Jan. 29, 1963 J. M. RAMRATH 3,076,080

FLUID BLAST INTERRUPTING DEVICE FOR OIL CIRCUIT BREAKERS EMPLOYING AUXILIARY CONTACT

Filed Feb. 17, 1961 2 Sheets-Sheet 1

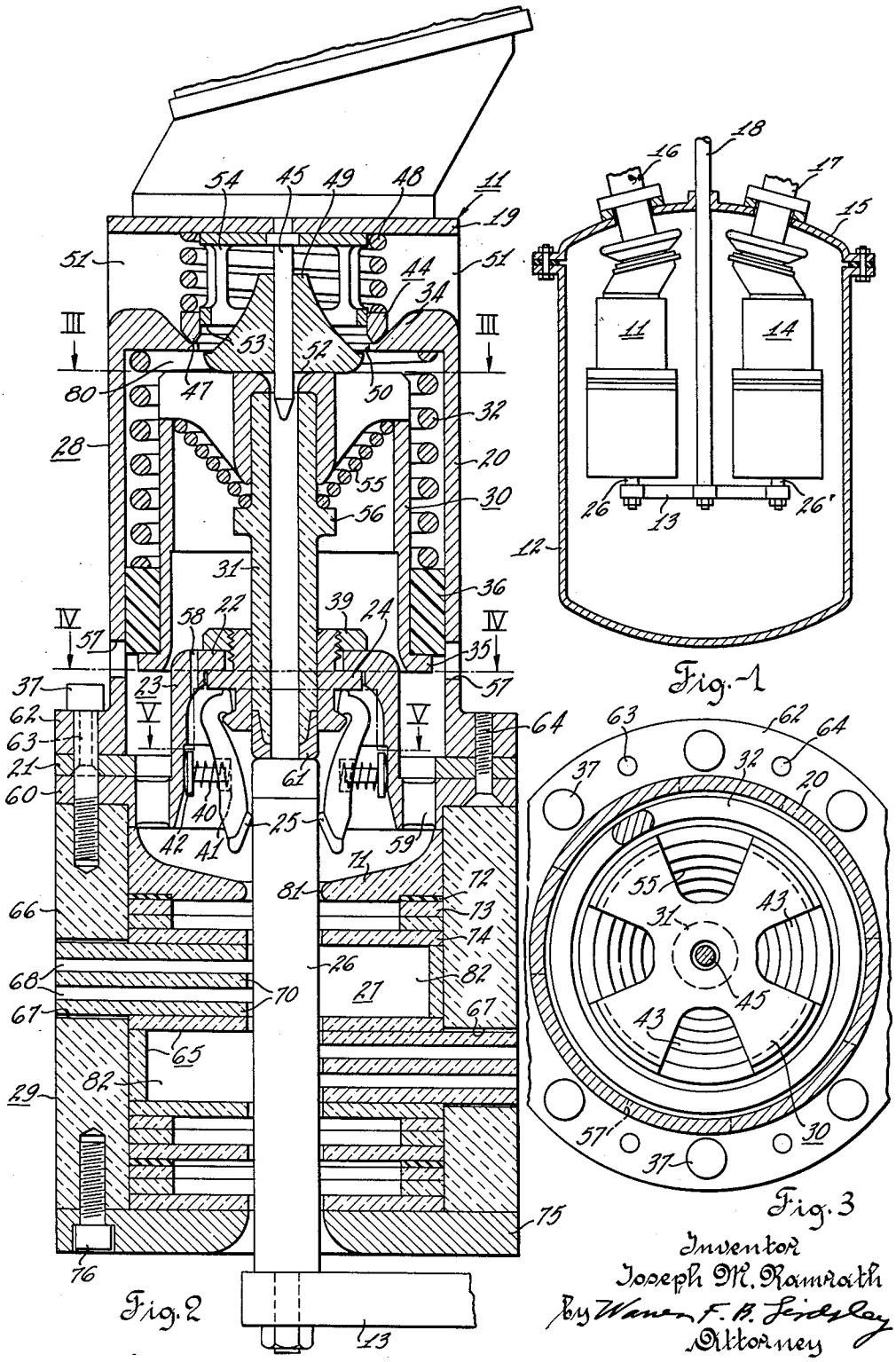


Fig. 2

Fig. 1

Fig. 3

Inventor
Joseph M. Ramrath
By Warren F. B. Fiddyment
Attorney

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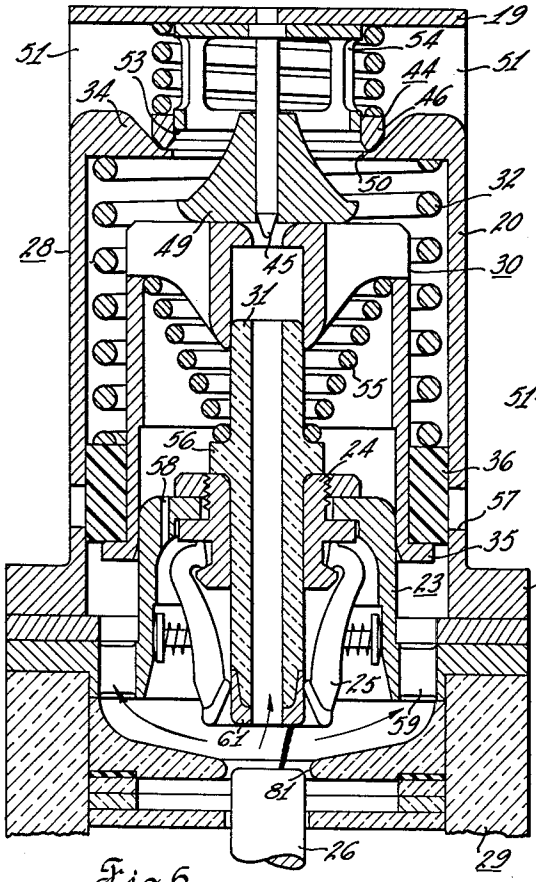


Fig. 6

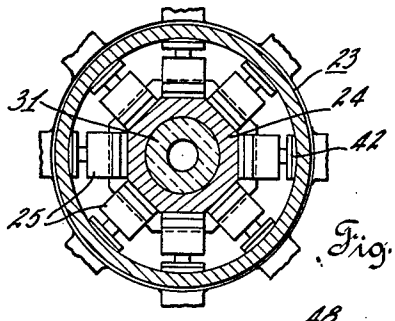


Fig. 5

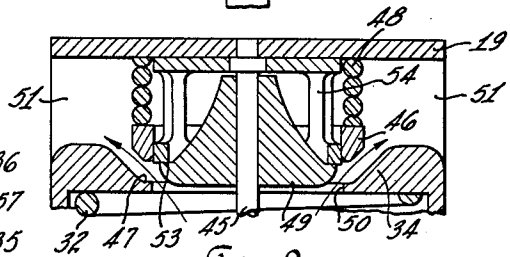


Fig. 8

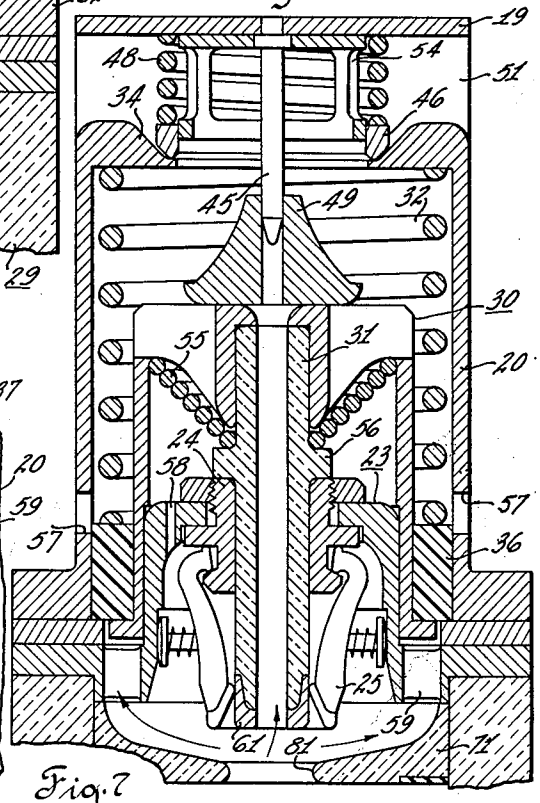


Fig. 7

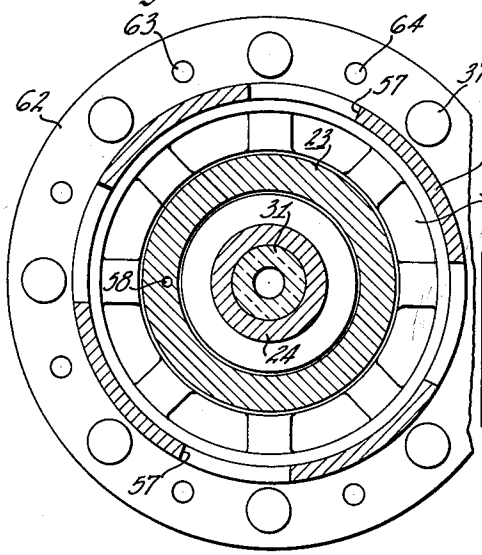


Fig. 4

Inventor
Joseph M. Ramrath
by Warren F. B. Lindsley
Attorney

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FLUID BLAST INTERRUPTING DEVICE FOR OIL CIRCUIT BREAKERS EMPLOYING AUXILIARY CONTACT

Joseph M. Ramrath, Mattapan, Mass., assignor to Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

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16 Claims. (Cl. 200—150)

This invention relates to electric circuit interrupters and more particularly to high speed oil circuit breakers of the fluid blast type.

More specifically this invention relates to a novel structure for effecting the very rapid initiation, elongation and extinction of electric arcs drawn in circuit interrupters. This invention is applicable to the interruption of high voltage arcs such as those drawn in 330 to 440 kv. circuits but is also applicable on low voltage circuits.

It is known that a rapid lowering of the dielectric strength of an arc extinguishing fluid, such as oil, occurs after it impinges upon the arc stream and that it is desirable to eliminate such contaminated fluid as quickly as possible and to subject the arc stream to the action of fresh fluid of high dielectric strength. The isolation or disconnection of a capacitance load by a circuit breaker in an alternating current system is subject to transient overvoltages, the magnitudes of which depend on the capacitance of the load, the voltage of the system and the type of the circuit breaker. In one-half cycle after the first current zero, the voltage of the source has reversed to its crest value and approximately double this voltage appears across the circuit breaker contacts as a circuit recovery voltage. Whether or not restriking of the arc occurs depends on several factors such as the type of the circuit breaker including the speed and the magnitude of the separation of its contacts, the magnitude of the circuit recovery voltage, the leading kva. of the load, and the position of the contacts when separated.

In accordance with the invention claimed a new and improved circuit interrupting device is provided within an enclosing structure. Relatively stationary and movable contacts are arranged to operate within an arc extinguishing fluid in the structure and are separated to draw an arc to be extinguished by blast action. A spring biased piston is provided employing a nonmetallic piston rod having a conductive portion extending therefrom. The movable contact and the piston rod engage each other in contact closed position. Means are provided which are operative during circuit closing movement of the circuit interrupter for engaging the movable contact with the piston rod for driving the piston to its biased position within the pressure structure so that during a circuit opening operation the piston moves in contact opening direction for applying an impulse blast to the arc immediately after separation of the contacts. During a contact opening operation the stationary contact is arranged in electrical connection with the conductive portion of the piston rod, which portion serves as an auxiliary contact, and the movable contact separates from the conductive portion of the piston rod at a distance from the stationary contact.

It is, therefore, one object of this invention to provide a new and improved circuit breaker structure for establishing and lengthening an arc.

Another object of this invention is to provide a new and improved circuit interrupting mechanism in which the interruption of the electric circuit between a pair of relatively movable contacts occurs at a given distance from one of the contacts.

A further object of this invention is to provide a new and improved circuit interrupting mechanism in which a fluid actuating piston employing a piston rod having a conductive portion forms an interruptable electrical connection between a pair of relatively movable contacts.

A still further object of this invention is to provide a new and improved circuit interrupting mechanism in which an oil impulse piston having a piston rod with a conductive portion forming an interruptable electrical connection between a pair of relatively movable contacts at a distance from each other, employs a closable opening forming a pressure equalizing passage therethrough.

A still further object of this invention is to provide a new and improved circuit interrupting mechanism in which an oil impulse piston employs a hollow, tubular piston rod forming a pressure equalizing passage through the piston wherein the piston rod has a conductive end forming an interruptable electrical connection between a pair of relatively movable contacts at a distance from each other.

A still further object of this invention is to provide a new and improved circuit interrupting device in which a hollow, tubular piston rod forming a pressure equalizing passage through the piston and an auxiliary contact at its open conductive end engages the movable contact during contact closing operation and disengages from the movable contact during its opening operation at a distance from the stationary contact, thereby exposing the equalizing passage to the arc gas pressure immediately upon contact separation.

Objects and advantages other than those set forth will be apparent from the following description when read in connection with the accompanying drawings, in which:

FIG. 1 is an elevational view partly in section of a circuit interrupter embodying the invention and shown in circuit closed position;

FIG. 2 is an enlarged sectional view through one of the interrupting devices shown in FIG. 1 in the breaker closed position;

FIG. 3 is a cross sectional view taken along the line III—III of FIG. 2;

FIG. 4 is a cross sectional view taken along the line IV—IV of FIG. 2;

FIG. 5 is a cross sectional view taken along the line V—V of FIG. 2;

FIG. 6 is an enlarged sectional view through one of the interrupting devices shown in FIG. 1 during a contact disengaging operation;

FIG. 7 is an enlarged sectional view similar to FIG. 6 of the internal parts of the piston and relief valve shown in breaker open position; and

FIG. 8 is an enlarged view of the relief valve shown in FIGS. 1, 6 and 7 during excessive pressure development.

Referring more particularly to the drawing by characters of reference, FIG. 1 illustrates an oil circuit breaker unit of the high voltage type such as that used in power transmission systems. Unit **11** is suspended from one line terminal of the circuit interrupter in a suitable enclosing or pressure confining structure such as tank **12** and submerged in a suitable insulating arc extinguishing fluid, such as oil. A conducting bridging bar **13** serves to connect electrically the arc extinguishing unit **11** with an identical unit **14** in a manner well known in the art. Supported on a cover **15** of the tank **12** are a pair of terminal bushings **16** and **17** (partially shown), to the lower ends of which are secured arc extinguishing units **11** and **14**. The cross bar **13** is actuated reciprocally in the vertical direction by an insulating lift rod **18** to open

and close relatively movable cooperating contacts of the arc extinguishing units 11 and 14.

FIG. 2 is an enlarged view in cross section of the left hand arc extinguishing structure shown in FIG. 1. The right hand arc extinguishing structure is of similar design. In FIG. 2 the breaker is shown in its contact closed position and current passes from a conductor (not shown) in bushing 16 through a mounting plate 19 which is suitably fastened to bushing 16 and is formed as an integral part of cylinder 20 through plate 21, flange 60 of contact housing 23, through flange 22 thereof, collar 24, a plurality of contact elements such as finger contacts 25 into a movable rod shaped contact 26. Contact 26 is arranged in a pressure chamber 27 which aids in extinguishing the arc drawn between the relatively movable contacts 61 and 26. Current flows in the contact closed position from contact 26 across the bridging bar 13 to the movable rod shaped contact 26' arranged in unit 14 and through substantially identical parts in unit 14 in a reverse manner. The current loop through the cluster of relatively stationary finger contacts 25 and the contact housing 23 magnetically increases contact pressure of the finger contacts against the relatively movable rod contact 26 at high magnitude currents in the well known manner.

The interrupting unit 11 comprises a metallic top section 28 and an insulating lower section 29. The top section comprises a pump arranged within cylinder 20 and employing a piston 30, nonmetallic piston rod 31 extending from and through piston 30 and a driving spring 32. Piston 30 and piston rod 31 are arranged for movement longitudinally of unit 11 with the driving spring 32 being arranged between an inturned flange 34 on one end of cylinder 20 and an outwardly turned flange 35 on the periphery of the dome shaped piston 30. A spacer ring 36 is arranged between spring 32 and flange 35 on the periphery of piston 30. Cylinder 20 is clamped to the lower section 29 by a plurality of spaced bolts 37 one of which is shown in FIG. 2.

The piston rod 31 shown herein as a hollow push rod extends through collar 24 and a clamping unit 39 and axially into contact housing 23. A plurality of finger contacts 25 (note FIGS. 2 and 5) are pivotally mounted in octagonally arranged grooves in collar 24 and rest with their arcing tips on the periphery of the movable rod shaped contact 26 within the cluster formed by these finger contacts. Contact pressure is provided by springs 40 each seated with one end in a spring well 41 of finger contacts 25 and in an insulating button 42 with the other end. The movable contact 26 supports the piston rod 31 against the pressure or bias exerted by spring 32.

Piston 30 shown and described herein integrates with contact housing 23 to form a piston means having two integrating parts i.e. a relatively movable part such as piston 30 and a relatively stationary part such as contact housing 23.

As shown more clearly in FIG. 3 the dome shaped piston 30 is provided with a spider-like configuration freely venting fluid from one side to the other side thereof through a plurality of apertures 43 thereby equalizing the pressure on both sides of the piston. A valve element or plug 49 loosely rests on the dome of piston 30 and is reciprocally guided by rod 45 fastened to mounting plate 19 and arranged to extend longitudinally of unit 11.

A valve assembly 44 comprising a movable valve element 46 is biased against its valve seat 47 on the dome of cylinder 20 by the compression spring 48. Compression spring 48 extends between valve element 46 and mounting plate 19 and is precompressed to permit lifting of valve element 46 from seat 47 at a predetermined value of pressure inside cylinder 20. As noted from FIG. 2 cylinder 20 has an inturned flange 34 which forms opening 50 and concentric valve seat 47 upon which valve element 46 is arranged to seat. Between valve seat 47 and plate 19 a plurality of exhaust passages 51 are arranged which are controlled by valve element 46 and valve plug 49. Valve plug 49 is slidably mounted on rod 45 and cooperates with valve seats 52 and 53 on the dome of piston 30 and the bottom of cage 54. Cage 54 having a plurality of relatively large ports therein is secured to the bottom of mounting plate 19 and arranged to extend therefrom toward cylinder 20. Valve seats 52 and 53 form stops for the downward and upward movement of valve plug 49.

As noted from the figures of the drawings piston rod 31 is slidably mounted in piston 30 and is biased toward the movable contact 26 by a spring 55 arranged between a flange 56 on piston rod 31 and the inside of the dome of piston 30. The end of piston rod 31 which engages movable contact 26 is provided with a conductive portion 61 which serves as an auxiliary contact for interconnecting the movable contact 26 and the finger contacts 25 during a part of the sequence of circuit interruption. Cylinder 20 is provided with further openings or ports 57 below spacer rings 36. Opening or port 58 is provided in housing 23 adjacent to collar 24 to permit escape of air or gases trapped therein.

The clamping unit or nut 39 clamps the collar 24 together with finger contacts 25 to the contact housing 23. Housing 23 has a number of openings 59 (shown in FIGS. 2 and 4) through its bottom flange 60 arranged immediately underneath spacer rings 36. Plate 21 is mounted to the bottom of flange 62 of cylinder 20 by means of flathead screws 63. Flathead screws 64 tap into flange 62 of cylinder 20 to hold contact housing 23 to the underside of plate 21. All three structural parts, namely cylinder 20, contact housing 23 and plate 21 are attached to the lower section 29 of unit 11 by means of cap screws or bolts 37.

The lower section 29 of unit 11 comprises a plurality of spaced stacked barrier plates 65 which are arranged within a shell 66. Shell 66 is provided with two openings 67 which may be arranged (as shown) to extend through shell 66 in opposite directions. Built into the grid structure formed by the barrier plates 65 are the exhaust nozzles 68 which protrude through the openings 67. These nozzles are keyed in place by check tubes 70. A deflector 71 is interposed between the contact housing 23 and the inner end of the barrier plate stack. A gasket 72 made of a resilient material such as a cork composition is arranged between the barrier plate 73 and deflector 71 to provide a tight stacking of the interrupting pot components of the lower section 29. The barrier plates 73 and 74 form stuffing box-like oil compartments. A metallic bottom plate 75 is fastened to the underside of shell 66 by means of a plurality of cap screws 76 (one of which is shown in FIG. 2.)

For contact inspection cap screws 37 are removed and the whole shell 66 with contents comes off. The tips of the finger contacts 25 then come into full view and can be readily examined. If the arcing tips of contacts 25 need dressing or if replacement is deemed necessary, flathead machine screws 64 are removed. With the removal of screws 64 the contact housing 23 may be removed including the piston 30 and piston or push rod 31. The piston 30 is able to pass through plate 21. Valve plug 49 and spring 55 also are removable with the contact housing 23 so that the valve plug 49 can be inspected. Spacers 36, however, cannot come out of cylinder 20 because plate 21 serves as a stop for them. This is important because pump spring 32 biased against spacers 36 is still highly compressed in the breaker open position.

Readjustment or realignment of the arcing contacts after contact inspection or replacement are not usually necessary because the contacts cannot go out of alignment as they can only be mounted in the same central position. In applications where a plurality of interrupting units similar to units 11 and 14 are used it might be

desirable to have nozzles 68 face in a particular direction. This can be readily accomplished as the fastening screws 37 are displaced from each other 45 degrees around the periphery of unit 11; thus one-eighth of a turn or more of the lower section 29 can be readily obtained. The lower sections, however, are usually keyed in the desired position so that a selected position is always assured. In applications of this invention utilizing a plurality of interrupting units 11 the metallic bottom plate 75 becomes the lower terminus of voltage grading resistors (not shown) connecting the finger contact cluster and this bottom plate. Bottom plate 75 approaches the moving rod contact 26 close enough to establish a spark over circuit, thus placing the grading resistors in parallel with the arc on the inside of units 11 and 14.

The circuit breaker interrupting structure functions selectively depending upon the range of the magnitude of the current it has to interrupt.

When interrupting low magnitude currents encountered at line dropping the tripping impulse from a current transformer (not shown) causes an operator of the circuit breaker (not shown) to move lift rod 18 downwardly as shown in FIG. 1. Since the piston or push rod 31 rests on the end of the movable contact 26, the whole piston assembly follows the movement of the movable contact 26 due to the pressure exerted by spring 32. Piston 30 having a spider-like central portion passes oil readily from the underside through apertures 43 to the space above the piston thereby equalizing the pressure on both sides of the spider-like portion of piston 30. The oil under the piston can readily escape out of the vent holes 57 in the side of cylinder 20 until these holes are covered by the spacer rings 36 and the inner periphery of piston 30 engages with the outer periphery of the contact housing 23. At this point in its operation piston 30 becomes a pump and renders the equalizing effect of aperture 43 ineffective. At this moment the simultaneous axial movement of the movable contact 26 and piston 30 and piston rod 31 ceases. The movement of the piston slows down because it has now become a pump and must displace the oil trapped under it in the annular space between cylinder 20 and contact housing 23. Up to this moment the stored energy of the spring has been fed back into the contact rod and added to its acceleration.

The conical push rod accelerating spring 55 has up to this point in the circuit interrupting action been held compressed by the much stronger spring 32. Now, however, when the piston velocity has been arrested by its pump action, spring 55 expands and propels push rod 31 downwardly, as shown in FIG. 2 thereby moving it in unison with the movable contact 26. The abutting metallic arcing tip or auxiliary contact 61 of the piston rod 31 moves into contact with finger contacts 25 as it passes therethrough. Auxiliary contact 61 remains in contact with finger contacts 25 and the movable contact 26 until contact 61 reaches the contour line of the tulip contact arrangement formed by finger contacts 25. At this point in the interrupting sequence the movable contact 26 is completely withdrawn from the tulip shaped finger contacts. The movable piston rod 31 is now stopped abruptly by its annular flange 56 engaging the collar 24 on top of contact housing 23, as shown in FIG. 7. The movable contact 26 continues its downward movement alone and an arc is drawn between the arcing tip of piston rod 31 and the tip of movable contact 26 as the current now passes from the finger contacts 25 of the tulip arrangement through the contact portion 61 on piston rod 31 which is now serving as an auxiliary contact to the movable contact 26.

The arc usually is extinguished at the first current zero after contact separation. A half cycle later, when the maximum voltage appears again between the stationary and movable contacts, the contact rod has had time to travel a considerable distance away from the auxiliary contact 61. In switching of capacitive circuits or unloaded transmission lines it is imperative to have the arc zone reestablish its full dielectric strength within a half cycle after the first current zero following contact separation in order to withstand the twice normal voltage that appears across the contacts. In designs wherein the movable contact separates within the tulip arrangement formed by a plurality of finger contacts this is difficult if not impossible to attain because the piston rod fixedly attached to the piston would be held back by pump action causing a void to be created within the tulip arrangement of the finger contacts. This void has to be filled with fresh oil by pump action of piston 30 in order to reestablish dielectric strength.

By means of the claimed structure contact separation occurs at the contour line of the tulip arrangement of the finger contacts. For this reason no void is created within the tulip contact. The contact separation takes place in a location most favorable to the pumping action of piston 30. This is in the zone of turbulence created by pump 30 and the arc space is almost instantly filled by oil converging concentrically into it under substantially sustained high pressure of the pump action of piston 30. By the time high voltage reappears at the arcing contacts after arc interruption fresh insulating oil is in the zone which prevents reignition of the arc.

If contact separation takes place at the contour line of the tulip arrangement of the finger contacts 25 as it does in the claimed structure, the metal to metal separation increases linearly. If contact separation occurs in the tulip contact arrangement as it does in some prior art, the tip of the movable contact still is inside of the tulip arrangement and remains inside until it is moved sufficiently to reach the said contour line. In this later case the metal to metal separation is much slower than the claimed structure and the chances for reignition, therefore, greater. A further advantage of the claimed structure is that the life of its finger contacts is greater because arcing is limited to the auxiliary contact and the movable contact.

In the breaker closed position as shown in FIG. 2 valve plug 49 rests on its seat 52 on the top of piston 30. Oil can circulate freely through port holes 57 in cylinder housing 20 and grid openings 68 in the lower structure 29 past contact housing 23, through a plurality of apertures 43 in the dome of piston 30, thence through the ports of cage 54 and then out through passages 51. Gravity and suction created by the downward movement of contact 26 draw valve plug 49 along with the piston 30 leaving it resting on its seat 52 on top of the piston as shown in FIG. 6. Fresh oil can flow freely through passages 51, through ports of cage 54 into space 80 impelled by the suction caused by the downward movement of the piston 30. The oil under pressure of the pump formed by piston 30 and housing 23 now causes an impulse blast to flow into the void created by the retreating contact 26 through the openings 59 in the bottom flange of the contact housing 23 and attacks the arc concentrically. Some of the oil under pressure of the pump will bypass contact 26 through the annular opening 81 in deflector 71. Thus, oil is in movement when the arc is drawn through opening 81 in deflector 71. At an early current zero the insulating oil forced into the void by the pump will extinguish the arc and reestablish dielectric strength thus preventing reignition.

When interrupting medium magnitude currents encountered at load switching and low power faults the initial phases of the interrupting operation are the same as that described above for interrupting low magnitude currents up to the point of drawing an arc. As a power arc develops, oil is decomposed and a gas pressure develops under the cluster formed by the finger contacts 25. This pressure is communicated through the hollow piston rod 31 to the space above piston 30. The oil in the column formed in piston rod 31 is driven upward

and the valve plug 49 is driven from its valve seat through the circular opening 50 onto seat 53 on the underside of cage 54. The pressure developed under the piston is thereby communicated through piston rod 31 to the now completely sealed chamber above piston 30 without loss of pressure and pressure compensation is achieved.

When interrupting high magnitude currents which stem from heavy short circuits the interrupting operation follows the same pattern as described above for interrupting medium magnitude currents encountered at load switching and low power faults including the pressure compensation effected by valve plug 49. However, as the arc energy increases due to the greater amount of electric power, the gas development becomes accelerated and dangerous pressures are created. The increased pressure above piston 30 compresses valve spring 48 driving valve element 46 upward from its seat 47 thereby opening passageways 51 to the zone above piston 30 and relieving the pressure therein as shown in FIG. 8. The balance of pressure below and above piston 30 is upset and compensation ceases. At the same time piston 30 is driven upward by the extreme pressure developed underneath it. The spacer rings 36 overrun the port holes 57 in cylinder 20 thereby relieving the pressure throughout cylinder 20. The interrupting device now functions as a pure suicidal device and interruption is achieved in the upper or lower nozzle chambers 82.

After the arc is interrupted and the circuit breaker is in its open position the valve and piston assemblies assume the positions shown in FIG. 7. In each of FIGS. 6, 7 and 8 the paths of the pressure waves created by the arcs are illustrated by arrows.

To close the circuit breaker the movable contact 26 is moved upward by an operator (not shown) and the contact rod strikes the lower metallic end of the piston rod 31 at the contour line of the tulip arrangement of the finger contacts 25, driving the piston assembly upward. Current flows from the finger contacts 25 through the auxiliary contacts 61 and into the movable contact 26. The current path from the bushings 16 and 17 to the finger contacts 25 occurs in the manner heretofore explained. The oil above the piston assembly escapes free to the outside of unit 11 through the openings in cage 54 and through passageways 51. Dashpot action is thus prevented. As the spacer rings 36 clear ports 57 in cylinder 20 oil from outside of unit 11 rushes in refilling the annular space around the contact housing 23. Spring 32 is now compressed. In its overtravel piston 30 abuts the underside of flange 34 as a stop.

At the moment in its upward movement of the movable contact 26 that the auxiliary contact 61 of the piston rod 31 disengages with the finger contacts 25, the movable contact 26 engages directly with finger contacts 25. The current path then comprises the path directly through the finger contacts and the movable contact. This transfer of current during the circuit closing operation is accomplished smoothly and without arcing because of the considerable contact pressure exterted by spring 32 on top of the dome of piston 20 and in turn piston rod 31. In the last three eighths of an inch of upward travel of the movable contact 26 the inner periphery of piston 20 becomes disengaged from the outer periphery of the contact housing 23. The interior of the piston body as well as the space immediately below the piston ring is in direct communication with the tank oil through the now uncovered port holes 57.

Although but one embodiment of the present invention has been illustrated and described it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

Having now particularly described and ascertained the nature of my said invention and the manner in which it is to be performed, I declare that what I claim is:

1. A circuit interrupter comprising an enclosing structure, a pair of relatively stationary and movable cooperating contacts adapted to separate in said structure to draw an arc, an arc extinguishing fluid in said structure, means for separating said stationary and movable contacts to draw an arc to be extinguished by blast action within said structure, a spring biased piston, a conductive portion on said piston forming an auxiliary contact, said movable and stationary contacts engaging each other in contact closed position, and means operative during circuit closing movement of said interrupter for engaging said movable contact and driving said piston to its biased position within said structure so that during a circuit opening operation said piston moves in contact opening direction for applying an impulse blast to the arc immediately after separation of said stationary and movable contacts, said auxiliary contact moving into engagement with said stationary contact upon separation of said stationary and movable contacts, said movable contact separating from said auxiliary contact at a distance from said stationary contact.

2. A circuit interrupter comprising a pressure confining structure, relatively stationary and movable cooperating contacts adapted to separate in said structure to draw an arc, an arc extinguishing fluid in said structure, means for separating said stationary and movable contacts to draw an arc to be extinguished by blast action within said structure, a spring biased piston, a piston rod having an auxiliary contact, said movable and stationary contacts engaging each other in contact closed position, and means operative during circuit closing movement of said interrupter for engaging said movable contact and driving said piston to its biased position within said structure so that during a circuit opening operation said piston moves in contact opening direction for applying an impulse blast to the arc immediately after separation of said stationary and movable contacts, said auxiliary contact moving into engagement with said stationary contact upon separation of said stationary and movable contacts, said movable contact separating from said auxiliary contact at a distance from said stationary contact.

3. A circuit interrupter comprising a pressure confining structure, relatively stationary and movable cooperating contacts adapted to separate in said structure to draw an arc, an arc extinguishing fluid in said structure, means for separating said contacts to draw an arc to be extinguished by blast action within said structure, a spring biased piston, a biased piston rod relatively movable with and arranged to extend from said piston, said piston rod having a current conductive portion, said movable and stationary contacts engaging each other in contact closed position, and means operative during circuit closing movement of said interrupter for engaging said movable contact and driving said piston and said piston rod to their biased positions within said structure so that during a circuit opening operation said piston and piston rod move in contact opening direction, said piston upon movement in contact opening direction applying an impulse blast to the arc immediately after separation of said contacts, said piston rod moving said conductive portion in engagement with said stationary contact upon separation of said contacts, said movable contact disengaging from said conductive portion at a distance from said stationary contact upon circuit interruption.

4. A circuit interrupter comprising a pressure confining structure, relatively stationary and movable cooperating contacts adapted to separate in said structure to draw an arc, said stationary contact comprising a cluster of finger contact elements, an arc extinguishing fluid in said structure, means for separating said contacts to draw an arc to be extinguished by blast action within said structure, a spring biased piston, a piston rod mounted to extend from said piston into said cluster of finger contact elements, said piston rod having a current conductive portion, said movable contact and said piston rod en-

gaging each other in said cluster of finger contact elements in contact closed position, and means operative during circuit closing movement of said interrupter for engaging said movable contact and driving said piston to its biased position within said structure so that during a circuit opening operation said piston moves in contact opening direction for applying an impulse blast to the arc immediately after separation of said contacts, said piston rod having said conductive portion in engagement with with said finger contact elements upon separation of said contact, said movable contact disengaging from said conductive portion outside of said cluster of finger contact elements.

5. A circuit interrupter comprising a pressure confining structure, relatively stationary and movable cooperating contacts adapted to separate in said structure to draw an arc, said stationary contact comprising a cluster of finger contact elements, an arc extinguishing fluid in said structure, means for separating said contacts to draw an arc to be extinguished by blast action within said structure, a spring biased piston axially arranged with said contacts, a piston rod mounted to extend from said piston into said cluster of finger contact elements, said piston rod having a current conductive portion, said movable contact and said piston rod engaging each other in said cluster of finger contact elements in contact closed position, and means operative during circuit closing movement of said interrupter for engaging said movable contact and driving said piston to its biased position within said structure so that during a circuit opening operation said piston moves in contact opening direction for applying an impulse blast to the arc upon separation of said contacts, said piston rod having said conductive portion in engagement with said finger contact elements upon separation of said contacts, said movable contact disengaging from said conductive portion and said piston rod at the contour line of said cluster of finger contact elements.

6. A circuit interrupter comprising a pressure confining structure, relatively stationary and movable cooperating contacts adapted to separate in said structure to draw an arc, said stationary contact comprising a cluster of finger contact elements, an arc extinguishing fluid in said structure, means for separating said contacts to draw an arc to be extinguished by blast action within said structure, a spring biased piston axially arranged with said contacts, a biased piston rod relatively movable with and arranged to extend from said piston into said cluster of finger contact elements, said piston rod having a current conductive portion, said movable contact and said piston rod engaging each other in said cluster of finger contact elements in contact closed position, and means operative during circuit closing movement of said interrupter for engaging said movable contact and driving said piston and said piston rod to their biased positions within said structure so that during a circuit opening operation said piston and said piston rod move in contact opening direction, said piston upon movement in contact opening direction applying an impulse blast to the arc upon separation of said contacts, said piston rod having said conductive portion in engagement with said finger contact elements upon separation of said contacts, said movable contact disengaging from said conductive portion and said piston rod at said contour line of said cluster of finger contact elements.

7. A circuit interrupter comprising a pressure confining structure, relatively stationary and movable cooperating contacts adapted to separate in said structure to draw an arc, said stationary contact comprising a cluster of finger contact elements, an arc extinguishing fluid in said structure, means for separating said contacts to draw an arc to be extinguished by blast action within said structure, a spring biased piston axially arranged with said contacts, a piston rod mounted to extend from said piston into said cluster of finger contact elements, said piston rod having a current conductive tip, said movable contact and said piston rod engaging each other in said cluster of finger contact elements in contact closed position, and means operative during circuit closing movement of said interrupter for engaging said movable contact and driving said piston to its biased position within said structure so that during a circuit opening operation said piston moves in contact opening direction for applying an impulse blast to the arc immediately after separation of said contacts, said piston rod having said conductive tip in engagement with said finger contact elements upon separation of said contacts, said movable contact disengaging from said tip of said piston rod outside of said cluster of finger contact elements.

8. A circuit interrupter comprising a pressure confining structure, relatively stationary and movable cooperating contacts adapted to separate in said structure to draw an arc, said stationary contact comprising a cluster of finger contact elements, an arc extinguishing fluid in said structure, means for separating said contacts to draw an arc to be extinguished by blast action within said structure, a spring biased piston axially arranged with said contacts, a piston rod mounted to extend from said piston into said cluster of finger contact elements, said piston rod having a current conductive tip, said movable contact and said piston rod engaging each other in said cluster of finger contact elements in contact closed position, means for equalizing the pressure on both sides of said piston during a part of its stroke in contact opening direction, and means operative during circuit closing movement of said interrupter for engaging said movable contact and driving said piston to its biased position within said structure so that during a circuit opening operation said piston moves in contact opening direction for applying an impulse blast to the arc immediately after separation of said contacts, said piston rod having said conductive tip in engagement with said finger contact element upon separation of said contacts, said movable contact disengaging from said tip of said piston rod outside of said cluster of finger contact elements.

9. A circuit interrupter comprising a pressure confining structure, relatively stationary and movable cooperating contacts adapted to separate in said structure to draw an arc, said stationary contact comprising a cluster of finger contact elements, an arc extinguishing fluid in said structure, means for separating said contacts to draw an arc to be extinguished by blast action within said structure, a spring biased piston axially arranged with said contacts, a biased piston rod relatively movable with and arranged to extend from said piston into said cluster of finger contact elements, said piston rod having a current conductive tip, said movable contact and said piston rod engaging each other in said cluster of finger contact elements in contact closed position, means for equalizing the pressure on both sides of said piston during a part of its stroke in contact opening direction, and means operative during circuit closing movement of said interrupter for engaging said movable contact and driving said piston and said piston rod to their biased positions within said structure so that during a circuit opening operation said piston and said piston rod move in contact opening direction, said piston upon movement in contact opening direction applying an impulse blast to the arc immediately after separation of said contacts, said piston rod having said conductive tip in engagement with said finger contact element upon separation of said contacts, said movable contact disengaging from said tip of said piston rod outside of said cluster of finger contact elements.

10. A circuit interrupter comprising a pressure confining structure, relatively stationary and movable cooperating contacts adapted to separate in said structure to draw an arc, said stationary contact comprising a cluster of finger contact elements, an arc extinguishing fluid in said structure, means for separating said contacts to draw an arc to be extinguished by blast action within said structure, a cylinder arranged within said structure, a spring

biased piston arranged within said cylinder and coaxially arranged with said contacts, a piston rod having a conductive tip mounted to extend through said piston and into said cluster of finger contact elements in abutting arrangement in contact closed position, means for equalizing the pressure on both sides of said piston during a part of its stroke in contact opening direction, and means operative during circuit closing movement of said interrupter for abutting said one of said contacts against said piston rod and driving said piston to its biased position with said cylinder so that during a circuit opening operation said piston moves in contact opening direction for applying after a predetermined movement an impulse blast to the arc immediately after separation of said contacts, said piston rod having said conductive tip in engagement with said finger contact elements upon separation of said contacts, said movable contact disengaging from said tip of said piston rod outside of said cluster of finger contact elements.

11. A circuit interrupter comprising a pressure confining structure, relatively stationary and movable contacts adapted to separate in said structure to draw an arc, said stationary contact comprising a cluster of finger contact elements, an arc extinguishing fluid in said structure, means for separating said contacts to draw an arc to be extinguished by blast action within said structure, a cylinder arranged within said structure, a spring biased piston arranged within said cylinder and axially arranged with said contacts, a hollow piston rod having a conductive end mounted to extend through said piston and into said cluster of finger contact elements for equalizing the pressure on both sides of said piston during a part of its stroke, said movable contact and said end of said piston rod engaging each other in said cluster of finger contact elements in abutting arrangement in contact closed position to close said end of said piston rod, and means operative during circuit closing movement of said interrupter for abutting said movable contact against said piston rod and driving said piston to its biased position within said cylinder, said piston rod and said movable contact moving together in abutting relationship during a part of said piston stroke and during the rest of said piston stroke separating from said movable contact for applying an impulse blast to the arc immediately after separation of said contacts, said piston rod having said conductive tip in engagement with said finger contact elements upon separation of said contacts, said movable contact disengaging from said tip of said piston rod outside of said cluster of finger elements.

12. A circuit interrupter comprising a pressure confining structure, relatively stationary and movable cooperating contacts adapted to separate in said structure to draw an arc, said stationary contact comprising a cluster of finger contact elements, an arc extinguishing fluid in said structure, means for separating said contacts to draw an arc to be extinguished by blast action within said structure, a spring biased piston means arranged within said structure, said piston means comprising two integrating parts, one of said parts being movable relative to the other part during a part of the movement of said piston means, said movable part being provided with means for equalizing the pressure on both sides thereof during at least a part of its movement relative to said other part, a piston rod having a conductive end mounted on said one of said parts to extend through said piston means, said movable contact and said piston rod engaging each other in abutting arrangement in contact closed position and means operative during circuit closing movement of said interrupter for abutting said movable contact against said end of said piston rod and driving said piston means to its biased position within said structure, said piston rod and said movable contact moving together in abutting relationship during a part of the piston stroke in contact opening direction and during the rest of the piston stroke separating from said movable contact for applying an impulse blast to the arc immediately after separation of said contacts, said piston rod having said conductive tip in engagement with said finger contact elements upon separation of said contacts, said movable contact disengaging from said tip of said piston rod at the contour line of said cluster of finger contact elements.

13. A circuit interrupter comprising a pressure confining structure, relatively stationary and movable contacts adapted to separate in said structure to draw an arc, an arc extinguishing fluid in said structure, said stationary contact comprising a cluster of finger contact elements, means for separating said contacts to draw an arc to be extinguished by blast action within said structure, a spring biased piston means arranged within said structure and axially arranged with said contacts, said piston means comprising two integrating parts, one of said parts being movable relative to the other part, said movable part being provided with means for equalizing the pressure on both sides thereof during a part of its movement relative to said other part, a piston rod having a conductive end mounted on said one of said parts to extend through said piston means, said movable contact and said end of said piston rod engaging each other in abutting arrangement in contact closed position, and means operative during circuit closing movement of said interrupter for abutting said movable contact against said end of said piston rod and driving said piston means to its biased position within said structure, said piston rod and said movable contact moving together in abutting relationship during a part of the piston stroke in contact opening direction and during the rest of the piston stroke separating from said movable contact and engaging said other part for applying an impulse blast to the arc immediately after separation of said contacts, said piston rod having said conductive tip in engagement with said finger contact elements upon separation of said contacts, said movable contact disengaging from said tip of said piston rod outside of said cluster of finger contact elements.

14. A circuit interrupter comprising a pressure confining structure, a pair of cooperating contacts, one of said contacts being relatively movable and the other of said contacts being relatively stationary, said contacts being adapted to separate in said structure to draw an arc, said stationary contact comprising a cluster of finger contact elements, an arc extinguishing fluid in said structure, means for separating said contacts to draw an arc to be extinguished by blast action within said structure, a cylinder arranged within said structure, a spring biased piston means arranged within said cylinder and coaxially arranged with said contacts, said piston means comprising two integrating parts, one of said parts being movable relative to the other part, said movable part being provided with means for equalizing the pressure on both sides thereof during a first portion of its movement relative to said other part, said equalizing means being rendered ineffective by said other part during a second portion of the movement of said movable part, a hollow piston rod having a conductive end mounted on said one of said parts to extend through said piston into said cluster of finger contact elements, said movable contact and said piston rod engaging each other in abutting arrangement in said cluster of finger contact elements in contact closed position to close said end of said piston rod, and means operative during circuit closing movement of said interrupter for abutting said movable contact against said end of said piston rod and driving said piston means to its biased position within said cylinder, said piston rod and said movable contact moving together in abutting relationship during a part of said piston stroke and during the rest of said piston stroke separating from said one of said contacts for applying an impulse blast to the arc immediately after separation of said contacts, said piston rod having said conductive tip in engagement with said finger contact elements upon separation of said contacts, said movable contact disengaging from said tip of

said piston rod outside of said cluster of finger contact elements.

15. A circuit interrupter comprising a pressure confining structure, a pair of relatively stationary and movable contacts adapted to separate in said structure to draw an arc, an arc extinguishing fluid in said structure, means for separating said contacts to draw an arc to be extinguished by blast action within said structure, a port arranged in and at one end of said structure, a cylinder arranged in said structure, one end of said cylinder at said one end of said structure defining a valve seat, a spring biased valve element arranged within said structure for cooperating with said seat to control said port, a spring biased piston movably arranged within said cylinder, a piston rod having a conductive end defining an opening extending through said piston, one of said contacts being arranged to engage with said end of said piston rod at the other end of said cylinder to close said opening and to drive said piston to its biased position within said cylinder so that during a circuit opening operation said piston moves in contact opening direction for applying after a predetermined movement an impulse blast to the arc immediately after separation of said contacts and uncovering of said opening, said valve element under pressure created by the arc being actuated to cooperate with said valve seat to close said port until the pressure created by the arc exceeds a predetermined value, said piston rod having said conductive tip in engagement with said finger contact elements upon separation of said contacts, said movable contact disengaging from said tip of said piston rod outside of said cluster of finger contact elements.

16. A circuit interrupter comprising a pressure confining structure, relatively movable contacts adapted to separate in said structure to draw an arc, an arc extinguishing fluid in said structure, means for separating said contacts to draw an arc to be extinguished by blast action within said structure, a port arranged in and at one end of said structure, a cylinder arranged in said structure, one end of said cylinder defining a valve seat, a valve element arranged within said structure for cooperating with said seat to control said port, a spring biased piston movably arranged within said cylinder, a piston rod having a conductive end portion defining an opening extending through said piston, one of said contacts being arranged to engage with said piston rod to close said opening, and means operative during circuit closing movement of said interrupter for abutting said one of said contacts against said piston rod at the other end of said cylinder to close said opening and to drive said piston to its biased position within said cylinder so that during a circuit opening operation said piston moves in contact opening direction for applying after a predetermined movement an impulse blast to the arc immediately after separation of said contacts and uncovering of said opening, said valve element under a first predetermined range of pressures created by the arc being driven against its spring bias to cooperate with said valve seat to close said port, said valve element when the pressure created by the arc exceeds said predetermined range being driven against its spring bias to a position where said valve element opens said port, said piston rod having said conductive tip in engagement with said finger contact elements upon separation of said contacts, said movable contact disengaging from said tip of said piston outside of said cluster of finger contact elements.

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