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SINGLE BREAK OIL CIRCUIT BREAKER STRUCTURE HAVING DUAL VALVE STRUCTURE

Filed Nov. 20, 1964 4 Sheets-Sheet 1

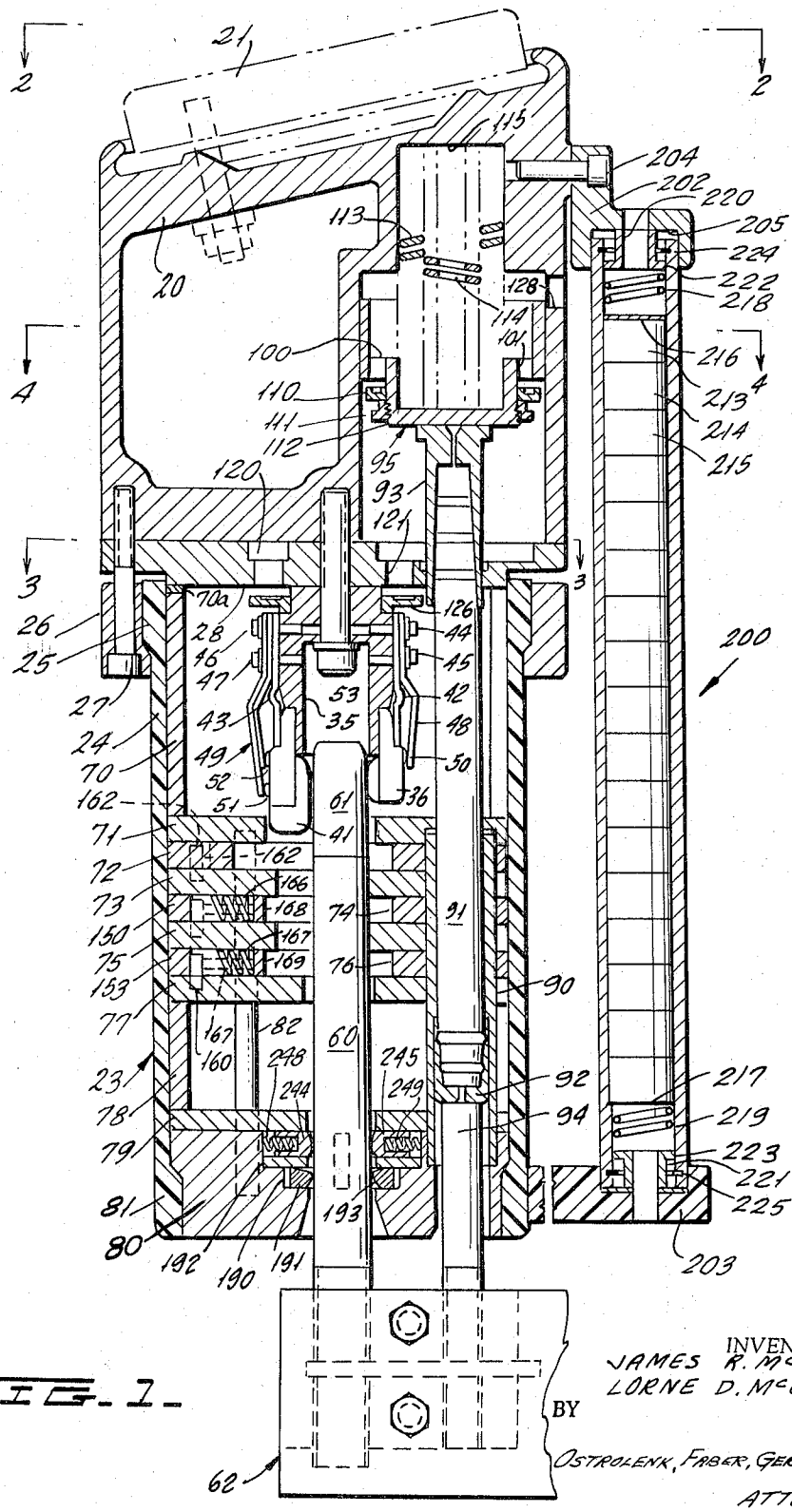


FIG. 1

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FIG. 2.

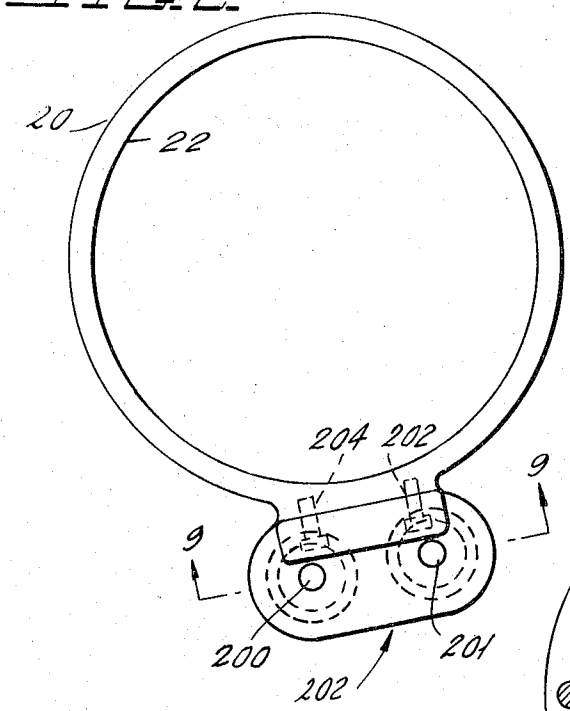


FIG. 9.

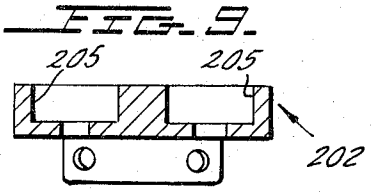


FIG. 3.

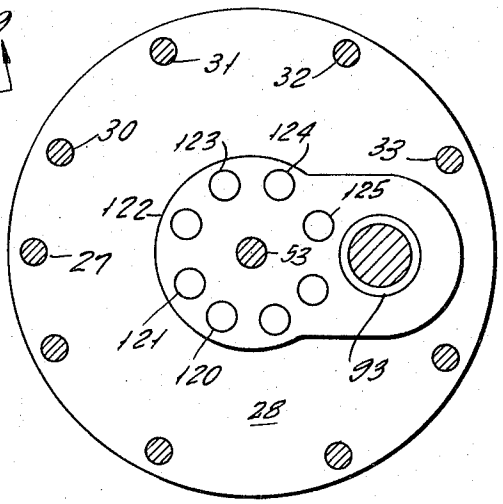


FIG. 4.

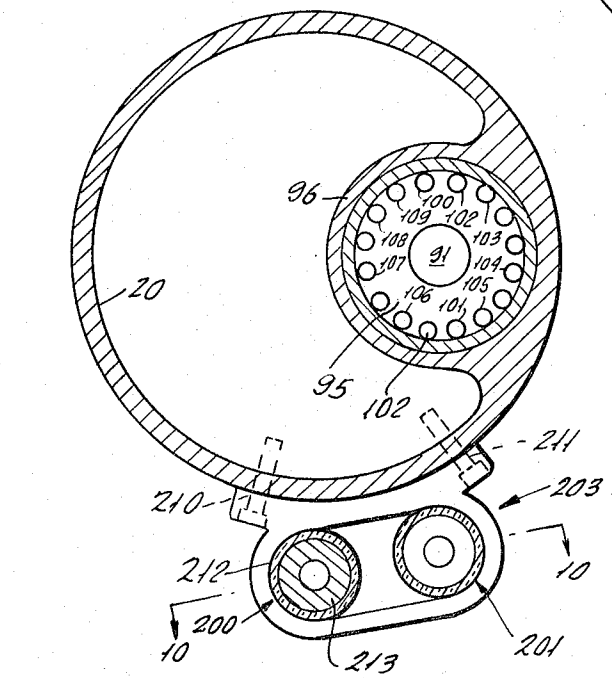
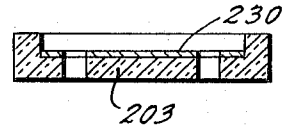


FIG. 10.



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FIG. 5

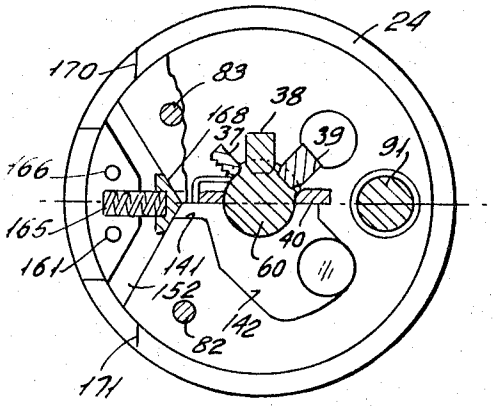


FIG. 8

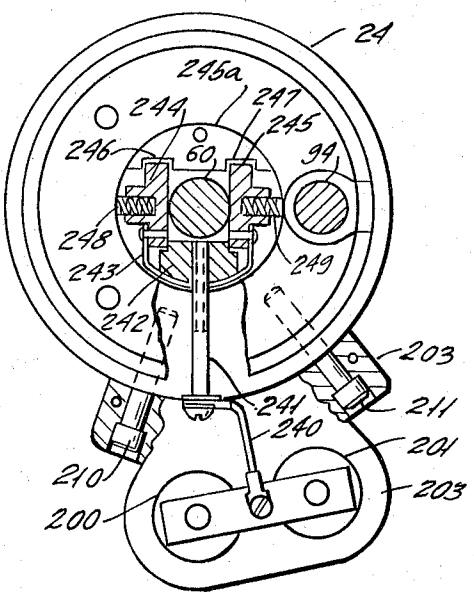


FIG. 6

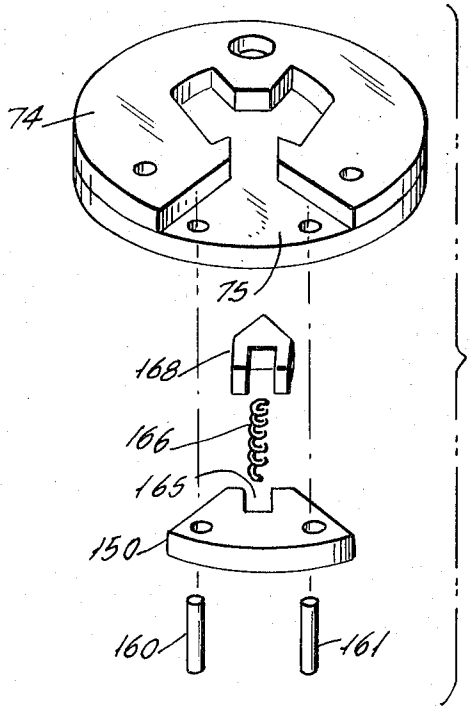
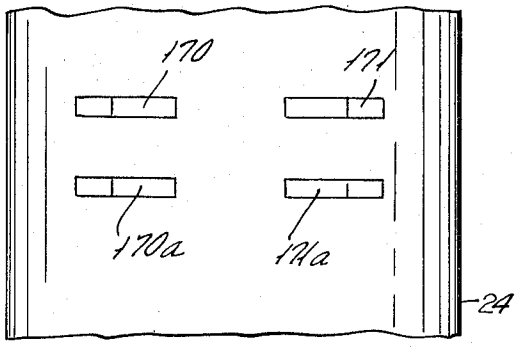


FIG. 7



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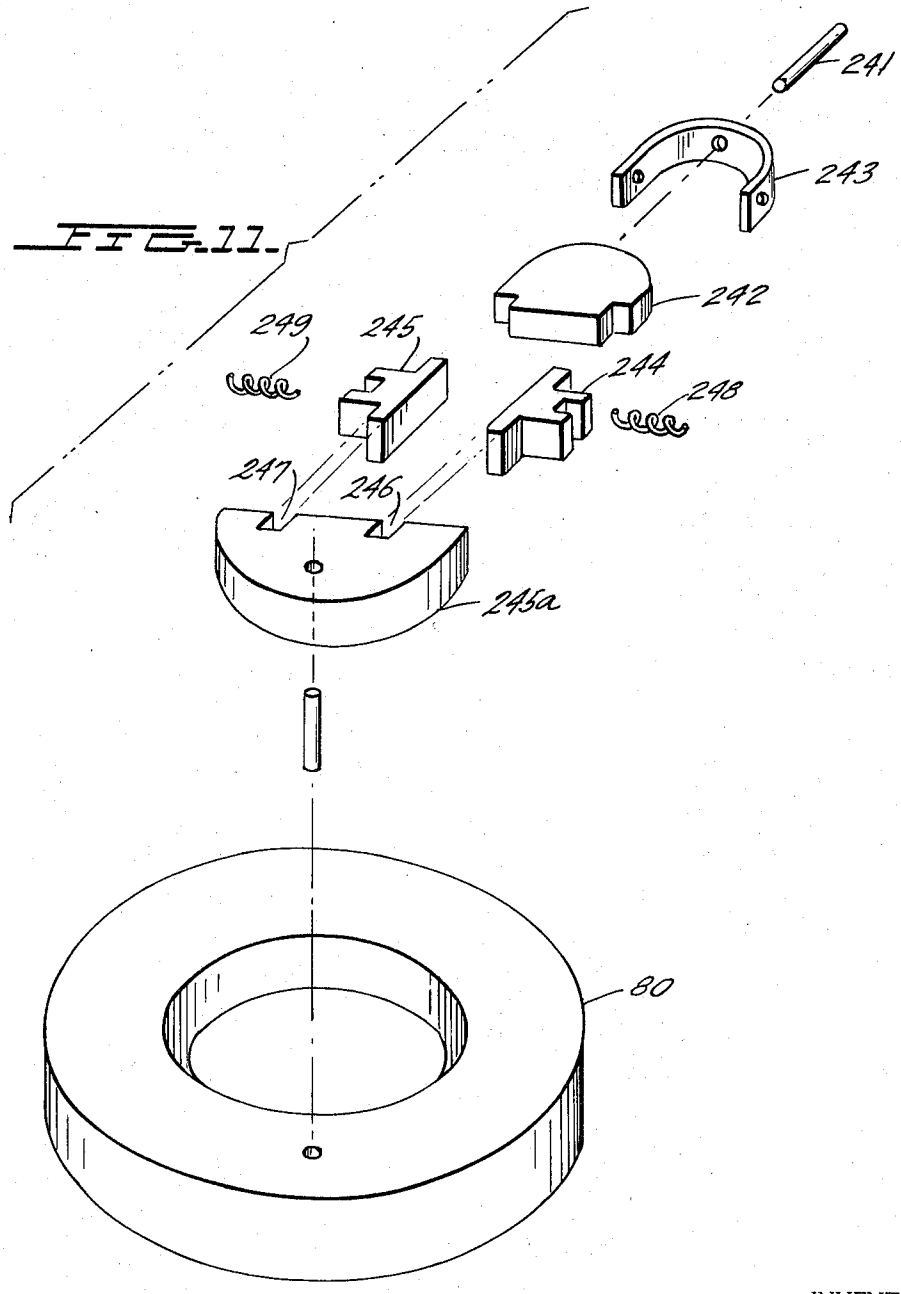
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FIG. 11.



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United States Patent Office 3,313,901 Patented Apr. 11, 1967

3,313,901

SINGLE BREAK OIL CIRCUIT BREAKER STRUCTURE HAVING DUAL VALVE STRUCTURE

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Filed Nov. 20, 1964, Ser. No. 412,662
3 Claims. (Cl. 200—150)

This invention relates to oil circuit breakers, and more specifically relates to a novel group of features for an improved single break oil circuit breaker interrupter and resistor structure therefor.

Interrupters for oil circuit breakers are well known to those skilled in the art. Such interrupters are generally shown in copending application Serial No. 67,125, filed November 3, 1960, entitled Tank Structure For Oil Circuit Breaker, in the name of James R. McCloud (now abandoned), and assigned to the assignee of the present invention, and include an interrupter structure which is immersed in oil and which has a stationary contact therein which is engaged by a movable rod-type contact. As the movable contact is moved to a disengaged position, the arc drawn within the interrupter chamber is extinguished by the flow of gaseous arc products and clean oil through the arc and out through exhaust ports in the interrupter chamber. In order to aid in the interruption of the arc, it is common practice to connect a resistor in parallel with the main contacts. This resistor circuit must be opened when the main movable contact moves to its fully disengaged position so that the current flow through the resistor will be interrupted.

A first feature of the present invention is directed to a novel pump structure for causing oil flow during low power arc interruption wherein a novel check-valve arrangement is provided which normally permits circulation of oil through the pump piston and into the interrupter. This novel valve arrangement includes a first annular valve disk carried by the main piston which is movable into sealing engagement with a series of openings in the main piston. Thus, during low arc current interruption, the novel annular valve closes off the ports in the cylinder so that the piston can properly operate. Under normal conditions, however, oil flow can easily take place through this series of openings so that improved cooling of the interrupter is achieved.

Moreover, during high current arcing conditions, the pressure generated within the interrupter container serves immediately to force a second check valve disk upwardly to seal off channels between the piston and interrupter to prevent the application of excessive pressure to the piston.

Accordingly, an important object of the present invention is to provide a novel pump arrangement for an oil immersed interrupter structure.

Another object of this invention is to provide a novel means for permitting circulation of oil through an interrupter structure, and to automatically seal the oil passages in the piston during interruption conditions.

Another object of this invention is to provide a novel piston arrangement which is automatically operated under spring biasing means when a movable contact of an interrupter structure is moved to a disengaged position.

A still further object of this invention is to provide a novel oil check-valve arrangement.

The present invention further provides a novel valve for the exhaust ports of the interrupter structure. That is to say, valves are often used which are in communication with the venting ports of an interrupter chamber wherein the valves seal the ports until a sufficient pressure build-up is provided for an oil piston or by other

means. The present invention provides a novel valve structure which is of low mass and provides large area venting with short travel. Moreover, the novel valve structure of the invention is inexpensive, easily assembled and easily replaced.

Each of the ports associated with the valve structure of the invention form two paths leading to two ports in the interrupter container. The ports are flared out to permit easy expansion of gases and other arc products passing through the ports. The two passages then join in a common passageway located internally of the interrupter, this passageway receiving the novel valve of the invention which is of triangular form so that it can block the passage between the common channel and the two outlet channels. If desired, the valve may be metallic or non-metallic, and is biased into sealing engagement with the main channel by a metallic or non-metallic biasing spring.

The seal ports, as previously indicated, are enlarged openings and preferably are positioned to direct the flow of emitted oil and gas in directions away from the nearest point of the tank which contains the interrupters and the oil in which the interrupters are immersed.

Accordingly, another important object of this invention is to provide a novel sealing valve for the port of an interrupter which provides large area venting with short travel.

Another object of this invention is to provide a novel valve for the ports of an interrupter structure which are of low mass.

A still further object of this invention is to provide a novel valve for the ports of an interrupter structure which is inexpensive, easy to assemble and easily replaced.

A still further object of this invention is to provide a novel valve for the ports of an interrupter structure wherein the ports increase in area as they approach the outside of the confining tube.

As a still further feature of the invention and in order to insure that pressure can be built up within the interior of the interrupter chamber, a novel seal is further provided around the moving contact rod to prevent loss of oil and oil pressure during opening operation of the interrupter. The novel seal of the invention is so arranged that it fits snugly around the movable contact rod, but is laterally movable within the bottom plug of the interrupter. Accordingly, the opening in the bottom of the tube will be sealed about the movable contact rod although the movable contact rod is permitted to have lateral motion to allow for misalignment between the contact rod and the opening in the bottom of the interrupter tube.

Thus, another important object of the invention is to provide a novel seal about the movable contact rod of an interrupter structure to permit pressure build-up within the interrupter during interrupting conditions.

Another object of this invention is to provide a novel seal for the movable contact of an interrupter structure which permits lateral movement of the contact rod.

As indicated in the foregoing, resistors are commonly provided in parallel with the main contacts of an interrupter structure. A further feature of the novel invention provides a novel mounting structure and assembly for a resistor to be connected in parallel with an interrupted structure. More specifically, the novel resistor structure includes a novel pair of floating contacts at either end of the resistor tube which are held assembled by a snap-ring arrangement at the ends of the tube. The floating contacts are further formed of hollow members to permit circulation of oil through the resistor for the cooling thereof.

Accordingly, another important object of this invention

is to provide a novel arrangement for mounting the resistor to be connected in parallel with the main contacts of an oil circuit breaker interrupter.

Another object of this invention is to provide a novel construction for the resistor of an oil circuit breaker interrupter.

A still further object of the invention is to provide a novel floating contact arrangement which is held in place by snap-rings for the easy assembly of a complete resistor.

As is well known, and as previously indicated, there is usually misalignment between the movable contact which is carried from a lift-rod and cross-bar assembly in the well-known manner and the opening at the bottom of the interrupter. The present invention further provides a novel structure for securing the movable contact rod to its cross-bar so that the contact may be adjusted on the cross-bar with respect to the opening in the interrupter. This novel arrangement includes a locking means for the adjustably positioned contact rod and a carrying block for receiving the contact rod.

Accordingly, a still further object of this invention is to provide a novel connection between the contact rod of an oil circuit breaker and the cross-bar.

A further object of this invention is to provide a novel locking means for adjustably connecting a lift-rod to a cross-bar assembly and the contact rods to the ends of the cross-bar assembly.

These and other objects of this invention will become apparent from the following description when taken in connection with the drawings, in which:

FIGURE 1 is a side cross-sectional view of an interrupter structure constructed in accordance with the present invention.

FIGURE 2 is a top plan view of FIGURE 1 seen from lines 2—2 in FIGURE 1.

FIGURE 3 is a cross-sectional view of FIGURE 1 across lines 3—3 in FIGURE 1.

FIGURE 4 is a cross-sectional view of FIGURE 1 across lines 4—4 in FIGURE 1.

FIGURE 5 shows a cross-sectional view of FIGURE 1 across the lines 5*a*—5*a* in FIGURE 1 for the right-hand side of FIGURE 5 and across the lines 5*b*—5*b* in FIGURE 1 for the left-hand side of FIGURE 5.

FIGURE 6 is an exploded perspective view of the port valve structure.

FIGURE 7 is a partial front plan view of the interrupter container of FIGURE 1 to illustrate the ports in the container.

FIGURE 8 is a cross-sectional view of FIGURE 1 taken across the lines 8—8 in FIGURE 1.

FIGURE 9 is a partial cross-sectional view of the resistor upper support cap taken across the lines 9—9 in FIGURE 2.

FIGURE 10 is a cross-sectional view of the resistor lower support structure taken across the lines 10—10 in FIGURE 4.

FIGURE 11 is an exploded perspective view of the resistor contact structure.

Referring now to the figures, an interrupter structure is shown for an oil circuit breaker of the type shown in copending application Serial No. 67,125 where the interrupter structure of the figures will be immersed in oil within an oil filled tank (not shown) and will be carried from suitable insulator bushings which enter the tank. Thus, the interrupter, as shown in FIGURES 1 and 2, is provided with an upper conductive cap assembly 20 which is securable to a suitable adapter structure 21 shown in dotted lines in FIGURE 1, which is, in turn, connected to the end of an insulator bushing. Note that the upper portion of cap 20 has a smooth circular opening 22 which is best suited for high voltage purposes.

The cap 20 which is cast of a suitable metallic material serves as the support for the interrupter structure generally shown by numeral 23 in FIGURE 1 which contains the various components of the interrupter equipment.

The interrupter structure 23 more specifically includes an insulation container 24 which may be formed of any suitable material such as fiber glass which has an enlarged upper section 25 (FIGURE 1) that receives a mounting ring 26. The mounting ring 26 then has a plurality of bolt holes therein which receive respective bolts such as bolt 27 in FIGURE 1, and bolts 30 through 34 in FIGURE 3, which extend upwardly through a conductive pressure pad 28 and into suitably tapped openings in the bottom of cap 20. The member 28 and the bottom of cap 20 further serve to receive the stationary contact structure generally indicated by numeral 34 in FIGURE 1. More specifically, the stationary contact structure includes a conductive hub 35 which carries a plurality of spring biased contact fingers about its periphery. FIGURE 1 shows two of these contact fingers 36 and 41, while the left-hand side of FIGURE 5 shows the manner in which similar contact fingers 37 through 40 surround and are carried by the contact hub 35. The contact finger 41 of FIGURE 1 is longer than the other of the contact fingers and serves as the arcing contact.

Each of the various contact fingers are carried from the hub 35, as shown in FIGURE 1, by conductive straps such as straps 42 and 43 for contacts 36 and 41 respectively which are secured to the contact hub by screws 44–45 and 46–47 respectively which are threaded to suitably tapped openings in the hub 35.

Each of the contact fingers are also biased inwardly by suitable biasing leaf springs such as leaf springs 48 and 49 in FIGURE 1 which bear upon insulated buttons 50 and 51–52 for contacts 36 and 41 respectively. These insulation buttons prevent the formation of a conductive path through the biasing springs so that the springs will not be heated by the conduction of current therethrough.

The contact hub 35 along with the various contacts assembled thereto then has a central opening therein which receives a theaded bolt 53 which passes through through-type openings in the top of hub 35 and in plate 28 and into threaded engagement with a suitably threaded opening in cap 20.

The stationary contact structure receives a co-operating movable contact rod 60 which may have an arcing tip 61 of suitable arc-resistant material secured to the conductive lower body of the rod 60. The rod 60 is then secured to a cross-bar 62 which is carried, in turn, from a lift-rod in the usual manner, and as shown, for example, in copending application Serial No. 67,125, and as will be described more fully hereinafter.

The cross-bars 62 are movable from a lower position at which the contact tip 61 is completely removed from the interrupter to the position shown in FIGURE 1 where the contact rod 60 is in engagement with the stationary contact structure. During movement of contact rod 60 to the disengaged position, an arc will be drawn directly from tip 61 to arcing contact finger 41. In order to extinguish this arc, the interrupter container 24 has therein a series of plates. More specifically, the interrupter container 24 has contained therein a spacing cylinder 70, the upper end of which is engaged by plate 28 through the gasket 70*a*. The lower end of cylinder 70, which may be of any suitable phenolic-type material, then seats upon and compresses the stack of plates 71 through 77 against a further spacing cylinder 78. The cylinder 78 then seats upon bottom plate 79 which is placed atop the throat bushing 80 which is captured in the necked-down portion 81 of the container 24.

Each of plates 72, 75 and 77 have the arrangement shown in FIGURE 1*a* and have a central opening 60*a* for receiving the contact rod 60 and an opening 91*a* for receiving rod 91. They also have keying openings 72*a* and 72*b* for receiving keying pins and through holes 82*a* and 82*b* for receiving alignment rods such as rod 82.

The upper plate 71 has the shape shown in FIGURE 1*b* and includes rod opening 91*b* for receiving rod 91 and a keyhole opening 60*b* for receiving contact rod 60

and contact finger **41**. Alignment rod openings **82***c* and **82***d* are also provided for alignment rods **82**. It will also be noted that two oil passages **71***a* and **71***b* also pass through plate **71**.

The plates **71** through **77**, plate **79** and throat bushing **80** are then aligned with respect to one another by suitable alignment rods such as rod **82** (FIGURE 1 and the right-hand side of FIGURE 5) and a similar rod **83** (left-hand side of FIGURE 5). The plates **71** through **77** also contain aligned openings therein which receive an insulation tube **90** through which an insulation rod **91** passes. The insulation rod **91** is terminated at its top and bottom by suitable fittings **92** and **93**, the rod **91** being axially movable within insulation tube **90**. The lower fitting **92** is then engaged by an operating rod **94** which is connected to the cross-bar **62**, while the upper fitting **93** engages the lower end of a piston **95**.

More particularly, rod **91** is formed of a densified wood. The fittings **92** and **93** are of steel and are secured to rod **91** over a tapered surface by a suitable epoxy cement. Key anchors are formed in the cemented joint by placing grooves such as goove **91***a* around the tapered wood ends and filling them with epoxy before connecting the fittings to the rod **91**. Preferably, escape openings such as openings **92***a* and **93***a* are formed in fittings **92** and **93** respectively to permit escape of excess glue.

The piston **95** is then movable within a cylinder **96**, as shown in FIGURES 1 and 4. The lower portion of piston **95** then carries a movable disk-shaped check-valve **110** (FIGURE 1) which is movable into sealing engagement with respect to the openings such as openings **100** through **109** in piston **95**. The check-valve **110** is retained on piston **95** by a suitable sleeve **111** which is threaded on to the threads **112** on the bottom of piston **95**. Once member **111** is in place, the threads **112** are preferably staked to prevent movement of member **111**.

Concentric compression springs **113** and **114**, as shown in FIGURE 1, are then captured between the interior of piston **95** and surface **115** formed within cap **20** to normally bias piston **95** downwardly. This movement is restrained by rods **91** and **94** when the cross-bar **62** is in the position shown.

The piston **95** serves as a pump for providing high pressure within the interior of the interrupter during low current interrupting conditions. To this end, it should be remembered that the volume beneath piston **95** is filled with oil. A plurality of channels **120** and **121** communicate with the volume beneath piston **95** and the internal volume of the interrupter. Other similar channels **122** through **125** are shown in FIGURE 4. Note that a further channel **128** (FIGURE 1) permits the introduction of oil into the interrupter structure from the area external thereof.

A second check-valve **126** is then formed on a reduced diameter portion of contact hub **35**, as shown in FIGURE 1, check-valve **126** being movable into sealing engagement with openings **120** through **125** in plate **28** when the pressure within the interrupter chamber exceeds the pressure below piston **95**.

As previously indicated, it is necessary that there be ports in the walls of container **24** through which gas and oil may be ejected during interrupting conditions. Moreover, it is desirable to provide a valve in such ports so that venting will not occur until some predetermined pressure is built up within the container (for low current switching).

To this end, plates **74** and **76**, which are each arranged as illustrated in FIGURES 1, 5 and 6, are provided with a V-shaped notch **140** which communicates with channel **141** which, in turn, communicates with the interior oil-containing volume **142** of each of the plates. The V-shaped notch **140** in each of plates **74** and **76** then receives an insert such as insert **150** which defines first and second channels **151** and **152** respectively in each of plates **74** and **76**. A similar insert **153** is shown in FIGURE 1 for the plate **76**. The inserts **150** and **153** are then held in place by suitable pins such as pins **160** and **161** in FIGURE 3 which enter into plates **75** and **77** respectively.

For purposes of pre-alignment of the various plates, a similar pin arrangement keys plates **72** and **73** with respect to one another so that they are automatically properly aligned.

Each of inserts **150** and **153** are then provided with a suitable notch such as notch **165** which receives compression springs such as springs **166** and **167** for inserts **150** and **153** respectively Each of springs **166** and **167** are then secured to a V-shaped, preferably non-metallic, valve such as valves **168** and **169** respectively. These valves are then biased into engagement with the main channel of their respective interrupter, as shown for the engagement between valve **168** in the channel **141** in FIGURE 3. Note that the adjacent plates **73** and **75** serve to seal the upper and lower portions of channel **141** in FIGURE 3 by overlapping the notch opening **14** at the point where valve **168** is positioned.

The channels **151** and **152** then communicate with ports **170** and **171** respectively in container **24** (FIGURE 7) and are normally isolated from main channel **141**. A similar port arrangement including ports **170***a* and **171***a* (FIGURE 7) will, of course, be found for plate **66** with its two respective channels and two respective ports being normally isolated from the interior of container **24**.

Moreover, it will be noted from FIGURE 5 that the ports **170** and **171** in container **24** flare outwardly so that the port area increases as the outer diameter of container **24** is approached. By using a dual port arrangement, the direction of gas blast through channels such as channels **151** and **152** may be directed toward those portions of the main tank which are furthest removed from the interrupter structure.

In order to maintain internal pressure within container **24** during line switching or low current interrupting conditions, it has been further found desirable to provide a seal about the movable contact rod **60**. This seal has previously been avoided because of unavoidable misalignment between the contact rod and the center of the interrupter container.

In accordance with the present invention, however, a shelf **190** (FIGURE 1) is provided in the throat bushing **80** which receives an internal gasket ring **191**. The internal diameter of ring **191** forms a snug fit on rod **60** which permits axial motion of rod **60**, yet forms a good pressure seal to the rod **60**. Moreover, the outer diameter of ring **191** has a smaller diameter than the diameter of shelf **190**. Accordingly, lateral movement of ring **191** along with contact rod **60** is permissible. The upper and lower surfaces of ring **191** are then confined between the bottom of this shelf **190** and the upper disk **192**. Note particularly that ring **191**, which may be of any suitable (phenolic) material, has a conically shaped interior surface **193** which permits the "camming" of the ring to a proper central position as the tip **61** of contact rod **60** is brought through the central opening in throat bushing **80**.

As previously indicated, it is desirable to provide a resistive path in parallel with the main contacts during interruption conditions. Clearly, auxiliary contact means are necessary to interrupt the resistive current path after the interrupter has successfully operated.

In accordance with the present invention, a novel resistor arrangement is provided which includes two parallel connected resistors **200** and **201** (FIGURES 1, 2, 4 and 8). Resistors **200** and **201** are identical and their structure is shown in cross-section in FIGURE 1 for resistor **200**.

Referring now to FIGURES 1 and 2, the resistor **200** is mounted between an upper mounting assembly which includes a conductive cap **202** (FIGURE 9) and a lower insulation support structure **203** (FIGURES 4 and 10). The upper support structure **202** is bolted to the upper cap **20** as by bolts such as bolt **204**. Each of resistors

200 and 201 are then received in openings 205 and 205*a* respectively in cap 202. A similar arrangement is provided for lower support 203 where the support 203 is suitably secured to container 24 as by suitable bolts 210 and 211, shown in FIGURE 4, which are threaded into the throat bushing 80.

Each of the resistors such as resistor 200 are then formed of an insulation tube 212 which has therein a stack of resistor elements such as resistor elements 213, 214 and 215. These resistor elements may be of any desired type well known to those skilled in the art, and are stacked to a desired height and are of a diameter to meet particular operating characteristics required.

The ends of the stack of resistor elements terminate in conductive washers 216 and 217 respectively which receive compression springs 218 and 219 respectively. The compression springs 218 and 219 are then contained by floating hollow contacts 220 and 221 respectively. The floating contacts 220 and 221 each have flanges 222 and 223 respectively which, after assembly of all of the various elements of the resistor within the tube 212, are captured by snap-rings 224 and 225 respectively. The floating contact 220 is biased into engagement with conductive support 202 to form one terminal connection for the resistor, while the lower floating contact 221 is biased toward engagement with contact strip 230 (FIGURES 1 and 4) which is captured within insulation support 203.

It is to be noted that in the mounting arrangement shown, the resistor casing 212 is directly received. It is, however, possible to form contacts 220 and 221 with lug-shaped ends so they may serve as both the mechanical support and electrical terminal for the resistor. The lower end of the resistors 200 and 201 are connected to the contact rod 60 as shown in FIGURES 8 and 11. The resistors 200 and 201 are connected in parallel by virtue of their common connection at the top through conductive support 202 and at the bottom through conductive strip 230 carried in insulation support 203 (FIGURE 10).

The conductive strip 230, as shown in FIGURE 8, is electrically connected to a conductor 240 which is, in turn, connected to a conductive bolt 241 which is threaded into throat bushing 80. The bolt 241 terminates in a conductive block 242 and pulls block 242 into engagement with a conductive shunt jumper 243. The conductive jumper 243 has a U-shape, as shown, and its opposite ends terminate on movable contact members 244 and 245 respectively, shown in FIGURES 1 and 4.

The central opening in the throat bushing 80 which receives conductive blocks 244 and 245 also receives insert 245*a* which has cut-out sections 246 and 247 for blocks 244 and 245 respectively which limit the motion of conductive blocks or contacts 244 and 245 toward and away from one another. Biasing springs 248 and 249 are then captured in the contacts 244 and 245 respectively with the opposite ends of springs 248 and 249 bearing against the internal walls of the opening in throat bushing 80. Thus, the contacts 244 and 245 are biased toward engagement with contact rod 60, thereby connecting the bottom of resistors 200 and 201 to the contact rod 60.

Note that when the contact rod 60 is moved to its disengaged position and withdrawn from the bottom of the throat bushing 80, the inward motion of contacts 244 and 245 is limited by the stop configuration of sections 246 and 247, as well as by the projecting section of member 242.

From the foregoing it is believed clear that the resistors are now connected in parallel with the main contacts where, for example, the upper end of resistors 200 and 201 are connected to contact hub 35 through the cap 20 and conductive support 202, while the bottom of the resistors is connected to the contact rod 60 by the circuit previously described.

During operation of the circuit interrupter to the disengaged position, it is believed further clear that the resistors 200 and 201 remain connected in parallel with the main interrupting contacts until, after interruption is successfully accomplished and tip 61 of contact rod 60 leaves throat bushing 80, the current path through the resistors will be interrupted at contacts 244 and 245.

As a further feature of the invention, I have provided a novel manner for the adjustable connection between contact rod 60 and the cross-rod 62. Moreover, a similar type connection may be made between the lift-rod and the cross-bar 62.

More particularly, and as shown in FIGURES 1, 1*c* and 1*d*, conductive cross-bars 300 and 301 have key ways 302 and 303 therein which receive keys 304 and 305 extending from block 306. Block 306 is slotted by slot 307 and has threaded openings 308 and 309 therein for receiving the threaded ends of rods 60 and 94. The rod height of rods 60 and 94 are then adjusted by threading and a pair of bolts 310 and 311 are then passed through openings 312 and 313 respectively, and lock rods 60 and 94 into place by squeezing slot 307 in a closing direction. Moreover, the key way connection between the block 306 and cross-bars 300 and 301 permits a limited lateral adjustment before locking by bolts 310 and 311.

The manner in which the novel interrupter operates is described in the following with the novel interrupter broken into various sections, as indicated.

A.—OIL CHECK-VALVE ARRANGEMENT

In order to operate the circuit interrupter of FIGURE 1 to the disengaged position from the engaged position shown, the cross-bar 62 is moved downwardly. During this downward motion, the contact rod 60 moves out of engagement with the various contacts carried from contact hub 35, and an arc is drawn from arcing contact finger 41.

It is necessary now to generate sufficient pressure within the interior of the container 24 so that arc products and oil will be caused to flow through the arc and out of the various ports such as ports 170 and 171 in the container wall.

When interrupting arcs of low power, insufficient pressure may be generated to effectively interrupt the arc. Accordingly, and particularly for the interruption of such low power arcs, the piston 95 serves as a pump to generate the pressure required to move oil and arc products through it and out of the venting ports. Thus, when the cross-bar 62 is moved downwardly, the operating rod 94 and rod 91 are also moved downwardly, thereby permitting powerful compression springs 113 and 114 to drive piston 95 downwardly.

As the pressure beneath piston 95 increases, the check-valve 110 moves into sealing engagement with the openings 100 through 109 in piston 95 whereby oil is forced from the volume beneath piston 95 through opening 120 through 125 and into the interior of container 24. This high pressure oil is then used to extinguish low current arcs.

In the event that a high current arc is drawn, then very high pressures are generated within container 24. This normally tends to force oil back through openings 120 through 124, thereby forcing piston 95 upward.

In order to prevent this action which could damage piston 95, the novel check-valve arrangement includes the further check-valve 126 which is forced upwardly by high pressure oil within the interrupter container 24 created by high current arcs, thereby closing off openings 120 through 125 and thus sealing the volume beneath piston 95 from the interrupter tube.

Note, however, that during normal operating conditions, both check-valves 111 and 126 will be open. Accordingly, a path is formed for the natural flow of oil through the interrupter, for example, due to convection so that continuous cooling by convection can occur.

B.—FLOATING SEAL FOR CONTACT ROD

As described above, it is necessary during interrupting conditions, particularly of low current arcs, that pressure be confined within container **24** until it increases to a sufficient value to interrupt the arc. To this end, a seal is provided about the movable contact **60** which includes the floating gasket or disk **191**. The gasket or disk **191** has sufficient lateral movement available to it so that it can accommodate minor misalignments of the contact rod **60** with respect to the interrupter chamber. However, the seal between the contact rod and the bottom of the interrupter is still maintained, since the gasket **191** snugly fits around contact rod **60**.

C.—VALVE STRUCTURE FOR VENTING PORTS

Further associated with the problem of permitting a build-up of sufficient pressure for the interruption of low current arcs, the venting ports such as ports **170** and **171** are normally closed by valves such as valves **168** and **169**. During a low current arc, no venting occurs until the pressure within the chamber becomes sufficiently high to overcome the biasing force of springs **166** and **167**. As soon as this pressure, which is a pressure sufficiently high to cause effective interruption of the arc, is reached, the valves **168** and **169** are moved outwardly so that venting can proceed from the interior of container **24** to the exterior channels such as channels **151** and **152**.

Note that a single triangularly shaped valve controls the communication to each of the two exhaust channels in any one plane. Furthermore, the valve arrangement is such that a large area is exposed for venting action responsive to a relatively short travel of the valve members. Moreover, the novel manner of assembly of the valves clearly permits inexpensive manufacturing techniques along with ease of assembly and maintenance.

By using two blast channels in each plane and causing them to increase in area as the ports near the outside of the tube, the outwardly directed jet of arc products may now have a lower velocity with a decreased resistance to flow. Therefore, lower reaction forces occur by the outward tapering of the exhaust ports such as ports **170** and **171**.

Note also that the arrangement shown provides an inherent stop surface for the movement of valves **168** and **169** wherein the motion of the valves is rigidly stopped when they engage their respective inserts **150** and **153**.

D.—RESISTOR AND MOUNTING STRUCTURE THEREFOR

The novel arrangement and mounting for the resistors **200** and **201** insure positive electrical contact under extreme vibration. Thus, all points of electrical contact include high compression springs such as springs **218** and **219** for contacts **220** and **221** respectively, and similar compression springs **248** and **249** which bias contacts **244** and **245** respectively into engagement with contact **60**.

Moreover, the novel mounting arrangement is such that oil may circulate through the resistors while much of the contamination from dirty circuit breaker oil is excluded. This circulation of oil, of course, occurs through the openings in floating contacts **220** down through the resistor stack, and out through opening in contact **221**.

A further important advantage of the resistor arrangement is that the unit assembly may be easily connected and removed from the interrupter structure proper, thus substantially simplifying assembly and maintenance.

A still further advantage of the novel resistor structure lies in the compact subassembly permitted by the use of the snap-rings **224** and **225** which capture the floating

contacts **220** and **221** respectively to maintain the integrity of the subassembled resistor.

Although this invention has been described with respect to its preferred embodiments, it should be understood that many variations and modifications will now be obvious to those skilled in the art, and it is preferred therefore that the scope of the invention be limited not by the specific disclosure herein but only by the appended claims.

The embodiments of the invention in which an exclusive privilege or property is claimed are defined as follows:

1. A check-valve structure for the interrupter structure of an oil circuit breaker; said interrupter structure including an interrupter container, stationary contact means secured within said interrupter container, movable contact means movable into and out of engagement with respect to said stationary contact means and a pump means for forcing fluid under pressure into said interrupter container responsive to movement of said movable contact to a disengaged position with respect to said stationary contact; said pump means including a piston and a cylinder; said cylinder communicating with the interior of said interrupter container; said piston having a plurality of openings circularly distributed around an end wall thereof; said piston having an annular check-valve connected to said end wall movable into and out of sealing engagement with said circularly distributed openings; said annular check-valve being moved to its said sealing engagement position responsive to the operation of said movable contact to said disengaged position; said circularly distributed openings forming a channel for the flow of oil into and out of said interrupter container when said movable contact is in engagement with said stationary contact; and a plate member for enclosing the top of said interrupter container and the bottom of said cylinder; said plate having second openings therein for permitting fluid flow from said interrupter chamber to said cylinder; and a second check valve; said second check valve being mounted with respect to said plate for movement into and out of sealing engagement with respect to said second openings; said second check valve being movable into its said sealing engagement position responsive to a higher pressure in said interrupter container than in said cylinder; and said second check valve being normally in an open position to normally permit circulation of oil therethrough.

2. The device substantially as set forth in claim **1** wherein said second openings are circularly arranged in said plate; said second check valve comprising a second annular member engageable with each of said second openings.

3. The device substantially as set forth in claim **1** wherein said stationary contact means is directly secured to a centrally located portion on the bottom of said plate; said second openings surrounding said stationary contact means; said second annular member being carried on said stationary contact means.

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