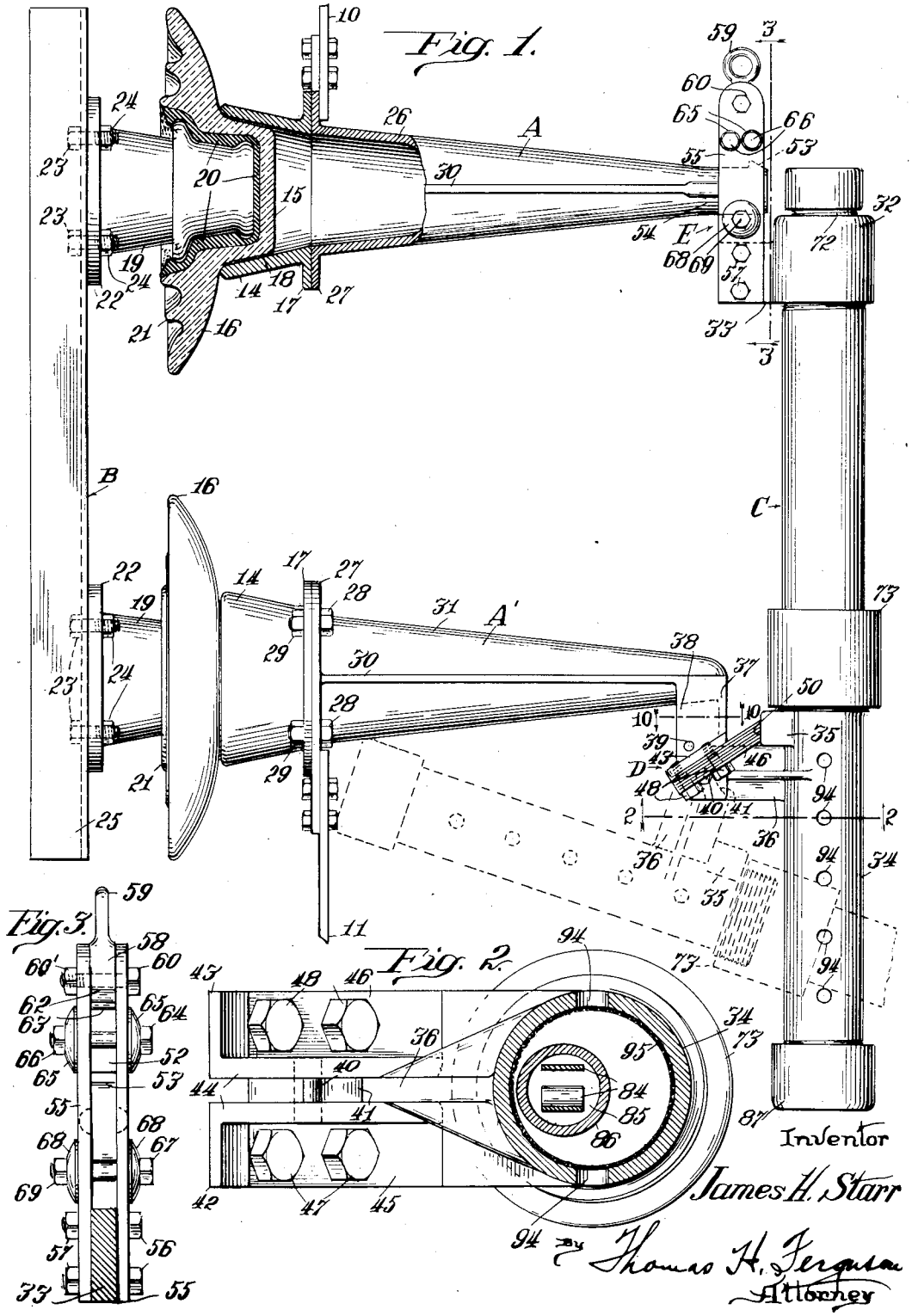
Sept. 3, 1935. J. H. STARR 2,013,427

ALTERNATING CURRENT CIRCUIT INTERRUPTER

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ALTERNATING CURRENT CIRCUIT INTERRUPTER

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Fig. 4.

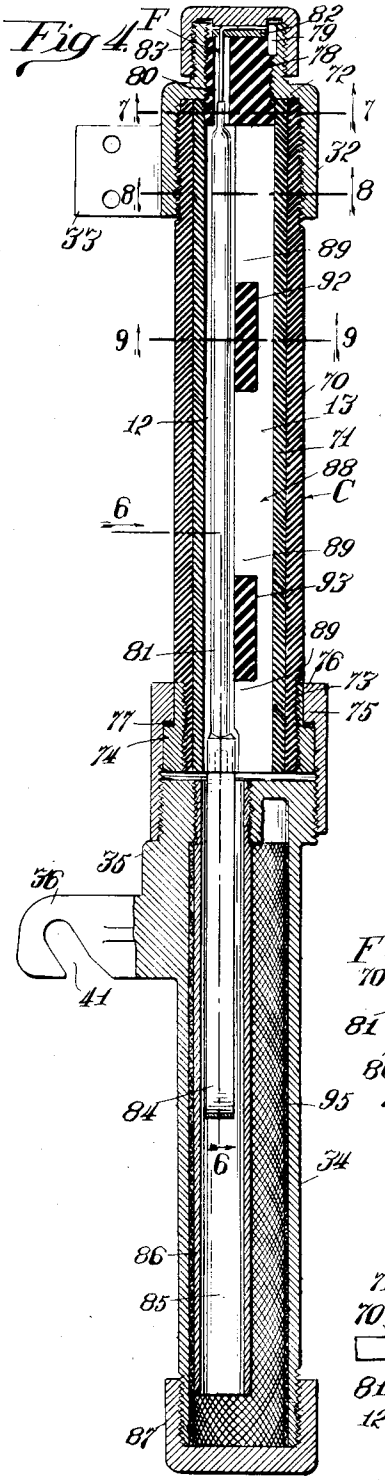


Fig. 5.

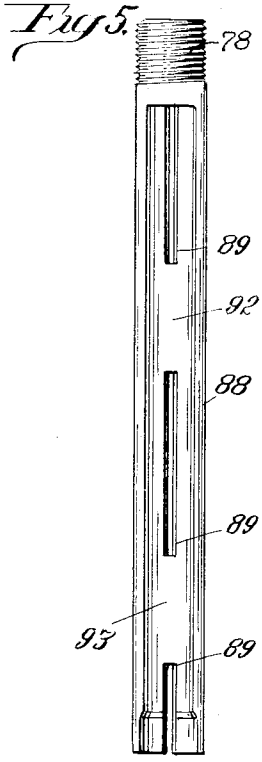


Fig. 6.

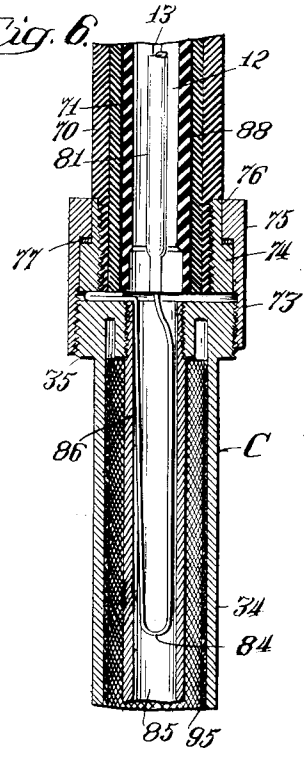


Fig. 7.

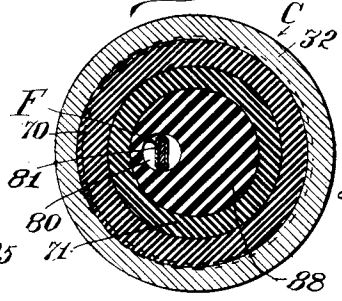


Fig. 8

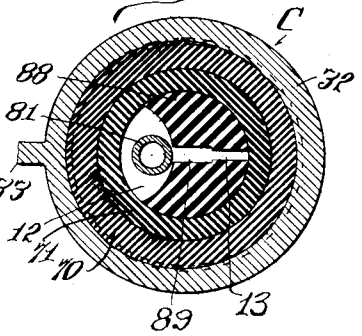
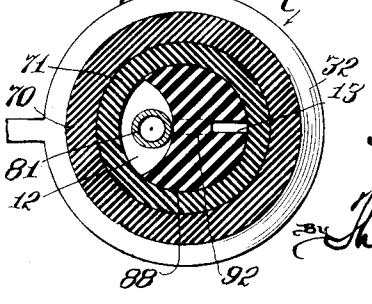


Fig. 9.



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Fig. 10.

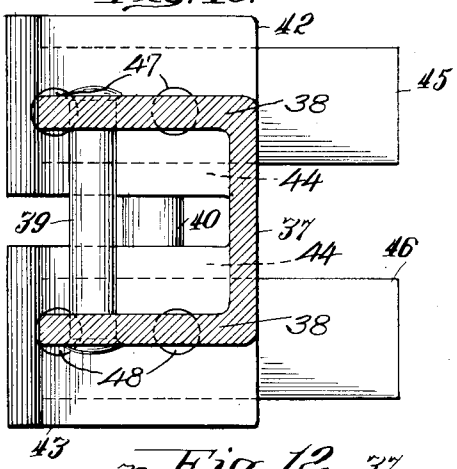


Fig. 11.

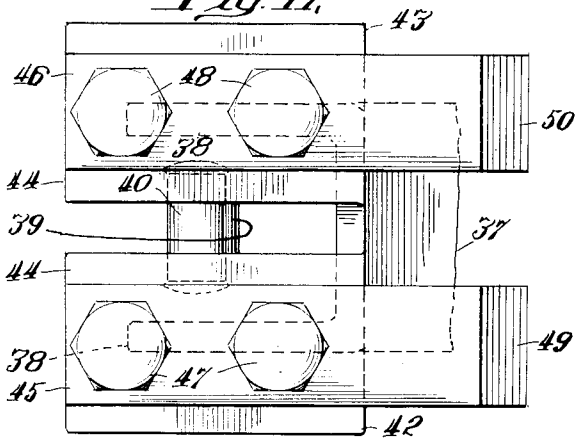


Fig. 12.

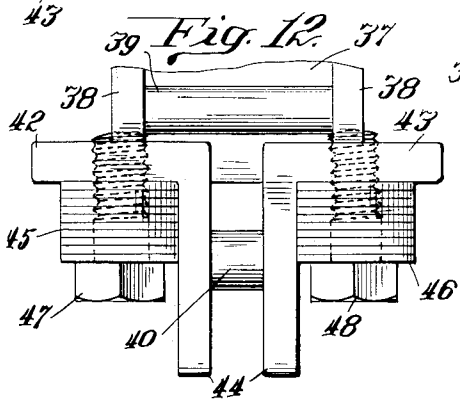


Fig. 13.

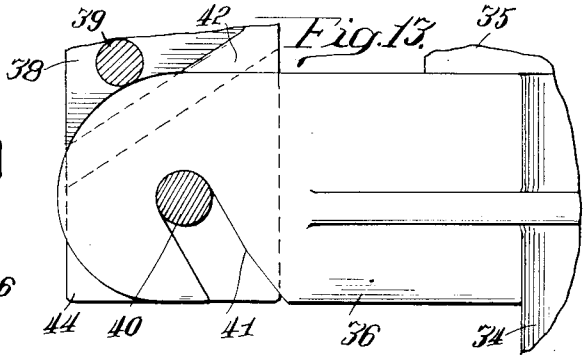


Fig. 14.

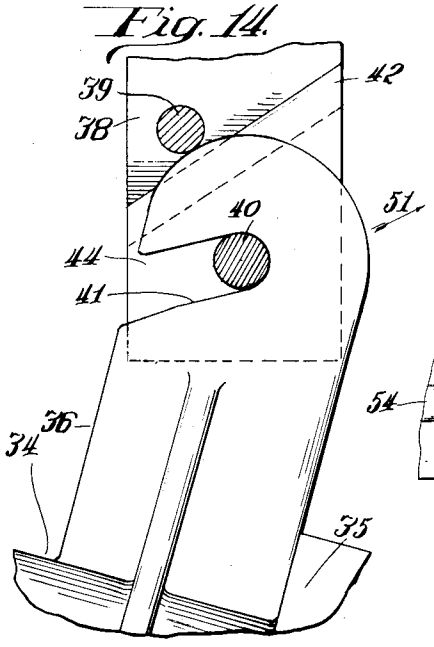
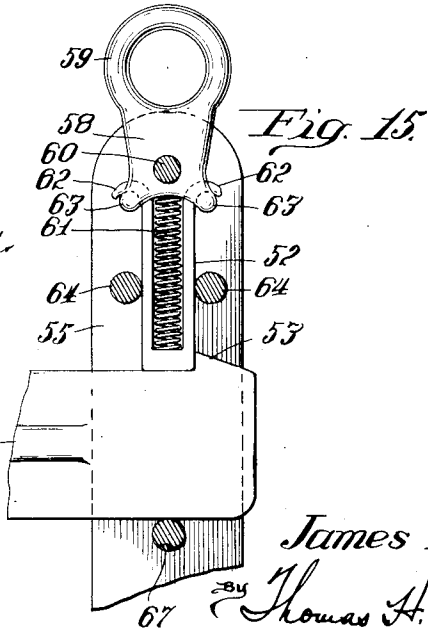


Fig. 15.



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2,013,427

UNITED STATES PATENT OFFICE

2,013,427

ALTERNATING CURRENT CIRCUIT INTERRUPTER

James H. Starr, Oak Park, Ill., assignor to Electrical Engineers Equipment Company, a corporation of Illinois

Application December 13, 1933, Serial No. 702,150

19 Claims. (Cl. 200—120)

The present invention relates to alternating current circuit interrupters and has for its principal object to provide an interrupter of this class which will more effectively interrupt the circuit than has been done in devices of this kind heretofore in use and to produce such effective interruption throughout an increased range of energy values.

As a preliminary to the brief statement of the invention, a few matters of theory may be stated with reference to the extinction of arcs in alternating current circuits.

The continuance of the alternating current arc depends, according to recognized theory, upon the repeated reignition of the arc for each new half cycle after a current zero. Just after a current zero the arc space is losing ionization and recovering dielectric strength; that is, its ability to withstand voltage. On the other hand, voltage tending to break down the arc space again is building up across the arc space terminals. If the dielectric strength measured by volts which the space can withstand, grows faster than the voltage which the external circuit impresses upon the terminals, then the arc will be extinguished. If the voltage supplied by the external circuit builds up faster than the dielectric strength of the arc space, then the arc will be reignited.

The recovery of dielectric strength by an arc space immediately following current zero is due to the disappearance of ions which are required for the conduction of the arc current. These ions are lost from an arc space in different ways, including the recombination of positive and negative ions throughout the arc space.

These and other like statements of theory will be found in various papers by J. Slepian, T. E. Brown, Jr., and others, found in the Transactions of the American Institute of Electrical Engineers, some of which are as follows:

Extinction of Long A-C. Arcs, by J. Slepian, vol. 49, No. 2, April 1930, page 421;

Arcs in Low Voltage A-C. Networks, by J. Slepian and A. P. Strom, vol. 50, No. 3, September 1931, page 847;

Extinction of Short A-C. Arcs, by T. E. Brown, Jr., vol. 50, No. 4, December 1931, page 1461;

Extinction of A-C. Arcs, by T. E. Brown, Jr., vol. 51, No. 1, March 1932, page 185.

From the various available statements of theory and from the various experiments which support that theory, it is clear that there is a considerable difference in the interrupting results obtainable with high and low voltages and with short and long arcs. What will do in one case will not suffice for another.

To illustrate, it is found in the case of expulsion fuses that the interrupting ability is dependent upon the length, inside diameter, and strength, of fuse tube. With tubes of a given length, the voltage of the circuit which may be successively interrupted, increases inversely as the tube diameter, that is to say, the less the diameter the greater the voltage which may be successively interrupted. Of course, a limiting point in the reduction of the diameter is reached when the limit of strength of the material of the tube is exceeded.

Again, with tubes of a given diameter, the voltage will increase roughly directly as the length of the tube. In this case the interrupting ability is usually expressed in voltage per inch length of tube.

As before pointed out and more fully set forth in the papers cited, the successful extinguishment of the arc in an inclosed fibre tube is traceable to the generation of gases by application of heat of the arc to the fibrous material of the tube and the rapid admixture of the gas molecules so formed with the ionized gas particles forming the gas stream. With a given tube diameter and a relatively small value of current, the arc does not produce sufficient gas, by destruction of the fibrous tube, to result in the violent admixture with the ionized gas particles comprising the arc stream, necessary to obtain a high interrupting ability in volts per inch. If, on the other hand, the same current were passed as an arc through a similar tube of materially smaller diameter, the more intimate contact of the arc with the tube wall would result in a more rapid destruction of the exposed fibers and consequently in greater turbulence of the arc stream which, as stated by Slepian and others, results in an increase in interrupting ability in volts per inch.

Thus it is clear that one diameter of tube will be necessary to meet one condition of service and another diameter to meet another condition. In brief, both conditions cannot be fulfilled by a single tube of the kind heretofore proposed.

Now, one of the objects of the present invention is to provide an interrupter which will meet these different requirements of service and work effectively at all times to rupture the circuit.

Another object is to provide an interrupter of this kind which will operate automatically to meet the different requirements of service.

From another view point, an important object of the invention is to provide an interrupter of

the type mentioned which will have an interrupting capacity throughout a wider range of current values than heretofore obtainable in devices of this class.

There are also other objects, features, and advantages, of the invention, which will appear hereinafter in the detailed description which is to be considered in connection with the accompanying drawings which disclose a preferred embodiment of the invention. For statements of the scope of the invention reference should be had to the appended claims.

In brief, the invention is put into practice by establishing the arc of the interrupter in a main chamber, or tube, of rated capacity, sufficient to carry the necessary current without rupture of the tube, and then forcing the arc thus produced laterally into an auxiliary chamber, preferably a slot, in communication with the main chamber. The cross sectional area of the slot is much less than that of the main tube. Consequently, by pressing the arc into the slot, the cross sectional area of the arc is greatly reduced, and the arc coming into contact with the walls of the slot, which are composed of fiber, or other material, capable of producing a deionizing action, increases the rate of production of the gas with a resultant improvement in the rupturing ability of the device, measured in volts per inch.

Preferably, too, the force for shifting the arc from the main chamber into the auxiliary chamber, is provided by a magnetic field occasioned by the current passing through the interrupter and consequently through the arc. A preferred way of accomplishing this is by arranging the conductors of the adjacent circuit to form a loop which will provide magnetic lines of force which will exert pressure against the arc stream in a direction transverse to, and at substantially right angles to, the direction of the arc.

When viewed in this way, the invention consists, insofar as this aspect of it is concerned, in providing an interrupter which employs an electromagnetic force derived from the current passing through it to force the arc to assume a position in which it is prevented from reestablishing itself after current zero.

Referring now to the drawings, Fig. 1 is a side elevation of an expulsion fuse constructed and arranged in accordance with the present invention, a portion of one of the pedestals and associated insulators being shown in section.

Fig. 2 is a view illustrating one way of establishing connection between a pedestal and the associated fuse tube, a portion of the latter being shown in section taken on a plane indicated by the line 2—2 of Fig. 1.

Fig. 3 is an elevation of locking mechanism by which the upper pedestal is secured to the tubular fuse structure.

Fig. 4 is a central vertical section through the tubular fuse structure.

Fig. 5 is an elevation of one of the tubes forming part of the structure of the tubular fuse element.

Fig. 6 is a longitudinal section through a portion of the tubular fuse structure, the plane of section being indicated by the line 6—6 of Fig. 4.

And Figs. 7, 8 and 9 are transverse sections through the same structure, taken respectively on planes indicated by the lines 7—7, 8—8 and 9—9 of Fig. 4.

Fig. 10 is a partial sectional view illustrating the structure at the outer end of one of the pedestals, the plane of section being indicated by the line 10—10 of Fig. 1.

Fig. 11 is an elevation of the same structure viewed in a direction at right angles to the plane of the contact brushes, the view being taken from beneath as the parts are shown in Fig. 1.

Fig. 12 is an end view of the same structure, the view being taken from the left as the parts are shown in Fig. 1.

Fig. 13 is a detailed structural view illustrating the connection between the lower pedestal and the fuse link when the latter is in connecting position.

Fig. 14 is a similar view of the parts when the fuse link is in a position to be withdrawn from the pedestal.

And Fig. 15 is a partial sectional view of the locking mechanism by which the upper pedestal is secured to the upper portion of the link element of the structure.

Throughout these views like characters refer to like parts.

In brief, the expulsion fuse form of the invention illustrated in the drawings, includes a pair of pedestals A, A^1, a base B upon which the pedestals are mounted, and a loop closing link C which constitutes the tubular fuse structure in which the arc is formed. The arrangement provides a current path extending from a conductor 10, outward through a conducting portion of the upper pedestal A, thence through conducting portions of the link C, and finally inward through a conducting portion of the lower pedestal A^1, to the associated conductor 11.

The current path, thus provided, constitutes a loop which produces a magnetic field which acts outward away from the base in a direction to force the circuit closing element C outward away from its pedestals. The link C is held to the lower pedestal by a suitable locking pin-and-slot connection D, and to the upper pedestal by a special lock. The lock may take different forms but is preferably like that illustrated in United States Patent No. 1,515,116, granted November 11, 1924 to E. H. Jacobs.

The outward driving force produced by the magnetic field cannot dislodge the link C but it can, and does, act upon the arc produced by the blowing of the fusible metal link F within the tubular body of the link C. The blowing of the fuse link F establishes the arc in a main expulsion chamber 12, which is in direct communication with a slot 13, which constitutes an auxiliary chamber of reduced cross sectional area, into which the arc may be thrust more or less completely by the magnetic force resulting from the current through the loop. The degree of lateral movement imparted to the arc by the magnetic field will depend upon the magnitude of the current passing through the arc.

The force tending to shift the arc into the slot is proportional to the square of the amount of arc current. The shifting of the arc toward and into the slot increases the destruction of the fibrous material of the walls of the chambers and thereby increases the gas pressure opposing further penetration. Thus with the smaller currents the force driving the arc into the slot is small but so also is the rate of gas generation producing opposing pressure, and the arc penetrates far into the slot before sufficient pressure is developed to neutralize the electromagnetic forces. In contrast with a large volume of current the driving force is great but the rate of

gas generation is correspondingly increased by the more rapid destruction of fibrous material and the condition of equilibrium is attained with a smaller amount of penetration.

From what has been said, it will be seen that my invention provides forces which tend to move the arc into the slot and other forces tending to prevent such motion, these forces balancing each other when the arc has progressed into the slot a distance sufficient to provide the turbulence of gas admixture requisite for prompt interruption but without permitting the arc to progress to a point in the slot at which the violence of gas generation approaches that at which mechanical tube failure is imminent.

The force tending to drive the arc from the longitudinal hole into the adjacent longitudinal slot is derived from the electromagnetic reaction of the current as it is lead to and from the fuse, upon the current in the arc. To produce this effect, the fuse is set a substantial distance above the top of the insulators on which it is mounted and the current is carried to and from it by members substantially perpendicular to the axis of the fuse tube. The electromagnetic force obtained on the arc by this means is determinable by application of the equation for mechanical forces acting on the blade of a disconnecting switch, presented by H. B. Dwight, in a paper entitled "Calculation of magnetic forces on disconnecting switches", published in the Transactions of the American Institute of Electrical Engineers, vol. 39, page 1337.

The force tending to prevent progress of the arc into the slot is derived from the gases generated by the action of the arc energy on the fibrous walls of the slot which produce an increasingly violent blast of gas across the arc stream as the arc penetrates the slot.

Referring now more particularly to the structure illustrated, it will be observed that each of the pedestals comprises a base and an extension. In the case of both pedestals the bases **14** are alike. They are tubular and embrace the head **15** of the insulator **16**. The outer end of each base **14** terminates in a laterally extending flange **17**. The base **14** is preferably secured to the pedestal head **15** by a suitable cement **18**. The pin **19** fits within a socket on the under side of the insulator **16** and is firmly held therein by suitable cement **20**. The petticoat **21** of the insulator is suitably shaped so as to increase the creepage distance of the outer surface as is usual with constructions of this sort. The lower end of the pin **19** which is preferably composed of metal, terminates in a flange **22**. Bolts **23** cooperating with suitable nuts **24** firmly secure the pin **19** to the base B. The latter may be formed of any suitable material but is here shown as comprising among its parts a channel iron **25**. The bolts **23** pass through suitable openings in the web of the channel iron **25** and in the flange **22** of the pin. In this way the insulator is firmly secured to the base.

The outer portions of the pedestals A, A', are provided with flanges **27** at their supporting ends. Suitable bolts **28** cooperate with nuts **29** to secure the flanges **17** and **27** together. Thus, each base **14** and its outer extension constitutes a single hollow tubular pedestal structure having a general conical outline. If desired, strengthening ribs **30** may be provided on the sides of the outer portions so as to strengthen the pedestal laterally.

The pedestals A, A' are similar but differ somewhat at their outer ends. Thus, the extension **26** of pedestal A is constructed so as to be locked by the Jacob's lock heretofore referred to as disclosed in U. S. Patent No. 1,515,116. On the other hand, extension **31** of pedestal A' is designed for a detachable mechanical and electrical connection with parts of the pedestal bridging link C. The various parts of these pedestals are composed of suitable metal and the insulator pin **19** is also preferably composed of metal. The insulator **16**, however, is composed of porcelain or other suitable electrically insulating material.

The link C which connects the outer ends of the two pedestals comprises a number of parts. These include a terminal member or head **32** provided with a lateral blade **33**. This head is located at the upper end of the link structure. At the lower end of the structure is a metal tube **34** which has a thickened head portion **35** provided with a blade **36** similar to the blade **33**. These blades **33**, **36** are for use in connecting the fuse link structure to the outer ends of the pedestals A and A', respectively.

The connecting mechanism D is provided by furnishing the outer end of the pedestal A' with a downwardly projecting housing or frame in the form of a channel member **37** having parallel flanges **38**. This frame **37** carries the pins **39** and **40** of the pin and slot connection. The slot which cooperates with the pin **40** is the slot **41** formed in the blade **36**. The lower ends of the flanges **37** terminate in flat plates **42**, **43** which extend on the opposite sides of the flanges as clearly shown in Fig. 12. The pin **39** is secured in place between the flanges **38**. The pin **40**, on the other hand, is secured between bosses **44** extending downwardly from the adjacent edges of the plates **42**, **43**. Both the pins **39** and **40** are held firmly in place, the latter, if preferred, by the brush terminals **45**, **46** which comprise in each instance a number of strips of thin metal, preferably copper, which are secured to the plates **42**, **43**, respectively, and butt up against the opposite ends of the pin **40**. The brushes **45** and **46** are secured in place by suitable bolts **47**, **48** which pass through openings in the brushes into threaded contact with openings in the plates **42** and **43**, respectively.

As clearly shown, the outer ends **49**, **50** of the brushes are beveled so as to fit against the head **35** upon the tube **34** or the fuse link C.

The slot **41** in the blade **36** is inclined with reference to the axis of the element C and when the pin and slot connection is completed and in assembled position the parts bear the relation to each other illustrated in Fig. 13. When in this relation the link C is firmly secured to the lower pedestal A'. When it becomes necessary to remove the link C then the latter must be rotated into the dotted line position illustrated in Fig. 1 which is the full line position of Fig. 14. When the parts are in this position the blade **36** may be moved in the direction of the arrow **51** of Fig. 14 and thereupon moved out of engagement with the pin **40**. This means that the link C is withdrawn from the pedestal A'. It will be noted that in this pin and slot connection the pin **39** is spaced from the pin **40** a distance such as to engage lightly upon the outer surface of the blade **36** which is a circular surface having its center of rotation at the axis of the pin **40**. In this way a connection is established without any lost motion.

The connection E between the upper pedestal

A and the blade 33 of the head 32 at the upper end of the link C is provided by a lock or latch of the kind illustrated in the aforesaid Patent No. 1,515,116. The essential parts of this mechanism include the latch bar 52 which cooperates with a nub or hook 53 on the blade 54 forming the outer extremity of the extension 26 of the pedestal A. The latch 52 is mounted between two housing plates 55 which are firmly secured to opposite sides of the blade 33 by means of bolts 56 and cooperating nuts 57. The upper ends of the plates 55 are spaced apart by an actuating member 58 provided with a ring 59 and mounted for oscillation upon a pivot formed by a bolt 60 having an associated nut 60¹. The latch bar 52 is preferably bifurcated so as to provide a central space for a compression spring 61 which acts at its lower end against the latch bar and at its upper end against the under side of the oscillating member 58. The function of the spring 61 is to normally press the latch bar 52 into position to engage the tooth 53 upon the pedestal end 54. The upper ends of the two arms of the latch bar 52 terminate in hooks 62. These pass over the forwardly extending ends 63 of arms forming part of the oscillating member 58. As clearly shown the ends 63 pass beneath the hooks 62. As a result of this construction a movement of the member 58 about its pivotal bolt 60 in either direction will cause one of the ends 63 to act upon the adjacent hook 62 to raise the latch against the compression of the spring 61. In its movements the latch bar 52 is guided by guide bolts 64 which pass between the plates 55. These bolts are provided in each instance with suitable spring washers 65 and securing nuts 66. The lower edge of the pedestal end 54 is also held up in proper position by a transverse bolt 67 which is also provided with spring washers 68 and an associated nut 69.

With this construction it will be seen that whenever the link C is properly positioned with reference to the lower pedestal A' and rotated at its upper end toward the pedestal A then the pedestal end 54 will pass into the space between the plates 55 and the latch bar 52 will ride up over the inclined face of the tooth 53 and finally lodge behind the same in position to hold all the parts securely together. When the link C is to be removed then it is only necessary to oscillate the member 52 to release the upper end of the link. The purpose of the ring is to enable an attendant with a suitable hook to bring about the release without coming too near to the equipment.

When it comes to the structure of the connecting fuse element C it will be noted that the head 32 at the upper end and the tube 34 at the lower end, both previously mentioned, are connected together by an outer tube 70 of insulating material, and that the latter is provided with an inner tube 71 in which are located the main and auxiliary arcing chambers 12, 13 in which the arc is drawn and extinguished. The lower end of the head is interiorly threaded and the upper end of the tube 70 is exteriorly threaded so that the parts may be properly joined mechanically. The core member 88 firmly fits against the interior wall of the tube 71. Both members abut against a peripheral shoulder formed by reducing the diameter of the head 32 at the offset 72. At its lower end the tube 70 is exteriorly threaded for the reception of a ring 73. The latter has a head 74 at its lower end which fits snugly within the bore of a gland 75 which is threaded over and upon the upper end of the tube 34. The overhanging flange 76 of the gland 75 cooperates with the head 74 to retain the intervening packing 77.

The tubular head 32 is closed at its outer end by a plug-like head 78 which constitutes the upper end of the core member 88. This head 78 finds threaded engagement in the reduced portion of the head 32. This head 78, which like the rest of the member 88, is composed of fiber or other suitable insulating material is keyed to the head 32 by a key 79 and is thus kept from accidental rotation. The head 78 is also provided with a longitudinal passage 80 in which the fusible metal element F is adapted to lie. As clearly shown the lower end of this element is firmly secured to a tubular rod 81 which operates to establish the arc in the longitudinal chamber 12 whenever the fuse is blown. The upper end of the fuse F passes through an opening in a plate or washer 82 and is bent at right angles so as to be compressed between that washer and a closing cap 83; when the latter is screwed home over the outside of the reduced portion of the head 32. When the cap 83 is screwed home then the upper end of the fuse is firmly held. The head 32, the washer 82 and the cap 83 are all composed of suitable electrical conducting material and the circuit is completed from the blade 33 through them to the fuse F and associated rod 81.

The remainder of the circuit is completed from the lower end of the rod 81 through a flexible conductor 84 which is firmly secured to the rod at one end and at the other end is inserted between the ring 74 and the head 35 of the tube 34. When these parts are drawn together by the gland 75 then the end of the tape 84 will be firmly held mechanically and at the same time will be in direct electrical communication with the blade 36 of the link element of the structure. The braid 84 is composed of fine threads of copper or other conducting metal which are woven together to provide a flexible conductor of high conductivity.

Thus, the fuse enclosing member C constitutes a container composed of insulating material capable of decomposition under the action of the arc to produce arc deionizing gases. The container C may properly be termed also an expulsion tube.

The construction thus provided is such that when the fuse F is blown the rod 81 will be forced by the expanding gases quickly down into a well 85 provided by a tube 86 which is threaded at its upper end into a threaded opening in the head 35 and extends downward to within a short distance of the bottom of the tube 34 which is closed by a cap 87. The length of the tape 84 is sufficiently long to allow the lower end of the rod 81 to engage the cap 87 at the bottom of the well. At this time the upper end of the rod will be near the lower end of the chamber 12 at about the level of the upper face of the head 35. Obviously, any arc which may be drawn will extend from the plug 78 at the upper end down through the chamber 12 to the upper end of the rod 81 when in its position adjacent to the head 35.

Thus, an arc is established in the chamber 12. This chamber is a longitudinal chamber extending practically the full length of the fiber tube 70 and its fiber liner 71. The chamber is provided by inserting a core 88 into the cylindrical liner 71. The core 88 is crescent shaped, as illustrated more particularly in Figs. 8 and 9, and at intervals, three in the present instance, the main expansion chamber 12 communicates through

slots 89 with the auxiliary longitudinal chamber 13. The portions of the core between the slots 89 constitute transverse members 92, 93. Viewed in one way, the chamber 12 is provided with a slot along one side bridged by the transverse members 92, 93.

It will be seen that when the arc is established within the chamber 12 in the way pointed out, the same will be crowded laterally away from the base B by the magnetic field produced by the current in the loop. The effect upon the arc will be to force the same against the transverse members 92, 93 and thus break it up or divide it into segments, and at the same time burn away some of the material of the fibrous members 71, 88 to produce gases which will act against the magnetic field and greatly increase the turbulence within the chamber 12 to the end that the arc may be the more readily extinguished. The action of the magnetic field will also crowd portions of the arc into the auxiliary chamber or slot 13 and this will tend to reduce the cross-sectional area of the arc and while thus attenuating it cause the fibrous material of the walls of the auxiliary chamber also to be broken down with the resulting production of large quantities of gas which will still further contribute to the extinction of the arc.

The walls of the chamber 12, formed in part by the core 88 and in part by the liner 71, restrict the arc formed therein to a definite cross-sectional area and as the arc is diverted from its normal path by the magnetic field its passage into the slot 13 results in further reduction of its cross-sectional area. The means for thus restricting such area is present in the walls of the slot.

During the continuance of the arc, gases will be generated and forced down through the tube 86 into the interior of the tube 34. From the latter they will pass out through openings 94 in the walls of the tube 34 to atmosphere. Obviously these openings may be variously positioned and any desired number may be employed. In order to prevent flame from passing from the interior of the tube 34 into the adjacent atmosphere the interior of the tube is preferably lined with a screen 95 of fine mesh. Any gases which escape must pass through this screen.

The rod 81 need not be of great weight as its action in drawing the arc is not dependent particularly upon gravity but rather upon the downward expulsive force within the chamber 12 resulting from the formation of gases due to the decomposition of the fibrous material of the walls of the chamber by the arc. This rod, of course, might be differently shaped but it is preferably made tubular in order to increase its strength without greatly increasing its weight.

The resistance of the rod 81 against transverse forces comes into play when, subject to excess flow of current through the loop prior to melting of the fusible strip F, there is present the strong magnetic field which applies pressure outward from the base. Although this condition persists for only a very brief period, this pressure is applied to the rod 81 and if the same did not have sufficient lateral strength it would be pressed against the transverse bars 92, 93 and distorted and thus rendered unreliable if not wholly inoperative for the purposes intended. The ends of the rod 81 may be secured to the fusible strip F by flattening the same out upon the strip in the manner shown, particularly in Figs. 4 and 7, and then soldering the two parts together or in any other way as desired. Similarly the lower end of the tube is flattened out upon the inserted end of the tape 84 and these parts may be soldered together also if desired.

Obviously, in carrying out my invention different ways of establishing the arc may be employed. The important thing is not how the arc is formed but rather what is done with it after it is formed. The essential thing is the crowding of the arc from a containing space in which it is established, by whatever means, into a more restricted space. Consequently various ways of establishing the arc in the first place may be employed and these will readily occur to persons skilled in the art and need not be particularly disclosed herein.

Besides these various modifications, the dimensions may be changed as desired. For example, should it be desirable to increase the outward force of the magnetic field acting upon the pedestal uniting element C, the pedestals may be placed closer together. Similarly other dimensional changes may be made with corresponding changes in results.

In view of the many possible alterations and modifications which may be made without departing from the spirit and scope of the invention I do not wish to be limited to the specific matters disposed but aim to cover by the terms of the appended claims all those changes which rightly come within the purview of the invention.

I claim:

1. An alternating current circuit interrupter comprising means for establishing an arc, means for restricting the arc when in its normal path to a definite cross sectional area, means for diverting the arc as a whole from its normal path laterally in a given direction, and means for still further restricting the cross sectional area of the arc when so diverted.

2. An alternating current circuit interrupter comprising means for establishing an arc, means for restricting the arc when in its normal path to a definite cross sectional area, means dependent upon the magnitude of arc current to divert the arc as a whole from its normal path laterally in a given direction, and means for still further restricting the cross sectional area of the arc when so diverted.

3. An alternating current circuit interrupter of the expulsive type comprising a main expulsion chamber, means for establishing an arc in said main chamber, said chamber operating to confine the arc to a definite cross sectional area, an auxiliary expulsion chamber for receiving the arc, said auxiliary chamber being of smaller cross sectional area than said main chamber, and means for diverting the arc as a whole from its position in said main chamber laterally into said auxiliary chamber to reduce the cross sectional area of the arc.

4. An alternating current circuit interrupter of the expulsive type comprising a main expulsion chamber, means for establishing an arc in said main chamber, said chamber operating to confine the arc to a definite cross sectional area, an auxiliary expulsion chamber for receiving the arc, said auxiliary chamber being of smaller cross sectional area than said main chamber, and means dependent upon the magnitude of arc current to divert the arc as a whole from its position in said main chamber laterally into said auxiliary chamber to reduce the cross sectional area of the arc.

5. An alternating current circuit interrupter

comprising a main arc chamber, an auxiliary arc chamber of less cross sectional area than said main chamber communicating with the latter, means for establishing an arc in said main chamber, and means for diverting the arc as a whole from its position in said main chamber laterally into said auxiliary chamber to reduce the cross sectional area of the arc.

6. An alternating current circuit interrupter comprising a main arc chamber, an auxiliary arc chamber of less cross sectional area than said main chamber communicating with the latter, means for establishing an arc in said main chamber, and means dependent upon the magnitude of arc current to divert the arc as a whole from its position in said main chamber laterally into said auxiliary chamber to reduce the cross sectional area of the arc.

7. An alternating current circuit interrupter comprising a longitudinal main arc chamber, a longitudinal auxiliary arc chamber of less cross sectional area than said main chamber communicating with the latter, means for establishing an arc in said main chamber, and means for diverting the arc as a whole from its position in said main chamber laterally into said auxiliary chamber to reduce the cross sectional area of the arc.

8. An alternating current circuit interrupter comprising a longitudinal main arc chamber, a longitudinal auxiliary arc chamber of less cross sectional area than said main chamber communicating with the latter, means for establishing an arc in said main chamber, and means dependent upon the magnitude of arc current to divert the arc as a whole from its position in said main chamber laterally into said auxiliary chamber to reduce the cross sectional area of the arc.

9. An alternating current circuit interrupter comprising a longitudinal main arc chamber, a longitudinal slot opening into said main chamber and constituting an auxiliary arc chamber, means for establshing an arc in said main chamber, and means for diverting the arc as a whole from its position in said main chamber laterally into said auxiliary chamber to reduce the cross sectional area af the arc.

10. An alternating current circuit interrupter comprising a longitudinal main arc chamber, a longitudinal slot opening into said main chamber and constituting an auxiliary arc chamber, means for establishing an arc in said main chamber, and means dependent upon the magnitude of arc current to divert the arc as a whole from its position in said main chamber laterally into said auxiliary chamber to reduce the cross sectional area of the arc.

11. An alternating current circuit interrupter comprising a main arc chamber, an auxiliary arc chamber of less cross sectional area than said main chamber communicating with the latter, said auxiliary chamber being composed of material readily converted to the gaseous state by contact with an arc, means for establishing an arc in said main chamber, and means for diverting the arc as a whole from its position in said main chamber laterally into said auxiliary chamber, said diverting being opposed by a force tending to move the arc out of said auxiliary chamber resulting from the formation of gases produced by the action of the arc upon the material of said auxiliary chamber.

12. An alternating current circuit interrupter of the expulsive type comprising a main arc chamber, an auxiliary arc chamber of less cross sectional area than said main chamber communicating with the latter, said auxiliary chamber being composed of material readily converted to the gaseous state by contact with an arc, means for establishing an arc in said main chamber, and means for diverting the arc as a whole from its position in said main chamber laterally into said auxiliary chamber, said diverting being opposed by a force tending to move the arc out of said auxiliary chamber resulting from the formation of gases produced by the action of the arc upon the material of said auxiliary chamber.

13. An alternating current circuit interrupter of the expulsive type comprising a longitudinal main arc chamber, a longitudinal auxiliary arc chamber of less cross sectional area than said main chamber communicating with the latter, said auxiliary chamber being composed of material readily converted to the gaseous form by contact with an arc, means for establishing an arc in said main chamber, and means dependent upon the magnitude of arc current to divert the arc as a whole from its position in said main chamber laterally into said auxiliary chamber to reduce the cross sectional area of the arc, said diverting being opposed by a force tending to move the arc out of said auxiliary chamber resulting from the formation of gases produced by the action of the arc upon the material of said auxiliary chamber.

14. An alternating current circuit interrupter comprising a base, spaced pedestals extending outward from said base, said pedestals having electrical conducting portions extending to the outer ends thereof, a circuit closing element connecting said conducting portions at the outer ends of said pedestals, said outwardly extending conducting portions and intervening circuit closing element forming a loop which when energized by current therethrough will produce an intense magnetic field applying a force outward from said base between said pedestals, said circuit closing element comprising a main arc chamber, an auxiliary arc chamber of less cross sectional area than said main chamber and communicating with the latter, said auxiliary chamber lying outwardly of said main chamber from said base, and means for establishing an arc in said main chamber, whereupon the arc thus established will be driven by said magnetic field from its position in said main chamber into said auxiliary chamber to reduce the cross sectional area of the arc.

15. An alternating current circuit interrupter comprising a base, spaced pedestals extending outward from said base, electrical conducting portions extending to the outer ends thereof, a circuit closing element connecting said conducting portions at the outer ends of said pedestals, said outwardly extending conducting portions and intervening circuit closing element forming a loop which when energized by current therethrough will produce an intense magnetic field applying a force outward from said base between said pedestals, said circuit closing element comprising a longitudinal main arc chamber, a longitudinal auxiliary arc chamber of less cross sectional area than said main chamber and communicating with the latter, said auxiliary chamber lying outwardly of said main chamber from said base, and means for establishing an arc in said main chamber, whereupon the arc thus established will be driven by said magnetic field from its position in said main chamber into said auxiliary chamber to reduce the cross sectional area of the arc.

16. An alternating current circuit interrupter comprising a conducting loop adapted to provide a magnetic field acting outwardly from the center

of the loop, said loop including a circuit interrupting element, said element comprising a main arc chamber, an auxiliary arc chamber located outwardly of and communicating with said main chamber, and means for establishing an arc in said main chamber, which arc will be subject to said magnetic field and be crowded thereby into said auxiliary chamber to assist in the disruption of the circuit.

17. An alternating current circuit interrupter comprising a conducting loop adapted to provide a magnetic field acting outwardly upon the loop, said loop including a circuit interrupting element, said element having a main arcing chamber, a fusible element at the upper end of said chamber, a longitudinal metal conducting member secured at its upper end to said fusible element and depending in said chamber, a flexible conductor extending from the lower end of said member, an auxiliary arcing chamber located outwardly of said main chamber so that the magnetic field tends to divert the arc from the main chamber to said auxiliary chamber, and transverse sustaining members in said interrupting element for engaging said longitudinal conducting member to prevent the diversion of said conducting member into said auxiliary chamber under the action of the magnetic field, whereby the formation of the arc in said main chamber initially is assured.

18. An alternating current circuit interrupter comprising a conducting loop adapted to provide a magnetic field acting outwardly upon the loop, said loop including a circuit interrupting element, said element having a main arcing chamber, a fusible element at the upper end of said chamber, a tubular conducting rod secured at its upper end to said fusible element and depending in said chamber and adapted to drop into a well beneath said chamber when freed by the rupture of said fusible element, a flexible conductor within said well for completing the circuit to said rod, an auxiliary arcing chamber located outwardly of said main chamber so that the magnetic field tends to divert the arc from the main chamber to said auxiliary chamber, and transverse sustaining members adjacent to said rod and operative to engage the same when forced outwardly by said magnetic field whereby the formation of the arc in said main chamber initially is assured.

19. An alternating current circuit interrupter comprising a conducting loop adapted to provide a magnetic field acting outwardly upon the loop, said loop including a circuit interrupting element, said element having an arcing chamber, means for drawing an arc in said chamber, and transverse members of deionizing material in said chamber in position to engage the arc at a plurality of points in its length when deflected by said magnetic field resulting in increased distortion of the arc and increased turbulence of disrupting gases with corresponding improvement in rupturing capacity.

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