

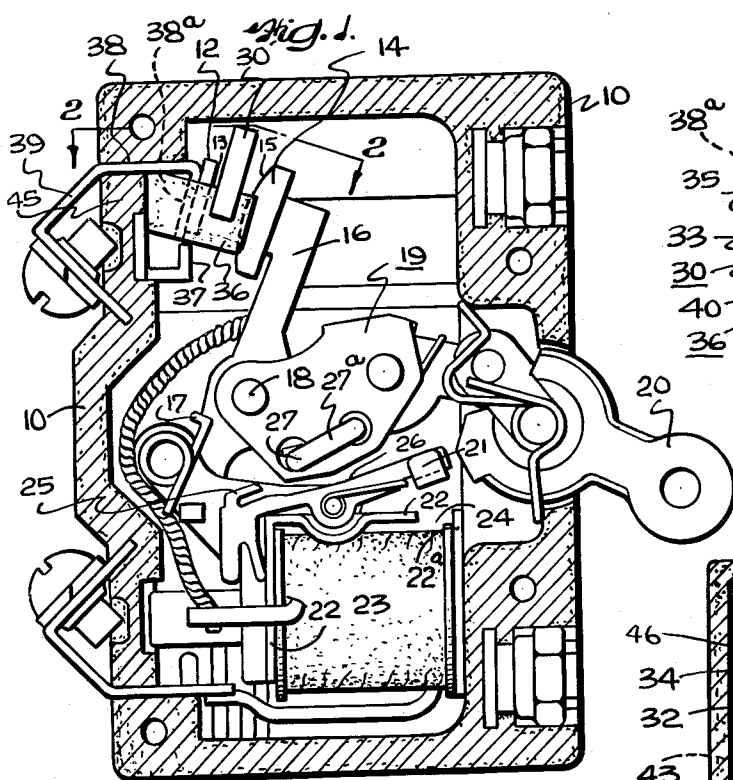
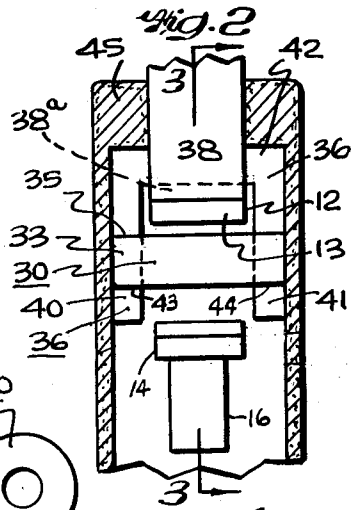
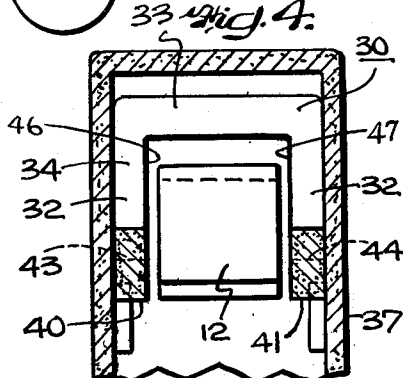
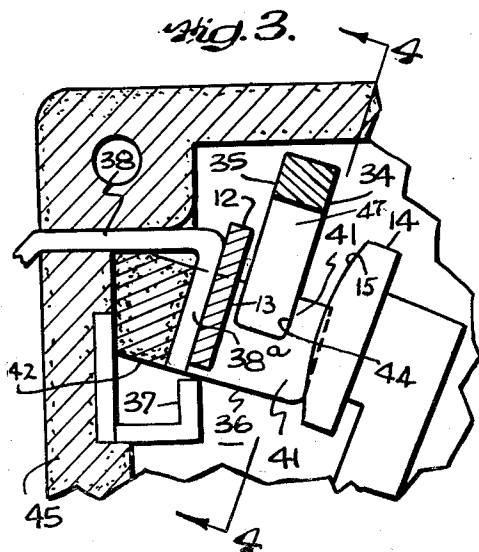
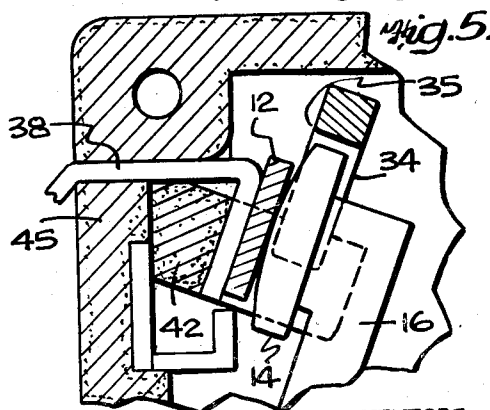
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INDUCTION BLOWOUT FOR CIRCUIT BREAKERS

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3,016,438 INDUCTION BLOWOUT FOR CIRCUIT BREAKERS

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This invention relates to electric circuit breakers and more particularly to an induction device for controlling the electric arcs that tend to arise between circuit breaker contacts.

It is an object of the invention to provide a device that will arrest the development of the arc that tends to form upon the opening of the contacts of a circuit breaker and to extinguish the arc before the arc has achieved a stable condition.

The arc which forms between contacts of a circuit breaker passes through several phases or stages before it becomes stable. Upon the initial separation of the contacts, the arc that occurs is characterized by a high current and a low voltage. At this time conduction in the arc is due to metal vapor expelled violently from both electrodes. During the next or second stage of the arc, conduction is due partially to vaporized metal and partially to an ionized column of air. With the passage of time and the increased separation of the contacts the arc resistance increases because of its increasing length. At this time the current is decreasing and the voltage is increasing. The second stage ends when the energy expended by the arc, which is a function of the current and voltage, attains a maximum.

The third and last stage of the arc starts as the energy expended by the arc starts to decrease from its maximum. In this stage, the arc, if not disturbed, becomes either stable or is extinguished if the voltage is less than that necessary to maintain it between the contacts. During this stage, the voltage is at its highest level, and the current is at its lowest. Electrical conduction at this stage is entirely due to a column of ionized air.

Heretofore, magnetic blowout of electrical arcs has concerned itself primarily with the extinguishment of an arc that has become stable between two contacts that have either (a) been separated their maximum amount or (b) separated for a long enough time to have allowed the arc to progress to the third stage.

The invention utilizes magnetic forces, induced in a magnetizable member straddling one of the contacts, prior to, during and after the start of abnormal current conditions that give rise to the separation of the contacts, for creating a field of magnetic flux having high magnetic potential and highly concentrated at the zone of initial separation of the contacts. Thus, upon contact separation strong magnetic forces exist which displace and disturb the incipient arc while it is in its first or second stage, causing a deterioration of conditions favorable to the emission of metallic vapors upon which the life of the arc initially depends thereby preventing the progression of the arc to its third or stable stage.

The existence of an arc after contact separation indicates that a large amount of power is being drawn and expended from the circuit to sustain the emission of metallic vapors from the contacts. Any device which minimizes the emission of metallic vapors will also be conservative of the power in the circuit. Therefore, it is a further object of the invention to minimize the quantity of power drawn from the circuit after contact separation.

Blowout means that are effective at sea level have frequently proved ineffective at the high altitudes of present day aircraft. A further object of the invention is to pro-

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vide an arc blowout device that is effective under varying atmospheric pressure conditions.

Another object is to provide magnetic blowout means that is effective in extinguishing the arc without the necessity of a vent from the inside to the outside of the circuit breaker, thus allowing the mechanism to be hermetically sealed.

A still further object of the invention is to reduce the size, cost and complexity of the magnetic arc arresting device from those heretofore used so as to allow the circuit breaker to be small in overall size.

The foregoing and other objects of the invention, the principles of the invention, and the best mode in which I have contemplated applying such principles will more fully appear from the following description and accompanying drawings in illustration thereof.

In the drawings:

FIG. 1 is a side view of a circuit breaker mechanism embodying the invention, the circuit breaker being shown in vertical section, and the circuit breaker mechanism being in the tripped open or disengaged position of the contacts.

FIG. 2 is a top plan, fragmentary view, partly in section, taken along the line 2-2 of FIG. 1;

FIG. 3 is a fragmentary, enlarged, cross-sectional view of the contacts portion of the circuit breaker;

FIG. 4 is a view, partly in section, taken along the line 4-4 of FIG. 3; and

FIG. 5 is a fragmentary view similar to FIG. 3 but illustrating the contacts in the closed or engaged position.

The invention is embodied in a circuit breaker comprising an outer insulating casing 10 enclosing a stationary contact 12, having a flat contact face 13, and a movable contact 14, having a curved contact face 15.

The action of the movable contact on predetermined overload is fully set forth in Patent No. 2,360,922 and such mechanism therefor does not form part of the invention but for clarity's sake may be briefly described as follows: The movable contact 14 is carried on the end of an arm 16 which is biased by a spring 17 toward open position of the contacts. The arm 16 is connected by a pintle 18 to latching mechanism 19 which is in turn connected to a handle 20. When the handle 20 is rotated counterclockwise, as viewed in FIG. 1, the latching mechanism 19 and the arm 16 all move to the left and bring the contact 14 into engagement with the contact 12 against the bias of the spring 17, the contacts 12 and 14 assuming the position illustrated in FIG. 5. Upon the occurrence of an overload condition, the armature member 21 is magnetically attracted toward the gap 24 located between the L-shaped permeable frame member 22 and the permeable pole piece 22a both of which form part of a magnetic flux circuit generated by the solenoid 23, with which the permeable members are associated. The movement of the armature 21 into the gap 24 between the permeable members 22 and 22a causes the oppositely extending member 25 mounted on the bar 26, which also carries the armature, to move upwardly and trip the arm 27 forming part of the U-shaped pintle 27a so that the latching mechanism 19 is free to collapse under pressure from the spring 17. When the contacts 12 and 14 are engaged the arm 27 is located immediately above the unlatching member 25.

To prevent the arc that tends to form between the contact faces 13 and 15 whenever the movable contact 14 is moved away from the stationary contact 12 under overload conditions or to quench the arc that may have already been initiated by the movement of the movable contact under overload conditions, I provide a U-shaped magnetizable member 30, preferably made of iron, which has a pair of legs 32 connected by a bight 33 at substantially right angles to the legs 32. The legs 32 and bight

33 are of the same cross section and have coplanar surfaces defining front and back faces 34 and 35 lying between the planes of the contact faces 13 and 15 when the circuit breaker is fully open, FIGS. 1 and 3. The induction member 30 is supported by an insulating member 36 which is supported by a boss 37 projecting from the casing 10 and held in place by the horizontal portion 38 of a terminal member 39 and the inclined lip 38a, to the front of which the contact 12 is secured. The insulating member 36 has a pair of arms 40 and 41 which extend from a cross member 42 beyond the stationary contact 12, the member 42 having a wedge shape as viewed in FIG. 3. Apertures 43 and 44 in the arms 40 and 41 receive and hold the ends of the legs 32 of the member 30. The insulating member 36, made of alkyd resin or the like, is snugly fitted against the vertical end wall 45 of the casing 10 by the lip 38a.

The legs 32 extend beyond the vertical mid point of the contact faces 13 and 15. The inner opposing faces 46 and 47 of the legs 32 are spaced but far enough apart to permit free passage of the movable contact 14 therebetween. Thus, the reluctance losses between the legs 32 are held to a minimum. The magnetic flux is concentrated adjacent the pole faces and in that area of the pole faces from which an arc would be pulled, the legs 32 having a thickness, along the path of travel of the movable contact 14, substantially less than the full travel of the movable contact 14 between open and closed position.

When the contacts are in the closed position, FIG. 5, and the circuit breaker is energized by the circuit to be protected, a magnetic field is induced in the magnetizable member 30 at all times due to the current passing through the contacts 12 and 14. The strength of this induced magnetic field is directly proportional to the amount of current passing through the circuit breaker. Upon the occurrence of a heavy overcurrent, for instance a short circuit, the strength of the magnetic field will be greatly increased so that a field of high flux value and high magnetic potential exists when the contacts are opened by the collapse of the linkage 19 and the bias of the spring 17.

As observed, the rear face 35 of the induction member 30 is located to the right (as viewed in the illustration) of the contact face 12 so that upon the opening of the contacts the flux of the magnetizable member is concentrated on the space and the arc, if any, between the stationary and movable contacts and immediately adjacent the face 13 of the stationary contact 12. Once the contacts separate some magnetic induction is received from the arc itself (and from the movable contact 14 while moving through the legs 32) but the energy stored in the magnetizable member 30 prior to the opening of the contacts 12 and 14 is vastly greater than that received thereafter from the arc and the movement of the movable contact.

The high magnetic potential alters the flux path from the circular path during induction (prior to contact separation) to the familiar horseshoe pattern between the ends of the legs 32 thereafter. This path persists until the stored magnetic energy in the magnetizable member is dissipated and generally outlives the flux induced by the arc and the contact 14 after contact separation.

Preferably the magnetizable member 30 is formed from a material that retains substantially no residual magnetism so that all or substantially all of the magnetic flux applied to the arc is due to the magnetism induced by the current passing through the movable contact 14.

From the foregoing it is seen that the magnetic flux of the magnetizable member 30 is concentrated on the initial opening between the contacts because the thickness of the legs is less than the distance between contacts 12 and 14. This high flux concentration or density causes a deterioration of conditions favorable to the emission of metallic vapors upon which the arc depends during the first and second stages, as previously described, by magnetic displacement and disturbance of the arc. The rate

of dispersion of the arc is such that the dielectric recovery of the arc is faster than circuit voltage recovery and the arc is extinguished before the energy of the arc attains the maximum value that it would otherwise.

In those instances when the voltage is sufficiently high to cause the arc to be drawn between contacts that have been separated their full distance the life of the arc will be of short duration because the displacement and disturbance that takes place prevents the necessary vapor emission to support the necessary current needed in the initial stages of the arc. Thus, even if the arc is fully drawn the high flux density concentrated on a part of the arc that is in the first or second stages impairs the vapor emission necessary for progression of the arc to its third stage and, hence, prevents the arc from ever becoming stable.

Having described my invention, I claim:

1. A circuit breaker having means for quenching arcs occurring between a stationary contact member and a movable contact member upon disengagement of the same on overload current, said contact members including portions less than the total contact areas from which arcs tend to be drawn, said means including a magnetizable member supported by means extending from one of said contact members and positioned in juxtaposition to the other of said contact members during engagement of said contact members, said magnetizable member having a width greater than the width of said contact faces and a length to define the densest magnetic flux field across only said portions of the contact members from which arcs tend to be drawn, said magnetizable member retaining substantially no residual magnetism after extinguishment of an arc, and said magnetizable member being disposed intermediate said contact members when fully separated.

2. In a circuit breaker, the combination of stationary and movable contact members having abutable faces, means for moving said movable contact member relative to said stationary contact member, said contact members including portions less than the total face areas from which arcs tend to be drawn, and an inductive magnetizable member wholly intermediate said contact members when said contact members are fully disengaged, said magnetizable member straddling one and not the other of said contact members when the contact members are fully engaged, said magnetizable member having a wall dimension along the path of movement of said movable contact which is less than the distance said movable contact member moves from the fully engaged position to the fully disengaged position, said magnetizable member defining the densest magnetic flux field across the parts of the contact members from which arcs tend to be drawn after initial separation of the contact members for concentrating the magnetic field to extinguish the arcs that tend to be drawn upon disengagement of said contact members, said magnetizable member being disposed to one side only of the contact member which is not straddled when the contact members are fully engaged and said wall dimension extending toward the other contact member when the latter is disengaged.

3. The combination set forth in claim 2 wherein the spacing between said magnetizable member and the edge of the movable contact member is the minimum amount necessary for relative movement there between, said magnetizable member retains substantially no residual magnetism after extinguishment of an arc drawn between said contact members, wherein a magnetic field is induced in said magnetizable member by the passage of current through said contact members, said magnetic field being proportional to the current passing through said contacts, said magnetizable member includes a surface that is immediately adjacent the surface of said stationary contact for concentrating the magnetic field upon incipient arcs, and said magnetizable member having a U-shape.

4. A circuit breaker comprising a housing, separable stationary and movable contact members, said stationary

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contact member including a face and supported within said housing, said movable contact member being controlled by an electro responsive mechanism, said movable contact member including a face engageable with the stationary contact face, said contact faces including portions less than the total face areas from which arcs end to be drawn, a magnetizable member, said magnetizable member being supported within said housing in a position to straddle neither of said contact members when said contact members are fully separated and only the movable contact members when said contact members are fully engaged, and said magnetizable member having one plane immediately adjacent the stationary contact face and another plane substantially spaced from the movable contact face when the contacts are fully disengaged said magnetizable member defining a magnetic flux field the densest part of which overlies only the part of the stationary contact member from which arcs tend to be drawn.

5. In a circuit breaker, the combination of stationary and movable contact members, a housing enclosing said contact members, a U-shaped insulator support, said U-shaped support having its base behind the stationary contact face and its legs extending generally parallel to the path of movement of the movable contact member, a magnetizable U-shaped member supported by said U-

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shaped insulator immediately adjacent to the stationary contact face, said magnetizable member lying wholly intermediate the stationary and movable contact faces when said faces are fully disengaged, and said magnetizable member having a wall dimension along the path of movement of said movable contact which is substantially less than the distance the movable contact traverses, said magnetizable member defining a flux field having its densest part overlying the portion of the stationary contact from which arcs tend to be drawn for concentrating the magnetic field induced in said magnetic member within a restricted space upon the initial separation of the contact members.

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