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HIGH VOLTAGE CIRCUIT BREAKER

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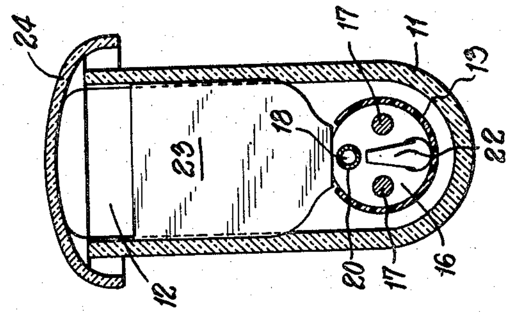

Fig. 2.

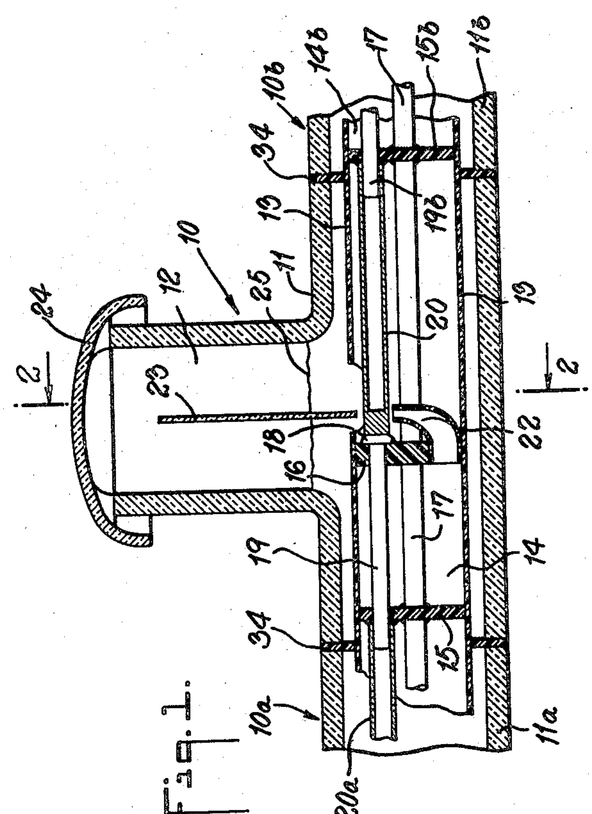

Fig. 1.

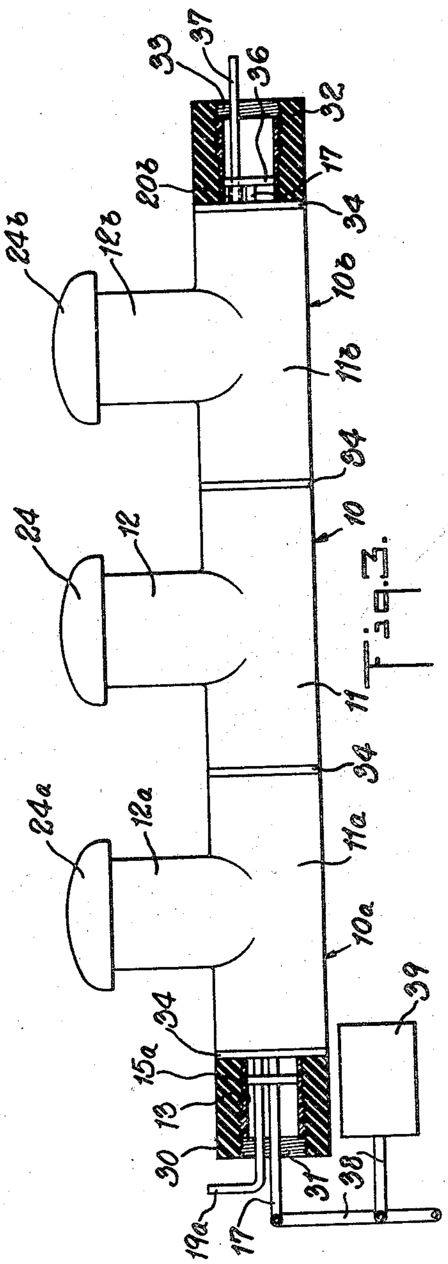

Fig. 3.

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HIGH VOLTAGE CIRCUIT BREAKER

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This invention relates to multi-break electric circuit breakers of the fluid blast type which are used to interrupt high voltage, high power circuits.

It is well known in the art that a blast of insulating fluid, such as oil or air, can be directed against an arc drawn between two contacts so as to force the arc against a splitter or baffle and thereby break the arc. Circuit breakers of this type are used in which the blast of dielectric fluid is directed through a nozzle located at one side of the arc gap opposite the splitter, the fluid being forced through the nozzle under the action of a piston operating in a cylinder.

In many instances, it is desirable to provide a circuit breaker of this type which will make a number of breaks in the circuit. These multi-break circuit breakers, as constructed heretofore, have serious disadvantages, among which are the tendency for the piston to stall due to excess back-pressures in the escape path of the fluid issuing from the nozzle, the complexity of the circuit-breaker construction and the difficulty in disassembling and servicing the breaker.

The principal object of the present invention is to provide an improved circuit breaker which will interrupt a high voltage, high power circuit, which requires a relatively low fluid pressure for successful operation, which simplifies the breaker structure, and which facilitates maintenance.

A fluid blast circuit breaker made according to the invention comprises an elongated housing of insulating material having a plurality of upwardly extending necks forming vents spaced along the housing. The housing may consist of a plurality of sections or units each of which is a hollow inverted T, the horizontal portions of these units being held together end-to-end in any suitable manner, so that the housing necks are formed by the vertical legs of the T-shaped sections. Within the elongated horizontal portion of the housing and extending lengthwise thereof is an insulating tube, which may be provided at its ends with suitable clamping means for holding the housing units together. This inner tube contains multiple pairs of contacts, one pair for each of the vents of the housing. One contact of each pair is mounted on a fixed barrier or bulkhead located near the corresponding vent and forming one end of a cylindrical chamber within the tube, this chamber constituting the cylinder for a piston. There is one such cylinder and piston for each pair of contacts and each vent, for pumping a blast of dielectric fluid across the arc drawn by the contacts and against an arc splitter or baffle leading to the corresponding vent.

The other contact of each pair, the movable contact, is mounted on the piston which pumps the fluid across the arc drawn by the next pair of contacts. The several pistons are connected to a common actuator, which may be a rod or rods projecting from the inner tube at one end of the housing and movable to operate the pistons in unison. Preferably, the movable contact of each pair is electrically connected to the stationary contact of the next pair through an extension of the latter contact which has a sliding or telescoping fit with the movable contact or with the piston carrying such movable contact, whereby the electrical connection is maintained throughout the range of movement of the piston.

With the construction as described, the escape path through which each fluid blast is vented, after passing between the corresponding pair of contacts, is in com-

munication with the interior of the inner tube adjacent the piston which pumps the fluid between the next pair of contacts. Thus, any back pressure developed in this escape path assists the movement of such piston incident to opening the contacts and blasting fluid between the next pair of contacts. Also, by increasing or decreasing the number of pistons and contact pairs in the housing, the breaker can be easily adapted for different voltages. In addition, each break is separately vented to provide freer venting, and each vent may be arranged to permit access to the corresponding contacts for replacement or servicing of the parts, without completely disassembling the breaker.

These and other features of the invention will be apparent from the following description of a specific example as illustrated by the drawings.

In the drawings:

Fig. 1 is a vertical longitudinal sectional view of one breaker unit of the multi-break circuit breaker;

Fig. 2 is a cross-sectional view on the line 2—2 in Fig. 1; and

Fig. 3 is a side elevation view, partly in section, of a plurality of breaker units assembled as a multi-break circuit breaker.

The embodiment of the invention chosen for the purpose of illustration comprises a breaker unit **10** (Fig. 1) having a housing **11**—**12** in the form of an inverted T and made of a suitable electrical insulating material, such as porcelain. The horizontal portion **11** of the housing is generally cylindrical and the leg of the T forms a venting neck **12** extending upward from the horizontal portion **11**. Rigidly secured within the horizontal portion **11** of the housing and coaxial therewith is a tube **13** adapted to extend through a plurality of breaker units **10**, as will be explained presently, the tube **13** being made of an insulating material such as a phenol. The tube **13** forms within each breaker unit **10** a cylinder **14** containing a piston **15** which has a snug sliding fit in the cylinder **14**. A transverse bulkhead **16** is secured tightly in the tube **13** and forms the fixed end of the cylinder **14**. The bulkhead **16** is disposed generally in vertical alignment with the vent **12**. Two piston rods **17** extend through the tube **13** parallel to the axis thereof and are rigidly connected to piston **15**, the rods having a close sliding fit in the bulkhead **16**. Piston rods **17** are actuated by an external control mechanism shown schematically at **39** in Fig. 3.

A stationary contact **18** mounted on the bulkhead **16** is provided with an extension in the form of an electrically conductive solid rod **19** having a close sliding fit in the piston **15** through which it projects into an adjacent breaker unit **10*a*** as shown in Fig. 1.

The breaker unit **10** also contains a movable contact **20** in the form of a hollow rod closed at one end and rigidly connected to a piston **15*b*** slidable in tube **13** within the other adjacent breaker unit **10*b***. The stationary contact extension **19*b*** in the unit **10*b*** projects through the corresponding piston **15*b*** and into the hollow conducting rod **20** within breaker unit **10**, the extension **19*b*** having a close sliding fit in the hollow rod **20**. The movable contact rod **20** is engageable at its closed or solid end with fixed contact **18** and is adapted to carry current from the contact **18** to the adjacent breaker unit **10*b*** through the electrical wiping contact with rod **19*b***.

A nozzle **22** communicates with cylinder **14** through an aperture in bulkhead **16** and is disposed in the lower portion of tube **13** so as to project a stream of fluid upwardly through the gap effected by the separation of contacts **18** and **20**. Fixed within an opening in the upper portion of tube **13** is a baffle or arc splitter **23** which extends into the vent **12** in substantial alignment with the outlet opening of nozzle **22**.

A cover assembly 24 covers the open upper end of vent chamber 12 and includes a conventional arrangement for separating the fluid, such as oil, from the exhaust gases created by the arc reacting with the fluid blast stream.

The multi-break circuit breaker comprises a plurality of breaker units similar to the unit 10 previously described, which are connected together end-to-end as shown in Fig. 3. For illustrative purposes, I have there shown three such units 10, 10*a* and 10*b* thus assembled. These units are substantially identical in construction and are held together by the inner insulating tube 13 which is common to all the units and extends through them. More particularly, the housings 11—12, 11*a*—12*a* and 11*b*—12*b* of the respective units are slid onto the tube 13 with its contained contacts, cylinders, pistons and nozzles corresponding to the respective units; and these housings are clamped together by suitable clamping means on the ends of the tube 13, projecting through the opposite end units 10*a* and 10*b*. The clamping means on the tube 13, as shown, include an insulating sleeve 30 screwed on a threaded end 31 of tube 13 and which may be adapted for connection to an end housing (not shown) to contain oil, and a similar sleeve 32 screwed on the opposite end 33 of the tube, these sleeves serving to clamp the housings together against sealing gaskets 34 interposed between adjacent housings. Similar gaskets 34 may be interposed between the end housings and the sleeves 31 and 32, respectively.

As shown in Fig. 3, the piston rod 17 and the stationary contact extension 19*a* of the breaker unit 10*a* extend through the end sleeve 31 from piston 15*a*, which seals the corresponding end of tube 13. The piston 15*a* within the end unit 10*a* does not carry a movable contact corresponding to contacts 20 and 20*a* on pistons 15 and 15*a*, respectively. The opposite end 33 of tube 13 contains a piston 36 to which the corresponding end of rod 17 is rigidly connected, this piston carrying the hollow movable contact 20*b* of breaker unit 10*b*. A stationary terminal 37 extends through sleeve 32 and piston 36 and has a close sliding or telescopic fit in the hollow movable contact 20*b*. Thus, the terminal 37 and stationary contact 19*a* form the opposite terminals of the multi-break circuit breaker, it being understood that these terminals may be arranged to extend through suitable insulators (not shown) on the end sleeves 30 and 32. The piston rod 17 may be connected through a suitable linkage 38 to an actuator 39 at one end of the breaker assembly.

The assembly of breaker units 10, 10*a* and 10*b* is filled with an insulating fluid, such as oil, so that the tube 13 between the piston 15*a* at one end and piston 36 at the other end, as well as the housings 11—12, 11*a*—12*a* and 11*b*—12*b*, are filled with the oil up to the level 25 within the vent necks 12, 12*a* and 12*b*. With the terminals 19*a* and 37 connected into the circuit to be broken, and the piston rod 17 retracted (to the left in Figs. 1 and 3), current flows through the breaker assembly by way of the interengaged contacts 18 and 20 of unit 10 and the corresponding contacts of the other units, and the telescoped parts 19—20*a*, 19*b*—20 and 37—20*b*.

Upon operation of the actuator 39, the piston rod 17 is advanced to the right (Figs. 1 and 3), thereby moving all of the pistons 15, 15*a*, 15*b* and 36 to the right. As a result, the movable contacts 20, 20*a* and 20*b* are withdrawn from the corresponding stationary contacts so that an arc is drawn between each pair of contacts 18—20, etc. At the same time, the pistons 15, 15*a* and 15*b* force oil through the corresponding nozzles 22, etc., and across the adjacent arc gaps. Thus, the blast of dielectric fluid from each nozzle forces the adjacent arc against the opposed splitter 23, thereby breaking and extinguishing the arc. The gaseous products created by interaction of the oil and the arcs tend to expand under the high temperature; but these arc products are separately vented from each arc through the overlying vent neck 12, 12*a* or 12*b*, thereby avoiding excessive back-pressures which would decrease the velocity of the oil blasts from the nozzles and tend to stall the pistons.

Preferably, each nozzle 22, etc., and the vented escape path for the fluid issuing therefrom are arranged according to the principles disclosed in my Patent No. 2,761,935 dated September 4, 1956, to further minimize such back-pressures.

It will be observed that any back-pressure created at the outlet of nozzle 22 (Fig. 1) is transmitted to the piston 15*b* of the next breaker unit 10*a*, as the cylinder for the latter piston is in direct communication with the outlet of nozzle 22. This back-pressure acts on piston 15*b* to assist the movement of piston rod 17 to draw and blast the arcs. In other words, the action of the back-pressure on piston 15*b* substantially counteracts the tendency of the back-pressure to oppose piston 15 which operates against such back-pressure. Similarly, any back-pressures created at the outlets of the nozzles of the other breaker units 10*a* and 10*b* will act on the pistons 15 and 36, respectively, to counteract the tendency for these back-pressures to stall the piston rod 17.

To close the circuit breaker, the piston rod 17 is moved to the left by the actuator 39, thus re-engaging the contacts 18—20, etc., of the several breaker units. As the pistons 15, 15*a*, 15*b* and 15*c* move to the left, oil is drawn into the cylinders 14, etc., of the respective breaker units through the corresponding nozzles 22, etc., to replace the oil previously expelled from these cylinders in drawing and blasting the arcs.

By providing each breaker unit 10, 10*a* and 10*b* with a separate piston located adjacent the break or arc gap, I avoid loss of oil pressure between nozzles and eliminate any lag in the operation of the several units. Also, the number of breaker units 10, etc., in the assembly can be easily varied to accommodate different voltages. In addition, the invention provides for much freer venting of the gaseous arc products; and since the venting of each break is separate from that of any other break, there is no possibility of an arc communicating electrically with another arc through the gases. The insulating tube 13 not only holds all of the housing units 11—12, 11*a*—12*a* and 11*b*—12*b* tightly together through the clamping means previously described, but also forms the cylinders for the several pistons of the assembly. Moreover, the use of such an insulating tube in place of a metal one results in a substantial increase in the "creepage" distances.

Maintenance problems of the breaker units are simplified since the parts within each breaker unit are accessible through vent 12 by simply removing the cover 24 and baffle 23. Contacts 18 and 20, if burned or corroded, may be replaced with ease.

It will be apparent that in the embodiment of the invention as illustrated in Fig. 1, the portion of tube 13 adjacent the venting neck 12, and to the right of baffle 23, is open to the discharge side of the nozzle 22 and thus forms a means affording communication from the exhaust side of the contacts 18—20 to the cylinder 14*b* for the adjacent pair of contacts to the right of contacts 18—20. This communication leads to the cylinder 14*b* at the side of the corresponding piston 15*b* which is remote from the corresponding nozzle (not shown), so that the back pressure at the exhaust side of contacts 18—20 acts through this communication to assist the piston 15*b* in forcing the fluid through its corresponding nozzle.

I claim:

1. In an electric circuit breaker for interrupting high voltage power circuits, a breaker unit comprising a horizontal insulating housing, an arc extinguishing and insulating liquid in the housing, the housing having a vent opening upward from the liquid, a hollow insulating cylinder fixed horizontally within the housing and provided at the top with an opening located in substantial

vertical alignment with said vent, a piston having a sliding fit in the cylinder, a bulkhead fixed within the cylinder, a fixed contact supported by the bulkhead adjacent said cylinder opening, a movable contact engageable with the fixed contact, a piston rod operatively connected to said piston and movable contact and operable to move the piston toward the bulkhead while disengaging the movable contact from the fixed contact to establish an arc gap between said contacts, a nozzle leading to said gap from the space between the piston and the bulkhead, and an arc-splitting baffle disposed on the opposite side of the gap from the nozzle outlet and extending from said cylinder opening into the vent, whereby movement of the piston rod to establish said gap causes the piston to displace liquid from said space through the nozzle and gap and thereby force the arc against said baffle.

2. A circuit breaker comprising a plurality of breaker units as defined in claim 1, the cylinders in the respective units forming a unitary cylinder extending continuously through the housings, clamping means on said unitary cylinder for holding the respective housings together in end-to-end relation, and an electrical connection between the movable contact of at least one of said units and the fixed contact of an adjacent unit.

3. A circuit breaker comprising a plurality of breaker units as defined in claim 1, the cylinders in the respective units forming a unitary cylinder extending continuously through the housings, clamping means on said unitary cylinder for holding the respective housings together in end-to-end relation, and an electrical connection between the movable contact of at least one of said units and the fired contact of an adjacent unit, said electrical connection being disposed in the unitary cylinder.

4. A circuit breaker comprising a plurality of breaker units as defined in claim 1, the cylinders in the respective units forming a unitary cylinder extending continuously through the housings, clamping means on said unitary cylinder for holding the respective housings together in end-to-end relation, and an electrical connection between the movable contact of at least one of said units and the fixed contact of an adjacent unit, said connection including an extension of the fixed contact of said adjacent unit, said extension having a sliding fit with the movable contact of said one unit.

5. A circuit breaker comprising a plurality of breaker units as defined in claim 1, the cylinders in the respective units forming a unitary cylinder extending continuously through the housings, clamping means on said unitary cylinder for holding the respective housings together in end-to-end relation, and an electrical connection between the movable contact of at least one of said units and the fixed contact of an adjacent unit, the rods in the respective units forming a unitary rod extending through the housings.

6. A fluid blast circuit breaker of the multi-break type comprising a plurality of pairs of fixed and movable contacts arranged to form a plurality of breaks in series, a housing containing the contacts and having separate vents for the respective breaks, cylinders in which the contacts are mounted in the housing adjacent the respective vents, a piston having a sliding fit in each cylinder, a nozzle leading from each cylinder to one side of the corresponding break and through which a dielectric fluid is adapted to be blasted from the cylinder by the corresponding piston, an arc splitter in the housing located outside the cylinders opposite each nozzle and against which an arc drawn between the corresponding pair of contacts is adapted to be blasted by the fluid from the nozzle, and an actuator operatively connected to the pistons and movable contacts for operating them in unison.

7. A fluid blast multi-break electric circuit breaker for interrupting high voltage, high power circuits, comprising a horizontal insulating housing, an arc extinguishing and insulating liquid in the housing, the housing having a plurality of vents opening upward from the liquid, a

hollow insulating tube fixed horizontally within the housing and provided at the top with a plurality of openings located in substantial vertical alignment with respective vents, a plurality of pistons each having a sliding fit in the tube, a plurality of bulkheads fixed within the tube, a fixed contact supported by each of the bulkheads adjacent one of said tube openings, a plurality of movable contacts each engageable with an associated fixed contact, a piston rod operatively connected to all of said pistons and movable contacts and operable to move each piston toward an associated bulkhead while simultaneously disengaging each movable contact from its associated fixed contact to establish an arc gap, a nozzle leading to each of said gaps from the tube space between the associated piston and bulkhead, and an arc-splitting baffle disposed on the opposite side of each gap from the corresponding nozzle outlet and extending from the adjacent tube openings into the associated vent, whereby movement of the piston rod to establish said plurality of gaps causes each piston to displace liquid from the corresponding tube space through the associated nozzle and gap and against the adjacent baffle.

8. In a fluid blast circuit breaker of the multi-break type having a plurality of pairs of relatively movable contacts arranged to form a plurality of breaks in series, each pair including a movable contact and a second contact engageable by the movable contact, an actuator connected to the movable contacts and operable to move said last contacts in one direction to draw an arc between each pair of contacts, a cylinder for each pair of contacts, a piston movable in each cylinder and operatively connected to said actuator, and a nozzle leading from each cylinder to one side of the corresponding contacts and through which a dielectric fluid is adapted to be blasted across the corresponding arc by the piston in the corresponding cylinder; the improvement which comprises a housing containing said contacts and cylinders, each pair of contacts having an exhaust side located within the housing opposite said one side to which the corresponding nozzle leads, and means affording communication from the exhaust side of a pair of contacts to the cylinder for an adjacent pair of contacts, said communication leading to said last cylinder at the side of the corresponding piston which is remote from the corresponding nozzle, whereby the back pressure at said exhaust side acts through said communication to assist said last piston in forcing the fluid through its corresponding nozzle.

9. The improvement according to claim 8, in which the housing has a vent at said exhaust side of each pair of contacts.

10. The improvement according to claim 8, comprising also a bulkhead in each cylinder supporting said second contact of the corresponding pair of contacts, the actuator being operable to move each piston toward its corresponding bulkhead while retracting the movable contact from the second contact supported by said bulkhead.

11. The improvement according to claim 8, comprising also a bulkhead in each cylinder located adjacent the corresponding nozzle and supporting said second contact of the corresponding pair of contacts, said second contact having an extension projecting from the bulkhead into the corresponding cylinder, the piston in one cylinder carrying the movable contact of a pair adjacent the pair of contacts corresponding to said last cylinder, said last movable contact being in sliding engagement with said extension from the adjacent pair of contacts.

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