Oct. 24, 1961 C. J. YARRICK 3,005,892

ARC CHUTE DESIGN FOR CIRCUIT BREAKERS

Filed March 19, 1957 3 Sheets-Sheet 1

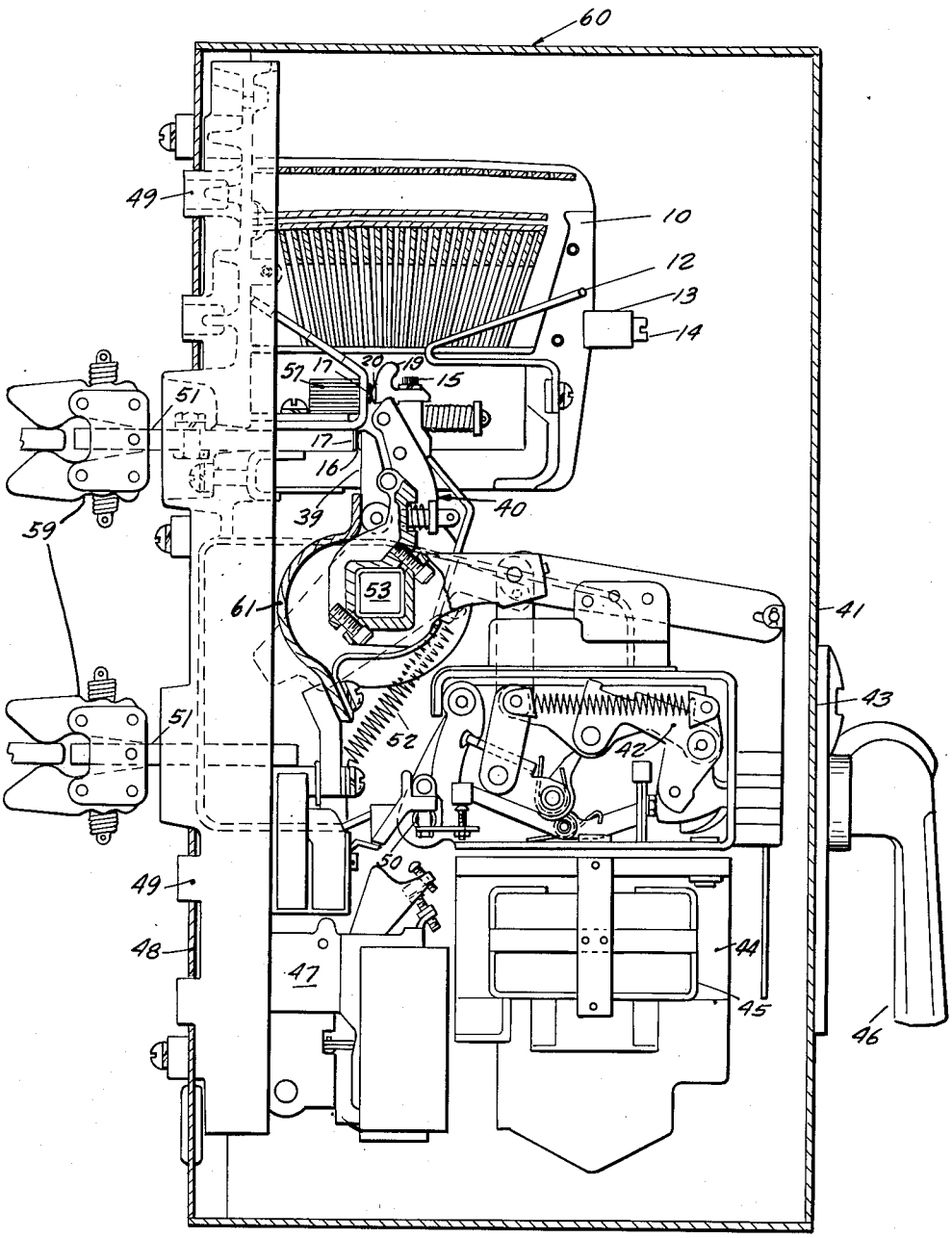


FIG. 1

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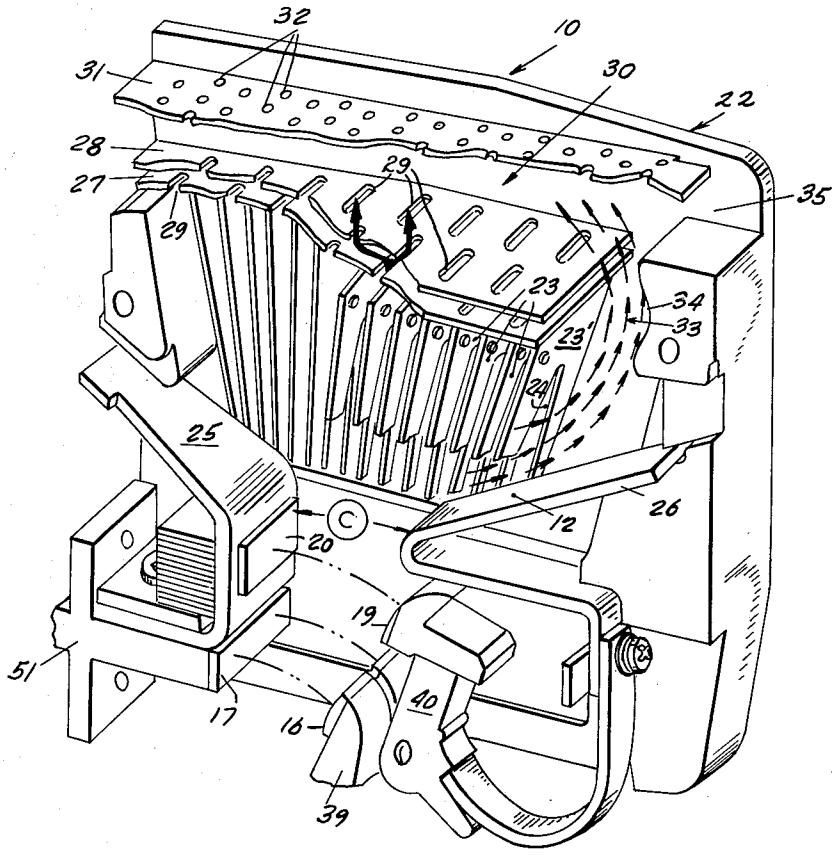


FIG. 2.

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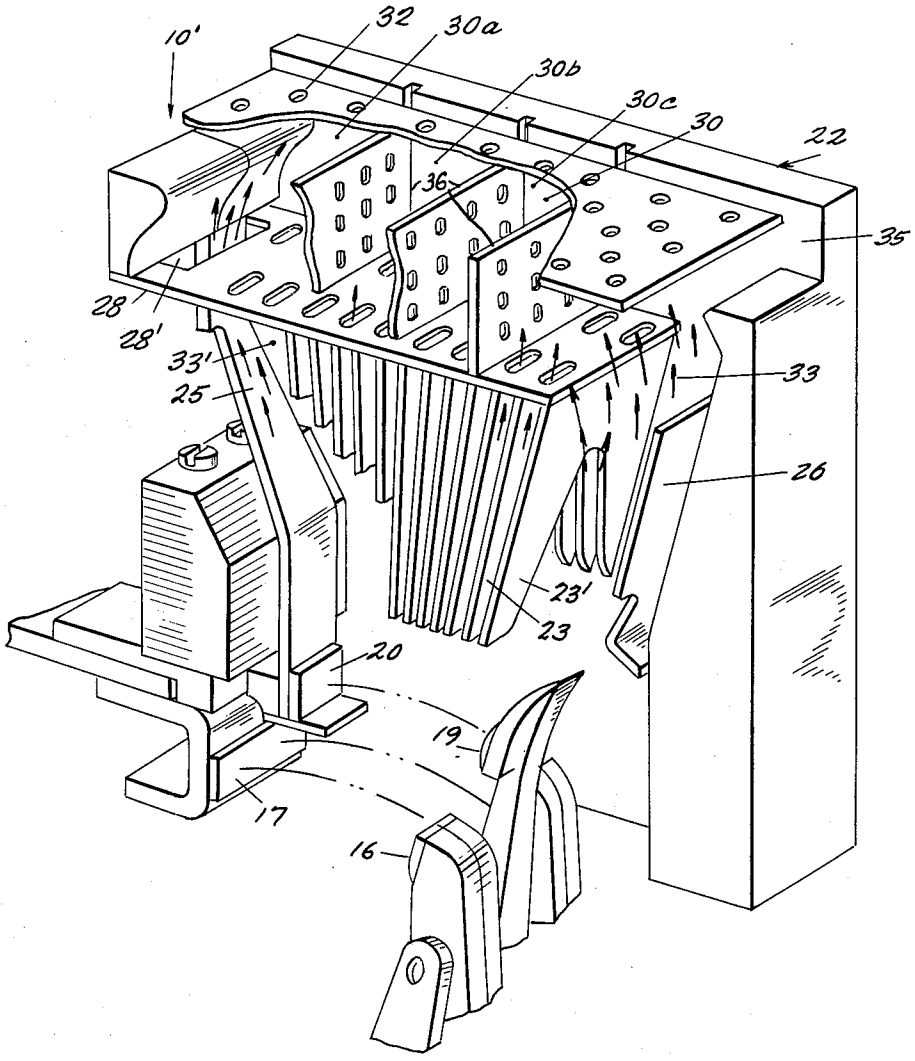


FIG. 3.

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3,005,892

ARC CHUTE DESIGN FOR CIRCUIT BREAKERS

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7 Claims. (Cl. 200—144)

My invention relates to arc chutes for air immersed circuit breakers, and more particularly is directed to a dual flow arc chute whereby the degree of turbulence within the arc chute is substantially increased to thereby aid in the de-ionization of the gases and eliminate the possibility of creating a conducting path to the grounding housing.

Specifically my invention is an improvement over the arc chute described in U.S. Patent No. 2,727,111 issued December 13, 1955, and assigned to the assignee of the instant application. In air immersed circuit breakers an accepted means for interrupting the arc drawn between cooperable contacts has been to provide an arc chute containing a plurality of spaced arc plates. Usually, although not necessarily, the arc plates are made of a magnetic metallic material and positioned immediately above the cooperating contacts of the circuit interrupter. Thus as an arc is drawn between the cooperating contacts upon separation thereof, the magnetic field of the arc passes through the low reluctance path provided by the magnetic arc plates of the arc chute. This, in turn, creates a force which tends to pull the arc up into the arc chute thereby exposing the arc and its associated ionized gases to the cooling effect of the metallic arc plates.

It is the practice to rely primarily upon the spacing and cooling effect of the arc plates to sufficiently de-ionize the air to extinguish the arc. Unfortunately the violent reaction accompanying the creation of an arc upon the separation of the cooperating contacts along with the mere existence of an arc between the cooperating contacts heats up and ionizes the air immediately surrounding the arc. Thus, in most situations the extinguishing of the arc does not in and of itself result in the complete deionization of all of the air in the immediate vicinity of the arc chute. Thus, although there may be a sufficient degree of de-ionization of the immediate gases which have maintained the particular arc in question there may still be a large degree of ionization of the air and gases surrounding the arc. As a result of the large degree of ionization of the air and gases during and after the arc has been extinguished, it is necessary to provide venting means from the arc chute in order to exhaust these hot gases so that the arc chute will be in the best possible condition for a subsequent interruption when the circuit breaker is again closed.

However, some prior are structures have resulted in a phase to ground fault either during or immediately following circuit interruption. That is, in air immersed circuit breakers it is necessary, for safety reasons, to ground the metallic housing of the breaker. Thus the exhausting of the ionized gases from the arc chute into the area enclosed by the metallic housing has resulted in an unfortunate condition whereby the ionized gases have provided a conducting path from one phase to the housing thereby resulting in a damaging phase to ground fault.

The structural arrangement of my novel dual flow arc chute overcomes this undesirable condition. To this end I have provided an arc chute in which there is a mixing chamber provided at the top of the arc chute with at least one vent to the mixing chamber other than through the plurality of arc plates. Thus, ionized gases can reach the mixing chamber above the arc chute by either passing directly through the plurality of spaced arc plates

or through a passage positioned at the end of the arc plates, which passage provides a low resistance path from the cooperating contacts directly to the mixing chamber. By this means it is possible to increase the turbulence of the ionized gas and air in the mixing chamber and due to this increased turbulence there will be a greater degree of de-ionization.

That is, the mere increase of turbulence per se creates a greater opportunity for ionized particles to reunite and de-ionize, and furthermore, the turbulence aids in forcing more of the gas to come into contact with more surface of the mixing chamber to thereby aid in cooling and de-ionizing the gas. Thus by providing a dual flow into a mixing chamber it is possible to increase the degree of turbulence of the ionized gas to thereby increase the degree of de-ionization and thereby safely permit the exhausting of these gases from the arc chute without resulting in a phase to ground fault. That is, the gases which are now exhausted from the arc chute can safely come in contact with the grounded housing since it has been sufficiently de-ionized to prevent the maintenance of an arc between the energized components and the housing so that it is not now possible to ground the energized parts through the housing.

Thus, a primary object of my invention is to provide a novel arc chute for a circuit breaker wherein there is a substantial increase in the degree of de-ionization of the gases to thereby prevent a phase to ground fault when the gases are exhausted from the arc chute.

Another object of my invention is to provide a novel arc chute construction in which there is a dual path to a mixing chamber above the arc chute to thereby increase the degree of turbulence and thereby more rapidly deionize the gas.

Still another object of my invention is to provide a construction in which all of the desirable features of the prior art arc chute constructions can be maintained, including the exhaust of gases, but has the added advantage of providing a large degree of turbulence in a mixing chamber to thereby increase deionization of the gases.

These and other objects of my invention will be apparent from the following description of the drawings in which:

FIGURE 1 represents a side view of an air circuit breaker and illustrates the manner in which the novel dual flow arc chute of my instant invention is used in conjunction therewith.

FIGURE 2 is an exploded perspective view of the arc chute illustrated in FIGURE 1 and represents the details of my invention.

FIGURE 3 is an exploded perspective view similar to FIGURE 2 and illustrates a modification of my instant invention.

In FIGURE 1, I have illustrated a side view of one pole of a circuit breaker in which my instant invention can be used. However, it will be apparent to those skilled in the art that my novel arc chute could be used on any number of circuit breakers and is not limited to the structure shown in FIGURE 1. Furthermore, I have only illustrated a single pole of a circuit breaker although it will be apparent that the breaker represents only one pole of a three pole breaker. Furthermore, since the particular circuit breaker forms no part of my instant invention the details of the operating and trip mechanism are not described in detail herein since a thorough description thereof can be found by reference to U.S. Patent No. 2,754,389.

The novelty of my instant invention is contained within the arc extinguisher or arc chute **10** which is usually contained within a circuit breaker, such as that illustrated in FIGURE 1, having stationary main contact **17**,

a movable main contact 16, a stationary arcing contact 20 and a movable arcing contact 19. The movable arcing contact 20 is contained on the contact arm 40 and the main movable contact is contained on the movable contact arm 39.

The entire circuit breaker is positioned within a housing 60 having a front door 41 and a metal back base 48. The circuit breaker is automatically and manually operated through the operating mechanism 42 and is provided with an escutcheon assembly 43 to which the manual operating handle 46 can open and close the breaker. The solenoid assembly 44 contains a closing coil 45 which when energized will automatically close the breaker through the operating mechanism 42. The breaker can be automatically tripped by means of the dual overcurrent device 47. The dual overcurrent device 47 is operative to simultaneously trip all poles of the breaker through the common tripper bar 50.

The circuit breaker is energized through the main separable contacts 59 to which the current studs 51 are connected. A common opening spring 52 is utilized to provide the opening force through the contact arm path 53 to simultaneously open all three poles of the breaker when it is either automatically tripped by means of the dual overcurrent device 47 or manual closing device 46. The arc chute assembly 10 is maintained in the circuit breaker by means of the support clamp 13, the mounting stud assembly 14 and the screw 15.

A detailed representation of the novel arc chute 10 is seen in the partial perspective view of FIGURE 2. The arc chute 10 is comprised of an insulating housing 22, one half of which is illustrated in FIGURE 2, it being understood that the remaining half of the structure is substantially the same as illustrated. The insulating housing contains a plurality of arc plates 23 which are placed in a spaced relation with respect to each other and can be supported in any desirable means as, for example, by being positioned within slots contained within the side of the insulated housing 22. The arc plates 23 are preferably made of iron so as to provide a magnetic assist once the arc is drawn between the cooperating contacts 19, 20. In addition, the arc plates 23 are preferably provided with a center slot such as 24 immediately above and adjacent to the cooperating contacts 19, 20.

The stationary arcing contact 20 is provided with a back arc runner 25, and a front arc runner 26 is electrically connected to the movable arcing contact 19. Baffle plates 27 and 28 are positioned immediately above and perpendicular to the plurality of spaced arcing plates 23 and are provided with a series of openings such as 29 which in themselves are in staggered relation to provide a tortuous path through which the gases in the arc chute must pass in order to reach the top part of the arc chute. The arc chute 10 is provided with a mixing chamber 30 adjacent to and immediately above the baffle plate 28. That is, a portion of the lower side of the mixing chamber is bounded by baffle plate 28 and the upper portion of the mixing chamber 30 is bounded by baffle plate 31 which also has a plurality of openings 32.

The insulated housing 22 is provided with a passageway 33 at the extreme right end thereof which on one side is bounded by the end arc plate 23' and on the right side by both the front arc runner 26 as well as the curved surface 34 of the insulated housing 22. Thus, there is a passage 33 extending from the cooperating contacts 19, 20 up to the mixing chamber 30 which bypasses the baffle plates 27, 28 and communicates directly with the mixing chamber 30 without introducing any resistance to the flow of ionized gases. The mixing chamber 30 is provided with a vent 35 in addition to the openings 32 so that the air and gases within the mixing chamber can be exhausted to the area surrounding the arc chute.

FIGURE 1 illustrates the condition of the cooperating contacts when the breaker is in the closed position and carrying normal load current. At this time the current will flow from the main upper separable contact assembly 59 through the current stud 51 and out through the lower main separable contact assembly 59. When the contacts separate, as for example on the occurrence of an overload current condition resulting in the operation of the dual overload trip device 47, the main contacts 16, 17 will initially disengage while the arcing contacts 19, 20 remain engaged. Thus, all of the current will initially flow through the cooperating arcing contacts 19, 20. Subsequently, the arcing contacts 19, 20 are separated, thereby drawing an arc therebetween.

The system is designed so that the arc will rise into the arc chute. That is, the arc itself will tend to rise with the hot gases created thereby and also will be forced into the arc chute due to the magnetic forces created from the magnetic field of the arc to the magnetic plates 23 of the arc chute. The ends of the arc will subsequently terminate on both the back and front arc runners 25, 26 as is well known in the prior art, and the arc plates 23 will be effective to cool and de-ionize the arc and the ionized gases associated therewith. The arc chute is designed so that the arc will not exist above the top of the arc plates 23. That is, the baffle plates 27, 28 are provided merely as a means of relieving the high pressure hot gases from the chamber which contains the arc plates and should prevent the arc from passing therethrough. However, the gases passing through the openings 29 in the baffle plates 27, 28 have a large degree of ionization and in the absence of applicant's novel passage 33, which will hereinafter be more fully described, these hot gases would be vented out through the openings 32, 35 and possibly create a conductive path from an energized component of the circuit breaker to the grounded housing 60 of the breaker thereby resulting in an undesirable phase to ground fault.

However, with the novel construction of my arc extinguisher, I have provided a second path by which gases can move into the mixing chamber 30. That is, a path 33 has a low end which communicates with the cooperating contacts and an upper end which communicates with the mixing chamber 30. Some of the hot gases generated by and immediately surrounding the arc at the cooperating contacts 19, 20 will find an unobstructed path directly from the cooperating contacts to the mixing chamber 30 and thus will enter the mixing chamber 30 with considerable velocity. These gases will mix with the other ionized gases which have reached the mixing chamber 30 through the usual means, namely the spaces adjacent the arc plates 30 and through the staggered openings 29 in the baffle plates 27, 28. The impingement of the high velocity gases entering the mixing chamber 30 through the passage 33 with those gases entering the mixing chamber 30 through the openings 29 will result in an increased degree of turbulence. As is well known in the circuit interruption art, the mere increase in turbulence per se will in itself result in a larger degree of de-ionization of the gases within the chamber by increasing the possibility of the positive ions and free electrons to reunite to become neutral. Also the increased turbulence of the hot gases will cause them to come into contact with a larger surface in the mixing chamber thereby substantially increasing the cooling effect or de-ionization of the gases. Accordingly, by increasing the turbulence within the mixing chamber, as a result of the passage 33, the gases which will be exhausted through the openings 32 and the vent 35 from the mixing chamber 30 will be substantially de-ionized, thereby preventing the possibility of providing a conducting path to the grounded housing 60.

Thus in summary, I have provided a dual flow arc chute in which there is a mixing chamber to which the gases are admitted by following the usual path through the spaced arc plates and through the baffle plate openings and through an additional unobstructed path 33.

I have illustrated the preferred embodiment of my invention in connection with FIGURE 2. However, it will be apparent to those skilled in the art that other embodiments of the concept of my invention are also possible. For example, as seen in FIGURE 3 is is possible to not only have a passage **33** adjacent to the front arc runner **26**, but it is also possible to provide a second passage **33'** adjacent to the back arc runner **25**. Furthermore, it is also possible to provide partial barriers by means of the baffle plates **36**, extending in a direction perpendicular to the baffle plate **28**, within the mixing chamber **30** so that a plurality of mixing chambers such as **30***a*, **30***b*, etc. are provided. It is also noted that in the event it is desirable to have a baffle plate such as **28** extend over a larger distance, openings such as **28'** can be provided in the baffle plate **28** so that there will be an unobstructed path through the passage **33'** from the cooperating contacts **19**, **20** directly to the mixing chamber **30***a*. In the embodiment of FIGURE 3, it also will be apparent that the degree of turbulence within the mixing chamber will be substantially increased thereby likewise increasing the degree of de-ionization of the hot gases so that when they are exhausted through the vent **35** and the openings **32** they will not provide a grounding path to the housing **60** through the circuit breaker.

In the foregoing I have described my invention only in connection with preferred embodiments thereof. Many variations and modifications of the principles of my invention with the scope of the description herein are obvious. Accordingly, I prefer to be bound not by the specific disclosure herein but only by the appending claims.

I claim:

1. An arc extinguisher comprising an insulating housing and a plurality of arc plates positioned within said housing; said plurality of plates having a center slot and being positioned in spaced relation above and adjacent to cooperable contacts of a circiut interrupter; a baffle plate immediately above said plurality of arc plates and extending in a direction perpendicular thereto; said insulating housing containing a mixing chamber above said arc plates and being partially defined by said baffle plate; a passage within and at one end of said housing extending from said cooperable contacts directly to said mixing chamber; said passage by-passing said baffle plate and being defined on one side by an end arc plate and on the other side by said insulating housing; and a baffle means, parallel to and spaced from said baffle plate, partially defining said mixing chamber.

2. An arc extinguisher comprising an insulating housing and a plurality of arc plates positioned within said housing; said plurality of plates having a center slot and being positioned in spaced relation above and adjacent to cooperable contacts of a circuit interrupter; said arc plates being positioned transverse to the arc drawn between the cooperable contacts; a baffle plate immediately above said plurality of arc plates extending in a direction perpendicular thereto; said insulating housing having a mixing chamber located above said baffle plate; said baffle plate having a plurality of openings communicating with said mixing chamber to thereby provide a path for arc gases created by separation of the cooperable contacts through the spaced arc plates into said mixing chamber; a passage within and at one end of said housing extending from the cooperable contacts directly to said mixing chamber; arc gases created by the separation of said cooperable contacts passing through said passage to said mixing chamber without passing through the openings in said baffle plate; and a baffle means, parallel to and spaced from said baffle plate, partially defining said mixing chamber.

3. An arc extinguisher comprising an insulating housing and a plurality of arc plates positioned within said housing; said plurality of plates having a center slot and being positioned in spaced relation above and adjacent to cooperable contacts of a circuit interrupter; a baffle plate immediately above said plurality of arc plates and extending in a direction perpendicular thereto; said insulating housing containing a mixing chamber above said arc plates and being partially defined by said baffle; a passage within and at one end of said housing extending from said cooperable contacts directly to said mixing chamber; said passage by-passing said baffle plate and being defined on one side by an end arc plate and on the other side by said insulating housing; and a baffle means, parallel to and spaced from said baffle plate, partially defining said mixing chamber; some gases generated by the arc drawn by the separation of the cooperable contacts reaching said mixing chamber by passing through said spaced arc plates, other gases generated by the arc drawn by the separation of the cooperable contacts reaching said mixing chamber by passing through said passage; said gases passing through said passage resulting in a large degree of turbulence in said mixing chamber to thereby aid in the de-ionization of the gases; a vent from said mixing chamber to the area surrounding said arc extinguisher.

4. An arc extinguisher comprising an insulating housing and a plurality of arc plates positioned within said housing; said plurality of plates having a center slot and being positioned in spaced relation above and adjacent to cooperable contacts of a circuit interrupter; said arc plates being positioned transverse to the arc drawn between the cooperable contacts; a baffle plate immediately above said plurality of arc plates extending in a direction perpendicular thereto; said insulating housing having a mixing chamber located above said baffle plate; said baffle plate having a plurality of openings communicating with said mixing chamber to thereby provide a path for arc gases created by separation of the cooperable contacts through the spaced arc plates into said mixing chamber; and a baffle means, parallel to and spaced from said baffle plate, partially defining said mixing chamber; a passage within and at one end of said housing extending from the cooperable contacts directly to said mixing chamber; arc gases created by the separation of said cooperable contacts passing through said passage to said mixing chamber without passing through the openings in said baffle plate; some gases generated by the arc drawn by the separation of the cooperable contacts reaching said mixing chamber by passing through said spaced arc plates, other gases generated by the arc drawn by the separation of the cooperable contacts reaching said mixing chamber by passing through said passage; said gases passing through said passage resulting in a large degree of turbulence in said mixing chamber to thereby aid in the de-ionization of the gases; a vent from said mixing chamber to the area surrounding said arc extinguisher.

5. An arc extinguisher comprising an insulating housing and a plurality of arc plates positioned within said housing; said plurality of plates having a center slot and being positioned in spaced relation above and adjacent to cooperable contacts of a circuit interrupter; a baffle plate immediately above said plurality of arc plates and extending in a direction perpendicular thereto; said insulating housing containing a mixing chamber above said arc plates and being partially defined by said baffle; a passage within and at one end of said housing extending from said cooperable contacts directly to said mixing chamber; said passage by-passing said baffle plate and being defined on one side by an end arc plate and on the other side by said insulating housing; at least one barrier, having openings, disposed within said chamber positioned transverse to said baffle plate thereby dividing said mixing chamber into a plurality of sections.

6. An arc extinguisher comprising an insulating housing and a plurality of arc plates positioned within said housing; said plurality of plates having a center slot and being positioned in spaced relation above and adjacent to cooperable contacts of a circuit interrupter; a baffle

plate immediately above said plurality of arc plates and extending in a direction perpendicular thereto; said insulating housing containing a mixing chamber above said arc plates and being partially defined by said baffle; a passage within and at one end of said housing extending from said cooperable contacts directly to said mixing chamber; said passage by-passing said baffle plate and being defined on one side by an end arc plate and on the other side by said insulating housing; another passage within and at another end of said housing extending from said cooperable contacts directly to said mixing chamber; at least one barrier, having openings, disposed within said chamber positioned transverse to said baffle plate thereby dividing said mixing chamber into a plurality of sections.

7. A circuit interrupter including a housing, a pair of cooperable contacts and an arc extinguisher; said cooperable contacts and said arc extinguisher being disposed within said housing; said arc extinguisher comprising an insulating housing and a plurality of arc plates; said plurality of arc plates supported within said insulating housing and being positioned in spaced relation with each other; each of said plurality of arc plates having a center slot and being positioned above and adjacent said cooperable contacts; said insulating housing containing a

mixing chamber immediately above said plurality of arc plates; a passage within said housing and located at one end thereof communicating at one end with said cooperable contacts and the other end with said mixing chamber; said passage including a portion constructed to direct ionized gases, generated by the parting of said cooperable contacts, which flow through said passage into said chamber in a direction transverse to the direction of ionized gas flowing between said arc plates to said chamber.

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