Westinghouse Electric Corporation
Switchgear Division
Recloser-Breaker Department
Bloomington, Indiana 47401

December, 1985
Supersedes DB 38-921 D WE A, pages 1-4,
dated February, 1975
Mailed to: E, D, C/38-000G

Ratings:
15.5 kV
600 thru 3000 Amps
12 thru 25 kA
Capacitor or Reactor Switching

Type R Vacuum Circuit Breakers

Advantages of Vacuum Interruption
The design of Westinghouse R Series Vacuum Circuit Breakers brings together all the advantages of the relatively new technology of power arc interruption in vacuum.

Maintenance — The absence of oil as an insulating and interrupting medium minimizes the maintenance and servicing required.

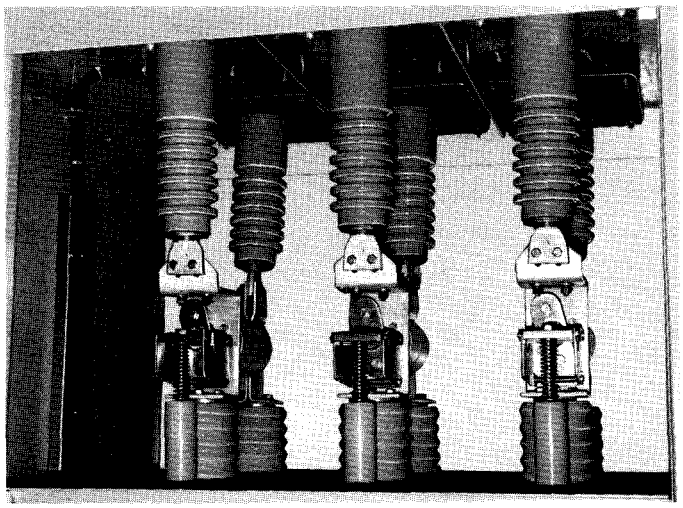
Installation — The forces generated during interruption are only those of the operating mechanism. This greatly simplifies foundation requirements.

Duty Cycle — No derating of interrupting capability is required regardless of the reclosing duty cycle.

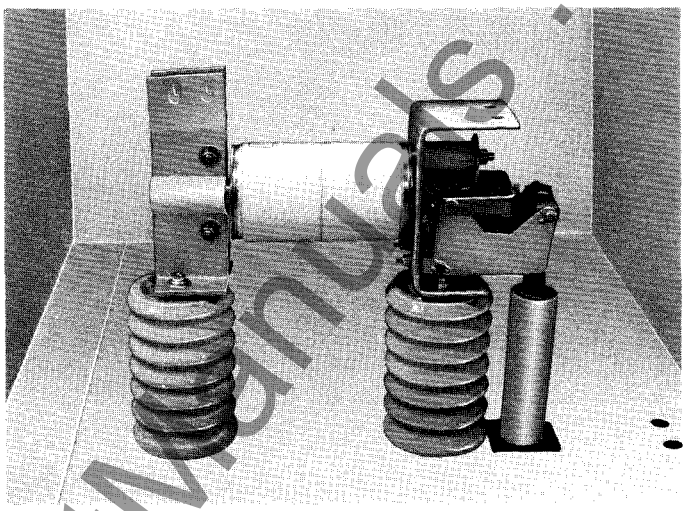
Safety — The use of air as the primary insulation minimizes the hazard from fire or explosion.

Type R Vacuum Circuit Breakers

High Voltage Compartment



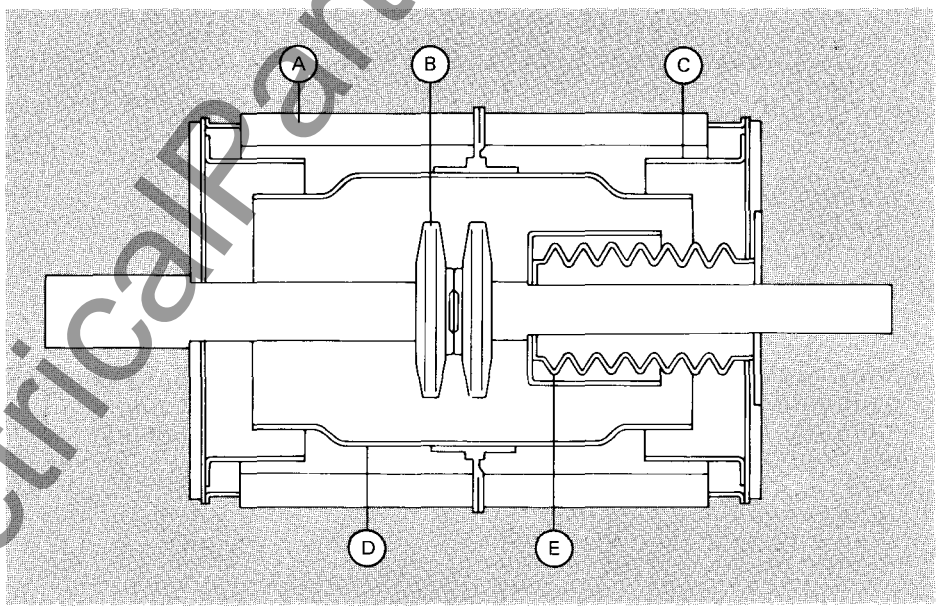
Interrupter Assembly



All components at line potential are contained in the high voltage section and are completely isolated from the control compartment. Porcelain entrance bushings are attached to the roof assembly by bolt and compression type clamps. Removal or replacement does not disturb existing breaker adjustments. Bushing current transformers mount on the entrance bushings. The accuracy class required determines the number that may be mounted.

Internal Vacuum Interrupter Construction

A Ceramic Envelope
B Butt Type Contacts
C Voltage Grading Shield
D Main Shield – Suspended from the center seal, the metal shield provides a condensing surface for the vaporized contact material generated during the arcing period. This action prevents contamination of the internal ceramic surface.
E Bellows – Brazed to the moving contact stem and end plate, the flexible stainless steel bellows allows the contact to move during operation while maintaining a perfect seal.



Vacuum Interrupter
The Westinghouse vacuum interrupter utilizes a ceramic envelope because of its high strength, good thermal properties and high density. The use of ceramic allows higher temperature processing during the brazing and degasing operation. The entire brazing and sealing operation is completed within the vacuum furnace assuring a high degree of reliability and longevity for the interrupter.

Two standoff insulators provide a rugged mounting for the interrupter and operating linkage.

Roller contacts transfer the current from the moving contact stem to the entrance bus.

The most effective way to switch an electrical circuit is to do it in vacuum. In normal operation the contacts of this alternating current vacuum interrupter are closed. Under fault conditions, an interruption is required and the contacts are quickly separated. An arc is established between the two contact faces. Current flows between the contacts through ionized vapor until the alternating current passes through zero. Almost instantaneously, the vapor condenses and the dielectric between the contacts recovers to levels above the transient recovery voltage applied by the circuit. Such fast, reliable interruption has important advantages over other methods of circuit breaking.

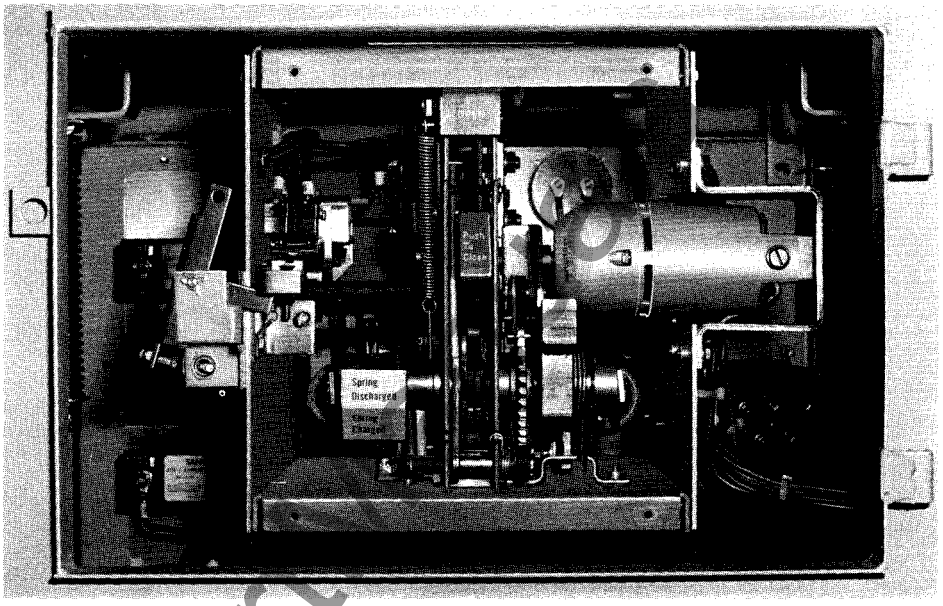
Over 150,000 Westinghouse vacuum interrupters are now in successful operation. This represents only a small fraction of the new AC and DC applications potentially available to industry. A continuing research and development effort which started in 1960, has resulted in improvements in metallurgical, vacuum processing and ceramic technologies which are steadily expanding the ratings and capabilities of Westinghouse Vacuum Interrupters. The range of ratings available from Westinghouse is one of the largest in the world.

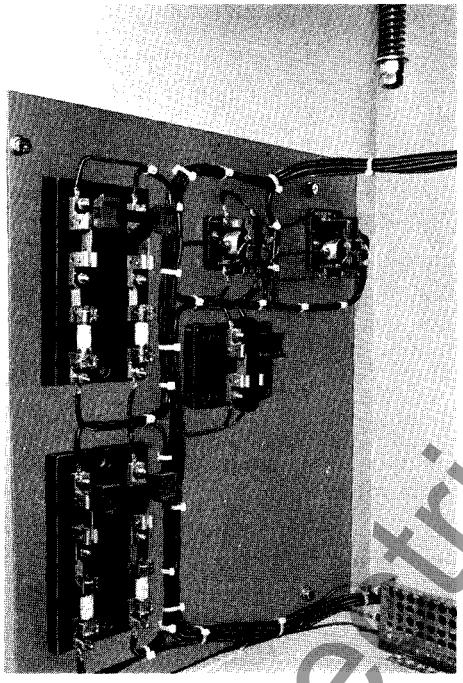
Type R Vacuum Circuit Breakers

Low Voltage Compartment

The low voltage compartment contains all relay, metering and mechanical functions and is completely insulated from the high voltage section.

Control Wiring
Panels located in the low voltage compartment are used to mount terminal blocks and the 52X and 52Y control relays. Secondary voltage circuits are normally wired through fused knife switches for circuit protection and easy disconnect. The trip circuit is connected through a knife switch, but is not normally fused. Bushing current transformer leads are brought from the high voltage compartment and connected to shorting type terminal blocks.





Operating Mechanism
The operating mechanism is the stored energy type, spring close– spring open. A motor driving through a ratchet mechanism is used to charge the main closing springs. Energy is stored in the tripping spring during the closing sequence to ensure adequate tripping energy whenever it is required. The mechanism is electrically and mechanically trip free.

The operating mechanism drives directly to the main shaft which connects all three phases. Each phase is operated from this shaft through an independently adjustable linkage.

A latch check switch, located on the mechanism, is provided as a standard feature to permit electrical closing only when the mechanism is fully reset.

A visible flag on the mechanism front cover plate indicates the spring condition as "SPRING CHARGED" or "SPRING DISCHARGED." This positive indication tells operating personnel whether the mechanism has properly stored the energy required to close the breaker during maintenance operations.

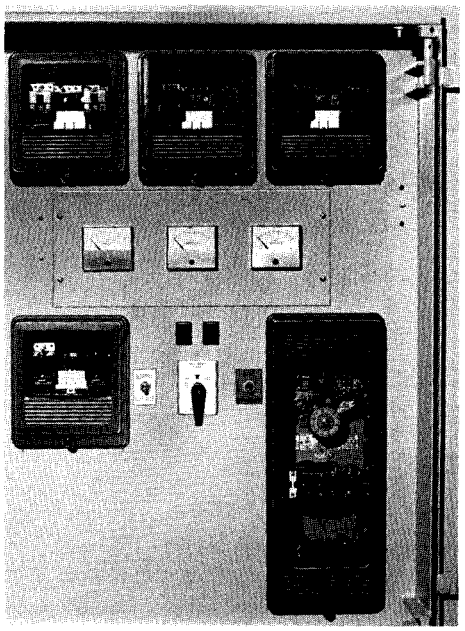
The operator can manually close the breaker by actuating the "PUSH TO CLOSE" button which discharges the closing springs. Stored energy makes the operating speed independent of operating personnel. This feature benefits the user in that the breaker can be manually closed into an energized circuit for load pickup when control power is not available.

A manual trip lever allows the breaker to be tripped quickly under emergency conditions.

As an added safety feature, a 69 device blocks automatic reclosing after manual trip by opening the electrical reclosing circuit. An external reset device is provided for restoring the normal reclosing function.

A cyclometer operations counter, which indicates the number of trip operations, is located behind the window in the mechanism cabinet permitting the user to determine if operations have occurred without having to incur the added labor cost of removing the housing door.

Relay Control
Design of all relay control functions is very flexible and is normally tailored to meet the required specification. A standard relay package mounted on the hinged relay panel would normally include: phase and ground overcurrent relays, a reclosing relay and a control switch with red and green indicating lights.



Type R Vacuum Circuit Breakers

Typical Specifications

Item	Continuous Current (Amps)											
	600				800		1200			2000		3000
Breaker Type	R-1	R-2	R-3	R-4	R-2	R-3	R-2	R-3	R-4	R-3	R-4	R-4
Rated Maximum Voltage (kV)	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5
Voltage Range Factor K	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Frequency (Hertz)	60	60	60	60	60	60	60	60	60	60	60	60
Dielectric Strength												
Low Frequency Withstand												
Dry 60 Hertz for 1 Minute	50	50	50	50	50	50	50	50	50	50	50	50
Wet 60 Hertz for 10 seconds	45	45	45	45	45	45	45	45	45	45	45	45
Full Wave Withstand (BIL)	110	110	110	110	110	110	110	110	110	110	110	110
Operating Duty (Standard Duty Cycle)	①	①	①	①	①	①	①	①	①	①	①	①
Interrupting Time (Cycles)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Permissible Tripping Delay Y (Seconds)	2	2	2	2	2	2	2	2	2	2	2	2
Closing Time (Cycles)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Reclosing Time (Seconds)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Short-Circuit Current (At Contact Part) KA, RMS, Sym.	12	16	20	25	16	20	16	20	25	20	25	25
KA, RMS, Asym.	15	19	24	30	19	24	19	24	30	24	30	30
Close and Latch (Initial Current Loop) KA, RMS, Asym.	20	26	32	40	26	32	26	32	40	32	40	40
Short Time Current (3 Seconds) KA, RMS, Sym.	12	16	20	25	16	20	16	20	25	20	25	25
Transient Recovery Voltage (kV Peak) (Time to peak 63 μsec)	28	28	28	28	28	28	28	28	28	28	28	28
Load Current Switching Capability (Amperes)	600	600	600	600	800	800	1200	1200	1200	2000	2000	3000
Capacitance Current Switching												
Open Wire Line Charging Switching Current (Amps)	②	②	②	②	②	②	②	②	②	②	②	②
Isolated Cable Charging Current (Amps)	②	②	②	②	②	②	②	②	②	②	②	②
Isolated Capacitor Bank Switching Current (Amps RMS)	600	600	600	600	600	600	600	600	600	600	600	600
Back-to-Back Shunt Capacitor Bank Switching Current (Amps RMS)	600	600	600	600	600	600	600	600	600	600	600	600
Transient Overvoltage Factor	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Transient Inrush Current (kA Peak)	40	40	40	40	40	40	40	40	40	40	40	40
Transient Inrush Frequency (Hertz)	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Interrupting Time (Cycles)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Capacitor Current Switching Life (Operations)	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Grounding of System and Capacitor Bank												
System	③	③	③	③	③	③	③	③	③	③	③	③
Capacitor Bank	③	③	③	③	③	③	③	③	③	③	③	③

Stored Energy Mechanism Control Power Requirements

Rated Control Voltage	Spring Run Amperes	Charge Motor Time Sec.	Close or Trip Amperes	Voltage Range Close	Voltage Range Trip
48V DC	9.0	6	16	38-56	28-56
125V DC	5.0	6	7	100-140	70-140
250V DC	3.0	6	4	200-280	140-180
120V AC	5.0	6	16	104-127	104-127
240V AC	3.0	6	8	208-254	208-254

① 0.5 Sec. CO, 15 Sec. CO, 15 Sec. CO
② Up to 600 Amps RMS.
③ Grounded or ungrounded.

Westinghouse Electric Corporation
Switchgear Division
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Bloomington, Indiana 47401

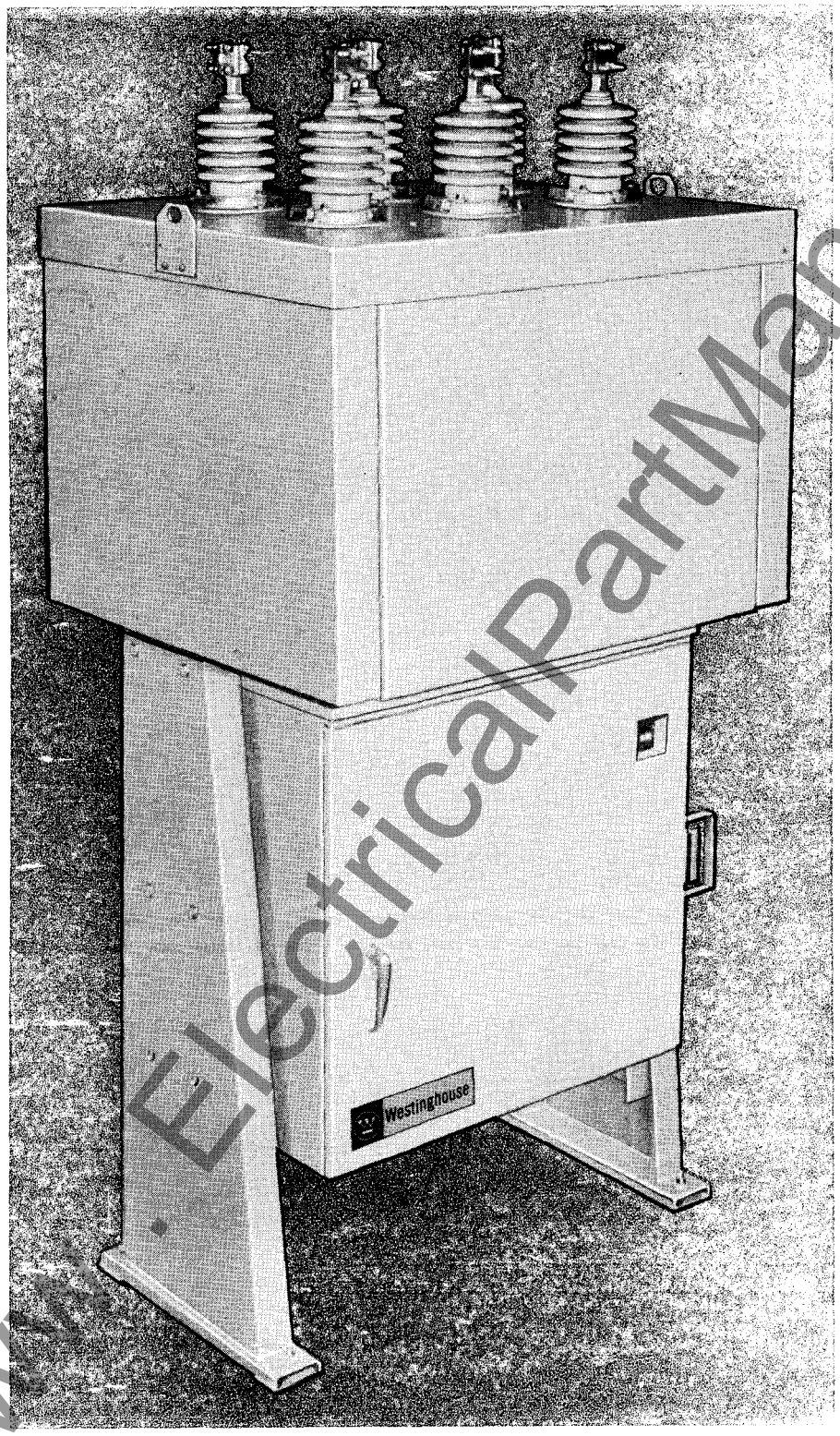
Printed in USA

Westinghouse

Vacuum Circuit Breaker

144V250

15 Kv
600 Amperes Continuous
12,000 Amperes Interrupting



General Description

The use of vacuum interrupters for fault protection is the most significant advance in the field of circuit breakers in the past thirty years.

The duty cycle of a vacuum interrupter is conservatively rated as four times that of a comparable oil unit.

The Westinghouse 144V250 Vacuum Circuit Breaker employs three vacuum interrupters mechanically linked for reliable three phase fault protection and there is no oil system to maintain.

The simplicity and reliability of vacuum interrupters provides flexible application and reliable performance over extended periods.

Advantages

• Safety

The design of the Westinghouse 144V250 Vacuum Circuit Breaker provides a high degree of safety for maintenance personnel, as well as for the equipment itself and its environment.

Vacuum interrupters completely eliminate the fire hazard inherent in oil-filled devices. Maintenance of the circuit breaker is also safer since there are no oil-filtering, oil-storage, or other special handling requirements.

• Maintenance

The absence of oil as an interrupting and insulating medium eliminates the frequent servicing associated with such devices.
Vacuum interrupters are hermetically sealed, high integrity vacuum envelopes designed for long, trouble-free service. The rated duty cycle of the vacuum interrupter is approximately four times that of a comparable oil-filled device.

• Construction

The breaker cabinet is divided into two sections: The high voltage compartment containing the vacuum interrupters, bushings and bushing current transformers and the low voltage compartment containing the operating mechanism and control functions. This separation provides personnel safety during routine inspection.

• Duty cycle

The duty cycle of a vacuum circuit breaker is conservatively rated as four times that of a comparable oil breaker. This figure is based on testing that is designed to compare the total capabilities of vacuum breakers with those of oil breakers.

• Installation

The mechanical forces evolved during interruption are only those of the operating mechanism. This greatly simplifies foundation requirements.

February, 1970
Supersedes DB 38-921 dated July, 1968
E, D, C/1949, 1994/DB

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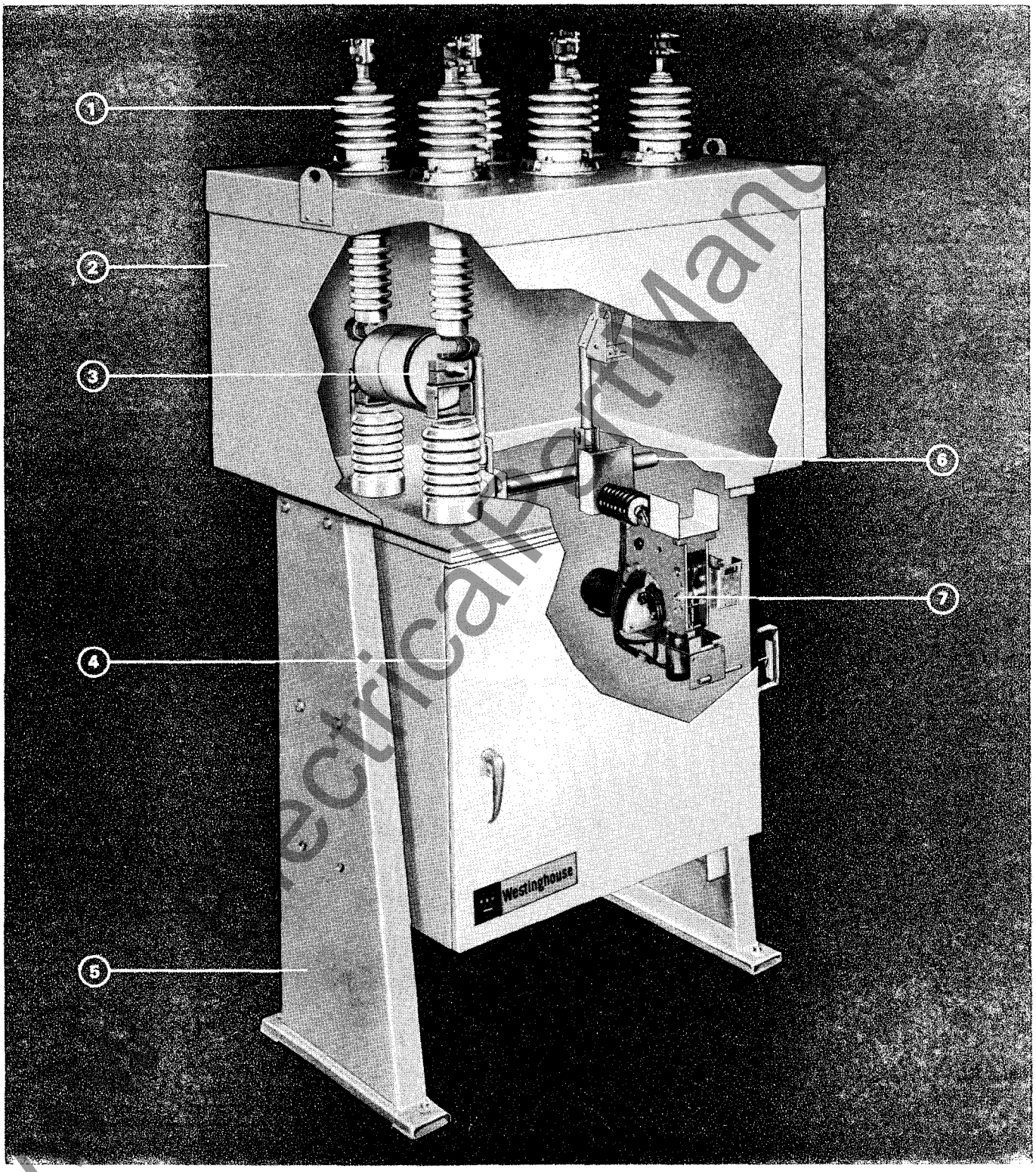


Vacuum Circuit Breaker
144V250

15 Kv
600 Amperes Continuous
12,000 Amperes Interrupting

Design Features

(1) High Voltage Bushings

The bushings are attached to the high voltage compartment by bolt on compression-type clamps. Note that removal is facilitated by removing the clamping bolts and flexible shunts. Replacement of the high voltage bushing does not disturb existing breaker adjustments or require re-adjustment after replacement.

The high voltage bushings are constructed of single piece, high strength wet process porcelain and are rated 15 Kv, 110 Kv BIL, with 17" creep.

(2) High Voltage Compartment

System-potential equipment is contained in the high-voltage section of the vacuum circuit breaker. This includes vacuum interrupters, entrance bushings, and bushing current transformers. **It is not necessary to enter the high-voltage compartment for routine maintenance.**

(3) Vacuum Interrupter

The Westinghouse Interrupter has introduced several advances to the "state of the art" in the manufacture of interrupters. The Westinghouse interrupter is equipped with a ceramic envelope. This envelope is used because of its extremely high strength, thermal properties, and high density. The use of a ceramic envelope allows processing and sealing of the vacuum interrupter at elevated temperatures. This high temperature processing promotes the removal of surface absorbed gases in the contact and bottle material, assuring a high degree of reliability and longevity for the interrupter.

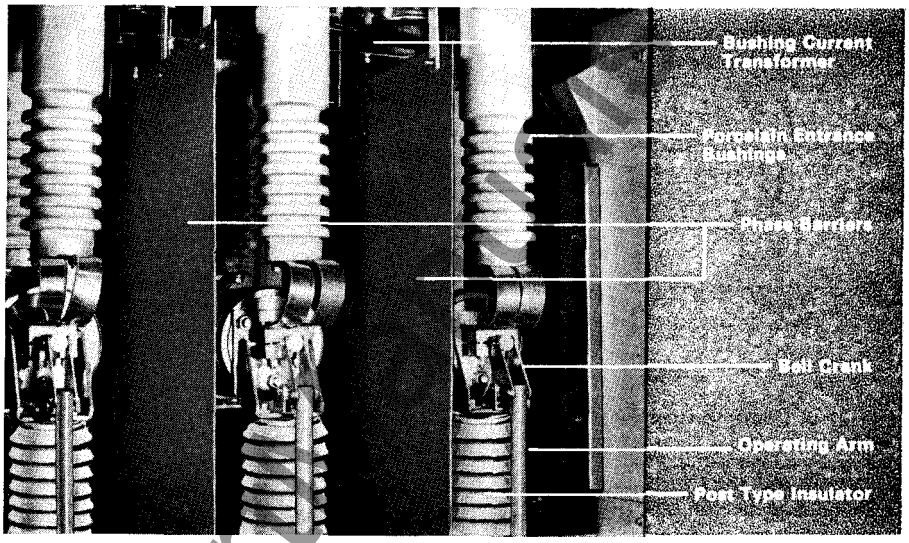
Since the seal of a vacuum device is of principal concern, it is desirable to eliminate, when possible, potential sources of leaks. The Westinghouse manufacturing process has done this with the elimination of the pinch-off tube.

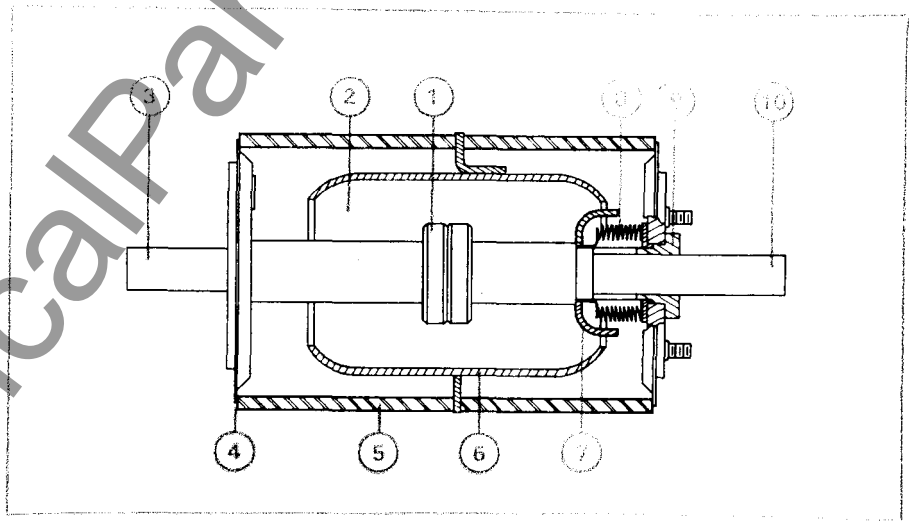
(1) *Contacts* – The Vacuum Interrupter utilizes butt type contacts. The contact material is a high purity copper alloy that resists welding and eliminates chopping.

(2) *Arc Chamber* – To assure proper arc interruption, the vacuum in the arc chamber is established at 10^{-7} torr.

(3) *Stationary Contact* – The stationary contact is firmly attached to the metal end plate.

(4) *Kovar® Seals* – A ceramic Kovar seal is used to weld the ceramic envelope to the metal end plates. Kovar seals have been successfully used for many years for high integrity bonds between metal and ceramic.





(5) *Ceramic Envelope* – The interrupter envelope is a high density ceramic designed to prevent gas diffusion and allow high temperature processing.

(6) *Arc Shields* – A metal envelope surrounds the contacts to provide a condensing surface for vaporized contact material resulting from arc interruption. This condensation also performs a getting action making the interrupter "self cleaning."

(7) *Bellows Shield* – A bellows shield protects the bellows during interruption.

(8) *Bellows* – A flexible metal bellows connects the moving contact to the vacuum interrupter end plate. This allows contact movement without disrupting the vacuum seal.

(9) *Micarta® Bearing* – The Micarta bearing maintains proper alignment of the moving contact rod.

(10) *Moving Contact* – The moving contact shaft is connected directly to the operating mechanism through the operation rod.

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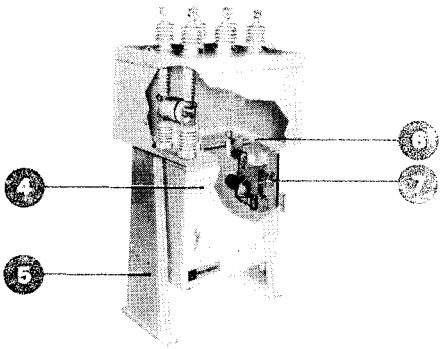


4 Low Voltage Compartment

The low-voltage compartment contains all relay, metering, and mechanical functions, and is completely isolated from the separately enclosed high-voltage section. **All routine servicing or adjustments are performed in the low-voltage compartment only.**

5 Substation Mounting Frame

The Vacuum Circuit Breaker is supplied with an adjustable substation mounting frame. This frame is bolted to the high voltage compartment and is adjustable from 78 inches to 102 inches.

6 Operating Linkage

The operating linkage is designed to transmit opening and closing motion from the operating mechanism to the moving contacts of the vacuum interrupter.

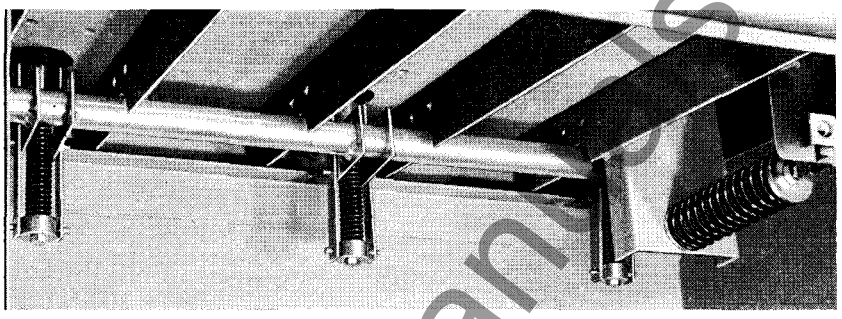
The operating linkage consists of:
1 connecting linkage, 1 operating shaft, 3 operating arms, 3 bell cranks.

Vacuum interrupter contact pressure is maintained by springs integral to the operating arms. These operating arms provide overtravel for the mechanism, assure consistent contact pressure, and allow for contact wear.

7 Operating Mechanism

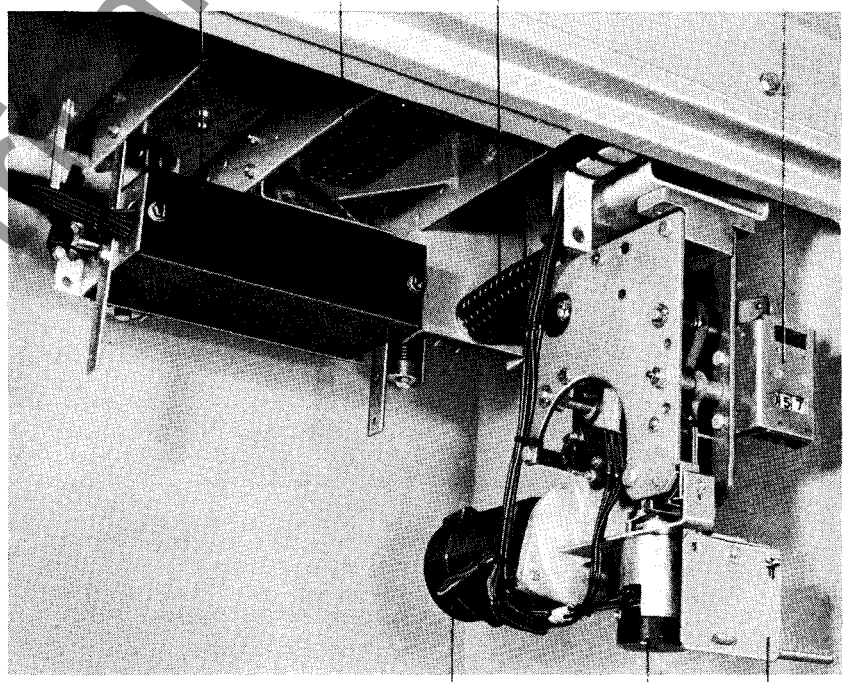
The operating mechanism is motor closed, spring opened, electrically and mechanically trip free utilizing over-toggle linkages.

Energy is stored in the trip spring during the closing sequence. When closed, the breaker always has tripping energy.



Operating Linkage with Operating Shaft, Operating Arms, and Stored Energy Trip Spring. 6

Operating Arm with Contact Pressure and Over-Travel Spring



Operating Mechanism 7

Vacuum Circuit Breaker
144V250

15 Kv
600 Amperes Continuous
12,000 Amperes Interrupting

Internal Construction

Figure 1. shows The Westinghouse Vacuum Circuit Breakers general construction. Note that each of the three interrupter units is supported by two post type insulators. This construction provides rigid support for the interrupters and prevents forces developed during operation from being transmitted to the interrupter seals.

The operating mechanism and shaft are mounted to the same channel section as the interrupters. This assures that the original contact adjustment will not change.

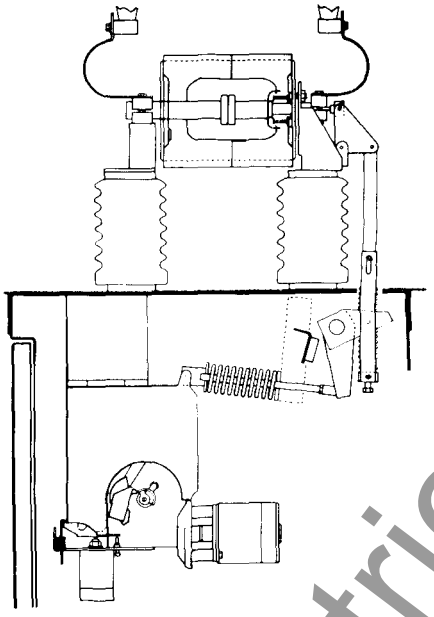


Figure 1.

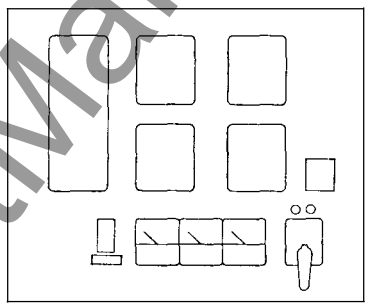
Breaker Control

Three phase overcurrent monitoring and protection may be provided by the addition of Westinghouse Type CO Relays. An additional CO Relay for ground fault protection is available as an optional accessory.

Automatic reclosing may be accomplished by the addition of the RC Reclosing Relay.

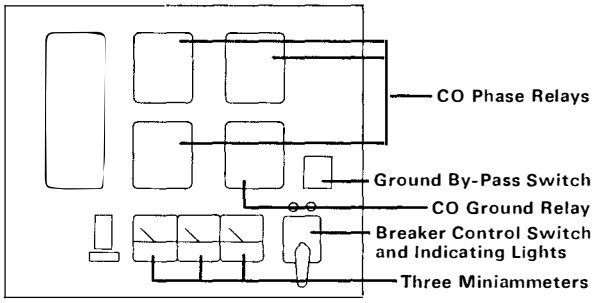
1 Basic Vacuum Breaker

Low Voltage Circuit Protection (Not Shown)



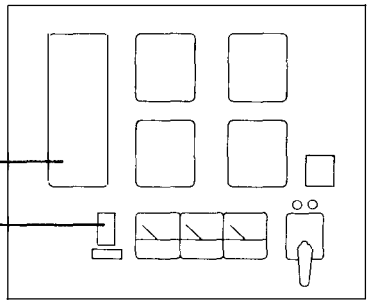
2 Relayed Vacuum Breaker

All items in 1 plus those illustrated.



3 Reclosing Relayed Vacuum Breaker

All items in 1 and 2 above plus those illustrated.



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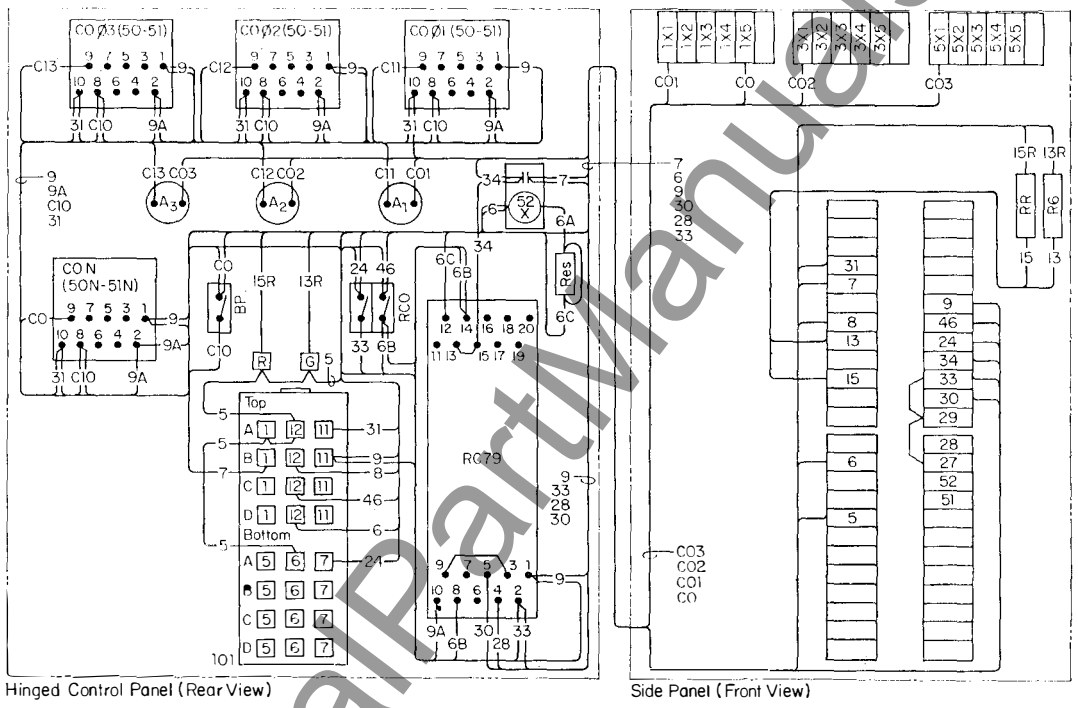
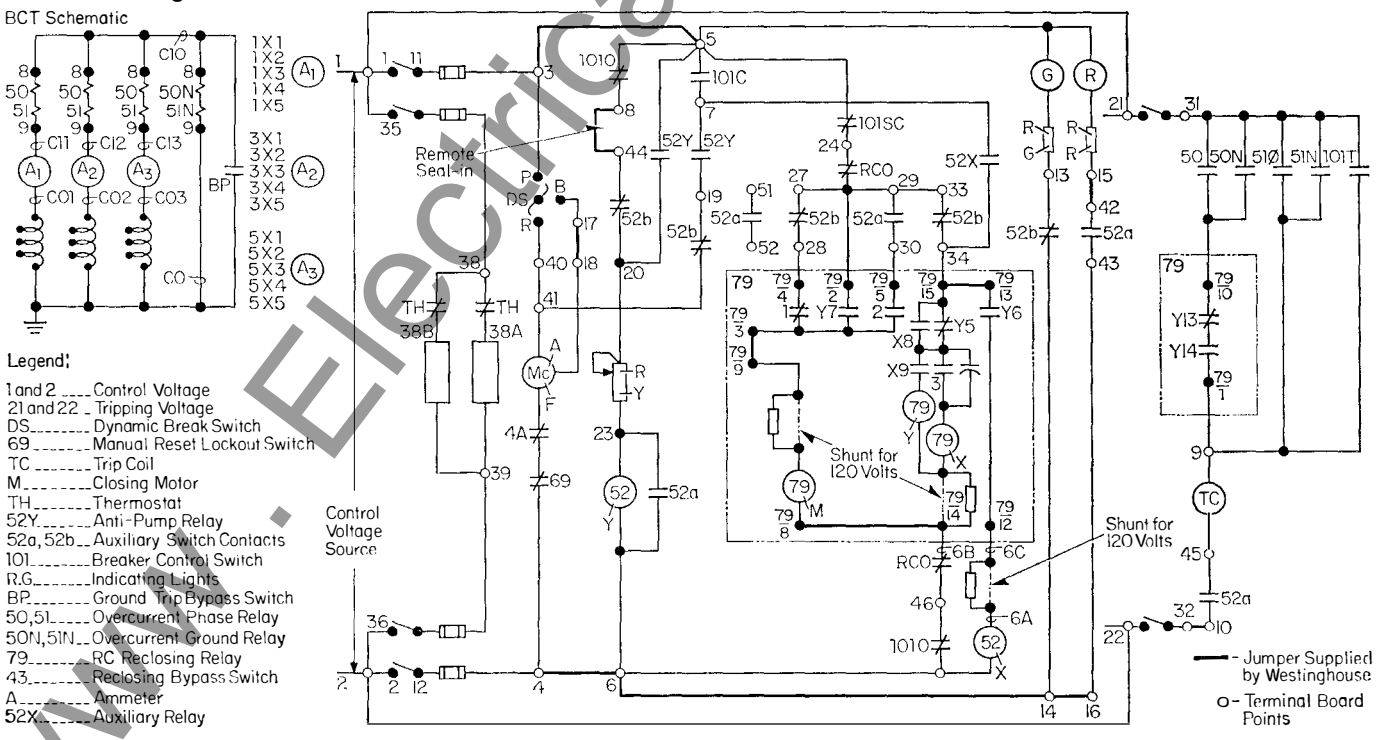
Schematic and wiring diagram shown for a Relayed Reclosing Vacuum Circuit Breaker as outlined on page two of PL 38-920

Wiring Diagram

Contact	Position P.T.	T	OFF AFT T	OFF AFT C	C	
A11-B11	X	X				T
A12-B12			X	X		O
A1-B1					X	C
A5-A6	X	X	X			
A6-A7				X	X	SC
B5-B5	X	X	X			
B6-B7				X	X	SC
C11-D11	X	X				T
C12-D12			X	X		O
C1-D1					X	C
C5-C6	X	X	X			
C6-C7				X	X	SC
D5-D6	X	X	X			
D6-D7				X	X	SC



Schematic Diagram



Legend:

1 and 2 ____ Control Voltage
21 and 22 _ Tripping Voltage
DS_____ Dynamic Break Switch
69_____ Manual Reset Lockout Switch
TC _____ Trip Coil
M_____ Closing Motor
TH_____ Thermostat
52Y_____ Anti-Pump Relay
52a, 52b__ Auxiliary Switch Contacts
101_____ Breaker Control Switch
R.G_____ Indicating Lights
BP_____ Ground Trip Bypass Switch
50,51____ Overcurrent Phase Relay
50N,51N__ Overcurrent Ground Relay
79_____ RC Reclosing Relay
43_____ Reclosing Bypass Switch
A_____ Ammeter
52X_____ Auxiliary Relay

Vacuum Circuit Breaker
144V250

15 Kv
600 Amperes Continuous
12,000 Amperes Interrupting

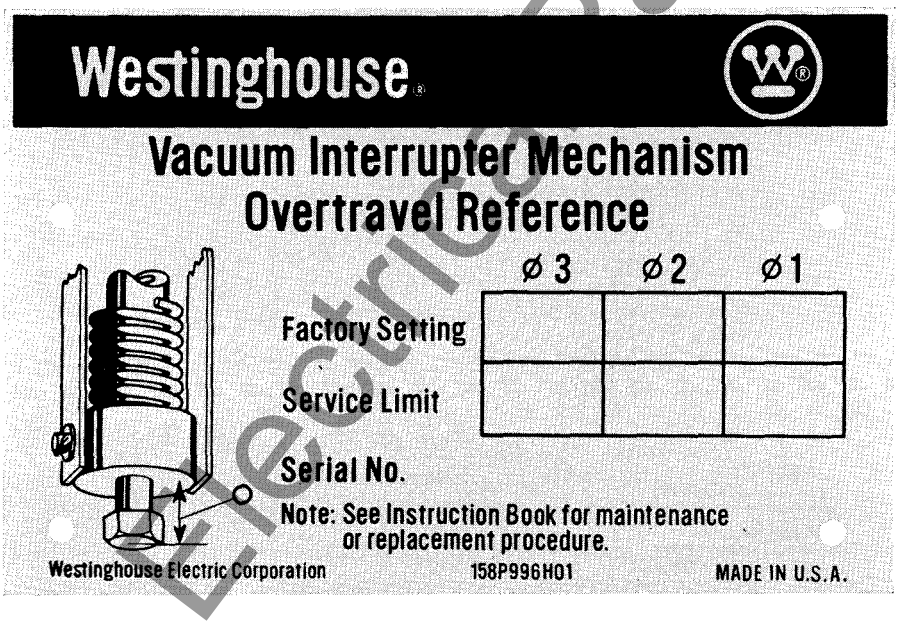
Specifications

Rated frequency	60 Hertz
Nominal operating voltage	2.4 – 14.4 kv
Maximum design voltage	15.5 kv
Continuous current	600 amps
Interrupting capacity, 2.4 – 14.4 kv	12,000 amps sym.
Momentary rating	20,000 amps sym.
Basic insulation level	110 kv
60 cycle withstand voltage – dry	50 kv
– wet	45 kv
Minimum creep distance	17 inches
Minimum strike distance, terminal to ground	8.5 inches
Minimum strike distance between bushing terminals	9.5 inches
Interrupting time	2.5 cycles or less
Closing time	25 cycles
Weight with one set of BCT's and adjustable substation frame	850 lbs.
Accuracy of 600/5 BCT's	10L100

Contact Wear Measurement

The Westinghouse VCB's Unique construction allows a greatly simplified method of contact wear measurement. This measurement is made in the low voltage compartment without de-energizing the breaker.

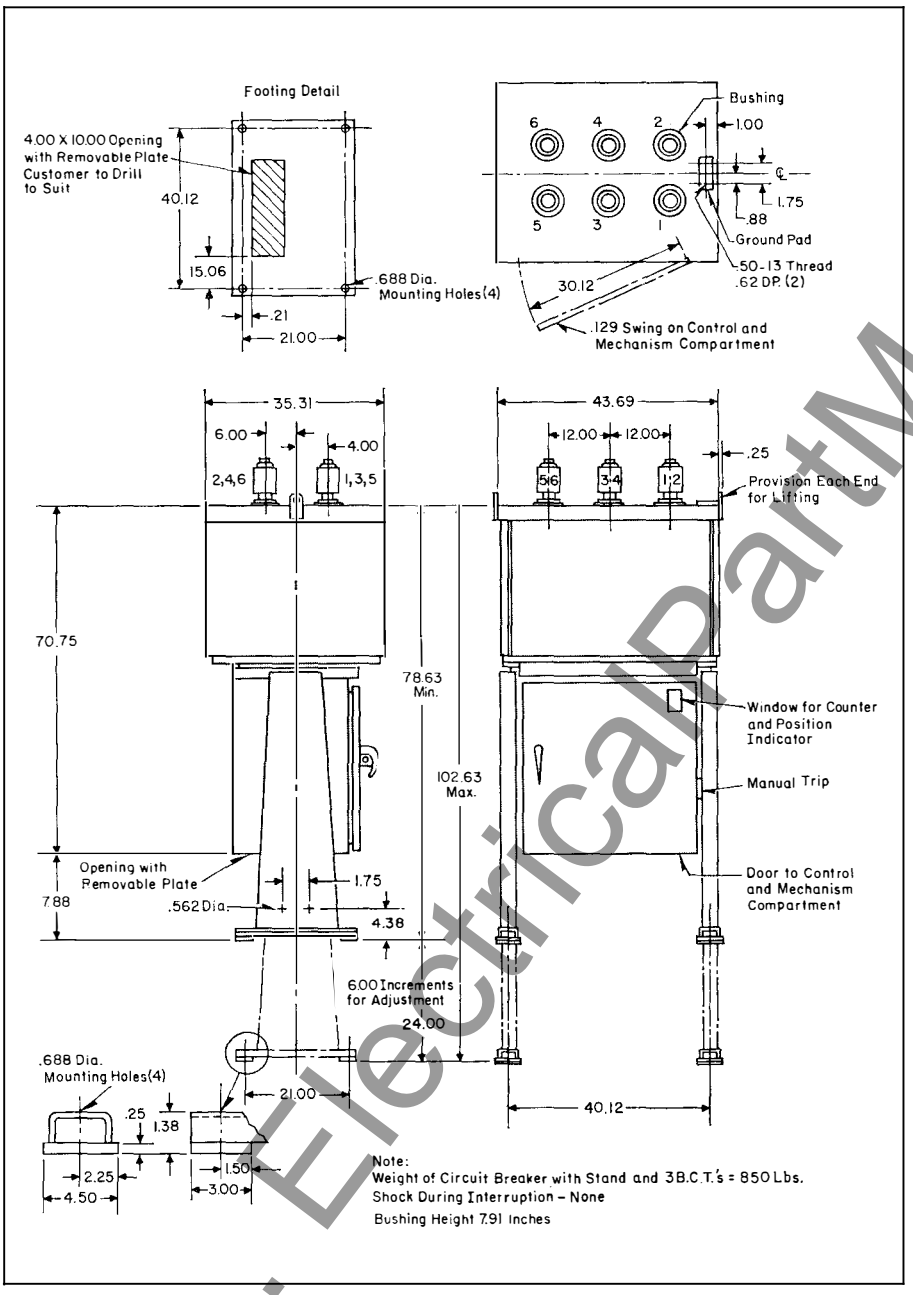
The low voltage compartment door has a nameplate showing where this measurement is made and the service limit of each interrupter. **This is the only routine inspection required on the breaker.**



Vacuum Circuit Breaker
144V250

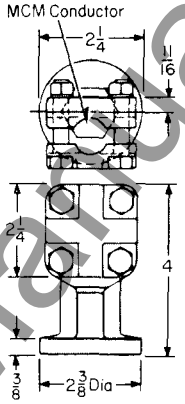
15 Kv
600 Amperes Continuous Current
12,000 Amperes Interrupting Ratings

Dimensions in Inches

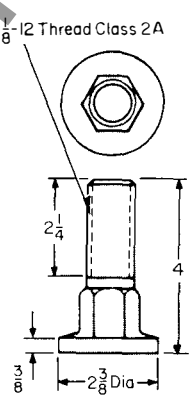


Terminals

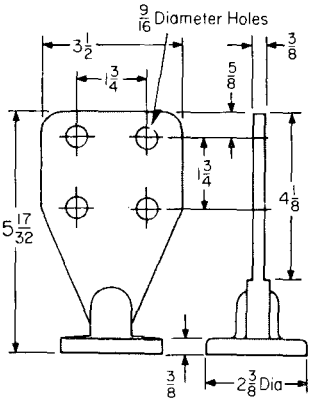
Standard Terminal
Number 2 to 800 MCM Conductor



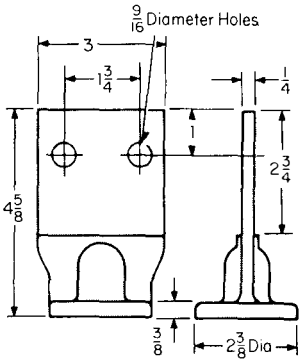
1 1/8 Threaded Stud Terminal



NEMA Standard 4 Bolt Flat Pad Terminal



NEMA Standard 2 Bolt Flat Pad Terminal



Further Information
Prices – PL 38-920

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