

July 15, 1941.

O. C. TRAVER

2,249,444

ELECTRIC CIRCUIT BREAKER

Filed May 16, 1940

2 Sheets-Sheet 1

Fig. 1.

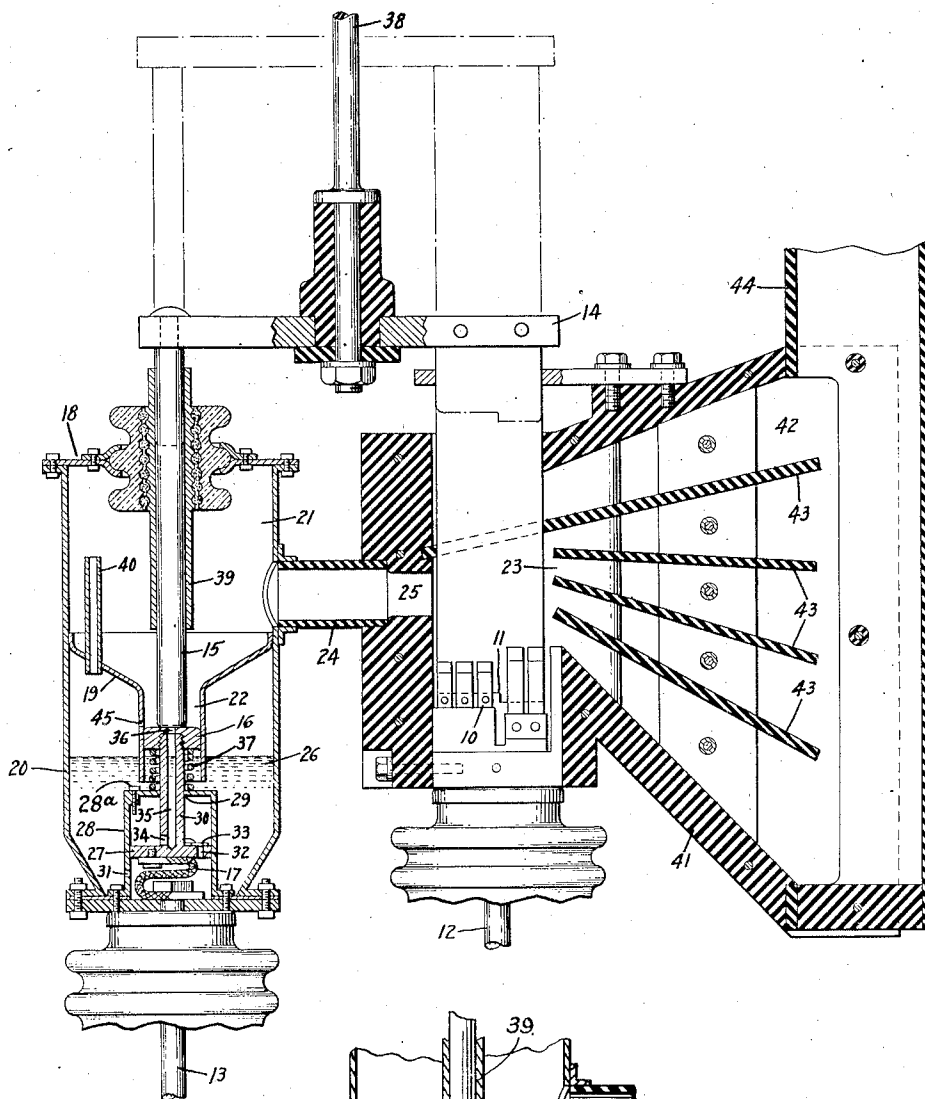
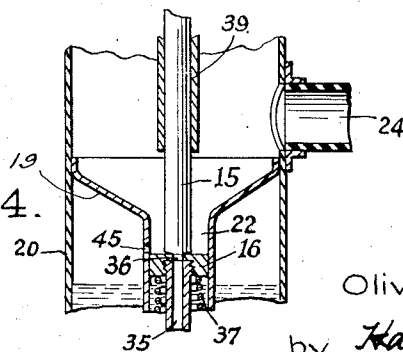


Fig. 4.



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2 Sheets-Sheet 2

Fig. 2.

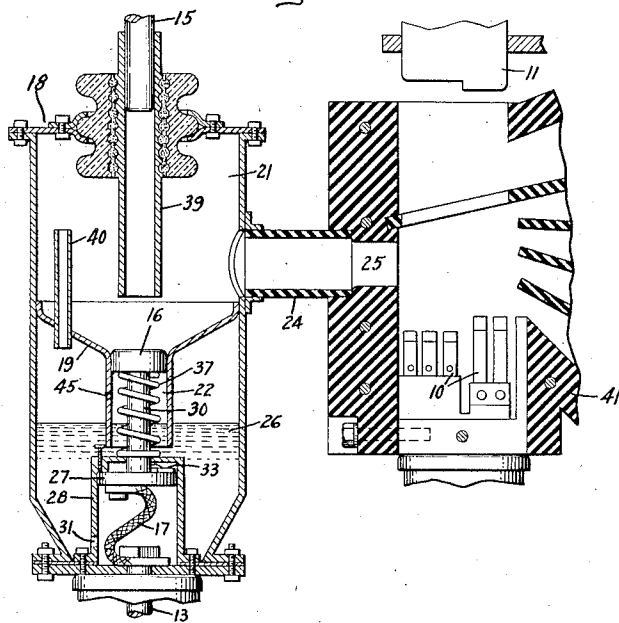
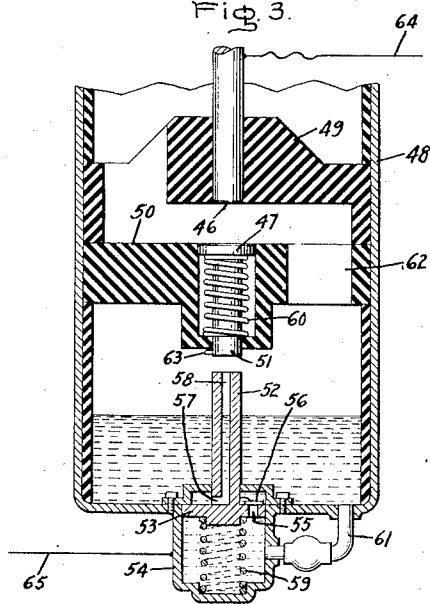


Fig. 3.



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UNITED STATES PATENT OFFICE

2,249,444

ELECTRIC CIRCUIT BREAKER

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New York

Application May 16, 1940, Serial No. 335,485

14 Claims. (Cl. 200—148)

My invention relates to circuit breakers and more particularly to electric circuit breakers of the gas blast type.

An object of my invention is to provide an improved electric circuit breaker of the gas or vapor blast type.

Another object of my invention is to provide an improved breaker of the above-mentioned type in which the total amount of gas passing across the breaker contacts may be limited to any desired value.

A further object of my invention is to provide an electric circuit breaker of the above-mentioned type which utilizes a pressure-forming arc to produce the desired gas pressure to extinguish the interrupting arc wherein a substantially constant pressure will obtain regardless of the magnitude of the arc current which is passing through the breaker at the moment of its opening operation.

I accomplish these and other objects by providing an electric circuit breaker with an arrangement for transforming a limited amount of arc-extinguishing liquid into a gas or vapor, this gas or vapor being then directed through the arc formed upon separation of the relatively movable circuit breaker contacts. In order to effect this result, I provide a gas generator having a gas accumulator chamber and a liquid reservoir. An arrangement, which includes a spring-biased piston, is provided for introducing a definite or predetermined amount of liquid into the gas accumulator when the circuit breaker contacts separate. I also provide in the gas accumulator relatively movable auxiliary contacts which are operated when the circuit breaker contacts move. Thus, when the blast of gas is desired for extinguishing the arc formed upon separation of the relatively movable contacts, the spring-biased piston injects a substantially definite quantity of liquid into the gas accumulator. An arc is also drawn between the auxiliary contacts which transforms the liquid into a gas. This gas is then conducted through an opening whose exit is adjacent the space between the relatively movable contacts. It will be seen, therefore, that regardless of the amount of current which is broken between the auxiliary contacts, a certain definite maximum pressure will obtain in the gas accumulator, because there is only a certain measured amount of liquid in the gas accumulator to be transformed into the arc-extinguishing gas.

Further objects and advantages of my invention will become apparent from the following

description referring to the accompanying drawings, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In the drawings, Fig. 1 is a partial sectional side elevation of an electric circuit breaker of the gas blast type being provided with an embodiment of my invention; Fig. 2 is a sectional side elevation of a portion of the circuit breaker illustrated in Fig. 1, the parts being illustrated in their position after circuit breaker operation, and Fig. 3 and Fig. 4 illustrate modifications of the electric circuit breaker illustrated in Figs. 1 and 2.

Referring to the drawings, in Fig. 1 I have illustrated an electric circuit breaker of the gas blast type having relatively movable contacts 10 and 11. The contact 10 is electrically connected to the terminal 12, while the contact 11 is electrically connected to the terminal 13 through a conducting cross-head 14, auxiliary contact 15, auxiliary contact 16, and the piston on which it is mounted, and pig-tail 17. In order to provide an arrangement for directing a substantially definite quantity of arc-extinguishing gas through the arc formed upon separation of the relatively movable contacts 10 and 11 to extinguish the arc, I provide a gas generator 18. The gas generator 18 is provided with a partition 19 so as to form a liquid reservoir 20 and a gas accumulator or forming chamber 21. The gas accumulator chamber and reservoir are connected together by a passage 22 which is formed by extending the sides of the partition 19 toward the reservoir. The gas accumulator chamber communicates with an interrupting chamber 23 through an insulating conduit 24. The exit end 25 of the conduit 24 is so spaced that it will be properly positioned with respect to the gap formed upon separation of the contacts 10 and 11. The reservoir 20 contains an arc-extinguishing liquid 26 of any suitable type, such as dichlorodifluoromethane, commonly known as freon, water, or carbon tetrachloride.

In order to provide an arrangement for introducing a definite or predetermined quantity of liquid from the reservoir 20 to the gas accumulator chamber 21, I provide a piston 27 which is adapted to move inside a piston cylinder 28. The cylinder has an opening 29 in its top head through which a tubular extension 30 of the piston 27 extends. The tubular extension or stem 30 is of sufficient length that when the piston 27

is in its downward position, as shown in Fig. 1, the tubular extension will extend up into the passageway 22 between the chamber and the reservoir. So that the liquid 26 from the reservoir may find its way into the space above the piston 27 in the cylinder 28, I provided a hole 31 in the lower portion of the side wall of the cylinder 28 which communicates with the interior of the reservoir. The piston is also provided with a passageway 32 which provides communication from the lower portion of the cylinder 28, which is in communication with the reservoir through the hole 31 to the upper portion of the cylinder above the piston. A flap valve 33 is provided over the top of the passageway 32 which allows the passageway 32 to open when the piston is descending, but which provides a closure member for the passageway 32 during the time the piston is ascending. The top portion of the cylinder communicates with the gas accumulator chamber through a transverse opening 34 and a longitudinal communicating passageway 35 in the piston extension member 30. The contact 16 which is carried by the stem 30 has a hole 36 through which it communicates with the passageway 35 and the passage 22. A spring 37 is provided between the auxiliary contact member 16 and the top of the cylinder which normally biases the piston to move toward the gas accumulator chamber. This piston, however, is held in its downward position as shown in Fig. 1 by means of the auxiliary movable contact 15 when the contacts 10 and 11 are in their closed position.

The operation of my improved circuit breaker is as follows: Upon relative movement of the contacts 10 and 11 through any suitable actuating mechanism which may be connected to the cross-head 14 by an insulating rod 38, the auxiliary movable contact 15 will tend to move away from the auxiliary contact 16 and piston stem 30. Since this piston is biased to move towards the gas accumulator through the medium of the spring member 37 the piston will tend to move with the auxiliary movable contact 15, but will be retarded somewhat by the work done in transferring the liquid from the cylinder 28 to the passage 22, the distance being limited by the available travel for piston 27 in cylinder 28. Upon such movement of the piston member, the liquid in the space between the top of the piston and the top of the cylinder will be displaced through the passageways 34, 35 and 36, and injected into the gas accumulator 21 in the region of the arc which is drawn between auxiliary contacts 15 and 16. A definite amount of liquid will be so injected, this amount being determined by the capacity of the space between the top of the piston and the top of the cylinder when the piston is in its downward position, as shown in Fig. 1. When the piston has moved a certain definite distance, or until it is stopped by contacting the inside surface of the top of the cylinder, this definite quantity of liquid will have been injected into the gas accumulator 21. If an adjustment is desired for the purpose of altering this quantity, a screw 28a can be provided to vary the stroke of the piston 27. During this movement the auxiliary contact 15 will have moved away from the auxiliary contact 16.

If current is flowing between the terminals 12 and 13, an arc will, of course, be drawn between these relatively movable auxiliary contacts 15 and 16 upon a gap being formed therebetween. This arc will produce heat which will transform the

liquid, which has been injected into the gas accumulator, into a gas. In order to make sure that this pressure generating arc drawn between the auxiliary contacts 15 and 16 will not become unduly long, I provide an auxiliary stationary contact 39 through which the contact 15 moves. As the end of the contact 15 is drawn inside this tubular contact 39, the arc will therefore transfer itself from the contact 15 to the tubular stationary contact 39. With such a structure the total amount of gas which is available for extinguishing the arc of the circuit breaker will be limited to a certain maximum amount. Thus, under extreme conditions, that is, under severe short circuits, when all the liquid which is injected into the gas accumulator 21 has been transformed into a gas, the pressure developed will be limited to a maximum value which will be safe for those parts of the breaker that must contain or control it. This maximum value will be determined by the amount of liquid which has been injected into the gas accumulator. Therefore, the total amount of gas injected across the interrupting contacts 10, 11 may be limited to any desired value. Under light current conditions, the heat generated by the pressure-forming arc may not be sufficient to transform all the liquid injected into a gas in the accumulator. However, a sufficient amount of gas will be present to extinguish the interrupting arc since, it, also, will be proportionally smaller. However, under all conditions of current, a limited amount of gas will be available for arc-extinguishing, and this amount will be a maximum when all the liquid which has been introduced into the chamber 21 has been transformed to a gas.

A vent 40 may be placed between the accumulator and the reservoir so as to equalize the pressure therebetween, thereby causing the rate of transfer of the liquid from cylinder 28 to passage 22 to be substantially independent of the amount of pressure in accumulator 21.

Therefore, the gas which has been formed in the gas accumulator 21 will pass through the conduit 24 into the space between the relatively movable contacts 10 and 11. This will cause the arc drawn therebetween to be blown into an arc chute 41 and extinguished. The arc-extinguishing gases will also pass into the arc chute 41. The arc chute 41 forms no part of my invention, it being described and claimed in a copending application Serial No. 313,126 to David C. Prince et al., filed November 6, 1939, and assigned to the same assignee as the present invention. This arc chute includes a fan-shaped portion 42 with barriers 43. The arc drawn between the relatively movable contacts 10 and 11 will therefore be blown by the gas which passes out through the conduit 24 into this fan-shaped passageway 42. The arc will be bent around the converging edges of the barriers 43 and blown into the space between these barriers and extinguished. A pipe 44 is provided at the large end of the fan-shaped arc chamber so as to provide a vent for the exhaust gases.

I have described above, a structure in which the total amount of gas available for arc extinguishing may be limited to any desired value. This is accomplished by introducing a definite quantity of liquid into a gas-forming chamber, the amount of gas developed up to a maximum value, being dependent upon the amount of current passing through the breaker at the time

of circuit-opening operation, or upon the heat of the pressure-forming arc.

I may also provide a breaker structure in which the gas pressure in the accumulator is kept to a substantially constant value throughout the entire range of current rating of the breaker. This result may be accomplished with a structure similar to that shown in Fig. 1, except that the vent 40 is stopped up or sufficiently restricted. This structure is illustrated in Fig. 4. As has already been pointed out, the function of vent 40 is to equalize the pressure in chambers 20 and 21 so that the rate of transfer of liquid from cylinder 28 to passage 22 is independent of the pressure inside of 21, and dependent on the characteristics of the spring 37. Therefore, this rate of transfer can be made dependent on the pressure developed in chamber 21 by causing this pressure to create a force against which the spring must push in order to raise the piston 27. This is accomplished by having only one communication between chambers 20, 21 and this being through the passage 22 through which the piston extension 30 and auxiliary contact 16 extends. Thus, when the pressure developed in the accumulator is equal to the force which the spring can bring to bear against the contact 16, the piston 27 will stop moving and no more liquid will be injected into the chamber 21, until the gas already developed passes out through the passage 24. Thus, assuming that the pressure-forming arc is not enough to transform into gas all the liquid injected into it, the pressure developed in the accumulator will remain at a determinable approximately constant value, or within a predetermined operating range, from the time that the pressure has built up to this value, until the circuit breaker interrupting arc has been extinguished.

In case the circuit breaker should be operated with no current flowing therethrough, the liquid introduced into the chamber 21 will not be transformed into a gas. Under such conditions there must be a way of removing the injected liquid or when the breaker operates again twice the measured liquid will be available. Thus I provide a hole 45 in the passageway 22 which is so placed in the partition 19 that it is just above the contact 16 when the breaker is in its fully closed position, as shown in Fig. 1. This provides a drain, but the hole 45 will be closed by the side of the contact 16 after the breaker starts to open, so that it will not interfere with normal operation.

In Fig. 2 I have illustrated the gas generator parts and the interrupting contacts in their circuit open position.

In Fig. 3 I have illustrated a modification of the gas blast circuit breaker which includes relatively movable contacts 46 and 47. The contacts 46 and 47 are placed in a container 48 which is provided with transverse barriers 49 and 50. The barriers 49 and 50 are placed a short distance apart so that the relatively movable contacts 46 and 47 will separate in the space between the transverse barriers. The contact 47 has an extension 51 which cooperates with a tubular contact member 52. Thus auxiliary contacts 51 and 52 provide upon separation a pressure generating arc. At the base of the tubular contact 52 there is provided a piston member 53 which is adapted to move in a cylinder 54. The piston member 53 and cylinder 54 provide an arrangement for injecting a definite amount of liquid into the space between the contacts 51 and 52. 75

The piston is provided with a passageway 55 and a check valve 56 similar to the passageway 32 and valve 33 illustrated in Fig. 1. The tubular extension 52 is also provided with a transverse passageway 57 and a longitudinal passageway 58 similar to the passageways 34 and 35 in the piston illustrated in Fig. 1. The piston 53 is biased in an upward direction by means of a spring member 59, which also makes the electrical connection between contact 52 and cylinder 54. The contact 47 is also biased toward the contact 46 by a spring member 60. The cylinder 54 communicates with the chamber formed between the barrier 50 and the bottom of the casing 48 by means of a pipe arrangement 61. This chamber forms a reservoir, in which a liquid is placed, similar to the reservoir 20.

The operation of the electric circuit breaker illustrated in Fig. 3 is as follows: when the contacts 46 and 47 are moved to their closed position, contact 47 will force its extension 51 against the contact 52, overcoming the force of the springs 59 and 60 by means of the downward movement of the contact 46. Thus the piston 53 will rest against the bottom of the cylinder 54 and contacts 46 and 47 and piston 53 will be in electrical contact. Upon actuation of the electric circuit breaker, the contact 46 will move upwardly causing the contact 47 to tend to move with it for a certain limited distance. This will cause the upwardly biased piston stem 52 to move also. The delay caused by the dashpot action of piston 53 will cause a gap to form between the contacts 51 and 52, and if current is flowing, an arc will be formed therebetween. Since the upward movement of the piston 53 has caused a spray of liquid to be injected into the space between the contacts 51 and 52, the arc drawn therebetween will cause this liquid spray to be transformed into a gas. When piston 53 reaches the top of cylinder 54, no further liquid can be sprayed into the pressure-forming arc, thereby limiting the maximum gas pressure under the highest short circuit conditions permissible. The gas formed will move upwardly through a passageway 62 in the barrier 50, which communicates with the space between the barriers 49 and 50. Further movement of the contact 46 will cause an arc to be drawn between the interrupting contacts 46 and 47, since further movement of the contact 47 is prevented by a stop member 63 on the contact extension 51 which contacts the bottom surface of the barrier 50. The gas generated below the barrier 50 will pass through the transverse passageway and interrupt the arc formed between the movable contacts 46 and 47 so as to open the circuit which is connected to the circuit breaker through lines 64 and 65.

In view of the foregoing it will be seen that I have provided an electric circuit breaker of the gas blast type which is so constructed that the pressure of the arc-extinguishing gas which is developed by a pressure-forming arc will be limited to a maximum value of pressure, which value may be determined by the value which the gas accumulator vessel can safely withstand. This is accomplished since a definite amount of liquid is injected into the space surrounding the pressure-forming arc so that only a limited amount of liquid is present to be transformed into the gas, which is then directed through the interrupting arc formed upon separation of the main circuit breaker contacts to extinguish that arc. Furthermore, a substantially constant pressure can be maintained in the gas accumulator

during the time the interrupting arc is extinguished by allowing the pressure in the accumulator to limit the distance of travel of the spring-biased piston which injects the liquid into the accumulator.

Modifications of the particular arrangements which I have disclosed as embodying my invention will occur to those skilled in the art, so that I do not desire my invention to be limited to the particular arrangements set forth, and I intend in the appended claims to cover all modifications which do not depart from the spirit and scope of my invention.

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

1. An electric circuit breaker including relatively movable contacts, an arc extinguishing liquid, means for forming a pressure generating arc for transforming a portion of said liquid into a gas, said portion being limited to a predetermined part of said liquid, and means for directing said gas through the arc formed upon separation of said contacts to extinguish the arc.

2. An electric circuit breaker including relatively movable contacts, an interrupting chamber for said relatively movable contacts, an arc extinguishing liquid, a gas forming chamber, means for introducing in accordance with the contact opening operation a definite quantity of said liquid into said gas forming chamber for transforming into a gas, and means for directing said gas into said interrupting chamber and through the arc formed upon separation of said contacts to extinguish the arc.

3. An electric circuit breaker including relatively movable contacts, an interrupting chamber, a gas forming chamber, an opening in said gas forming chamber communicating with said interrupting chamber, said contacts being separable in said interrupting chamber substantially adjacent said opening, means for introducing a definite quantity of liquid into said gas forming chamber, and means in said gas forming chamber responsive to the movement of said contacts for transforming liquid into a gas so that the gas will flow out of said opening and through the gap formed upon separation of said contacts for interrupting the arc at said gap.

4. An electric circuit breaker including an interrupting chamber, relatively movable contacts in said chamber, an arc extinguishing liquid, a gas forming chamber for transforming liquid into a gas, and means for introducing a definite quantity of said liquid into said gas forming chamber so that a limited quantity of gas may be directed into said interrupting chamber and through the arc formed upon separation of said contacts to extinguish the arc.

5. An electric circuit breaker including relatively movable contacts, a gas forming chamber, an opening in said chamber, said contacts being separable substantially adjacent said opening, an arc extinguishing liquid, means including a pressure generating arc within said gas forming chamber for transforming liquid into a gas, and means for introducing a predetermined portion of said liquid into said gas forming chamber so that the gas transformed will flow out said opening and through the gap formed upon separation of said contacts for interrupting the arc at said gap.

6. An electric circuit breaker including relatively movable contacts, relatively movable auxiliary contacts, actuating means for said relatively movable contacts and relatively movable aux-

iliary contacts, said relative movement causing arcing between said contacts and between said auxiliary contacts, a gas generating chamber, said auxiliary contacts being separable in said chamber, an arc extinguishing liquid, means for introducing a definite quantity of said liquid into said chamber upon relative movement of said auxiliary contacts so that the arc therebetween will transform liquid into a gas, and means for directing said generated gas through the arc formed upon separation of said contacts to extinguish the arc.

7. An electric circuit breaker including relatively movable contacts, a gas generator having a reservoir chamber and a gas accumulator chamber, an arc extinguishing liquid in said reservoir, means for introducing a definite quantity of said liquid from said reservoir into said accumulator chamber, means in said accumulator chamber responsive to the movement of said contacts for transforming liquid into a gas, and means for directing said gas into the space between said relatively movable contacts.

8. An electric circuit breaker including relatively movable contacts, a gas generator having a reservoir and a gas accumulator chamber, an opening in said chamber, said contacts being separable substantially adjacent said opening, arc extinguishing liquid in said reservoir, a passage between said reservoir and said chamber, means including a spring biased piston for injecting a definite quantity of said liquid from said reservoir through said passage into said chamber, and means in said chamber for transforming injected liquid into a gas at substantially the moment said contacts separate so that the gas will flow out said opening and through the gap formed upon separation of said contacts for interrupting the arc at said gap.

9. An electric circuit breaker including relatively movable contacts, a gas generator having a reservoir and a gas accumulator chamber, an opening in said chamber, said contacts being separable substantially adjacent said opening, an arc extinguishing liquid in said reservoir, a passage between said reservoir and said chamber, a cylinder within said reservoir, communicating means between said cylinder and said reservoir, a piston within said cylinder, said piston having a portion extending into said passage between said reservoir and said chamber, a bore within said piston and extending portion, a spring biasing said piston for movement toward said chamber, means for allowing said piston to move upon separation of said contacts so that the measured quantity of liquid above said piston within said cylinder will be injected through said bore and passage into said chamber, and means in said chamber for transforming said injected liquid into a gas so that said gas will flow out said opening and through the gap formed upon separation of said contacts for interrupting the arc at said gap.

10. An electric circuit breaker including relatively movable contacts, a gas generator having a reservoir and a gas accumulator chamber, an opening in said chamber, said contacts being separable substantially adjacent said opening, arc extinguishing liquid in said reservoir, a piston in said reservoir, spring means for moving said piston, means including said spring biased piston for injecting a definite quantity of said liquid from said reservoir into said chamber, vent means extending between said reservoir and chamber so as to substantially equalize the pres-

sure therebetween, and means in said chamber for transforming said injected liquid into a gas at substantially the moment said contacts separate so that the gas will flow out said opening and through the gap formed upon separation of said contacts for interrupting the arc at said gap.

11. An electric circuit breaker including relatively movable contacts, a gas forming chamber, means for forming a pressure generating arc in said chamber for transforming liquid into a gas, means for introducing a predetermined quantity of liquid into said chamber, the amount of said injected liquid which is transformed into a gas being determined by the amount of heat generated from said pressure generating arc, and means for directing said generated gas through the arc formed upon separation of said contacts to extinguish the arc.

12. An electric circuit breaker including relatively movable contacts, a gas-forming chamber, means in said chamber for transforming liquid into a gas, means for introducing liquid into said chamber at such a rate that the gas pressure developed in said chamber remains below

a maximum value, and means for directing said gas through the arc formed upon separation of said contacts to extinguish the arc.

13. An electric circuit breaker including relatively movable contacts, a gas generator having a reservoir and a gas accumulator chamber, means in said accumulator chamber for transforming liquid into a gas, means including a spring-biased piston for injecting liquid from said reservoir into said chamber at such a rate that the gas pressure developed in said chamber remains below a maximum value, and means for directing said gas into the space between said relatively movable contacts.

14. An electric circuit breaker including relatively movable contacts, a gas forming chamber, means in said chamber for transforming liquid into a gas, means for introducing liquid into said chamber at such a rate that the gas pressure developed in said chamber remains fixed at a value within a predetermined operating range, and means for directing said gas through the arc formed upon separation of said contacts to extinguish the arc.

OLIVER C. TRAVER.