Feb. 7, 1939. W. F. SKEATS 2,146,656

ELECTRIC CIRCUIT INTERRUPTER

Filed Feb. 18, 1938

Fig. 1.

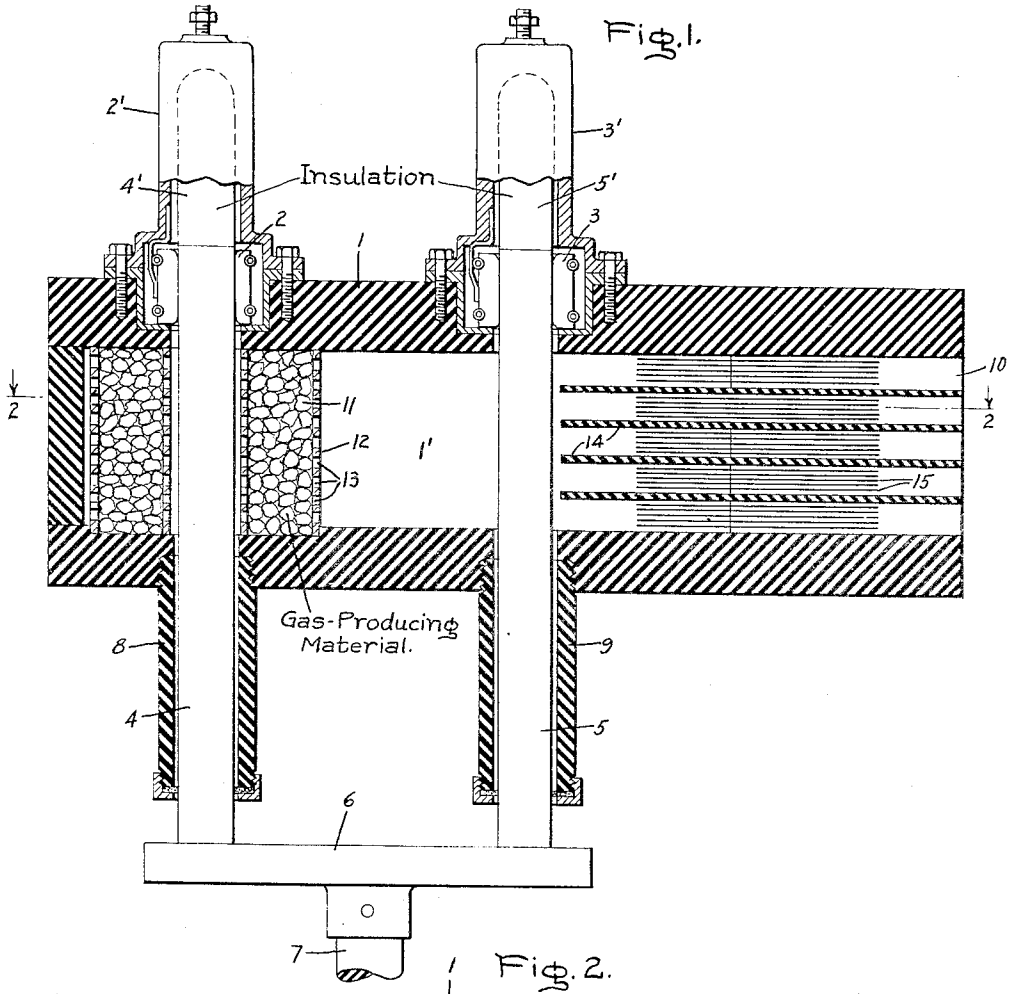
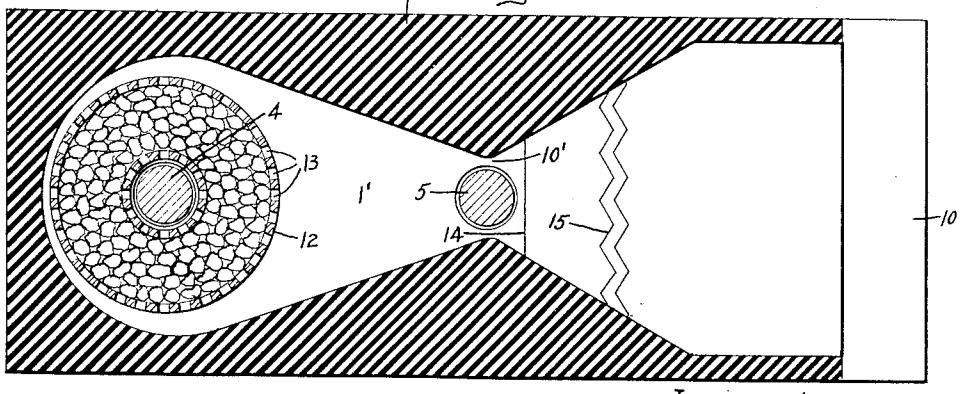


Fig. 2.



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ELECTRIC CIRCUIT INTERRUPTER

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12 Claims. (Cl. 200—144)

My invention relates to electric circuit interrupters, more particularly to air circuit breakers, and has for its principal object the provision of an improved air circuit breaker of the gas-blast type having a large interrupting capacity. A circuit interrupter of this character is disclosed and claimed in a copending application, Serial No. 56,050, filed Dec. 24, 1935, by David C. Prince, for "Electric circuit interrupters" and assigned to the same assignee as the present invention.

The interruption of high voltage power arcs by a jet of liquid, such as an oil blast, produced by and in accordance with the arc pressure formed upon opening of the circuit is well known and established practice in the oil circuit breaker art. The so-called "oil-blast" circuit breakers are capable of interrupting very large power currents at high operating voltages with but few half cycles of arcing, and this positive action enables the breaker to clear a short circuit before other parts of the transmission system are disturbed and before any damage has been done to the circuit breaker or other apparatus.

Although recognized as a preferred method of arc interruption the application of the arc-generated blast principle to air circuit breakers has heretofore been unsuccessful, an outstanding source of failure being in the re-ignition or re-establishing of the arc after actual interruption thereof by the gas blast. A further source of failure has resided in the difficulty of avoiding heating and thus destruction of the insulating value of the gas used for blast purposes. For these reasons practically no progress had been made in applying the arc-generated blast principle to air circuit breakers notwithstanding many years of successful and widespread use of the arc-generated oil blast circuit breaker.

I have found that an arc-generated gas blast can be successfully applied to air circuit breakers by positioning in a predetermined manner the pressure-generating arc and the arc or portion thereof that is to be subjected to the gas blast, and by interposing in the blast path a cooling and gas-producing material that offers comparatively small resistance to gas flow and that actually augments the blast. In this improved arrangement a high velocity gas blast of sufficient volume is applied without appreciable time lag to the arc to be interrupted and, upon interruption, the cooled and augmented gas blast is of sufficient dielectric strength to prevent re-ignition of arcing.

My invention will be more fully set forth in the following description referring to the accompanying drawing, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

Referring to the drawing Fig. 1 is an elevational view, partly in section, of an air circuit breaker in the closed circuit position embodying the present invention, and Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1.

In the specific embodiment of my invention illustrated, a pair of breaks in series are formed within an insulating casing 1 by relatively movable contact structure comprising a pair of fixed socket contacts 2 and 3 of the segmental type and a movable bridging structure including contact rods 4 and 5 operable through the casing for engaging the socket contacts 2 and 3 respectively. The rod contacts are electrically bridged at 6 and are adapted to be moved reciprocally by an operating member indicated at 7.

The fixed contacts 2 and 3 are electrically connected to and mounted within terminal structures 2' and 3' respectively which also form extensions for receiving in the closed circuit position of the switch insulating extensions 4' and 5' of the contact rods 4 and 5 respectively. The contact rods including the insulating tips thereof are guided for reciprocal rectilinear movement by insulating tubes 8 and 9 which extend an appreciable distance below the casing 1 and have a sleeve-like fit with respect to the contact rods.

In the arrangement so far described lowering of the bridging member to open the circuit results in the formation of two breaks in series within the casing 1, the break 2–4 being within a closed portion or arc chamber 1' of the casing as illustrated, and the break 3–5 being disposed opposite an exhaust port or chute 10. This general arrangement is well known in the oil blast circuit breaker art above referred to, the pressure generated by the arc at the break 2–4 tending to cause a blast of gas through the arc at the break 3–5 during exhaust from the port 10. In prior attempts to utilize this gas blast for arc interruption, it has been found that the hot blast consisting of highly heated gases and products of arcing, was of such conducting nature as to be ineffective in causing interruption so that the breaker failed. Sufficient spacing of the pressure-generating arc from the arc to be interrupted to avoid this difficulty resulted in an inordinately bulky and expensive structure.

In accordance with my invention the above difficulties are eliminated and the interrupting capacity and efficiency of this type of air circuit

breaker greatly increased by closely spacing the pressure-generating arc and the point of interruption, and by interposing a cooling structure that is traversed by the gas from the pressure-generating break for increasing the dielectric strength of said gas, said structure including a material which is adapted to emit additional arc-extinguishing gas when subjected to the arc heat and the highly heated arc gases.

To this end the pressure-generating break 2–4 is located in a comparatively confined portion of the arc chamber 1' and is closely surrounded by a cooling structure including in the present instance loose material 11 that is effective by reason of its large contact surface not only to cool the hot gases passing across the same toward the break 3–5 but also to yield additional gas of desirable dielectric properties. By way of example, chopped fiber tubing in small sections about ¼'' in length has been found to be satisfactory in that it provides a more free passage for the gas than granular material. This additional gas compensates for the loss of volume due to the cooling action of the fiber while at the same time introducing additional dielectric between the contacts at the break 3–5.

In the specific arrangement shown the gas-emitting material 11 is retained in an annular sieve-like structure 12 concentrically positioned with respect to the contact rod 4. The structure 12 is provided with a large number of openings indicated at 13 for presenting as small resistance as possible to the flow of gas under pressure from the break 2–4. Other suitable gas-producing materials can be used, if desired, further examples being boric acid, carbonates in general and urea resin. In each case the material is preferably broken up in irregular pieces of such size and shape that the interstices allow a comparatively free flow of gas through the material.

In the operation of this device opening of the circuit by lowering of the bridging structure is accompanied by arcs at the breaks 2–4 and 3–5 respectively. As previously pointed out the arc at 2–4 being within the comparatively confined part of the arc chamber 1' generates considerable pressure within the chamber due to the rapid expansion of the air or gas under influence of the arc heat. As the pressure-generating arc is drawn into the space surrounded by the fiber 11, the heat of the arc, in addition to the heat of the arc gases and arc products which are driven by the arc pressure through the annular structure 12, causes decomposition of some of the fiber. This results in the addition of arc-extinguishing gas of comparatively high dielectric strength to the interrupting blast. Also, the hot arc gases in passing across the fibre and through the structure 12 are appreciably cooled so that the dielectric strength thereof is increased.

These gases combine to exhaust under pressure through the break 3–5 which is preferably located at a restricted part of the exhaust 10' so that high blast velocity at the point of interruption is assured. This high velocity blast being of adequate volume and dielectric value is effective in both positively interrupting the arc within a very few half cycles of arcing and preventing re-establishment of arcing after the circuit has once been cleared. In certain cases it may be desirable to make imperforate the side of the structure 12 immediately opposite the break at 3–5, thereby causing deflection and greater cooling of the arc gases from the break at 2–4.

I have found that this arrangement is particularly effective in the case of large power currents within a wide voltage range, the increased pressure due to the large arc currents serving to interrupt arcing in a very positive manner. For the purpose of insuring equally good performance in the low current range where the arc pressures are obviously comparatively low, the insulating extensions or tips 4' and 5' of the contact rods are arranged to coact with the insulating sleeves 8 and 9 respectively in the manner of an arc snuffer. Normally in the case of moderate or heavy currents the circuit is cleared before the arcs are drawn into the tubes 8 and 9. However, in the case of low current arcs where the pressure within the arc chamber is insufficient to produce a blast of sufficient velocity the insulating tips 4' and 5' serve to confine the arc within such a small space in the sleeves 8 and 9 that a sufficient pressure is built up for arc interruption.

For the purpose of further aiding arc interruption at the break 3–5 the diverging part of the exhaust passage 10 is provided with a plurality of spaced insulating plates or arc splitters 14 arranged edgewise with respect to the path of the arc. When the arc is blown by the blast into the arc splitters, it tends to draw out the arc into a fine thread at the edge of each splitter as the current zero approaches, and these threads are interrupted by the blast when the current zero occurs.

In order to cool the exhaust gases from the breaker and so reduce or eliminate the noise and flame emission, as well as any momentary impairment of the dielectric strength of the surrounding air, cooling structure may be placed in the chute defining the exhaust passage. For this purpose, I prefer a plurality of closely spaced very thin copper sheets 15 disposed parallel to and between the arc splitters 14. As shown the metallic plates 15 are preferably more remotely positioned with respect to the arc than the insulating plates 14. Also, for the purpose of minimizing the resistance that these plates offer to flow of exhaust gases, the effective area available for the passage of the gases may be increased by giving the entrance edges of the copper plates a saw-tooth or zigzag form.

Although I have shown my invention as incorporated in a double break switch, it will be apparent that it can readily be applied to other forms such as, for example, a single break switch or circuit interrupter wherein one section of an arc is utilized to generate pressure for a blast that is directed through another section of the arc. In all these arrangements the cooling and gas-producing material is interposed with respect to the points of pressure generation and arc interruption so that the gas blast necessarily is in intimate contact with said material. It is understood that the term "air" as used in the specification and claims is intended to comprehend a gas of suitable dielectric and insulating properties and is not limited to a gas at atmospheric pressure.

It should also be understood that my invention is not limited to specific details of construction and arrangement thereof herein illustrated, and that changes and modifications may occur to one skilled in the art without departing from the spirit of my invention.

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

1. An electric air circuit interrupter comprising an arc chamber, arcing means disposed in said chamber and located so that a section of

arc is opposite an exhaust opening of said chamber, another section of arc being more confined for generating arc pressure in said chamber for causing a gas blast through said exhaust and said first section of arc, and cooling structure interposed with respect to said sections of arc permitting substantially free flow of said gas blast, said cooling structure including material adapted to emit an arc-extinguishing gas when subjected to the arc heat and the hot gases from said second section of arc.

2. An electric air circuit interrupter comprising an arc chamber, circuit-controlling means adapted to form two breaks in series in said chamber, one of said breaks being located opposite an exhaust opening of said chamber, the other of said breaks being in a more confined part of said chamber so that the corresponding arc generates pressure for causing a gas blast through said exhaust and the adjacent arc, and a cooling structure interposed with respect to said breaks having a large effective contact surface and permitting substantially free flow of said gas blast, said structure being composed in part of material adapted to emit an arc-extinguishing gas when subjected to the heat of arcing at said pressure-generating break and to the heat of the gas blast from said break passing through said structure.

3. An electric air circuit breaker comprising an arc chamber, relatively movable contact structure separable within said chamber to cause arcing, one section of arc being located substantially opposite an exhaust opening of said chamber arranged so that gas in exhausting from said chamber is confined to a high velocity path directly traversing said arc, another section of arc being more remotely located in said chamber for generating pressure, and cooling structure interposed with respect to said arc sections so that the gases from said pressure-generating arc necessarily pass through said structure in exhausting from said chamber, said structure presenting a large cooling surface to said gas and being composed in part of a material adapted to emit an arc-extinguishing gas when subjected to the heat of the arc and the arc gases.

4. An electric air circuit breaker comprising an arc chamber, relatively movable contacts arranged to form two breaks in series in said chamber, one of said breaks being opposite an exhaust passage of said chamber so that gas in exhausting from said chamber traverses at high velocity the arc at said break, the other of said breaks being located in a comparatively confined part of said chamber for generating pressure causing a gas blast through the arc at said exhaust passage, and cooling structure interposed with respect to said breaks including a mass of material arranged to provide large interstices and adapted to emit an arc-extinguishing gas for augmenting said gas blast when subjected to the arc heat, said material permitting comparatively free flow of the expanding gas from said pressure-generating break while presenting a large cooling surface to said gases.

5. An electric air circuit breaker comprising an insulating casing forming an arc chamber having a restricted nozzle-like exhaust opening, relatively movable contacts arranged to form two breaks in series in said chamber, one of said breaks being directly opposite the restricted part of said exhaust, the other of said breaks being more remotely positioned with respect to said exhaust for generating arc pressure, and annular cooling structure concentrically positioned with respect to and surrounding said pressure-generating break whereby the hot gases from said break necessarily pass through said cooling structure in exhausting from said chamber, said annular structure being composed in part of a large number of fragments of material adapted to emit an arc-extinguishing gas when subjected to the arc heat at said pressure-generating break whereby the effective gas blast through the break at said exhaust is both cooled and augmented.

6. An electric air circuit breaker comprising an insulating casing forming an arc chamber having a restricted nozzle-like exhaust opening, relatively movable contacts arranged to form two breaks in series in said chamber, one of said breaks being at the restricted part of said exhaust and the other break being more remotely positioned for generating arc pressure, and cooling structure positioned in said chamber directly between said breaks arranged so that the expanding hot gases from said pressure-generating break necessarily pass through said structure in exhausting from said chamber, said structure being composed in part of a large number of fragments of material adapted to emit an arc-extinguishing gas when subjected to the arc heat and the heat of said expanding gases whereby the effective gas blast through the break at said exhaust is both cooled and augmented.

7. An electric air circuit comprising an arc chamber having an exhaust opening, relatively movable contact structure arranged to form two breaks in series in said chahmber, said chamber being in closely confining relation to said breaks one of said breaks being opposite said exhaust and the other being more remotely positioned for generating arc pressure in said chamber, cooling structure disposed in said chamber and interposed with respect to said breaks, said cooling structure including a mass of loose material permitting free flow of the expanding hot gases from said pressure-generating break, said material also being adapted to emit an arc-extinguishing gas when in contact with said hot gases whereby the gas blast through the arc at said exhaust is augmented.

8. An electric air circuit breaker comprising an arc chamber, relatively movable contacts arranged to separate in said chamber including a fixed contact and a movable coacting contact rod, porous structure adapted to yield an arc-extinguishing gas when subjected to arc heat, said structure being adjacent to the path of movement of said rod contact in said chamber whereby arc pressure generated in said chamber at large currents is effective to cause an arc-extinguishing gas blast through said porous structure and laterally from said chamber, an insulating sleeve arranged to guide said contact rod along a rectilinear path with respect to said fixed contact, said insulating sleeve being spaced a predetermined distance from said fixed contact, and an insulating member forming an extension of said contact rod arranged to coact with said insulating sleeve for extinguishing low current arcs that are drawn through said chamber.

9. An electric air circuit interrupter comprising an arc chamber, arcing means disposed in said chamber and located so that arc is formed opposite an exhaust opening of said chamber whereby arc pressure in said chamber is effective to cause a gas blast through said exhaust and said arc, insulating plates forming arc splitters at said exhaust for said arc, and spaced me-

tallic cooling plates having high conductivity disposed generally parallel to and between said arc splitters, said metallic plates being more remotely positioned from said arc than said insulating plates.

10. An electric air circuit breaker comprising an insulating casing forming an arc chamber having an exhaust opening, relatively movable contact structure arranged to form two breaks in series in said chamber, said chamber being in closely confining relation thereto, one of said breaks being opposite said exhaust and the other of said breaks being more remotely positioned with respect to said exhaust for generating arc pressure for causing a high velocity gas blast through the break at said exhaust, cooling structure disposed in said chamber and interposed with respect to said breaks, said cooling structure including a mass of loose material permitting free flow of gas from said pressure-generating break and presenting a large cooling surface to the expanding hot gas, said material also being adapted to emit an arc-extinguishing gas when subjected to the arc heat during the passage of said gas therethrough whereby the gas blast through the arc at said exhaust is augmented, and arc cooling means disposed in said exhaust opening immediately beyond the point of arc interruption including a plurality of thin closely spaced metallic plates having high heat conductivity and insulating plates alternating with groups of said thin metallic plates.

11. An electric air circuit breaker comprising relatively movable contacts, insulating structure forming an arc chute for receiving heated arc gases formed upon separation of said contacts, and arc-quenching means in said chute including a plurality of parallel spaced insulating plates disposed adjacent to and edgewise with respect to the arc formed between said contacts, and a plurality of parallel spaced comparatively thin metallic plates of high conductivity disposed within said chute between said insulating plates and adjacent to the exhaust part of said chute, said metallic plates as a group being more remotely positioned with respect to said arc than said insulating plates.

12. An electric air circuit breaker including arcing means, an arc chute structure for receiving the arc to be interrupted comprising an insulating casing having an exhaust opening, spaced insulating plates forming arc splitter for said arc within said casing and between said exhaust and said arc, and spaced metallic plates having high conductivity disposed between said arc splitters, said metallic plates being more remotely positioned from said arc within said insulating plates.

WILFRED F. SKEATS.

CERTIFICATE OF CORRECTION.

Patent No. 2,146,656. February 7, 1939.

WILFRED F. SKEATS.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 31, claim 7, after the word "circuit" insert breaker; line 34, for "chahmber" read chamber; line 36, same claim, after "breaks" first occurrence, insert a comma; page 4, second column, line 23, claim 12, for the word "splitter" read splitters; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 21st day of March, A. D. 1939.

Henry Van Arsdale.

(Seal) Acting Commissioner of Patents.