Dec. 5, 1967 G. B. CUSHING ETAL 3,356,811

OIL-TYPE CIRCUIT BREAKERS HAVING OUTER CONTINUOUS INSULATING SUPPORT TUBE AND INNER STACKED INSULATING PLATES PROVIDING LATERAL VENT OPENINGS

Filed Jan. 15, 1965 5 Sheets-Sheet 1

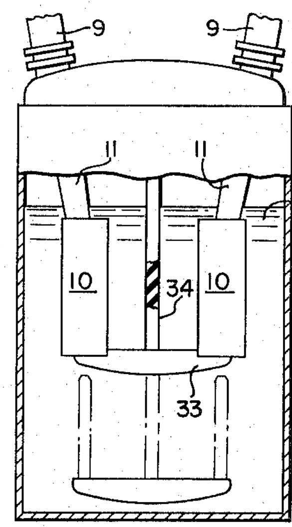
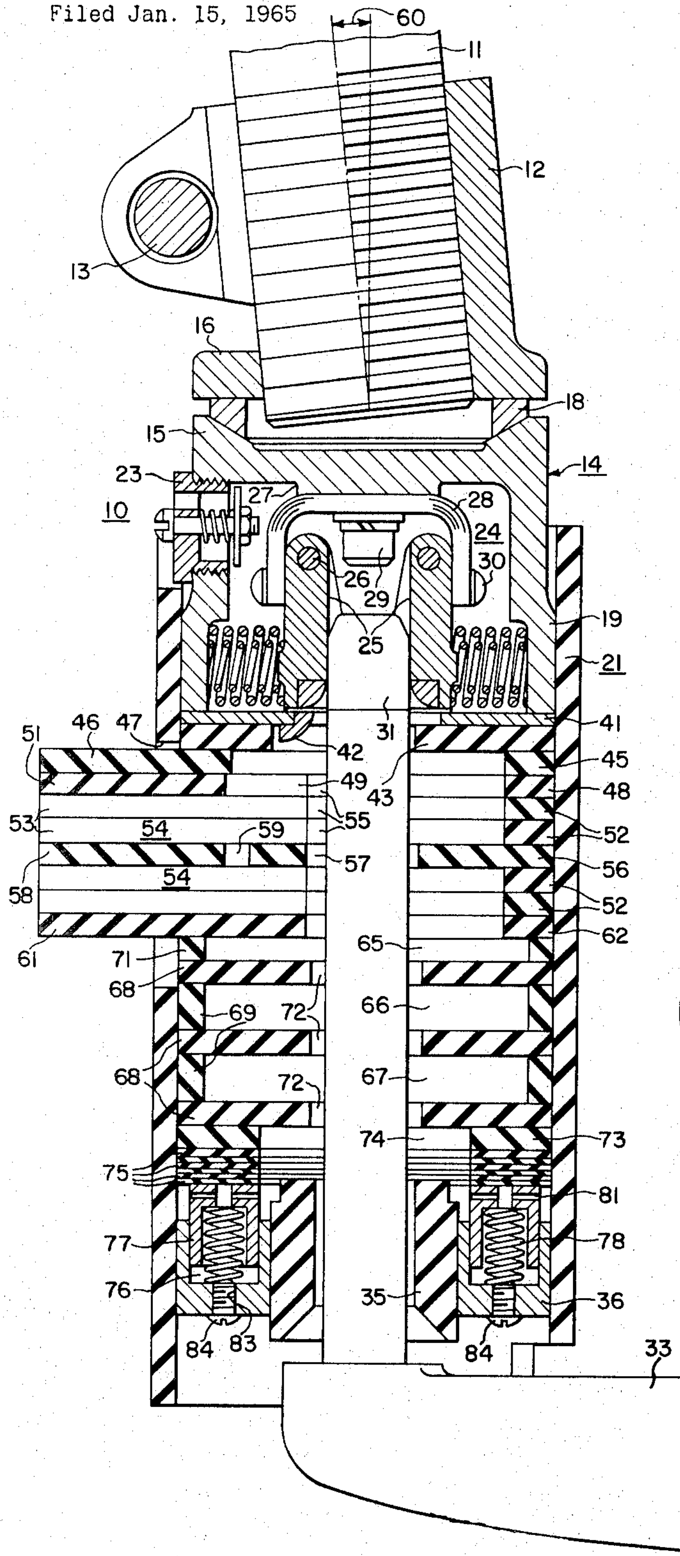


FIG.1.



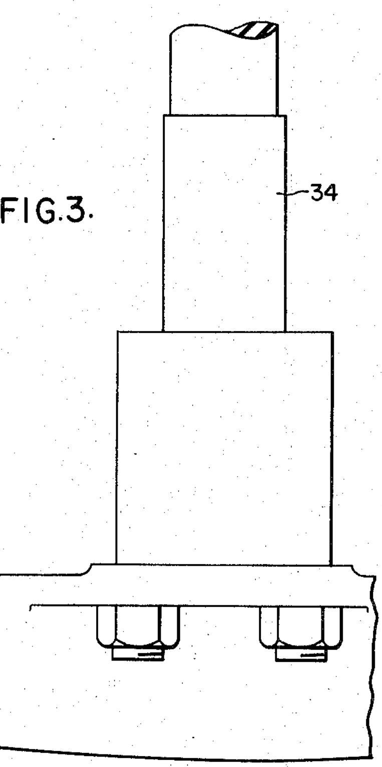


FIG.3.

OIL-TYPE CIRCUIT BREAKERS HAVING OUTER CONTINUOUS INSULATING SUPPORT TUBE AND INNER STACKED INSULATING PLATES PROVIDING LATERAL VENT OPENINGS

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FIG.2.

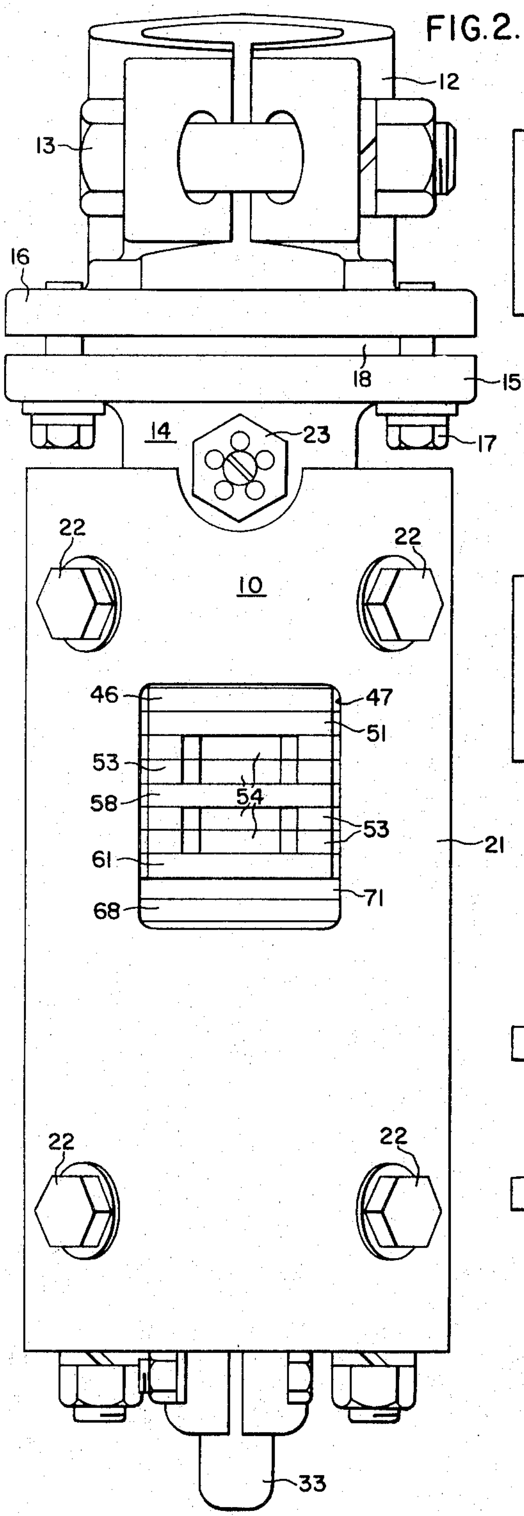

FIG.4.

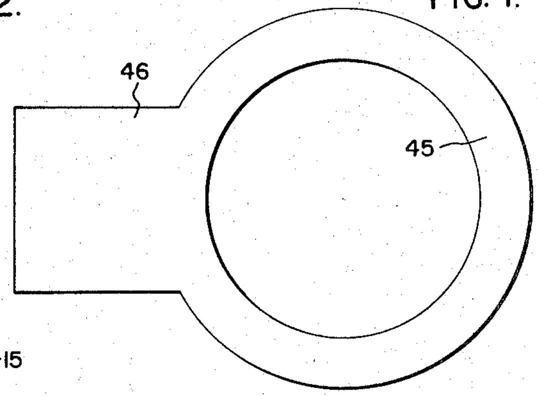

FIG.5.

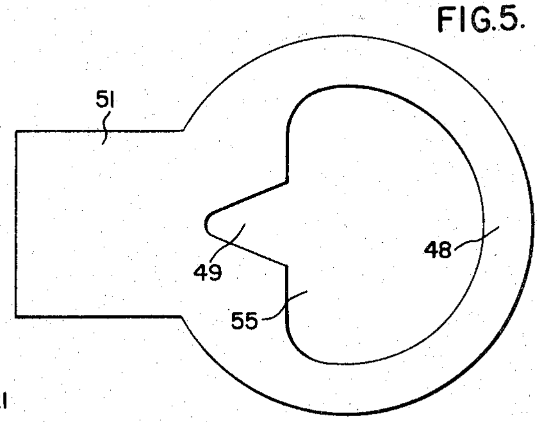

FIG.6.

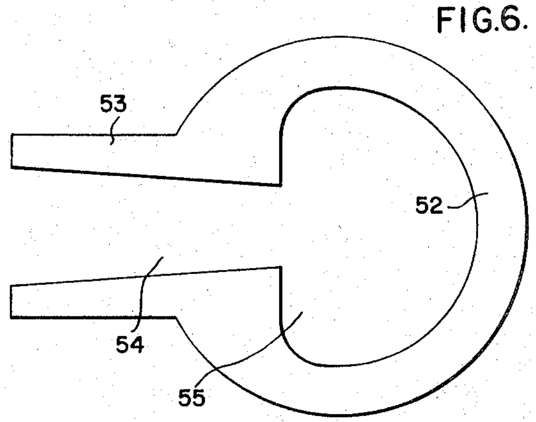

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FIG. 7.

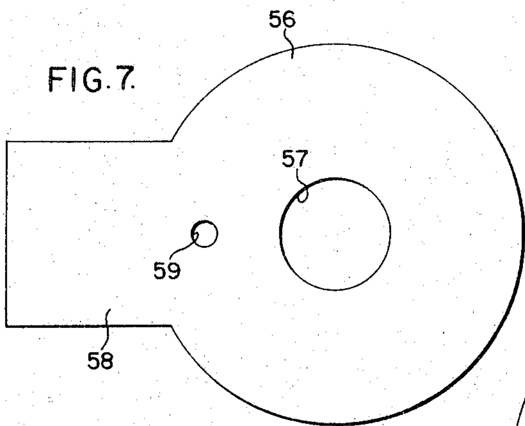


FIG. 10.

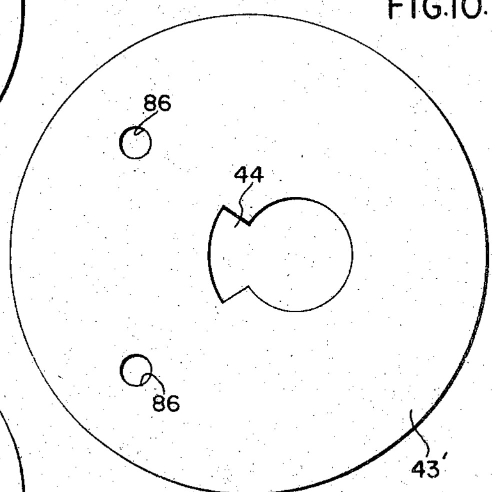


FIG. 8.

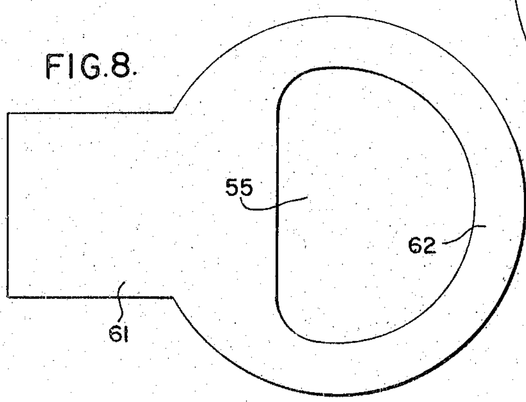


FIG. 11.

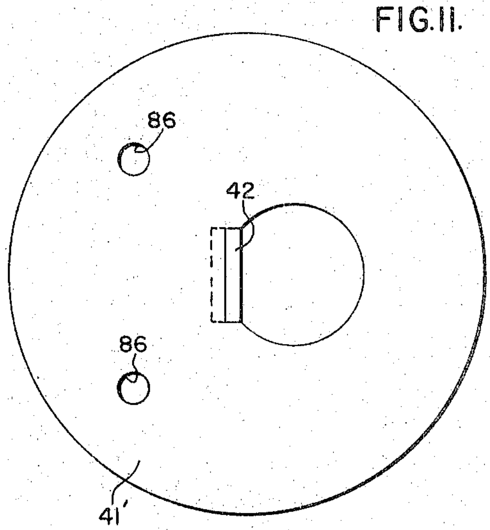
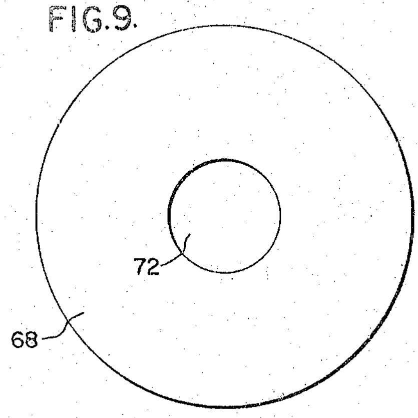


FIG. 9.



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OIL-TYPE CIRCUIT BREAKERS HAVING OUTER CONTINUOUS INSULATING SUPPORT TUBE AND INNER STACKED INSULATING PLATES PROVIDING LATERAL VENT OPENINGS

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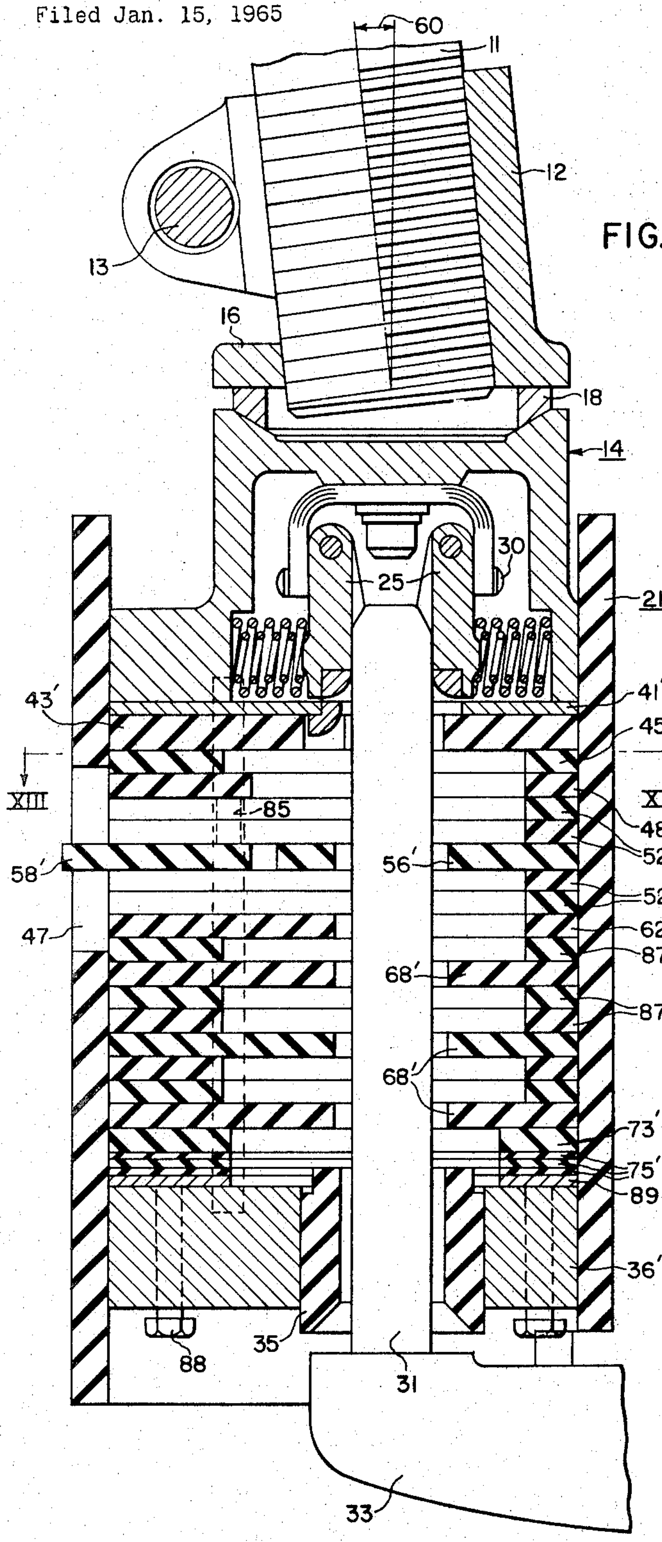
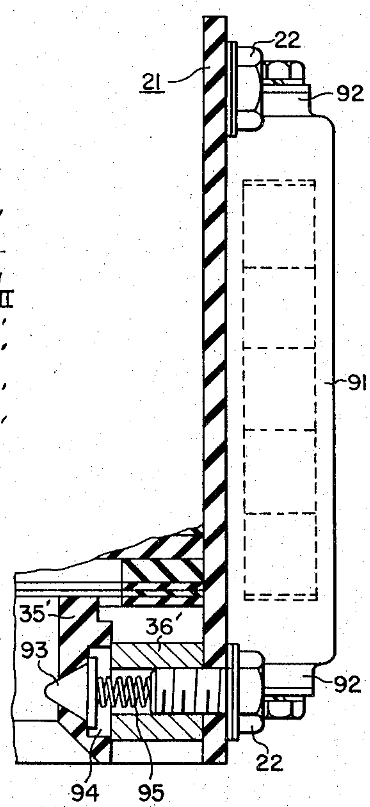


FIG.12.

FIG.14.



OIL-TYPE CIRCUIT BREAKERS HAVING OUTER CONTINUOUS INSULATING SUPPORT TUBE AND INNER STACKED INSULATING PLATES PROVIDING LATERAL VENT OPENINGS
Filed Jan. 15, 1965

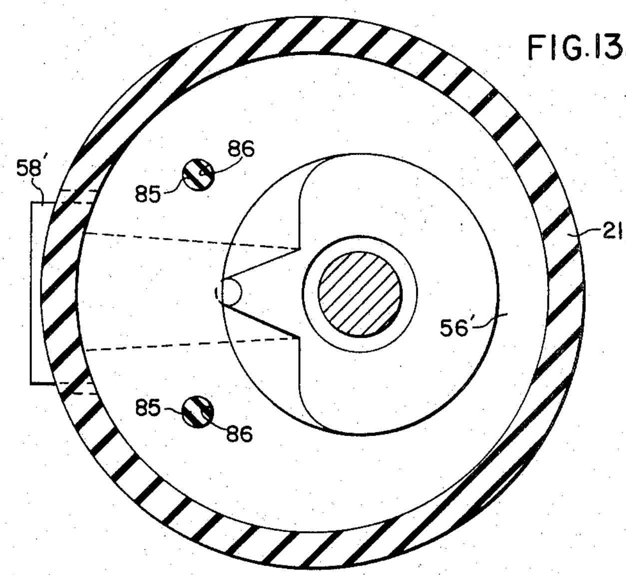


FIG.13.

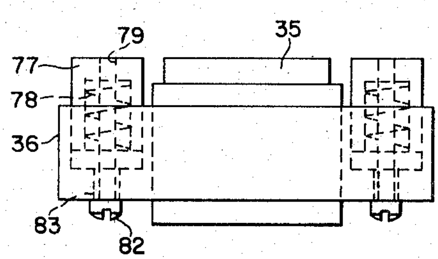


FIG.15.

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OIL-TYPE CIRCUIT BREAKERS HAVING OUTER CONTINUOUS INSULATING SUPPORT TUBE AND INNER STACKED INSULATING PLATES PROVIDING LATERAL VENT OPENINGS

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Filed Jan. 15, 1965, Ser. No. 425,728
10 Claims. (Cl. 200—150)

ABSTRACT OF THE DISCLOSURE

An oil-type interrupting unit is provided with apertured stacked internal insulating plates supported in an outer continuous insulating tube, which may be cut for various voltage ratings. Resilient compression means is provided to compress the several internal plates, but nevertheless to resist expansion of the plates due to internal pressure developed during interruption. A shunting resistance may be provided for voltage division between two interrupting units.

This invention relates, generally, to circuit breakers and, more particularly, to grid structures or arc-extinguishing units for circuit breakers in which a liquid dielectric, such as oil, is utilized as the arc-extinguishing medium.

Prior grid structures have performed excellently within certain voltage and current limitations. However, opportunities for improvement have become apparent through testing. In the higher voltage applications, the insulated steel tie rods or bolts which hold the assembly of fiber laminations together become contaminated with carbon blasted outwardly through crevices between the laminations and fail lengthwise electrically when recovery voltage is impressed. Also, immediately following an interruption, the internal pressure of the grid falls rapidly due to its leaky construction and the internal dielectric strength within the contact slot drops simultaneously. Consequently, electrical breakdowns occasionally follow which result in a violent though temporary re-establishment of the fault current arc.

At the low voltage end of the application range, the currents which must be interrupted are very high. These cause the generation of abnormally high internal pressures during interruption. To withstand these pressures a relatively large fiber structure has been necessary.

Another shortcoming of the prior grid structures is their inability to withstand the sharply rising, explosive-like internal pressures encountered when switching one of several parallel static capacitor banks. The individual laminations comprising a grid stack have material removed to form oil channels and pockets, vent passages, contact slots and tie rod holes, leaving very limited sections of material to withstand hoop stresses imposed by internal pressures. The low tensile strength of the fiber material limits the application of interrupting grids so constructed to parallel capacitive loads of no more than 6000 kilovars and combined parallel bank installations of no more than 12,000 kilovars. Furthermore, it has been found that parallel banks restricted to this size must be separated by a significant footage of bus work to limit interbank transient currents to tolerable magnitudes and preclude damage to the grids.

An object of this invention is to provide a circuit interrupter of a laminated grid type which shall be capable of withstanding relatively high internal pressures.

Another object of the invention is to reduce the surface area of the grid elements exposed to pressure, to preclude leakage through cracks between adjacent plates of the grid, and to eliminate tie bolts as a means of holding a grid stack together.

A further object of the invention is to provide an improved vent arrangement for the grid stack.

Still another object of the invention is to encase circular or discoidal plate elements of an interrupting grid in a section of pipe readily cut off to the required length depending upon the voltage application.

A still further object of the invention is to provide for readily attaching a pre-assembled grid structure to a conductor stud of a terminal bushing of the circuit breaker.

Another object of the invention is to prevent rotation of the circular grid plates inside the enclosing pipe or tube.

A further object of the invention is to provide a spring arrangement which will allow for expansion and contraction of fiber elements of the grid as their moisture content changes and which will also oppose and cushion instantaneous movement of the elements when high pressures are generated within the interrupter during short-circuit interruption.

Another object of the invention is to provide for equally dividing the voltage impressed on two interrupters connected in series in a circuit.

Other objects of the invention will be explained fully hereinafter or will be apparent to those skilled in the art.

In accordance with one embodiment of the invention, round or discoidal plate elements of an interrupting grid are encased in a tube manufactured as pipe of continuous filaments of glass, bonded with epoxy resin. A section of pipe is cut off to provide a tube of the required length depending upon the voltage application. The grid plates are pre-assembled in the tube which is attached to a contact housing having a generally cylindrical bottom portion by screws threaded into the bottom portion. The housing is adjustably atached to a terminal stud of a circuit breaker. The plates are supported by hydrosprings to provide for expansion and to cushion instantaneous movement of the plates when high pressures are generated within the interrupter which is vented by two channels opening through a single port in the tube. The channels are separated by a plate having a tongue which projects through the port to isolate the parallel streams of gas discharged from the opening. The tongue also keys the plate in position and prevents rotation. Other plate elements may be doweled to it to prevent them from rotating.

For a better understanding of the nature and objects of the invention, reference may be had to the following detailed description, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a view, partly in elevation and partly in section, of a circuit breaker embodying principal features of the invention;

FIG. 2 is a view, in elevation, of an interrupter unit utilized in the circuit breaker;

FIG. 3 is a view, primarily in section, of the interrupter unit and cooperating moving contact assembly;

FIGS. 4 to 11, inclusive, are detail views of grid elements or plates utilized in the grid;

FIG. 12 is a view, in section, of a modified grid structure;

FIG. 13 is a view taken along the line XIII—XIII in FIG. 11;

FIG. 14 is a view, partly in section and partly in elevation, of a portion of another modification of the invention; and

FIG. 15 is a detail view showing one method of assembling certain parts of the grid structure.

Referring to the drawings, and particularly to FIGS. 2 and 3, the interrupting unit **10** shown therein is adapted to be mounted, along with a similar unit, inside a circuit breaker tank 7 shown in FIG. 1 containing a suitable arc extinguishing dielectric, such as oil 8. The interrupting unit 10 is attached to the lower end of a terminal stud 11 by means of a clamping member 12 which may be threaded onto the stud 11 and also clamped in position by a bolt 13. The stud 11 extends into the breaker tank through a terminal bushing 9 shown in FIG. 1. A contact housing 14 has a flange 15 at its upper end which is attached to a flange 16 on the clamping member 12 by means of screws 17. As shown most clearly in FIG. 3, a beveled ring 18 is disposed between the flanges 15 and 16, thereby permitting the contact housing 14 to be adjustably attached to the clamping member 12.

The contact housing 14 has a generally cylindrical bottom portion 19 to which a cylindrical tube 21 is attached by means of screws 22 which extend through the wall of the tube and are threaded into the cylindrical portion 19. A check valve 23 may be threaded into the side wall of the contact housing 14. The valve 23 permits oil to flow through the interrupter when the breaker is closed. On a fault interruption the valve is closed by internal pressure within the interrupter.

As shown in FIG. 3, a relatively stationary contact assembly 24 is disposed inside the contact housing 14. The assembly 24 comprises two generally semi-cylindrical contact members 25 each of which is pivotally mounted in the housing 14 by means of a bolt 26 shown in FIG. 2. The contact members 25 are electrically connected to a boss 27 on the inside of the housing 14 by means of a flexible shunt 28 which is attached to the boss 27 by a screw 29. One end of the shunt 28 is attached to each contact member 25 by riveting or peening a projection 30 on the contact member which extends through a hole in the shunt 28. The contact members 25 are biased inwardly to engage a movable contact member 31 by compression springs 32 disposed between the wall of the contact housing 14 and the contact members 25. The movable contact member 31 is preferably an elongated round rod having its lower end threaded into a cross arm 33. The cross arm 33 is carried by a lift rod 34 which may be raised and lowered by means of any suitable operating mechanism of a type well known in the art. Another contact member, similar to the member 31 is secured in the other end of the cross arm 33 for cooperation with another interrupting unit 10 similar to the one illustrated.

The insulating tube 21 is preferably manufactured as pipe of continuous filaments of glass, bonded with epoxy resin. Tubes of this type possess exceptional mechanical properties and are capable of withstanding relatively high pressures. The outstanding mechanical strength of this material enables it to contain the radial and longitudinal forces arising from pressure generated within the interrupter during an interrupting operation. Thus, tie rods have been eliminated from the assembly and the internal grid elements are made of a relatively small section since they are now backed up by the tube wall and will no longer be subjected to pressure differences that result in damaging hoop stresses.

The tubular case reduces leakage from the interrupter during power interruptions. Leakage between the grid elements or plates is prevented by the tube and the round moving contact also reduces the leakage. As long as the contact is projecting into the interrupter there will be very little leakage through the close clearance between the contact member 31 and an insulating sleeve 35 in a bottom plate or supporting member 36 through which the contact member 31 extends when in its closed position. The reduced leakage is advantageous in maintaining internal pressure and avoiding delayed restrikes when the grid is applied in a relatively high voltage range, for example, 46 to 69 kv.

The use of pipe cut to length for the interrupter case has distinct advantages. For low voltage applications a grid comprised of a relatively few plate elements is usually satisfactory; higher voltages demand a larger number of elements to effectively interrupt the circuit. Procurement of the tube in pipe form which may be cut to the desired length leads to economy by minimizing the number of sizes which must be stocked. A tubular body of unique form and length does not have to be procured for each voltage class of equipment.

As shown most clearly in FIGURE 3, the grid structure comprises a plurality of stacked discoidal plates having openings therein which provide a passageway for the movable contact member 31, which passageway also functions as an arc passage when the contact member 31 is separated from the stationary contact assembly 24 to draw an arc. Beginning at the top of the grid structure, there is provided a metal plate 41 which is similar in shape to the plate 41′ shown in FIG. 11 with the exception that the opening through the plate is centrally disposed in the plate 41 while it is eccentrically disposed in the plate 41′ as will be explained more fully hereinafter. An arc tip or horn 42 is attached to the plate 41 and is disposed underneath the lower end of the one contact member 25. The plate 41 is disposed underneath the springs 32 to prevent the arc and ionized gases from burning the springs and the contact members 25 during an interruption. The arcing horn on this plate is used for one terminal of the arc and positions the arc above and on the axis with the vents. The plate electrically connects the arcing horn to the housing 14. The arc is transferred from the contact members 25 to the arc tip 42 when the upper end of the movable contact member 31 passes below the arc tip 42.

An insulating plate 43 is disposed underneath the plate 41. The plate 43 is similar in shape to the plate 43′ shown in FIG. 10 with the exception that the opening through the plate 43 is centrally disposed instead of being off-center as in the plate 43′. One side of the opening is enlarged, as shown at 44 in FIG. 10, to accommodate the arc tip 42. The plate 43 shields remote areas of the plate 41 and prevents the arc from running back into these remote areas. It positions the arc on the protruding arcing horn 42 on the plate 41.

The next lower plate is an insulating plate 45 having a generally round opening therein and a tongue 46 which projects through a vent port 47 in the side wall of the insulating tube 21. The plate 45 is shown in FIG. 4. It forms a pocket containing oil which when exposed to an arc decomposes into a gas which is discharged downwardly along the arc and out the vent. The next plate 48 is shown in FIG. 5. This plate has a generally semi-circular opening therein with a laterally extending V-shaped notch 49 at the base of the semi-circular opening. The plate contains oil and positions the arc in front of the vent. This plate also has a tongue 51 which projects into the vent opening 47.

The next two lower plates are venting plates 52, the configuration of which is shown in FIGURE 6. Each plate has a generally semi-circular opening therein and a projecting tongue 53 with a venting passage 54 extending from the centrally disposed opening through the projection 53 which extends through the vent port 47. Thus, the high pressure arc gases and oil are permitted to escape from the central arc passage 55 through the venting passages 54. The arc is so located that the oil discharge passes around the arc.

An insulating splitter or divider plate 56 is disposed between the upper pair of venting plates 52 and a similar pair of venting plates 52 disposed directly underneath the splitter plate 56. As shown in FIG. 7 of the drawings, the plate 56 has a relatively small round hole 57 therein and a tongue 58 which projects into the vent port 47. The plate 56 also has a small diameter hole 59 therein which permits oil to flow from one side of the plate 56 to the other. The plate 56 acts as a barrier to isolate the two channels formed by the two pairs of venting plates 52 which open through the vent port 47. Thus, two parallel streams of gas are discharged through the vent port. Gas is evolved from the fiber material to enhance extinguishing the arc. This plate seals off the lower section of the interrupter until the moving contact 31 travels approximately 2½" thus keeping the pressure up in the uppermost part of the interrupter. The projecting tongue 58 prevents the arc from restriking outside the wall of the tube 21. Likewise, the projecting tongue 51 on the plate 48 and a tongue 61 on a plate 62 disposed below the lower venting plate 52 prevent the arc gases from flowing along the inside of the tube 21. The plate 62 is shown in FIG. 8 of the drawings. It contains oil and restricts the arc terminal from traveling down back edge of the moving contact.

Oil pockets 65, 66 and 67 are provided below the plate 62. The oil pockets are obtained by utilizing three plates 68 which are spaced apart by spacing rings 69. The top plates 68 is spaced from the plate 62 by a narrow spacing ring 71. As shown in FIG. 9, each plate 68 has a circular opening 72 therein which is slightly larger in diameter than the diameter of the movable contact member 31. The oil pockets aid in the interruption of low currents by providing reservoirs of oil and orifices which direct axial oil flow into close proximity of the arc. A plate 73 is disclosed below the bottom plate 68. The plate 73 is similar to the plates 68 except that it has a larger circular opening 74 therein.

The oil channels and pockets in the present interrupter function in a manner generally similar to those provided in prior interrupters. However, the surface area of elements exposed to pressure has been reduced since the diameter of the discs or plates has been reduced. This results in two advantages. First, since less area is exposed to pressure, forces developed longitudinally tending to blow the interrupter apart will be less for a given internal pressure than if larger plates were used. Second, cost limitations in choosing newer, but more expensive materials, for example "Teflon," "Delrin," "Celcon" or "Exarc" are less restrictive.

Relatively thin filler or spacing plates 75 are provided between the plate 73 and the bottom plate or supporting member 36. The number of spacing plates 75 utilized may be varied in accordance with the space available when the plates are assembled in the grid structure. As shown in FIGURE 2, the supporting member 36 is held in the tube 21 by means of screws 22 which extend through the side wall of the tube 21 and are threaded into the member 36. The member 36 is preferably composed of metal, such as aluminum.

If the insulating plates in the grid structure are composed of fiber, provision should be made for the dimensional instability of this material. Fiber swells when it absorbs moisture. Therefore, provision must be made for expansion and contraction of the fiber plates. This is accomplished by providing a hydro-spring construction as shown in FIG. 3. Four spaced wells 76 are provided in the metal support member 36. An inverted cup-shaped piston or dash-pot 77 is movably disposed in each well 76. A compression spring 78 biases the piston 77 upwardly. A tapped hole 79 extends through the top of the piston 77 and vent holes 81 are drilled through the side of the piston into the hole 79. Thus, oil is permitted to escape from the dash-pot assembly, the rate of escape being determined by the size of the vent holes 81.

With the foregoing construction, the four spring-biased dash-pots support the fiber elements comprising the grid. The springs 78 exert sufficient force to hold the fiber elements in the their proper position, but are light enough to facilitate manual assembly in the breaker. The four dash-pots have sufficient stroke to allow for normal expansion and contraction of the fiber elements as their moisture content changes. In addition, when high pressures are generated instantaneously within the interrupter concurrent with short-circuit interruption, the dash-pots act to oppose and cushion instantaneous downward movement of the fiber elements, thus maintaining the desired relationship of the individual grid plates with respect to each other.

The grid plates are preferably assembled in the tube 21 prior to its installation in the circuit breaker. With smaller interrupters the springs 78 can be compressed manually sufficiently to permit the interrupter to be installed in the breaker by attaching the upper end of the tube 21 to the contact housing 14 by means of the screws 22 as previously explained.

The method of compressing the springs 78 shown in FIG. 15 may be utilized for interrupters of the larger sizes required for higher voltages. As shown in FIG. 15, a screw 82 is inserted through an opening 83 in the bottom of the member 36 and threaded into the tapped opening 79 in the piston 77. The piston may be drawn downwardly by means of the screw 82 to compress the spring 78 prior to installation of the interrupter unit in the circuit breaker. After the interrupter unit is installed, the screws 82 may be removed to release the springs 78. The holes 83 may be closed by inserting short screws 84 and are threaded into the tapped holes 83.

The modified interrupter unit shown in FIGS. 12 and 13 is in general similar to the one shown in FIGS. 2 and 3 and previously described. The insulating grid plates are similar to those previously described except that the openings in the plates for the movable contact member 31 are eccentrically located. Since these openings also constitute a passage for the arc drawn between the movable contact member and the stationary contact members, the arc passage is offset from the vent port 47. Thus, the arc gases must travel through longer passageways in the venting plates before reaching the vent port. Consequently, there is less danger of the arc restriking outside of the tube 21. The splitter or divider plate 56′ is the only one that has a tongue projecting through the vent port. Since the tongue 58′ on the plate 56′ does extend through the vent port 47 the plate 56′ cannot rotate. Rotation of the other plates is prevented by means of dowel pins 85 which extend through openings 86 in the plates. The dowel pins 85 are composed of a suitable insulating material. Thus, the plate 56′ is utilized to prevent rotation of the other plates in the grid assembly. Spacing plates 87 are utilized in place of the spacing rings 69 and 71 previously described.

If the insulating plates are composed of a material such as polytetrafluoroethylene, which is sold under the trade name "Teflon," or other material which is not adversely affected by moisture, it is not necessary to allow for expansion and contraction of the plates. Accordingly, screws 88 may be utilized in place of the hydro-springs previously described to maintain the desired pressure on the grid plates. As shown in FIG. 12, the screws 88 are threaded into the bottom plate or supporting member 36′ to adjust the pressure on the grid plates. A metal washer 89 is provided between the screws 88 and the spacer plates 75′.

The performance of the interrupter on higher voltage applications, for instance at 69 kv., can be improved by providing a high-ohmic-value grid-shunting resistor. Such a resistor equally divides the voltage that is impressed on the two interrupters which are connected in series so that each will do its share to block the re-establishment of current flow immediately following an interruption and before the moving contact member has been withdrawn from the grids.

As shown in FIG. 14, a resistor 91, which may be of the carbon block type, may be mounted externally of the grid by means of brackets 92 attached to the grid structure by the screws 22 previously described. A contact member 93 is movably disposed in an opening 94 in the insulating sleeve 35′ through which the moving contact member 31 extends. The contact member 93 is biased into engagement with the movable contact member 31 by a compression spring 95 disposed between the contact member 93 and the end of the bottom screw 22 which is utilized to mount the resistor 91. Thus, the lower terminal of the resistor is electrically connected to the movable contact member **31** during the time that the member **31** is within the grid structure. The upper mounting screw **22** electrically connects the upper terminal of the resistor to the contact housing **14**. In this manner, the resistor **91** is connected across the grid during an interruption.

From the foregoing description it is apparent that the invention provides an interrupter assembly encased in low-cost, high-strength, filament-wound glass epoxy pipe readily cut-off to the required length. The tie bolts previously utilized to hold a grid stack together are eliminated and leakage through cracks between adjacent plate elements is precluded. The present structure is capable of sustaining a high internal pressure and is able to withstand such a pressure.

While certain embodiments of the invention have been shown and described, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit and scope of the invention.

We claim as our invention:

1. In a circuit breaker, in combination, a terminal stud, a generally cylindrical metallic contact housing attached to the stud, relatively stationary contact members disposed within the metallic housing, an elongated movable contact member engaging the stationary contact members, an insulating cylindrical tube having its upper end overlapping the metallic contact housing, means extending through the wall of the tube into the metallic housing for attaching the tube to the housing, a metallic cylindrical supporting member disposed inside the bottom end of the tube, means extending through the wall of the tube into the metallic supporting member for retaining it in the tube, a plurality of insulating discoidal plates stacked within the tube between the bottom of the metallic contact housing and said metallic supporting member, means movably disposed in the metallic supporting member for resiliently raising said plates toward the housing, and said plates and supporting member having openings therein to provide a passageway through the plates for the movable contact member.

2. In a circuit breaker, in combination, a terminal stud, a generally cylindrical metallic contact housing attached to the stud, relatively stationary contact members disposed within the metallic housing, an elongated movable contact member engaging the stationary contact members, an insulating cylindrical tube having its upper end overlapping the metallic contact housing, means extending through the wall of the tube into the metallic housing for attaching the tube to the housing, a cylindrical metallic supporting member disposed inside the bottom end of the tube, means extending through the wall of the tube into the metallic supporting member for retaining it in the tube, a plurality of insulating discoidal plates stacked within the tube between the bottom of the metallic contact housing and said metallic supporting member, movable compressing means disposed in the supporting member for compressing said plates together, and said plates and supporting member having a aligned openings therein to provide a passageway through the plates for the movable contact member.

3. In a circuit breaker, in combination, a terminal stud, a generally cylindrical contact housing attached to the stud, relatively stationary contact members disposed within the housing, an elongated movable contact member engaging the stationary contact members, an insulating cylindrical tube having its upper end overlapping the contact housing, threaded means extending through the wall of the tube into the housing for attaching the tube to the housing, a cylindrical supporting member disposed inside the bottom end of the tube, means extending through the wall of the tube into the supporting member for retaining it in the tube, a plurality of discoidal plates stacked within the tube between the bottom of the contact housing and said supporting member, a plurality of wells in said supporting member, resilient means disposed in said wells for biasing said plates toward the housing, and a passageway extending through said supporting member and said plates for said movable contact member.

4. In a circuit breaker, in combination, a terminal stud, a generally cylindrical contact housing attached to the stud, relatively stationary contact members disposed within the housing, an elongated movable contact member engaging the stationary contact members, an insulating cylindrical tube having its upper end overlapping the contact housing, threaded means extending through the wall of the tube into the housing for attaching the tube to the housing, a cylindrical supporting member disposed inside the bottom end of the tube, means extending through the wall of the tube into the supporting member for retaining it in the tube, a plurality of discoidal plates stacked within the tube between the bottom of the contact housing and said supporting member, a plurality of wells in said supporting member, a piston in each well, spring means for biasing each piston upwardly to compress said plates together, and a passageway extending through said supporting member and said plates for said movable contact member.

5. In a circuit breaker, in combination, a terminal stud, a generally cylindrical contact housing attached to the stud, relatively stationary contact members disposed within the housing, an elongated movable contact member engaging the stationary contact members, an insulating cylindrical tube having its upper end overlapping the contact housing, threaded means extending through the wall of the tube intto the housing for attaching the tube to the housing, a cylindrical supporting member disposed inside the bottom end of the tube, means extending through the wall of the tube into the supporting member for retaining it in the tube, a plurality of discoidal plates stacked within the tube between the bottom of the contact housing and said supporing member, a plurality of wells in said supporting member, an inverted cup-shaped piston in each well, a vent hole in each piston, a compression spring in each well to bias each piston upwardly to compress said plates together, aligned openings in said plates and said supporting member to provide a passageway for the movable contact member, and an insulating sleeve in the opening in the supporting member.

6. In a circuit breaker, in combination, a terminal stud, a metallic contact housing having a cylindrical bottom portion, means for adjustably attaching the metallic housing to the stud, spring-biased contact members pivotally mounted within the housing, an elongated movable contact member separable from the spring-biased contact members to establish an arc, a high-strength insulating cylindrical tube having its upper end overlapping the bottom portion of the metallic contact housing, means extending through the wall of the tube into the metallic housing to attach the tube to the housing, a metallic cylindrical supporting member disposed inside the bottom end of the tube, means extending through the wall of the tube into the metallic supporting member for retaining it in the tube, a metal plate disposed within the tube in contact with the bottom of the contact housing, an arcing member attached to the plate adjacent one of the spring-biased contact members, a plurality of insulating discoidal plates stacked within the tube between said metal plate and said metallic supporting member, and said plates having aligned openings therein to provide a passageway through the plates for the movable contact member.

7. In a circuit breaker, in combination, a terminal stud, a metallic contact housing having a cylindrical bottom portion, means for adjustably attaching the housing to the stud, spring-biased contact members pivotally mounted within the metallic housing, an elongated movable contact member separable from the spring-biased contact members to establish an arc, a high strength insulating cylindrical tube having its upper end overlapping the bottom portion of the metallic contact housing, means extending through the wall of the tube into the metallic housing to attach the tube to the housing, a cylindrical metallic supporting member disposed inside the bottom end of the tube, means extending through the wall of the tube into the metallic supporting member for retaining it in the tube, a metal plate disposed within the tube underneath the springs of said spring-biased contact members and in contact with the metallic contact housing, an arcing member attached to the plate adjacent the lower end of one of said contact members, a plurality of insulating discoidal plates stacked within the tube between said metal plate and said supporting member, and a passageway extending through said plates for said movable contact member.

8. In a circuit breaker, in combination, a terminal stud, a generally cylindrical metallic contact housing attached to the stud, relatively stationary contact members disposed within the metallic housing, an elongated movable contact member engaging the stationary contact members, an insulating cylindrical tube having its upper end overlapping the metallic contact housing, means extending through the wall of the tube into the metallic housing for attaching the tube to the housing, a metallic cylindrical supporting member disposed inside the bottom end of the tube, means extending through the wall of the tube into the metallic supporting member to retain it in the tube, a plurality of insulating discoidal plates stacked within the tube between the bottom of the metallic contact housing and said metallic supporting member, means movably disposed in the metallic supporting member for resiliently raising said insulating plates toward the metallic contact housing, a passageway through the supporting member and the plates for the movable contact member, and resistance means connected to the metallic contact housing and to the metallic supporting member.

9. In a circuit breaker, in combination, a terminal stud, a generally cylindrical metallic contact housing attached to the stud, relatively stationary contact members disposed within the metallic housing, an elongated movable contact member engaging the stationary contact members, an insulating cylindrical tube having its upper end overlapping the metallic contact housing, means extending through the wall of the tube into the metallic housing for attaching the tube to the housing, a cylindrical metallic supporting member disposed inside the bottom end of the tube, means extending through the wall of the tube into the metallic supporting member to retain it in the tube, a plurality of insulating discoidal plates stacked within the tube between the bottom of the metallic contact housing and said metallic supporting member, means movably disposed in the metallic supporting member for resiliently raising said insulating plates toward the metallic contact housing, a passageway through the supporting member and the plates for the movable contact member, resistance means connected to the metallic contact housing and to the metallic supporting member by means of said threaded means, and contact means connecting the metallic supporting member to the movable contact member.

10. A circuit interrupter comprising a cylindrical insulating tube having a vent port in its wall adjacent one end thereof, a plurality of insulating discoidal plates stacked within the insulating tube, said plates having eccentric openings therein providing an offset arc passage through the plates, at least two of said plates being vent plates each having a venting passage from the arc passage to the vent-port, a splitter plate disposed between said vent plates, a tongue on the splitter plate projecting into the vent port a metallic cylindrical supporting member disposed inside the other end of the tube, and means movably disposed within the metallic supporting member for resiliently raising said plates toward said one end of the cylindrical insulating tube.

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