ABB
ASEA BROWN BOVERI

ABB Power T&D Company Inc.
Medium Voltage Outdoor
Equipment Division
Bloomington, Indiana 47404

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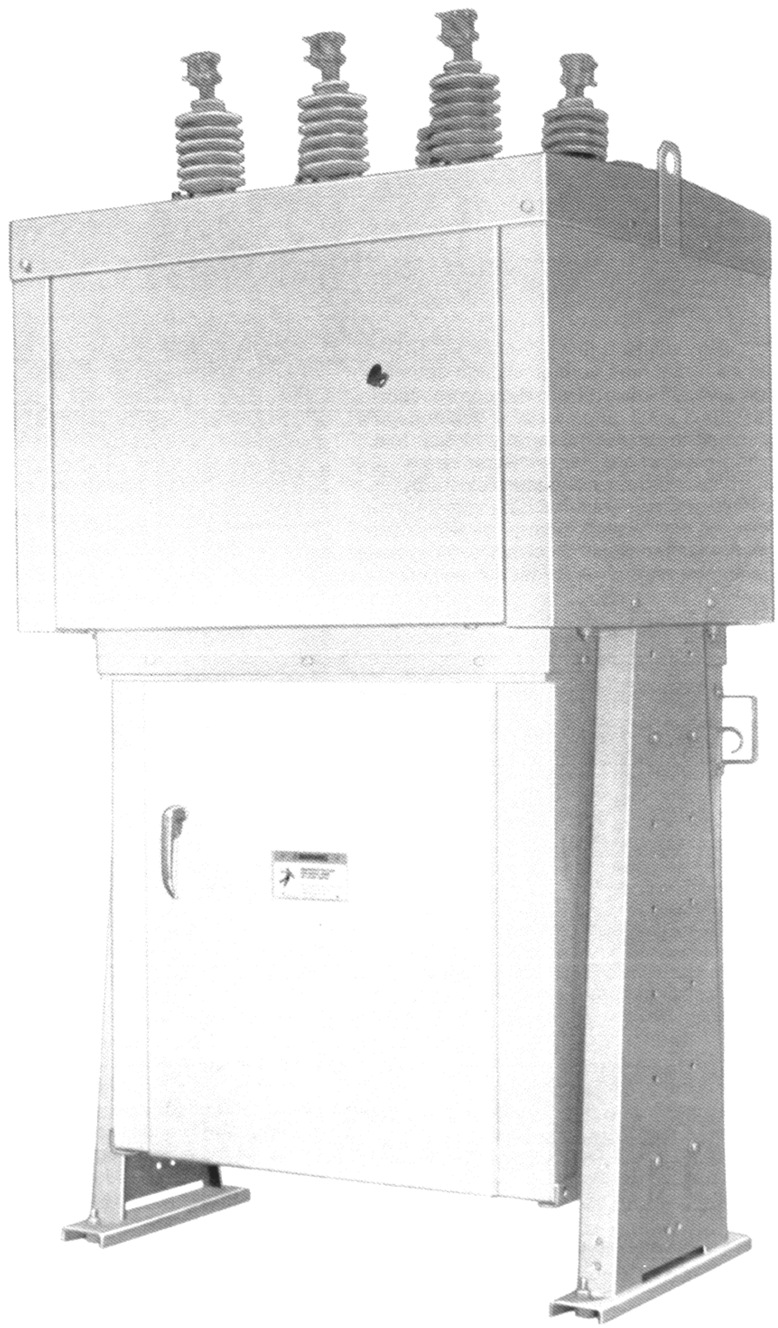
Ratings:
15.5 thru 27 kV
600 thru 3000 Amps
12 thru 40 kA
Capacitor and Reactor Switching

Type R & Type VKD-R Vacuum Circuit Breakers



Advantages of Vacuum Interruption
The design of 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.

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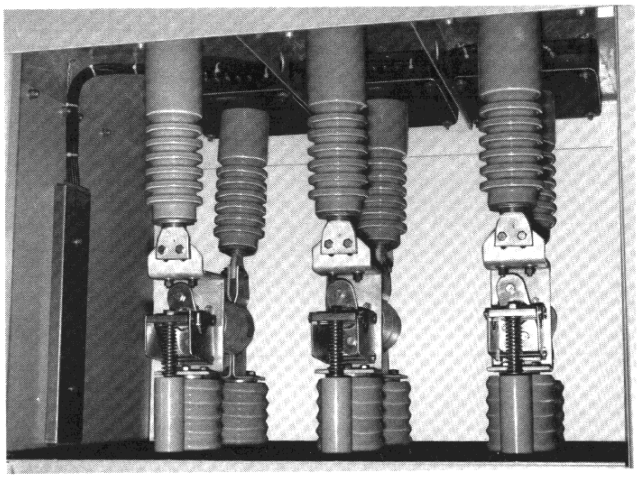
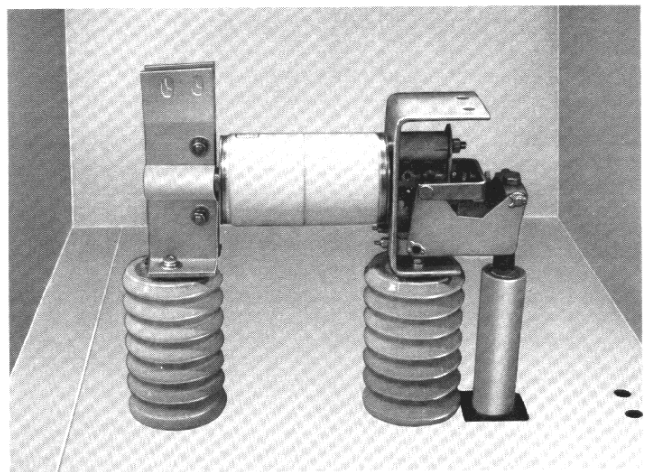
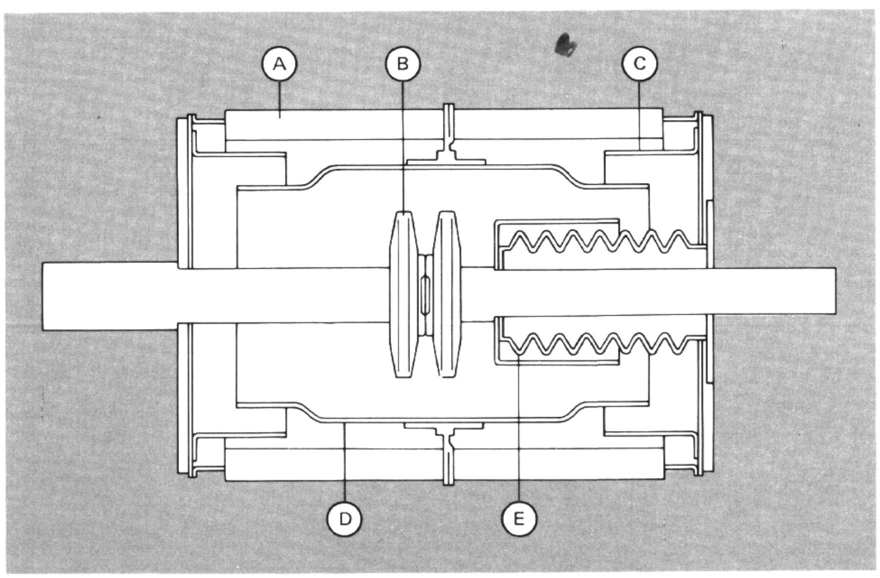
High Voltage Compartment



Interrupter Assembly



All components at line potential are contained in the high voltage section and are completely isolated from the control compartment. Insulating 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 and/or exit 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 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.

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.

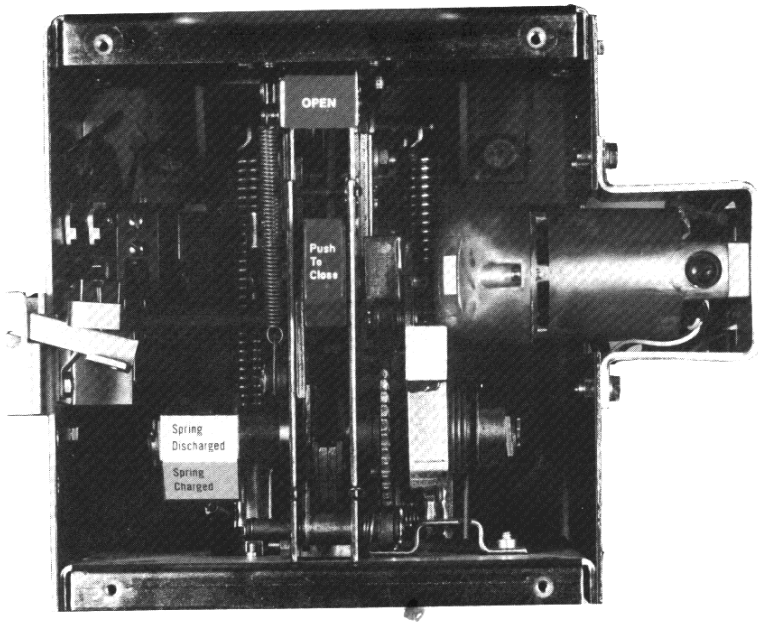
Over 500,000 of these vacuum interrupters are now in successful operation. This represents only a small fraction of the new AC applications potentially available to industry. A continuing research and development effort which started in 1960, has resulted in improvements in metallurgical, vacuum processing and ceramic technologies which are steadily expanding the ratings and capabilities of our vacuum interrupters. The range of ratings available from ABB is one of the largest in the world.

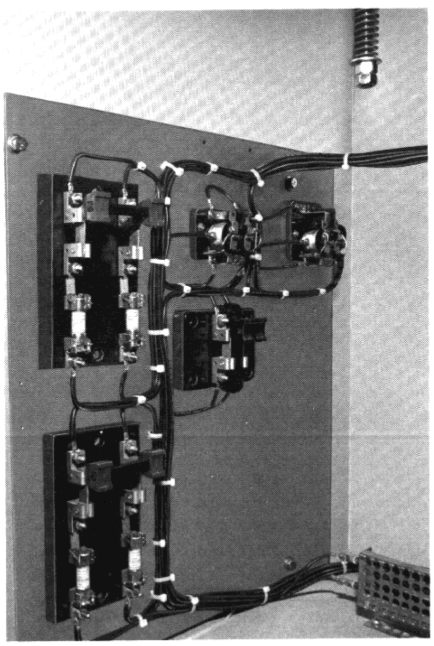
Type R & Type VKD-R Vacuum Circuit Breakers

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 disconnection. 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.

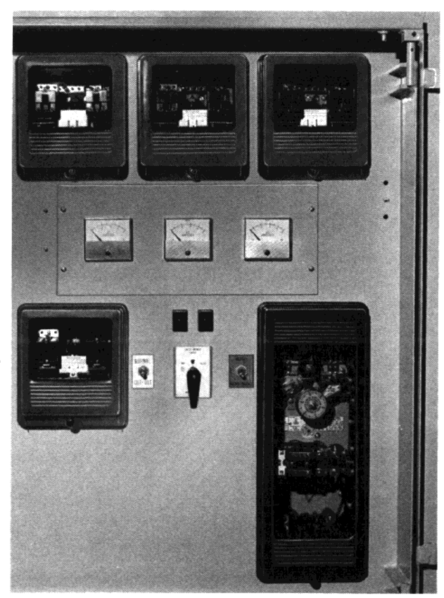
The operator can manually close the breaker by actuating the "PUSH TO CLOSE" button which discharges the closing springs. Stored energy makes the operating speed independent of operating personnel. This feature benefits the user in that the breaker can be manually closed into an energized circuit for 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.



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Type R & Type VKD-R Vacuum Circuit Breakers

Typical Specifications

Item	Continuous Current (Amps) 600				800		1200				2000			3000	1200					2000						
Breaker Type	R-1	R-2	R-3	R-4	R-2	R-3	R-2	R-3	R-4	VKD-R	R-3	R-4	VKD-R	R-4	R-1	R-1	R-2	R-2	R-3	R-3	R-1	R-1	R-2	R-2	R-3	R-3
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	15.5	15.5	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0
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	1.0	1.0	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	60	60	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	50	50	60	60	60	60	60	60	60	60	60	60	60	60
Wet 60 Hertz for 10 seconds	45	45	45	45	45	45	45	45	45	45	45	45	45	45	50	50	50	50	50	50	50	50	50	50	50	50
Full Wave Withstand (BIL)	110	110	110	110	110	110	110	110	110	110	110	110	110	110	125	150	125	150	125	150	125	150	125	150	125	150
Operating Duty (Standard Duty Cycle)	①	①	①	①	①	①	①	①	①	①	①	①	①	①	①	①	①	①	①	①	①	①	①	①	①	①
Interrupting Time (Cycles)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Permissible Tripping Delay Y (Seconds)	2	2	2	2	2	2	2	2	2	3	2	2	3	2	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	6.0	6.0	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	0.33	0.5	0.5	0.33	0.5	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	40	20	25	40	25	12.5	12.5	16.0	16.0	20.0	20.0	12.5	12.5	16.0	16.0	20.0	20.0
kA, RMS, Asym.	20	26	32	40	26	32	26	32	40	48	32	40	48	40	20.0	20.0	25.0	25.0	32.0	32.0	20.0	20.0	25.0	25.0	32.0	32.0
Close and Latch (Initial Current Loop) kA, RMS, Asym	20	26	32	40	26	32	26	32	40	64	32	40	64	40	20.0	20.0	25.0	25.0	32.0	32.0	20.0	20.0	25.0	25.0	32.0	32.0
Short Time Current (3 Seconds) kA, RMS, Sym	12	16	20	25	16	20	16	20	25	40	20	25	40	25	12.5	12.5	16.0	16.0	20.0	20.0	12.5	16.0	16.0	16.0	20.0	20.0
Transient Recovery Voltage (kV Peak) (Time to peak 63 µsec)	28	28	28	28	28	28	28	28	28	28	28	28	28	28	48	48	48	48	48	48	48	48	48	48	48	48
Load Current Switching Capability (Amperes)	600	600	600	600	800	800	1200	1200	1200	1200	2000	2000	2000	3000	1200	1200	1200	1200	1200	1200	2000	2000	2000	2000	2000	2000
Capacitance Current Switching Open Wire Line Charging Switching Current (Amps)		②	②	②	②	②	②	②	②	②*	②	②	②*	②	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*	②	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*	600	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	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	2.5	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)		50	50	50	50	50	50	50	50	50	50	50	50	50	20	20	20	20	20	20	20	20	20	20	20	20
Transient Inrush Frequency (Hertz)		2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	4240	4240	4240	4240	4240	4240	4240	4240	4240	4240	4240	4240
Interrupting Time (Cycles)		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Capacitor Current Switching Life (Operations)		1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	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	③	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	③	③	③	③	③	③	③	③	③	③	③	③	③

① 0-0.5 Sec. CO-15 Sec. CO-15 Sec. CO
② Up to 600 Amps RMS.
③ Grounded or ungrounded.
*1200 Amps available upon request

Stored Energy Mechanism Control Power Requirements

Rated Control Voltage	Spring Run Amperes	Charge Motor Time Sec.	Close① or Trip Amperes	Voltage Range Close	Voltage Range Trip
24V DC		6		—	14-28
48V DC	9.0	6	16	36-56	28-56
125V DC	5.0	6	15	90-140	70-140
120V AC	5.0	6	40	104-127	104-127
240V AC	3.0	6	29	208-254	208-254

① These are "worst case" continuous values for sizing protection or batteries only. Since trip and close coils normally operate in 1 cycle or less, actual currents during operation will be approximately half of these values.

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