll (55) against block (15), center of main toggle roll (55) should be 3/16 to 5/16 of an inch beyond line of centers of latch roll (56) and pin (3). Adjustment is made by adding or removing shims (8).

Trip Latch – The trip latch (9) should engage its roll (56) 1/8 to 3/16 of an inch above the lower edge of the latch face. Adjustment is made by shimming plate (36). This adjustment affects the clearance between the trip pin (49A) and the trip latch (9). With the springs charged and the breaker open, the trip latch (9) should clear its latch roll (56) by 1/64 to 3/64 of an inch. Adjustment is made by screw (7).

Closing Latch – The closing latch (18) should engage its roll (54) 3/16 of an inch above the lower edge of the latch face. See Spring Release Latch and Over-toggle Linkage (Page 29) for adjustment.

Tripping and Closing solenoid – The trip (49) and closing (50) solenoids action and adjustments are identical. Each solenoid has been adjusted at the factory and should require no further adjustment. If readjustment is required it should be made only when the trip and closing latch bites are in correct adjustment.

The armature should move freely and have no binds. The travel of the armature should be such that slow manual actuation will trip the latch and have 1/32 to 1/16 of an inch overtravel. Adjustment is made by shimming the solenoid with washers on the mounting screws.

Manual Charging of Closing Springs – A charging handle is provided to charge the closing springs manually. Open the control power circuit and engage the charging handle with the coupling on the front of the motor (48). The springs are charged by a counterclockwise rotation of the handle. Full spring compression will be realized by an audible snap as roll (54) drops back on latch (18) when cam (34) clears follower roll (35). Continue to rotate handle until motor coupling rotates freely without load.

Manually Slow Closing the Breaker (Figure 18) – Manual slow closing the breaker is done with a counterclockwise

rotation of the charging handle. Rotate handle only to the point where latch (9) drops in front of roll (56). Do Not Proceed Until You Are Sure That:

1. Cam (34) is engaged with following roll (35).
2. Latch (18) is not engaged with roll (54).

Breaker can now be closed to the point of contact touch by slowly turning charging handle clockwise.

The breaker mechanism can be cranked to any position and held because the motor gears are self-locking. Push trip button to open.

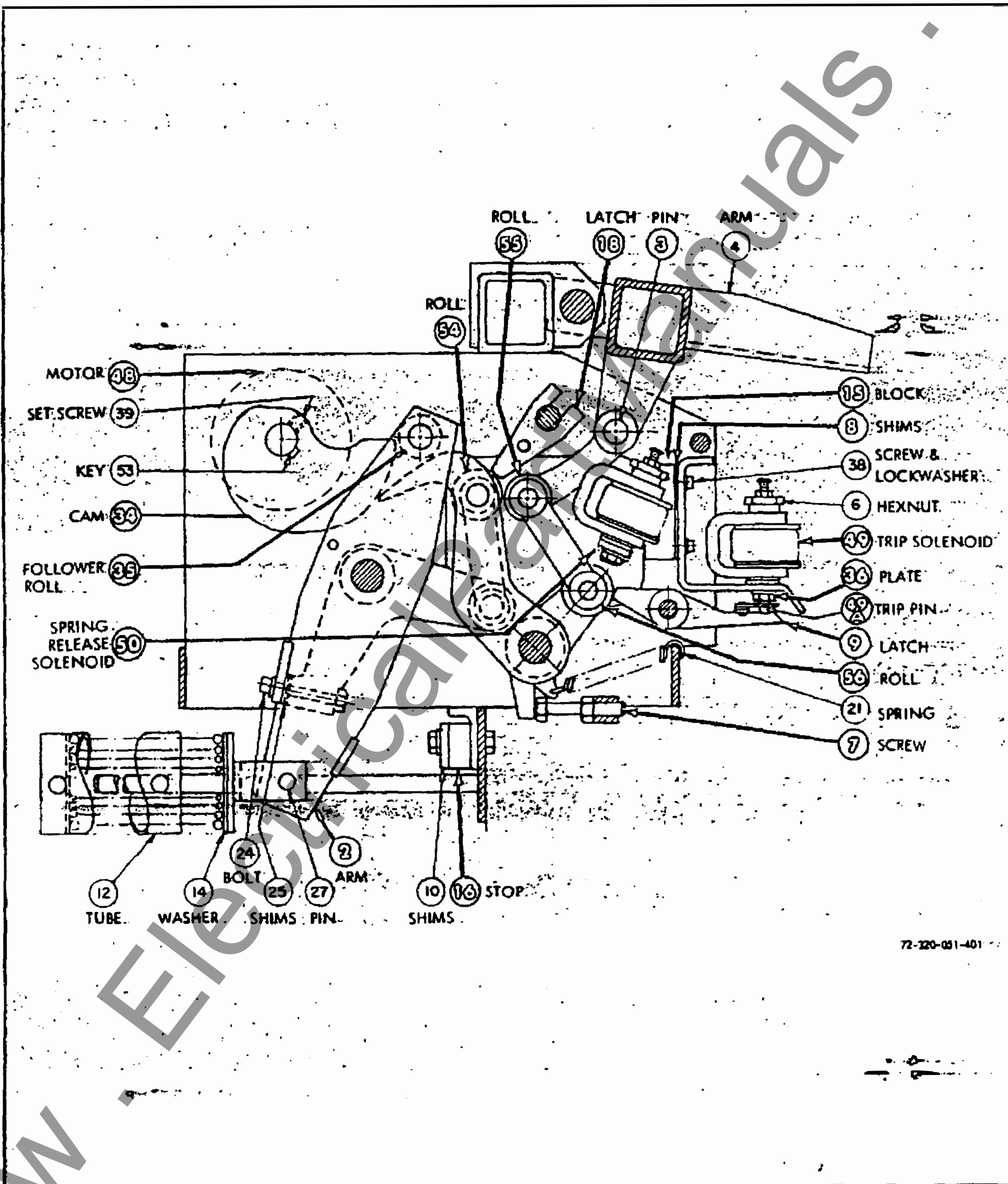


Figure 18 — Type SE-3 Stored Energy Operator Assembly

Control Switch (Figure 7) — The 88 control switch assembly is factory adjusted and pinned in position. If it should become inoperative, clean contact areas with an electrical cleaning solvent and spray dry silicon lubricant lightly between contact surfaces and pivot points. If readjustment is required, remove roll pin (2), loosen nut (3) and rotate the switch assembly clockwise as far as it will travel.

Manually charge the closing springs fully as described under "Manual Charging of Closing Springs," above. Place a 1/32-inch shim between one of the switch rolls (5) and arm (4). Slowly rotate the switch assembly counterclockwise until the switch roll reaches its extreme travel. Tighten nut (3). Relocate and drill .190 diameter hole (at a convenient location) and drive in roll pin (2). Remove 1/32-inch shim.

Spring Release Latch and Over Toggle Linkage (Figure 20) — To change bite of spring release latch, disconnect links (W and X) by removing pin (P) and turning screw (A) against crank (M). Check visually to see that bite is 3/16-in., or point of contact at about the center of the latch (18). Lock screw (A) with locknut (C). Adjust link (X), if necessary, so that pin (P) can be easily inserted. To adjust link (X), loosen locknut (B) and rotate the link end to increase or decrease its length.

The over toggle linkage (links W and X) functions to stabilize the position of the spring release latch (18). It is in proper adjustment when the center of pin (P) is 1/32 to 1/16-in. below a line drawn between the pivot points of links W and X. This adjustment is made with screw (C) which acts to position link (X).

With link (X) raised 1 3/8-inch to hold toggle in raised position (Fig. 11b), add or remove shims (F) to attain stop that limits raised position of toggle to 1 3/8-inch + 1/16 - .0 inch.

Add or remove shims (G) to provide 1/16 to 1/8-inch overtravel after latch releases and to raise pin (N) to height of link (L) ears with mechanism as shown in Fig. 11a. Adjust gap setting (1/8 to 3/16-inch), Fig. 20, with stop nut (H) and lock securely with nut (J).

CAUTION

Over toggle linkage (W, X and Pin P) must be free to move through the toggle position with crank (M) against screw (A) without moving latch (18). Otherwise, excessive load may exceed the output of the spring release coil (50), preventing the breaker from closing.

Spring Discharge (Figure 21) — During insertion or removal of the breaker from its cubicle, the closing springs of the operator will discharge automatically. This is done by release roll (6) passing over interlock angle (5), mounted on the cubicle floor. As the release roll passes over the inter-

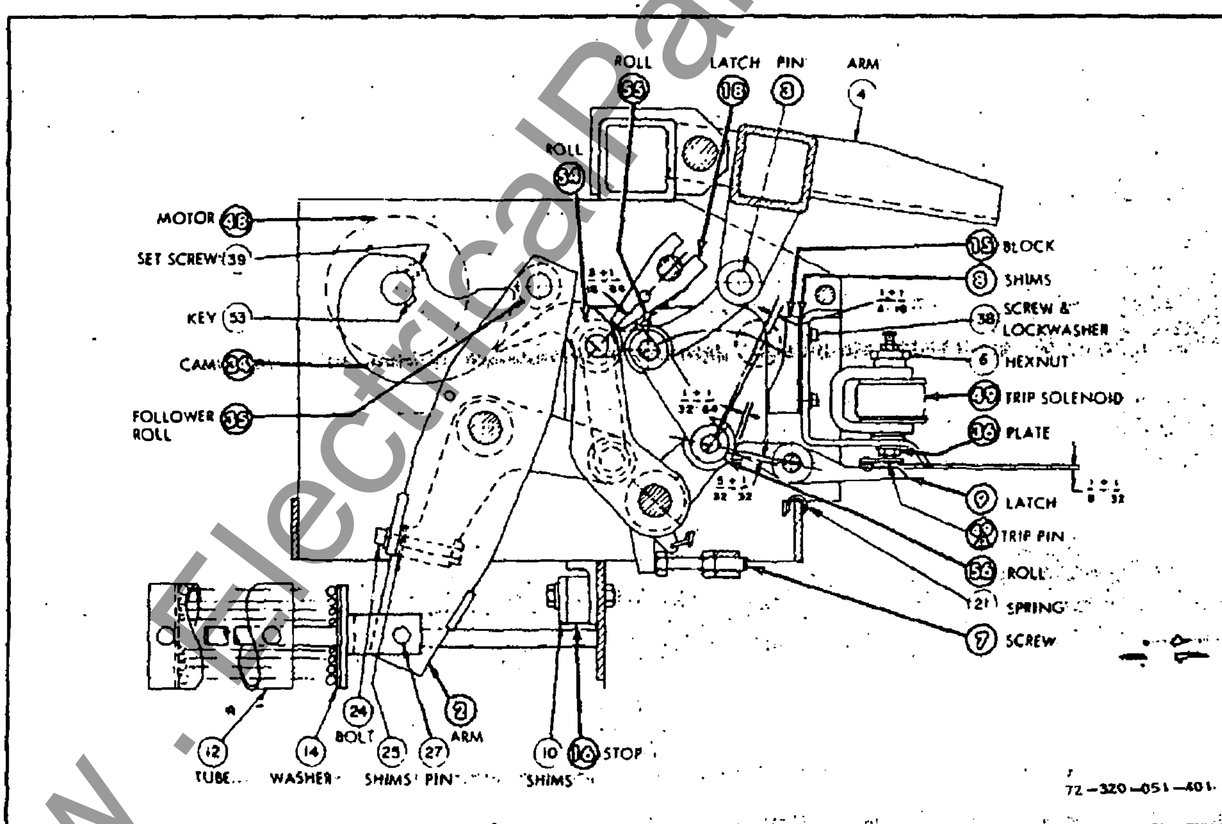


Figure 19. — Type SE-3 Stored Energy Operator Assembly Adjustments

lock angle, it rises and pushes up on the spring assembly (3). This causes link (1) to rotate pin (8) which raises lever (D) and link (X) (Fig. 19), releasing the closing springs. The length of the spring assembly can be increased, or decreased, if necessary, by adjusting clevis (11).

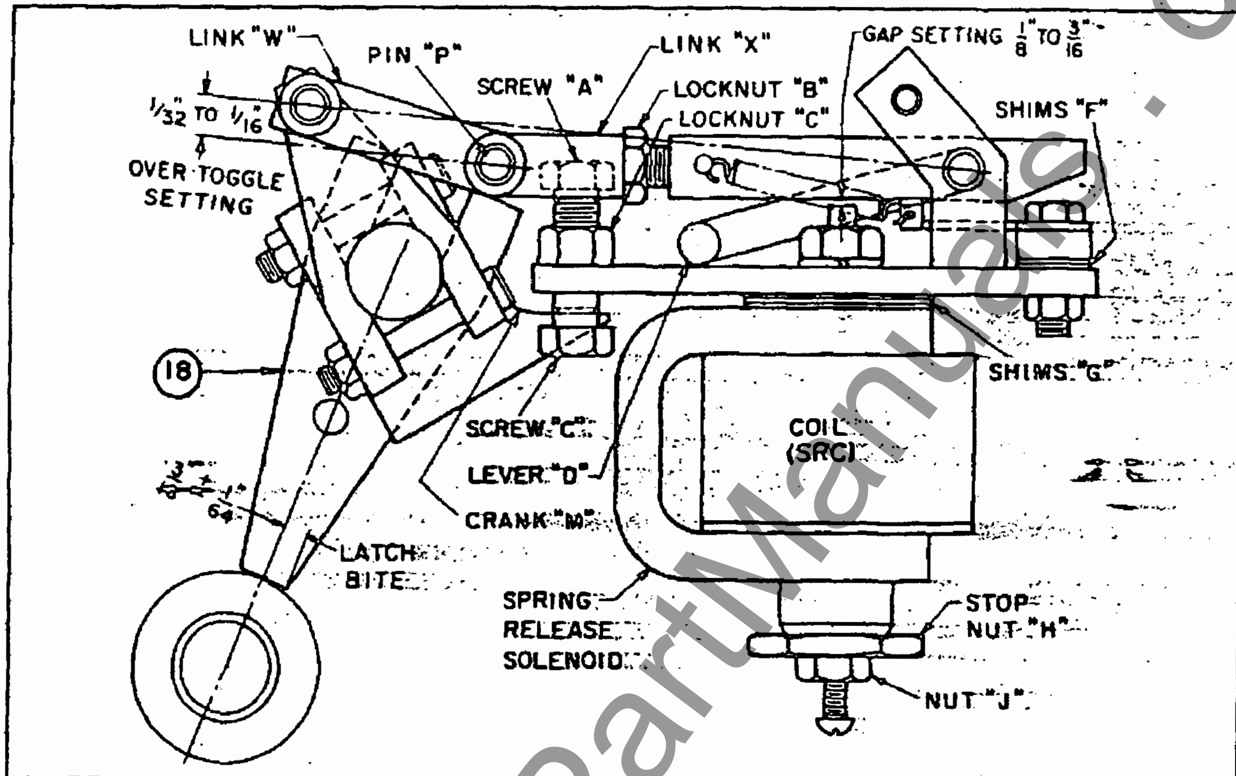


Figure 20. – Spring Release Latch.

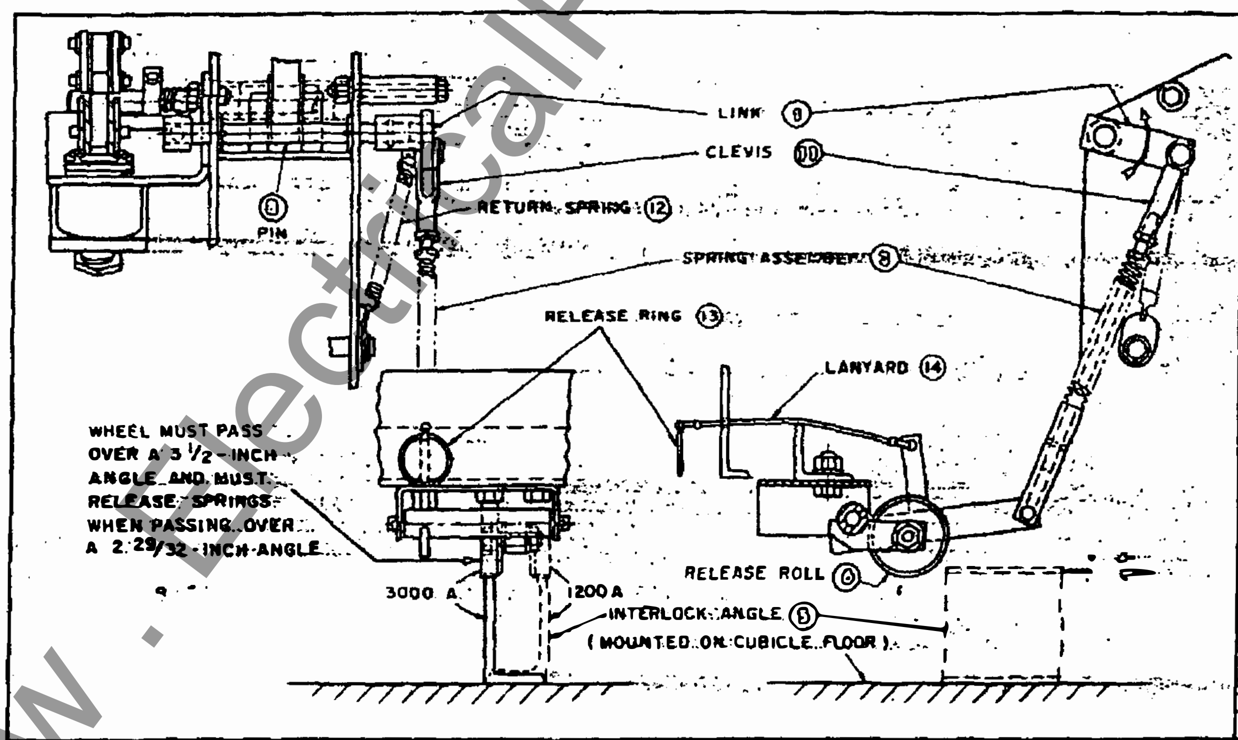


Figure 21. – Spring Release Arrangement, Type SE-3 Stored Energy Operator.

MAINTENANCE

General

Thorough, periodic inspection is important to satisfactory operation. Inspection and maintenance frequency depends on installation, site, weather and atmospheric conditions, experience of operating personnel and special operation requirements. Because of this, a well-planned and effective maintenance program depends largely on experience and practice.

Always inspect a breaker which has interrupted a heavy fault current.

All current carrying joints should be inspected to be sure all contact surfaces are free of protrusions or sharp plane changes. Rub microfine graphite well into contact surfaces and remove any excess. Do not get graphite on insulation. Insulation contaminated by graphite must be replaced.

Lubrication

The lubricant supplied ~~with~~ the cubicle accessories is intended to be used only on the cubicle's disconnect contacts and must not be used on any part of the circuit breaker.

Recommended circuit breaker lubrication points are shown in Figures 22 through 25. The chart (Fig. 22) outlines two methods of lubrication. The first method requires no disassembly and is suggested for the prevention of problems which could be created by severe environmental or operating conditions.

The second method follows a procedure similar to that performed on the breaker at the factory. Follow this procedure only in case of a general overhaul or disassembly.

Method for Cleaning Bearings

Needle and roller bearings are factory lubricated for life and should not require attention. However, the best of greases are affected by time and atmospheric conditions and may require service.

To lubricate these bearings when parts are disassembled, the following procedure is recommended: Clean in solvent, wash in alcohol, spin in light machine oil, drain and repack with beacon P-325 grease.

DO NOT REMOVE NEEDLE BEARINGS FROM THE RETAINING PART

The sleeve bearings should be removed, washed in clean solvent, drained and dried thoroughly before lubricating with beacon P-290.

LUBRICATION KEY	PART DESCRIPTION	SUGGESTED LUBRICATION AT EVERY 2000 OPERATIONS OR ONCE EVERY YEAR.	ALTERNATE LUBRICATION (REQUIRES DISASSEMBLY) RECOMMENDED AFTER EVERY 10,000 OPER.
A	GROUND SURFACES SUCH AS LATCHES, ROLLERS, PROPS, ETC.	WIPE CLEAN AND SPRAY WITH 'MOLYCOTE 557' 15-171-270-001	WASH CLEAN AND SPRAY WITH 'MOLYCOTE 557' 15-171-270-001
B	NYLON SLEEVE BEARINGS. SUCH AS: THE CONTACT ARM HINGE PIN.	NO LUBRICATION REQUIRED.	NO LUBRICATION REQUIRED.
C	SLEEVE BEARINGS AND PIVOT PINS, ROTATING PARTS SUCH AS DRIVE PINION, DRIVING CRANKS, WALKING BEAM PIVOT PIN, SLIDE AND PIVOT PIN.	LIGHT APPLICATION OF 'MOLYCOTE PENELUBE' 15-171-270-002	REMOVE PINS OR BEARINGS, CLEAN PER INSTRUCTIONS AND APPLY 'BEACON P-290' 00-337-131-001
D	SLIDING SURFACES SUCH AS: THE MAIN SOLENOID ARMATURE.	LIGHT APPLICATION OF 'MOLYCOTE 557'	WIPE CLEAN AND APPLY 'MOLYCOTE 557' LIBERALLY.
E	AIR PUFFER CYLINDERS.	WIPE CLEAN AND APPLY TRANSFORMER OIL #3 TO FELT	WASH CLEAN AND WET FELT RING IN TRANSFORMER OIL #3.
F	ROLLER AND NEEDLE BEARINGS.	NO LUBRICATION REQUIRED.	CLEAN PER INSTRUCTIONS AND REPACK WITH 'BEACON P-325'
G	DRY PIVOT POINTS.	NO LUBRICATION REQUIRED.	NO LUBRICATION REQUIRED.
H	PRIMARY DISCONNECT FINGERS, GROUNDING CONTACT.	WIPE CLEAN AND APPLY A THIN FILM OF 'LUBRIPLATE'. 00-337-111-011	WIPE CLEAN AND APPLY A THIN FILM OF 'LUBRIPLATE'. 00-337-111-011
I	ARCING CONTACTS.	DO NOT LUBRICATE.	DO NOT LUBRICATE.
J	CONTACT ARM HINGE ASSEMBLY, SILVER WASHER BETWEEN BUSHING AND THE CONTACT ARM.	WIPE CLEAN AND RUB IN MICROFINE DRY GRAPHITE.	WIPE CLEAN AND RUB IN MICROFINE DRY GRAPHITE.

Figure 22. – Lubrication Chart (Refer to figures 23-25)

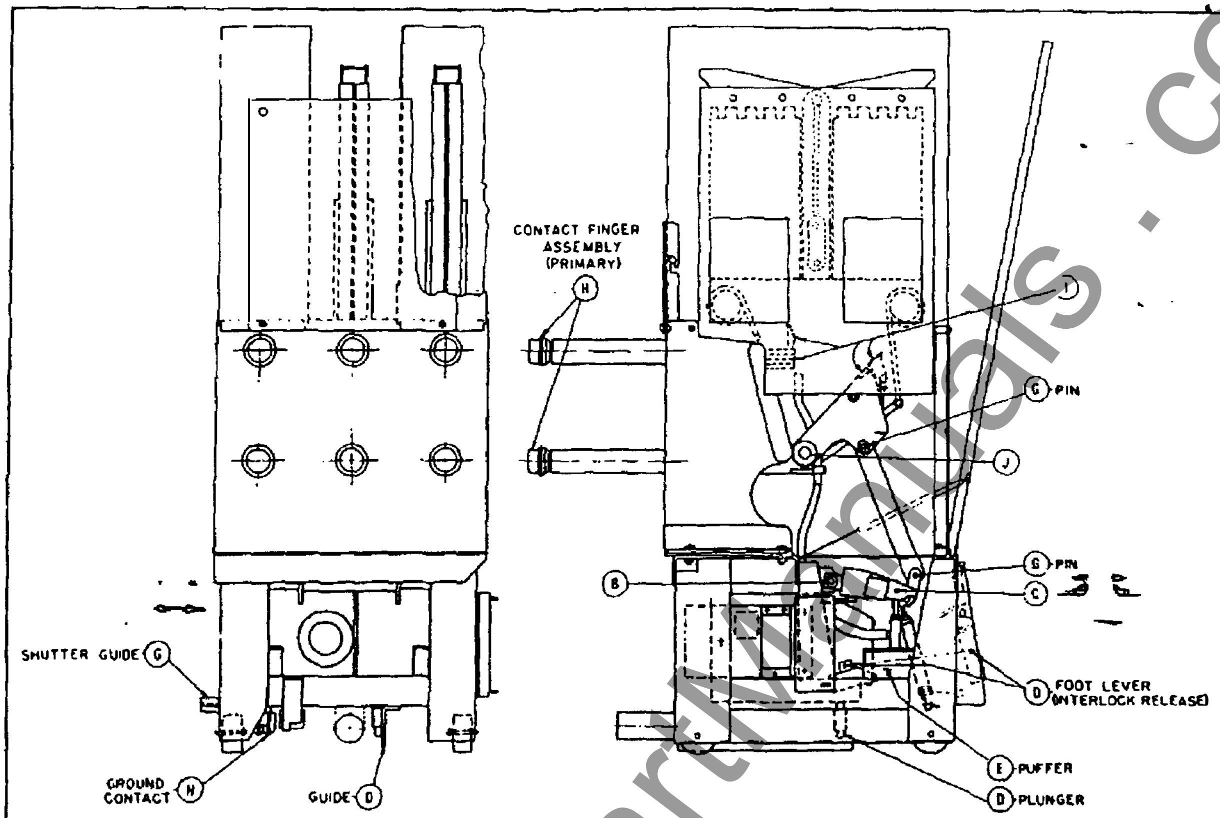


Figure 23. – Lubrication Points on Breaker

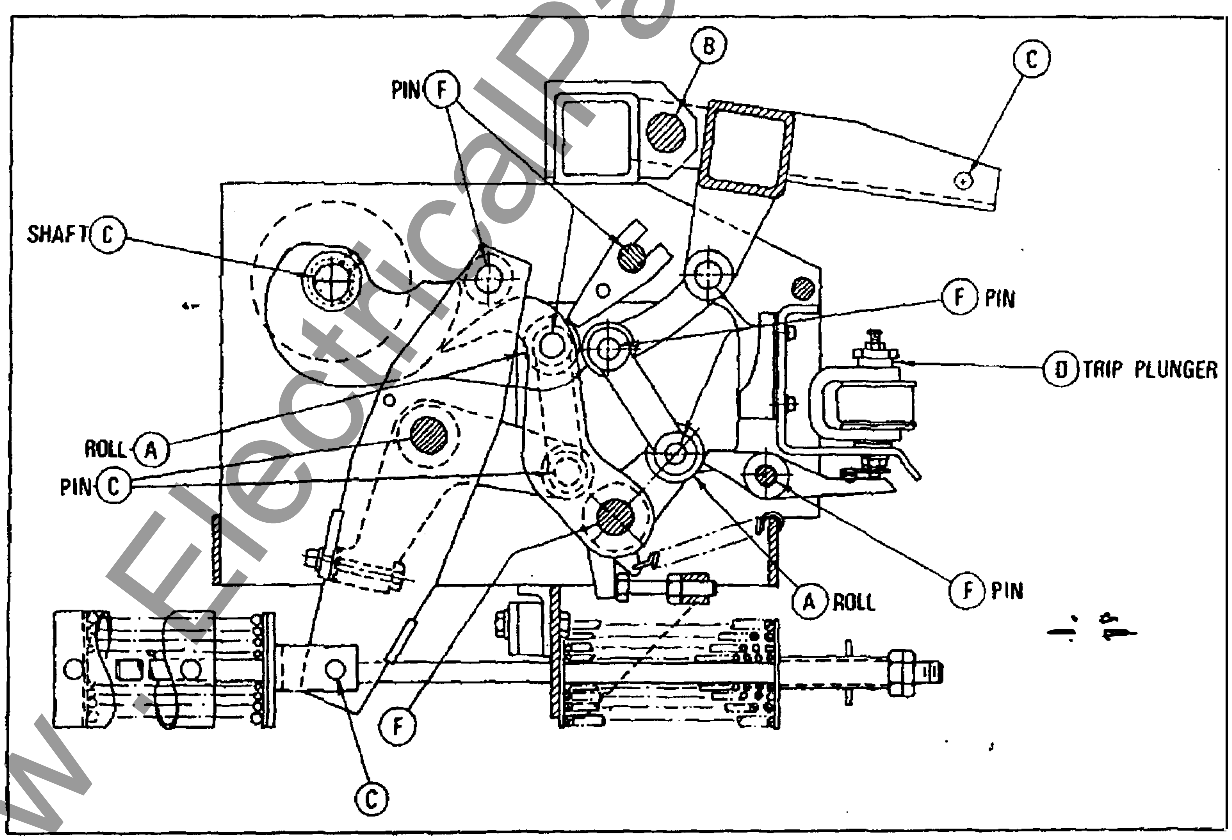


Figure 24. – Lubrication Points on Stored Energy Operator

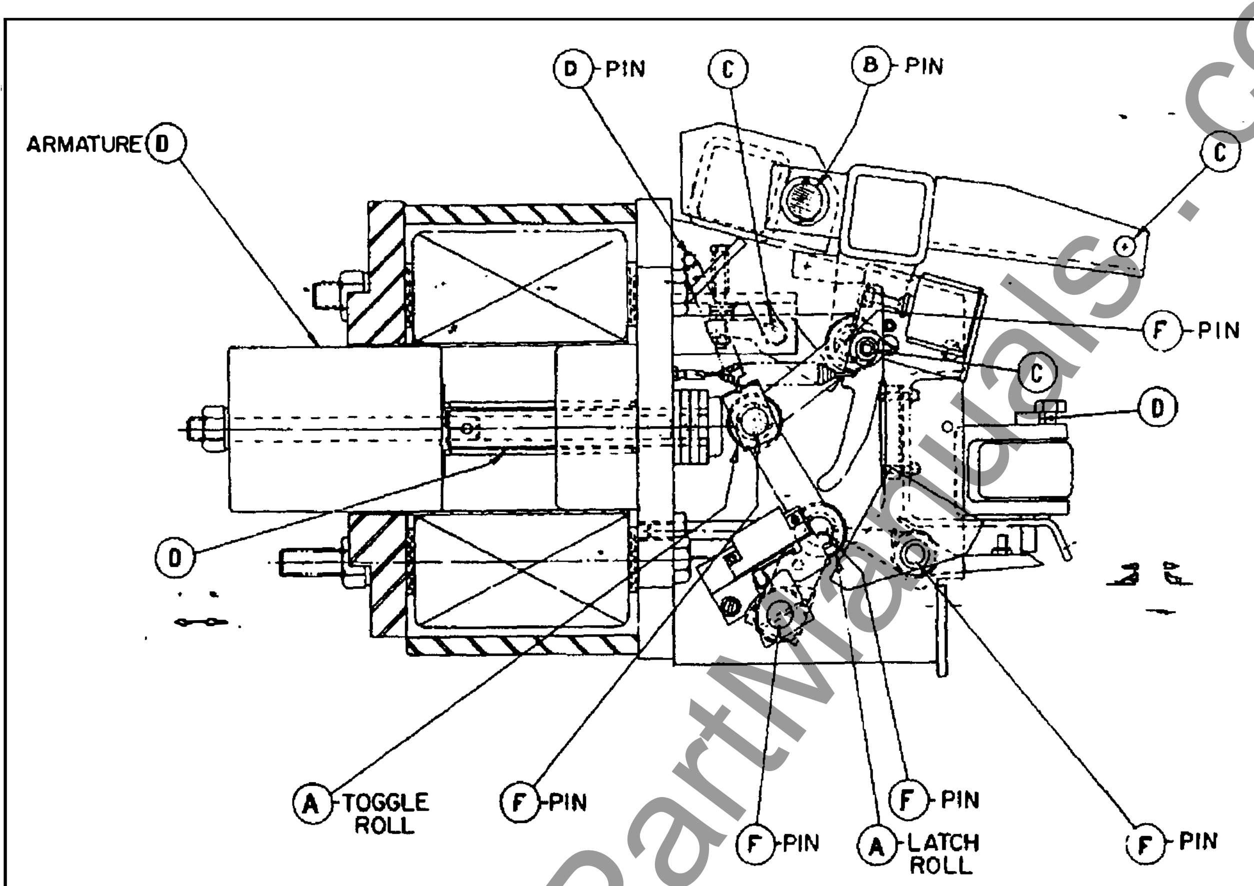


Figure 25. – Lubrication Points on Solenoid Operator

Air Puffers

Air puffers (E, Fig. 23) are important to the interruption process because they provide a flow of air which assists in controlling the shape of the arc column at low current values. This control causes the arc to make an earlier transfer to the arc runners, thereby energizing the magnetic circuit which drives the arc into the barrier stack. This action produces a shorter arcing time than would be possible by relying only on the thermal effects of the arc to achieve the transfer to the arc runners.

Puffers should be inspected during regular breaker maintenance periods. Hoses should be checked for flexibility, freedom from kinking or collapse and soundness of connection to mating parts. Cylinders should be checked for cleanliness and freedom from deposits which might retard the motion of the piston. Pistons should be checked for free movement within the cylinder and that the seals are flexible and contact the walls of the cylinder. Transformer oil is used on felt seals to keep the material pliable, reduce shrinkage and to provide lubrication. The oil should moisten but not saturate the felt.

Replace seal material if it becomes inflexible or does not make contact with the cylinder walls.

The air output from the puffer nozzle may be checked with the arc chutes tilted (refer to "Tilting Arc Chutes", page 23 and Figures 13A through G). Crush a 4½ x 4½-inch sheet of tissue paper, place it in the nozzle opening and check to see that it is dislodged when the breaker is opened.