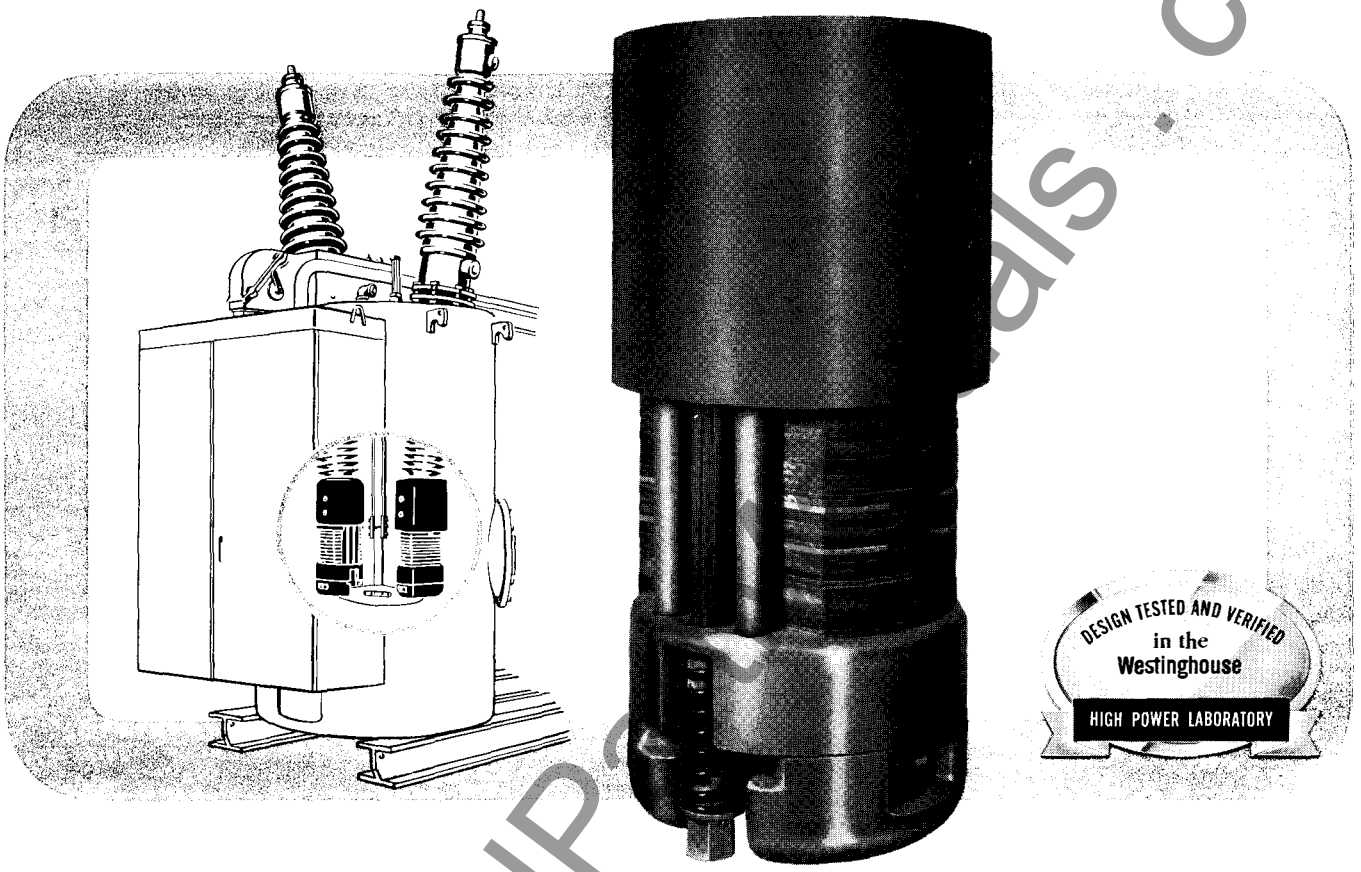
De-ion® grids for oil circuit breakers

7.2 kv to 345 kv • 100 mva to 25000 mva



application

De-ion grids are supplied with all Westinghouse frame or floor mounted types F, B, G, GM and GW power circuit breakers. There are three basic types of grids: tubular, multi-flow and magnetic, each designed effectively to utilize the proven De-ion principle of fast arc interruption.

advantages

reduced system disturbances

faster arc interruption under actual fault conditions

reduced breaker maintenance

longer oil life

increased station capacity without increased floor space

June, 1961
supersedes descriptive bulletin 33-355, dated April, 1957
mailed to: E/276, 279, 280/DB; C/330, 331/DB

Introduction

In the development of oil circuit breakers for system protection, early models relied solely upon the separation of contacts under oil. At the relatively low voltages and currents then used, the long arcing period which followed the physical separation of the breaker contacts was of little consequence.

Steadily increasing transmission line voltages which came about with the growth of system demands and loads focused attention upon the need for development of higher voltage breakers with higher interrupting ratings and shorter interrupting times.

In the early 1920's, Westinghouse engineers began a comprehensive study of the arc interruption problem and in 1929 the first positive-action arc interrupting device was developed—the magnetic De-ion grid. This was followed by the multi-flow grid in 1940 and the tubular De-ion grid in 1954.

The De-ion grid provides fast arc interruption at high capacity with resultant greater system stability. Because of the reduced liberation of energy during the arcing period, oil decomposition is lessened with consequent reduction in maintenance expense.

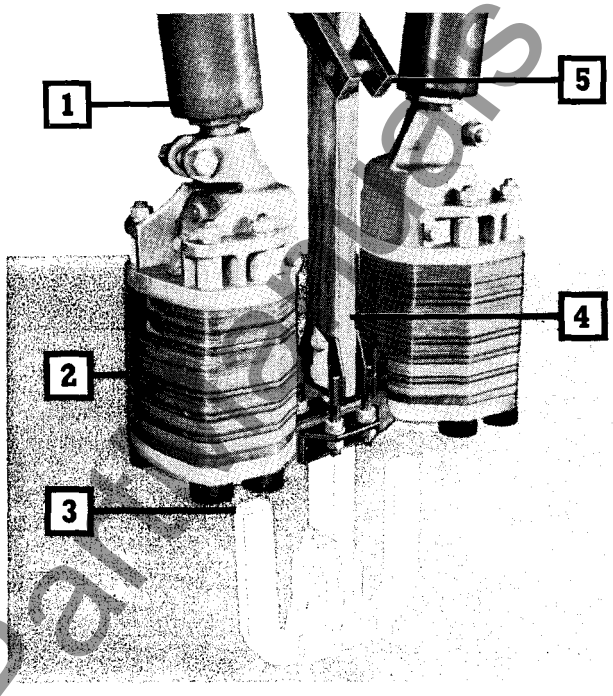
The interruption of an a-c arc is facilitated by the fact that twice during each cycle the current drops to zero value and the arc is extinguished momentarily. Prevention of re-ignition after arc extinction, depends upon building up the dielectric strength of the contact gap at a faster rate than the recovery voltage tending to reestablish the arc.

De-ionization of the arc region, by displacing the ionized gas in the gas bubble with un-ionized oil molecules, is accomplished by Westinghouse grids.

The Westinghouse High Power Laboratory at East Pittsburgh has been invaluable to the design engineer and scientist in facilitating rapid development and testing of new ratings. All new ratings have been verified in this laboratory which now has operated for over a third of a century with well over a quarter million tests made in the course of these developments.

magnetic De-ion grids

100 through 2500 mva, 7.2 to 69 kv
8 and 5 cycle interrupting time



1 condenser bushing

2 stationary contact assembly with De-ion grid

3 moving contact open

4 Micarta® lift rod

5 Micarta lift rod guide

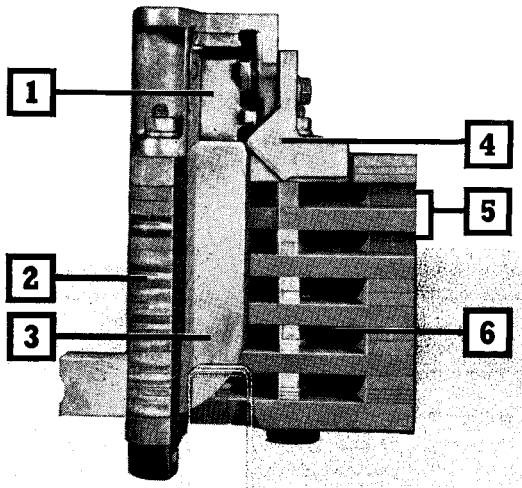
The magnetic type De-ion grids are supplied with Westinghouse types G, F and B power circuit breakers. They contain the stationary contact fingers and fiber interrupting structure and are mounted on the lower terminal of the high voltage bushings.

For rapid maintenance, the stack assembly, fingers and arcing horn may be removed and replaced without altering the positions of the bushings or moving contact and linkage.

De-ion grids for oil circuit breakers

7.2 kv to 345 kv • 100 mva to 25000 mva

construction



1 finger-type contact

2 fiber plates

3 blade contact with copper tungsten tip

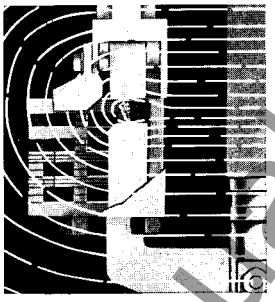
4 arc horns

5 exhaust vents

6 oil pockets

Magnetic De-ion grids are built as a vertical stack of fiber plates. 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 mount two spring-backed stationary finger contacts which part slightly to hold the moving blade contact with proper pressure over entire contact surface. Arcing horn is faced with arc-resistant alloy.

operation



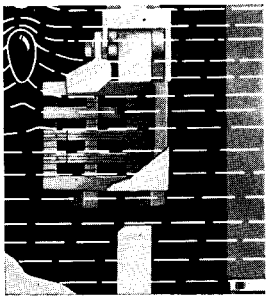
1. As the contacts open, nearby oil flashes into ionized gas to conduct a heavy arc between the stationary and moving contacts. The arc terminals quickly move to stationary arc horn, and moving contact arc tip protects contact surfaces from burning.

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 gases 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.

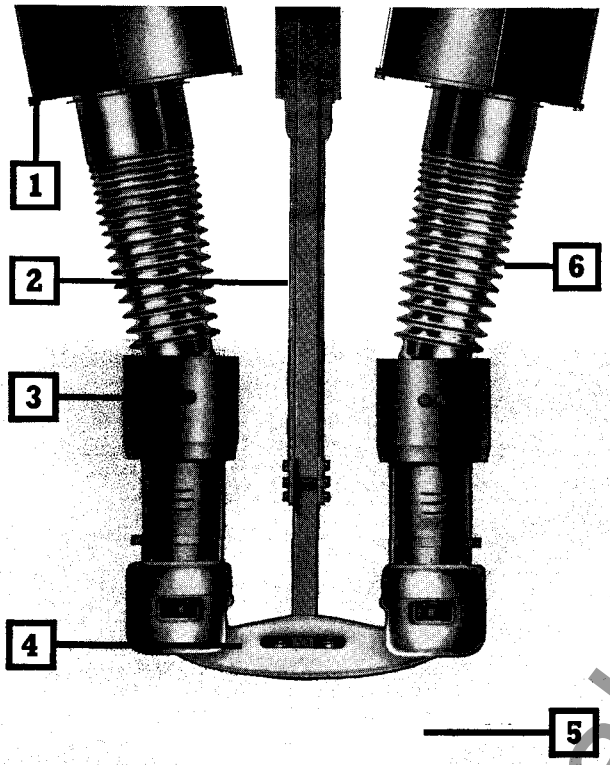
During low current interruptions, relatively little pressure is generated. The action of the top section is reduced but as the arc is lengthened, it is continuously exposed to new supplies of fresh oils. The arc is lengthened and cooled, causing rapid de-ionization and interruption.



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

multi-flow De-ion grids

1500 through 10,000 mva, 69 to 230 kv
5 and 3 cycle operation



1	current transformers	4	moving contact closed
2	Micarta lift rod	5	moving contact open
3	De-ion grid interrupter	6	condenser bushing

Multi-flow type De-ion grids are available for high-voltage types GM and GW power circuit breakers. They are particularly applicable for short interrupting times at intermediate interrupting ratings.

The multi-flow types are comprised of fiber plates bolted together with wood base Micarta rods. Construction is designed to provide two main chambers: an upper chamber where a pressure generating arc is drawn and a lower de-ionizing chamber where the main arc is confined and extinguished.

The current path through the interrupter consists essentially of an upper contact, an intermediate contact located between the two chambers and a lower contact which may or may not be affixed rigidly to the crossarm.

This type of grid is manufactured in various sizes for different capacities and is also produced for either three or five-cycle interrupting times.

five-cycle grids

type **MF-1**

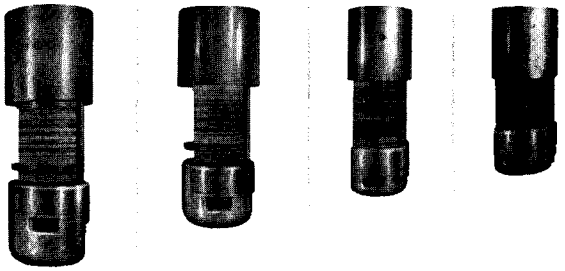
type **MF-2A**

Type MF-1 grids are arranged to provide sequential opening first forming the pressure-generating arc (between the upper and intermediate contacts) then the interrupting arc (between the intermediate and lower contacts). This is accomplished by spring biasing the intermediate contact downward to travel with the moving contact of the breaker a predetermined distance then to stop and allow formation of the lower arc beneath it.

Type MF-2A grids provide simultaneous opening of pressure-generating contacts and interrupting contacts. A side operating rod, actuated by the breaker crossarm, operates the upper rocker-type pressure-generating contact at the same time as the lower contact parts. High ohmic resistors paralleling the contacts divide the recovery voltage equally between the two grids in each pole.

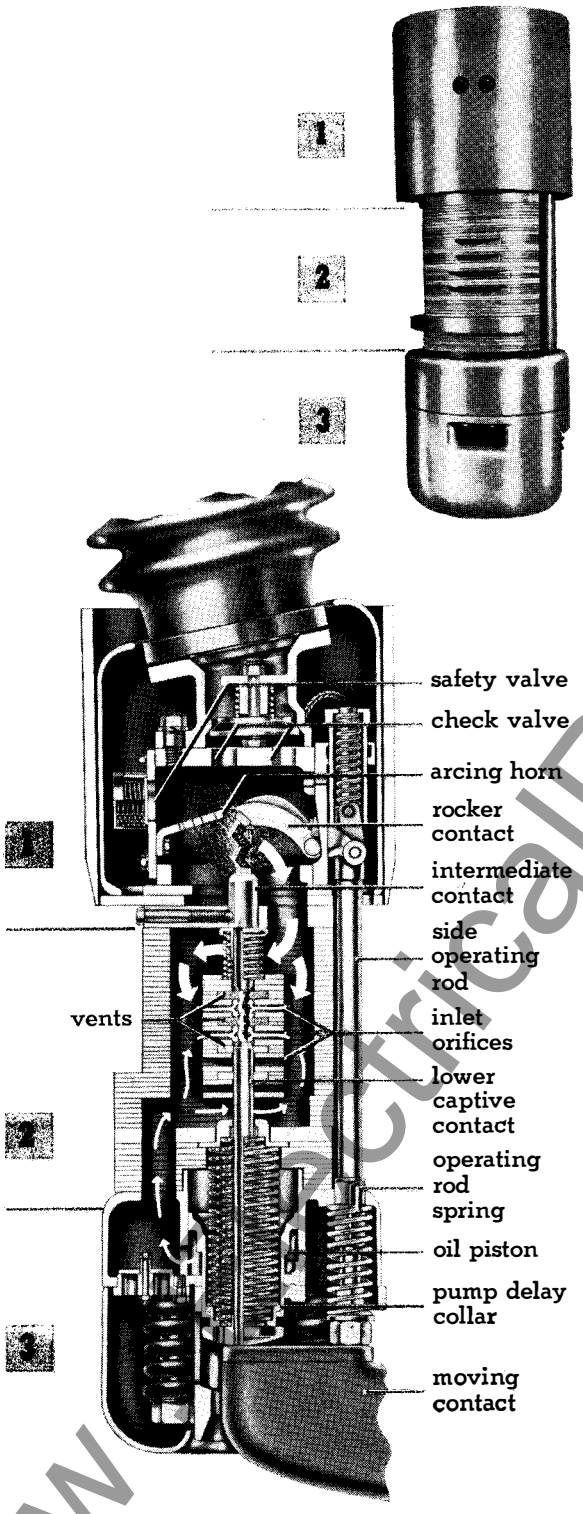
three-cycle grids

type **MF-3**



Type MF-3 three-cycle grids have simultaneous contact operation similar to the MF-2A. In addition a spring-operated piston acts as an oil pump to provide supplementary oil flow to the interrupting chamber when the breaker interrupts low currents and flushing action after high current interruption. This is particularly important on high speed reclosing operation. The pump action is intentionally delayed to allow sufficient contact separation for efficient interruption before oil flow begins. The captive construction of the lower moving contact within the grid (as compared with the bayonet construction of the MF-1) permits closer fit in the fiber orifice plates, more efficiently directing the flow of oil into the interrupting chamber. It also allows greater tolerance in the alignment between the lower end of the grids and the moving contact crossarm on the breaker lift rod which contributes to ease of assembly and adjustment.

operation



Type MF-3A grid cut away to show the action during interruption. White arrows show oil flow. Type MF-3F is similar except for finger-type contacts instead of butt type.

types MF-3A and MF-3F grids

Types MF-3A and MF-3F multi-flow De-ion grids used on 230 kv breakers provide highly effective circuit interruption. They consist essentially of three chambers:

1. The upper pressure chamber, in which a pressure-generating arc is drawn between the upper and intermediate contacts.
2. The central interrupting chamber, in which the arc drawn between the intermediate and lower contacts is confined, de-ionized, and extinguished. This chamber is formed of vulcanized fiber plates bolted together with wood-base Micarta tie rods with heavy springs to maintain proper pressure between plates.
3. The lower contact chamber, containing the captive contact spring and the auxiliary oil pump.

three-cycle fault current interruption

When the breaker is called upon to open under fault conditions, the breaker accelerating springs act through the lift rod to open the moving contacts rapidly. These springs open the lower contact inside the grid and at the same time the rocker-type upper contact is opened by the action of the spring-operated side operating rod extending from the moving contact to the top of the grid.

As the contacts part, the pressure-generating arc drawn in the upper chamber between the upper and intermediate contacts, forces the oil in the center chamber through the inlet orifices into and along the closely confined main interrupting arc. Gases formed by contact of oil with the arc pass through exhaust vents in the grid into the main body of oil in the breaker tank.

The multi-flow principle of arc interruption uses a number of inlet orifices and exhaust vents proportioned to the voltage rating. As the moving contact uncovers successive inlet orifices the flow of fresh oil from the pressure generating chamber de-ionizes the entire length of the arc and interrupts it at a minimum length and in the shortest time.

The symmetrical arrangement of the inlet orifices and vents within the grid structure provides balanced flow and reaction forces. The flow of oil and gas centers the arc in the interrupting chamber away from the fiber plates, minimizing wear of the interrupter.

Following the interruption, the arc gases and carbonized oil are flushed through the vents and replaced by fresh oil in preparation for the next operation. This flushing action is provided by the operation of a spring driven piston located at the bottom of the grid. The check valve in the top of the pressure chamber opens to release the residual gas and the chamber refills with fresh oil.

During normal operations this open valve permits circulation of oil through the grid to cool the current carrying parts.

As a protective feature, a safety valve is provided to open if the gas pressure within the pressure chamber should become too great during an interrupting operation.

low current operation

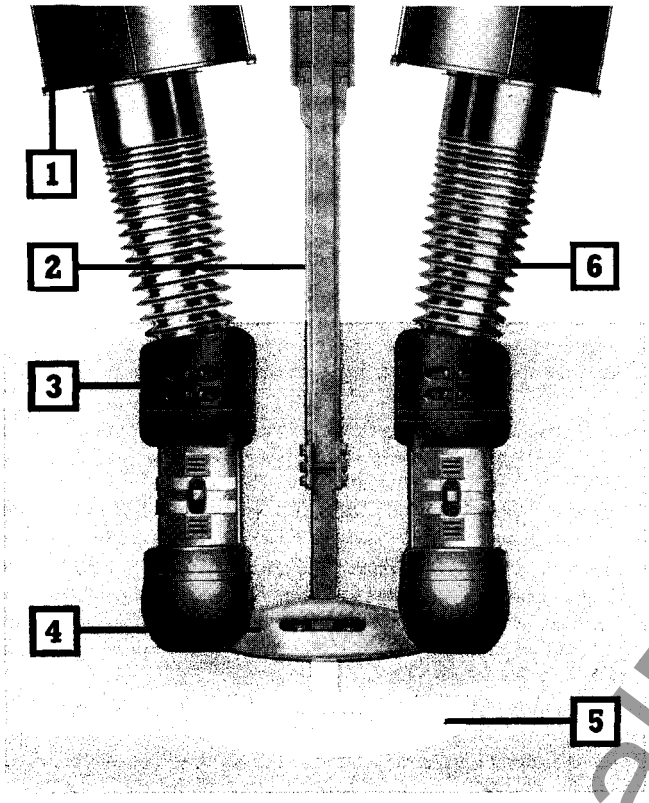
To assure three-cycle interrupting time for low magnetizing and line-charging currents, the oil driving piston at the bottom of the grid augments the oil flow from the pressure arc. To avoid arc re-strikes and overvoltage surges when interrupting line-charging currents, the oil piston action is purposely delayed. Interruption is attempted only after the contacts are parted sufficiently to support the double voltage which will appear across the contacts one-half cycle after interruption.

scavenging action for reclosing duty

At higher currents, where the pressure-arc generates greater pressure than that obtainable from the piston, the piston does not operate until after the arc is interrupted; it then serves to flush the arc products from the grid. This is particularly important on high speed reclosing where it is desirable to clean out the gases from the first interruption before the circuit breaker may be called to open the circuit again within 20 cycles or less.

tubular De-ion grids

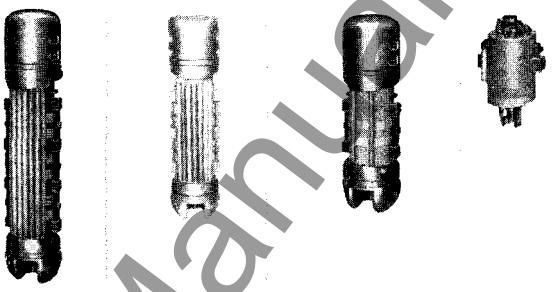
69 through 345 kv high capacity ratings



1. current transformers
2. Micarta lift rod
3. De-ion grid interrupter
4. moving contact closed
5. moving contact open
6. condenser bushing

tubular De-ion grids

345 kv | 230 kv | 138 and 161 kv | 69 kv

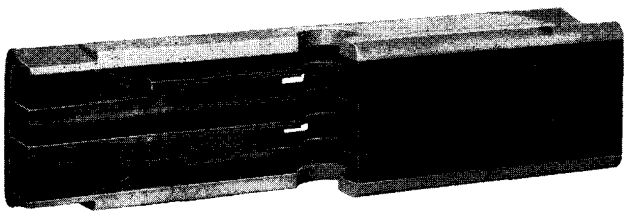


Tubular type multi-break de-ion grids are available for types GM and GW circuit breakers. Interrupting times are five and three cycles.

This type, the latest product of Westinghouse grid research, consists of one, two, three or four sets of finger and blade contacts and interrupting blocks mounted in series and contained within a heavy-walled insulating tube. The number of sets of contacts and blocks depends on the voltage and interrupting ratings of the breaker. The contact elements are unit assemblies that operate in unison and require only one simple adjustment. Stationary contacts are heavy-duty, silver plated fingers with arc resisting silver tungsten surfaces. Contact accelerating springs and spring driven pump are contained in the one piece top casting. The pump action serves to provide oil flow for low current interruptions, and to expel gases and arc products after high current interruption, thereby preparing for instantaneous reclosing.

For quick inspection of the fixed and moving contacts, fiber interrupter blocks can be removed without completely disassembling the grid unit merely by loosening the "keeper" block on one side of the interrupter tube.

grid interrupter block, cutaway view



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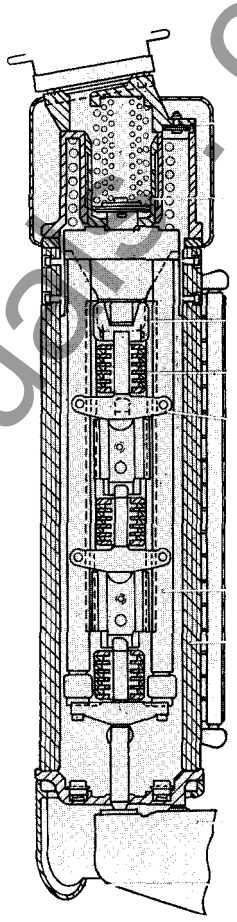

operation

This type grid uses a self-generated pressure and oil flow principle, differing from the multi-flow grid as it does not have a pressure generating break and chamber.

The top casting assembly of the multiple break assemblies contains the accelerating springs for the interrupter contacts and a spring-driven pump which provides oil flow for low current interruption. This pump action also serves to expel gases and arc products after high current interruption, thus preparing for another interruption in a very few cycles.

The simple contact structure introduced with the 345 kv interrupter has been applied to the lower kv rating; in fact, interrupter blocks and other contact parts are identical. The moving components of this contact structure consist of several heavy duty contacts, mounted in ladder arrangement between a pair of wood Micarta push rods. The stationary components are used in pairs, and carry the current from one moving contact to the next. Each consists of finger type contact assemblies which are mounted in a ladder arrangement between two insulating Micarta tie rods. Surfaces upon which the arc impinges are protected with arc-resistant silver-tungsten material. During interruption, voltage distribution between the two interrupters in each pole is controlled by a series of high resistance carbon resistor units, mounted across each interrupter.

5-cycle interrupters

The 69 kv five-cycle tubular interrupter differes from the higher voltage, three-cycle devices in that the piston is located at the bottom of the interrupter assembly.

A high ohmic resistor is utilized to provide equal voltage distribution across each interrupter and to prevent voltage stress across the interrupter itself while the breaker is in the open position.

fault operation

In both the three-cycle and five-cycle interrupters the arcs are drawn between the captive contacts and the stationary fingers. Fiber blocks located between the finger assemblies. which contain the arcs, are constructed to provide a maximum amount of dielectric build-up after interruption of the current.

The interrupter block in addition to several oil pockets, has two intake passages on each side of the interrupter block and one unobstructed main vent on each end of the block assembly with two additional vents having pressure relief devices which will open on high capacity faults and allow additional venting.

low currents

The piston that is present in all of the interrupters will operate on low capacity faults, and low currents in general, and serves to furnish the additional oil flow through the inlet passages of each interrupter block required for arc interruption.

scavenging action

On high capacity faults, the pump is stalled due to back pressure. After this pressure is relieved following arc interruption and the breaker is still in the open position, the piston will release and cause a flow of oil into each interrupter block, through the orifices and out vents furnishing scavenging action to remove the gases in the interrupter to make it suitable for proper operation on the next interruption. This makes the tubular interrupter an excellent device for high speed reclosing.

1 shield

2 top casting assembly

3 oil driving piston

4 stationary finger contacts

5 grid interrupter blocks

6 captive moving contacts

7 resistor

8 contact operating rods

9 insulating tube

10 moving contact crossarm

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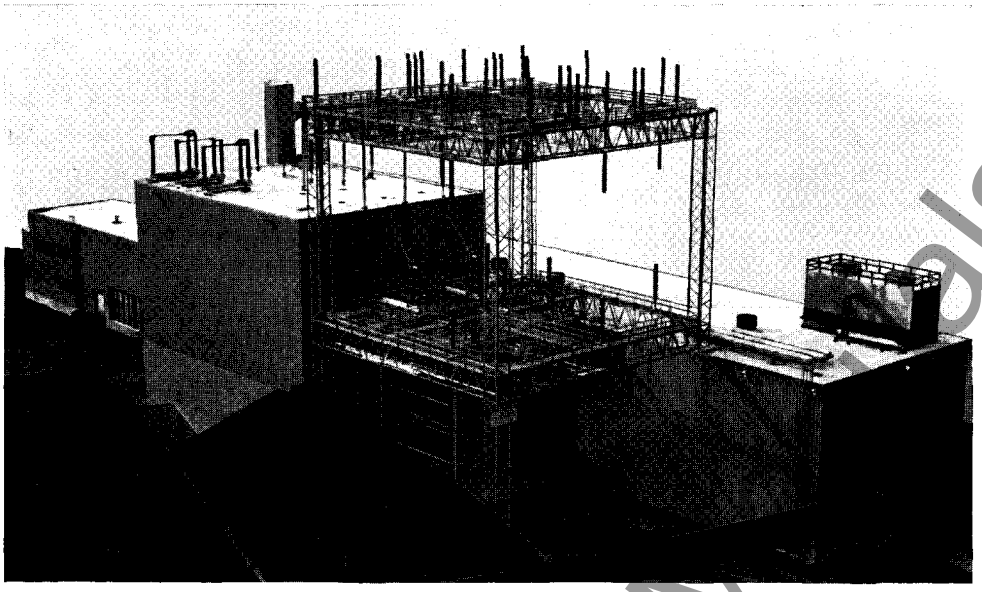

Westinghouse De-ion grids are high power laboratory tested and proven . . .

The availability of outstanding test facilities in the high power laboratory at East Pittsburgh has made possible the careful development and thorough verification of the interrupting ability of the magnetic, multi-flow and tubular types of De-ion grids as used in Westinghouse power oil circuit breakers.

With the aid of the high power laboratory, De-ion circuit interrupters have been improved and applied to practically every circuit interrupting device built by Westinghouse . . . up to and including 345 kv, 25,000 mva. As important advances have been made in De-ion grid development, numerous typical tests have been witnessed by customer and national technical association groups.

Since 1925 the Westinghouse high power laboratory has been the proving ground for electrical apparatus. Here, power circuit breakers, power fuses, arresters, reactors and other equipment are tested under short-circuit conditions. Each trial in the high power laboratory has been another step toward products that are known for their performance and dependability.

Only Westinghouse power oil circuit breakers have De-ion grid control offering these advantages . . . *shorter arcing time, greater systems stability, better service.*

use of modern De-ion grids up-rates out-dated breakers

The use of modern De-ion grids in applying the Westinghouse power breaker modernization program can provide up to 200 percent more capacity in existing breakers to meet the growing loads . . . and at only ⅓ the cost of new breakers. Additional benefits are improved quality and economy of breaker operation.

Westinghouse can provide new contacts and interrupters for any type O, G, GO or GM frame of floor-mounted breakers. Breaker capacity can be increased 50 to 200 percent. Customer crews can make the installation without replacing the tanks or disturbing foundations.

The new interrupters will be the exclusive Westinghouse magnetic, multi-flow or tubular De-ion grid.

Here are their advantages . . .higher interrupting capacity, extra bonuses of faster arc interruption, less oil deterioration, fewer inspections, less maintenance, years of useful life added to present breakers.

here's how the modernization plan works . . .

To develop this breaker modernization plan for the existing breakers of your system, tell us the style and rating of your present Westinghouse breakers. Westinghouse will provide you with a bill of material and price of the new interrupter and contact assembly for Westinghouse type O, G, GO or GM breakers. In many cases only new stationary contacts, grids, moving contacts, lift rods and guides, a trip coil and an accelerating spring are needed. You make the installation. No need to relocate or remount your breakers.

further information: **refer to Westinghouse**

Westinghouse Electric Corporation
Power Circuit Breaker Department: East Pittsburgh Divisions • Trafford, Pa.
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