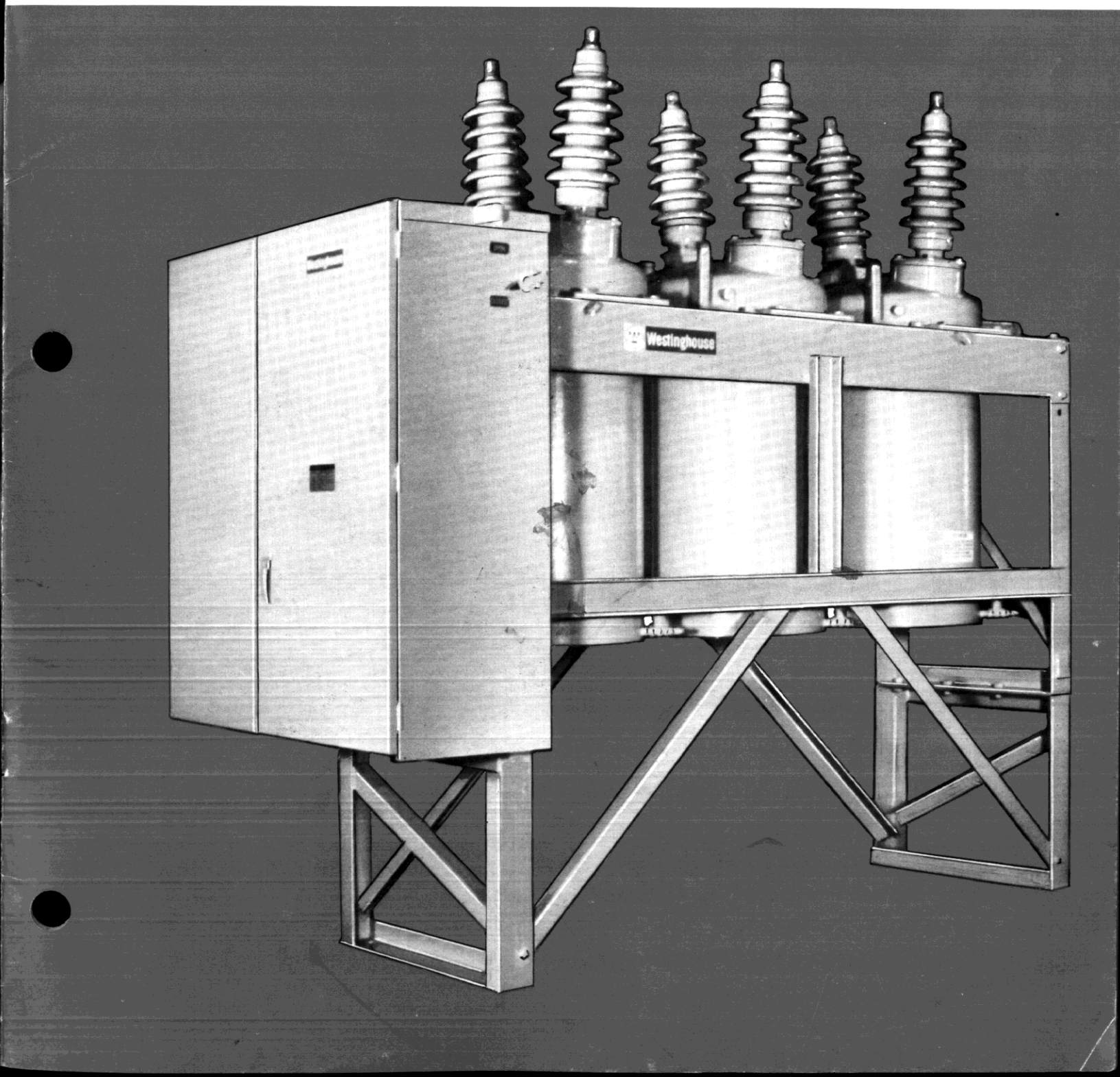
Westinghouse Electric Corporation
Power Circuit Breaker Division
Trafford, Pa. 15085

November, 1978
Supersedes DB 33-252,
Dated June, 1972

E,D,C/1949/DB

14.4 thru 69 kV, 1500 thru 3500 mVA

Type G Outdoor Three Tank Oil Circuit Breakers



Application

For 14.4 through 69 kV transmission systems where phase isolation, high continuous current, or capacitor switching applications are required.

Type G breakers combine high interrupting capacities, short arcing time and high-speed 20 Hz reclosing with streamlined tank top construction to provide complete reliability, fast fault-clearing and easy maintenance.

Advantages

High Unit Reliability
Simplicity of design reduces dependence on auxiliary equipment.

Use of designs, components and materials which have proven reliable in service, for example relatively simple and rugged pheumatic operating mechanisms and "De-ion" grid interrupters.

Manufacture and selection of materials are closely controlled, and units are thoroughly tested during and after manufacture.

High System Reliability
Pneumatic mechanism with air reservoir allows 5 closing operations even if control power to the compressor is lost.

Low Maintenance
Pneumatic operation of the closing mechanism provides uniform pressure throughout the complete closing stroke and smooth breaker operation.

Arc resistant surfaces are brazed to contacts and 100% quality control checked reducing the possibility of separation.

Reduced Shipping Cost and Time
Split frame design allows shipment by standard flat bed truck directly to the substation.

At the site the breaker is bolted to the subframe, raising it to the proper height.

Superior Electrical Characteristics
"De-ion" grid arc-quenching interrupters provide high interrupting capacity, short arcing time and high-speed reclosing.

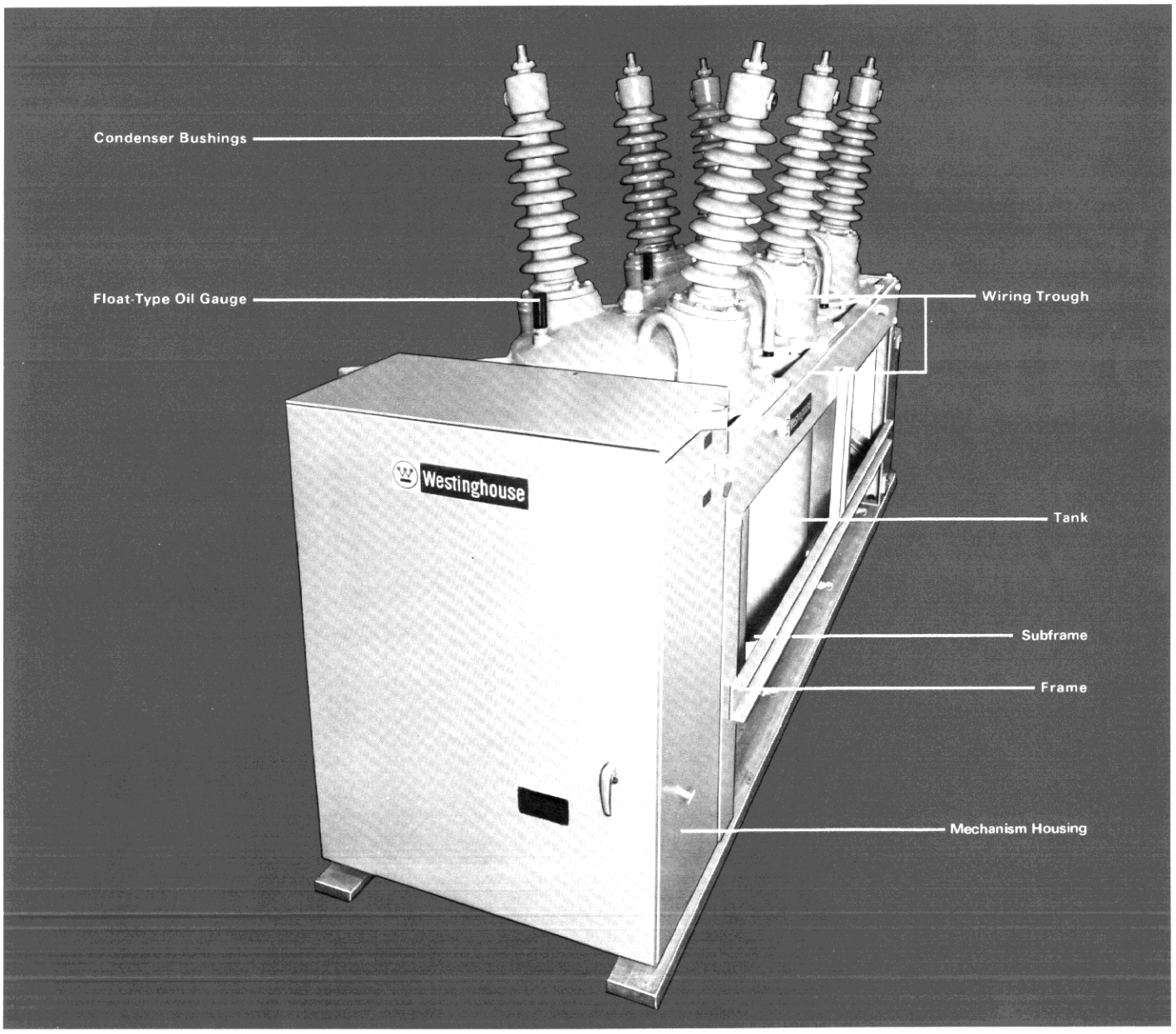
Mechanically and Electrically Trip-Free Mechanisms
When closing against a faulted circuit, duration of the fault current on the system is minimized, reducing damage to line and breaker.

Standard Ratings

14.4 kV Through 69 kV, Type G, Three Tank, Frame Mounted Oil Circuit Breakers

Breaker Type	Nominal Voltage Class kV	Rated Continuous Current Amperes	Nominal 3-Phase MVA
144 G 1000	14.4	1,200	1,000
144 G 1500	14.4	3,000	1,500
144 G 1500	14.4	4,000	1,500
144 G 1500	14.4	6,000	1,500
230 G 1500	23.0	1,200	1,500
345 G 1500	34.5	1,200	1,500
345 G 1500	34.5	2,000	1,500
345 G 2500	34.5	2,000	2,500
345 G 2500	34.5	3,000	2,500
460 G 1500	46.0	1,200	1,500
460 G 2500	46.0	1,200	2,500
460 G 2500	46.0	2,000	2,500
690 G 2500	69.0	1,200	2,500
690 G 3500	69.0	1,200	3,500

Design Features



Type G oil circuit breakers are mounted on a split frame permitting the breaker to be shipped by conventional truck directly to the substation site. This feature saves additional transportation and crane charges in transporting the breaker from the nearest rail siding to the substation. In addition, it eliminates the possibility of rail damage in transit. Once at the site, the breaker is bolted to the subframe, raising it to the proper height required by standards. When completely assembled, tanks can be lowered with the use of (optional) tank lifters and slid clear of the frame without removing structural members.

The top frame member is also used as a weatherproof wiring trough. Wiring is accessible underneath through a removable plate. Bushing current transformer leads are brought out through conduit to wiring trough.

All tap leads are run through wiring trough to readily accessible terminal blocks in the operating mechanism housing. Pressure seals prevent oil or arc gas from passing from the tank to the trough and can be easily removed for changing transformer leads.

Deep drawn steel tank tops enclose the pole unit lever assemblies, giving greater accessibility to moving parts. The resulting streamlined top design makes cleaning faster and easier. Tanks are seam-welded steel boiler plate hydrostatically pressure-tested. The large diameter base provides stability when the tank is lowered.

Float-type oil gauge on each pole unit gives positive indication of oil level without leakage.

Standard Condenser Bushings
Westinghouse Type G oil circuit breakers are available with various standard types of condenser bushings based on breaker rating:

Rating	Standard Bushing Type
14.4-46 kV, 1200 Amperes	Type QS
14.4-46 kV, 2000 Amperes	Type S
14.4 and 34.5 kV, 3000 Amperes	Type S
14.4 kV, 4000 and 6000 Amperes	Type E
69 kV, 1200 Amperes	Type O

The Type OS oil-filled condenser bushings are for ratings 14.4 kV through 46 kV, 1200 amperes continuous current ratings. On this design the entrance conductor is a hollow copperstud threaded for terminal connection. Insulating layers of treated paper are wound around the stud under heat and pressure. Epoxy Resin on the paper binds them into a homogeneous insulation. Interspersed at regular intervals between the layers of paper are sheets of metal foil, which form condenser plates. This series of condensers distributes the voltage stress evenly through and across the insulation.

A single piece porcelain weather casing surrounds the condenser. Effective solder seals at both the top and bottom of the weather casing secure the oil contained in the space between the weather casing and the condenser. A leakproof magnetic coupled gauge at the top of the bushing provides continuous oil level indication.

The type OS bushing meets all ANSI standards for these ratings of bushings.

The Type S condenser bushings are used for ratings 14.4 kV and 34.5 kV at 2000 and 3000 amperes continuous current and at 46 kV, 2000 amperes continuous current. The entrance conductor is a hollow copper stud threaded for terminal connection. Insulating layers of treated paper are wound around the stud under heat and pressure.

Treating compound in the paper binds them into a homogeneous insulation.

Interspersed at regular intervals between the paper layers are sheets of metal foil, which form condenser plates. This series of condensers distributes the voltage stress evenly through and across the insulation.

A single-piece porcelain weather casing surrounds the condenser. The porcelain is flexibly supported at the base by a copper diaphragm and at the top by a flexible copper cap, to compensate for expansion and contraction differentials. Solder-seal joining of porcelain to copper ring and caps forms a hermetically-sealed, moisture-tight housing without gaskets. The space between the porcelain and condenser is filled with a plastic compound which retains its plastic and adhesive properties over the temperature range of breaker operation.

The Type E solid core epoxy condenser bushings are available for ratings 14.4 kV, 4000 and 6000 amperes continuous current. The Type E epoxy bushing incorporates a solid epoxy core-condenser assembly, a metallic mounting flange and a track-resistant, weatherable epoxy weather case that is bonded directly to the epoxy core.

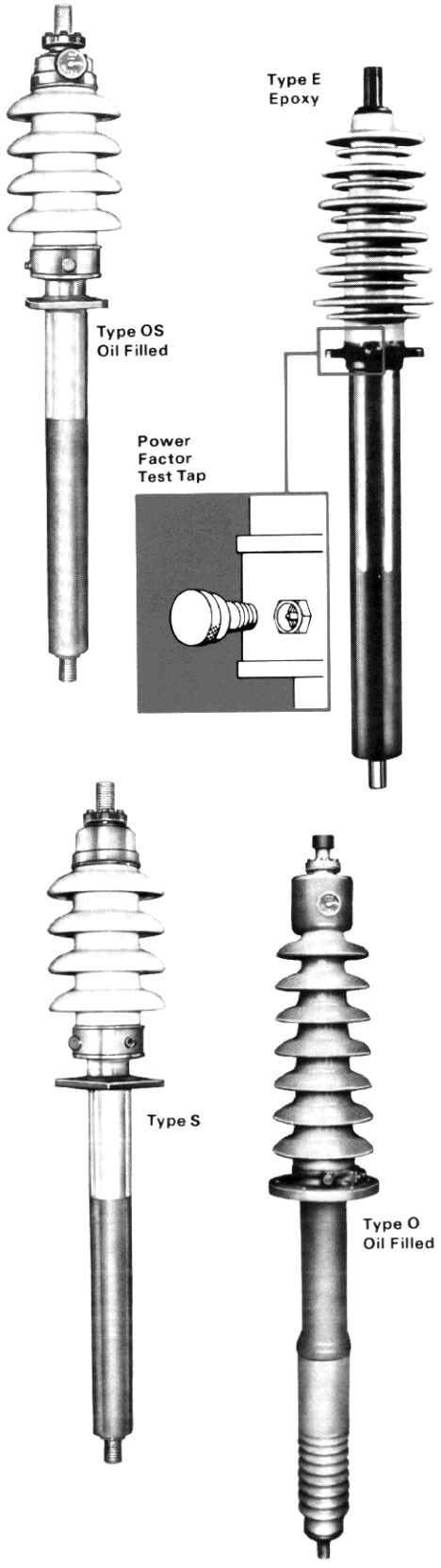
With the solid core epoxy bushing there is no oil impregnated paper but rather solid epoxy. However, the condenser principle used in the oil-filled bushings is retained. The construction of the solid epoxy core is such that when the epoxy is poured the resultant surrounding the central hollow copper conductor is a layer of epoxy, a sheet of metal foil, another layer of epoxy, another sheet of metal foil, etc., ending with a layer of epoxy. This forms the cylindrical capacitor required to uniformly divide the voltage vertically, as well as, horizontally in the bushing. Through utilizing the proper fillers the solid epoxy core will have the same thermal coefficient of expansion as the conductor.

Bonded to the solid epoxy core is a metal mounting flange and bonded to both the core and the flange is an outer weatherable single piece epoxy insulator.

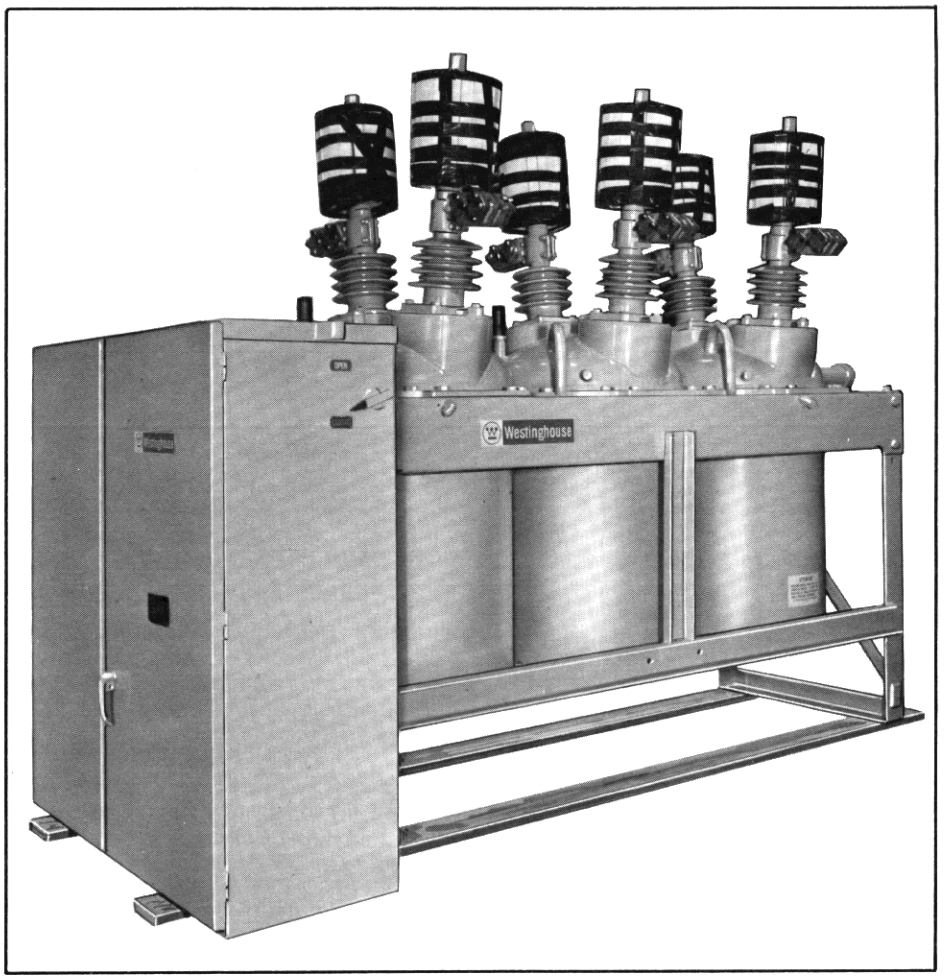
The Type O oil-filled condenser bushings are available at the 69 kV breaker ratings. This design incorporates a series of condensers formed by alternate layers of oil-impregnated paper and metal foil wound on a central copper conductor. The foils equalize the electrical stress internally and over the top and bottom of the weather casing surfaces. The single-piece porcelain weather casing and the epoxy inner frustum comes standard. This construction is radio influence voltage free. Effective seals and allowance for overload temperature ranges ensure long life.

A leakproof indicator at the top of the bushing provides continuous oil level indication. Type O bushings meet ANSI Standards for apparatus bushings.

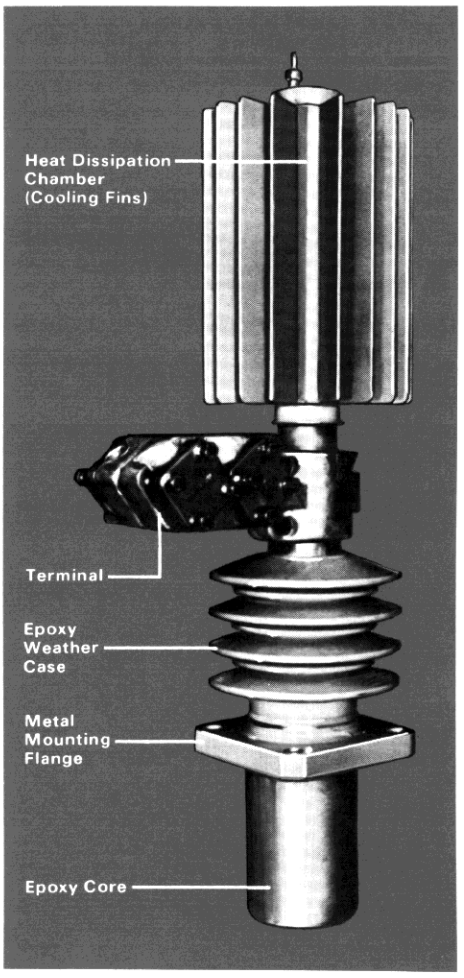
Power Factor Test Tap
Accurate power factor testing of the complete bushing, in place, is simplified by an ungrounded test-tap. The power factor tap is grounded to the bushing flange while the breaker is in service. For testing, the ground is removed. The power factor of the insulation, only, can then be measured, by using an ungrounded test set. This eliminates extraneous effects of oil, De-ion grids, or parallel insulation of incoming lines.



High Ampere Breakers Carry Up to 6000 Amperes Continuous Current.



6000 ampere continuous current breaker—a Westinghouse exclusive.



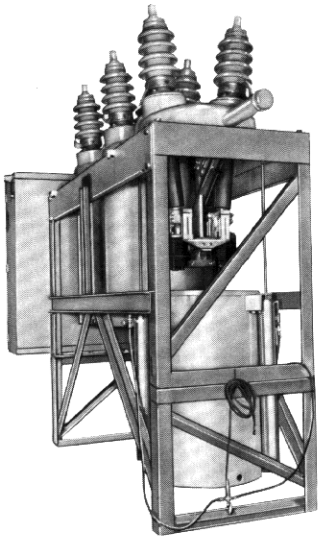
Patented Bushing, Developed by Westinghouse specifically for the 6000 Ampere Breaker Rating.

Westinghouse offers a complete line of high ampere breakers, made possible by high current-carrying auxiliary contacts and a new bushing design. The full line includes a 2000 and 3000 ampere continuous current design at 34.5 kV, a 2000 ampere rating at 46.0 kV and at 14.4 kV, 1500 MVA a 3000 and 4000 ampere rating in addition to the new 6000 ampere continuous current rating is also offered at 23 kV, 2000 MVA.

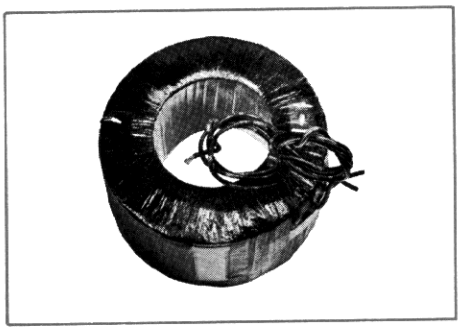
To efficiently dissipate the heat in this new 6000 ampere design, the Westinghouse bushing utilizes an effective heat-dissipation principle previously unused in bushings. This unique Type E bushing design uses a copper conductor filled with Freon (or Methanal) sealed at the bottom and top and equipped with cooling fins at the top. The Freon (or Methanal) circulates by natural convection within the conductor from the bottom to the conductor fins at the top, dissipating the heat from the fins again through convection to the atmosphere.

In addition to this unique cooling procedure, the bushing utilizes epoxy instead of impregnated paper. The design retains the condenser principle, whereby equal capacity condensers or capacitors in series divide the voltage uniformly from the conductor outwardly. However, in the 6000 ampere continuous current breaker, the use of epoxy to replace the impregnated paper provides an improved dielectric with a lower power factor. In addition the outer weatherable insulator is providing the same advantages as the standard Type E epoxy bushings discussed on page 4.

Tank Lifter
For raising and lowering pole tanks, pneumatic tank lifters are available.



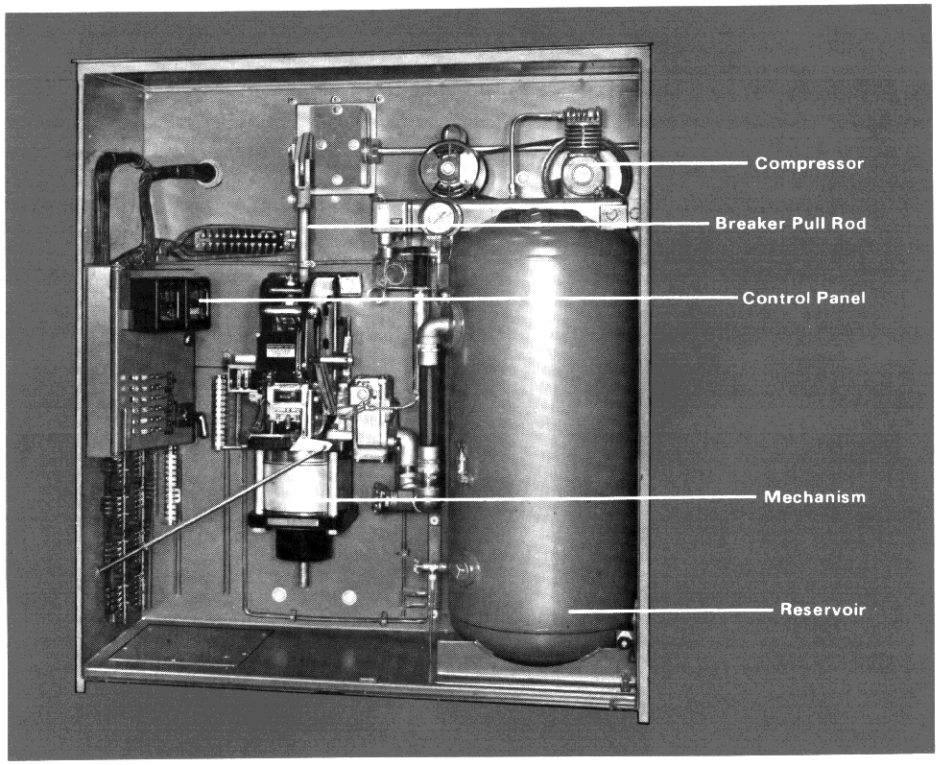
Bushing Current Transformers



On standard breakers, a multi-ratio current transformer is provided around each bushing. These current transformers meet all ANSI and NEMA requirements for relaying and indicating instrument applications. If additional standard accuracy current transformers are required, a total of three per bushing can be supplied. Additional current transformers can be installed on customers' breakers at any time without distrubing the mounting of the original transformers.

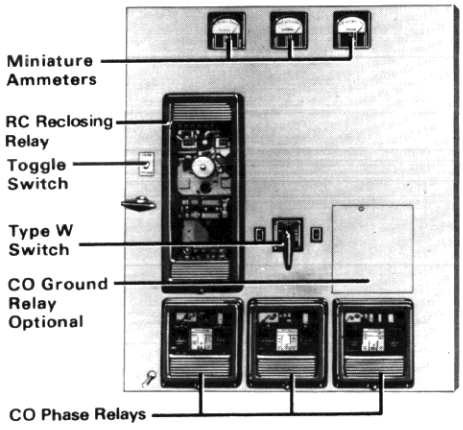
ANSI metering accuracy single-ratio current transformers can be supplied in place of, or in addition to , relaying transformers. Linear couplers can be supplied for bus differential protection.

Operating Mechanisms



Pneumatic Mechanism
The Type AA-7 or AA-10 pneumatic mechanisms used on Type G breakers are fast operating with low control currents, and are particularly suited for high-speed reclosing or installations with limited station battery capacity. Mechanisms are mechanically and electrically trip-free with unrestrained opening under all conditions. The Type AA-7 pneumatic mechanism is used at 1200 amperes continuous current while the AA-10 pneumatic mechanism (pictured above) is used on all high current ratings.

High-Speed Reclosing Equipment is Available at 1200 Ampere Continuous Current Ratings.



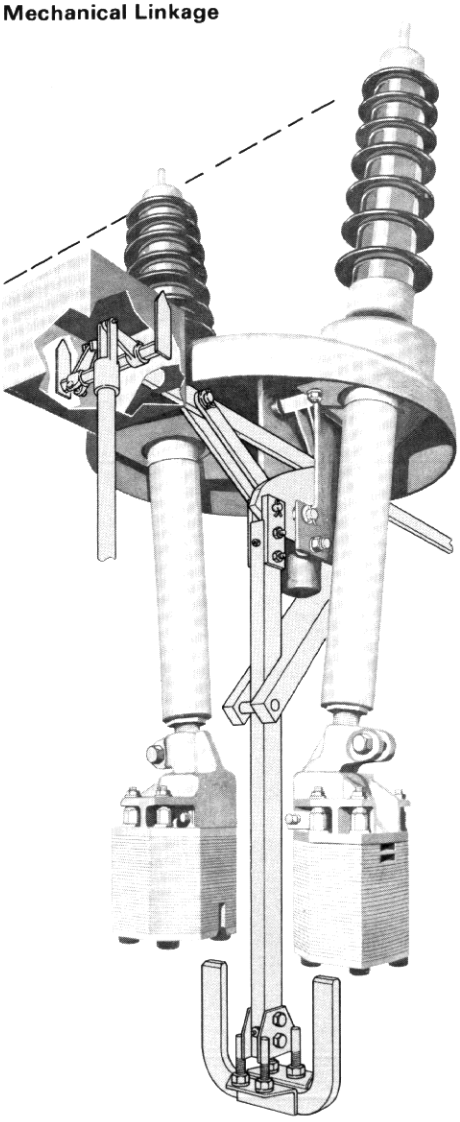
The mechanism-control cabinet includes an automatically controlled motor-driven compressor, an air storage reservoir, a pressure relay, a pressure gauge, a safety valve and a condensation drain valve. At normal pressure, the reservoir holds enough air for five successive closings without compressor operation. The air supply system meets ASME insurance codes.

For a complete listing of electrical control components included, see "specification details" on page 11.

Pneumatic mechanisms can be supplied on 1200 amperes continuous current ratings with reclosing equipment suitable for 20-cycle reclosing. Three reclosing schemes are available:

RC Recloser: Three-shot reclosing with automatic reset, first reclosure instantaneous or time delay, automatic lockout after third reclosure.
SGR-12 Recloser: Single-shot instantaneous reclosure, automatic reset and lockout if breaker opens after first reclosure.
SGR-1 Recloser: Single-shot instantaneous reclosure with hand reset.

Mechanical Linkage



For high-speed opening and closing, the mechanism travel is straight through: the mechanism pull rod and bell crank to the horizontal pull rod to individual pole levers which open and close the contacts. The forward motion of the horizontal pull rods also compresses the heavy accelerating springs, allowing low control energy tripping. Dashpot dampers control only on the last few inches of opening travel to cushion shock and to prevent bouncing without sacrificing speed. Lift rods and guides are high-strength, non-conducting and oil resistant glass epoxy-with mechanical strength to withstand impact shock. Streamlined tank top gives access to all adjustments.

Interrupters

Moving Contacts

For maximum capacity, all contacts will carry...

- The continuous-current rating without exceeding the allowable ANSI temperature rise.
- The momentary and interrupting-current ratings without damage.
- General maintenance intervals are whichever comes first:
  - Five years elapsed time.
  - Four times interrupting rating (4 full rated faults, 8 half rated faults, etc.).
  - 1000 no load mechanical operations.

Completing the current path from bushing to bushing, all contacts are pressure held to insure low contact resistance. The curved shape and rounded edges of the contacts minimize dielectric stress. All contacts are easily adjusted.

For 1200 Amperes

Breakers rated 1200 amperes continuous current are equipped with a single set of contacts for each pole. Blade-type moving contacts are hard-drawn copper with brazed copper-tungsten arcing tips. When the breaker is closed, the blades are extend well into the De-ion grids where they are gripped between spring-backed stationary contact fingers.

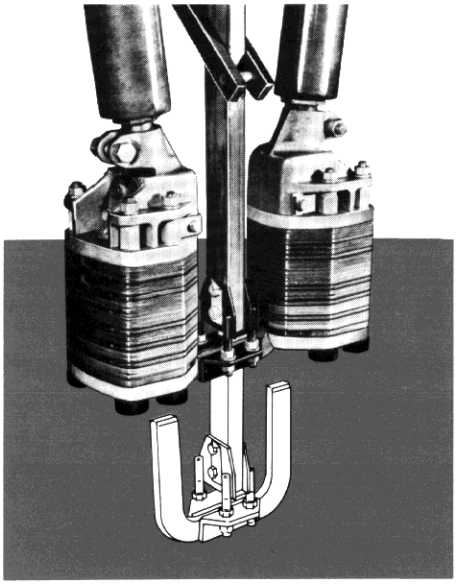
For 2000 Amperes and Above

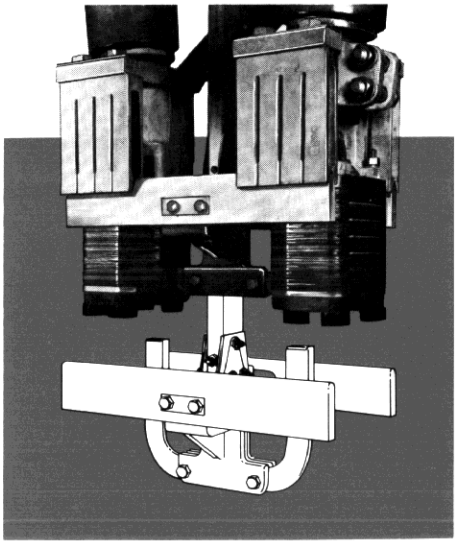
Breakers rated 2000 amperes and above have "tuning fork" auxiliary contacts in parallel with the main blade type contacts and external to the interrupter. Auxiliary contacts are silver plated, copper alloy with extremely high conductivity. When the breaker opens, the auxiliary contacts part first; and when closing, the reverse holds true, with the main blade contacts making first and the auxiliary contacts following. Thus arcing is confined to the main blade contacts within the De-ion grid.

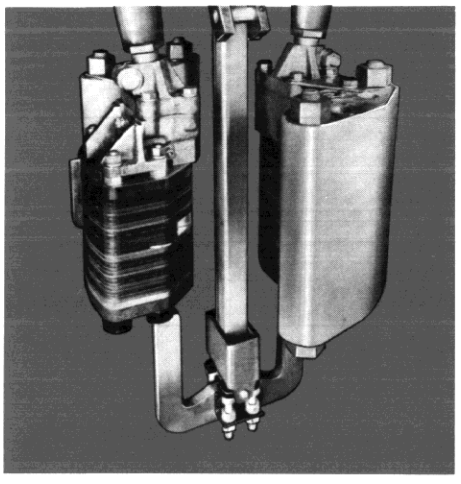
Shown in the illustration is a four-pronged, 4000 or 6000 ampere contact. The main contacts of 2000 and 3000 ampere units have two prongs.

Capacitor for Switching Applications

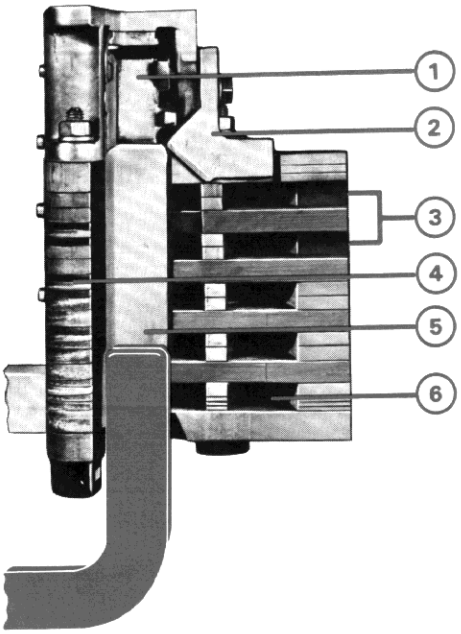
For capacitor switching, Westinghouse offers the Type G three tank breakers with specially designed resistor-equipped interrupters. In this configuration, a resistor is inserted in series with the interrupting contacts to modify the circuit power factor and to facilitate arc interruption. And of utmost importance: this construction is capable of switching up to 30,000 kVAR capacitor banks (isolated or parallel), thus eliminating the need to purchase additional auxiliary capacitor switching equipment.







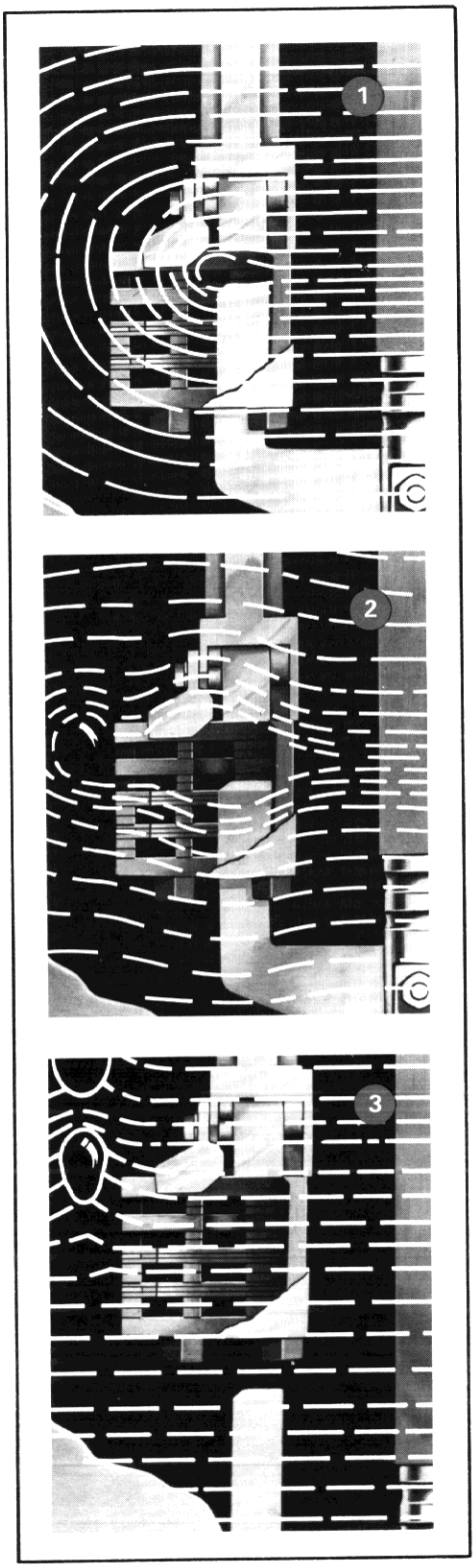
De-ion Grid Construction



1. Finger-Type Contact
2. Arc Horns
3. Exhaust Vents
4. Fiber Plates
5. Main Blade Contact with copper Tungsten arcing Tip
6. Oil Pockets

De-ion grids for type G breakers are built as a vertical stack of fiber plates. The Plates are cut out in the center for moving contact travel, with pockets for trapping oil and vents to release arc gas. Atop the grid are mounted two spring-backed stationary finger contacts which part slightly to hold the moving main blade contact with proper pressure over the entire contact surface. The arcing horn is faced with an arc-resistant alloy.

Arc Extinction



1. As the contacts open, nearby oil flashes into ionized gas to conduct a heavy arc between the stationary and moving contacts. The arc quickly moves to the stationary arcing horn, and moving contact arc tip protecting the continuous current carring contact surfaces from burning.

2. The top section interrupts high current arcs with a minimum of arc length and energy. It is composed of oil pockets, vent plates and a splitter plate. When a high current arc is drawn, pressure builds up quickly in this section.

The gasses formed are vented through the channels provided. Flow of gas into these channels forces the arc to move into the direction of the flow. The arc is drawn, de-ionized and extinguished in a period of one to two cycles.

The remainder of the grid is composed of alternate oil pockets and close-fitting plates which serve to interrupt a middle range or low current.

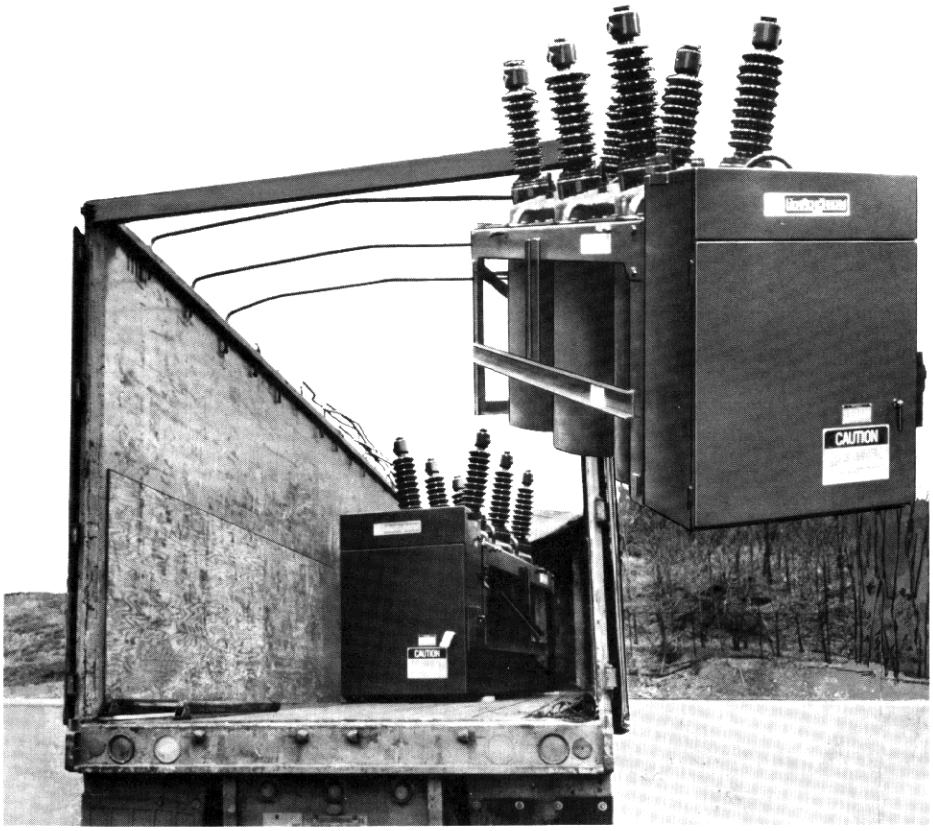
During low current interruptions, relatively little pressure is generated. The action of the top section is reduced but as the arc is lengthened, it is continuously exposed to new supplies of fresh oils. The arc is lengthened and cooled, causing rapid deionization and interruption.

3. After the arc has been completely extinguished and the contacts are fully open, fresh oil replaces the gas in the grids.

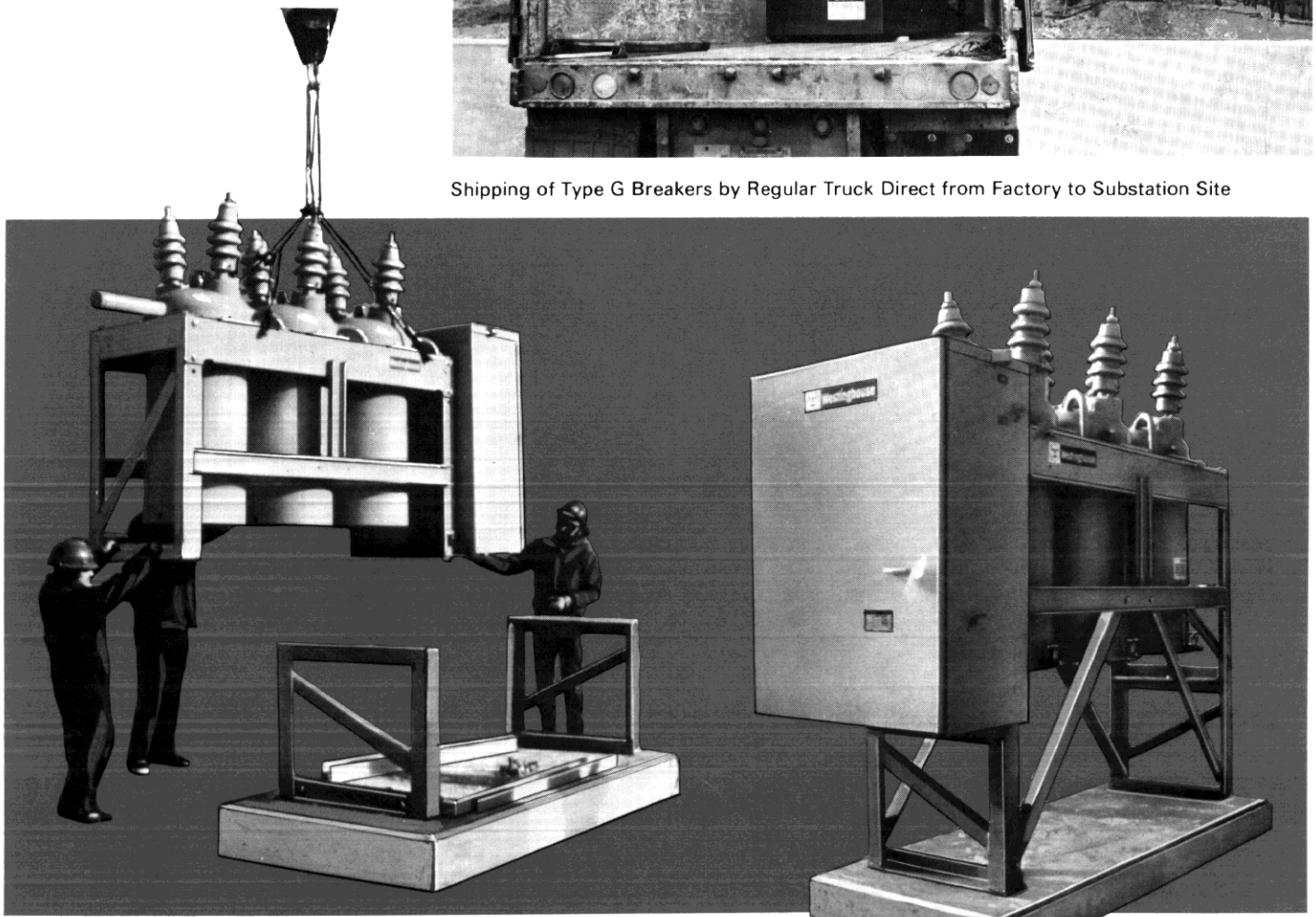
Split Frame Design Offers Important Shipping Benefits and Reduced Installation Costs.

Inasmuch as most subtransmission substations are **not** located on rail sidings, in the past there has been substantial expense required in off-loading and transporting breakers from the nearest rail siding to the installation site. In addition, damage due to rail shipment has been increasing substantially. Rail cars have been (and are) in short supply, and often those available are in poor condition. The new split frame construction eliminates these problems.

By incorporating the split-frame design in the Type G breakers, Westinghouse can now make shipments by regular truck directly to the customer's substation. This exclusive Westinghouse feature eliminates the user's need to pay an additional $300-$500 to move the breakers from the nearest rail siding to the substation site.



Shipping of Type G Breakers by Regular Truck Direct from Factory to Substation Site



Once the breaker is at the installation site, the breaker is simply bolted to the subframe to raise it to the proper height to meet electrical clearances.

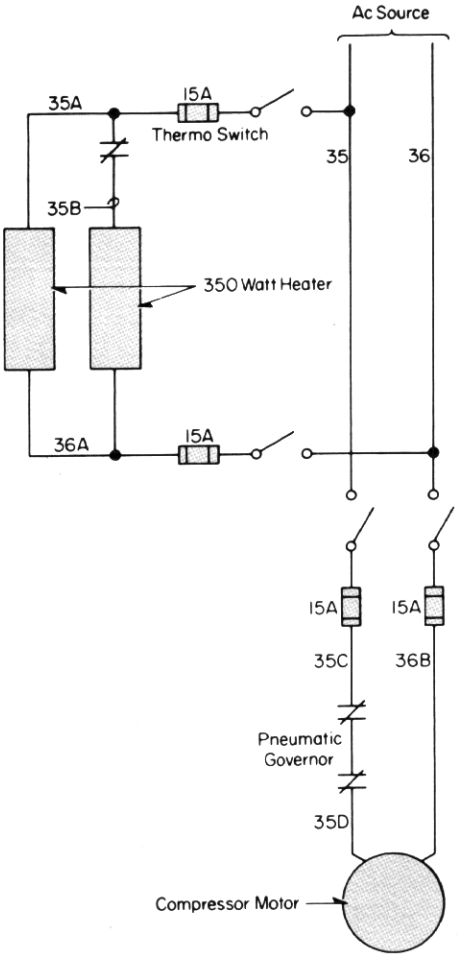
Selector Guide

Standard Duty Cycle: CO + 15 seconds + CO
Ratings: Ratings based on Recommendations of the American National Standards Institute for Outdoor Oil Circuit Breakers.

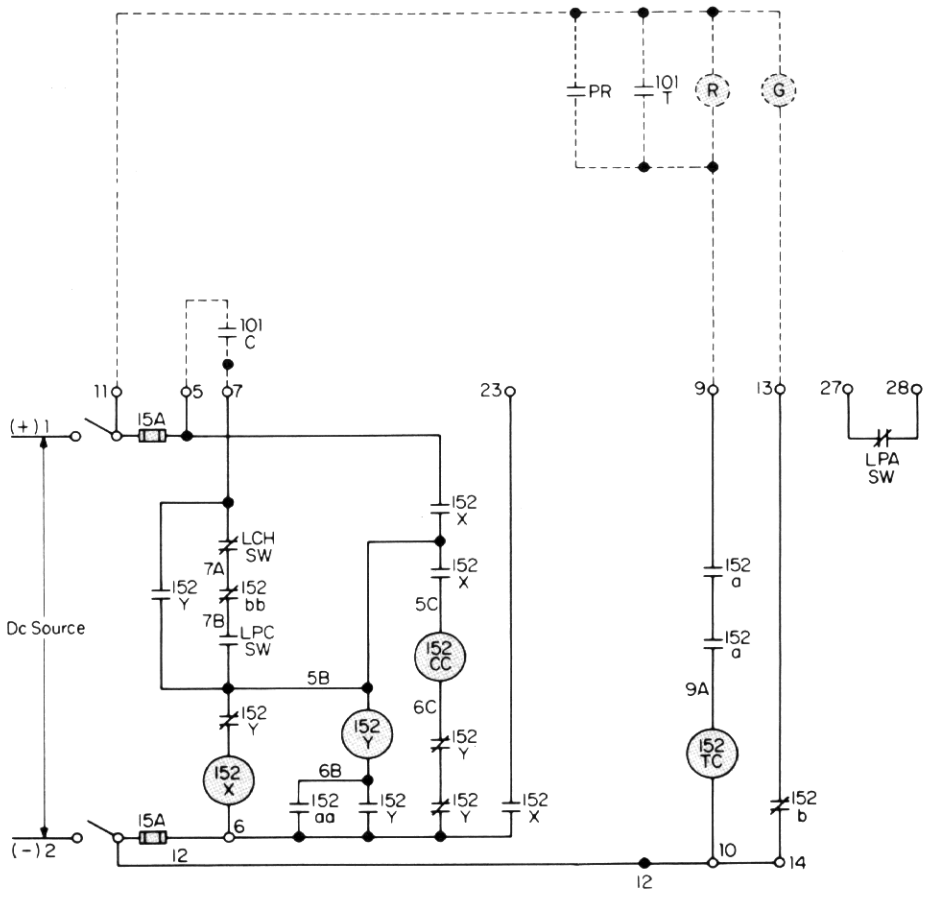
Type	144 G 1000	144 G 1500			230 G 1500	345 G 1500		345 G 2500		460 G 1500	460 G 2500		690 G 2500	690 G 3500
Voltage Ratings														
Rated kV, rms	14.4	14.4	14.4	14.4	23.0	34.5	34.5	34.5	34.5	46.0	46.0	46.0	69.0	69.0
Maximum design kv, rms	15.5	15.5	15.5	15.5	23.0	38.0	38.0	38.0	38.0	48.3	48.3	48.3	72.5	72.5
Minimum for rated MVA kV, rms	12.0	12.0	12.0	12.0	19.2	23	23	23	23	40.0	40.0	40.0	60.0	66.0
Current Ratings														
Continuous 60 Hz amp.	1200	3000	4000	6000	1200	1200	2000	2000	3000	1200	1200	2000	1200	1200
Close and latch, amp.	74					58	58	91	91	33	54	54	37	46
3 second, amp.	46					36	36	57	57	21	34	34	23	29
momentary ka, rms		115	115	115	72									
4 second ka, rms		72	72	72	45									
Interrupting Capability														
Nominal 3 phase MVA	1000	1500	1500	1500	1500	1500	1500	2500	2500	1500	2500	2500	2500	3500
Maximum kV, symmetrical amp.	36000					22000	22000	36000	36000	17000	28000	28000	19000	26000
Minimum kV, symmetrical amp.	46000					36000	36000	57000	57000	21000	34000	34000	23000	29000
Current at rated voltage kA, total rms		60	60	60	37.8									
Maximum kA, total rms		72	72	72	45									
Opening, cycles	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Insulation Level														
60 Hz test kV	50	50	50	50	60	80	80	80	80	105	105	105	160	160
Impulse, withstand, kV	110	110	110	110	150	200	200	200	200	250	250	250	350	350
Components														
Pneumatic mechanism type	AA-7	AA-10	AA-10	AA-10	AA-7	AA-7	AA-10	AA-10	AA-10	AA-7	AA-10	AA-10	AA-7	AA-7
De-ion grid type	144C	144C	144C	144C	230A	345B	345B	345B	345B	460C	460C	460C	690A	690A
Bushing Current Transformers														
Relaying accuracy, Maximum tap	C200	C400	C800	C800	C200	C200	C400	C400	C400	C200	C200	C400	C200	C400
Maximum rating	1200/5	3000/5	4000/5	6000/5	1200/5	1200/5	2000/5	2000/5	3000/5	1200/5	1200/5	2000/5	1200/5	1200/5
Additional available ratios	100	300	500		100	100	300	300	300	100	100	300	100	100
	200	500	1000		200	200	400	600	500	200	200	400	200	200
	300	800	1500		300	300	500	500	800	300	300	500	300	300
	400	1000	2000		400	400	800	800	1000	400	400	800	400	400
	500	1200	2500		500	500	1100	1100	1200	500	500	1100	500	500
	600	1500	3000		600	600	1200	1200	1500	600	600	1200	600	600
	800	2000	3500		800	800	1500	1500	2000	800	800	1500	800	800
	900	2200	4000		900	900	1600	1600	2200	900	900	1600	900	900
	1000	2500			1000	1000			2500	1000	1000		1000	1000
Condenser Bushing Type	OS	S	E	E	OS	OS	S	S	S	OS	OS	S	O	O
Weight and Oil Requirements														
Net weight with oil, lbs.	6400	9500	10800	10900	6400	6540	9480	9620	9620	8360	10500	10500	12435	12435
Shipping weight without oil, lbs.	4760	7450	8280	8200	4760	4900	6900	7100	7100	5750	7800	7800	7825	7825
Oil capacity, gal.	219	273	336	360	219	219	336	336	336	348	360	360	615	615
Operating Currents Pneumatic Mechanism														
Closing (125 V. dc) amp.	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Tripping (125 V. dc) amp.	11	20	20	20	11	11	20	20	20	11	20	20	11	11
Motor (230 V. ac) amp.	4.3	7.7	7.7	7.7	4.3	4.3	7.7	7.7	7.7	4.3	7.7	7.7	4.3	4.3

Wiring Diagrams

Pneumatic Mechanism



Dc Control Circuit Standard ANSI Diagram



Auxiliary switches shown for open breaker.
Relay contacts shown de-energized.
Pressure switch shown for low pressure.

⊣⊢	Open Contact ⊣/⊢ Closed Contact
O	Accessible Terminals
PR	Protective Relay (Remote)
101	Control Switch (Remote)
143	Toggle Cutoff Switch (Remote)
152X	Breaker Closing Relay
152Y	Breaker Closing Cutoff Relay
152CC	Intake Magnet Valve Coil
152TC	Breaker Trip Coil
LCH	Latch Check Switch
LPA	Low Pressure Alarm (Closed on Low Pressure)
LPC	Low Pressure Cutout (Open on Low Pressure)

Dc control circuit standard ANSI diagram.

Westinghouse Electric Corporation
Power Circuit Breaker Division
Trafford, Pa. 15085