SIEMENS

Vacuum Circuit Breakers
Type FSV and MSV

Instructions
Installation
Operation
Maintenance
SG-3248-01

THIS EQUIPMENT CONTAINS HAZARDOUS VOLTAGES AND MECHANICAL PARTS WHICH MOVE AT HIGH SPEED AND MAY BE CONTROLLED REMOTELY. SEVERE PERSONAL INJURY OR PROPERTY DAMAGE CAN RESULT IF SAFETY INSTRUCTIONS ARE NOT FOLLOWED. ONLY QUALIFIED PERSONNEL SHOULD WORK ON OR AROUND THIS EQUIPMENT AFTER BECOMING THOROUGHLY FAMILIAR WITH ALL WARNINGS, SAFETY NOTICES, AND MAINTENANCE PROCEDURES CONTAINED HEREIN. THE SUCCESSFUL AND SAFE OPERATION OF THIS EQUIPMENT IS DEPENDENT UPON PROPER HANDLING, INSTALLATION, OPERATION AND MAINTENANCE.

Qualified Person

For the purpose of this manual and on product labels, a qualified person is one who is familiar with the installation, construction and operation of the equipment, and the hazards involved. In addition, he has the following qualifications:

(a) Is trained and authorized to energize, de-energize, clear, ground, and tag circuits and equipment in accordance with established safety practices.

(b) Is trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.

Signal Words

Distinctive signal words (DANGER, WARNING, CAUTION) are used in this instruction book and on product labels to indicate degrees of hazard that may be encountered by the user. These signal words are defined below.

DANGER

Indicates death, severe personal injury or substantial property damage will result if proper precautions are not taken.

WARNING

Indicates death, severe personal injury or substantial property damage can result if proper precautions are not taken.

CAUTION

Indicates minor personal injury or property damage can result if proper precautions are not taken.

DANGER

Power circuit breakers are applied at high voltages and have mechanical parts which move at high speeds and will cause death, personal injury, and property damage.

To avoid injuries due to electrical shock, burns, and entanglement in moving parts, this equipment must be installed, operated, and maintained only by qualified persons thoroughly familiar with the equipment, instruction manual and drawings.

Field Service Operation

Siemens Energy & Automation, Inc. can provide competent, well-trained Field Service Representatives to provide technical guidance and advisory assistance for the installation, overhaul, repair and maintenance of Siemens Energy & Automation, Inc. equipment, processes and systems. Contact regional service centers, sales offices or factory for details.

Table of Contents

Table Of Contents

Note

The instructions contained within this manual are necessary for the safe installation, maintenance and operation of this equipment. If this manual is misplaced or lost, replacement manuals are available through the local Siemens Energy & Automation, Inc. sales office.

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency, to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local Siemens Energy & Automation, Inc. sales office.

THE CONTENTS OF THIS INSTRUCTIONAL MANUAL SHALL NOT BECOME PART OF OR MODIFY ANY PRIOR OR EXISTING AGREEMENT, COMMITMENT OR RELATIONSHIP. THE SALES CONTRACT CONTAINS THE ENTIRE OBLIGATION OF SIEMENS ENERGY & AUTOMATION, INC. THE WARRANTY CONTAINED IN THE CONTRACT BETWEEN THE PARTIES IS THE SOLE WARRANTY OF SIEMENS ENERGY & AUTOMATION, INC. ANY STATEMENTS CONTAINED HEREIN DO NOT CREATE NEW WARRANTIES OR MODIFY THE EXISTING WARRANTY.

If drawings or other supplementary instructions for specific applications are forwarded with the manual or separately, they take precedence over any conflicting or incomplete information in this manual

Table of Illustrations

Introduction

The MSV and FSV series of vacuum circuit breakers are precision built devices designed to function efficiently under normal operating conditions. They are designed and manufactured to operate within the ANSI C37 standards for "Indoor" oiless circuit breakers. Performance requirements of these standards are met or exceeded by these designs.

Specific Standards which apply include:

C37.04	IEEE Standard Rating Structure
C37.06	Preferred Ratings and Related Required Capabilities
C37.09	IEEE Standard Test Procedures
C37.010	IEEE Standard Application Guide

The successful performance and application of these vacuum breakers depends as much on proper installation and maintenance as it does on good design and careful manufacture.

The instructions included in this book are necessary for safe installation, maintenance and operation and are provided to aid you in obtaining longer and economical service from your Siemens circuit breakers. For proper installation and operation—resulting in better service and lower maintenance costs—this information should be distributed to your operators and engineers.

By carefully following these instructions, difficulties should be avoided. However, they are not intended to cover all details or variations that may be encountered in connection with the installation, operation and maintenance of this equipment.

Should additional information be desired, including replacement instruction books, contact your Siemens representative.

Receiving:

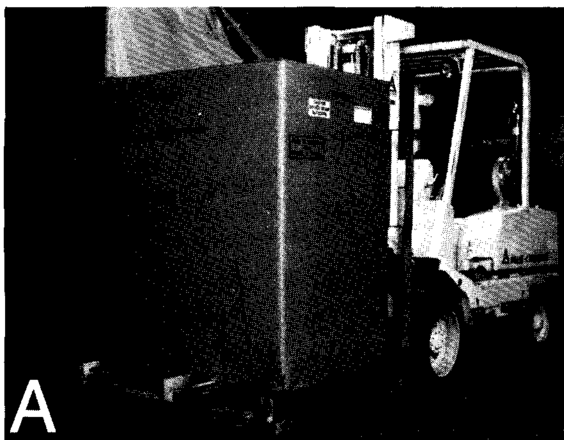
Circuit breakers are normally shipped from the factory completely assembled, inspected, tested and packed. Immediately upon receipt of a breaker check each item with the shipping manifest and make an examination for evidence of any damage that may have occurred during shipment, removing packaging carefully with correct tools where necessary. **If any shortage, damage or indication of rough handling is found, immediately call it to the attention of the local freight agent handling the shipment. Proper notation should be made by him on the freight bill.** This prevents any controversy when claim is made and facilitates adjustment. **Also, immediately file a damage claim with the transportation company and notify the nearest Siemens sales representative.**

Note

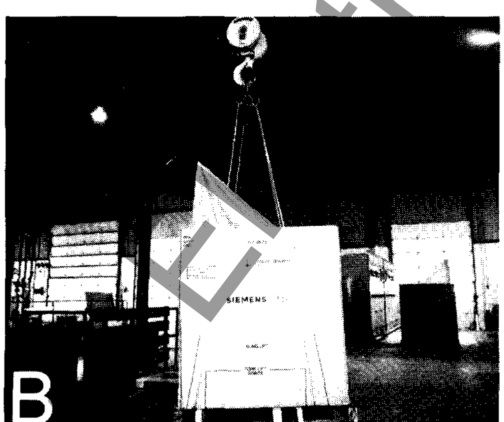
Damage claims must be processed within the time period specified by the carrier. Siemens cannot be held responsible for shipping damage, either external or internal, if the inspection is not made and claim forwarded within the set time limit.

Circuit breakers are normally shipped from the factory completely assembled. Observe weight markings on the carton and ensure that capable handling equipment is used.

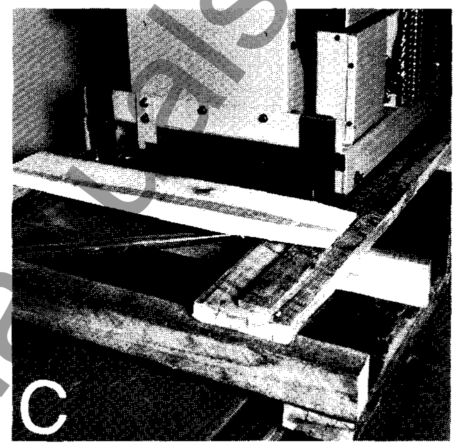
Remove packaging carefully with the correct tools. Check each item with the shipping manifest. **If any shortage or damage is found, immediately call it to the attention of the local freight agent handling the shipment. Proper notation should be made by him on the freight bill.** This prevents any controversy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



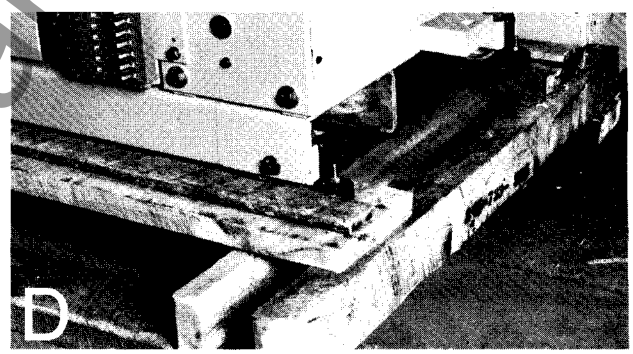
When moving breaker to location with a fork lift, observe weight and lifting locations on the carton. Carefully remove carton and plastic cover.



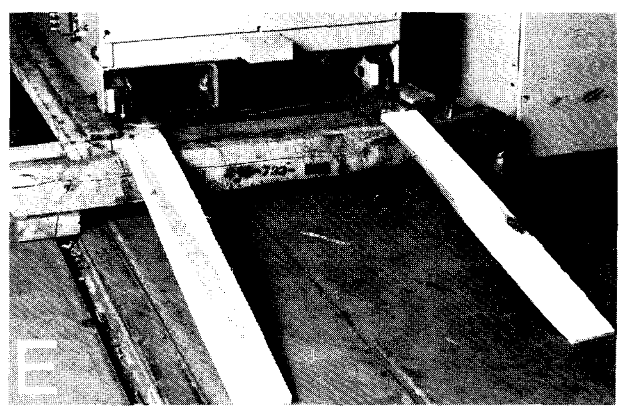
When moving breaker to location with a crane, observe weight and sling lifting locations on the carton. Use a spreader to prevent frame distortion and/or damage to the barriers. Carefully remove carton and plastic cover.



Remove ramp pieces nailed to the back of the pallet.



Remove hold down bolt and angle located in the front and back of the breaker.



Place ramp pieces in front of the pallet in line with the breaker wheels and nail to pallet as shown. Slowly roll the breaker off the pallet.

Figure 1 Circuit Breaker Handling Instructions

Storage

The circuit breaker should be installed as soon as possible. If storage is necessary, 'As Found' tests are recommended prior to and after storage for comparison. For storage, the **circuit breakers should be kept indoors in a clean dry protected location** where they will not be exposed to such items as dirt, construction dust, corrosive atmospheres, mechanical abuse or rapid temperature variation.

Outdoor storage of circuit breakers is not recommended. If breakers must be stored outdoors, they must be completely covered and protected from the elements. A heat source must be provided to prevent condensation and subsequent corrosion. Covering should allow for ventilation. Often 500 watts heat per breaker is used.

It is recommended that periodic inspection of the breakers be made during storage and if necessary procedures adjusted to keep the breakers in proper condition.

"As Found" Tests

When the equipment is received, perform and record "As Found" insulation tests using megger or Doble tests to give an initial value for future comparative indication of insulation change. Contact resistance tests can also be made using a ductor. This is recommended for all new circuit breakers especially if they are to be stored for extended periods, as they may absorb moisture and contaminants. This should also be done after storage and prior to placing breakers into service.

Changes in values between subsequent tests should be evaluated and corrective action taken where needed.

Since wide variations can occur in insulation values and contact resistance because of atmospheric conditions, contamination and type of test equipment, discrete values cannot be given. However, making and recording these tests on new equipment, and again at regular intervals, will give a comparative indication of insulation and/or contact resistance change. Maintaining a permanent record of these values for each circuit breaker should be part of the Maintenance Program.

a. Insulation resistance tests should be made to verify the insulation integrity. These can include megger or Dobel tests. If possible, a high-potential test should be made for one minute at:

RATED VOLTS (MAX.)	TEST VOLTAGE A.C.	D.C.
4.75 kV	14,000	20,000
8.25 kV	27,000	38,000
15.0 kV	27,000	38,000

NOTE:

Before testing the procedures and safety precautions indicated in High Potential Testing and Interrupter Vacuum Check on page 25 must be reviewed.

With the breaker open, check each phase across the open contacts by connecting from the upper to the lower primary disconnects. With the circuit breaker closed, check phase-to-phase and each phase-to-ground

b. A dielectric test on secondary and control circuits should be made at 1125 volts AC for one minute.

c. If desired, contact resistance tests can be made using a Ductor.

d. Make a permanent record of all tests performed.

Installation Checkout

The following agenda provides a convenient check list of activities to be performed while preparing the circuit breaker for use, and prior to insertion into the cubicle.

DANGER

Hazardous voltages and high speed mechanical parts will cause death or severe personal injury and property damage.

Read instruction manual, observe safety instructions and use to qualified personnel.

Prepare circuit breaker for insertion into its cubicle as follows:

1. Carefully remove packaging. Note: Vacuum breakers are normally supplied with their primary contacts open. Press "TRIP" (Red), "close" (black) and again "TRIP" (Red) push buttons to confirm this is true. See Fig. 2a & 2b Front elevations.
2. Carefully note and check rating plate to ensure maximum voltage, continuous current, interruption rating, and control voltages are compatible with the system and the cubicle into which the breaker is to be inserted.
3. Remove breaker from the shipping skid following requirements shown pictorially in Figure 1.
4. Remove interphase and external barriers. Note the interphase barriers are dissimilar from the external barriers, and that this dissimilarity must be recognized when installing the barriers.

5. Perform a careful visual inspection noting any damage which may have occurred in shipment. Clean all dust, dirt and foreign materials accumulated in shipment.
6. Using procedures described in the maintenance section of this manual, carry out a vacuum check, P.00.
7. Complete a manual spring charge, close and trip operation.
8. Reinstall all interphase and external barriers (see 4 above).
9. Check primary contact assemblies. Fingers should be fully engaged, spring loaded and arranged with symmetry about the axis of the primary stud.
10. De-energize cubicle control power, and install plug jumper between cubicle secondary disconnects and those of the breaker. Re-energize control power springs should charge. With the local control switch close and trip breaker.

11a. (Lever type racking only) Note that with the breaker closed, that the racking release handle, (Fig. 2a and 2b.), cannot be raised. Open breaker by pressing trip button and note the racking lever may be freely raised.

11b. (Screw type racking only) Refer to the panel mounted cautionary statement and safety instructions (reproduction below). Read and understand this information before inserting the circuit breaker into the cubicle.

CAUTION

CIRCUIT BREAKER IS EQUIPPED WITH SCREW RACKING AND MAY INCLUDE A KEY TYPE INTERLOCK, AS WELL. KNOW HOW THIS EQUIPMENT IS TO BE OPERATED BEFORE ATTEMPTING TO INSERT OR RACK CIRCUIT BREAKER. FAILURE TO DO SO COULD RESULT IN PERSONAL INJURY AND PROPERTY DAMAGE.

OBSERVE SAFETY INSTRUCTIONS AND RESTRICT OPERATION TO QUALIFIED PERSONNEL ONLY.

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SAFETY INSTRUCTIONS

FOR CIRCUIT BREAKERS WITH SCREW RACKING

1 THIS CUBICLE MAY BE EQUIPPED WITH KEY TYPE INTERLOCK IF SO THE LOCK BOLT MUST BE IN THE WITHDRAWN POSITION AND THE CIRCUIT BREAKER OPEN BEFORE ATTEMPTING TO CHANGE POSITION OF BREAKER

2 BEFORE INSERTING BREAKER THE FOLLOWING NORMAL OPERATING CONDITIONS SHOULD BE VERIFIED THE DRIVE NUT IS FULLY RACKED OUT AGAINST STOP AND BREAKER IS OPEN PUSH BREAKER INTO CUBICLE DISCONNECT POSITION WHERE INTERLOCK PLUNGER WILL STRIKE A POSITIVE STOP RAISE RACKING RELEASE HANDLE AND PUSH BREAKER TO TEST POSITION WHERE IT WILL MAKE A POSITIVE STOP AND WILL BE AUTOMATICALLY COUPLED TO THE DRIVE MECHANISM

3 MOVING THE BREAKER BETWEEN THE DISCONNECT AND TEST POSITION IS ACCOMPLISHED BY FIRST RAISING THE RACKING RELEASE HANDLE AND EITHER
PUSHING BREAKER FROM DISCONNECT TO TEST POSITION OR
PULLING BREAKER FROM THE TEST TO DISCONNECT POSITION

4 IT IS NOT RECOMMENDED THAT THE BREAKER BE SCREW RACKED FROM DISCONNECT TO TEST POSITION (ONLY POSSIBLE IF THE BREAKER S RACKING RELEASE HANDLE IS RAISED) IF THIS IS DONE BREAKER WILL NOT AUTOMATICALLY STOP IN TEST POSITION

5 CLOCKWISE CRANK ROTATION WILL MOVE BREAKER FROM TEST TO CONNECTED POSITION COUNTERCLOCKWISE ROTATION WILL MOVE BREAKER FROM CONNECTED TO TEST POSITION UPON REACHING EITHER CONNECTED OR TEST POSITION. BREAKER WILL AUTOMATICALLY STOP AND LATCH IN PLACE

6 THE BREAKER MAY BE REMOVED FROM THE CUBICLE BY RAISING THE RACKING RELEASE HANDLE AND PULLING THE BREAKER FROM THE DISCONNECT POSITION UNTIL IT IS FULLY WITHDRAWN FROM THE CUBICLE

7 THE KEY INTERLOCK IF SPECIFIED IS USED TO LOCK THE BREAKER "TRIP FREE" TO LOCK THE BREAKER TRIP FREE PROCEED AS FOLLOWS
WITH BREAKER IN CONNECTED POSITION AND LOCK BOLT WITHDRAWN
TURN DRIVE MECHANISM CRANK EXACTLY FOUR (4) TURNS IN A COUNTERCLOCKWISE DIRECTION
TURN KEY ON LOCK TO EXTEND LOCK BOLT BREAKER IS NOW LOCKED IN A TRIP-FREE CONDITION

8 TO RELEASE INTERLOCK AND RETURN BREAKER TO NORMAL CONDITION
TURN KEY TO WITHDRAW LOCK BOLT
THEN TURN CRANK IN A CLOCKWISE DIRECTION UNTIL IT STOPS

18-810-099-001

12. Perform and record results of the "as found" tests. Compare with pre-storage "As Found" test values if stored.
13. De-energize control power and remove plug jumper.
14. Coat *movable* primary and secondary disconnects with a light film of Siemens contact lubricant, 15-171-370-002.

DANGER

HAZARDOUS VOLTAGES ASSOCIATED WITH THE APPLICATION OF THIS BREAKER WILL CAUSE DEATH, PERSONAL INJURY, AND PROPERTY DAMAGE.

Before proceeding with the initial circuit breaker insertion and racking to the bus, be certain the bus is de-energized.

15. On FSV circuit breakers examine aramid cords to ensure they are aligned over each of the guides (refer to page 37, Fig. 29 for location).
16. Insert breaker into its cubicle and rack to the "disconnect" position. Reenergize control power
17. Advance the breaker to the "test" position and close breaker electrically. Try an opening operation. Observe that the breaker closes and opens.
18. During this racking exercise note the alignment of the stationary and movable secondary disconnects. Check also the alignment between the auxiliary switch bayonet on cubicle wall and operating yoke on breaker. See Fig. 2a and 2b or reference to the breaker operating yoke.

WARNING

A fully connected breaker controls high voltage and currents. Improper use can cause death, personal injury or property damage.

Perform initial racking to connect position on de-energized bus. If an energized bus is unavoidable obtain appropriate clearances before beginning the next two steps.

19. Move breaker to fully connected position on a de-energized bus. Close and trip breaker from main control position.
20. If a lock-out key interlock has been provided, place this interlock in the breaker "locked out" position, key removed, and perform a close operation. Check that the breaker has gone trip free. Open the interlock, "key held" position and repeat the closing trial. The breaker now should successfully close.
21. The breaker should now be ready for service.

Circuit Breaker Elevations

Typical front elevations and side elevations of the type MSV and FSV Vacuum Circuit Breakers are shown in figures 2a and 2b. The 5-MSV-250A circuit breaker has a front panel design about 4⅜" higher than as shown for use with type 'DG' ground and test devices. The cubicle barrier is about 4⅜" shorter for this design. The cubicle and breaker are not interchangeable without changing panels.

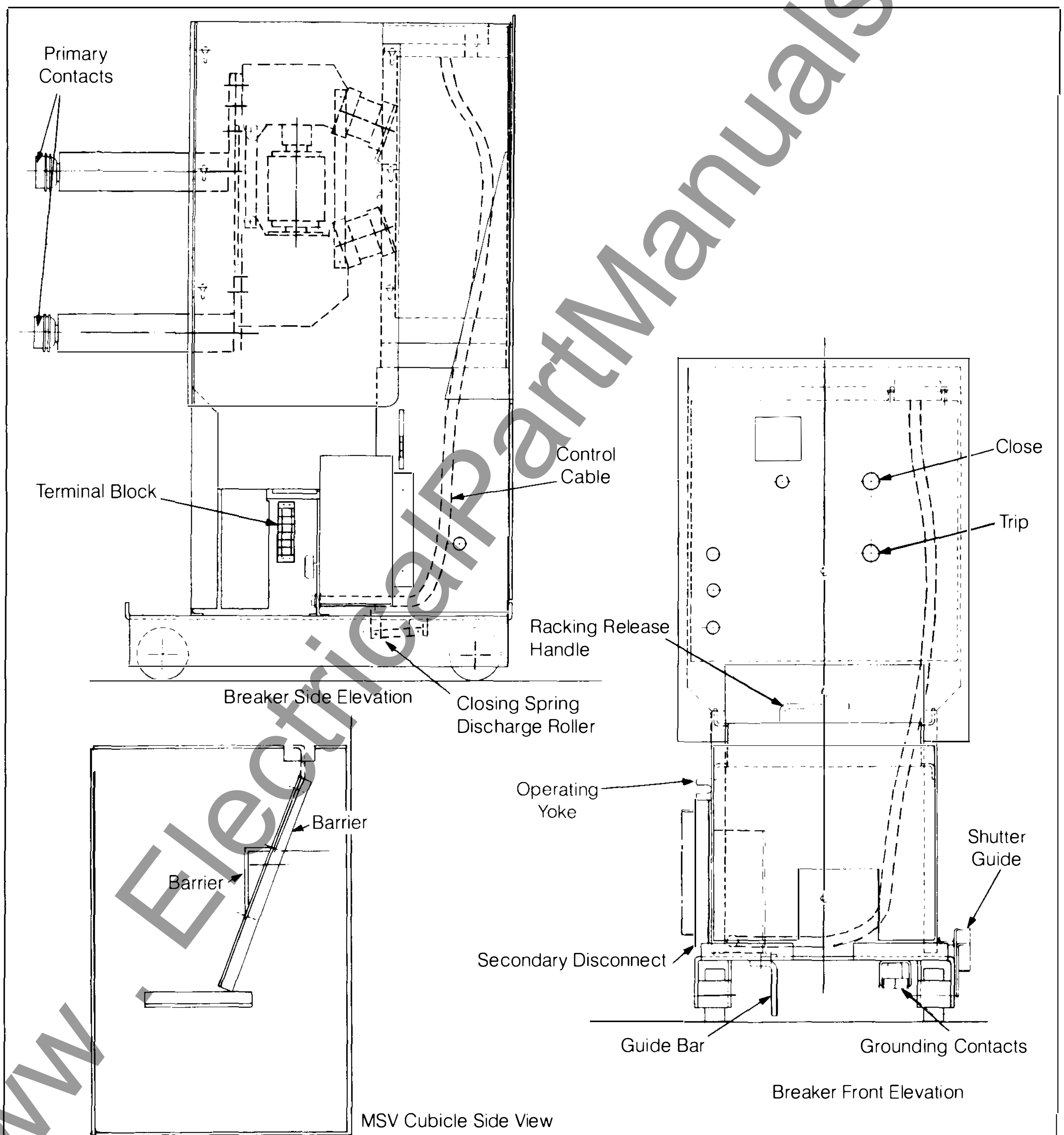


Figure 2a
MSV Breaker Front and Side Elevation

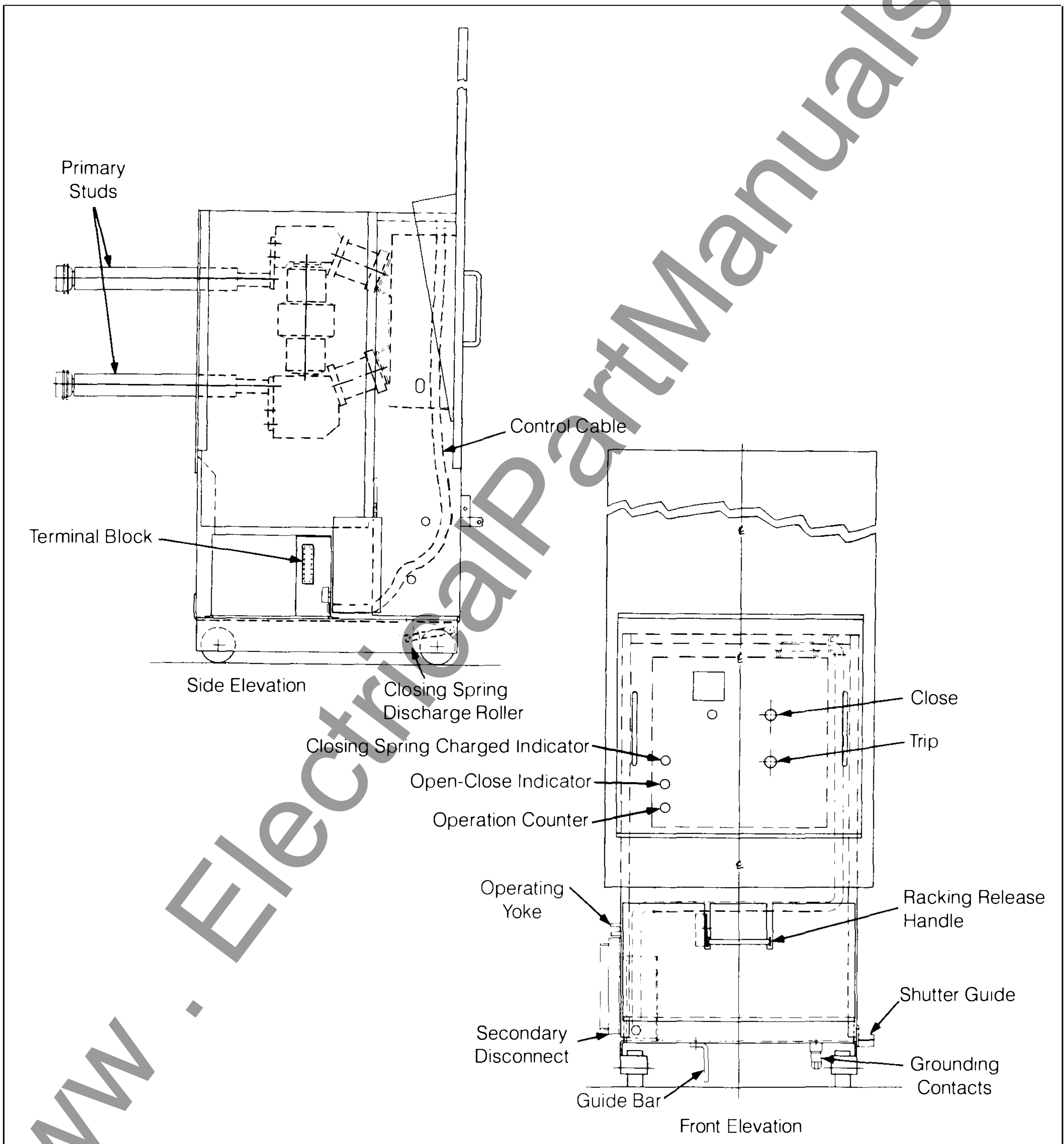


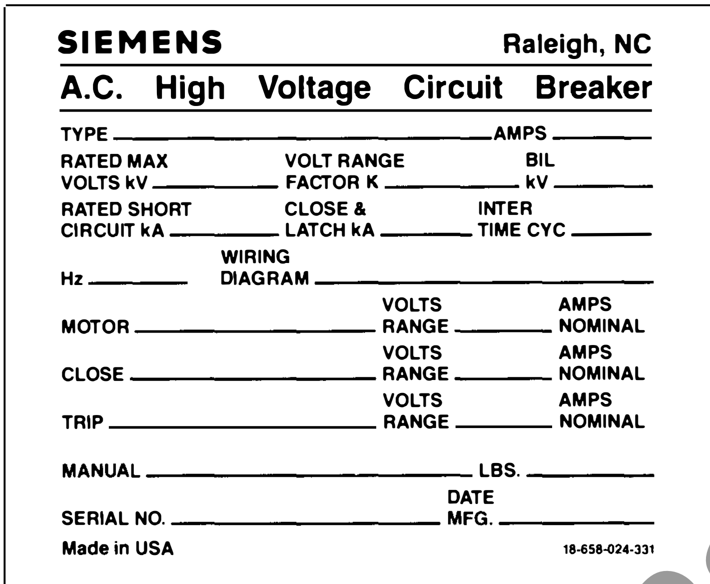
Figure 2b
FSV Breaker Front and Side Elevation

Rating Plate Content

Type	Designated circuit breaker model number and broadly identifies application in terms of maximum voltage and interruption capability.
Amps	Rated continuous current is the designated limit of current in RMS amperes at rated frequency which the breaker may be expected to carry without exceeding temperature limitations.
Rated Max Volts kV	The highest RMS voltage above nominal system voltage for which the circuit breaker is designed, and is the upper limit for operation
Voltage Range Factor (K)	The ratio of rated maximum voltage to the lower limit of the range of operating voltage in which the required symmetrical and asymmetrical interrupting capabilities vary in inverse proportion to operating voltage.
Bil kV	The rated full wave impulse withstand voltage. The crest value of a standard 1.2 x 50 impulse voltage wave which a new circuit breaker must be capable of withstandning without flashover or puncture during design tests.
Rated Short Circuit kA	The symmetrical component of short-circuit current in RMS amperes which the breaker may be expected to interrupt.
Close & Latch kA	The maximum making current into which the circuit breaker may be expected to close and latch.
Inter Time Cyc	The maximum permissible interval between energizing the trip circuit at rated control voltage and the interruption of the main circuit in all poles.

Rating Plate Content

Hz	Rated frequency is the sinusoidal periodicity at which the circuit breaker is designed to operate.
Wiring Diagram	An elementary diagram providing detailed information regarding electrical function and wiring within the circuit breaker.
Motor (Spring Charging) Volt Range	Range of control voltages required to serve the motor which stores energy in the closing springs.
Amps Nominal	Effective value of current required at nominal control voltage when applied to the serve the motor which stores energy in the closing springs.
Close (Spring Release Coil) Volt Range	Required range of control voltage applied to the spring release coil which will ensure successful release of the closing springs
AMP. Nominal	The effective value of current required at nominal control voltage when applied to the spring release coil.
Trip (Shunt Trip Coil) Volt Range	Required range of control voltage applied to the shunt trip coil which will ensure a successful tripping operation.
Amps Nominal	Effective value of current required at nominal control voltage when applied to the shunt trip coil solenoid.
Manual	Reference to the instruction manual applicable to the circuit breaker by publication number.
LBS	Weight in pounds of the complete circuit breaker assembly.
Serial No.	Specifically identifies an individual breaker and affords traceability to test records and manufacturing dates.
Date Mfg.	The month and year within which the circuit breaker was manufactured.


SIEMENS Raleigh, NC

A.C. High Voltage Circuit Breaker

TYPE ______ AMPS ______

RATED MAX VOLTS kV ______ VOLT RANGE FACTOR K ______ BIL kV ______

RATED SHORT CIRCUIT kA ______ CLOSE & LATCH kA ______ INTER TIME CYC ______

Hz ______ WIRING DIAGRAM ______

MOTOR ______ VOLTS RANGE ______ AMPS NOMINAL

CLOSE ______ VOLTS RANGE ______ AMPS NOMINAL

TRIP ______ VOLTS RANGE ______ AMPS NOMINAL

MANUAL ______ LBS. ______

SERIAL NO. ______ DATE MFG. ______

Made in USA 18-658-024-331

Figure 3
Rating Plate

Rating Summary

1. Breaker Type
2. Rated Maximum Voltage, kV
3. Continuous Current, AMP
4. Power System Frequency, Hz
5. Rated Short Circuit Interrupt Current, kA
6. Voltage Range Factor K
7. Interruption Time, Cycles 60 Hz
8. Rated Withstand test Voltage, Low Frequence, kV rms
9. Rated Withstand Test Voltage—Impulse kV crest
10. Closing of Latching Capability, kA

Type	Vmax kV	I kA	Freq Hz	Isc kA	K -	Int T. Cycles	Withstand-kV Low Freq.	Withstand-kV Impulse	C&L kA	Weights, Approx. Pounds	Weights, Approx. Kilograms
Number 1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
5-MSV -250	4.76	1200	60	29	1.24	5	19	60	58	600	272
5-MSV -250	4.76	2000	60	29	1.24	5	19	60	58	625	283
5-FSV -350	4.76	1200	60	41	1.19	5	19	60	78	1200	544
5-FSV -350	4.76	2000	60	41	1.19	5	19	60	78	1200	544
5-FSV -350	4.76	3000	60	41	1.19	5	19	60	78	1200	544
7-FSV -500	8.25	1200	60	33	1.25	5	36	95	66	860	390
7-FSV -500	8.25	2000	60	33	1.25	5	36	95	66	860	390
7-FSV -500	8.25	3000	60	33	1.25	5	36	95	66	900	408
15-FSV -500	15.0	1200	60	18	1.30	5	36	95	37 (1)	860	390
15-FSV -500	15.0	2000	60	18	1.30	5	36	95	37 (1)	860	390
15-FSV -750	15.0	1200	60	28	1.30	5	36	95	58 (2)	860	390
15-FSV -750	15.0	2000	60	28	1.30	5	36	95	58 (2)	860	390
15-FSV -750	15.0	3000	60	28	1.30	5	36	95	58 (2)		
15-FSV-1000	15.0	1200	60	37	1.30	5	36	95	77	1200	544
15-FSV-1000	15.0	2000	60	37	1.30	5	36	95	77	1200	544
15-FSV-1000	15.0	3000	60	37	1.30	5	36	95	77	1200	544

Table 1
Rating Summary

(1) 58kA OPTIONAL
(2) 77kA OPTIONAL

Service Conditions

The following parameters define the usual service conditions under which the circuit breakers shall be considered suitable for operating at their standard ratings. Conditions of use beyond these limits must be given special consideration, consultation with the factory or reference to the IEEE Application Guide, ANSI C37.0I0.

Maximum Ambient Temperature	40 C (104 F)
Minimum Ambient Temperature	−30 C (−22 F)
Altitude	1000 meters (3300 Feet)

Unusual service conditions which expose the equipment to dust, steam, salt spray, corrosive gases, dripping water, vibration, shocks, high and low temperatures, high altitudes and the like may require special construction. Refer concerns to the factory.

The values of insulation level compiled above are referred to sea level in accordance with ANSI C37.04-1979 consolidated standards. The higher the site altitude, the lower the insulating capacity of the air. The decrease in insulating capacity is neglected by standards for altitudes of up to 3,300 ft. (1000m) above sea level. For higher altitudes, the values of low-frequency withstand voltage, impulse withstand voltage and rated continuous current must be corrected in accordance with table 2.

Table 2
Altitude Correction Factors, k

Altitude ft.	Altitude (m)	Rated Maximum Voltage and Insulation Level	Rated Continuous Current
3300	(1000)	1.00	1.00
5000	(1500)	0.95	0.99
10000	(3000)	0.80	0.96

NOTE: Interpolated correction factors shall be used in determining factors for intermediate altitudes.

General Performance Data

Operating Times - Typical Values

Characteristic	Cycles (60 Hz)	MS
Closing Time	4.5	75
Opening Time	2.0	33
Arcing Time at 60Hz	0.9	15
Interrupting Time	5	50

General Performance Data

Typical Closing and Tripping Solenoid Characteristics

Control Voltages ANSI C37.06 Tbl. 10	Close Coil Ohms	Close Coil Amps	Trip Coil Ohms	Trip Coil Amps
48 VDC	23	2.1	2.4	20.0
125 VDC	121	1.0	23	5.4
250 VDC	487	0.5	121	2.1
120 VAC 60Hz	121	0.9	23	4.7
240 VAC 60	487	0.4	121	1.8

General Performance Data

Typical Spring Charging Motor Characteristics

Control Voltages ANSI C37.06 Tbl. 10	Current Amps	Charge Time Seconds
48 VDC	8	10
125 VDC	4	10
250 VDC	2	10
120 VAC 60Hz	6	10
240 VAC 60Hz	3	10

General Performance Data

Auxiliary Switch Ratings

Characteristic	Rating
Maximum Operating Voltage	500 V
Continuous Current, Max.	10 A
Making Current, Max.	30 A
Breaking Capacity	
Resistive Load DC or AC	1200 VA
Inductive Load at 220VDC (L/R = 20ms)	750 VA

The type MSV and FSV vacuum circuit breakers are of drawout construction, and conform to the requirements of ANSI C37.20 for breakers to be applied in metal clad switchgear. The vacuum circuit breakers consist of a combination of two sub-assemblies. The "interrupter/operator" sub-assembly is a unitized assembly of the three vacuum interrupters, primary insulators, and operating mechanism. The second sub-assembly, the "vehicle" is the supporting draw-out structure sub-assembly into which is fitted the first sub-assembly. The drawout structure sub-assembly provides primary stud extensions, closed breaker racking interlocks, closing spring discharge feature, and other requirements needed to ensure safe and reliable use during racking and fully connected operations.

These two sub-assemblies will be separately described.

Interrupter/Operator Sub-Assembly

The interrupter/operator sub-assembly consists of the three poles, each with its vacuum interrupters and primary insulators, mounted on the common motor or hand charged spring stored energy operating mechanism housing. This sub-assembly is shown in figures 4 - 5.

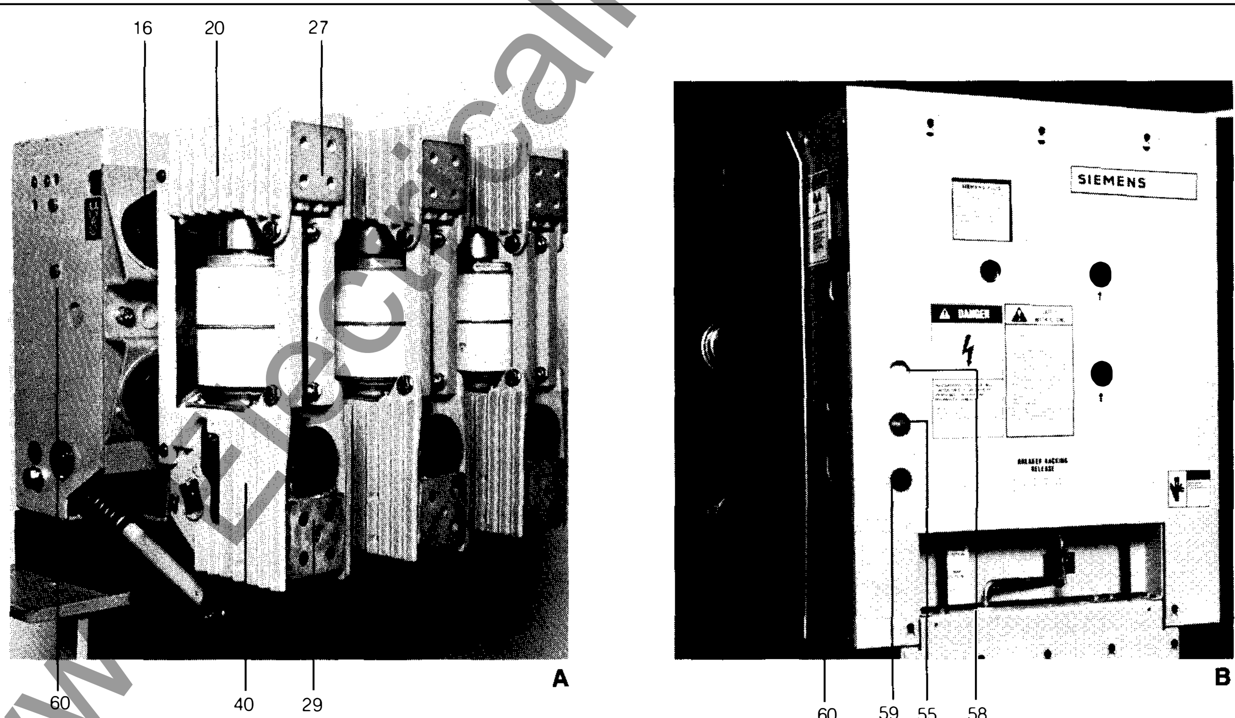
Construction (Refer to Figures 4 - 8)

Each of the circuit breaker poles are fixed to the rear of the operating mechanism housing (60) by two cast-resin insulators (16). The insulators also connect to the upper (20 and lower (40) poles supports which in turn support the ends of the vacuum interrupter (30). Where required by dielectric requirements, assemblies are fitted with phase barriers (80).

The pole supports are aluminum castings on all circuit breaker ratings, except for 3000A continuous current where copper castings are used and on the 15-FSV-500, 1200A where sheet steel supports are used.

The support pole terminals, (27) and (24) each receive primary stud extensions.

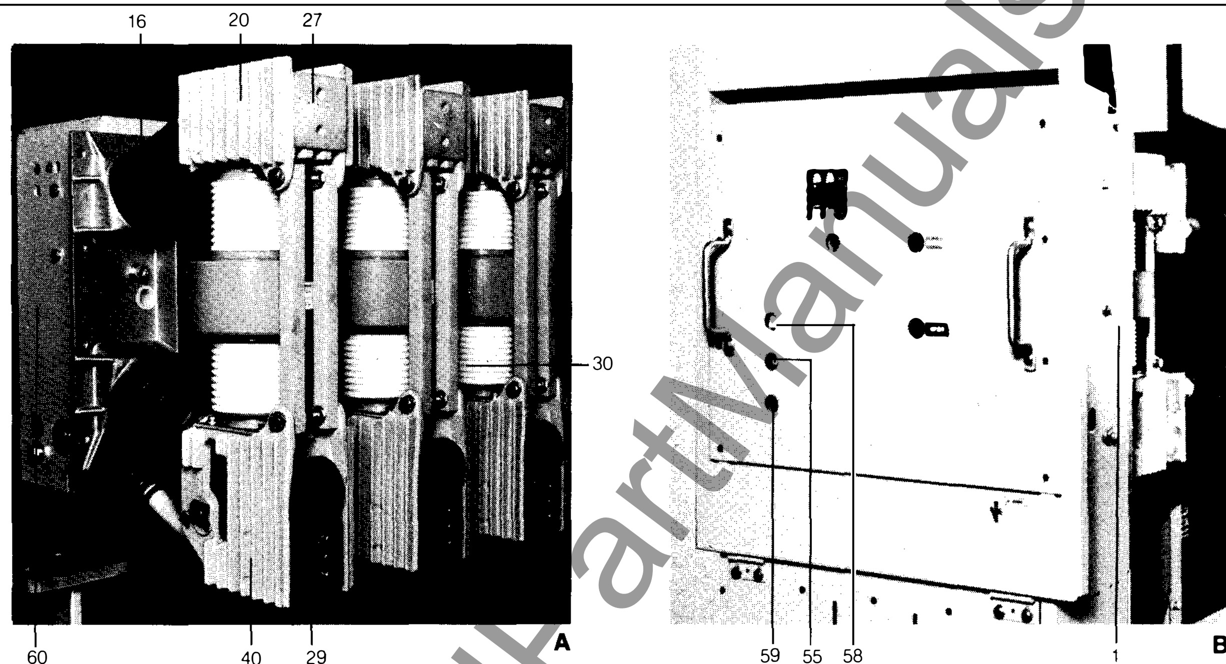
The energy-storing mechanism and all the control and actuating devices are installed in the mechanism housing (60). The mechanism is of the spring charged stored energy type and is mechanically and electrically trip free.



Typical Vacuum Tube and Operating Mechanism Subassembly

Mechanism Housing

Figure 4
5KV Vacuum Breaker



Typical Vacuum Tube and Operating Mechanism Subassembly

Mechanism Housing

Figure 5
15KV Vacuum Breaker

The close-open indicator (55), closing spring charge indicator (58), and the operation counter (59) are fitted on the front of the mechanism housing (60).

The control connector (68.7) for the control and signalling cables is a 64 contact plug or 24 point terminal block applied internally to the drawout unit.

Breaker Pole (Figure 6)

The vacuum interrupter (30) is rigidly connected to the upper terminal angle (27.1) and pole support (20) by its terminal post (31.2). The lower part of the interrupter is stabilized against lateral forces by a centering ring (28.1) on the pole support (40). The external forces due to switching operations and the contact pressure are absorbed by the struts (28).

Current-Path Assembly (Figure 6)

The current-path assembly consists of the upper terminal angle, 27.1. and pole support. 20, the stationary contact, 31, and the moving contact, 36, which is connected with the lower terminal, 29, by terminal clamp, 29.2, and a flexible shunt. 29.1.

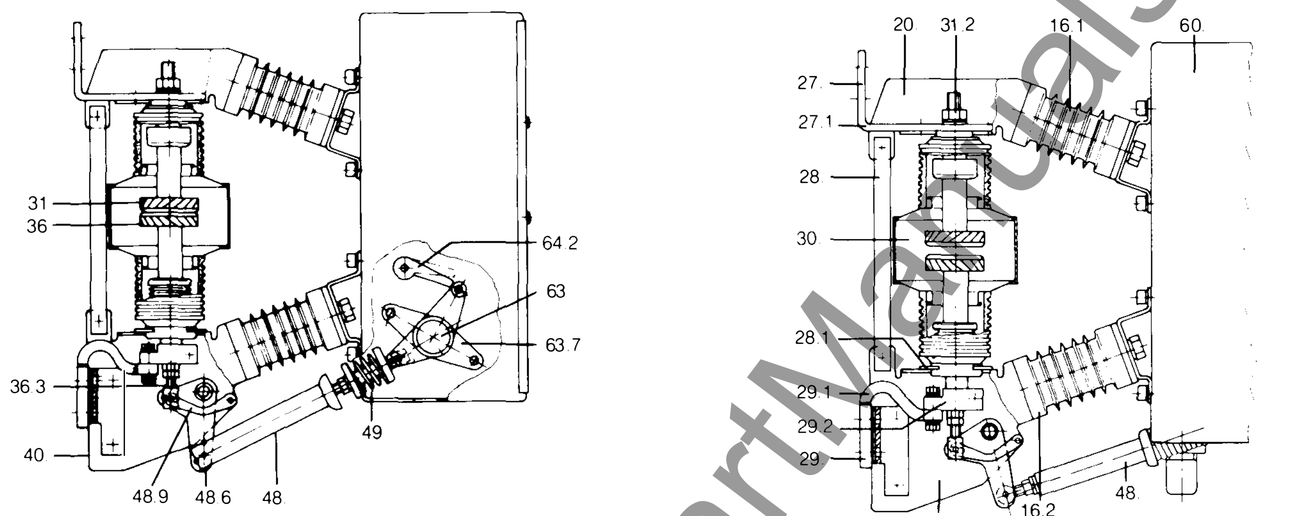
Vacuum Interrupter (Figure 7)

The moving contacts', (26), motion is aligned and stabilized by guide busing, (35). The metal bellows, (34), follows the travel of contact, (36), and seals the interrupter against the surrounding atmosphere.

The Arc-Quenching Principle

When the contacts separate, the current to be interrupted initiates an ionized metal vapor arc discharge and flows through this plasma until the next current zero. The arc is then extinguished and the conductive metal vapor condenses on the metal surfaces of the arcing chamber, (33), (Fig. 7) within a matter of microseconds. As a result, the dielectric strength in the increasing contact gap builds up very rapidly.

Below a limit of about 10,000 amperes, the arc is distributed across the contacts and the arc is easily interrupted. At currents larger than about 10,000 amperes the arcs own electromagnetic forces cause the arc to contract to essentially a point arc. If the contracted arc is allowed to remain stationary, it overheats the contacts at the arc roots to the point where the molten metal vapor does not allow the dielectric to rebuild during the current zero and large magnitude currents could not be interrupted.



A	Terminal	27.	Upper terminal	29.2	Terminal clamp	48.	Insulated coupler
B	Fixing screw	27.1	Upper Terminal Angle	30.	Vacuum interrupter	48.5	Pin 48.6 Lever
P	Evacuation nipple	28.	Strut	31.2	Terminal post	49.9	Drive link
16.1	Upper insulator	28.1	Centering ring	36.1	Movable Contact Stern	49.	Contact Pressure Spring
16.2	Lower insulator	29.	Lower terminal	36.3	Eye Bolt	60.	Mechanism housing
20.	Upper pole support	29.1	Flexible strap	40.	Lower pole support	80.	Phaser barrier

Figure 6 Section Through A Vacuum Breaker Pole

31	Stationary contact	34	Bellows
31.1	Washer	35	Guide
31.2	Stationary Contact Stem	36	Moving contact
32	Insulator	36.1	Movable contact stem
33	Arcing chamber	36.2	Mechanical coupling

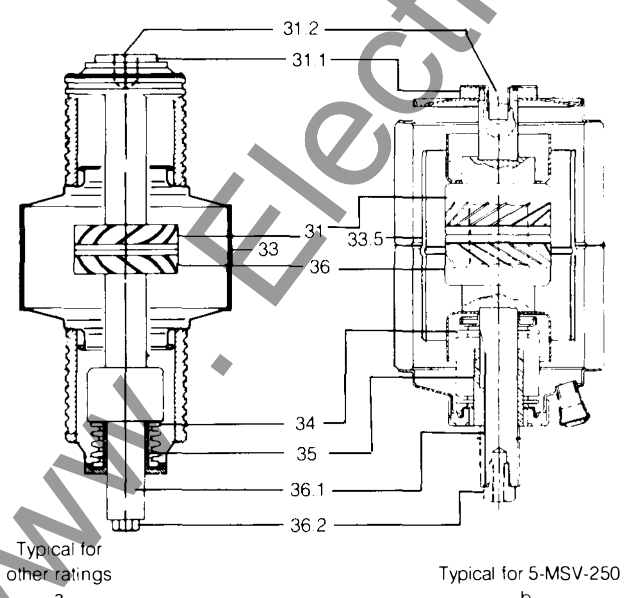


Figure 7 Section Through A Vacuum Interrupter

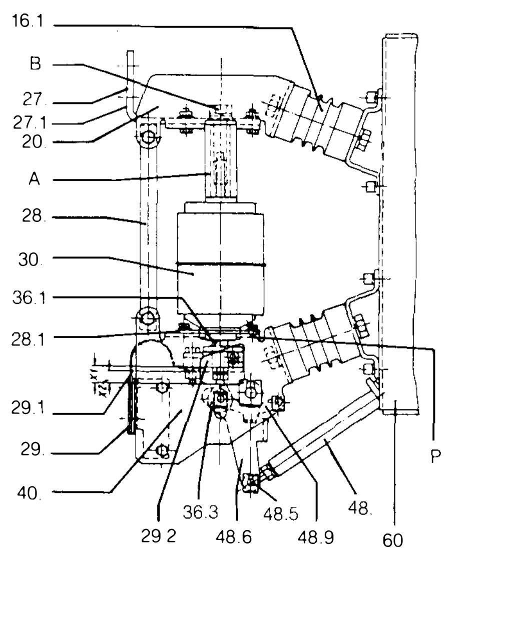


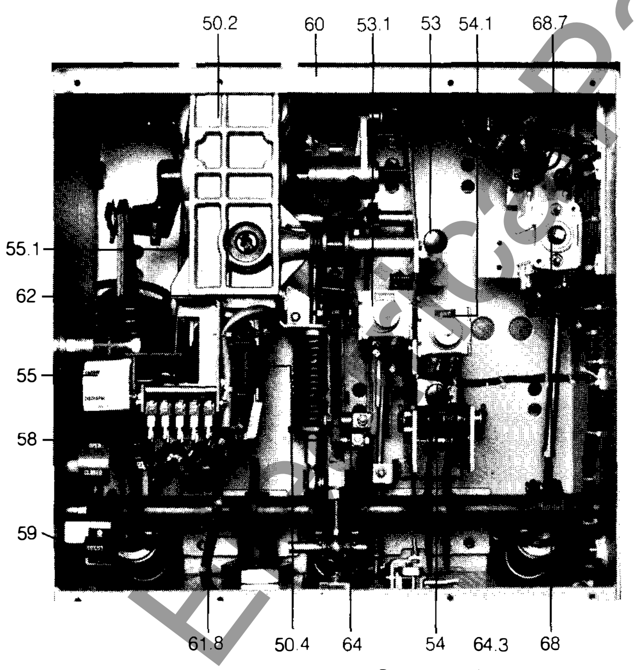
Figure 8 Section Through the Vacuum Breakers

The contacts are designed so that a self-generated field causes the arc to travel around the contacts. This prevents local overheating while interrupting large magnitudes of short circuit current.

The ionized metal vapor arc discharge can only be maintained if a certain minimum current flows. A current that does not maintain this level may be extinguished abruptly prior to current zero. This chopping current must be kept to a minimum in order to prevent unduly high overvoltages building up when inductive circuits are switched. The use of a special contact material ensures that current chopping is limited to 4-5 Amp.

The rapid build-up of the dielectric strength in the break enables the arc to be safely extinguished even if contact separation occurs immediately prior to current zero.

The arc drawn in the vacuum breaker is not cooled. The metal vapor plasma is highly conductive and the resulting arc voltage only attains values between 20-200 V. For this reason and because of the short arcing times, the arc energy developed in the break is very small. This also accounts for the long electrical life expectancy of the vacuum interrupter



50.2	Charging mechanism	58	Open-close indicator
50.4	Motor	59	Operation counter
53	Close button	60	Mechanism housing
53.1	Sring Release Coil 52SRC	61.8	Dashpot
54	Trip button	62	Closing spring
54.1	Shunt Trip Coil 52T	64	Opening spring
55	Closing spring charged Indicator	64.3	Lever (Lever omitted when applied to screw type racking)
55.1	Linkage	68.7	Control Connector

Figure 9
Vacuum Breaker Mechanism CLosed Position, Tripping Springs Charged and Closing Springs Discharged

Owing to the high vacuum (less than 10^{-9} bar) in the interrupter, contact clearances in the range of 6 to 20 mm (0.25 to 0.80 inches) are adequate to attain a high dielectric strength.

Switching Operation (Figure 6)

When a closing command is initiated the closing spring, which was previously charged by hand or by the motor, actuates the moving contact, (36), through breaker shaft, (63), lever, (63.7), insulated coupler, (48), and lever, (48.6).

The forces that occur when the action of the insulated coupler is converted into the vertical action of the moving contact are absorbed by guide link, (48.9), which pivots on support, (40), and eye bolt, (36.3)

During closing, the tripping spring and the contact pressure springs, (49), are charged and latched by pawl, (64.2).

The closing spring of motor-operated breaker is recharged immediately after closing.

In the closed state, the necessary contact pressure is maintained by the contact pressure spring and the atmospheric pressure. The contact pressure spring automatically compensates for arc erosion, which is very small.

When a tripping command is given, the energy stored in the tripping and contact pressure springs is released by pawl, (64.2). The opening sequence is similar to the closing sequence. The residual force of the tripping spring arrests the moving contact, (36) in the open position.

Operating Mechanism

The operating mechanism is comprised of the mechanical and electrical components required to:

- Charge the closing springs with sufficient potential energy to close the breaker and to store opening energy in the tripping and contact pressure springs.
- Mechanisms to release closing and tripping actions.
- Means of transmitting force and motion to each of three pole positions.
- Operate all these functions automatically thru electrical charging motor, cutout switches, antipumping relay, release solenoids, and auxiliary switches.
- Signal thru indicators the breaker status, (open, closed) and spring condition (charged or discharged) and number of operations.

50.1	Opening for handcrank
50.2	Charging mechanism
50.3	Charging flange
50.3.1	Driver
50.4	Motor
53	Close button
53.1	Spring Release Coil
55.1	Linkage
55.2	Control lever
62	Closing spring
62.1	Charging shaft
62.2	Crank
62.3	Cam
62.5	Lever
62.5.1	Pawl roller
62.5.2	Latching Pawl
62.6	Drive lever
62.8	Trip free Coupling rod

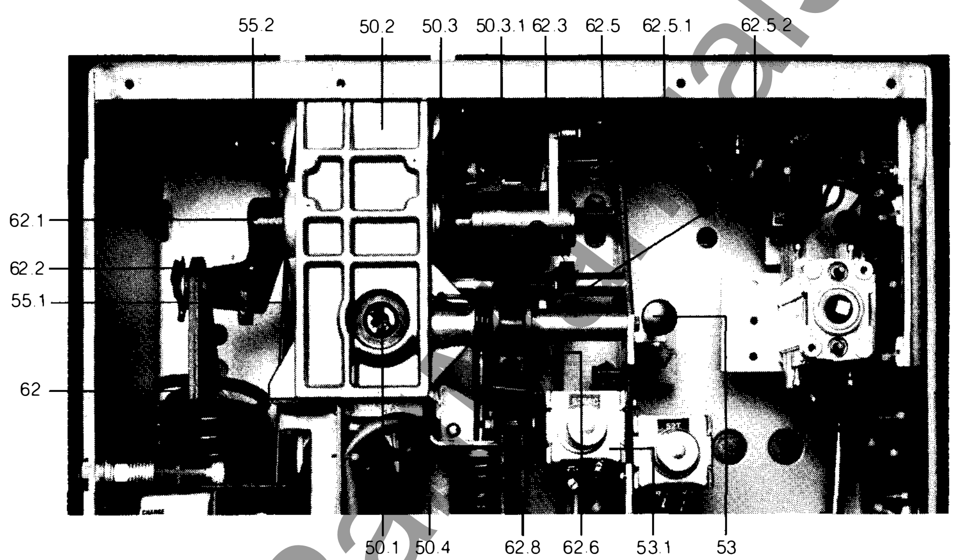


Figure 10
Operating Mechanism, Details of Closing Spring Charging Components

Construction

The essential parts of the operating mechanism are shown in Fig. 9. Its actuation is described under "Operator Sequential Operation Diagram" on page 17.

Indirect Releases (Tripping Coils)

The shunt releases convert the electrical tripping pulse into mechanical energy, it's function being to release the tripping spring. The undervoltage release may be manually actuated by a make or a break contact. In the make contact case, its coil is shorted out, built-in series resistors limiting the current.

Motor Operating Mechanism

The spring charging motor (50.9) is bolted to the charging mechanism (50.2) gear box installed in the mechanism housing. Neither the charging mechanism nor the motor require any serving.

Auxiliary Switch

The auxiliary switch is actuated by the breaker shaft.

Mode of Operation

The operating mechanism is of the stored-energy trip free type, i.e. the charging of the spring is not automatically followed by the contacts changing position, and the closing function may be overridden by a trip command at any time.

When the stored-energy mechanism has been charged, the instant of operation can be chosen as desired.

The mechanical energy for carrying out an "open-close-open" sequence for auto-reclosing duty is stored in the closing and tripping springs.

Charging

The details of the closing spring charging mechanism are shown in figures 9, 10, 11 and 12. The charging shaft, (62.1), is supported in the charging mechanism, (50.2), but is not coupled mechanically with the charging mechanism. Fitted to it are the crank, (62.2), at one end and the cam, (62.3), together with lever, (62.5), at the other.

When the charging mechanism is actuated by hand with a hand crank opening or by a motor, the flange, (50.4), the flange. 50.3, turns until the driver, (50.3.1), locates in the cutaway part of cam disc, (62.3), thus causing the charging shaft to follow. The crank, (62.2), charges the closing spring (62). When this has been fully charged the crank actuates the linkage, (55.1), via control lever, (55.2), for the "closing spring charged" indicator, (55), and actuates the limit switches, (50.4.1), for interrupting the motor supply. At the same time, the lever (62.5) at the other end of the charging shaft is securely locked by the latching pawl (62.5.2). When the closing spring is being charged, cam disc, (62.3), follows idly, i.e. it is brought into position for closing.

53	Close button
54	Trip button
55	"Closing spring Charges" indicator
58	Open-Close indicator
59	Operation counter
61.8	Shock Absorber
62	Closing Spring
62.1	Charging Shaft
62.2	Crank
62.3	Cam
62.5	Lever
62.5.1	Pawl roller
62.5.2	Pawl
63	Breaker Shaft
64	Tripping Spring
64.2	Tripping Spring
64.2	Pawl
64.3	Lever (Lobes are omitted when applied with screw type racking
64.3.1	Pawl roller

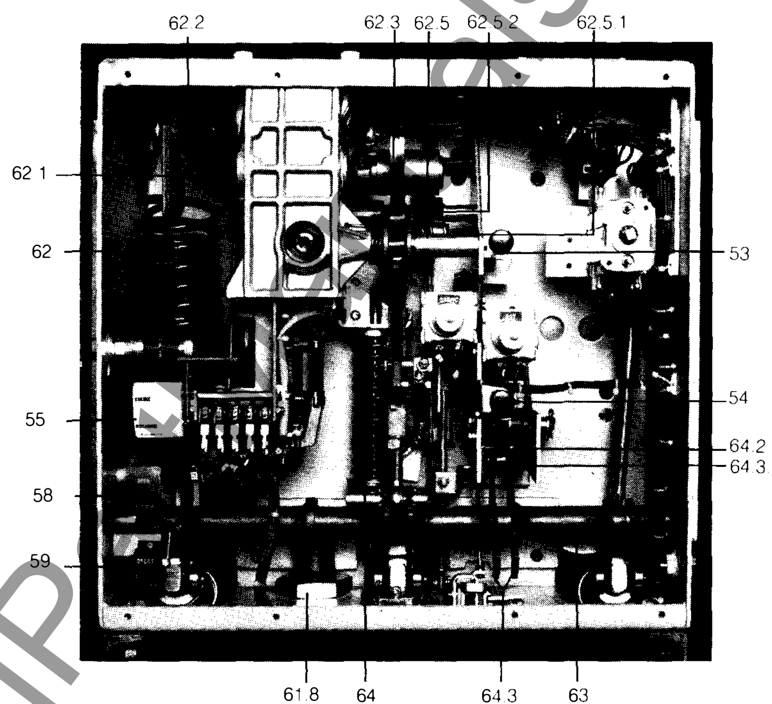


Figure 11
Operating Mechanism Open Position Closing Spring Charged and Latched

Closing (See Fig. 9, 10, 11 & 12)

If the breaker is to be closed locally, the closing spring is released by pressing CLOSE button, (53). In the case of remote control and the spring release coil 52SRC, (53.1), unlatches the closing spring.

As the closing spring discharges, the charging shaft, (62.1), is turned by crank, (62.2). The cam disc, (62.3), at the other end of the charging shaft actuates the drive lever, (62.6), with the result that breaker shaft, (63), is turned by lever, (63.5), via the trip free coupling rod, (62.8). At the same time, the levers, (63.1), (63.5) and (63.7) fixed on the breaker shaft operate the three insulated couplers for the breaker poles. Lever, (63.7), changes the open-close indicator over to open Lever, (63.5), charges the tripping spring, (64), during closing, and the breaker is latched in the closed position by lever, (64.3), with pawl roller, (64.3.1), and by pawl, (64.2). Lever, (63.1), actuates the auxiliary switch, through the linkage, (68.1).

The crank, (62.2), on the charging shaft moves the linkage, (55.1), by acting on the control lever, (55.2). The "Closing spring charged" indication is thus cancelled and, the limit switches, (50.4), switch in the control supply to cause the closing spring to recharge immediately.

Trip Free Operation

The trip free coupling rod, (62.8) permits the immediate decoupling of the drive lever (62.6) and breaker shaft, (63) to override closing action by trip command or by means of the racking interlocks.

The trip free coupling rod (62.8) forms a link between the drive lever (62.6) and breaker shaft (63). The rigidity of this link depends upon a spring return latch carried within the coupling rod. The latch is pivotable within the coupling rod and is normally positioned to ensure the couplers rigidity. Trip Free Coupling Link (62.8.2) and Trip Free Coupling lever (62.8.3) cause the spring return latch position to be dependent upon the breakers normal tripping components and the breaker's racking interlock. Thus, whenever a trip command is applied or the breaker is not in the fully "connected" or test position, the trip free coupling rod is no longer rigid, effectively decoupling the drive lever and breaker shaft. Under these conditions the breaker main contacts can not be closed.

48. Insulated coupler
50.4.1 Limit switch
54. Trip Button
62.8 Trip Free Coupling Rod
62.8.1 Spring Return Latch
62.8.2 Trip Free Coupling Link
62.8.3 Trip Free Coupling Lever
63 Breaker shaft
63.1 Lever
63.5 Lever
63.7 Lever
64.2 Pawl
64.3 Lever (Lobes are omitted when applied with screw type backing)
64.3.1 Pawl roller
68.1 Linkage

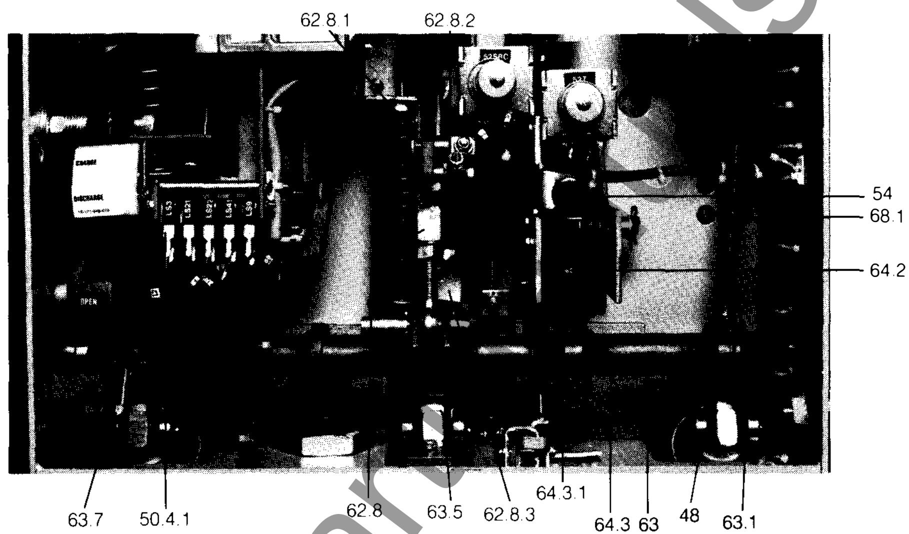


Figure 12
View of Mechanism Breaker Shaft in Open Position

Opening

If the breaker is to be tripped locally, the tripping spring (64) is released by pressing the trip button, (54). In the case of an electrical command being given, the shunt trip coil 52T, (54.1), unlatches the tripping spring (64).

The tripping spring turns the breaker shaft, (63), via lever, (63.5), the sequence being similar to that for closing.

Rapid Auto-Reclosing

Since the closing spring is automatically recharged by the motor operating mechanism when the breaker has closed the operating mechanism is capable of an open-close-open duty cycle as required for rapid auto-reclosing.

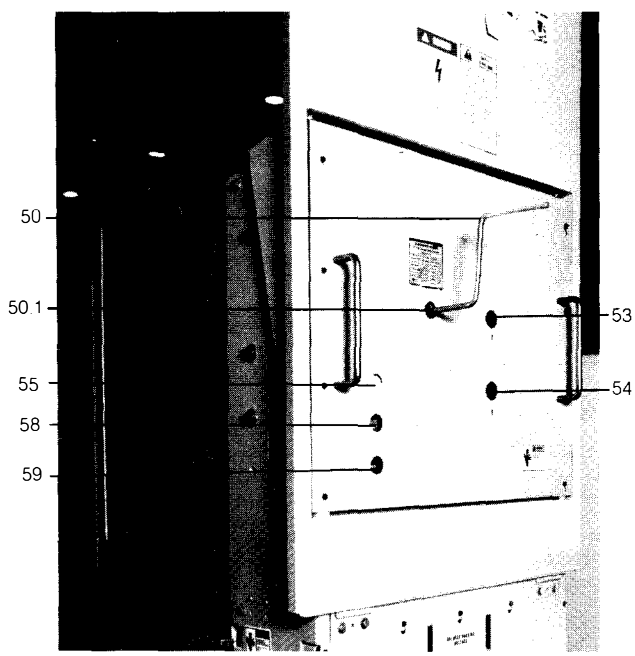
Manual Operation

Electrically operated vacuum circuit breakers can be operated manually if the control supply should fall.

Manually Charging the Closing Spring (Fig. 13)

Insert the hand-crank, (50), in hole, (50.1), and turn it clockwise until the indicator, (55), shows "CHARGED".

The hand-crank is coupled with the charging mechanism via an overruning coupling thus, the operator is not exposed to any risk should the control supply recover during charging.



50 Hand crank
50.1 Opening for hand-crank
53 Close button
54 Trip button
55 "Closing spring charged" Indicator
58 Open-Closed
59 Operations Counter

Figure 13
Front View of Mechanism Enclosure Arranged for Manual Operation

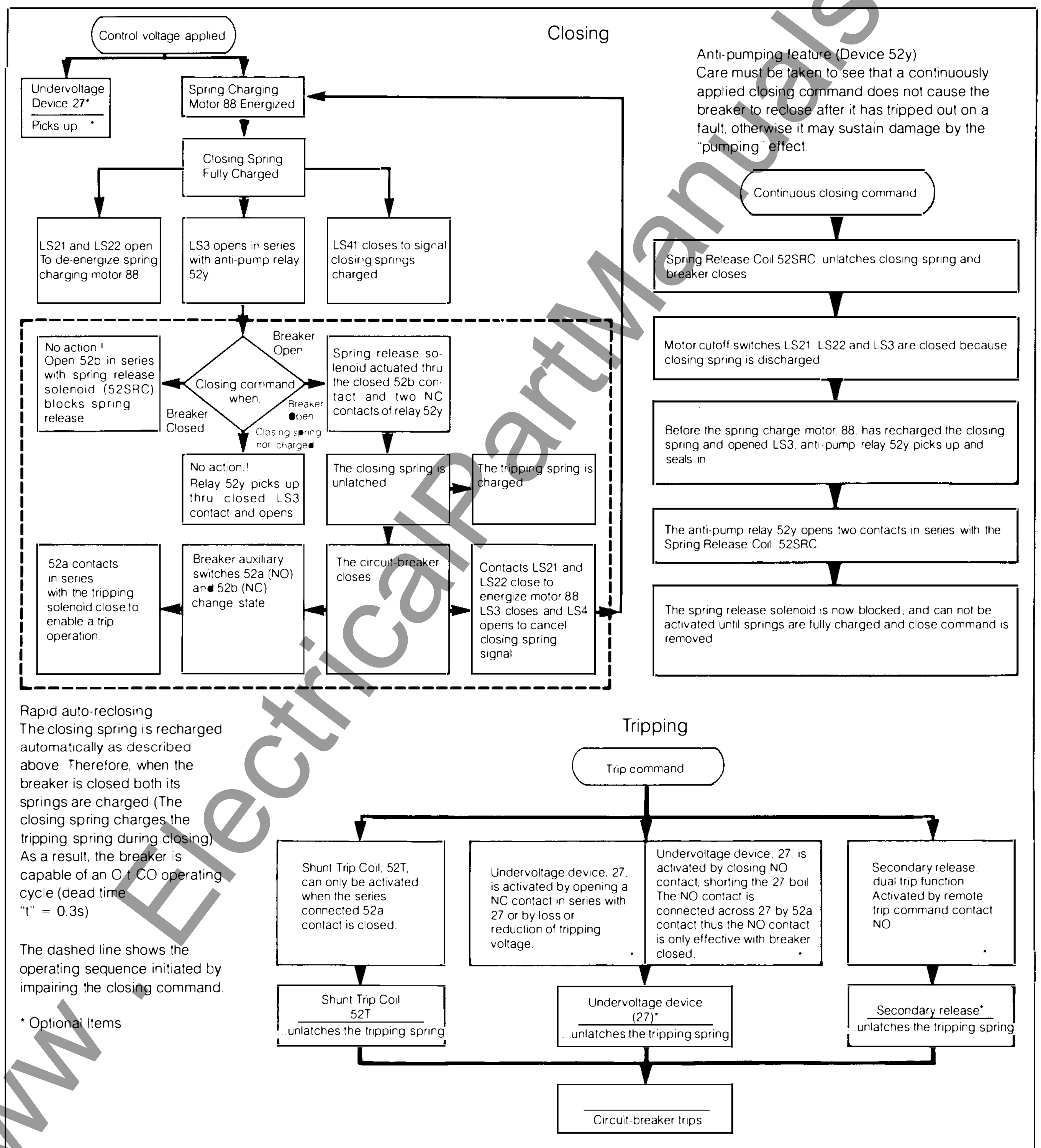


Figure 14 Operator Sequential Operation Diagram

Elementary Diagram

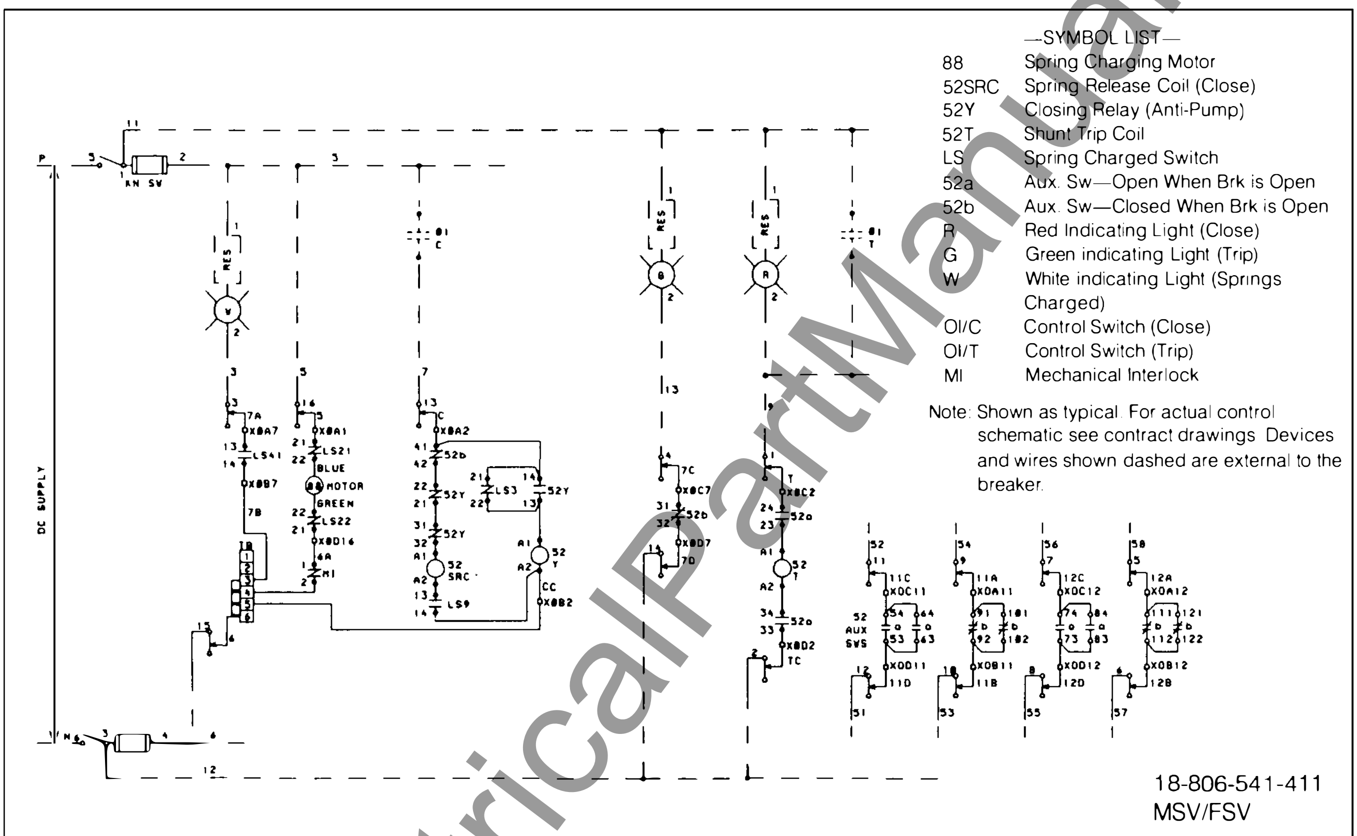


Figure 15.
Typical Elementary Diagram

Manual Closing

Press the close button, (53). The close-open indicator, (58), will then display "closed" and the closing spring condition indicator will now read "DISCHARGED".

Manual Opening

The tripping spring is charged during closing.
To open the breaker, press the trip button, (54), and "OPEN" will be displayed by indicator, (58)

Indirect Releases (Dual Trip and Undervoltage)

The indirect release provides for the conversion of modest control signals into powerful mechanical energy impulses. It is primarily used to trip high voltage circuit breakers while functioning as a secondary (dual trip) release or undervoltage release device.

These releases are mechanical energy storage devices. Their internal springs are charged as a consequence of the breakers mechanism operating, and are released upon application or removal of applicable control voltages.

Refer to Figures 16, 16a, 16b, & 16c

Secondary Release

Shunt releases (two trip coils) are used for the automatic or manual tripping of the circuit breaker by suitable protective relays or manual control devices when more than one is required. They are generally intended for connection to a separate auxiliary supply (DC or AC)

Undervoltage Release

The undervoltage release is used for continuous monitoring of the tripping supply voltage. If this supply voltage falls excessively, the undervoltage release will provide for automatic tripping of the breaker.

The undervoltage device may be used for manual or relay tripping by employing a contact in series with undervoltage device holding coil. Relay tripping may also be achieved by employing a normally open contact in parallel with the holding coil. A resistor must be provided to limit current when the normally open contact is closed.

Secondary and undervoltage releases are available for all standard ANSI Control Voltages.

Construction and Mode of Operation

The release consists of a spring-power storing mechanism, a latching device and an electromagnet. These elements are accommodated side by side in a housing, (16-3) with a detachable cover and three through holes, (16-5), for fastening screws. The supply leads for the trip coil are connected to a terminal block, (16-33). Two lugs, (16-17), are fitted beside the tripping pin, (16-15), for the attachment of a manual tripping lever.

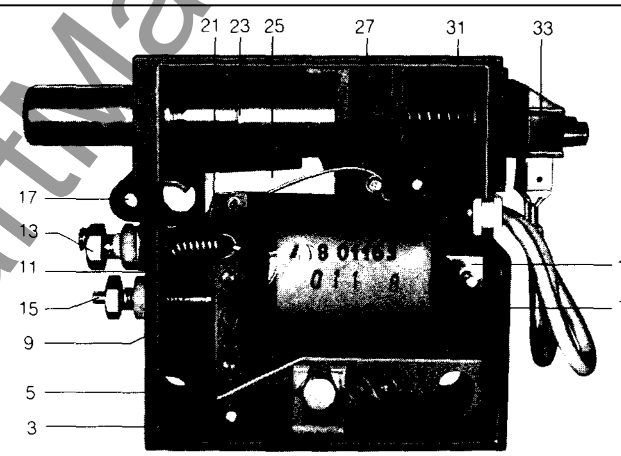
The energy-storing mechanism consists of the striker pin, (16-23), and its operating spring, (16-31), which is mostly located inside the striker pin (16-23). When the spring is compressed, the striker pin is held by a latch, (16-25), whose sloping face is forced against the appropriately shaped striker pin, (16-23), by spring, (16-27). The other end of the latch, (16-25), is supported by a partly milled locking pin, (16-21), (16a) pivoted in the cover sheets of the magnet armature, (16-9). The armature, (16-9), is pivoted in front of the poles of the U-shaped magnet core, (16-1), and is pulled away from it by the tension spring, (16-11)

If the magnet coil of the shunt release 3AX1101 is energized by the tripping impulses or if the tripping pin, (16-15), is mechanically actuated, magnet armature, (16-9), is swung against the pole faces. When this happens, the latch, (16-25), loses its support and releases the striker pin, (16-23), which is forced out by the spring, (16-31).

On the undervoltage release 3AX1103 the latch, 25, is held by the locking pin, (16-21), as long as the armature, (16-9), is attracted, (Fig. 16b). If the circuit of the trip coil, (16-7), is interrupted, the armature, (16-9), drops off, thus causing the latch, (16-25), to lose its support and release the striker pin, (16-23).

Following every tripping operation the striker pin. (16-23). must be reset to its normal position by loading the spring. (16-31). This takes place automatically via the operating mechanism of the circuit breaker.

Since the striker pin of the undervoltage release 3AX1103 is latched only when the armature is attracted, this trip is fitted with a screw, (16-29) (see 16c), for locking the striker pin, (16-23), in the normal position for adjusting purposes or for carrying out trial operations during breaker servicing



1	Magnet core	15	Tripping pin
3	Housing	17	Lug for lever
5	Through-hold for mounting screws	21	Locking pin
		23	Striker pin
7	Magnet coil	25	Latch
9	Magnet armature	27	Spring
11	Extension spring	31	Striker pin spring
13	Adjusting screw for 11	33	Terminal block

Figure 16 Construction of Shunt Release Shown Released

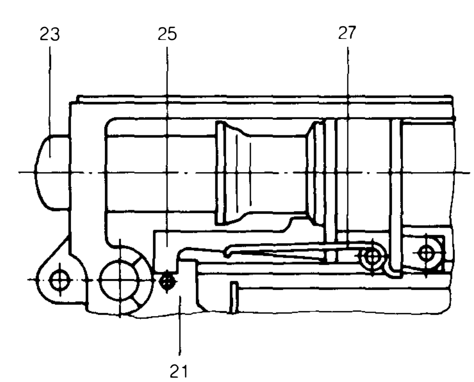


Figure 16a. Latch Detail (16-25) Shunt Release Shown Charged

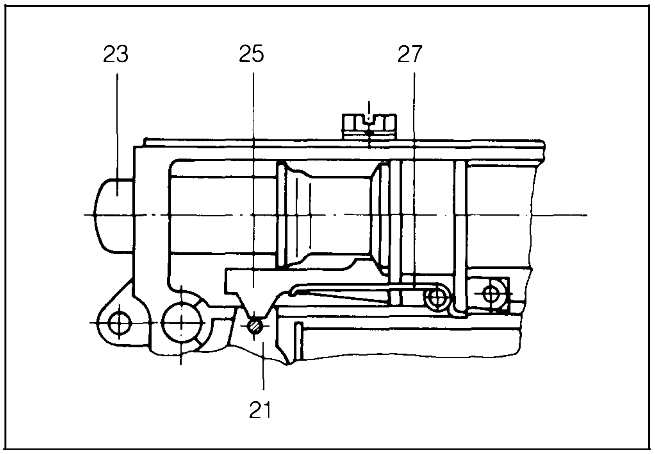


Figure 16b. Latch Detail (25)-Undervoltage Release Shown Charged

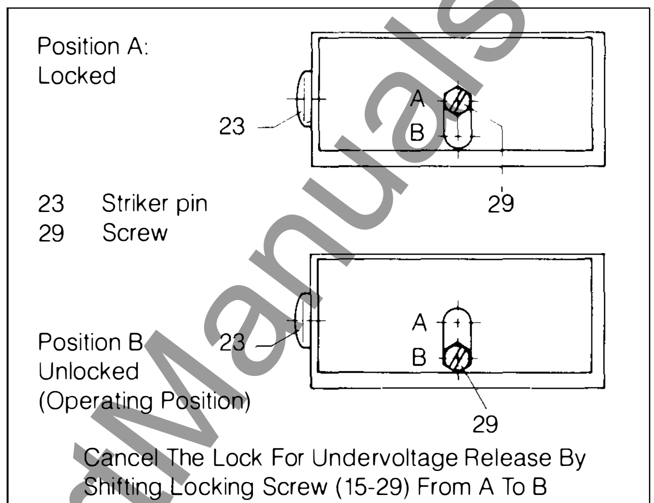


Figure 16c. Undervoltage Blocking Feature

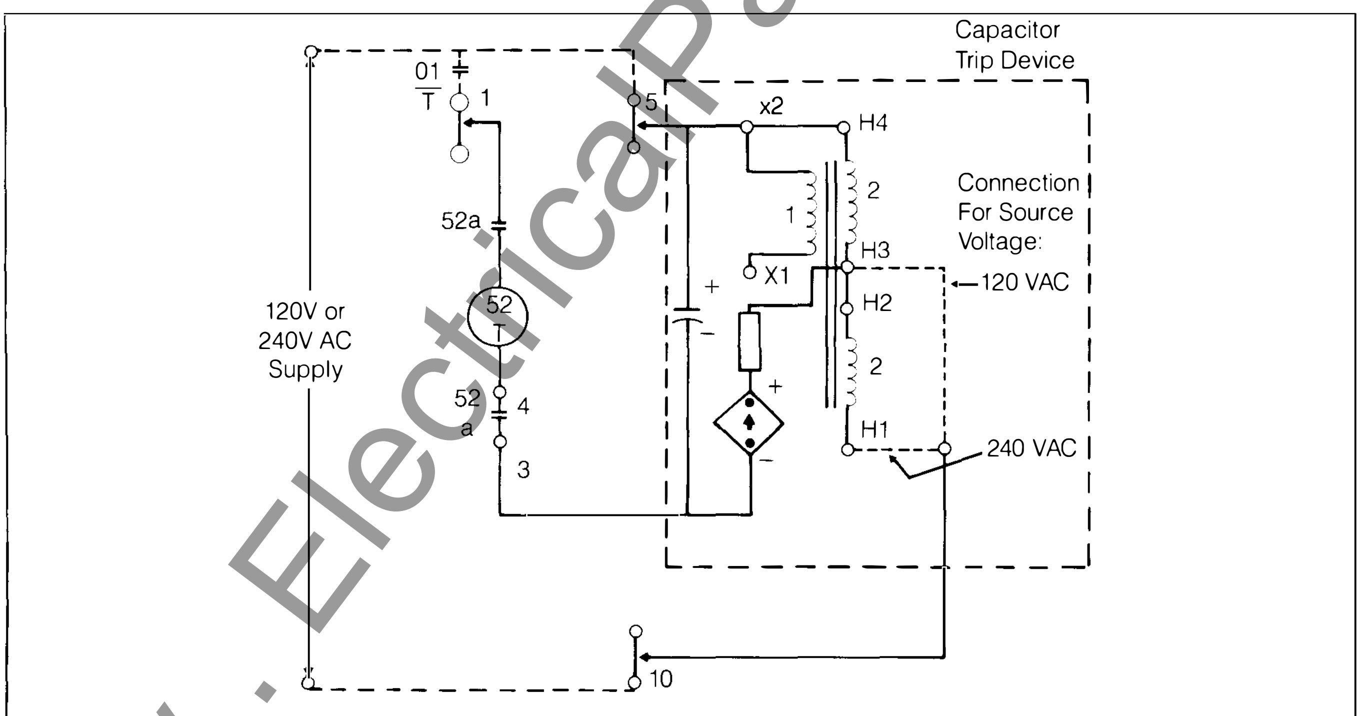


Figure 17. Capacitor Trip Device

Capacitor Trip Device

The capacitor trip device is an auxiliary tripping option providing a short term means of storing adequate electrical energy to ensure breaker tripping.

This device is applied in breaker installations lacking independent auxiliary control power or station battery. In such installations, control power is usually derived from the primary source. In the event of a primary source fault, or disturbance with attendant depression of the primary source voltage, the capacitor trip device will provide short term tripping energy for breaker opening due to relay operation.

The capacitor trip converts 120 or 240 VAC control voltage to a DC full wave voltage which is used to charge a large capacitor to the peak of the converted wave, see below.

General

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

FAILURE TO PROPERLY MAINTAIN THE EQUIPMENT CAN RESULT IN SEVERE PERSONAL INJURY AND PRODUCT FAILURE. THE INSTRUCTIONS CONTAINED HEREIN SHOULD BE CAREFULLY REVIEWED, UNDERSTOOD AND FOLLOWED. THE FOLLOWING MAINTENANCE PROCEDURES SHOULD BE PERFORMED REGULARLY:

- General visual inspection of de-energized circuit breaker.
- Keep mechanism clean and adequately lubricated.
- Keep insulation materials dry and clean.
- Keep connectors in place and properly adjusted
- Repair or replace any items functioning improperly.
- Check circuit breaker for smooth and correct operation before returning to service.

Once a year, a general visual inspection should be performed on de-energized breakers, and if necessary the exposed insulating parts wiped with a rag.

Where the application imposes dusty or other severe ambient condition and/or frequent switching operations the following inspection checks should be more frequently applied than for normal maintenance.

THESE INSTRUCTIONS DO NOT REPRESENT AN EXHAUSTIVE SURVEY OF MAINTENANCE STEPS NECESSARY TO ENSURE SAFE OPERATIONS OF THE EQUIPMENT. PARTICULAR APPLICATIONS MAY REQUIRE FURTHER PROCEDURES. SHOULD FURTHER INFORMATION BE DESIRED OR SHOULD PARTICULAR PROBLEMS ARISE WHICH ARE NOT COVERED SUFFICIENTLY FOR THE PURCHASER'S PURPOSES, THE MATTER SHOULD BE REFERRED TO THE LOCAL SIEMENS OFFICE.

THE USE OF UNAUTHORIZED PARTS IN THE REPAIR OF THE EQUIPMENT OR TAMPERING BY UNQUALIFIED PERSONNEL, WILL RESULT IN DANGEROUS CONDITIONS WHICH CAN CAUSE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE. FOLLOW ALL SAFETY INSTRUCTIONS CONTAINED HEREIN.

WARNING

Hazardous voltages and high speed mechanical parts can cause death or severe personal injury and property damage.

Read instruction manual, observe safety instructions and limit use to qualified personnel.

Inspection Check List

1. Check vacuum, procedure follows.
2. Check contact erosion, procedure follows.
3. Clean circuit breaker, especially post insulators and insulating couplers.
4. Lubricate all bearings and sliding surfaces, procedure and materials follow.
5. Check all terminal screws.
6. Check all screw connections and locking devices on mechanism parts.
7. Check all control cables and connections.
8. Perform functional test of circuit breaker.

Hand Tools Recommended

The MSV and FSV breakers employ both English and Metric fasteners. Metric fasteners are confined to the circuit breaker subassembly. The supporting draw-out vehicle uses English sizes. The following tool list has been prepared primarily to identify the tool requirements.

General
- Screw Drivers, 0.032 x l/4 and 0.055 x 7/16
- Pliers
- Light Hammer
- Drift Pin, 1/8, 3/16, 1/4
- Retaining Ring Plier; External Type Tip Diameter 0.040"
- Inspection Mirror
- Flashlight

Metric
- 7mm, 8mm, 9.5mm, 10mm, 11.0mm, 13mm, 17mm, 19mm, 24mm Socket and Open-End Wrench
- 2mm, 5mm, 6mm, 8mm, 10mm Hex Key
- Torque Wrench, 0-150Nm (0-100 lb ft)

English
- 3/16", 1/4 Hex Key
- 5/16", 3/8", 7/16", 1/2", 9/16", 3/4", 7/8" Socket and Open End Wrench

Minimum Maintenance Schedule

Lubrication:

The operating mechanism should be oiled and lubricated at least every 10 years or 10,000* make break operations under 'usual' operating conditions as defined by A.N.S.I. per the instructions which follow.

Overhaul:

Before 30,000* operations the breaker should be maintained in accordance with the following recommendations and the following components replaced:

A) Vacuum Interrupters
B) Spring Release Coil, 52SRC
C) Shunt Trip Coil, 52T
D) Trip Free Drive Bar Mechanism

When these parts are changed, locking devices must also be removed and replaced. These include lock-washers, retaining rings, retaining clips, spring pins, cotter pins, etc.

DANGER

Hazardous voltages and high speed mechanical parts will cause death, personal injury and property damage.

Read instruction manual, work only on an electrically isolated breaker whose energy storage devices have been fully discharged. Limit work to fully qualified personnel.

1. Replace Vacuum Interrupter, instructions follow.
2. Spring Release Coil, 52SRC, and Shunt Trip Coil, 52T.
   • Remove two "push on" terminal connections.
   • Remove two M4 hex head screws and dismount solenoid drawing it towards you.
   • Install replacement solenoids with two M4 hex head screws and replace "push on" terminals.
3. Lubricate operating mechanism in accordance with instructions which follow.
4. When work is finished operate circuit breaker, close open, several times, and check that all screw connections are tight.

Lubrication of the Operating Mechanism

WARNING

Hazardous voltages and high speed mechanical parts can cause death, personal injury and property damage.

Before starting any work, breaker should be isolated, short circuited and grounded. Control power should be disconnected and breaker closed and opened by hand until both springs have been discharged.

The main points to be lubricated with grease (bearings and sliding surfaces) are indicated in Fig. 18. All the points not marked (bearings, articulated joints and auxiliary switch) should be treated with light machine oil with rust inhibitor.

To relubricate the mechanism remove the cover. Lubricate all the approximate points starting at the top left and working through systematically. Parts that are not rigidly fixed (e.g. articulated joints) should be moved slightly to and fro to let the oil penetrate. Following this, operate the breaker several times to test it.

Articulated joints and bearings that cannot be dismantled should not be cleaned with a cleaning agent prior to being oiled.

Lubricating Materials:

Bearings and Sliding Surfaces

Beacon 325, Humble Oil and Refining Co., Or
15-337-131-001
Centoplex 24.DL, Klueber Lubrication Corp.
Grenier Industrial Park, Manchester, N.H. 03103

Pivots and Articulated Joints, Auxiliary Switches, etc.

Tectyl 910 Valvoline Oil Co., Division of Ashland Oil Inc.
Ashland Dr., Ashland, Ky. 41101

See Vehicle Lubrication Section for Additional Information

*Perform lubrication at 3,000 operations and overhaul at 10,000 operations for type 5-FSV-350 and 15-FSV-1000 circuit breakers.

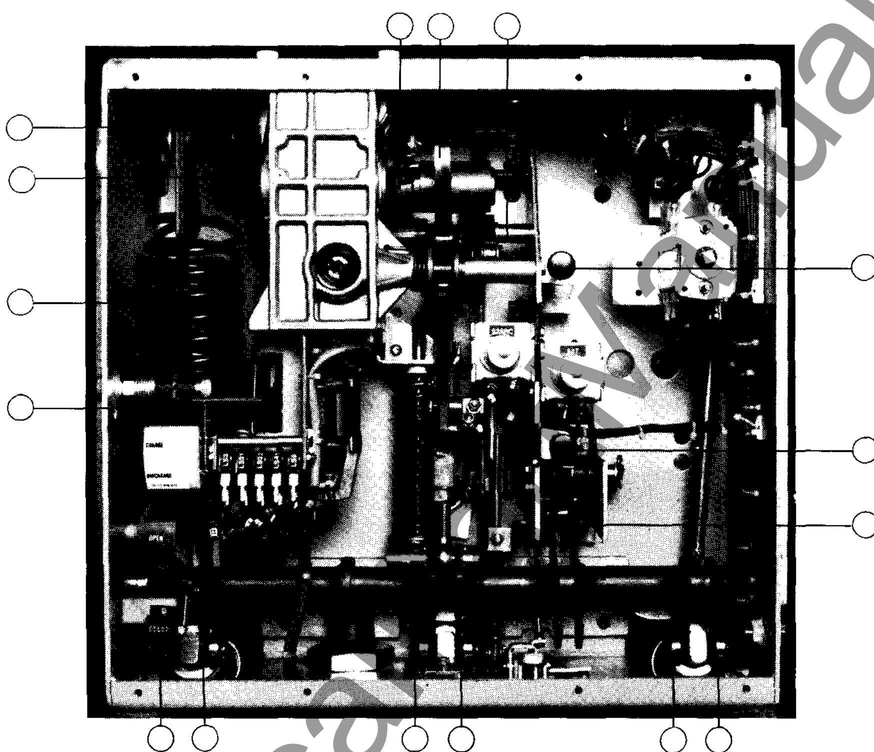


Figure 18
Lubrication of Operator

Vacuum Interrupters

The life expectancy of vacuum interrupters is a function of the number of interruptions and magnitude of current interrupted

Life = Interruptions x Current

They must also be replaced before 30,000* mechanical operations or when the contacts have been eroded beyond allowed limits. Vacuum tube replacement procedures are detailed in the following maintenance instructions.

The curves in figure 19 are offered as a guide to life expectancy.

*Perform lubrication at 3,000 operations and overhaul at 10,000 operations for type 5-FSV-350 and 15-FSV-1000 circuit breakers

Rated Max. Volts, kV	4.76	8.25		15.0		
Rated Short-Circuit Current, kA	**29**	**41**	**33**	**18**	**28**	**37**
Rated Continuous Current, A						
1200	a	b	c	d	e	f
2000	a	b	c	d	e	f
3000	-	b	c	-	e	f

Applicable Curve a Function of Breaker Rating

Contact Erosion

Contact erosion is checked by visually observing an "erosion mark" on the exposed movable contact stem of the interrupter, see Figure 20. Note the mark is a white dot.

This mark may be seen above the lower primary connection, and just above the terminal clamp which fastens the flexible connector to the movable stem of the vacuum tube.

The MSV and FSV breaker constructions will require a mechanics mirror and flash light to view the erosion mark.

The criteria of acceptance is that as long as the white erosion mark or any part of it can be seen with the breaker closed, contact wear is within permissible limits.

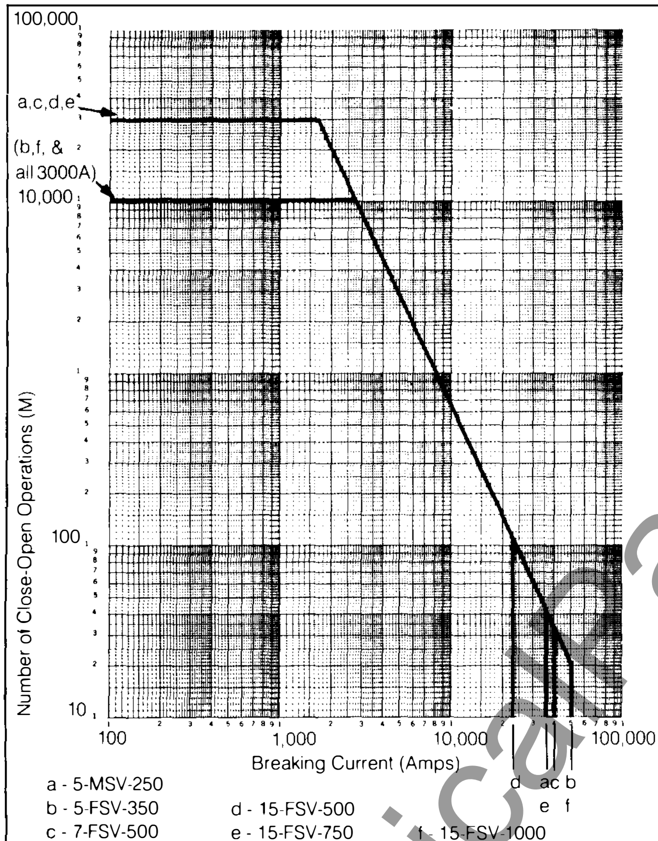


Figure 19
Typical Primary Interrupter Contact Life Curve

Interrupter Vacuum Check Mechanical

(Ref. figs. 21a, 21b, & 21c)

Before putting the breaker into service, or if an interrupter is suspected of leaking as a result of mechanical damage, check the vacuum either mechanically as described in this section or alternatively electrically using a high potential test set as described in the next section.

Open and isolate the breaker and detach the insulated coupler, 48, from lever, 48.6, Fig. 21a.

The atmospheric pressure will force the moving contact of a hermetically sealed interrupter into the "Closed" position, causing lever, 48.6, to move into the position shown in Fig. 21b.

A vacuum interrupter may be assumed to be intact if it shows the following characteristics:

An appreciable closing force has to be overcome when lever, 48.6, is moved to the "OPEN" position by hand, Fig. 21c. When the lever is released, it must automatically return to the "CLOSED" position with an audible sound as the contacts touch.

After checking the vacuum, reconnect the lever, 48.6, to the insulated coupler 48.

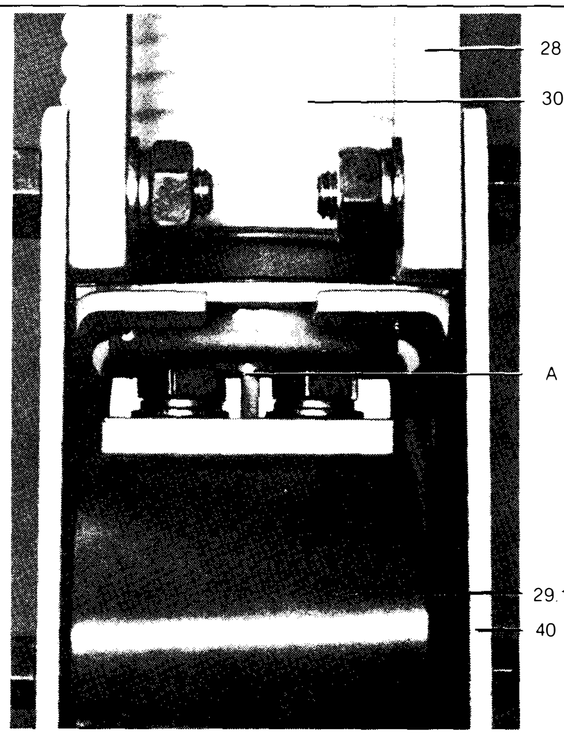
High Potential Testing and Electrical Interrupter Vacuum Check

High Potential tests are performed to affirm the breakers dielectric integrity, and to establish by alternate means of checking the interrupters vacuum.

The primary insulation system of the circuit breaker may be checked by closing the breaker, and applying the voltages listed below between a primary conductor of each pole and ground.

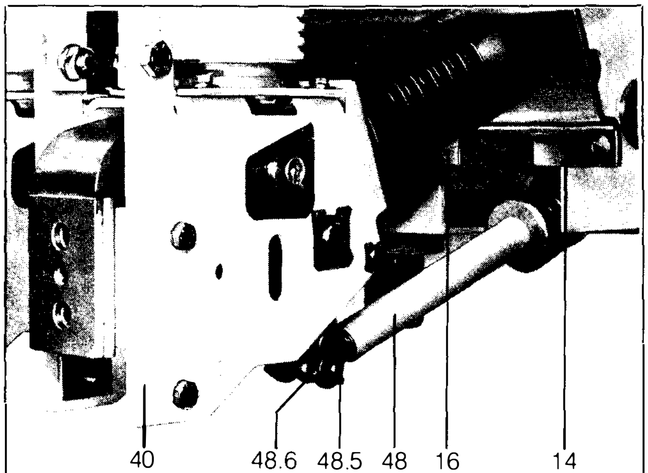
Prior to applying the test voltage, each pole not under test shall be grounded. Apply test voltage for one minute. If no disruptive discharge occurs which permanently reduces the test voltage to zero, the primary insulation system is acceptable.

Interrupter vacuum may be checked by applying the test voltages listed below across each interrupter with the breaker



28	Strut	40.	Lower pole support
29.1	Flexible Connector	A	Check mark
30.	Vacuum interrupter		

Figure 20
Contact Erosion Check



14	Cross Arm	48.5	Pin
16	Post Insulator	48.6	Lever
40	Lower pole support	48	Insulated Coupler

Figure 21a Lower Pole Support With Insulated Coupler

open. Test voltage should be raised gradually, and the contact gap must sustain the voltages listed below, appropriate for the breakers rating, for one minute. If it does not, the interrupter is faulty and must be replaced.

Breaker Max. KV	A.C. Potential	D.C. Potential
5 kV	14 kV	20
15 kV	27 kV	38

CAUTION

HIGH PEAK VOLTAGES CAN RESULT IN ERRONEOUS TEST RESULTS & X-RADIATION CAUSING PERSONAL INJURY.

DC high potential test voltage sources using half-wave conversion will apply peak voltages 3 times greater than the measured averge DC voltage. Repetitive application of high peak voltage can result in erroneous test results & X-Radiation causing personal injury.

Do not use DC high potential voltage sources which employ half-wave conversion circuits.

DANGER

High Potential Tests employ extremely hazardous voltages which will cause severe personal injury and death.

Follow safe procedure, exclude unnecessary personnel, barrier test vehicle and keep well away from breaker during test voltage application. After test, ground ends and middle of vacuum tube to remove static charge.

CAUTION

Vacuum Interrupters can emit X-Radiation causing personal injury.

Do not apply test voltages to the interrupters which exceed the values listed below. All personnel must remain a minimum of six feet away from interrupter under test.

Vacuum Tube Replacement

Replacement interrupters are furnished as a complete assembly. They have been completely tested and dielectrically and mechanically conditioned. The interrupters, when installed, do not require that they be operated no-load a set number of times or voltage tested to condition the contacts

It is recommended that one interrupter be removed and replaced completely rather than removing two or more interrupters at a time. The following procedure in check list format describes the procedure for removing and replacing a vacuum interrupter. Components may be identified by reference to figure 6, 7, 8, 22 & 23.

1. Removing The Interrupter

1.1 Before starting work, the circuit breaker should be isolated from all primary and control power sources and all stored energy discharged by tripping, closing, and tripping the breaker by hand. Discharge any static charge by grounding all and center metal sections of the vacuum interrupter. Carefully remove exterior and interphase barriers.

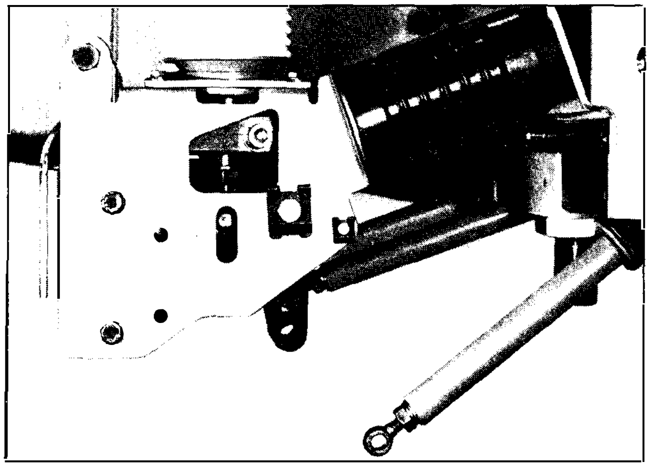


Fig. 21b Primary Contact Closed - Free Position

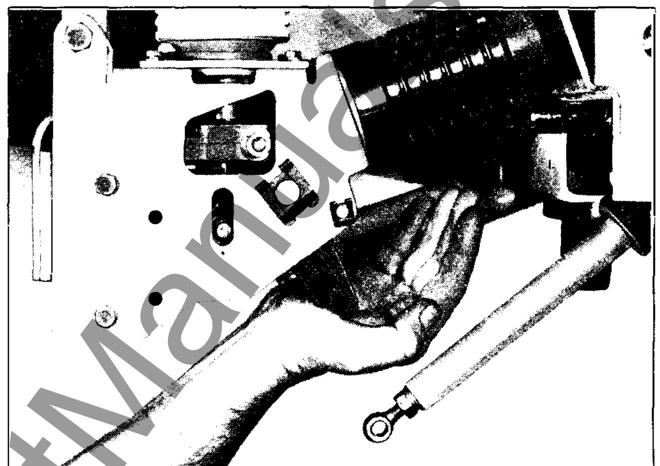
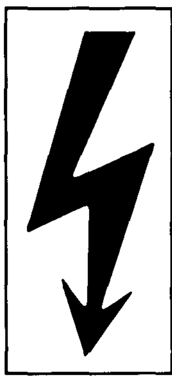


Fig. 21c Primary Contact Forced Open by Manual Pressure



WARNING

Hazardous voltages and high speed mechanical parts can cause death, personal injury and property damage.

Before starting any work, breaker should be isolated, short circuited and grounded. Control power should be disconnected and breaker closed and opened by hand until both springs have been discharged.

1.2 Loosen the lateral bolt(s) on terminal clamp. 29.2. Refer to figure 23 and employ the illustrated procedure to loosen clamp hardware. (8mm hex allen and 17mm socket)

1.3 Withdraw pin, 48.5, from insulating coupler, 48, and levers, 48.6.

1.4 Remove coupling pin from the eye bolt, 36.3.

1.5 Free struts, 28, from the upper pole support, 20. Loosen the strut hardware on the lower support, 40, and swing the struts forward and downward. (17mm open end and 17mm socket)
NOTE: Some breakers may employ four struts. The additional struts should also be freed from the upper pole support, loosened at the lower pole support and swung the struts rearward and downward.

1.6 Loosen screws fastening the centering ring, 28.1. (10mm open end)

1.7 Remove bolt "B", lockwasher and large washer at stationary contact of the vacuum interrupter. (24mm socket) Carefully note location of conductive spacers between interrupter and pole support, if included.

1.8 Using a deep 24 mm socket loosen and remove hex capscrew fastening the upper pole support to the post insulator. Completely remove the upper pole support and set aside.

1.9 Grasp the vacuum interrupter and withdraw vertically. Assistance may be required to work the terminal clamp off the movable stem of the tube. FORCIBLE TWISTING EFFORT IS NOT ALLOWED. If the terminal clamp cannot be easily removed, STOP!, check to be certain hardware is loose and the clamp is not bound.

2. Installing an Interrupter

NOTE

Replacement interrupter, 30, will be received from the factory with an eye bolt, 36.3, in place, adjusted and torqued to specific requirements. *DO NOT ALTER THE ADAPTER SETTING.*

2.1 Inspect all silver plated connection surfaces for cleanliness. Clean only with a cloth and solvent. Do not abraid.

2.2 Insert interrupter, 30, in the lower pole support, 40, with the evacuation nipple, P, fcing the mechanism housing. Slip terminal clamp, 29.2, into position on the movable stem.

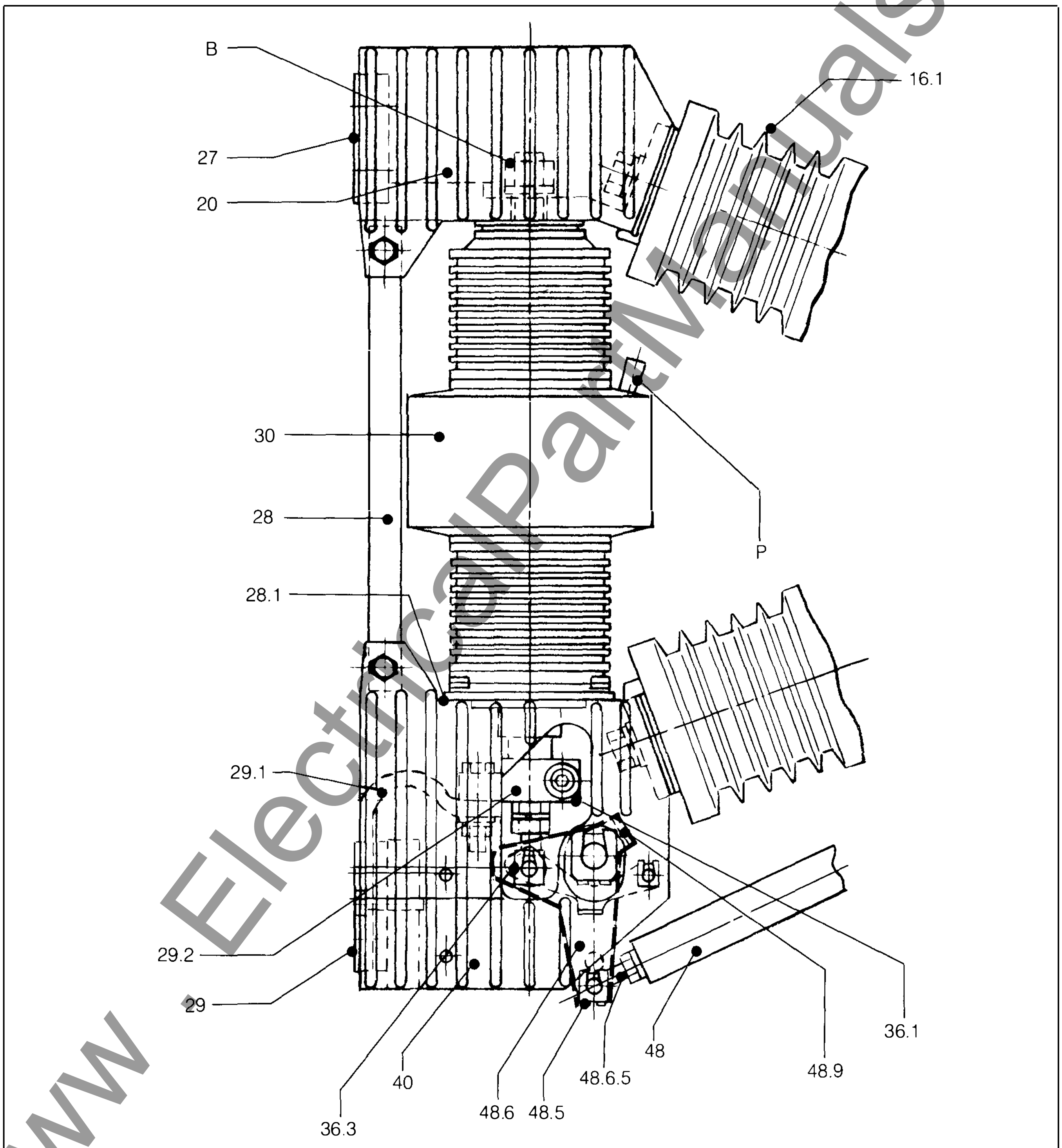


Figure 22
Vacuum Tube Replacement Illustration

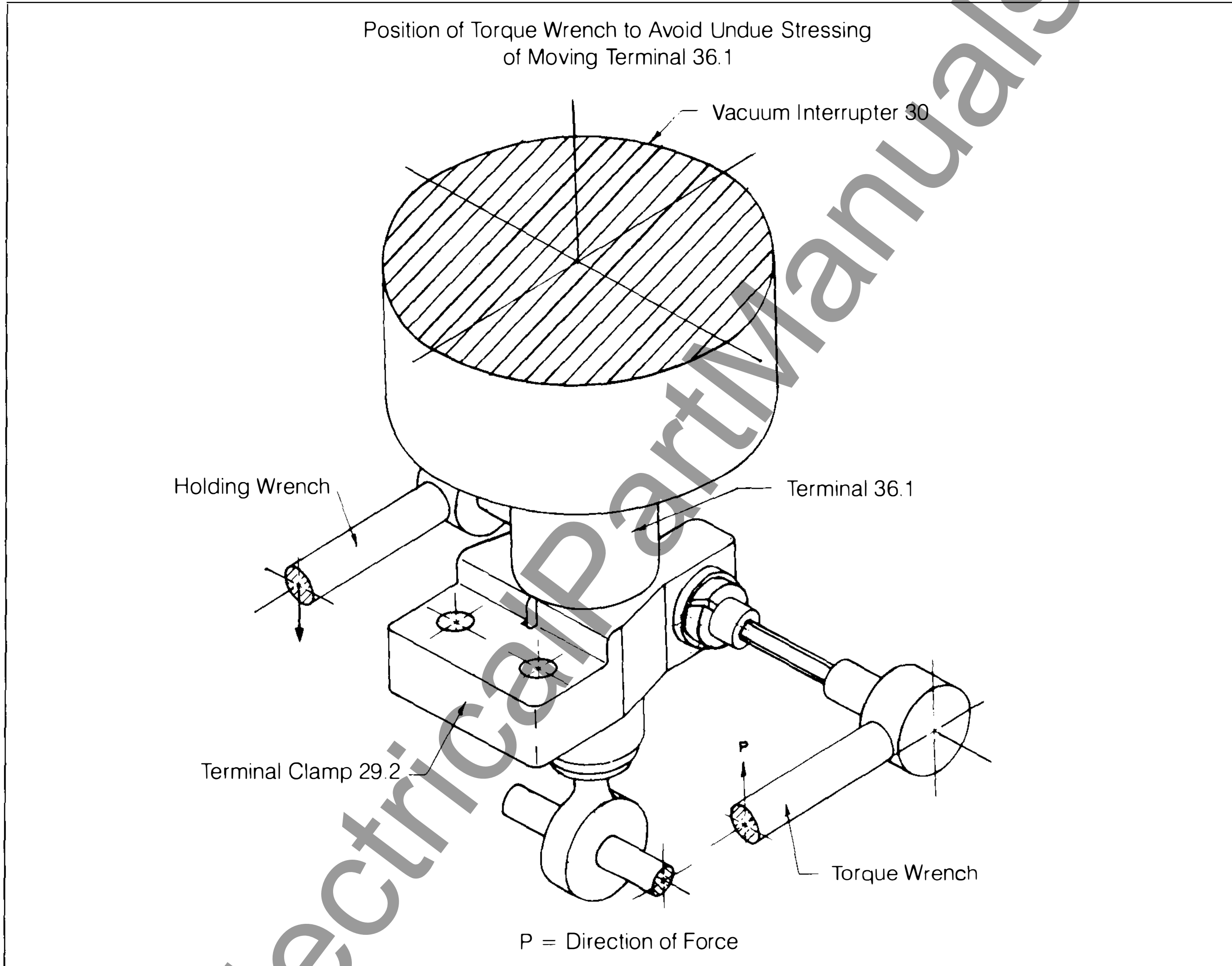


Figure 23
Illustration Showing Required Technique For Fastening Terminal Clamp Hardware

2.3 Restore any conductive spacers which may have been provided to span the space between tube and pole support. Locate the upper pole support and fasten "finger tight" using heavy flat washer, lockwasher and nut, 'B'.

2.4 Fasten the upper pole support to the post insulator using finger pressure only using hex head bolt, lock-washer and flat washer.

2.5 Attach struts, 28, to the upper pole support, 20. replace hardware, but do not tighten at this time.

2.6 Couple levers, 48.6, and drive link, 48.9 to the eye bolt, 36.3, using the pin supplied. Apply retention clips. Appropriate pin is modestly chamfered, not to be confused with pin for the insulated coupler.

2.7 Elevate terminal clamp, 29.2, against the locking ring on the movable terminal of the vacuum tube, 36.1 and position the interrupter 30, so that its groove faces the connecting surface of flexible strap 29.1. Refer to Figure 23 and employ technique illustrated to fasten terminal clamp. Note opposing wrenches. Tighten the bolt(s) of the terminal clamp to a torque of (30 Ft. Lbs.) 40 Nm, taking care to see that the terminal of the interrupter is not subjected to excessive bending movement.

NOTE:
Excessive bending movement exerted while fastening the terminal clamp will damage the vacuum interrupter.

2.8 Align pole support, 20, correctly and tighten bolt fastening it to the post insulator. Fasten securely all bolts associated with struts, 28

2.9 Tighten interrupter fastening bolt 'B' on the upper pole support, 20, holding the interrupter firmly by its upper insulator, and operate levers, 48.6, by hand to see whether the movable contact moves freely. If any binding or lack of freedom is noted, loosen bolt 'B' and adjust the interrupter in pole support by turning and moving it slightly.

2.10 Press centering ring segments firmly against base of tube, and fasten securely. On some breaker a one piece ring is used, and this is simply fastened in place.

2.11 Attach insulating coupler, 48, and lever, 48.6 together using pin 48.5. Apply retaining clips. Correct pin has ends which have been generously chamfered.

2.12 Open and close breaker several times, and then check to see that all bolted joints and devices are tight.

3 Checking the Contact Stroke

3.1 Open the circuit breaker.

3.2 Free insulating coupler, 48, by removing pin 48.5. The interrupter contacts must now close automatically as a consequence of atmospheric pressure.

3.3 Observe the terminal clamp, 29.2 thru the openings on each side of the lower pole support, 40. Using vernier calipers measure the distance from the bottom surface of the terminal clamp to the bottom edge of the cutout opening. Measure carefully, and record your result.

3.4 Connect the insulating coupler, 48, using pin, 48.5, and the retaining clips provided.

3.5 Repeat the measurement described in step 3.3 again with care to maximize accuracy, record your result.

3.6 Determine difference between the measurements made under steps 3.3 and 3.5. Your result should be:

Type 5-MSV-250 Breakers: 5 to 7mm (0.20 to 0.27 inches)

Type 7-FSV-500, 15-FSV-500, and 15-FSV-750 Breakers: 10 to 12mm (0.40 to 0.47 inches)

Type 5-FSV-350, 15-FSV-1000 and all 3000A breakers: 7.5 - 8.5mm (0.30 - 0.33 inches)

3.7 If you fail to achieve the listed results carefully repeat the entire procedure making certain of your measurements.

3.8 If, after confirming your measurements, and you find the stroke not in agreement with the values given above, an adjustment can be made by adjusting the eyebolt, 48.6.5.
- Excessive stroke is corrected by turning the eyebolt out.
- Insufficient stroke is corrected by turning the eyebolt in.

3.9 Loosen locking nut on eyebolt, on insulated coupler (48) and retain position of the eye. Make adjustments in one-half turn increments. After adjustment is completed, tighten eyebolt locking nut to 30 ± 4 lb. ft. (40 ± 5Nm).

4. After eyebolt is tightened to proper torque, repeat all measurement procedures making certain they are in agreement with values indicated in 3.6

5. Complete all other maintenance procedures. Completely reassembled breaker should pass high potential test before it is ready for service.

Hydraulic Shock Absorber

The 3AF mechanism is equipped with hydraulic shock absorber and a stop bar that functions when the breaker opens. See item 61.8 Figure 11. The shock absorber should require no adjustment. However, at maintenance checks, the shock absorber should be examined for evidence of leaking. If evidence of fluid leakage is found, the shock absorber must be replaced to prevent damage to the vacuum interrupter bellows.

Vehicle Function and Operational Interlocks

Type MSV and FSV vacuum circuit breakers are comprised mainly of the interrupter/operator sub-assembly fitted to a vehicle. This interrupter/operator sub-assembly is an integral arrangement of operating mechanism, dielectric system, vacuum interrupters, and means of connecting the primary circuit. The vehicle supports the interrupter/operator sub-assembly, providing mobility and fully coordinated application in Siemens type "D" and "F" switchgear.

Successful coordinated application of the fully assembled MSV or FSV vacuum breaker is achieved thru precise fixtured alignment, and important functional interlocking.

Alignment

Elements of the vehicle structure, which are assembled under fixture control and then are secured and pinned in place, include the following (no adjustments are required):

- Side channels which provide support to the interrupter/operator sub-assembly are fixtured square (90) to the wheel axle holes in the vehicles base.
- The primary circuit conductors are fixtured to appropriate elevation, phase spacing and alignment to the inside surface of the guide bar. The guide bar, is set in the fixture firmly secured and ten pinned in place.
- Secondary disconnects are fixtured and pinned in place
- Shutter cam which raises and lowers protective primary bushing barriers, is fixtured firmly secured and pinned.
- Breaker grounding contacts, are aligned and securely bolted in place.
- Closing spring discharge roller, is located and secured.
- The hinged protective barrier is aligned, adjusted vertically and then pinned in place.

Thus, all those features which must align with elements of the switchgear "draw out" enclosure, are precisely set, firmly secured and pinned while the complete breaker is located in a rigid fixture.

Interlocks

DANGER

Inoperative or by-passed interlocks will cause death, serious personal injury and property damage.

Mechanical and electrical interlocks are provided as integral components of this equipment to ensure safe use. Interlocks must be in operation at all times. Read this instruction manual. Know and understand correct interlock function. Check interlock function prior to inserting breaker into switchgear cubicle.

Breaker Racking Interlock (Lever Type)

Reference: Figures 24a & 24b

The racking interlock functions to block movement of the circuit breaker from the connected or test positions whenever the breaker is closed, and to maintain the breakers mechanism in a "trip free" state whenever the circuit breaker is "released"

- The breaker is *closed* whenever the primary circuit is completed through the vacuum interrupter contacts. This closed condition is caused by rotation of the breaker shaft, 63 to the position shown in figure 24b.
- The breaker is released (free to rack) when the plunger shown in figure 24a is elevated sufficiently to clear the slot in the cubicle rail.

Function of the closed breaker racking release is initiated by elevating the racking release handle. This action causes the interlock bell crank, 1, to attempt CCW rotation. If the breaker were closed, the bell crank will rotate incrementally causing the "push rod", 2, to rise thru the action of crank, 1, and link, 3. This action will be immediately blocked, because the push rods "mushroom" head will encounter a cam surface of lever 64.3 on the breaker shaft, 63, typically after 1 to 2mm (.040 to .080 inches) of motion. With motion blocked after this short movement, it is not possible to raise the plunger above the cubicle rail. **Thus, The Breaker Can Not Be Released For Racking When The Primary Contacts Are Closed.**

If the breakers primary contacts were open, the cam surface of lever 64.3 on the breaker shaft, 63 will have rotated beyond the push rods "mushroom" head allowing the push rod to rise freely.

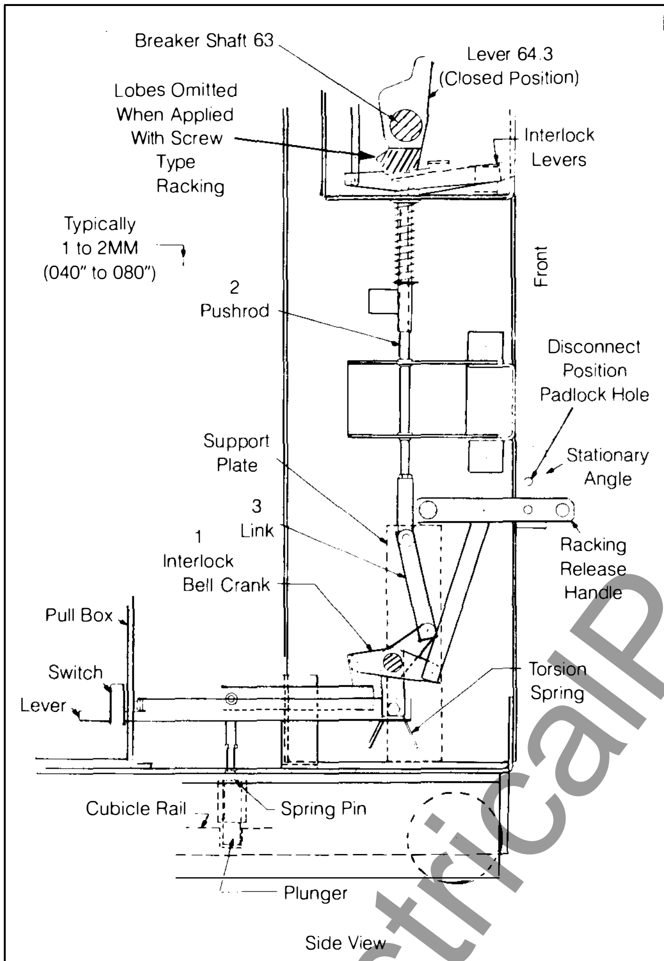


Figure 24a-1
Details of Closed Breaker Racking Interlock—Type FSV

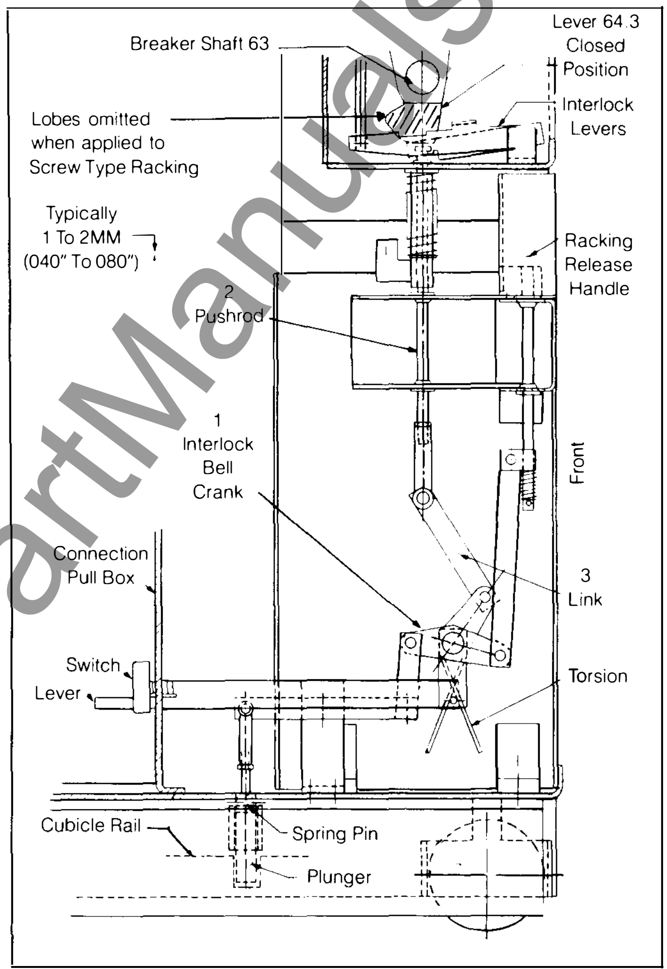


Figure 24a-2
Details of Closed Breaker Racking Interlock—Type MSV

As the push rod rises, its "mushroom" headed appendage, within the breakers mechanism enclosure, causes the "interlock" levers to rotate, elevating the "trip free push rod and cam". This cam encounters the "trip latch lever", and after typically 8 to 12mm (0.3 to 0.5 inches) of motion forces the mechanism, thru the "trip latch lever", to the "trip free" state.

Continued full CCW rotation of the interlock bell crank causes the plunger to clear the cubicle rail allowing the "open trip free breaker" to be moved from the connected position.

The lower interlock bell crank is returned to the plunger engaged position, fully clockwise, by the action of double torsion springs at each end of the bell crank. It is stopped and maintained in the position which ensures full plunger engagement by a spring pin of sufficient length at the top of the plunger which straddles the guide bar and guiding channel.

The breaker may be pad locked in an "open trip-free" state. Provision has been made for looping a padlock through the "racking release handle" and a stationary cover mounted angle. The position of the racking release handle at the point of padlock hole alignment ensures the breaker is trip-free yet the plunger engages the rail-preventing breaker movement.

Breaker Racking Interlock (Screw Type)

Reference: Figures 24a & 24b

The racking interlock functions to maintain the breakers mechanism in a "trip free" state whenever the circuit breaker is "released".

- The breaker is *closed* whenever the primary circuit is completed through the vacuum interrupter contacts. This closed condition is caused by rotation of the breaker shaft, 63 to the position shown in figure 24b.
- The breaker is released (free to rack) when the plunger shown in figure 24a is elevated sufficiently to clear the slot in the cubicle rail.

Function of the closed breaker racking release is initiated by elevating the racking release handle. This action causes the interlock bell crank, 1, to rotate CCW. The bell crank will rotate causing the "push rod", 2, to rise thru the action of crank, 1, and link, 3.

As the push rod rises, its "mushroom" headed appendage, within the breakers mechanism enclosure, causes the "interlock" levers to rotate, elevating the "trip free push rod and cam". This cam encounters the "trip latch lever", and after typically 8 to 12mm (0.3 to 0.5 inches) of motion forces the mechanism, thru the "trip latch lever", and coupled "trip latch" to an opened and "trip free" condition.

Continued full CCW rotation of the interlock bell crank causes the plunger to clear the cubicle rail allowing the "open trip free breaker" to be moved from the connected position.

The lower interlock bell crank is returned to the plunger engaged position, fully clockwise, by the action of double torsion springs at each end of the bell crank. It is stopped and maintained in the position which ensures full plunger engagement by a spring pin of sufficient length at the top of the plunger which straddles the guide bar and guiding channel.

The breaker may be pad locked in an "open trip-free" state. Provision has been made for looping a padlock through the "racking release handle" and a stationary cover mounted angle. The position of the racking release handle at the point of padlock hole alignment ensures the breaker is trip-free yet the plunger engages the rail preventing breaker movement.

Plunger Position Mechanical Interlock

In order to prevent the motor charging circuit from "making and breaking" as the breaker and cubicle secondaries make or break physical contact, an electrical switch is provided. This switch is mounted within the connection box, and is operated by a lever attached to a member on the interlock bell crank. The switch is adjusted to ensure the breakers charging circuit is made up before the racking plunger achieves full engagement. Typically, the plunger will be 51mm (2 inches) off the floor when this switch makes the circuit.

Automatic Closing Spring Release

Reference Figures 24a, 25a and 24b

The automatic closing spring release feature is provided to ensure all spring energy has been discharged in the mechanism prior to the breakers removal from the cubicle. The opening springs are discharged prior to the breakers release for racking, and since automatic closing spring discharge occurs while the breaker is trip free and its charging circuit is opened, we can be assured all spring energy has been released as the breaker exits the cubicle.

Reference to Figure 25b reveals the essential elements of this system. As the breaker exits the cubicle, the roller encounters an actuating angle in the floor of the cubicle. As the roller strikes the angle it must rise, and this change in elevation is amplified thru a lever and fulcrum arrangement located above the roller. Movement of the roller from a typical free height of 65mm (2 56 inches) to 74mm (2.91 inches) must produce approximately 20mm (0.75 inches) of vertical motion at the "spring dump tube"

Reference to Figure 24b shows the spring dump tube telescoping the trip free push rod, and thus, the spring dump tube is able to move against the mechanisms interlock levers independently of the trip free function. As the dump roller approaches the actuating angle the trip free rod will be elevated, holding the mechanism trip free. When the roller strikes the actuating angle, it overtakes the trip free push rod and moves beyond the trip free position. This action is allowed because the "mushroom" tip at the top of the trip push rod is not attached to this push rod, but simply "floats" above it, captured by the mechanisms interlocking levers.

The spring dump tube now more fully elevates the mechanisms trip push rod cam and closing spring release cam (each attached to the same push rod). The spring release cam contacts and displaces the close latch lever causing release of the closing springs into a trip free mechanism. Thus all spring energy is discharged as the breaker leaves the cubicle.

The spring dump roller must now overtravel the structural actuating angle, and not be allowed any further elevation. The spring dump push rod accommodates this overtravel by employing a number of collars and bellville washers. The upper most collar is fixed and provides a definite stop after approximately 22mm (0.88 inches) displacement. The additional motion of rollers and levers required to complete overtravel is allowed by compression of the bellville washers. The collar immediately above the bellville washers is fixed, and the one below free to slide.

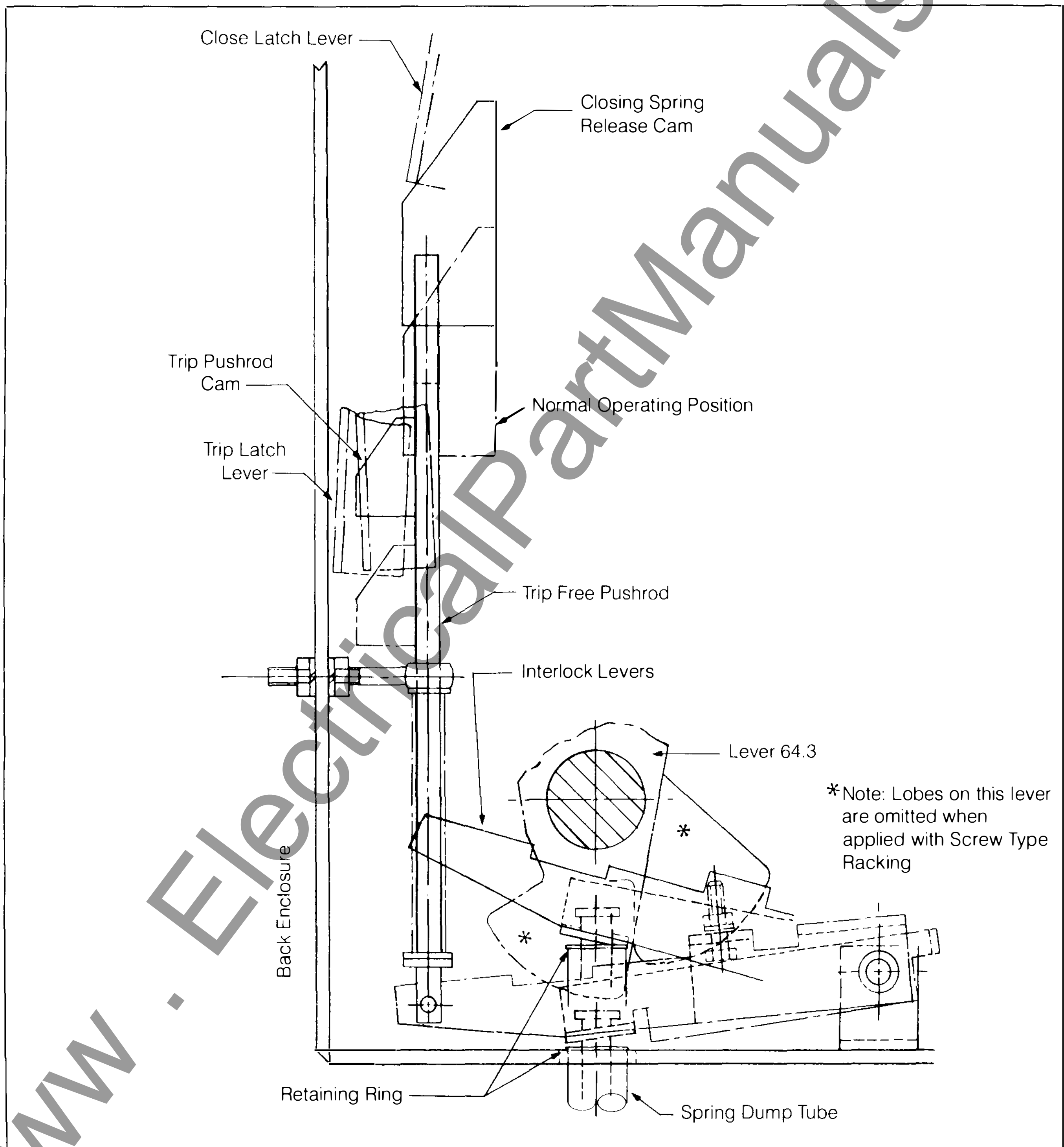


Figure 24b
Details of Closed Breaker Racking Interlock Internal to Mechanism Enclosure

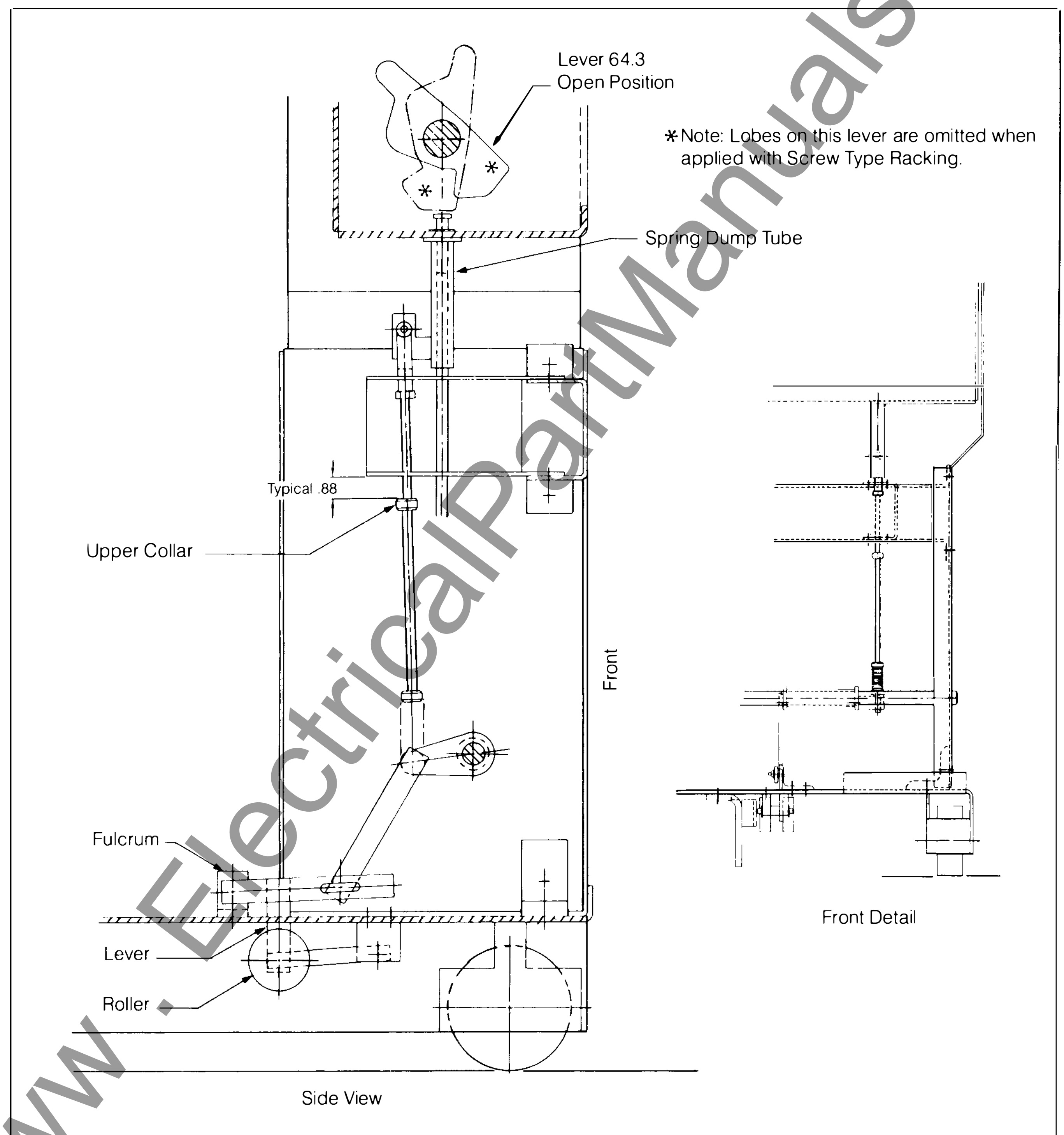


Figure 25a
Details of Automatic Closing Spring Discharge System — Type MSV

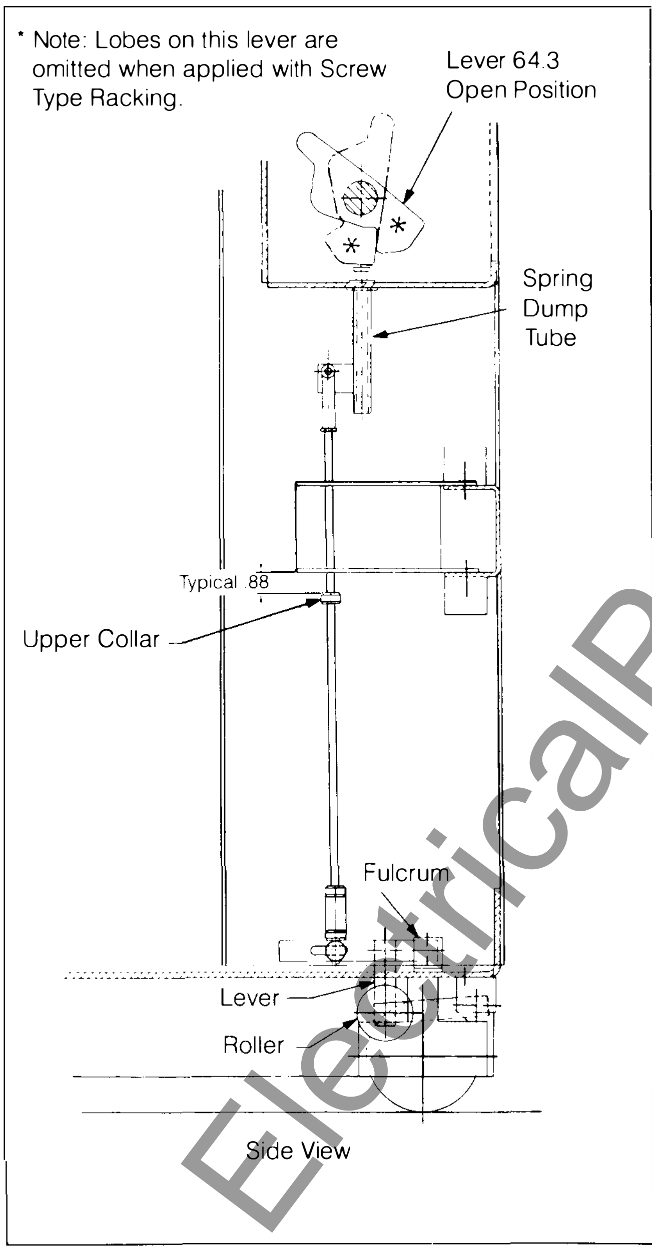


Figure 25b
Details of Automatic Closing Spring Discharge System — Type FSV

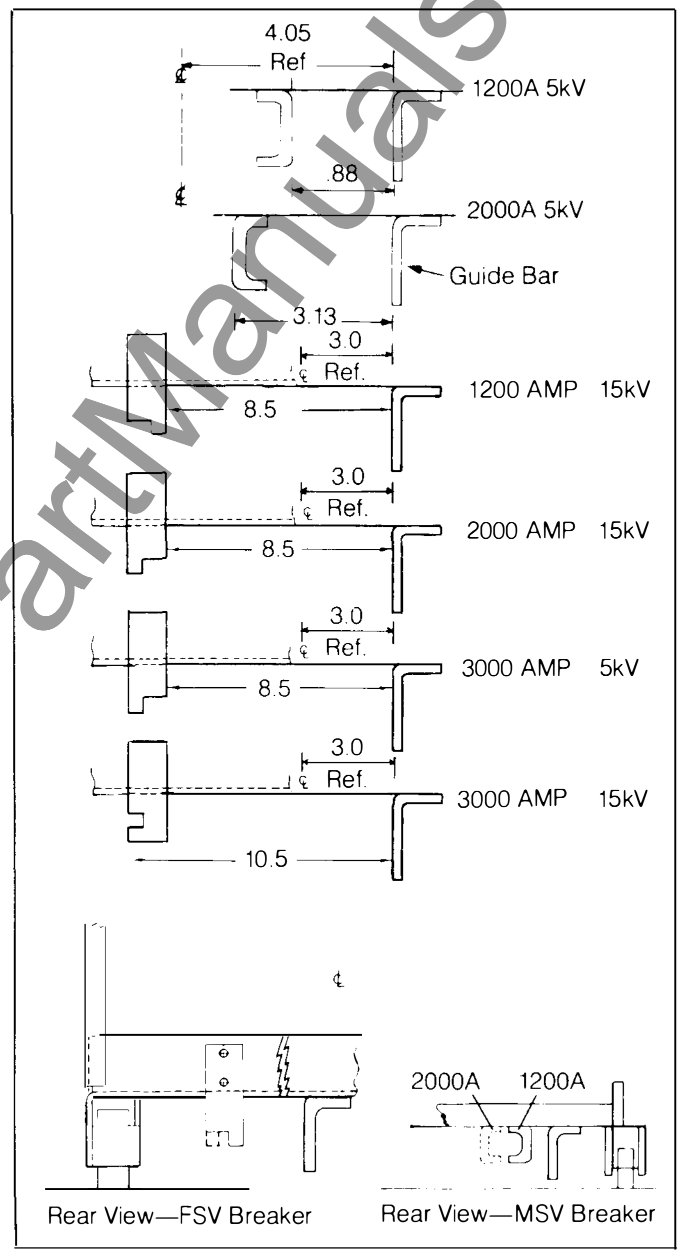


Figure 26
1200, 2000, and 3000 Amp
Continuous Current Interlock Orientation

Continuous Current Interlock

Reference Figure 26

The continuous current interlock functions to ensure breakers and cubicles of like continuous rating are applied, and that breakers with dissimilar continuous current ratings are excluded from cubicles of unlike current ratings

Figure 26 provides detail necessary to determine continuous current ratings and appropriate interlock orientation.

Control Cable And Connection Box

The MSV and FSV type circuit breakers employ a plug-in cable which completes all standard circuit breaker electrical connections between the mechanism housing and the vehicles secondary disconnects. Figure 27 provides the detail of the cables wiring and a typical schematic diagram.

The wiring from this cable is terminated at a connection box which provides a convenient and versatile means of accommodating various control options and modes of common sourcing while maintaining a common breaker enclosure wiring diagram.

Devices which will be mounted in the connection box include.

- Plunger Position Mechanical Interlock Switch
- Terminal Blocks
- Capacitor Trip (Optional)

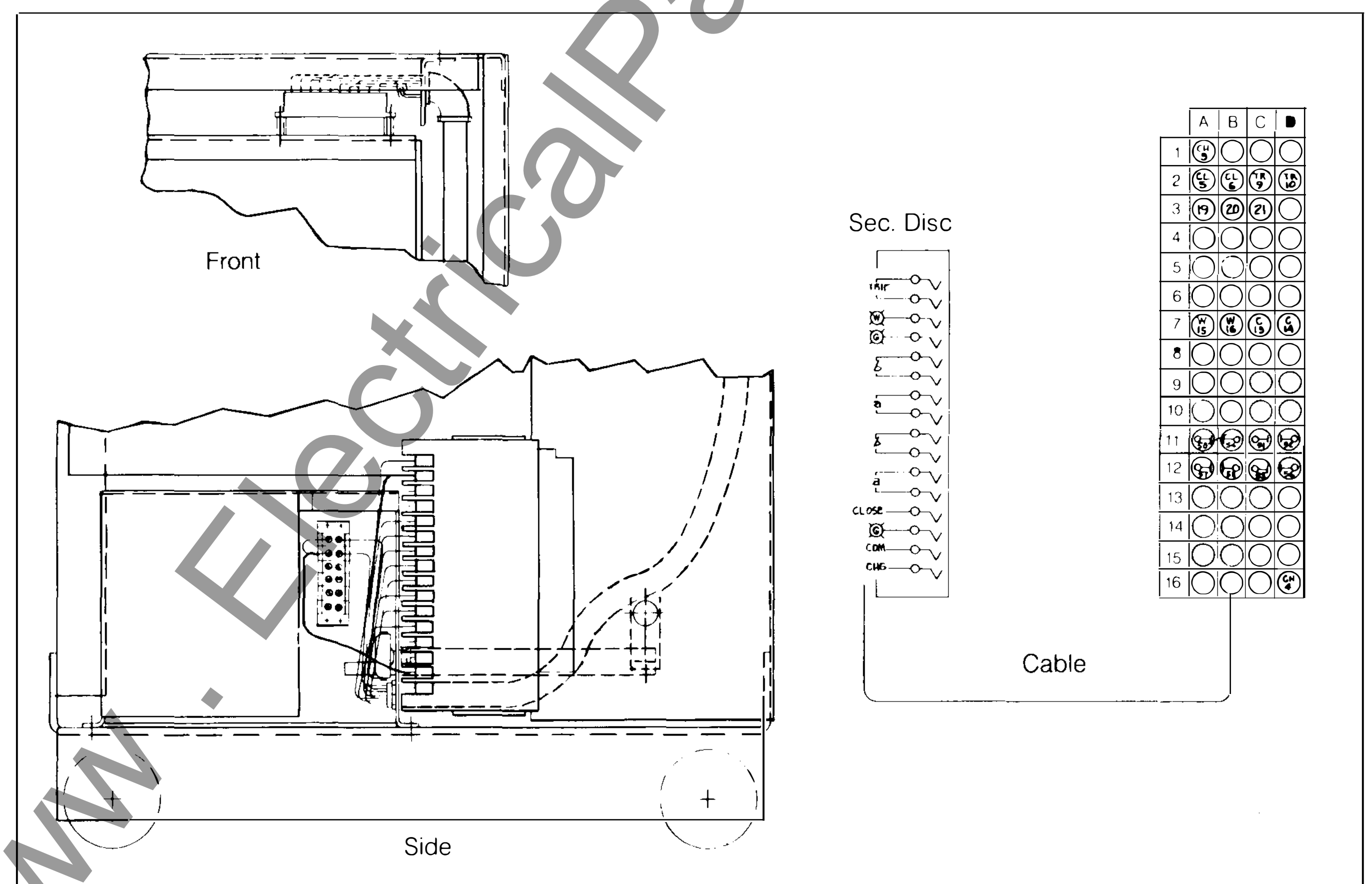


Figure 27
Control Cable Connection Detail

Insulating Barriers

Reference Figure 28

Insulating barriers are required for use on type MSV and FSV circuit breakers.

Interphase (with cutout) and exterior barriers on type FSV circuit breakers are removed or inserted by sliding them in the vertical channels.

Interphase barriers on type MSV circuit breakers are removed or inserted by sliding them in the vertical channels. Exterior barriers are secured with the mounting posts inserted into the teardrop holes and slid down to hold in place. This may require a slight deflection of the barrier against the interrupter heat sink.

Type MSV and FSV breakers require a full compliment of two exterior and two interphase barriers. Refer to the parts guide for location of barriers.

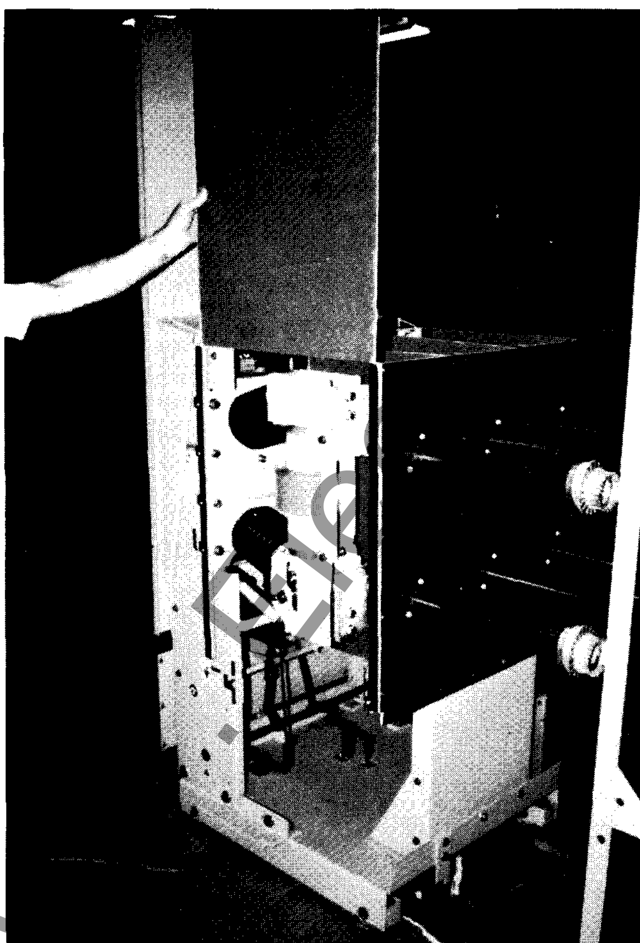


Figure 28 Insulating Barrier—Type FSV

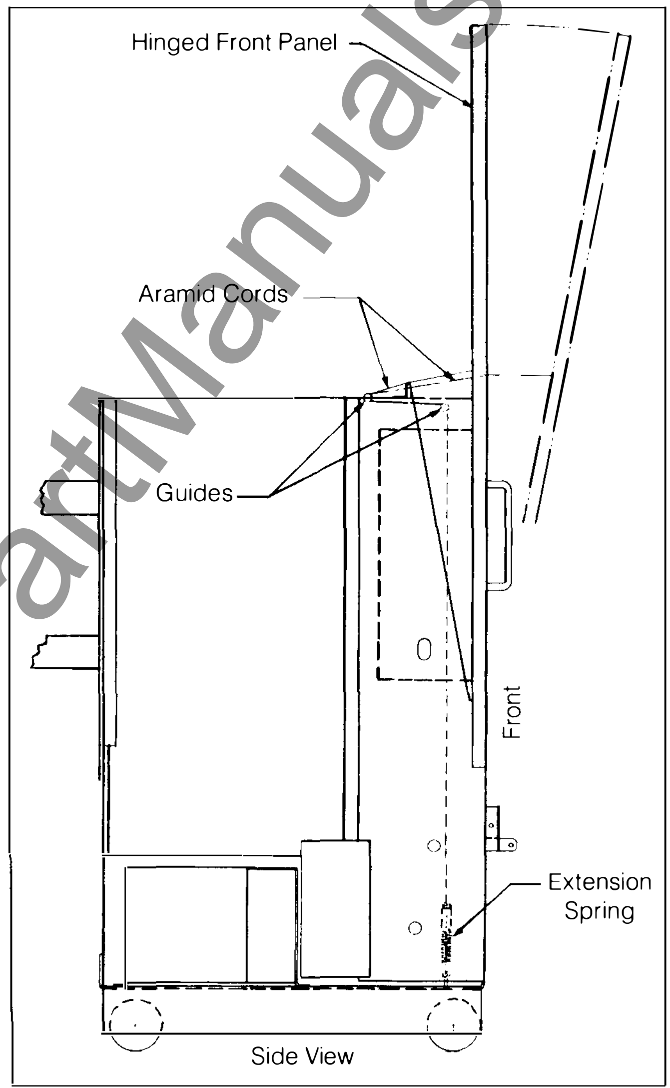


Figure 29 Hinged Front Panel—Type FSV

Front Hinged Panel, Type FSV

Reference Figure 29The *FSV breaker* employs a hinged front panel which is spring loaded to seek a vertical position. Helical extension springs maintain tension in aramid fiber cords which are trained over guides to apply a horizontal pull on the front panel towards the rear of the breaker.

If the front panel fails to move easily and freely against the spring tension. DO NOT FORCE. STOP! Examine aramid cord to ensure it is aligned over each of two guides. Tensioned cords are applied symmetrically to each side of the front panel. Helical springs may be accessed by removing the front lower panel of the breaker.

Cubicle Interface Barrier For Type MSV & FSV Circuit Breakers

The type 5-MSV-250 circuit breaker to "D" cubicle interface requires a two piece metal barrier be mounted in the "D" cubicle, above and adjacent to the upper front of the breakers, to isolate the high voltage area above the breaker, (Figure 2a and 30). The hinged front panel, which provides this isolation for air magnetic breakers, cannot be used, due to the required configuration of the vacuum interrupter/operator and vehicle subassemblies to fit in the 26 inch wide, "D" cubicles. These barriers are automatically factory installed in all new cubicles designed for use with MSV breakers. Check with factory for special procedures for ground and test device usage in these modified "D" cubicles.

The replacement of Type MA-250 air magnetic circuit breakers with type 5-MSV-250 vacuum circuit breakers will require the mounting of two barriers in the existing "D" cubicles plus notching the internal "iris" barrier as indicated on replacement instructions. Type FSV new and replacement breakers do not require additional barriers or notching of the "F" cubicles.

The interface barrier on the "D" cubicle for MSV breakers and an interference barriers used across the "F" cubicle for FSV breakers are designed to prevent air magnetic breakers from being inserted into cubicles exclusively designed for vacuum breakers. If proper insulating barriers are installed across the top of "F" cubicles, either air magnetic or vacuum breakers could be properly used.

Figure 30
Cubicle Barrier for Type MSV Circuit Breaker

Vehicle Lubrication

Primary contacts (multi-fingered clusters) and secondary control contacts (strips and fingers) are to be wiped clean and a film of Siemens contact lubricant applied, 15-171-370-002.

Sliding surfaces such as shutter cam, rail plunger, etc. may be wiped clean and treated with "Molycote Penelube", 15-171-270-002.

Nylon sliding and rotational bearings require no lubrication.

Pivots thru out the interlocking linkages should be treated with a light oil (SAE #10) which includes rust inhibitors.

See Interruptor/Operator Lubrication Section for Additional Information.

WARRANTY - Company warrants that on the date of shipment to Purchaser the goods will be of the kind and quality described herein, merchantable, and free of defects in workmanship and material.

If within one year from date of initial operation, but not more than eighteen months from date of shipment by Company, of any item of the goods, Purchaser discovers that such item was not as warranted above and promptly notifies Company in writing thereof, Company shall remedy such defect by, at Company's option, adjustment, repair or replacement of the item and any affected parts of the goods. Purchaser shall assume all responsibility and expense for removal, reinstallation and freight in connection with the foregoing remedy. The same obligations and conditions shall extend to replacement items furnished by Company hereunder. Company shall have the right of disposal of items replaced by it. Purchaser shall grant Company access to the goods at all reasonable times in order for Company to determine any defects in the goods. In the event that adjustment, repair or replacement does not remedy the defect, the Company and Purchaser shall negotiate in good faith an equitable adjustment in the contract price.

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