Aug. 2, 1938. H. THOMMEN 2,125,525

ELECTRIC CIRCUIT BREAKER

Filed May 1, 1937 3 Sheets-Sheet 1

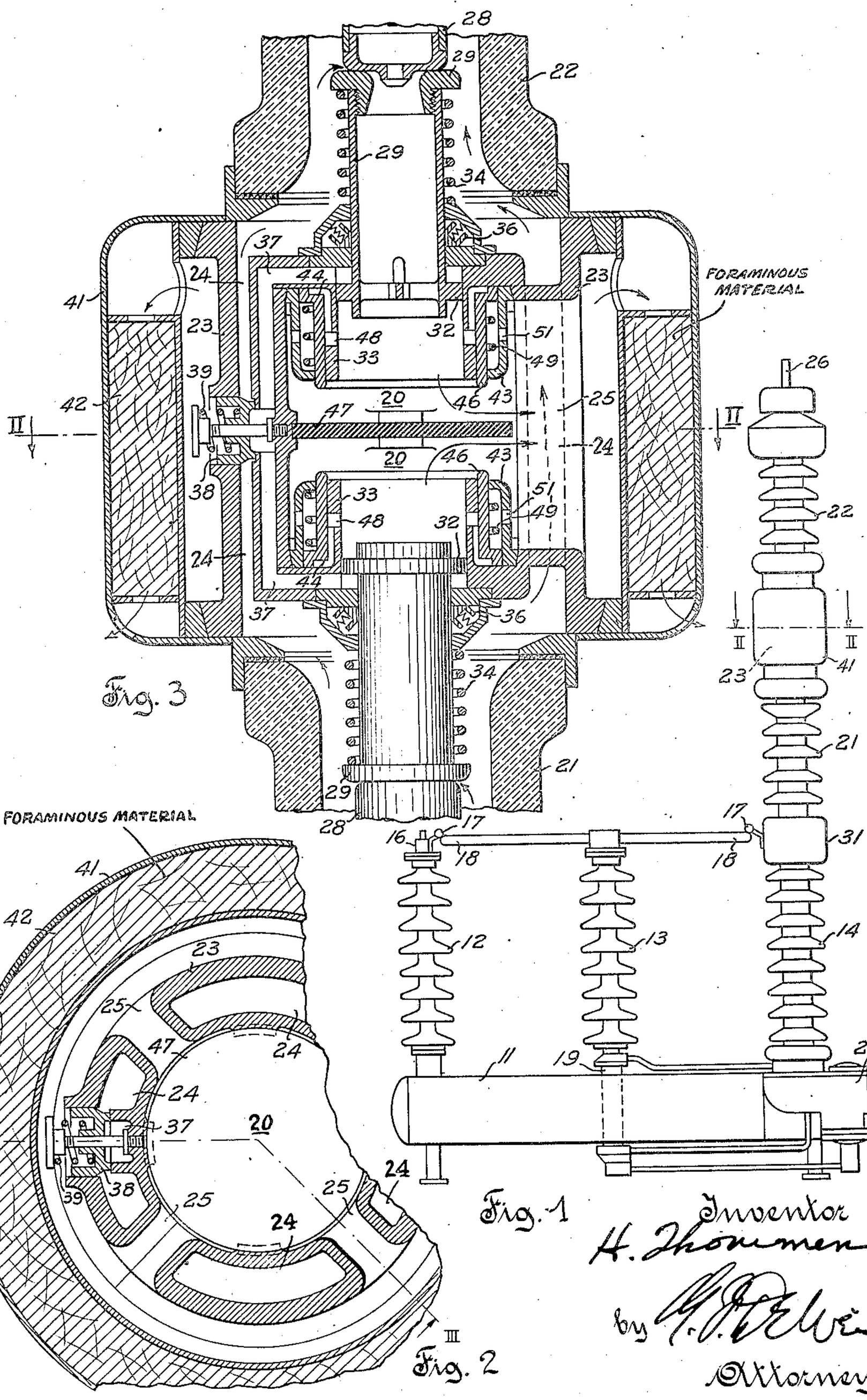

Fig. 3

Fig. 1

Fig. 2

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ELECTRIC CIRCUIT BREAKER

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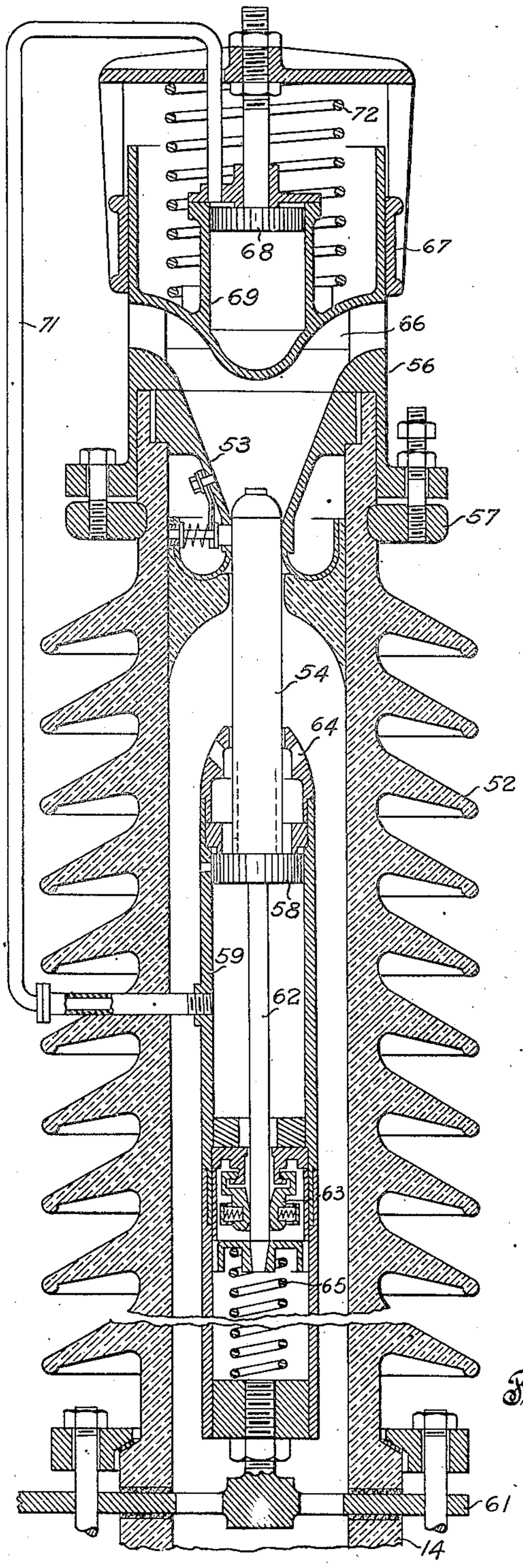

Fig. 4

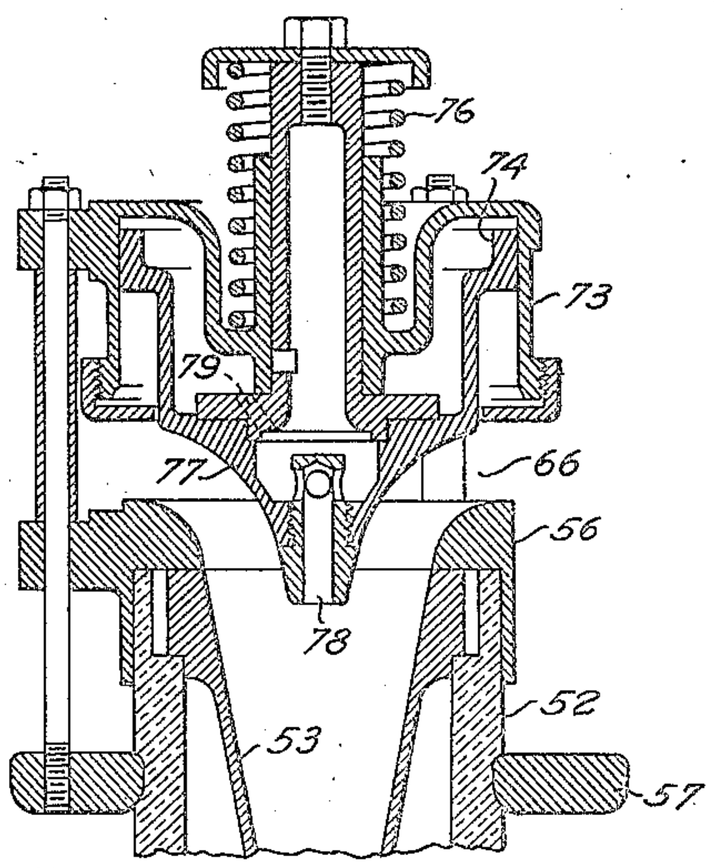

Fig. 5

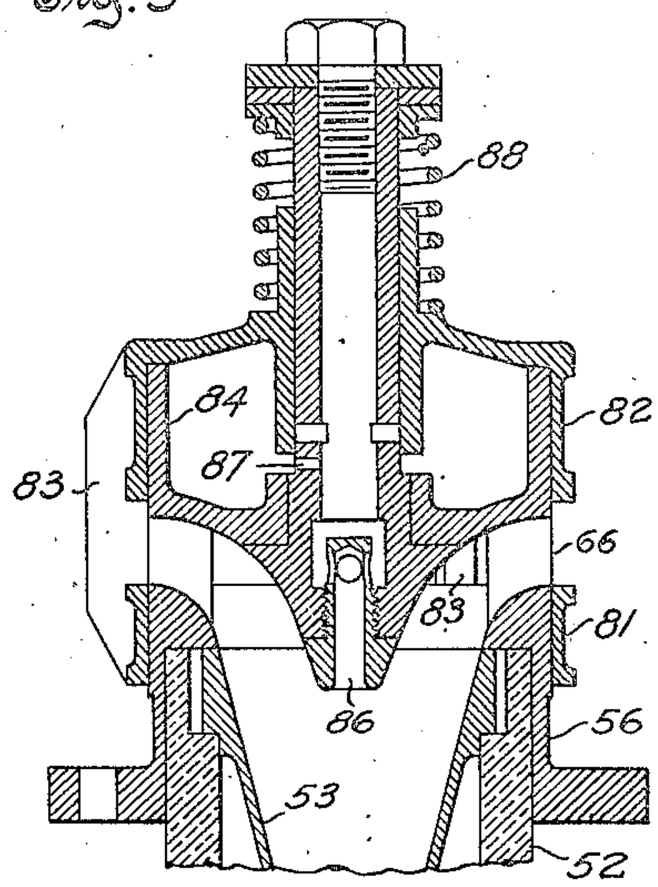

Fig. 6

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ELECTRIC CIRCUIT BREAKER

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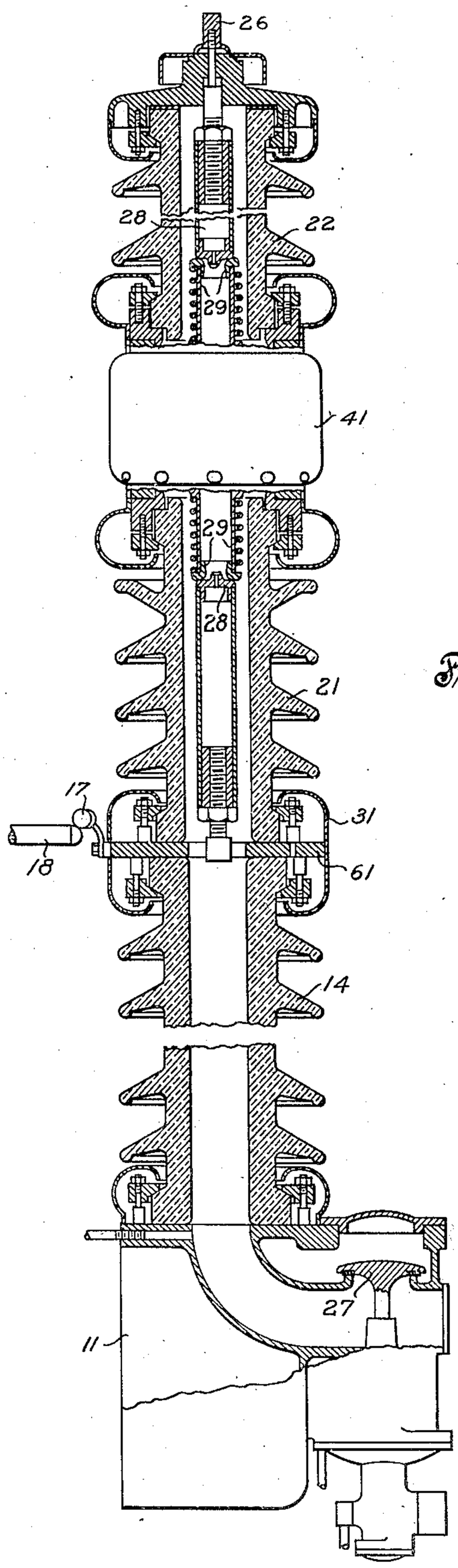

Fig. 7

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UNITED STATES PATENT OFFICE

2,125,525

ELECTRIC CIRCUIT BREAKER

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Application May 1, 1937, Serial No. 140,078
In Germany July 13, 1935

16 Claims. (Cl. 200—148)

This invention relates in general to improvements in electric circuit breakers, and more particularly to circuit breakers of the fluid blast type in which the functions of interrupting the flow of current in a circuit and of thereafter maintaining the circuit opened are performed by separate elements.

In the operation of circuit breakers of the fluid blast type, the current interruption takes place under the most advantageous conditions when the arcing contacts are rapidly separated to a distance permitting the flow therebetween of a blast of fluid of maximum velocity from the available source of fluid under pressure. The contacts are thus separated only for such distance that an arc would be reestablished therebetween upon interruption of the fluid blast, and it is thus necessary to open the circuit by means of a pair of disconnecting contacts while the fluid blast is being maintained between the arcing contacts. Such procedure results in the consumption of an amount of fluid which is considerably greater than the amount required for actually interrupting the arc.

Such consumption may be materially reduced by providing the arcing chamber outlet with a valve for stopping the flow of fluid thereinto and for confining fluid under pressure within the chamber after interruption of the arc. As is well known, the dielectric strength of atmospheric air and of a number of other fluids utilized in fluid blast circuit breakers increases with the pressure of the fluid at least up to a predetermined value of pressure. By suitably selecting the pressure of the fluid and the distance separating the arcing contacts, the breakdown voltage of the space between the contacts may be maintained at such a high value that the arc will not be reestablished between the contacts, and the opening of the circuit by the disconnecting contacts may then take place at such time as may be found desirable or convenient. If a plurality of pairs of arcing contacts separately operated by fluid under pressure are utilized in series, the several contact actuating means should receive fluid under pressure simultaneously from the arcing chamber when the pressure within such chamber has reached a predetermined value to insure simultaneous opening of all contacts when the pressure within the arcing chamber is sufficient to interrupt the arc drawn between the contacts.

It is, therefore, one of the objects of the present invention to provide a circuit breaker of the fluid blast type in which arcing contacts and disconnecting contacts may be sequentially opened with a suitable time interval between such opening operations.

Another object of the present invention is to provide a circuit breaker of the fluid blast type in which arcing contacts are separated by fluid under pressure confined within the arc chamber after interruption of the arc between the contacts.

Another object of the present invention is to provide a circuit breaker of the fluid blast type in which a plurality of pairs of arcing contacts are caused to open simultaneously only when the pressure within the arcing chamber exceeds a predetermined value.

Objects and advantages other than those above set forth will be apparent from the following description when read in connection with the accompanying drawings, in which:

Fig. 1 is a view in elevation of a circuit breaker embodying the present invention and comprising a plurality of pairs of arcing contacts and a plurality of pairs of disconnecting contacts;

Fig. 2 is a horizontal cross sectional view of the arcing chamber of the embodiment illustrated in Fig. 1 taken on plane II—II in Fig. 1 and in Fig. 3;

Fig. 3 is a vertical cross sectional view of a portion of the arcing chamber of the embodiment illustrated in Figs. 1 and 2 taken on two planes III—III joining at the axis of the chamber;

Fig. 4 is a vertical cross sectional view of the arcing chamber of a modified embodiment of the invention utilizing only one pair of arcing contacts;

Fig. 5 is a vertical cross sectional view of a modified form of the arcing chamber outlet valve illustrated in Fig. 4;

Fig. 6 is a vertical cross sectional view of another modified form of the arcing chamber outlet valve illustrated in Fig. 4; and

Fig. 7 is a vertical sectional view of a part of the circuit breaker shown in Fig. 1.

Referring more particularly to the drawings by characters of reference, Fig. 1 illustrates a circuit breaker comprising a reservoir 11 constituting a source of supply of fluid under pressure. Such fluid is assumed herein to be compressed air supplied to the reservoir by a suitable compressor (not shown) to maintain the pressure within the reservoir at a substantially constant value, but it will be understood that other fluids such as nitrogen or helium, may also be utilized. Reservoir 11 is provided with suitable means for supporting the circuit breaker on ground or on a

suitable frame work, and supports three insulators 12, 13 and 14 of dimensions which are determined by the voltage of the circuit in which the circuit breaker is to be inserted. Insulators 12 and 14 are fixed and support one terminal 16 and the fixed disconnecting contacts 17 of the circuit breaker. Insulator 13 carrying the movable disconnecting contacts 18 of the circuit breaker is pivotally mounted on reservoir 11 and may be rotated about a vertical axis of a suitable compressed air motor 19.

Insulator 14 is hollow and forms a part of the arcing chamber of the circuit breaker, such chamber also comprising a pair of insulators 21, 22 joined by a double walled metallic member 23. Member 23 defines a plurality of passages 24, 25, and cooperates with contacts 29 to form a chamber or a plurality of chambers 20. The walls of member 23 may be made of several segmental portions to permit introduction within the chamber 20 of certain elements of the circuit breaker. Insulator 22 carries the second terminal 26 of the breaker. The bottom flange of insulator 14 is provided with an inlet for introducing air under pressure into the arcing chamber. An inlet valve 27 or an equivalent element is provided for controlling the admission of air from reservoir 11 into the arcing chamber for causing separation of the arcing contacts enclosed therein and for interrupting the arc drawn between such contacts upon separation thereof by a blast of air issuing from the chamber through outlets 25. Valve 27 also controls the admission of compressed air to motor 19. The valve may be of any suitable type known in the art, but is preferably of the type disclosed and claimed in copending application Serial No. 60,362 of Arnold Haller and Hans Thommen, filed February 21, 1936.

As illustrated in Figs. 3 and 7, each of the insulators 21 and 22 contains a pair of cooperating arcing contacts 28, 29. Contacts 28 are fixed contacts, the upper contact 28 being rigidly mounted on terminal 26 and the lower contact 28 being rigidly mounted on a perforated diaphragm 61 inserted between insulators 14 and 21 and connected with one of contacts 17 through an electrostatic shield 31. Contacts 29 are hollow movable contacts penetrating within member 23 in sliding engagement therewith. Contacts 28 and 29 may be made of any suitable conductive material and may be provided with renewable arcing tips of difficultly fusible conductive material if desired. When the contacts 28, 29 are closed, such contacts divide the arcing chamber into two portions, an inlet portion and an outlet portion. The inlet portion of the chamber comprises the space extending from the inlet valve 27 through the insulator 14, the space between the arcing contacts 28, 29 and insulators 21 and 22, and passages 24 in member 23. The outlet portion of the arcing chamber consists of the space 20 extending through contacts 29 and member 23 to the outlets 25. Compressed air is admitted to the outlet portion from the inlet portion through contacts 29 upon separation of the arcing contacts.

A plurality of contact separating means operable by air under pressure are severally associated with the different pairs of contacts 28, 29. Each such means comprises an annular piston 32 mounted on the associated contact 29 and arranged within a cylinder 33 mounted on or forming part of member 23. Each piston moves the associated contact 29 against the action of a spring 34 tending to maintain the associated pair of contacts closed. During such movement of contacts 29, the electrical connection between such contacts is maintained by member 23 and by a plurality of sliding contacts 36 each urged by springs against the associated contact 29 and against a portion of member 23. Pistons 32 are actuated by compressed air introduced into the inlet portion of the arcing chamber of the circuit breaker.

When compressed air is introduced into the inlet portion, the pressure therein can only rise gradually due to the throttling action of the small valve 27. If cylinders 33 were in direct communication with the inlet portion, the pressure within the cylinders would also rise gradually. Each contact 29 would then move when the pressure on the associated piston 32 became sufficient to overcome the action of the associated spring 34 and the friction of the contact against the fixed members adjacent thereto. The different moving contacts would therefore not open simultaneously, and additional means should be provided for insuring simultaneous operation of the different contact separating means. For obtaining such result, compressed air is supplied from the inlet chamber portion to cylinders 33 through channels 37 within the inner wall of member 23 and through a plurality of additional valves 38. Valves 38 tend to be opened by the pressure of the compressed air within the inlet portion and are normally maintained on the seats thereof by springs 39. The valves are thus made responsive to increase of the pressure within the inlet portion for supplying compressed air from such portion simultaneously to all the contact separating means at such pressure that all contacts 29 may be actuated simultaneously. The compressed air blast produced upon opening of the contact escapes from the arcing chamber through outlets 25 and thereafter passes through a muffler 41 containing a suitable sound deadening material 42.

Outlets 25 may be closed after operation of contacts 29 by means which are responsive to the operation of the contact separating means and which are preferably distinct from such contact separating means. For this purpose each cylinder 33 cooperates with another cylinder 43 coaxial therewith to form an annular space receiving an annular piston 44. Each piston 44 is provided with a cylindrical extension forming a slide valve 46 cooperating with a partition 47 arranged transversely to separate chambers 20, for controlling outlets 25. Each piston 44 is actuated by compressed air introduced between the associated cylinders 33 and 43 from within cylinder 33 through ports 48 in response to the operation of the associated piston 32. Piston 44 then urges the associated valve 46 toward partition 47 against the action of a spring 49 associated therewith. The air confined within the space containing springs 49 may be allowed to escape through ports 51 in cylinders 43. In providing the above operation, cylinders 33 and 43 and pistons 44 constitute compressed air motors arranged to receive air under pressure in response to the operation of the associated contact separating means for actuating the associated valves only upon separation of the arcing contacts to a predetermined distance.

Assuming the circuit breaker to be in the closed position shown in Figs. 1, 3 and 7, if it is desired to cause the circuit breaker to open, valve 27 is opened either manually or in any other manner. Compressed air is thereby admitted through

the inlet valve 27 into the inlet portion of the arcing chamber. The pressure of the air within the inlet portion rises at a rate depending upon the volume of the chamber and on the size of the opening of valve 27, and such pressure finally becomes sufficient to cause valve 38 to open. Compressed air is then admitted from the inlet portion into cylinder 33 through valves 38 and passages 37 thereby causing pistons 32 to be actuated simultaneously to separate the associated contacts 29 from the cooperating contacts 28. Upon such separation of a pair of contacts, an arc is drawn therebetween and simultaneously a blast of compressed air is projected between the contacts from the inlet portion to the outlet portion, such blast escaping from the arcing chamber through outlets 25 and muffler 41 to the ambient atmosphere, following the paths as shown by the arrows in Fig. 3. The arc is forced to leave the shortest path between the contacts by the air blast and the point of attachment thereof to contact 29 is moved to different points on the inner surface of the movable contact more and more remote from the fixed contact. The stroke and inner diameter of each contact 29 are so chosen as to allow the establishment of an air blast capable of cooling and deionizing the arc path to a sufficient extent to prevent reestablishment of the arc after passage of the arc current through the value zero when the circuit breaker is utilized in an alternating current circuit. After passage of piston 32 over port 48, compressed air is admitted behind piston 44 and such piston urges the associated valve 46 into contact with partition 47. Each valve 46 thus functions responsive to the operation of the associated contact separating means for closing outlets 25 thereby confining compressed air within the arcing chamber after interruption of the arc. The reestablishment of the arc between contacts 28 and 29 is thus prevented as effectively as if the air blast were maintained between such contacts, with the advantageous result that further consumption of air is substantially prevented. The operation of valves 46 takes place with a time delay depending upon the size and number of ports 51. Upon closure of valves 46 the air pressure within member 23 becomes equal on both sides of pistons 32 and springs 34 return contacts 29 to the closed position shown.

Simultaneously with the admission of air to the arcing chamber of the circuit breaker, air is admitted by valve 27 to compressed air motor 19. Such motor causes insulator 13 to rotate and to separate contacts 17 and 18. The speed of operation of contacts 29, of valves 46 and of motor 19 must be so related that contacts 18 begin to open only after interruption of the arc drawn in the arcing chamber and that such contacts reach substantially the end of the travel thereof before reclosure of contacts 29. If valve 27 is of the type disclosed in the above cited application, completion of the operation of motor 19 causes the valve to reclose. The air confined within the arcing chamber may then leak past the cooperating surfaces of contacts 28 and 29 and between valve 46 and partition 47 to the atmosphere. When the air pressure within the arcing chamber outlet portion decreases below a predetermined value, springs 49 return valves 46 to the position shown. The exhaust of air from the arcing chamber may be accelerated by providing valve 27 with a passage placing the arcing chamber in communication with the atmosphere when valve 27 is closed. Contacts 29 thus being returned to the closed position shown on the drawings, the circuit breaker may be reclosed by returning contacts 18 to the position shown by means of motor 19.

The embodiment partially illustrated in Fig. 4 utilizes reservoir 11, valve 27 and an arcing chamber comprising insulator 14 and a single other insulator 52 mounted thereon. Insulator 52 supports a single fixed annular contact 53 which is made at least partially resilient to insure the satisfactory conductive engagement thereof with a single cylindrical contact 54 coaxial with insulator 52 and movable in the longitudinal direction thereof. Contact 53 is maintained in position by a terminal member 56 bolted to a clamp 57 mounted on the upper portion of insulator 52. Contact 54 is provided with suitable contact separating means such as a piston 58 mounted thereon and movable in a cylinder 59 arranged within insulator 52. The cylinder is mounted on a perforated diaphragm 61 arranged between insulators 14 and 52. Piston 58 is provided with a piston rod 62 and is urged upward by a spring 65. The electrical connection between terminal 56 and the contact 17 mounted on insulator 14 is effected through contact 53, contact 54, piston 58, piston rod 62, one or more sliding contacts 63, cylinder 59 and diaphragm 61. Cylinder 59 is adapted to receive air under pressure from the arcing chamber inlet portion through ports 64. The arcing chamber outlet portion consists of contact 53 and of terminal 56, and the latter is provided with an interrupted annular outlet 66 which may be closed by a sliding valve 67. Valve 67 is actuated by a piston 68 within a cylinder 69 supported by or forming part of terminal 56. Air under pressure may be admitted on the upper side of piston 68 from cylinder 59 through a pipe 71 of suitable insulating material. A spring 72 tends to maintain valve 67 in the open position thereof.

The operation of the present embodiment differs only in detail from the operation of the embodiment illustrated in Fig. 1. Upon operation of valve 27, air is admitted within insulators 14 and 52 and such air is admitted on the upper side of piston 58 through ports 64. Piston 58 is then urged downward against the action of spring 65 and causes separation of contacts 53 and 54. An arc is drawn between such contacts and is interrupted by the blast of air passing between the contacts and escaping from the arcing chamber through outlet 66. After passage of piston 58 over the inlet of pipe 71, air under pressure is admitted from cylinder 59 into pipe 71 to the upper side of piston 68. Piston 68 moves valve 67 downward against the action of spring 72 to close outlet 66. Contact 54 remains open and valve 67 remains closed until subsequent closure of valve 27. Upon such closure of valve 27, the air confined within the arcing chamber escapes by leakage past valve 67 or by means of a discharge passage controlled by valve 27. Spring 72 then returns valve 67 to the open position shown and spring 65 returns contact 54 to the closed position shown.

The embodiment illustrated in Fig. 5 utilizes an outlet valve actuated by a compressed air motor connected with the arcing chamber outlet portion. Terminal 56 extends only up to outlet 66 and supports the motor cylinder 73 containing a differential piston 74, which is urged upward toward the position shown by a spring 76. Piston 74 is provided with an extension 77 protruding from cylinder 73 and cooperating with contact 53 and with terminal 56 to form the arcing

chamber outlet portion. Extension 77 also forms a valve operable to close outlet 66 upon downward movement of piston 74. Ports 78 and 79 are provided for placing the upper face of piston 74 in communication with the arcing chamber outlet portion whereby the piston is rendered responsive to the admission of compressed air into such outlet portion upon separation of contacts 53 and 54 for actuating valve 77. It will be understood that such operation of piston 74 is possible for the reason that the air pressure is applied to the entire upper face of piston 74 and that such pressure may thus overcome the pressure exerted on the lower face of extension 77, which is of smaller diameter than piston 74, in addition to the effect of spring 76. Valve 77 remains closed as long as pressure is maintained in the arcing chamber outlet portion. When such pressure is released by leakage about valve 77 or by the action of the inlet valve of the circuit breaker, spring 76 returns valve 77 to the position shown.

In the embodiment partially illustrated in Fig. 6, a cylindrical outlet valve 81 is arranged about terminal 56 below outlet 66 for controlling such outlet. A cylinder 82 is mounted on valve 81 and is connected therewith through a plurality of supports 83. Cylinder 82 is slidably mounted on a piston 84 forming part of terminal 56. The space within cylinder 82 is placed in communication with the arcing chamber outlet portion through ports 86 and 87 to cause the cylinder to receive compressed air in response to the operation of the contact separating means. Cylinder 82 tends to be maintained in the position shown by a spring 88. Upon separation of contacts 53 and 54 compressed air is admitted into cylinder 84 and the cylinder is thereby caused to move upward against the action of spring 88 to close valve 81. The valve remains in the closed position as long as pressure is maintained within the arcing chamber outlet portion and the valve is returned to the position shown by spring 88 upon release of the pressure within such chamber portion.

Although but a few embodiments of the present invention have been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. An electric circuit breaker comprising a source of supply of fluid under pressure, an arcing chamber having an outlet, a pair of cooperating contacts arranged in said chamber, means operable by fluid under pressure for separating said contacts, means for controlling the admission of fluid from said source into said chamber and to said contact separating means to cause separation of said contacts and interruption of the arc drawn therebetween, and means distinct from said contact separating means and responsive to the operation of said contact separating means for closing said outlet and maintaining fluid under pressure in said chamber.

2. An electric circuit breaker comprising a source of supply of fluid under pressure, an arcing chamber having an outlet, a pair of cooperating contacts arranged in said chamber, means operable by fluid under pressure for separating said contacts, means for controlling the admission of fluid from said source into said chamber and to said contact separating means to cause separation of said contacts and interruption of the arc drawn therebetween, a valve for controlling said outlet, and a fluid actuated motor arranged to receive fluid under pressure in response to the movement of said contact separating means for actuating said valve.

3. An electric circuit breaker comprising a source of supply of fluid under pressure, an arcing chamber having an outlet, a pair of cooperating contacts arranged in said chamber, means operable by fluid under pressure for separating said contacts, means for controlling the admission of fluid from said source into said chamber and to said contact separating means to cause separation of said contacts and interruption of the arc drawn therebetween, a valve for controlling said outlet to maintain fluid under pressure at said contacts after separation thereof, a cylinder arranged to receive fluid under pressure in response to the operation of said contact separating means, and a piston within said cylinder for actuating said valve.

4. An electric circuit breaker comprising a source of supply of fluid under pressure, an arcing chamber having an outlet, a pair of cooperating contacts arranged in said chamber, means operable by fluid under pressure for separating said contacts, means for controlling the admission of fluid from said source into said chamber and to said contact separating means to cause separation of said contacts and interruption of the arc drawn therebetween, a valve for controlling said outlet, a cylinder mounted on said valve and arranged to receive fluid under pressure in response to the operation of said contact separating means, and a piston arranged within said cylinder and fixedly mounted on said chamber.

5. An electric circuit breaker comprising a source of supply of fluid under pressure, an arcing chamber having an inlet and an outlet, a pair of cooperating contacts arranged to divide said chamber into an inlet portion and an outlet portion, means for separating said contacts, means for controlling the admission of fluid from said source into said inlet portion, a valve for controlling said outlet, and means responsive to the admission of fluid under pressure into said outlet portion upon separation of said contacts for actuating said valve.

6. An electric circuit breaker comprising a source of supply of fluid under pressure, an arcing chamber having an inlet and an outlet, a pair of cooperating contacts arranged to divide said chamber into an inlet portion and an outlet portion, means for separating said contacts, means for controlling the admission of fluid from said source into said inlet portion, a valve for controlling said outlet, and a fluid pressure motor connected with said outlet portion for actuating said valve to maintain fluid under pressure after separation of said contacts.

7. An electric circuit breaker comprising a source of supply of fluid under pressure, an arcing chamber having an outlet, a pair of cooperating contacts arranged in said chamber, means operable by fluid under pressure for separating said contacts, means for controlling the admission of fluid from said source into said chamber and to said contact separating means to cause separation of said contacts and interruption of the arc drawn therebetween, a valve for controlling said outlet, and means responsive to sepa-

ration of said contacts to a predetermined distance for actuating said valve.

8. An electric circuit breaker comprising a source of supply of fluid under pressure, an arcing chamber having an inlet and an outlet, a pair of cooperating contacts arranged to divide said chamber into an inlet portion and an outlet portion, means for separating said contacts, means for controlling the admission of fluid from said source into said inlet portion, a valve for controlling said outlet, means responsive to increase of the pressure within said outlet portion above a predetermined value for closing said valve, and means responsive to decrease of the pressure within said outlet portion below said predetermined value for opening said valve.

9. An electric circuit breaker comprising a source of supply of fluid under pressure, an arcing chamber having an inlet and an outlet, a plurality of pairs of cooperating contacts arranged to divide said chamber into an inlet portion and an outlet portion, a plurality of contact separating means operable by fluid under pressure severally associated with said pairs of contacts, means for controlling the admission of fluid from said source into said inlet portion and to said contact separating means, means for insuring simultaneous operation of said contact separating means, valve means for controlling said outlet, and means responsive to the operation of said contact separating means for actuating said valve means.

10. An electric circuit breaker comprising a source of supply of fluid under pressure, an arcing chamber having an inlet and an outlet, a plurality of pairs of cooperating contacts arranged to divide said chamber into an inlet portion and an outlet portion, a plurality of contact separating means operable by fluid under pressure severally associated with said pairs of contacts, means for controlling the admission of fluid from said source into said inlet portion, means responsive to increase of the pressure within said inlet portion above a predetermined value for supplying fluid from said inlet portion simultaneously to all said contact separating means, valve means for controlling said outlet, and means responsive to the operation of said contact separating means for actuating said valve means.

11. An electric circuit breaker comprising a source of supply of fluid under pressure, an arcing chamber having an inlet and an outlet, a plurality of pairs of cooperating contacts arranged to divide said chamber into an inlet portion and an outlet portion, a plurality of contact separating means operable by fluid under pressure severally associated with said pairs of contacts, means for controlling the admission of fluid from said source into said inlet portion, and means responsive to increase of the pressure within said inlet portion above a predetermined value for supplying fluid from said inlet portion simultaneously to all said contact separating means.

12. An electric circuit breaker comprising a source of supply of fluid under pressure, an arcing chamber having an outlet, a pair of cooperating contacts arranged in said chamber, means for separating said contacts, means for controlling the admission of fluid from said source into said chamber for producing a fluid blast across said contacts for extinguishing an arc drawn therebetween upon separation thereof, and means for thereafter closing said outlet to confine fluid under pressure in said chamber.

13. An electric circuit breaker comprising a source of supply of fluid under pressure, an arcing chamber having an outlet, a pair of cooperating contacts arranged in said chamber, means for separating said contacts, means for controlling the admission of fluid from said source into said chamber for interrupting the arc drawn between said contacts upon separation thereof by a blast of fluid issuing from said chamber through said outlet, and means responsive to the operation of said contact separating means for closing said outlet.

14. An electric circuit breaker comprising a source of supply of fluid under pressure, an arcing chamber having an outlet, a pair of cooperating contacts arranged in said chamber, means operable by fluid under pressure for separating said contacts, means for controlling the admission of fluid from said source into said chamber and to said contact separating means to cause separation of said contacts and interruption of the arc drawn therebetween, and means responsive to the operation of said contact separating means for closing said outlet.

15. An electric circuit breaker comprising an arcing chamber having an outlet, a pair of cooperating contacts arranged in said chamber, means for separating said contacts, means for producing a fluid blast across said contacts for extinguishing an arc drawn therebetween upon separation thereof, and means for thereafter closing said outlet to confine fluid under pressure in said chamber.

16. An electric circuit breaker comprising an arcing chamber having an outlet, a pair of cooperating contacts arranged in said chamber, means for separating said contacts, auxiliary contacts in series with said contacts, means for producing a fluid blast across said first said contacts for extinguishing an arc drawn therebetween upon separation thereof, means for thereafter closing said outlet to confine fluid under pressure in said chamber, and means for thereafter separating said auxiliary contacts.

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