CIRCUIT BREAKER WITH ELECTRODE DISPOSED BETWEEN AN INTERRUPTING DEVICE AND A CONTACT OPENING


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6 Claims. (Cl. 200—150)

This invention relates to electric circuit breakers for interrupting high voltage power circuits and more particularly to power circuit breakers having means for inserting an impedance in the circuit upon opening of the circuit breaker.

Heretofore it has been the practice to use impedance means to reduce or eliminate the switching overvoltage hazards in alternating current circuit, especially of high voltage. The isolation or disconnection of a capacitance load in 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 isolating such a capacitance load, interruption at the first current zero in the arc of the leading current is readily effected at a relatively small contact separation. 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, and the leading kva. of the load.

These circuit conditions are difficult if not impossible to control. Therefore, restriking in most breakers must be expected especially under severe operating conditions, and the circuit interrupting structures must operate efficiently under such conditions.

In accordance with this invention, a new and improved circuit interrupting structure is provided in which an arc interrupting blast chamber is immersed in an arc extinguishing liquid. The blast chamber comprises a plurality of barrier plates arranged substantially transversely of the longitudinal axis of the chamber, an arc passageway through the barrier plates extending longitudinally of the axis of the blast chamber, a plurality of venting passageways extending laterally of the arc passageway and another passageway or nozzle arranged in the wall of the chamber along the passageway forming an opening through which a movable contact may pass. Contacts are arranged to separate in the arc passageway to interrupt a power circuit. An arcing electrode is further arranged within the chamber between the barrier plates and the nozzle and comprises a disk arranged transversely to the axis of the chamber and provides a plurality of spaced finger like probes extending from the circumference of the disk toward the axis of the chamber and arc passageway. The probes are spaced apart from each other far enough to offer little resistance to the flow of liquid therethrough. A resistor is associated with the chamber and electrically connected between one of the contacts and the arcing electrode. Means are provided to separate the contacts so that the circuit through the contacts is interrupted while one of the contacts is moved through the probe electrode. The resistor is arranged to shunt the contacts upon current flow between the arcing electrode and the movable contact whereby the resistor is inserted in the circuit to be interrupted.

It is, therefore, one object of the present invention to provide a new and improved arc interrupting device of the blast chamber type inserting an impedance element in the circuit arranged to form an interrupting unit that is electrically efficient, simple and compact in construction.

Another object of this invention is to provide a new and improved arc interrupting device employing an impedance structure which is introduced into the power circuit by means of a power arc.

A further object of this invention is to provide a new and improved circuit interrupting device in which an auxiliary arc used to introduce an impedance in the power circuit to limit the arcing current is drawn in a chamber subjected to pressure.

Objects and advantages other than those above 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 arc interrupting devices shown in Fig. 1 and embodying the present invention;

Fig. 3 is an enlarged top view of the arcing electrode shown in Fig. 2; and

Fig. 4 is a sectional view taken along the lines IV—IV of Fig. 2.

Referring 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 1 is suspended from one line terminal of the circuit interrupter in a suitable tank 2 and submerged in a suitable insulating arc extinguishing fluid, such as oil. A conducting bridging bar 3 serves to connect electrically the arc extinguishing unit 1 with an identical unit 4 in a manner well known in the art. Supported on a cover 5 of the tank 2 are a pair of terminal bushings 6 and 7 (partially shown), to the lower ends of which are secured arc extinguishing units 1 and 4. The cross bar 3 is actuated reciprocally in the vertical direction by an insulating lift rod 8 to open and close the contacts of the arc extinguishing units 1 and 4.

Fig. 2 illustrates the internal construction of the arc extinguishing unit 1. Clamped to the lower end of a terminal bushing 6 is a conductive housing 11 which forms a conductive path between it and a movable contact 16. Contact 16 is arranged in a pressure chamber 41. In the closed circuit position, as shown in Fig. 2, the contact 16 engages a stationary or intermediate contact 13, the latter, in turn, engaging a rod shaped contact 14 secured to the extremity of the cross bar 3. Contact 14 is arranged in a pressure chamber 42. Contact 13 comprises two contact engaging surfaces. Contact 16 cooperates with one of the contact engaging surfaces to produce a first arc and contact 14 cooperates with the other of the contact engaging surfaces to produce a second arc.

A plurality of rocking finger contacts 15 rest against the upper end of rod shaped contact 16. Current is transferred from housing 11 to contact 16 through rocking finger contacts 15. This arrangement dispenses with braids or similar flexible conductors and also eliminates the necessity of the actuating means for the contact 16 for carrying current. In other words, there is a complete and desirable segregation of the current carrying function and the contact operating or actuating function.
In the closed circuit position of the interrupting unit 1, as shown in Figs. 1 and 2, the electric circuit there through comprises the terminal studs (not shown) in bushing 6, housing 11, under contact 19, movable contact 14, conducting cross bar 3, movable interrupting contact 14', and the right hand arc extinguishing unit 4 as in housing 11 to the terminal stud (not shown) in bushing 7.

Contact 16 is actuated by a lever 17 having an oblong hole 18 in one end thereof and adapted to be rocked about a stud 19. A pin 10 in rod 16 engages oblong hole 18 in lever 17. A cradle 20 is journalled to lever 17 by means of a pin 21 and biased downward by a spring 22. Cradle 20 supports rod 23 for the operation of a piston pump 12. Cradle 20 is adapted to be operated by an insulating operating tube or rod 25 which is turned in the closed position by the cross bar 3 of the circuit breaker. When cross bar 3 and operating rod 25 are raised or lowered, the cradle 20 is simultaneously raised or lowered and rocks about pin 21 relative to lever 17 simultaneously with its raising or lowering movement. The circuit breaker unit 1 may employ contacts 16 and 15 alone or in combination with spring actuated oil pump 12 for the interrupting currents and such low value of inductive currents as are not effectively interrupted by other types of devices.

A valve disk 27 is loosely mounted on rod 23 and biased against the piston 24 of pump 12 by a spring 25. Spring 25 is disposed between the valve disk 27 and a flange 29 secured to housing 11. The piston 24 is provided with a plurality of apertures 30 which form a passageway for oil flow under certain conditions between the upper and lower portions of the housing through piston 24. The apertures are controlled by disk 27.

During a circuit closing operation of the interrupter, the bridging contact member or bar 3 forces the operating rod 25 upward. Operating rod 25 in its upward movement rotates arcing contact lever 17 counterclockwise to cause contact 16 to engage the contact surfaces of the fixed contact 13. Rod 25 in its upward movement to closed circuit position pushes rod 23 upward against the biasing action of the spring biased piston 24 of pump 12.

The arc interrupting unit 1 utilizes two groups of barrier plate assemblies 35 and 36 of suitably shaped insulating plates which form part of the walls of the paths through which the arcs produced by contacts 16, 13 and 14 are drawn.

As shown in Fig. 2, an aperture 69 may be provided in plate 61 which separates the upper grid assembly 35 from the chamber 42 and particularly from the lower grid assembly 36. This aperture 69 may be omitted if it is desired to substantially completely isolate the upper chamber 41 from the lower chamber 42.

If aperture 69 is provided in plate 61 then the arc drawn between the contacts 16 and 13 may be called a pressure generating arc and the arc drawn between contacts 13 and 14 an interrupting arc. With aperture 60 in plate 61, piston 24 causes a first flow of fluid under pressure through the passageway 37, through the passageway 62 extending across the barrier plates of assembly 35. The passageway 62 extending across the barrier plates longitudinally of the axis of the interrupter. Piston 24 also causes a second flow of fluid under pressure through passageway 37, aperture 69 in plate 61, chamber 42 and into the barrier plate assembly 36. The first flow of liquid under pressure cools and extinguishes the pressure generating arc and the second blast of fluid under pressure cools and extinguishes the interrupting arc.

Each interrupting unit is provided with two parallel cylindrical resistor assemblies 45. The upper end of each resistor assembly 45 is conductively connected to the electrostatic shield 46. Shield 46 is conductively connected to housing 11 which in turn is conductively connected to the lower terminal end of the breaker bushing 6.

The lower end of each resistor assembly 45 is conductively connected to the lower electrostatic shield 47. Shield 47 is conductively connected to a nonconducting insulating disk like member 48 through a conductive circuit comprising bolts 49, plate 50, bolts 51 and ring support 52.

The disk 48 is arranged transversely to the longitudinal axis of chamber 42 housing the barrier plate assembly 36 and at one end thereof. The disk 48 may be provided with a plurality of spaced finger like probes 53 extending from the circumference of the disk toward the axis of chamber 42.

The lower end of the arc interrupting chamber 42 comprises an insulating nozzle 55 forming an opening 56. The arcing electrode 49 is secured within chamber 42 between the lower end of the barrier plate assembly 36 and the blast opening 56. The finger like probes 53 may be arranged to extend from the circumference of the disk toward the axis of chamber 42 in a common plane or in different planes. The probes are spaced apart far enough to offer negligible resistance to the flow of liquid from the barrier plate assembly 36 through the opening 56 upon the withdrawal of contact 14 completely through opening 56. Nozzle 55 is arranged to surround the movable contact 14 and to have slight mechanical clearance therewith.

When it is desired to open the electric circuit passing through the interrupter, or when overload conditions exist in the electric circuit controlled by the interrupter suitable operating mechanism (not shown) moves the insulating lift rod 8 to result in a downward movement of the conducting cross bar 3 and the movable contacts 14, 14'. The downward movement of cross bar 3 causes insulating operating rod 25 to rotate lever 17 clockwise about the pivot shaft 19 to draw an arc between contacts 16 and 13.

Substantially simultaneously therewith or with a slight delay the movable contact 14 separates from the intermediate or fixed contact 13 to draw an arc between contact 13 and 14. The downward movement of operating rod 25 causes the downward movement of piston 24 to move the oil within the pump cylinder 26. The oil, now under pressure within the pump cylinder 26 flows under pressure out of the cylinder 26 through passage 37, through the barrier plate stack 35 transversely of the longitudinal axis of the arc extinguishing unit 1, through the passageway 38 into chamber 39 and through orifice 40 to the inside of tank 2.

During the interruption of low currents, the operating rod 25 moves downward at some point in the circuit cross bar 3 to result in the lever rotating clockwise about point 19 to draw an arc between contacts 16 and 13. The rod 23 and piston 24 follow the downward movement of operating rod 25. Valve disk 27 closes apertures 30 and moves the oil in cylinder 26 into passageway 37. This action occurs during the interruption of low currents.

During the interruption of high current area, the pressure created by the arc drawn between contacts 16 and 13 may prevent the downward movement of the piston 24 and this, in turn, halts the downward movement of the rod 23. The cradle 20 then separates from rod 23.

When the pressure subsides within the barrier plate assembly 35 oil under pressure flows out through barrier plate assembly 35 to flush the region where the arc occurred between contacts 16 and 13. This scavenging action raises the dielectric strength of the oil in the barrier plate assembly 35 and prevents restriking between contacts 16 and 13 which would prolong the lasting time of the interruption. It also prevents premature breakdown of the contact gap during an immediately following closing operation.

The downward movement of contact 14 draws an arc in the barrier plate stack assembly 36 between contact 14 and the fixed contact structure 13. The arc drawn between contacts 13 and 14 breaks down a portion of the arc extinguishing liquid which surrounds the arc and saturates the barrier plate assembly 36. The barrier plate assembly 36 may be of the type shown and claimed.
Most of the disks shown in the barrier plate assembly 36 have three cutout sections 64, which sections are aligned in the stack to form longitudinal venting passages 65. As the contact passageway 32 extends downward through the barrier plate assembly 36, vents 66 arranged in a number of the barrier plates of assembly 36 extend laterally from the contact passageway 32 to the longitudinal venting passages 65 as shown in Fig. 3. Venting passages 65 communicate with a plurality of exhaust ports 67 provided in the insulating shell 68 forming a part of the structure of unit 1.

After interruption of the power arc in the circuit breaker during an opening operation, the arcing surface 33 of the movable contact 14 passes the arcing electrode 48 and then passes through nozzle 55. Part of the body of contact 14 moves through the nozzle during interruption of the power arc. Immediately after momentary interruption at a current zero the returning voltage between contacts 13 and 14 causes current to flow through the resistor assembly 45 because the voltage breaks down the gap at one or more of the probes 53 of arcing electrode 48 (due to the short gap between the electrode 48 and the body of contact 14 as compared with the main interrupting gap between surface 33 and contact 13). The resistor assembly 45 is thereby inserted in series with the power circuit through an auxiliary arc so that the resistance circuit now shunts the contacts 14, 16 and 13.

The magnitude of the arc current is correspondingly decreased by the resistance and the difficulty of completely interrupting the current is greatly diminished, particularly in the case of circuits having high rates of interruption of the recovery voltage and also in the case of capacitance switching. The ohmic value of the resistance 45 depends on the characteristics of the circuit to be controlled.

The purpose of this invention is to provide a resistance inserting probe electrode that is particularly adaptable to the newer types of oil fluid pressure interrupting devices as shown in U. S. Patent 2,467,542. In the device shown in this patent the arc must be extinguished in the upper portion of assembly 36 to assure the normal interrupting time of five cycles for this circuit breaker.

Such quick extinction of the interrupting arc is accomplished by inserting the movable arc extinguishing electrode or blast chamber immersed in said liquid, cooperating fixed and movable contacts comprising arcing surfaces separable in said chamber to interrupt the circuit, said chamber comprising a nozzle shaped opening for said movable contact, an arcing electrode arranged within said chamber and comprising a plurality of finger like probes extending toward the axis of said chamber, a resistor associated with said chamber and electrically connected between said fixed contact and said electrode, and means for separating said contacts so that the circuit through said contacts is interrupted while said movable contact is moved through said opening, said movable contact's arcing surface passing said arc extinguishing electrode before passing through said opening, said resistor being arranged to shunt said contacts upon current flow between said arcing electrode and the body of said movable contact forming a part of the interrupting arc.

It is claimed and desired to secure by Letters Patent:

1. An electric circuit breaker comprising an insulating arc extinguishing liquid, an arc interrupting blast chamber immersed in said liquid, cooperating fixed and movable contacts comprising arcing surfaces separable in said chamber to interrupt the circuit, said chamber comprising a nozzle shaped opening for said movable contact, an arcing electrode arranged within said chamber and comprising a plurality of finger like probes extending toward the axis of said chamber, a resistor associated with said chamber and electrically connected between said fixed contact and said electrode, and means for separating said contacts so that the circuit through said contacts is interrupted while said movable contact is moved through said opening, said movable contact's arcing surface passing said arc extinguishing electrode before passing through said opening, said resistor being arranged to shunt said contacts upon current flow between said arcing electrode and the body of said movable contact forming a part of the interrupting arc.

2. An electric circuit breaker comprising an insulating arc extinguishing liquid, an arc interrupting blast chamber immersed in said liquid, cooperating fixed and movable contacts comprising arcing surfaces separable in said chamber along the longitudinal axis of said chamber to interrupt the circuit comprising a nozzle shaped opening for said movable contact, an arcing electrode arranged within said chamber comprising a disk arranged transversely to said axis of said chamber and providing a plurality of spaced finger like probes extending from the circumference of said disk toward said axis of said chamber, a resistor associated with said chamber and electrically connected between said fixed contact and said electrode, and means for separating said contacts so that the circuit through said contacts is interrupted while said movable contact is moved through said opening, said movable contact's arcing surface passing said arc extinguishing electrode before passing through said opening, said resistor being arranged to shunt said contacts upon current flow between said arcing electrode and the body of said movable contact whereby said resistor is inserted in the circuit to be interrupted.

3. An electric circuit breaker comprising an insulating arc extinguishing liquid, an arc interrupting blast chamber immersed in said liquid, cooperating fixed and movable contacts comprising arcing surfaces separable in...
said chamber along the longitudinal axis of said chamber to interrupt the circuit, said chamber comprising a nozzle shaped opening for said movable contact, an arcing electrode arranged within said chamber comprising a disk arranged transversely to said axis of said chamber and providing a plurality of spaced finger like probes extending in a common plane from the circumference of said disk toward said axis of said chamber, a resistor associated with said chamber and electrically connected between said fixed contact and said electrode, and means for separating said contacts so that the circuit through said contacts is interrupted while said movable contact is moved through said opening, said movable contact's arcing surface passing said arcing electrode before passing through said opening, said resistor being arranged to shunt said contacts upon current flow between said arcing electrode and said movable contact whereby said resistor is inserted in the circuit to be interrupted.

4. An electric circuit breaker comprising an insulating arc extinguishing liquid, an arcing interrupting blast chamber immersed in said liquid comprising a plurality of barrier plates arranged within said chamber substantially transversely of the longitudinal axis of said chamber and providing a passageway and a nozzle arranged at one end of said barrier plates forming an opening, cooperating fixed and movable contacts separable to draw an arc in said passageway to interrupt the circuit, an arcing electrode arranged within said chamber between said barrier plates and said opening and comprising a plurality of spaced finger like probes extending toward said axis of said chamber, a resistor associated with said chamber and electrically connected between one of said contacts and said electrode, and means for separating said contacts so that the circuit through said contacts is interrupted while said movable contact is moved through said opening, said nozzle surrounding said movable contact and having slight mechanical clearance therewith, said resistor being arranged to shunt said contacts upon current flow between said arcing electrode and said movable contact whereby said resistor is inserted in the circuit to be interrupted.

5. An electric circuit breaker comprising an insulating arc extinguishing liquid, an arcing interrupting blast chamber immersed in said liquid comprising a plurality of barrier plates arranged within said chamber substantially transversely of the longitudinal axis of said chamber and providing a passageway and a nozzle arranged at one end of said barrier plates forming an opening, cooperating fixed and movable contacts separable to draw an arc in said passageway to interrupt the circuit, an arcing electrode arranged within said chamber between said barrier plates and said opening and comprising a disk arranged transversely to said axis of said chamber and providing a plurality of spaced finger like probes extending from the circumference of said disk toward the axis of said chamber, said probes being spaced apart far enough to offer negligible resistance to the flow of liquid therebetween, a resistor associated with said chamber and electrically connected between said fixed contact and said electrode, and means for separating said contacts so that the circuit through said contacts is interrupted while said movable contact is moved through said opening, said nozzle surrounding said movable contact and having slight mechanical clearance therewith, said resistor being arranged to shunt said contacts upon current flow between said arcing electrode and said movable contact whereby said resistor is inserted in the circuit to be interrupted.

6. An electric circuit breaker comprising an insulating arc extinguishing liquid, an arcing interrupting blast chamber immersed in said liquid comprising a plurality of barrier plates arranged within said chamber substantially transversely of the longitudinal axis of said chamber and providing a passageway and a nozzle arranged at one end of said barrier plates forming an opening, cooperating fixed and movable contacts separable to draw an arc in said passageway to interrupt the circuit, an arcing electrode arranged within said chamber between said barrier plates and said opening and comprising a plurality of spaced finger like probes extending toward said axis of said chamber, a resistor associated with said chamber and electrically connected between said fixed contact and said electrode, and means for separating said contacts so that the circuit through said contacts is interrupted while the body of said movable contact is moved through said opening, said nozzle being arranged to shunt said contacts upon current flow between said arcing electrode and said movable contact whereby said resistor is inserted in the circuit to be interrupted, said arcing electrode being arranged in the helical flow of oil produced by the passage of liquid through said barrier plates.

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