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L. R. LUDWIG ET AL

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CIRCUIT INTERRUPTER

Filed Jan. 13, 1940

2 Sheets-Sheet 1

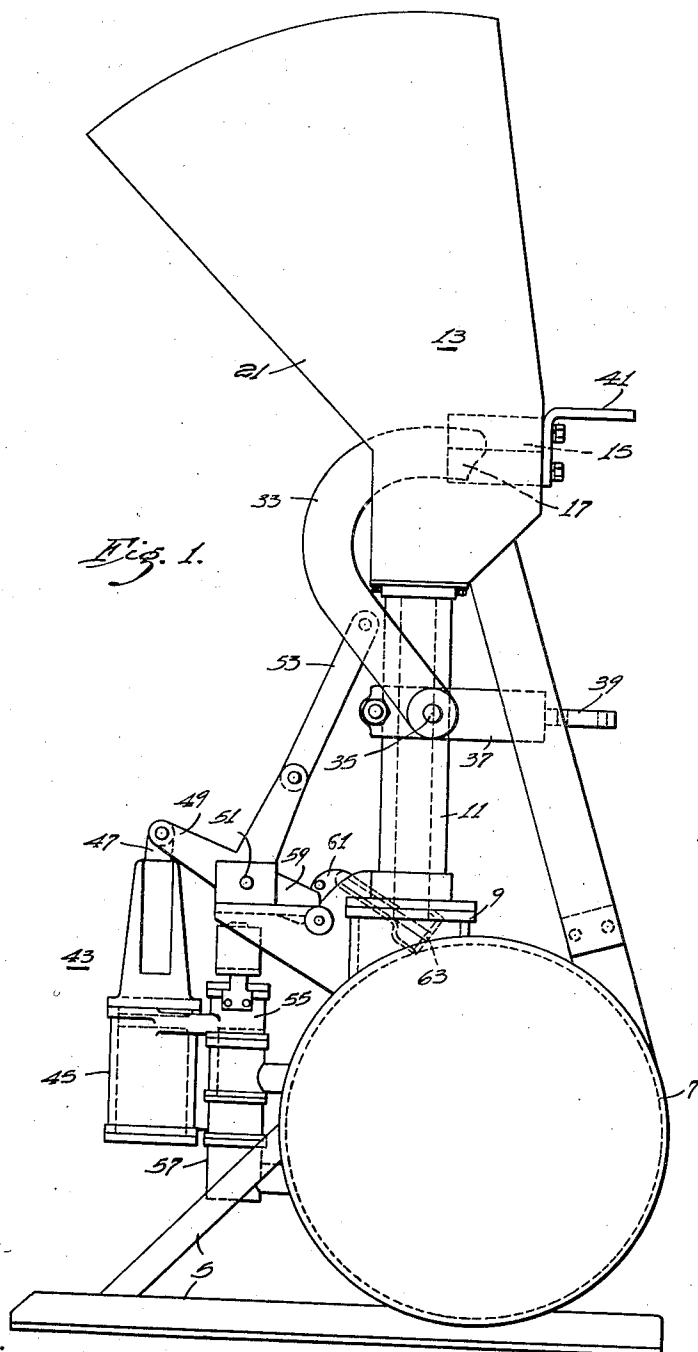


Fig. 1.

WITNESSES:

E. C. Gliding
Walter E. Muller

INVENTORS

Leon R. Ludwig, Herbert L. Remlin
Benjamin P. Baker

BY

Ralph H. Swingle
ATTORNEY

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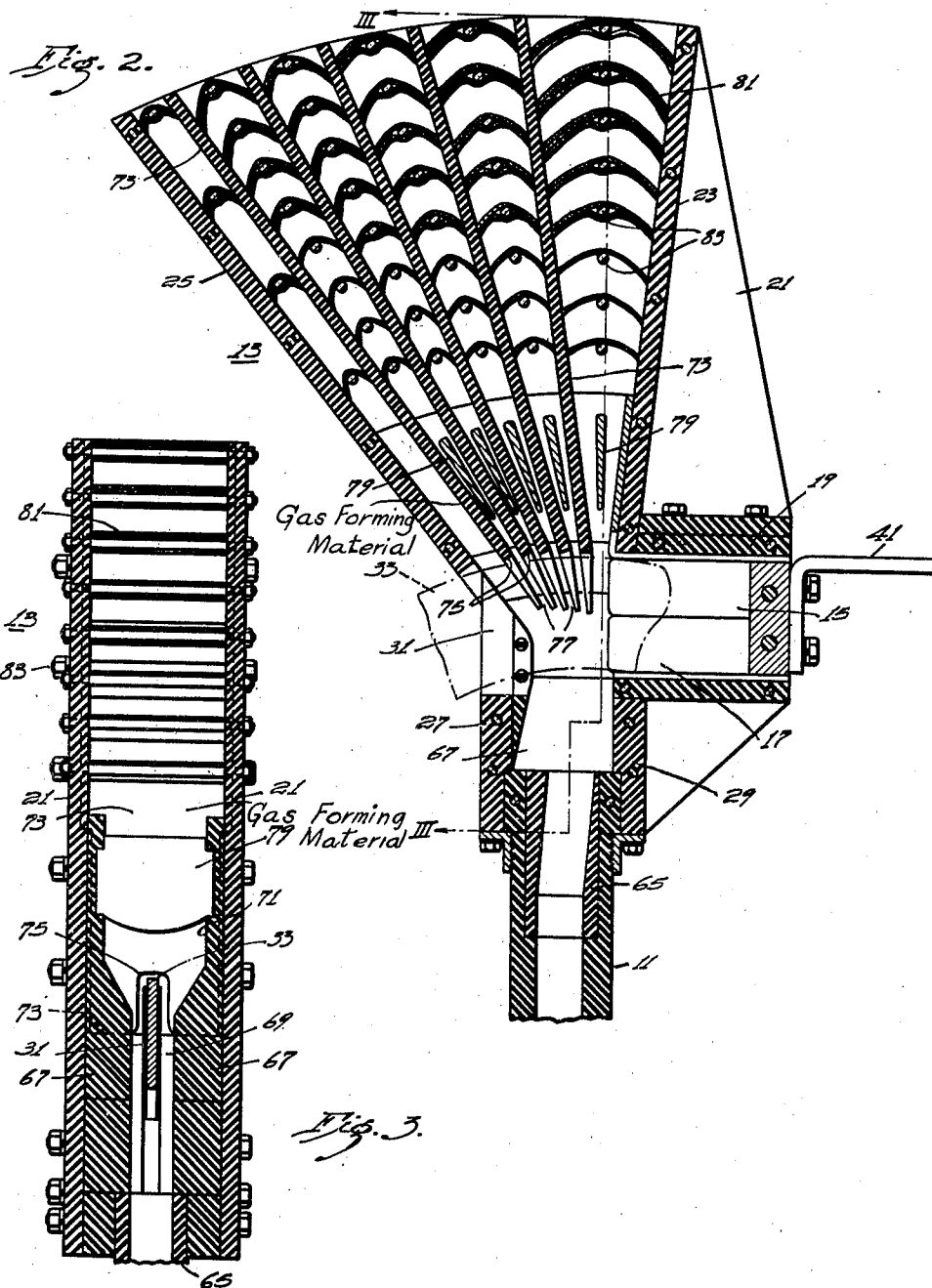
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2 Sheets-Sheet 2



WITNESSES:

E. E. Kidding
Walter C. Miller

INVENTORS

Leon R. Ludwig, Herbert L. Rowland
Benjamin P. Baker

BY

Ralph H. Swingle
 ATTORNEY

UNITED STATES PATENT OFFICE

2,272,380

CIRCUIT INTERRUPTER

Leon R. Ludwig, Forest Hills, Herbert L. Rawlins, Wilkinsburg, and Benjamin P. Baker, Turtle Creek, Pa., assignors to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

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24 Claims. (Cl. 200—148)

This invention relates to improvements in circuit interrupters and, more particularly, to circuit breakers of the air break type wherein an arc established between separable contacts is extinguished by a blast of air or other suitable gas. Compressed air has been recognized as a suitable arc extinguishing medium by the electrical engineering profession for some time. Particularly in European countries, considerable progress has been made in the development of circuit breakers of this type. This development, however, has led to the almost universal adoption of the longitudinal blast interrupter wherein the stationary contact is arranged in the form of a nozzle at the end of a pressure chamber in which the arc is drawn. Compressed air is admitted to the pressure chamber and blasts the arc principally along its longitudinal axis in order to bring about arc extinction.

Although the longitudinal blast type of interrupter is fairly efficient at low interrupting capacities, it has a marked disadvantage at high interrupting capacities since the amount of air required to effectively extinguish the arc increases rapidly with an increase in current. Thus it appears that the interrupting capacity of the longitudinal blast type of interrupter has a practical upper limit which is principally determined by the maximum practical air pressure available.

We have discovered that the extinction of an arc by directing a blast of air crosswise of the arc is less dependent upon the air pressure employed. It has been found that moderate air pressures, such as 150 pounds per square inch, are sufficient when employed in conjunction with a properly designed arc extinguishing structure to interrupt as high as 66,000 amperes at 13,200 volts, whereas an interrupter of the longitudinal blast type would require air pressures many times this value.

The main object of our invention is to improve the interrupting ability of gas blast circuit breakers without resorting to high gas pressures. In accomplishing this object, particular attention has been given to the method of treatment of the arc in the presence of a cross blast of gas, which method contemplates utilizing the gas blast more effectively to quickly remove the ionized gas particles from the arc stream so as to render the inter-contact space non-conducting in the short interval of time during which the arc current passes through zero.

Further in obtaining our improved results, we have recognized the value of spaced arc splitter plates arranged edgewise of the path of the arc and against which the arc is driven by the later-

ally directed blast of gas. It is a known fact that by the use of gas forming material in the arc splitter plates, such as fiber, arc extinction particularly at the higher values of current, is enhanced. Attempts have been made to utilize fiber arc splitter plates in an arc extinguishing device, wherein the arc is drawn in a narrow throat-like air blast passage disposed in front of the splitter plates. Although this form of interrupter is effective at low and medium values of current, interruption at high currents is difficult, if not impossible. The reason for the failure of this type of device to interrupt on the higher currents is believed to be that the action of the arc upon the fiber splitter plates generates gas in such quantities to create a local pressure sufficient to block the air blast and thereby prevents the removal of ionized gas surrounding the arc.

Consequently a quantity of ionized gas is trapped in back of the arc stream as it has no means of escape other than through the arc itself, which is at the source of the locally generated pressure. Thus, when the arc passes through current zero, the accumulated ionized gas must be expelled which results in a cannon-like detonation and often is the cause of failure of the extinguisher to interrupt because of the presence of excessive ionized gas in the intercontact space.

A further object of our invention is to provide an arc extinguishing structure of the aforesaid type employing spaced gas forming arc splitter plates, but in which provision is made for sweeping away the ionized arc gases surrounding the arc substantially as quickly as these gases are formed, to thereby make the intercontact space non-conducting at the first current zero. The particular structure whereby this improved result is obtained depends upon the arc chamber configuration, as well as the method of directing the air blast upon the arc stream, and will be specifically described hereinafter.

Our invention further contemplates improving the interrupting ability of a gas blast interrupter of the cross blast type by confining the arc to a slot-like passage in the arc splitter plates and arranging these plates so that they diverge from each other in the direction of gas flow in order that more accurate control of the arc may be obtained. The converged or arc receiving ends of the splitter plates are closely spaced and tapered so as to obtain uniform spacing therebetween, thus avoiding a change in spacing as the plates erode due to frequent circuit interrupting operations.

It is also an object of our invention to improve the interrupting ability of a gas blast circuit breaker of the aforesaid type by the provision of means for limiting the arc length which consequently limits the arc voltage and arc energy which must be dissipated during the interrupting operation.

Another object of our invention resides in the improvement of the circuit interrupting ability of gas blast circuit breakers by the provision of a more effective treatment of the ionized gases driven from the arc stream by the blast of compressed gas. In this connection, it has been observed that in an arc chute provided with fiber arc splitter plates, a greater volume of gas is generated by the arc at the side of the arc chute adjacent the stationary contact. This gas must be allowed to escape freely and uniformly from the space surrounding the arc and at the same time must be cooled sufficiently so that an arc will not reform across an ionized path at any point along the length of the splitter.

To obtain a uniform flow of gas between the arc splitters, the splitters are arranged with a decreasing degree of divergence from the stationary contact side of the arc chute in the direction of movement of the movable contact. The arc gases driven into the arc chute must also be sufficiently cooled and deionized by the time they reach the exhaust end of the chute so that reignition across the ends of the splitter plates will not take place.

It is a further object of our invention to provide adequate cooling of the hot arc gases driven through the spaces between the arc splitters by the use of metallic cooling elements which are desirable in that they do not throw off more uncondensable gas under the influence of high temperatures. It is also found desirable to shape the cooling elements in such manner that the hot arc gases are deflected away from the arc splitter plates, thereby further decreasing the gas generation along the splitter plates.

Our invention also has for its object the proper spacing of the metallic cooling elements along the arc splitter plates in an endeavor to decrease the velocity of the ionized gas so as to obtain the maximum cooling effect incident to long time exposure of the gas to the cooling elements but without decreasing the velocity of the gas to such an extent that excessive back pressure is obtained. We have also found that greater efficiency is obtained by exposure of the individual cooling elements to the same amount of heat which has led us to provide a larger number of cooling elements in the gas discharge spaces between the splitter plates adjacent the stationary contact than in the remaining spaces, and also to make the cooling elements more numerous at the exhaust ends of the gas discharge spaces since the time of exposure to the gas is materially greater at the exhaust end than at the gas receiving end of the spaces.

Other objects and advantages will be apparent from the following description when taken in connection with the accompanying drawings, in which

Figure 1 is an elevational view showing the circuit interrupter of our invention;

Fig. 2 is a sectional view taken longitudinally of the circuit interrupting unit of the circuit interrupter shown in Fig. 1; and

Fig. 3 is a sectional view of the circuit interrupting unit of Fig. 2, taken at right angles thereto and along the line III—III of that figure.

Referring to the drawings, the reference number 5 designates a frame for supporting a tank 7 in which gas, such as air, may be stored under pressure. The upper side of the pressure tank 7 is provided with a flanged outlet conductor 9 upon which is mounted a hollow insulator 11. Mounted upon the upper end from the hollow insulator 11 is an arc extinguishing unit generally indicated at 13. The arc extinguishing unit, as more clearly shown in Fig. 2, includes a stationary contact assembly 15 comprising a plurality of yielding mounted contact fingers 17 supported in a box-like compartment 19 disposed between the two side walls 21 of the arc extinguishing unit. The side walls 21 are preferably of insulating material and cooperate with the end walls 23 and 25 to form a flared arc chute, as shown. The wall 25 joins a wall 27 so as to define one narrow side of an arc chamber. Opposite the wall 27 is a wall 29 which joins the box-like structure 19 housing the stationary contact assembly 15. The walls 25 and 27 are provided with a slot-like aperture 31 through which blade-like moving contact 33 is adapted to move to coact with the contact fingers 17 of the stationary contact assembly 15. The moving contact 33 is mounted for pivotal movement at 35 to a bracket 37 clamped about the hollow insulator 11. The bracket 37 is of conducting material and is provided with an extension 39 which serves as a terminal to which external circuit connections may be made. The stationary contact assembly 15 is provided with a similar terminal 41 for also making connection to the external circuit. Thus, when the moving contact 33 is in engagement with the contact fingers 17, an electrical circuit is established through the interrupter from the terminal 41, the contacts 17, moving contact 33, conducting bracket 37 to the terminal 39.

Operation of the moving contact 33 to the open and closed circuit position is effected by an air actuated mechanism 43 supported from the side of the pressure tank 7. The mechanism 43 includes a piston (not shown) operable within the cylinder 45, which piston is connected by a rod 47 to a bell crank 49 pivotally mounted at 51. The bell crank 49 is coupled by a link 53 to the movable contact 33. Thus, when the piston rod 47 is actuated downwardly to rotate the bell crank 49 in a counterclockwise direction, the moving contact 33 will be moved to the open circuit position, and similarly when the piston rod 47 is moved upwardly, the moving contact 33 will be moved to the closed circuit position.

Air to operate the mechanism 43 to open and closed circuit positions is admitted to the cylinder 45 by valves 55 and 57, respectively. The control of these valves may be effected in any conventional form and does not constitute a part of the present invention. The bell crank 49 is also provided with a cam mechanism 59 which actuates a pivoted rocker arm 61 which, in turn, operates a spring closed valve 63 disposed in the flanged conduit 9 extending above the pressure tank 7. The valve 63 controls the flow of air from the tank 7 into the hollow insulator 11. The passage through the insulator 11 is provided with a gas directing nozzle 65 at the upper end thereof which extends into the entrance portion of the arc extinguishing unit 13 defined by the end walls 27 and 29 and the lower sides of the two side walls 21. Thus, as the valve 63 is moved to the open position, a blast of air will be released from the tank 7 through the insulator 11

into the arc extinguishing unit 13 between the contacts 17 and 33. Opening movement of the valve 63 takes place both during the opening and closing operation of the contact 33, thus the cam means 59 is normally inoperative to open the valve 63 where the moving contact 33 is in the fully open or closed position. However, during movement from one position to the other, the valve 63 is opened to admit the required blast of gas to extinguish the arc. Inasmuch as the specific contact structure, the operating mechanism including the cam means 59 and the air blast control valve 63 are not a part of this invention but are more fully disclosed and claimed in the application of A. H. Bakken Serial No. 313,745 filed January 13, 1940, and assigned to the assignee of this application, it is not deemed necessary to further describe such mechanism. Inasmuch as our invention is particularly directed to the arc extinguishing structure of a circuit breaker, the same will now be specifically described.

As previously mentioned, the side walls 21 and the walls 23 and 25 form an arc chute for extinguishing the arc formed between the contacts 17 and 33. The lower end of the arc chute is provided with a pair of lining members 67 disposed along the inside walls of the walls 21 so as to provide a narrow passageway 69 of generally rectangular cross section. The slot-like opening 31 in the walls 25 and 27 communicates with the passageway 69 and is preferably disposed centrally thereof. The passage 69 from a point substantially opposite the midpoint of the contact 33, diverges rapidly to a width as that shown at 71. Disposed between the walls 21 are a plurality of arc splitter plates 73 preferably of material which gives off gas when acted upon by an arc such as fiber. The plates 73 are preferably supported along their side edges in grooves provided for that purpose disposed on the inner surface of the walls 21. The lower end of the arc splitter plates 73 are adapted to be received by suitable slots formed in the lining member 67, as more clearly shown in Fig. 3. The arc splitter plates 73 are also provided with a U-shaped notch or slot 75 extending inwardly from the lower end thereof so as to form a passageway through which the moving contact 33 may operate.

It will be noted that the lower ends of the splitter plates 73 are tapered for a distance somewhat greater than the length of the notches 75 so as to provide spaces 77 of uniform width between the ends of the plates. It will be seen that by making the spaces 77 of uniform width, the spacing will not be affected by erosion of the plates 73 as a result of action of the arc thereon. Disposed above the notches 75 and in the spaces between the plates 73 are a plurality of short plates 79 of conducting material. A single plate 79 is preferably symmetrically positioned between two adjacent plates 73 and, for example, may be held in position by having their side edges recessed in the lining members 67. The plates 79 are preferably tapered, as shown, and have their lower edges curved for the purpose of offering less resistance to the flow of gas therearound. The purpose of the plates 79 will appear more fully hereinafter. Also disposed in the spaces between the arc splitter plates 73 are a plurality of metallic cooling elements 81 which may be formed of perforated sheets of metal or metallic screening bent in the form shown and secured to bolts 83 extending transversely through the

side walls 21. The cooling elements 81 will also be more fully described in connection with the operation of the arc extinguishing structure.

The operation of the circuit interrupter is as follows. Upon separation of the contacts 17 and 33, an arc is drawn in the notches 75 of the plates 73. At the same time, a blast of air is admitted by the valve 63 through the insulator 11 and through the nozzle 65 into the passage 69. The air is preferably maintained at such a pressure that it is injected into the passage 69 at a high velocity, preferably the velocity of sound so that it will not normally be deflected or caused to follow the divergence of the side walls of the passage. The air stream thus strikes the arc and drives it to the ends of the notches 75 and causes the arc to elongate somewhat between the arc splitter plates 73. Further arc looping between the splitter plates 73 is prevented as a result of the presence of the cooler plates 79. If a low current arc is being interrupted, very little gas generation will take place as a result of the action of the arc upon the splitter plates 73 and the air blast through the nozzle 65 will continue to drive the ionized gas particles surrounding the arc against and around the metallic plates 79. The metallic plates 79, in addition to serving as buffers to prevent excessive elongation of the arc, also serve as coolers to initially cool the hot arc gases. As the arc gases pass beyond the buffer plates 79, they encounter the metallic cooling elements 81 disposed between the splitter plates which further cool and deionize the gases and bring about complete deionization of the gases in the discharged spaces between arc splitters and thereby prevent the issuance of flame from the upper or open end of the arc chute. In the event that a heavy current arc is drawn, considerable gas may be generated as a result of action of the arc upon the splitter plates 73. The generation of this gas, if not excessive, is beneficial in aiding extinction of the arc provided proper means are at hand to quickly remove the ionized gases surrounding the arc. The pressure resulting from the gas generated by action of the arc on the splitter plates 73 may become sufficient to completely block the high velocity stream of air emanating from the nozzle 65. The air blast from the nozzle 65 would normally be ineffective to sweep the ionized gas out from in back of the arc in the event the arc were held confined in a narrow throat-like passage. It will be noted with particular reference to Fig. 3 that the notches 75 will generally control the position of the arc and permit it to be moved upwardly a short distance into the rapidly diverging portion of the arc chute, as defined by the portion 71 of the lining member 67. Thus there is adequate space between the sides of the arc and the lining members 71 for the ionized arc gases to be blown to either side of the arc and into the spaces between the arc splitter plates 73. If no provision were made to quickly remove the ionized gases from in back of the arc under the conditions above referred to, the accumulated gases would have to be expelled across the arc path as the arc current passes through zero. It has been observed as the result of a study of the extinction of arcs under these circumstances that the expulsion of the ionized gases in this manner causes a cannon-like detonation and very often causes reignition of the arc and ultimate failure of the arc extinguishing device

to interrupt the circuit. Thus, the particular arrangement of the slot structure in the splitter plates for positioning the arc with respect to an arc passage of predetermined width, permits the air blast directed against the arc to remove the ionized gases surrounding the arc substantially as quickly as these gases are formed and thus insure prompt circuit interruption at the first current zero.

In practice, we have found that in a circuit interrupter which is capable of interrupting 66,000 amperes at 13,200 volts, a slot width of approximately $1\frac{1}{2}$ inches and a length of approximately 3 inches in the splitter plates 73 is suitable when used in conjunction with an air blast passage 69 having a width of approximately 2 inches, and which starts to diverge at a point approximately $1\frac{1}{2}$ inches from the closed end of the notches 75. The preferred amount of divergence of the air blast passage is from 2 to approximately 7 inches for a longitudinal length of approximately $2\frac{1}{2}$ inches.

A further improvement in the interrupting ability of our arc extinguishing structure is obtained by directing the blast of air from the nozzle 65 into the gas blast passage 69 at an angle with respect to the vertical longitudinal axis thereof.

As more clearly shown in Fig. 2, the nozzle 65 extending into the insulator 11 has a discharge opening of generally circular cross section and its longitudinal axis generally in alignment with the right-hand arc splitter plate 73 so that the gas blast is directed generally to the end of the arc formed adjacent the stationary contact 17. Directing the blast of gas towards the stationary contact renders the interrupter more efficient during the interruption of both light and heavy currents. During interruption of the circuit, the arc will be extinguished before appreciable contact separation has taken place if the current zero occurs at that time, in that the gas blast is directed upon the section of arc immediately adjacent the stationary contact. In the event the current zero occurs after appreciable contact separation, the arc gas generation, particularly at high currents, as a result of action of the arc upon the splitter plates 73, will cause an intense pressure to be generated at or near the stationary contact 17 as soon as the arc is drawn, which pressure will also cause the gas blast from the nozzle 65 to be deflected to the left towards a lower pressure area. Thus, the intense local pressure at or near the stationary contact, instead of blocking the air blast and preventing it from removing the ionized gas quickly will cause the air blast to deflect and carry with it the ionized gases from in back of the arc into the gas discharge spaces between the arc splitter plates towards the left-hand side of the arc chute.

It is thus seen that by directing the air blast at an angle to the general longitudinal axis of the air passage provides for more rapid clearing of the inner contact space of ionized gas and, therefore, improves the arc extinguishing ability of the interrupter.

It has been previously mentioned that more intense local gas pressures are generated at or near the stationary contact. This is due largely to the fact that as the arc is drawn from the stationary contact through the notches 75 in the successive arc splitter plates 73, the first plates contacted by the arc will have been subjected

to the action of the arc for a longer period of time than those last contacted. In other words, the heating effect upon the splitter plates will diminish in the direction of movement of the moving contact 33. It, therefore, follows that the gas discharge spaces between the splitter plates to the right-hand side of the arc chute must discharge greater volumes of gas than those towards the left-hand side of the arc chute. In order to maintain a more uniform flow of gas which is essential to proper cooling and deionizing the gases, the splitter plates 73 are not uniformly spaced as shown. That is, the degree of divergence of the plates decreases progressively in the direction of movement of the movable contact.

It has previously been mentioned that the efficiency of the interrupter also largely depends upon its ability to quickly cool and deionize the arc gases driven into the gas discharge spaces adjacent the arc splitter plates. In this connection, it will be noted with particular reference to Fig. 2, that the cooling elements 81 are made more numerous in the region of the exhaust portion of the arc chute whereas they are more sparse at the entrance portion of the gas discharge spaces. This arrangement is provided in order to subject each cooling element to substantially the same amount of heat and also to avoid decreasing the velocity of the discharged gas to such an extent as would cause excessive back pressure. This is based upon the theory that the cooling effect of the metallic cooling elements is proportional to the time of exposure to the hot gases. It will be apparent that as the arc gases are cooled, their velocity is decreased and also as the space in which the gases are discharged increases in volume, the velocity will also decrease. Therefore, in order to maintain uniform cooling effect per unit length of gas travel between the arc splitter plates, only relatively few units can be placed in the lower end of the spaces whereas an increasing number per unit length may be advantageously employed towards the exhaust end of the gas discharge spaces.

It will also be noted that the right gas discharge space is required to conduct gases from the arc stream of higher temperature than the gas in the discharge passages between the remaining passages. In order to keep the cooling effect more uniform through the entire arc chute a progressively smaller number of metallic cooling elements 81 are employed in the gas discharge spaces in a direction from the right-hand to the left-hand side of the arc chute.

A further improvement in the circuit interrupting performance of our device is obtained by shaping the cooling elements 81, as shown, so that they present a concave surface facing the source of the arc gases. This particular arrangement has the advantage that it deflects the hot arc gases away from the arc splitter plates 73, thereby preventing the further formation of gas during movement of the gas through the gas discharge spaces.

Although we have shown and described a specific circuit interrupting structure and in certain instances have given specific dimensions and a preference for certain materials, it is to be understood that the same is for the purpose of illustration and that changes and modifications may be made by those skilled in the art without departing from the spirit and scope of the appended claims.

We claim as our invention:

1. In a gas blast circuit interrupter, relatively movable contacts for establishing an arc, means defining a passage for directing a blast of gas transversely of the arc gap formed upon separation of said contacts, the side walls of said passage diverging rapidly in a direction laterally of the arc in the region of contact separation, means causing a blast of gas to flow through said passage of velocity sufficient to prevent substantial divergence of the gas stream at the diverging portion of said passage during the existence of relatively small current arcs, and partition members at least partially of gas forming material disposed in spaced relation transversely of said passage and having their ends extending close to said arc gap, said blast of gas driving the arc against the ends of said partition members, said partition members having the ends thereof against which the arc is driven positioned in the widened portion of the diverging passage and producing gas under pressure during the existence of relatively high current arcs and causing said gas blast to be deflected to either side of the arc at the widened portion of said diverging passage and sweep the ionized gas out of said passage.

2. In a gas blast circuit interrupter, an arc chute having a relatively narrow entrance portion, an exhaust portion and an intermediate portion which rapidly diverges in width laterally of the arc towards said exhaust portion, relatively movable contacts separable at least partially in said widened intermediate portion to establish an arc, a plurality of spaced plate members of insulating material extending across said arc chute within said exhaust and said intermediate portions, and means for directing a high velocity blast of gas into said entrance portion to drive said arc against the ends of said plate members, said plate members having an inwardly extending notch wherein said arc is adapted to play, said notches having a width less than the width of said intermediate portion at the notches to hold the arc out of engagement with the side walls of said chute and permit said blast of gas to sweep the ionized gas substantially as quickly as formed from the intermediate portion of the arc chute to the exhaust portion thereof.

3. In a gas blast circuit interrupter, means defining a relatively narrow passage, spaced plate means at least partially of gas forming material extending across said passage, contact means for drawing an arc transversely of said passage adjacent and across the ends of said plate means, and means directing a blast of gas of high velocity into said passage to drive the arc against the ends of said plate means, said gas directing means being aimed to cause said blast of gas to play principally upon a relatively short first formed section of the arc and to flow in almost a straight line out of the gas directing means and through the space between said plate means adjacent said short section of arc.

4. In a gas blast circuit interrupter, an arc chute having an entrance portion and an exhaust portion, separable contact means for establishing an arc transversely of said entrance portion, a plurality of spaced arc splitter plates arranged across said arc chute edgewise with respect to the path of the arc, and means directing a blast of gas of high velocity into said entrance portion for moving the arc against the edges of said splitter plates, said gas blast di-

recting means being positioned to cause said gas blast to play principally upon one end of the arc and exhaust principally along an almost straight line from the gas blast directing means through the first space adjacent said end of the arc, said splitter plates comprising material which gives off gas when acted upon by an arc and being adapted when subjected to relatively large current arcs to cause the gas given off to be directed principally through the remaining spaces between said splitter plates for quickly driving the ionized gases to the exhaust portion of the arc chute.

5. In a gas blast circuit interrupter, an arc chute having a constricted entrance portion and an exhaust portion, said arc chute diverging in width laterally of the arc from said entrance to said exhaust portion, separable contact means for establishing an arc transversely of said arc chute, a plurality of spaced arc splitter plates disposed across said arc chute and arranged edgewise with respect to the path of the arc, said splitter plates having the edges thereof engaged by the arc positioned in the widened portion of the arc chute, and nozzle means for directing a high velocity blast of gas into the entrance portion of said chute for moving the arc against the edges of said splitter plates, said nozzle means directing said blast of gas substantially upon one end of said arc and causing said blast to exhaust principally through the spaces between the splitter plates adjacent said end of the arc during the extinction of relatively small current arcs, said splitter plates being composed at least in part of gas forming material which when subjected to relatively large current arcs generates gas in sufficient quantities to deflect said gas blast both around the sides of the arc and into the spaces between the remaining splitter plates for sweeping the arc path of ionized gases.

6. In a gas blast circuit interrupter, an arc chute having an entrance portion and an exhaust portion, a plurality of spaced partitions arranged across said chute, said partitions diverging from the entrance portion toward the exhaust portion of the chute and being provided with a U-shaped notch at the converged ends thereof, relatively movable contacts for establishing an arc in said notches, and means for directing a blast of gas transversely of said arc to drive it against the closed ends of said notches, the converging ends of said partitions being tapered to provide uniform spacing therebetween for a distance at least equal to the length of said arc receiving notches.

7. In a gas blast circuit interrupter, an arc chute having an entrance portion and an exhaust portion, a plurality of spaced partitions of insulating material arranged across said chute, said partitions diverging from the entrance portion toward the exhaust portion of said chute and having a slot at the converged ends thereof, means for establishing an arc in said slots, means for directing a blast of gas into the entrance portion of said chute to move the arc toward the closed ends of said slots, and metallic plate means disposed in spaced relation to said partitions in the diverging spaces between said partitions and extending adjacent the closed ends of said slots for limiting movement of the arc between said partitions in the region of said slots and for cooling the arc gases.

8. In a gas blast circuit interrupter, an arc chute having a throat-like entrance portion and a flared exhaust portion, spaced arc splitter plates of insulating material arranged across said

chute to divide the chute into a plurality of gas discharge passages, said arc splitter plates extending from said throat portion to adjacent the exhaust end of said chute and having arc receiving slots adjacent said throat portion, means for establishing an arc in said slots, means for directing a blast of gas into said throat portion to drive the arc to the end of said slots, and plates of conducting material arranged across said chute in said gas discharge passages and extending adjacent but not to the closed ends of said slots to provide terminals for the arc and prevent excessive lengthening of the arc beyond said slots.

9. In a gas blast circuit interrupter, an arc chute having a throat-like entrance portion and a flared exhaust portion, spaced arc splitter plates of insulating material arranged across said chute to divide the chute into a plurality of gas discharge passages, which increase progressively in cross section toward said exhaust portion, said arc splitting plates having arc receiving edges adjacent said throat portion, means for establishing an arc adjacent said edges, means for blowing a blast of gas into said throat portion to force the arc to against said edges, and plate means of conducting material arranged across said chute in the flared gas discharge passages and extending to within a relatively short distance of said edges for preventing excessive looping of the arc into said gas discharge passages, said arc splitter plates being composed at least in part of a material which gives off gas when acted upon by an arc, said plate means of conducting material being spaced from the arc splitter plates on each side thereof and permitting said blast of gas to sweep the ionized gases from around the arc into the flared exhaust portion of the arc chute along each side of each of said plate means of conducting material.

10. In a gas blast circuit interrupter, an arc chute having an entrance portion and an exhaust portion, a plurality of partitions extending across said chute and arranged to diverge from each other in a direction toward said exhaust portion, means for drawing an arc across the converged ends of said partitions, and means for directing a blast of gas into said entrance portion for moving the arc against the ends of said partitions, said partitions being progressively more closely spaced in the direction in which said arc is drawn to provide gas discharge spaces between adjacent partitions which are approximately proportional to the quantity of gas to be discharged therethrough during each circuit interrupting operation.

11. In a gas blast circuit interrupter, an arc chute having an entrance portion and an exhaust portion, a plurality of arc splitting plates of insulating material extending across said chute and being arranged to diverge from each other in a direction toward said exhaust portion, means for drawing an arc across the converged ends of said partitions, means for injecting a blast of gas into said entrance portion to drive the arc against the ends of said arc splitting plates, and a plurality of metallic cooling elements disposed across each of the spaces between adjacent arc splitting plates for cooling and deionizing the arc gases discharged through said spaces, said cooling elements being more numerous per unit length along said plates in a direction toward said exhaust portion.

12. In a gas blast circuit interrupter, an arc chute having an entrance portion and an exhaust

portion, a plurality of arc splitting plates of insulating material arranged in diverging relation across said chute with their converged ends adjacent the entrance portion thereof to divide

5 said chute into a plurality of gas discharge passages, said arc splitting plates having a progressively decreasing degree of divergence from one side of said chute to the other, means for establishing an arc across the converged ends of
10 said plates, means for subjecting said arc to a lateral blast of gas, and a plurality of metallic cooling elements disposed across each of said passages, said cooling elements being more numerous in the discharge passages of greater divergence and also more numerous in each discharge passage at the exhaust portion than at the entrance portion in order to provide a maximum cooling effect without creating excessive back pressure in each of said passages.

13. In a gas blast circuit interrupter, an arc chute, a plurality of partitions of insulating material extending across said chute to divide it into a plurality of gas discharge passages, means for establishing an arc across one end of said
25 partitions, means subjecting said arc to a lateral blast of gas, said blast of gas driving the ionized gas from the arc stream into said gas discharge passages, and cooling means disposed in said passages for cooling and deionizing said arc gases,
30 said cooling means comprising a plurality of curved perforated metallic plates disposed with their concave sides facing the flow of gas through said passages and positioned at spaced intervals along said passages, said curved metallic plates
35 deflecting the hot arc gases away from said partitions to avoid further formation of gas by the action of the hot arc gases on said partitions.

14. In a gas blast circuit interrupter, means defining a relatively narrow passage, spaced plate
40 means of insulating material extending across said passage, contact means for drawing an arc in said passage adjacent and generally normal to the ends of said plate means, and means for directing a high velocity blast of gas against the
45 arc at an angle with respect to the longitudinal axis of the arc for moving the arc inclined toward the first-formed section of the arc against the ends of said plate means and subjecting a relatively short first-formed section of the arc
50 to substantially the full effect of said blast.

15. In a gas blast circuit interrupter, an arc chute having an entrance portion and an exhaust portion, a plurality of spaced partitions of insulating material arranged across said chute, said
55 partitions diverging from the entrance portion toward the exhaust portion of said chute, means for establishing an arc in a direction generally normal to the converging ends of said partitions, means for directing a blast of gas into the entrance portion of said chute to move the arc
60 against the converging ends of said partitions, and buffer plates of conducting material and of substantially less length than said partitions disposed in the diverging spaces between said partitions adjacent but spaced from the converging ends thereof, said buffer plates acting to confine the arc in the region of the converging ends of
65 said partitions.

16. In a gas blast circuit interrupter, an arc chute having an entrance portion and an exhaust portion, a plurality of spaced partitions arranged across said chute, said partitions diverging from the entrance portion toward the exhaust portion of the chute, relatively movable contacts for
70 establishing an arc across the converging ends

of said partitions, and means for directing a blast of gas laterally of said arc to drive it against the ends of said partitions, the converging ends of said partitions being tapered to provide uniform spacing therebetween at least in the region of arc engagement.

17. In a gas blast circuit interrupter, an arc chute having an entrance portion and an exhaust portion, a plurality of arc splitting plates of insulating material arranged in diverging relation across said chute with their converged ends adjacent the entrance portion thereof to divide said chute into a plurality of gas discharge passages, said arc splitting plates having a progressively decreasing degree of divergence from one side of said chute to the other, means for establishing an arc across the converged ends of said plates, means for subjecting said arc to a lateral blast of gas, and a plurality of metallic cooling elements disposed across each of said passages.

18. In a gas blast circuit interrupter, an arc chute in which an arc may be established, said arc chute having a constricted entrance portion, an exhaust portion and a portion widened laterally of the arc between the constricted entrance portion and the exhaust portion, spaced partition members in the arc chute having at least portions adjacent the path where the arc is established of insulating material which gives off gas when acted upon by the arc, means causing gas under pressure to flow into the arc chute through the constricted entrance portion and blow the arc against the edges of said partition members, and said edges of the partition members against which the arc is blown being in said widened portion of the arc chute.

19. In a gas blast circuit interrupter, an arc chute in which an arc may be established, said arc chute having a constricted entrance portion, an exhaust portion and a portion widened laterally of the arc between the constricted entrance portion and the exhaust portion, spaced partition members in the arc chute having at least portions adjacent the path where the arc is established of insulating material which gives off gas when acted upon by the arc, means causing gas under pressure to flow into the arc chute through the constricted entrance portion and blow the arc against the edges of said partition members, said edges of the partition members against which the arc is blown being in said widened portion of the arc chute, and means for holding the arc against substantial lateral movement in said widened portion of the arc chute and directly in the concentrated blast of gas from the constricted entrance portion.

20. In a gas blast circuit interrupter, an arc chute, a movable contact for drawing an arc therein, said arc chute having a narrow entrance portion, a portion widened in a direction transversely of the arc, and an exhaust portion, said movable contact having at least one edge movable in said widened portion of the arc chute, a plurality of insulating members positioned in the arc chute and having edge portions extending closely adjacent to the path of movement of said edge of the contact movable in the widened portion of the arc chute, a source of gas under pressure connected to cause a blast of gas through the narrow entrance portion of the arc chute, and means preventing transverse move-

ment of the arc in said widened portion of the arc chute and holding the arc in the concentrated blast of gas from said narrow entrance portion.

21. In a gas blast circuit interrupter, an arc chute in which an arc may be established, said arc chute having a constricted entrance portion, an exhaust portion and a portion widened laterally of the arc between the constricted entrance portion and the exhaust portion, spaced partition members of insulating material in the arc chute and having notches adjacent the path where the arc is established, means causing gas under pressure to flow into the arc chute through the constricted entrance portion and blow the arc toward the closed ends of the notches, said closed ends of the notches lying in said widened portion of the arc chute and restricting lateral movement of the arc in said widened portion so as to hold the arc in the path of the concentrated blast of gas through the constricted entrance portion of the arc chute.

22. In a gas blast circuit interrupter, an arc chute having an entrance portion and an exhaust portion, a plurality of spaced partitions arranged across said chute, said partitions diverging from the entrance portion toward the exhaust portion of the chute, relatively movable contacts for establishing an arc adjacent the converged ends of said partitions, means supplying a blast of gas through the entrance portion of the chute for driving the arc against the converged ends of the partitions, and said converged ends of the partitions being of reduced thickness to facilitate flow of said blast of gas into the exhaust portion of the chute.

23. In a gas blast circuit interrupter, an arc chute having an entrance portion and an exhaust portion, a plurality of spaced partitions of insulating material arranged across said chute, means for establishing an arc adjacent the edges of said partitions of insulating material nearest the entrance portion of the chute, means supplying a blast of gas through the entrance portion of the chute to move the arc against said edges of said partitions of insulating material, and metal plates positioned between said partitions of insulating material and generally parallel therewith, said metal plates extending adjacent to but being spaced away from the edges of said partitions of insulating material against which the arc is moved by the blast of gas.

24. In a gas blast circuit interrupter, an arc chute, a plurality of partitions of insulating material extending across said chute to divide it into a plurality of gas discharge passages, means for establishing an arc across one end of said partitions, means subjecting said arc to a lateral blast of gas, said blast of gas driving the ionized gas from the arc stream into said gas discharge passages, and cooling means disposed in said passages for cooling and deionizing said arc gases, said cooling means including a plurality of metallic members permitting flow of gas thereover and having inclined surfaces deflecting the hot arc gases away from said partitions to retard the further formation of gas by the action of the hot arc gases on said partitions.

LEON R. LUDWIG.
HERBERT L. RAWLINS.
BENJAMIN P. BAKER.