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Power Systems Group
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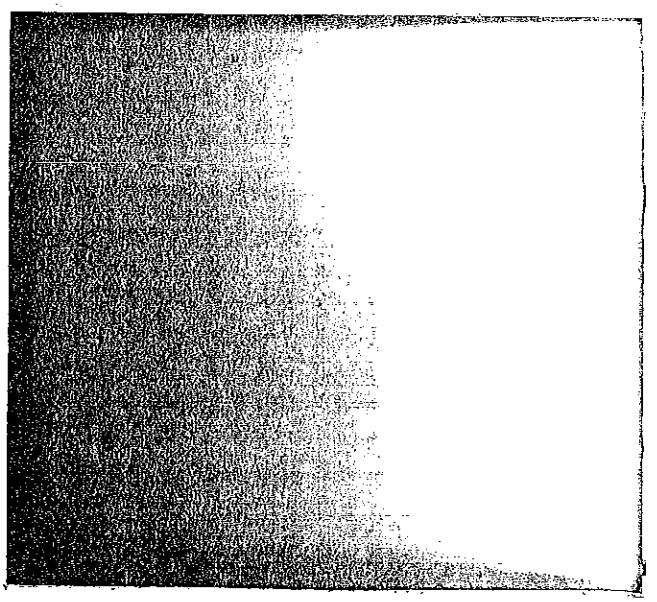

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McGRAW-EDISON

Power Systems Group
McGraw-Edison Company
Canonsburg, PA 15317

VACUUM CIRCUIT BREAKER

VAC-15.5KV-20KA-1200AMPERE

S. O. NO. C-03956-4

CONSOLIDATED ALUMINUM CORPORATION

LAKE CHARLES, LOUISIANA

P. O. NO. LCCP55569A

SERIAL NUMBER 26149

412-873-2390 - KEN MARRACCINO

STEVE - ENGINEER

ISSUE 8	7	6	5	4	3	2	1 (5-10-82, 3-10-82)	DESCRIPTION	△	NUMBER	REV
					IR	A		BREAKER OUTLINE		SVB01920A	
					IR	A		SCHEMATIC DIAGRAM		SHC03230A	
					IR	A		MECHANISM WIRING DIAGRAM		SHC03231A	
								PRINTED LITERATURE			
					IR	F		LEGEND DRAWING FOR ASSEMBLED SWITCHGEAR		SGA01186A	
					IR	A		OE-12 C.T. EXCITING CURVES		IX-385575	
					IR	A		OE-12 C.T. RATIO CURVES		RCF-385575	
					IR	A		ELECTRICAL BILL OF MATERIAL		C-03956-4	
					IR			VAC-15.5-20 KA VACUUM BREAKER		S290-10-1	
					IR			VAC-15.5 VACUUM BREAKER (SUPPL. #1)		S290-10-1	
					IR			MO-1 OPERATING MECHANISM		S290-54-1	
					IR			MO-1 OPERATING MECHANISM (SUPPL. #1)		S290-54-1	
					IR			MO-1 OPERATING MECHANISM (SUPPL. #2)		S290-54-1	
					IR			"OE" BUSHING CURRENT TRANSFORMER		S290-80-2	
							1				

						4	3	CUSTOMER
						2	2	SALES OFFICE
						1	-	WITH BREAKER

CODES: A-APPROVAL, D-DELETED, F-FOR REFERENCE ONLY, I-INSTRUCTION BOOK, R-RECORD

REV

McGRAW-EDISON Power Systems Division
McGraw-Edison Company
Canonsburg, PA 15317 USA

DWN GDY	DATE 2/82	CONFIDENTIAL MUST NOT BE USED IN ANY WAY DETRIMENTAL TO McGRAW-EDISON CO.
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CONSILIDATED ALUMINUM CORPORATION
LAKE CHARLES, LOUISIANA
P.O. NO. LCCP55569A
VAC-15.5KV-20KA-1200AMPERE V.C.B.

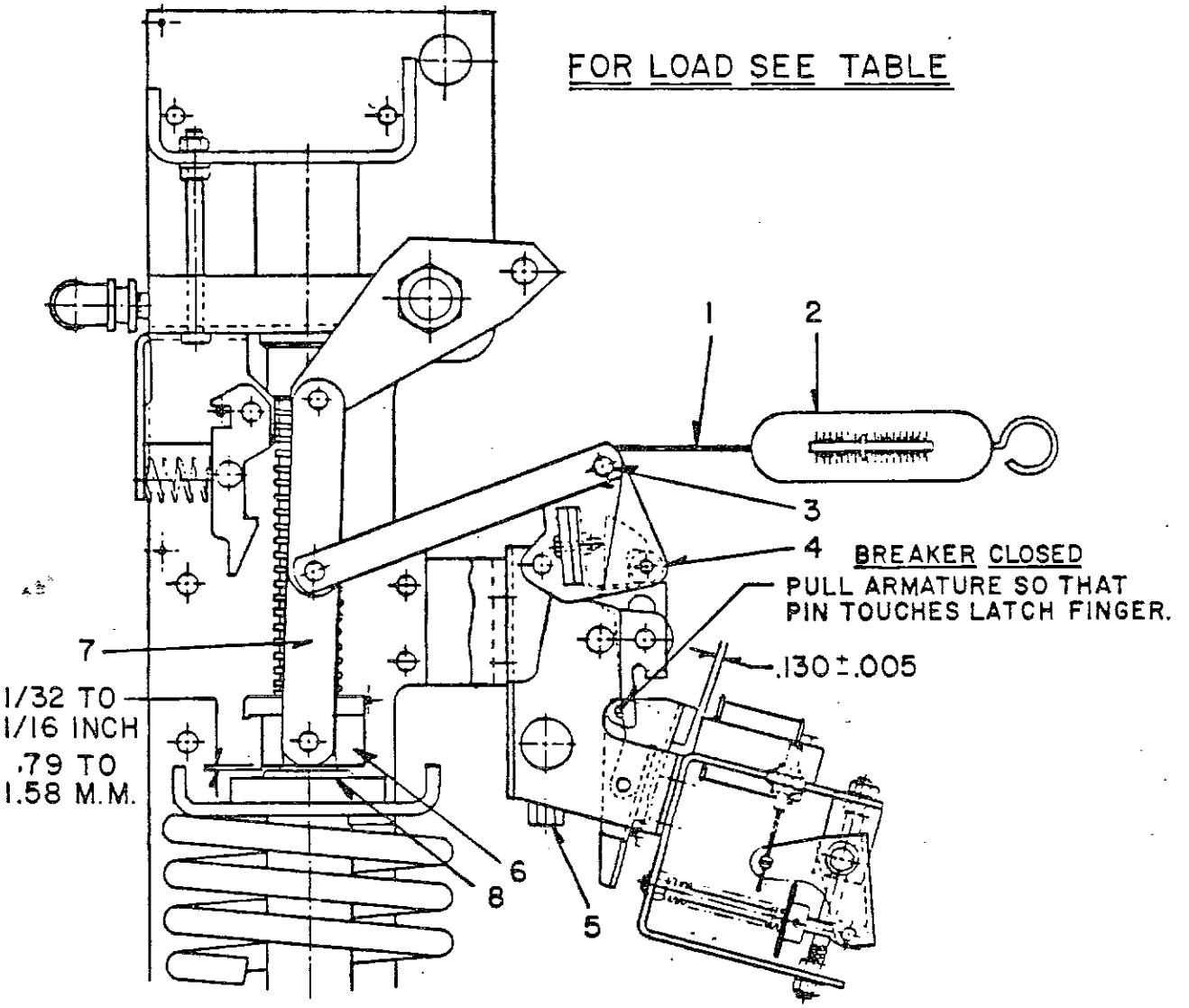
MASTER DWG LIST

SHEET OF	C-03956-4	REV.

McGRAW-EDISON

Power Systems Group
McGraw-Edison Company
Post Office Box 2850
Pittsburgh, PA 15230

APPLICABLE FOR UNITS MANUFACTURED AFTER JULY 1981.



KV	LOAD		RESET MIN.	
	POUNDS	NEWTONS	POUNDS	NEWTONS
15	50-70	133-222	20	89
25.8	70-90	311-400	20	89
38	70-90	311-400	20	89

Figure 11
Trip latch adjustment.

1. Metal strap or wire hooked around trip pin.
2. Spring scale--(10 to 100 lbs.)(45 to 450 newtons).
3. Trip pin.
4. Trip latch roller.
5. 5/8" trip latch adjustment bolt.
6. Drive block.
7. Trip link.
8. Bellewille washer.

Power Circuit Breakers
Type MO-1 Operating Mechanism
Close Latch

Service Information S290-54-1
Supplement 1
April 1980

Applicable for units manufactured after February 1, 1980.

The stationary end of the close lever torsion spring is located at the underside of the close solenoid support plate as shown in Figure 9A.

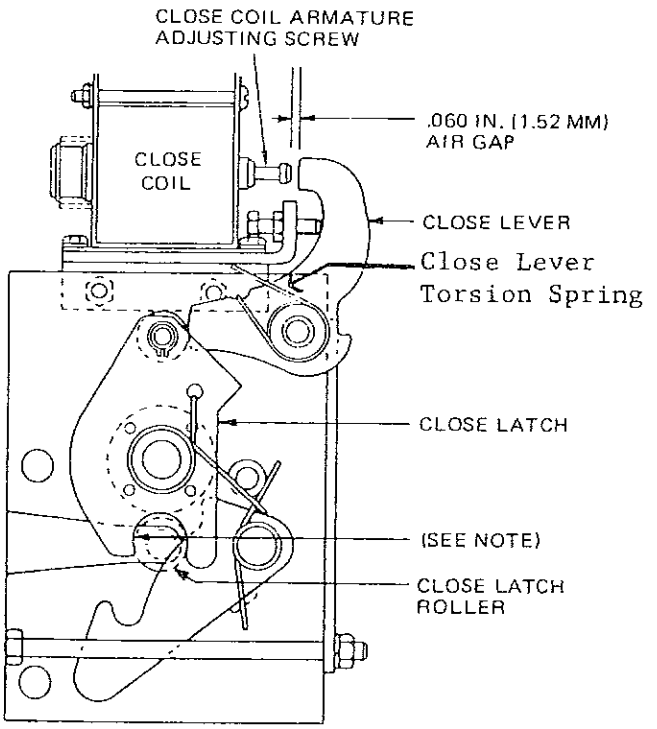


Figure 9 A
Close coil armature air gap.
NOTE: With closing spring discharged, insert screwdriver and pull close latch to set position.

Power Circuit Breakers
Type VAC 15.5 kV
Vacuum Interrupter
Test During Installation

Service Information S290-10-1
Supplement 1
January 1980

After completing all electrical and mechanical connections for the Type VAC 15.5 kV vacuum breaker in accordance with the Installation Section of Service Information S290-10-1, electrically test and establish the vacuum by performing a simple a-c high voltage potential test on each interrupter.

RADIATION WARNING

Refer to Vacuum Interrupter Test in the Maintenance Section of Service Information S290-10-1 for the proper procedure and observe all safety precautions during the tests to ensure personnel safety.

McGraw-Edison Company
Power Systems Division
Canonsburg, Pennsylvania 15317

NOTES:

5. Replace the new vacuum interrupter by performing steps 4A through 4F in reverse order leaving the stationary terminal clamping bolts loose.

   NOTE: As a positioning check the connecting bar should penetrate the movable terminal clamp to within 15/16 inch (2.29 cm) (measured from the outside surface of the block to the stud of the vacuum interrupter).

   A. Tighten the movable terminal clamping bolts.

   B. Tighten the stationary terminal clamping bolts with the annular ring on the stationary stud positioned against the face of the stationary terminal clamp.

      NOTE: For breakers with interrupters without annular rings, use of a 1/4 inch (6.35 mm) spacer between the edge of the vacuum interrupter and the block will yield proper positioning of the vacuum interrupter.

   C. Adjust open contact gap to 1/2 inch + 1/32 inch – 0 (12.7 mm + .8 mm – 0) by adjusting operating rod length at adjustment nut (Figure 4).

      NOTE: In the open position the scribe mark is 1/2 inch (12.7 mm) further from the insulation guide than it is in the closed position.

6. Operate the breaker several times with the maintenance positioning wrench to insure proper alignment.

SPARE PARTS

Recommended spare parts stock should include one interrupter for each quantity of one to six breakers.

Description	Identification	Quantity Per Pole	Recommended Stock
Vacuum Interrupter	322061001	1	1
Bushing, 1200 Amp	SBB01090A	1	—
Bushing 2000 Amp	SBB01104A	1	—

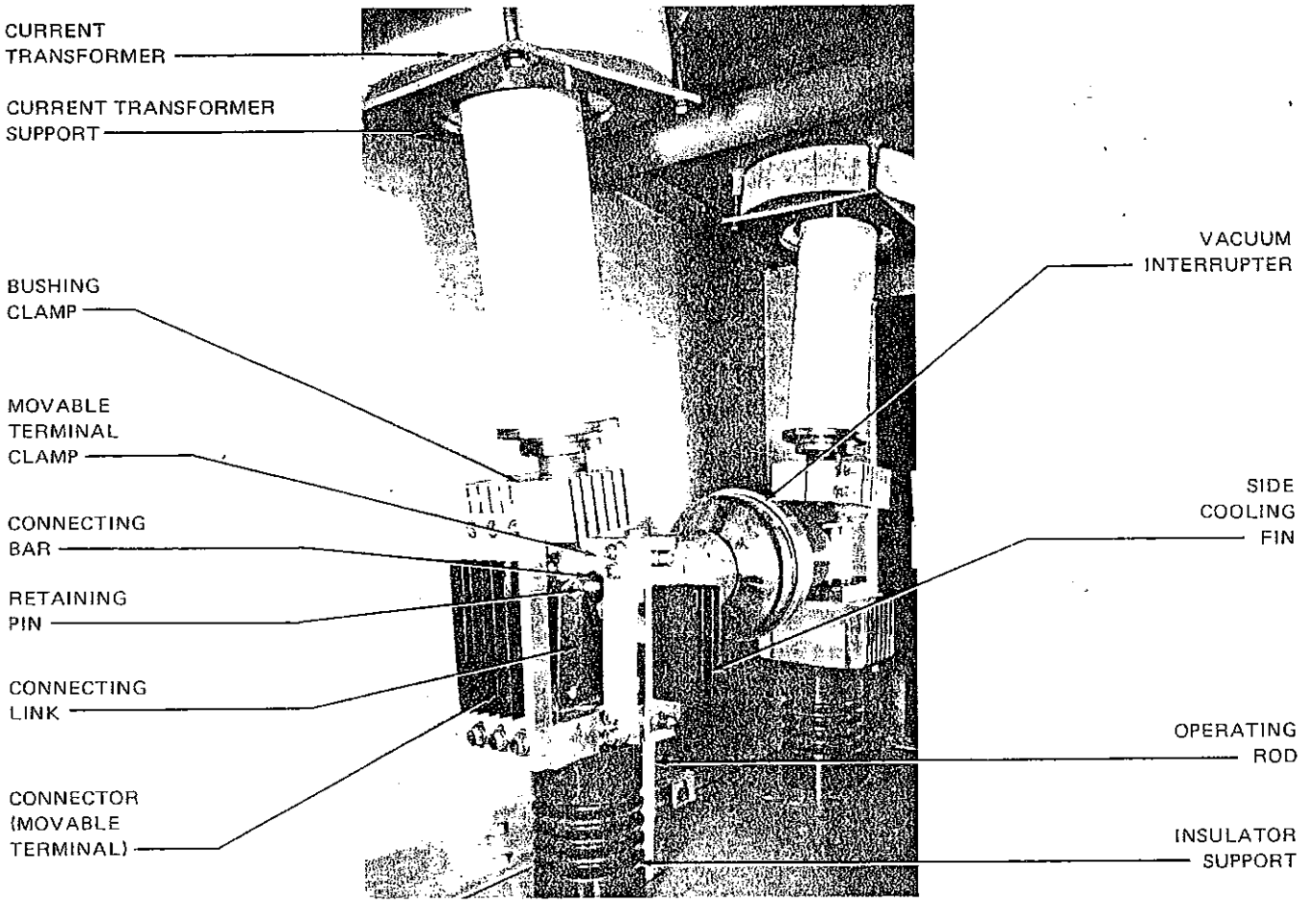


Figure 15
Movable terminal (2000 ampere breaker).

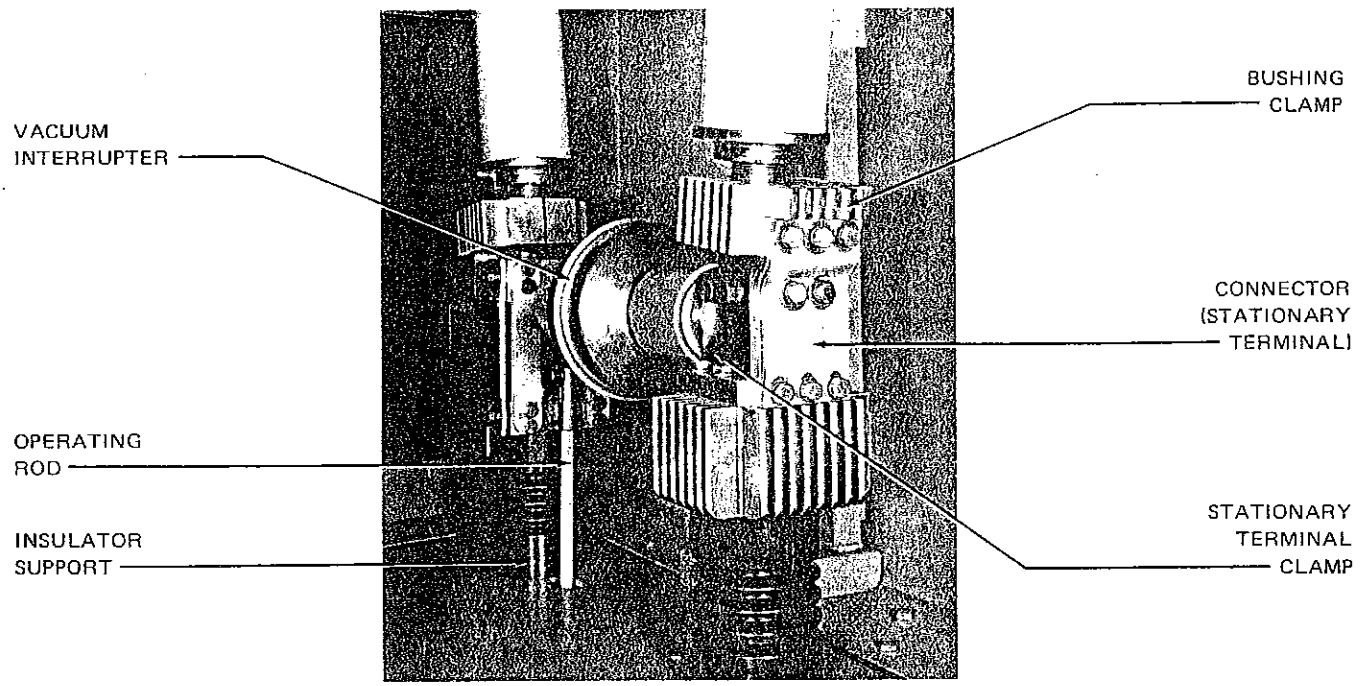


Figure 16
Stationary terminal (2000 ampere breaker).

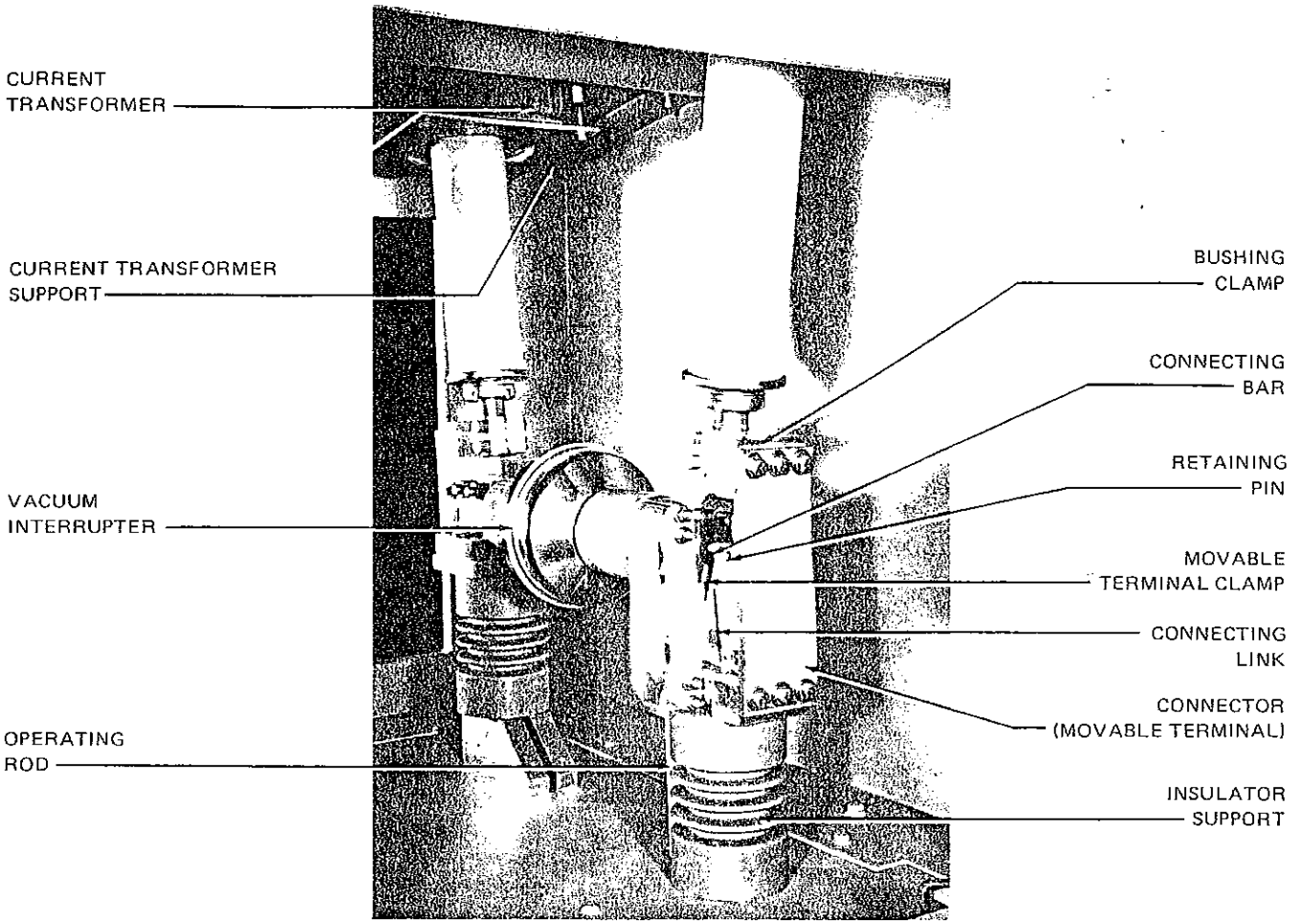


Figure 13
Movable terminal (1200 ampere breaker).

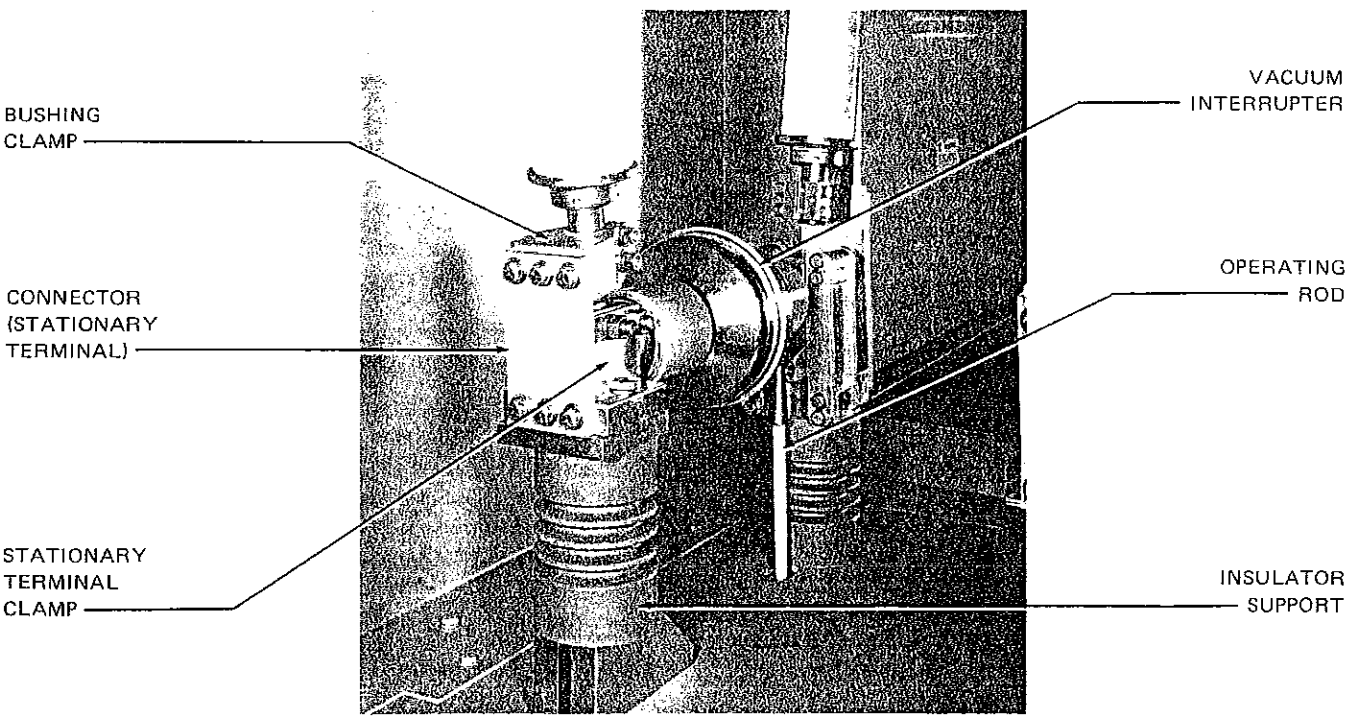


Figure 14
Stationary terminal (1200 ampere breaker).

6. Loosen four hex nuts and remove nuts, washers, and lockwashers fastening bushing flange to roof.
7. Carefully raise bushing slightly and support bushing flange. Remove bushing clamp.
8. Carefully remove bushing through roof.
9. Remove existing sealing material.
10. Clean painted surface of roof thoroughly.
11. Replace bushing clamp (do not tighten clamping bolts).
12. Reseal bushing flange to roof with "Ready Seal" rope provided with the replacement bushing. (Use Chemfluor Ready Seal with 3/32 inch bead.)

    NOTE: Loop the "Ready Seal" rope around each of the four bushing studs by stringing the rope from stud to stud until a complete loop is formed on the bolt circle insuring a complete seal.
13. Lower the replacement bushing into place carefully.

    NOTE: Be sure bottom of bushing passes through current transformer(s) and support, and flange is sealed properly.
14. Draw up the washers, lockwashers, and hex nuts on the bushing studs evenly.
15. Tighten the hex nuts in diagonally opposite pairs to insure proper bushing alignment.
16. Raise current transformer(s) and support into position.
17. Replace bolts and secure current transformer(s) and support.

    NOTE: Be sure to check current transformer secondary leads.
18. Replace connector between the bushing clamp and the terminal assembly.
19. After aligning connector with terminal assembly and bushing clamp properly, tighten all bolts on the connector.
20. Tighten bolts on the bushing clamp.
21. Operate the breaker several times with the maintenance positioning wrench to insure proper alignment.

BUSHING CURRENT TRANSFORMERS

Refer to and follow Service Information S290-80-2 Type OE Bushing Current Transformer Instructions.

1. To replace a bushing current transformer, the breaker should be open, isolated from the system with the closing springs discharged.
2. Open both sides of the high-voltage compartment (Figure 3).
3. Cut the secondary leads near the current transformer(s) to be removed.
4. Follow steps 3 through 20 under Bushing in the Parts Replacement section. Refer to and follow Service Information S290-80-2, Type OE Bushing Current Transformer Instructions for:
   A. Polarity marks.
   B. Wiring and connections.
   C. Short circuiting at the terminal blocks.
5. Operate the breaker several times with the maintenance positioning wrench to insure proper alignment.

VACUUM INTERRUPTERS

1. To replace a vacuum interrupter the breaker must be open, isolated from the system and the closing springs discharged.
2. Open both sides of the high-voltage compartment (Figure 3).
3. When interrupter contacts are new, the scribe mark (Figure 11) on the moving contact rod is approximately 1/8 inch (3.2 mm) above the insulation guide. **When the scribe mark is even with the insulation guide, the interrupter must be replaced.**
4. The vacuum interrupter is removed as follows:
   A. At the stationary terminal, Figure 12, loosen the bolts and remove the connector between the bushing clamp and the terminal assembly (also see Figures 14 and 16).
   B. Loosen the two clamping bolts securing the stationary terminal to the vacuum interrupter.
   C. At the movable terminal clamp, remove the pin retaining the connecting link to the connecting bar on the vacuum interrupter (Figures 13 and 15).

      NOTE: Relieve tension on connecting link by moving jackshaft toward closed position with maintenance positioning wrench (Figure 10).
   D. Loosen two movable terminal clamping bolts, Figure 12.

      NOTE: Inside clamping bolt may be difficult to reach due to laminations. Slide vacuum interrupter forward slightly.

      NOTE: On 2000 ampere breakers also remove the side cooling fin (Figure 15).
   E. Remove stationary clamp terminal by removing bolts at base.
   F. Remove vacuum interrupter and stationary terminal clamp together **being careful not to drop terminal clamp or interrupter.**
   G. Transfer the stationary terminal clamp to the replacement vacuum interrupter.

> **CAUTION**
>
> Be careful not to stress the bellows (Figure 11) coupling the movable contact to the body of the interrupter. Although life expectancy of the bellows is many times the rated life of the interrupter, external stresses, particularly torsional, can have a markedly deleterious effect on bellows life.

   H. Transfer the connecting bar and 1/2 inch lockwasher from the old interrupter to the replacement interrupter. Use a thin wrench to hold the interrupter stud while tightening; do not apply torque through the bellows to the interrupter.

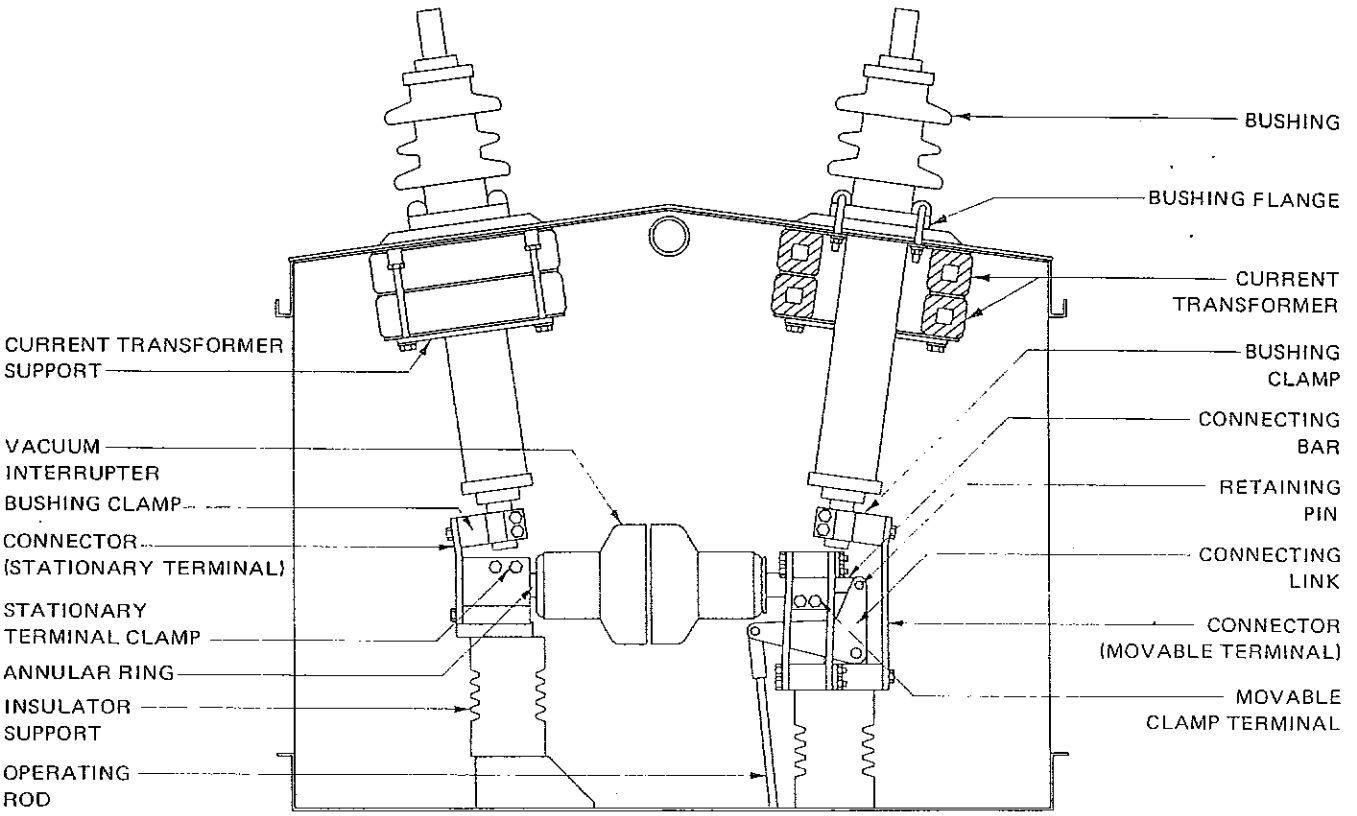


Figure 12
Section of one pole of Type VAC 15.5 kv vacuum breaker showing assembly details.

Time Travel Test

1. Using the operating mechanism maintenance positioning wrench slow close the breaker (Figure 10).
2. Time travel device can be set up on the floor of the low-voltage compartment behind the mechanism.
3. Connect the time travel device directly to the crank provided on the jack shaft assembly (Figure 4).
4. Record direct readings of contact speed/motion characteristics.
5. Disconnect time travel device from crank on drive shaft.

PARTS REPLACEMENT

SAFETY PRECAUTION

Before replacing any part in a Type VAC-15.5 kv vacuum circuit breaker, the breaker must be out of service.

Refer to and follow instructions in S290-54-1 Type MO-1 Operating Mechanism prior to replacing any parts.

The operating mechanism maintenance positioning wrench can be used when replacing some parts. Observe all safety precautions in S290-54-1 as well as those throughout these instructions when replacing parts. Although the Type VAC breaker was designed with the safety of operating personnel foremost in mind, the inherent mechanical characteristics of the breaker along with the necessary activities of operating personnel make cautious work habits essential.

Refer to Spare Parts section for parts-ordering data.

Keep complete records of all parts replaced.

BUSHINGS

1. To replace a bushing, the breaker should be open, isolated from the system with the closing springs discharged.

   NOTE: If any change in–or addition to–bushing current transformers is desired, make the change or addition at the same time the bushing is replaced.

2. Open both sides of the high-voltage compartment (Figure 3).
3. Referring to Figure 12, loosen bolts and remove the connector between the bushing clamp and the terminal assembly.
4. Loosen clamping bolts on the bushing clamp. (Do not attempt to remove bushing clamp at this time.)
5. Remove bolts holding current transformer in place and carefully lower support and current transformer(s) (Figure 12).

   NOTE: Support and current transformer(s) should be held in this lowered position until bushing is removed. If any change in–or addition to–bushing current transformers is desired, change out after bushing removal and in accordance with instructions on current transformer replacement in this section.

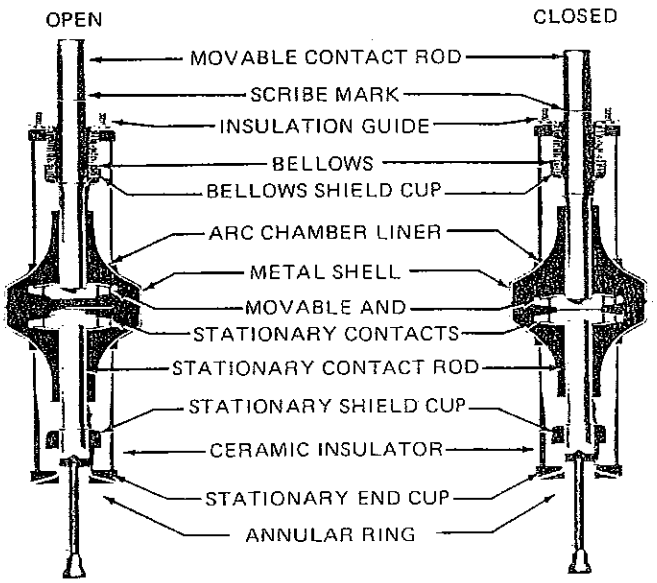


Figure 11

Scribe mark on interrupter indicates extent of contact erosion. (Interrupter must be replaced if mark disappears when contacts are closed.)

Vacuum Interrupter Test *(See Radiation Warning)*

To electrically test and establish the integrity of the vacuum, each interrupter should be given a simple a-c high-voltage potential test. Breaker contacts must be in the open position. The vacuum condition is satisfactory provided the interrupter withstands 38 kv for one minute for a 15.5 kv breaker.

WARNING

Take care to insure that all panels and doors are secured during vacuum dielectric test.

NOTE: Before applying a-c voltage, wipe each interrupter with a clean, lint-free cloth.

1. Connect a high potential voltage source across the open interrupter contacts (a bushing-to-bushing connection is recommended for each phase). All other bushings are to be grounded.
2. Test voltage should be gradually increased to 38 kv (rms).
3. Maintain peak test voltage for one minute.
4. Test voltage should then be gradually decreased to zero.
5. If the vacuum interrupter fails the high potential test, replace the interrupter in accordance with the instructions in the Parts Replacement section.

NOTE: During high potential testing the outer metal shell of the vacuum interrupter can acquire an electrical charge which may be retained after the test voltage is removed. Before touching the interrupter, use a grounding stick to discharge the shell as well as other metal parts of the interrupter.

RADIATION WARNING

X-radiation can result when voltage in excess of rated maximum voltage is applied across the open-contact gap in a vacuum interrupter. Such radiation can become a health hazard on long exposure at close range. When performing high-voltage tests on vacuum interrupters, personnel safety can be insured by noting the following information and taking the necessary precautions.

1. American National Standard C37.09-1964 "A-C High-Voltage Circuit Breakers" allows tests after delivery which include application of 75 percent of rated low-frequency withstand voltage across open contact of the interrupters. This voltage (50-60 hertz) is tabulated below.
2. At test voltages listed in Columns C and D, radiation is negligible when interrupters are mounted in their respective operating structures, installed in their normal apparatus enclosure, with metal enclosure panels in place, and have contacts open to their recommended open-contact gap as listed in Column E.
3. Testing at voltages higher than those listed in Columns C and D may cause radiation emission injurious to personnel. If testing is to be performed at voltages above those listed in Columns C and D, additional radiation shielding is required.
4. Vacuum interrupter testing above 50 kv ac rms is not recommended.

CAUTION

5. If direct-current dielectric tests (15 minute dc) are to be conducted on an underground system with apparatus connected, be sure vacuum interrupter contacts are closed.
6. Normal electrical safety precautions should be observed.

Apparatus Type Designation	Interrupter Rated Maximum Voltage (kv ac rms)	75% of Rated Low-Frequency Withstand Voltage (kv ac rms) (1 min. dry)	Recommended D-C Withstand Voltage (kv dc)* (1 min. dry)	Recommended Open-Contact Gap (inches) (mm)
Column A	Column B	Column C	Column D	Column E
VAC-15.5-20	15.5	37.5	53	1/2 (12.7)

*To prevent possible interrupter damage, d-c test source should be limited to 100 milliamps maximum.

Mechanical

Check all fasteners for tightness. After the first 500 operations, all fasteners should be retorqued to standard values as follows:

1/4 - 20	8 ft-lb	(11 N-m)
5/16 - 18	17 ft-lb	(23 N-m)
3/8 - 16	30 ft-lb	(41 N-m)
1/2 - 13	75 ft-lb	(102 N-m)

N-m = Newton-meters

NOTE: These torque values do not apply to fasteners tapped in aluminum.

Operating Mechanism

NOTE: Also see S290-54-1 Type MO-1 Operating Mechanism Service Information.

1. Listen for excessive noise or bearing rumble in motor.
2. Check linkage for signs of wear.
3. Check for hydraulic leaks.
4. Check hydraulic fluid level in sump.
   A. Check level with closing spring discharged.
   B. Dip stick connected to fill hole plug indicates fluid level.
   C. An empty hydraulic system requires approximately 1-1/2 pints of fluid to fill the sump.
   D. Add hydraulic fluid through fill-hole with one of the recommended hydraulic fluids to proper level.

   NOTE: Recommended fluids are: Chevron Oil Company Aviation Hydraulic Fluid A, Texaco Inc. Aircraft BB Hydraulic Oil, Shell Oil Company Aeroshell Fluid #4, Exxon Company Univis J-43.

Bushings

1. Bushings should be cleaned at regular intervals where abnormal conditions prevail such as salt deposits or any accumulation of foreign substances.
2. Bushing porcelain should be checked for cracks or chips.
3. If a bushing must be replaced refer to Bushings in the Parts Replacement section.

   Make this replacement before proceeding to the next maintenance step.

   NOTE: If any change in—or addition to—bushing current transformers is desired, make the change or addition at the same time the bushing is replaced.

Bushing Current Transformers

Check the bushing current transformer visually to make sure the leads are intact.

NOTE: If a change in—or addition to—bushing current transformers is desired, refer to Bushing Current Transformers in the Parts Replacement section and Service Information S290-80-2, Type OE Bushing Current Transformer Instructions. Make this change or addition before proceeding to the next maintenance step.

SAFETY PRECAUTION

Current transformer secondaries not connected to relays, instruments, or meters must be short-circuited and grounded at the terminal blocks in the low-voltage compartment.

Top-of-Bushing Terminal-to-Terminal Resistance

1. With the breaker closed conduct a top-of-bushing terminal-to-terminal resistance test on each of the three breaker poles (Figure 2).

   NOTE: Resistance test results indicate the current carrying condition of the breaker not its ability to interrupt faults.

Electrical Resistance Level	Electrical Resistance* (microohms)	
	1200 Amp Breaker	2000 Amp Breaker
Normal	100 ± 15	35 to 40
Caution	125	42
Service Limit	135	45

*Measured externally—terminal-to-terminal with the breaker closed. Resistance values must be maintained below the caution level.

2. If resistance test values are at or above the caution level shown in the table, make the following checks and rectify as necessary.
   A. Check the current carrying path of each pole for contamination. Wipe all current carrying parts with a clean, lint-free rag.
   B. Check all connections in the current carrying path for tightness. All fasteners should be secure *but be sure to observe standard torque values mentioned under Mechanical of the Maintenance and Adjustment section.*
3. With the breaker closed, recheck the top-of-bushing, terminal-to-terminal resistance values.

   NOTE: The resistance of vacuum interrupter contacts does not vary appreciably throughout interrupter life and therefore does not contribute to a change in terminal-to-terminal resistance.

Contact Wear

1. To check contact wear, the breaker contacts must be closed.
2. When the scribe mark on the movable contact rod (Figure 11) is even with the insulation guide, the interrupter must be replaced. See interrupter under Parts Replacement section.

B. Time travel device can be set up on the floor of low-voltage compartment behind the mechanism.

C. Connect time travel device directly to the crank provided on the jack shaft assembly (Figure 4).

D. Record direct readings of contact speed/motion characteristics.

E. Disconnect time travel device from crank on jack shaft.

16. Check all painted surfaces making sure they are clean. Retouch painted surfaces where necessary for complete protection.

17. Place the breaker and operator in the following service-ready condition.

A. Breaker in the open position.

B. Closing spring charged.

C. Heaters in the low-voltage compartment energized.

18. Establish permanent service records.

A. Record the operation-counter registration.

B. Record pertinent facts regarding the condition of the breaker.

C. Record complete nameplate information.

MAINTENANCE AND ADJUSTMENT

The frequency of routine inspections depends on the degree of exposure to contamination and severity of the operating duty. It is suggested practice to inspect the breaker at 500 mechanical operation intervals or after a severe fault interruption near the maximum rating of the breaker. All adjustments are factory set and further adjustment should not be required unless the breaker has had severe wear or rough handling. Operating mechanism maintenance covered by S290-54-1, MO-1 Operation Mechanism Instructions, must be coordinated with the Type VAC breaker maintenance.

Keep complete records of all maintenance work performed.

SAFETY PRECAUTIONS

Before performing any maintenance on a Type VAC vacuum circuit breaker, the breaker must be removed from service.

Refer to and follow instructions in Service Information S290-54-1, Type MO-1 Operating Mechanism prior to making any maintenance checks.

Use the operating mechanism maintenance-positioning wrench during the performance of some of the maintenance steps. Observe all safety precautions in S290-54-1 as well as those throughout these instructions when performing maintenance.

Although the Type VAC breaker was designed with the safety of operating personnel foremost in mind, the inherent mechanical characteristics of the breaker along with the necessary activities of operating personnel make cautious work habits essential.

MATERIALS

- Clean, lint-free rags.
- Lubricants.

Wipe all parts to be lubricated with clean, lint-free rags. Lubricate non-current-carrying moving parts such as operating linkages, pins, roller bearings, and gear teeth with a light film of Humble Oil and Refining Lidok 000 grease.

Wipe off excess grease with clean, lint-free rags.

NOTE: Roller bearings require packing only after they have been removed for a complete overhaul.

- Cleaning solution.

The preferred cleaning solutions are heptane, Stoddard's solvent or cleaner's naptha.

WARNING

Preferred cleaning solutions are flammable. Avoid sparks and flames. Use in an area where there is adequate ventilation.

WARNING

Deenergize the circuit breaker before performing any maintenance or inspection work. Unless stated otherwise in the procedure, all maintenance and inspection should be performed with the breaker open and the closing spring discharged.

Contact position indicator must read OPEN.

Closing spring position indicator must read DISCHARGED.

PROCEDURES

Cleanliness is the best assurance of trouble-free operation. If it is necessary to replace or adjust a breaker component, refer to Adjustments and Parts Replacement.

Wiring Checks

1. Terminal strip—check all connections and mounting screws to insure tightness. Check terminal strips for cracks.
2. Auxiliary switch—check all connections and mounting screws to insure tightness. Check for cracks and contact burns. Check the drive linkage.
3. Micro switches—check all connections for tightness, no cracks, and to insure plunger operates switch (a test light or ohmmeter can be used).

NOTE: Capacity of the ground connection should be sufficient to carry—without damage—the full ground short circuit of the system.

C. Install grounding connection.

4. Remove all packing materials from both compartments.
5. Check all fasteners for tightness. Secure but do not overtighten.
6. Remove operator blocking as follows:
   A. Open rear door of low-voltage compartment.

      NOTE: Be careful not to damage gasket.

   B. Use maintenance positioning wrench as illustrated (Figure 10).
   C. Apply upward force toward closing position to relieve pressure on blocking pin.
   D. Remove blocking pin.
   E. Very slowly relieve the force on maintenance closing wrench until breaker is fully open.
   F. Reseal low-voltage compartment.

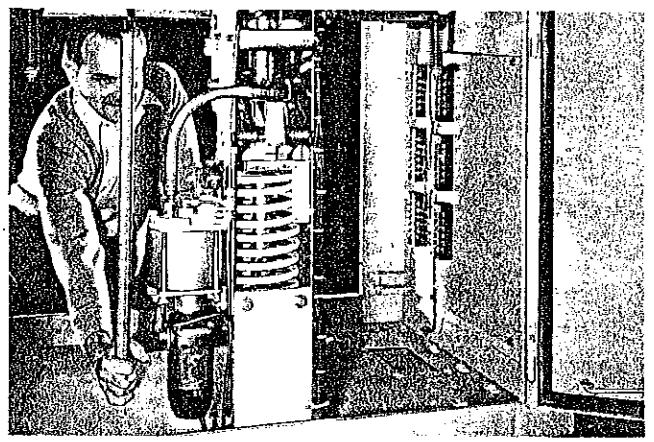


Figure 10
To remove blocking rod from Type MO-1 operating mechanism use maintenance positioning wrench.

CONNECTIONS

1. Make line, auxiliary and control connection as overall installation progresses and as indicated on drawings.

SAFETY PRECAUTION

Main (load) connections should not impose more than a 100-pound (444.8 newtons) maximum cantilever pull on the bushings. Forces may be caused by expansion, contraction, wind loading, or foundation movement.

CAUTION

When making line connections, do not torque the bushing top-terminal assembly over 60 ft-lb (81.4 newton-meters); overtorquing the bushing top terminal assembly will turn the core in the bushing, thus breaking the internal ground lead.

2. Prepare the operating mechanism for service in accordance with Service Information S290-54-1, Type MO-1 Operating Mechanism.

   NOTE: If permanent heater connections cannot be made promptly, a temporary supply should be provided to prevent moisture condensation in the mechanism cabinet.

3. To operate the breaker during installation if permanent source is not available, temporary a-c and d-c power must be made available.
4. Make sure all internal and external fasteners are tight.
5. Make sure all entrance bushings are clean.
6. Check the bushing current transformers visually to make sure the leads are intact.

SAFETY PRECAUTION

Current transformer secondaries not connected to relays, instruments, or meters must be short-circuited and grounded at the terminal blocks in the low-voltage compartment.

7. Make sure that the operating mechanism is ready for normal operation and that all safety blocking has been removed. Refer to and follow Service Information S290-54-1, Type MO-1 Operating Mechanism Instructions.
8. Connect a temporary two-pushbutton station with open and close buttons close enough together to coordinate electrical control of the breaker.

   NOTE: Refer to and follow connection diagrams that accompany the breaker.

9. After the mechanism blocking has been removed in accordance with previous instructions, the breaker is in the open position with the closing spring and opening springs discharged.
10. Energize the control circuit and charge the closing spring. When the closing spring is compressed, the breaker is ready for a closing operation.

    NOTE: Closing spring can also be charged by hand pumping (Figure 7).

11. To close breaker momentarily energize closing circuit. Breaker should close instantly.
12. To open breaker momentarily energize opening circuit. Breaker should open instantly.
13. Using the temporary electrical controls repeat the closing and opening operations.
14. With the breaker open check the operation of the Y (anti-pump) relay.
    A. Close the opening switch and hold it.
    B. Close the closing switch and hold it. The breaker should close and open and remain open.
15. Perform time travel tests (optional).
    A. Using the operating mechanism maintenance positioning wrench (Figure 10), close the breaker.

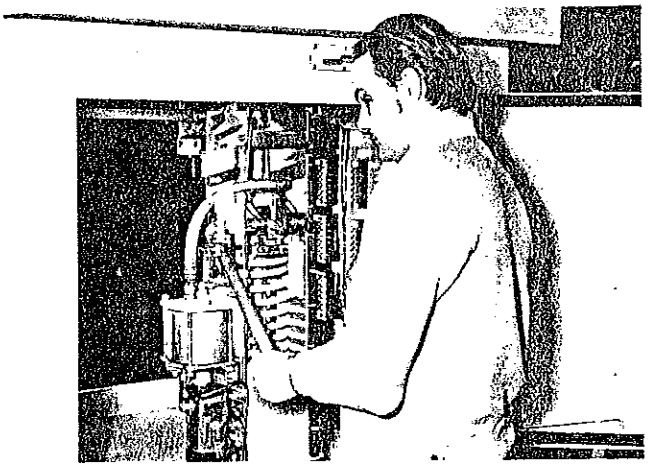


Figure 7
Manual charging of closing springs.

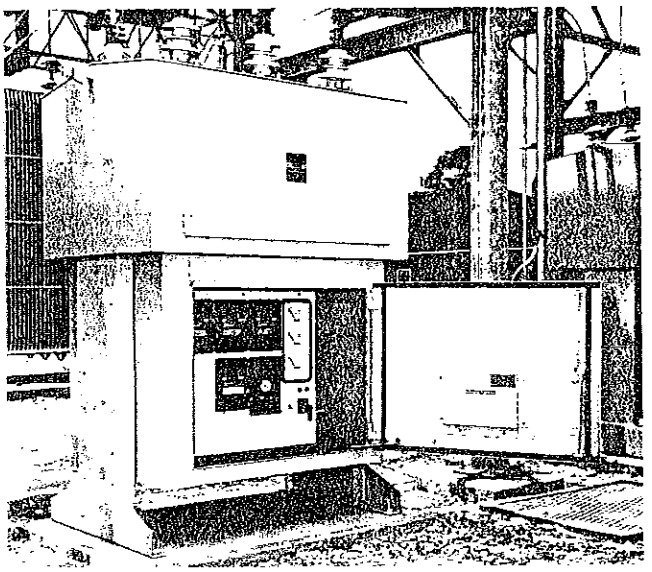


Figure 8
Typical hinged relay panel (optional).

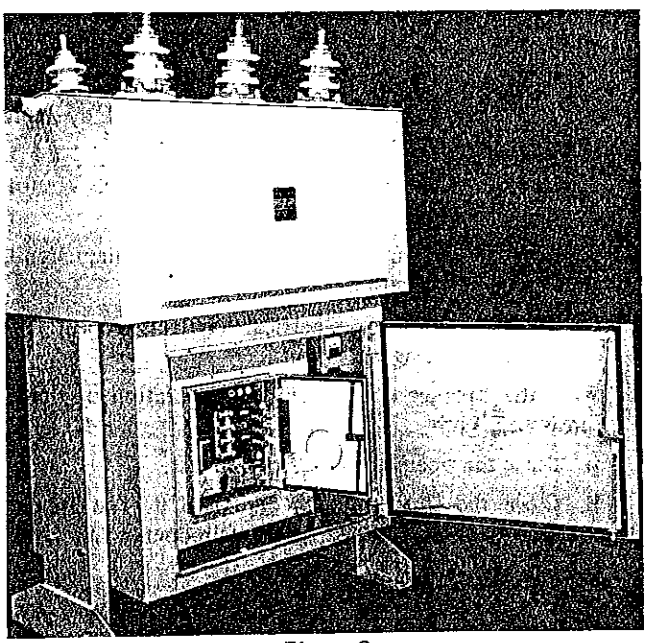


Figure 9
Typical hinged ME electronic control panel (optional).

Contact position is indicated by an externally visible flag indicator. The manual trip can be furnished with a permissive control device as an option to prevent reclosure without operating an internal manual reset. Various convenient locations are provided for terminal blocks.

INSTALLATION

SAFETY PRECAUTIONS

It is extremely important that all safety precautions described in Service Information S290-54-1, Type MO-1 Operating Mechanism Instructions, be clearly understood and carefully followed.

Personnel performing work on a Type VAC vacuum breaker or a Type MO-1 operating mechanism must clearly understand and follow both the breaker instructions and the operating mechanism instructions.

When it is necessary to use the operating mechanism for operational checks, stay clear of all moving parts.

Although the Type VAC breaker was designed with the safety of operating personnel foremost in mind, the inherent mechanical characteristics of the breakers along with the necessary activities of operating personnel make cautious work habits essential.

If not already accomplished, adjust leg extensions to specified height as prescribed under Unloading or Moving section.

WARNING

Remember that all Type VAC breakers are shipped at minimum possible height and customer must adjust breaker height to insure compliance with safety codes for clearance.

FOUNDATION

1. To adjust leg extensions remove four bolts from each leg.
   A. Slide leg downward to proper position and replace bolts.
   B. Make sure shipping holddown clips at side of breaker have been removed and discarded.
2. Continue with installation by leveling and anchoring the breaker.
   A. Prepare a flat slab or concrete piers to meet foundation requirements of drawings submitted for the breaker.
   B. Level breaker and bolt solidly in position at points indicated on outline drawing.
      (1) Shims of generous area should be located as required to insure even load distribution.
      (2) Check for level in lateral and longitudinal directions with spirit level.
3. Ground breaker as follows:
   A. Clean ground pad.
   B. Two ground pads with standard NEMA drilling are furnished on breaker legs.

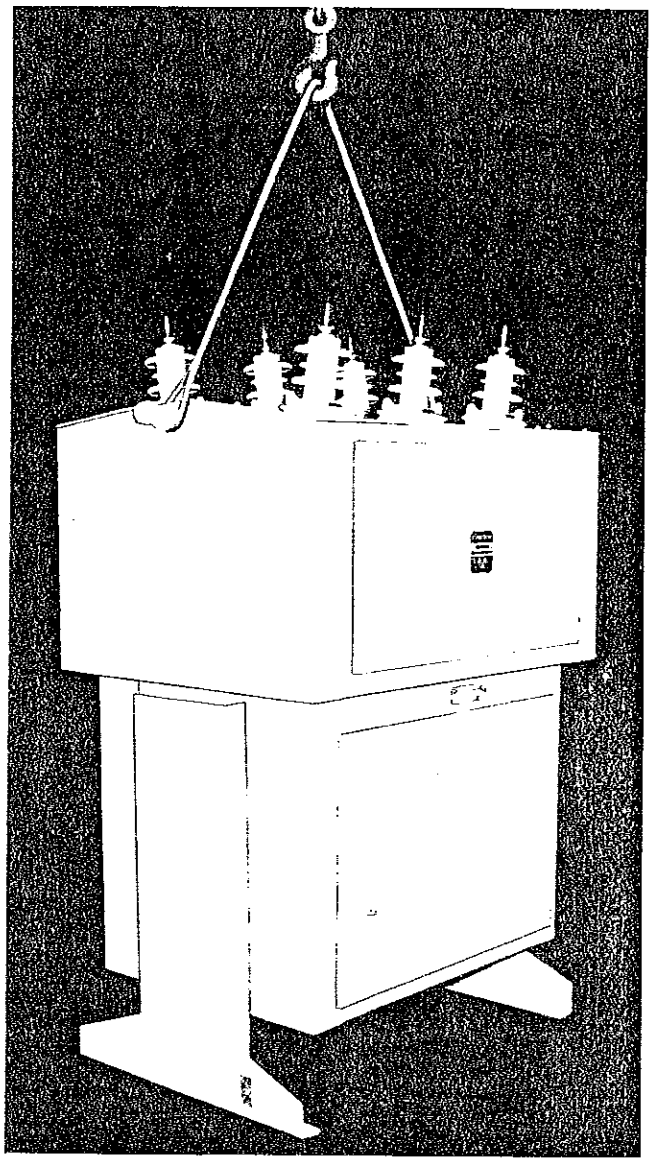


Figure 6
Sling arrangement.

STORAGE

If the Type VAC breaker is not to be placed in the service-ready condition immediately upon receipt, it is considered to be in storage. To prepare a breaker for storage:

1. Open the high-voltage compartment by removing cover plate bolts.
2. Open the low-voltage mechanism compartment.
3. Remove all packing material that might possibly collect moisture from both compartments.
   A. Do not remove desiccants, if furnished, at this time. Desiccants should be maintained in effective condition until such time as the breaker is made ready for service.
   B. Do not remove any blocking or bracing at this time.
   C. Open all boxes, inspect, and reseal.
   D. Store all boxes indoors in a dry place.
   E. Inspect the interiors of both compartments to insure they are clean and free from foreign materials.
4. Inspect bushings thoroughly. Make sure all bushings are clean, dry, and in good condition.
5. Energize compartment heaters with a temporary electrical source until permanent connections can be made.
6. Insure all openings are properly resealed to exclude moisture.
7. Close both compartments.

DESCRIPTION

The McGraw-Edison Type VAC vacuum circuit breaker is a three pole, integrally housed, electrically operated breaker suitable for outdoor operation. The operating mechanism is an electric-motor charged, compressed-spring stored energy Type MO-1. It is mechanically and electrically trip free. For detailed information on the Type MO-1 operating mechanism, refer to Service Information S290-54-1.

The Type VAC vacuum breaker should only be installed on circuits which operate within the voltages or currents given on the nameplate. Short-circuit conditions imposed on the breaker must not exceed the breaker rating.

HIGH-VOLTAGE COMPARTMENT

The upper section of the enclosure is the high-voltage compartment of the breaker. Contained therein are the lower ends of the bushings, current transformers, vacuum interrupters, transfer means, supporting stand off insulators, and operating rods to the interrupters. Access is by means of two bolted, hinged and gasketed panels. Except for an aluminum roof, the entire structure is heavy-gauge steel, treated and painted to inhibit corrosion.

The single- or multiple-ratio bushing current transformers are attached to the roof with all leads terminating at terminal blocks in the low-voltage compartment. The movable contact combination support-transfer scheme affords excellent repetitive guidance to the movable terminal for control of contact orientation and maximum bellows life.

LOW-VOLTAGE COMPARTMENT

The lower portion of the enclosure is the low-voltage compartment of the breaker which contains all control devices and the operator.

The Type MO-1 operator consists of a motor-driven, spring-stored-energy mechanism. Contact position indication and operations counter are visible with compartment door closed. The manual trip function is externally accessible. A means of manually charging the closing springs in case of charging power failure or for maintenance purposes is provided. Access to the opposite side of the low-voltage compartment is by means of a hinged, gasketed door with provisions for padlocking. (Some breakers are equipped with hinged relay panels or Type ME electronic controls which are mounted at the rear of the low-voltage compartment.

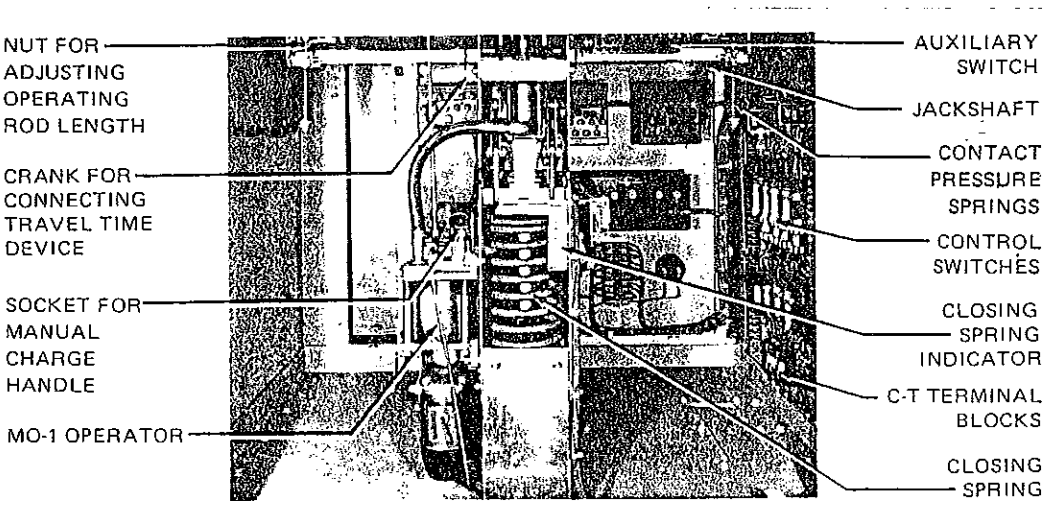


Figure 4
Low-voltage compartment.

INITIAL INSPECTION

Refer to Service Information S290-54-1, Type MO-1 Operating Mechanism Instructions, for initial inspection of the operating mechanism.

NOTE: Do not remove bracing or blocking from the operating mechanism at this time.

Immediately upon receipt of the breaker:

1. Check breaker exterior for evidence of damage in transit.
2. Open mechanism cabinet door and inspect low-voltage compartment for evidence of rough handling or damage in transit.
3. Close and latch the mechanism cabinet door to prevent entrance of dirt and moisture.
4. Open the front and rear panels (hinged and bolted) of the high-voltage compartment.
5. Inspect the interior of the high-voltage compartment for evidence of damage to the vacuum interrupter, bushings, and linkage due to rough handling in transit.
6. Reseal both front and rear openings promptly.
7. Remove all masking tape (later removal may be very difficult).
8. Secure bolts on both front and rear panels.

Should this initial inspection reveal evidence of rough handling or damage in transit or shortage, notify and file a claim with the carrier at once. Also notify the Service Department, McGraw-Edison Power Systems Division, Canonsburg, Pennsylvania 15317.

INDENTIFICATION RECORDS

Retain permanently complete identification records for each breaker including detailed outline drawings, control drawings, connection diagrams, and all pertinent instructions.

Accurate and complete identification including serial number and rating must accompany any reference to or inquiry about the breaker to McGraw-Edison Power Systems Division.

UNLOADING OR MOVING

The Type VAC breaker should be unloaded and moved by hoisting. Slings used for hoisting must have adequate lifting capacity. The weight of each breaker is shown on its nameplate. Attach slings at the top of each side of the breaker as illustrated (Figure 6).

> WARNING
>
> Do not permit sling to bear against porcelain bushings. Do not use holddown angles to lift breakers.

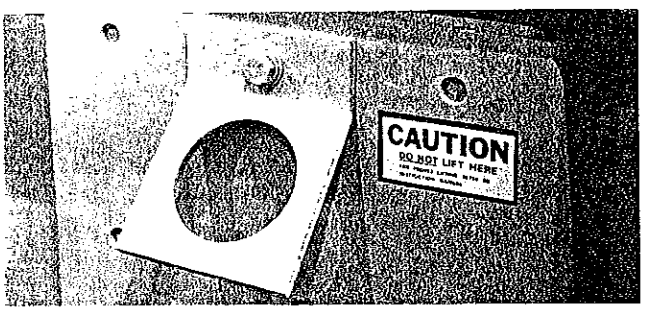


Figure 5
Do not use holddown angles to lift breakers.

With slings properly secured lift breaker straight up being careful not to damage the bushings with the rigging.

While breaker is off the ground adjust leg extensions per specific height requirements.

> WARNING
>
> For shipping convenience all Type VAC breakers are assembled and shipped with the minimum height possible. Customer must adjust breaker height to comply with electrical safety codes for clearance.

Remove and discard shipping holddown bolts and clips. Height adjustment is accomplished by removing four bolts from each leg, slide leg downward to proper position and replace the bolts.

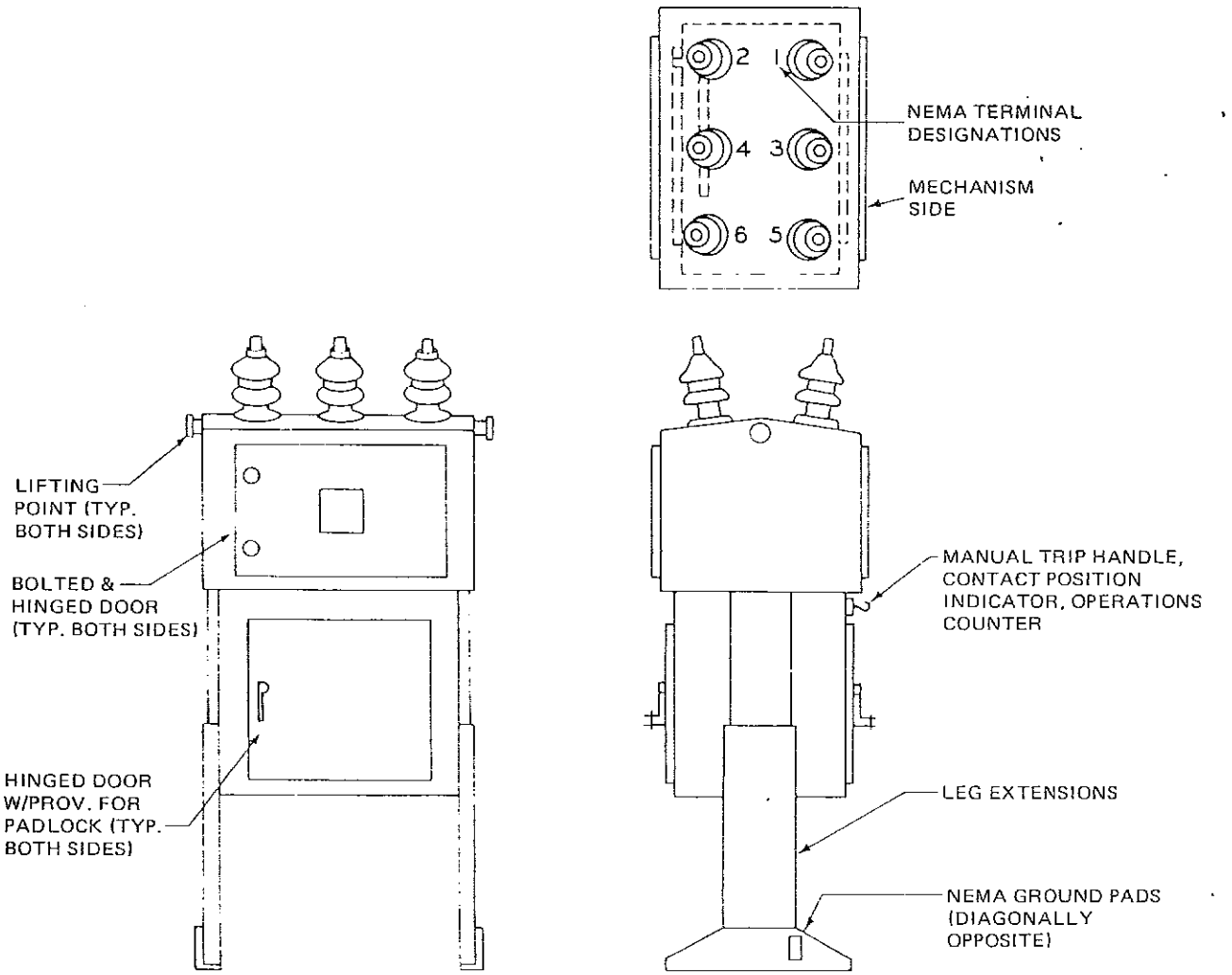


Figure 2
Outline of type Type VAC, 15.5 kv vacuum circuit breaker.

SHIPPING

Except in special cases, each Type VAC breaker is shipped completely assembled with the MO-1 operating mechanism in place. Small accessory items are shipped in suitably marked packages.

Each breaker is shipped with the contacts blocked closed by a red rod inserted in the mechanism. The mechanism is unlatched so that opening-spring pressure is on the rod. For removal of this rod refer to the Installation section of these instructions and Type MO-1 Operating Mechanism Service Information S290-54-1.

Detailed outline drawings, control drawings, connection diagrams, all pertinent instructions, and packing lists are shipped protected in the mechanism cabinet. A shipping list in a weatherproof envelope is attached to each shipment.

NOTE: Breakers shipped overseas require special disassembled packaging.

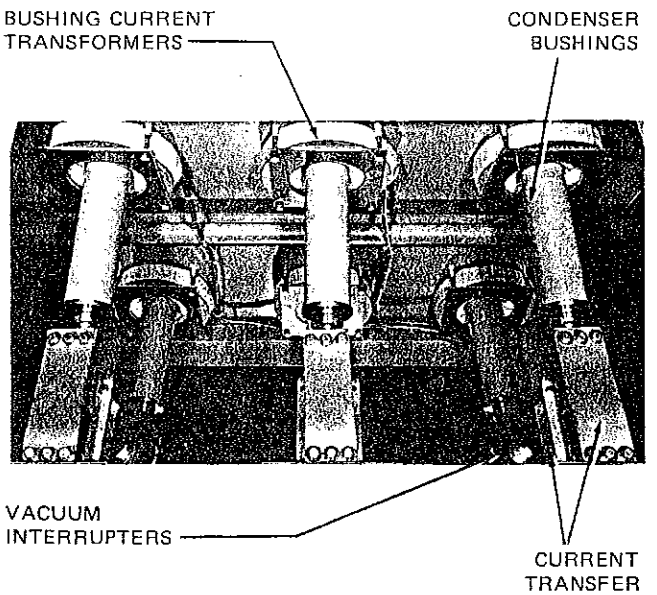


Figure 3
High-voltage compartment.

Power Circuit Breakers
Type VAC 15.5 kv
Installation and Maintenance Instructions

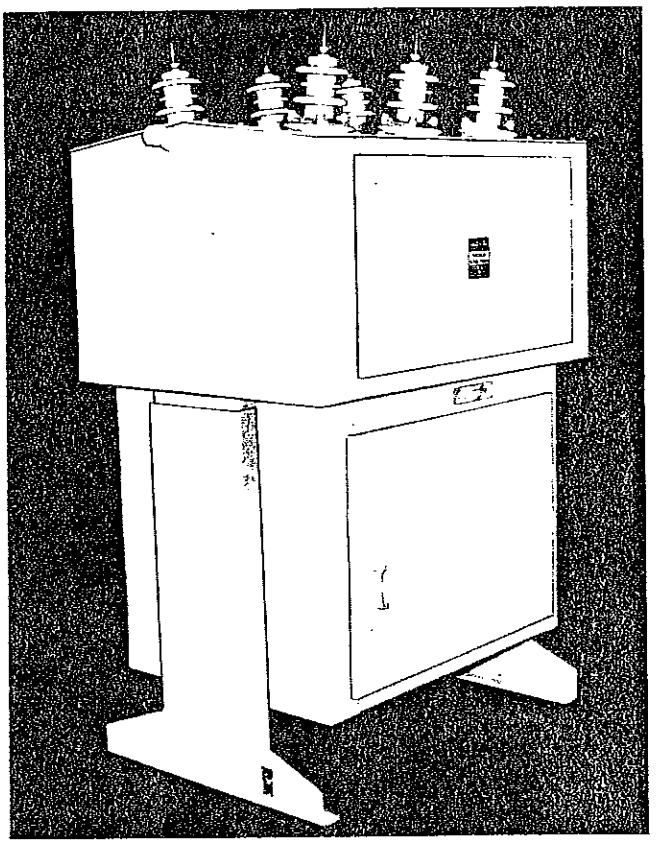


Figure 1
A typical McGraw-Edison 15.5 kv Type VAC vacuum circuit breaker.

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GENERAL

Service Information S290-10-1 pertains specifically to McGraw-Edison 15.5 kv Type VAC vacuum circuit breakers. Detailed outline, control drawings, and connection diagrams are issued for and accompany each breaker.

When installing, performing maintenance work, making adjustments, or replacing parts on a 15.5 kv Type VAC vacuum circuit breaker, the latest revision of the following instructions—copies of which accompany each breaker—must be followed.

Operating Mechanism: Service Information S290-54-1, Type MO-1 Operating Mechanism

Bushing Current Transformers: Service Information S290-80-2, Type OE Bushing Current Transformers

Separate instruction books are furnished for relays and auxiliary switches as required for each application.

Type VAC vacuum breakers conform to all applicable national standards for electrical characteristics, mechanical features, and accessories. Auxiliary provisions include an external trip device, a mechanical position indicator, trip counter, and facilities for proper mounting and electrical grounding.

Standard NEMA terminal designations are shown in Figure 2. Facing the mechanism side of the low-voltage compartment from front to rear, terminals are numbered 1 and 2 on the right, 3 and 4 in the center, and 5 and 6 on the left.

McGraw-Edison Company
Power Systems Division
Canonsburg, Pennsylvania 15317

July 1977
New Issue

C-ORDER# C-03956-4 ITEM# 01 REVISION# 00
FOR: P.O.# LCCP55569A CONSOLIDATED ALUMINUM CORP
VAC00 15.5 KV 1200A 20 KA

FOR IT. LOCATION REFER TO MECHANISM CONNECTION DIAGRAM SHC03231A
** - INDICATES CHANGE FROM LAST REVISION #

ITEM#	QTY	U/M	MEPS NO.	D E S C R I P T I O N
24	1	EA	333041055	50-103131LSSJ, AMMETER, 0-600 AMP AC, 60 HZ, SEMI-FLUSH MOUNTING, GENERAL ELECTRIC TYPE AB-40.
25	1	EA	323021153	16SB1CA19X2, AMMETER SWITCH, FIXED KNURLED HANDLE, GENERAL ELECTRIC TYPE SB-1.
26	1	EA		50-103021PZXE, VOLTMETER, 0-150 VOLT AC RATING, 0-18 KV SCALE, 60 HZ, SEMI-FLUSH MOUNTING, GENERAL ELECTRIC TYPE AB-40. (FOR USE WITH 14,400-120 VOLT P.T.'S CONN. IN DELTA ON A 13.8 KV SYSTEM.)
27	1	EA		16SB1CF11X2, VOLTMETER SWITCH, FIXED KNURLED HANDLE, GENERAL ELECTRIC TYPE SB-1.

CKD.	DATE 3/5/82
APPD.	DATE 3-5-82

C-ORDER# C-03956-4 ITEM# 01 REVISION# 00
FOR: P.O.# LCCP55569A CONSOLIDATED ALUMINUM CORP
VAC00 15.5 KV 1200A 20 KA

FOR IT. LOCATION REFER TO MECHANISM CONNECTION DIAGRAM SHC03231A
** - INDICATES CHANGE FROM LAST REVISION #

ITEM#	QTY	U/M	MEPS NO.	D E S C R I P T I O N
				16-14, AMP OR BURNDY.
13	42	EA	351045017	YAD 10-10 OR #33457, TERMINAL, RING TONGUE, WIRE RANGE 12-10, BURNDY OR AMP.
14	1	EA	SVC00132A001	MECHANISM CONTROL PANEL.
15	1	EA	SVC00133A001	CT TERMINAL BLOCK PANEL.
16	1	EA	SVB00237A00B	HEATER ASSEMBLY, 250 WATT, 240 VOLT.
17	1	EA	SVA00960A001	RELAY PANEL
18	1	EA	SVA00889A00A	METER PANEL FRAME, STANDARD WIDTH, FOR VAC BREAKER.
19	4	EA		264C900A06, OVERCURRENT RELAY, 60 HZ, 1-12 AMP MAIN, INVERSE TIME, WESTINGHOUSE TYPE CO-8.
20	1	EA		121JC51B4A, CURRENT BALANCE RELAY, THREE PHASE, 60 HZ, 5 AMP, GENERAL ELECTRIC TYPE IJC
21	1	EA	323021101	16SB1B1X2, CIRCUIT BREAKER CONTROL SWITCH, PISTOL GRIP HANDLE, GENERAL ELECTRIC TYPE SB-1.
22	1	EA	SHB00984A00E	INDICATING LIGHT ASSEMBLY, 240 VOLT AC, WITH RED COLOR CAP, GENERAL ELECTRIC TYPE ET-16.
23	1	EA	SHB00984A00K	INDICATING LIGHT ASSEMBLY, 240 VOLT AC, WITH GREEN COLOR CAP, GENERAL ELECTRIC TYPE ET-16.

CKD. [illegible]	DATE 3/3/82
APPD. [illegible]	[illegible]E 5-82

C-ORDER# C-03956-4 ITEM# 01 REVISION# 00
FOR: P.O.# LCCP55569A CONSOLIDATED ALUMINUM CORP
VAC00 15.5 KV 1200A 20 KA

FOR IT. LOCATION REFER TO MECHANISM CONNECTION DIAGRAM SHC03231A
** - INDICATES CHANGE FROM LAST REVISION #

ITEM#	QTY	U/M	MEPS NO.	D E S C R I P T I O N
1	2	EA	SHB00701A00E	AUXILIARY RELAY, 230 VAC, SURFACE MOUNTED, FRONT CONNECTED, GENERAL ELECTRIC TYPE CR205.
2	1	EA	334061213	MODEL 295-240, CAPACITOR TRIP DEVICE, 208/240 VAC SOURCE, TIME MARK CORPORATION.
3	2	EA	323021313	TC-1130, KNIFE SWITCH, 30 AMP, 250 VOLT, 2 POLE, OPEN TYPE FUSED, GENERAL ELECTRIC.
4	1	EA	323021312	TC-3041, KNIFE SWITCH, 30 AMP, 250 VOLT, 2 POLE, OPEN TYPE UNFUSED, GENERAL ELECTRIC.
5	1	EA	351071152	FUSE BLOCK, 30 AMP, 250 VOLT, 2 POLE.
6	4	EA	351071463	NON-15, FUSE, CARTRIDGE TYPE, 15 AMP, 250 VOLT, BUSSMANN.
7	2	EA	351071467	NON-30, FUSE, CARTRIDGE TYPE, 30 AMP, 250 VOLT, BUSSMANN.
8	1	EA	334041371	RESISTOR, 25 OHM, 175 WATT.
9	3	EA	351063919	1612, TERMINAL BLOCK, 12 POLE, 30 AMP, 600 VOLT, MARATHON.
10	6	EA	351063905	1606-SC, TERMINAL BLOCK, 6 POLE, 30 AMP, 600 VOLT, SHORT CIRCUITING, MARATHON.
11	800	FT	236041533	CU. WIRE, SYN901, #14-41 STR, BLACK. (MECHANISM AND RELAY CABINET WIRING)
12	200	EA	351045011	34123 OR BB-339-10, TERMINAL, RING TONGUE, WIRE RANGE

CKD.	DATE 3/1/82
APPD.	DATE 3-5-82

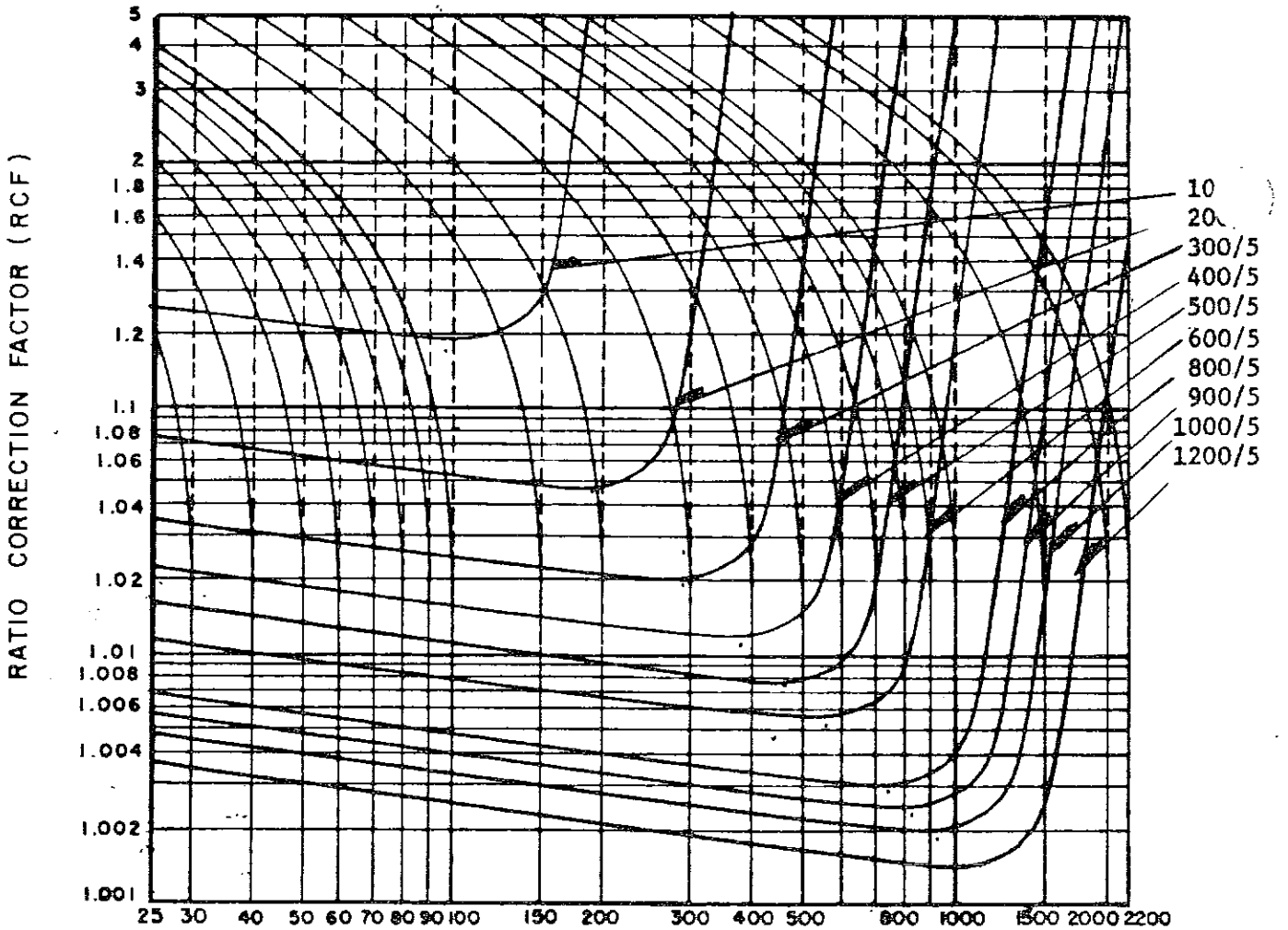
McGRAW-EDISON
POWER SYSTEMS DIVISION

BTCT RATIO CORRECTION FACTOR CURVES

ASA STANDARD B-2(2 OHMS, 50 PERCENT PF LAG) SEC BURDEN

MARKED RATIO	SEC. TURNS	SEC. TAPS
100/5	20	X_2-X_3
200/5	40	X_1-X_2
300/5	60	X_1-X_3
400/5	80	X_4-X_5
500/5	100	X_3-X_4
600/5	120	X_2-X_4
800/5	160	X_1-X_4
900/5	180	X_3-X_5
1000/5	200	X_2-X_5
1200/5	240	X_1-X_5

TYPE OE- 1200
DWG. NO. A-385575
OCB TYPE-
FREQUENCY 60 CYCLES
MAXIMUM RATIO 1200/5
TOTAL SEC. TURNS 240
SEC. RES..0019 OHMS/TURN + .052 OHMS @ 75°C
ASA ACCURACY 10C200



Dwg. No. RCF-385575-2C

DOTTED LINE - SECONDARY COORDINATE

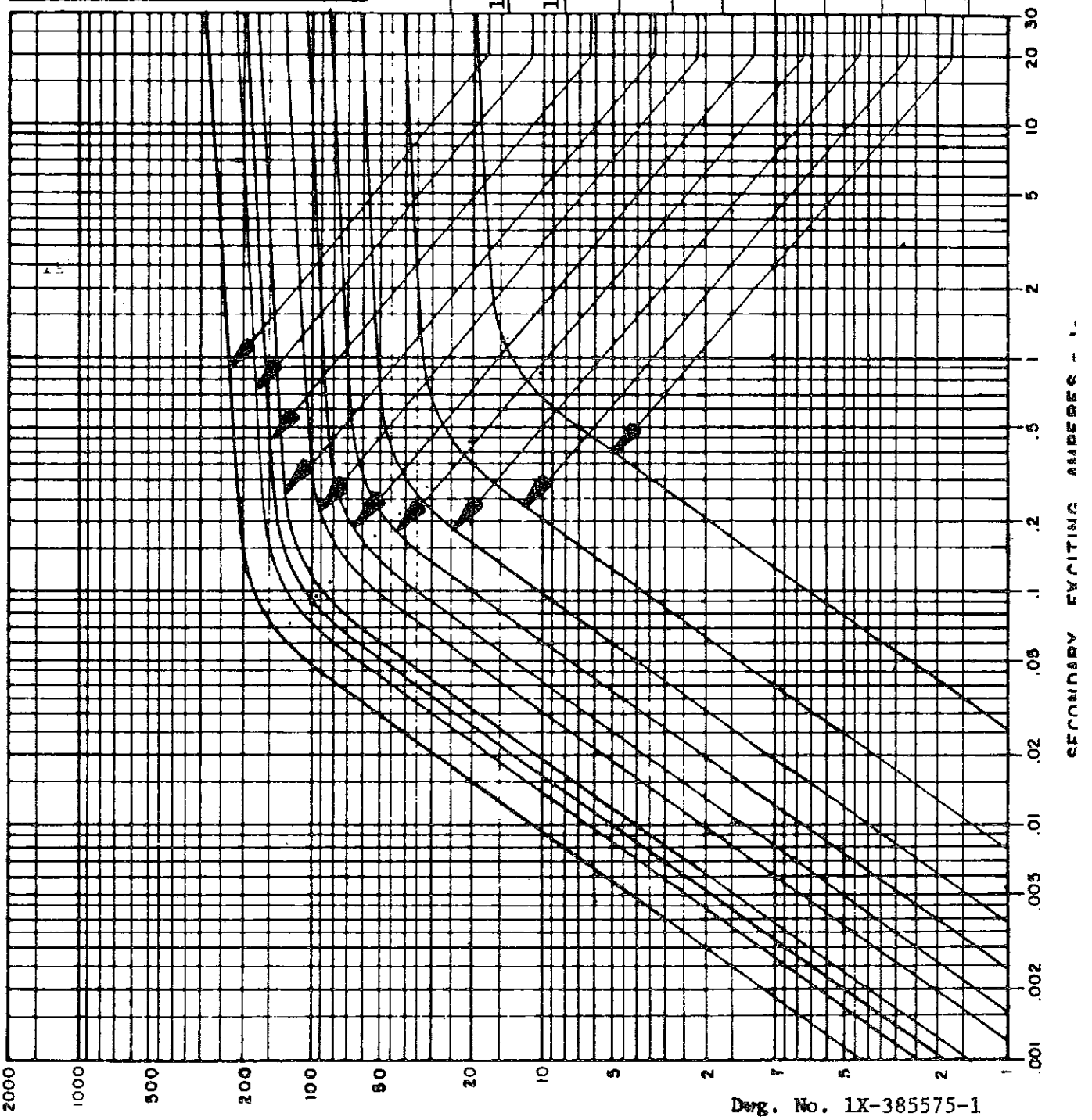
SOLID LINE - PRIMARY COORDINATE

REF

McGRAW-EDISON
POWER SYSTEMS DIVISION
BTCT EXCITING CURRENT CURVES

TYPE OE- 1200
DWG. NO. A-385575
OCB TYPE -
FREQUENCY 60 CYCLES
MAXIMUM RATIO 1200/5
TOTAL SEC. TURNS 240
SEC. RES..0019 OHMS/TURN + .052 OHMS @ 75°C
ASA ACCURACY 10C200

MARKED RATIO	SEC. TURNS	SEC. TAPS
100/5	20	X_2-X_3
200/5	40	X_1-X_2
300/5	60	X_1-X_3
400/5	80	X_4-X_5
500/5	100	X_3-X_4
600/5	120	X_2-X_4
800/5	160	X_1-X_4
900/5	180	X_3-X_5
1000/5	200	X_2-X_5
1200/5	240	X_1-X_5



Dwg. No. 1X-385575-1

REF-

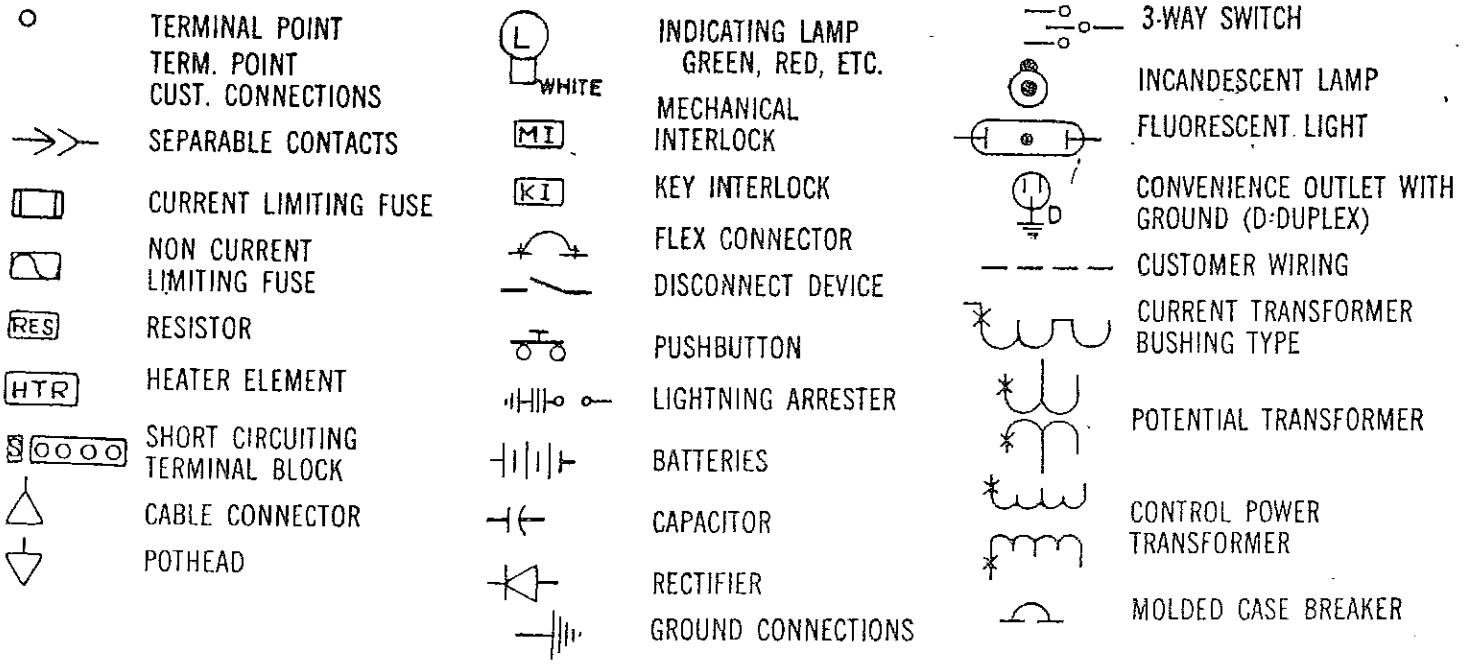


DIAGRAM ABBREVIATIONS *

A	AMPERE
AC	ALTERNATING CURRENT
ACB	AIR CIRCUIT BREAKER
Am	AMMETER
ANN	ANNUNCIATOR
ARM	ARMATURE
	AMMETER SWITCH
	AUTOMATIC
AUTO RECL	AUTOMATIC RECLOSING
AUTO T	AUTO TRANSFORMER
AUX	AUXILIARY
BASw	BELL ALARM SWITCH
BAT	BATTERY
BAT CHG	BATTERY CHARGER
BB	BENCH BOARD
BC	BACK CONNECTED
BCT	BUSHING CURRENT TRANSFORMER
BD	BOARD
BE	BREAKER END
BKR	BREAKER
BPD	BUSHING POTENTIAL DEVICE
BRKT	BRACKET
BV	BACK VIEW
C	CURRENT
CAB	CABINET
CAL	CALIBRATING
CAP	CAPACITOR; CAPACITY
CAT	CATALOG
CC	CLOSING COIL
CKT	CIRCUIT
CNTOR	CONTACTOR
CO	CUT OUT
COMP	COMPENSATOR
COMPT	COMPARTMENT
CONN	CONNECT CONNECTION
CONT	CONTINUED; CONTROL
CONV	CONVERTER
CPT	CONTROL POWER TRANSFORMER
CR	CONTROL RELAY
CS	CONTROL SWITCH
CT	CURRENT TRANSFORMER
c	CYCLE
DC	DIRECT CURRENT
DD	DISCONNECTING DEVICE
DEV	DEVICE
DIAG	DIAGRAM
DIFF	DIFFERENTIAL
DIR	DIRECTION, DIRECTIONAL
DISC	DISCONNECT
DISCH	DISCHARGE
Dm	DEMAND METER
D	DRAWOUT
D	DOUBLE POLE DOUBLE THROW
DPST	DOUBLE POLE SINGLE THROW
DSw	DISCONNECT SWITCH
DSCT	DOUBLE SECONDARY CURRENT TRANSFORMER
DWG	DRAWING
DX	DUPLEX
ELEC	ELECTRIC
ELEM	ELEMENTARY
EMER	EMERGENCY
ENCL	ENCLOSURE
EQ	EQUALIZER
EQUIP	EQUIPMENT
EXC	EXCITER; EXCITATION
EXIST	EXISTING
FB	FUSE BLOCK
FC	FRONT CONNECTED
FDR	FEEDER
FIG	FIGURE
FLD	FIELD
FLEX	FLEXIBLE
fm	FREQUENCY METER
f	FREQUENCY
FRWK	FRAMEWORK
FU	FUSE
FUT	FUTURE
FV	FRONT VIEW
FWD	FORWARD
G	GENERATOR
GD	GROUND DETECTOR
GOV	GOVERNOR
GRD	GROUND
HC	HOLDING COIL
hp	HORSE POWER
HR	HAND RESET
HTR	HEATER
HV	HIGH VOLTAGE
IMPR	IMPEDOR
INC	INCOMING
INST	INSTANTANEOUS; INSTRUMENT
INT CONN	INTERNAL CONNECTION
IT	INSULATING TRANSFORMER
kV	KILOVOLT
kVA	KILOVOLT AMPERE
kVAh	KILOVOLT AMPERE HOUR
kVAhm	KILOVOLT AMPERE HOUR METER
kVAm	KILOVOLT AMPERE METER
kvar	KILOVOLT AMPERE REACTIVE
kvarh	KILOVAR HOUR
kW	KILOWATT
kWh	KILOWATT HOUR
kWhm	KILOWATT HOUR METER
L	LAMP; LOWERING
LA	LIGHTNING ARRESTER
LC	LATCH CHECK
LH	LEFT HAND
LIR	LOAD INDICATING RESISTOR
LLM	LOAD LIMITING RESISTOR
LRC	LOAD RATIO CONTROL
LSw	LIMIT SWITCH
LSR	LOAD SHIFTING RESISTOR
LSS	LEFT SIDE SHEET
LT	LIGHT
LTG	LIGHTING
LV	LOW VOLTAGE
mAm	MILLIAMMETER
MAN	MANUAL
MAN OP	MANUALLY OPERATED
MC	METAL-CLAD
MCM	THOUSAND CIRCULAR MILS
MECH	MECHANICAL MECHANISM
μF	MICROFARAD
MFR	MANUFACTURER
MG	MOTOR GENERATOR
MISC	MISCELLANEOUS
M	MOTOR
MTD	MOUNTED
mV	MILLIVOLT
NC	NORMALLY CLOSED
NEG	NEGATIVE
NEUT	NEUTRAL
NO	NORMALLY OPEN; NUMBER
NOR	NORMAL
NP	NAMEPLATE
OC	OVERCURRENT
OCB	OIL CIRCUIT BREAKER
OPER	OPERATE
OVLD	OVERLOAD
ϕ	PHASE
PB	PUSH BUTTON
PB STA	PUSH BUTTON STATION
PCB	POWER CIRCUIT BREAKER
PF	POWER FACTOR
PFD	PREFERRED
PFm	POWER FACTOR METER
PH	POTHEAD
PNEU	PNEUMATIC
PNL	PANEL
POS	POSITION, POSITIVE
POS Sw	POSITION SWITCH
POT	POTENTIAL
PRI	PRIMARY
PT	POTENTIAL TRANSFORMER
PU	PICK UP
PWR	POWER
RCD	REVERSE CURRENT DEVICE
RE	RECEPTACLE
REAC	REACTOR
REC	RECORDING
RECL	RECLOSING
RECT	RECTIFIER
REG	REGULATOR
RES	RESISTANCE; RESISTOR
REV	REVERSE, REVISE
RH	RIGHT HAND
RHEO	RHEOSTAT
RSS	RIGHT SIDE SHEET
RTD	RESISTANCE TEMPERATURE DETECTOR
RV	REAR VIEW
s	SECONDS
SEC	SECONDARY
SECT	SECTION
SEQ	SEQUENCE
SER	SERIES
SH	SHUNT
SI	SEAL-IN DEVICE
SOL	SOLENOID
SP	SPARE
SPDT	SINGLE POLE DOUBLE THROW
SPST	SINGLE POLE SINGLE THROW
STA	STATION; STATIONARY
STAB	STABILIZER
STD	STANDARD
STG	STARTING
STR	STRUCTURE
SUB STA	SUBSTATION
SUPV	SUPERVISORY
Sw	SWITCH
SWBD	SWITCHBOARD
SWR BKT	SWINGING BRACKET
SWGR	SWITCHGEAR
SYM	SYMBOL
SYN	SYNCHRONISM; SYNCHRONIZING; SYNCHRONOUS; SYNCHROSCOPE
SYN CONV	SYNCHRONOUS CONVERTER
SS	SYNCHRONIZING SWITCH
TB	TERMINAL BLOCK
TC	TRIP COIL
TD	TESTING DEVICE
TDC	TIME DELAY CLOSING
TDO	TIME DELAY OPENING
TEL	TELEPHONE
TELE	TELEMETER
TEMP	TEMPERATURE
TERM	TERMINAL
Tm	TEMPERATURE METER
TPST	TRIPLE POLE SINGLE THROW
T	TRANSFORMER
UV	UNDERVOLTAGE
UVD	UNDERVOLTAGE DEVICE
V	VOLT
VA	VOLT-AMPERE
vac	VACUUM
V ADJ R	VOLTAGE ADJUSTING RHEOSTAT
var	VOLT-AMPERE REACTIVE
varh	VAR HOUR
varm	VARMETER
Vm	VOLTMETER
V REG	VOLT REGULATOR
VS	VOLTMETER SWITCH
W	WATT; WIRE
WhDm	WATTHOUR DEMAND METER
Whm	WATTHOUR METER
Wm	WATTMETER
Wt	WEIGHT

* Most Commonly Used Abbreviations.

ANSI DEVICE FUNCTION NUMBERS

1. Master Element
2. Time-Delay Starting or Closing Relay
3. Checking or Interlocking Relay
4. Master Contactor
5. Stopping Device
6. Starting Circuit Breaker
7. Anode Circut Breaker
8. Control Power Disconnecting Device
9. Reversing Device
10. Unit Sequence Switch
11. Reserved for future application
12. Over-Speed Device
13. Synchronous-Speed Device
14. Under-Speed Device
15. Speed or Frequency Matching Device
16. Reserved for future application
17. Shunting or Discharge Switch
18. Accelerating or Decelerating Device
19. Starting-to-Running Transition Contactor
20. Electrically Operated Valve
21. Distance Relay
22. Equalizer Circuit Breaker
23. Temperature Control Device
24. Reserved for future application
25. Synchronizing or Synchronism-Check Device
26. Apparatus Thermal Device
27. Undervoltage Relay
28. Flame Detector
29. Isolating Contactor
30. Annunciator Relay
31. Separate Excitation Device
32. Directional Power Relay
33. Position Switch
34. Master Sequence Device
35. Brush-Operating or Slip-Ring Short-Circuiting Device
36. Polarity Device
37. Undercurrent or Underpower Relay
38. Bearing Protective Device
39. Mechanical Condition Monitor
40. Field Relay
41. Field Circuit Breaker
42. Running Circuit Breaker
43. Manual Transfer or Selector Device
44. Unit Sequence Starting Relay
45. Atmospheric Condition Monitor
46. Reverse-Phase or Phase-Balance Current Relay
47. Phase-Sequence Voltage Relay
48. Incomplete Sequence Relay
49. Machine or Transformer Thermal Relay
50. Instantaneous Overcurrent or Rate-of-Rise Relay
51. A-C Time Overcurrent Relay
52. A-C Circuit Breaker
53. Exciter or D-C Generator Relay
54. Reserved for future application
55. Power Factor Relay
56. Field Application Relay
57. Short-Circuiting or Grounding Device
58. Rectification Failure Relay
59. Overvoltage Relay
60. Voltage or Current Balance Relay
61. Reserved for future application
62. Time-Delay Stopping or Opening Relay
63. Liquid or Gas Pressure or Vacuum Relay
64. Ground Protective Relay
65. Governor
66. Notching or Jogging Device
67. A-C Directional Overcurrent Relay
68. Blocking Relay
69. Permissive Control Device
70. Electrically Operated Rheostat
71. Liquid or Gas-Level Relay
72. D-C Circuit Breaker
73. Load-Resistor Contactor
74. Alarm Relay
75. Position Changing Mechanism
76. D-C Overcurrent Relay
77. Pulse Transmitter
78. Phase Angle Measuring or Out-of-Step Protective Relay
79. A-C Reclosing Relay
80. Liquid or Gas Flow Relay
81. Frequency Relay
82. D-C Reclosing Relay
83. Automatic Selective Control or Transfer Relay
84. Operating Mechanism
85. Carrier or Pilot Wire Receiver Relay
86. Locking-Out Relay
87. Differential Protective Relay
88. Auxiliary Motor or Motor Generator
89. Line Switch
90. Regulating Device
91. Voltage Directional Relay
92. Voltage and Power Directional Relay
93. Field Changing Contactor
94. Tripping or Trip-Free Relay
95.
96.
97. Used only on specific applications on individual installations where none of the assigned numbered functions from 1 to 94 are suitable.
98.
99.

NOTES:

Suffix letters X, Y or Z are added to the appropriate device function numbers to denote separate auxiliary relays. Example: 27X, 52Y, 79Z.

If two or more devices with the same function number and suffix letter (if used) are present in the same equipment, they may be distinguished by numbered suffixes. Example: 27-1, 27-2, 27X-1, 27X-2.

MISCELLANEOUS DEVICE DESIGNATIONS

52/X	CLOSING RELAY
52/Y	ANTI-PUMP RELAY
52/CC	BREAKER CLOSING COIL
52/TC	BREAKER TRIP COIL
52/M	BREAKER PUMP MOTOR
52/SS	MOTOR CUTOFF HIGH PRESSURE SWITCH
52/S	CONTROL CUTOFF LOW PRESSURE SWITCH CLOSED WHEN PRESSURE IS SUFFICIENT FOR CLOSING
52/a	NORMALLY OPEN AUXILIARY SWITCH CONTACT
52/b	NORMALLY CLOSED AUXILIARY SWITCH CONTACT
52/ae	ADVANCE MAKE "a" CONTACT—CLOSES DURING FIRST 15° OF CLOSING MOTION
52/be	ADVANCE BREAK "b" CONTACT—OPENS DURING FIRST 15° OF CLOSING MOTION
52/Sa	STATIONARY SWITCH—MECHANISM OPERATED
52/Sb	IN TEST, OPERATE OR BOTH POSITIONS AS INDICATED
52/Ha	HOUSING SWITCH—TRUCK OPERATED, SHOWN
52/Hb	WITH BREAKER IN TEST OR WITHDRAWN POSITION
52/UV	UNDERVOLTAGE TRIP
24	BUS TIE BREAKER
W/VS	WATT-VAR SWITCH
PTD	POTENTIAL TEST DEVICE
CTD	CURRENT TEST DEVICE
VRR	VOLTAGE REGULATING RELAY
LTC	LOAD TAP CHANGER
PST	PHASE SHIFTING TRANSFORMER
ETM	ELAPSED TIME METER
201X	SUPERVISORY CLOSING DEVICE
294X	SUPERVISORY TRIPPING DEVICE
43LS	LOCAL—SUPERVISORY TRANSFER SWITCH
43MA	MANUAL—AUTOMATIC TRANSFER SWITCH
87L	PILOT WIRE RELAY
85/74-R	PILOT WIRE RECEIVING AND ALARM RELAY
85/74-S	PILOT WIRE SENDING AND ALARM RELAY
50/CO	INSTANTANEOUS RELAY CUTOFF DEVICE
79/CO	RECLOSER RELAY CUTOFF DEVICE

McGRAW-EDISON Power Systems Group
McGraw-Edison Company
Canonsburg, PA 15317 USA

LEGEND DRAWING FOR ASSEMBLED SWITCHGEAR | SGA01186A

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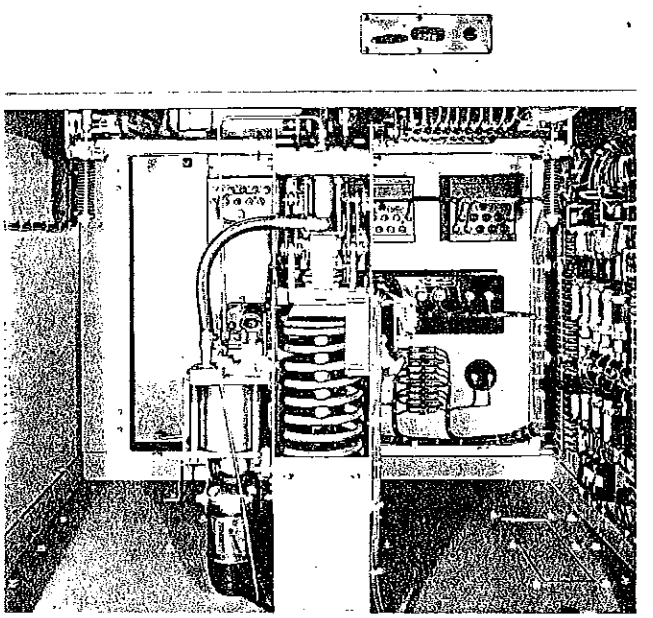

Figure 1
MO-1 operating mechanism mounted in low-voltage compartment of Type VAC vacuum circuit breaker.

GENERAL

Service Information S290-54-1 pertains specifically to the MO-1 operating mechanism, a hydraulically charged, spring-driven device that operates a McGraw-Edison vacuum circuit breaker electrically or manually at high speeds. The MO-1 operating mechanism is mounted in the low-voltage compartment of the vacuum circuit breaker (Figure 1).

Detailed connection diagrams are issued for and accompany each MO-1 operating mechanism.

When preparing an MO-1 operating mechanism for initial service, making in-service inspections, performing maintenance work, making adjustments, or replacing parts, the latest revision of the following instructions—copies of which accompany the breaker—must also be followed:

- Vacuum Circuit Breaker: applicable service information covering the vacuum circuit breaker in which the MO-1 operating mechanism is mounted.
- Bushing Current Transformers: Service Information S290-80-2, Type OE Bushing Current Transformers.

The MO-1 operating mechanism conforms to all applicable standards for electrical characteristics, mechanical features, and accessories.

Power Systems Group
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New Issue

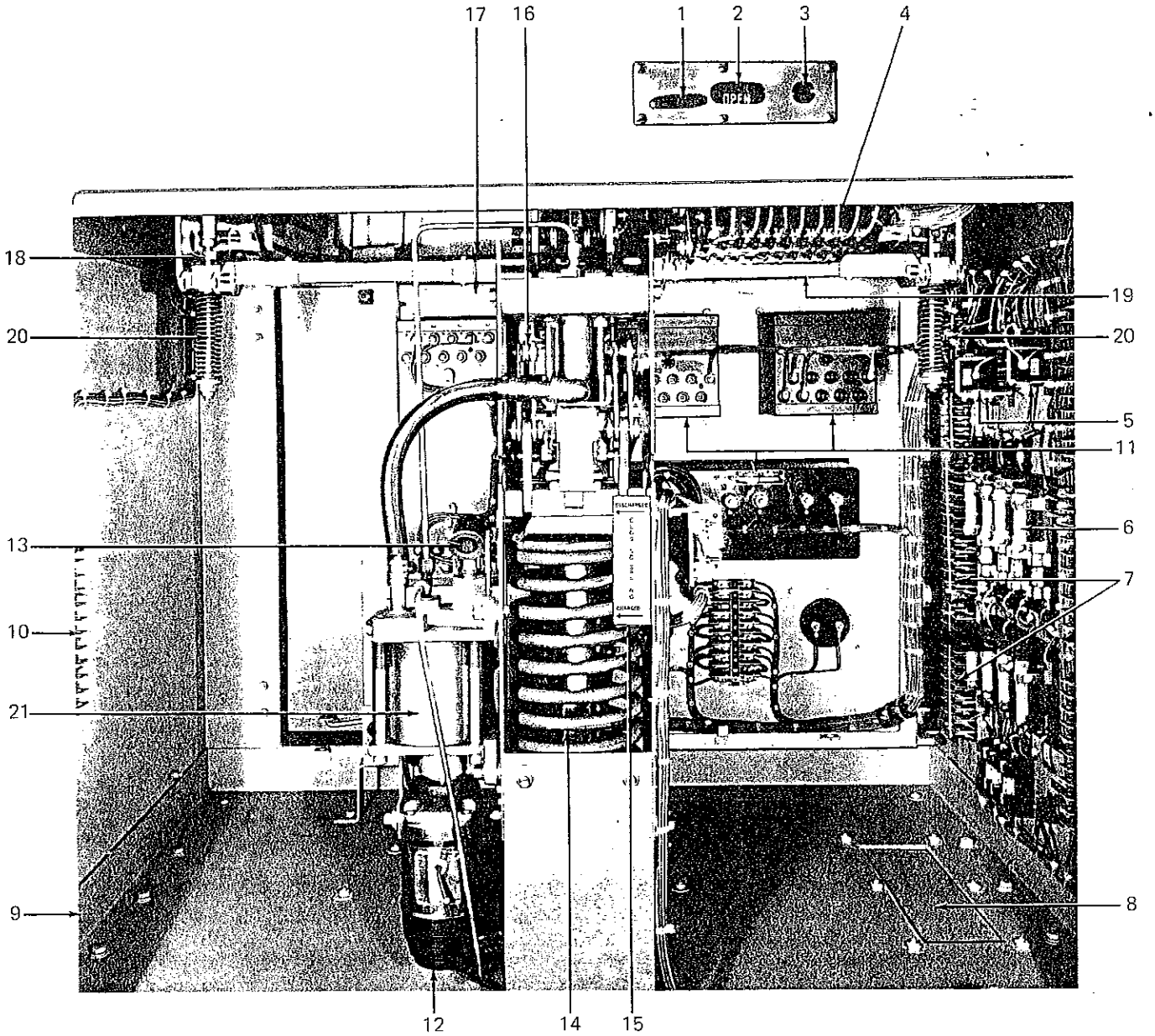

Figure 2
Auxiliary equipment and operator components.

1. Manual trip handle.
2. Contact position indicator.
3. Operations counter.
4. Auxiliary switch.
5. Auxiliary operating relays.
6. Control supply switches.
7. Control wiring terminal blocks.
8. Control conduit entrance plate.
9. Heaters (on cabinet wall, not shown).
10. Current transformer terminal blocks.
11. Hinged relay panel with relays (optional).
12. Pump motor.
13. Socket for manual charge handle.
14. Closing spring.
15. Closing spring indicator.
16. Operating linkage.
17. Crank for connecting time travel device.
18. Nut for adjusting operating rod length.
19. Jackshaft.
20. Contact pressure springs.
21. Sump.

SHIPPING

The MO-1 operating mechanism is shipped fully assembled and mounted in the low-voltage compartment of the vacuum circuit breaker.

Each breaker is shipped with the contacts blocked closed by a red rod inserted in the mechanism. The MO-1 mechanism is unlatched so that opening-spring pressure is on the rod. For removal of this rod, refer to the Installation section of these instructions.

Detailed outline drawings, control drawings, connection diagrams, all pertinent instructions, and packing lists are shipped protected in each MO-1 operating mechanism cabinet.

NOTE: Breakers shipped overseas require special packaging.

INITIAL INSPECTION

Refer to the applicable vacuum circuit breaker instructions for initial inspection of the breaker.

NOTE: *Do not remove bracing or blocking from the operating mechanism at this time.*

Immediately upon receipt of the breaker:

1. Inspect the exterior and interior of the operating mechanism compartment for evidence of rough handling or damage in transit and shortage.
2. Remove all masking tape (later removal may be very difficult).
3. After checking the operating mechanism compartment interior, close the doors promptly to prevent entrance of dirt and moisture. Should this initial inspection reveal evidence of rough handling or damage in transit or shortage, notify and file a claim with the carrier at once. Also notify the Service Department, McGraw-Edison Power Systems Division, Canonsburg, Pennsylvania 15317.

IDENTIFICATION RECORDS

Retain, permanently, complete identification for each operating mechanism including connection wiring diagrams and all pertinent instructions.

Accurate and complete identification records—including the vacuum circuit breaker serial number and rating—must accompany any reference to, or inquiry about, the operating mechanism to McGraw-Edison Power Systems Division.

UNLOADING AND/OR MOVING FROM TRANSPORTING VEHICLE TO INSTALLATION LOCATION

When unloading or moving a breaker on which an MO-1 operating mechanism is mounted, the operating mechanism must be braced and blocked in the original shipping position. Refer to and follow the vacuum circuit breaker instructions for unloading or moving the breaker from the transporting vehicle to the installation location.

PREPARING MECHANISM FOR STORAGE

If a vacuum circuit breaker in which an MO-1 operating mechanism is mounted is not to be placed in the service-ready condition immediately upon receipt, it is considered to be in storage.

To prepare an MO-1 operating mechanism for storage:

1. Open the low-voltage compartment doors.
2. Check to be sure all bracing and blocking are secure, but do not remove any bracing or blocking at this time.
3. To prevent moisture from entering and damaging the operating mechanism, energize the cabinet heaters with a temporary electrical supply until permanent connections are made. *Refer to—and follow—the connection diagrams for heater circuit connections and voltage.*
4. Close the cabinet doors promptly.

PRINCIPLES OF OPERATION

Schematic representations, Figures 3, 4 and 5, illustrate the operating principles of the MO-1 operating mechanism.

In Figure 3 the breaker is open, the closing spring charging,

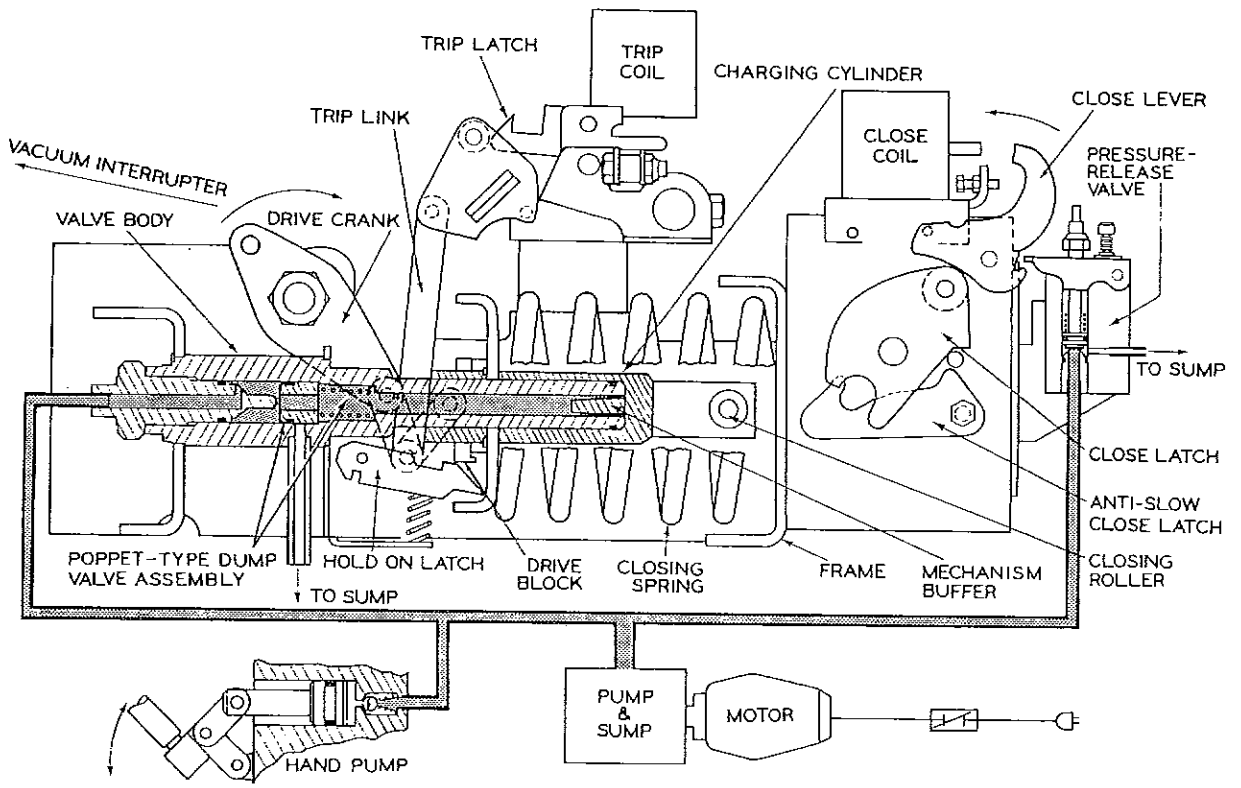

Figure 3
Breaker open, closing spring charging, hydraulic system operating.

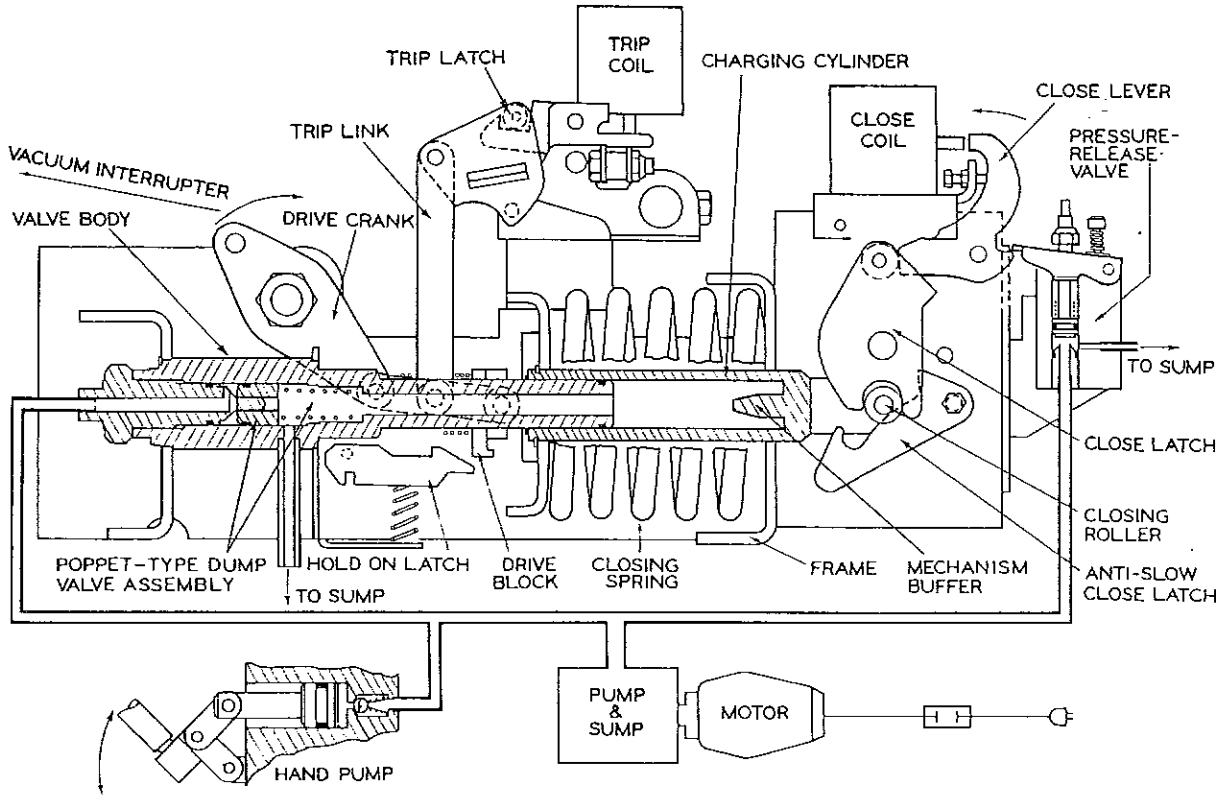

Figure 4
Breaker open, closing spring charged, no hydraulic pressure.

and the hydraulic system operating. The trip link is in the collapsed position and the hold-on-latch is held down by the trip link. The closing spring must have an initial charge for the breaker to be operated.

INITIAL CHARGING OF THE CLOSING SPRING

1. As soon as control voltage is supplied, the motor-driven hydraulic pump forces hydraulic fluid into the charging cylinder.
2. The charging cylinder compresses the closing spring towards the charged position; drive block follows.
3. Charging cycle continues until the close latch engages the closing roller. At this time through the mechanical linkage a motor cutoff switch interrupts the supply voltage to the motor, completing the charging sequence (Figure 4).
4. Meanwhile, the movement of the drive block has set the trip link, trip roller on trip latch and closes a trip latch switch in series with the close coil.
5. Simultaneous with the completion of the charging sequence, the pressure-release valve opens to the sump relieving hydraulic pressure to the charging cylinder and permitting the close roller to load the close latch.
6. As the pressure-release valve opens, the poppet-type dump valve opens to the sump and brings the charging fluid to sump pressure.
7. As the close lever moves to the set position, the close coil switch, in series with the close coil is made.

The breaker is now ready for a closing operation, Figure 4.

CLOSING OPERATION

1. After applying proper control voltage to the close coil, the closing roller is moved from under the close latch and the close latch is driven free by the force of closing spring.
2. Charging cylinder moves forward forcing drive block along with it.
3. Interconnecting links will rotate the drive crank and jackshaft and will close the breaker contacts.
4. Hydraulic fluid is returned to the sump through the dump valve.
5. Rotation of the drive crank and jackshaft compresses the opening springs.
6. Mechanical linkage closes charging motor cutoff switch, energizing motor and closes pressure-release valve so that there is pressure in charging cylinder.
7. Poppet-type dump valve closes.
8. Charging cylinder moves closing spring to the charged position, Figure 5.
9. Drive block is held in set position and trip link is loaded.

The breaker is now ready for an opening operation. Figure 5.

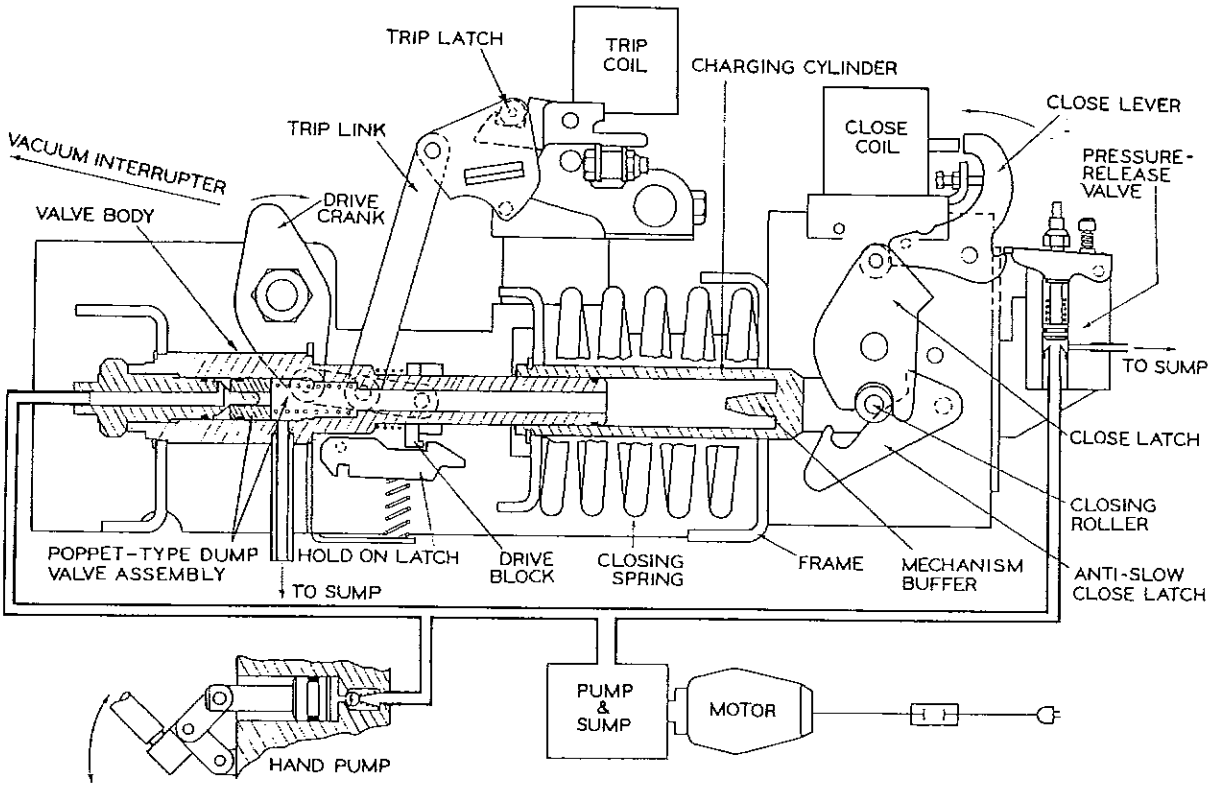

Figure 5
Breaker closed, closing spring charged, no hydraulic pressure.

OPENING OPERATION

1. When proper voltage is applied to the trip coil, the trip latch moves mechanically, allowing trip link to collapse by the component of force from the opening spring.
2. Interconnecting links rotate the drive crank and jackshaft moving the breaker contacts into the open position.
3. As trip link collapses, hold-on latch disengages and drive block moves back toward charging cylinder and trip link resets, Figure 5.

When the trip latch resets, the trip roller and the trip latch switch is made up, the breaker is ready to be reclosed.

INSTALLATION

SAFETY PRECAUTIONS

It is extremely important that all safety precautions described in these instructions and the breaker instructions be clearly understood and carefully followed.

Although the MO-1 operating mechanism and the breaker on which it is mounted have been designed with the safety of operating personnel foremost in mind, the inherent mechanical characteristics of the breaker—along with the necessary activities of operating personnel—make cautious work habits essential.

The MO-1 operating mechanism is mounted and tested in the breaker before shipment. Since it is shipped mounted and mechanically complete, there is no actual installation work required. However, certain checks must be thoroughly performed.

It is necessary to fully understand the principles of operation of the MO-1 operator before any attempt is made to energize the control circuits. Before the mechanism is actuated, operation of the breaker should be understood and specific checks made.

Before preparing the MO-1 operating mechanism for service, prepare the foundation, level and bolt the breaker in place, and install grounding connections in accordance with the breaker instructions.

The MO-1 operating mechanism is adjusted at the factory. Ordinarily factory-set adjustments need not be altered.

To prepare an MO-1 operating mechanism for service:

1. Make electrical connections in accordance with the connection diagram furnished with the equipment.

   NOTE: If a permanent supply is not available, make temporary electrical connections until permanent connections can be made.

CAUTION

Mechanism operating circuits should not be closed until called for in both the breaker and these mechanism instructions.

2. Check hydraulic fluid level in the sump.

   NOTE: Closing spring must be discharged when checking fluid level.

   A. Dip stick connected to fill hole plug indicates fluid level.

   B. If addition of fluid is required, refer to the Maintenance section. *Correct this condition before proceeding to the next installation step.*

3. Remove any bracing or blocking placed in the relays for shipping purposes.

4. If not already accomplished, remove operator blocking as follows:

   A. Open rear door of low-voltage compartment.

   NOTE: Be careful not to damage gasket.

   B. Use maintenance-positioning wrench as illustrated, Figure 6.

   C. Apply upward force toward closed position to relieve pressure on blocking pin.

   D. Remove blocking pin.

   E. Using the maintenance-positioning wrench, very slowly relieve the opening spring force on the jackshaft until the breaker reaches the fully open position.

   F. Reseal low-voltage compartment.

5. Energize the motor and control circuits with a permanent supply (or a temporary supply until a permanent power source is available).

6. *Refer to–and follow–the vacuum breaker instructions for final installation instructions.*

MAINTENANCE AND INSPECTION

Schedule and coordinate maintenance work on the MO-1 operating mechanism with maintenance work on the vacuum circuit breaker. Refer to–and follow–the instructions covering the breaker on which the MO-1 operating mechanism is mounted. Keep complete records of all maintenance work performed.

SAFETY PRECAUTIONS

The vacuum circuit breaker on which the MO-1 operating mechanism is mounted must be removed from service before performing any maintenance work on the operating mechanism or the breaker.

Use the operating mechanism maintenance-positioning wrench during the performance of some of the maintenance steps. Observe all Safety Precautions in the vacuum circuit breaker instructions as well as those throughout these instructions when performing maintenance.

Although the Type MO-1 operator was designed with the safety of operating personnel foremost in mind, the mechanical characteristics of the operating mechanism and breaker, along with the necessary activities of operating personnel, make cautious work habits essential.

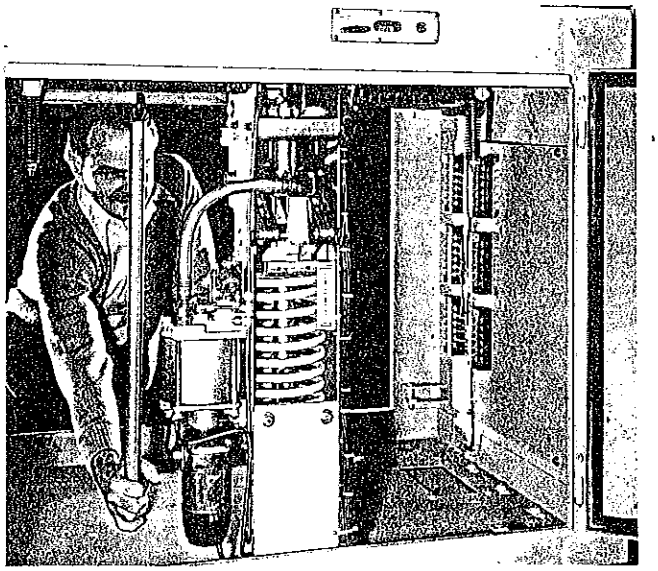

Figure 6
Maintenance-positioning wrench permits manual rotation of jackshaft for blocking pin removal or for maintenance checks.

WARNING

Deenergize the circuit breaker before performing any maintenance or inspection work. Unless stated otherwise in the procedure, all maintenance and inspection should be performed with the breaker open and the closing spring discharged.

Contact position indicator must read OPEN. Closing spring position indicator must read DISCHARGED.

MATERIALS

- Clean-lint-free rags.
- Cleaning solutions.

  The preferred cleaning solutions are heptane, Stoddard's solvent, or cleaner's naphtha.

WARNING

Preferred cleaning solutions are flammable. Avoid sparks and flames. Use in an area where there is adequate ventilation.

LUBRICANTS

Wipe all parts to be lubricated with clean, lint-free rags. Lubricate parts such as operating linkages, pins and roller bearings with a light film of Humble Oil and Refining Lidok 000 grease. Wipe off excess grease with clean lint-free rags.

NOTE: Roller bearings require packing only after they have been removed for a complete overhaul.

HYDRAULIC FLUID

Recommended fluids are: Chevron Oil Company Aviation Hydraulic Fluid A, Texaco Inc. Aircraft BB Hydraulic Oil,

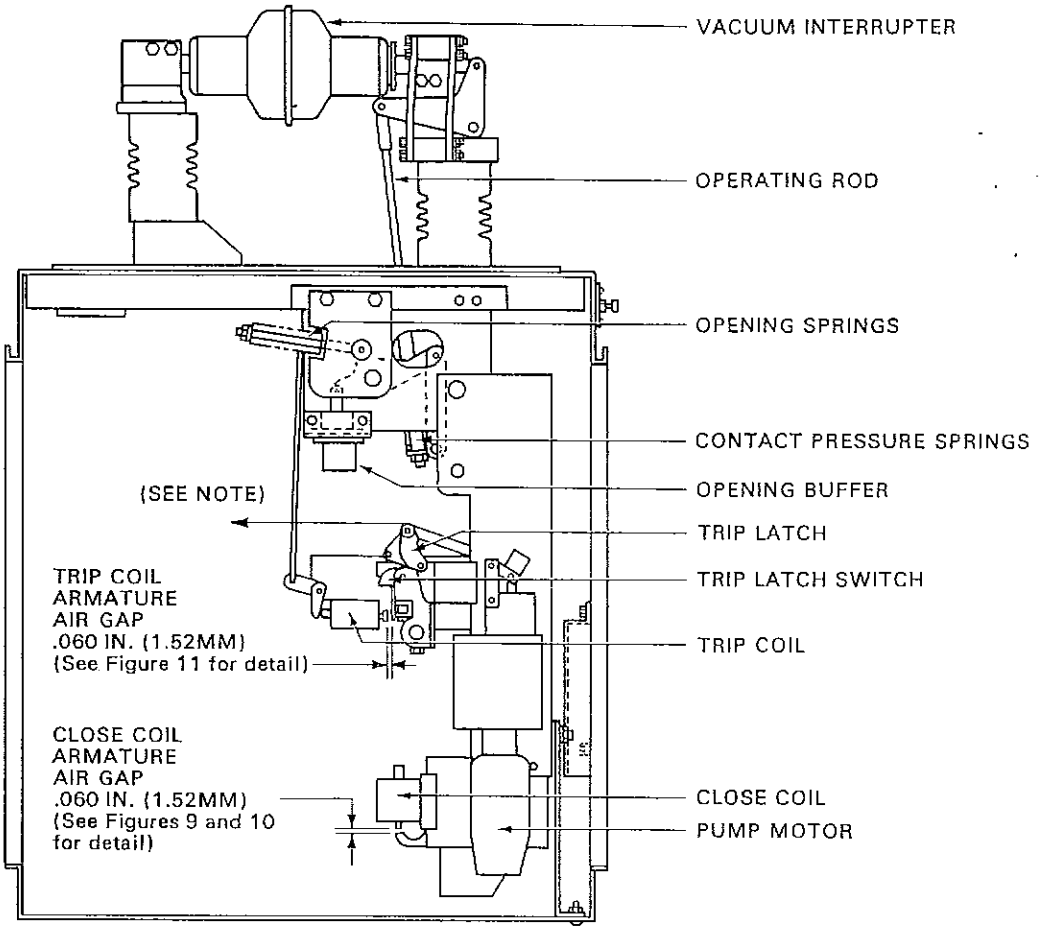

Figure 7
Maintenance check points.
NOTE: Arrow indicates direction of pull for checking trip latch load (see Figure 11 for detail).

Shell Oil Company Aeroshell Fluid #4, Exxon Company Univis J-43.

Cleanliness is the best assurance of trouble-free operation. When performing these routine maintenance steps, if the equipment is out of adjustment, refer to the corresponding Adjustments section; if a part must be replaced, refer to the corresponding Parts Replacement section.

Following is the procedure for checking the hydraulic fluid level in sump.

1. Check level with closing spring discharged.
2. Dip stick connected to fill hole plug indicates fluid level.
3. An empty hydraulic system requires approximately 1-1/2 pints of fluid to fill sump.
4. Add one of the recommended hydraulic fluids through the fill hole to reach the proper level.

AUXILIARY SWITCH

1. Refer to the auxiliary switch manufacturer's instruction book that accompanies the breaker.

CLOSE COIL

> WARNING
>
> To inspect the close coil, the breaker must be OPEN and the closing spring DISCHARGED. Keep fingers and loose objects away from the closing spring and linkage.

1. Insure that the breaker is open and closing spring discharged.
2. Manually move the close latch to the set position by inserting a screwdriver through the opening in the operating mechanism frame and pulling the close latch to the set position (Figure 9).
3. With the close latch in the set position (Figure 9), the close coil armature air gap should measure .060 inches (1.52 mm).
4. If the close coil armature air gap requires adjustment, see close coil in the Adjustments section.

CLOSE COIL SWITCH, MOTOR CUTOFF SWITCH

1. Check for cracked switches or loose wires.

2. Refer to the wiring diagram and test the circuit to make sure the switches function properly when the switch buttons are depressed by the actuating arm on the valve block. The wiring diagram number is stamped on the nameplate.

   NOTE: If an adjustment is made to obtain the correct close coil armature air gap, check the pressure-release valve, close coil switch and motor cutoff switch for proper operation in accordance with the Adjustments section.

TRIP COIL

> WARNING
>
> To inspect the trip coil, the breaker must be CLOSED and the closing spring DISCHARGED. Keep fingers and loose objects away from springs and associated linkage.

1. Close the breaker.
2. With the closing spring discharged and the trip latch set, measure the trip latch armature air gap (Figure 7).
3. Air gap should be .060 inch (1.52 mm).
4. If necessary adjust to this dimension in accordance with the Adjustments section.

TRIP LATCH

1. With the breaker open, charge the closing spring and check that the trip latch resets.
2. Close the breaker.
3. Trip the breaker and observe the trip latch action.
   A. The trip latch will disengage allowing the linkage to collapse and the breaker to open.
   B. The linkage will immediately reset on the trip latch, provided the closing spring is recharged.
4. The trip latch should function with a quick positive action.
5. If the trip latch does not function properly, measure the latch load and reset values and adjust as necessary in accordance with the Adjustments section (Figure 11).

OPENING BUFFER

Check that there is no fluid leakage.

NOTE: Normally, the opening buffer will not require adjustment. However, to insure that the drive linkage can function properly, the drive block must clear the belleville washer as shown in Figure 11. Refer to opening buffer in the Adjustments section if drive linkage does not function properly.

MOTOR

Since the motor is sealed, no maintenance should be required other than checking that the mounting bolts are tight and listening for excessive noise or bearing rumble.

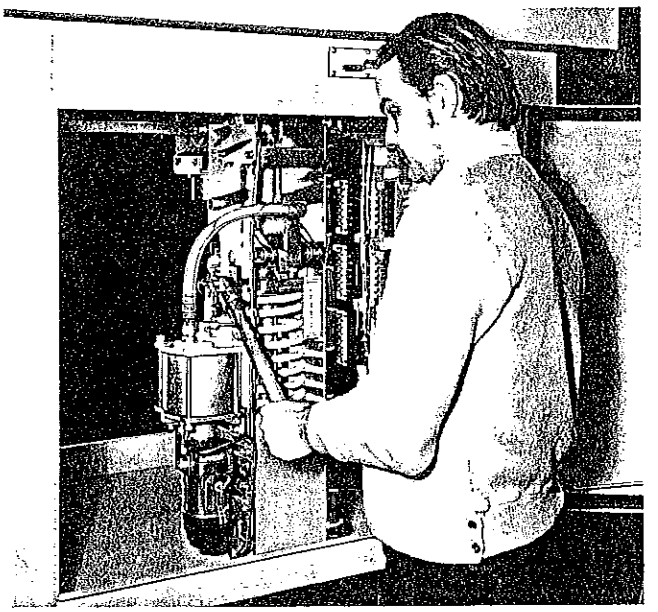

Figure 8
Handpump used to manually charge closing spring.

Check motor mounting bolts for tightness. See Motor, in the Parts Replacement section if motor must be replaced.

HANDPUMP

1. Insert the handpump handle (furnished with the breaker) into the socket.
2. Pump approximately ten to twelve strokes to charge the closing spring.
   A. When the closing spring is charged, loss of pressure will be felt in the pumping operation.
   B. If no pressure loss is felt, refer to Pressure-Release Valve in the Adjustments section.

   NOTE: The handpump can be used to charge the closing spring in the event of a loss of control power.
3. Check that the close latch is holding the close latch roller.

DUMP VALVE

Dump valve is factory set and will not require adjustment.

AUXILIARY DEVICES

Make sure all auxiliary devices are clean. If it is necessary to replace an auxiliary device, refer to auxiliary devices in the Parts Replacement section.

INTERIOR AND EXTERIOR CABINET SURFACES

Clean all internal and external cabinet surfaces.

NOTE: An industrial vacuum cleaner is recommended.

1. Using clean, lint-free rags wipe down all surfaces.
2. Check the interior and the exterior of the cabinet for

evidence of corrosion caused by leakage, moist air, or heater malfunction.

A. Eliminate the cause of such corrosion if it exists. Correct this condition before proceeding to the next maintenance step.

B. Make sure all electrical connections are tight.

C. Make sure all fasteners are tight.

D. Retouch painted surfaces where necessary for appearance and complete protection.

ADJUSTMENTS

WARNING

Deenergize the circuit breaker before making any adjustments on the MO-1 operating mechanism or the breaker. Unless stated otherwise in the procedure, all adjustments should be performed with the breaker open and the closing spring discharged. Contact position indicator must read OPEN. Closing spring position indicator must read DISCHARGED.

Observe all safety precautions in the vacuum circuit breaker instructions as well as those throughout these instructions when making adjustments. Although the Type MO-1 operator was designed with the safety of operating personnel foremost in mind, the mechanical characteristics of the operating mechanism and breaker, along with the necessary activities of operating personnel, make cautious work habits essential.

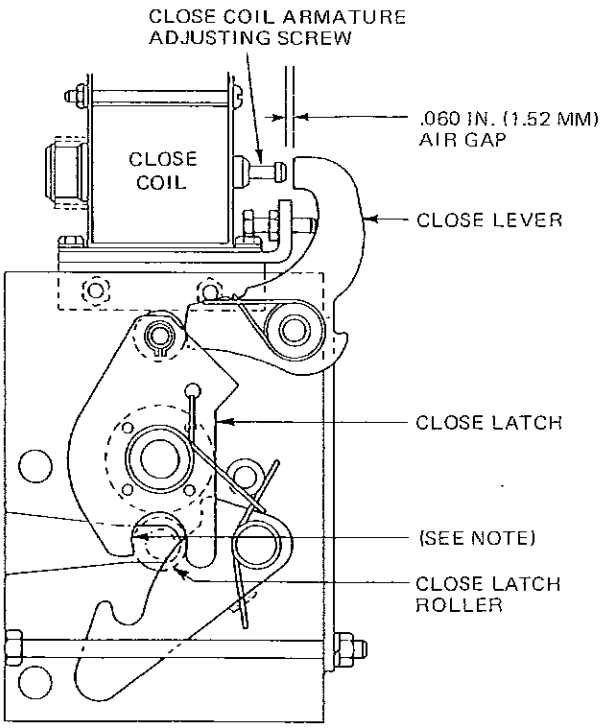

Figure 9
Close coil armature air gap.
NOTE: With closing spring discharged, insert screwdriver and pull close latch to set position.

CLOSE COIL

1. Check that the breaker is in the open position and the closing spring discharged.
2. Manually set the close latch roller to the set position as shown in Figure 9.

   NOTE: Insert a screwdriver through the opening in the operating mechanism frame and pull the close latch to the set position.
3. Measure the close coil armature air gap.
4. Set the gap to .060 inch (1.52 mm) by using close coil armature adjusting screw.

   NOTE: *Once an adjustment is made, to obtain the correct close coil armature air gap, the pressure-release valve, close coil switch, and motor cutoff switch must be checked for proper operation.*

PRESSURE-RELEASE VALVE, CLOSE COIL SWITCH, AND MOTOR CUTOFF SWITCH

1. With a .135 inch (3.43 mm) shim in the close coil armature air gap, the pressure-release valve adjusting nut should rest on the raised surface of the pressure-release valve operating arm – but not raise the pressure-release valve stem. Adjust as required.
2. Also, with a .135 inch (3.43 mm) shim in the close coil armature air gap, both the close coil switch and the motor cutoff switch should operate.
3. If the switches do not operate, adjust with the setscrews on the actuating arm (contact operation can either be determined audibly or by a continuity check).

NOTE: *If adjustment is made to the close coil and motor cutoff switches, recheck the positive stop of the pressure-release valve operating arm against the raised surface of the valve block. Final adjustment should produce following results:*

- .060 inch (1.52 mm) close coil armature air gap, pressure-release valve opens.
- .135 inch (3.43 mm) close coil armature air gap, close coil switch and motor cutoff switches operate.

See Figure 7 for close coil location reference and Figure 10 for detail.

TRIP LATCH

NOTE: The *latch load* is the pulling force required to move the trip roller in the trip latch. The force at which the trip roller returns to its original position is the *reset force*. Since this movement is very slight, be sure to observe carefully.

To measure trip latch load and reset values:

1. Close the breaker and wait for the closing spring to recharge.
2. As demonstrated in *Figures 7 and 11*, hook a metal strap or wire around the trip pin, bring it out the rear of the mechanism compartment, and attach a spring scale

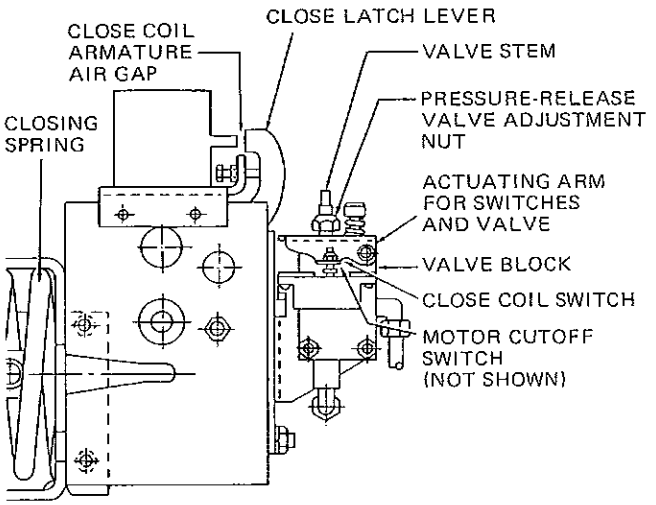

Figure 10
Adjustment; high pressure-release valve, close coil switch, and motor cutoff switch.

which will measure from 10 to 100 lbs. (45 to 450 newtons).

3. Slowly pull on the scale until a release of the roller is observed—*latch load*—and record this value.
4. Slowly relax while pulling on the scale until roller returns—*reset*—record this value.
5. The latch load value should be between 50 and 75 lbs. (222.4 and 333.6 newtons). The minimum latch reset value should be 15 lbs. (66.7 newtons).
6. Measure and record three sets of latch load and reset values; between each set of measurements remove the strap and trip open then reclose the breaker.
7. Adjust the trip latch with the breaker closed, and the closing spring charged by turning the 5/8-inch adjustment bolt clockwise to increase the reset load and counterclockwise to decrease it.

   NOTE: Latch load will increase approximately 2-1/2 lb. (11 newtons) per flat, when turned clockwise, and decrease 2-1/2 lb. (11 newtons) per flat when turned counterclockwise.
8. Check for proper adjustment by again taking latch-load and reset measurements.

TRIP COIL ARMATURE AIR GAP

> **WARNING**
>
> While adjusting the trip coil, the opening and closing springs will discharge at high speed. Keep fingers and foreign objects away from the springs and associated linkage.

1. The trip coil armature air gap should be .060 inches (1.52 mm) (Figure 7).
2. If adjustment is required:
   A. Loosen lock nut on armature.
   B. With pliers, turn knurled machine screw until .060 inch (1.52 mm) air gap is attained.
   C. Retighten locknut.

NOTE: With the trip linkage set, check that the trip link does not hit the head of the stop bolt mounted in the mechanism frame. Maintain a 1/32-inch (.79 mm) gap between the stop bolt and the trip link by adjusting the stop bolt as needed.

OPENING BUFFER

To insure the drive linkage can function properly, the factory setting of 1/32 to 1/16-inch (.79 to 1.58 mm) gap must be maintained between the drive block and the belleville washer with the breaker in the open position, and the closing spring charged.

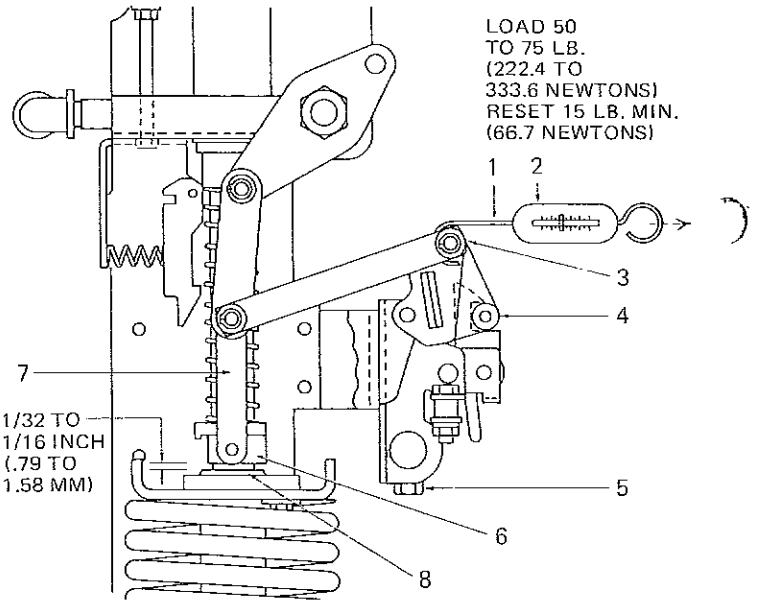

Figure 11
Trip latch adjustment.

1. Metal strap or wire hooked around trip pin.
2. Spring scale – (10 to 100 lbs.) (45 to 450 newtons).
3. Trip pin.
4. Trip latch roller.
5. 5/8" trip latch adjustment bolt.
6. Drive block.
7. Trip link.
8. Belleville washer.

1. If the trip linkage does not set, adjust for 1/32 to 1/16-inch (.79 to 1.58 mm) clearance between the drive block and belleville washer by adjusting the opening buffer (Figure 7).
2. To increase the clearance, the opening buffer is adjusted by turning clockwise.

3. The measurement must be made from the rear of the mechanism compartment. Measure from the top of the belleville washer to the drive block (Figure 11).

TRIP LATCH SWITCH

1. Check to see that plunger on trip latch switch clicks when trip linkage is set on trip latch (Figure 7).
2. If switch does not operate when trip linkage is set, bend the trip latch switch actuating arm to permit proper operation.

DUMP VALVE

The dump valve is factory set and requires no adjustment.

PARTS REPLACEMENT

> SAFETY PRECAUTION
>
> The vacuum breaker on which the MO-1 operating mechanism is mounted must be removed from service prior to replacing operating mechanism parts. Proper parts replacement procedures require that the breaker be open, closing spring discharged and the auxiliary electrical system be deenergized.

CLOSE COIL

1. Disconnect the close coil wiring from the terminal block.
2. Remove the bolts and washers which mount the close coil to the mechanism.
3. Remove the coil.
4. Mount replacement coil on the mechanism frame, with the bolts and washers.
5. Check following items per Adjustment section:
   A. Close coil.
   B. Pressure-release valve.
   C. Close coil and motor cutoff switches.

TRIP COIL

1. Disconnect the trip coil wiring from the terminal block, then use same procedure used to replace the close coil.
2. Check following items per Adjustment section:
   A. Trip coil.
   B. Trip latch switch.
   C. Linkage.

AUXILIARY SWITCH

NOTE: Follow the switch manufacturer's instructions for internal adjustments to switch.

1. Remove auxiliary switch wiring at the switch.
2. Remove cotter pin, washer, and operating link from switch.
3. Remove bolts securing switch mounting bracket to the breaker frame; then remove bolts securing switch to mounting bracket.
4. Note the position of the contacts and the remaining linkage on the switch:
   A. Looking from the linkage end, the linkage should be at an approximate 7:30 o'clock position and typically a contacts 1 and 2 should be open, b contacts 3 and 4 should be closed, etc.
   B. Contact for contact the replacement switch must operate the same as the old switch (discounting a broken stage in the old switch).
   C. Operate the old switch counterclockwise 90° to approximately a 4:30 o'clock position, and observe the action of the contacts.
5. Remove the remaining linkage from the old switch shaft.
6. Install operating arm on shaft of new switch.
7. Bolt new switch to mounting bracket.
8. Secure mounting bracket to breaker frame.
9. Replace switch wiring.
10. Replace operating link, washer, and cotter pin in switch linkage.

MOTOR

1. Disconnect wires.
2. Remove two mounting bolts.
3. Put replacement motor in position.
4. Connect wires.
5. Replace and tighten mounting bolts.

See Troubleshooting Chart, page 12.

TROUBLESHOOTING

FAILURE TO CHARGE THE CLOSING SPRING

POSSIBLE CAUSE	SOLUTION
1. Motor does not run	
A. No supply voltage to motor	A. Check fuses, wiring, secondary contact
B. Charging motor cutoff switch	B. Check adjustment
2. Motor continues to run	
A. Insufficient oil to sump	A. Fill sump as prescribed
B. Pressure release valve open	B. Check adjustment
C. Charging motor cutoff switch	C. Check adjustment

FAILURE OF BREAKER TO CLOSE

POSSIBLE CAUSE	SOLUTION
1. Closing spring not charged	1. Charge spring
2. No supply voltage to closing coil	2. Check fuses, wiring, secondary contacts
3. Closing coil switch	3. Check adjustment
4. Open circuited closing coil	4. Replace coil
5. Auxiliary switch	5. Inspect auxiliary switch
6. Linkage doesn't reset	6. Adjust closing buffer
7. Trip latch switch	7. Check adjustment

FAILURE OF BREAKER TO OPEN

POSSIBLE CAUSE	SOLUTION
1. Breaker not closed	1. Close breaker
2. No supply voltage to trip coil	2. Check wiring secondary contacts
3. Auxiliary switch	3. Inspect auxiliary switch
4. Open circuited trip coil	4. Replace coil

Power Systems Group
McGraw-Edison Company
Post Office Box 2850
Pittsburgh, PA 15230

Power Circuit Breakers

Type OE Bushing Current Transformers Installation and Maintenance Instruction

S290-80-2
Service Information

GENERAL

Service Information S290-80-2 pertains specifically to McGraw-Edison Type OE bushing current transformers (Figure 1) for use in relay operation. Provided only a general indication of values is satisfactory. Type OE bushing current transformers are also suitable for use with indicating meters or for nonrevenue metering purposes.

Type OE bushing current transformers conform to both NEMA and ANSI standards for relaying accuracy current transformers.

When installing or performing maintenance work on a Type OE bushing current transformer, the latest revision of the oil circuit breaker instructions—copy of which accompanies each breaker—must be followed.

SHIPPING

Except when ordered as replacement parts, Type OE bushing current transformers are shipped installed in the equipment for which they are required. When supplied separately, bushing current transformers are crated for shipping.

INITIAL INSPECTION

Immediately upon receipt—preferably before unloading—thoroughly inspect the current transformer for evidence of rough handling or damage in transit. Should there be evidence of rough handling or damage in transit, notify—and file a claim with—the carrier at once. Also notify McGraw-Edison Power Systems Division, Canonsburg, Pa. 15317.

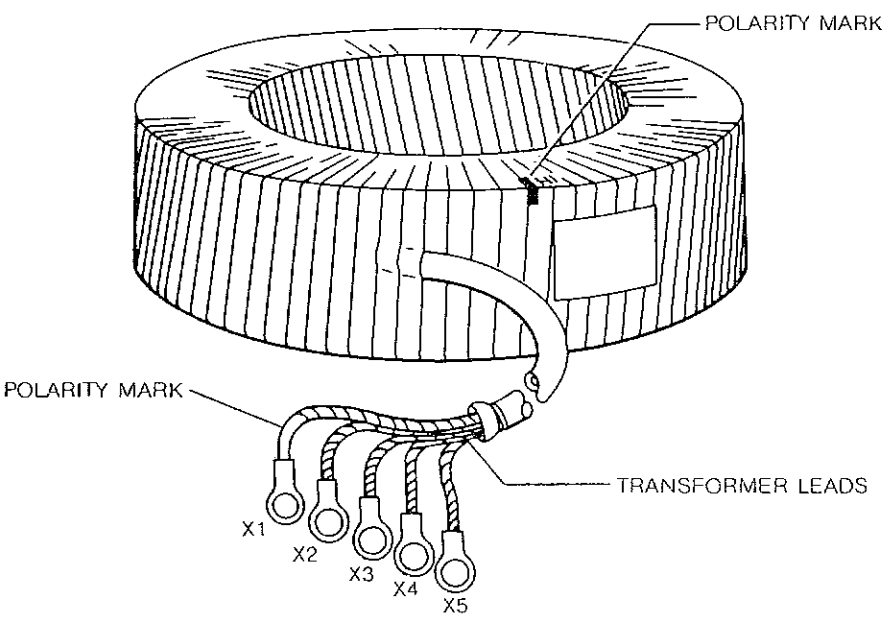

Figure 1.
Typical Type OE bushing current transformer.

IDENTIFICATION

Amp Ratings

McGraw-Edison Type OE bushing current transformers are identified by amp rating: an OE-6 transformer is rated at 600 amps; an OE-12 transformer is rated at 1200 amps, etc.

Leads

Refer to the wiring diagram and ratio tables that accompany the circuit breaker for winding and lead data for the specific equipment.

Standard NEMA markings are used to identify secondary leads and polarity. Leads are marked X1, X2, X3, X4, and X5. When two current transformers are used around a single entrance bushing, the leads from the second current transformer are lettered Y1, Y2, etc., at the terminal block—although the actual leads on the transformers have the X markings. Polarity for current transformers is indicated by a white paint mark on the X1 lead. The top of the current transformer is indicated by a white mark or an H1 mark. This mark (white or H1) must be placed upward when the current transformer is installed.

NOTE: If the X1 lead is not used as a tap, the lead that is numerically closest to X1 will have the same polarity as the X1 lead.

HANDLING

When handling a bushing current transformer, take special care to prevent deforming its shape. Deformation could result in an increase in excitation current and a reduction in ratio accuracy.

STORAGE

If a bushing current transformer is not to be placed in service immediately upon receipt, it must be stored indoors in a dry, protected location. Under no circumstances should a bushing current transformer be left outdoors, exposed to the weather.

INSTALLATION

To replace a bushing current transformer, refer to—and follow—applicable portions of the circuit breaker instructions.

For bushing current transformer connections, refer to the wiring diagram supplied with the equipment on which the current transformer is installed. For transformer ratios, refer to the nameplate located near the transformer terminal block.

Before installing a bushing current transformer:

1. Check to be sure the current transformer is free from moisture.
2. If moisture is present, heat the current transformer with dry, warm air —not to exceed 150 F (66 C)—until all traces of moisture are gone.

CAUTION:

Type OE bushing current transformers are wound for subtractive polarity (Figure 2). To retain this polarity, it is imperative that the current transformer be installed with the polarity mark (the white mark or the H1 mark) upward.

WIRING AND CONNECTIONS

Wiring to the control cabinet terminal block is completed at the factory. If bushing current transformers are installed in the field, connections to the terminal blocks and from the terminal blocks to the relays or the instruments of the burden circuit must be made in such a manner as to assure low resistance.

SAFETY PRECAUTION:

At no time should a bushing current transformer operate with an open circuit. The current transformer must either be connected to a burden or be short-circuited.

SHORT CIRCUITING A BUSHING CURRENT TRANSFORMER AT THE TERMINAL BLOCK

The terminal blocks are provided with shorting screws for short circuiting the current transformer when no burden is connected (Figure 3).

To disconnect the burden and assure that the bushing current transformer circuit is not opened:

1. Short circuit the current transformer by inserting the shorting screws—stored in the holes in the ends of each terminal block—in the terminals that are connected to the current transformer.
2. Remove the burden.

To connect the burden:

1. Make sure the burden circuit is closed.
2. Connect the leads to the terminal blocks.
3. Remove the shorting screws.

   NOTE: Immediately upon removing the shorting screws, store them in the holes in the ends of each terminal block.

It is recommended that the entire bushing current transformer winding be short circuited even though only part of it is used to supply the burden. Therefore, although the bushing current transformer may be connected by the X1 and the X3 taps:

4. Firmly insert the shorting screws into the holes adjacent to the X1 and the X5 terminals.

   Do not remove the shorting screws until the burden is connected.

   Insert the shorting screws before the burden is disconnected.

   NOTE: The terminal blocks also contain a ground terminal that is usually connected to a grounded portion of the cabinet or directly to a ground grid.

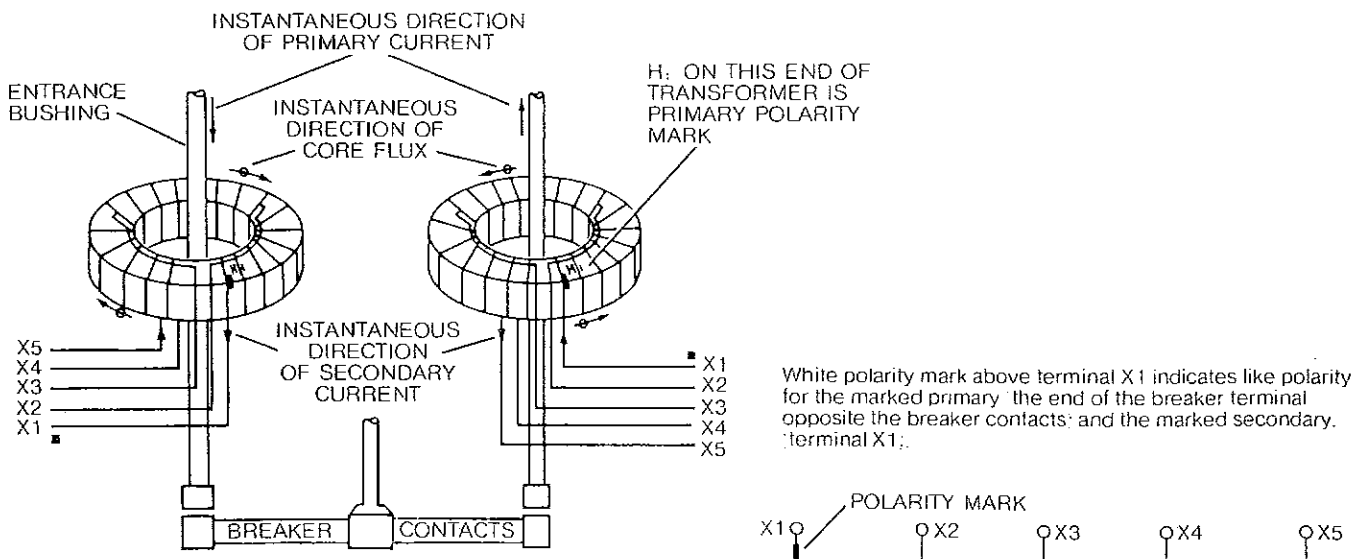

Figure 2.
Typical transformer arrangement and polarity.

INSULATION TEST

Bushing current transformers are not subjected to line potential, but they are subjected to a moderate, induced voltage. After installation, each bushing current transformer should be subjected to a one-minute potential test at 2500 volts rms between the shorted secondary winding and ground, including leads.

NOTE: If a potential test is conducted as a routine check, it should be made at a reduced voltage of approximately 1500 volts rms

INSULATION CHECK

After a bushing current transformer has been installed and all connections have been made, it should be checked for:

1. Accidental ground.
2. Proper connections.
3. Correct polarity.

To check the current transformer for accidental grounding or low-leakage resistance, use a 500 or 1000 volt megger:

1. Short circuit the terminal blocks and megger the resistance between the secondary winding and the circuit breaker frame. This resistance should have a value in megohm range.
2. If the resistance is unusually low, the bushing current transformer and secondary leads should be inspected for accidental grounding or moisture.

MAINTENANCE

Type OE bushing current transformers generally do not require attention beyond an occasional check to make sure that leads have not been damaged or shorted and that connections are tight.

SAFETY PRECAUTION:

If the secondary of the bushing current transformer has been accidentally opened when line current is flowing in the primary (entrance bushing), a dangerous, excessive peak voltage that could damage the insulation may develop in the secondary. A ratio test should be made on the installed bushing current transformer if symptoms indicate a short-circuit condition in the bushing current transformer winding.

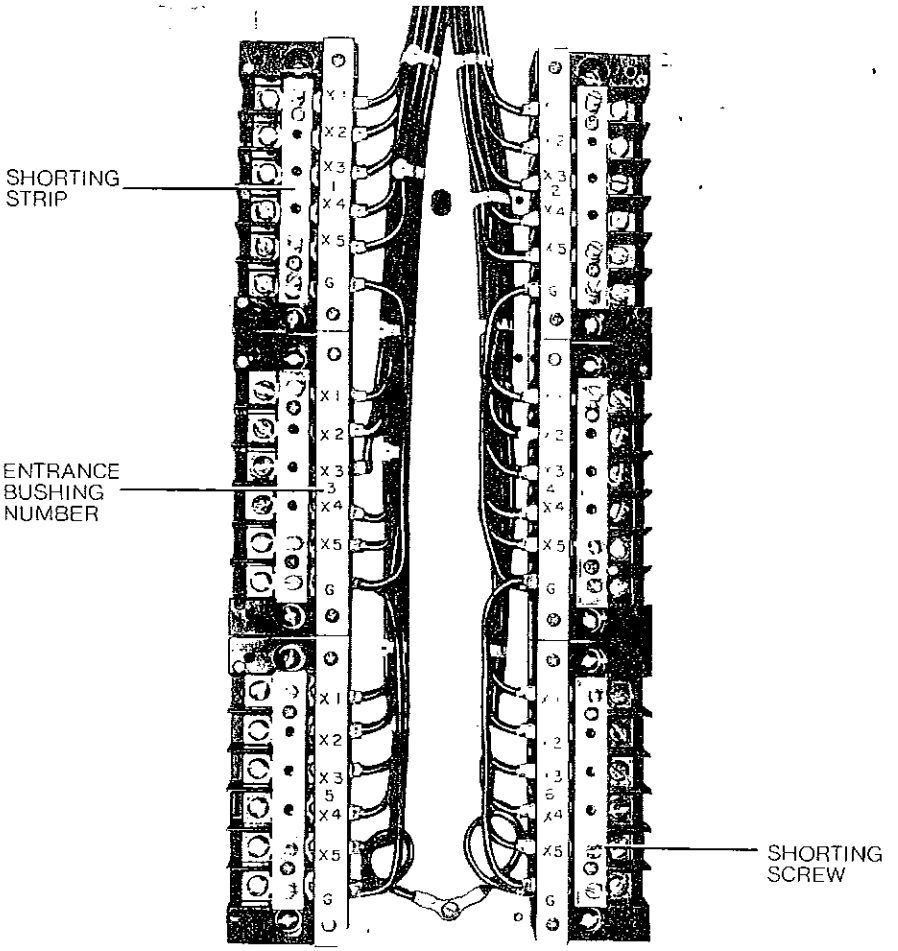

Figure 3.
Short-circuit terminal blocks.

X2/X3 = 100:5

X1/X2 = 200:5

X1/X3 = 300:5

X4/X5 = 400:5

X3/X4 = 500:5

X2/X4 = 600:5

X1/X4 = 800:5

X3/X5 = 900:5

X2/X5 = 1000:5

X1/X5 = 1200:5