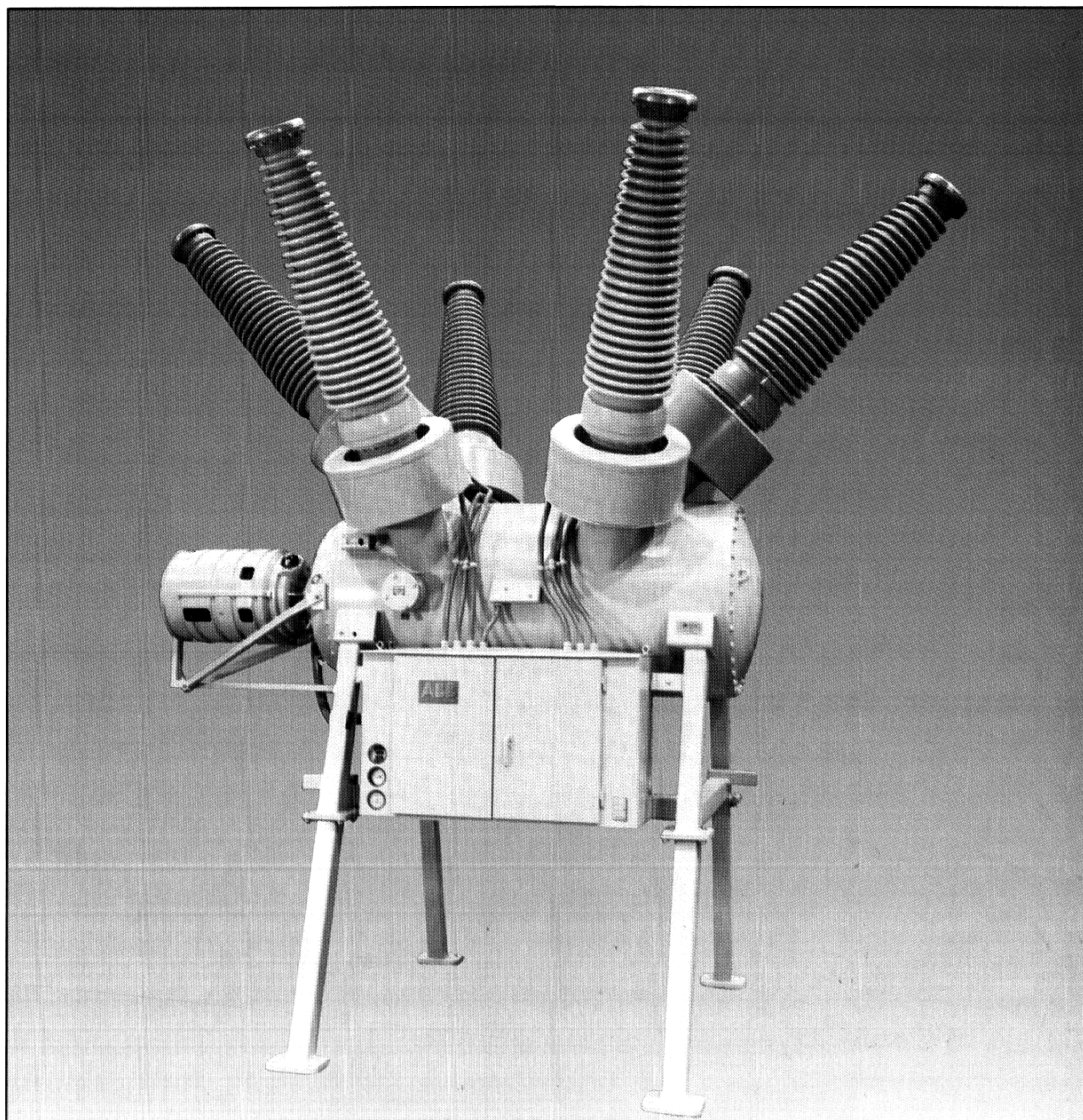




Type PA SF₆ Power Circuit Breakers

121 thru 242 kV Max. Voltage
1600 thru 4000 Amperes Continuous



Excellence In SF₆ Technology

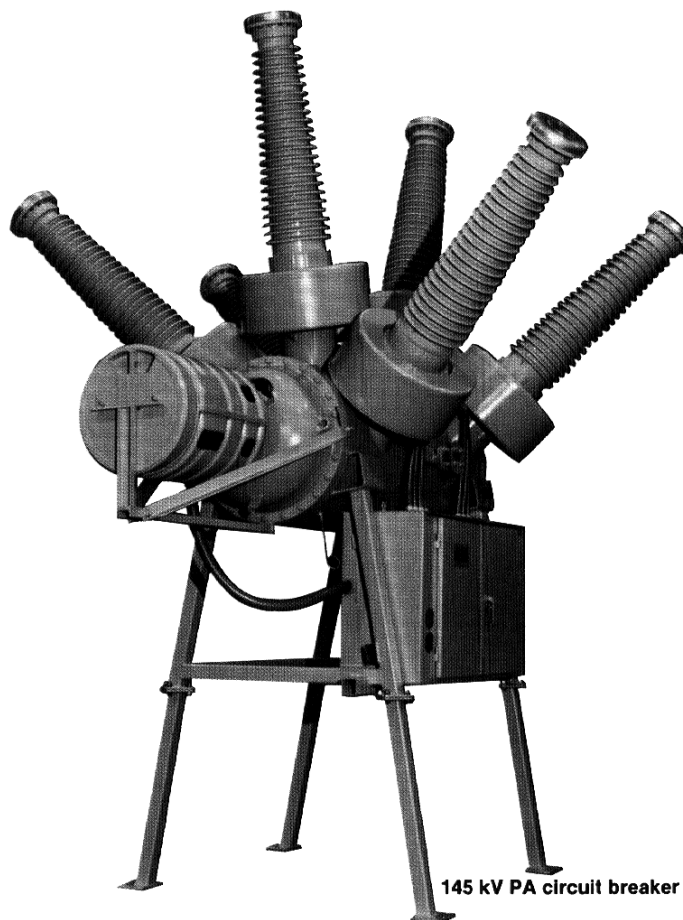
ASEA Brown Boveri PA Breakers

Tested Beyond ANSI Standards for the Highest In-Service Reliability and Performance

General

Type PA SF₆ power circuit breakers utilize the field-proven puffer principle of arc interruption. This principle entails compressing SF₆ during the opening stroke of the breaker and exhausting compressed SF₆ through the breaker contacts to extinguish the arc current.

The ABB line of dead tank, type PA SF₆ puffer circuit breakers has passed environmental and life tests far more severe than those required by ANSI standards. This extra testing has resulted in proven reliability, with over 900 PA breakers successfully operating in the field since June 1981. Further, the PA interrupter, operating mechanism and current transformers are proven in thousands of installations throughout the world.



145 kV PA circuit breaker

Features

- Puffer interrupter
- Dead tank design
- Breaker shipped fully assembled
- Hydraulic operating mechanism
- Single interrupter per phase
- Factory test of fully assembled breaker
- Single tank construction
- Exterior mounted current transformers on both sides of interrupter

User Benefits

- Reduced foundation requirements
- Minimum maintenance
- Out of phase switching
- High speed interruption
- No oil handling
- Reduced installation time
- Low noise level
- Capacitor switching capability
- Fire hazards removed
- Increased seismic capability
- Ease of installation

Table of Contents

General, Features and Benefits	2	Hydraulic Operating Mechanism	4-5
Description	3	Bushings, Control Cabinet	6
Ratings and Insulation Levels	3	Weights and Dimensions	7-8
Interrupter Design	4	Bushing Current Transformer	9
Interrupter Operation	5		

This brochure does not cover all details or variations in equipment design. Should further information be desired or particular applications arise which are not covered sufficiently, please refer to our nearest Regional Office.

Description

The PA breaker tank and interrupter are charged to a single SF₆ gas pressure of 87 psig. All three interrupters are enclosed in the breaker tank. Each interrupter is within a fiber reinforced epoxy tube to isolate arcing from one phase to another, and from the grounded tank wall.

The PA breaker is designed to optimize the mechanical drive and gas sealing systems, while maximizing accessibility for breaker maintenance. Illustrations show the principal breaker components which are discussed below:

The **main tank** houses three single

phase SF₆ puffer interrupters while supporting the hydraulic operating mechanism and six bushings with a maximum of three CTs per bushing.

The **hydraulic-mechanical mechanism** incorporates control valves, hydraulic actuator, hydraulic pump and spring accumulator. The hydraulic actuator is located in line with the main drive shaft of the breaker, eliminating the need for bell cranks or lever systems, enhancing reliability of the mechanical drive system.

The **main drive shaft** provides connection to the mechanical drive

spreader, delivering opening and closing forces to the interrupters of all three phases simultaneously.

Each **insulating support tube** supports an interrupter assembly.

Bushing connections to the interrupter assemblies are accomplished by flexible shunts off the bushing lower end studs.

Current transformers are external to the breaker SF₆ system for maximum accessibility. Each bushing can accommodate up to three current transformers.

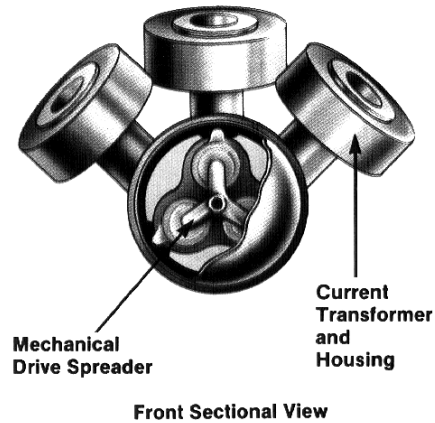
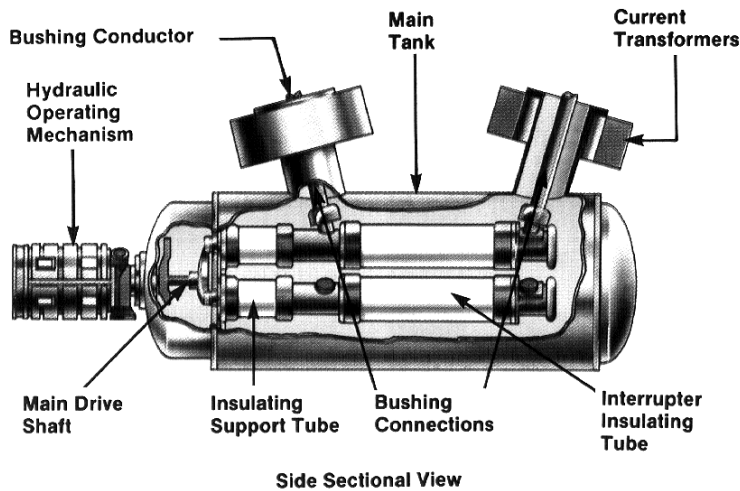


Table 1 — Ratings

Breaker Type	Voltage	Current (1) (2)				Inter-rupting Time, Cycles
	Maximum kV, RMS	Interrupting kA, RMS		Continuous A., RMS	Closing & Latching Capability kA., RMS	
		Sym.	Asym.			
121PA	121	40 50 63	52 65 82	1600	64 80 101	2
145PA	145	40 50 63	52 65 82	2000 2500 3000 4000	64 80 101	3
169PA	169	40 50 63	52 65 82		64 80 101	3
242PA	242	40 50 63	52 65 82		64 80 101	3

Table 2 — Insulation Level

Breaker Type	Insulation Level (Withstand Test Voltage)			
	Low (60 Hz) Frequency kV, RMS	Impulse kV, Crest	Chopped Wave	
			2 Micro-seconds, kV	3 Micro-seconds, kV
121PA	260	550	710	632
145PA	310	650	838	748
169PA	365	750	968	862
242PA	425	900	1160	1040

Notes: (1) The current values for the 3 second short-time current carrying capability are the same as the symmetrical interrupting current.
(2) Interrupting value does not have to be derated for reclosing duty.

Interrupter Design

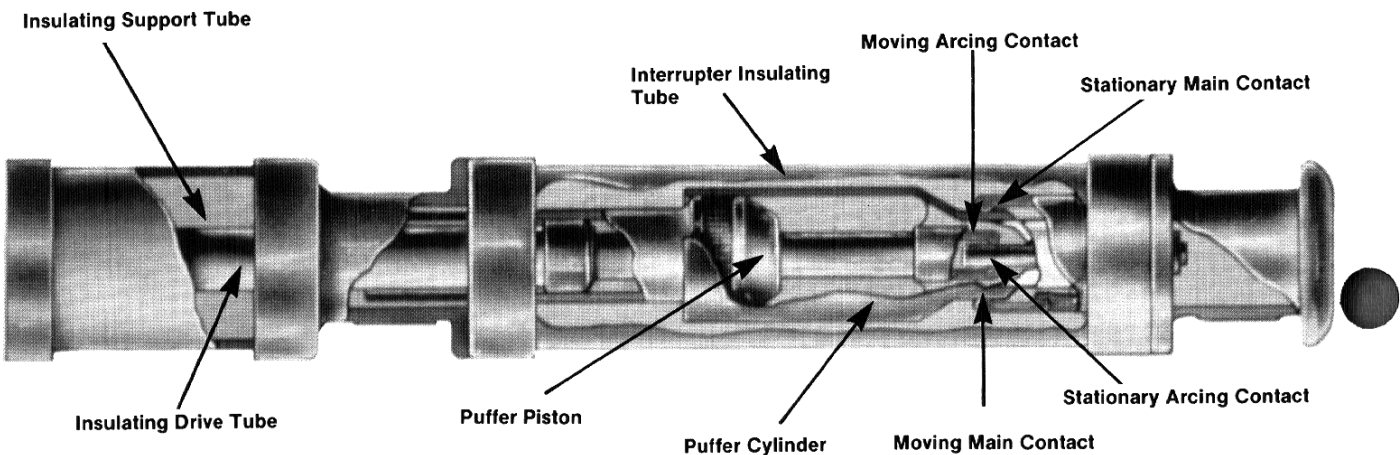
The PA breaker design incorporates one single break puffer interrupter per phase. The interrupters are precision manufactured, eliminating the need for adjustment or alignment. The PA interrupter is rated for two or three cycle interrupting time at all current levels up to its full short circuit rating. It is restrike free on 180° out of phase switching or capacitor switching operations; and, is capable of handling repetitive reclosing duty without derating.

The ABB puffer interrupters are

supported by a common mounting plate within the tank assembly. The three interrupting assemblies are mounted in a triangular, horizontal configuration inside the breaker tank. Each interrupter is enclosed in a reinforced epoxy tube which isolates any arcing within each phase and from adjacent phases and the grounded tank.

The interrupting contacts are directly connected to the operating mechanism via the drive rod extending from the hydraulic actuator.

Interrupter wear is confined to the arcing contacts by the teflon nozzle. PA interrupters are capable of 2000 load switching operations without maintenance. Main and arcing contacts and the teflon nozzle can be easily inspected or removed without disturbing the interrupters, operating mechanism or bushings. The principal components of a single phase interrupter (shown in the closed position) are illustrated below.



Hydraulic-Mechanical AHMA Mechanism

The hydraulic-mechanical AHMA mechanism employed for the Type PA circuit breaker combines the advantages of the hydraulic operating mechanism with the advantages of a mechanically stored energy.

The operating mechanism AHMA offers:

- Mechanically Stored Energy
- Long-Term Stability and Temperature Independence of the Storage Energy System
- Hydraulic Fluid as an Energy Carrier
- Wear-Free Cylinder-Piston Unit for Power Transmission
- Integrated Hydraulic Damping
- No External High-Pressure Friction Seals, No Pipe Unions in the Hydraulic Systems,

- Reducing Potential Oil Leakage
- Hydraulic System Hermetically Sealed Against the Atmosphere, Minimizing Corrosion Possibility

Energy storage is accomplished with the aid of a plate spring assembly. Long term stability, reliability and temperature independence are primary advantages of the AHMA system.

Table 3 - Rating

Breaker Rating	Closing Time	Reclosing Time (Adjustable)	Hydraulic Pump Motor	Tripping				Closing				Space Heaters	
				Voltage Range	Current	Voltage Range	Current	Voltage Range	Current	Voltage Range	Current		
				125 V DC		250 V DC		125 V DC		250 V DC		WATTS	
kV	Cycles	Cycles	HP	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Op. Mech.	Control Cabinet
121 145 169 242	4	15-120	1.2	70-140	3	140-280	1.7	90-140	3	180-280	3	70*	300**
							1.8						

* 210 W optional for -40°C

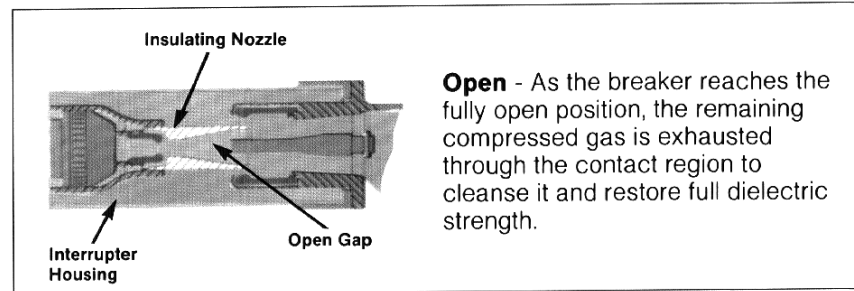
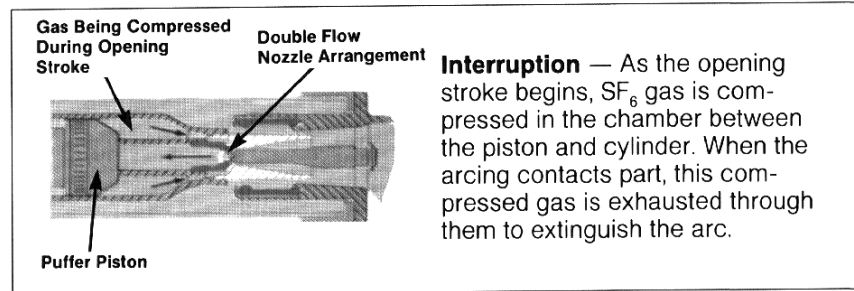
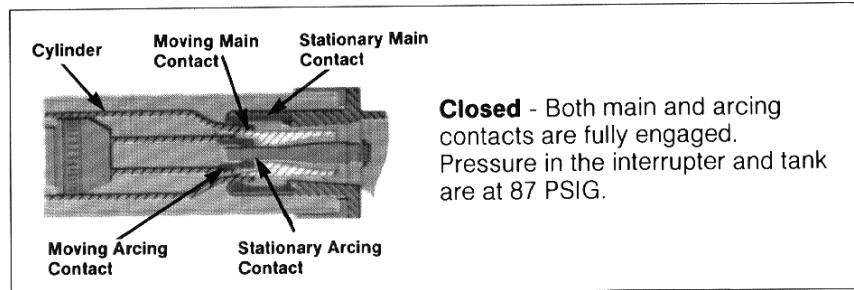
** Note: 150 watts continuously energized and 150 watts thermostatically controlled

Interrupter Operation

The SF₆ gas pressure required to interrupt the arc is generated by the moving contact assembly. When the contacts part, the resulting arc limits the flow of SF₆ gas out of the moving cylinder. As the gas volume is reduced by the movement of the cylinder the SF₆ gas pressure is increased between the arc and the stationary piston. The compressed gas flows from the cylinder through the arcing zone, interrupting the current.

After interruption, the breaker opening movement continues to the end of the stroke. The gas flow during this portion of the opening movement clears all arc products and hot gases from the arcing zone. The SF₆ gas reverts to the single low pressure of 87 psig. Final contact separation is sufficient to provide full dielectric withstand at that pressure.

During the closing stroke the SF₆ gas is drawn back into the moving cylinder through a check valve and through the nozzle end of the moving contact. The arcing contacts are closed prior to the main contacts, which carry the continuous current.



The design of the AHMA operating mechanism allows for high efficiency and easy maintenance. All hydraulic elements are integrated in the high pressure section, and all of the components are arranged around the main axis of the central high pressure section. The cover of the

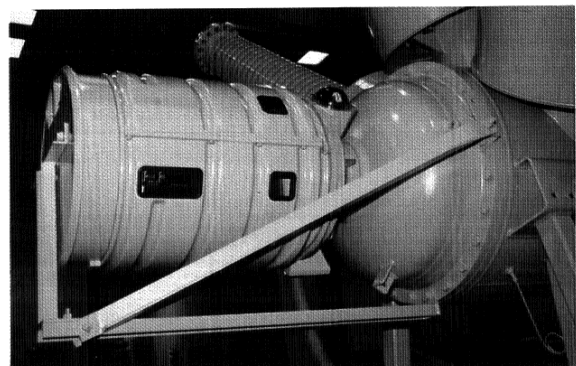
mechanism is easily removed and provides quick access to the electrical monitoring and control elements.

Monthly and yearly recommended maintenance of the mechanism involves little more than a check of the oil level and examination for

external leakage or damage. A more detailed inspection of the internal elements of the mechanism is recommended every five years.

Table 4 - SF₆ Gas System

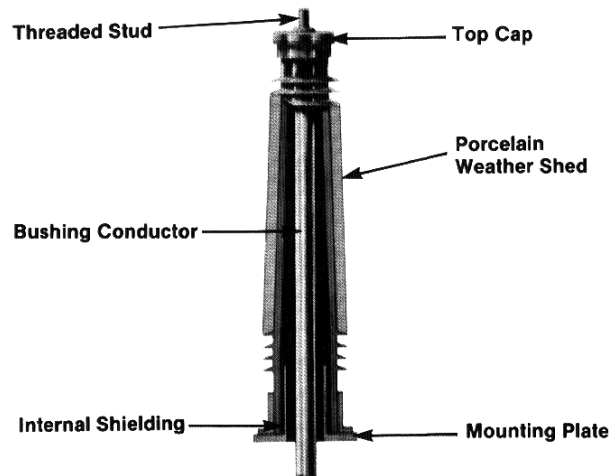
Breaker Rating	Rated Operating Pressure	Minimum Operating Pressure for full Interrupting Capability	Weight		
			With Gas	Without Gas	SF ₆ for Breaker
kV	PSIG	PSIG	LBS.	LBS.	LBS.
121	87	72	10900	10700	200
145			13320	13000	320
169 242			15200	14850	350



Bushings

Breaker bushings are filled with SF_6 which enters the bushing from the breaker tank. The voltage stress at the lower end of the porcelain weather shed is effectively graded by using internal shielding. The bushings are factory installed and the breaker is shipped with bushings in place and filled with SF_6 at 7 psig. Bushings are designed to meet applicable ANSI and NEMA design specifications when assembled to the breaker.

Optional high creep and high altitude designed bushings are available with the PA line of power circuit breakers.

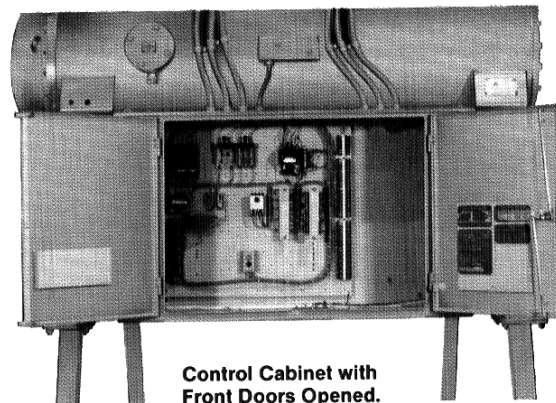


Control Cabinet

The control cabinet houses the components required for electrical control of the breaker including relays, density monitor, SF_6 pressure gage, and control switches. Terminal blocks for internal and customer connections are readily accessible.

Mechanically driven auxiliary switches are easily adjustable and convertible from A to B contacts.

Operating controls are surface mounted on a panel attached to the rear wall of the cabinet.

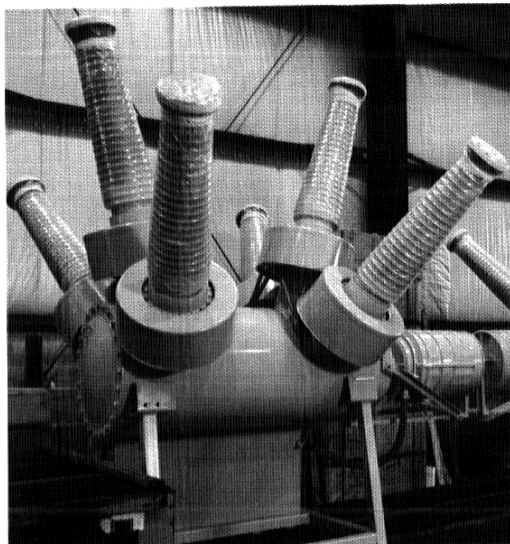


Control Cabinet with Front Doors Opened.

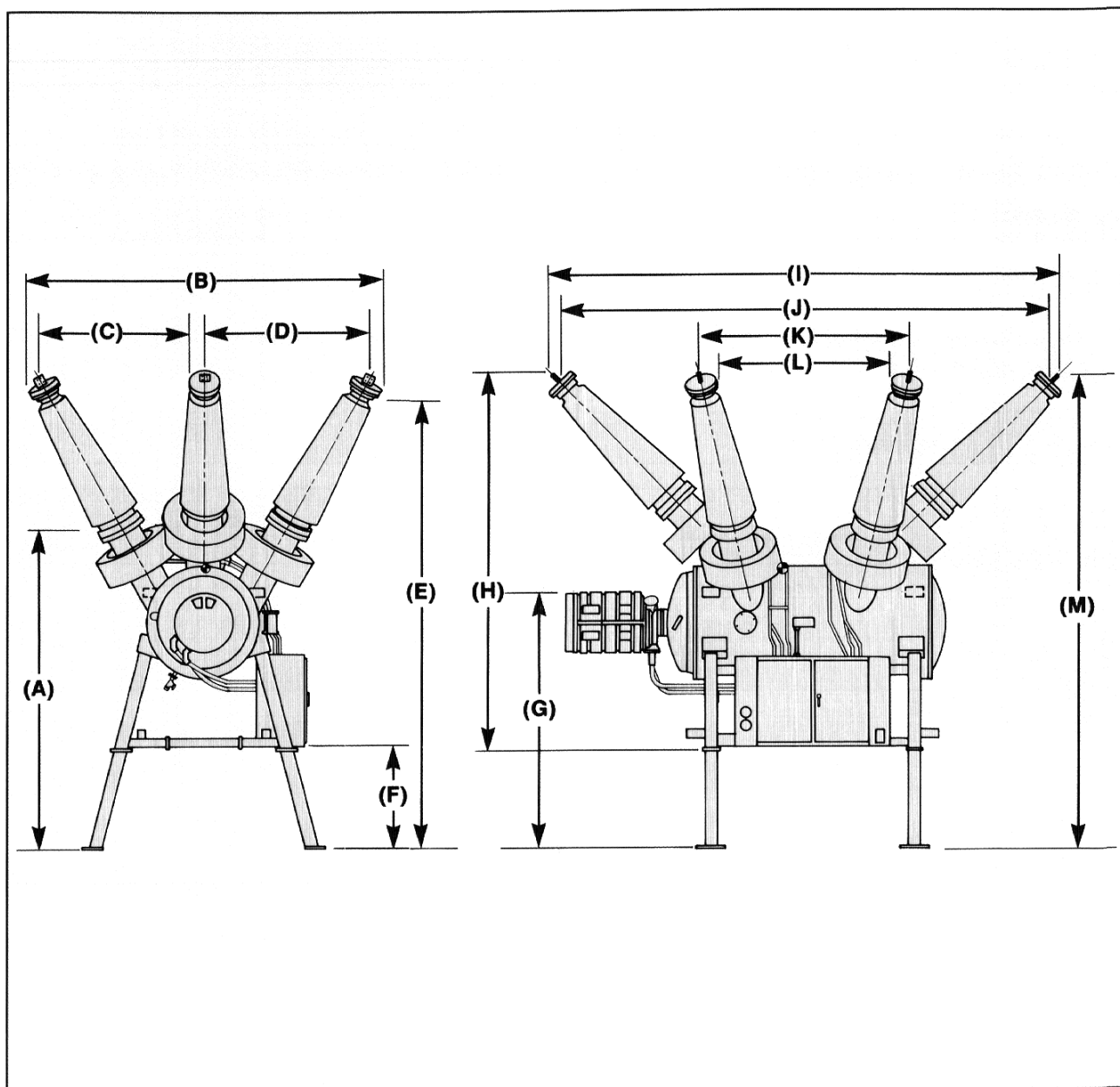
Shipping and Installation

ABB PA power circuit breakers are shipped with tanks and bushings fully assembled for ease of installation. Only the breaker extension legs and bushing top terminals are shipped unassembled and must be installed after receipt in the field.

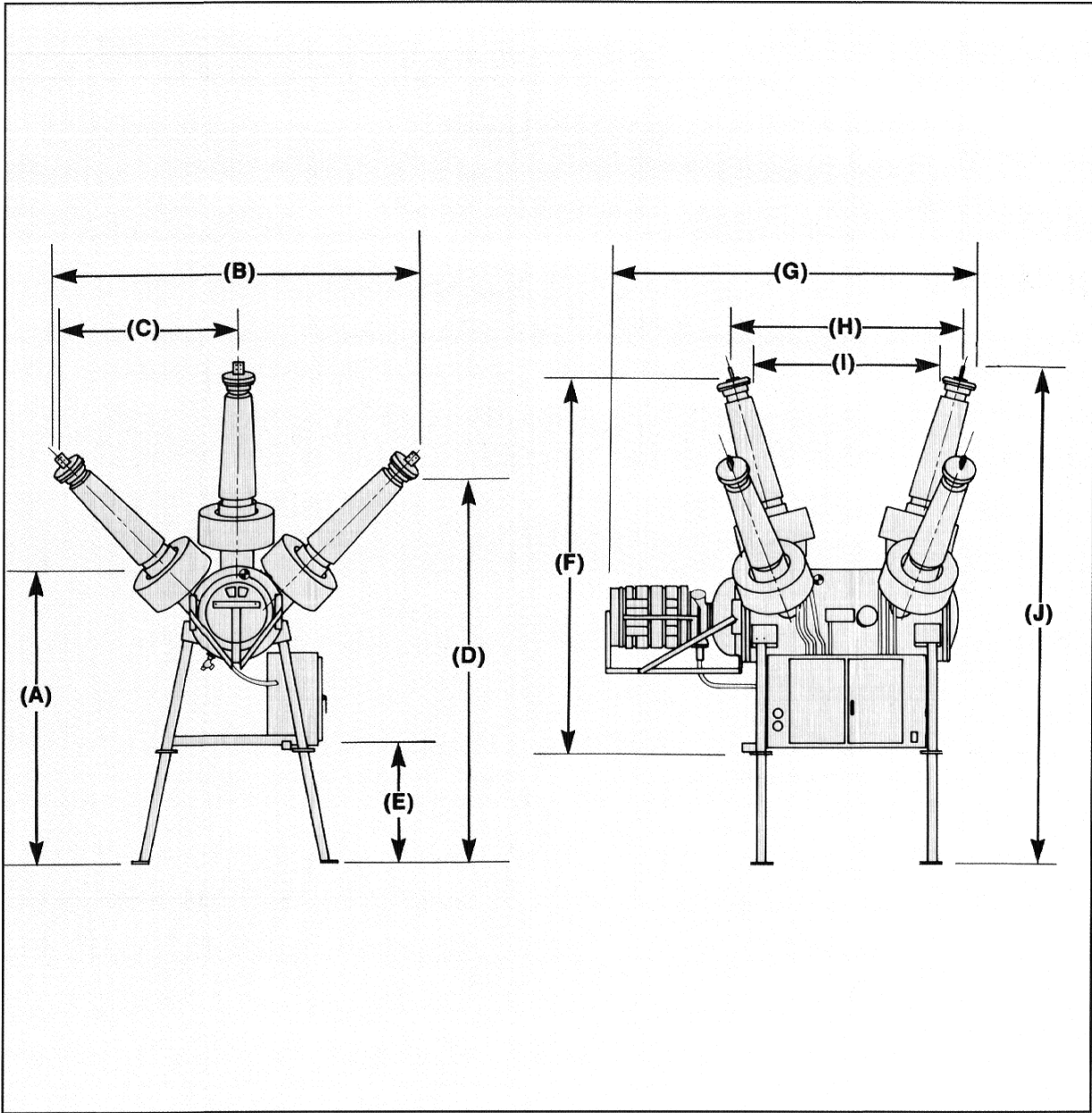
Along with the breaker assembly, extension legs and bushing top terminals, the PA comes with a field assembly kit, service kit and instruction manual.



Typical Breaker Delivery



Breaker Type	Dimension in inches													Weight in Pounds	
	A	B	C	D	E	F	G	H	I	J	K	L	M	With Gas	Without Gas
169 PA	121	136	72	88%	172 $\frac{1}{4}$	36	98 $\frac{1}{4}$	151 $\frac{1}{2}$	198 $\frac{3}{4}$	190 $\frac{7}{8}$	83 $\frac{1}{2}$	69 $\frac{1}{4}$	182 $\frac{1}{2}$	13320	13000
242 PA	127%	143 $\frac{1}{4}$	74 $\frac{1}{4}$	91 $\frac{1}{4}$	183 $\frac{1}{2}$	40 $\frac{7}{8}$	103 $\frac{1}{8}$	151	209 $\frac{7}{8}$	198 $\frac{15}{16}$	86 $\frac{1}{4}$	70%	192	15200	14850



Breaker Type	Dimension in inches										Weight in Pounds	
	A	B	C	D	E	F	G	H	I	J	With Gas	Without Gas
121PA/145PA	117½	139¾	70 1/16	149¼	46¾	151¼	143½	88 9/16	72 3/16	197¼	10900	10700

Bushing Current Transformers

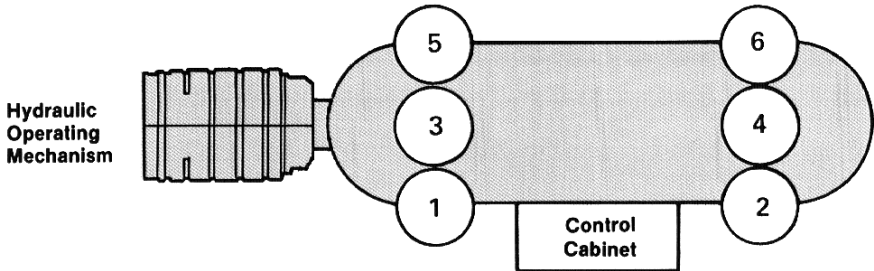
Current transformers are located external to the bushings. They may be installed or removed without disturbing the bushings. Multi-ratio relaying or single ration metering current transformers are in accordance with ANSI standards, and available in combinations up to three current transformers per bushing. The current transformers

are enclosed in removable weather-proof housings.

The cores are wound of special grain-oriented silicon steel strip and are individually tested for electro-magnetic properties. All CT's are wound with distributed windings to provide high accuracy. The insulating materials provide high

dielectric and mechanical strengths.

CT leads are conveniently terminated inside the control cabinet where all control circuitry is housed. All customer conduit enters at the bottom of the control house. A removable plate suitable for field drilling is provided.

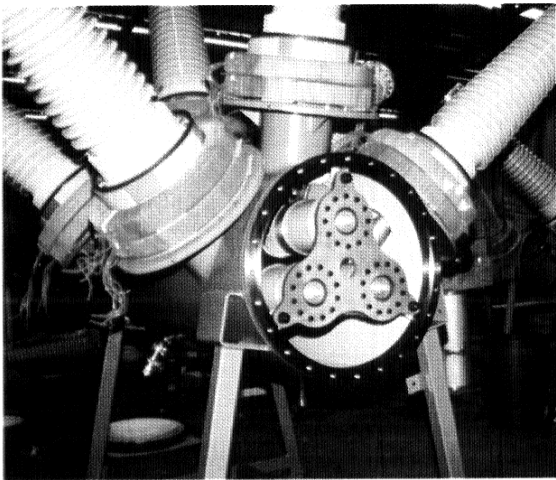


Schematic Top View Showing CT location

Table 5 — Bushing Current Transformers
Relaying — 5 Lead, ANSI C800 Accuracy

Ratio	Tap Ratios	Ratio	Tap Ratios
1200-5	100-5	2000-5	300-5
	200-5		400-5
	300-5		500-5
	400-5		800-5
	500-5		1100-5
	600-5		1200-5
	800-5		1500-5
	900-5		1600-5
	1000-5		2000-5
	1200-5		
1600-5	200-5	3000-5	300-5
	400-5		500-5
	600-5		800-5
	800-5		1000-5
	1000-5		1200-5
	1200-5		1500-5
	1400-5		2000-5
	1600-5		2200-5
			2500-5
Metering — 2 Lead			
Ratio		Accuracy	
1600-5		0.3 B 0.5	
2000-5		0.3 B 0.5	
3000-5		0.3 B 0.5	

Custom designed current transformers to meet specific requirements are available.



Bushing current transformer shown without housing & secondary leads not connected.



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