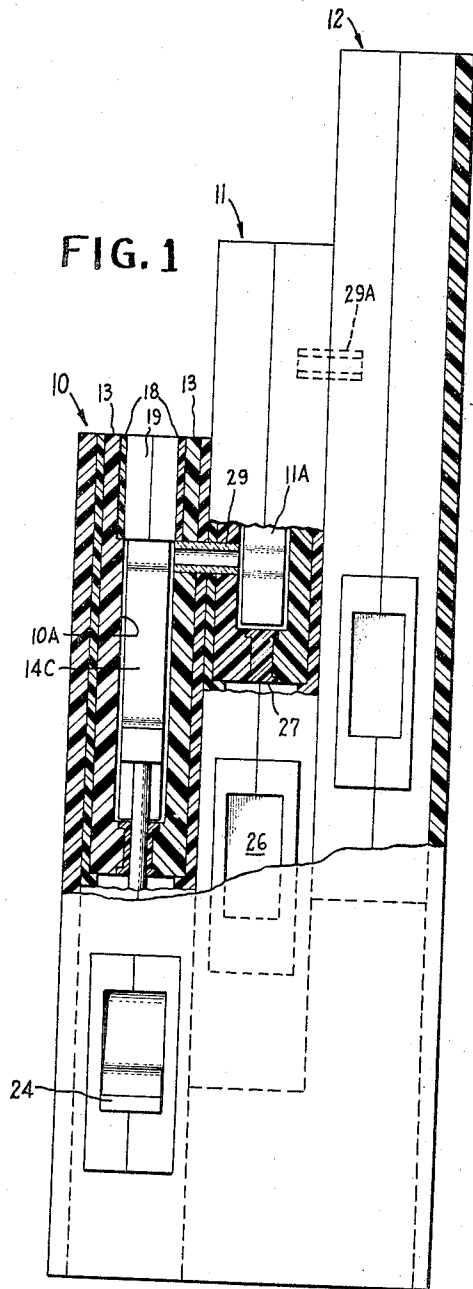
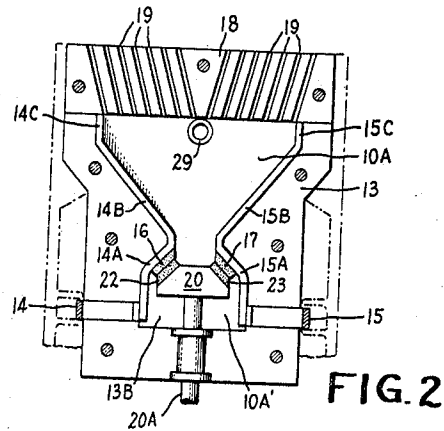
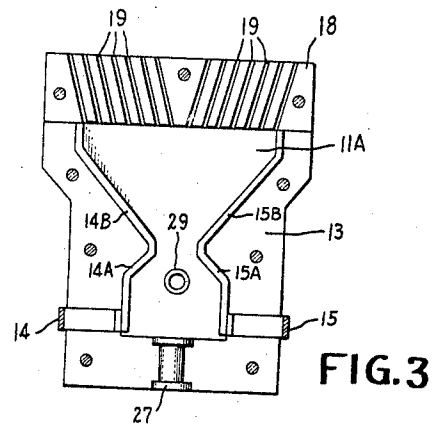
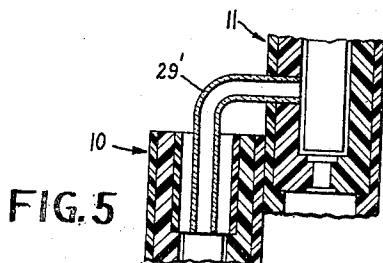
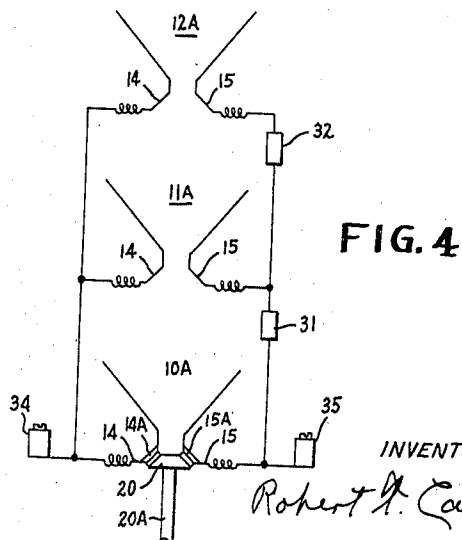


Jan. 13, 1970

R. T. CASEY
MODULAR TYPE MULTI-STAGE INTERRUPTER WITH IONIZED GAS
ASSISTING IN BREAKDOWN AND EVENTUAL ARC EXTINCTION
Filed Sept. 22, 1967

3,489,872



INVENTOR

Robert T. Casey

1

2

3,489,872

MODULAR TYPE MULTI-STAGE INTERRUPTER WITH IONIZED GAS ASSISTING IN BREAK- DOWN AND EVENTUAL ARC EXTINCTION

Robert T. Casey, Southington, Conn., assignor to Gen-
eral Electric Company, a corporation of New York

Filed Sept. 22, 1967, Ser. No. 669,942

Int. Cl. H01h 33/76, 9/30

U.S. Cl. 200—144

9 Claims

ABSTRACT OF THE DISCLOSURE

A circuit interrupter having a first arc chamber in which an arc is generated by a moving contact and elongated upon diverging arc runners; the gases from the interruption are vented to the external air, but a small portion of the gases is also directed into a second arc chamber having a pair of spaced electrodes connected electrically in parallel with the first contacts and having a second pair of diverging arc runners; when the arc has been drawn and elongated in the first chamber, creating a high voltage drop thereacross, the gases deflected to the second chamber cause breakdown between the second electrodes; the second arc is also elongated on diverging arc runners and extinguished; each of the arc chambers is separately enclosed and forms a module such that one, two, three or more may be utilized, depending upon the voltage of the system involved.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to electric circuit interrupters of the type utilizing contacts operating in air or other dielectric gaseous media.

Description of the prior art.

Patent application No. 669,918 filed Sept. 22, 1967 by R. L. Hurtle discloses an electric circuit breaker in which an arc is initiated in a first chamber and then transferred to a second pair of electrodes in another chamber for further elongation and final interruption. Patent application No. 669,900 filed Sept. 22, 1967 by H. G. Willard discloses an improved form of such "multi-stage" interrupter in which the arc is not only initiated in the first chamber, but is elongated to a high voltage condition there and then its gases are used to trigger breakdown between a parallel connected set of electrodes, permitting further elongation and voltage development. In the Willard application, no voltage generation occurs in the first arc chamber prior to "triggering" of the second arc chamber. Thus no "voltage escalation" of the arc is achieved. In the Hurtle application, venting of the first arc chamber is impeded. Moreover, a very specialized casing is required for its use, making it relatively expensive.

OBJECTS OF THE INVENTION

It is an object of the present invention to provide a multi-stage interrupter of the general type shown in the aforementioned Willard and Hurtle applications which permits the first unit as well as succeeding units to operate in their best manner without venting being impeded by the succeeding stage.

It is a further object of the invention to provide a multi-stage interrupter of the type described in the aforesaid applications utilizing a plurality of assemblies of arc extinguishing units which may all be substantially identical, and of the type used for single pole circuit breakers, thereby greatly facilitating manufacture and assembly, and reducing cost.

SUMMARY OF THE INVENTION

In accordance with the invention in one form, a multi-stage circuit interrupter is provided including at least two separately enclosed arc interruption chambers. The first of these chambers contains a movable contact movable to generate an electric arc and means for elongating the arc to develop a high voltage thereacross; the second chamber contains a pair of spaced electrodes connected electrically in parallel with the contacts of the first chamber, including diverging arc runner portions for elongating the arc. The second arc chamber is positioned so that its electrodes at their closely spaced point are adjacent the widely spaced portion of the first arc chamber but are laterally spaced therefrom. The major portion of the arc gases from the first chamber accordingly may be vented therefrom without restriction. An insulating conduit of suitable refractory material leads from a point adjacent the output of the first arc chamber to the closely-spaced point of the electrodes of the second arc chamber, whereby a small portion of the hot arc gases emitted from the first arc interrupting chamber are deflected into the space between the second electrodes, causing breakdown and transfer of the arc thereto. Electrical resistive devices, which may be of the positive temperature coefficient of resistance type are preferably connected in series relation in the line connecting the second electrodes in parallel with the first electrodes. The invention will be more fully understood from the following detailed description, and its scope will be set forth in the appended claims.

BRIEF DESCRIPTION OF THE DRAWING

FIGURE 1 is a front elevation view of an electric circuit breaker constructed in accordance with the invention, portions of the top wall and insulating casing portions thereof being broken away to show the interior construction;

FIGURE 2 is a side elevation view of a first arc chamber portion of the circuit breaker of FIGURE 1, the side wall thereof nearest the observer being removed;

FIGURE 3 is a side elevation view of a second arc chamber portion of the circuit breaker of FIGURE 1;

FIGURE 4 is a schematic diagram of the electric circuit connections of the circuit breaker of FIGURE 1, and

FIGURE 5 is a fragmentary view of a modified arc chamber interconnecting means for the circuit breaker of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the drawing, the invention is shown as incorporated in a multi-stage electric circuit breaker comprising three main sections 10, 11, and 12.

Section 10 comprises a generally rectangular casing including insulating side walls 13 of suitable gas evolving material defining a first arc chamber 10A having supported therein a pair of terminal straps 14 and 15. The straps 14 and 15 have stationary contacts 16 and 17 respectively supported on intermediate portions 14A, 15A thereof. The straps 14 and 15 also include arc runner portions 14B, 15B diverging outwardly from each other and terminating in tip portions 14C, 15C. The arc chamber 10A is closed at the top by a baffle 18 of suitable material having angularly diverging slot-like openings 19 therein to permit the exhaust of arc gases.

A movable contact member 20 is supported in the arc chamber 10A carrying a pair of movable contacts 22, 23, cooperating with the stationary contacts 14A, 15A, respectively. A contact operating rod 20A is provided for operation of the contact member 20 by suitable means, not shown. It will be understood that any desired operating mechanism may be utilized to operate the movable contact member between open and closed circuit positions, includ-

ing if desired, means from moving the movable contact in either or both directions by solenoid action. In the form illustrated, a circuit breaker mechanism, not shown, is provided, which may be manually operated by means of the handle 24.

When the movable contact member 20 is moved from the closed position as shown in FIGURE 2 to the open position (i.e., downwardly as shown), a pair of short arcs are drawn between the corresponding movable and stationary contacts. These short arcs quickly blend together to form a single arc extending between the straps 14 and 15 at their narrowest point. This single arc is subsequently moved upwardly by action of the gases trapped in the contact chamber 13B, and also by its own magnetic blow-out action. The arc moves outwardly along the runners 14B, 15B to a final position between the tips 14C, 15C where it remains until extinguished, it being understood that a large quantity of extremely hot gases generated by the arc during its movement continue on and are vented through the openings 19.

The casing of the section 11 is substantially identical to that of the section 10, with the opening which is provided in the section 10 for the handle 24 being closed by a closure plate 26. The arc chamber 11A of the section 11 in the illustrated embodiment is identical to that described above in connection with section 10, excepting that the movable contact member 20 and its operating rod 20A are omitted, and the opening for the operating rod 20A is closed by a suitable closure plug of insulating material 27. Otherwise, similar numbers indicate similar parts.

An interconnecting conduit or pipe 29 of suitable refractory insulating material extends through aligned openings in the side walls of the chambers 10 and 11 and serves to interconnect the upper portion of the arc chamber 10A with the lower portion of the arc chamber 11A. Accordingly, when hot arc gases are generated in the arc chamber 10A, the greatest portion thereof are vented directly to the outer atmosphere through the openings 19, but a small portion thereof is also led to the chamber 11A in the space between the electrodes 14 and 15 thereof for a purpose to be described.

The third section 12 is identical to section 11 and is also connected thereto by a similar interconnecting conduit 29A.

The conductive straps 14 and 15 of each of the sections 10, 11 and 12 are connected electrically in parallel as indicated in the schematic diagram of FIGURE 4, there being resistors 31, 32 connected between the sections 10A and 11A and the sections 11A and 12A respectively as shown.

OPERATION

In operation, assuming the circuit breaker to be closed and conducting current, the primary current path, referring to FIGURE 4, is from incoming terminal 34 to the terminal strap 14 of the section 10 and stationary contact 14A and thence through the movable contacts and bridging contact member 20 to the stationary contact 15A and its supporting strap 15 to the outgoing terminal 35. When the movable contact member is moved toward open position, a pair of short arcs are drawn between the stationary contacts 14A, 15A and the corresponding movable contacts 22, 23. These short arcs quickly bridge together to form a single arc extending between the terminal straps 14 and 15. This arc is moved upwardly by the force of gases generated in the portion 10A' of the arc chamber 10A and also by its own magnetic action (which may be supplemented by magnetic blowout means if desired) until the arc reaches its final elongated condition at the ends 14C, 15C. The ionized gases generated by the arc in its movement to its elongated condition are for the most part blown out of the interrupting chamber 10A through the vent-openings 19. A small portion, however, are directed through the conduit 29 to the arc chamber 11A of the adjacent section 11.

Since there is a high voltage existing across the arc in its elongated condition, and since the terminal straps 14, 15 of the adjacent section 11A are connected electrically in parallel, this voltage appears between these electrodes of the adjacent chamber 11A. If the air in the space between the straps 14, 15, of the chamber 11A were to maintain good dielectric condition, no breakdown could occur therebetween. Because of the introduction of hot ionized gases through the conduit 29, however, the space between the electrodes 14, 15 in the chamber 11A becomes conductive, and breakdown occurs therethrough, the current then taking the path from the terminal 34 through the interconnecting lead to the terminal strap 14 of the chamber 11A to the terminal strap 15 thereof, through the resistor 31 to the outgoing terminal 35. Since this path by-passes the original arc position, the arc becomes extinguished in the chamber 11A, it being appreciated that the space in the chamber 11A has had good dielectric restored by reason of the generation therein of high dielectric gases from the side walls thereof by the action of the arc and simultaneous expulsion of arc gases. Following initiation of the arc in the chamber 11A, the arc is moved out along the runners 14 and 15 to an elongated condition thereby further increasing the voltage drop therethrough. In accordance with a preferred form of the invention, resistors 31 and 32 are made of high positive temperature coefficient of resistance material, whereby after a short period of conducting current therethrough their resistance increases substantially because of the flow of current therethrough, further increasing the voltage drop.

In systems of medium voltage levels, such as 600 to 2000 volts, only the first two stages of the interrupter may be necessary. For higher voltages, however, a third stage may be used, such as illustrated at section 12. A communicating conduit 29A is used to interconnect the arc chamber 11A with the arc chamber 12A so as to initiate breakdown between the electrodes 14 and 15 of the arc chamber 12A when the arc has been developed to its longest length by the section 11. This causes the circuit to take the path through the electrodes 14 and 15 of the arc chamber 12A and through both of the resistors 31 and 32 shown in FIGURE 4. By this means the arc drop may be "escalated" to extremely high values, such for example as 5,000 to 10,000 or more volts.

The invention has been shown as utilizing three identical insulating enclosures for the sections 10, 11 and 12 since this affords convenience and manufacturing advantages. It will be apparent, however, that the insulating material required in the second and third sections may be reduced by utilizing a casing only just large enough to enclose the respective arc chambers.

Referring to FIGURE 5, another embodiment of the invention is disclosed in which an ionized-gas conduit or pipe 29' is utilized which has a right angle bend therein so as to receive arc gases in the direction of main flow from the first arc chamber such as 10A and then direct these gases sidewise to adjacent arc chamber such as 11A. This form has the advantage of not requiring a hole through the side wall of the first arc chamber, since the conduit 29' may be positioned with its open end closely adjacent one of the openings 19 of the arc baffle member 18, thereby requiring no modification of the basic circuit breaker 10.

While a specific embodiment of the invention has been shown, it will be readily appreciated that many modifications thereof may be readily be made and it is therefore intended by the appended claims to cover all such modifications as fall within the true spirit and scope of the invention.

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

1. A multi-stage electric circuit interrupter comprising:
 - (a) an insulating casing having at least first and second arc chambers therein;

5

6

- (b) separable contact means in said first arc chamber for drawing an arc therein;
- (c) a pair of diverging arc runners in said first arc chamber having closely spaced end portions and widely spaced end portions for elongating said arc to increase the voltage drop therethrough;
- (d) a pair of spaced electrodes in said second arc chamber said electrodes having diverging arc runner portions having closely spaced end portions and widely spaced end portions;
- (e) means connecting said electrodes of said second arc chamber electrically in parallel with said arc runners of said first arc chamber;
- (f) conduit means extending between said first and second arc chambers from a position between said widely spaced end portions of said arc runners of said first arc chamber to a position between said closely spaced end portions of said electrodes in said second arc chamber.
2. A multi-stage electric circuit interrupter as set forth in claim 1 wherein said first arc chamber includes a series of arc venting openings disposed along a line extending between said widely spaced end portions of said arc runners, whereby most of the arc gases generated in said first arc chamber are discharged through said openings, and a small portion thereof are diverted to said second arc chamber to initiate breakdown of the air space between said electrodes in said second arc chamber.
3. A multi-stage electric circuit interrupter is set forth in claim 2 wherein said means connecting said electrodes of said second arc chamber to said arc runners of said first arc chamber include an electrical resistance device.
4. A multi-stage electric circuit interrupter as set forth in claim 3 wherein said resistance means comprises a high positive temperature coefficient of resistance type material.
5. A multi-stage electric circuit interrupter as set forth in claim 1 wherein said circuit breaker also includes a third arc chamber containing a pair of spaced electrodes having closely spaced portions and widely spaced portions, means electrically connecting said arc runners of said third chamber electrically in parallel with said arc runners of said second arc chamber, and ionized-gas conduit

means extending from said second arc chamber at a point adjacent said widely spaced portions of said runners of said second arc chamber to a point adjacent said closely spaced portions of said arc runners of said third arc chamber.

6. An electric circuit interrupter as set forth in claim 5 wherein said connections between said electrodes of said third enclosure and said electrodes of said second arc chamber include electrical resistance means.

7. An electric circuit interrupter as set forth in claim 6 wherein said resistance means comprise high positive temperature coefficient of resistance materials.

8. An electric circuit interrupter as set forth in claim 1 wherein said interconnecting means for said ionized gases comprises conduit means having a portion thereof extending in the same direction as the vents of said first enclosure and a second portion extending at an angle to said first portion.

9. An electric circuit interrupter as set forth in claim 1, said circuit breaker comprising a plurality of substantially identical generally rectangular insulating casing portions, each of said arc chambers being contained in a different one of said casing portions.

References Cited

UNITED STATES PATENTS

1,819,207	8/1931	Slepion	200—144
2,508,954	5/1950	Latour et al.	313—306 X
2,900,566	8/1959	Fischer	315—36
3,093,766	6/1963	Cobine	313—306 X
3,430,016	2/1969	Hurtle	317—11 X

FOREIGN PATENTS

25,287	12/1905	Great Britain.
991,926	5/1965	Great Britain.
199,715	12/1965	Sweden.

ROBERT S. MACON, Primary Examiner

R. A. VANDERHYE, Assistant Examiner

U.S. Cl. X.R.

200—145, 147, 168