May 21, 1968 E. O. MARX ETAL 3,384,724

CIRCUIT BREAKER WITH LIQUID ARC QUENCHING

Filed March 23, 1965

Fig. 1

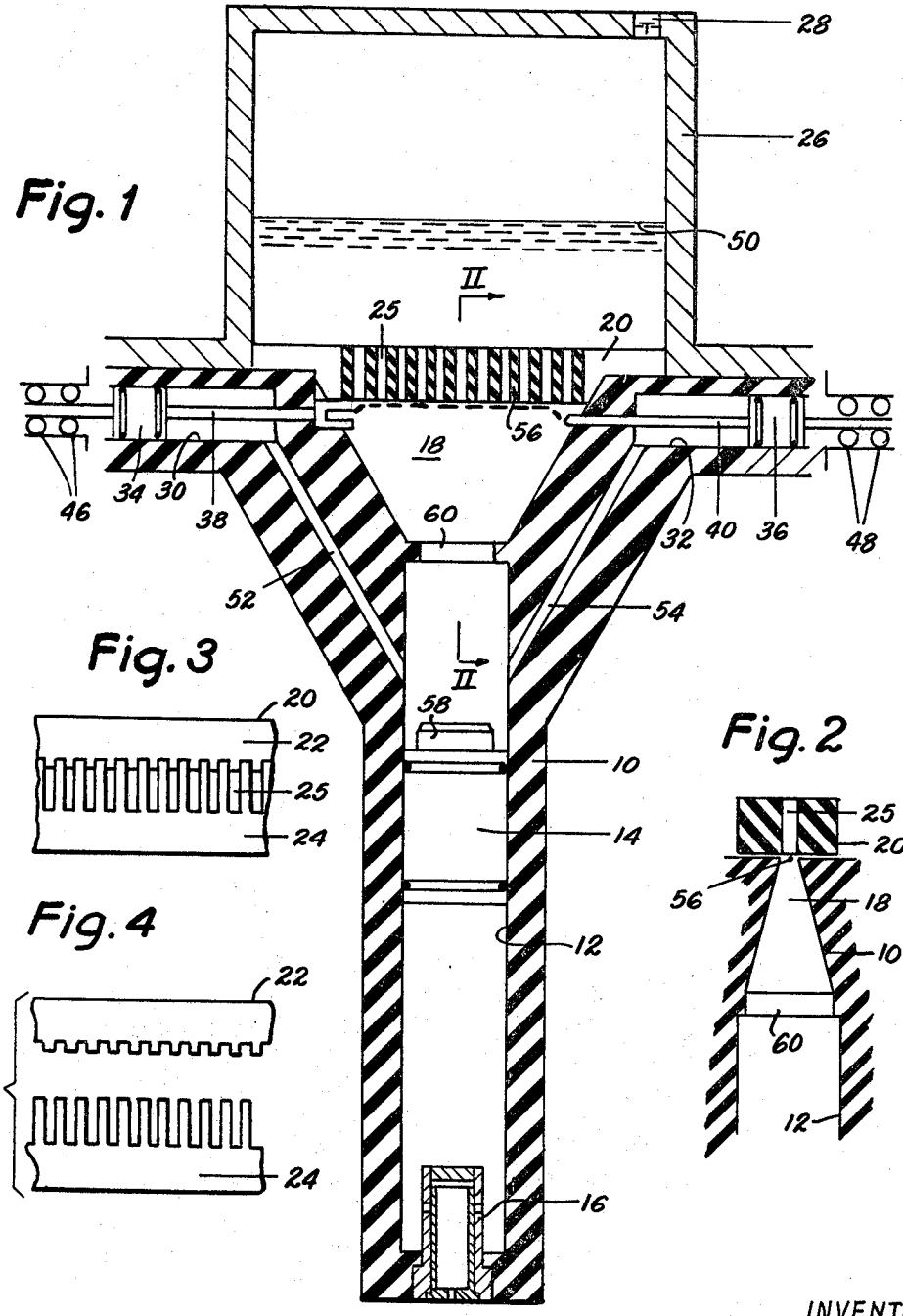

Fig. 3

Fig. 4

Fig. 2

INVENTORS
Erwin O. Marx, Rudolf E. Grosskopf
Wilfred Kruckewitt, Holger Ann,
Adil Erk, Ludwig Schmitz and
Klaus Mollenhoff
BY Toulmin & Toulmin
ATTORNEYS

United States Patent Office

3,384,724

Patented May 21, 1968

3,384,724

CIRCUIT BREAKER WITH LIQUID ARC QUENCHING

Erwin Otto Marx, Braunschweig, Rudolf Erich Grosskope, Wolfenbuttel, Wilfried Kruckewitt, Braunschweig, Holger Ann, Erlangen-Sieglitzhof, Adil Erk, Braunschweig, Ludwig Schmitz, Ratingen, and Klaus Mollenhoff, Dortmund-Derne, Germany, assignors to Erwin Marx, Braunschweig, Germany

Filed Mar. 23, 1965, Ser. No. 442,016
Claims priority, application Germany, Apr. 2, 1964, M 60,516; Feb. 13, 1965, M 64,158
6 Claims. (Cl. 200—150)

ABSTRACT OF THE DISCLOSURE

Circuit breaker in which current carrying contacts are moveable in separating direction in a narrow chamber and adjacent a grating while simultaneously cooling and quenching liquid is caused to flow through the chamber and grating in a direction transverse to the length of the arc drawn between the contact members as they separate.

The invention relates to an electric liquid switch or circuit breaker having an electric arc chamber and means for establishing a transverse current of quenching fluid in the chamber to extinguish the arc.

The object of this invention is to construct and improve the above mentioned kind of liquid switch so that it can be used as a high voltage switch, especially for direct current, and which, if used with alternating current, will effect a considerable shortening of the arcing time as compared with that of known AC high voltage switches.

The present invention solves this problem by providing a burning chamber with a narrow end space for the electric arc, said arc limited in the direction of movement by an arc-stopping grating of narrow mesh.

By the "narrow end space" mentioned above is meant a space which is laterally limited in such a manner that the electric arc cannot escape transversely to the direction of flow of the quenching fluid. Because of these lateral arc enclosures in combination with a current of quenching fluid, consisting preferably of oil, the electric arc is effectively cooled and during its entire time of burning, especially after its subsequent lengthening, is continuously brought into contact with fresh quenching fluid. In consequence of such quenching and lateral enclosure of the arc a previously unattained voltage gradient per unit of length of the arc is realized. The narrow mesh grating serves to limit the movement of the arc after it has become extended to its full length by contact with the grating and intense cooling by the quenching fluid is continued until the arc is completely extinguished. The arc is not to be permitted to strike through the grating and ignite on the outside thereof where it would largely escape from the restrictive effect of the grating and the cooling effect of the quenching fluid. Such a striking through of the arc is prevented by providing a grating with a suitable wall structure, in combination with devices such as cooling ribs on the outside of these walls.

Further objects and advantages of this invention may

become clear from an examination of the following figures which show particular embodiments of the invention and are not intended to limit the invention in any way.

The drawings show schematically different modifiications of this invention.

FIGURE 1 shows a schematic representation of the new switch having a horizontally positioned narrow mesh grating wall;

FIGURE 2 is a section along the line II—II of FIGURE 1; and

FIGURES 3 and 4 show details of the grating wall.

In FIGURE 1, 10 is a body of insulating material with a bore 12 in which piston 14 is reciprocably sealingly mounted. Piston propelling means, such as the explosive cartridge 16, is operable for impelling piston 14 upwardly in bore 12 when actuated.

Bore 12 at its upper end opens into a chamber 18 which tapers outwardly in the upward direction when viewed in one lateral direction (FIGURE 1) and tapers inwardly in the upward direction when viewed in another lateral direction at right angles to the first mentioned lateral direction (FIGURE 2).

The upper end of chamber 18 is in the form of an elongated slit-like opening and resting thereon is a grating 20 of insulating material that may be made up of the interfitting comb-like parts 22, 24 which are shown assembled in FIGURE 3 and disassembled in FIGURE 4. The grating has rather small passages 25 therethrough.

Above grating 20, is a chamber of reservoir 26, which is also preferably of insulating material. Reservoir 26 at the bottom freely communicates with the top of grating 20 and at the top has an outwardly opening check valve 28.

Body 10 has laterally aligned cylinders 30 and 32 in the upper portion thereof with metal pistons 34 and 36 reciprocably mounted therein.

Projecting from the ends of piston 34, 36 that face each other are the contact members 38, 40 which, when pistons 34, 36 move toward each other, will interengage in electrically conductive nature.

The contact members, or electrodes 38, 40 are disposed just beneath grating 20 so that an arc drawn therebetween when piston 34, 36 move apart and separate the contact members from each other will also be disposed just beneath the grating.

Wires or rods 42, 44 are connected to and project axially from the sides of the pistons 34, 36 that face away from each other and these wires or rods are engaged by metal guide rollers 46, 48.

Reservoir 26 contains oil, as indicated at 50. When contact members 38, 40 are engaged and piston 14 is at the bottom of bore 12, the oil level in reservoir 26 is preferably above the upper level of grating 20.

To open the switch while simultaneously extinguishing the arc drawn between the contact members 38, 40, the piston propelling means is activated. When the piston propelling means is an explosive cartridge, detonation thereof will impel piston 14 upwardly in bore 12. In any case, the piston is impelled upwardly in the bore rapidly and the liquid above piston 14 is displaced from the bore 12.

Part of the displaced liquid will pass through passages 52, 54 to the inner faces of piston 34, 36 and drive

the pistons away from each other toward their FIGURE 1 position and which will simultaneously cause contact members 38,40 to separate and move apart, also toward the FIGURE 1 position thereof.

Another part of the liquid driven from bore 12 by piston 14 moves upwardly through chamber 18 and through grating 20 into reservoir 26. This second part of the liquid drives the arc between contact members 38, 40; the arc being indicated by dashed line 56 in FIGURE 1 and by dot 56 in FIGURE 2, upwardly toward the bottom of grating 20 while simultaneously cooling the arc. In this manner the arc is extinguished very quickly and the circuit under the control of the switch is interrupted with corresponding quickness.

The upper end of piston 14 has a reduced diameter portion 58 which fits in a reduced diameter upper end portion 60 of bore 12 so that the piston is cushioned by the liquid in the upper end of the large diameter portion of bore 12 at the top of the piston stroke thereby preventing the piston from impacting with damaging force against the body 10 at the upper end of the piston stroke.

The new switch construction according to the present invention has an advantage in that the relatively narrow space for the electric arc in its final position, after the quenching, will be cooled and deionized by the continued flow of quenching fluid. A recommencement of the electric arc in AC switches after it has once been extinguished is prevented with certainty.

After studies, calculations and experiments, it was found that an important requirement is to provide a strong transverse flow of oil across the electric arc while it is in its final position. The velocity of the quenching fluid must be many times that heretofore used for quenching purposes if the desired average potential gradient of several thousand volts per cm. along the electric arc is to be reached. The switch of this invention is designed in such a manner that the oil flows through the narrow-meshed grating with a velocity greater than 25 m./sec.

Since the walls of the grating which come into contact with the electric arc are subjected to severe thermal stresses, it is advisable to form such walls of interchangeable and preferably separate parts. Such parts may be comb-like sections assembled to form gratings on the outlet side and if desired also on the inlet side of the burning chamber.

The grating walls or the built-in parts thereof can be formed advantageously of a gas-producing insulating substance whereby the useful life of such substance will be prolonged and the liberated gas will exert a cooling effect.

In order to expose the entire length of the electric arc to the quenching fluid and to spray it continually from the time it is first formed, the slot in which the arc is formed is designed to receive quenching fluid along the entire length of the arc and the conduit for delivering the quenching fluid is connected directly to the burning chamber.

It is advantageous to have the switch break contact directly in front of the narrow-meshed grating and to subject the electric arc in the slot of the burning chamber to a stream of quenching fluid until it has been extinguished so as to avoid the formation of excessive voltages.

With such an arrangement there will be no time required for bringing the electric arc into contact with the grating. The entire amount of quenching fluid will also be available for intense cooling of the electric arc and where the electric arc will be kept in the slot of the burning chamber by the flow of quenching fluid and will be surrounded on all sides by the flow of quenching fluid around it.

In order to make sure that the electric arcs are traversed by the quenching fluid and are pressed thereby into the narrow slots and against the grating walls from the time of their formation, it is important that the breaking of the contacts and the application of the quenching fluid should be effected simultaneously by the same actuating means.

It is important that the electric arc should be enveloped by the flow of quenching fluid during the entire burning time of the arc so that by intense cooling along the entire length of the arc, as high a voltage control as possible will be produced and maintained.

The electric arc always tries to avoid the current of quenching fluid and burn wherever it will not be exposed to the latter. In order to counteract this tendency of the arc, and especially to prevent the arc from leaning against the side of the slot, the walls of the latter are provided with transverse grooves extending to the grating. Since the arc will not follow the irregular contour of the grooves, it will remain in the middle of the slot, surrounded by the current of quenching fluid.

The piston by which the quenching fluid is put into motion can be actuated by an explosive or propulsion charge if the switch is to be opened as quickly as possible for interrupting the DC or AC current as quickly as possible.

For returning the opened switch parts to their closed position, rods and/or cables can be provided, and also control members such as valves which upon rearward movement of the quenching fluid piston permit fresh quenching fluid to enter the quenching fluid cylinder and the burning chamber.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

What is claimed is:

1. In a circuit breaker; a body with a chamber therein, contact members insulatingly supported by the body and moveable in the chamber from a first position of contact with each other to a second position of spaced relation to each other, port means for supplying quenching liquid to said chamber on one side of the line along which an arc will be drawn between said contact members upon separation thereof, a grating in said body on the opposite side of said line parallel to and adjacent said line, means for supplying quenching liquid via said port means to said one side of said chamber for flow therethrough and through said grating simultaneously with movement of said contact members in separating direction, said chamber on the said one side of said line tapering outwardly from said port means to the region of said line in the direction parallel to said line and tapering inwardly from said port means to the region of said line in the direction at right angles to said line.

2. A circuit breaker according to claim 1 in which said means for supplying liquid to said chamber via said port means comprises a bore in said body communicating with said port means, a piston in the bore moveable toward said port means for causing said supply of liquid to said chamber, piston impelling means for moving the piston in the bore toward said port means, and a reservoir communicating with the side of said grating which faces away from said chamber.

3. A circuit breaker according to claim 2 which includes a cylinder in said body into which each contact member extends, piston members in said cylinder substantially smaller in area than the said piston in said bore and connected to respective contact members, and passage means connecting said bore with said cylinders so that movement of the piston in the bore toward said chamber to displace liquid therethrough will cause a simultaneous supply of liquid to said cylinders to urge said piston members away from each other thereby to separate said contact members.

4. A circuit breaker according to claim 1 in which said grating is formed by a pair of interfitting comb-like members.

5. A circuit breaker according to claim 2 in which said piston is a free piston and said piston impelling means is carried by said body at the end of said bore which is remote from said port means and is operable for impelling the said piston in said bore rapidly toward said port means .

6. A circuit breaker according to claim 5 in which said piston impelling means is in the form of an explosive device which, upon detonation, impels said piston toward said port means.

References Cited

UNITED STATES PATENTS

2,345,724	4/1944	Baker et al.	200—148.3
2,655,578	10/1953	Sillers	200—144
2,668,217	2/1954	Vogelsanger et al.	200—150
2,709,735	5/1955	Phillips et al.	200—144
3,281,561	10/1966	Marx et al.	200—150

ROBERT S. MACON, *Primary Examiner.*