ABSTRACT: A circuit maker and breaker has a removable arc chute for interrupting an arc formed between the movable and stationary contacts and interlock means to prevent operation of the contacts when the arc chute is removed to thereby prevent damage to the contacts.
INTERLOCK BETWEEN CONTACTOR AND ARC CHUTE

This invention relates to circuit makers and breakers and in particular to high-current capacity circuit makers and breakers having an arc-extinguishing chute to interrupt the current.

Circuit interrupters of high-current capacity such as direct current contactors often have an arc-extinguishing chute which is removable to permit inspection, maintenance and repair. If the contactor is operated when the arc chute is removed from or is improperly assembled on the contactor, the contactor contacts can be eroded and damaged if they operate under overload conditions without the arc-extinguishing chute.

It is an object of the invention to provide a circuit maker and breaker having a removable arc chute and an interlock to prevent operation of the circuit maker and breaker when the arc chute is removed.

This and other objects and advantages of the invention will be more readily apparent from the following detailed description when considered in conjunction with the accompanying drawing wherein:

FIG. 1 is an elevation view of a direct current contactor embodying the invention, one wall of the arc chute being removed to illustrate the internal construction and the insulating base and the magnetic core of the blowout coil being shown in section;

FIG. 2 is a view taken at right angles to FIG. 1 with a portion of the arc chute cut away;

FIGS. 3 and 4 are enlarged partial views similar to FIG. 1 respectively representing the arc chute in solid lines when properly assembled on the contactor and in dot-dash lines when improperly assembled or removed; and

FIGS. 5 and 6 are front and side views respectively of the arc chute interlock spring contact.

A direct current contactor 10 embodying the invention has a U-shaped ferromagnetic frame 11 which embraces a cylindrical electrical operating coil 12 wound in surrounding relation to a ferromagnetic core 14 extending axially of coil 12. A ferromagnetic armature 16 pivotally connected to one leg 17 of U-shaped frame 11 is pulled against the other leg 18 of frame 11 when coil 12 is energized. Armature 16 is preferably split into two parts 19 and 20 (FIG. 2) to create a high-reluctance path between the two parts in the manner disclosed in U.S. Pat. No. 3,238,326 to Robert J. Frey having the same assignee as this invention.

The contactor movable contact 21 is rigidly secured by screws 31 to a cross section bus bar conductor 22 mounted on armature 16. A U-shaped clamping plate 23 fits over bus bar conductor 22 and has laterally projecting ears 24. An insulating member 25 is disposed between conductor 22 and armature 16, and headed pins 26 extend through clearance holes in armature 16 and in the ears 24 of clamping plate 23. Springs 27 surrounding pins 26 react between the ears 24 and snap rings affixed to the end of pins 26 to mount conductor 22 on armature 16, and springs 27 are compressed after the contactor stationary and movable contacts 49 and 21 engage, when armature 16 is attracted to frame 11, and provide part of the restoring force which returns armature 16 to its open position.

One end of a pair of flexible conductors 28 that carry the load current which the contactor interrupts is clamped within a U-shaped opening 29 at the end of bus bar conductor 22 opposite movable contact 21. The opposite ends of the flexible conductors 28 are clamped between a clamp 30 on an interlock support frame 31 and a metallic terminal block 32 by means of screws 33. Terminal block 32 may be affixed to frame 11 by screws 34, and a connector 35 is clamped to lead 36 from a source of electrical current may be fastened to terminal block 32 by screws 37.

Frame 11 is affixed to an insulating base 39 which may be mounted on a switch panel by bolts (not shown) received within U-shaped openings 40 (see FIG. 2) in side flanges 41 integral with base 39. One end of a bus bar conductor 46 secured by screws to insulating base 39 terminates at an oblique angle and protrudes into the opening in a generally V-shaped contactor stationary contact 49 that has limited rocking movement about bus bar conductor 46. One leg 50 of V-shaped stationary contact 49 is disposed between bus bar conductor 46 and base 39 and has a plurality of spring-receiving recesses which retain coil wiping springs 51 that are compressed against base 39 when the movable and stationary contacts 21 and 49 are engaged and provide wiping action between these contacts upon separation.

A magnetic blowout coil 54 mounted on insulating base 39 has a plurality of helical turns 55 of heavy copper strap surrounding a ferromagnetic core 56. The copper strap at one end of blowout coil 54 is electrically connected to bus bar conductor 46 by screws 58, and the other end of blowout coil 54 terminates in contactor plate 59 having threaded terminal means 60 extending therethrough adapted to secure a conductor from an electrical load. Ferromagnetic flux carrying pole pieces 61 abut against the ends of magnetic core 56 and extend radially beyond the blowout coil turns 55 and are adapted to engage ferromagnetic pole piece plates 62 of the arc chute.

The legs of a U-shaped ferromagnetic yok 64 are secured to the two halves 19 and 20 of armature 16 so that yoke 64 embraces flexible conductors 28 to form a pair of closed, low-reluctance magnetic flux paths in surrounding relation to the members carrying load current. Each such flux path includes yok 64, one-half 19 or 20 of armature 16, the adjacent leg 17 or 18 of frame 11 and through frame 11 to the other leg 17 or 18 thereof, the other half 19 or 20 of armature 16 and back to the yoke 64. Load current flowing through flexible conductors 28 induces magnetic flux in both such magnetic paths, including yoke 64 and frame 11, which result in forces tending to hold armature 16 in engagement with frame 11 even after coil 12 is deenergized.

A mechanically operated interlock 70 for auxiliary circuits includes an insulating casing 71 mounted by screws on the generally L-shaped metallic support bracket 31 having one end 72 supported from contactor base 39 and the flange 30 at its opposite end secured to terminal block 32. Interlock 70 is actuated by reciprocation of an elongated operating member 74 slidably mounted within casing 71. The ends of a U-shaped interlock actuating member 76 are secured to armature 16, and the crosspiece of member 76 is disposed against the face of an interlocking member 74 and moves it longitudinally to operate the auxiliary circuit interlock 70 when armature 16 is attracted to frame 11. Armature restoring springs 77 disposed between interlock actuating member 76 and protruding ears 78 on support bracket 31 are compressed when armature 16 is attracted to frame 11 and urge armature 16 to its open position wherein the contactor stationary and movable contacts 49 and 21 are separated.

The arc chute is disclosed in U.S. Pat. No. 3,511,950 in the name of Donald R. Boyd having the same assignee as this invention, and has a housing 80 formed by a pair of abutting hollow side members 81 and 82 held with their open sides facing each other by a plurality of screws 85. Side members 81 and 82 are preferably molded of a gas-evolving insulating material and may be of a phosphoric acid-bonded asbestos material. Housing 80 has a pair of laterally extending, elongated guide flanges 86 of L-shaped cross section adapted to slide within complementary grooves 88 (see FIG. 2) in the contactor base 39 to mount arc chute housing 80 on base 39. At the end adjacent contactor 10, the side members 81 and 82 are spaced apart to define an arcing compartment 89 which embraces the stationary contact 49 and movable contact 21 when the arc chute is assembled on contactor 10. The ferromagnetic pole piece plates 62 secured to the exterior of side members 81 and 82 engage the pole pieces 61 of the blowout coil 54 and generate a magnetic field therebetween within the housing 80 in a direction transverse to the side members 81 and 82.

An arc splitter plate 92 of suitable arc resistant insulating material is disposed within housing 80 and divides it into two narrow side-by-side arcing chambers 93 and 94 parallel to the
plane of movement of contact 21. Chamber 93 is formed between arc splitter plate 92 and side member 81, and arc chamber 94 is formed between plate 92 and side member 82.

Two elongated metallic arc runners 97 and 98 and a V-shaped metallic bridging electrode 99 disposed within housing 80 form a first pair of diverging electrodes for lengthening and extinguishing an arc segment within arc chamber 93 and a second pair of diverging electrodes for lengthening and extinguishing an arc segment within arc chamber 94. Arc runner 97 has a straight portion 106 of reduced width within arcing chamber 93 which merges into a full width portion 112 disposed adjacent stationary contact 49 within arcing compartment 89 and then is bent into a protruding straight terminal portion 108.

An L-shaped metallic bracket 109 (see FIG. 1) is affixed to bus bar conductor 46 by screws, and a pair of spring contacts 110 mounted on bracket 109 by a rivet are resiliently biased against each other and form a female connector. When arc chute housing 88 is assembled on contactor base 39, terminal portion 108 of arc runner 97 fits between spring contacts 110 to electrically connect arc runner 97 to bus bar conductor 46 and stationary contact 49.

Arc runner 98 has a straight portion 111 of reduced width disposed within arcing chamber 93 which merges into a full width portion 112 disposed within arcing compartment 89 adjacent the path of movement of movable contact 21 and which is bent into a protruding, straight terminal portion 113. A pair of spring contacts 118 and 119 resiliently urged toward each other are secured by rivets 120 to support bracket 31 and form a female connector to receive terminal portion 113 of arc runner 98 and electrically connect arc runner 98 to movable contact 21 through flexible conductor 28. An arc chute interlock spring 121 of U-shaped cross section is also affixed to support bracket 31 by rivets 120 and functions as part of the interlock means between arc chute and the contactor as explained in detail hereinafter.

Bridging electrode 99 is of V-shape with the legs 123 and 124 disposed in different planes and on opposite sides of arc splitter plate 92. One pair of divergent electrodes is formed between leg 123 and portion 111 of arc runner 98 in arcing chamber 93, and another pair of divergent electrodes is formed between leg 124 and portion 106 of arc runner 97 in arcing chamber 94. The apex portion 126 of V-shaped bridging electrode 99 is disposed within arcing compartment 89 approximately midway between arc runners 97 and 98 and spaced slightly away from the path of movable contact 21.

A plurality of spaced arc splitter ridges, or vanes 127 molded on the interior of side members 81 and 82 abut against arc splitter plate 92 and divide the arc segments within each of the chambers 93 and 94 into a series of arclets, or arc stream as the arc is forced outward within these chambers by the magnetic field between pole piece plates 62.

The edge 128 of side member 81 and the edge 129 of side member 82 diverge outwardly and define exhaust openings 130 for arcing chambers 93 and 94, and arc splitter plate 92 carries a V-shaped in cross section member 131 which partially defines such exhaust openings 130 and flares them in opposite directions to prevent the arcs in chambers 93 and 94 from combining.

When stationary and movable contacts 49 and 21 separate under overload conditions, an arc is formed therebetween which lengthens as the contacts separate. The magnetic field between pole pieces 62 is in a direction perpendicular to side members 81 and 82 and interacts with the current of the arc to lengthen it and force it to move from compartment 89 outward into arcing chambers 93 and 94. After partial separation of contacts 21 and 49, the arc transfers to portion 107 of arc runner 97 which is electrically connected to the stationary contact 49. Movable contact 21 is provided with a hook shaped portion 132 which approaches the bent over portion 112 of arc runner 98 (which is electrically connected to the movable contact 21) and transfers the arc to runner 98 near the final travel of the opening movement of contact 21. As the ends, or roots of the arc are driven outward under the influence of the magnetic field, the arc jumps to the apex portion 126 of bridging electrode 99 and is split into two arc segments, or arclets, by arc splitter plate 92. One arc segment is within arcing chamber 94 between arc runner 97 and leg 124 of bridging electrode 99 and is in series with the other arc segment in arcing chamber 93 between leg 123 of bridging electrode 99 and arc runner 98. The pair of electrodes in each arcing chamber 93 and 94 diverge and the magnetic field generated by blowout coil 54 in a direction to cause the arc roots to continuously move outward along the divergent electrodes, thereby lengthening the arc and cooling it as it is driven outward. The arc is split into two arc segments and reduced in cross section in being forced into the entrance chutes into the arcing chambers 93 and 94, and the arc segments in each of the chambers 93 and 94 is further subdivided into a plurality of arclets by the splitter ridges 127 as the arc segments approach the widest separation between the divergent electrodes.

The stationary and movable contacts 49 and 21 of the contactor may be melted and damaged if movable contact 21 is operated under overload conditions when the arc chute is removed from the contactor or is incorrectly assembled on the contactor (in the position schematically represented in dot-dash lines in FIG. 4) so that the arc chute does not extinguish the arc. In order to prevent such damage to the stationary and movable contacts 49 and 21, means are provided to prevent operation of the contactor when the arc chute is removed or incorrectly assembled to the contactor. Arc chute interlock spring 121 is preferably of resilient material such as beryllium copper and is of U-shape cross section. One depending leg 133 of spring 121 has clearance apertures 134 therethrough which receive the rivets 120 that affix spring contacts 118 and 119 to support bracket 31. The other depending leg 136 of interlock spring 121 diverges into ear portions 137 which are in the path of obliquely inclined portions 138 on side members 81 and 82 of arc chute housing 88 when the arc chute is properly assembled to the contactor as shown in solid lines in FIG. 3 so that leg 136 is normally bent toward support bracket 31 by arc chute portions 138 when the arc chute is properly assembled to the contactor. Leg 136 of arc chute interlock spring 121 terminates in a bent over planar interferring lip 140 extending parallel to the direction in which the arc chute is reciprocated in being assembled to, and removed from the contactor. Interfering lip 140 projects laterally as far as the ear portions 137 and is in the path of reciprocation of auxiliary switch interlock operating member 74 when the arc chute is removed from the contactor or is improperly assembled, as shown in dot-dash lines in FIG. 4, and thereby prevents reciprocation of operating member 74 when the arc chute is removed from, or improperly assembled on the contactor, armature 16 is prevented from pivoting and thus the contactor movable and stationary contacts 21 and 49 cannot be operated between open and closed positions when the arc chute is removed from the contactor.

When the arc chute is properly assembled on the contactor as shown in full lines in FIG. 3, the obliquely inclined portions 138 on side members 81 and 82 of arc chute housing 88 strike the ear portions 137 and bend spring 121 toward support bracket 31 to the position shown in FIGS. 1 and 3 where lip 140 is out of interfering relation with auxiliary switch operating member 74, thereby permitting operating member 74 to be reciprocated pair wise and thus the armature 16 is not lost and close movable and stationary contacts 21 and 49 of the contactor.

It should be understood that I do not intend to be limited to the particular embodiment shown and described for many modifications thereof will be obvious to those skilled in the art.
The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In combination, a circuit maker and breaker having a stationary contact and a movable contact adapted to engage said stationary contact, an electromagnet having an operating coil and a pivotally mounted armature operatively connected to said movable contact and being attracted when said operating coil is energized to actuate said movable contact into engagement with said stationary contact first and second female connector means on said circuit breaker, an interlock member reciprocable on said circuit breaker, means affixed to said armature for reciprocating said interlock member in a longitudinal direction when said armature is pivoted, an arc chute, complementary guide flange and guide groove means, one of which is on said circuit breaker and one of which is on said arc chute, for slidably and removably mounting said arc chute on said circuit breaker, said arc chute having an arcing compartment which embraces said stationary and movable contacts and a pair of diverging metallic arc runners provided with protruding male connector means adapted to engage said first and second female connector means respectively when said arc chute is assembled on said circuit breaker, and a U-shaped interlock spring having one leg affixed to said circuit breaker and the second leg disposed in the path of longitudinal movement of said reciprocable interlock member to prevent pivotal movement of said armature when said arc chute is removed from said circuit breaker and also disposed in the path of said arc chute when said complementary guide flange and guide groove means are in engagement and said arc chute is slidably assembled on said circuit breaker, said second leg of said interlock spring being adapted to be pushed by said arc chute to a position wherein said interlock member is free to reciprocate when said circuit breaker is assembled on said circuit breaker to the position wherein said male and female connector means are engaged.