

March 27, 1945.

W. M. LEEDS ET AL

2,372,589

CIRCUIT INTERRUPTER

Filed Sept. 18, 1942

2 Sheets-Sheet 1

Fig. 1.

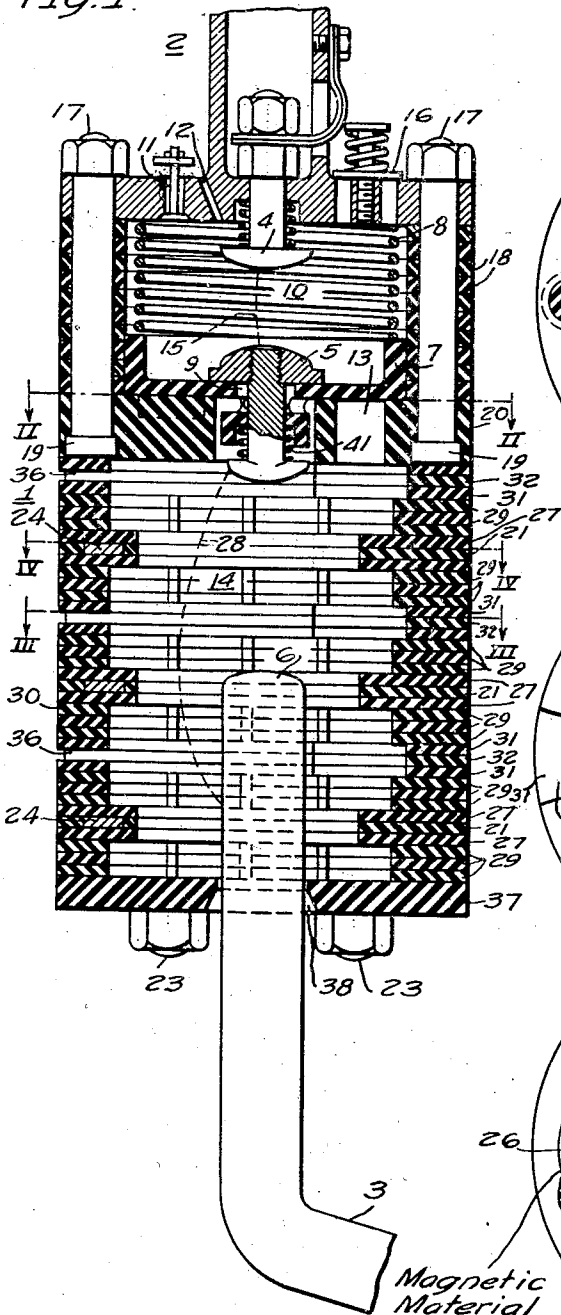


Fig. 2.

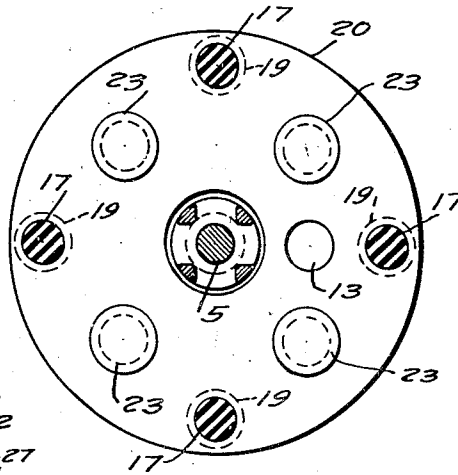


Fig. 3.

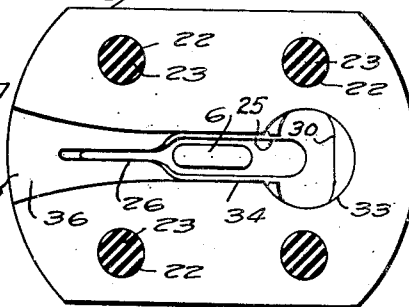
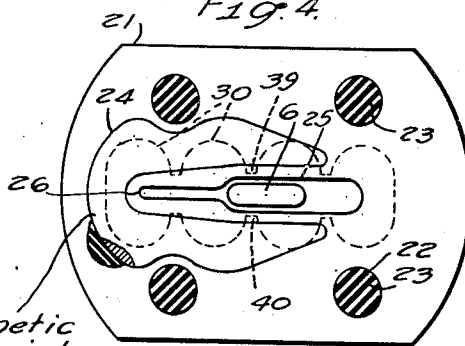


Fig. 4.



WITNESSES:

E. A. McLeskey
W. R. Crout

INVENTORS

Winthrop M. Leeds
and Benjamin P. Baker.

BY *Ralph H. Swingle*
ATTORNEY

March 27, 1945.

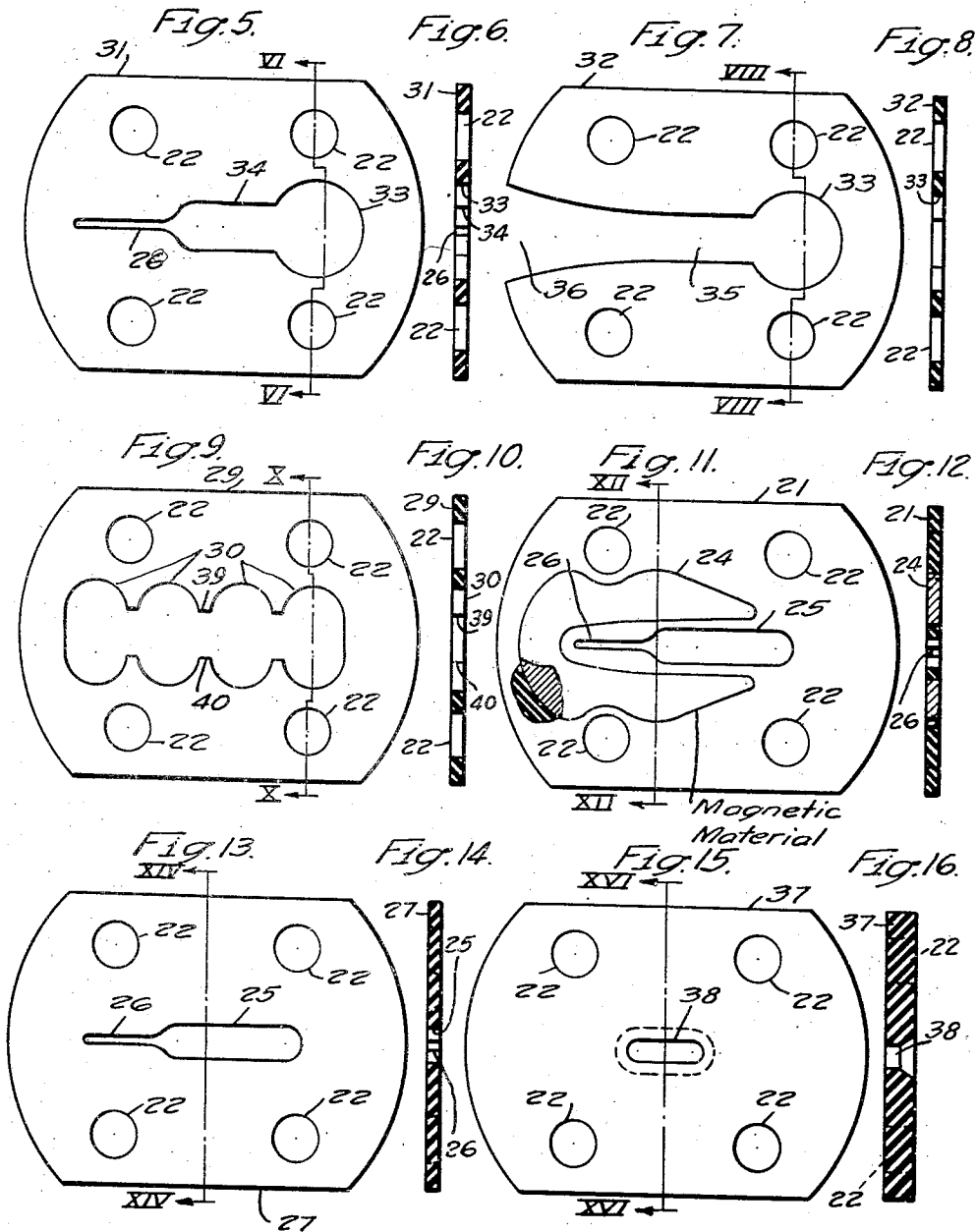
W. M. LEEDS ET AL

2,372,589

CIRCUIT INTERRUPTER

Filed Sept. 18, 1942

2 Sheets-Sheet 2



WITNESSES:

E. A. M. L. L. L.

W. R. Crout

INVENTORS

Winthrop M. Leeds
and Benjamin P. Baker.

BY

Ralph H. Swingle
ATTORNEY

UNITED STATES PATENT OFFICE

2,372,589

CIRCUIT INTERRUPTER

Winthrop M. Leeds, Wilkinsburg, and Benjamin P. Baker, Turtle Creek, Pa., assignors to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application September 18, 1942, Serial No. 458,778

17 Claims. (Cl. 200—150)

This invention relates to circuit interrupters in general and, more particularly, to circuit interrupters which effect arc extinction by a blast of arc extinguishing fluid.

An object of the present invention is to provide an improved arc extinguishing structure in which a pressure generating arc and an interrupting arc are established and which provides a more effective flow of arc extinguishing fluid from said pressure generating arc to said interrupting arc to effectively quench the latter.

Another object is to provide an improved circuit interrupter in which a pressure generating arc and an interrupting arc are established, the interrupting arc being established adjacent to a constricted arcing slot and to provide improved passage means for connecting the pressure generating arc with the interrupting arc to force the latter by fluid flow into said constricted arcing slot to effect the extinction of said interrupting arc therein.

Another object is to provide an improved circuit interrupting structure in which a pressure generating arc is formed together with an interrupting arc, and to dispose in said interrupting structure a piston to prevent a contamination of the fluid flow toward said interrupting arc.

Another object is to provide an improved circuit interrupter in which a piston is secured to and movable with the intermediate contact so that the contaminated arc extinguishing fluid immediately adjacent to the pressure generating arc is not forced into the region surrounding the interrupting arc to lower the dielectric strength of the fluid adjacent to the interrupting arc.

Another object is to provide an improved circuit interrupter in which both a pressure generating arc and an interrupting arc are established, and to provide spring biased piston means secured to and movable with the intermediate contact to not only prevent a contamination of the fluid adjacent the interrupting arc from the pressure generating arc, but also to provide sufficient fluid flow during the interruption of small currents.

Another object is to provide an improved arc extinguishing structure in which a pressure generating arc and an interrupting arc are established with suitable passage means between said arcs, and also to provide magnetic means for controlling the lateral movement of the interrupting arc as a function of the instantaneous value of arcing current.

Another object is to provide an improved cir-

cuit interrupter in which a pressure generating arc and an interrupting arc are established, said interrupting arc being drawn adjacent to a constricted arcing slot, with suitable vents disposed along one side of said constricted arcing slot, and to provide magnetic means to cooperate with the fluid flow created by said pressure generating arc to force said interrupting arc laterally toward the constricted arcing slot in the direction of said vents.

Another object is to provide an improved interrupting structure in which a concentrated blast of fluid is employed both for rapid arc lengthening and for scavenging purposes.

Another more specific object is to provide an improved circuit interrupter in which an arc is established, and in which a fluid blast is concentrated and directed against the initially formed portion of said arc which tends to lengthen the same at a greater rate than the rate of separation of the movable contacts, and to provide means to prevent such lengthening until relatively low instantaneous values of arcing current. It will be readily apparent that such a concentrated fluid blast will build up the dielectric strength in the relatively short gap between the contacts to prevent restriking in this region after the greatly lengthened arc itself has been extinguished.

A specific object of the invention is to provide an improved interrupting structure in which both a pressure generating arc and an interrupting arc are established with a piston attached to and movable with the intermediate contact structure, and to provide an improved valve construction associated with the intermediate contact structure.

Another object is to provide an improved circuit interrupter in which both a pressure generating arc and an interrupting arc are established, and in which the main movable contact serves as a directing valve to concentrate and direct a blast of fluid from said pressure generating arc into the initially formed portion of the interrupting arc to tend to lengthen the same at a greater rate than the rate of separation of the main contacts.

The term "fluid" as used in the specification and in the appended claims includes gases, liquids, vapors and sprays.

It will be readily apparent to one skilled in the art that our invention is applicable to circuit interrupters operating in gaseous mediums, such as air, as well as in liquid mediums. However, for purposes of illustration, and not by way of

limitation, we illustrate our invention as applied to a circuit interrupter of the liquid immersed type.

Further objects and advantages will become apparent upon a reading of the following specification taken in conjunction with the drawings, in which:

Fig. 1 is an enlarged elevational view in cross section of an arc extinguishing structure embodying the present invention;

Fig. 2 is a view in cross section taken on the line II—II of Fig. 1;

Fig. 3 is a view in cross section taken on the line III—III of Fig. 1;

Fig. 4 is a view in cross section taken along the line IV—IV of Fig. 1; and

Figs. 5 through 16 show plan and sectional views of insulating plates used in the arc extinguishing structure shown in Fig. 1.

Referring to the drawings, and particularly to Fig. 1, the reference numeral 1 designates generally one of two arc extinguishing structures symmetrically located within a suitable tank, not shown, which is filled to a level above the top of the extinguishing structures with an arc extinguishing liquid, in this instance oil. Each arc extinguishing structure 1 is supported from the cover of the tank, not shown, by the stationary contact structure generally designated by the reference numeral 2. A movable conducting bridging member 3, operated by the reciprocating longitudinal movement of an insulating lift rod (not shown), serves to connect the two arc extinguishing structures 1 in series in the closed circuit position of the interrupter.

Each arc extinguishing structure 1 has a stationary contact 4, an intermediate contact 5, and a lower movable contact 6, which constitutes the upstanding portion of the movable bridging member 3. An insulating piston 7 is secured to the intermediate contact 5 and is movable therewith, being biased to its lower position by a compression spring 8. An annular opening 9, provided in the insulating piston 7, is closed by the intermediate contact 5 during the existence of high pressure conditions in the pressure generating chamber generally designated by the reference numeral 10. A check valve 11 is also closed during high pressure conditions in the pressure generating chamber 10. A small gas bleed hole 12 may be provided to permit a sufficient reduction in pressure within the pressure chamber 10 to allow the check valve 11 to open following a circuit interrupting operation.

A conduit 13 connects the region below the piston 7 with the interrupting chamber generally designated by the reference numeral 14 in Fig. 1. The stationary contact 4 cooperates with the intermediate contact 5 to form a pressure generating arc indicated by the reference numeral 15. A relief valve 16 is provided to prevent rupture of the arc extinguishing structure 1 on excessive pressure. Insulating tie rods 17 hold the insulating rings 18, constituting the pressure generating chamber 10, in a fixed position, the lower ends of the insulating tie rods 17 terminating in off standing shoulders 19 which are imbedded in the insulating partition plate 20.

The insulating plates constituting the arc interruption chamber 14 will now be described. An insulating insert plate 21, the configuration of which is more clearly shown in Fig. 11, is provided, having therein apertures 22 for the reception of insulating studs 23, an insert 24 composed of magnetic material, in this instance iron,

and an elongated slot 25, communicating with a constricted slot 26. Immediately above and below the insulating insert plate 21 is an insulating guard plate 27, the configuration of which is more clearly shown in Fig. 13. The insulating guard plate 27 has the same configuration as the insulating insert plate 21 except it has no provision for a magnetic insert and serves the purpose of protecting the magnetic insert 24 from the effect of the interrupting arc 28 (see Fig. 1). Immediately adjacent to each guard plate 27 are a plurality, in this instance three, of insulating pocket plates 29, the configuration of which is more clearly shown in Fig. 9. Each insulating pocket plate 29 contains apertures 22 for the reception of the insulating studs 23 and a plurality, in this instance four, of pockets 30 which serve to retain a plentiful supply of oil adjacent the interrupting arc 28.

Between each group of three insulating pocket plates 29 (see Fig. 1) is a group of insulating plates, in this instance three, comprising two insulating restriction plates 31, the configuration of which is more clearly shown in Fig. 5 and an intermediately disposed vent plate 32, the configuration of which is more clearly shown in Fig. 7.

The insulating restriction plates 31 contain apertures 22 for the accommodation of the insulating studs 23, an enlarged annular opening 33, an enlarged arcing slot 34 and a restricted arcing slot 26. Each vent plate 32 contains an enlarged opening 35 which communicates by a passage 35 to a vent 36. The bottom insulating plate is designated by the reference numeral 37 and is more clearly shown in Fig. 15. The bottom insulating plate 37 contains apertures 22 for the reception of the insulating studs 23 and an elongated beveled slot 38 to accommodate the longitudinal movement of the movable contact 6.

When the several insulating plates are assembled on the insulating studs 23, it will be apparent that the interrupting arc 28 will remain in the enlarged arcing slot 34 as defined by the insulating restriction plates 31 until the cross section of the arc column is sufficient small to enter the restricted arcing slot 26, this occurring near a current zero at a time most suitable for interruption. It will be observed that the pockets 30 provided in the pocket insulating plates 29 (see Fig. 9) will provide a sufficient readily available supply of oil adjacent the enlarged arcing slot 34 and also adjacent the restricted arcing slot 26.

The operation of the interrupter illustrated in Fig. 1 will now be explained. In the closed circuit position of the interrupter the movable contact 6 engages the intermediate contact 5 maintaining the latter in abutting relation with the fixed contact 4, the piston 7 maintaining the compression spring 8 in its compressed state. When it is desired to interrupt the circuit passing through the interrupter the movable contact 6 is moved down by suitable mechanism, not shown, to permit the intermediate contact 5 to separate from the stationary contact 4 to draw a pressure generating arc 15. Usually the piston 7 will move down more slowly than the movable contact 6 because of the dashpot action, and hence the separation of the movable contact 6 from the intermediate contact 5 will draw an interrupting arc 28 in the interrupting chamber 14. During the interruption of high R. M. S. currents the pressure generating arc 15 will assist the compression spring 8 in forcing the piston 7 down-

ward to cause oil flow through the conduit 13 into the lower interruption chamber 14. During the interruption of low R. M. S. currents the pressure generating arc 15 will have little effect on the downward motion of the piston 7, the compression spring 8 being relied upon to produce this downward motion of the piston 7 and the consequent oil flow through the conduit 13. It will be observed that in the interrupter shown in Fig. 1 the magnetic inserts 24 bias the interrupting arc 28 toward the vents 36 provided in the vent plates 32.

This biasing action exerted by the magnetic plates 24 is in the same direction as the oil flow through the conduit 13 and tends to carry the lower terminal of the interrupting arc 28 down along the side of the movable contact 6 as shown in Fig. 1. During relatively high instantaneous values of arcing current the cross section of the interrupting arc 28 is too large to permit it to be forced into the restricted arcing slot 26 provided in the plates 31, 27 and 21. However, when the instantaneous value of arcing current through the interrupting arc 28 drops to a relatively small value, that is approaches a current zero on the alternating current wave, the cross section of the interrupting arc 28 at this time will be sufficiently small to permit both the oil flow through the conduit 13 and also the biasing force exerted by the magnetic inserts 24 to carry it into the restricted arcing slot 26 and toward the vents 36 in the vent plates 32. During the time that the arc 28 is in the restricted arcing slot 26 the interrupting arc 28 rapidly elongates by the combined action of the magnetic force and the fluid flow to run down the side of the movable contact 6 to consequently attain a considerable length as shown in Fig. 1. It will be observed that the length of the interrupting arc 28 is considerably greater than the distance between the movable contact 6 and the lower portion of the intermediate contact 5. Thus a distinct advantage in having the magnetic inserts 24 bias the interrupting arc 28 in the same direction as the fluid flow through the conduit 13 is that the arc 28 is lengthened exceedingly rapidly as compared to the distance between the movable contact 6 and the intermediate contact 5. Higher speed interruption consequently follows from such a construction.

It will be noted that the movable contact 6 serves somewhat as a valve between the points 38, 40 on the pocket insulating plates 29, as Fig. 4 more clearly shows. This valve action of the movable contact 6 concentrates the oil flow through the conduit 13 in the short gap between the movable contact 6 and the intermediate contact 5 to build up the dielectric between the movable contact 6 and the intermediate contact 5 to prevent restriking in this gap after the arc 28 has been extinguished in the narrow end of the slot. This scavenging action is essential to obtain maximum benefits of the arc lengthening action.

When the cross section of the interrupting arc 28 is sufficiently small for it to enter the narrow arcing slot 26 it rapidly elongates in a manner shown in Fig. 1, as previously described, and is blasted by a transverse flow of oil and gas particles flowing toward the vents 36 in the vent plates 32. Extinction of the interrupting arc 28 soon follows, and the valve action of the movable contact 6 concentrates oil flow from the conduit 13 into the region between the movable contact 6 and the intermediate contact 5 to build

up the dielectric in this region to prevent restriking of the interrupting arc 28.

The movable contact 6 withdraws from the arc extinguishing chamber 14 to effect an isolating break in the open circuit position of the interrupter. The check valve 11 will open upon a subsidence of pressure within the pressure generating chamber 10 to allow escape of gas and to permit a fresh quantity of arc extinguishing oil to enter the pressure generating chamber 10. Fresh oil will also enter the interrupting chamber 14 through the vents 36 and also through the beveled slot 38 in the bottom insulating plate 37.

In the closing of the interrupter it will be apparent that the movable contact 6 will strike the intermediate contact 5, moving it slightly upward against the biasing action of the compression spring 41 to open the annular opening 9 provided in the piston 7 to permit oil to flow out of the pressure generating chamber 10 during the closing of the interrupter. During the opening operation the movable contact 6 soon withdraws from the intermediate contact 5 to permit the intermediate contact 5 to close the annular opening 9 by means of the pressure within the pressure generating chamber 10 and also because of the compression spring 41.

It will be observed that by the provision of a piston 7 decomposed products of decomposition from the pressure generating arc 15 which tend to lower the dielectric strength of the oil flowing through the conduit 13 will be prevented from entering the region adjacent the interrupting arc 28. Consequently, only clean fresh oil of high dielectric strength will be forced by the piston 7 through the conduit 13 and into the interrupting chamber 14.

As stated previously during the interruption of low R. M. S. currents when the pressure built up in the pressure generating chamber 10 is relatively small the compression spring 8 will at this time move the piston 7 downward to create the fluid flow through the conduit 13 necessary for rapid extinction of the interrupting arc 28.

Some of the features of the general method of arc extinction just described in connection with the interrupter shown in Fig. 1 are set forth and broadly claimed in Patent 2,138,382 which issued November 29, 1938, to Winthrop M. Leeds and Ennio Ortensi and which was assigned to the Westinghouse Electric & Manufacturing Company.

It will be apparent to one skilled in the art that our invention is readily applicable not only to liquid immersed circuit interrupters but also to circuit interrupters operating in a gaseous medium, such as air. The insulating plates described in connection with the arc extinguishing structure 1 shown in Fig. 1 may be made of a suitable gas evolving material to facilitate the interruption of the interrupting arc. Consequently the arc extinguishing structure 1 could be operated in air with the insulating plates composed of a suitable gas evolving material such as horn fiber or boric acid. Merely for purposes of illustration, and not by way of limitation, we have described our invention as embodied in an oil immersed circuit interrupter.

Although we have shown and described a specific structure, it is to be understood that the same was only for purposes of illustration and that changes and modifications may be made therein 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 circuit interrupter, means for establishing a pressure generating arc and an interrupting arc, means defining a constricted arcing slot disposed adjacent said interrupting arc, magnetic means for biasing said interrupting arc into said constricted arcing slot, and means utilizing said pressure generating arc to assist said magnetic means in forcing said interrupting arc into said constricted arcing slot to effect its extinction therein.
2. In a circuit interrupter, an arcing chamber, a stationary contact at one end of said arcing chamber, a movable intermediate contact, a piston secured to and movable with said intermediate contact, a movable contact operative through the other end of said arcing chamber, said stationary contact and said intermediate contact cooperating to establish a pressure generating arc, said intermediate contact cooperating with said movable contact to form an interrupting arc, the region about said pressure generating arc being confined by said piston so as to prevent contaminated fluid adjacent said pressure generating arc from contacting said interrupting arc.
3. In a circuit interrupter, contact means for establishing a pressure generating arc and an interrupting arc, fluid passage means connecting said arcs, and piston means intermediate said arcs and associated with the contact means for preventing contamination of the fluid adjacent said interrupting arc with the fluid adjacent said pressure generating arc.
4. In a circuit interrupter, contact means for establishing a pressure generating arc and for establishing an interrupting arc after said pressure generating arc is established, and piston means operative in response to motion of the contact means for insuring uncontaminated fluid flow from said pressure generating arc to said interrupting arc at the time when the latter is established.
5. In a circuit interrupter, a pressure generating chamber, contact means for establishing a pressure generating arc within the pressure generating chamber, an interrupting chamber, means for establishing an interrupting arc within the interrupting chamber, a single passage connecting said two chambers, piston means disposed in said single passage and responsive to motion of the contact means, and biasing means to operate said piston means during the interruption of low currents.
6. In a circuit interrupter, stationary contact means, movable intermediate contact means, and movable contact means, a pressure generating arc being established between said stationary contact means and said intermediate contact means, an interrupting arc being established between said intermediate contact means and said movable contact means, a single passage for connecting said two arcs, and a piston secured to and movable with said intermediate contact means within said single passage, a compression spring biasing said piston and said movable intermediate contact means away from said stationary contact means, said spring being of help in interrupting low currents.
7. In a circuit breaker of the liquid break type, a pressure generating chamber in which a stationary contact is disposed, a piston disposed within said pressure generating chamber, an intermediate contact secured to and movable with said piston, spring means biasing said piston and said intermediate contact away from said stationary contact, an interrupting slot in which a movable contact operates to draw an interrupting arc with said intermediate contact, venting means disposed along one side of said interrupting slot, passage means connecting said pressure generating chamber with said interrupting slot, and valve means disposed in said intermediate contact to facilitate the closing of said interrupter.
8. In a circuit interrupter, a stationary contact, an intermediate contact, a movable main contact, a pressure generating arc being established between said stationary contact and said intermediate contact, an interrupting arc being established between said intermediate contact and said movable main contact, means defining a constricted arcing slot disposed adjacent to said interrupting arc, passage means connecting said two arcs to permit fluid flow from said pressure generating arc to bias said interrupting arc into said constricted arcing slot, and magnetic means assisting said fluid flow to bias said interrupting arc into said constricted arcing slot.
9. In a circuit interrupter, means for establishing a pressure generating arc and an interrupting arc, means defining a constricted arcing slot disposed adjacent said interrupting arc and of such a narrow width that said interrupting arc can only enter said constricted arcing slot during relatively low instantaneous values of arcing current, fluid flow created by said pressure generating arc biasing said interrupting arc into said constricted arcing slot, and magnetic means also biasing said interrupting arc into said constricted arcing slot.
10. In a circuit interrupter, means for establishing a pressure generating arc, means for establishing an interrupting arc, slot means disposed adjacent said interrupting arc into which said interrupting arc can enter only during relatively low instantaneous values of arcing current, passage means connecting said arcs to transmit a blast of arc extinguishing fluid from said pressure generating arc to said interrupting arc to bias the latter into said slot means to effect its extinction therein, and one or more U-shaped plates of magnetic material at least partially surrounding said slot means to bias said interrupting arc into said slot means.
11. In a circuit interrupter, means for establishing a pressure generating arc, means for establishing an interrupting arc, an elongated arcing slot disposed adjacent said interrupting arc, venting means disposed along one side of said elongated arcing slot, passage means connecting said two arcs for permitting a blast of fluid from said pressure generating arc to bias said interrupting arc into said elongated arcing slot toward said venting means, and magnetic means also biasing said interrupting arc into said elongated arcing slot toward the venting means.
12. In a circuit interrupter, a stationary contact, an intermediate contact, and a movable main contact, said stationary contact and said intermediate contact cooperating to establish a pressure generating arc, said intermediate contact and said movable main contact cooperating to establish an interrupting arc, a relatively narrow arcing slot disposed adjacent to said interrupting arc into which said interrupting arc may be forced to cause its extinction, passage means connecting said two arcs for permitting a flow of arc extinguishing fluid to bias said interrupting arc into said relatively narrow arcing slot, and a movable piston secured to and movable with said inter-

mediate contact to insure uncontaminated fluid flow through said passage means toward said interrupting arc.

13. In a circuit interrupter, means for establishing a pressure generating arc and an interrupting arc, an elongated arcing slot disposed adjacent said interrupting arc and of such narrow width that said interrupting arc can only enter said arcing slot during relatively low instantaneous values of arcing current, passage means connecting said two arcs for permitting a fluid blast from said pressure generating arc to bias said interrupting arc into said arcing slot, and piston means for insuring uncontaminated fluid flow through said passage means.

14. In a circuit interrupter, relatively movable contacts for establishing an arc, an elongated arcing slot disposed adjacent said arc into which said arc may be forced to cause its extinction, passage means disposed adjacent said relatively movable contacts for transmitting fluid flow toward said arc, one of said relatively movable contacts serving at least partially as a valve in said passage means to direct the fluid flow through said passage means toward said arc, and magnetic means for biasing said arc into said elongated arcing slot.

15. In a circuit interrupter, means for establishing an arc, said means comprising a movable contact, a constricted arcing slot of such narrow width that said arc may only enter said arcing slot during relatively low instantaneous

values of arcing current, means for causing fluid flow for biasing said arc into said arcing slot, said movable contact serving as a directing valve for directing a concentrated blast of fluid toward the initially formed portion of said arc.

16. In a circuit interrupter, means for establishing an arc, said means comprising a movable contact, a constricted arcing slot of such narrow width that said arc may only enter said arcing slot during relatively low instantaneous values of arcing current, passage means for directing a blast of fluid toward said arc to bias said arc into said arcing slot, magnetic means for biasing said arc toward said arcing slot, said movable contact serving at least partially as a fluid directing valve in said passage means.

17. In a circuit interrupter, a stationary contact and an intermediate contact cooperable to establish a pressure generating arc, a movable contact cooperable with said intermediate contact to establish an interrupting arc, a constricted arcing slot disposed adjacent said interrupting arc and of such narrow width that said interrupting arc can only enter said arcing slot during relatively low instantaneous values of arcing current, passage means connecting said two arcs to transmit a flow of fluid to bias said interrupting arc toward said arcing slot, said movable contact serving at least partially as a directing valve in said passage means.

WINTHROP M. LEEDS.
BENJAMIN P. BAKER.