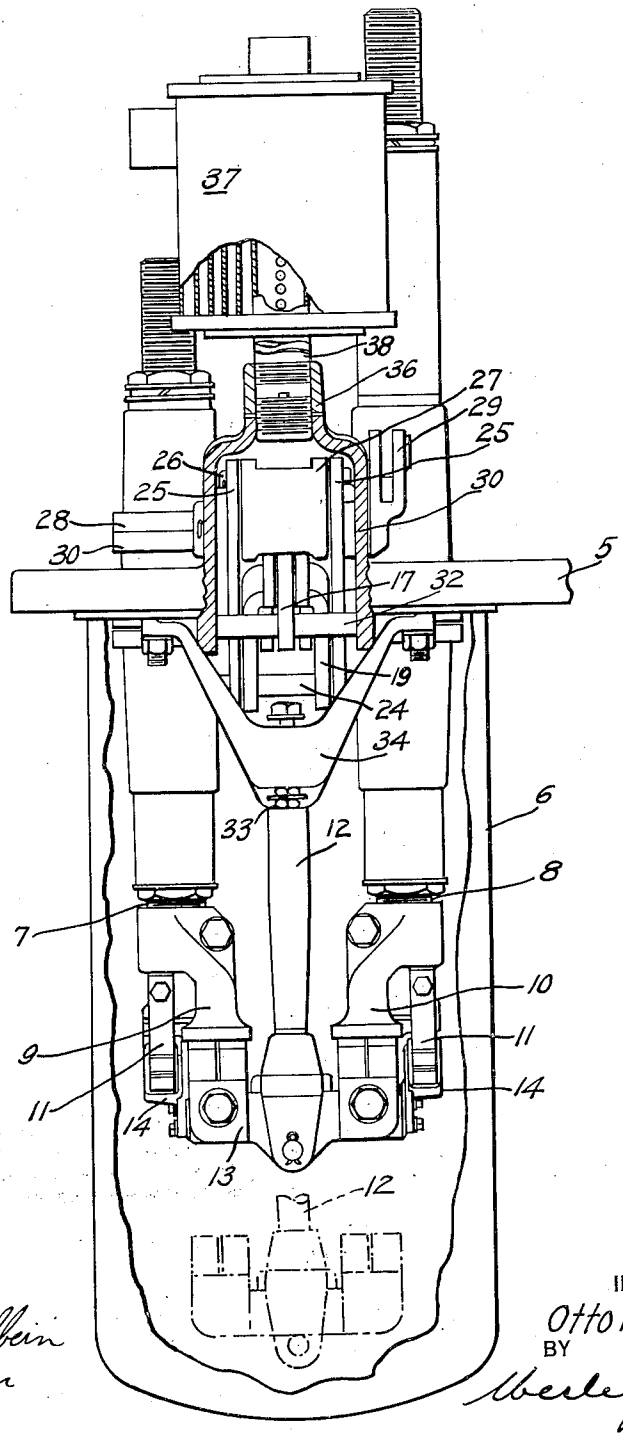
Aug. 14, 1928. 1,680,671

O. H. ESCHHOLZ

APPARATUS FOR INTERRUPTING ELECTRIC ARCS

Filed April 1, 1922 3 Sheets-Sheet 1

Fig. 1.



WITNESSES:
A. J. Schiefelbein
A. Martin

INVENTOR
Otto H. Eschholz.
BY
Merle G. Barr
ATTORNEY

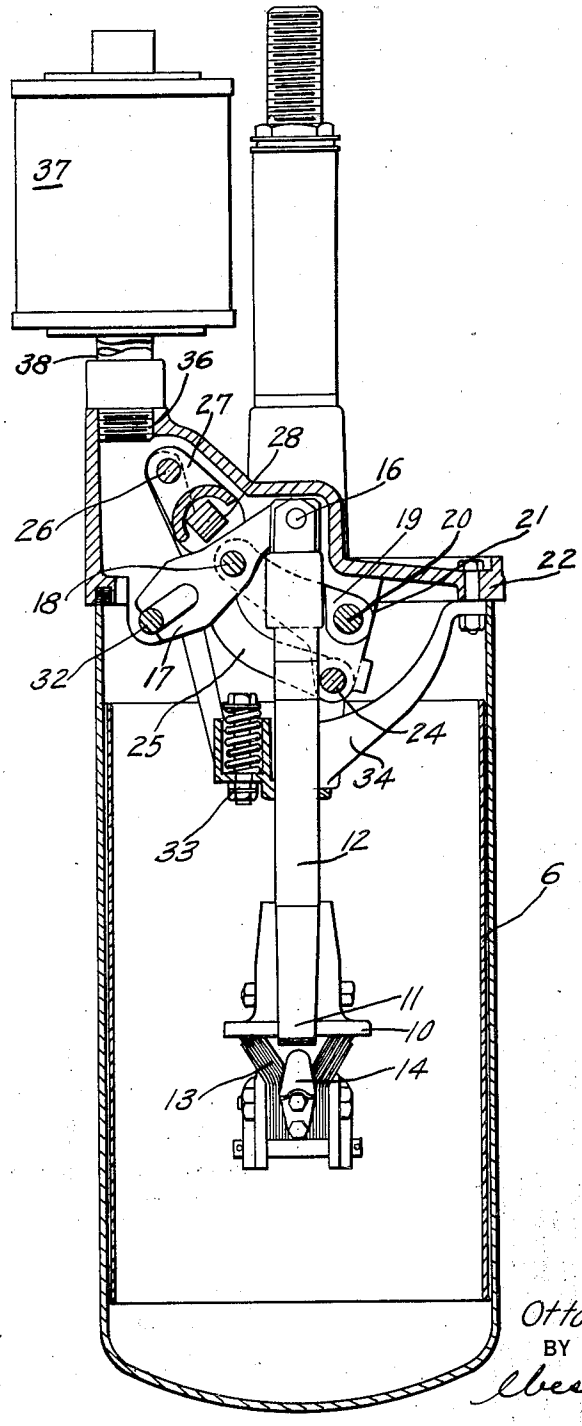
Aug. 14, 1928. 1,680,671

O. H. ESCHHOLZ

APPARATUS FOR INTERRUPTING ELECTRIC ARCS

Filed April 1, 1922 3 Sheets-Sheet 2

Fig. 2.



WITNESSES:
A. J. Schiefelbein
A. Martin

INVENTOR
Otto H. Eschholz
BY
Wesley G. Carr
ATTORNEY

Aug. 14, 1928. 1,680,671

O. H. ESCHHOLZ

APPARATUS FOR INTERRUPTING ELECTRIC ARCS

Filed April 1, 1922 3 Sheets-Sheet 3

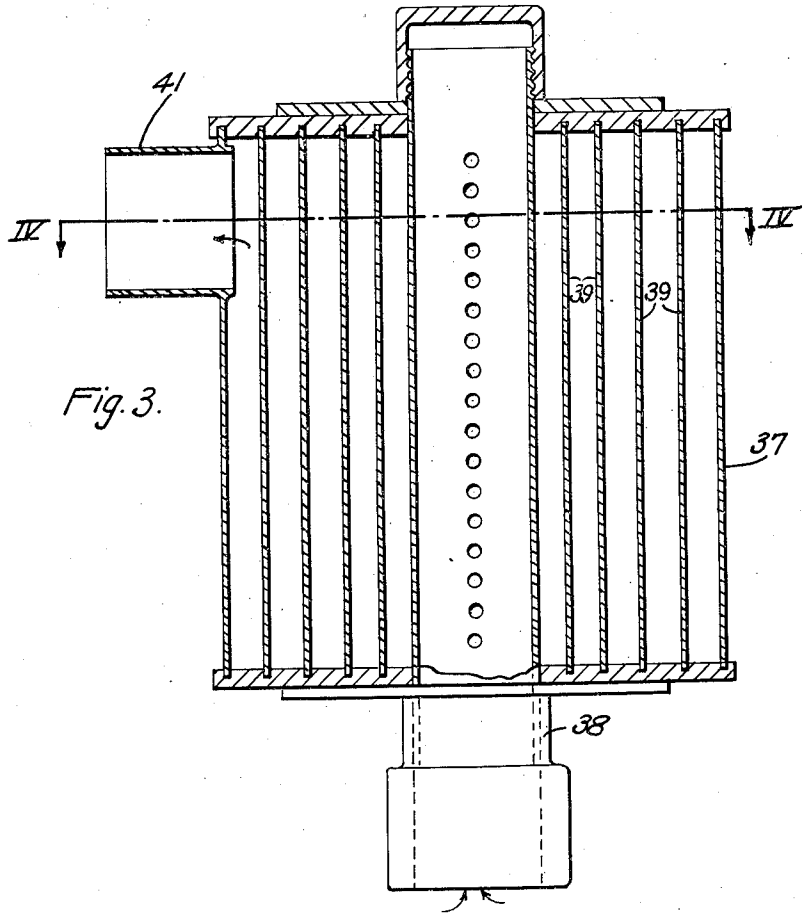


Fig. 3.

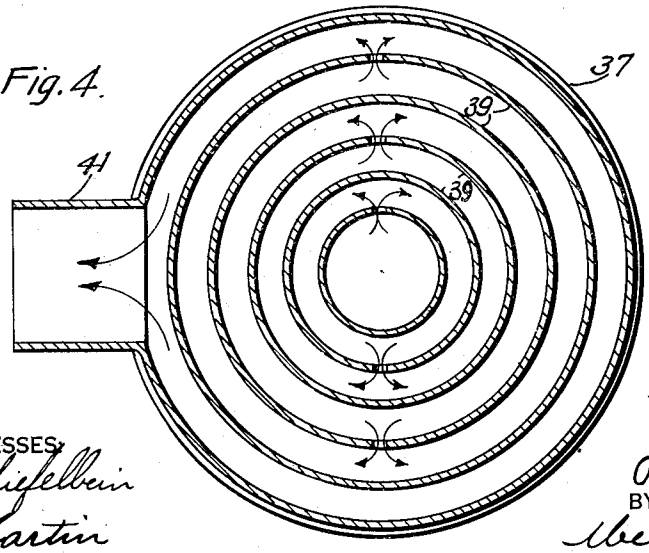


Fig. 4.

WITNESSES:
A. J. Schiefelbein
H. Martin

INVENTOR
Otto H. Eschholz
BY
Merley G. Carr
ATTORNEY

Patented Aug. 14, 1928. 1,680,671

UNITED STATES PATENT OFFICE.

OTTO H. ESCHHOLZ, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

APPARATUS FOR INTERRUPTING ELECTRIC ARCS.

Application filed April 1, 1922. Serial No. 548,792.

My invention relates to methods of and apparatus for interrupting electrical circuits and particularly to means for facilitating the rupture of arcs that are formed between spaced electrical conductors that are contained in tanks such as those of transformers and circuit breakers of the fluid immersed type.

My invention has for its object the provision of means for preventing the development of excessive pressure within the fluid-containing tanks of electrical apparatus and for maintaining sufficient pressure therein to insure the effective extinguishment of arcs that are formed in the electrical apparatus.

Another object of my invention is the provision of a throttling chamber or muffling device of such form that liquid and gaseous mixtures that are thrown from the tank, as a result of forces developed during and immediately after the period of arc rupture may be separated and the liquid returned to the tanks, and the provision of means whereby explosions of mixtures of arc gases and air within the throttling chamber are prevented and the gas is thoroughly vented to the atmosphere.

Upon separating current carrying contacts immersed in a body of quenching fluid, such as oil, energy is rapidly liberated in the form of an electric arc. Due to the high temperature of the arc stream, the liquid in its immediate vicinity is "cracked" or disintegrated. The chief disintegration products when drawing such an arc in oil have been found to be hydrogen, methane and carbonaceous material. The gaseous products, when mixed with the oxygen in the air space, may produce an explosive mixture that is ignitible by hot gases, incandescent metal, etc. It is recognized that the destructive forces developed by igniting mixtures of air-space oxygen and either arc gases, or arc gases and finely divided oil, constitute an important pressure hazard in this form of apparatus.

To minimize such pressure hazard, it is proposed to utilize the movement imparted to the oil head above the arcing contacts by the sudden generation of a large quantity of gas at the arc terminals to eject from the breaker tank gases that are normally present in the air space, before the arc gases have had an opportunity to combine with them and thereby form an explosive mixture.

In order to permit the exit of oxygen from the tank in advance of the hot generated gases and oil and to insure the retention of sufficient pressure therein, I provide an opening or vent in the tank of a proper relative dimension, as will be hereinafter described.

Upon the rapid generation of a large gaseous volume within the body of liquid in the tank, the oxygen is forced through the opening above referred to and into a muffling chamber that is connected to said opening. This chamber serves to separate the liquid from the gas and permits the oxygen and the cooled arc gases to exhaust to the atmosphere and also facilitates a return flow of the liquid to the tank. The design of the muffler is such that a slight resistance is offered to a return movement of the expelled gases after the explosive force has been spent. However, this resistance is so small as to produce little or no opposition to the escape of the arc gases under relatively high pressure during the duration of the electrical arc.

After the liquid has returned to the tank, the space above the liquid is occupied by the remaining portion of the arc gases generated by the electrical arc. As has been previously stated, these gases are found to be hydrogen, methane and carbonaceous material, which are nearly free from uncombined oxygen. Such gases are obviously inert gases when mixed with any subsequent gases which may be generated by the electrical arc, whereby danger from the explosive effects of subsequent arc gases is eliminated.

In the accompanying drawings,

Figure 1 is a view, partially in side elevation and partially in section, of a circuit breaker tank embodying my invention,

Fig. 2 is a similar view looking from the right of Fig. 1,

Fig. 3 is a view, partially in side elevation and partially in section, of the throttling or muffling chamber, on an enlarged scale, and

Fig. 4 is a view taken on the line IV—IV of Fig. 3.

The circuit breaker may be of any form with which a fluid-containing tank is employed. In the present instance, it consists of a base 5 upon which an operating mecha-

nism and a tank 6 are mounted. The breaker comprises a pair of insulated conductors 7 and 8 that have main stationary contact members 9 and 10, respectively, and auxiliary contact members or arcing tips 11. A lifting rod 12 carries, at its lower end a bridging member 13 that is provided with a pair of arcing tips 14. The lifting rod is raised or lowered by mechanism, which will be hereinafter described. to cause movement of the bridging member 13 into and out of engagement with the stationary contact members 9 and 10 and to cause the arcing tips 11 and 14 to co-operate in the usual manner.

The lifting rod 12 is supported at its upper end by a pivot pin 16 that is carried by a lever 17 which is pivoted at 18, to a bell crank lever 19. The lever 19 is pivotally supported at 20 from a lug 21 which is carried by the cover casting 22.

The bell crank lever, at its other end, is provided with a pin 24 upon which a pair of links 25 are pivotally supported. The other ends of the links 25 are supported upon a pivot pin 26 that is carried by a crank 27.

The crank 27 is carried upon a squared shaft 28 that may be operated from the exterior of the breaker by a crank 29 (Fig. 1).

The shaft 28 is rotatable supported by the walls 30 of the circuit breaker cover 22. Upon rotation of the shaft 28 in a counter-clockwise direction, the upper end of the crank arm 27 (Fig. 2) is moved downwardly through an arc, carrying with it the upper ends of the links 25. This causes the pivot pin 24 of the bell crank lever 19 to move in a counter-clockwise direction. This movement causes the pivot 18 to travel downwardly, carrying with it the upper end of the lever 17 and the lifting rod 12, thus moving the bridging member and the arcing tips carried thereby out of engagement with the contact members 9 and 10 and the auxiliary contact members 11.

The downward movement of the link 17 causes the forked end thereof to slide along its supporting pin 32 that is mounted upon the frame-work of the breaker. A cushioning device 33 is secured to a casting 34 that serves also as a guide for the lifting rod 12. At substantially the end of the downward movement of the bell crank lever 19, the underside thereof engages the cushioning bolt and spring, and thus avoids excessive shock to the moving parts.

A vent 36 is provided at the highest point in the upper portion of the breaker tank 6, and a muffling chamber or throttling device 37 is secured thereto. The muffling chamber is provided with a passage 38 through which it communicates with the vent 36 and is also provided with a series of concentric partitions 39 that are perforated, as indicated more clearly in Figs. 3 and 4. It will be noted that the perforations through each succeeding partition are disposed substantially 180° from the perforations in the next preceding partition, and that, therefore, the gas will pass through and around the partitions in substantially the paths indicated by the arrows in Fig. 4, and will eventually pass out through an opening 41 at the upper end thereof. But because of the tortuous passage between the vent 36 and the opening 41 a resistance is presented to the return movement of a column of air. The structure of the muffling device is such as to readily cool the gases therein.

During the rupture of the electrical circuit within the tank, arcs are drawn between the relatively movable contact members and particularly across the arcing tips 11 and 14, within the body of a liquid such as oil. As heretofore explained, a rapid displacement of the oil occurs, causing an expulsion of oxygen, oil and arc gases, in this order, through the vent 36 into the muffler. The arrangement of walls and openings provides a tortuous path of such character that the liquid, by virtue of its greater density and inertia impinges upon, and is baffled by, the partitions of the chamber 37, while oxygen and arc gases continue their travel to the opening 41 and the liquid drains back, through the lower openings in the partitions 39 and the vent 36, to the tank 6.

The rush of oil and arc gases from the tank 6 into the chamber 37 drives before it the oxygen contained in the upper portion of the tank and in the throttling chamber so that, when the hot gases reach the chamber 37, the oxygen has been largely expelled therefrom and the danger of an explosion through ignition of the oxygen incident to the hot arc gas coming into contact therewith is avoided. Furthermore, the extensive surfaces presented by the partitions 39 causes a cooling of the heated gases so that liability of ignition in the chamber or at the exit 41 is minimized.

When the explosive force of the electric arc has been spent, the space between vent 36 and the fluid level is filled by the remaining portion of the gases produced by the prior electric arc. By reason of the fact that these gases contain little or no uncombined oxygen, they are inert gases when brought into contact with subsequent arc-rupture gases. By this design of a circuit-breaker, I am able to generate inert gases entirely within the device during an initial operation of the device, which gases are retained in the circuit-breaker for the purpose of preventing an explosive action between these inert gases and arc rupture gases generated upon subsequent operations of the circuit-breaker.

In practicing my invention, it has been found that with a tank 20″ in diameter, a vent therefrom of substantially 1½″ diameter gives satisfactory results. That is, with a vent that has a diameter substantially 7½% of the diameter of the tank, air space gases will be readily expelled, while sufficient back pressure is maintained within the tank to insure a rapid circulation of liquid across the arc stream, the arcing contacts, and the gaseous zone enveloping the said arc stream.

In constructions employing materially smaller vents, the free flow of gases will be impeded to such extent that explosive mixtures of arc gases and oxygen in the tank air space may be secured. Larger vents may be employed to advantage in facilitating exit of air space gases, but, owing to the necessity of maintaining an appreciable back pressure to prevent throwing of oil and to secure oil circulation in the tank, as well as to space limitations in tank structure, such orifices need rarely to exceed in area 5% that of the tank cross section.

If the tank were made of such strength as to permit of safely retaining all the pressure therein, the increasing pressure caused by the accumulation and ignition of the arc gases would result in an increasing arc voltage gradient and, therefore, in a further increase of arc energy and volume of disintegration products, tending to prevent free movement of arc gases from arcing contacts and thereby greatly increasing the difficulties of rupturing the arc and clearing the electrical circuit.

I have found that the orifice 41, to permit the free escape of oxygen, should be of relatively large dimensions. The cubical contents of the gas-escaping structure may ordinarily approximate from one-tenth to full air space volume of the circuit breaker tank. However, a smaller muffler will function properly on liberating comparatively small volumes of arc gases. The head of oil above the contacts of course must be taken into consideration, as well as the amount of arc energy it is planned to dissipate, in properly proportioning the gas-escaping structure. The vent should preferably be placed at the highest point in the tank and the walls of the tank should preferably be such as to offer very little resistance to the flow of gas to the vent.

I am familiar with the prior art in which it is shown to be old to provide a muffler for a circuit interrupter. These prior art devices were defective because they functioned merely as valves to relieve explosive pressures produced within the tank. These means, inasmuch as they still permitted explosions to take place, did not sufficiently relieve pressure hazards. In order to obtain satisfactory results it was necessary to determine the cause of explosions in an oil-containing tank and then design the muffler and vent to preclude the explosion. It was not my intention to design a muffler to reduce the shock of an explosion as in an automobile muffler, but to actually preclude the starting of an explosion by forcing the oxygen from the tank before the hot gases could mix and ignite the same and yet avoid the throwing of oil from the tank as well as to entrap a portion of the arc gases generated upon an initial arc rupture for displacing the oxygen-containing gases which occupied a portion of the tank before the initial arc rupture.

I wish also to point out that the relief valves of the prior art have all been of such dimensions as to generate a large back pressure which, in addition to facilitating the production of explosive mixtures of arc gases and air in the tank air space, served to increase the difficulty of arc rupture by increasing the arc voltage gradient and hence arc energy and volume of liberated gases. The essential results achieved by me are the free venting of oxygen and gas while maintaining a slight pressure in the tank to insure circulation of the oil across the contacts, and precluding the throwing of oil from the tank through the vent. I have found that, with pressures as low as twenty pounds per square inch, sufficient movement was imparted to the oil and gas to preclude re-ignition of the arc between the contacts and assure the development of but a small arc energy.

It will be apparent that, as conditions vary, the dimensions and arrangement of parts herein set forth may be also varied without departing from the spirit and scope of the invention as defined in the accompanying claims.

I claim as my invention:

1. The combination with a liquid immersed circuit breaker, of a venting device therefor comprising means for permitting reduction of the excessive pressures in the tank and for maintaining sufficient pressure within the tank to quench the arcs, comprising a baffling device, for permitting the passage of gas to the atmosphere and for detraining liquid from the vented gases, the baffling device comprising a central chamber free from obstructions, surrounded by spaced vertical partitions having therethrough vertically disposed passages through the upper areas of which the expanding mixture passes and through the lower areas of which a return flow of the separated liquid to the tank may take place.

2. The combination with a liquid immersed circuit breaker, of a venting device therefor comprising means for reducing the excessive pressures in the tank and for maintaining sufficient pressure within the tank

to quench the arcs, comprising a baffling device into which the vent leads, for permitting the passage of gas to the atmosphere and for detraining liquid from the vented gases, the baffling device comprising a chamber free from obstructions and having a substantially vertical wall provided with vertically extending openings, one or more partitions substantially parallel to said wall having vertically extending openings and disposed to form a labyrinthine passage for the mixture of liquid and gas and to provide passages in a lower plane through which detrained liquid may flow back to the tank.

3. In combination with an oil circuit breaker comprising an enclosed tank, a venting device therefor comprising an entrance chamber communicating with said tank through a passage and having an apertured wall extending substantially parallel to the axis of said passage, one or more other spaced partitions having apertured areas extending substantially parallel to said axis and disposed to provide a tortuous path for outflowing gases, and an outlet to the atmosphere from the apertures in the last partition.

4. In combination with an oil circuit breaker, comprising an enclosed tank, a venting device therefor comprising an entrance chamber communicating with said tank through an opening in the top thereof, and having a vertical apertured wall, one or more vertical spaced partitions having apertured areas and disposed to provide a tortuous path for outflowing gases, and an outlet from the apertures in the last partition to the atmosphere.

5. In combination with an oil circuit breaker, comprising an enclosed tank, a venting device therefor comprising an entrance chamber communicating with said tank through an opening in the top thereof, a vertical apertured wall, one or more annular vertical partitions having apertures therein, and disposed to provide a tortuous path for outflowing gases and an outlet from the apertures in the last partition to the atmosphere.

6. In combination with an oil circuit breaker, comprising an enclosed tank partly filled with oil, a venting device therefor comprising a central chamber opening out of the top of said tank, a vertical row of openings in the wall of said chamber, one or more other walls surrounding said first wall and each having a vertical row of openings, the rows in successive partitions being displaced by substantially 180°.

7. In combination with an AC line and an oil circuit breaker therefor comprising an enclosed tank, a venting device therefor comprising an entrance chamber communicating with said tank through a passage and having an apertured wall extending substantially parallel to the axis of said passage, one or more other spaced partitions having apertured areas extending substantially parallel to said axis but disposed to provide a tortuous path for outflowing gases, and an outlet to the atmosphere from the apertures in the last partition, the size of said passage and said apertures and the number of said partitions being such that when said circuit breaker opens under the maximum load which it is rated to rupture, substantially no oil will be ejected to the outer air and any air space above the oil will be emptied in less time than one alternating current period.

8. The method of controlling the passage of liquid and gaseous mediums from a container in which an electrical switch is disposed, which comprises impelling substantially the entire portion of said gaseous medium along a path into a chamber under the influence of said liquid medium as affected by the operation of said switch, and passing said gaseous medium along with progressively decreasing portions of said liquid medium successively into a plurality of chambers removed from said path by way of passages angularly related with respect to said path.

In testimony whereof, I have hereunto subscribed my name this 27th day of March, 1922.

OTTO H. ESCHHOLZ.