May 4, 1948. T. W. WILCOX 2,440,995

ELECTRIC CIRCUIT BREAKER

Filed June 10, 1944

Fig. 2.

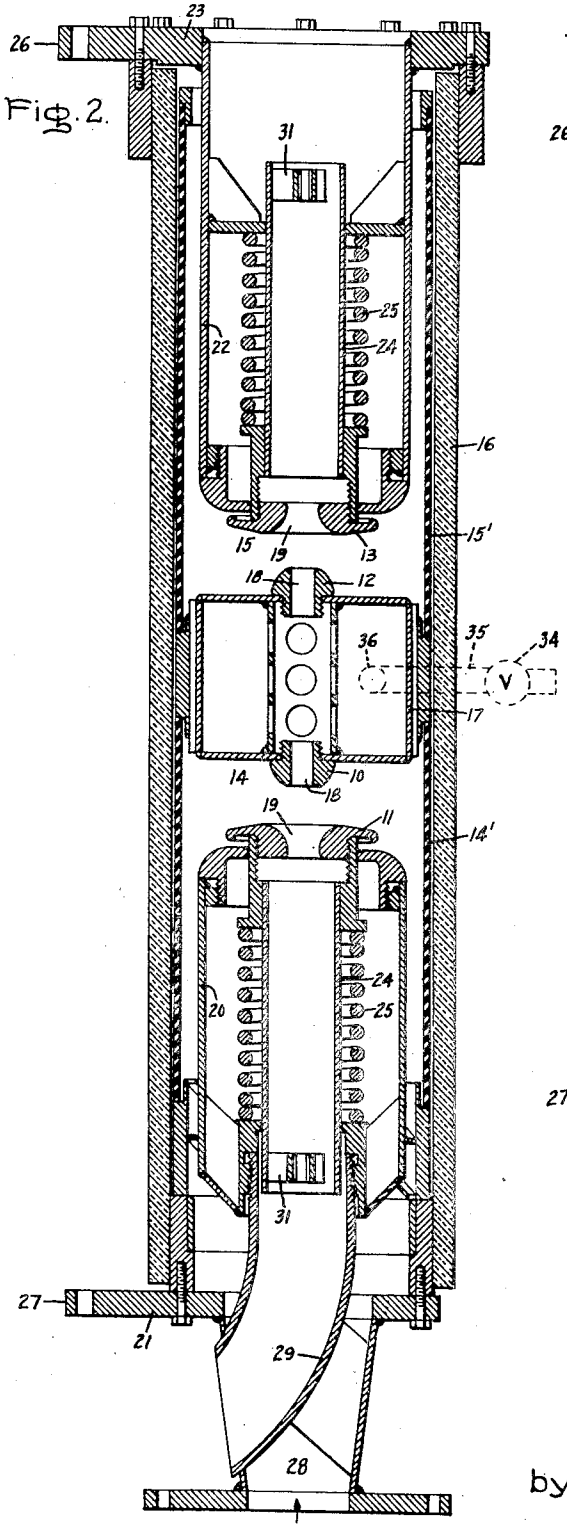
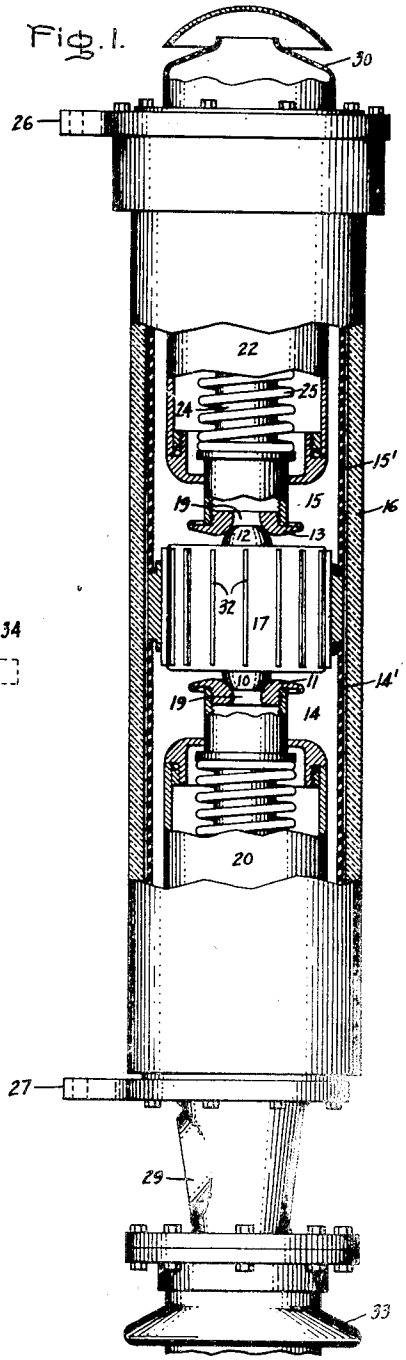


Fig. 1.



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2,440,995

ELECTRIC CIRCUIT BREAKER

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2 Claims. (Cl. 200—148)

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My invention relates to high voltage electric circuit breakers, and more particularly to circuit breakers of the fluid or gas blast type having separable contacts between which a blast or gas or fluid is directed for extinguishing arcs. Specifically, my invention is an improvement on Rankin Patent 2,306,186, granted December 22, 1942, and assigned to the same assignee as the present application.

The interruption of a high voltage power circuit such as for example, a 138 kv. circuit by means of a gas blast involves a number of difficult problems due to the limited dielectric strength of gases (such as air) most commonly used. A few years ago oil circuit breakers were almost exclusively used for such interrupting duty since the dielectric strength of oil is many times that of air. Accordingly, when the arc is extinguished at current zero by the oil circuit breaker the intervening oil dielectric is much better able to withstand the returning recovery voltage than air. Re-establishment of the arc, therefore, does not occur and the circuit remains open. Air, on the other hand, may be so stressed by the recovery voltage across the interrupting gap that breakdown occurs. The power arc is thereby reignited and failure of the breaker results.

It is known that the dielectric strength of a gas increases according to pressure increase. It is also known with respect to gases flowing through an orifice, that the velocity of flow through the orifice occurs at a so-called "critical velocity" so long as the back pressure at the orifice is not more than 53% of the source pressure. In the above mentioned Rankin patent effective use was made of these phenomena in that a back pressure in excess of 50% of the applied pressure is utilized with no appreciable decrease in the velocity of the gas through the nozzle. Consequently, the contacts are maintained within a reasonably high pressure atmosphere of gas furnishing a good dielectric to prevent the recovery voltage from causing restriking of the arc.

It is an object of my invention to utilize the advantages mentioned above and in addition provide a prolonged blast without requiring unduly large quantities of gas under pressure.

It is another object of my invention to provide a gas blast electric circuit breaker for high voltage alternating current circuit having a high operating efficiency based upon conservation of compressed gas and at the same time providing

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better interrupting characteristics at high voltages.

Further objects and advantages of my invention will become apparent as the following description proceeds and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In practicing my invention the alternating current gas blast circuit breaker may comprise a pair of relatively movable contacts between the arcing surfaces of which a gas blast is forced during separation of the contacts, the gas exhausting into a chamber which is efficiently closed for the arc interrupting period and is thereafter effectively open to atmosphere, the chamber being of such volume having regard to the pressure of the gas and the area of the opening into the chamber, that gas flows into the chamber at its "critical velocity" for a time period at least sufficient to secure arc extinction. By "critical velocity" I mean the maximum velocity at which gas will flow through an orifice across which exists a pressure difference, this velocity being substantially that of sound in air.

A gas blast circuit breaker according to the present invention may comprise relatively movable contacts each of which is provided with a central orifice for the passage of a gas blast during circuit interruption whereby the products of ionization of the arc drawn are swept away from the inter-engaging arcing surfaces, the orifice in one of the contacts leading freely to atmosphere, while that in the other contact leads to a closed or nearly closed chamber in which pressure due to the gas blast is built up during initial contact opening movement and is subsequently relieved by regurgitation when the gas supply is interrupted.

For a better understanding of my invention reference may be had to the accompanying drawing in which Fig. 1 is an elevational view, partly in section, of a high voltage electric circuit breaker embodying the present invention with the arcing contacts thereof shown in closed position, and Fig. 2 is an enlarged sectional view of a portion of the circuit breaker shown in Fig. 1 with the arcing contacts shown in a position assumed during a circuit interrupting operation.

Although my invention may be applied to a circuit interrupter having a single set of arc extinguishing contacts, I have chosen to illustrate my invention as applied to a circuit interrupter comprising two sets of arcing contacts arranged in series so as to form two breaks in series.

Referring now to the drawing, the high voltage circuit breaker comprises essentially two sets of relatively separable arcing contacts 10—11 and 12—13, respectively. These sets of contacts 10—11 and 12—13 are each suitably enclosed in an arcing chamber, the former in a chamber 14 and the latter in a chamber 15. Arcing chamber 14 is partially defined by a cylindrical wall of insulating material 14' while arcing chamber 15 is partially defined by a similar cylindrical wall of insulating material 15'. Cylindrical walls or members 14' and 15' are preferably enclosed in an outer insulating cylinder or housing 16, of weather-proof construction such as porcelain or the like. The contacts 10 and 12 are illustrated as identical in construction and furthermore are preferably stationary contacts suitably supported within their respective arcing chambers 14 and 15.

In accordance with my invention I provide a fluid storage or regurgitation chamber 17 in the form of a cylindrical housing suitably supported within housing 16, between members 14' and 15'. Chamber 17 defines the boundary between the two arcing chambers 14 and 15 containing the arcing contacts 10—11 and 12—13, respectively.

Preferably regurgitation chamber 17 supports each stationary arcing contact 10 and 12 within its respective arcing chamber, and furthermore provides the means by which these arcing contacts are electrically connected in series. In accordance with my invention communication between chamber 17 and each of the arcing chambers 14 and 15 is provided in the form of fluid passageways 18, one through each stationary arcing contact 10 and 12 which are illustrated as being arranged on the axis of housing 16.

The arcing contacts 11 and 13 which are substantially identical with each other, are illustrated as movable contacts of the retractable type. It should be understood, however, that stationary contacts 10 and 12 might also be movable contacts, and movable contacts 11 and 13 might be stationary contacts. The arrangement disclosed in the drawing is believed to be preferable since it does not necessitate movement of regurgitation chamber 17. Each of the movable contacts 11 and 13 is reciprocally movable along the axis of housing 16 and is provided with an orifice 19 symmetrical about this axis. As illustrated movable contact 11 is supported for reciprocal movement within a housing or enclosure 20 suitably supported from the lower end of insulating casing 16, as by a lower conducting support 21. Similarly, contact 13 is supported for movement in a housing 22 suitably supported from the upper end of housing 16 by upper conducting support 23. Within each enclosure or housing 20 and 22 there is provided a tubular member 24 coaxially arranged with respect to orifices 19 in arcing contacts 11 and 13, respectively. Arcing contacts 11 and 13 are guided for reciprocal movement as is clearly shown in Fig. 2 of the drawings, by tubular members 24 within enclosures 20 and 22, respectively.

A suitable spring 25 is provided within each of the enclosures 20 and 22 to bias arcing contacts 11 and 13 to the closed position indicated in Fig. 1. Preferably, the contact engaging portions of arcing contacts 10—11 and 12—13 are so arranged that the orifices therethrough are blocked by the interengaging faces of the contacts when in the closed position as indicated in Fig. 1. Arcing contact 13 is electrically connected by means of enclosure 22 and support 23 with an upper terminal 26 which may be suitably connected to an associated electric circuit. Arcing contact 11 on the other hand is electrically connected through its associated enclosure 20 and support 21 with a lower terminal 27. In view of the fact that the arcing contacts are normally biased toward the closed position by means of springs 25, it is desirable to provide a suitable isolating contact in series with these arcing contacts. In accordance with the disclosure of the above mentioned Rankin patent, the lower terminal 27 of my circuit breaker may conveniently form the stationary contact of a set of relatively movable isolating contacts. Since the construction of the isolating contacts form no part of my invention they have been omitted from the drawing, and in this regard reference may be had to the above mentioned Rankin patent.

A source of fluid under pressure (not shown) is preferably connected to a gas supply conduit 28 which enters the lower end of insulating housing 16. When gas under pressure is supplied to gas conduit 28 it flows into arcing chamber 14 around enclosure 20 and into arcing chamber 15 around regurgitation chamber 17. This gas under pressure impinges against the faces of retractable contacts 11 and 13 which are preferably arranged to have a greater diameter than the fixed contacts 10 and 12. Consequently, this pressure causes contacts 11 and 13 to retract against the force of their respective biasing springs 25 away from fixed contacts 10 and 12, whereupon two arcs in series are drawn one between contacts 10 and 11 and the other between contacts 12 and 13. Upon relative separation of the arcing contacts the orifices or openings 18 and 19 within these contacts are exposed and a blast of fluid under pressure is caused to flow through each of these orifices so as to subject the arc drawn to a strong arc-quenching influence. The blast of gas or fluid flowing through the orifices 19 in movable contacts 11 and 13 passes through tubular members 24 to atmosphere. Tubular member 24 associated with arcing contact 11 extends into a conduit 29 leading directly to atmosphere. Tubular member 24 associated with arcing contact 13 also opens directly to atmosphere. A suitable weather-proof cowl 30 (Fig. 1) prevents the interior of the upper portion of casing 16 from being exposed to the weather without interfering with the free venting to atmosphere of the gas blast flowing through orifice 19 in contact 13.

The blasts of gas to which the two arcs in series are subjected during a circuit opening operation might cause the two arcs to combine into a single long arc which may attach itself to extremity electrodes such as 31, one provided adjacent one end of each tubular member 24. Preferably extremity electrodes 31 may be provided with means for causing movement of the arc roots on the extremity electrode, which is illustrated as of the type disclosed and claimed in U. S. Patent 2,391,759, granted on an application filed by me and assigned to the same assignee as the present application. The provision of orifices in both fixed and movable contacts ensures minimum burning of the current carrying contact surfaces, for both arc roots of each series arc are instantly blasted well away from their points of origin at the line of contact and are driven effectively through the orifices 18 and 19. Because the arc roots are permitted no dwell on the metal constituting the interrupting nozzles, and due

to the total absence of vaporable insulating materials in the immediate vicinity, a minimum of products of vaporization is generated which might impede the rapid passage of arc extinguishing gas through the nozzles.

When gas under pressure is supplied to the arcing chambers 14 and 15, as mentioned above, causing relative separation of the serially arranged arcing contacts, the openings or passageways 18 in stationary arcing contacts 10 and 12 are uncovered and a portion of the blast of fluid flows through each of the passages 18 into regurgitation chamber 17. The volume of regurgitation member 17, the areas of the fluid passageways 18, and the pressure of the gas supplied to the arcing chambers 14 and 15 are so related that during the relatively short period of time required for the main blast of pressure fluid to extinguish the arc, and which may be of the order of three cycles of the alternating current producing the arc, exhaust pressure is not built up in the chamber 17 to cause the flow of pressure fluid through the orifices 18 to decrease below its critical value which, as previously mentioned, is the same as the velocity of sound. As is well known in the art, pressure on the exhaust side of an orifice or nozzle does not become back pressure effective to reduce the critical velocity flow through the orifice until it rises above a value approximating 53% of the entrance pressure. Therefore, by maintaining the velocity of the fluid flowing into the chamber 17 during the entire arcing period at the maximum value at which fluid can be delivered from the chambers 14 and 15 through the orifices 18, the process of storing the pressure fluid in the closed chamber 17 does not in any way impede the flow of fluid from the chambers 14 and 15 during the arcing period because the flow of fluid therefrom is exactly the same as though the orifices 18 connected these chambers directly to atmosphere. As soon as the circuit is interrupted and the supply of gas passing through supply conduit 28 is shut off, the gas under pressure stored in regurgitation chamber 17 is regurgitated through passageways 18 so as to produce a flow of gas in the reverse direction through passageways 18 which regurgitated gas blast flows through orifices 19 to atmosphere.

It now will be apparent that these regurgitated blasts of fluid surround the contacts with a high pressure dielectric to decrease the possibility of restriking of the arc and furthermore provide a prolonged blast which maintains the contacts open by using stored fluid which otherwise would be lost and which already has usefully contributed to the interrupting process. Since the orifices 19 are relatively large, the gas jets flowing from regurgitation chamber 17 may exhaust to atmosphere with no excessive back pressure so that retracting contacts 11 and 13 may vigorously and decisively reclose.

Regurgitation chamber 17 may be provided with suitable cooling fins 32 on the outside thereof to aid in cooling the gases which may be forced therein.

Preferably my improved circuit breaker is arranged to be vertically mounted as shown in Fig. 1 on a suitable insulator 33 through which supply conduit 28 may extend. It should be understood, however, that the housing 16 might equally well be mounted horizontally if it is so desired, or in some other suitable position.

In certain cases, as for example when instantaneous reclosing of the interrupting contacts

without isolating is required it may be desirable to provide means for dumping the fluid under pressure stored within regurgitation chamber 17 immediately after the circuit interrupting operation has been completed. Accordingly in Fig. 2 I have illustrated by dotted lines, a dumping valve 34 which may be connected by a conduit 35 with an opening 36 in regurgitation chamber 17. Suitable control means may be provided for valve 34 to cause it to open to atmosphere after the circuit has been interrupted.

Although I have disclosed my invention in connection with a circuit breaker employing a retractable arcing contact of the type disclosed in Biermanns Patent 2,084,885, it should be understood that it is also applicable to gas blast circuit breakers of the type disclosed and claimed in U. S. Letters Patent 2,284,842, Prince et al., assigned to the same assignee as the present application.

In view of the detailed description included above, the operation of the circuit breaker embodying my invention will be obvious to those skilled in the art. During the circuit interrupting operation a portion of the fluid blast is stored within regurgitation chamber 17. As soon as the circuit is interrupted and the supply of pressure gas stopped, regurgitation of the gas stored in chamber 17 takes place to provide a prolonged fluid blast adjacent the contacts without requiring any additional fluid from the source of gas under pressure.

It will be apparent to those skilled in the art that my invention is not limited to the particular construction shown, but that changes and modifications may be made without departing from the spirit and scope of my invention, and I aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a circuit interrupter, means defining a pair of substantially enclosed arcing chambers with a closed chamber interposed between said pair of arcing chambers, said closed chamber having a common wall between it and each of said pair of arcing chambers, a pair of relatively movable cooperating contacts in each arcing chamber comprising a movable contact having an opening therein extending between the interior and the exterior of the arcing chamber and a cooperating fixed contact mounted on the associated common wall and having an opening therein extending between the arcing chamber and said closed chamber, all of said openings being in alignment, means normally biasing each movable contact into engagement with its associated fixed contact to cover the openings therein so as to shut off communication between said openings and the interior of the associated arcing chamber, means for supplying a blast of arc extinguishing fluid into each arcing chamber, and means in each arcing chamber responsive to fluid pressure therein for moving the associated movable contact out of engagement with its cooperating fixed contact to establish an arc therebetween and to establish communication between the associated openings and the arcing chamber.

2. In a circuit interrupter, means defining a pair of substantially enclosed arcing chambers with a closed chamber interposed between said pair of arcing chambers, said closed chamber having a common wall between it and each of said pair of arcing chambers, a pair of relative-

ly movable cooperating contacts in each arcing chamber connected in series circuit relationship with said closed chamber, said pair of contacts comprising a movable contact having an opening therein extending between the interior and the exterior of the arcing chamber and a cooperating fixed contact mounted on the associated common wall and having an opening therein extending between the arcing chamber and said closed chamber, all of said openings being in alignment, means normally biasing each movable contact into engagement with its associated fixed contact to close the series circuit through said interrupter and to cover the openings in said fixed contacts so as to shut off communication between said openings and the interior of the associated arcing chamber, means for supplying a blast of arc extinguishing fluid into each arcing chamber, and means in each arcing chamber responsive to fluid pressure therein for moving the associated movable contact out of engagement with its cooperating fixed contact to establish an arc therebetween and to establish communication between the associated openings and the arcing chamber.

THOMAS W. WILCOX.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,947,224	Paul	Feb. 13, 1934
1,981,404	Whitney et al.	Nov. 20, 1934
2,084,885	Biermanns	June 22, 1937
2,125,525	Thommen	Aug. 2, 1938
2,144,372	Haller et al.	Jan. 17, 1939
2,160,673	Prince	May 30, 1939
2,303,825	Cox	Dec. 1, 1942
2,304,529	Baker	Dec. 8, 1942
2,306,186	Rankin	Dec. 22, 1942
2,306,242	Bartlett	Dec. 22, 1942
2,313,159	Ludwig et al.	Mar. 9, 1943

FOREIGN PATENTS

Number	Country	Date
480,405	Great Britain	Feb. 22, 1938