

May 31, 1966

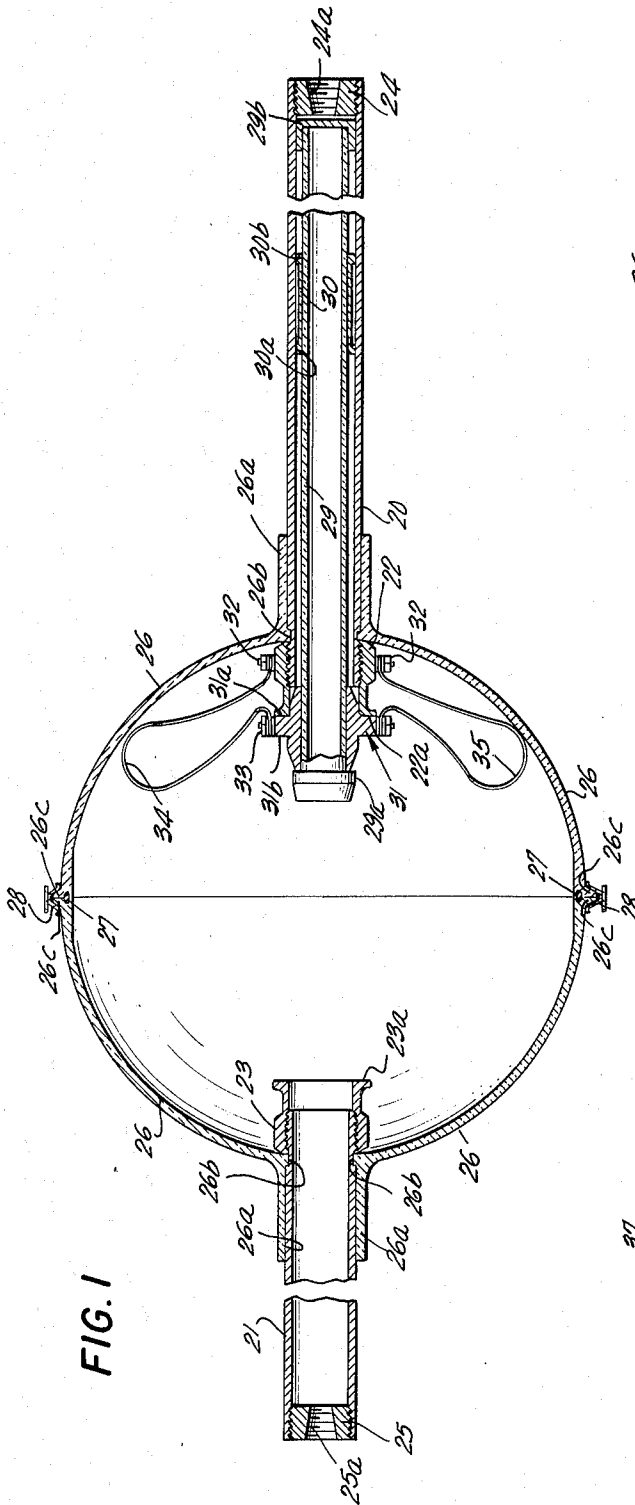
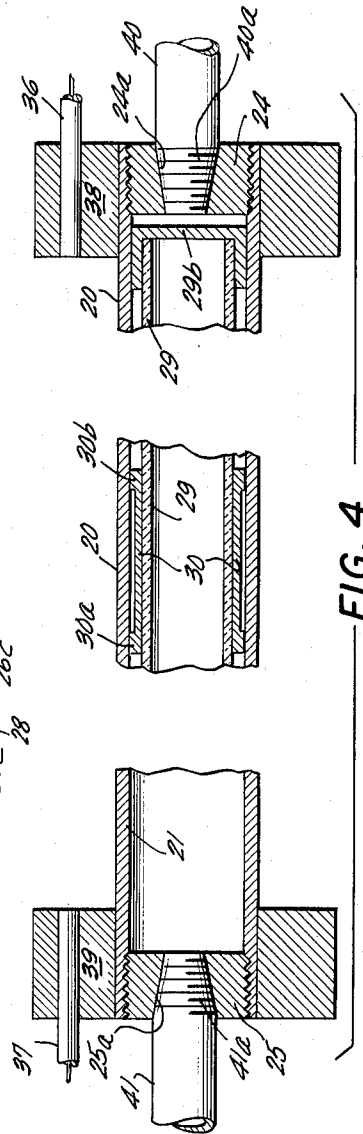
H. T. ADKINS

3,254,185

PRESSURE OPERATED CIRCUIT BREAKER WITH ARC EXTINGUISHER

Filed July 24, 1963

3 Sheets-Sheet 1



INVENTOR.
HAROLD T. ADKINS
BY *Messrs. McBlair and Town*
ATTORNEYS

May 31, 1966

H. T. ADKINS

3,254,185

PRESSURE OPERATED CIRCUIT BREAKER WITH ARC EXTINGUISHER

Filed July 24, 1963

3 Sheets-Sheet 2

FIG. 2

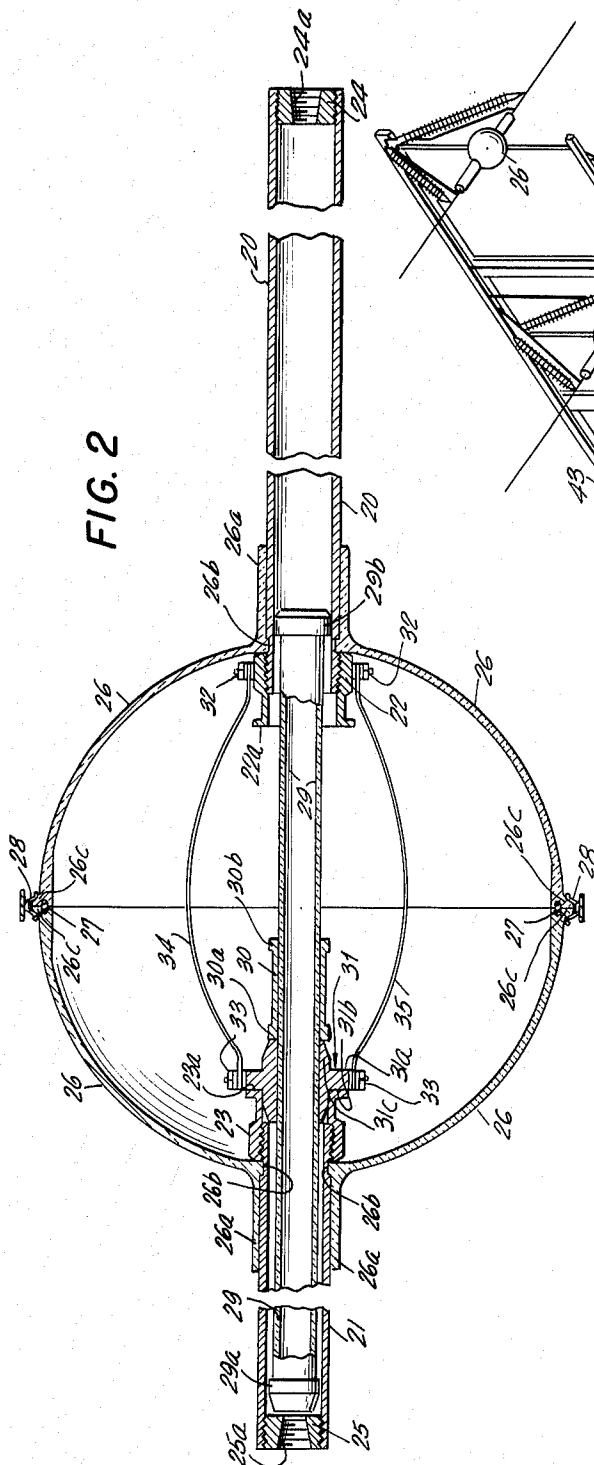
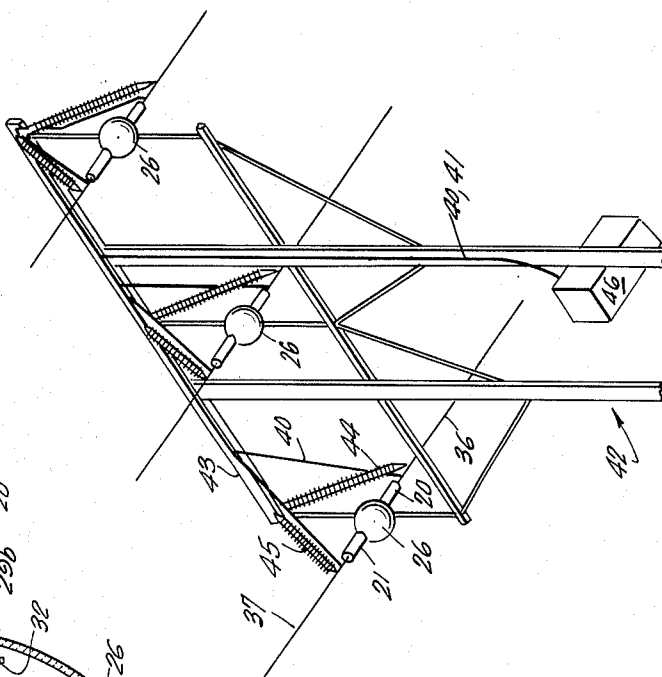


FIG. 5



INVENTOR
HAROLD T. ADKINS
BY *Moses, McGraw, and Joren*
ATTORNEYS

1

3,254,185

PRESSURE OPERATED CIRCUIT BREAKER WITH ARC EXTINGUISHER

Harold T. Adkins, Hanover, Mass., assignor to Sigma Instruments, Inc., a corporation of Massachusetts
Filed July 24, 1963, Ser. No. 297,247
9 Claims. (Cl. 200-148)

This invention pertains to circuit breakers, generally; and, more particularly, to a new and improved circuit breaker, or circuit interrupter, for use in electrical systems of high volt-ampere capacities.

Presently known circuit breakers which are to be subjected to high steady state currents and voltages and even higher transient currents and voltages are relatively complex, weighty and costly. Moreover, the cost of installing such prior art breakers is high. Usually, large concrete foundations are required as well as protective fencing, steel frameworks, insulators, etc. In addition, because of the size of these prior art breakers, there must be provided sufficient land to accommodate the foundations. Sometimes the cost of the additional land, or easement, to accommodate these breakers becomes prohibitive.

An object of the present invention is to provide a circuit breaker which will operate rapidly and reliably in electrical systems having high steady state as well as transient currents and voltages.

Another object of the present invention is to provide a circuit breaker which, as compared with presently known circuit breakers is relatively simple, less bulky, lighter, and relatively inexpensive; the subject circuit breaker having, in addition, a relatively smaller installation cost.

Another object of the present invention is to provide a circuit breaker which is operated at high speed by a pressurized fluid.

Accordingly, in one embodiment of the circuit breaker of the present invention, there is provided a piston rod of dielectric material having an electrical contact element slidably mounted thereon. The piston rod is so arranged with respect to two spaced-apart axially-aligned hollow cylinders of electrically conductive material that it may be reciprocally moved partly out of one cylinder into the other. Flexible conductor elements are electrically connected between the contact element on the piston rod and one of the conductive hollow cylinders. When the piston rod is situated within said one cylinder, the subject circuit breaker is open. However, upon the introduction of a pressurized fluid, such as compressed air or sulphur tetrafluoride, into said one cylinder, the piston rod is rapidly accelerated toward and into the other conductive hollow cylinder. As a consequence, the piston rod's contact element is driven into contact with said other cylinder and the circuit breaker is in a closed position by virtue of the electrical continuity between both said cylinders through the flexible conductor elements and the piston rod's contact element.

One feature of the circuit breaker of the present invention resides in employing a dome-like housing of dielectric material, such as reinforced fiberglass, or the like. Both of the axially-aligned spaced-apart hollow cylinders protrude outwardly from this housing. Advantageously, if a translucent housing is employed, a visual indication of the breaker's open or closed position is provided.

According to another feature of the invention, the circuit breaker, being relatively light and non-bulky, is adapted for being mounted directly on a high tension tower between strain insulators.

According to another feature of the invention, the piston rod is accelerated to its maximum velocity before the slidably mounted contact element is impacted by an

2

engaging surface on the piston rod to slide the contact element on the piston rod in the same direction in which the piston rod is accelerating to rapidly make or break the circuit connection.

According to another feature of the present invention, the slidable contact element encompassing the piston rod and the opposing end portions of the conductive hollow cylinders are so shaped that the contact element when accelerating to make or break the circuit connection is in wiping contact action with respect to the end portion of the hollow conductive cylinder with which it is making contact or breaking contact.

According to another feature of the present invention, the opposing ends of the conductive hollow cylinders are provided with contact flanges. These contact flanges are provided with short longitudinal slits; having the short longitudinal slits, these contact flanges exert a relatively high bearing pressure against the wiping contact surfaces which are integral with the slidable contact element encompassing the piston rod. As a result, the slidable contact comes into firm pressure contact with the slit end flange toward which it is accelerated, and remains in contact therewith due to the bearing pressure exerted by the slit end flange. Moreover, because of the bearing pressure, a good electrical contact is achieved.

According to another feature of the invention, the internal surfaces of the conductive hollow cylinders and the end flanges attached thereto are contoured with respect to the nose of the piston rod and the wiping contact surfaces of the contact element so that as the piston rod is being accelerated to open the circuit breaker there is provided a very narrow constriction between the outer surface of the piston rod's nose and the internal surface of the conductive hollow cylinder and end flange such that the pressurized fluid driving the piston rod attains a very high velocity and is directed so as to extinguish the arc which tends to form upon the breaking of a high tension electrical circuit.

According to still another feature of the invention, a substantially spherical housing is provided for enclosing the air gap between the opposing ends of the conductive hollow cylinders. Advantageously, the eddying pressurized fluid emanating from one of the hollow cylinders during the circuit breaking operation tends to retain flow velocities and vortices breaking up ionized paths within the spherical housing thereby enhancing the aforementioned arc extinguishing function.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there is illustrated and described a preferred embodiment of the invention.

In the drawings:

FIG. 1 is a cross sectional illustration of the circuit breaker according to the present invention, as shown in its open condition;

FIG. 2 is another cross sectional view of the circuit breaker of the present invention, as shown in its closed condition;

FIG. 3 is another cross sectional view of the circuit breaker according to the present invention showing the movable elements thereof starting to move into the closed condition of FIG. 2;

FIG. 4 is a partial view in section showing the means for connecting the pressurized fluid conduits with the hollow cylindrical conductors of the circuit breaker and also the mode of connecting two sections of a power line with the breaker;

3

FIG. 5 is a perspective view of the circuit breaker of the present invention as shown mounted on a tower between strain insulators;

FIG. 6 is a sectioned view of part of the breaker, according to the present invention, showing the position of the piston rod and slidable contact element just prior to the time when the circuit interrupting function occurs;

FIG. 6a is a sectioned view, like FIG. 6, showing the position of the piston rod and slidable contact element shortly after the circuit interruption has occurred; and,

FIG. 7 is a perspective view of one of the end flanges employed as contact elements which are fastened to one end of a conductive hollow cylinder.

As shown, two hollow cylinders 20 and 21 are arranged in a spaced-apart axially aligned relationship. Each cylinder is fashioned from a tubular-shaped electrically conductive material such as copper, aluminium or the like. Opposing ends of the hollow cylinders 20 and 21 are externally threaded for threadably receiving the internally threaded end flanges 22 and 23. These end flanges 22 and 23 are made of a similar electrically conductive material. Each end flange 22 and 23 is provided with a smooth annular contact surface 22a and 23a, respectively. The other ends of the hollow cylinders 20 and 21 are internally threaded for the purpose of threadably receiving the threaded plugs 24 and 25, respectively. As shown, each plug 24 and 25 has a threaded tapered aperture, 24a and 25a, centrally therethrough. The plugs 24 and 25 are, as discussed hereinafter, for the purpose of receiving suitable nozzle fittings of conduits which extend to a pressurized fluid source.

As shown, a dome 26 of dielectric material is fitted over the ends of the hollow cylinders 20 and 21. The dome 26 encloses the gap between the opposing cylinders 20 and 21; i.e., more particularly the gap between opposing end flanges 22 and 23. The dome 26 is comprised of two hemispherical sections which are intended to be fitted together to form a generally spherical dome. Each hemispherical section of the dome 26 includes an integrally formed pipe section 26a and an internal annular shoulder 26b. The pipe sections 26a are fitted over the hollow cylinders 20 and 21, as shown, and bonded to the surfaces thereof. As indicated, the annular shoulders 26b bear against mating shoulder surfaces formed in the outer surfaces of the hollow cylinders 20 and 21. Thus, the shoulders 26b bear against the shoulders provided in the hollow cylinders 20 and 21 and against the end flanges 22 and 23. Also, as indicated, the rim portions 26c of each of the hemispheres forming the dome 26 are flanged outwardly and includes slots therein so that when the flanged rim portions 26c of the hemisphere are mated an O-ring 27 of resilient material may rest in the generally rectangular or square slot portion so as to effect an adequate sealing of the dome sections. As indicated, a circular clamp 28 fitted over the outwardly flanged rim portions 26c is used for locking the hemispherical dome sections together.

A movable element of the subject circuit breaker is the piston rod 29. The piston rod 29 is made from a hollow tube of dielectric material such as fiberglass. The use of fiberglass makes for a relatively light weight circuit breaker. As indicated, the hollow piston rod 29 has, at one end thereof, a tapered nose portion 29a which is of a greater diameter than the diameter of the piston rod 29. Similarly, at the opposite end of the hollow piston rod 29 there is affixed the end cap 29b. Thus, by virtue of the nose portion 29a and the end cap 29b the hollow space within the piston rod 29 is sealed. The end cap 29b is fashioned from material the same as, or similar to, that which is used in forming the piston rod 29. As shown, there is securely fixed about the outer surface of the piston rod 29 the elongated collar on engaging means 30, which includes at each end thereof the annular flange portions 30a and 30b. The flange portions 30a and 30b bear against the inner surface of the hollow

4

cylinder 20 (see FIGS. 3 and 4). The collar 30 being affixed around the outer surface of the piston rod 29 provides a slide bearing surface for the movable piston rod 29. The diameters of the annular flanges 30a and 30b as well as the diameters of the nose portion 29a and the end cap 29b are sufficiently smaller than the internal diameters of the hollow cylinders 20 and 21 so that there is always sufficient clearance between these elements. Thus, the clearances provided enable pressurized fluid, such as compressed air, used to drive the piston rod 29, to be vented from the cylinder toward which, or into which, the piston rod 29 is accelerating.

Loosely fitted so that it may easily slide along the piston rod 29 is the contact element 31 which is fashioned of an electrically conductive material such as copper, or aluminium, or the like. As shown, the contact element 31 is so shaped that it has two opposing contact faces 31a and 31b. When the subject circuit breaker is in a closed condition, the contact face 31b will be in contact with the annular contact surface 23a of the end flange 23; the contact face 31a, when the circuit breaker is in the open condition, being in contact with the annular contact surface 22a of the end flange 22. Also, as may be appreciated from the drawing figures, the contact element 31 also has formed therein the annular wiping contact portions 31c and 31d. These wiping contact portions 31c and 31d are, as shown, tapered toward their ends. Thus, when the breaker is in the closed condition the portion 31d is in contact with the annular contact surface 23a. (See FIG. 2). Likewise, as is shown at FIG. 1, when the breaker is in the open condition, the portion 31c is within the end flange 22 so that the portion 31c makes contact with the inner surface of the end flange 22 and the portion 31a is in contact with the annular contact surface 22a.

As shown in FIG. 7, the end flanges 22 and 23 have a number of short longitudinally extending slots 22b or 23b therein. With respect to the wiping contact portions 31c and 31d of the contact element 31, the internal diameter of the slit end flanges 22 and 23 is such that there is a high bearing pressure exerted by the flanges 22 and 23 upon the surfaces 31c and 31d, respectively. Because of this high bearing pressure, or frictional contact, the contact element 31, when it has been driven into one of the hollow cylinders 20 or 21, will remain in contact with the flanges 22 or 23, respectively, due to the force or pressure exerted by the flanges 22 or 23 upon the surfaces 31c or 31d. In addition, a good electrical contact is achieved by virtue of this bearing pressure.

Threaded screws or bolts such as 32 and 33 serve to fasten the extremities of the stranded flexible electrical cables 34 and 35 between the contact element 31 and the end flange 22. The stranded flexible electrical cables 34 and 35 are fashioned from electrically conductive strands of copper, aluminium or the like.

As shown in FIG. 4, two conductors 36 and 37, by virtue of the respective conductive clamps 38 and 39, are electrically connected with cylinders 20 and 21, respectively. The conductors 36 and 37 form two sections of one phase of a power line.

Also as shown in FIG. 4, the apertures in plugs 24 and 25 receive the externally threaded nozzle portions 40a and 41a of the conduits 40 and 41, respectively, which are fashioned from a flexible tubular dielectric material such as, for example, polyethylene. The conduits 40 and 41 extend to a four-way valve (not shown) which is connected to an atmospheric vent and a receiver which contains the pressurized operating fluid. Operationally, when the circuit breaker is in its open condition illustrated in FIG. 1, it may be moved into the closed position illustrated in FIG. 2, by operation of the aforesaid valve means to admit the pressurized fluid from the receiver through conduit 40 (FIG. 4) into the hollow cylinder 20 for the purpose of driving the piston

5

rod 29 across the open gap whereby the piston rod 29 will be received in the hollow cylinder 21; the hollow cylinder 21 being vented through the conduit 41 (FIG. 4) by the aforesaid valve means.

As illustrated in FIG. 3, (piston rod 29 being shown at the beginning of its travel toward the hollow cylinder 21) the contact element 31 which is not secured to the piston rod 29 tends, due to its inertia, to stay at rest. However, as the annular collar 30 which is fixed about the outer surface of the piston rod 29 approaches the area of the annular contact surface 22a of the end flange 22, it slaps against the contact element 31 thereby sliding it over the surface of the moving piston rod 29 toward contact with the annular contact surface 23a of the end flange 23. The inwardly tapering apertures 24a and 25a in the plugs 24 and 25, respectively, serve to decelerate the motion of the piston rod 29 as the nose portion 29a or the end cap 29b approach the plug 25 or the plug 24, depending on whether the circuit breaker is being opened or closed.

In order to open the circuit breaker when it is in the closed condition as illustrated in FIG. 2, pressurized air is admitted into the hollow cylinder 21 through conduit 41 and the aperture in plug 25 while the hollow cylinder 20 is vented through the aperture at plug 24 through the conduit 40 by the valve means. Of course, when the piston rod 29 is situated within the hollow cylinder 21 in the condition shown in FIG. 2 and pressurized fluid is introduced into the cylinder 21 for the purpose of returning the breaker to the condition of FIG. 1 (the open condition), the enlarged nose portion 29a will, on the return stroke, slap the contact element 31 and drive it back across the gap into contact with the annular contact surface 22a and the end flange 22.

It will be appreciated that the piston rod 29 is moving at a relatively high velocity when the enlarged nose portion 29a strikes the contact element 31. This highly accelerates contact element 31 in a direction toward the breaker open position. With the contact element 31 moving at a high velocity toward the open position, and with the piston rod 29 also moving at a high velocity toward the open position, the contact 31 moves into firm engagement with the sleeve 22 and, the enlarged portion 29a of the piston 29 enhances such engagement. It will further be appreciated that there is a pressure differential existing between the outer closed end 29a of piston rod 29 and the inner closed end thereof, so that this pressure differential also has an effect in ensuring complete opening of the circuit breaker.

FIG. 6 shows the position of the nose portion 29a of the piston rod 29 just prior to the time the circuit breaker is about to open. FIG. 6a shows the position of the nose portion 29a of the piston rod 29 just after the subject circuit breaker has opened. The contour of the nose portion 29a and the complementary internal surfaces of the hollow cylinder 21 and the end flange 23 are such that just prior to the opening of the circuit breaker (FIG. 6) the constricted fluid passage between the nose portion 29a and the internal surface of the flange 23 occasions a high fluid pressure which continues for a short time even after the opening of the breaker (FIG. 6a). This increase in fluid pressure occasions a high velocity fluid stream to be directed into the region where an arc usually forms when the wiping contact surface 31d breaks contact with the internal surface of the flange 23. This high pressure stream, being directed into the arc, enables a rapid extinguishment of the arc. Because the fluid pressure is still at a high level for a short while after the opening of the circuit breaker (FIG. 6a), there is prevented a restriking of the arc.

A preferred form of the housing 26 is that of a hollow sphere (as shown). Because of the spherical symmetry of the sphere, with respect to the axially aligned flange 23 and its hollow cylinder 21, the fluid streams emanating from the hollow cylinder 21, as indicated in FIG. 6a,

6

will be directed angularly outward from the flange 23 and move in a generally circular path, evenly distributed about the axial center line of the piston rod 29 to enhance the prevention of the restriking of the arc.

FIG. 5 illustrates a particularly advantageous mounting of the subject circuit breaker, i.e., three circuit breakers one in each line of a three phase high tension power line. As illustrated, there is a high tension tower line generally designated by the reference number 42. Suitably mounted from an upper cross arm 43 of the tower 42 are two strain insulators 44 and 45 which support the conductor sections 36 and 37, respectively. The conductor sections 36 and 37, in turn, serve to support the circuit breaker through the clamps 38 and 39 (FIG. 4). Suitably mounted at an upright portion of the tower 42 is the compressed fluid receiver and valve means, generally designated by the reference number 46. Extending outwardly from this unit 46 are the two conduits 40 and 41 which as illustrated in FIG. 5, extend to the apertured plugs 24a and 25a of the hollow cylindrical conductors 20 and 21, respectively. Advantageously, in the arrangement shown in FIG. 5, the subject circuit breaker, being light and relatively unbulky, is supported directly in the conductor lines by the strain insulators 44 and 45.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the inventive principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A circuit breaker comprising: two axially-aligned hollow conductors having axially-spaced opposing inner ends; a dielectric piston rod slidably mounted in one hollow conductor for reciprocating movement partly out of said one hollow conductor into the other hollow conductor, said piston rod including two spaced-apart enlarged portions; an electrically conductive element slidably mounted on said piston rod and adapted to be engaged by said enlarged portions of said piston rod during reciprocating movement of said piston rod to slide said conductive element into contact with the hollow conductor toward which said piston rod is moving; and flexible conductor means connected between said one hollow conductor and said conductive element.

2. The circuit breaker according to claim 1, wherein a dielectric housing encloses the opposing inner ends only of said hollow conductors, and encloses said conductive element and flexible conductor means.

3. A circuit breaker comprising: two axially-aligned spaced-apart hollow conductors; a dielectric piston rod slidably mounted in one of said hollow conductors for reciprocation from within said one conductor to the interior of the other conductor; fluid pressure operated means for reciprocating said piston rod; contact means carried by said piston rod for making contact with the conductor toward which said piston rod is moving; and flexible conductor means connected between said contact means and the conductor from which said piston rod is moving.

4. A circuit breaker comprising: first and second spaced-apart hollow conductor means; a dielectric piston rod normally situated within said first conductor means and adapted for being moved partly out from within said first conductor means and into said second conductor means; said piston rod having an enlarged nose portion on one end thereof and an enlarged collar portion on a central portion thereof spaced-apart from said nose portion; a source of pressurized fluid; valve means operable for admitting pressurized fluid from said source into either hollow conductor means to selectively move said piston rod so that it assumes said normal situation or is situated within said second conductor means and partly within said first conductor means; contact means slidably encompassing said piston rod in the space between

7

said nose portion and said collar portion; and flexible conductor means connected between said contact means and said first conductor means.

5. The circuit breaker according to claim 5, further comprising a dielectric housing extending between said first and second conductor means and, together with said first conductor means, enclosing said piston rod, said housing also enclosing said contact means and flexible conductor means.

6. The circuit breaker according to claim 3, wherein the fluid pressure is operative to extinguish arcing as said contact means breaks contact with said other conductor.

7. A circuit breaker comprising: two axially-aligned, spaced-apart hollow conductors; a dielectric piston rod, including engaging means thereon, slidably mounted in one hollow conductor and arranged for reciprocating movement partly out of said one hollow conductor into the other hollow conductor; an electrically conductive element slidably mounted on said piston rod and adapted to be engaged by said engaging means of said piston rod during reciprocating movement of said piston rod to move said conductive element in a direction toward the hollow conductor towards which said piston rod is moving; and flexible conductor means connected between said slidably mounted conductive element and one of said hollow conductors.

8

8. A circuit breaker according to claim 7, wherein said slidably mounted conductive element includes contact surfaces making wiping contact with said hollow conductors.

9. A circuit breaker according to claim 7, wherein the clearance between the surface of said piston rod and the internal surface of said other hollow conductor forms a constricted passage and said circuit breaker further comprising a source of pressurized fluid and means selectively operable for introducing the pressurized fluid into said other hollow conductor, whereby said pressurized fluid is subjected to an increasing pressure as it passes through said constricted passage.

References Cited by the Examiner

UNITED STATES PATENTS

2,943,173 6/1960 Level ----- 200—150

FOREIGN PATENTS

20 629,046 4/1936 Germany.
570,511 7/1945 Great Britain.
606,754 8/1948 Great Britain.

BERNARD A. GILHEANY, *Primary Examiner*.

H. M. FLECK, *Assistant Examiner*.