ALLIS-CHALMERS

INSTRUCTION BOOK

SDO OIL CIRCUIT BREAKER

Type-15 & 23

WITH SE-3B STORED ENERGY OPERATOR

AND TC-2 INTERRUPTING DEVICE

DECEMBER 1970

BWX-6753

ALLIS-CHALMERS

TABLE OF CONTENTS
TYPE SDO-15 AND 23
OIL CIRCUIT BREAKER

CONTENTS

ALLIS-CHALMERS

TABLE OF ILLUSTRATIONS

ALLIS-CHALMERS

INSTRUCTIONS FOR INSTALLATION AND OPERATION

GENERAL

An Allis-Chalmers Type SDO Power Oil Circuit Breaker is a three phase single tank, distribution type, outdoor unit for use under the 15.5 or the 25.8 maximum design KV rating. It is shipped in assembled form, with only the diagonal braces removed to permit economical shipment with the lowest possible clearance.

Upon receipt of the oil circuit breaker, remove all packing traces and examine carefully to see that it has not been damaged in transit. If any injury is discovered, a claim for damages should be filed at once with the transportation company. Then notify the nearest District Office of Allis-Chalmers with a copy of the inspector's report.

LIFTING A TYPE SDO BREAKER

An SDO breaker may be lifted by the use of a sling and chain-and hooks of proper size. (Check local, state, or underwriter's specifications for regulations on safe chain vs load values.)

CAUTION: DO NOT ALLOW THE CHAINS OR SLINGS TO TOUCH THE BUSHINGS.

STORAGE

Immediately upon receipt of your Allis-Chalmers Oil Circuit Breaker it should be set upon its permanent foundation. If the breaker is not to be connected in service immediately, the tank should be cleaned, dried, and filled with approved insulating oil. When it is not possible to set the breaker on its permanent foundation, the tank should be filled with Allis-Chalmers Universal #3 Insulating Oil to protect the insulating parts of the breaker. If it is not possible to fill the tank with oil, the insulating parts must be kept dry through the use of space heaters or light bulbs which will maintain the inside temperature of the tank above the ambient.

The operating mechanism housing is weatherproof. However, to prevent corrosion due to moisture in the cabinet, the space heaters should be energized within a day or two at the latest, after their receipt, even to the extent of using temporary wiring. Machined parts of the operating mechanism should be coated with a light oil to protect them against corrosion.

Periodic inspection of the breaker while it is in storage is recommended to check for possible corrosion of mechanical parts. If the breaker has been filled with insulating oil and stored for some time, the oil should be tested and possibly filtered (refer to Section on Care of Insulating Oil).

OPERATION

GENERAL

All adjustments have been made at the factory before shipment and generally no change is required. Therefore, proceed to lower the oil tank; clean the bushings and examine them carefully for damage.

See that all contact surfaces are clean and all current carrying members are in good mechanical condition. Operate the breaker carefully by hand using the means provided to see that the settings are in accord with the adjustment instructions. Do not operate the unit electrically until all adjustments are correct. In particular, check to see that the plungers pass into the center of the hole in the bottom of the Type TC-2 interrupting device.

POLE UNIT (Refer to Fig. 2)

The essential elements of the SDO pole unit mechanism are a pair of radius arms 2-7 attached at one end to hexagonal main shaft 2-30, each carrying on the opposite end a link 2-28 connected to the crosshead 2-20 which drives movable member 2-1. A mechanism frame 2-15 guides the crosshead 2-20, retains the main shaft bearing 2-16 and holds the lift rod guiding system composed of two supports 2-21 and two rods guides 2-26. Bar 2-6 between the two radius arms 2-7 serves as the mechanical element which limits crosshead travel by coming against overtravel stop 2-9 on the close stroke and by striking the open position stop 2-5 of shock absorber 2-4 on the opening stroke. Yoke 2-14, mounted on the crosshead 2-20, provides a #10-32 tapped hole as means for connecting the user's speed analyzer.

OPERATING MECHANISM (Refer to Fig. 3)

The Type SDO breaker is equipped with an SE-3B spring type stored energy operator. This mechanism supplies the force (from compressed springs) which simultaneously closes the breaker and compresses the springs used to impart the opening velocity.

A motor compresses the springs through a gear reduction unit, cam and latching system. Energizing the close (spring release) coil operates the latch to release the compressed springs and close the breaker.

Refer to Figure 1 and note that the design and suspension of the SE-3B is unique in that it is mounted directly on the hexagonal main shaft which operates, and passes into, the pole unit without need for complex cabinet seals. In addition, it is so balanced with the pole unit mechanism that the only fastening needed for stability is a tab at the lower right of the operator to attach it to the control housing.

breaker from being closed if it is opened) while pushing up on the close coil armature to release latch roll 3-25 and discharge springs 3-62.

Now proceed to slow close the breaker as follows:

1. Using the manual closing crank, proceed as in charging the closing spring manually, as previously described, except stop as soon as the toggle roll 3-12 moves far enough to the right to permit toggle release latch 3-60 to reset behind the latch roll 3-75. (This action is evidenced by an audible click.)

2. At this point the roll crank 3-49 will not be sufficiently retrieved to latch its roll 3-25 behind latch 3-14, consequently the breaker closing action can now start by slowly releasing the spring charge against the closing toggle roll 3-12 by reversing the rotation of shaft 3-44 to the discharge direction. This is counterclockwise as viewed from the top of the gear reduction unit 3-39.

3. In the process of slowly discharging the closing springs against the breaker actuating toggle system (upper toggle link 4-10, toggle roll 4-12, lower toggle link 4-77), the follower roll 4-26 will cease to track on the surface of cam 4-30. The reason for this is that rolls 4-12 and 4-25 are in contact under the balanced forces of breaker load vs closing spring force thus holding themselves, and consequently arm 4-28 motionless. As cam 4-30 continues to run, it rotates out from under the follower roll 4-26 leaving it stationary.

4. Continue to rotate cam 4-30 by means of the manual handle until the cam shaft 4-31 no longer moves as shown by the stationary position of relay cam 4-37.

CAUTION: TO PREVENT DAMAGE TO THE MECHANISM, DO NOT PROCEED TO USE THE MAINTENANCE LEVER 4-53 UNTIL THE RELAY CAM 4-37 IS IN THE POSITION JUST DESCRIBED.

Remove the manual closing crank. Place the indented end of the maintenance lever 4-53 vertically against the notch in the chassis 4-55 above the spring assist pin.

Press the maintenance lever 4-53 to the left against the spring assist pin 4-51 until roll 4-25 pushes roll 4-12 over toggle against toggle stop 4-92 with a loud snap. The breaker is now closed.

OPEN POSITION STOP (Refer to Figs. 3 & 2)

1. By manual means charge springs 3-36 up to the point where the follower roll 3-26 is at the highest part of cam 3-30 as under "BREAKER TRIPPING SYSTEM", Step 1.

2. At this point, check the overtravel clearance of 1/16 ± 1/64 between latch roll 3-25 and latch 3-14. This clearance is factory preset by location of pin 3-50 in the proper hole.

3. Complete the spring charging sequence.

4. Trip the breaker open, check and adjust if necessary the open position stop 2-5 to create in the SE-3B mechanism a gap of 1/16 -0 +1/16 maximum between latch roll 3-12 and latch roll 3-25 with toggle release latch 3-60 and roll crank 3-46 reset. With this setting, the movable member, 2-1, should have a minimum stroke of 5-1/4".

TRIP FREE CLEARANCE (Refer to Fig. 4)

1. Close the breaker by pushing up on armature 3-20 as noted on the "PUSH TO CLOSE NAMEPLATE".

2. In the circuit breaker closed spring discharged position, there must be a clearance of 3/16" (+ 1/16, -0) between rolls 4-12 and 4-25. Modify the quantity of shim 4-56 to achieve this dimension. Adjustment within these limits permits the operator to go trip free and let the breaker come fully open (by permitting roll 4-12 to pass between stop 4-92 and roll 4-25).

CLOSING SPRING RELEASE (Refer to Fig. 3)

1. Adjust stop 3-16 to make the bottom edge of latch face 3-14 come 5/32 ± 1/32 below the line of centers between roll 3-25 and shaft 3-11.

2. With armature 3-20 against pole head 3-23, add or subtract shim 3-18 to set the bottom edge of latch 3-14 on the line of centers between roll 3-25 and shaft 3-11.

3. Adjust by bending, the armature stop 3-21 to position armature 3-20 to gain a clearance of at least 1/8" between plunger 3-17 and latch arm 3-15.

CAM FOLLOWER ROLL CLEARANCE (Refer to Fig. 3)

1. With closing spring 3-62 discharged and cam follower roll 3-26 opposite the minimum radius of cam 3-30, a clearance of 1/4 ± 1/8 between cam 3-30 and roll 3-26 is required.

the contact to one side against the spring and rotating it within its insulated rotor housing until it snaps into the desired position. Any changes made on this switch should be done carefully.

3. Power close breaker with plungers (8-3) extending no more than 5" from top surface of cross bar (8-4) and measure distance from bottom plate (6-8) to top of cross bar (8-4), dimension 9-b.

4. Add dimensions 9-a and 9-b and subtract 5/16" therefrom. Readjust plunger (8-3) to this value, ± 1/16", and lock securely with clamp bolts (8-7).

5. Wipe, clean, and coat top end of plunger with petroleum jelly.

6. Repeat Steps 2 through 5 for each individual plunger setting.

TC-2 INTERRUPTING DEVICE (Refer to Fig. 6)

The shell of the TC-2 interrupting device must be oriented so that the exhaust port faces outward, and in line with the lift rod. The proper position is maintained by a clip (6-14) which keys the contact block (6-2) to the shell (6-3) via a slot in the contact block, and a choice of 3 slots in the shell.

To change the position of the exhaust port, the following procedure is recommended:

1. Loosen clip (6-14) and set screw (6-15).

2. Using a 2-1/4" spanner wrench, loosen the bottom plate (6-8).

3. Rotate the contact block in the shell into correct alignment, having the top of the thread in the contact block 1/2 to 1 turn above the top of the shell within 1/2 turn.

4. Install clip (6-14).

5. Using a 2-1/4" spanner wrench, run in bottom plate (6-8) to provide a tight stacking, and tighten set screw (6-15).

CONTACT CLEANING

In general, before putting the tank in place, wipe all contact surfaces clean with a cloth soaked in a suitable solvent and re-coat with light application of petroleum jelly. After the breaker has been in service for a period of time or after an interruption, a file or sandpaper may be required to dress the arcing contacts. Abrasives, however, should never be used on the silver plated contact surfaces of the current carrying parts. Unlike copper, these contact surfaces are good electrical conductors, even when tarnished.

OIL & GAS SEPARATOR

The oil and gas separator is provided to facilitate escape of gases incident to circuit interruption and to prevent oil throw. It consists of a specially shaped chamber which provides a restricted passage leading from the interior of the insulator support to the

3. THE INTERNAL HYDRAULIC SHOCK ABSORBER IS EFFECTIVE ONLY WHEN UNDER OIL. THE OIL CIRCUIT BREAKER SHOULD BE TRIPPED AS LITTLE AS POSSIBLE BEFORE THE TANK WITH OIL IS IN PLACE TO AVOID THE POSSIBILITY OF DAMAGE TO THE APPARATUS.

CONNECTIONS

Oil circuit breakers of this class may be furnished with up to nine bushing type current transformers in accordance with service requirements. The standard arrangement and markings of current transformer leads conform with NEMA Standards. All breakers are wired according to this arrangement unless otherwise specified.

The current transformer ratios and taps are shown on the current transformer nameplates mounted in the operator housing opposite the terminal blocks for the bushing type current transformer leads. All current transformer leads are brought out to a terminal block and the identity of each lead indicated.

Bushing type current transformers have the equivalent of only one primary turn and must, therefore, operate on low values of ampere turns, particularly for low values of primary current. Below 200 amperes primary current, they require special consideration of the secondary burdens in their application.

GROUND CONNECTIONS

The frame of the oil circuit breaker should be permanently grounded. A good permanent low resistance ground is essential for adequate protection. A poor ground may be worse than no ground at all. It gives a false feeling of safety to those working around the equipment and may also result in ultimate loss of life or damage to the apparatus.

FINAL INSTALLING INSPECTION

1. Make sure that the oil circuit breaker is properly set up and levelled on its supporting structure.

2. See that all bearing surfaces of the operating mechanism have been lubricated.

3. Inspect all insulated wiring and see that it has not been damaged. Test the wiring for possible grounds or short circuits.

4. Make sure that all current carrying parts outside the oil circuit breaker are correctly insulated in accordance with standard practice.

5. Make sure that all joints are made correctly whether they are soldered joints, clamped joints made with wires or cables or bolted joints of copper bars.

REPAIR PARTS

When ordering supply parts, refer to the figures in this book and then specify quantity, name, figure number and reference, type, amperage, voltage and serial number of the breaker on which the parts are to be used. Use the recommended spare parts lists whenever possible.

EXAMPLE: - 6 - Plunger (Ref. #3, Fig. 8, Instruction Book BWX-6752) for Type SDO-15, 600 Ampere, 15 KV Oil Circuit Breakers, S/N 338134.

time in cycles must be converted to seconds by dividing by 60. Distance or travel must be converted to feet by dividing by 12.

EXAMPLE: Assume that on an SDO the triangle ABC is constructed. Time (CB) by measurement is found to be 2.0 cycles and travel (AC) is 3", then Speed equals 3" divided by 2.0 cycles. To convert this to feet per second -

$$\frac{\text{3" divided by 12}}{\text{2.0 cycles divided by 60}} = \frac{3}{12} \times \frac{60}{2.0} = \frac{15}{2.0} = 7.5 \text{ Feet per Second}$$

It can be seen that if the travel (AC) is a constant (which in our case is 3") then the breaker contact speed is expressed by the simple equation $\frac{15}{T}$ where T is the time (CB) in cycles.

The Cincinnati Analyzer is a dual speed device and the chart paper supplied by the manufacturer has two measurement scales. On the high drum speed scale 3/4" (horizontal measurement) equals one electrical cycle. On the low drum speed scale 3/8" equals one electrical cycle.

Care should be taken to construct the triangle as carefully as possible. A small drafting triangle is an excellent aid in constructing the velocity triangle.

SUMMARY OF MEASUREMENTS

Contact Part Time	2.0-2.5 cycles	for	5 cycle breakers
	1.5-1.6 cycles	for	3 cycle breakers
Opening Velocity	7 1/2-8 1/2 F.P.S.	for	both 3 cycle and 5 cycle breakers
Closing Velocity	5.5 F.P.S.		minimum for stored energy operators
	4.5 F.P.S.		minimum for solenoid operators at nominal rated voltage.
Closing Time	6-8 cycles		typical for stored energy operators.
	14-20 cycles		typical for solenoid operators at nominal voltage

ALLIS-CHALMERS

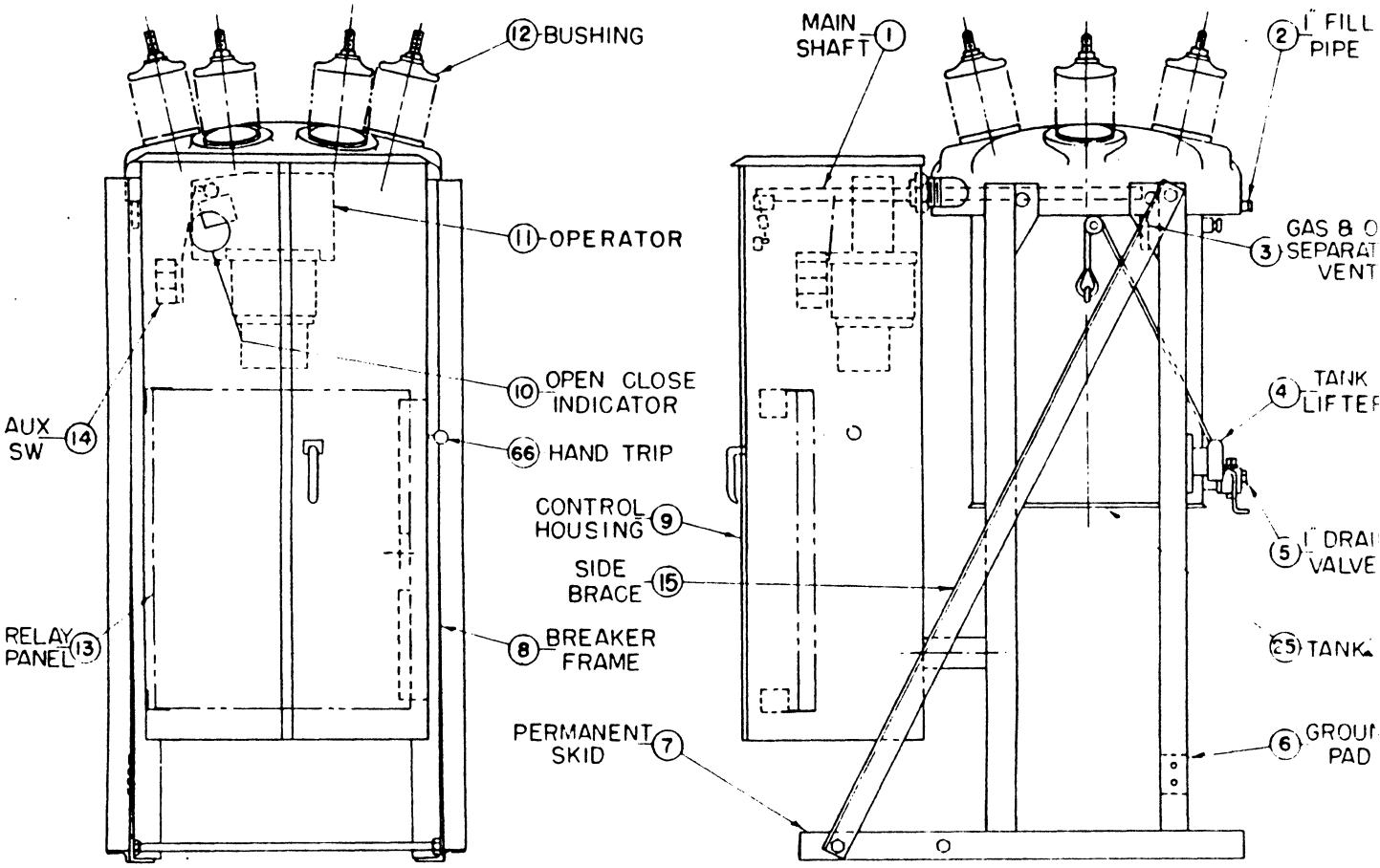


FIG. 1

TYPICAL SDO-15 FIXED FRAME OIL CIRCUIT BREAKER

OCT. 19, 1970 72-310-054-402

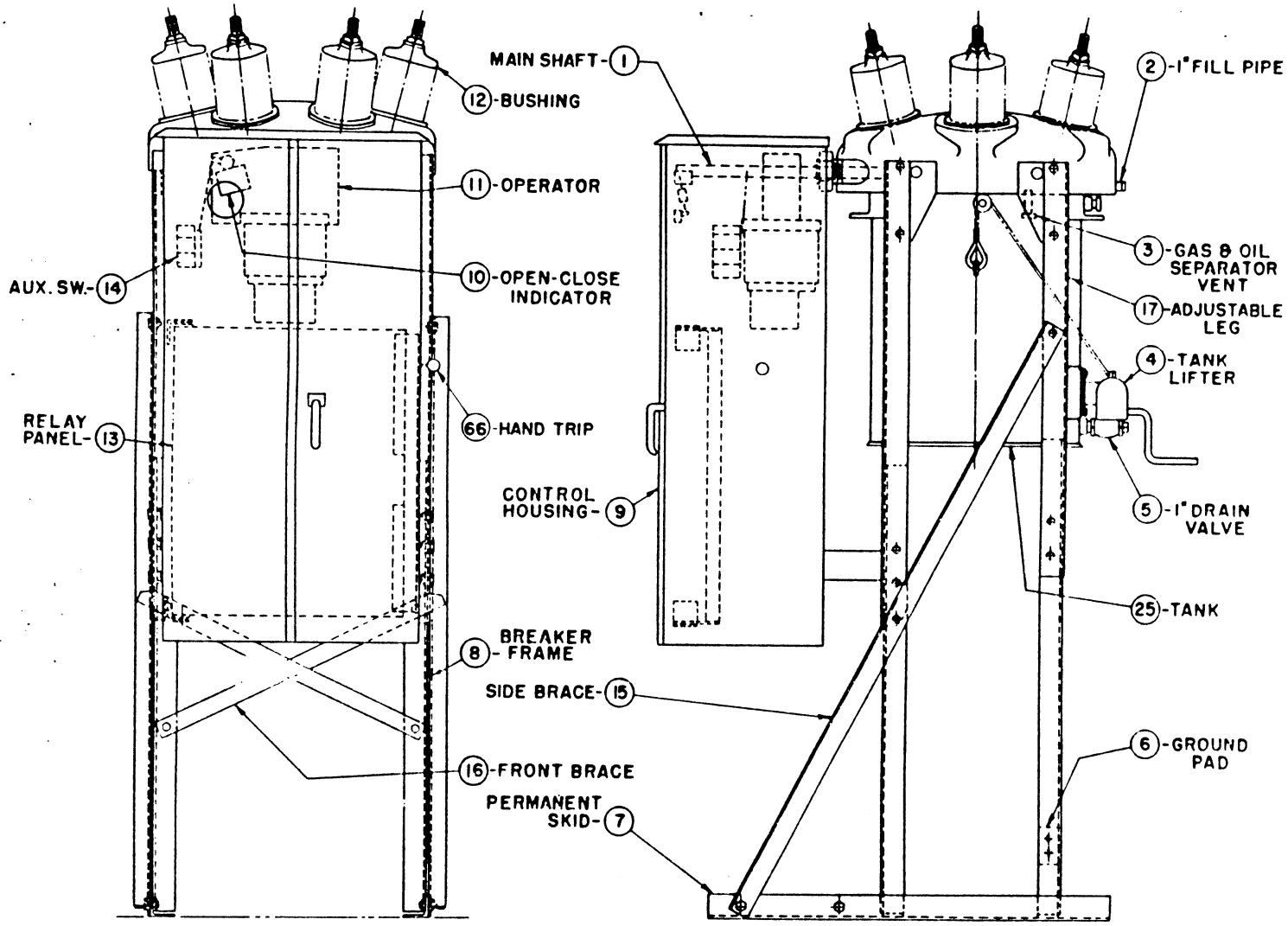


FIG. 1A

TYPICAL SDO-15/23 ADJUSTABLE FRAME OIL CIRCUIT BREAKER

OCT. 19, 1970

72-310-053-402

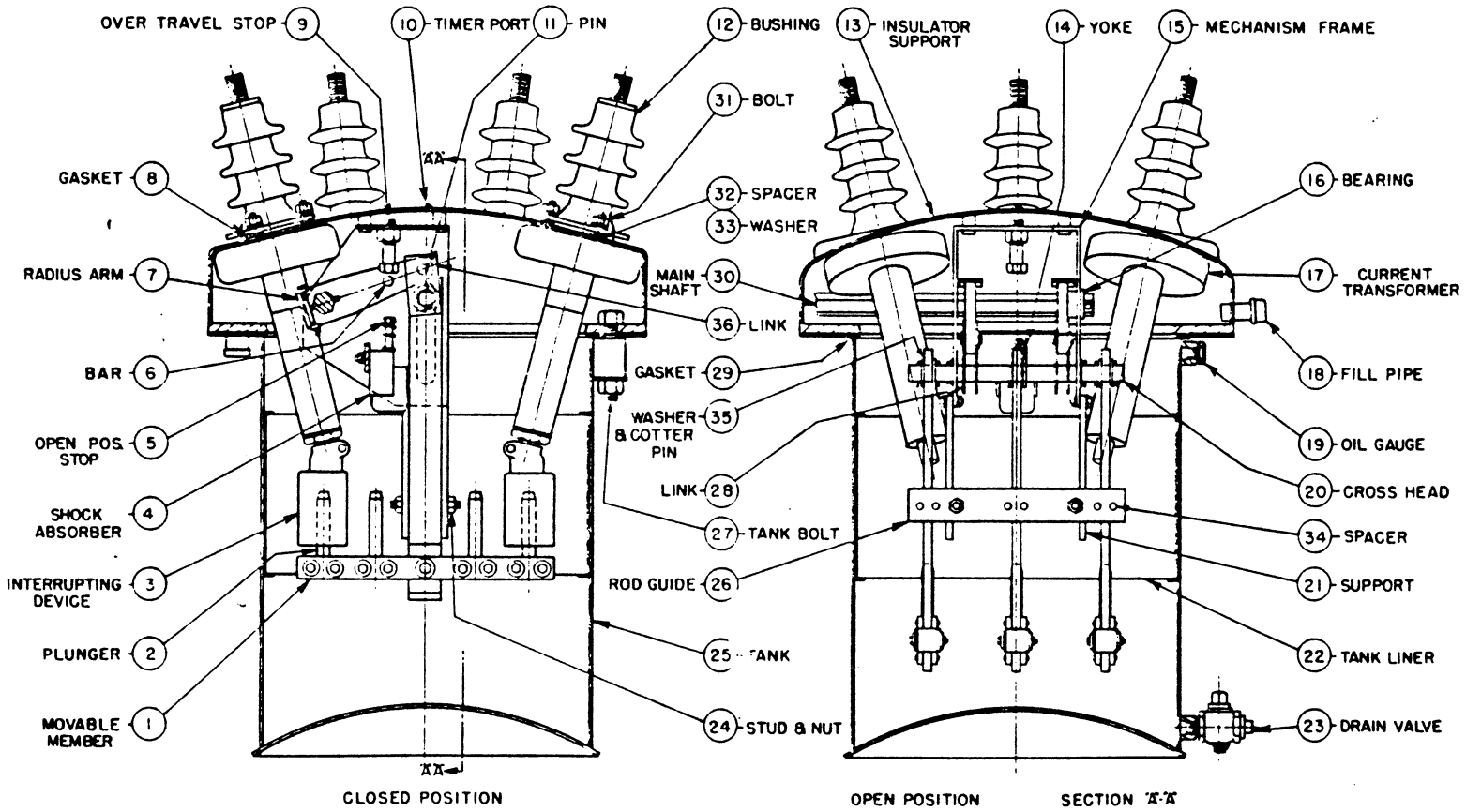


FIG. 2

TYPICAL SDO-15 POLE UNIT

SEPT 12, 1963 71-401-665-401

ALLIS-CHALMERS

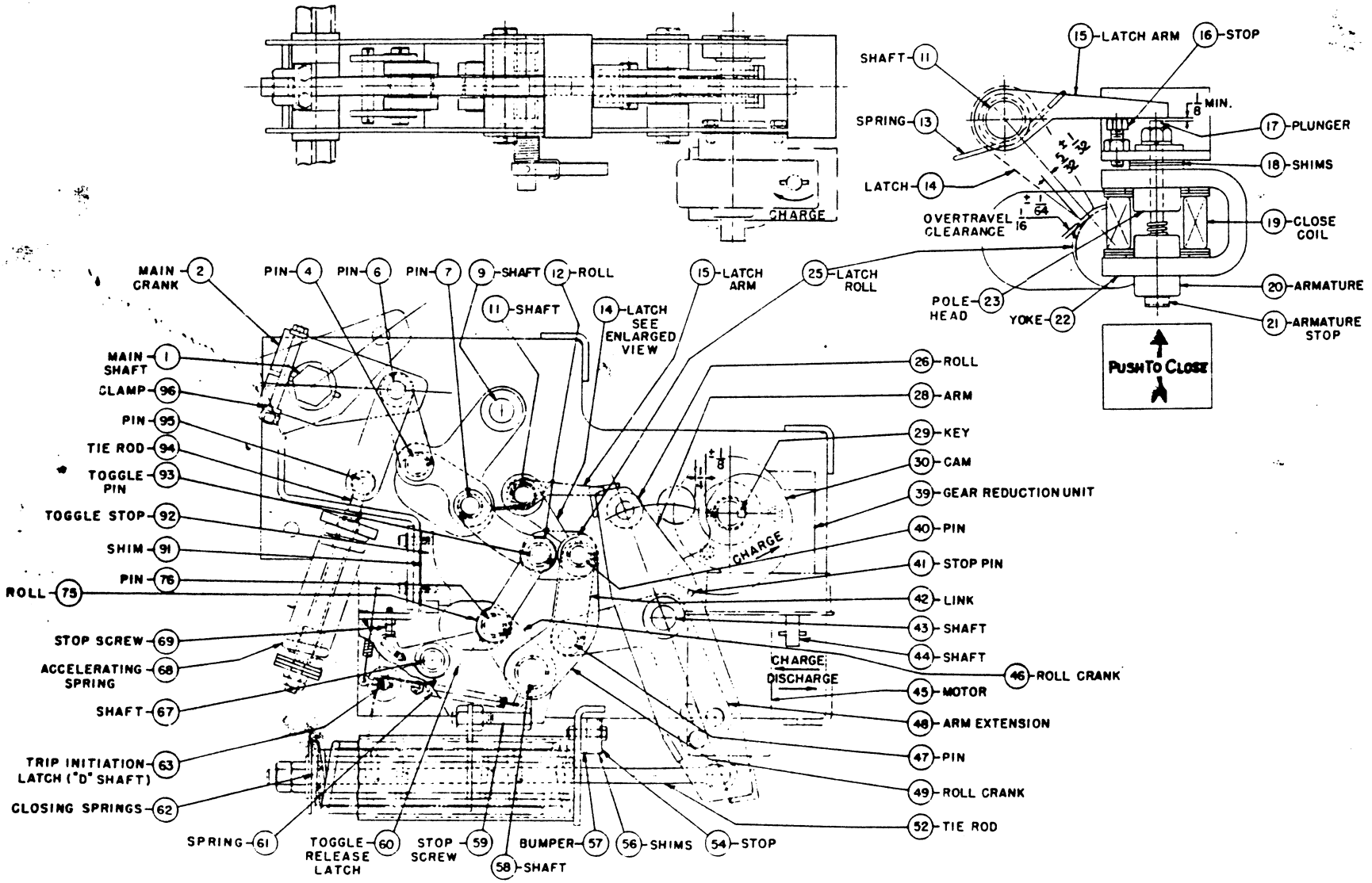


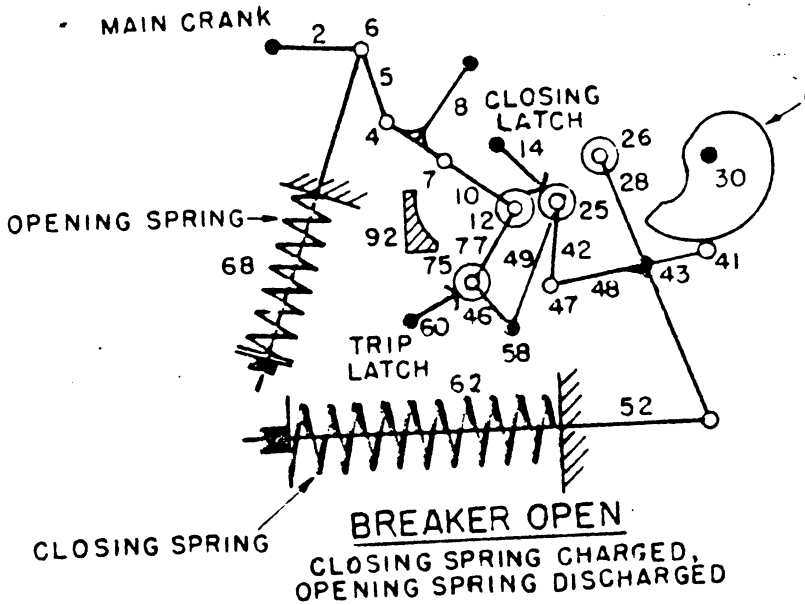
FIG. 3

TYPICAL SE-3B OPERATOR

SEPT 10, 1963

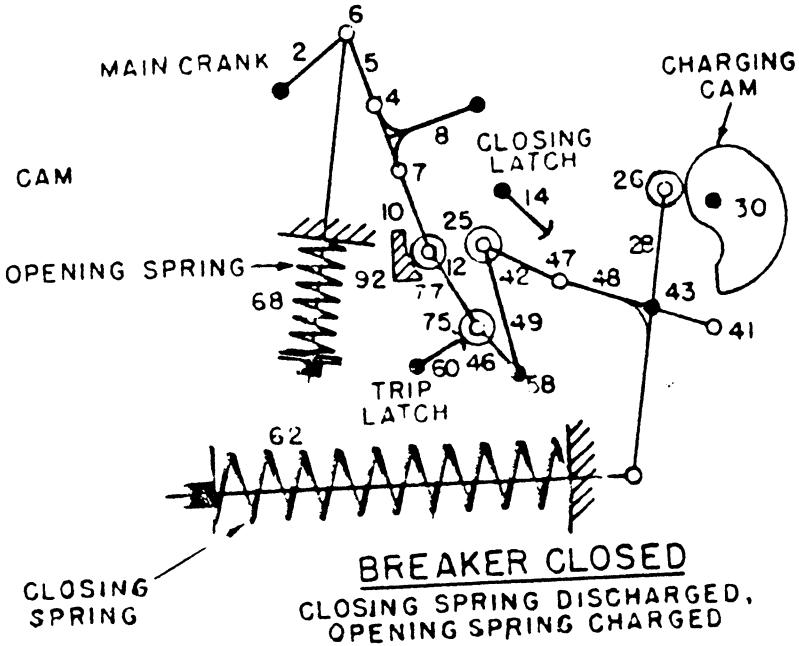
71-401-663-401

ALLIS-CHALMERS



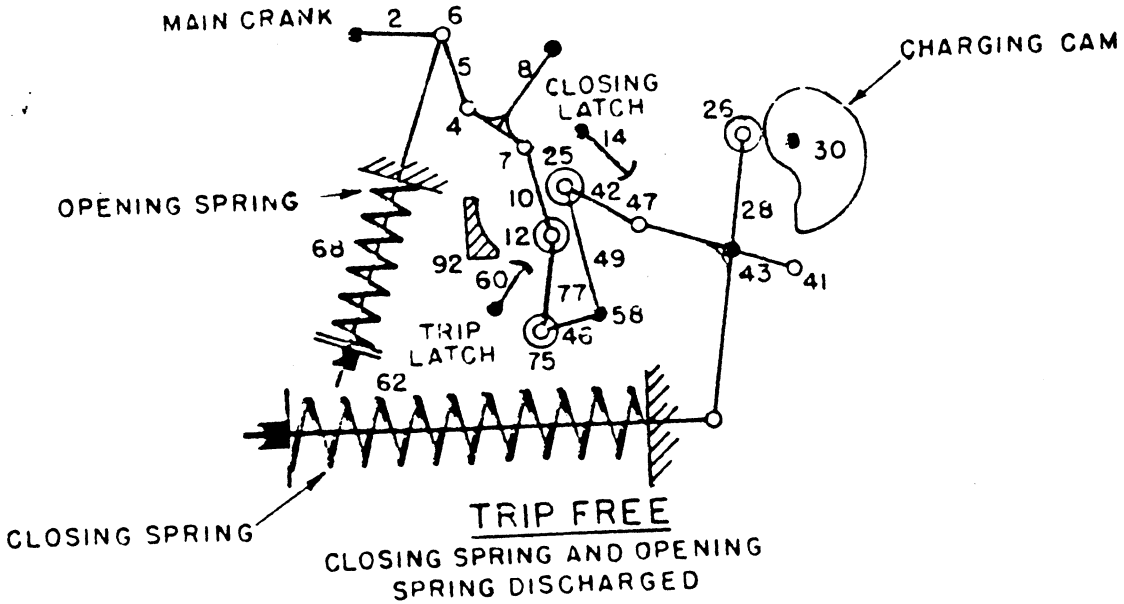
BREAKER OPEN

CLOSING SPRING CHARGED, OPENING SPRING DISCHARGED



BREAKER CLOSED

CLOSING SPRING DISCHARGED, OPENING SPRING CHARGED



TRIP FREE

CLOSING SPRING AND OPENING SPRING DISCHARGED

TYPICAL OPERATOR LINKAGE DIAGRAM

FIG. 3A

ALLIS-CHALMERS

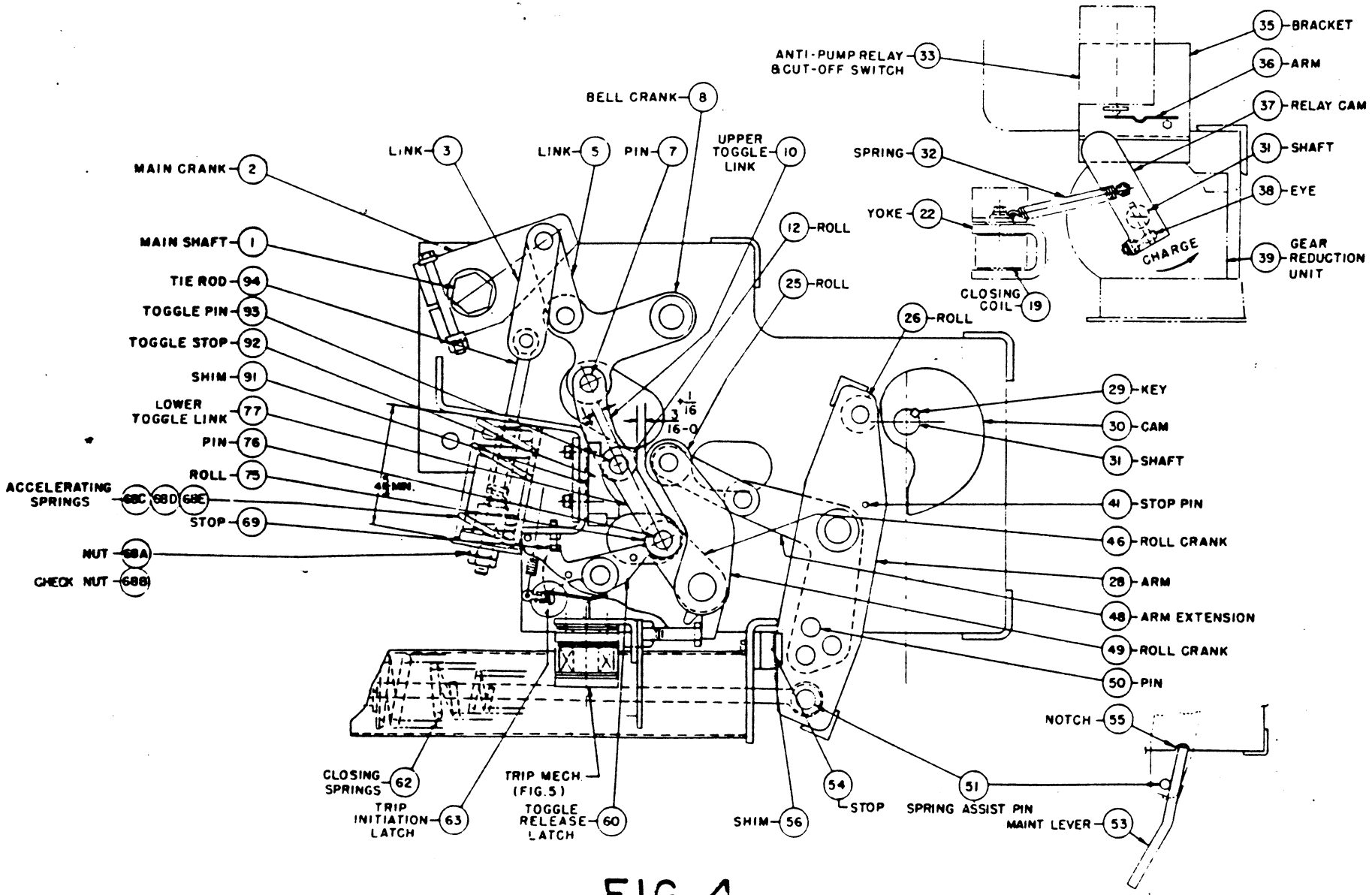


FIG. 4

TYPICAL SE-3B OPERATOR

SEPTEMBER 26, 1969

71-401-669-403

ALLIS-CHALMERS

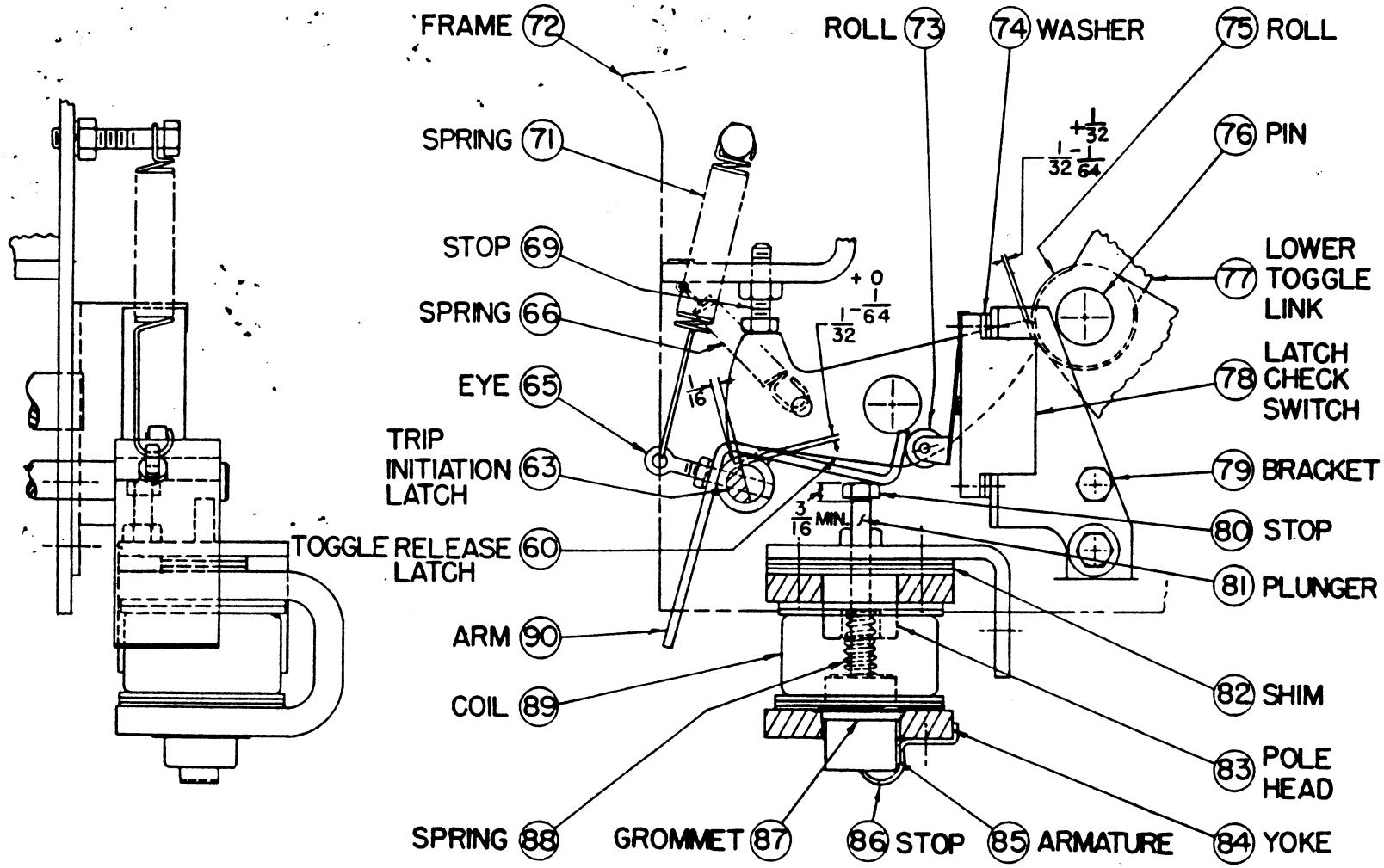


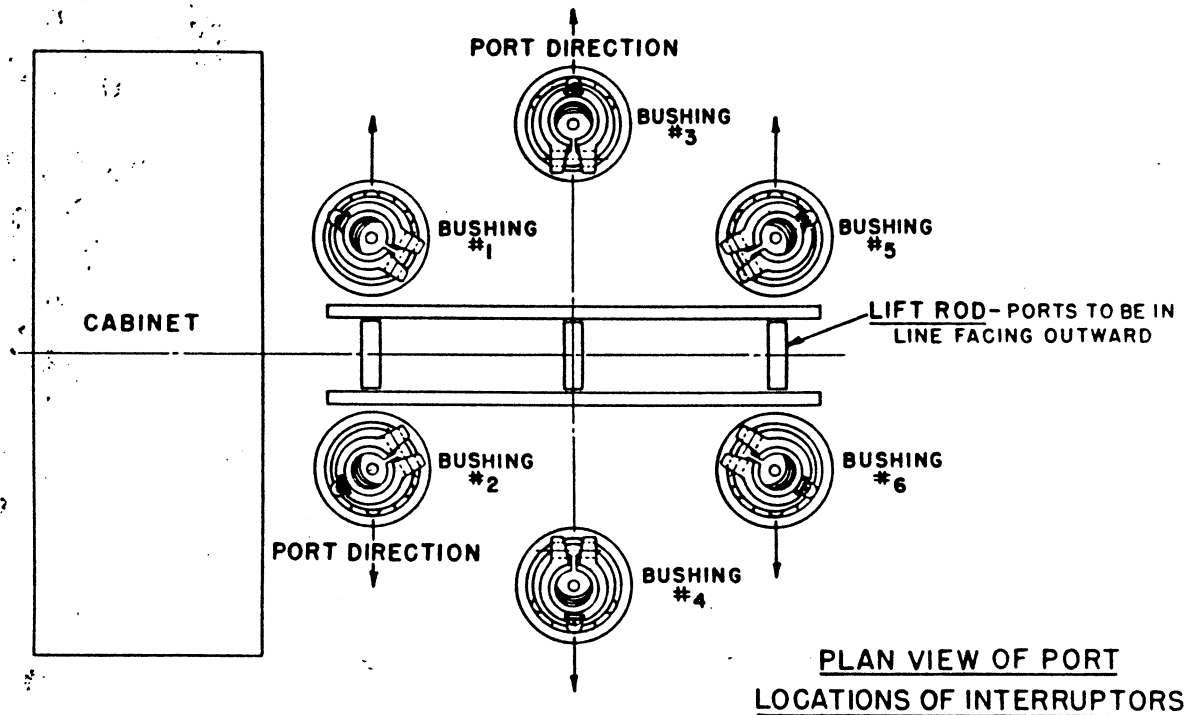
FIG. 5

TYPICAL TRIP MECHANISM, BREAKER OPEN

SEPTEMBER 24, 1963 71-303-335-401

ALLIS-CHALMERS

ALLIS-CHALMERS



PLAN VIEW OF PORT LOCATIONS OF INTERRUPTORS

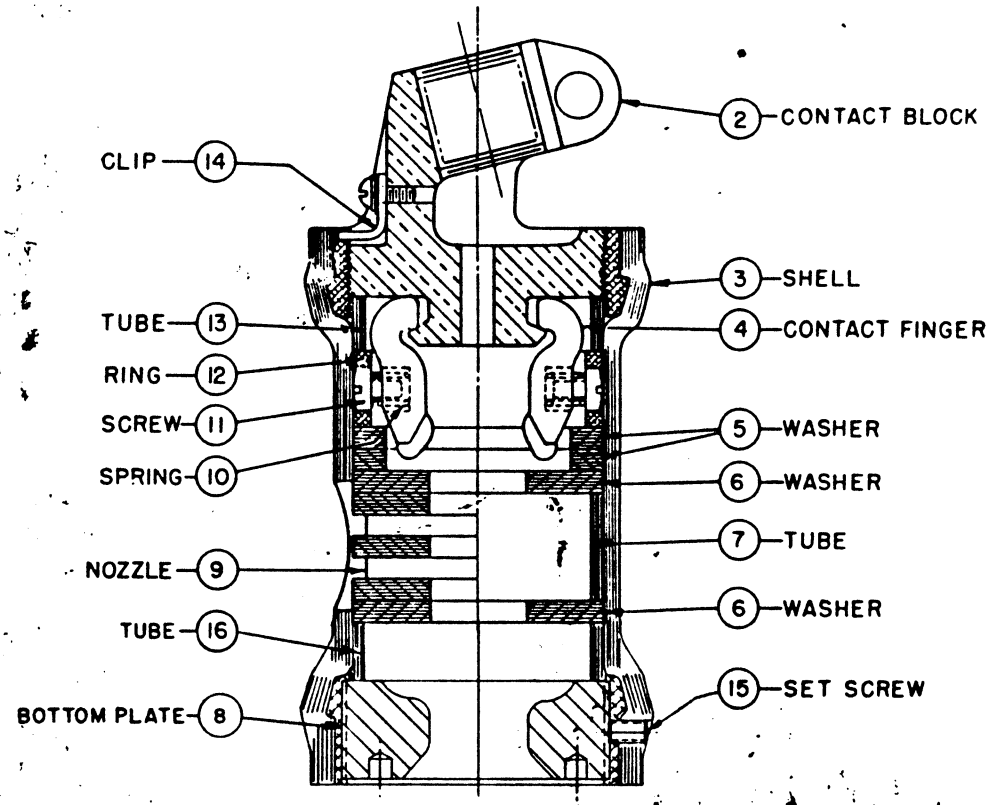


FIG. 6
TYPICAL TC-2 INTERRUPTER
OCT. 20, 1970 72-310-361-401

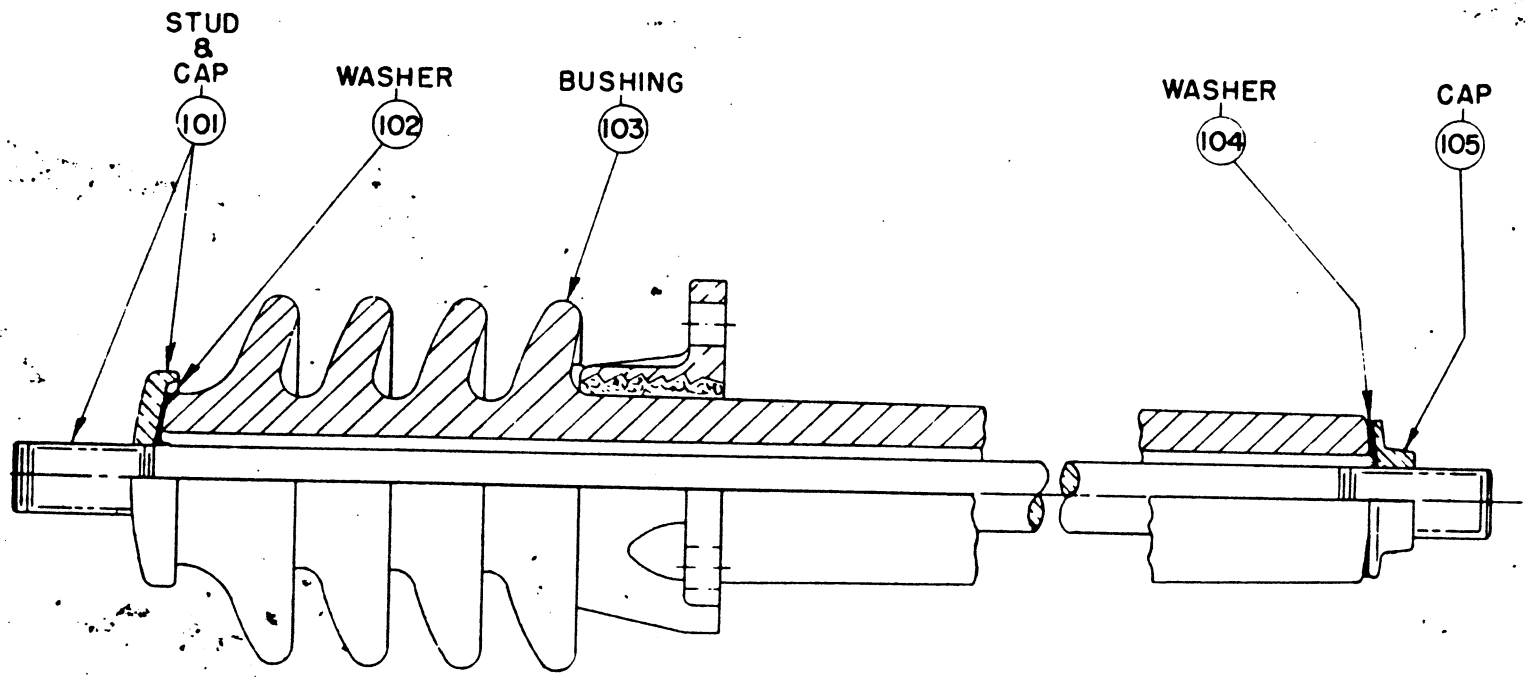


FIG. 7

TYPICAL 14.4 K.V. BUSHING

SEPT. 26, 1969 71-210-179-402

ALLIS-CHALMERS

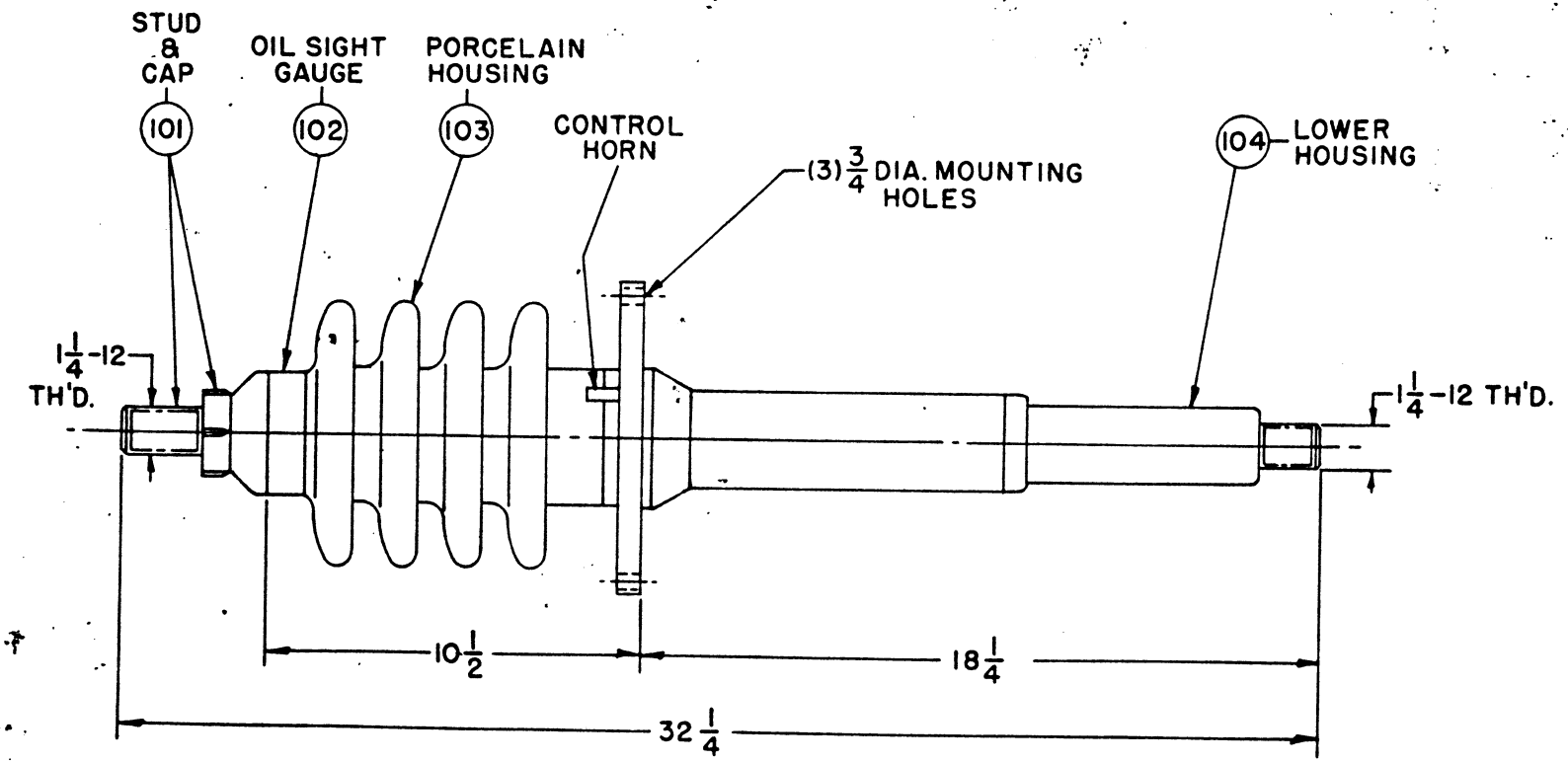


FIG. 7A

TYPICAL 23KV BUSHING

OCT. 20, 1970 72-211-109-401

ALLIS-CHALMERS

ALLIS-CHALMERS

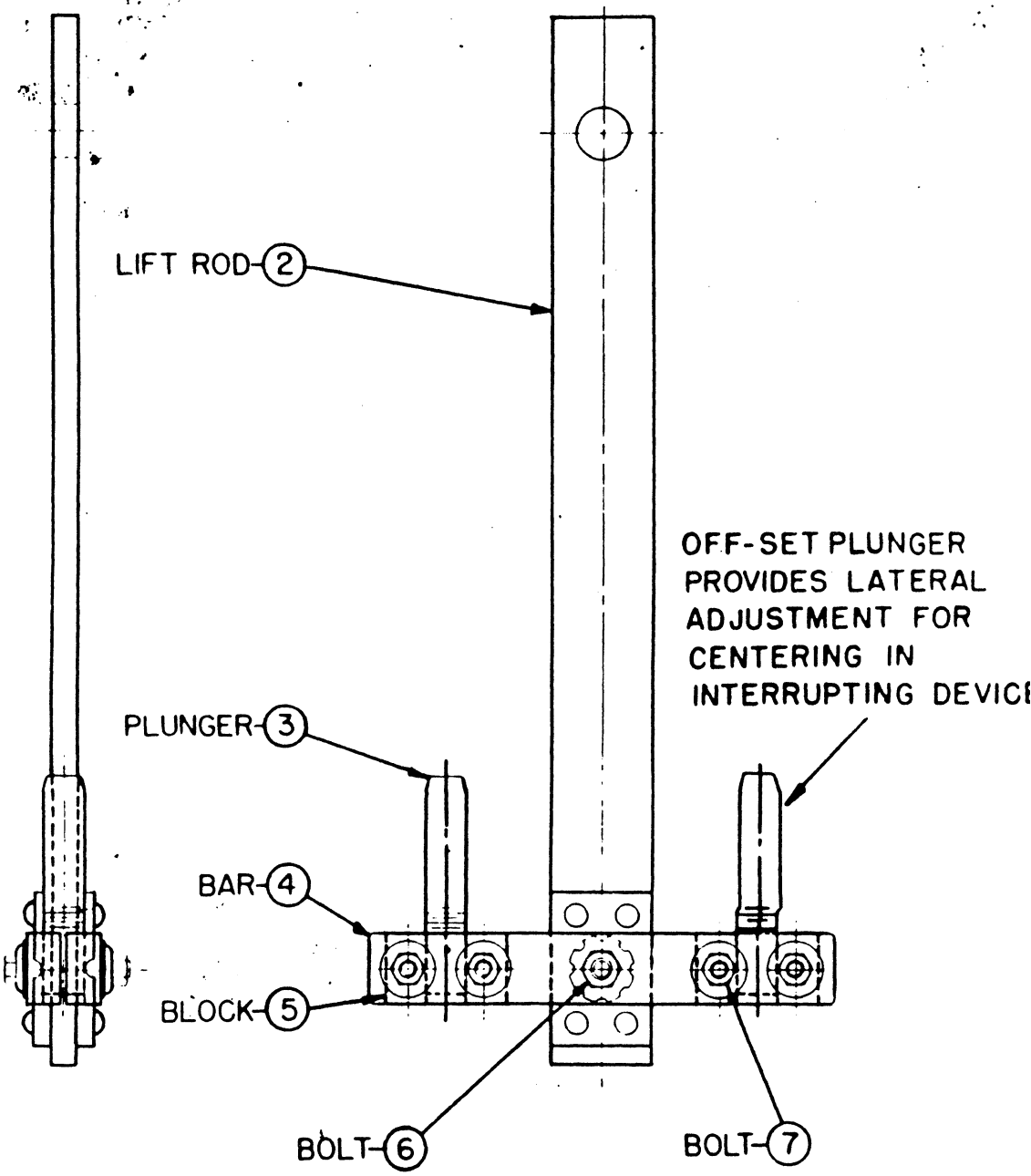


FIG. 8

TYPICAL SDO-15 MOVABLE MEMBER

JUNE 20,1968 72-111-168-401

ALLIS-CHALMERS

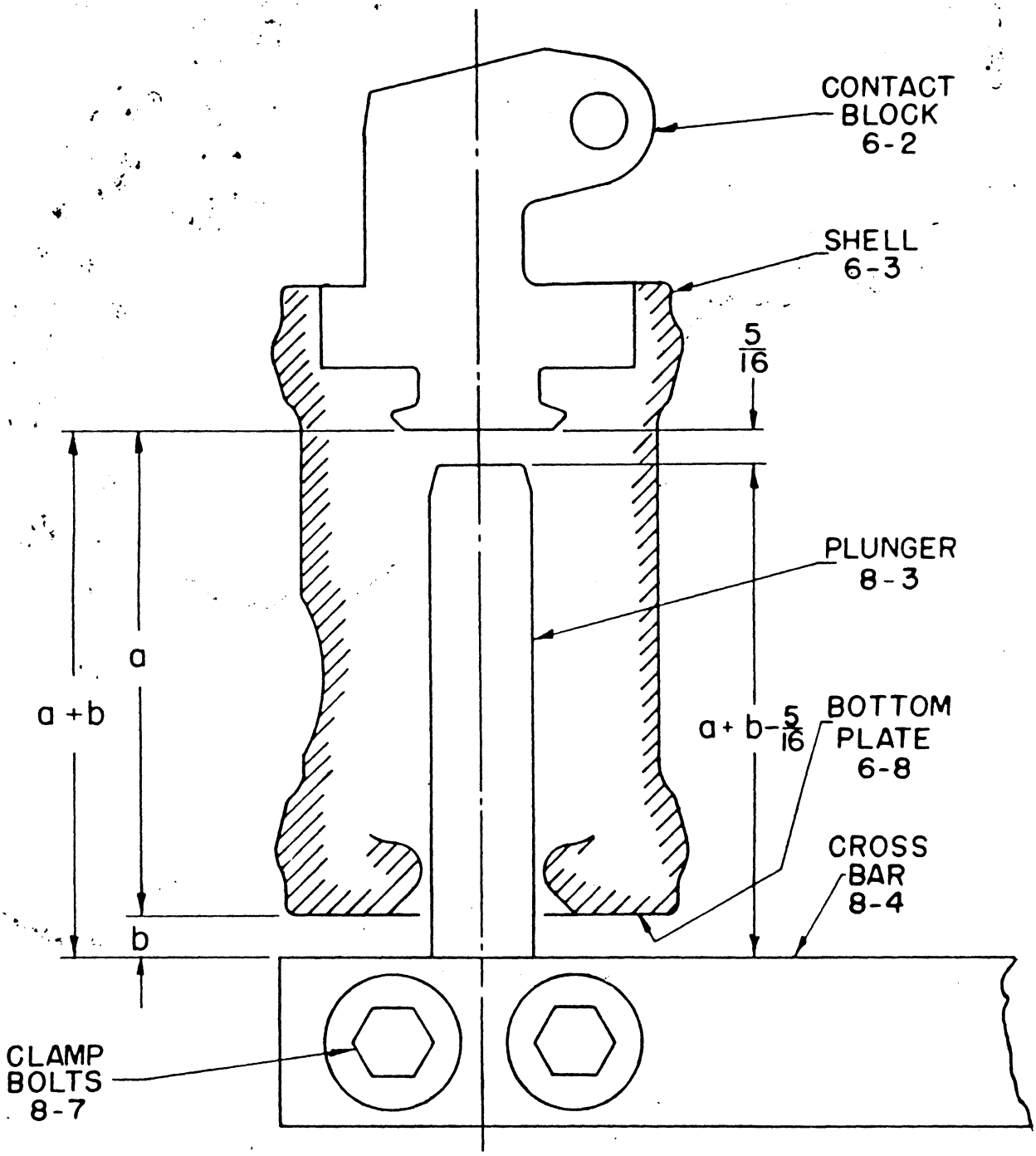
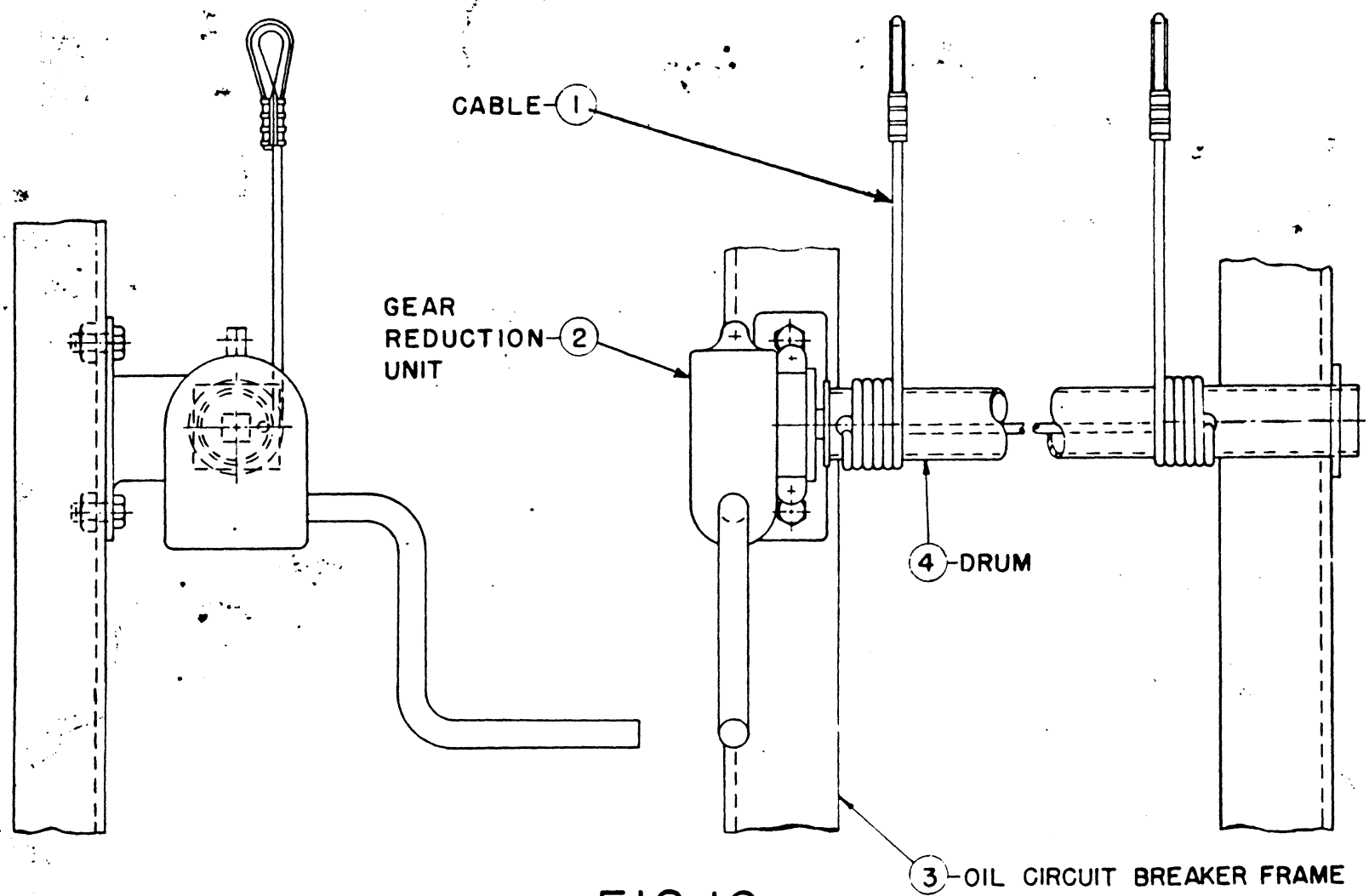


FIG. 9

PLUNGER ADJUSTMENT (FOR TC-2 INTERRUPTOR)

OCT. 19, 1970 72-211-108-401



ALLIS-CHALMERS

FIG. 10

TYPICAL TANK LIFTER

OCTOBER 3, 1963 71-303-342-401

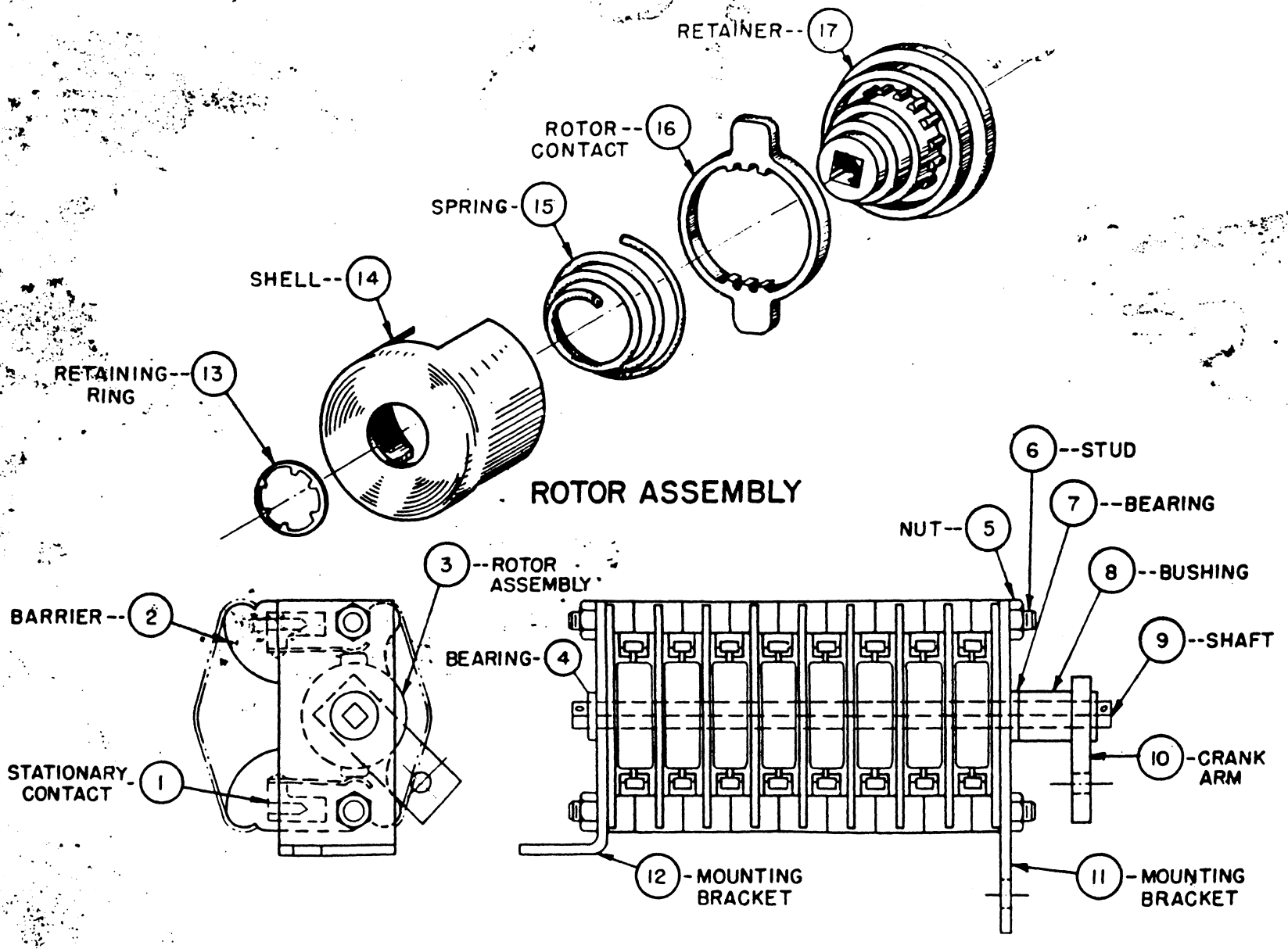


FIG. 11

TYPICAL AUXILIARY SWITCH

JULY 16, 1958 71-301-758

ALLIS-CHALMERS

ALLIS-CHALMERS

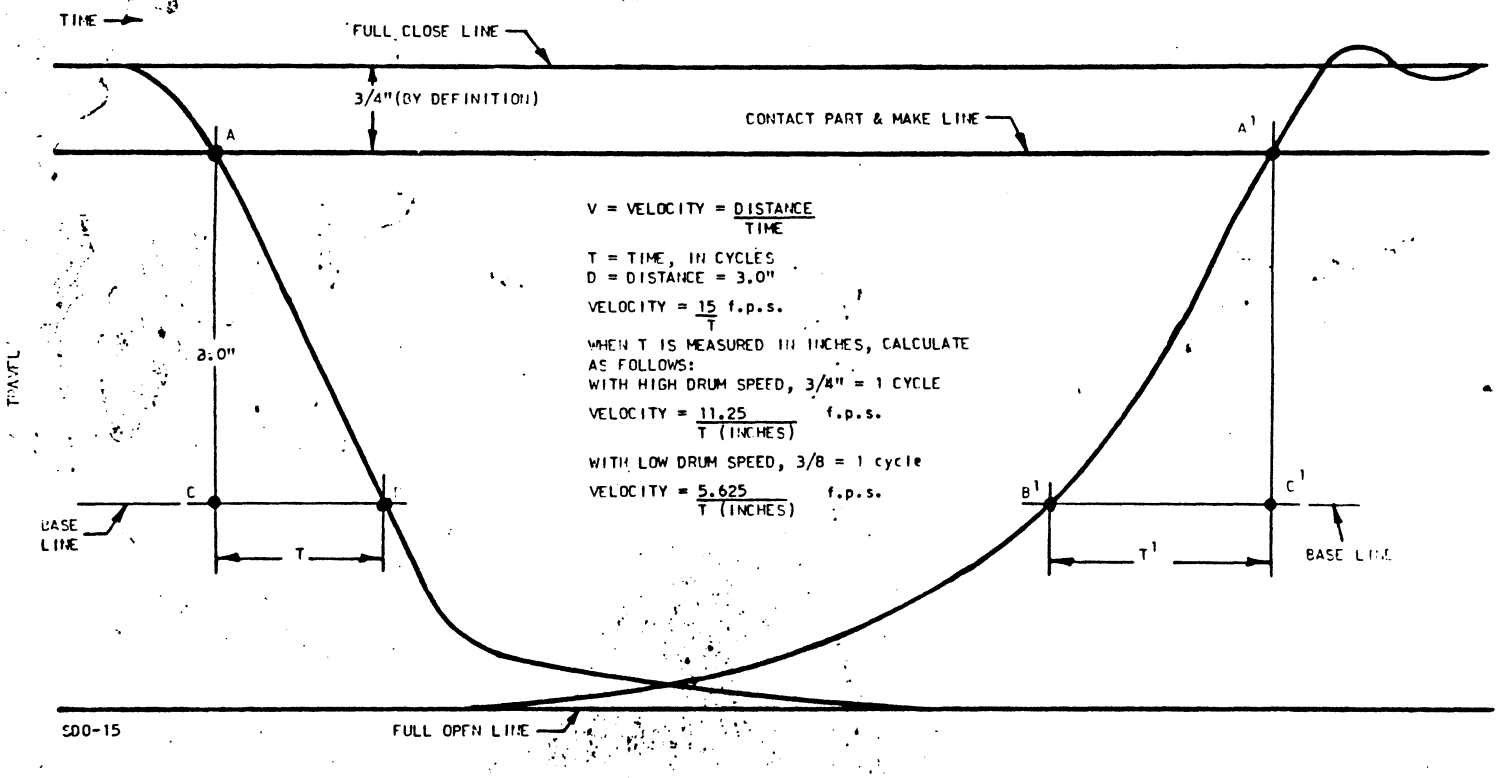
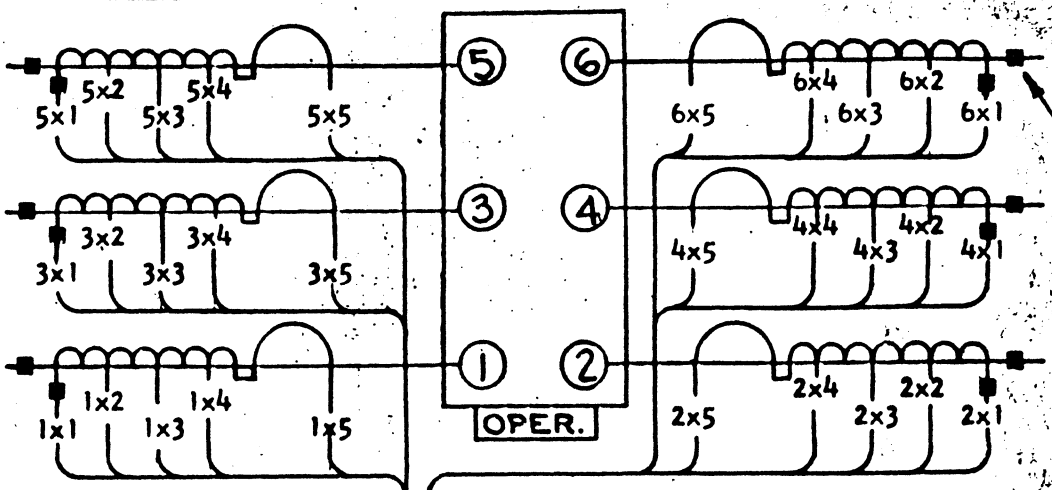


FIG. 12

TYPICAL SPEED GRAPH

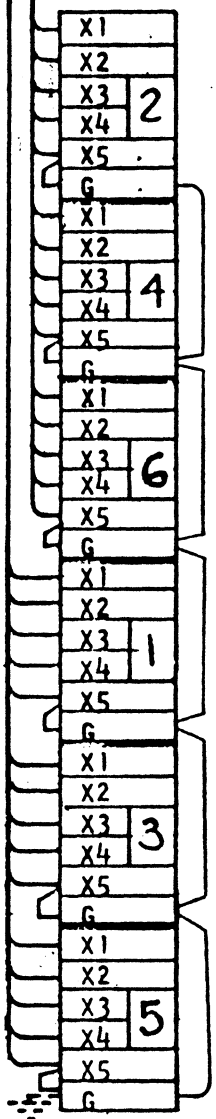
SDO WITH SO-35C SOLENOID OPERATOR

OCT. 20, 1970 72-211-110-402



SHORT CIRCUITING TERM. BL'KS. MTD. IN OPERATOR HSG. →

NOTE 1: SHORT CIRCUIT EACH BCT USING SHORTING SCREWS IN X1 & X5 AT ASSEMBLY



TAP	600/5 AMP.		1200/5 AMP.	
	TURNS	RATIO	TURNS	RATIO
X2-X3	10	50/5	20	100/5
X1-X2	20	100/5	40	200/5
X1-X3	30	150/5	60	300/5
X4-X5	40	200/5	80	400/5
X3-X4	50	250/5	100	500/5
X2-X4	60	300/5	120	600/5
X1-X4	80	400/5	160	800/5
X3-X5	90	450/5	180	900/5
X2-X5	100	500/5	200	1000/5
X1-X5	120	600/5	240	1200/5

TAP	2000/5 AMP.	
	TURNS	RATIO
X3-X4	60	300/5
X1-X2	80	400/5
X4-X5	100	500/5
X2-X3	160	800/5
X2-X4	220	1100/5
X1-X3	240	1200/5
X1-X4	300	1500/5
X2-X5	320	1600/5
X1-X5	400	2000/5

LEAD	COLOR
X1	RED
X2	BLACK
X3	WHITE
X4	GREEN
X5	YELLOW

SDO 15 D/L

01 REVISION ECL 1-16-64

— CONFIDENTIAL — PROPERTY OF
ALLIS-CHALMERS MFG. CO.

CONN. DIAG.

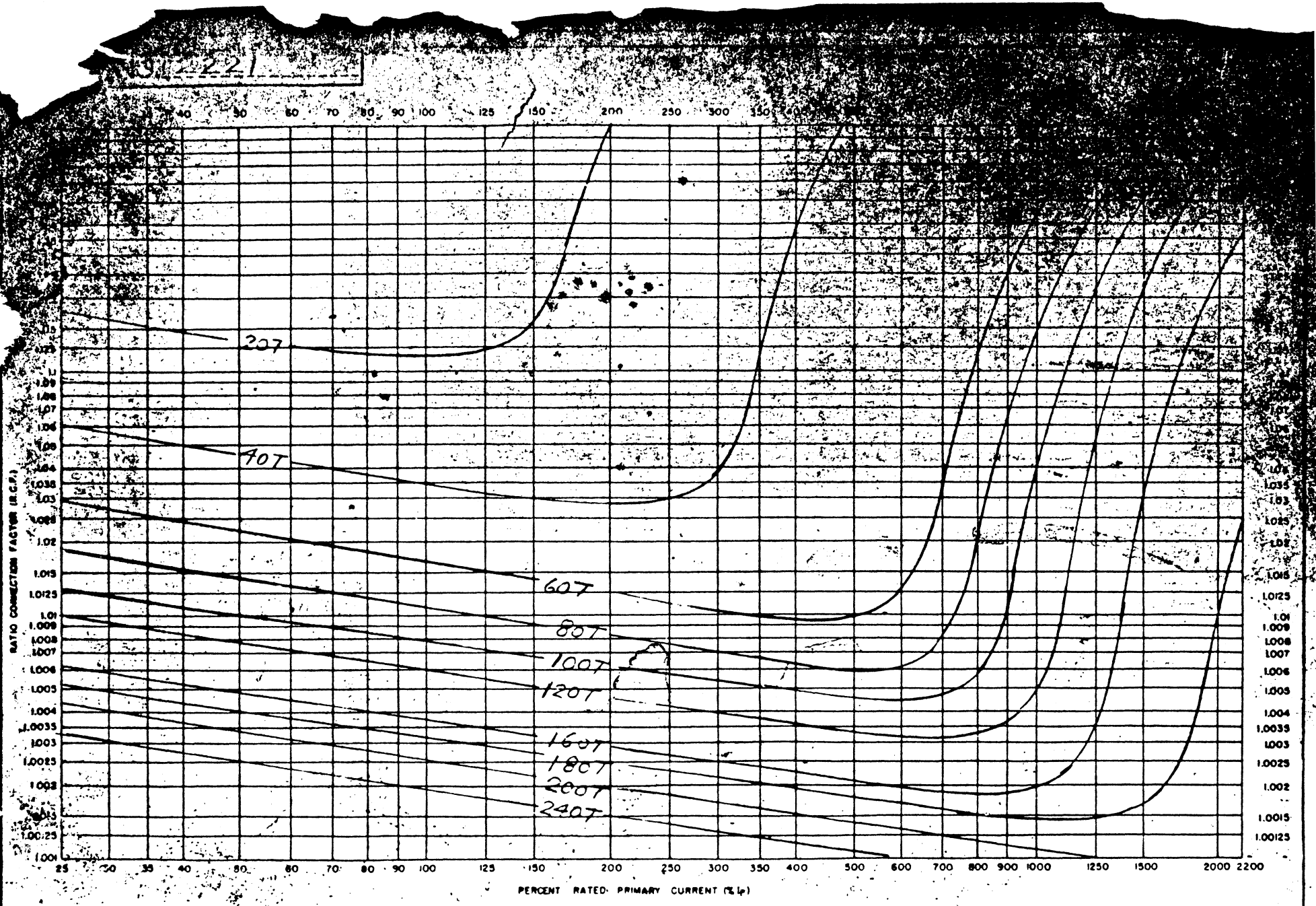
BUSHING CURR. TRANS.
MULTI-RATIO
3 ON EACH SIDE

E. T. & D. DIV. BOSTON PLANT

ENGINEERING SPECIFICATION

DRAWN	DATE	APPROVED	DATE
WRJ	1-15-64	JW	1-16-64
CHECKED JW	DATE 1-16-64		

DRAWING NO. 71-115-547-425 ISSU



ALLIS-CHALMERS MANUFACTURING CO.
BOSTON, MASS. U.S.A. SW. GEAR DEPT.

DRAWN FHP DATE 1-2-63
CHECKED FHP DATE 1/2/63
O.K. DATE 1-2-63

CALCULATED RATIO CORRECTION FACTOR CURVES

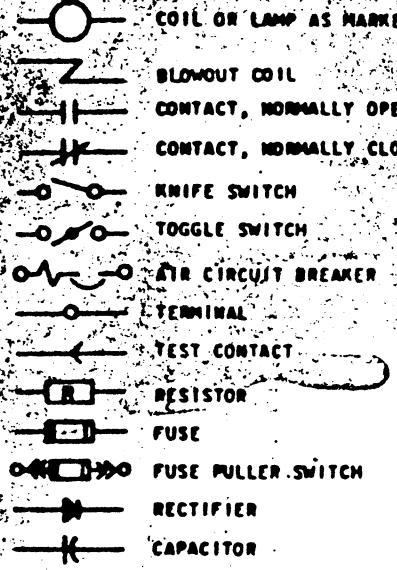
BUSHING CURRENT TRANSFORMER TYPE BCM-15-1,1A

RATIO 1200 /5A MAX 60 CYCLE 2 OHM EXTERNAL BURDEN

CURVE NO. 2221

71-210-130-402

SYMBOLS



A.C. CO. CONTROL SWITCH (01) TYPE 210-1-4

CONTACTS	POSITION				
	CLOSE	NORMAL AFTER CLOSE	TRIP	NORMAL AFTER TRIP	PULL-OUT IN TRIP
3-4	X				
5-6			X		X
7-8	X	X	X	X	
9-10		X		X	
11-12	X	X			
13-14	X	X			

X = CLOSED CONTACTS

DESCRIPTION OF DEVICE NUMBERS

01	CONTROL SWITCH
08H	HEATER POWER SWITCH
08M	MOTOR POWER SWITCH
08C	CLOSE POWER SWITCH
08T	TRIP POWER SWITCH
23	THERMOSTAT
27	UNDERVOLTAGE RELAY
43	TRANSFER DEVICE
51	A.C. OVERCURRENT RELAY
52	OIL CIRCUIT BREAKER
52a	AUX. SWITCH, OPEN WHEN BREAKER IS OPEN
52b	AUX. SWITCH, CLOSED WHEN BREAKER IS OPEN
52 LC	TRIP LATCH CHECK SWITCH (SEE NOTE 3)
52 SRC	SPRING RELEASE COIL FOR CLOSING O.C.B.
52T	TRIP COIL FOR OPENING O.C.B.
52Y	ANTI PUMP RELAY (SEE NOTE 4)
67	DIRECTIONAL OVERCURRENT RELAY
69	CLOSING CUTOUT SWITCH (SEE NOTE 5)
79	RECLOSING RELAY
88	MOTOR FOR CHARGING SPRINGS
64	GROUND PROTECTIVE RELAY

NOTES

1. ALL EQUIPMENT IS SHOWN WITH CIRCUIT BREAKER OPEN AND RELAYS DE-ENERGIZED, AND SPRING DISCHARGED.
2. MATERIAL TO BE FURNISHED BY ALLIS-CHALMERS WILL BE AS SPECIFIED ON ORDER OR CONTRACT AND DOES NOT NECESSARILY INCLUDE ALL DEVICES SHOWN ON ATTACHED PRINTS WHICH WERE INCLUDED TO MAKE THE DIAGRAMS COMPLETE.
3. LATCH CHECK SWITCH (52 LC) IS CLOSED ONLY WHEN OPERATOR IS LATCHED TO BREAKER.
4. ANTI-PUMP RELAY (52Y) IS MECHANICALLY OPERATED AS A MOTOR CUTOFF SWITCH BY AN ARM ON GEAR UNIT. DURING CLOSING (SPRING RELEASE) IT IS ELECTRICALLY OPERATED TO PREVENT MOTOR FROM RECHARGING SPRING UNTIL CONTROL SWITCH IS RELEASED (ANTI-PUMP).
5. CLOSING CUTOUT SWITCH (69) IS OPENED BY THE EXTERNAL TRIP ROD AND IS MANUALLY RESET.

NOTES & SYMBOLS

APRIL 13, 1964 71-210-130-402

USED ON

TYPE

DRAWN AAS 4-13-64
CHECKED
TRACED
SCALE

— CONFIDENTIAL — PROPERTY OF ALLIS-CHALMERS MFG CO. BOSTON PLANT

PART MADE

NOTES & SYMBOLS

71-210-130-402

01 6-16-64 ECN REVISIONS